Fire Hazard Reduction and Resource Protection on Chaparral Landscapes

Jon E. Keeley

U.S. Geological Survey
Sequoia Field Station

&

University of California,
Los Angeles
Department of Ecology
& Evolutionary Biology

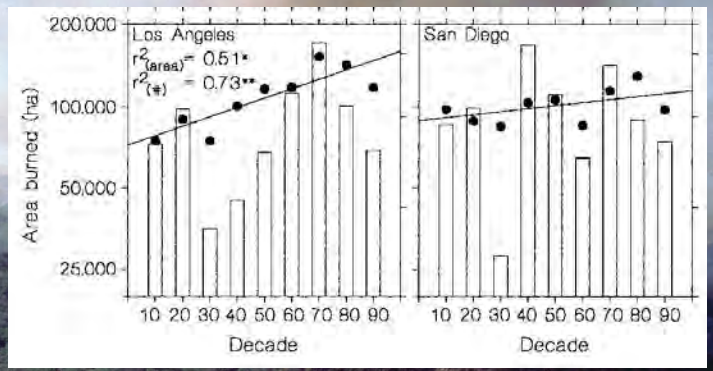
Photo: Chris Doolittle

- lightning ignited
- low intensity surface fires
- fire suppression = fire exclusion
- a century of fuel accumulation
- restoration of historical fire regimes
- frequent fire regimes are compatible with plant and animal life histories

Fire Hazard Reduction is Compatible with Resource Protection

- anthropogenic
- high intensity crown fires
- limited fire exclusion
- chaparral is threatened by short fire return intervals

Fire Hazard Reduction is sometimes Incompatible with Resource Protection



Crown-fire regime

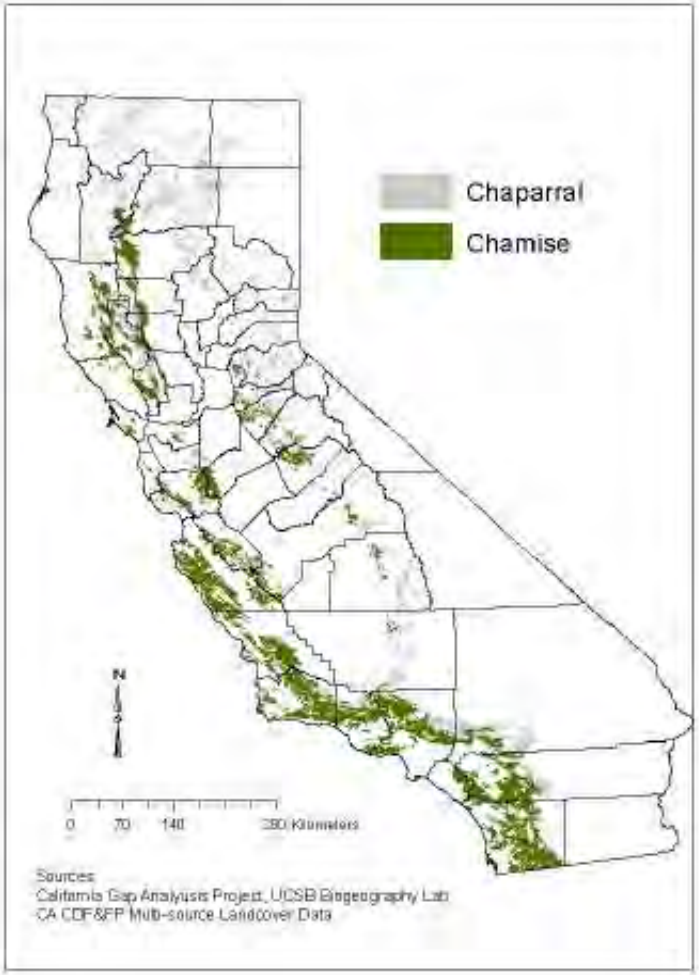
Fire history in the region

Impact of Fires & Fire Management on Resources

Effectiveness of fuel treatments (Rx & Mechanical)

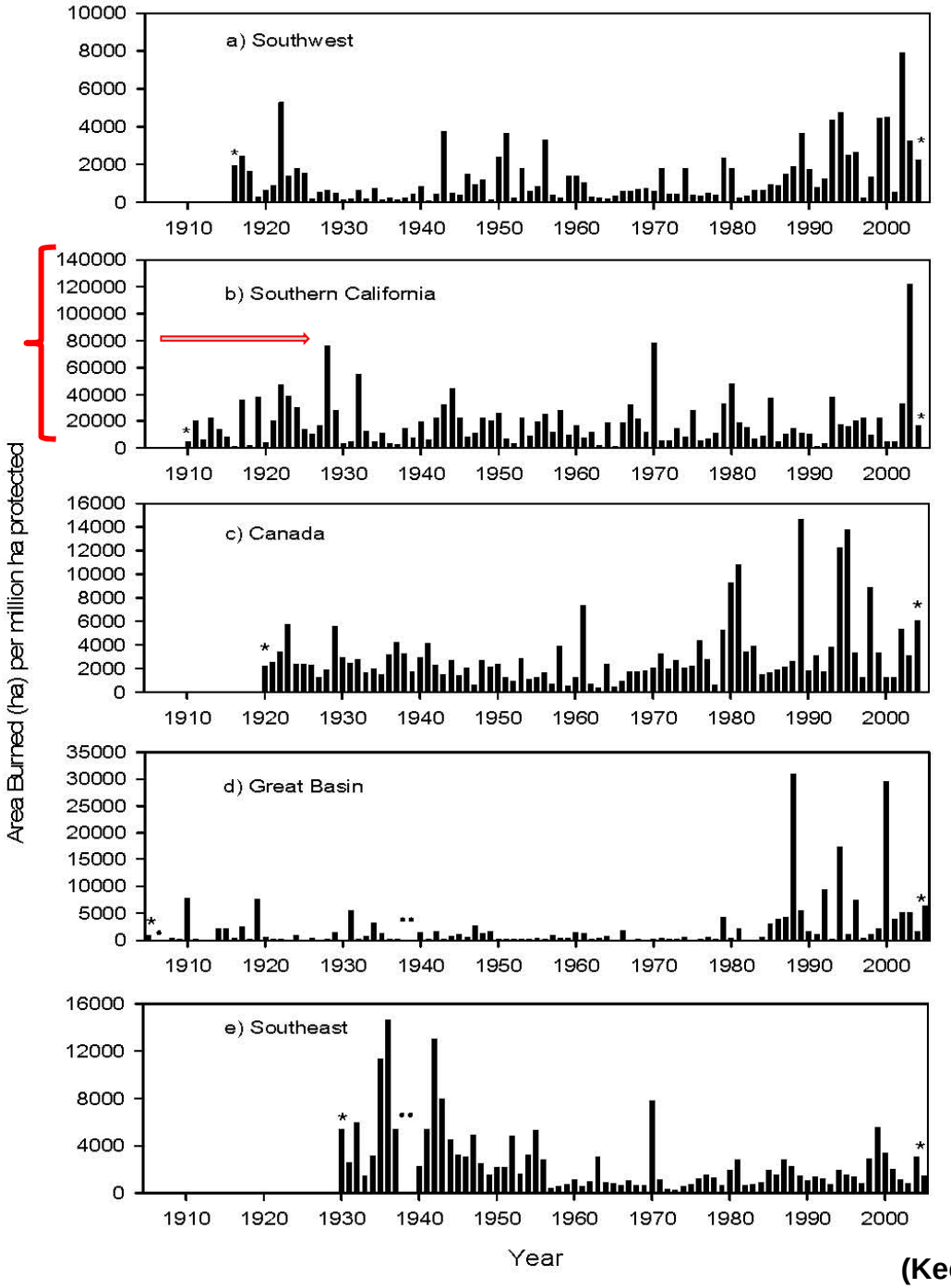
Future fire regimes and appropriate management

Adenostoma fasciculatum (chamise)

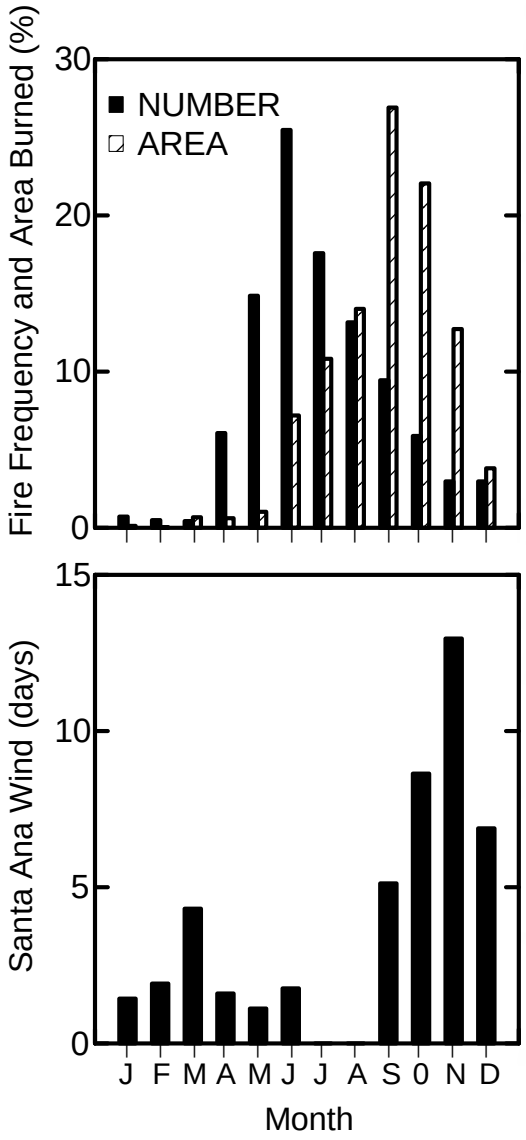


(from Keeley & Davis 2006)

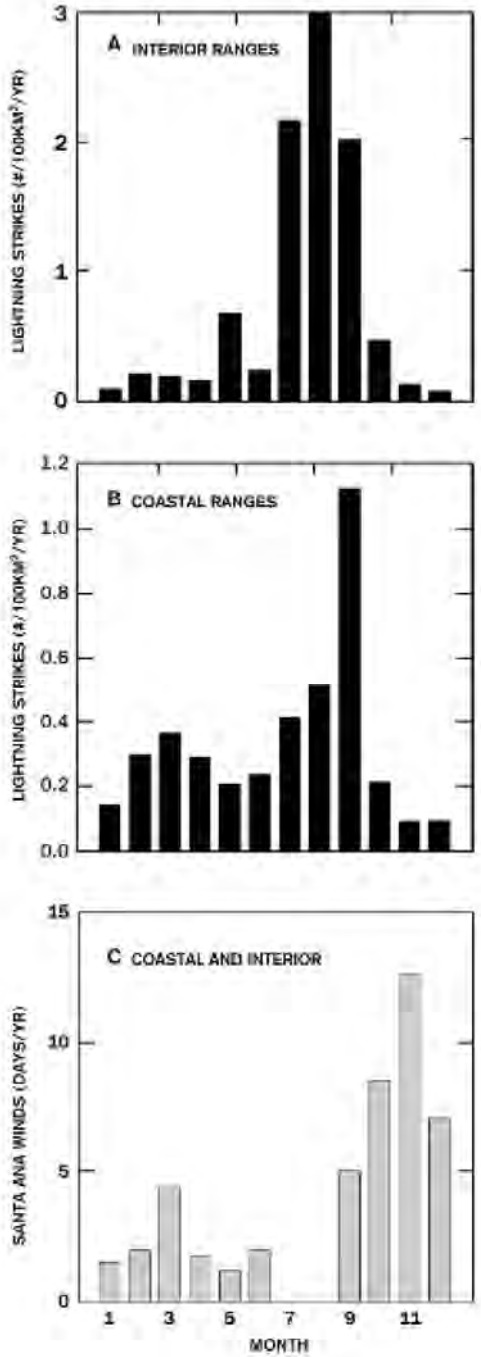
Fire history



(Keeley et al 2009)



(Keeley 2006)



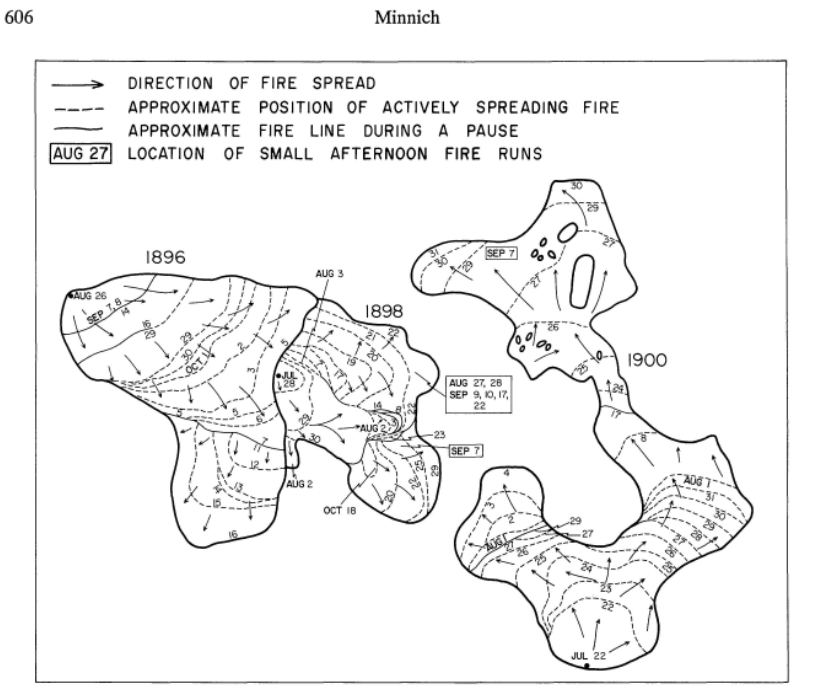
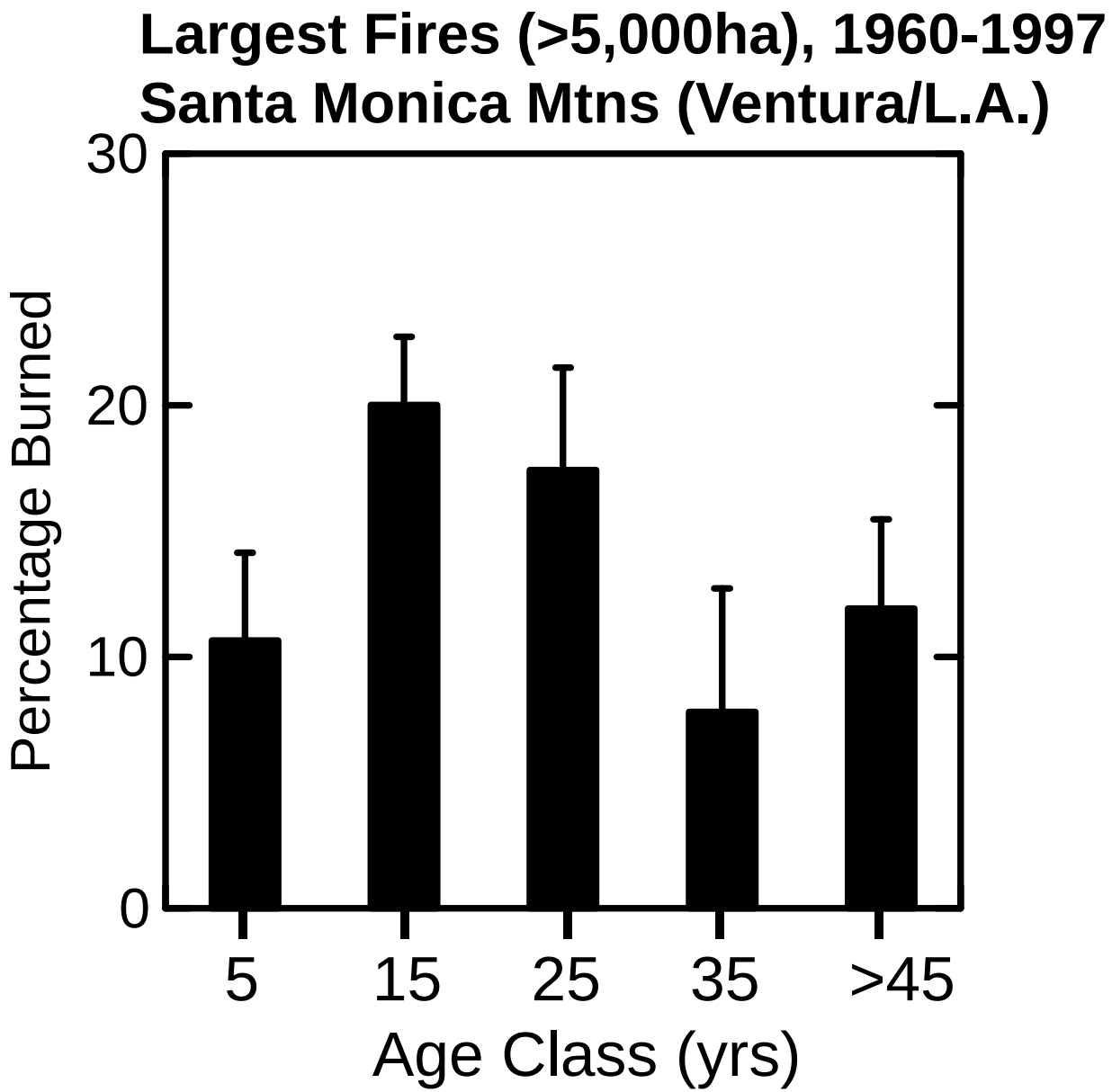
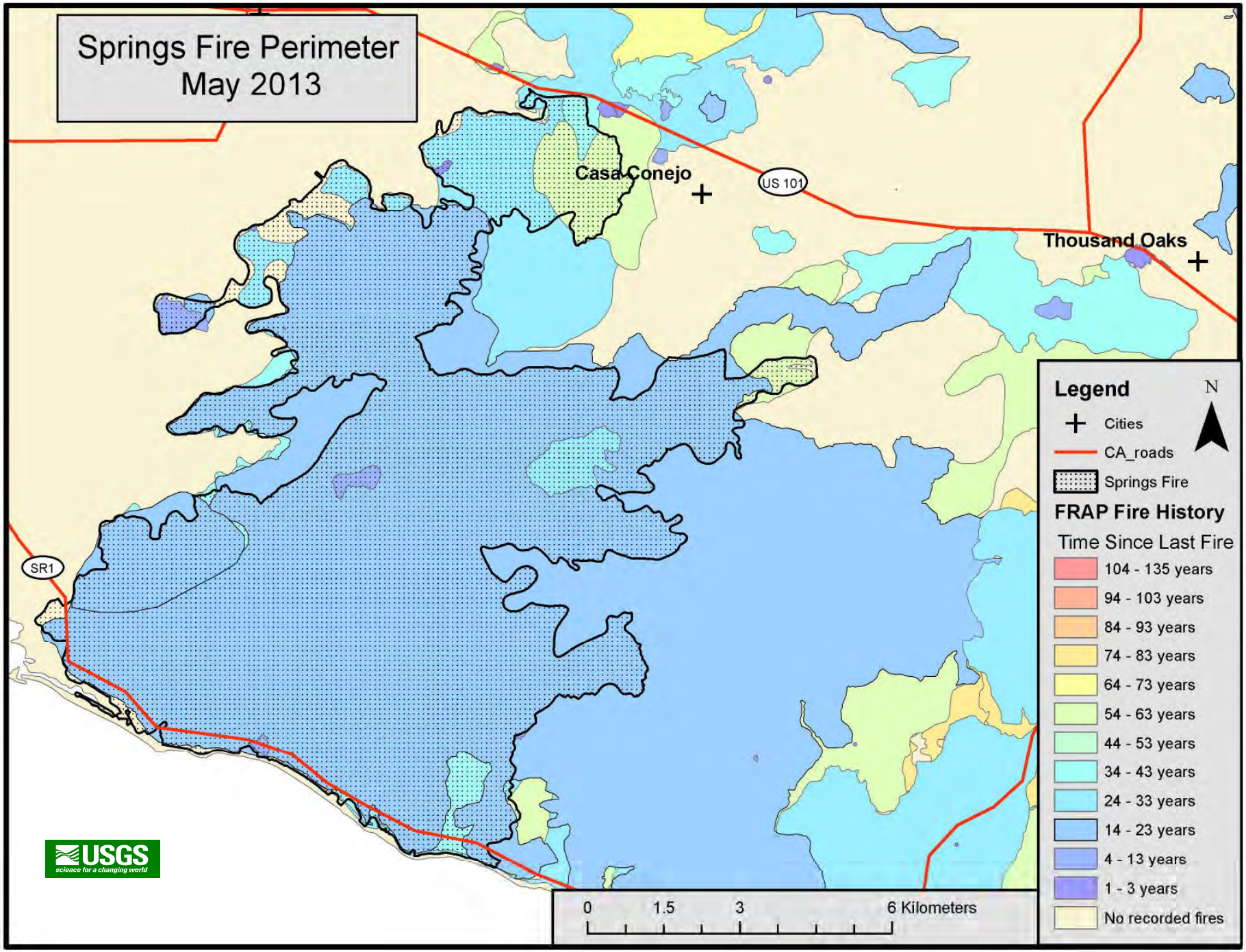


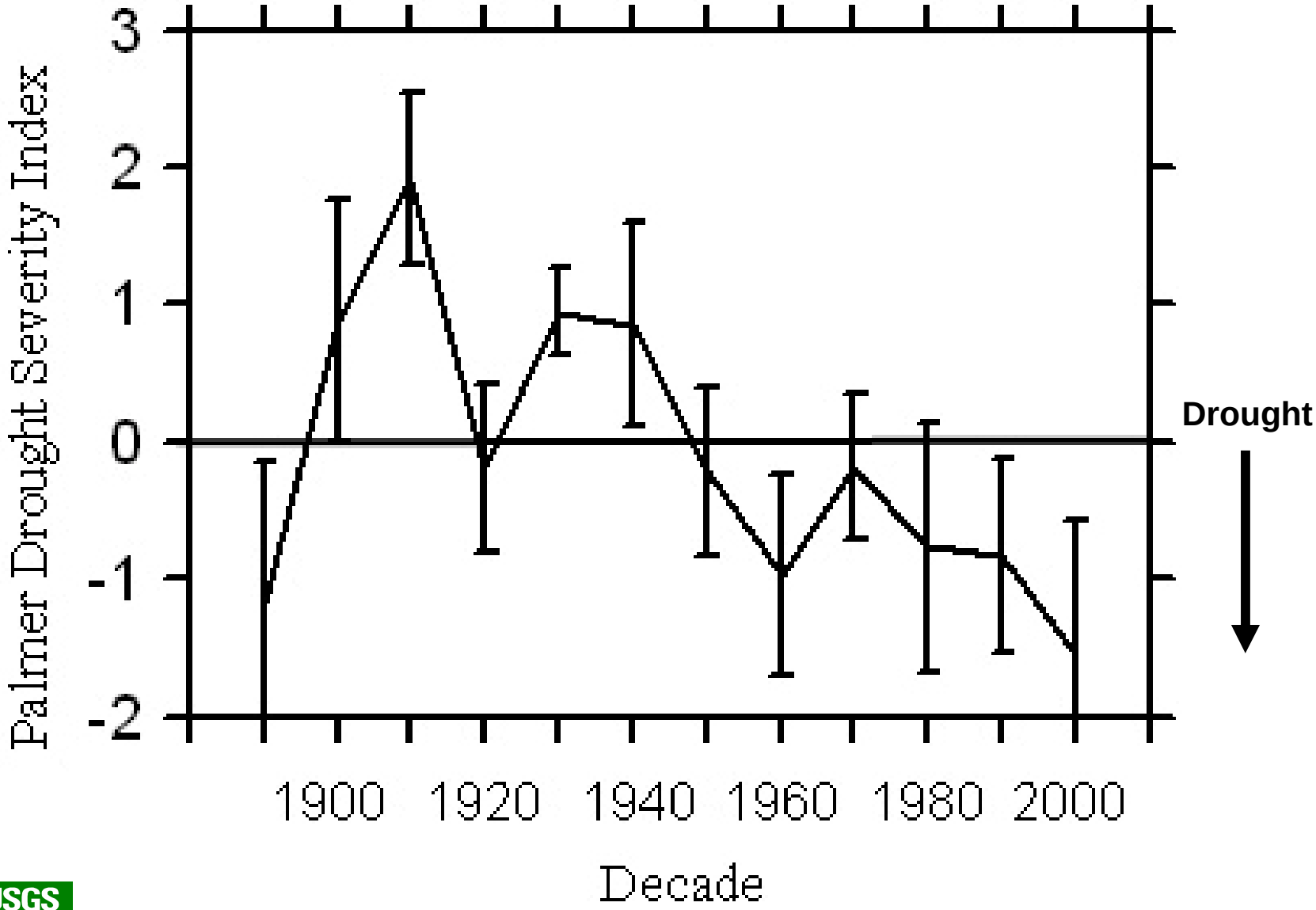
Figure 2. (a) Generalized daily spread of the Arroyo Seco (1896), Mt. Lowe (1898), and Santa Anita Canyon (1900) fires.

(Minnich 1987)

Year	Fire	County	Month	Acres
1889	Santiago Cyn	Orange	Sept	308,900
1932	Matilija	Sta Barbara	Sept	219,900
1970	Laguna	San Diego	Sept	174,200
1985	Wheeler #2	Ventura	July	122,800
2003	Cedar	San Diego	Oct	270,575
2006	Day	Ventura	Sept	161,850
2007	Zaca	Sta Barbara	July	240,425
2007	Witch	San Diego	Oct	198,175
2009	Station	Los Angeles	August	166,600


Largest Fires (>5,000ha), 1960-1997
Santa Monica Mtns (Ventura/L.A.)
Percentage Burned
30
20
10
0
5
15
25
35
>45
Age Class (yrs)


Springs Fire Perimeter
May 2013
Casa Conejo
US 101
Thousand Oaks
SR1
Legend
N
Cities
CA_roads
Springs Fire
FRAP Fire History
Time Since Last Fire
104 - 135 years
94 - 103 years
84 - 93 years
74 - 83 years
64 - 73 years
54 - 63 years
44 - 53 years
34 - 43 years
24 - 33 years
14 - 23 years
4 - 13 years
1 - 3 years
No recorded fires
0
1.5
3
6 Kilometers
USGS
science for a changing world



(Keeley & Zedler in press)

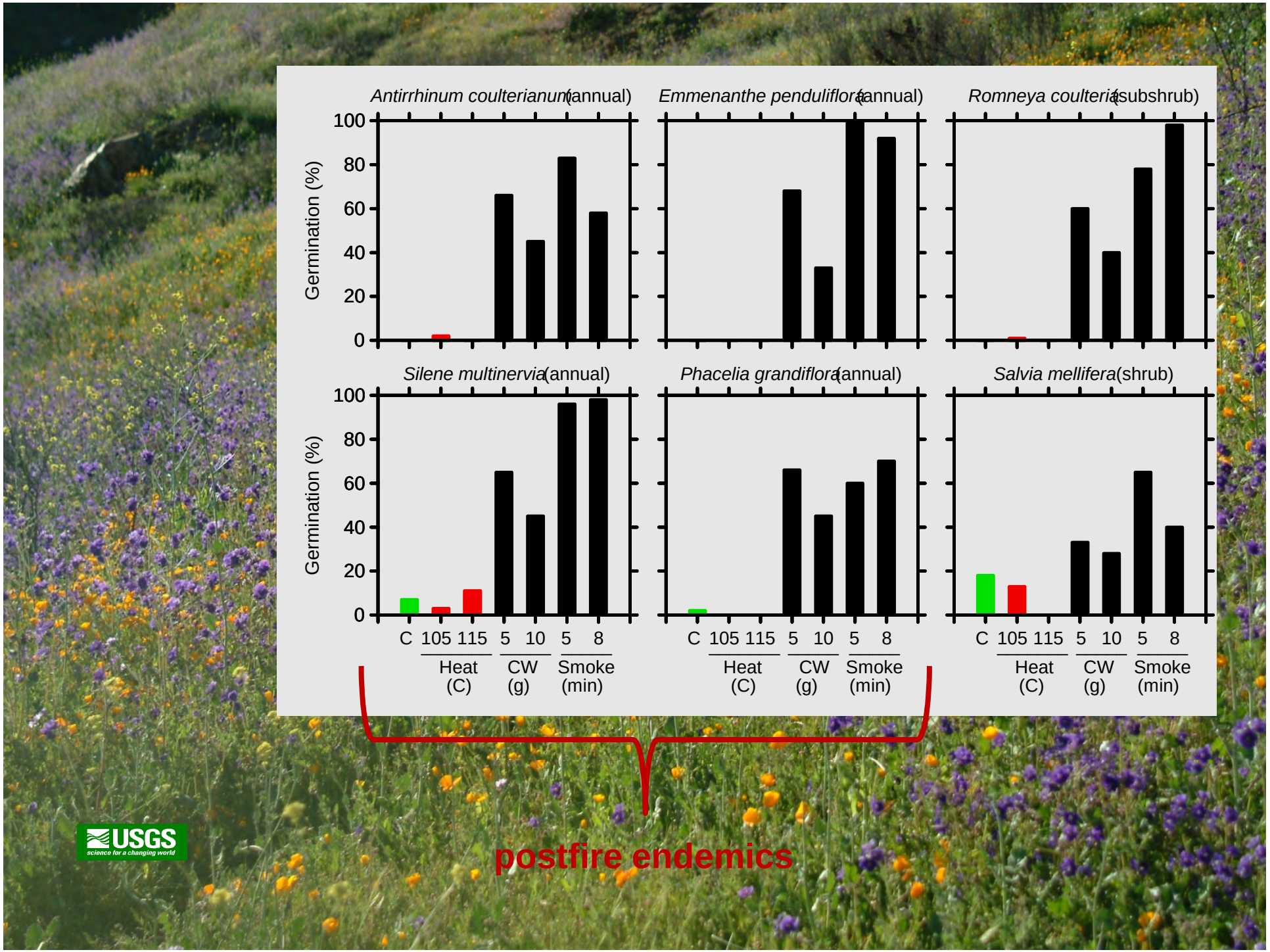
Impact of fire and fire management

Not just fire-adapted but fire-dependent!

Species	Life form[$]	Total seedling recruitment for all 5 years (#/ha): Chaparral # sites	Chaparral $\bar{X} \pm$ S.E.	Sage scrub # sites	Sage scrub $\bar{X} \pm$ S.E.	Percentage by year: 1	2	3	4	5
Obligate-Seeders										
Ceanothus crassifolius	s	10	62,100 ± 17,800	3	1,500 ± 800	99	1	0	0	0
C. cuneatus	s	1	14,000	2	9,800 ± 9,800	97	3	0	0	0
C. greggii	s	8	18,500 ± 18,500	1	1,000	100	0	0	0	0
C. megacarpus	s	9	55,700 ± 24,200	2	11,000 ± 7,000	96	4	0	0	0
C. oliganthus	s	6	103,900 ± 95,500	0	-	100	0	0	0	0
C. tomentosus	s	2	56,300 ± 700	0	-	99	1	0	0	0
Dendromecon rigida	ss	1	53,000	0	-	95	5	0	0	0
Helianthemum scoparium	su	12	33,500 ± 17,500	3	109,200 ± 75,200	73	13	7	0	7
Lotus scoparius	su	39	46,100 ± 8,400	43	77,600 ± 33,900	72	9	2	1	16
Facultative Seeders										
Adenostoma fasciculatum	s	31	104,500 ± 22,800	11	23,700 ± 12,700	94	3	0	0	3
Artemisia californica	ss	12	11,600 ± 4,800	41	31,500 ± 10,600	41	42	13	1	4
Calystegia macrostegia	su	25	49,700 ± 12,100	34	38,630 ± 7,200	92	5	2	0	1
Ceanothus spinosus	s	9	36,600 ± 25,100	1	2,000	92	3	0	0	5
Encelia farinosa	ss	0		8	21,100 ± 8,500	10	19	18	0	53
Eriodictyon crassifolium & E. trichocalyx	ss	4	3,100 ± 800	1	1,000	52	24	10	12	2
Eriophyllum confertiflorum	su	25	168,700 ± 42,900	30	24,000 ± 8,500	20	33	24	10	13

USGS science for a changing world

(Keeley, Fotheringham & Keeley 2006)

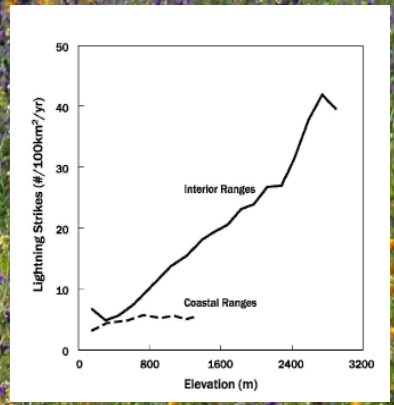

Antirrhinum coulterianum (annual)
Emmenanthe penduliflora (annual)
Romneya coulteri (subshrub)
Silene multinervia (annual)
Phacelia grandiflora (annual)
Salvia mellifera (shrub)
Germination (%)
0
20
40
60
80
100
C
105
115
5
10
5
8
Heat (C)
CW (g)
Smoke (min)
postfire endemics
USGS
science for a changing world

Chaparral species are not adapted to all fires,

rather to a particular fire regime

- high fire intensity

- fire return intervals 30 – 130 years



(Minnich & Chou 1997 ~ 70 yrs)

Fire is a natural ecosystem process
Disturbances are perturbations to this regime:

1) Insufficient fire,
2) Not enough fire

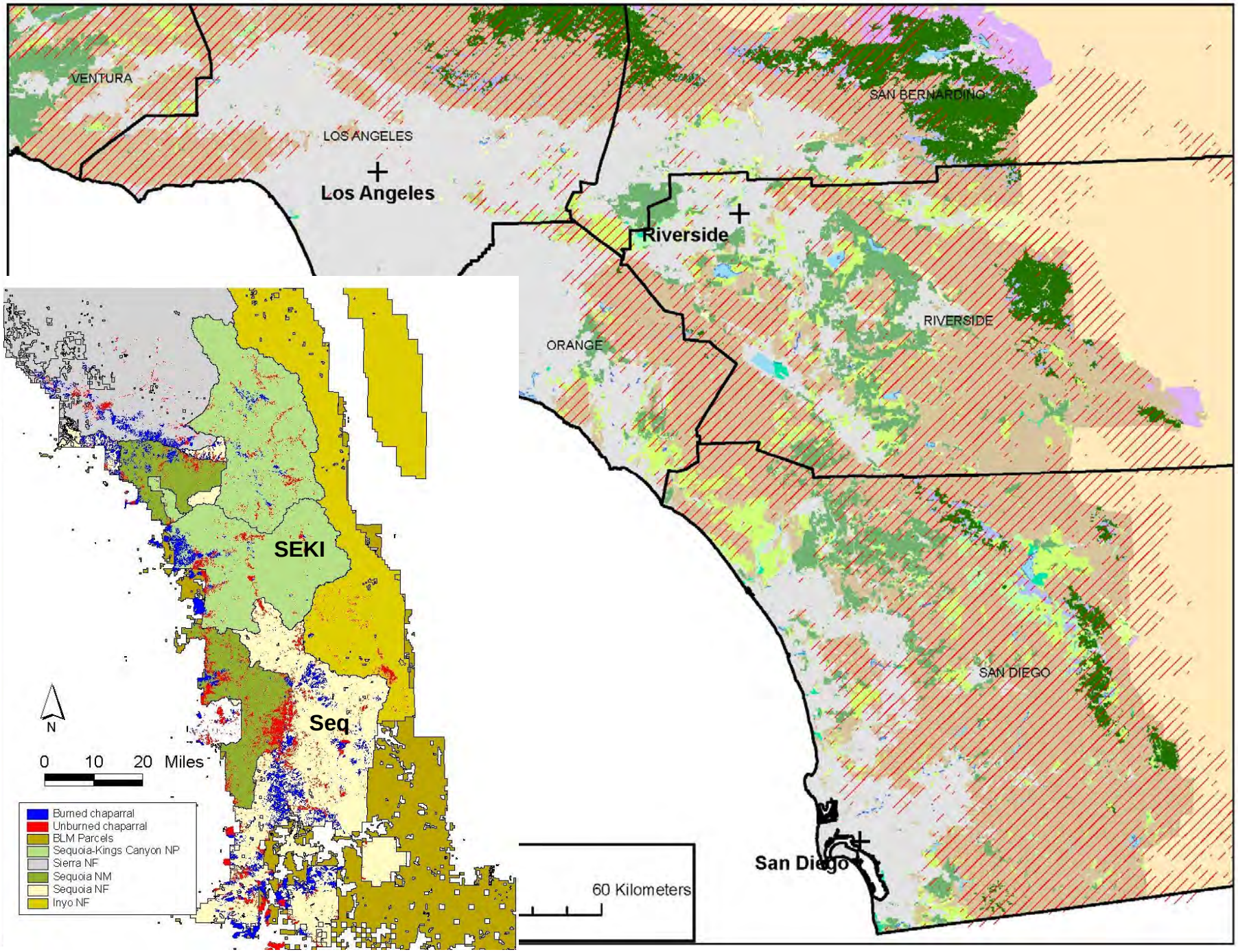
Senescence Risk

- ► due to long fire return intervals
- ► resprouters loose vigor
- ► seed production declines
- ► soil seed banks deteriorate

Immaturity Risk

- ► due to short fire return intervals
- ► seeders fail to replenish soil seed bank
- ► resprouters do not replenish burls

(terms from Zedler 1995)

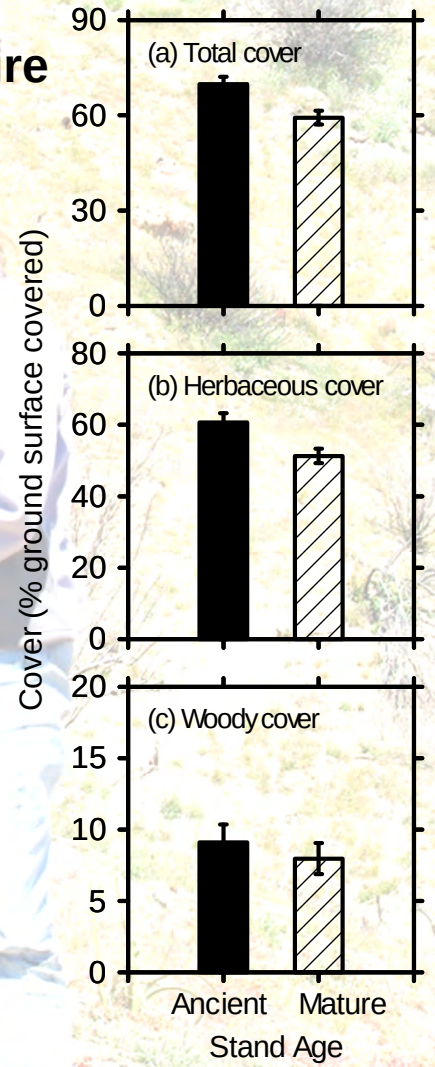

VENTURA
LOS ANGELES
Los Angeles
SAN BERNARDINO
Riverside
RIVERSIDE
ORANGE
SAN DIEGO
San Diego
60 Kilometers
SEKI
Seq
N
0 10 20 Miles
Burned chaparral
Unburned chaparral
BLM Parcels
Sequoia-Kings Canyon NP
Sierra NF
Sequoia NM
Sequoia NF
Inyo NF

USGS
science for a changing world

Ancient chaparral 90 – 150 yrs old

Mature chaparral 50 – 60 yrs old

at time of McNally Fire



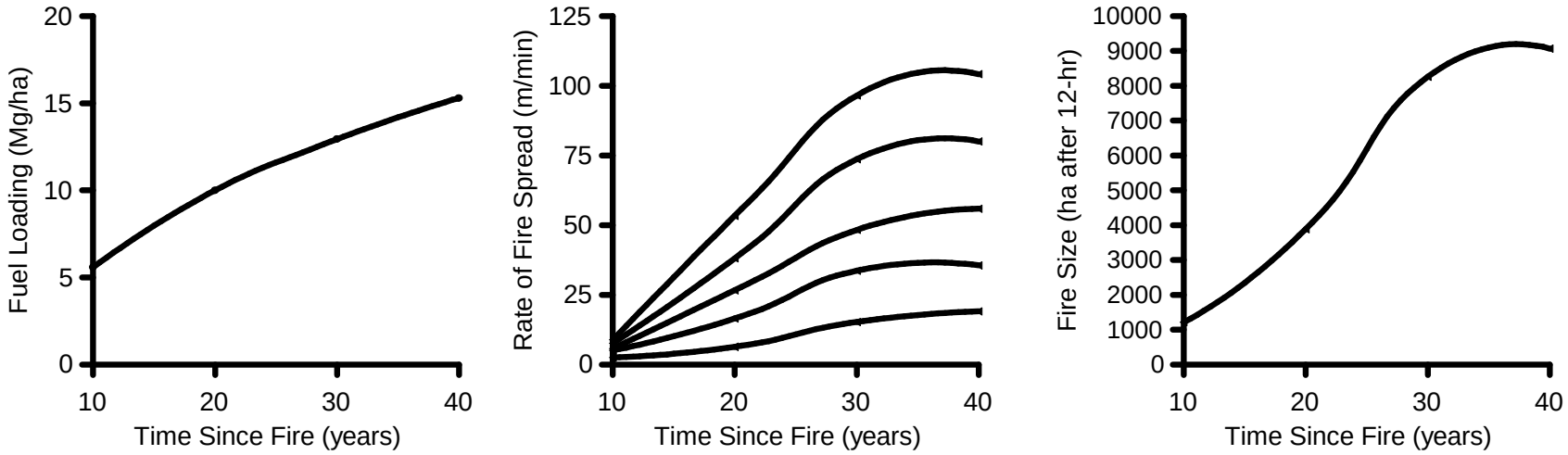
Senescence Risk

- No lack of fire
- Resilient to long fire intervals

Immaturity Risk

- due to short fire return intervals
- seeders fail to replenish soil seed bank
- resprouters do not replenish burls

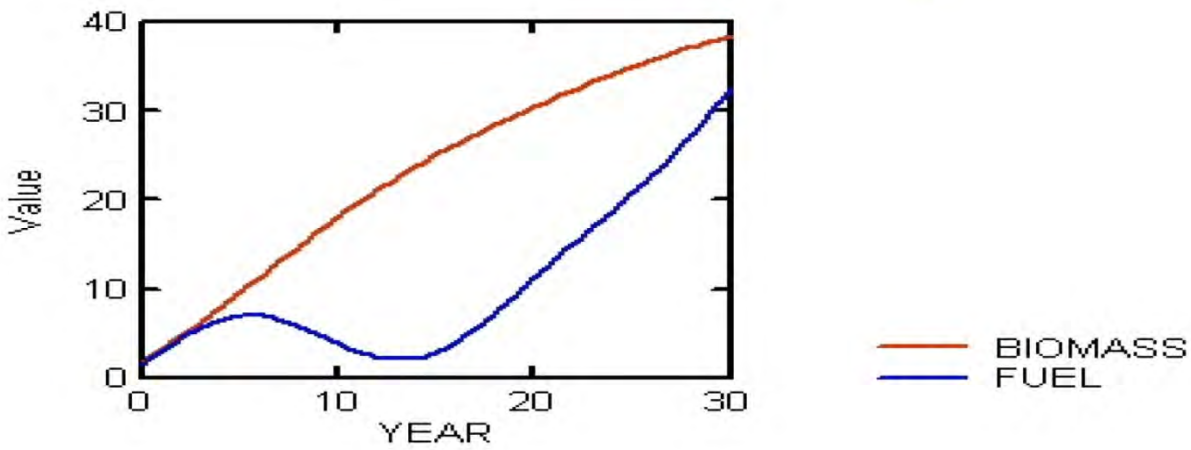
(terms from Zedler 1995)



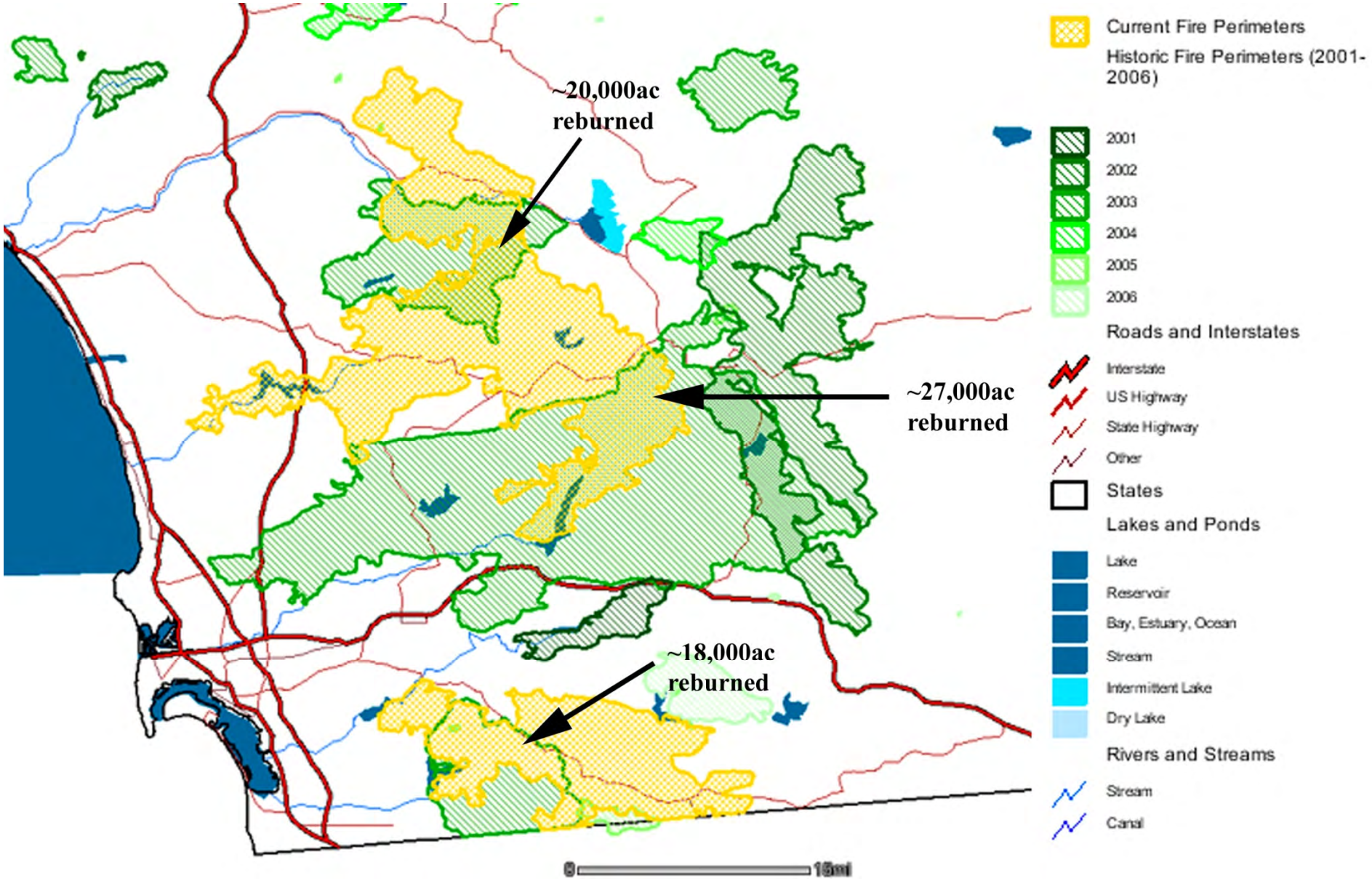
Early modeling studies by Charles Philpot (1974) were interpreted to mean immaturity risk was not a factor….*'no chaparral will burn before its time*'

But: It only considered live/dead fuels in shrubs

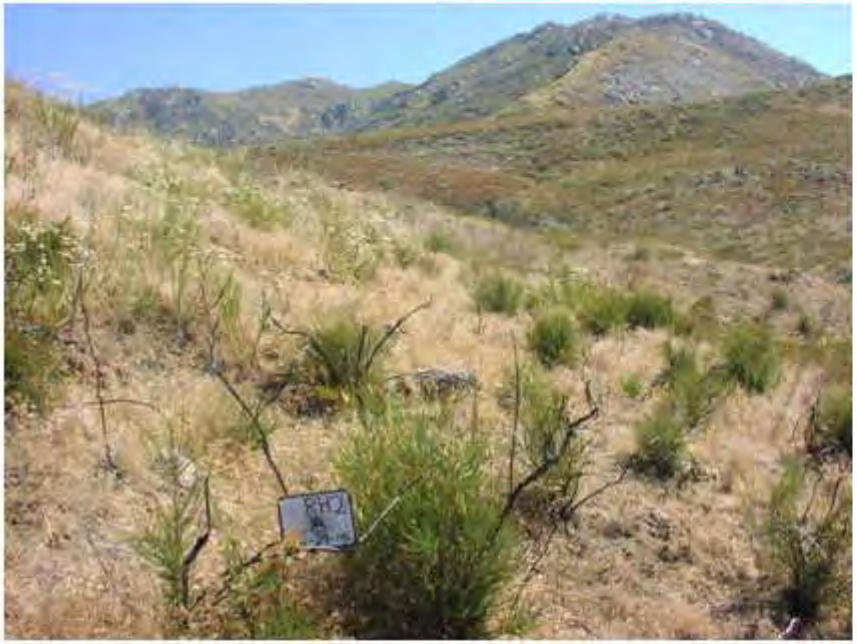
and used data from prescription burns



San Diego County --- 2003 & 2007 fires

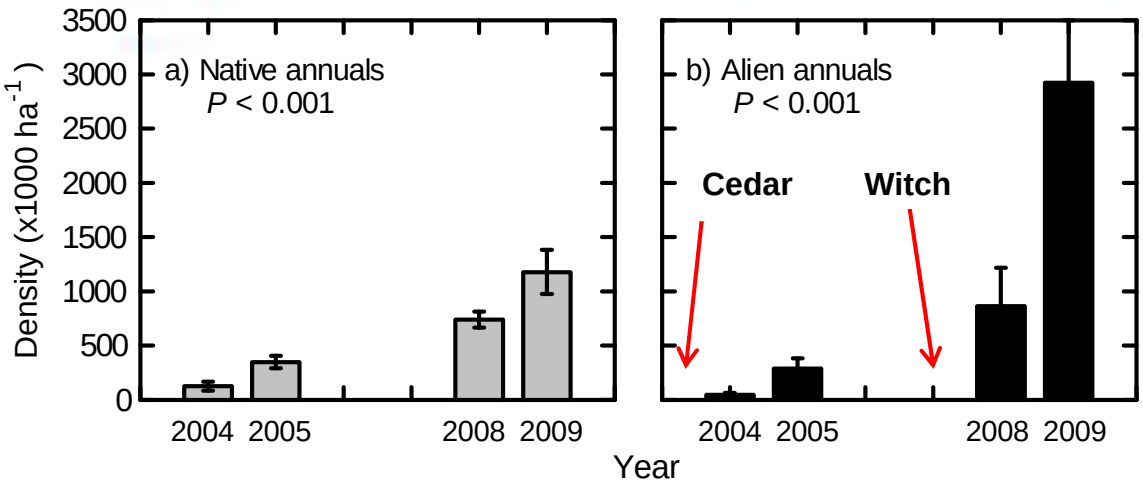


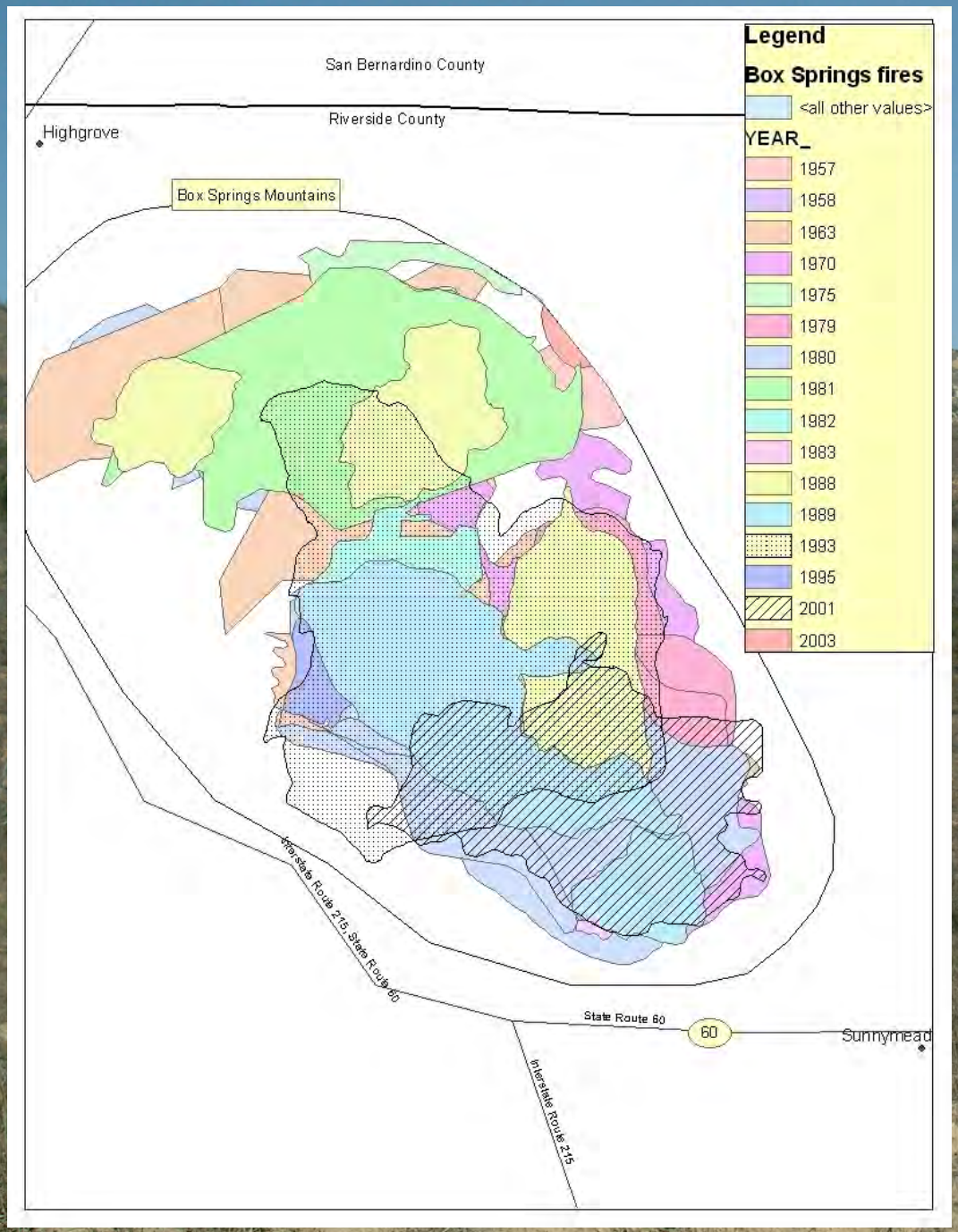
a) Prefire age 3 years

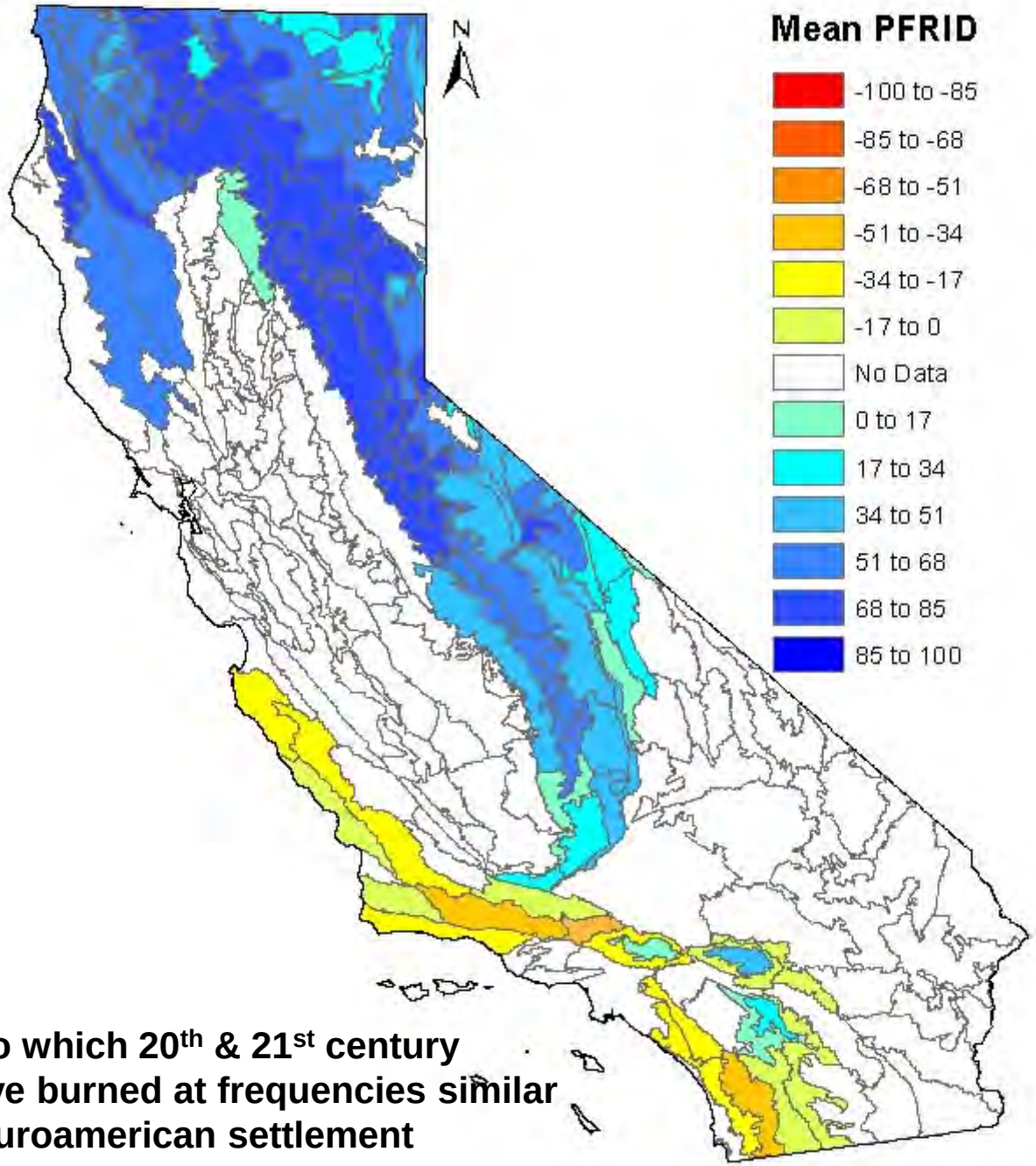


b) Prefire age 24 years

Fires 4 years apart

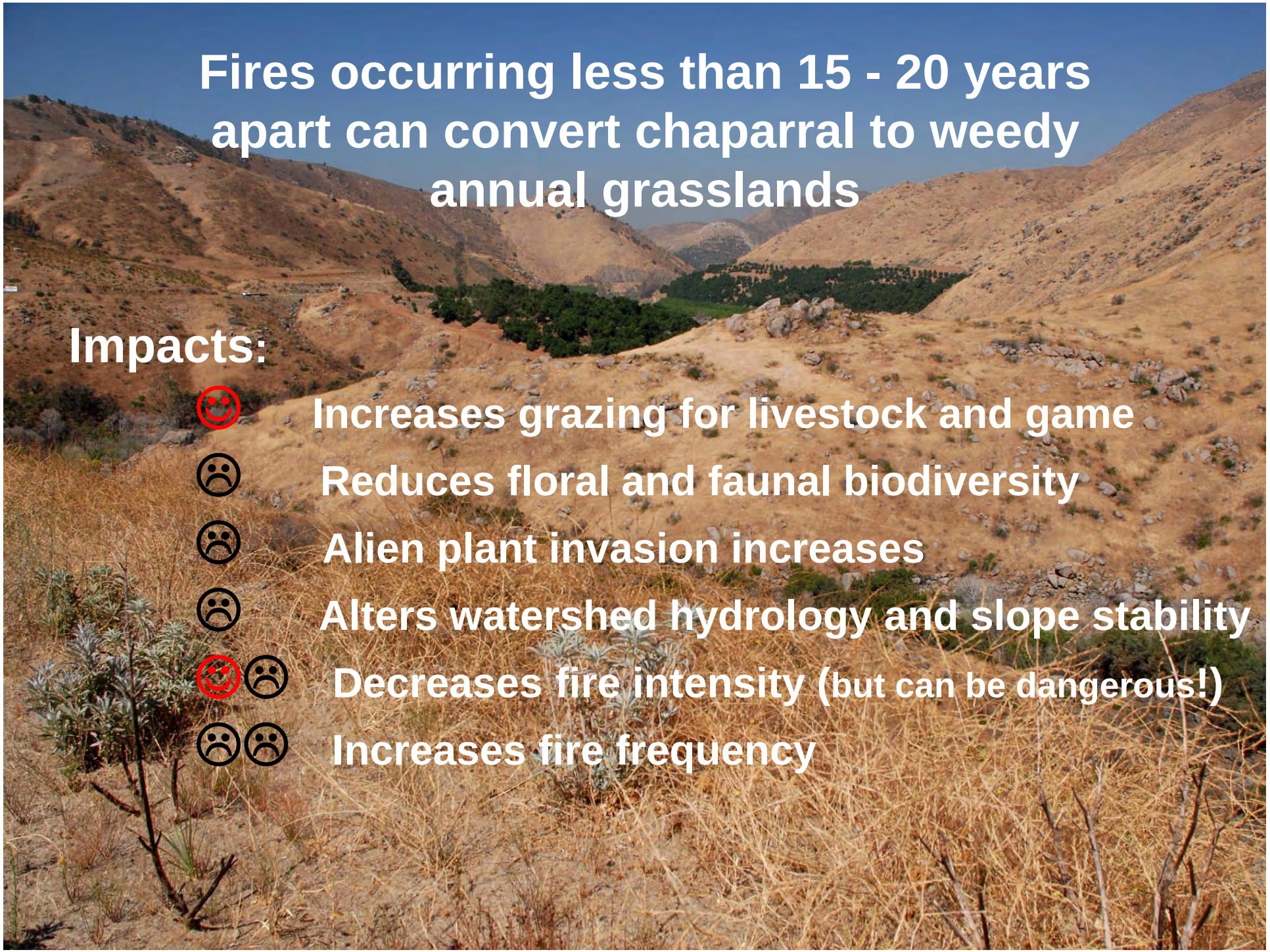



Legend
Box Springs fires
<all other values>
YEAR_
1957
1958
1963
1970
1975
1979
1980
1981
1982
1983
1988
1989
1993
1995
2001
2003
San Bernardino County
Riverside County
Highgrove
Box Springs Mountains
Interstate Route 215, State Route 60
State Route 60
60
Sunnymead
Interstate Route 215



Extent to which 20th & 21st century fires have burned at frequencies similar to pre-Euroamerican settlement

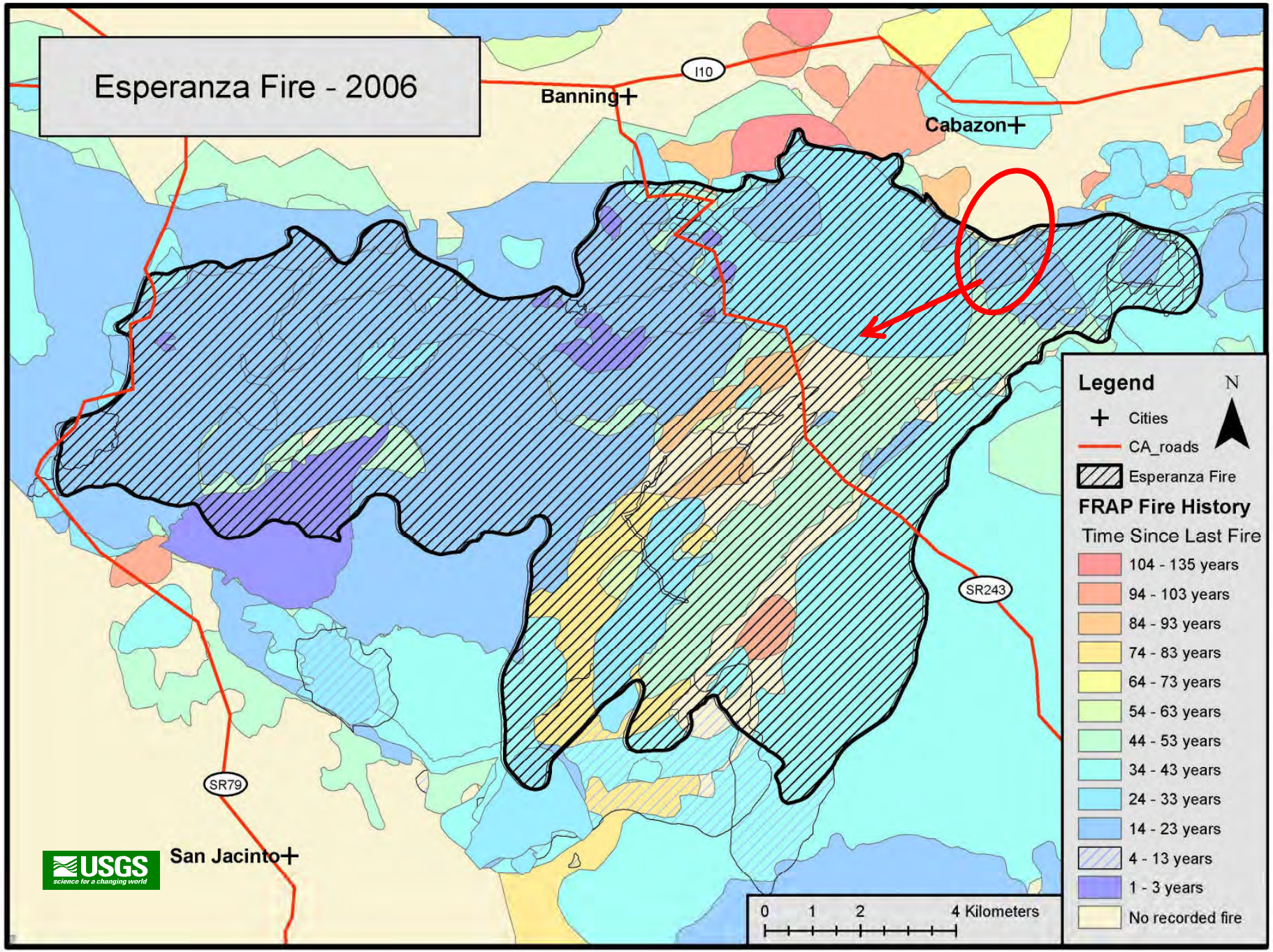
(Safford & van DeWater in review)

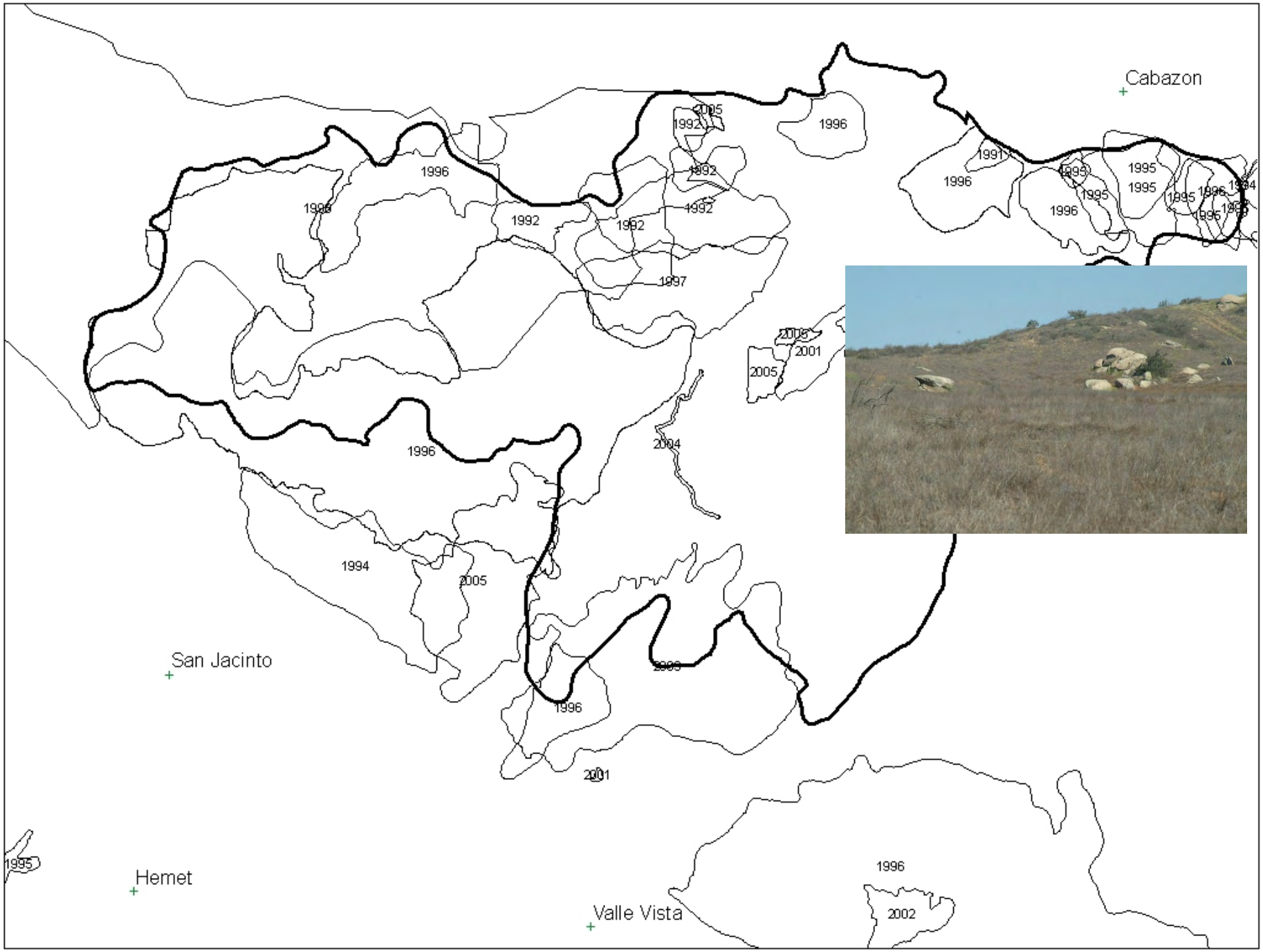


Fires occurring less than 15 - 20 years apart can convert chaparral to weedy annual grasslands

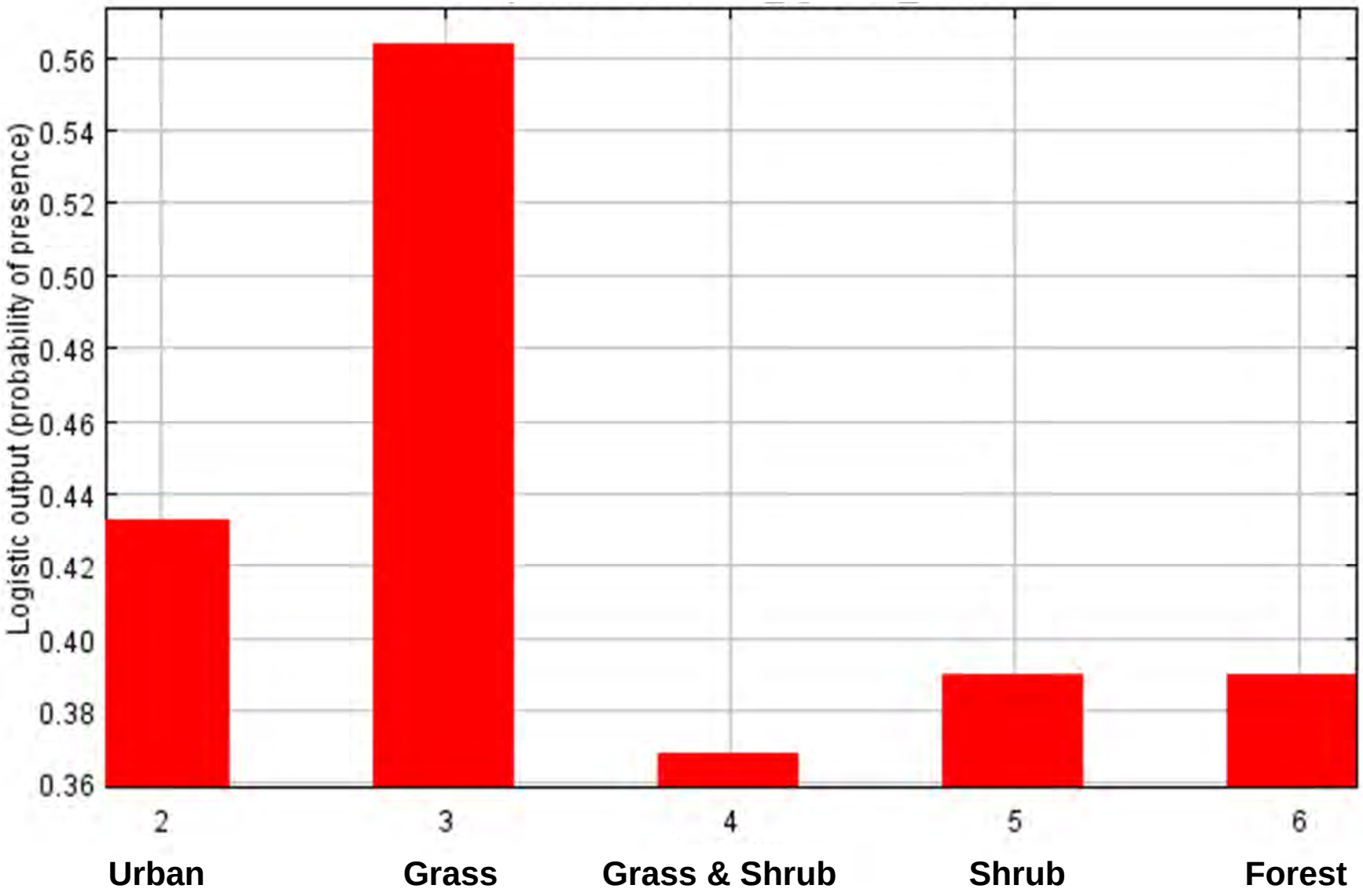
Impacts:

- ☺ Increases grazing for livestock and game
- ☹ Reduces floral and faunal biodiversity
- ☹ Alien plant invasion increases
- ☹ Alters watershed hydrology and slope stability
- ☺☹ Decreases fire intensity (but can be dangerous!)
- ☹☹ Increases fire frequency


Esperanza Fire - 2006
I10
Banning
Cabazon
SR243
SR79
San Jacinto
USGS
science for a changing world
Legend
N
Cities
CA_roads
Esperanza Fire
FRAP Fire History
Time Since Last Fire
104 - 135 years
94 - 103 years
84 - 93 years
74 - 83 years
64 - 73 years
54 - 63 years
44 - 53 years
34 - 43 years
24 - 33 years
14 - 23 years
4 - 13 years
1 - 3 years
No recorded fire
0 1 2 4 Kilometers


Cabazon
San Jacinto
Hemet
Valle Vista
1996
1992
2005
1991
1995
1994
1997
2001
2004
2002

Ignitions



(Syphard, Brennan & Keeley in review)

Senescence Risk

Immaturity Risk

Resources and Fire Management

Senescence Risk

- **Prescription burning has limited capacity for enhancing resources,**
  i.e., Rx not a 'win-win proposition'
  It needs to be evaluated solely on its effectiveness for fire hazard reduction

Immaturity Risk

- **Prescription burning adds to fire-load and could, but not always, have negative impacts**
- **What about mechanical treatment impacts?**

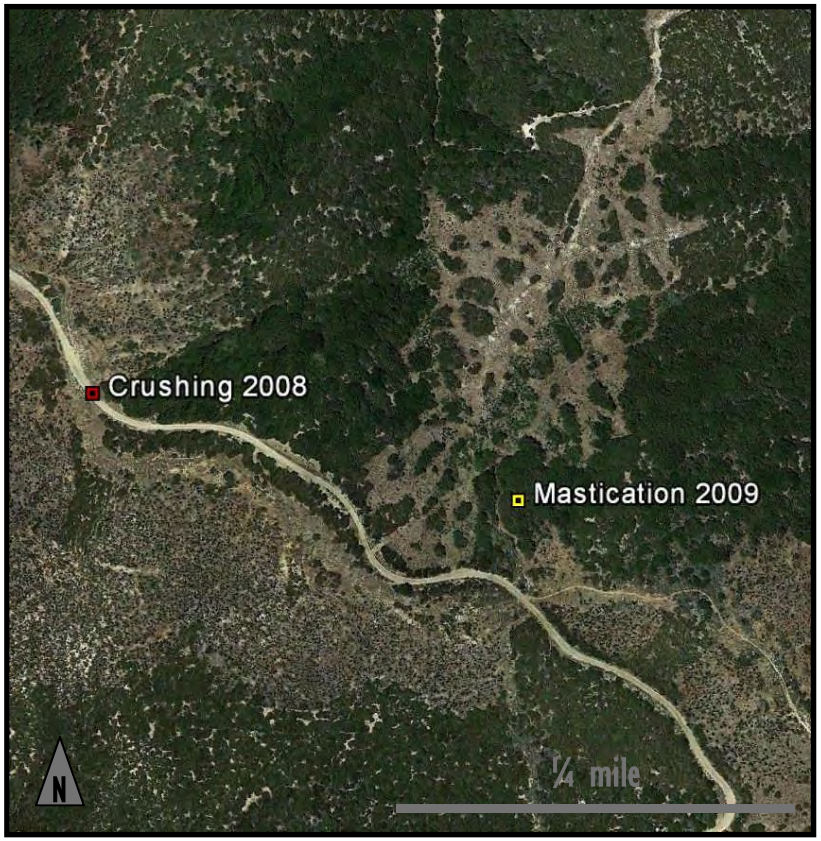
Aerial Views of Mastication

Corte Madera Mastication Spring 2008-2009
Cleveland National Forest

Lone Pine Mastication Winter 2003-2004
San Bernardino National Forest

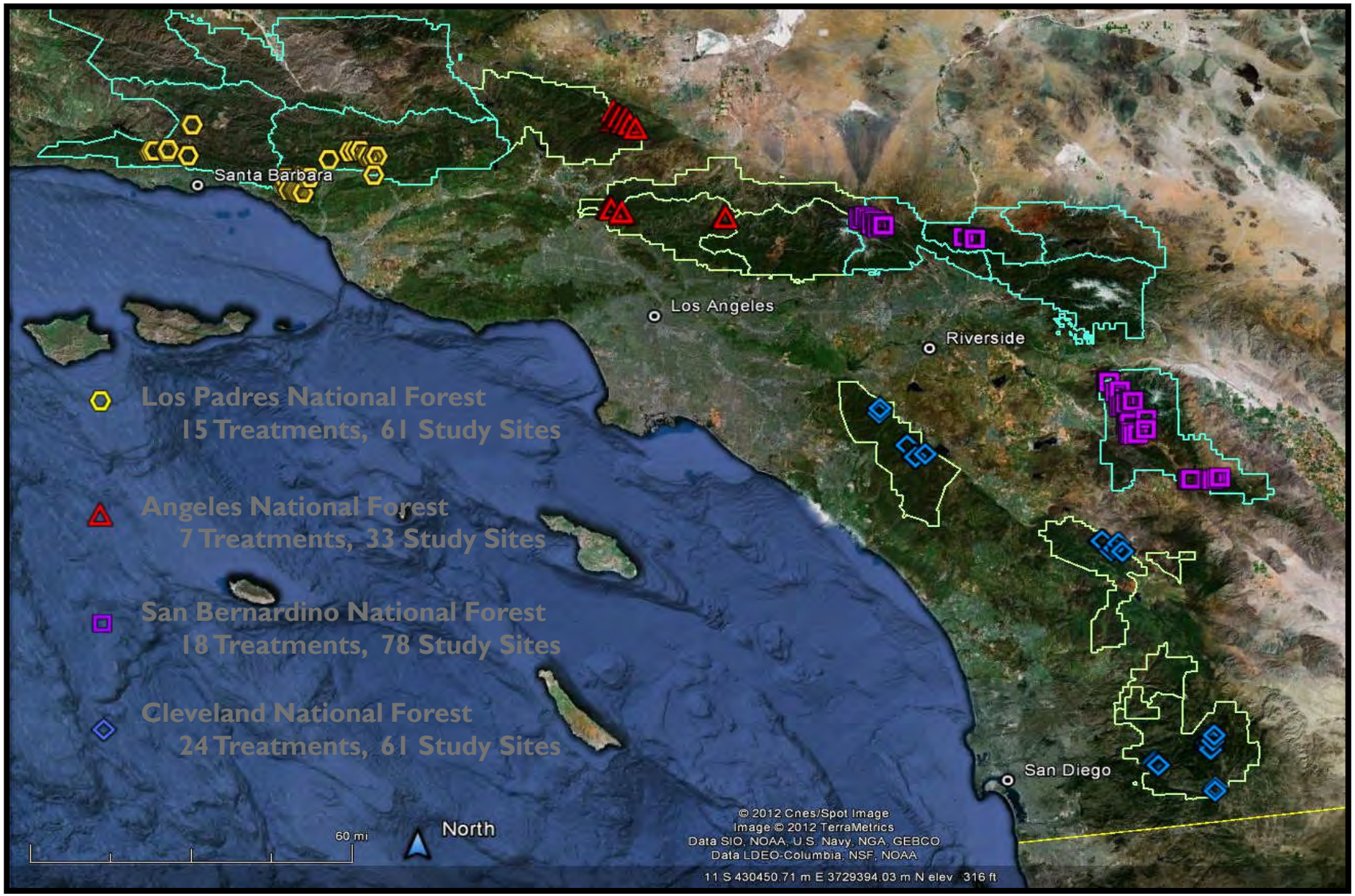
Aerial Views of Crushing

Leona Divide Crushing, 2006-2007
Angeles National Forest



Leona Divide-Crushing,2008 & Mastication 2009
Angeles National Forest

Study Site Locations



Goals

Effects on resources
Effectiveness in altering fire behavior
Quantifying flame lengths/spread
Developing custom fuel models

All Forests (64 treatments)			
Treatment type by age	1-4	5-8	Total
Mastication	85	64	149
Mastication w/Rx Burn	11	8	19
Mastication w/Rx Burn & Wildfire		3	3
Mastication w/Wildfire	5	4	9
Repeat Mastication	1	13	14
Repeat Mastication w/Rx Burn		1	1
Crushing	12	2	14
Crushing w/Rx Burn		2	2
Wildfire	19	3	22
Total # of study sites	133	100	233
Total by forest			

Forest (# of treatments)							
ANF (7)		BDF (18)		CNF (24)		LPF (15)	
1-4	5-8	1-4	5-8	1-4	5-8	1-4	5-8
29	4	39	39	47	14	18	43
33		78		61		61	

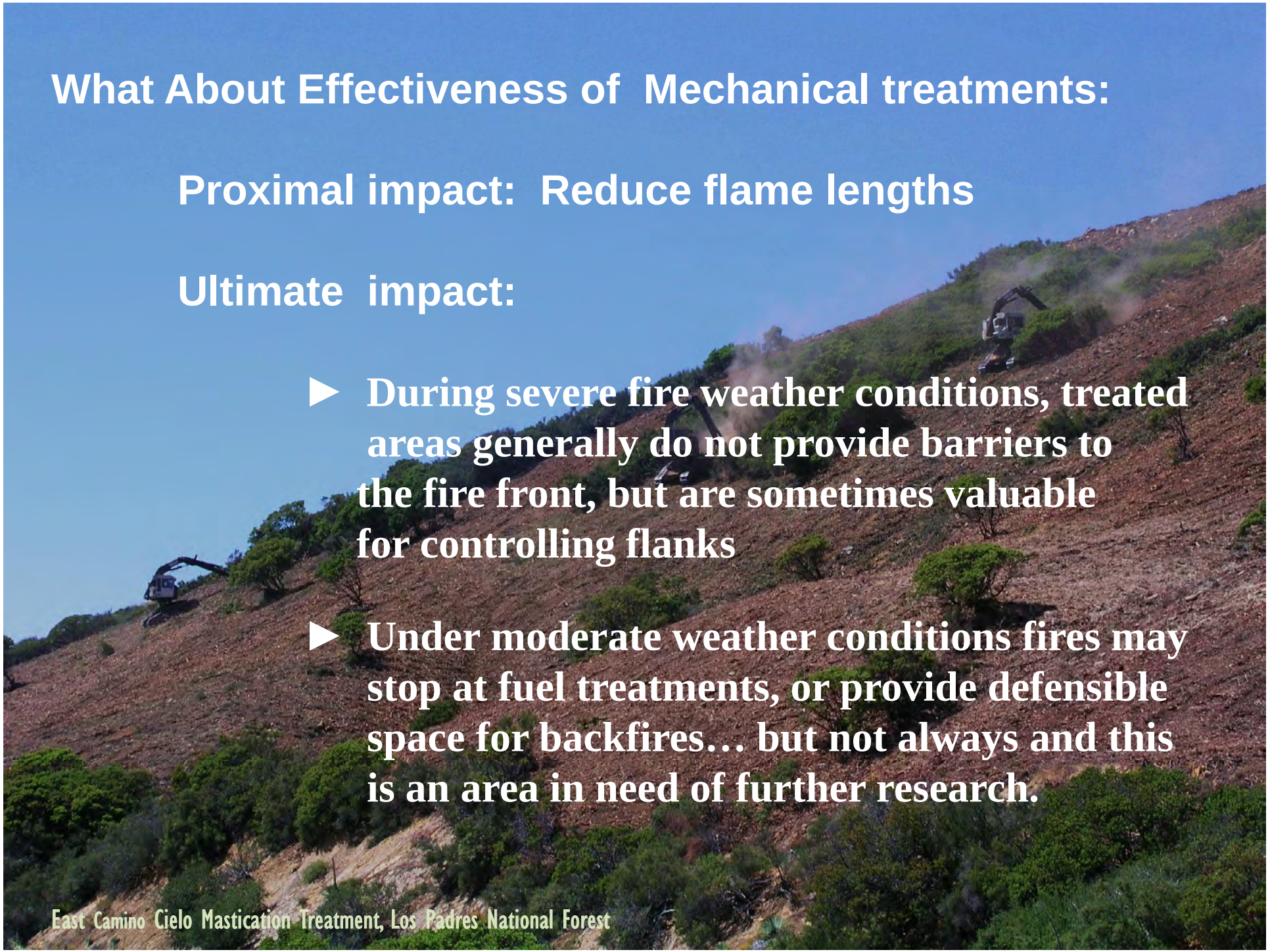
Long Canyon Mastication Fall 2010

Long Canyon Wildfire Fall 2010

Mechanical treatments:

- ► Not generally damaging to resprouting shrubs,
- ► Significant negative impacts on seeding shrubs
- ► Does not include postfire endemics
- ► Invasives annuals favored

Ω May cause some degradation in resources



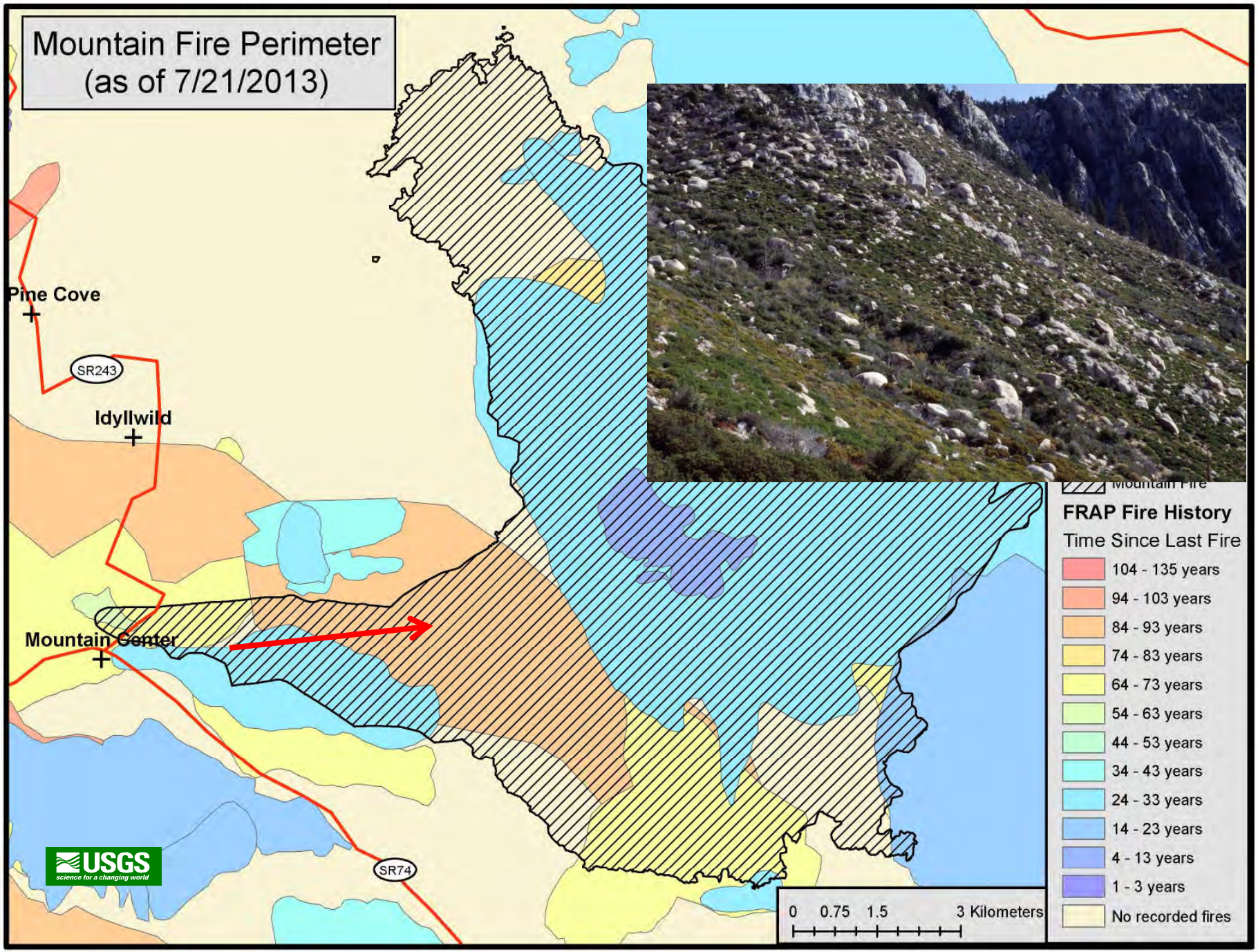
What About Effectiveness of Mechanical treatments:

Proximal impact: Reduce flame lengths

Ultimate impact:

- **During severe fire weather conditions, treated areas generally do not provide barriers to the fire front, but are sometimes valuable for controlling flanks**
- **Under moderate weather conditions fires may stop at fuel treatments, or provide defensible space for backfires… but not always and this is an area in need of further research.**

East Camino Cielo Mastication Treatment, Los Padres National Forest


Mountain Fire Perimeter
(as of 7/21/2013)
Pine Cove
SR243
Idyllwild
Mountain Center
SR74
USGS
science for a changing world
0 0.75 1.5 3 Kilometers
Mountain Fire
FRAP Fire History
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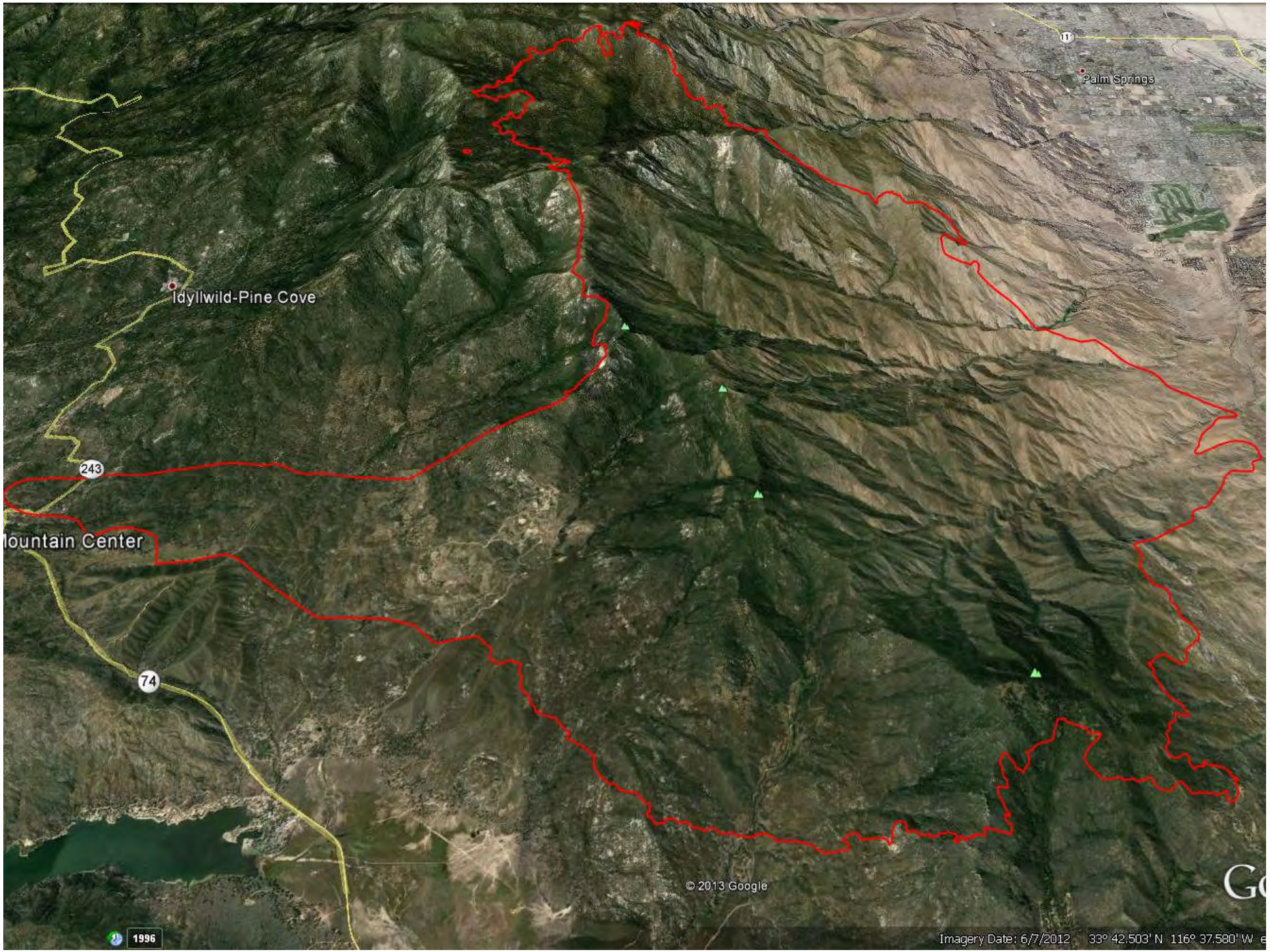
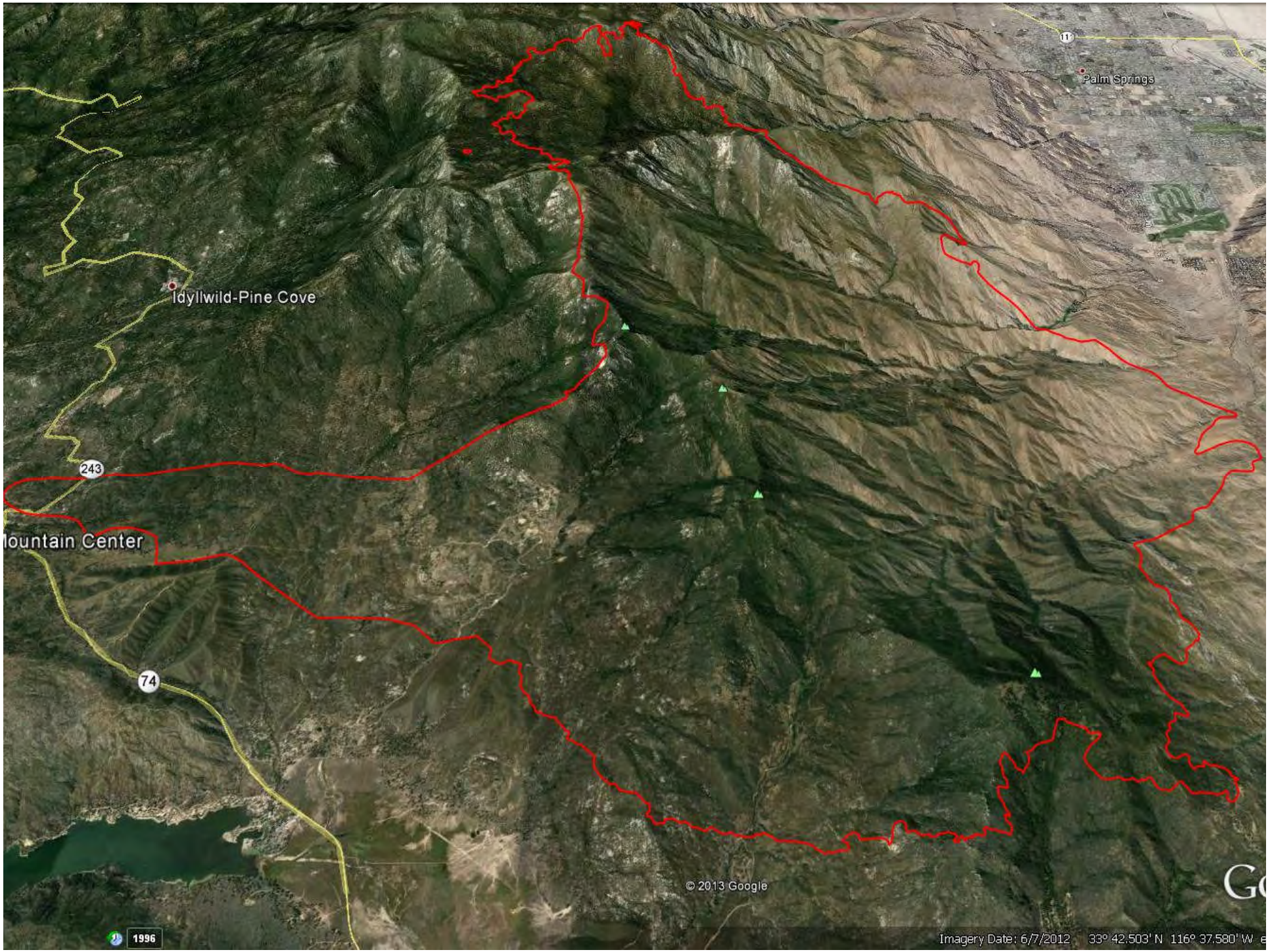
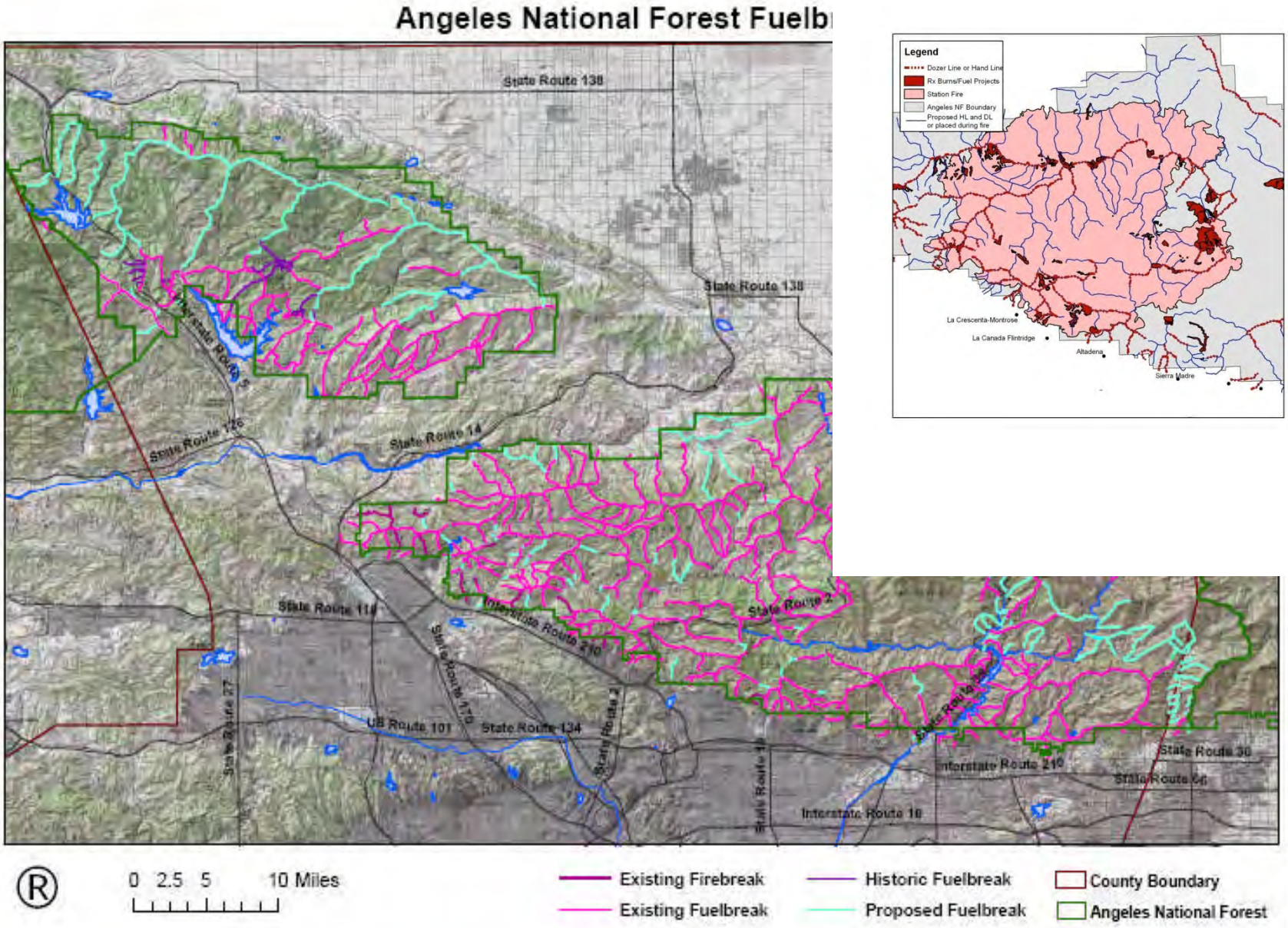
44 - 53 years
34 - 43 years
24 - 33 years
14 - 23 years
4 - 13 years
1 - 3 years
No recorded fires


Palm Springs
11
Idyllwild-Pine Cove
243
ountain Center
74
© 2013 Google
1996
Imagery Date: 6/7/2012 33° 42.503' N 116° 37.580' W


Palm Springs
11
Idyllwild-Pine Cove
243
ountain Center
74
© 2013 Google
1996
Imagery Date: 6/7/2012 33° 42.503' N 116° 37.580' W

What about fuel breaks?

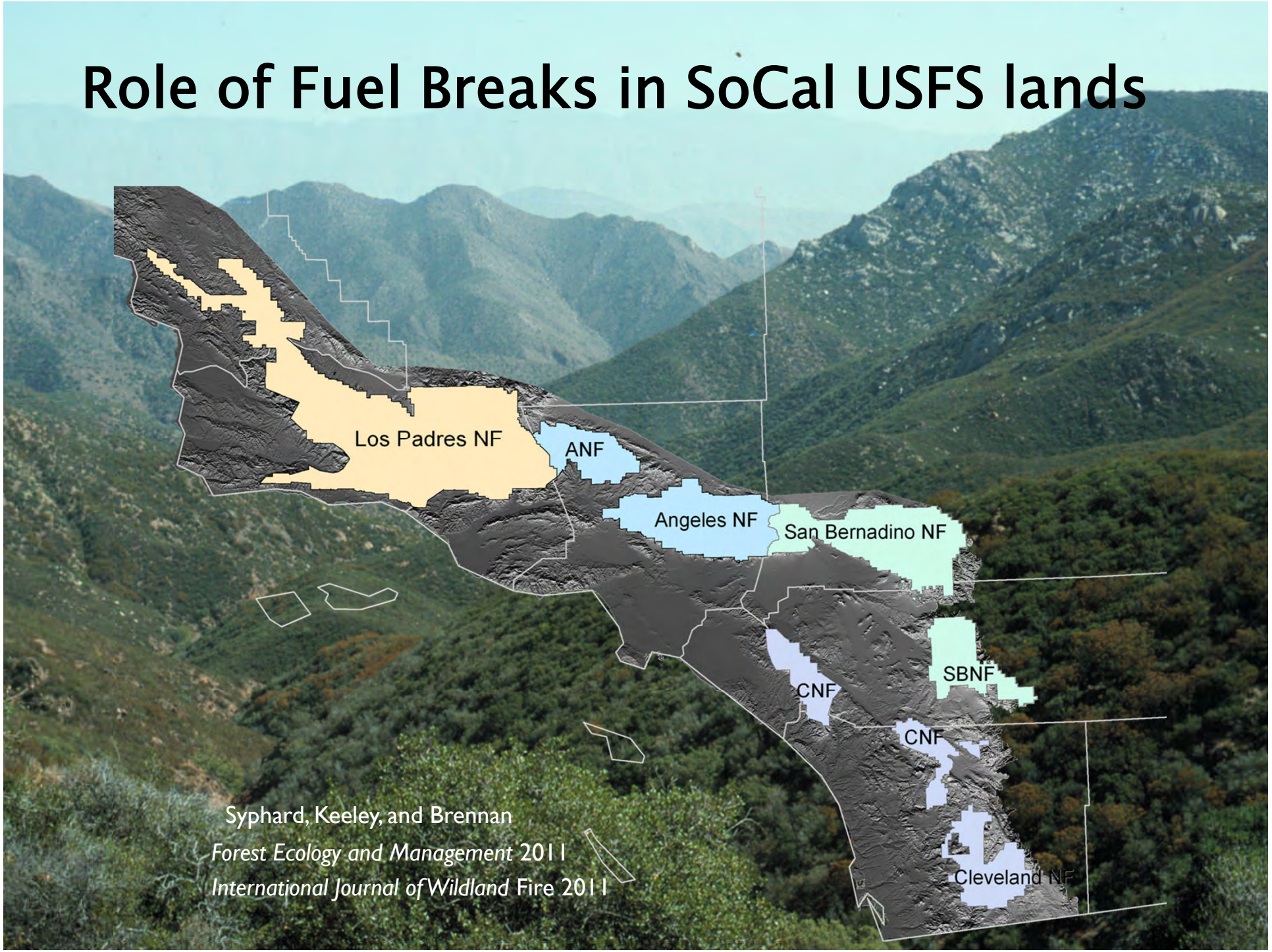


(Brennan, Keeley and Pfaff, unpublished)

Before Cedar Fire:
Extensive fuel breaks on
the Elliot Reserve
© 2010 Google

After the Cedar Fire:
Fire crossed entire reserve
and burned deep into the urban
environment
© 2010 Google
Image © 2010 DigitalGlobe
© 2010 INEGI
1074 m
©2010 Google
3, 2004
32°54'12.38" N 117°03'20.10" W elev 227 m
Eye alt 3.94 km

Role of Fuel Breaks in SoCal USFS lands



Syphard, Keeley, and Brennan

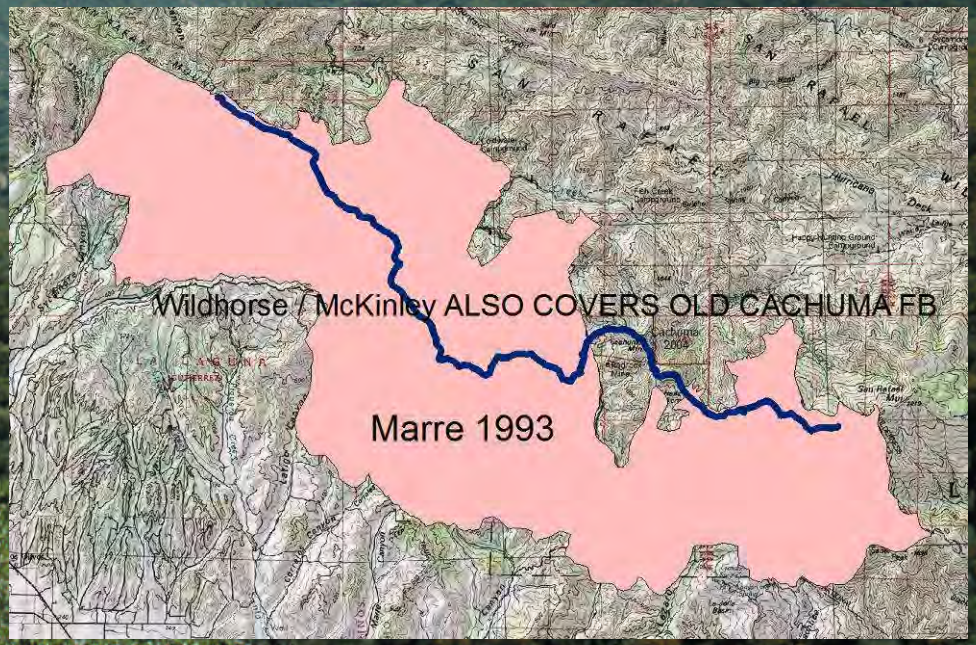
Forest Ecology and Management 2011

International Journal of Wildland Fire 2011

What is the role of fuel breaks in controlling large fires & what factors influence this role?

GIS overlay and analysis

Personal interviews



The Role of Fuel Breaks

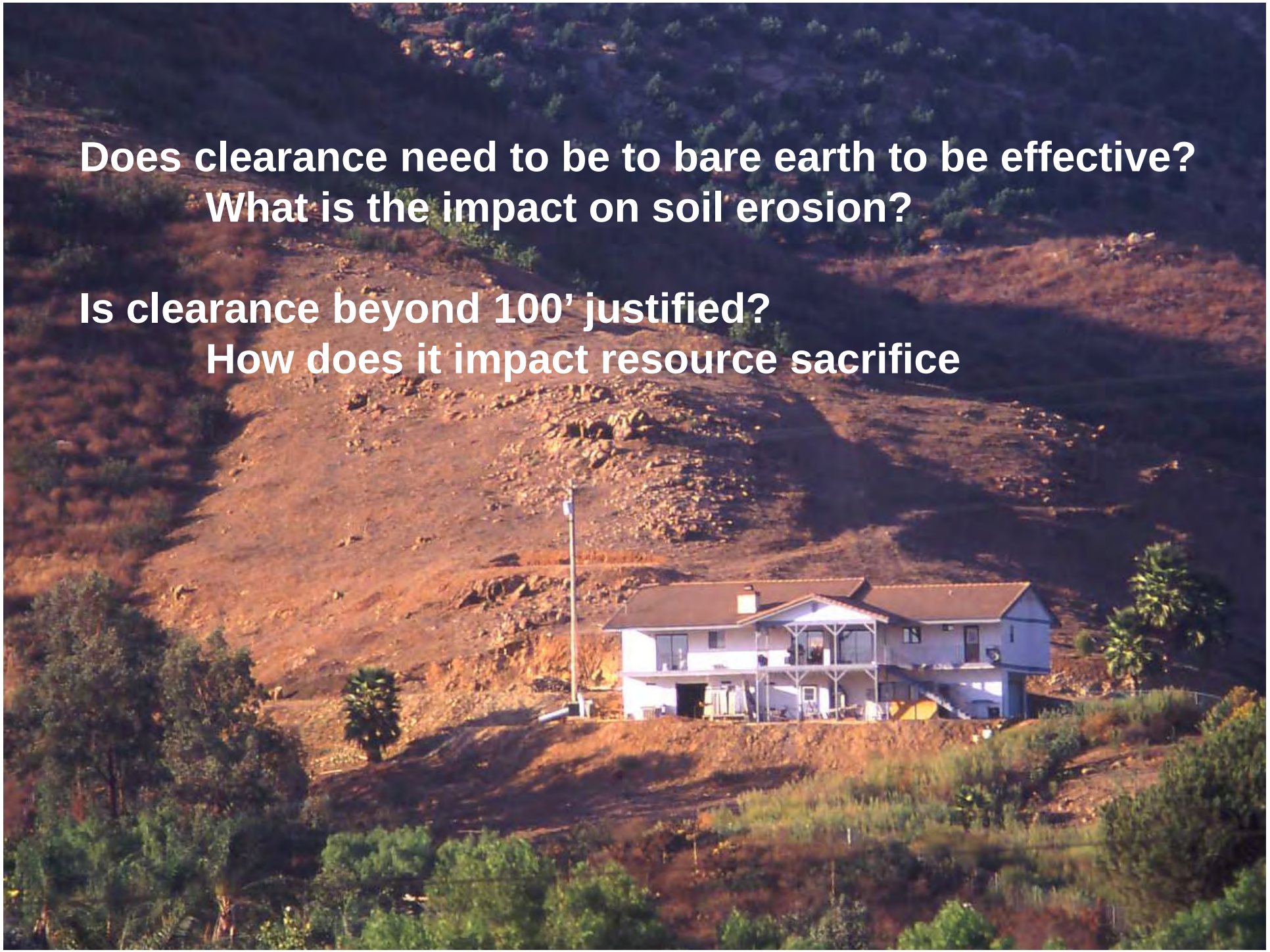
Most fires didn't encounter a fuel break

Fires that encountered a fuel break had behavior altered only when they were accessed by fire suppression crews

Strategic placement of fuel breaks is likely to be most cost-effective when located near resources at risk, eg WUI

A potential strategy is to shift from wildland vegetation management to focus from the home out

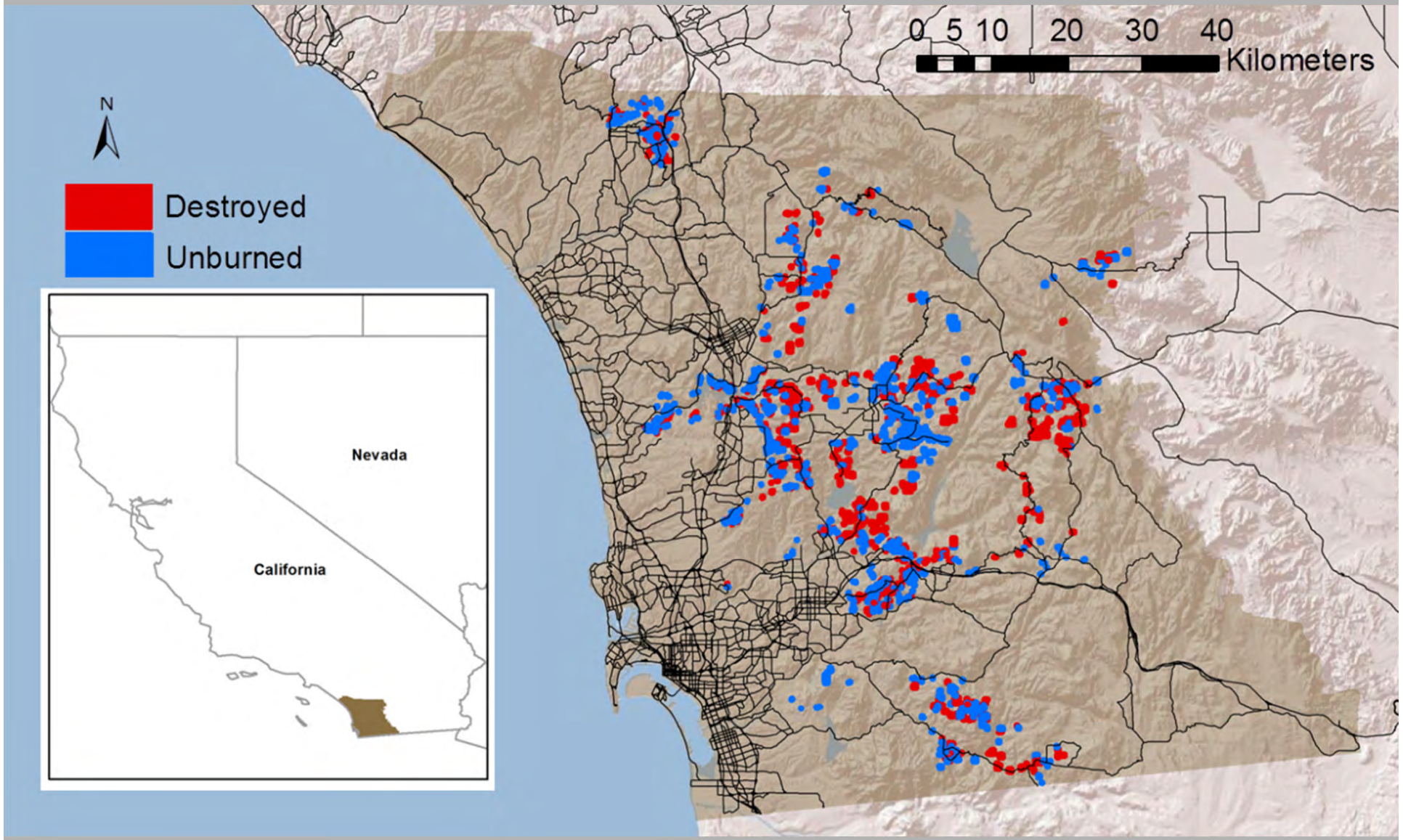
.



Does clearance need to be to bare earth to be effective?
What is the impact on soil erosion?

Is clearance beyond 100' justified?
How does it impact resource sacrifice

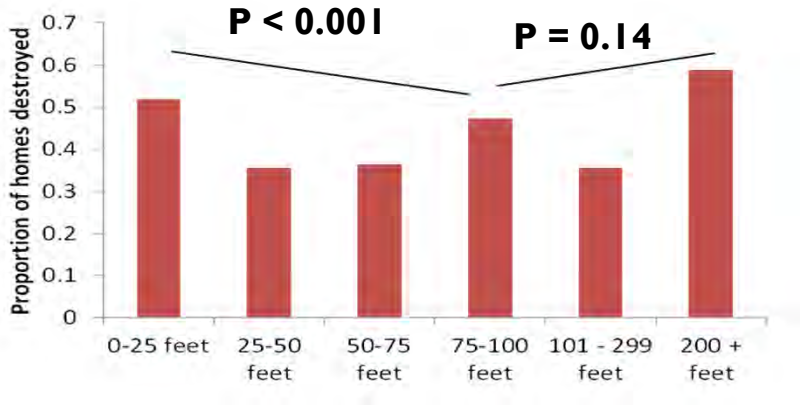
Defensible Space



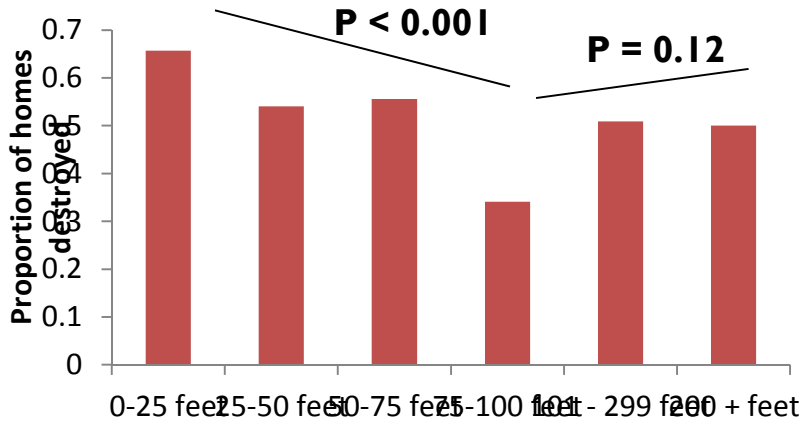
(Syphard, Brennan, Keeley in review)

Defensible Space

•Low slope properties



•High slope properties



What does the future hold?

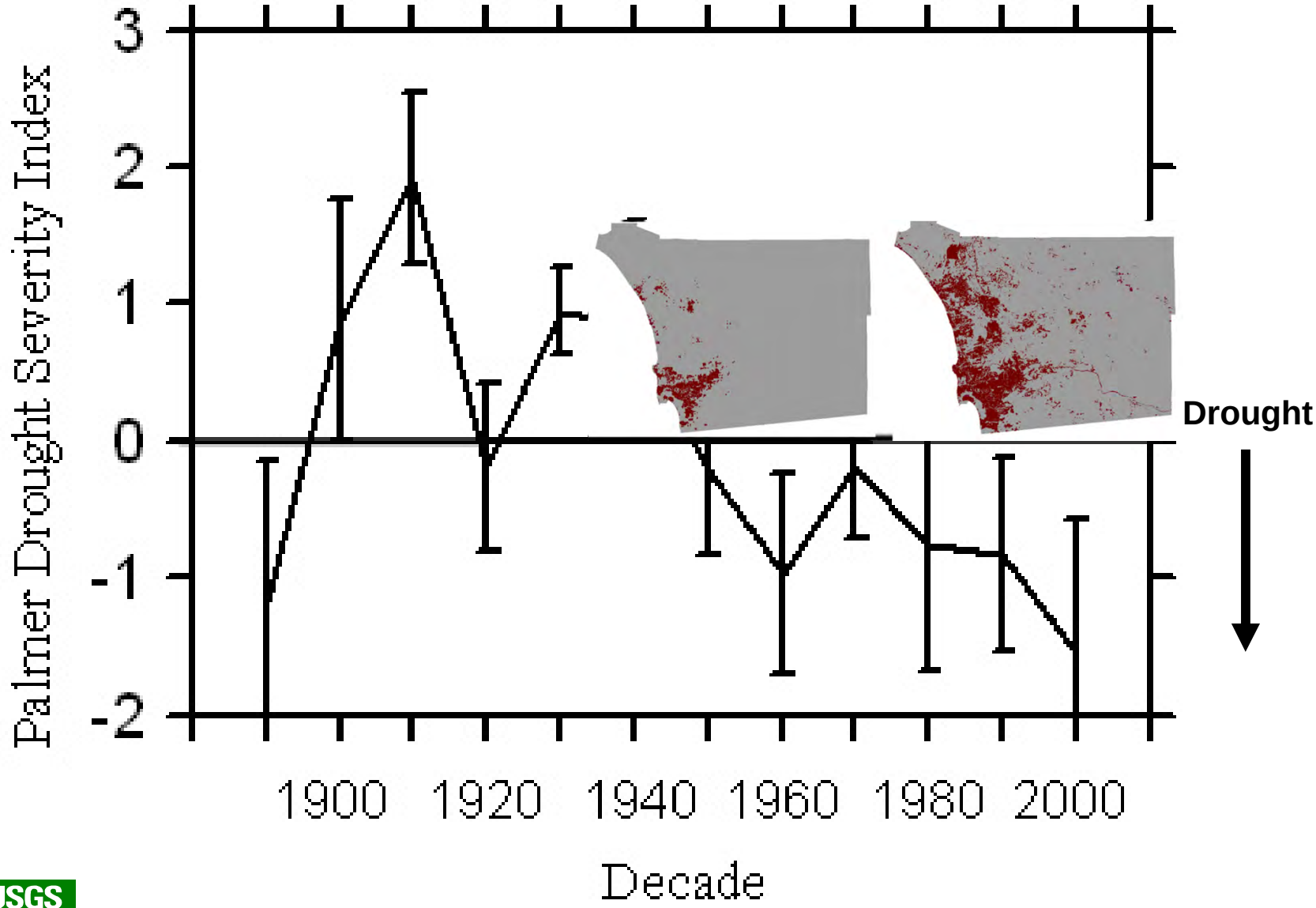
Climate change?

In southern California we need to think more broadly in terms of global changes

>99% of all lands are burned by human-ignited fires

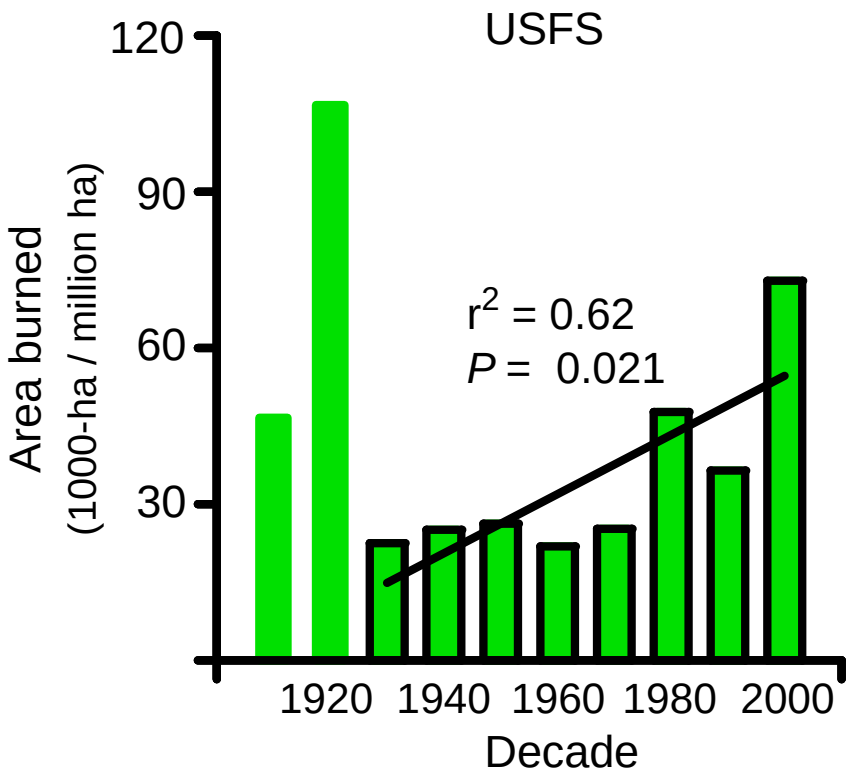
In the next several decades populations will increase by more than 50% while temperatures are predicted to increase 2-3%

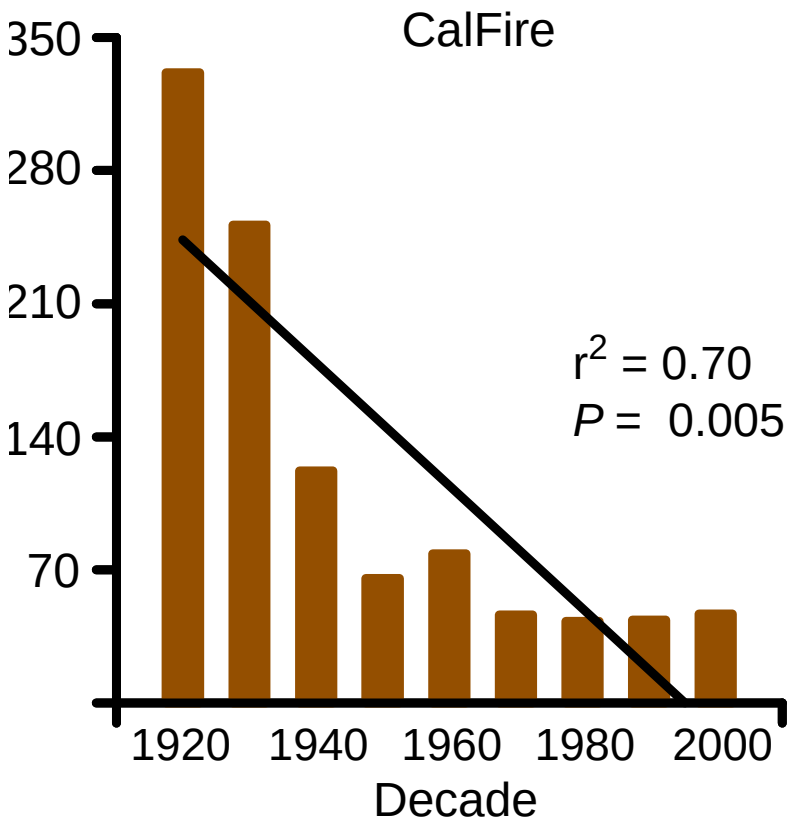
Year	Fire	County	Month	Acres
1889	Santiago Cyn	Orange	Sept	308,900
1932	Matilija	Sta Barbara	Sept	219,900
1970	Laguna	San Diego	Sept	174,200
1985	Wheeler #2	Ventura	July	122,800
2003	Cedar	San Diego	Oct	270,575
2006	Day	Ventura	Sept	161,850
2007	Zaca	Sta Barbara	July	240,425
2007	Witch	San Diego	Oct	198,175
2009	Station	Los Angeles	August	166,600



(Keeley & Zedler in press)

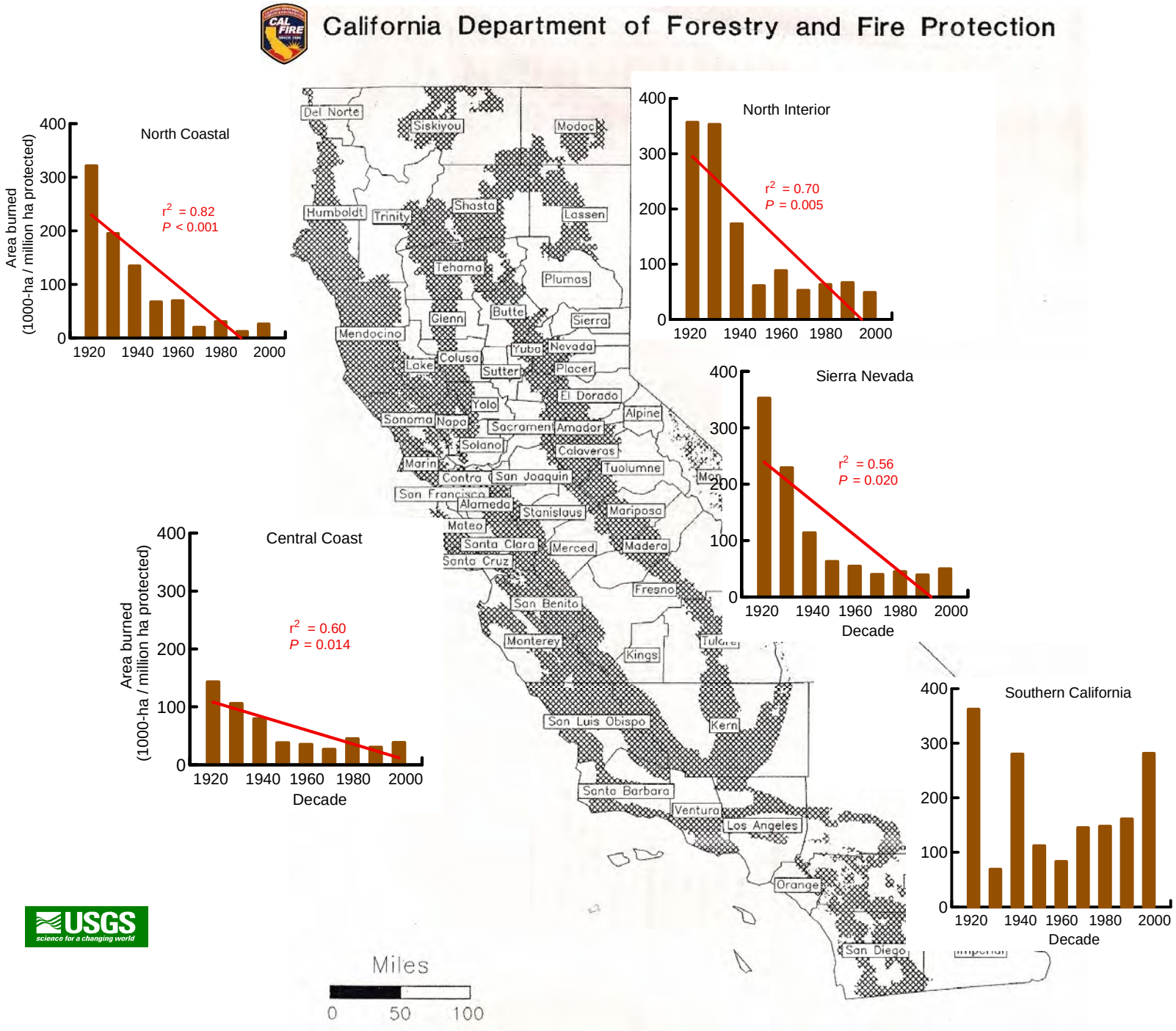
California

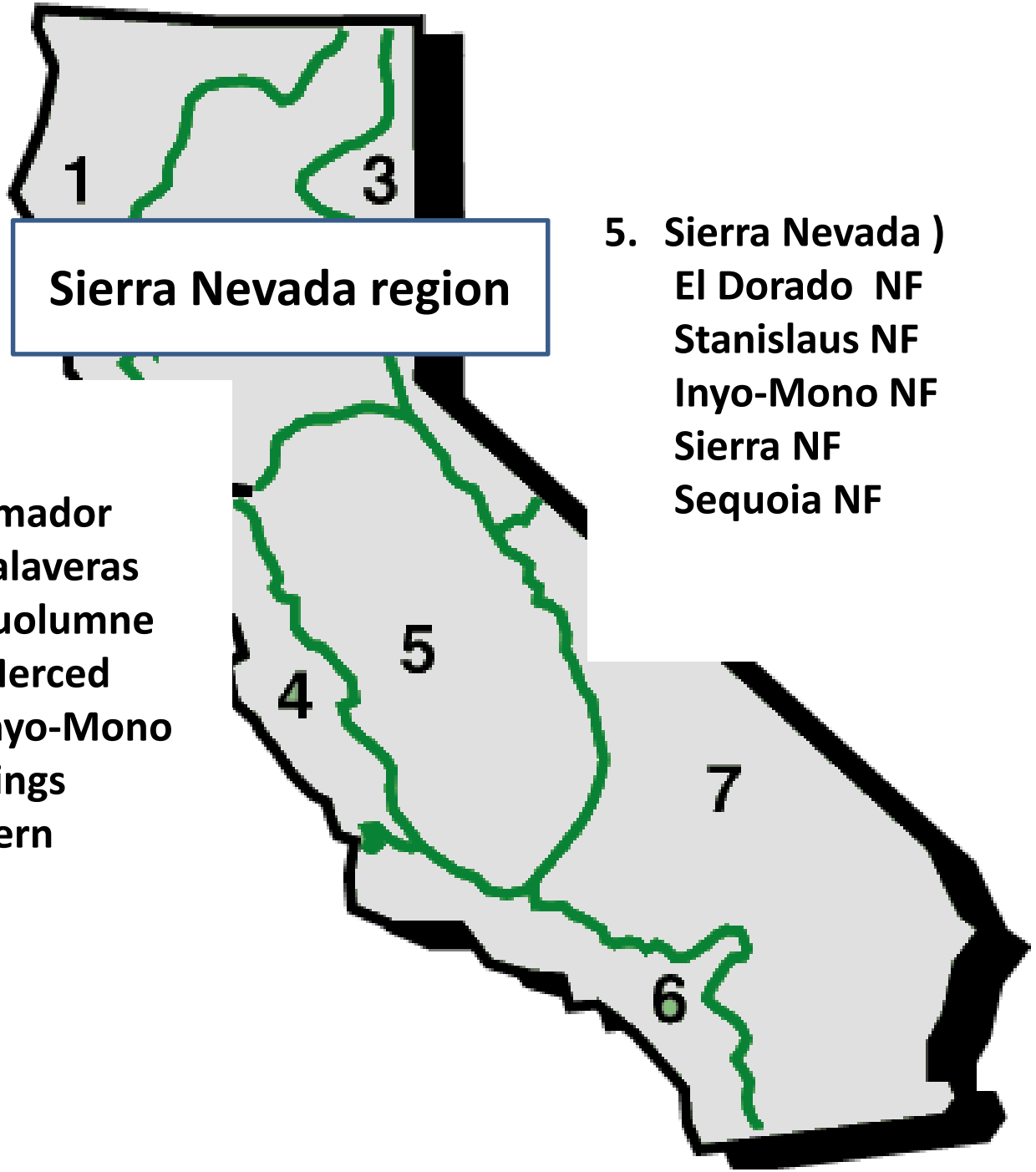




9Keeley & Syphard in preparation)

California Department of Forestry and Fire Protection



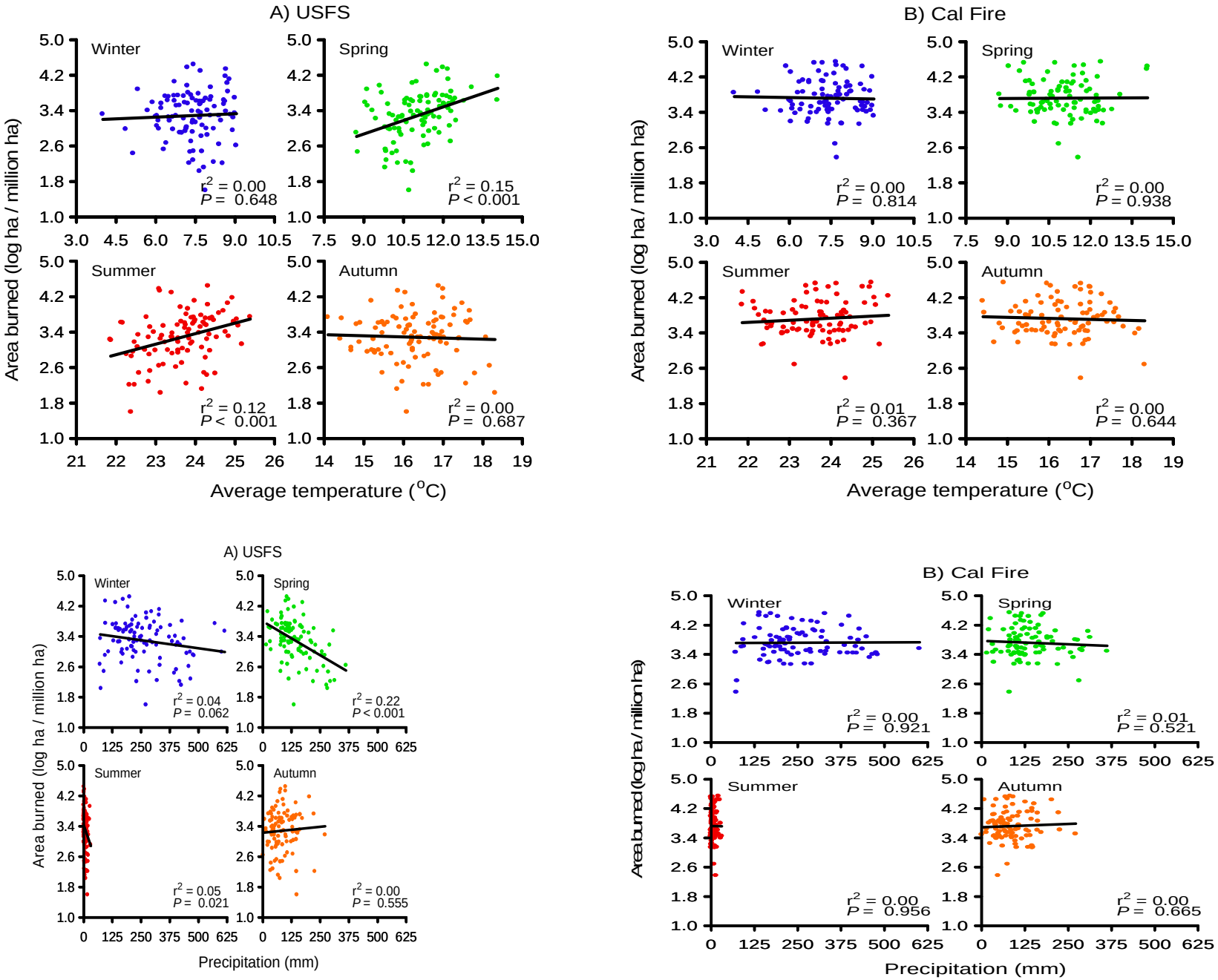


Sierra Nevada region

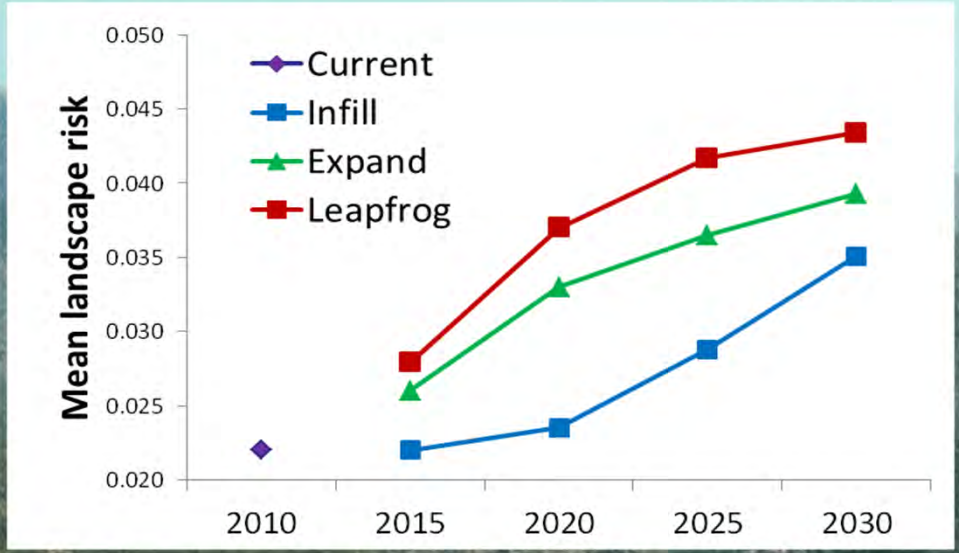
5. Sierra Nevada)
   - El Dorado NF
   - Stanislaus NF
   - Inyo-Mono NF
   - Sierra NF
   - Sequoia NF

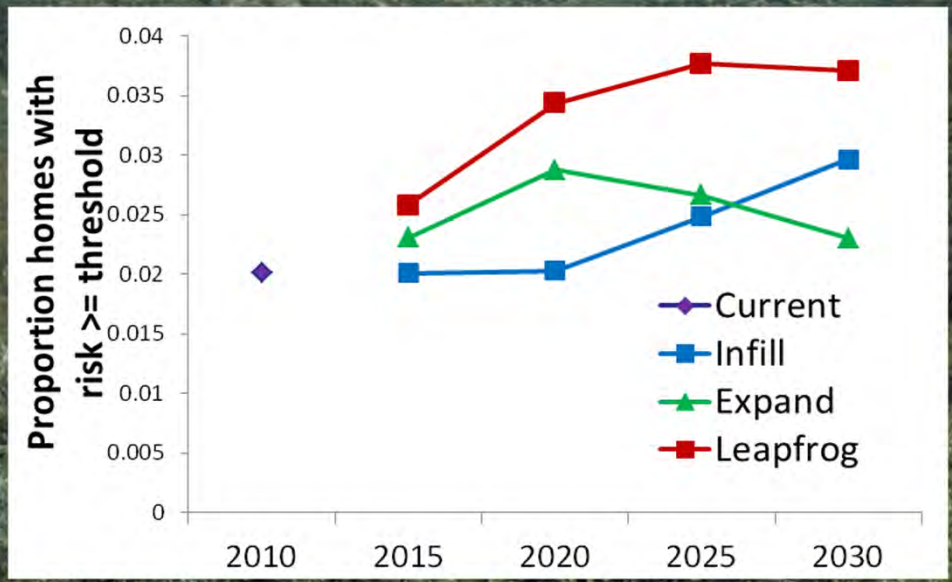
5. Sierra Nevada

El Dorado	Amador
San Joaquin	Calaveras
Stanislaus	Tuolumne
Mariposa	Merced
Madera	Inyo-Mono
Fresno	Kings
Tulare	Kern


A) USFS
B) Cal Fire
Winter
Spring
Summer
Autumn
Area burned (log ha / million ha)
Average temperature (°C)
Precipitation (mm)
r2 = 0.00
P = 0.648
r2 = 0.15
P < 0.001
r2 = 0.12
P < 0.001
r2 = 0.00
P = 0.687
r2 = 0.00
P = 0.814
r2 = 0.00
P = 0.938
r2 = 0.01
P = 0.367
r2 = 0.00
P = 0.644
r2 = 0.04
P = 0.062
r2 = 0.22
P < 0.001
r2 = 0.05
P = 0.021
r2 = 0.00
P = 0.555
r2 = 0.00
P = 0.921
r2 = 0.01
P = 0.521
r2 = 0.00
P = 0.956
r2 = 0.00
P = 0.665

Land Use Planning

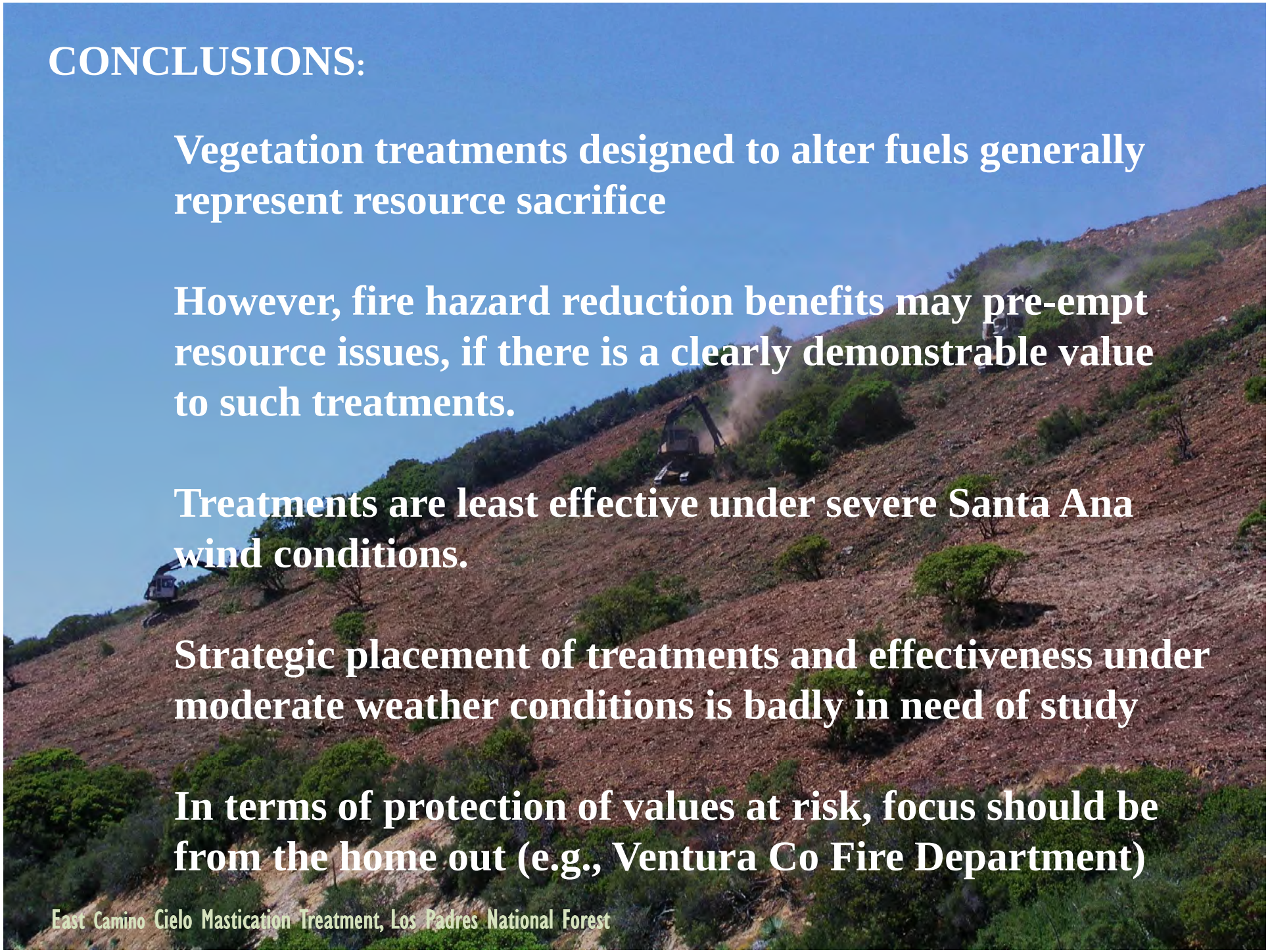




Syphard et al. 2012, PLoS ONE

Syphard et al. 2007, Ecological Applicati

Syphard et al. 2009, Conservation Biolo



CONCLUSIONS:

Vegetation treatments designed to alter fuels generally represent resource sacrifice

However, fire hazard reduction benefits may pre-empt resource issues, if there is a clearly demonstrable value to such treatments.

Treatments are least effective under severe Santa Ana wind conditions.

Strategic placement of treatments and effectiveness under moderate weather conditions is badly in need of study

In terms of protection of values at risk, focus should be from the home out (e.g., Ventura Co Fire Department)

East Camino Cielo Mastication Treatment, Los Padres National Forest

The Poetry of D.H. Rumsfeld

—Feb. 12, 2002, Department of Defense news briefing

The Unknown

As we know,
There are known knowns.
There are things we know we know.
We also know
There are known unknowns.
That is to say
We know there are some things
We do not know.
But there are also unknown unknowns,
The ones we don't know
We don't know.

Acknowledgments

USGS
science for a changing world

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DEPARTMENT OF AGRICULTURE

Joint Fire Science Program

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CAL FIRE
SINCE 1885

SANDAG
San Diego's Regional Planning Agency

FIRE
ORANGE COUNTY
CALIFORNIA
AUTHORITY

MHDP
USGS Hazards Project

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