

A century of Climate Change on the National Forests of Northwestern California

Sarah Sawyer and Ramona Butz
USFS Regional Ecology Program



Assessing Climate Impacts

A summary of current trends and probable future trends in climate and climate-driven processes for the Six Rivers National Forest and surrounding lands

Ramona J. Butz, Northern Province Ecologist, USDA Forest Service, Pacific Southwest Region.
rbutz@fs.fed.us; 707-441-3584.

Sarah Sawyer, Assistant Regional Ecologist, USDA Forest Service, Pacific Southwest Region.

Hugh Safford, Regional Ecologist, USDA Forest Service, Pacific Southwest Region.

Last Update: December, 2015

Contents

Introduction.....	2
Local and regional trends over the last century linked to climate change.....	2
Temperature and Precipitation.....	2
Temperature.....	2
Precipitation.....	7
Hydrology.....	12
Fire.....	13
Vegetation.....	13
Wildlife.....	14
Future projections.....	15
Temperature and Precipitation.....	15
Hydrology.....	16
Fire.....	18
Vegetation.....	19
Wildlife.....	22
Literature Cited.....	25

Assessing Climate Impacts



[Forest Service Home](#) [About the Agency](#) [Contact the National Office](#)

Search

Go

Site Map

Region 5

- ▶ [Home](#)
- ▶ [Special Places](#)
- ▶ [Recreation](#)
- ▶ [Alerts & Notices](#)
- ▶ [Passes & Permits](#)
- ▶ [Maps & Publications](#)
- ▶ [Fire & Aviation](#)
- ▶ [Land & Resource Management](#)
- ▶ [Forest & Grassland Health](#)
- ▶ [State, Private & Community Forests](#)

Plants & Animals

- [Fish](#)
- [Plants](#)
- [Wildlife](#)

- ▶ [Learning Center](#)
- ▶ [Working Together](#)
- ▶ [Jobs & Volunteering](#)

Ecology Program Documents, Reports, and Publications

The Ecology Program continually works to prepare and provide documents useful to land management decision-making. Below is a list of such documents available on this site. Please check back soon as we update past documents for accessibility in order to provide them here.



Documents

Natural Range of Variation of Sierra Nevada habitats

- ▶ [Aspen](#)
- ▶ [Chaparral](#)
- ▶ [Hardwood](#)
- ▶ [Meadows](#)
- ▶ [Pinyon-Juniper](#)
- ▶ [Red Fir](#)
- ▶ [Riparian \(non-meadow\)](#)
- ▶ [Sagebrush](#)
- ▶ [Supalpine](#)
- ▶ [Yellow Pine/Mixed Conifer](#)

Ecology Program Reports

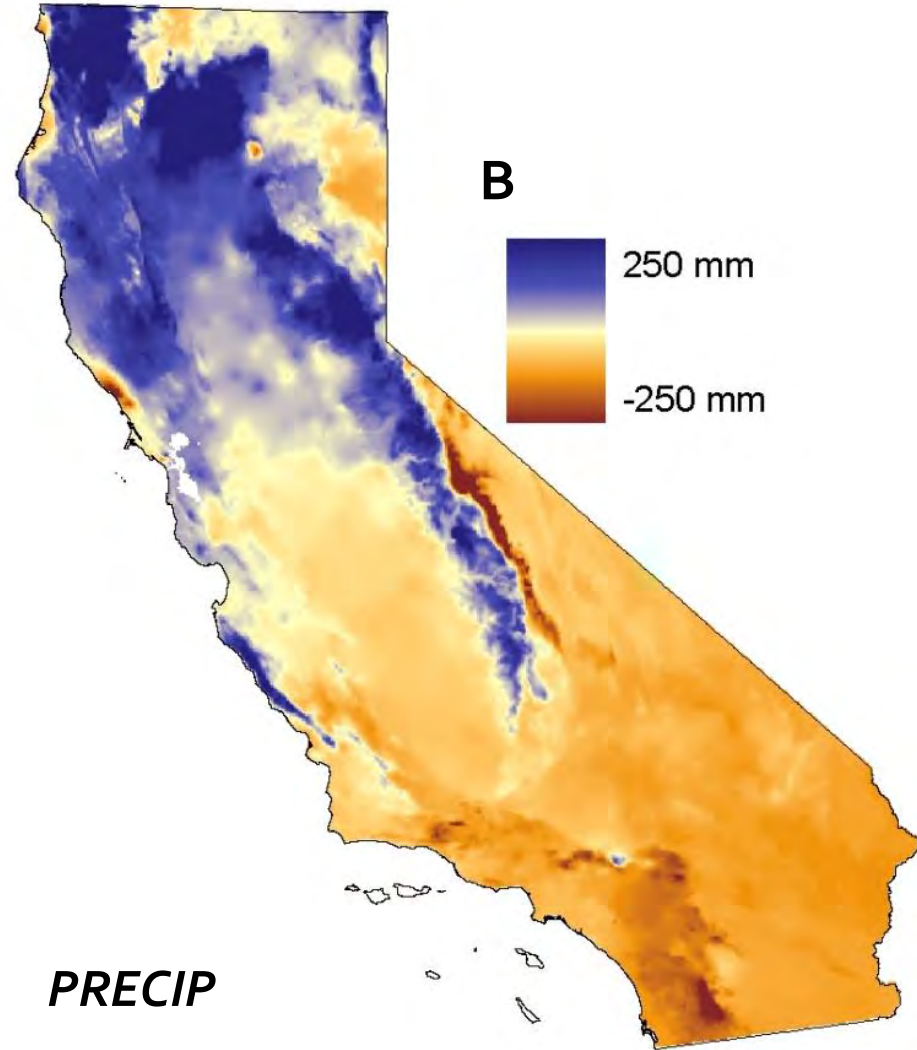
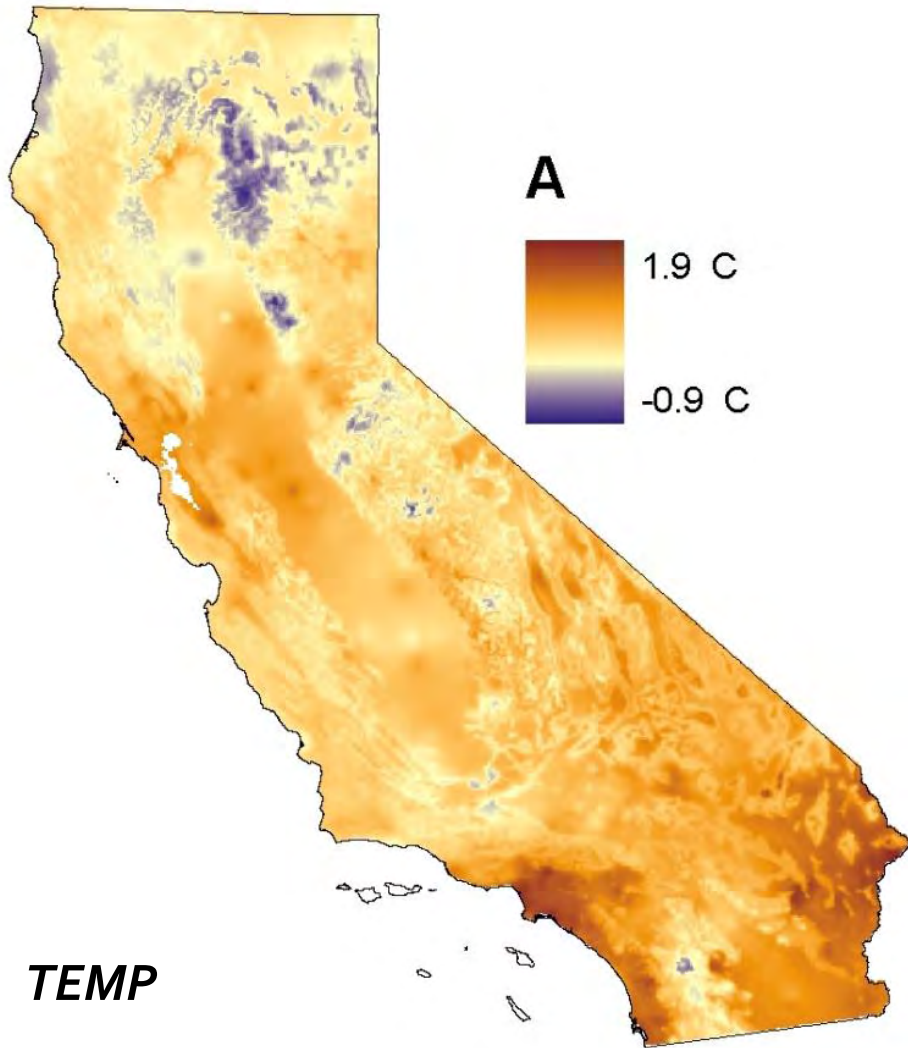
Climate Change Trend Summary Documents

- ▶ [Angeles and San Bernardino National Forests](#)
- ▶ [Eldorado and Tahoe National Forests](#)
- ▶ [Inyo National Forest](#)
- ▶ [Lassen, Modoc, and Plumas National Forests](#)
- ▶ [Sequoia National Forest](#)
- ▶ [Sierra National Forest](#)
- ▶ [Stanislaus National Forest](#)
- ▶ [Trend summaries for most of the other California Forests are](#)

Programs

- [Southern Sierra Province Ecology Program](#)
- [Central Sierra Province Ecology Program](#)

Climate Trends:



Spatial differences in mean annual temperature (A), and mean annual precipitation (B) between the 1930's and 2000's, as derived by the PRISM climate model. *S Dobrowski Univ of Montana*

Climate Trends: Temperature

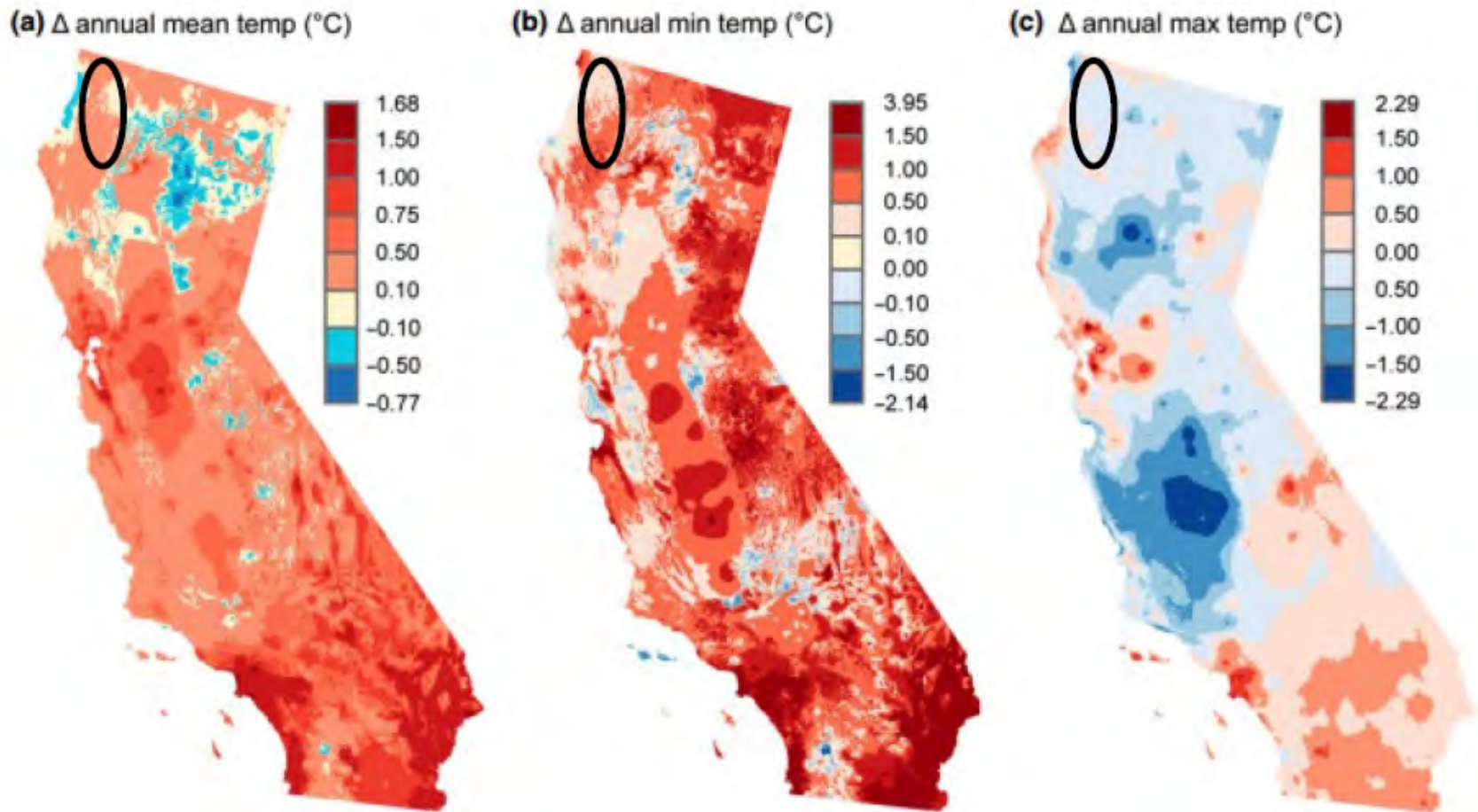
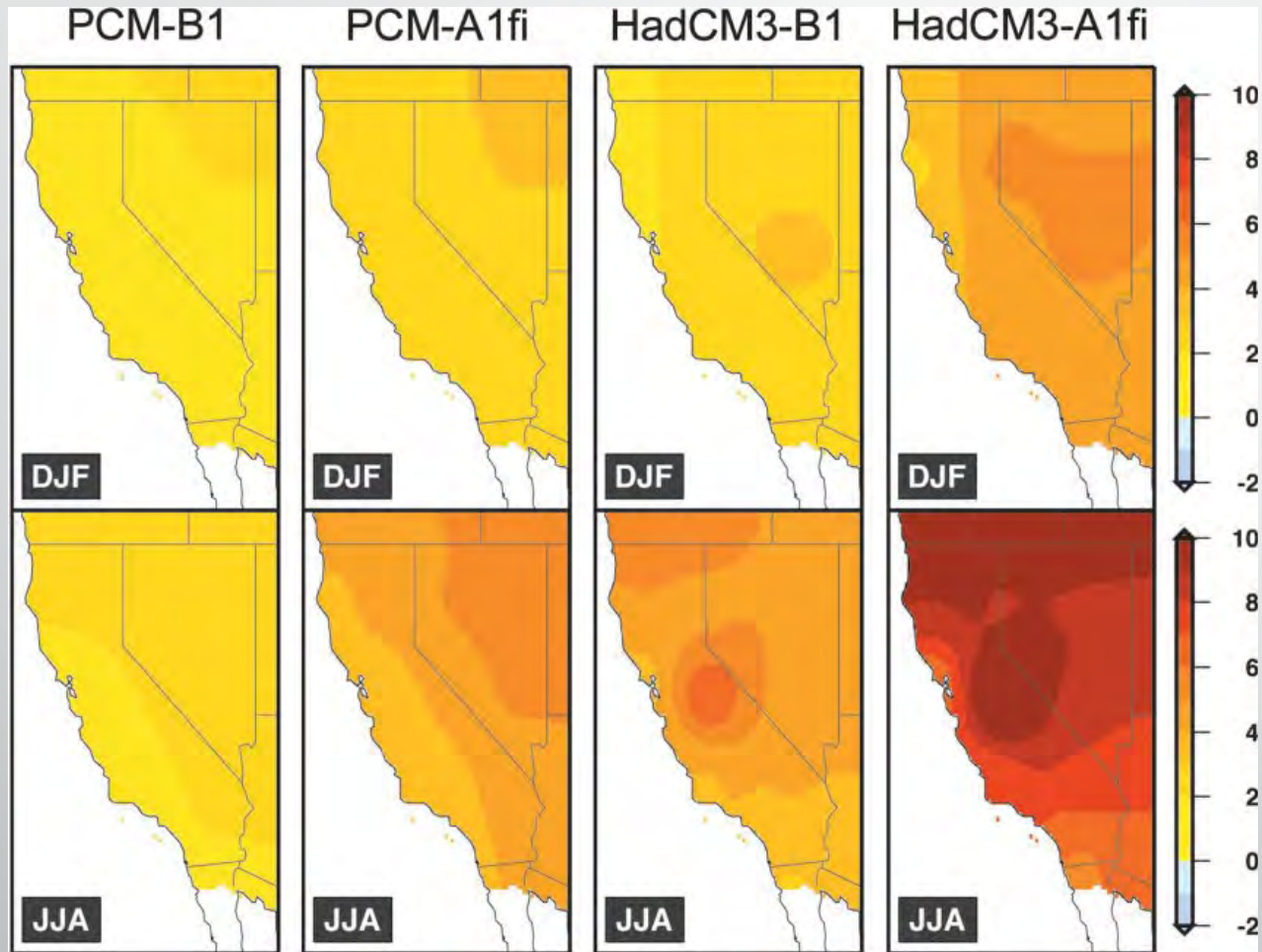


Figure 1. Spatial representation of differences in A) annual mean, B) annual minimum and C) annual maximum temperature ($^{\circ}\text{C}$) between historic (1900-1930) and modern times (1970-2009). Black circles represent the vicinity of the SRF. Figures from Rapacciuolo et al. 2014.

Climate Trends: Temperature



Downscaled winter (DJF) and summer (JJA) temperature change (°C) for 2070–2099, relative to 1961–1990 for a 18° grid. Statewide, SRES B1 to A1fi winter temperature projections for the end of the century are 2.2–3°C and 2.3–4°C for PCM and HadCM3, respectively, compared with previous projections of 1.2–2.5°C and 3–3.5°C for PCM and HadCM2, respectively. End-of-century B1 to A1fi summer temperature projections are 2.2–4°C and 4.6–8.3°C for PCM and HadCM3, respectively, compared with previous projections of 1.3–3°C and 3–4°C for PCM and HadCM2, respectively (11–14).
From Hayhoe et al. 2004

Climate Trends: Precipitation

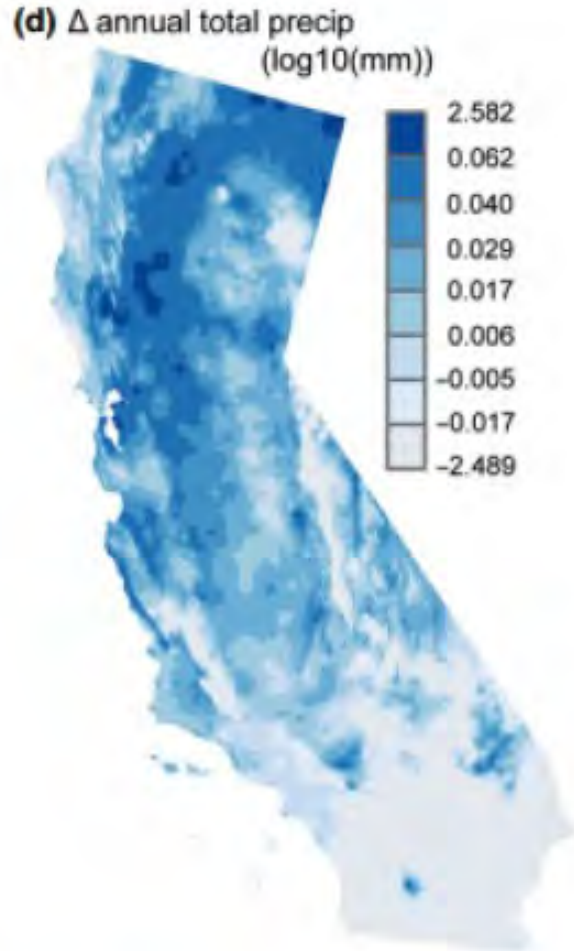
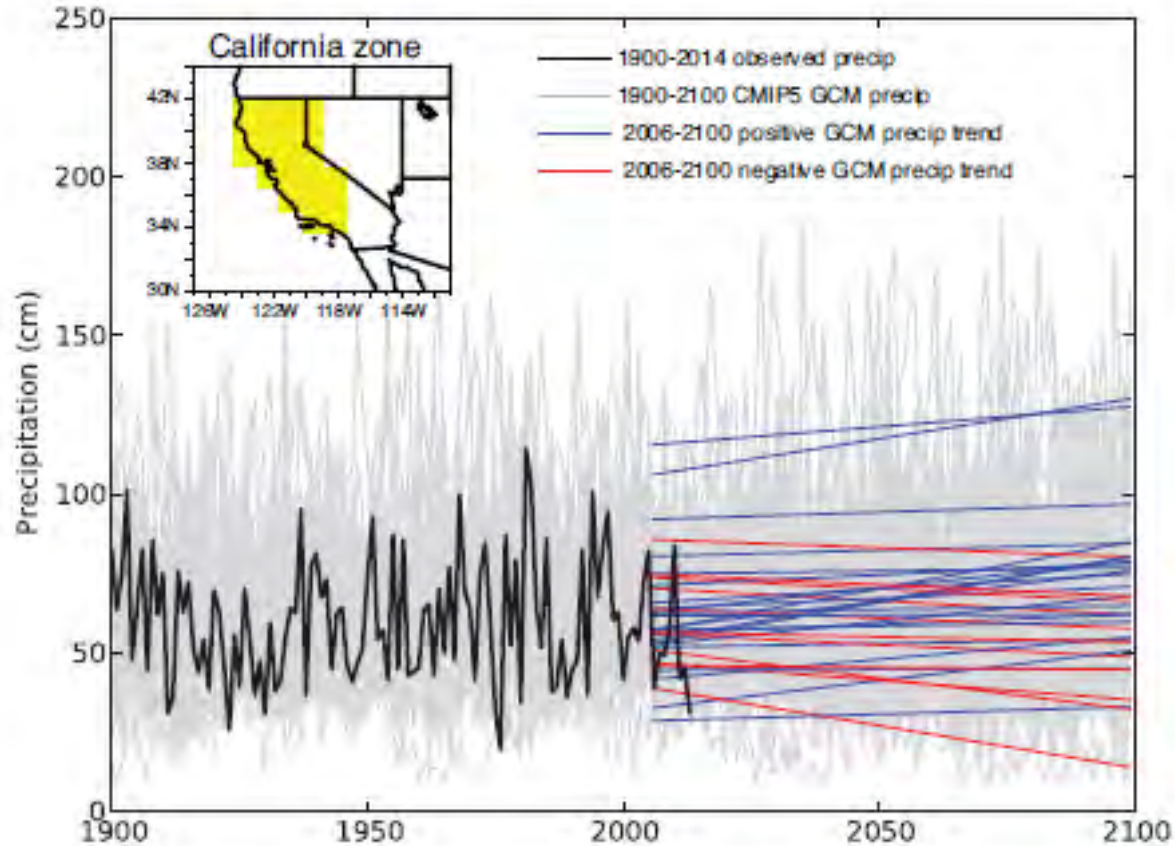


Figure 4. Spatial representation of difference in total annual precipitation between historic (1900-1930) and modern times (1970-2009). Figures from Rapacciuolo et al. 2014.

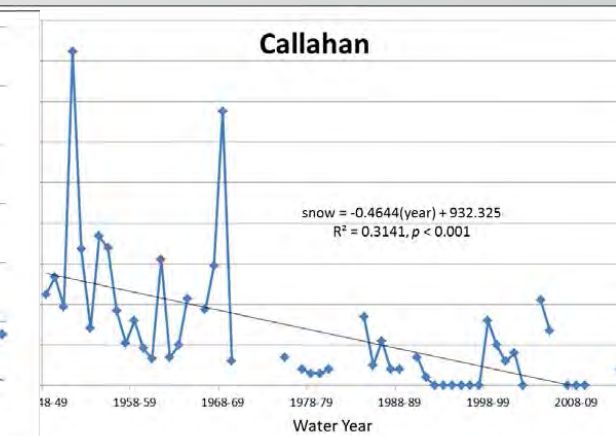
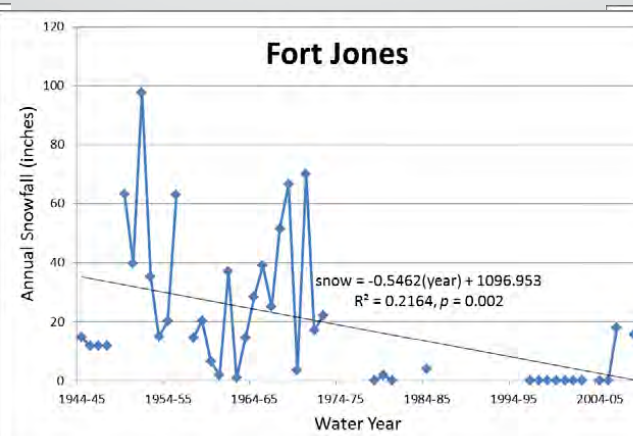
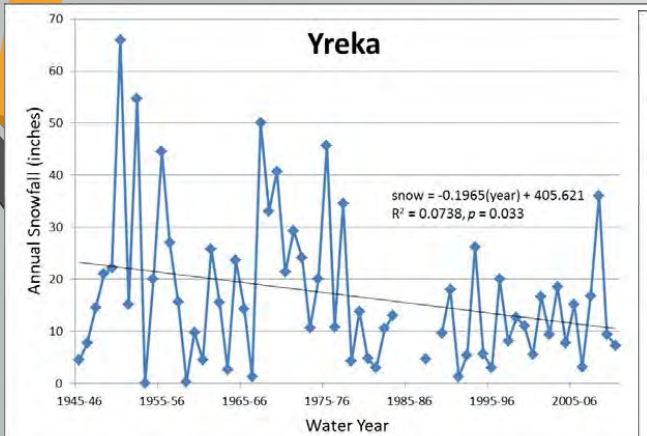
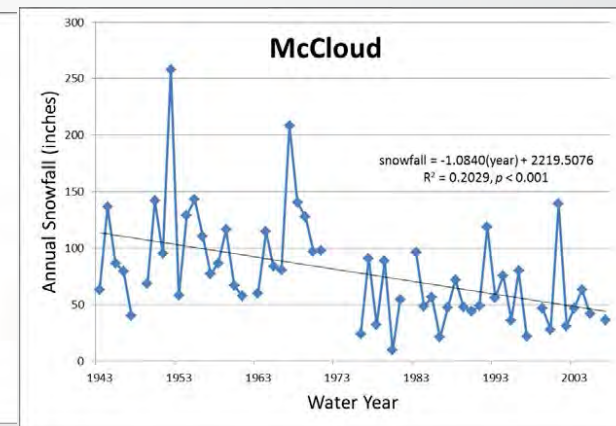
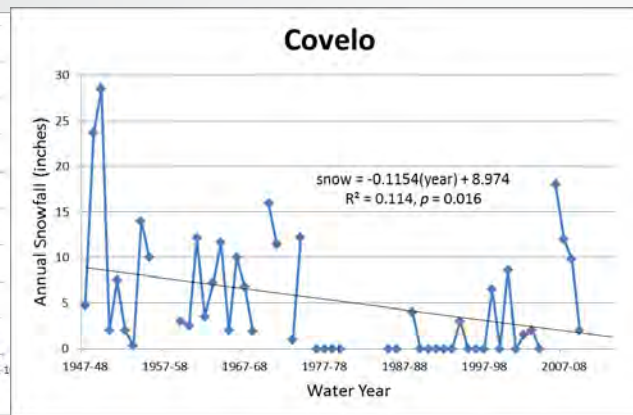
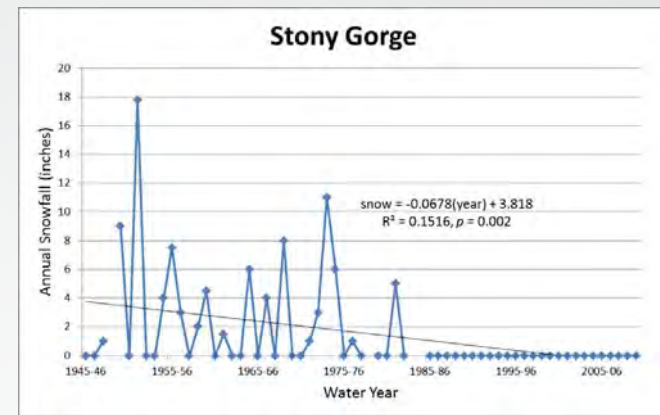
Climate Trends: Precipitation



1900-2014 wet season accumulated precipitation according to station averaged observations (thick black line and 1900-2100 wet season accumulations averaged over California in 34 GCMs (thin grey lines). Also overlaid are 2006-2100 trends for each GCM (RCP8.5 forcing scenario). These trends are colored according to their sign (blue for positive trends, red for negative trends).

From Berg and Hall 2015

Climate Trends: Snow

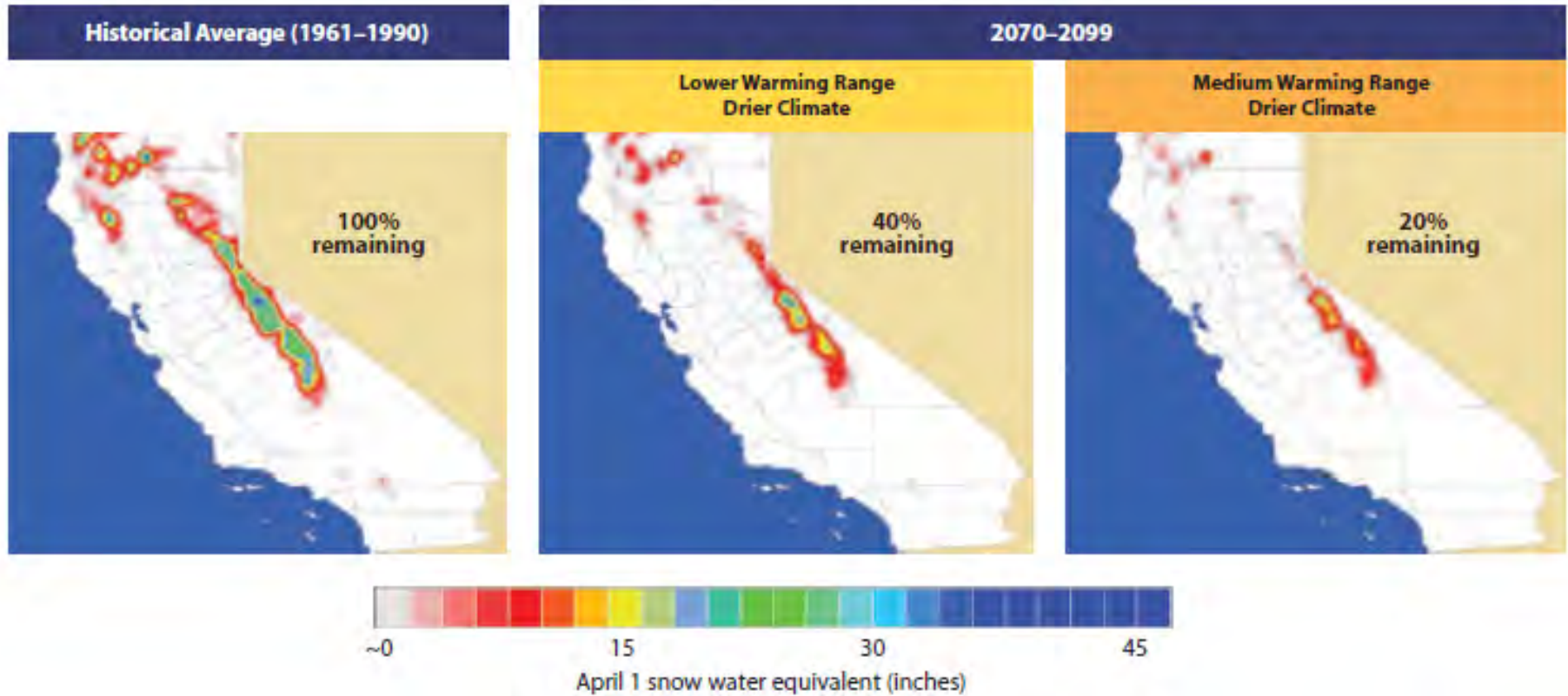


Climate Trends: Snow



Source: NRCS, 2011

Decreasing California Snowpack



Climate Trends: Hydrology

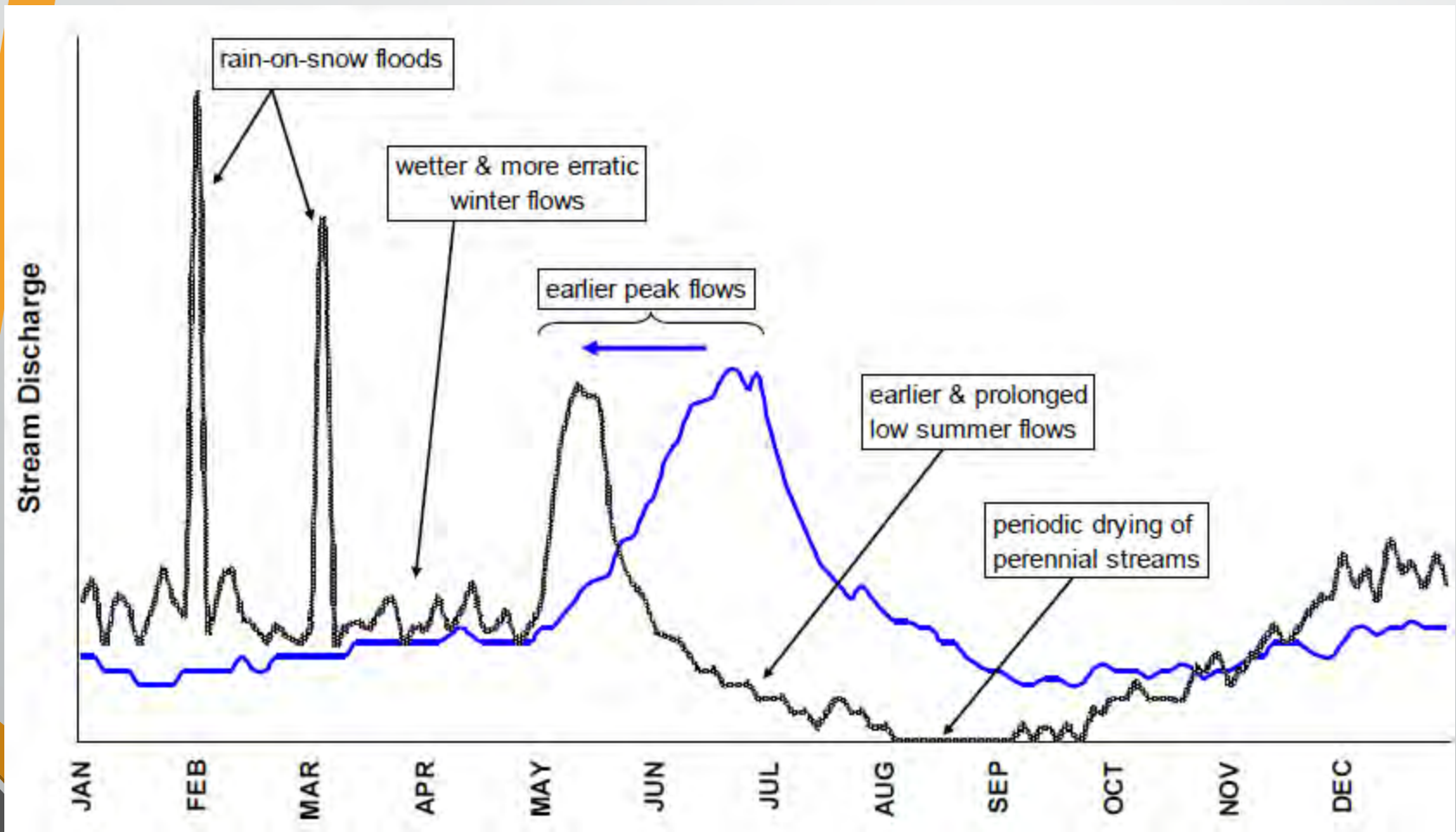
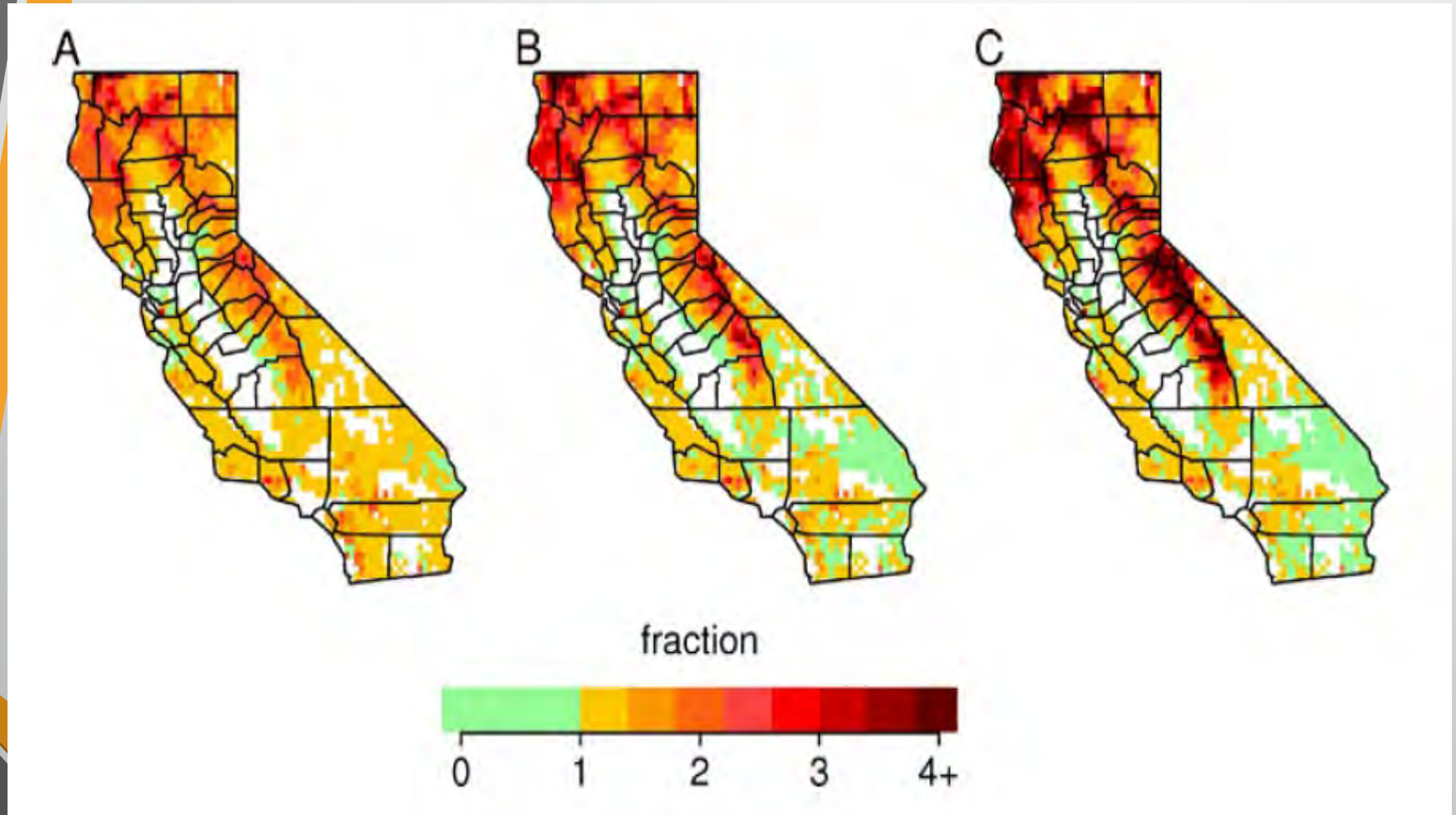
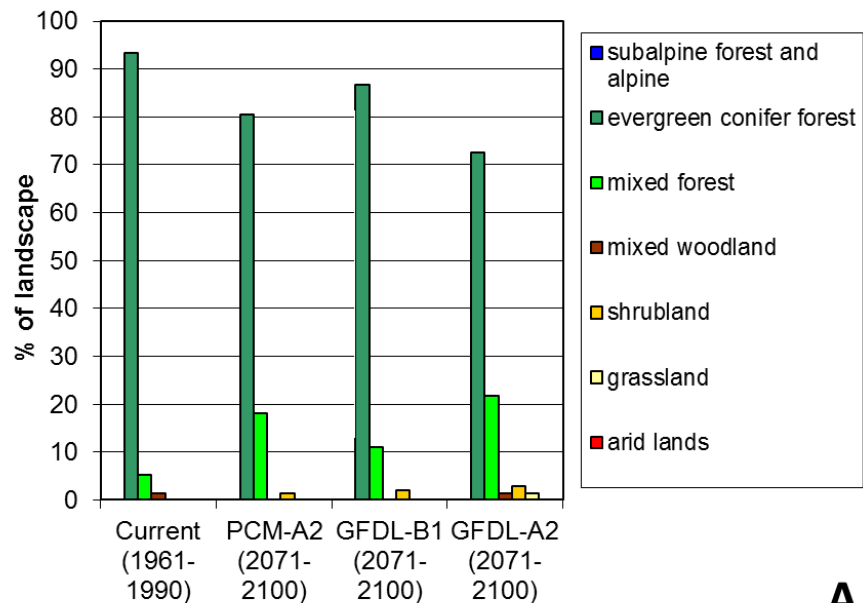


Figure by David Herbst, UC Sierra Nevada Aquatic Research Laboratory

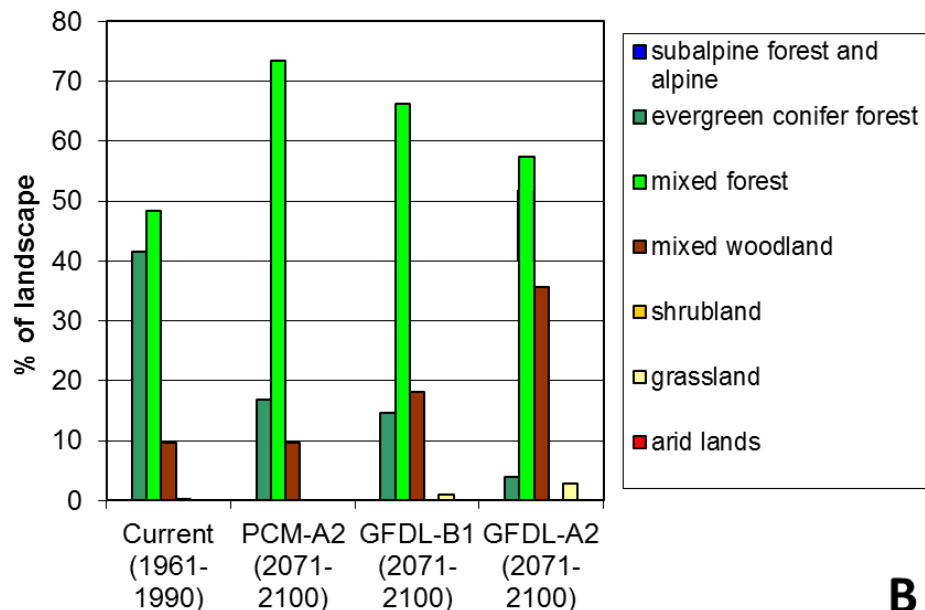
Climate Trends: Fire



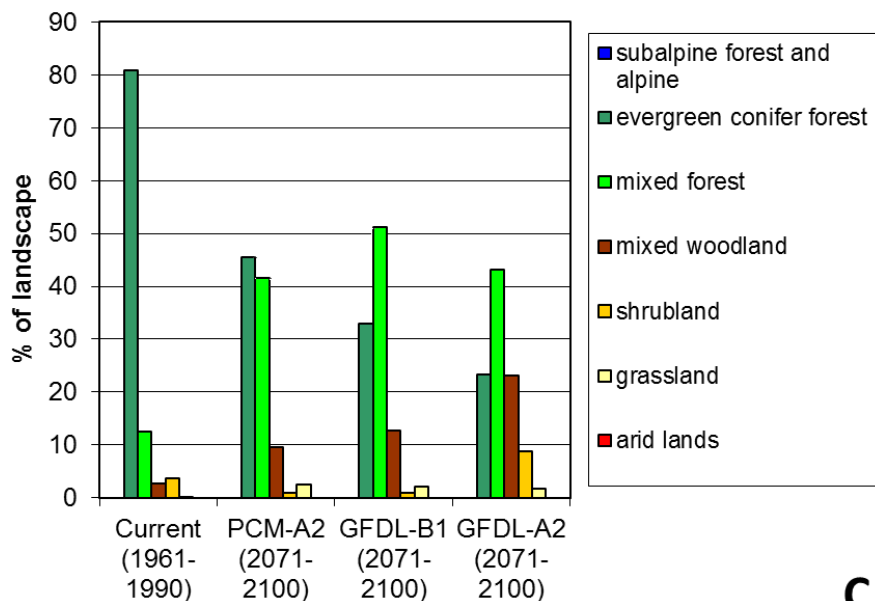
Climate Trends: Vegetation



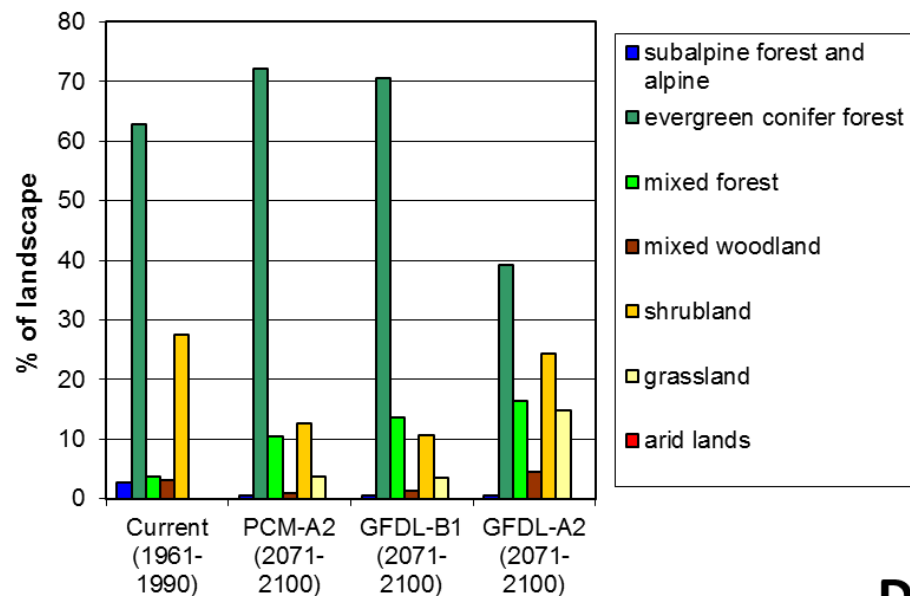
A



B



C



D

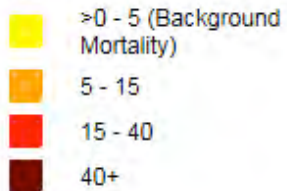
From Lenihan et al. (2008).

Climate Trends: Vegetation

Tree Mortality Viewer

LEGEND

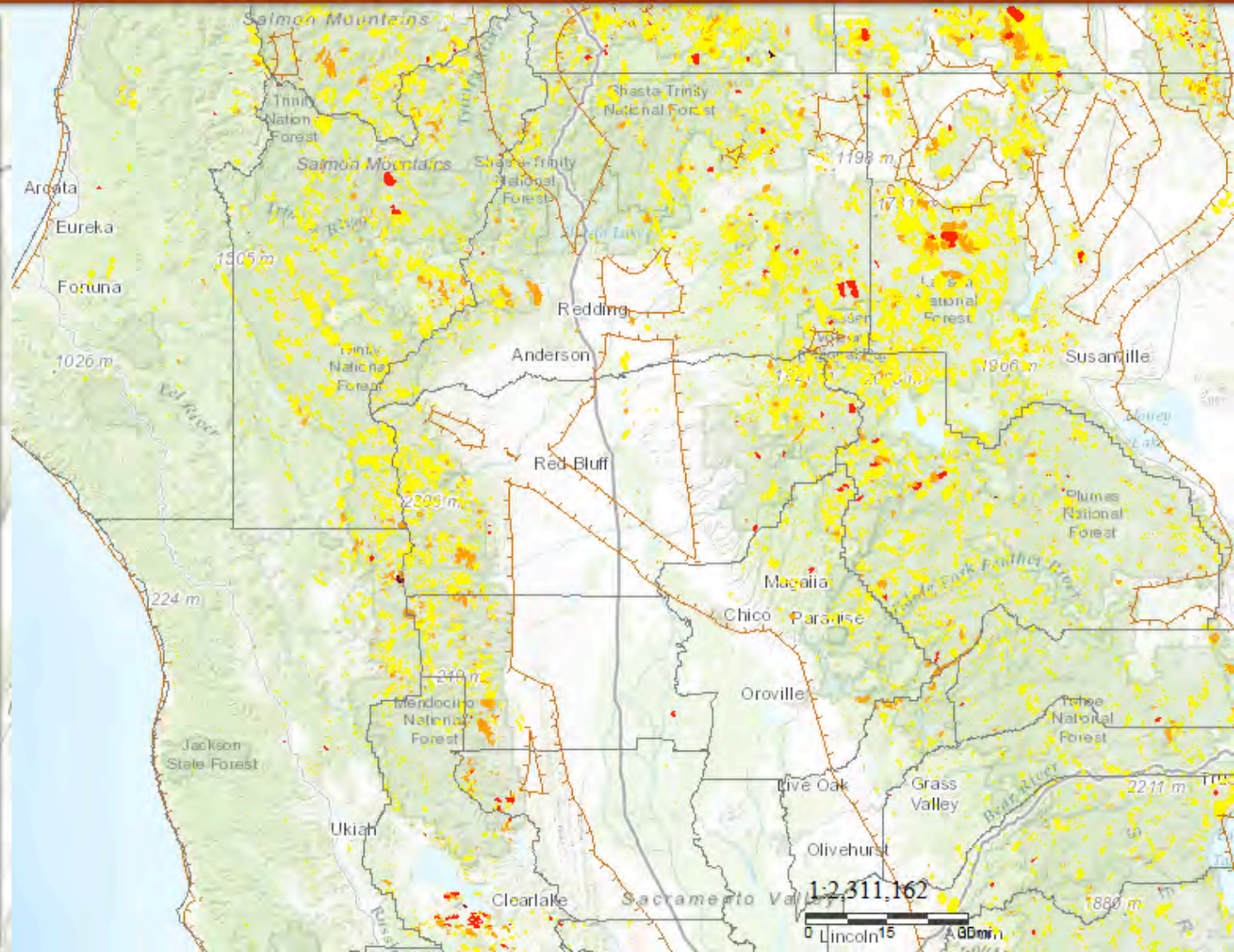
Tree Mortality (Dead Trees Per Acre)



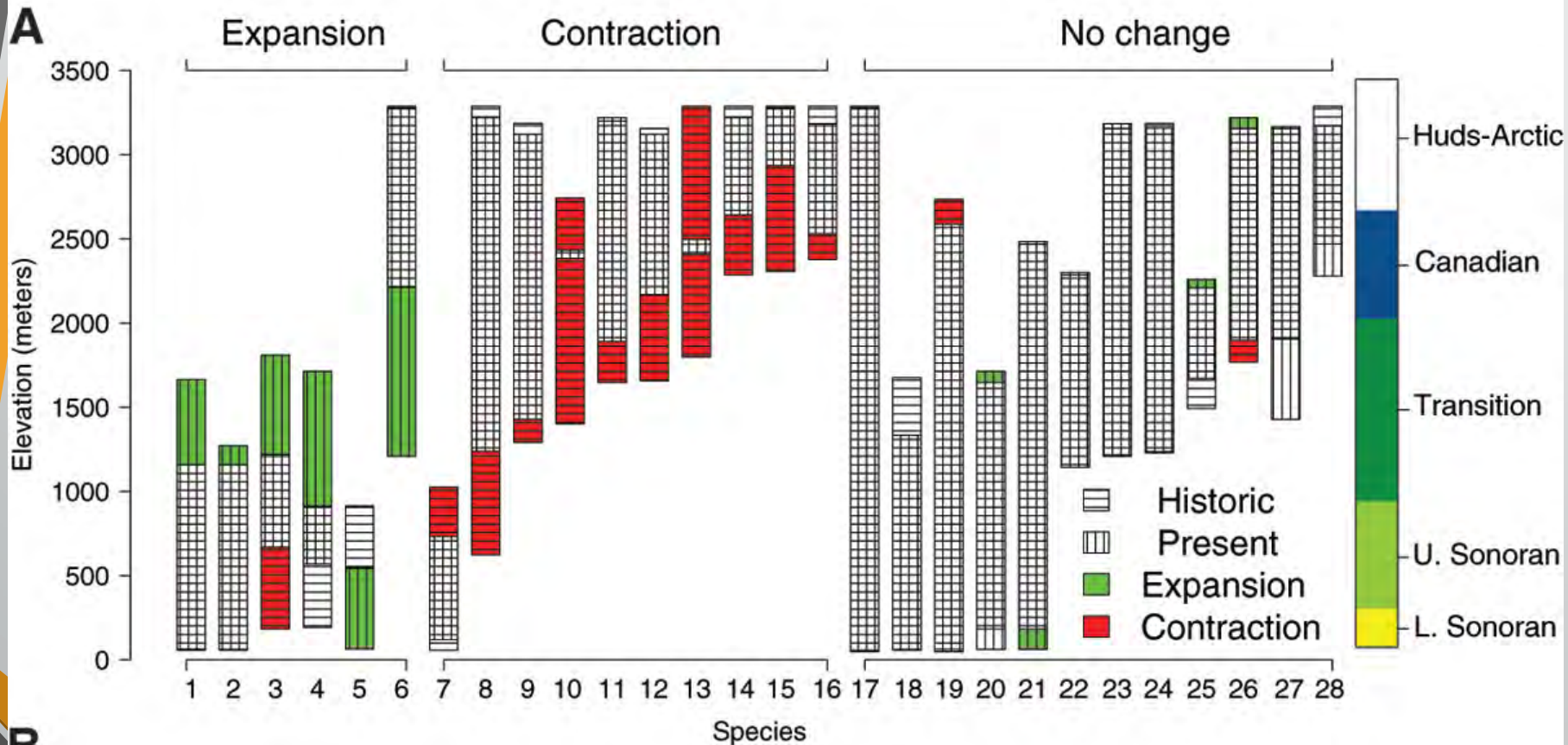
County Boundaries



USFS 2015 Flown Area



Climate Trends: Wildlife



B

Moritz, C., J. L. Patton, C. J. Conroy, J. L. Parra, G. C. White, and S. R. Beissinger. 2008. Impact of a century of climate change of small-mammal communities in Yosemite National Park, USA. *Science* 322:261-264.

Climate Trends on our Coasts



- decreased pH of oceans
- increasing sea levels
- Increased coastal erosion and runoff