Future forest health concerns for Southern California

Susan Frankel,
USDA Forest Service,
Pacific Southwest Research Station,
Albany, CA, sfrankel@fs.fed.us

Photos: Downtown Pasadena.com; Californiachapparal.org

Outline

What is shaping change in Southern CA forests?

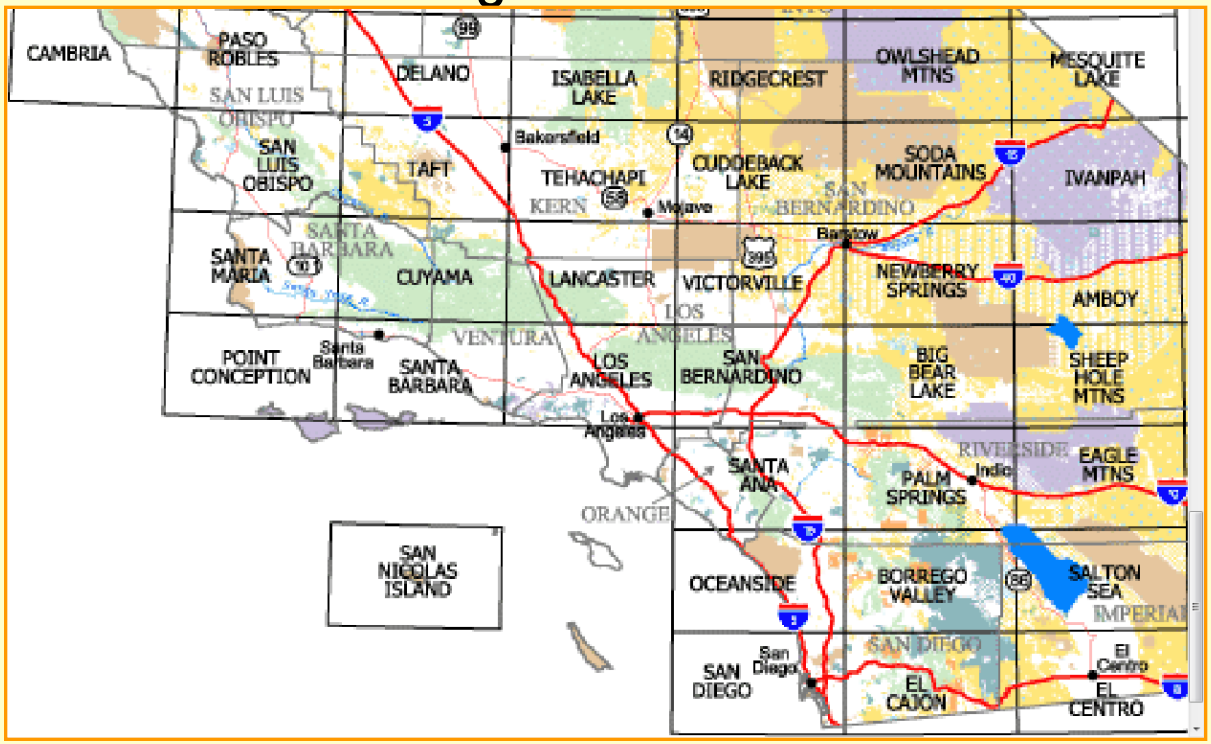
What will Southern CA forests contain in 2114?

Current and future concerns???

- Climate Change
- Drought
- Fire
- Laurel wilt
- Insects from Mexico?
- Lack of resources to care for land; politics

Photo: Torrey Pines State Reserve

Southern CA Bioregion



Photos: Californiachaparral.org

Threats

Drought

Fire

Water Diversion

Development. Urban encroachment.

Recreation over use. Off-road vehicles. Tourism. Recreational shooting areas. Drug manufacturing.

Grazing

Oil and gas drilling. Mining

Poor vegetation management

Air pollution

Lack of care for species valued by tribes

Photos: Los Padres Forest Watch, Popular Mechanics

Threatened and Endangered Species

- 76 federally listed threatened & endangered species in the 4 Southern CA National Forests.

- 405 at-risk species

San Joaquin kit fox, Smith's blue butterfly,
California spotted owl, bald eagle,
California red-legged frog,
arroyo toad,
California jewelflower, California gnatcatcher,
California condor, ash-gray Indian paintbrush,
bird-footed checkerbloom, steelhead trout,
Santa Ana sucker and many more

Photos: Los Padres Forest Watch, Chris Brown - USGS

Southern CA – 2014 Aerial Survey

Cleveland NF: Drought effects on CA black oak

Angeles NF: Coulter pine plantations with Ips

San Bernardino NF: Jeffrey pine killed by CA fivespined Ips. These trees are located in Idyllwild.

Angeles NF: Coulter pine killed by CA fivespined Ips

Photos: USFS Forest Health Protection

Laurel Wilt – Threat to California Bay Laurel

Redbay ambrosia beetle,
Xyleborus glabratus

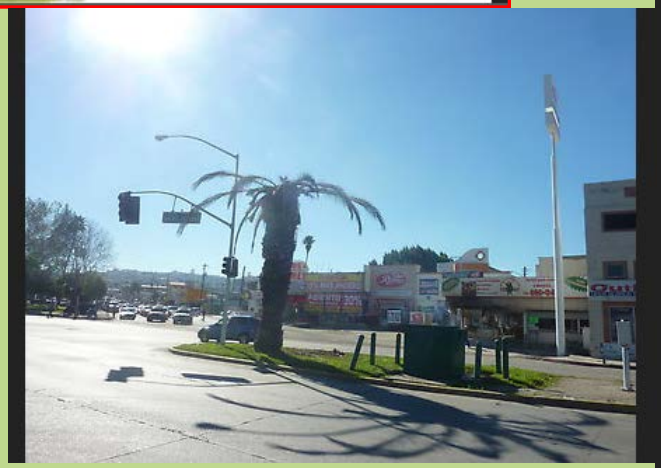
Raffaelea lauricola – a fungus

Credit: UC Riveride, Center for Invasive Species Research

1.Red Palm Weevil, *Rhynchophorus ferrugineus*
2.South American Palm Weevil, *Rhynchophorus palmarum*

Laguna Beach (Orange Co.) 2010

San Ysidro (San Diego Co.) 2011



Mexican pine beetle,
Dendroctonus mexicanus

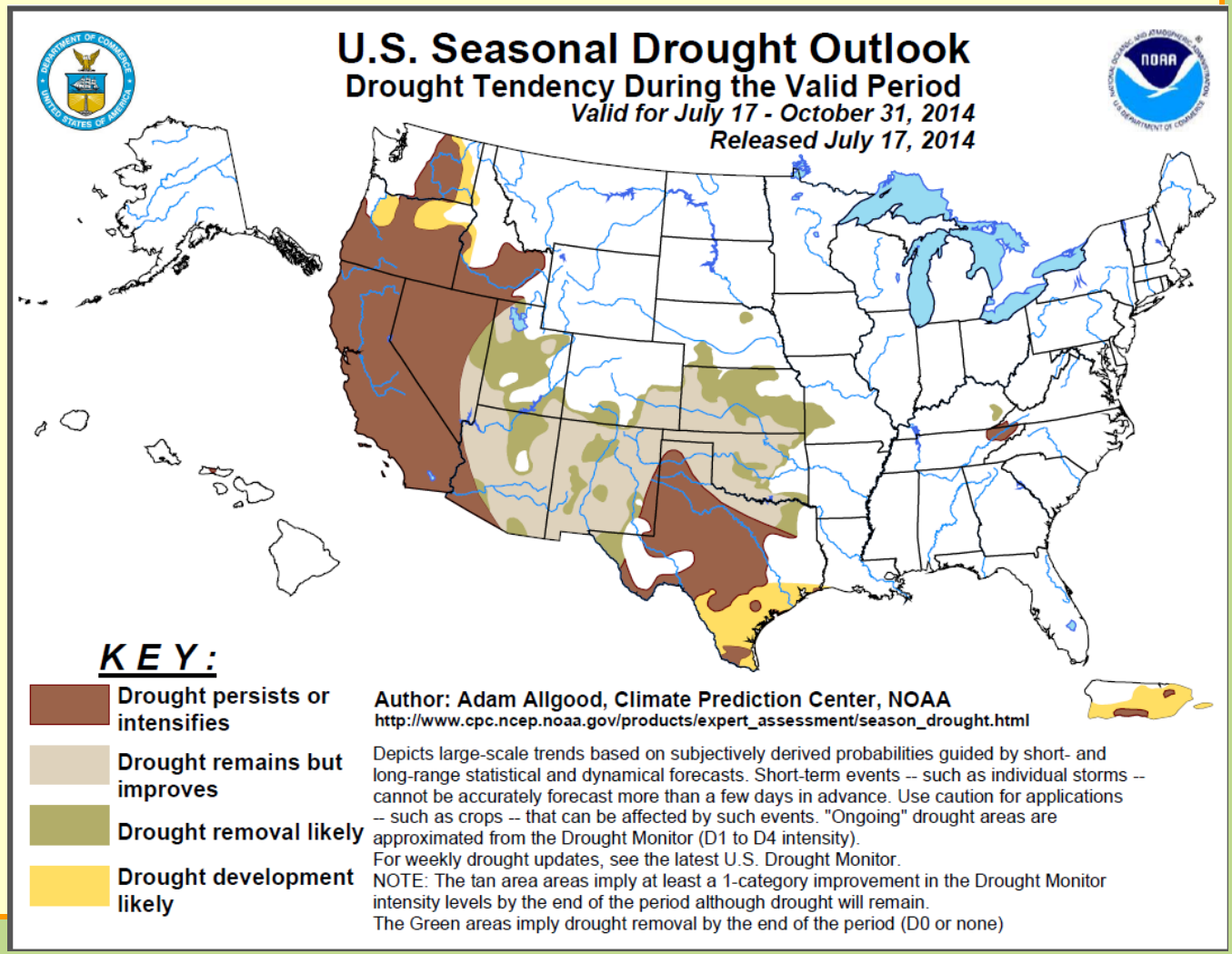
Credit: UC Riverside; Center for Invasive species Research

Climate & Climate Change

- 2014 is warmest year in 120 years of recordkeeping.
- CA's average temperature has been 4.6°F above average. That smashes the previous record by 1.4°F.

Los Angeles currently sees 23 days above 90°F. Increases to 41 days by 2050.

Climate Central.org



Sea Level Rise

- 6 inches within 20 years, and 3 feet or more by the end of the century
- Loss of approximately 23% of freshwater marshes (by 2100)
- A slight gain of salt marshes because freshwater marshes and swamplands convert to salt marshes when inundated.
- Beaches?

Credit: San Diego Coast Keeper, Newport – D. Ramey-Logan

Fire! Drought stress! Lack of water!

New Mexico News and Views

Photo Credit: CBS News

Southern CA Ecosystems – Fire and Climate Change

- Fire is an essential ecosystem process in many southwestern forests.
- Fire prone forests are likely to become more flammable with climate change.
- Restoring fire may facilitate climate change adaptation.

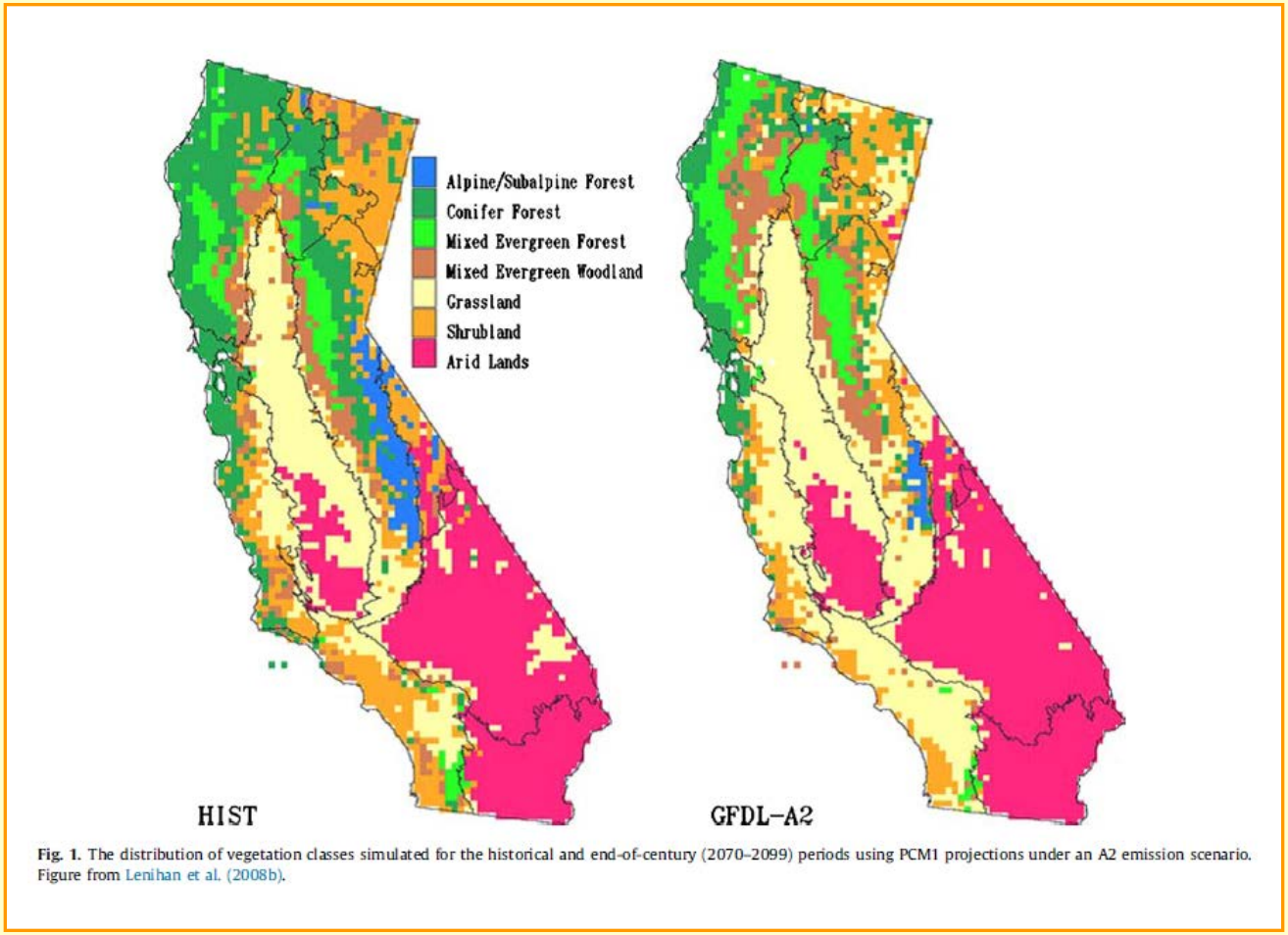


Fig. 1. The distribution of vegetation classes simulated for the historical and end-of-century (2070–2099) periods using PCM1 projections under an A2 emission scenario. Figure from Lenihan et al. (2008b).

MD Hurteau, JB Bradford, PZ Fulé, AH Taylor, KL Martin. 2014. Climate change, fire management, and ecological services in the southwestern US. Forest Ecology and Management. 327 (2014) 280–289

In 1980 the largest wildfire was about 50,000 acres over 3 weeks of burning. Now we're seeing 40,000, 50,000, 60,000 acres burned in a day. – Tom Swetnam, Univ. Of Arizona

Top 20 Largest California Wildfires

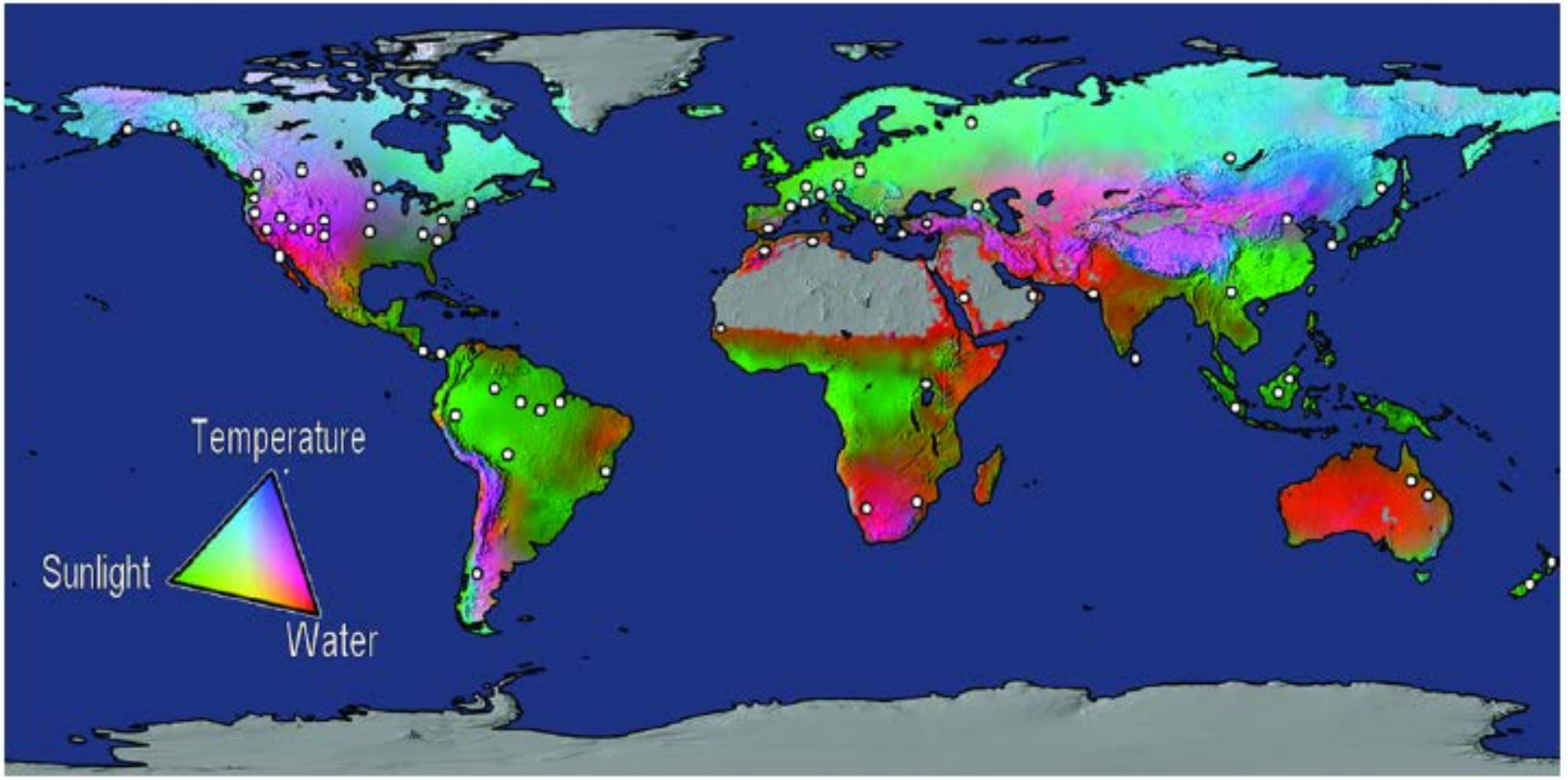
	FIRE NAME/CAUSE	DATE	COUNTY	*ACRES*	STRUCTURES	DEATHS
1	CEDAR *(HUMAN RELATED)*	October 2003	SAN DIEGO	273,246	2,820	14
2	RUSH (*LIGHTNING*)	August 2012	LASSEN	271,911 CA / 43,666 NV	0	0
3	RIM (HUMAN RELATED)	August 2013	TUOLUMNE	257,314	112	0
4	ZACA (HUMAN RELATED)	July 2007	SANTA BARBARA	240,207	1	0
5	MATILIJA (UNDETERMINED)	September 1932	VENTURA	220,000	0	0
6	WITCH (POWERLINES)	October 2007	SAN DIEGO	197,990	1,650	2
7	KLAMATH THEATER COMPLEX (LIGHTNING)	June 2008	SISKIYOU	192,038	0	2
8	MARBLE CONE (LIGHTNING)	July 1977	MONTEREY	177,866	0	0
9	LAGUNA (POWERLINES)	September 1970	SAN DIEGO	175,425	382	5
10	BASIN COMPLEX (LIGHTNING)	June 2008	MONTEREY	162,818	58	0
11	DAY FIRE (HUMAN RELATED)	September 2006	VENTURA	162,702	11	0
12	STATION FIRE (HUMAN RELATED)	August 2009	LOS ANGELES	160,557	209	2
13	McNALLY (HUMAN RELATED)	July 2002	TULARE	150,696	17	0
14	STANISLAUS COMPLEX (LIGHTNING)	August 1987	TUOLUMNE	145,980	28	1
15	BIG BAR COMPLEX (LIGHTNING)	August 1999	TRINITY	140,948	0	0
16	CAMPBELL COMPLEX (POWERLINES)	August 1990	TEHAMA	125,892	27	0
17	WHEELER (ARSON)	July 1985	VENTURA	118,000	26	0
18	SIMI (UNDER INVESTIGATION)	October 2003	VENTURA	108,204	300	0
19	HWY. 58 (VEHICLE)	August 1996	SAN LUIS OBISPO	106,668	13	0
20	IRON ALPS COMPLEX (LIGHTNING)	June 2008	TRINITY	105,805	2	10

There is no doubt that there were fires with significant acreage loss in years prior to 1932, but those records are less reliable, and this list is meant to give an overview of the large acreage-loss fires in more recent times. (Also note that this list does not include fire jurisdiction. These are the top 20 within the state, regardless of whether they were state, federal, or local responsibility.)

CAL FIRE

10/25/2013

Locations of increased forest mortality due to drought & high temperatures



C. D. Allen et al. 2010. A global overview of drought and heat-induced tree mortality reveals emerging climate change risks for forests. For. Ecol. Manage. 259: 660–684.

Which areas & which trees will die?

Soil depth and quality is key

LETTER

doi:10.1038/nature11688

Global convergence in the vulnerability of forests to drought

Brendan Choat[1]*, Steven Jansen[2]*, Tim J. Brodribb[3], Hervé Cochard[4,5], Sylvain Delzon[6], Radika Bhaskar[7], Sandra J. Bucci[8], Taylor S. Feild[9], Sean M. Gleason[10], Uwe G. Hacke[11], Anna L. Jacobsen[12], Frederic Lens[13], Hafiz Maherali[14], Jordi Martínez-Vilalta[15,16], Stefan Mayr[17], Maurizio Mencuccini[18,19], Patrick J. Mitchell[20], Andrea Nardini[21], Jarmila Pittermann[22], R. Brandon Pratt[12], John S. Sperry[23], Mark Westoby[10], Ian J. Wright[10] & Amy E. Zanne[24,25]

ARTICLES
PUBLISHED ONLINE: 30 SEPTEMBER 2012 | DOI: 10.1038/NCLIMATE1693
nature climate change

Temperature as a potent driver of regional forest drought stress and tree mortality

A. Park Williams[1]*, Craig D. Allen[2], Alison K. Macalady[3,4], Daniel Griffin[3,4], Connie A. Woodhouse[3,4], David M. Meko[4], Thomas W. Swetnam[4], Sara A. Rauscher[5], Richard [illegible], Henri D. Grissino-Mayer[7], Jeffrey S. Dean[4], Edward R. Cook[6], Chand[illegible], Michael Cai[8] and Nate G. McDowell[1]

Review
Cell PRESS

The interdependence of mechanisms underlying climate-driven vegetation mortality

Nate G. McDowell[1], David J. Beerling[2], David D. Breshears[3], Rosie A. Fisher[4], Kenneth F. Raffa[5] and Mark Stitt[6]

[1] Los Alamos National Laboratory, Los Alamos, NM, USA
[2] Department of Animal and Plant Sciences, University of Sheffield, Sheffield, UK
[3] School of Natural Resources and the Environment, and Department of Ecology and Evolutionary Biology, University of Arizona, Tucson, AZ, USA
[4] National Center for Atmospheric Research, Boulder, CO, USA
[5] Department of Entomology, University of Wisconsin, Madison WI, USA
[6] Max Planck Institute for Molecular Plant Physiology, Potsdam, Germany

Carbon. Beetles cause forest to go from sink to source.

nature International weekly journal of science

Letter

Nature **452**, 987-990 (24 April 2008) | doi:10.1038/nature06777; Received 9 December 2007; Accepted 29 January 2008

Mountain pine beetle and forest carbon feedback to climate change

W. A. Kurz[1], C. C. Dymond[1], G. Stinson[1], G. J. Rampley[1], E. T. Neilson[1], A. L. Carroll[1], T. Ebata[2] & L. Safranyik[1]

1. Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Victoria, British Columbia, V8Z 1M5, Canada
2. British Columbia Ministry of Forests and Range, Victoria, British Columbia, V8W 9C2, Canada

Kurz, W. A., C. C. Dymond, G. Stenson, G. J. Rampley, A. L. Carroll, T. Ebata, and L. Safranyik. 2008. Mountain pine beetle and forest carbon feedback to climate change. Nature 452:987–990.

Carbon and forest fungi - understanding is pretty basic

Global Change Biology

Global Change Biology (2011), doi: 10.1111/j.1365-2486.2011.02543.x

REVIEW

Effects of biotic disturbances on forest carbon cycling in the United States and Canada

JEFFREY A. HICKE*, CRAIG D. ALLEN†, ANKUR R. DESAI‡, MICHAEL C. DIETZE§, RONALD J. HALL¶, EDWARD H. (TED) HOGG¶, DANIEL M. KASHIAN**, DAVID MOORE††, KENNETH F. RAFFA‡, RONA N. STURROCK‡‡ and JAMES VOGELMANN§§

*University of Idaho, Moscow, ID 83844, USA, †U.S. Geological Survey, Los Alamos, NM 87544, USA, ‡University of Wisconsin, Madison, 53706, WI 53706, USA, §University of Illinois at Urbana-Champaign, Urbana, IL 61801, USA, ¶Natural Resources Canada, Canadian Forest Service, Edmonton, T6H 3S5, AB T6H 3S5, Canada, **Wayne State University, Detroit, MI 48202, USA, ††University of Arizona, Tucson, AZ 85721, USA, ‡‡Natural Resources Canada, Canadian Forest Service, Victoria, BC V8Z 1M5, Canada, §§U.S. Geological Survey, Sioux Falls, SD 57198, USA

Hicke, J. A., Allen, C. D., Desai, A. R., Dietze, M. C., Hall, R. J., Hogg, E. H., Kashian, D. M., Moore, D., Raffa, K. F., Sturrock, R. N. and Vogelmann, J. 2012. Effects of biotic disturbances on forest carbon cycling in the United States and Canada. Global Change Biology, 18: 7–34.

Manage water for forest health!

Mulch
Thinning and species selection
Soil conservation
Irrigation

Water for fish? Water for farms? Water for city people?
Or – water for the forest?

Photo credit : TNC

Gordon E. Grant, Christina L. Tague, and Craig D. Allen 2013. Watering the forest for the trees: an emerging priority for managing water in forest landscapes. *Frontiers in Ecology and the Environment* 11: 314–321

Photo credit : TNC

Acknowledgements

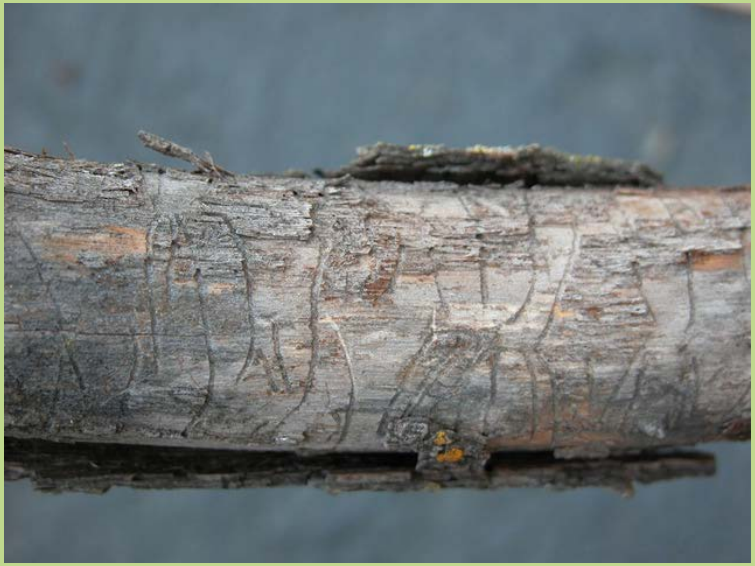
USDA Forest Service,

Pacific Southwest Research Station

Thousand Cankers Disease and the Walnut Twig Beetle in California

Walnut twig beetle, *Pityophthorus juglandis*

& *Geosmithia morbida*



Credit: UC IPM Online

Increasing stand density

Fire suppression

Altered species composition

Root disease,
Dwarf mistletoe,
Beetles

D. Conklin, USFS

How will forests respond to climate change?

Photo: Craig Allen, USGS

Warming will

- - decrease snowpack,
  - cause earlier snowmelt,
  - increase summer evapotranspiration,
  - increase the frequency and severity of droughts,
  - increase risk of frost injury
  - change germination time
  - change time of bud set and bud break

Chumua, D.J., P.D. Anderson, G.T. Howe, C.A. Harrington, J.E. Halofsky, D.L. Peterson, D.C. Shaw, and B. St. Clair. 2011. Forest Responses to climate change in the northwestern United States: Ecophysiological foundations for adaptive management. Forest Ecology and Management. 261: 1121-1142

Shot hole borer

Shot Hole Borer (*Euwallacea sp.*) and Fusarium Dieback (*Fusarium* sp.)

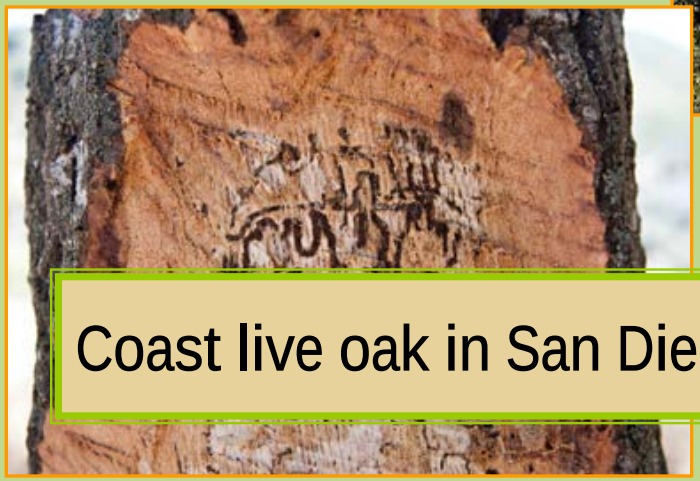
- **Los Angeles and Orange Counties**

- **Hosts: Coast live oak, box elder, avocado,big leaf maple,California sycamore and more**

UC Riverside, Afik Escalen

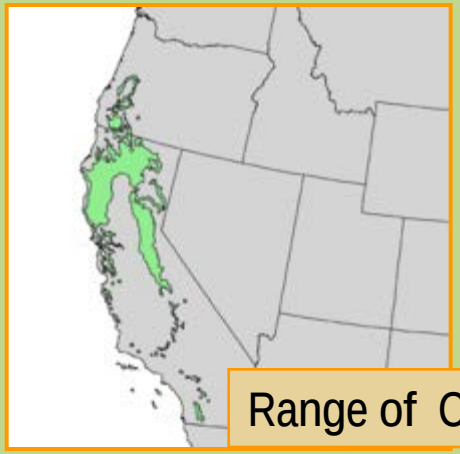
What will drive forest change?

Gold spotted oak borer, ***Agrilus auroguttatus***

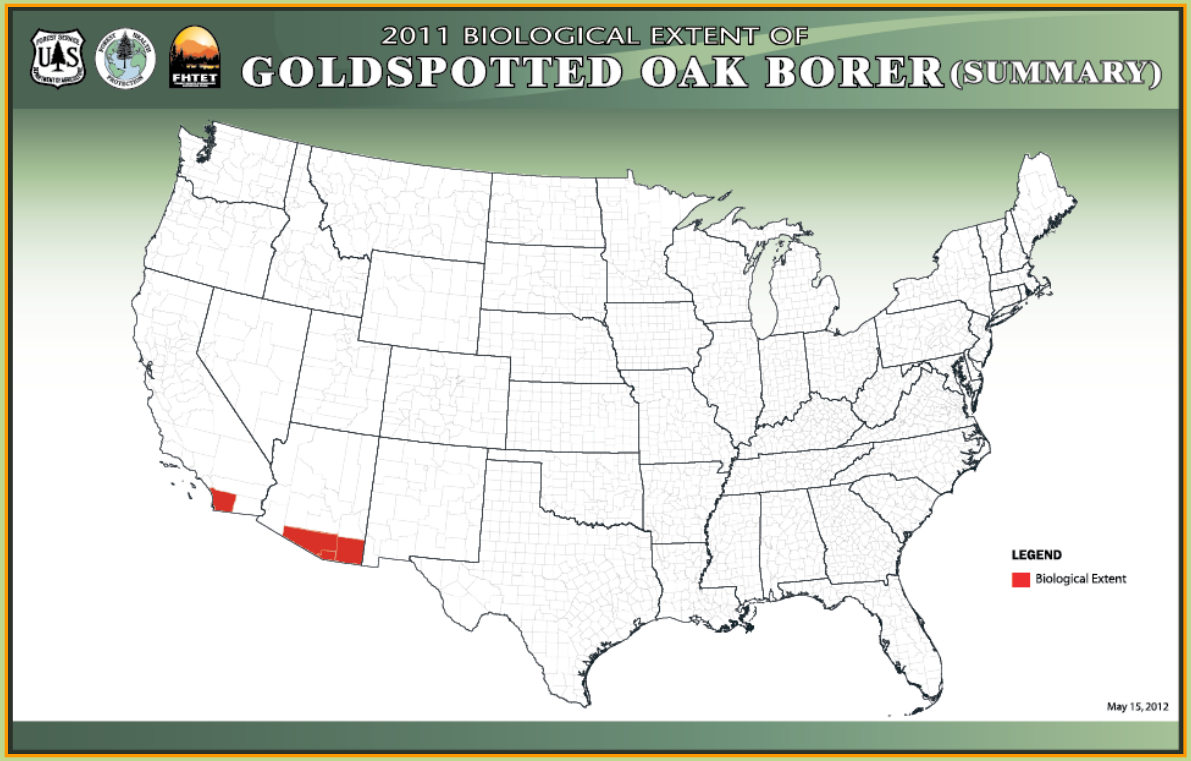


Coast live oak in San Diego Co. and CA black oak in Riverside Co.

Range of coast live oak



Range of CA black oak



Range of gold spotted oak borer?