

Estimating the Impacts of Wildfire on Ecosystem Services in Southern California



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Mediterranean-type ecosystems



- Cool moist winters, warm dry summers
- Long dry season
- High inter-annual variability in precipitation
- Fire is a major ecological process

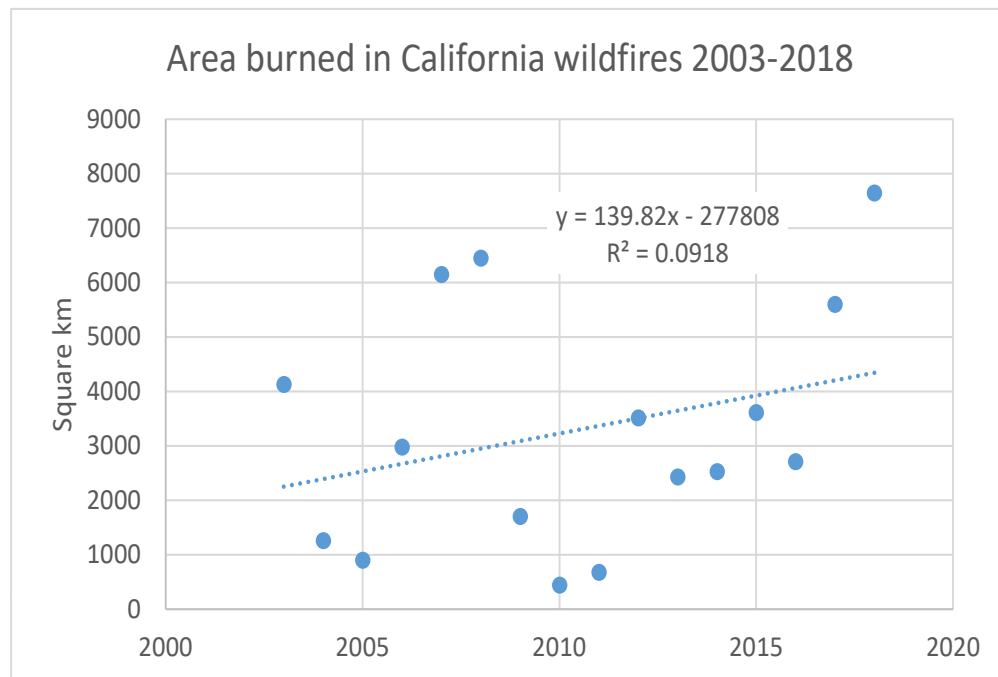
Characterized by

- High levels of biodiversity
- High population densities
- High levels of threats





Estimate of insured fire loss, the 10 worst wildfires in US history



Rank	Date	Name, Location	Structures destroyed	Deaths	Insured loss (\$ millions)
1	Nov. 8-25, 2018	Camp Fire, CA	18800	86	9000
2	Oct. 8-20, 2017	Tubbs Fire	5640	22	>4000
3	Nov. 8-12, 2018	Woolsey Fire, CA	1600	3	3000
4	Oct. 8-20, 2017	Atlas Fire, CA	780	6	>2000
5	Dec. 4-Jan. 12, 2017	Thomas Fire, CA	1070	21*	1800
6	Oct. 20-21, 1991	Oakland Hills Fire, CA	3290	25	1700
7	Jul. 23-Aug. 30, 2018	Carr Fire, CA	1605	8	1650
8	Oct. 21-24, 2007	Witch Fire, CA	1265	2	1300
9	Oct. 25-Nov. 4, 2003	Cedar Fire, CA	2820	15	1060
10	Oct. 25-Nov. 3, 2003	Old Fire, CA	975	6	975

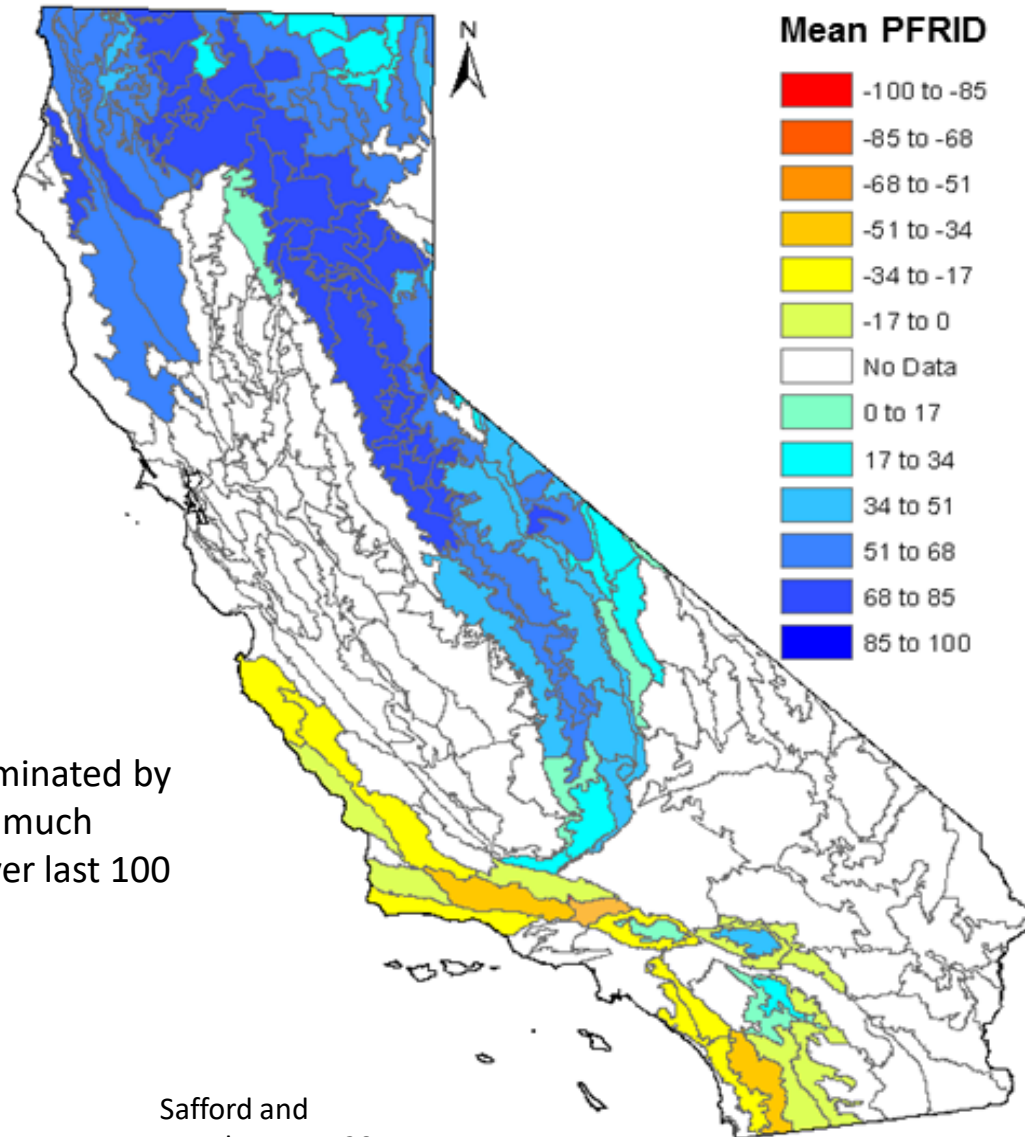
Insurance Information institute, <https://www.iii.org/fact-statistic/facts-statistics-wildfires>; Updated for 2017 & 2018 fires from preliminary online data



Current fire situation in northern v. southern California

Blue = dominated by conifer forest, severe *lack* of fire over last 100 years

Yellow = dominated by shrublands, much *more* fire over last 100

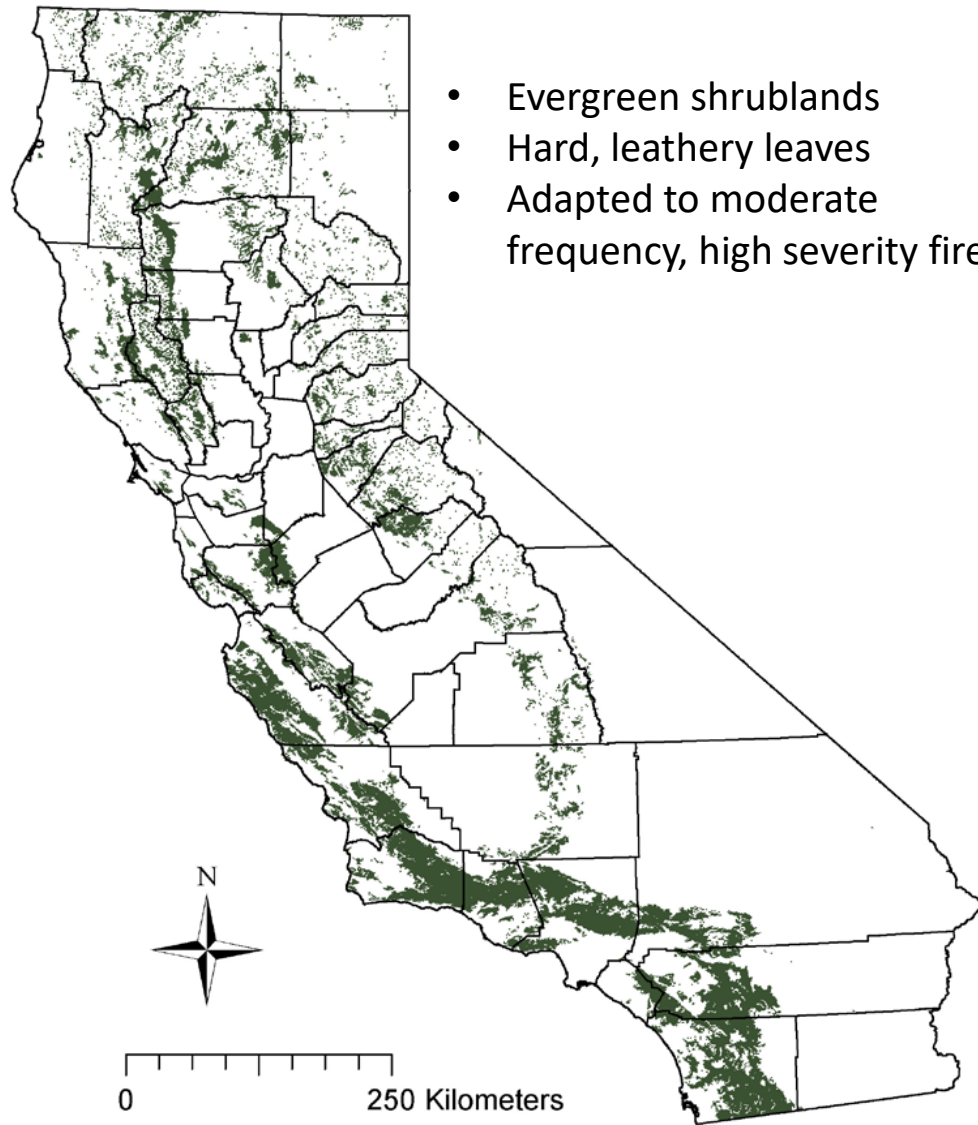


Safford and
Van de Water 2014

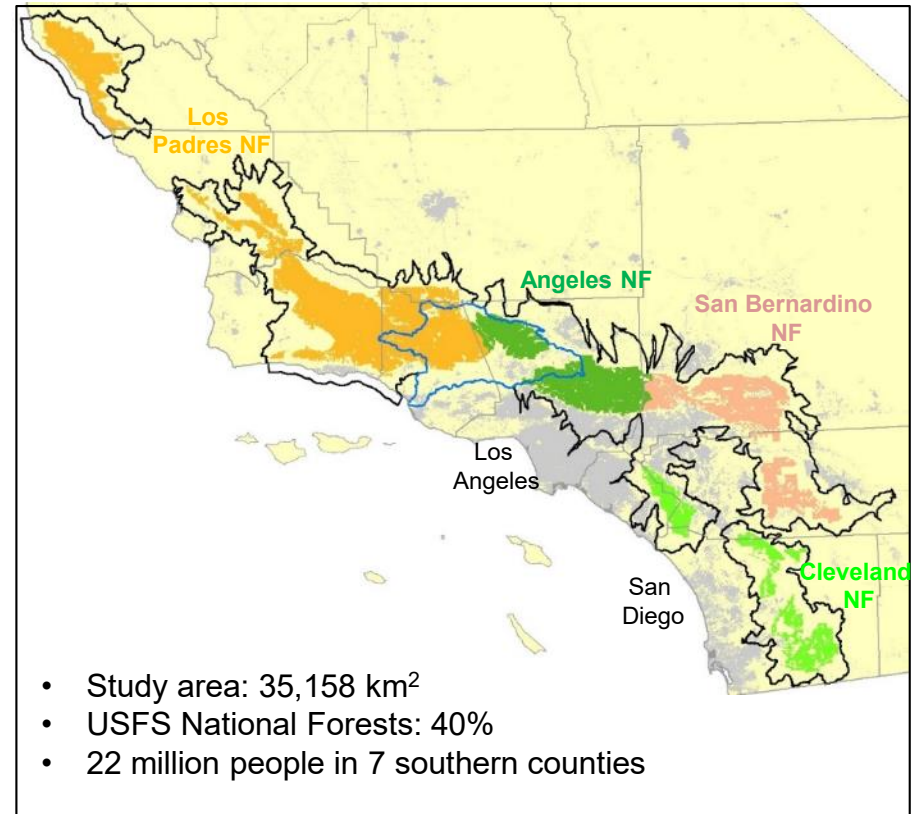
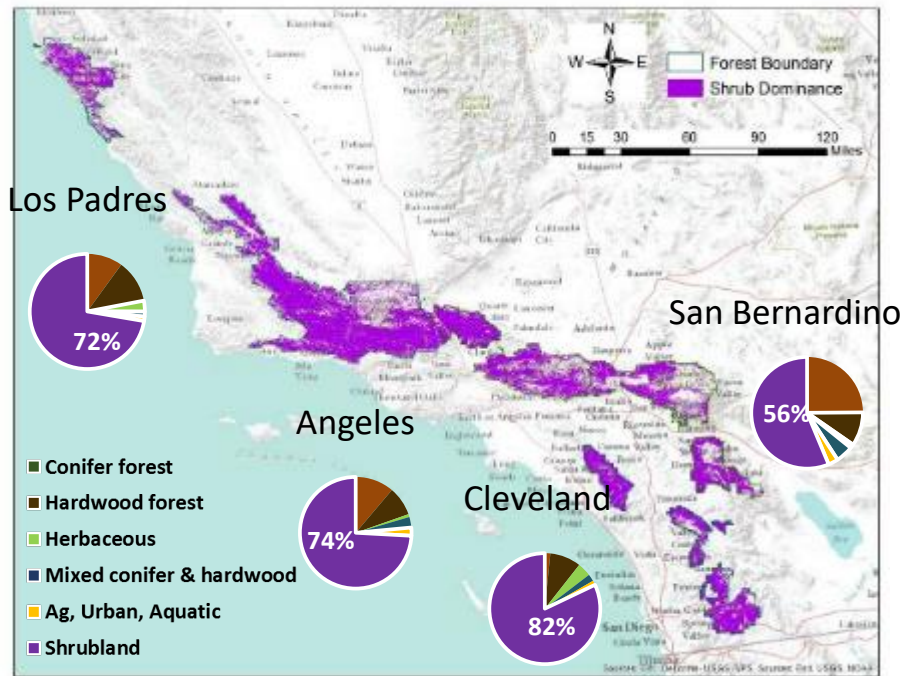
↑
More fire today
% departure
from mean FRIs
before 1850

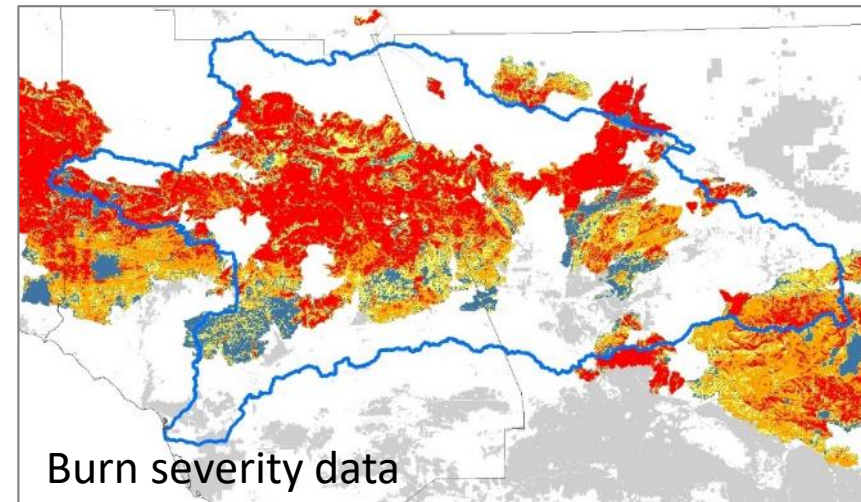
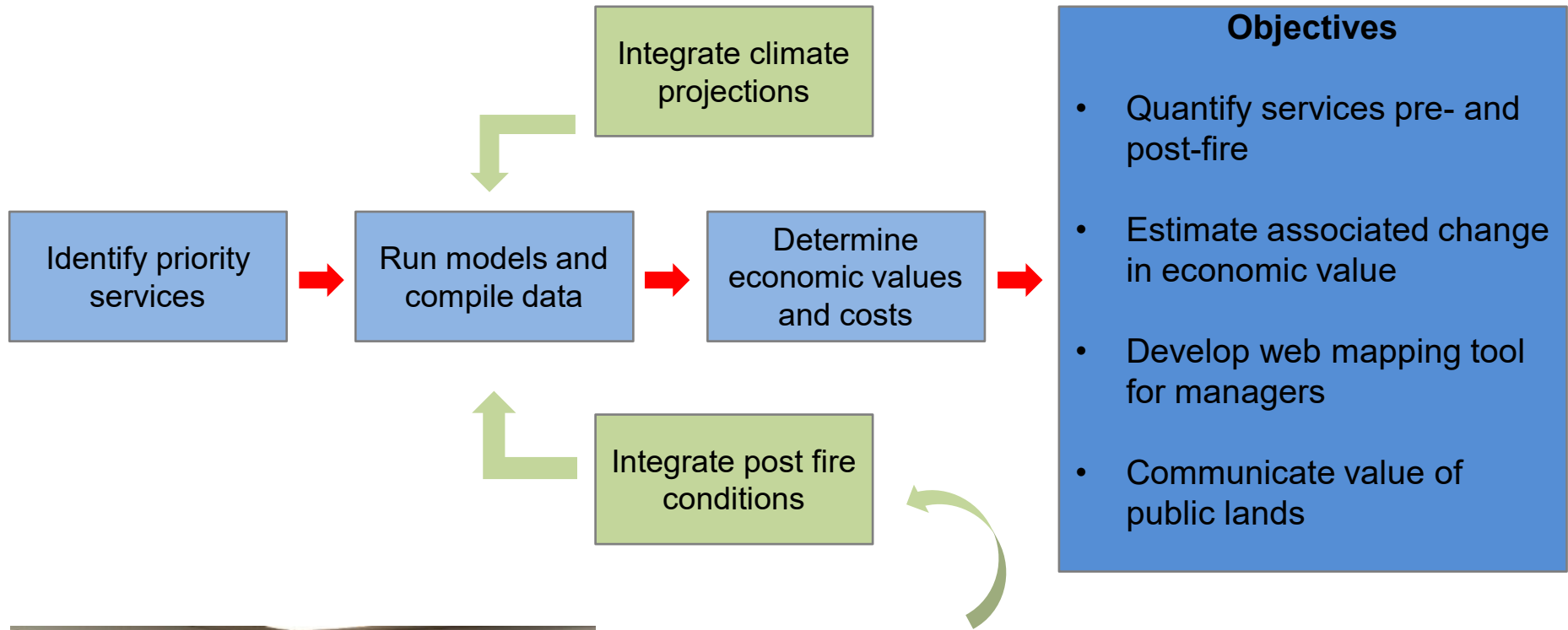
↓
Less fire today

Chaparral shrubland-dominated landscapes



Ecosystem services and wildfire project



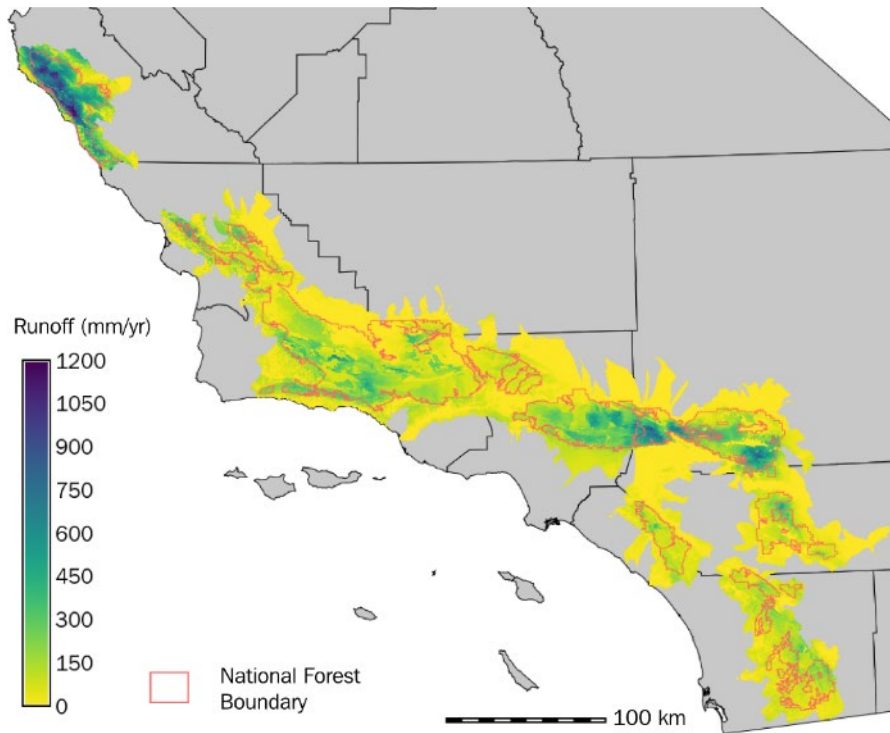


Ecosystem services assessed

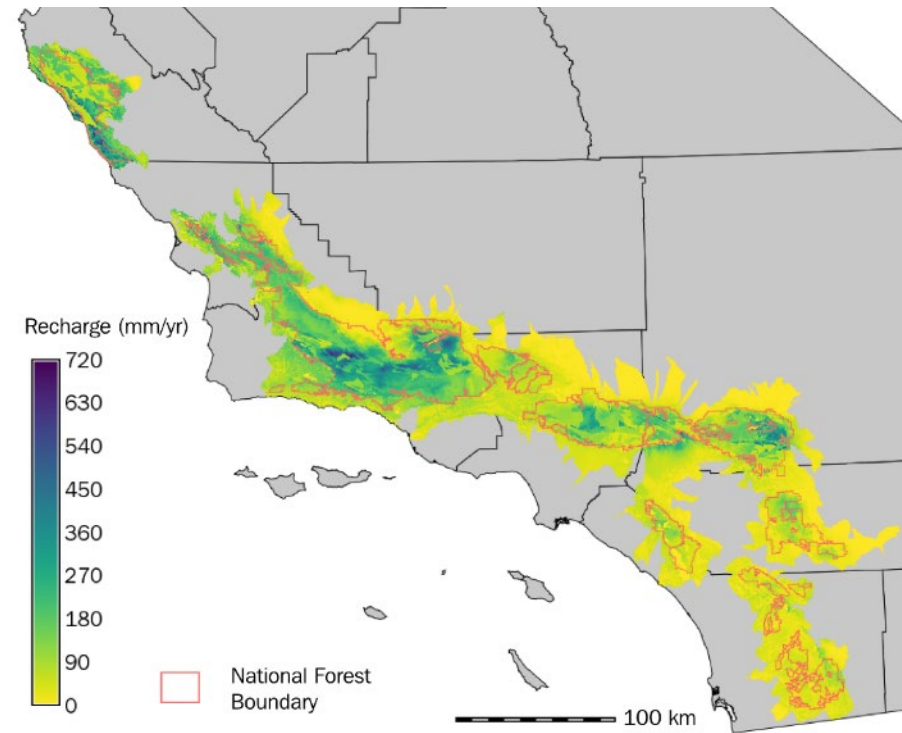
- Water runoff
- Groundwater recharge
- Sediment retention/erosion avoidance
- Carbon storage
- Biodiversity
- Recreation

Water runoff and groundwater recharge

Surface runoff (mm/yr)



Groundwater recharge (mm/yr)



- Basin Characterization Model
- 270 m resolution

Burn severity data

- US Forest Service maps severity on fires >1000 acres on federal lands
- Uses Landsat imagery pre- and post-fire to derive Relative Differenced Normalized Burn Ratio
 - % basal area lost
 - % change in canopy cover

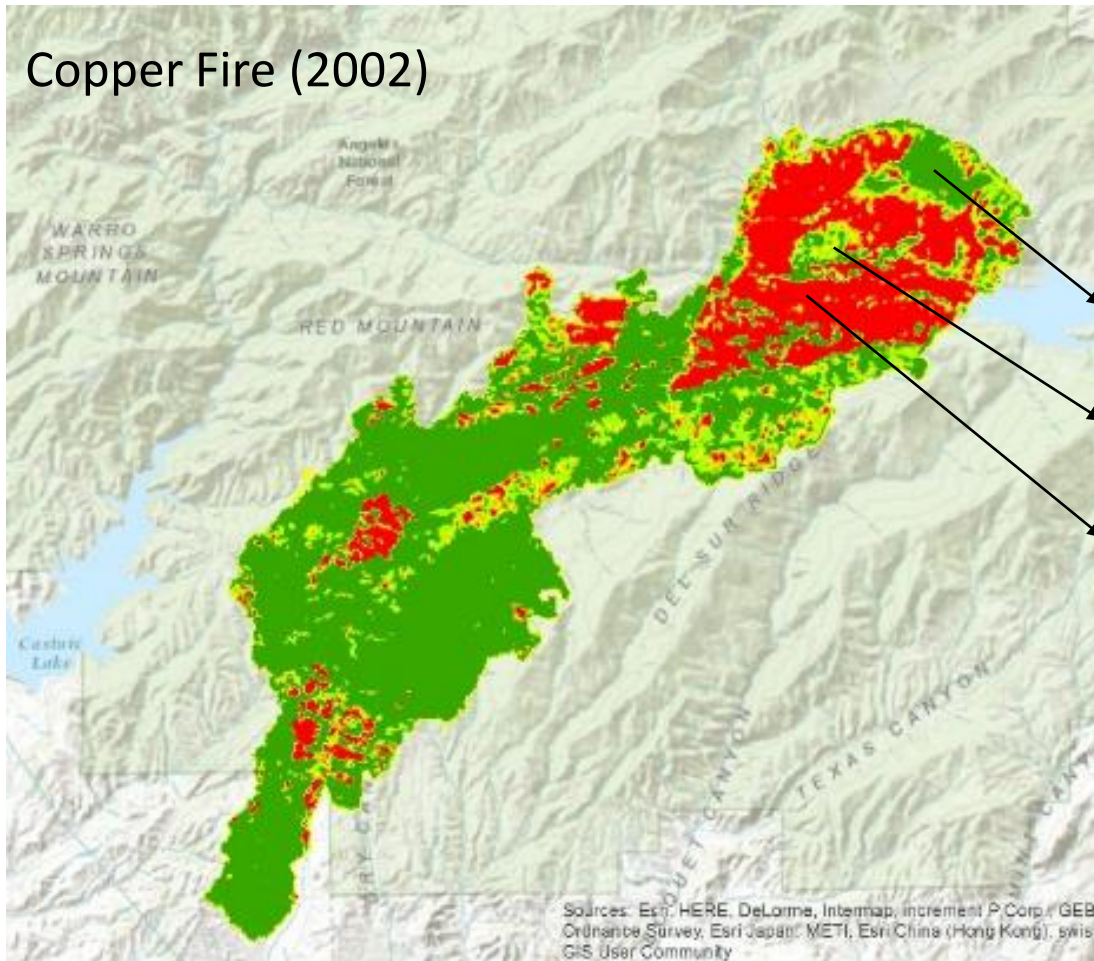


Fire impacts on runoff / recharge

Pre-fire: Use runoff data from year before the fire

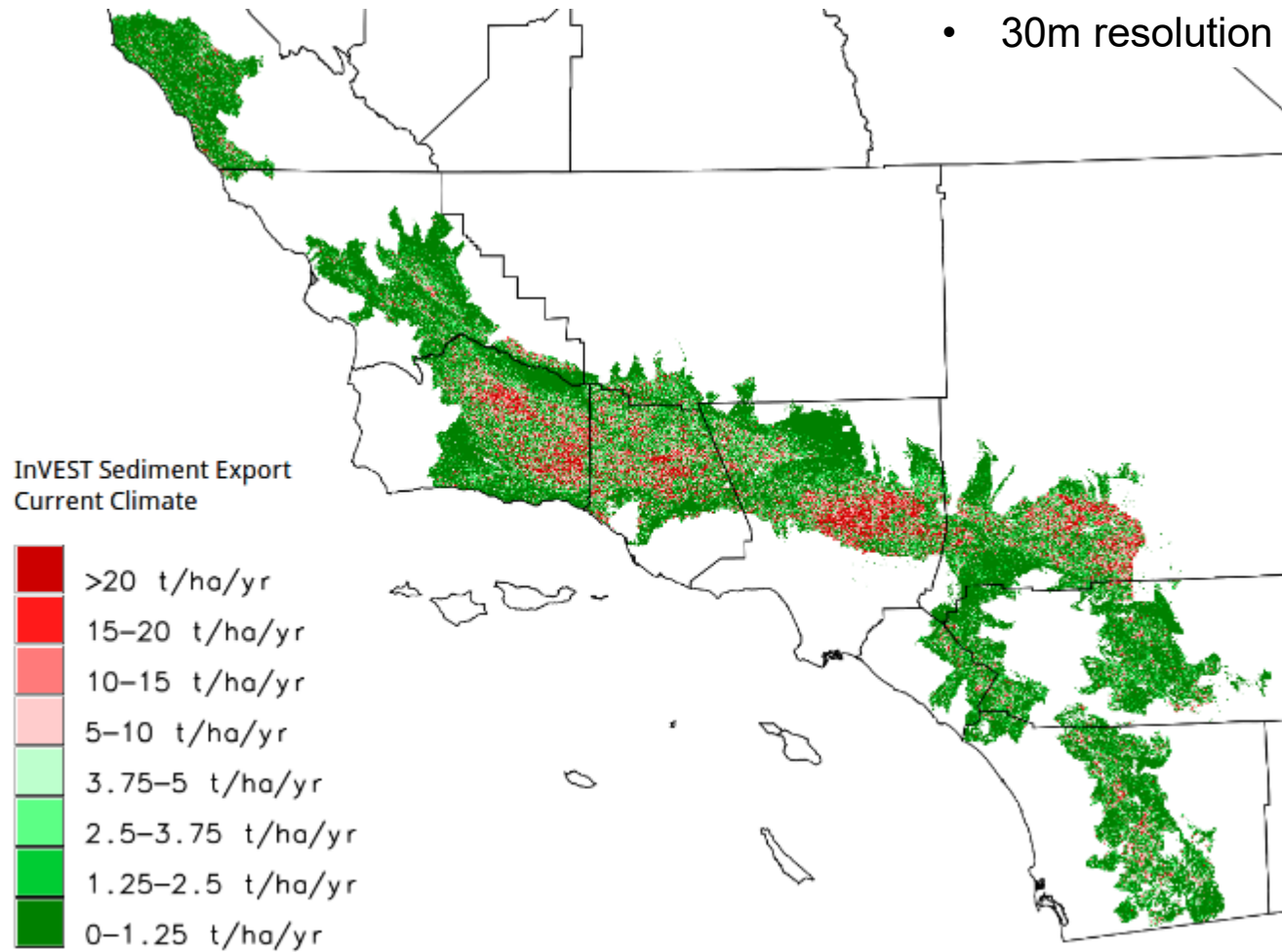
Post-fire: Integrate burn severity data with runoff estimates

Copper Fire (2002)

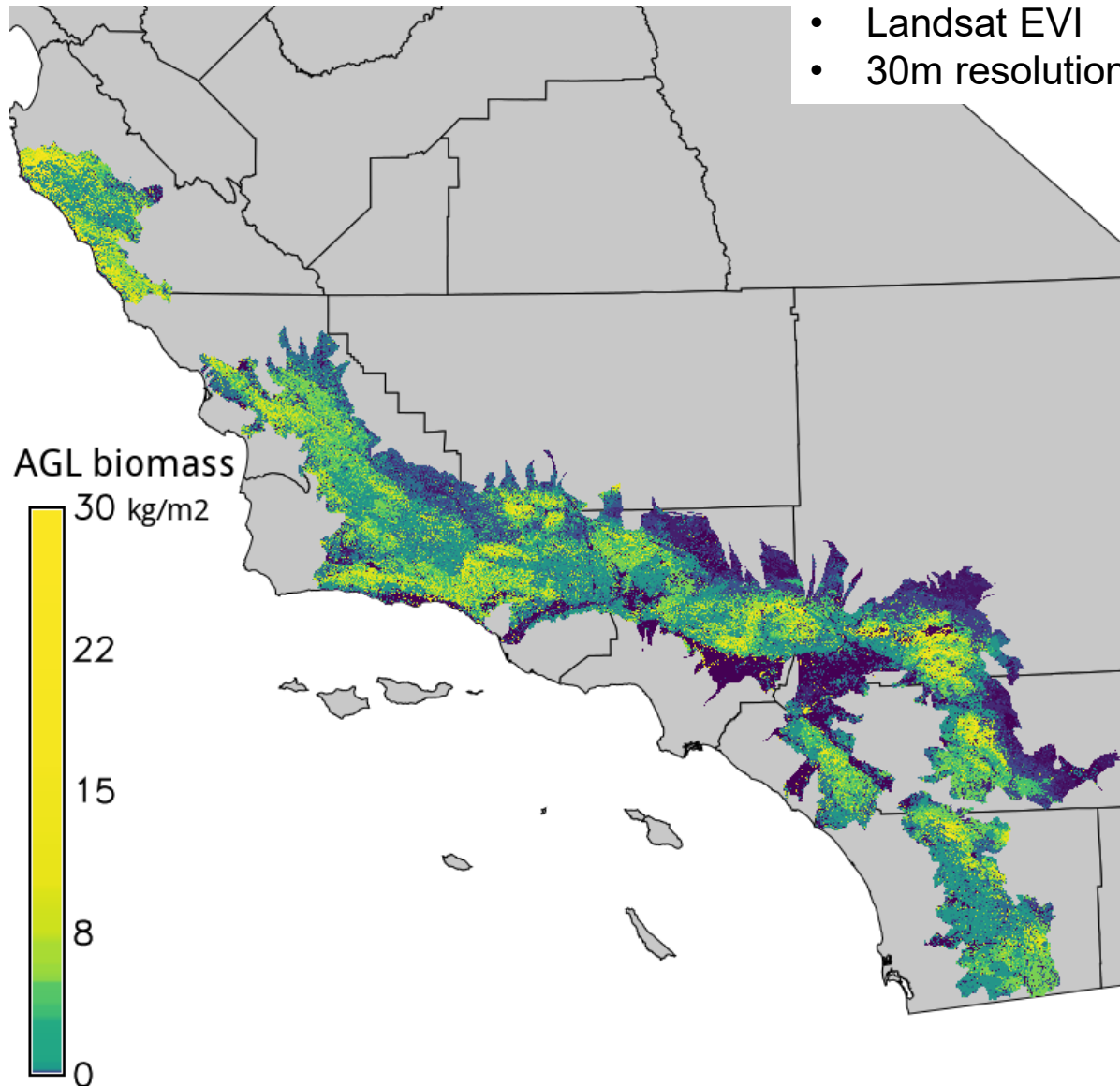


Sediment erosion / erosion avoidance

- InVEST software
- 30m resolution



Aboveground live biomass

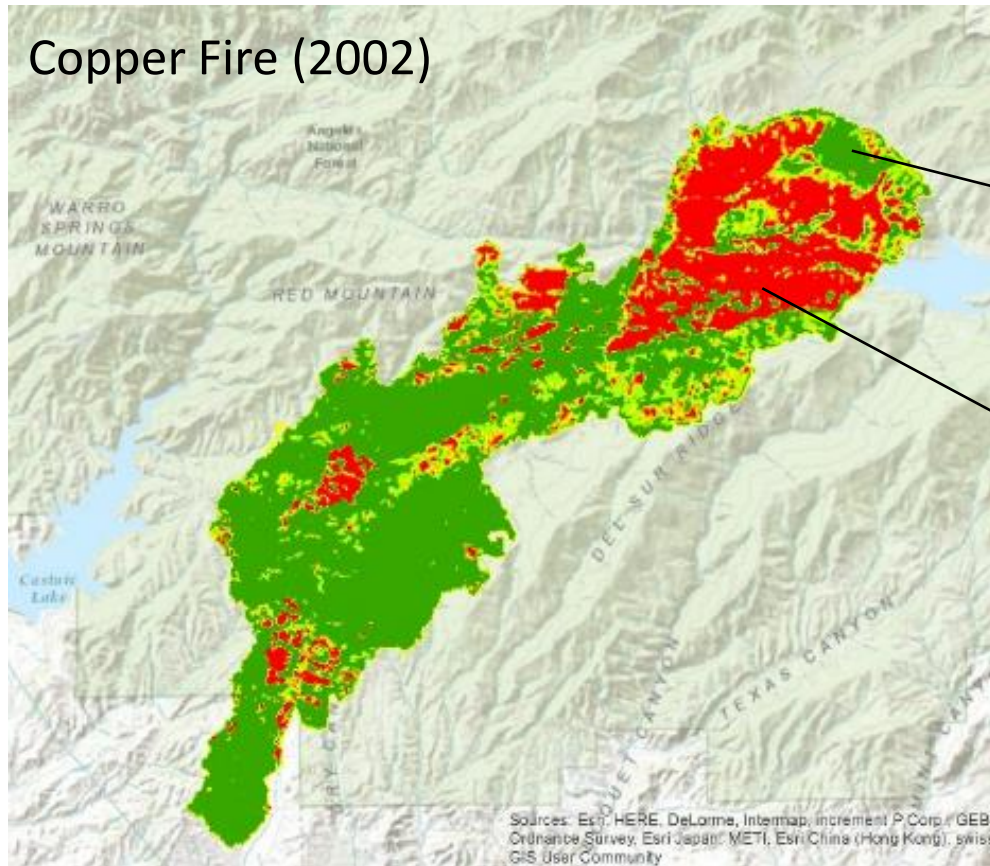


Fire impacts on biomass






Pre-fire: Biomass data from 2001

Post-fire: Integrate burn severity data with biomass

Copper Fire (2002)



Canopy cover loss classes

	0% Change
	0% < Change < 25%
	25% <= Change < 50%
	50% <= Change < 75%
	75% <= Change <= 100%

Decrease biomass by:

0%
20%
40%
60%
80%

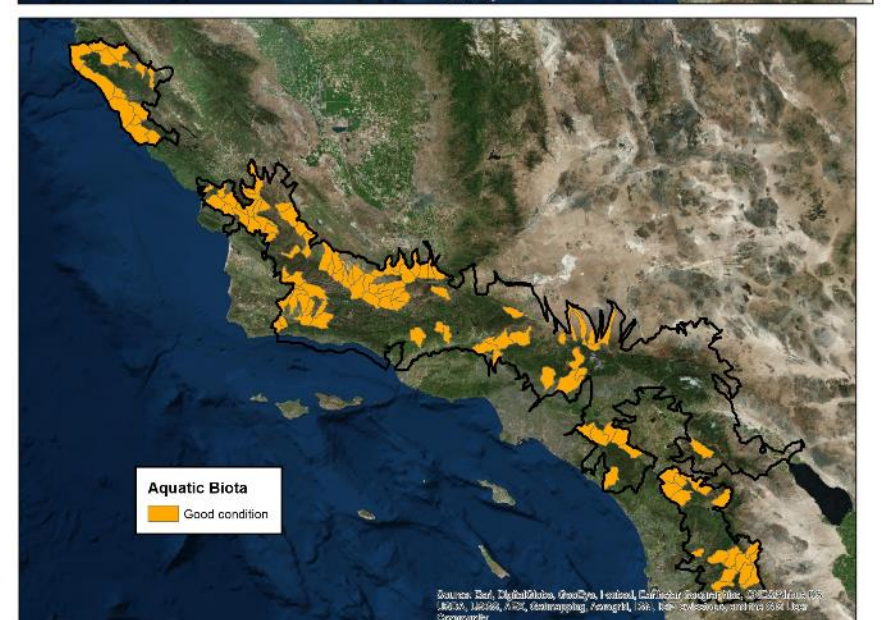
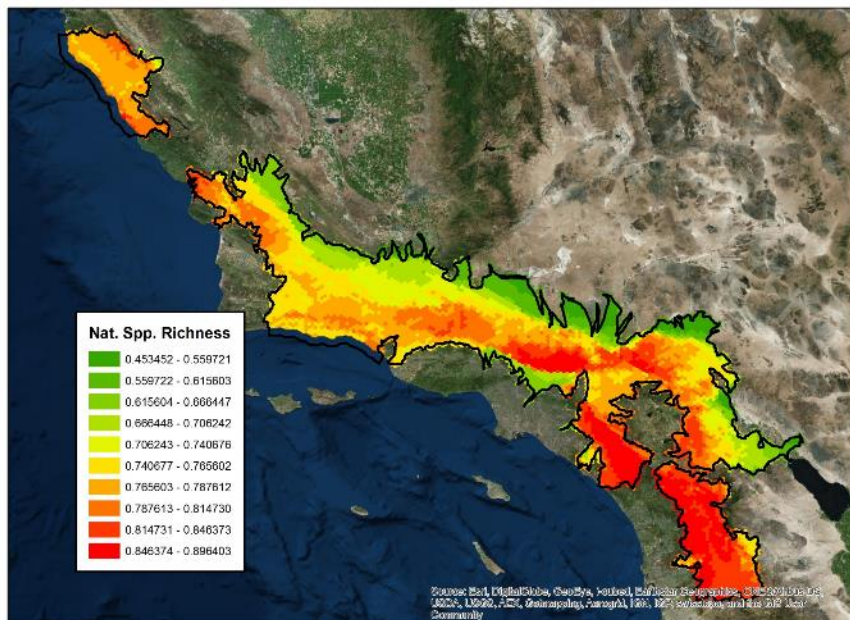
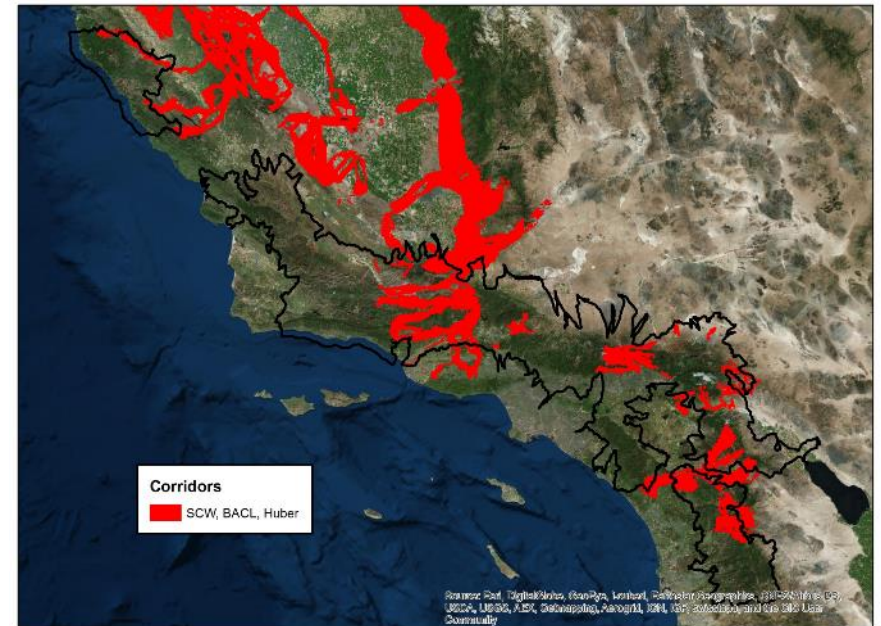
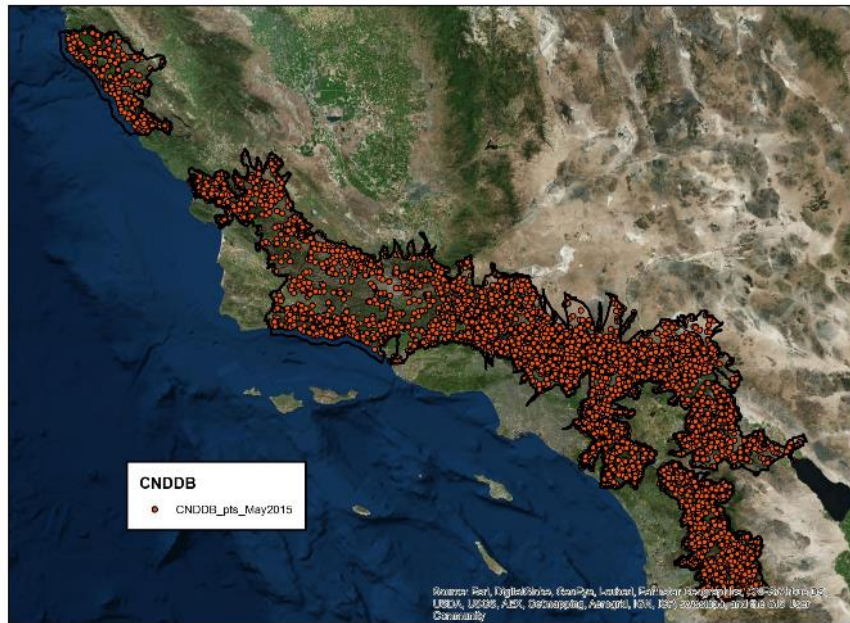
Recreation

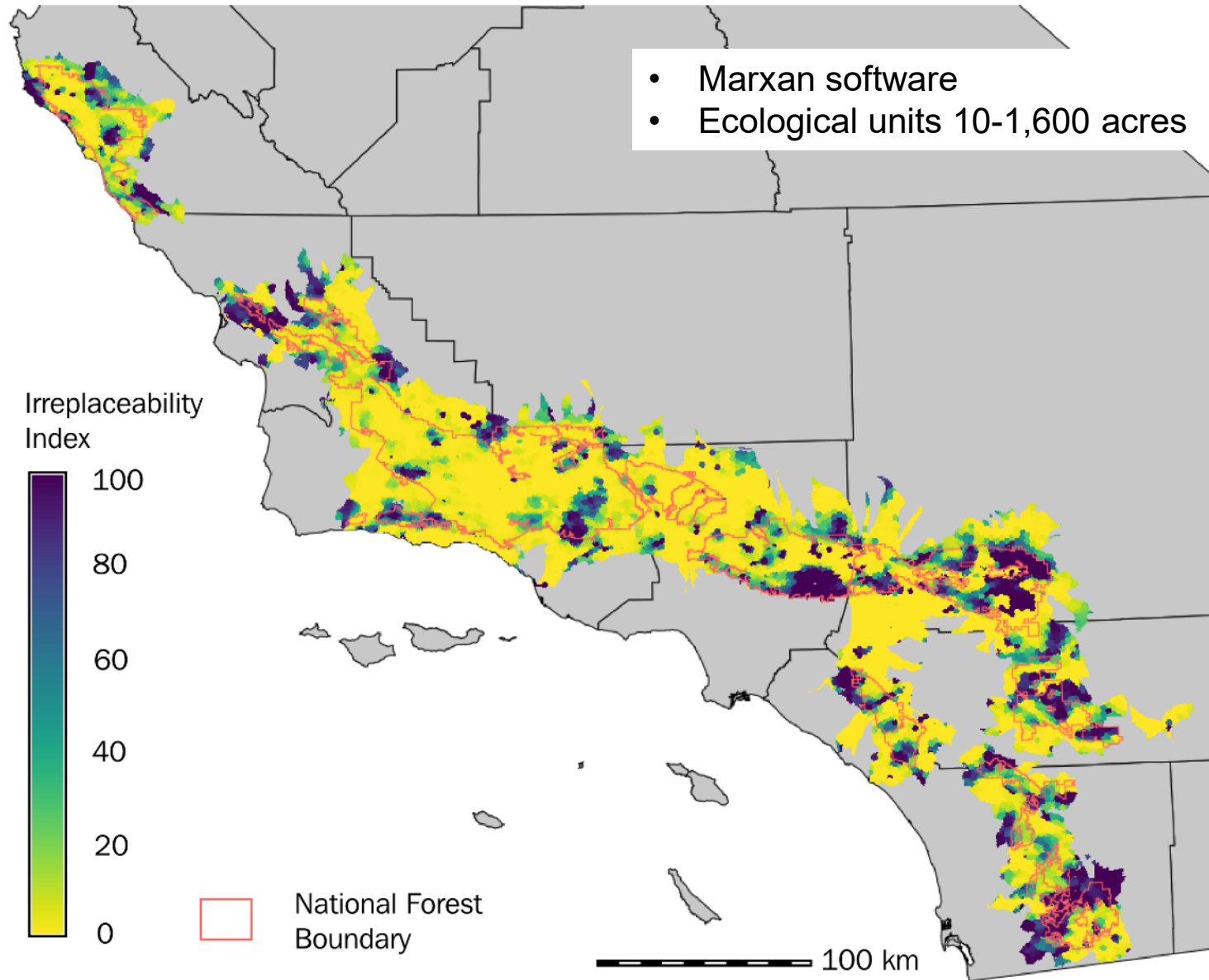
- Assume fire impact is the closure of recreation sites within the fire perimeter
- Use benefits transfer approach based on national study of visitor use
- Calculate per acre value for each national forest



West Fork of the San Gabriel River, Angeles National Forest

Biodiversity

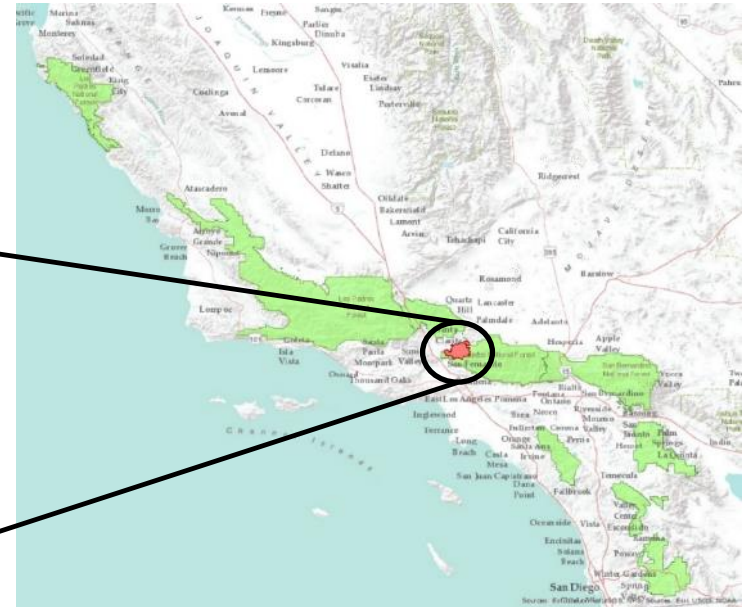
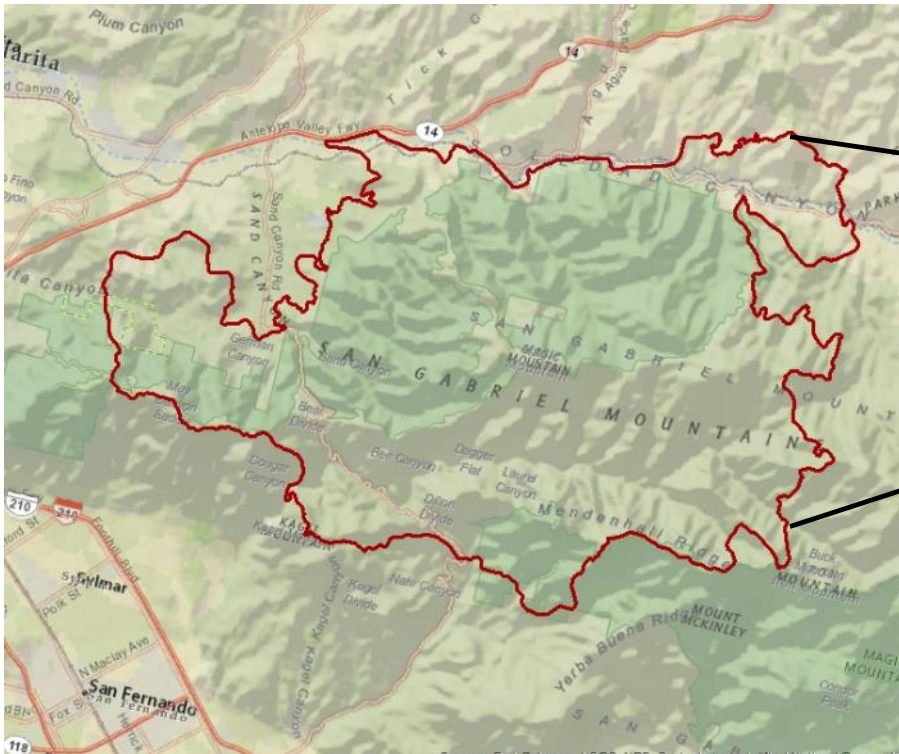




Higher values indicate areas of greater importance for meeting goals for each conservation target

Case study – where to restore post-fire?

Sand Fire (2016) Angeles National Forest

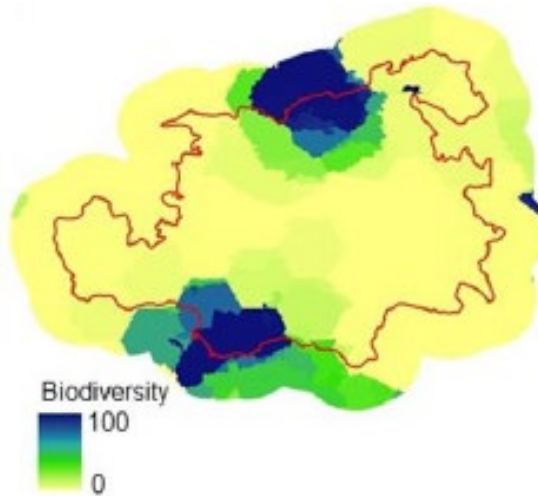
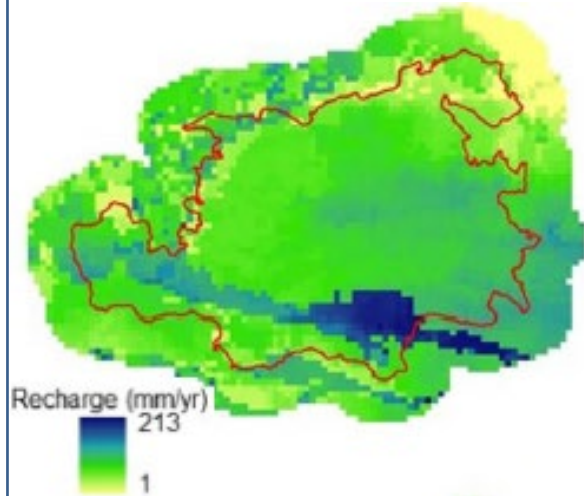


- 51,000 acres
- 80% chaparral
- Many recent fires

Pre-fire patterns of ecosystem services

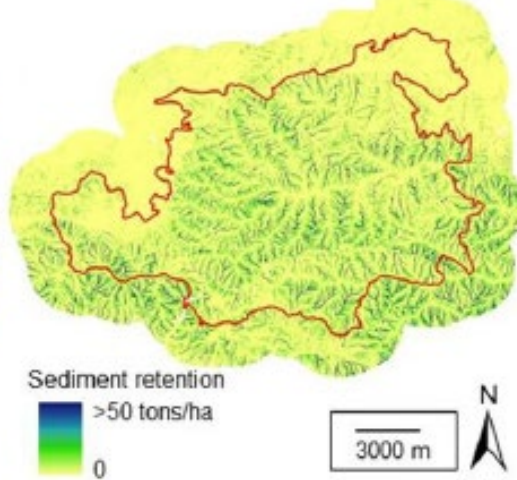
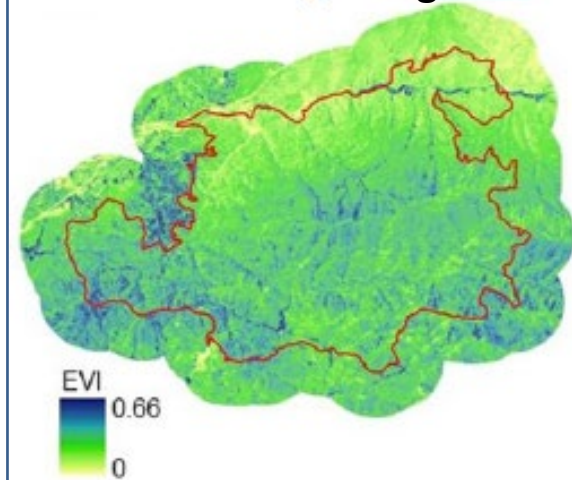
Recharge

Biodiversity

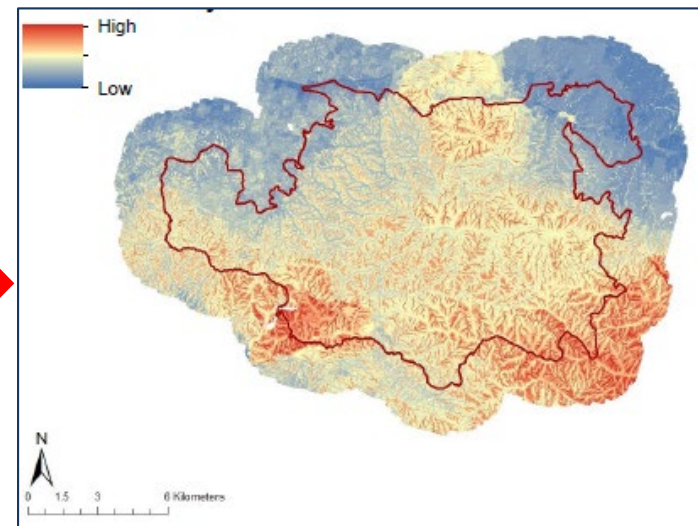


Carbon storage

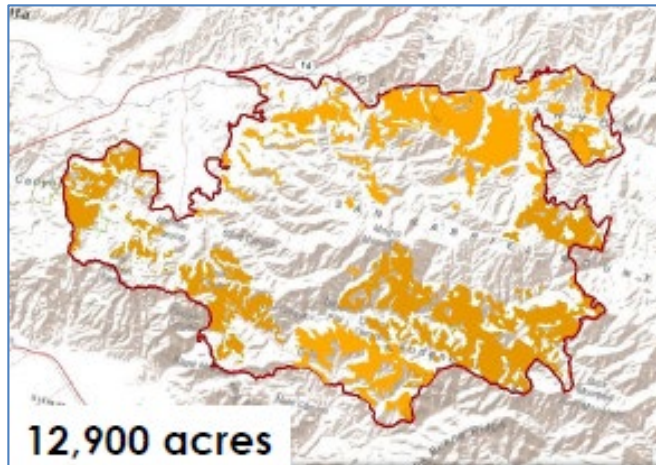
Sediment retention



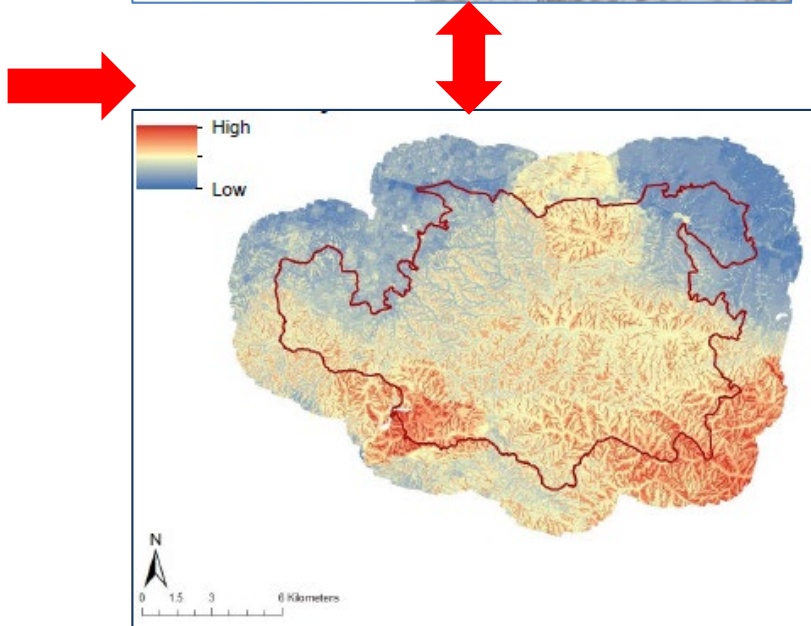
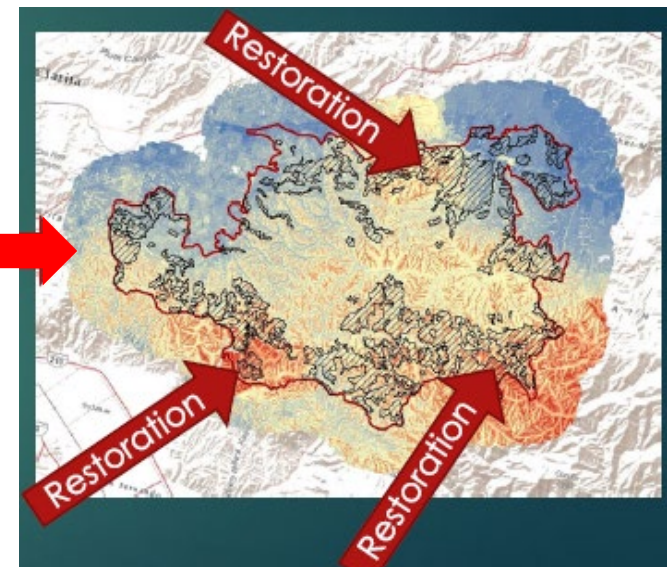
Hotspots of services



Restoration need



Overlay to identify restoration priorities



Identify ecosystem service hotspots

Ecosystem services web mapping tool

- Contribute to revisions of US Forest Service management plans
- Inform environmental damage assessments through change in services pre- v. post-fire

SoCal
EcoServe

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Case Studies


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The Southern California Ecosystem Services Tool (SoCal EcoServe) developed by the USDA Forest Service is a web-based geospatial information tool designed to quantify and report on ecosystem services and the impacts of fire on ecosystem services in the National Forests of southern California - the San Bernardino, Cleveland, Angeles, and Los Padres National Forests.

GET STARTED

SoCal EcoServe

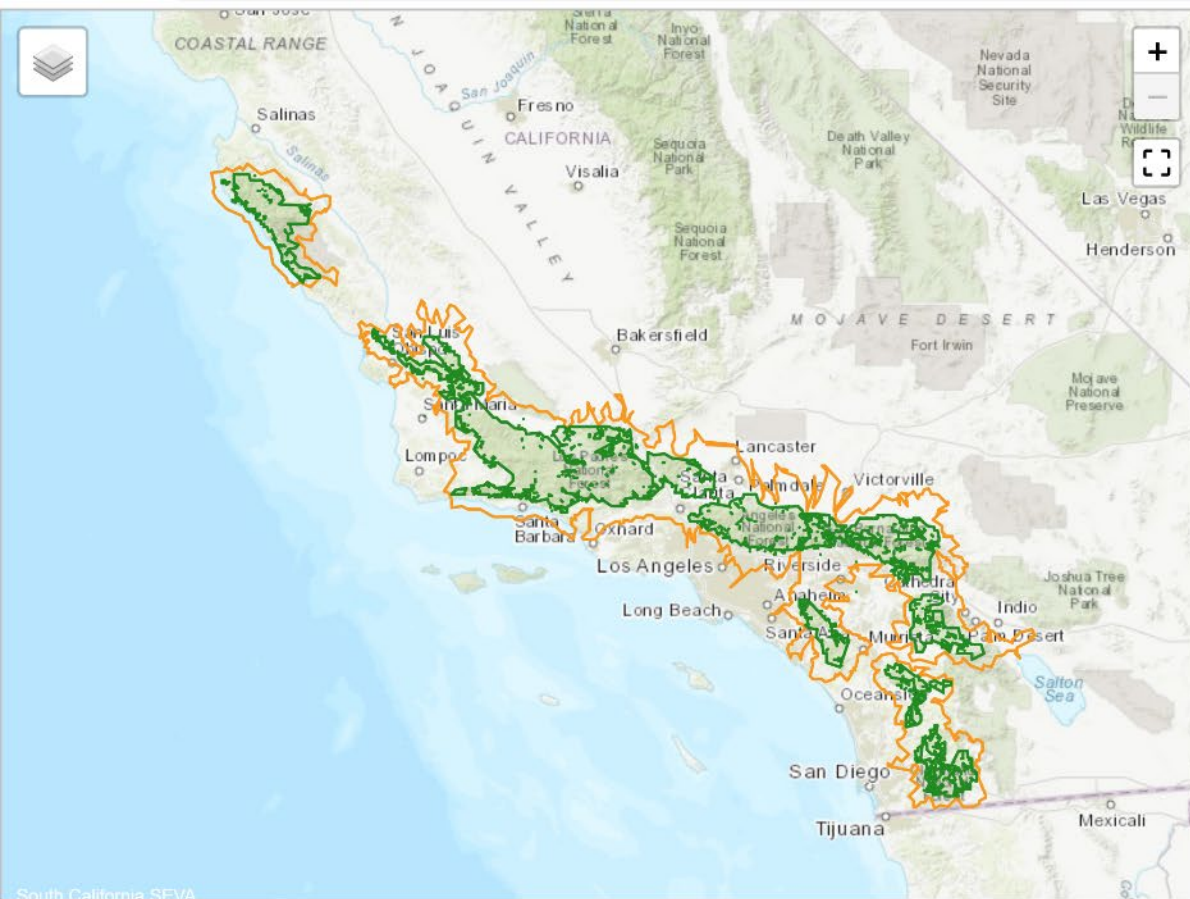
SoCal EcoServe calculates the effects of wildfire on biomass (carbon storage), biodiversity, recreation, and watershed functions such as recharge, runoff and sediment erosion retention. Maps, graphs, and tables are produced for both pre- and post-fire conditions.

[Open SoCal EcoServe »](#)

Users Manual

A tutorial on the functions of SoCal EcoServe. Learn how the tool functions and how you can obtain ecosystem services data on selected wildfires.

[Users Manual »](#)



SoCal EcoServe: Fire Impacts on Ecosystem Services

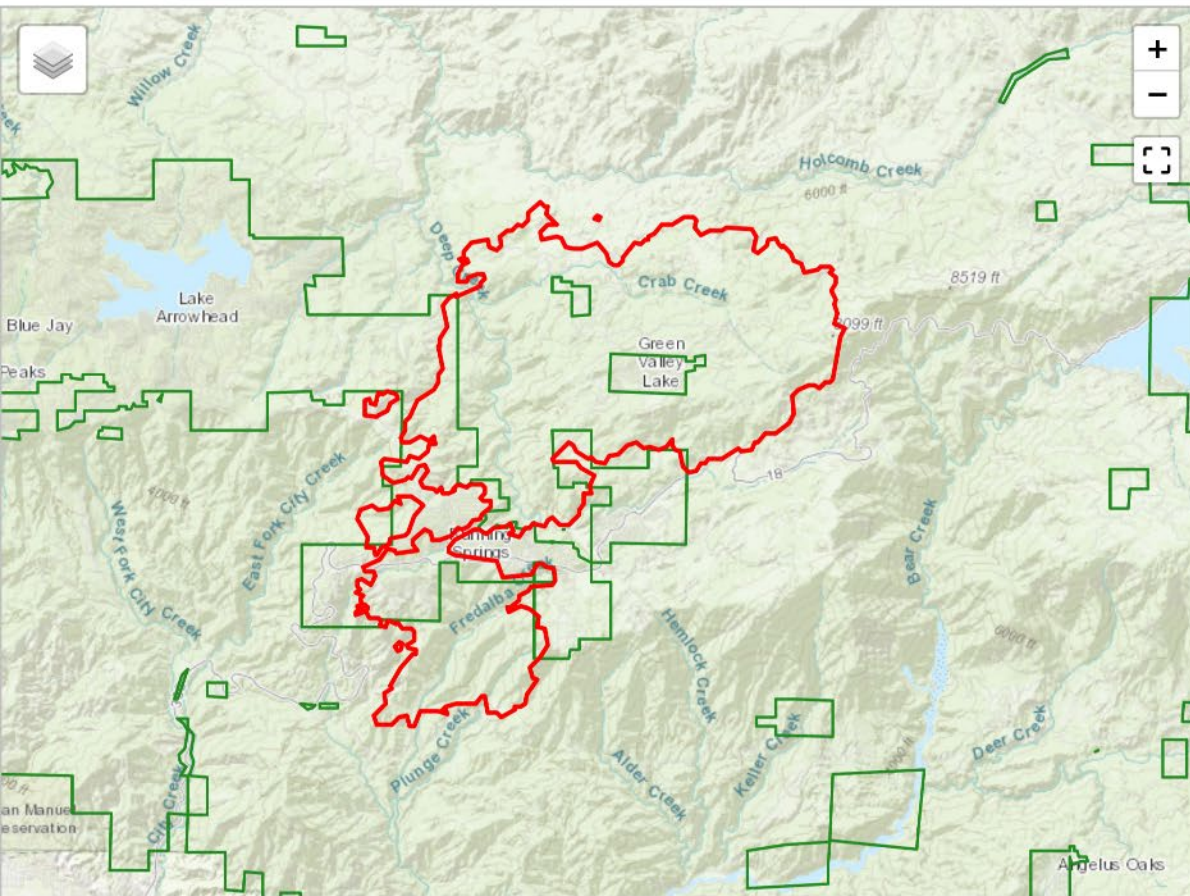
To assess the impacts of fire on ecosystem services in the Angeles, Cleveland, Los Padres, and San Bernardino National Forests and surrounding areas in Southern California [?], first select the year, then select the fire (entire perimeter or USFS portion only), and then select one of six ecosystem services. Pre-fire values correspond to modeled outputs of services that assume 0% canopy cover loss for that year, while the post-fire values report modeled outputs that integrate fire induced canopy cover losses informed by burn severity vegetation data (RAVG) [?]. For more information, see the [SoCal EcoServe](#) home page.

STEP 1: SELECT YEAR [?]

STEP 2: SELECT FIRE

STEP 3: SELECT ECOSYSTEM SERVICE





SoCal EcoServe: Fire Impacts on Ecosystem Services

To assess the impacts of fire on ecosystem services in the Angeles, Cleveland, Los Padres, and San Bernardino National Forests and surrounding areas in Southern California [?], first select the year, then select the fire (entire perimeter or USFS portion only), and then select one of six ecosystem services. Pre-fire values correspond to modeled outputs of services that assume 0% canopy cover loss for that year, while the post-fire values report modeled outputs that integrate fire induced canopy cover losses informed by burn severity vegetation data (RAVG) [?]. For more information, see the [SoCal EcoServe](#) home page.

STEP 1: SELECT YEAR [?]

Biodiversity

Carbon Storage

Groundwater Recharge

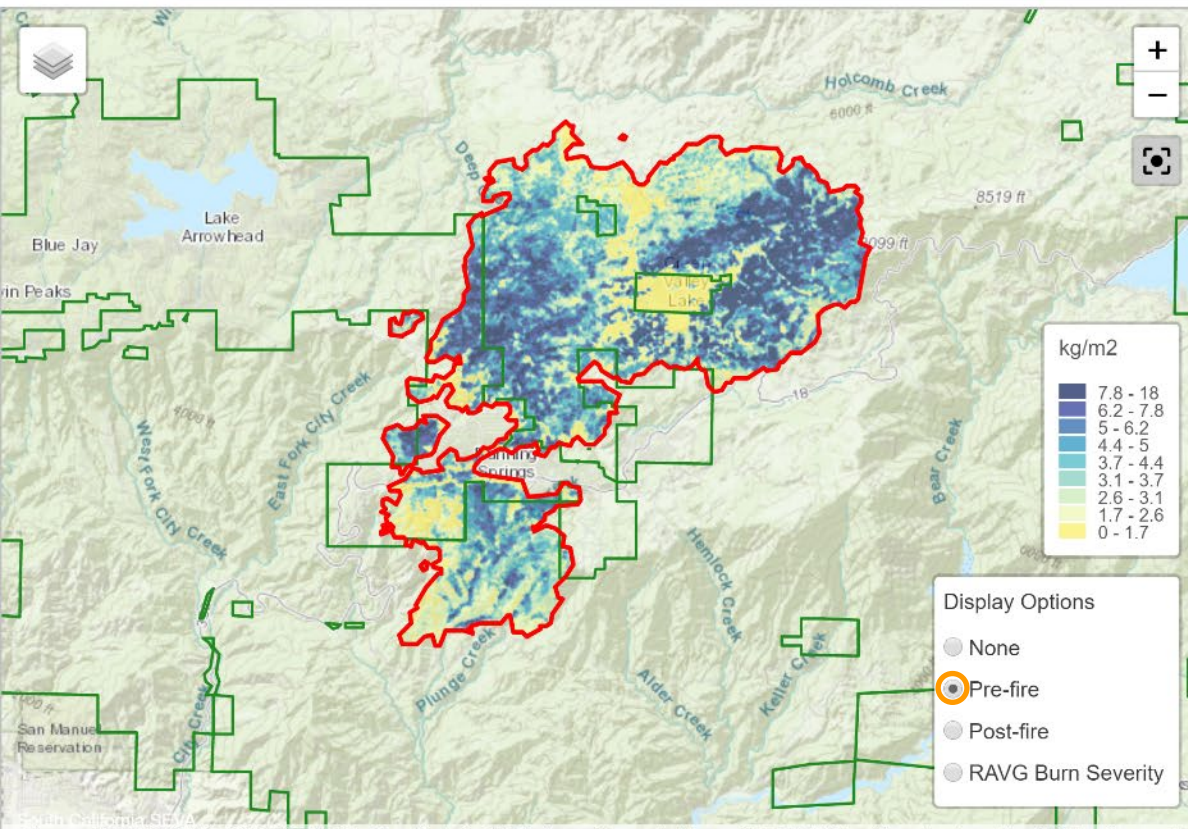
Recreation

Sediment Export

Water Runoff

Select Eco Service... ✕ ▼

Carbon storage



SoCal EcoServe: Fire Impacts on Ecosystem Services

To assess the impacts of fire on ecosystem services in the Angeles, Cleveland, Los Padres, and San Bernardino National Forests and surrounding areas in Southern California [?], first select the year, then select the fire (entire perimeter or USFS portion only), and then select one of six ecosystem services. Pre-fire values correspond to modeled outputs of services that assume 0% canopy cover loss for that year, while the post-fire values report modeled outputs that integrate fire induced canopy cover losses informed by burn severity vegetation data (RAVG) [?]. For more information, see the [SoCal EcoServe](#) home page.

STEP 1: SELECT YEAR [?]

2007

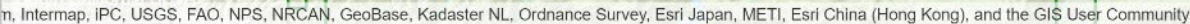
STEP 2: SELECT FIRE

Slide

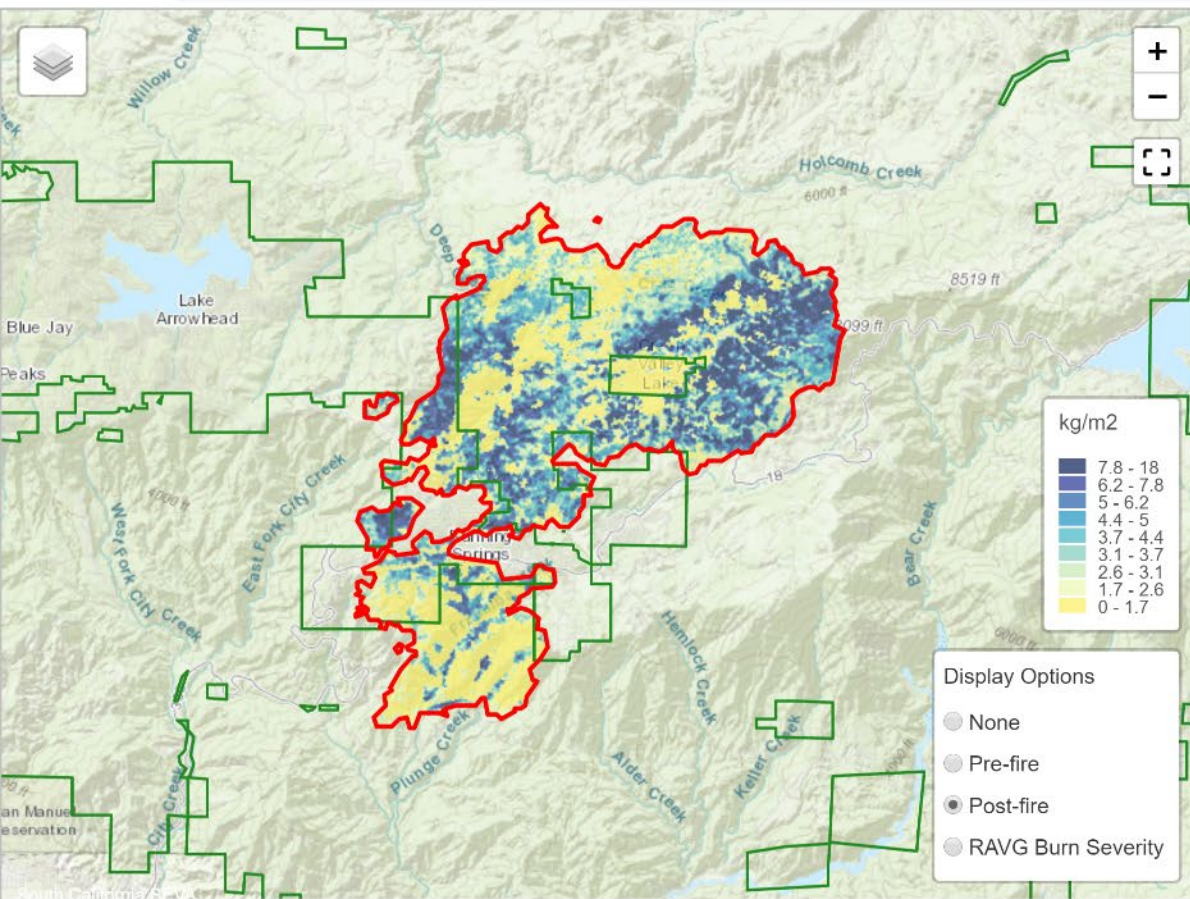
STEP 3: SELECT ECOSYSTEM SERVICE [?]

Carbon Storage

TABLE



TABLE



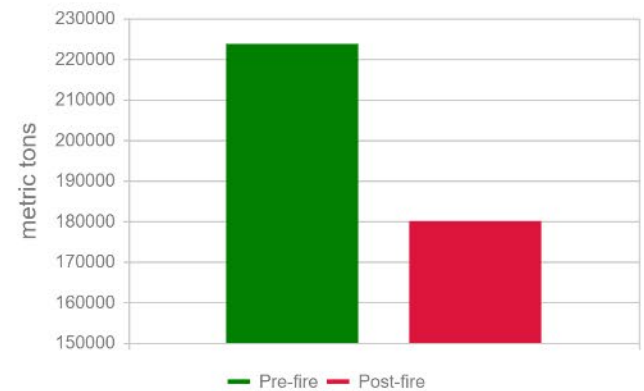
Slide

STEP 3: SELECT ECOSYSTEM SERVICE ?

Carbon Storage

GRAPH

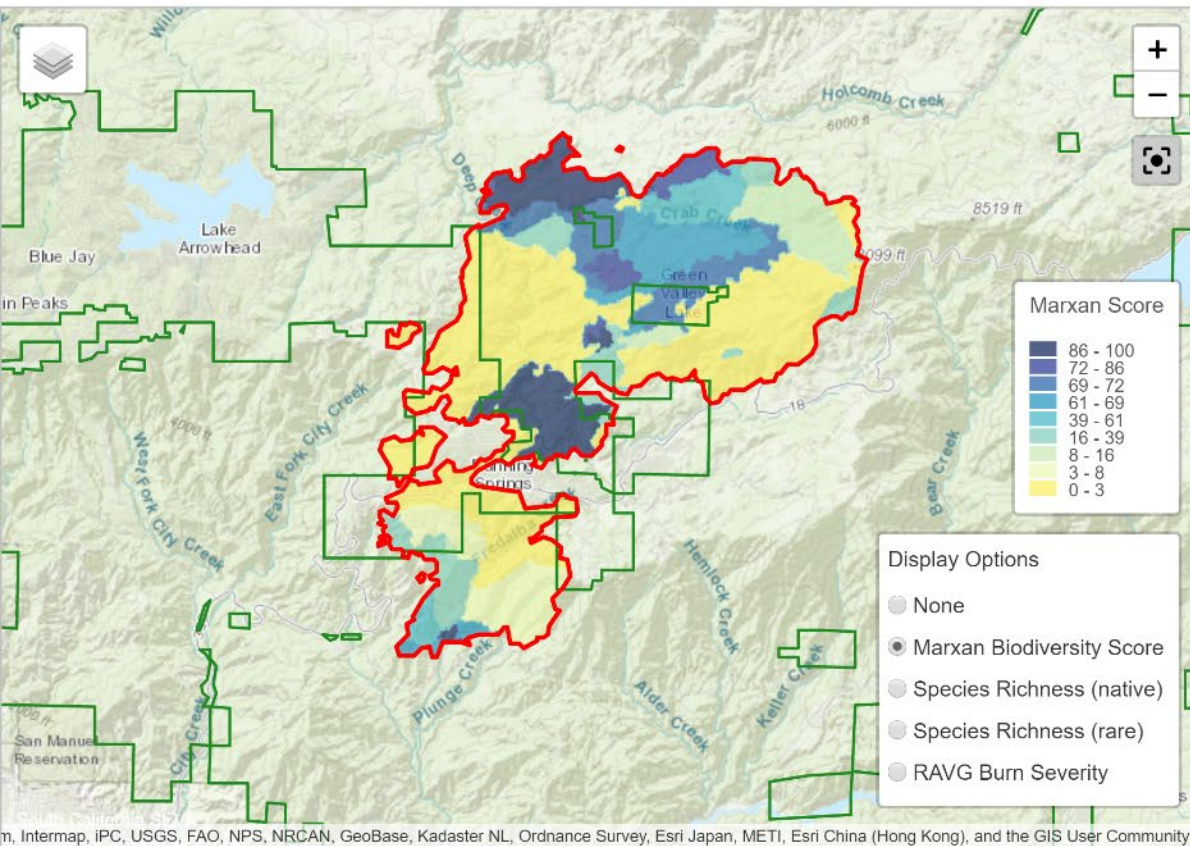
Carbon Storage
Slide Fire
Start Date: 10/22/2007



* Pre-fire data is for the year of the fire, or the previous year if the fire started in May or earlier.

Download data: [Table](#) [Chart](#) [Spatial Data](#) [Map](#)

Biodiversity



Biodiversity (Independent of Fire Effects)	Fire Perimeter	San Bernardino NF	Angeles NF	Los Padres NF	Cleveland NF
Acres (x1000 for NF)	12,769	663	659	1774	659
Percent of fire area in each NF	NA	81	0	0	0
Mean Marxan Biodiversity	28.23	45.27	25.58	14.95	38.05
Percent Low Marxan Biodiversity	67.4	55.91	76.81	87.89	66.14
Percent Moderate Marxan Biodiversity	20.06	6.76	4.78	3.76	6.01
Percent High Marxan Biodiversity	12.55	37.33	18.40	8.35	27.85
Native species richness (mean)	0.8	0.78	0.79	0.76	0.85
Rare species richness (mean)	0.15	0.15	0.16	0.10	0.20
Percent area with high value aquatic biota	0	3.93	17.4	36.4	47.6
Percent area with linkage zone	0	18.7	9.1	13.1	4.1
Number of rare plant species	9	112	48	82	74
Number of rare bird	0	0	0	0	0

Integrate monetized value of services

- **Carbon:** social cost of carbon
- **Recreation:** per acre value for each national forest
- **Water:** water treatment rates (TBD)
- **Sediment erosion:** cost of clearing debris basins



Next steps

- Explore Landsat EVI and field plots to assess aboveground biomass recovery
- Understand carbon dynamics during and after wildfire
- Conduct field work to measure removed shrubs (seeders versus resprouters)
- Model wildfire risk under future climates

Partners and collaborators

Funding

- USDA Forest Service Pacific Southwest Region
- USDA Forest Service WWETAC
- California Landscape Conservation Cooperative
- California Department of Forestry and Fire Protection

Research

- *UC Davis*: Emma Underwood, Allan Hollander, Patrick Huber, Lorie Srivastava
- *USFS*: Hugh Safford, Nicole Molinari, Charlie Schrader
- *USGS*: Lorrie Flint, Alan Flint
- *Michigan State University*: Cloe Garnache, Frank Lupi

