



# Climate Change and Adaptation: Nature-based Solutions for Wildlife and People

Training for CA Dept. of Fish & Game --State Wildlife Action Plan Climate Change Update  
Ellie M. Cohen and PRBO Staff

March 7, 2012

PRBO Conservation Science

# Applied Bird & Ecosystem Studies to Improve Conservation Outcomes- *using birds and other indicator species*

- Founded in 1965
- 140+ staff and seasonal biologists
- 2011 Budget: ~\$9m



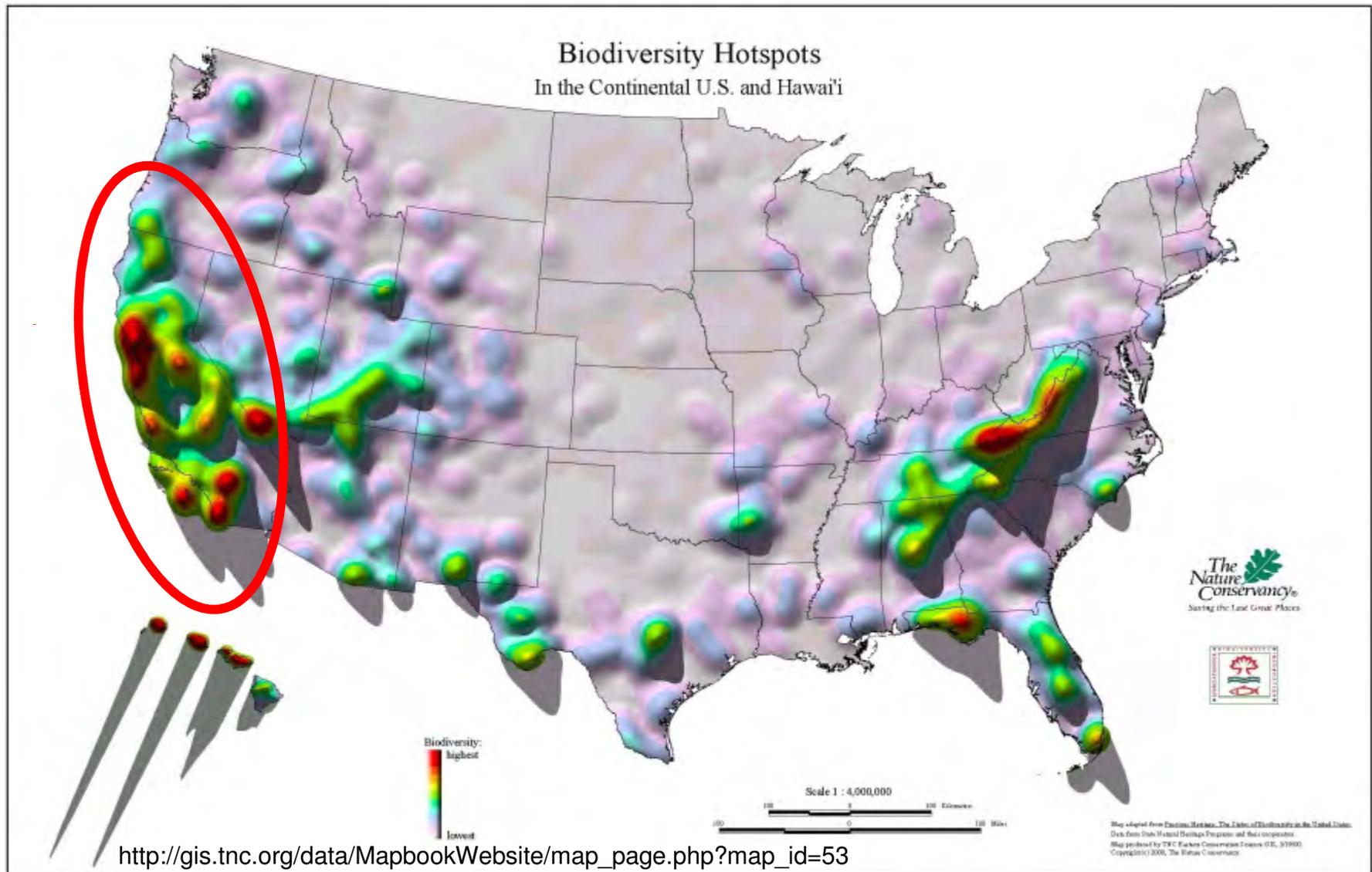
PRBO Conservation Science

# PRIORITY: Reduce Impacts of Environmental Change on Ecosystems & Enhance Capacity to Adapt



Left: Photodisc. Right: Corbis

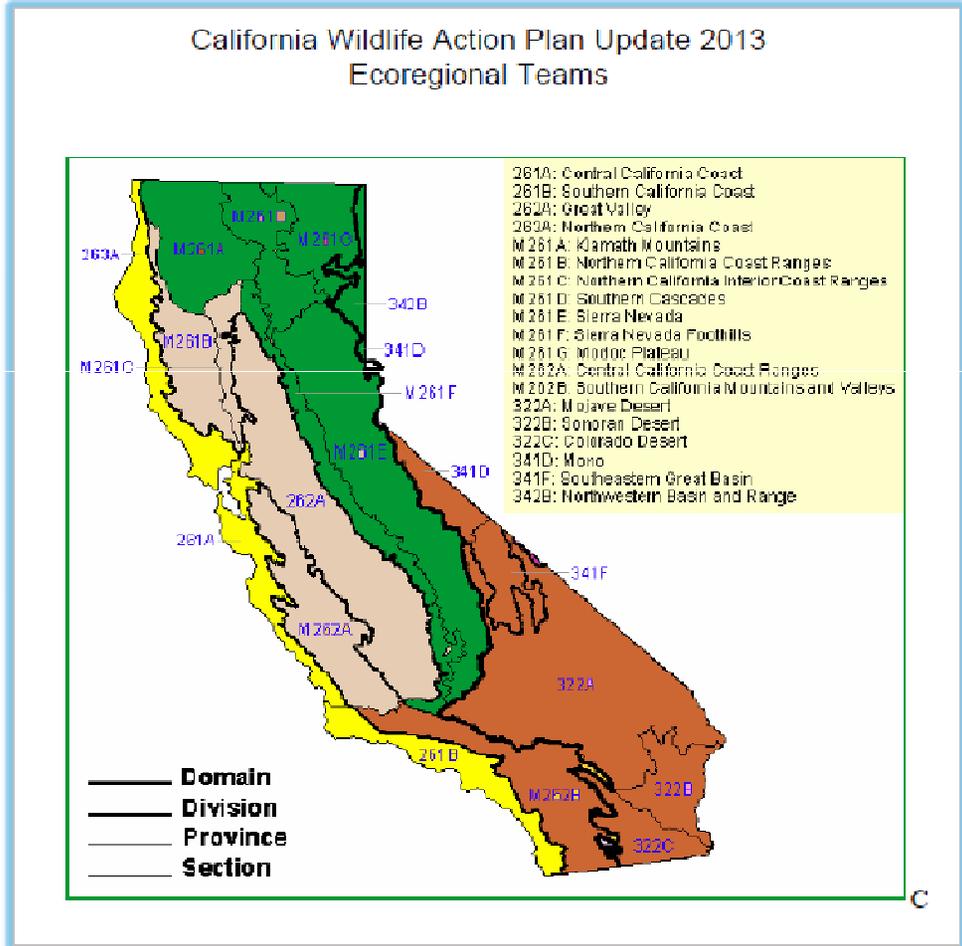
# Biodiversity Hotspot: California vital globally!





# California Wildlife Action Plan Update 2013

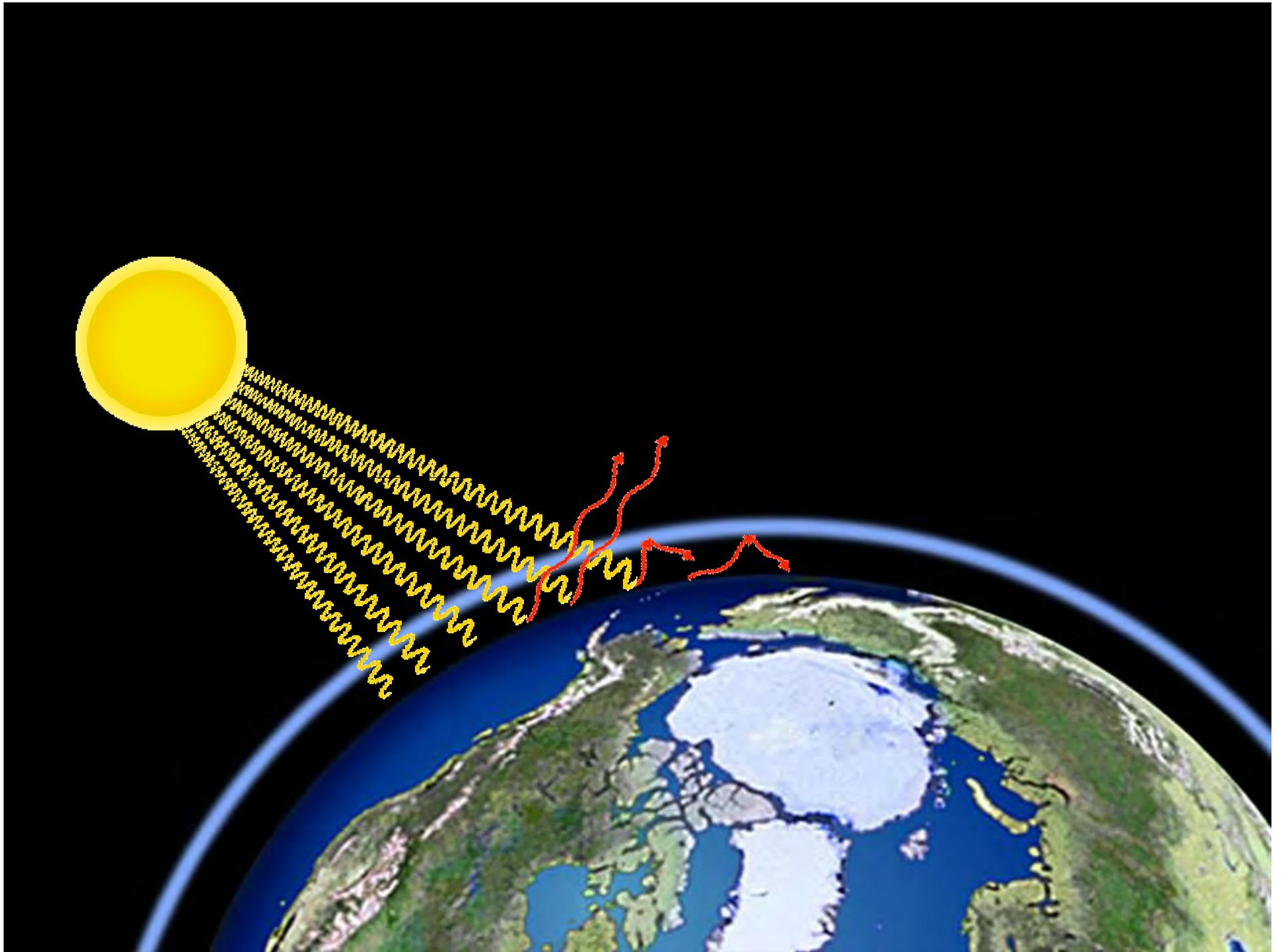
California Wildlife Action Plan Update 2013  
Ecoregional Teams



# Today's Presentation

1. Climate Change – Latest Findings
2. Impacts on Wildlife
3. Adaptive Solutions
4. Climate Smart Conservation
5. Other Considerations



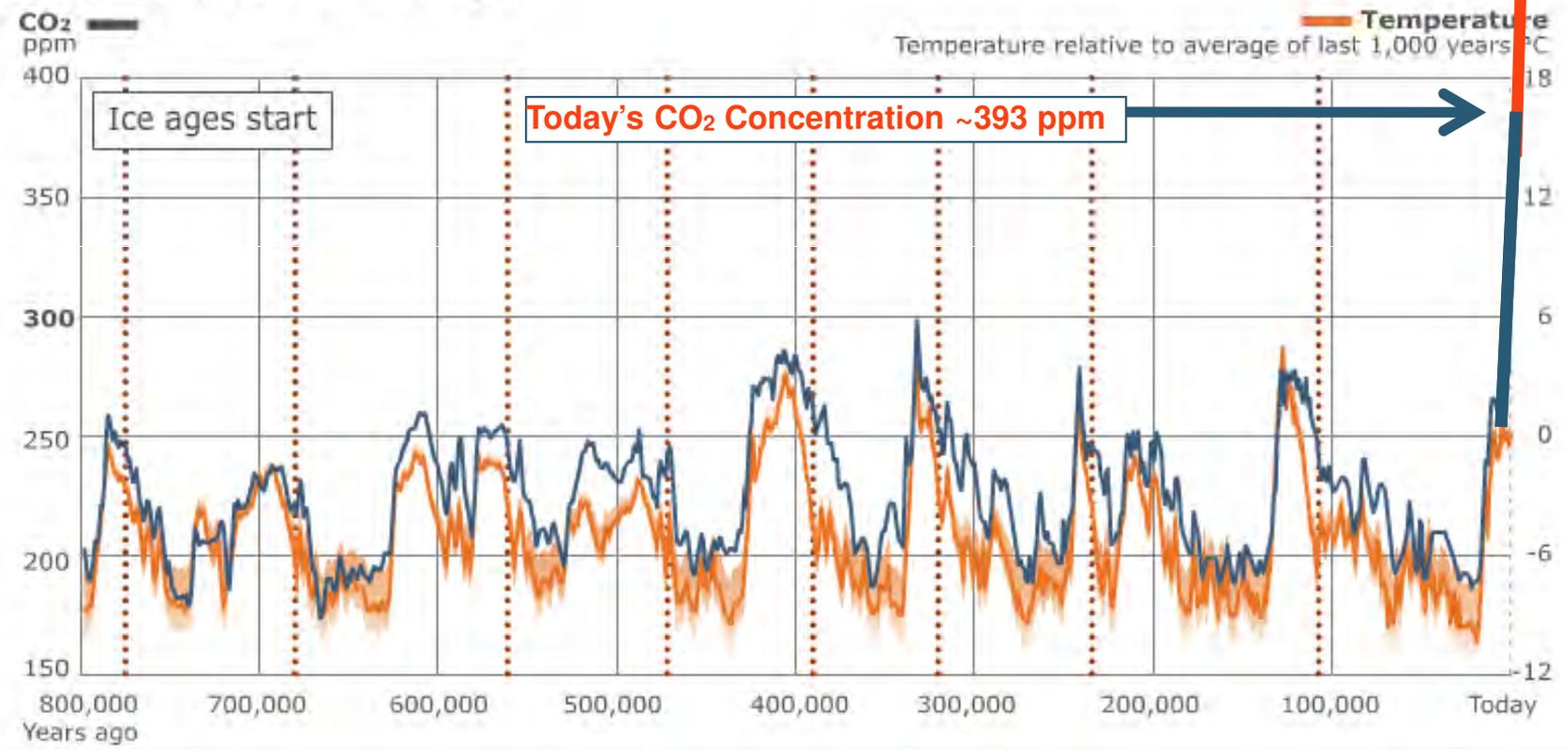


# CO<sub>2</sub>- higher than anytime in 800,000 years ... or 15-20 million years?

By 2050 with "business as usual" -CO<sub>2</sub> at 600 ppm



## 800,000 years of change



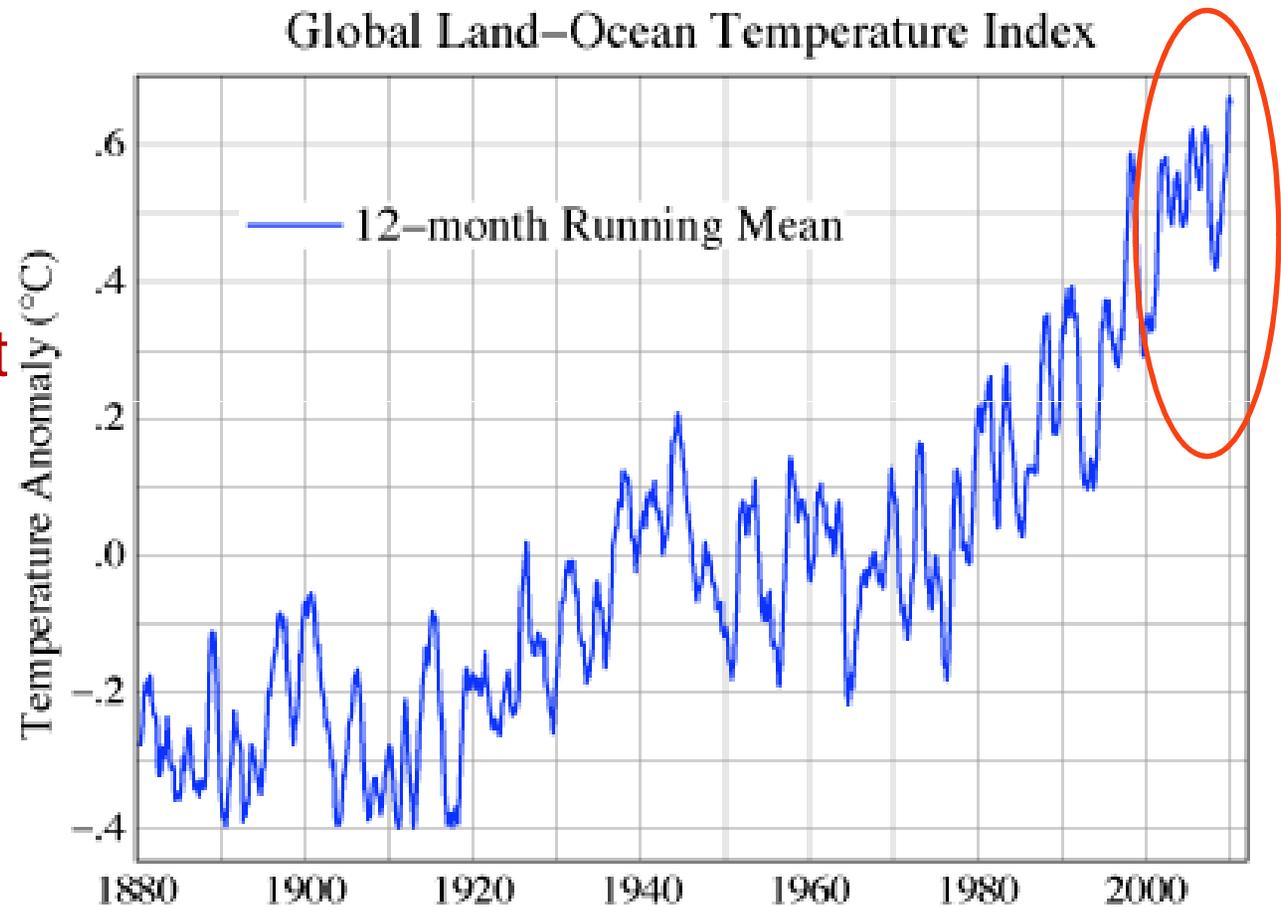
British Antarctic Survey; *BBC News*, December 3, 2009

Last time sustained CO<sub>2</sub> levels this high --15-20 m years ago, SL 25-40 m higher, 3-6C warmer– Tripathi et al, *Science*, Dec 2009 used ratios of boron to calcium in foraminifera - marine algae ; \*\*atmospheric CO<sub>2</sub> was stable at about 280 ppm for almost 10,000 years until 1750



## 2000-2009 Warmest Decade on Record (1990-1999 was warmest before that) was warmest before that)

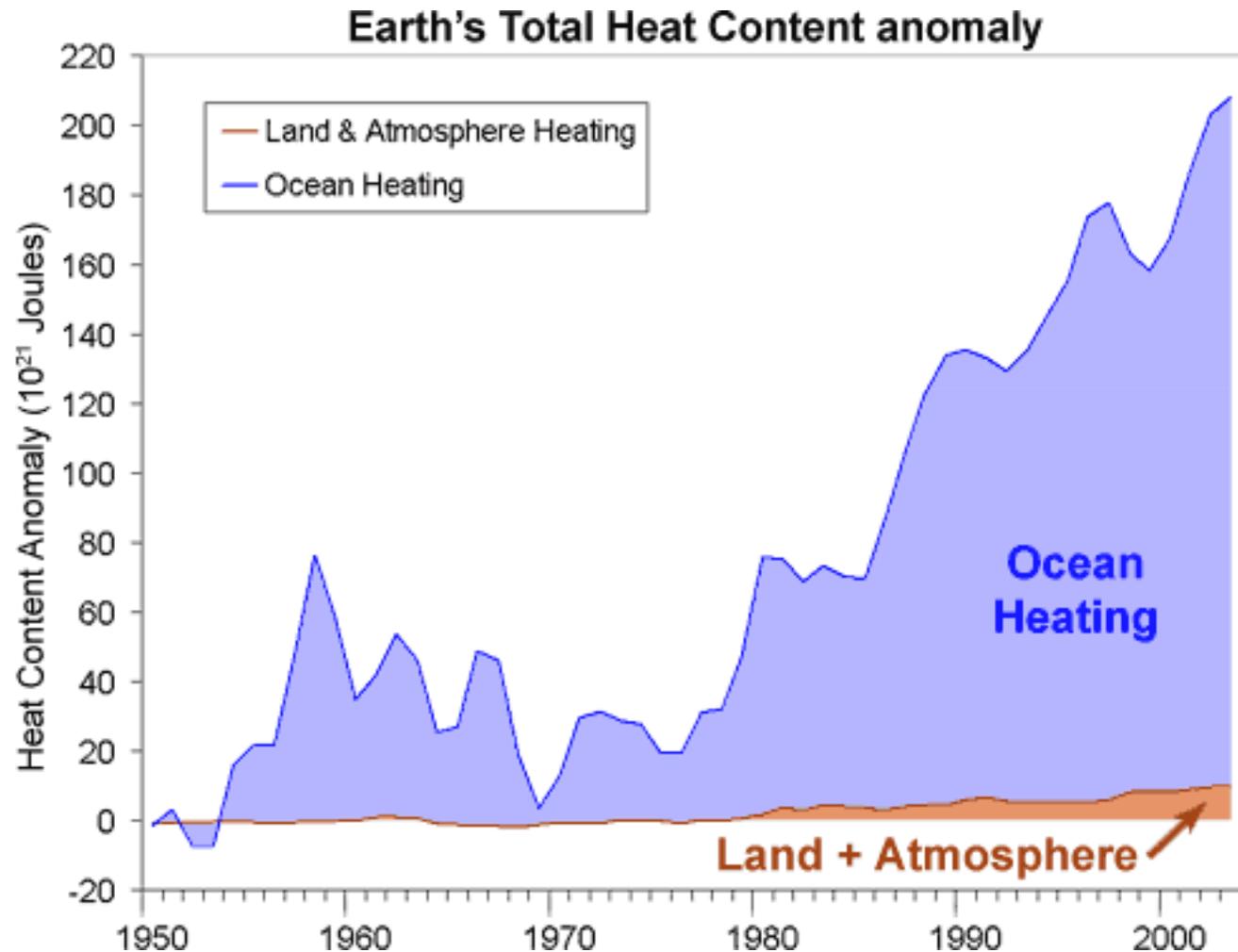
- 2010 tied for warmest year (with 2005)
- 2011 9<sup>th</sup> warmest & warmest La Nina year on record
- another record breaking year expected soon



NASA's Goddard Institute for Space Studies <http://data.giss.nasa.gov/gistemp/>  
<http://www.nasa.gov/topics/earth/features/2010-warmest-year.html> --differed by less than 0.018 degrees F  
[http://www.nasa.gov/home/hqnews/2012/jan/HQ\\_12-020\\_2011\\_Global\\_Temp.html](http://www.nasa.gov/home/hqnews/2012/jan/HQ_12-020_2011_Global_Temp.html)  
NOAA National Climatic Data Center- <http://www.ncdc.noaa.gov/sotc/global/>

# ↑ Ocean Heating

Since 1950, almost all of warming that actually heated Earth went into the ocean.

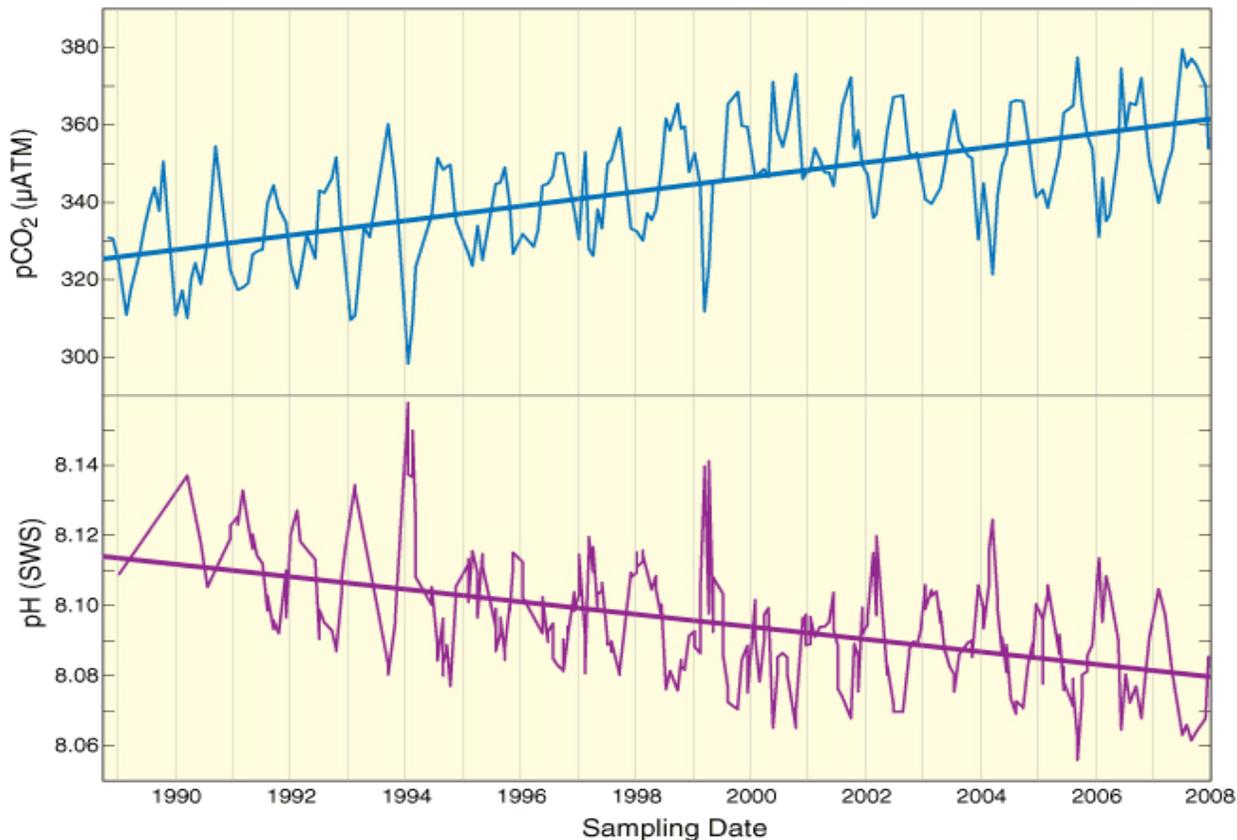


*Journal of Geophysical Research-Atmospheres Figure 1: "Total Earth Heat Content [anomaly] from 1950 (Murphy et al. October 2009). Ocean data taken from [Domingues et al 2008](#)."*

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↑ Ocean Acidification Rate- *Fastest in 300m yrs*  
.....*too fast for many species to adapt?*

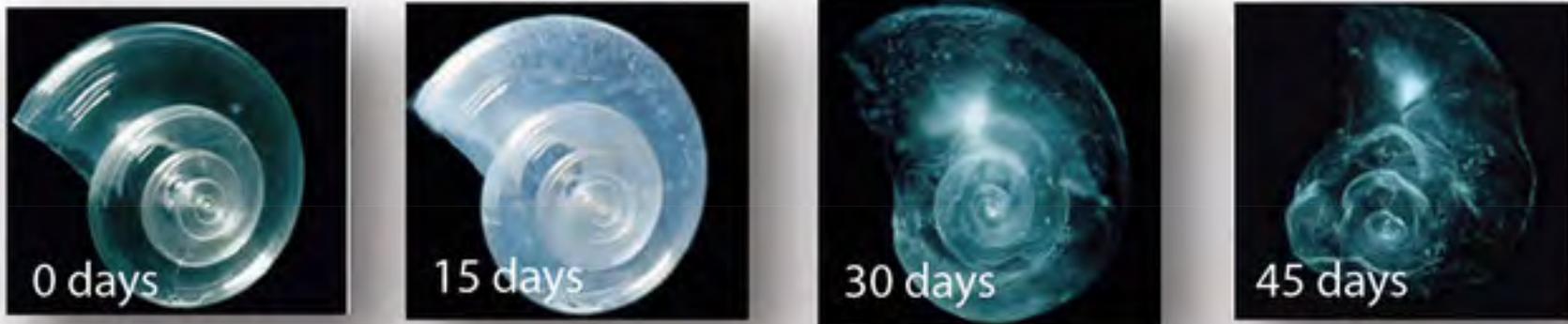
The Station ALOHA Curve



- Hönisch et al **The Geological Record of Ocean Acidification**. *Science*, March 2, 2012 DOI: [10.1126/science.1208277](https://doi.org/10.1126/science.1208277); *Ridgwell & Schmidt Feb 14 2010 Nature Geoscience*
- lower ph in past =mass extinctions; tipping point is pH of 7.8- calcified organisms begin to disappear, jellies, algae take over; [http://www.eoearth.org/article/Ocean\\_acidification](http://www.eoearth.org/article/Ocean_acidification)

# Puget Sound: measured 7.7 pH already in 2010; impacts on estuaries? (current global average is 8.1 pH; IPCC projected 7.8 pH globally by 2100)

## Pteropods dissolve in pH ~7.7



Size of a small pea- eaten by krill, whales, juvenile salmon....

*pH of ~7.8 projected global avg by 2100 under IPCC "business as usual" scenario*

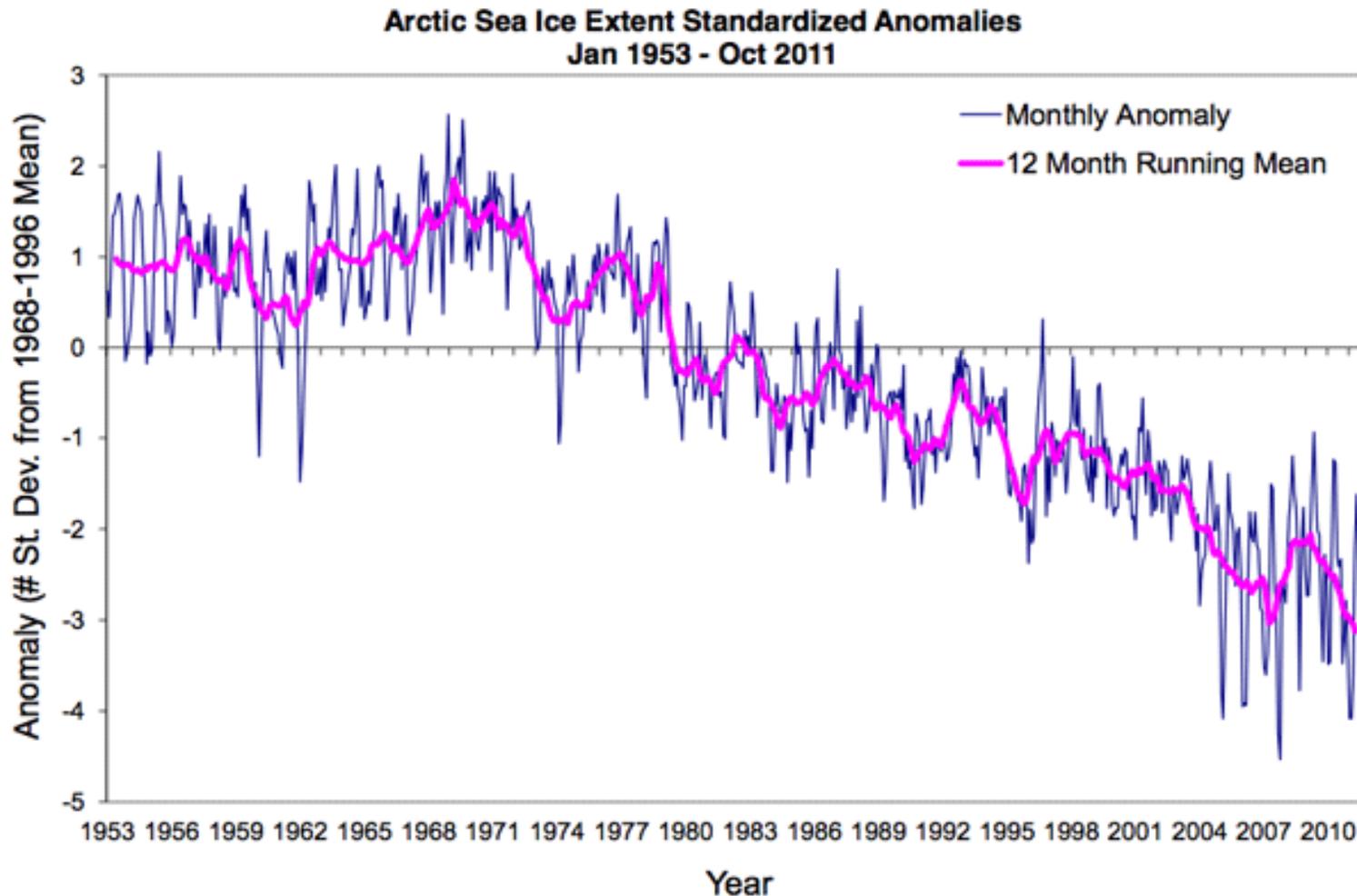
Feb 27 2012 [http://seattletimes.nwsourc.com/html/localnews/2017613197\\_acidification28m.html](http://seattletimes.nwsourc.com/html/localnews/2017613197_acidification28m.html)

NOAA: <http://www.pmel.noaa.gov/co2/story/What+is+Ocean+Acidification%3F>

Comeau et al (2010) Response of the Arctic Pteropod *Limacina helicina* to Projected Future Environmental Conditions. PLoS ONE 5(6): e11362.

# Arctic Sea Ice Extent 1953-2011

## Lowest Volume on Record--*Sept 2010-Feb 2011*



**Mean sea ice anomalies, 1953-2011:** Sea ice extent departures from monthly means for the Northern Hemisphere. For Jan 1953 –Dec 1979, from the UK Hadley Centre operational ice charts and other sources. For Jan 1979 –Oct 2011, data are from passive microwave (SMMR / SSM/I). Image by Walt Meier and Julienne Stroeve, National Snow and Ice Data Center, University of Colorado, Boulder [http://nsidc.org/cryosphere/sotc/sea\\_ice.htm](http://nsidc.org/cryosphere/sotc/sea_ice.htm)

“...the  
Arctic  
summer  
sea ice  
cover is  
in a  
death  
spiral.  
It’s not  
going to  
recover,”

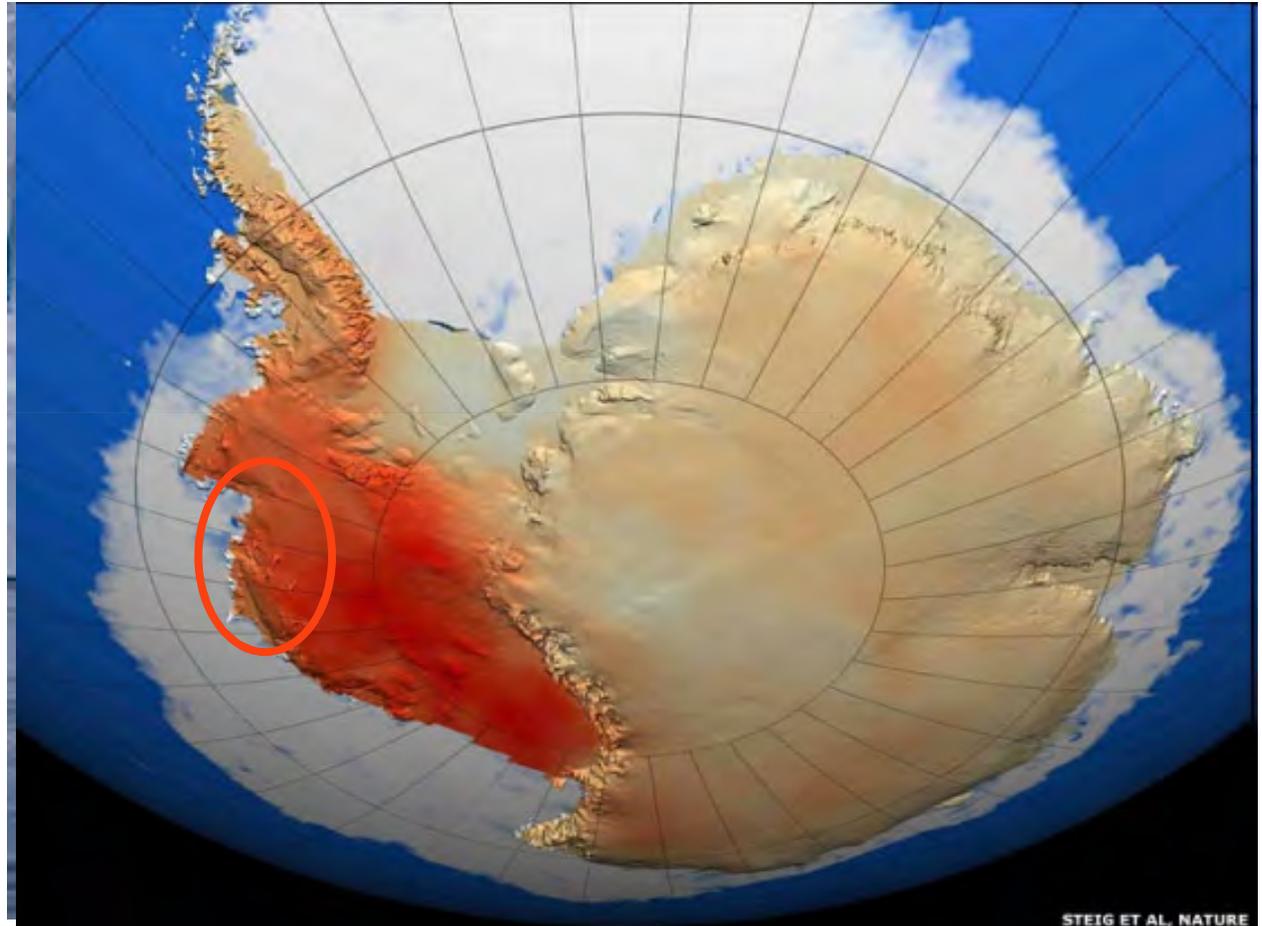
Mark  
Serreze,  
Director,  
Natl.Snow &  
Ice Data  
Center  
(NSIDC)



# ↑ Ice Sheets Melting Faster— *both polar regions*

Pine Island  
Glacier (bigger  
than NYC):

melting into  
sea at rate of  
2.5 miles per  
year or 35 ft  
per day



Steig, et al, *Nature* 457, 459-462 Jan 22 2009 “State of Polar Research” Feb 25, 2009  
World Meteorological Organization (WMO) and Intl. Council for Science (ICSU) ;  
*Observations beneath Pine Island Glacier in West Antarctica and implications for its retreat*  
Nature Geoscience <http://www.earth.columbia.edu/articles/view/2815> June 6 2011

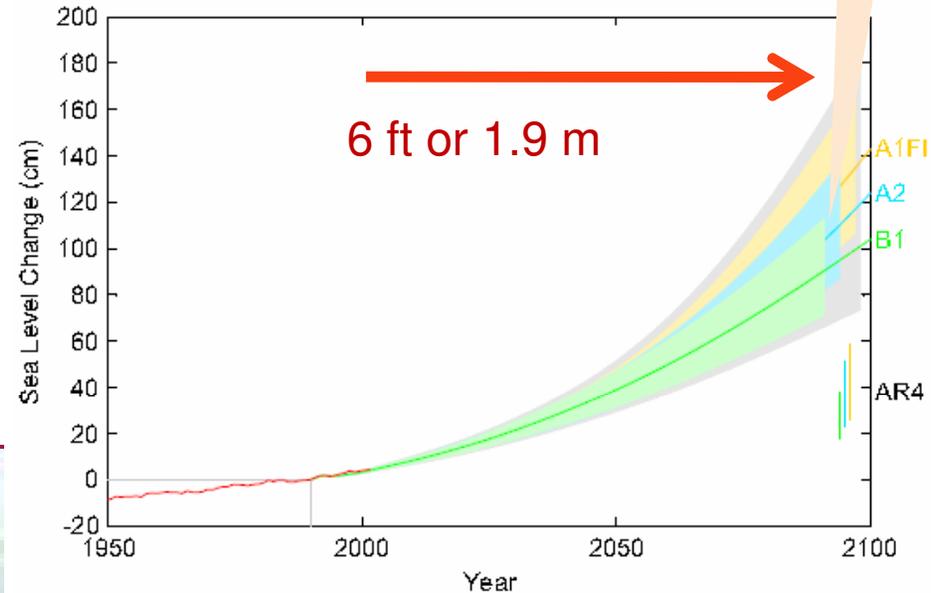


# Sea Level Rise— 6 ft or more by 2100

16.4 ft or 5 m?

**-Rate of global SLR  
already >2x faster  
than IPCC 2007  
predictions**

[www.climateinstitute.org.au](http://www.climateinstitute.org.au)



Vermeer, M., Rahmstorf, S. *Global sea level linked to global temperature. Proceedings of the National Academy of Sciences, December 2009*

Hansen, Sato:/ NASA: July 2011 Paleoclimate Implications for Human-Made Climate Change . Milutin Milankovitch 130<sup>th</sup> Anniversary Symposium. <http://arxiv.org/abs/1105.0968v3> - doubling ice loss every decade = meters SLR by 2100;

[www.energybulletin.net/stories/2012-01-03/hansen-still-argues-5m-21st-c-sea-level-rise-possible](http://www.energybulletin.net/stories/2012-01-03/hansen-still-argues-5m-21st-c-sea-level-rise-possible)

# ↑ SLR + High Tides + Storm Surges

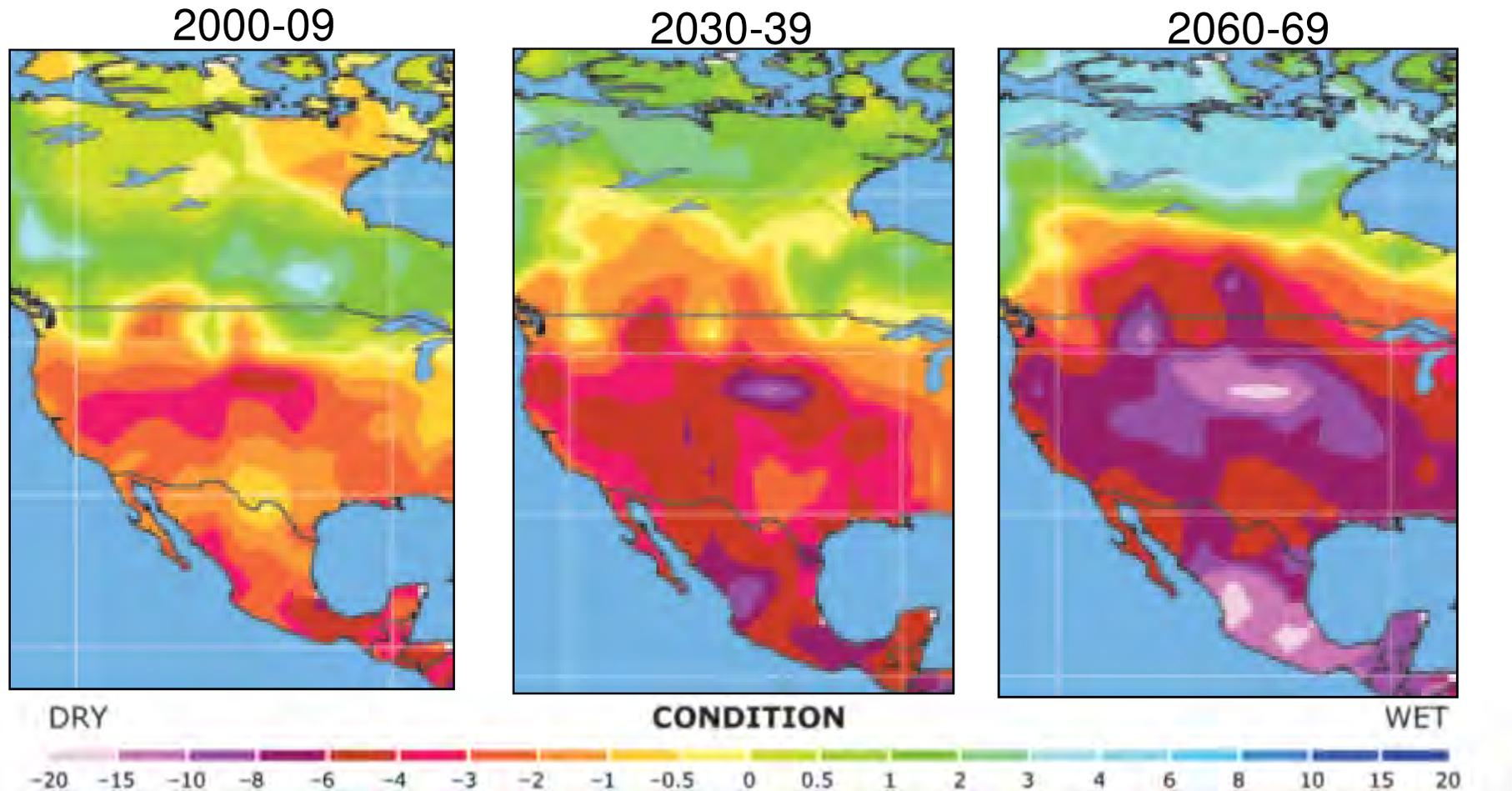
## 17 ft SLR with

- 3 ft. sea level rise (slr)
- 4 ft.+ high tide
- 10 ft. wave surges



[www.climatechange.ca.gov](http://www.climatechange.ca.gov)

# Extreme Drought - Permanent Dust Bowls Predicted in Southwest over Decades Ahead



Palmer Drought Severity Index of -4 or lower considered extreme drought; UCAR graphics; not forecasts  
*Drought under global warming: a review*, Aiguo Dai, National Center for Atmospheric Research, 19 Oct 2010

<http://onlinelibrary.wiley.com/doi/10.1002/wcc.81/full>

# ↑ Extreme, Unpredictable, Deadly Weather Events

**“It’s not the right question to ask if this storm or that storm is due to global warming, or is it natural variability. Nowadays, there’s always an element of both.”**

- Kevin Trenberth, National Center for Atmospheric Research, Aug 15, 2010



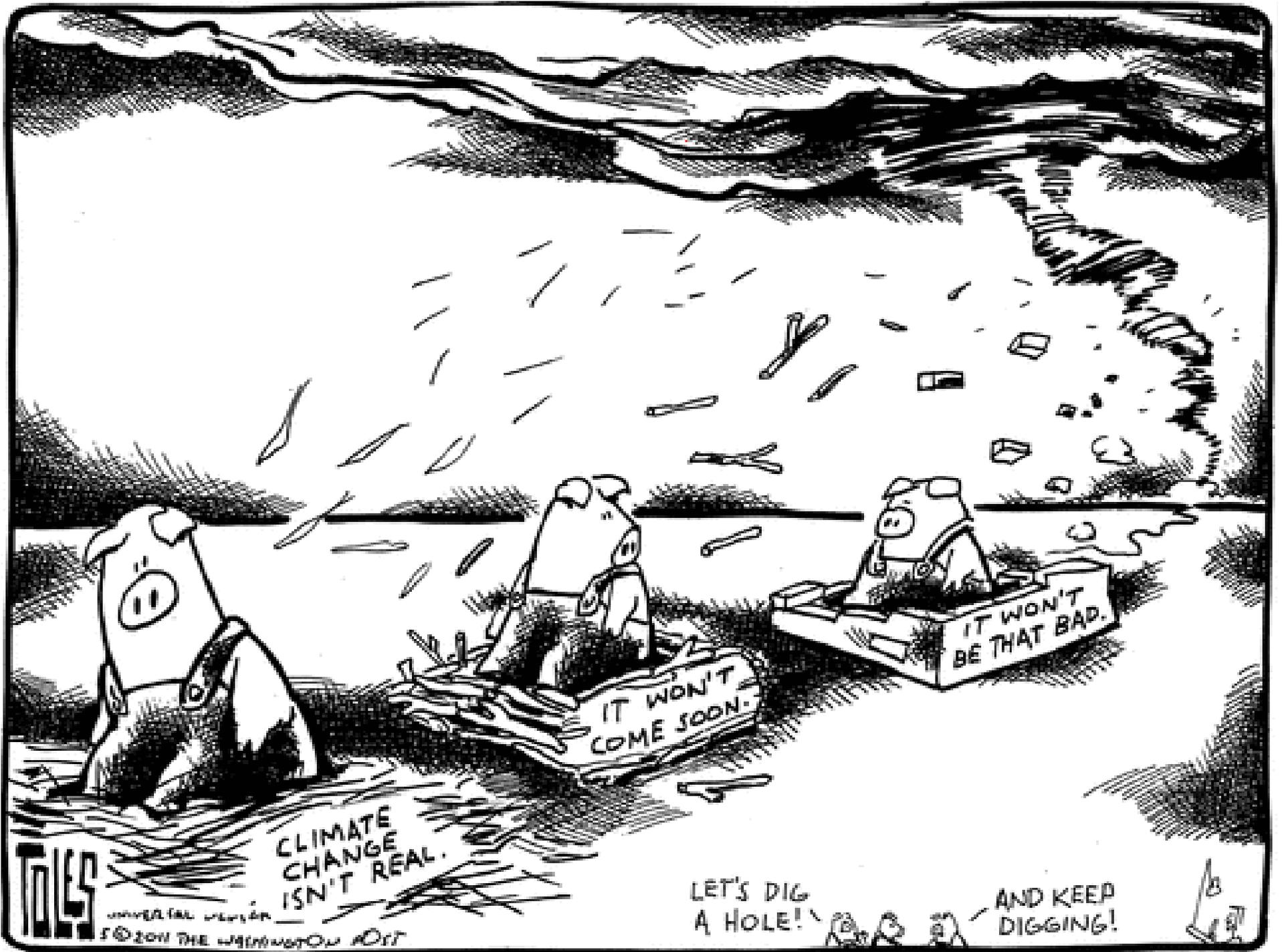
**Record-breaking:** flooding in Pakistan; heat/fire in Russia summer 2010; mud slides in China NY Times, Aug 15, 2010; Australian flooding Dec-Jan 2011; rain, snow and flooding in Midwest spring 2011; tornadoes in April 2011; drought and fire in AZ, TX and NM spring 2011

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2011- record number of extreme events; 2012- 4<sup>th</sup>  
warmest winter on record, 80 tornadoes March 2nd



..a record 14 weather and climate disasters in 2011 each caused \$1 billion or more in damages &....loss of human lives --NOAA  
<http://www.noaa.gov/extreme2011/drought.html>; [January was USA's 4th-warmest on record – USATODAY.com](http://www.usatoday.com/story/news/nation/2011/01/26/usa-4th-warmest-winter-on-record/20110126/)  
<http://www.torontosun.com/2012/03/05/scientists-see-rise-in-tornado-creating-conditions>;



CLIMATE CHANGE ISN'T REAL.

IT WON'T COME SOON.

IT WON'T BE THAT BAD.

LET'S DIG A HOLE!

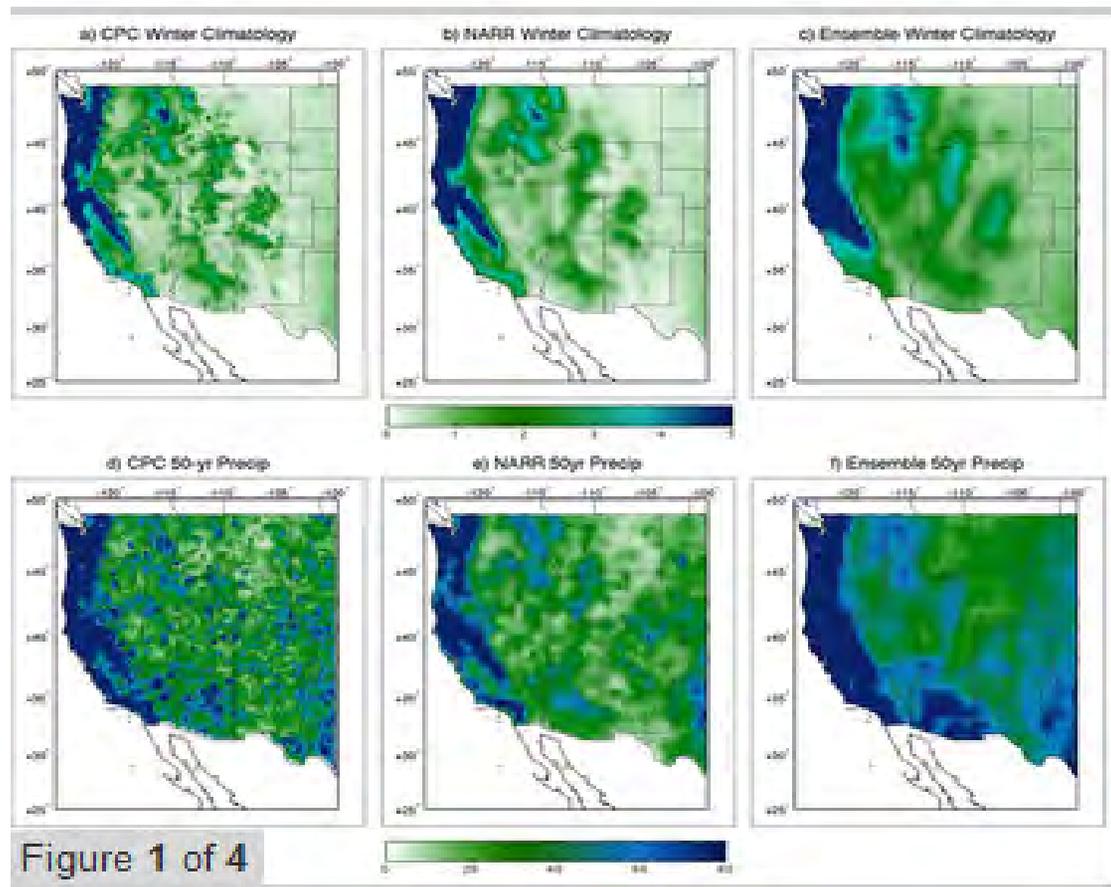
AND KEEP DIGGING!

TLS

UNIVERSAL UPI/ST  
©2011 THE WASHINGTON POST



# ↑ Intensity of extreme winter precipitation in West projected over next 50 yrs



...but a decrease in mean precipitation in Southwest

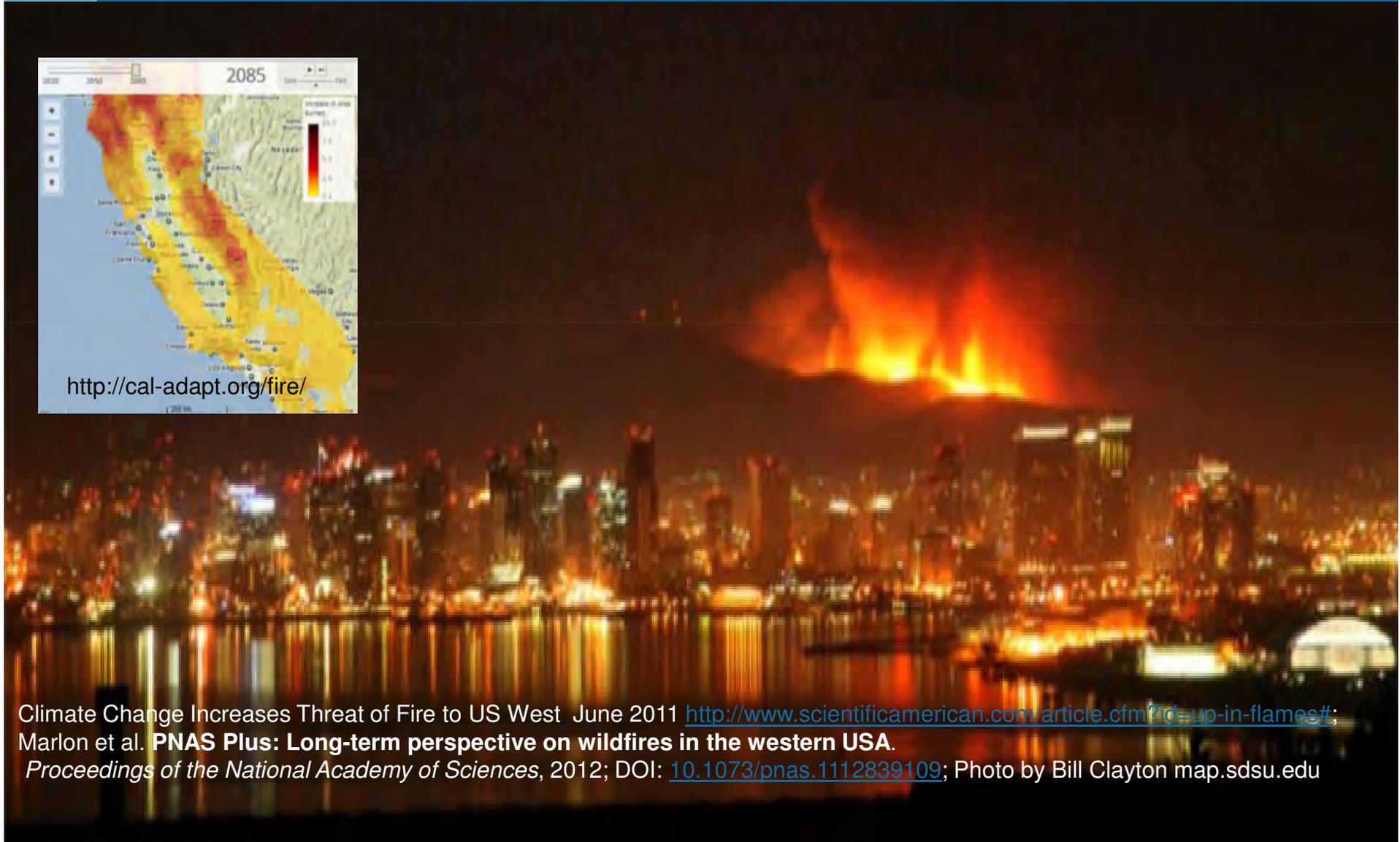


San Anselmo, CA Jan. 1, 2006

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# Nighttime Temperatures, Intense Heat Days, Drought, Wildfires



Climate Change Increases Threat of Fire to US West June 2011 <http://www.scientificamerican.com/article.cfm?id=up-in-flames#>;  
Marlon et al. **PNAS Plus: Long-term perspective on wildfires in the western USA.**

*Proceedings of the National Academy of Sciences*, 2012; DOI: [10.1073/pnas.1112839109](https://doi.org/10.1073/pnas.1112839109); Photo by Bill Clayton map.sdsu.edu

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# ↓ Snowpack over western US; project 70%- 90% loss in Sierra by 2075



Last 50 yrs-- so. Sierra snowpack larger, no. Sierra pack has shrunk,  
snowpack has declined over  $\frac{3}{4}$  of western US--

Feb 15, 2012 Mike Dettinger, USGS Hydrologist, Scripps

CA Climate Change Center [www.climatechange.ca.gov](http://www.climatechange.ca.gov)

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**Water Shortages**



**Water Storage**

Left: Photodisc. Right: Corbis



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# Fog on West Coast past 100 yrs; impact on entire Redwood ecosystem?



National Park Service



Johnstone, et al, Proceedings of the National Academy of Sciences. February 2010

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Wave Height Extremes- increased by ~30% last 2-3 decades; project up to 46 ft.+ next 100 years



Impacts potentially greater than sea level rise

Science Daily- Jan. 26, 2010, University of Oregon, *Coastal Engineering*  
March 2011 - [www.sciencenewsline.com/nature/2011032607430000.html](http://www.sciencenewsline.com/nature/2011032607430000.html)



## Biological diversity

**~25% of all  
species extinct  
by 2050;**

Thomas et al Nature 2004

**- underestimate?**

M. C. Urban, J. J. Tewksbury, K. S. Sheldon. **On a collision course: competition and dispersal differences create no-analogue communities and cause extinctions during climate change.** *Proceedings of the Royal Society B: Biological Sciences*, 2012; DOI: [10.1098/rspb.2011.2367](https://doi.org/10.1098/rspb.2011.2367)



Edith's Bay Checkerspot- Jasper Ridge population extinct; mismatch in timing between emergence of plantain, caterpillar

# Alpine species have nowhere to go

Pika or rock rabbit

Elevation at  
Yosemite  
(Grinnell):

- 1900- 7,800 ft
- 2004- 9,500 ft
- 500ft higher elevation just in last 10 years



United States Geological Survey

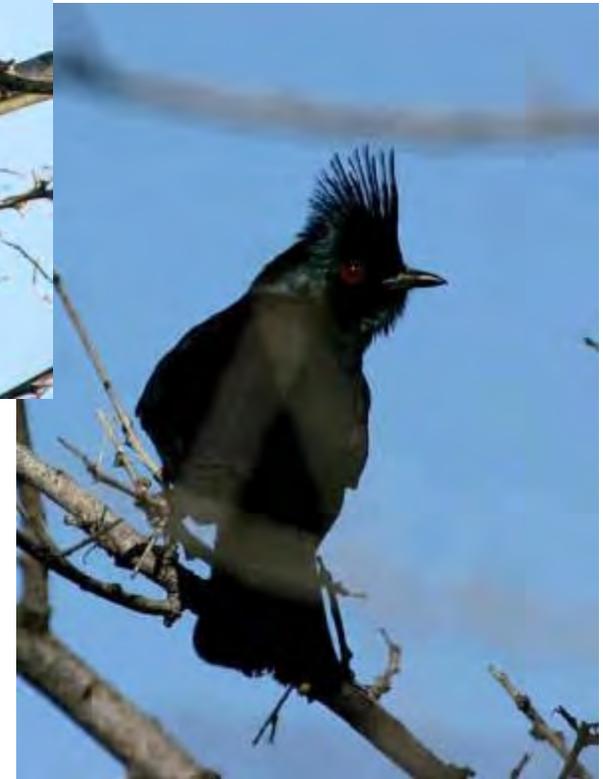
NY Times June 3, 2011 <http://green.blogs.nytimes.com/2011/06/03/pikas-have-moved-to-higher-ground/>



# So CA/ Sonoran Desert Record Drought 2006, 2007= Reduced or No Songbird Breeding



Crissal Thrasher



Phainopepla



# Changes in Songbird Arrival Dates

- ~50% have changes in arrival & departure dates
- Mismatch in timing between birds and food?



Swainson's Thrush



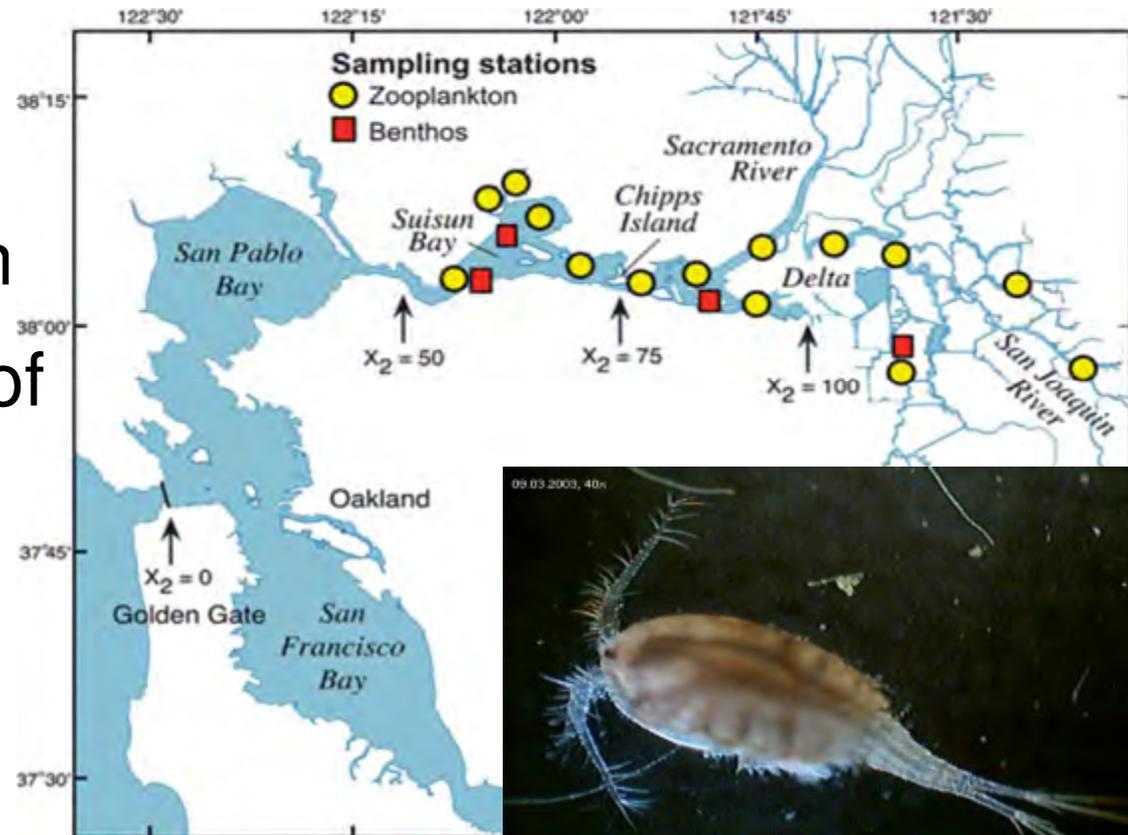
Black-headed Grosbeak



Barn Swallow

# Dramatic decline in SF Estuary copepods with non-native spp invasion during saltwater intrusions

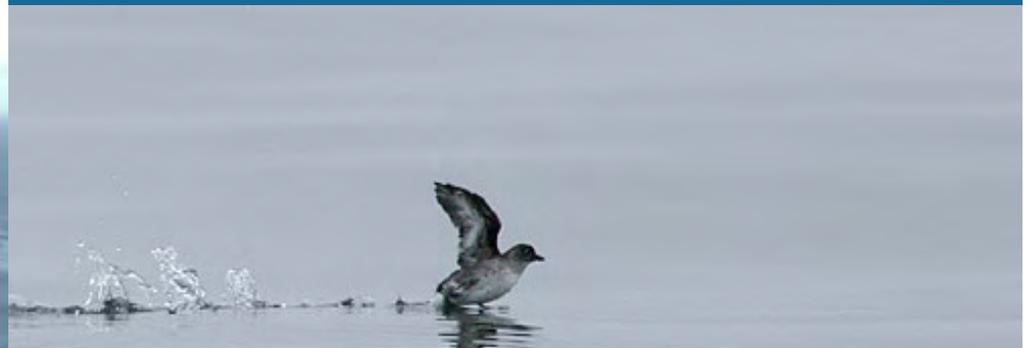
- due to drought & freshwater diversion
- synergistic effects of climate extremes & environmental perturbation facilitated invasives



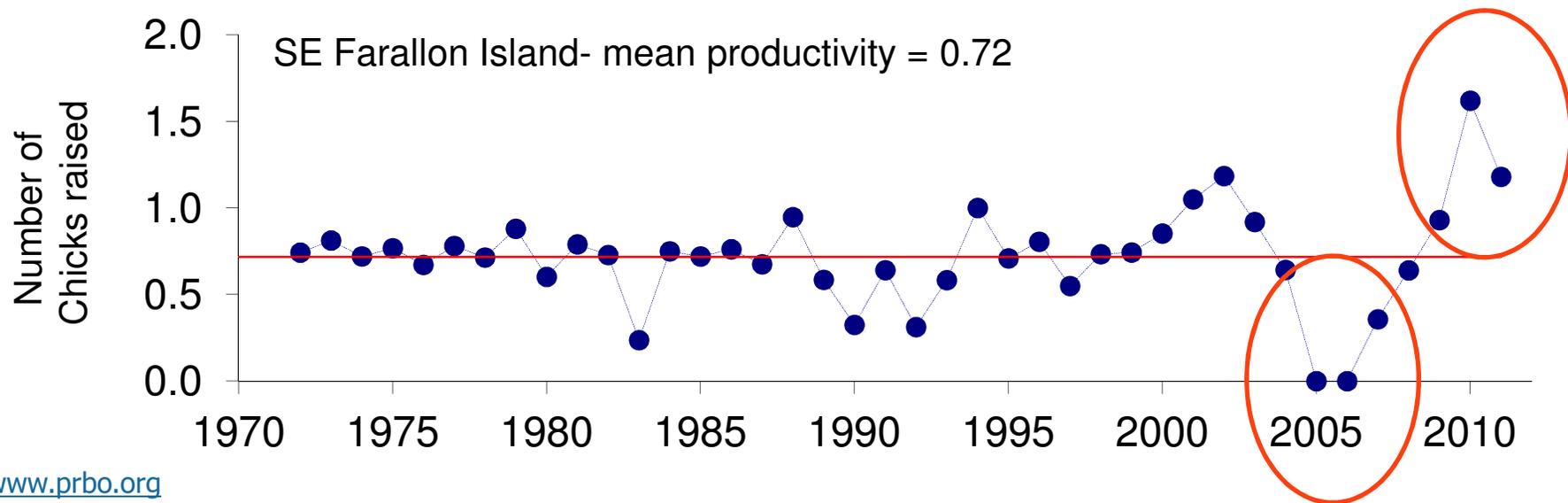
Droughts 76-77, 87-92 and refilling 76-80 and 87-95 with severe decrease in fresh H<sub>2</sub>O 92-93. Winder, Jassby & MacNally *Ecology Letters* (2011) 14: 749–757



# Increased Ocean Variability– *wildlife impacts*



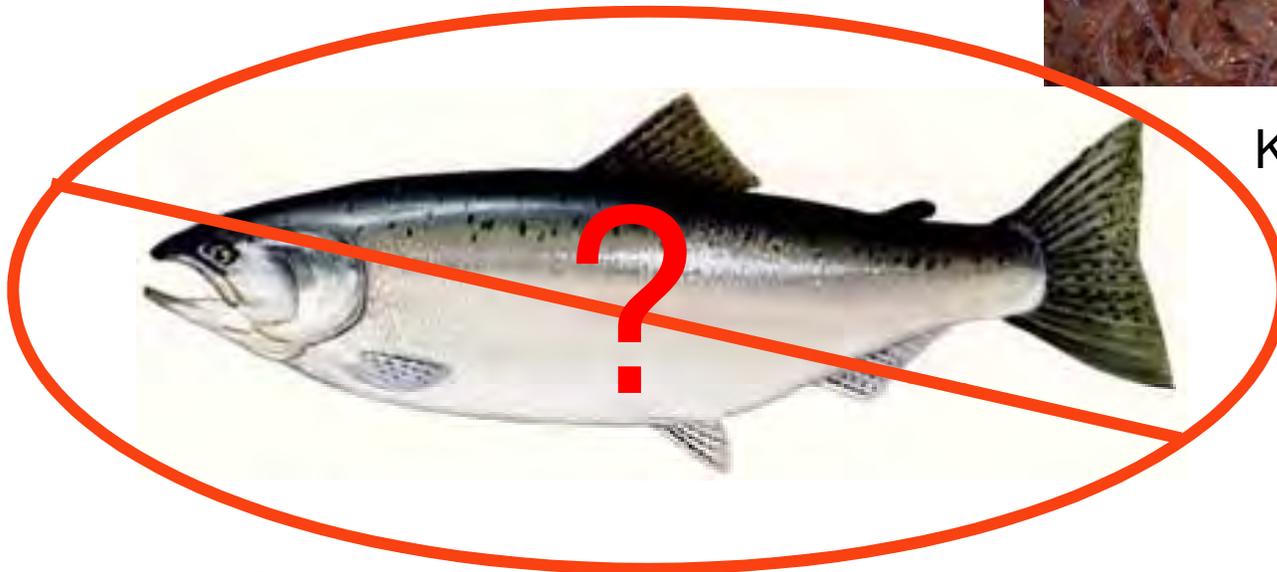
Cassin's auklets are expected to decline by >62% over next 20 yrs if 2005-2006 anomaly repeats.



# Future of Salmon in CA?



Krill



## *San Francisco Chronicle:*

“Salmon season called off in bid to save chinook”

April 11, 2008

“Smallest fall run of chinook salmon reported”

February 19, 2009

“Feds: Calif. returning chinook salmon a record low”

February 11, 2010

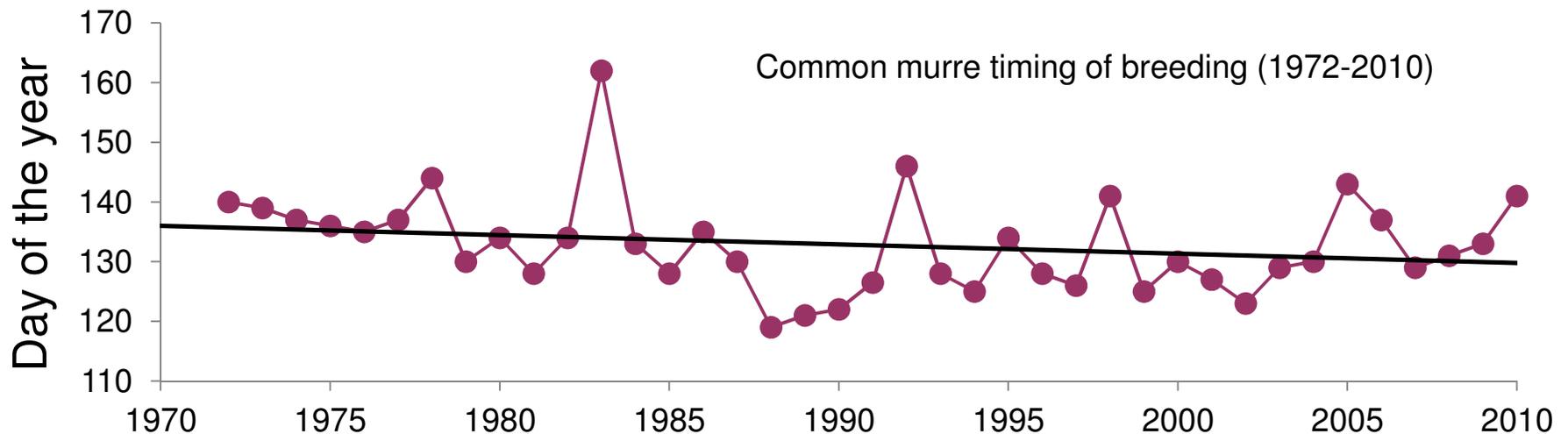


# Other Changes



## Common murre:

- breeding 20 days earlier
- likely tracking changes in upwelling
- impact on population?





# Extreme Heat Events... *Nest Abandonment, Chick Mortality on Alcatraz, Farallon Refuge*

## Brandt's Cormorant



Record Heat in SF Bay Area- May 15-16, 2008

# Acorn Woodpecker: negative response to projected future climate *(precipitation)*

http://data.prbo.org/...hange-distribution

**Modeling Bird Distribution Responses to Climate Change:**  
*A mapping tool to assist land managers and scientists in California*

prbo

**Species Distribution** [Start Over](#)

**Select a habitat type:** Oak Woodland

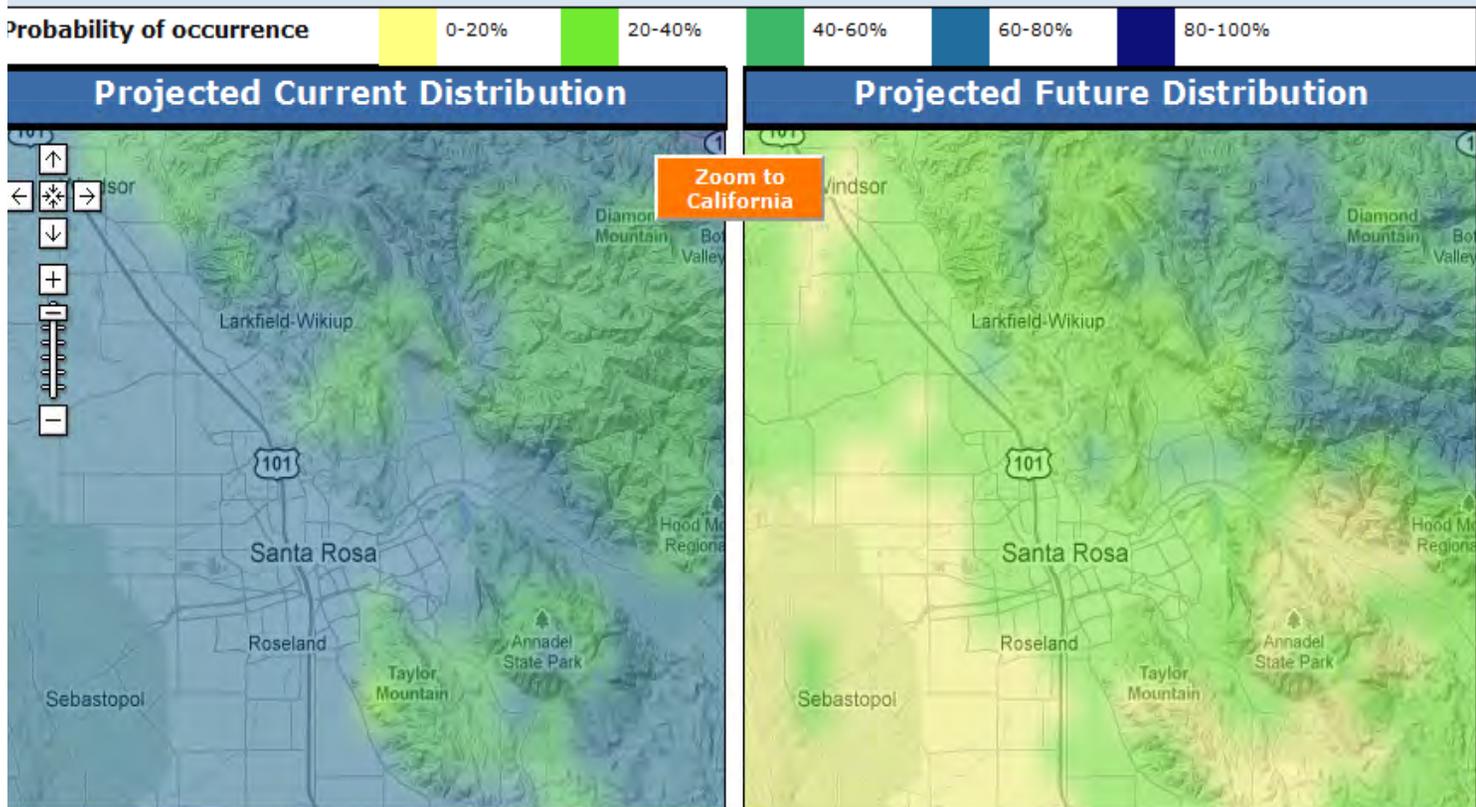
**Select a species:** Acorn Woodpecker

Results from GFDL CM2.1 climate model and Maxent algorithm

**Select other data:** [www.prbo.org/data](http://www.prbo.org/data)

Current range maps (more info)

Show locations for this species



## Acorn Woodpecker



Photo (c) Peter LaTourrette

Learn more about the **Acorn Woodpecker** at [All About Birds](#) or read the [Partners In Flight](#) species account

### Variables in order of Importance

1. Annual precipitation
2. Maximum temperature

# Oak Titmouse: positive response (vegetation)

http://data.prbo.o...hange-distribution

**Modeling Bird Distribution Responses to Climate Change:**  
A mapping tool to assist land managers and scientists in California

**Species Distributions**

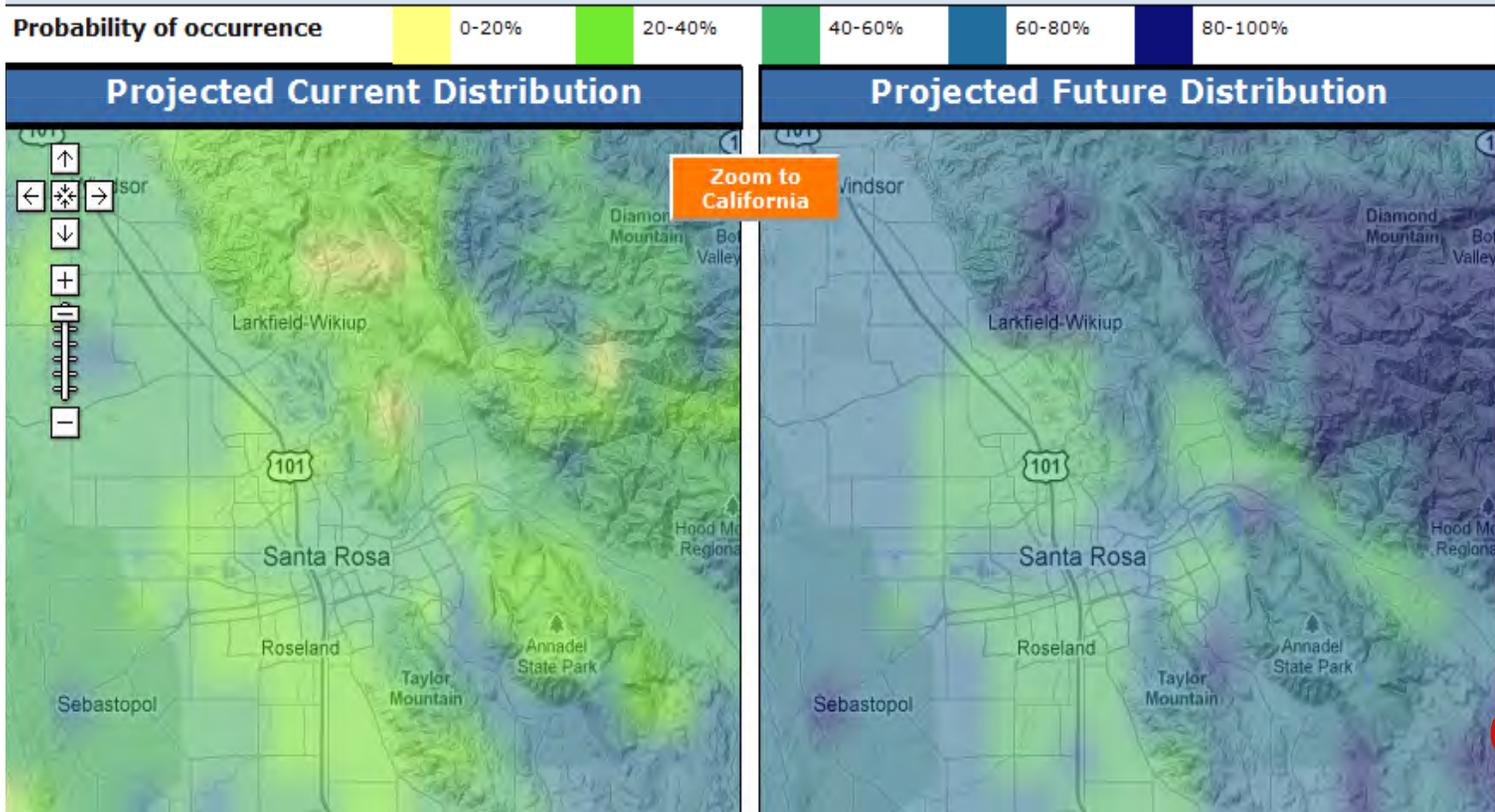
**Select a habitat type:** Oak Woodland

**Select a species:** Oak Titmouse

Results from GFDL CM2.1 climate model and Maxent algorithm

Start Over

Two oak woodland associated bird species but different responses to changing conditions....



## Oak Titmouse



Photo (c) Peter LaTourrette

Learn more about the **Oak Titmouse** at [All About Birds](#) or read the [Partners In Flight](#) species account

**Variables in order of Importance**

1. Vegetation
2. ...

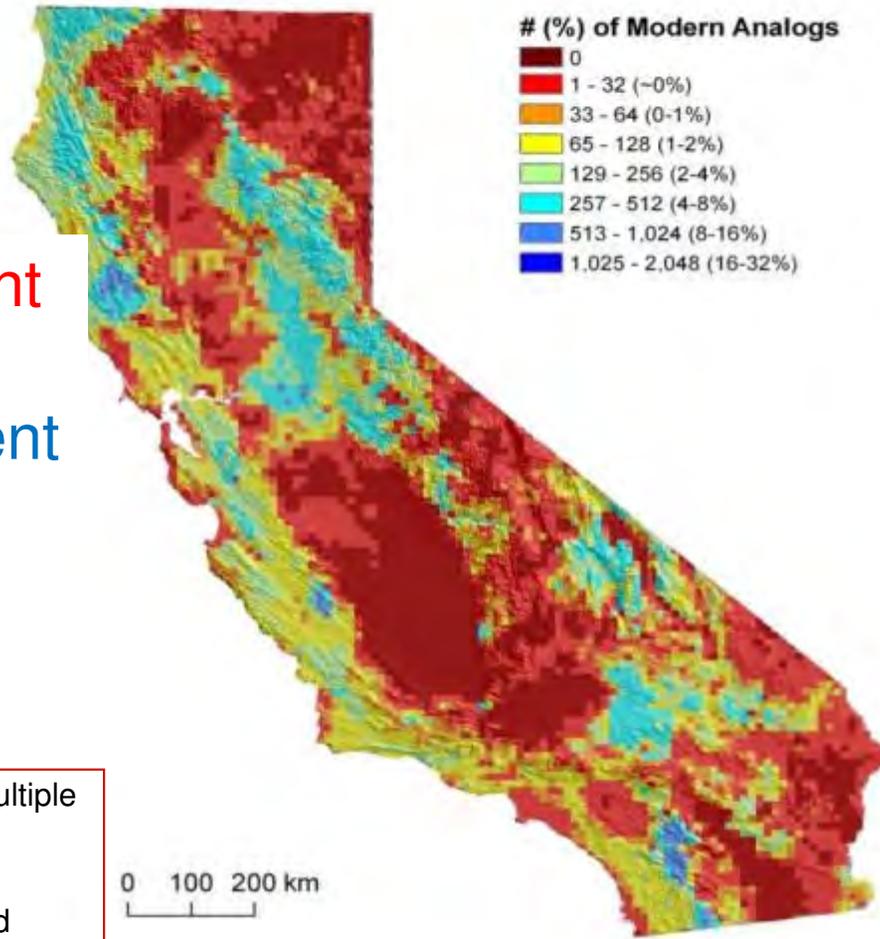
# By 2070: Over 50% of CA with very different “no-analog” bird communities

Red= Very Different

Blue= Less Different

[www.prbo.org/data](http://www.prbo.org/data)

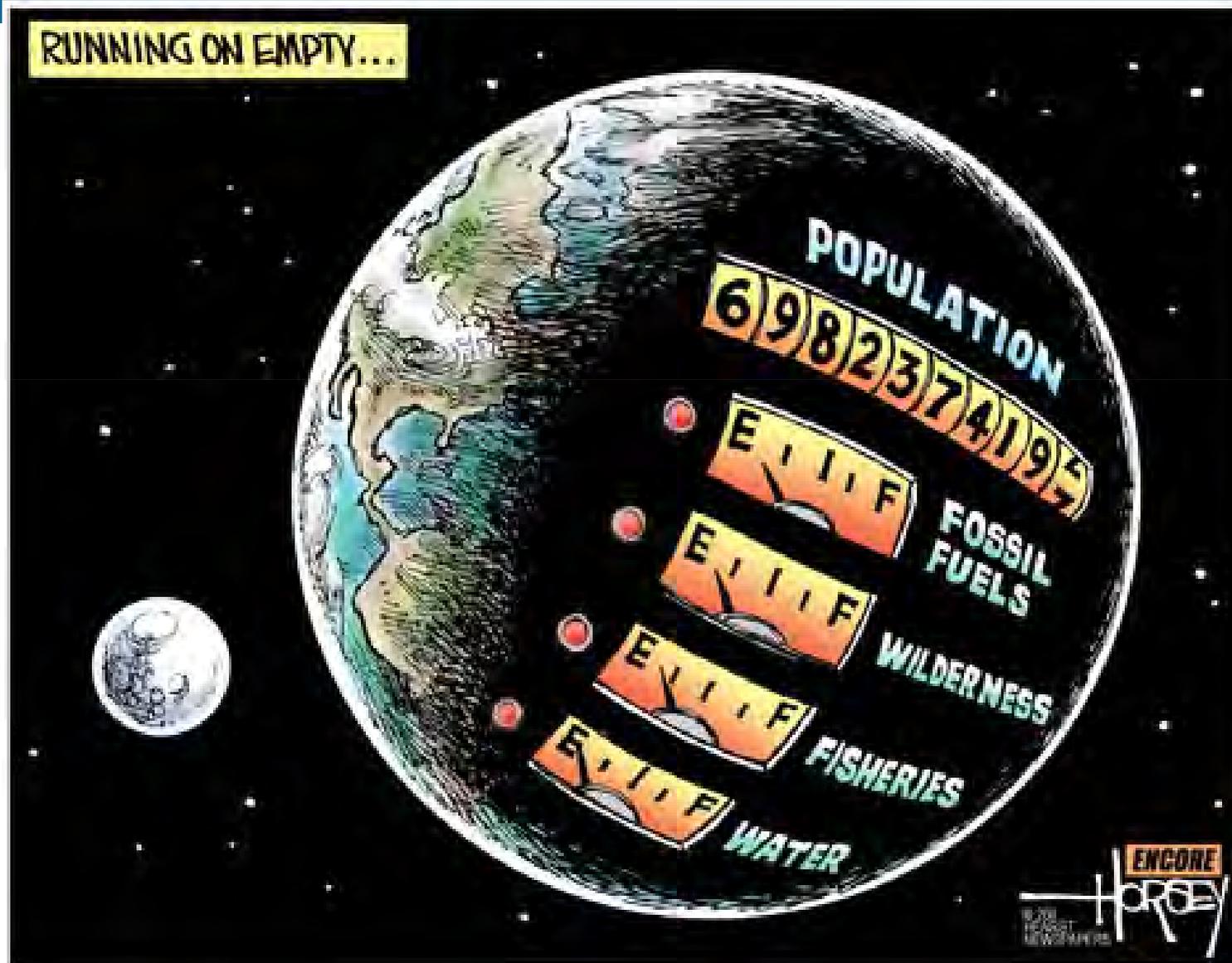
- Data from 60 land bird focal species; from multiple partners including KBO, CDFG, others
- Assumes all exist 60 years from now
- Combined with temperature, precipitation and vegetation variables
- From IPCC moderate climate scenarios A1B, A2



Source: PRBO, Stralberg et al., PLoS One, 2009



# Business as Usual



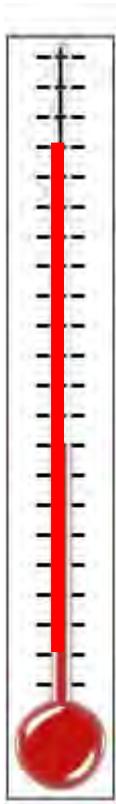
# Humans Rely on Healthy Ecosystems!

## *Ecosystem Services*

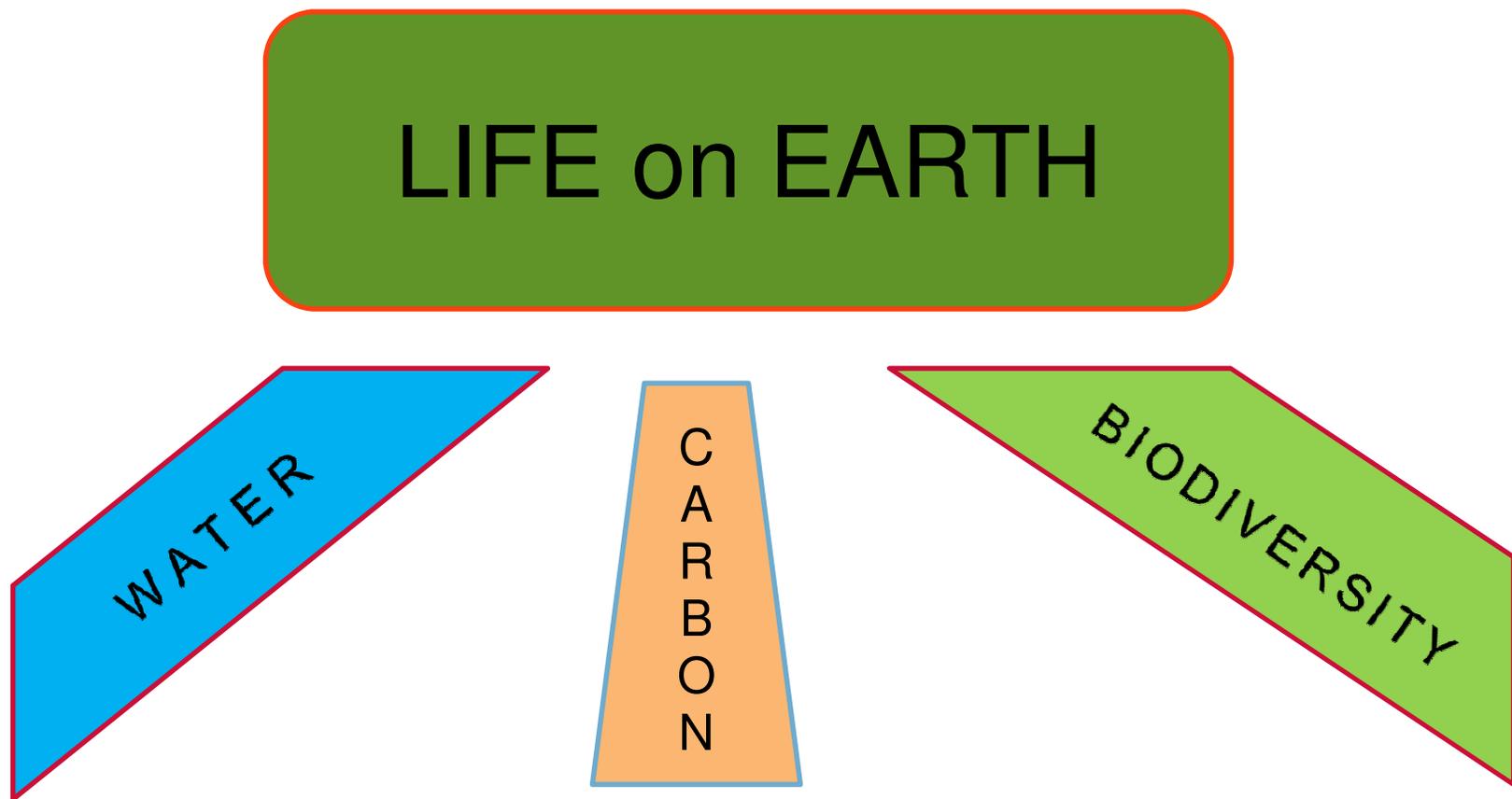
- Food
- Freshwater
- Wood and Fiber
- Fuel
  
- Climate
- Flood
- Disease
- Water quality
  
- Recreational
- Educational
- Spiritual



# How Might We Provide Time for Wildlife and People to Adapt? (*adaptive capacity*)



# Must Manage for Multiple Benefits Simultaneously- *move from single species to whole ecosystem approach*



# To Prevent Extreme Climate Disruption- Engage in Mitigation and Adaptation

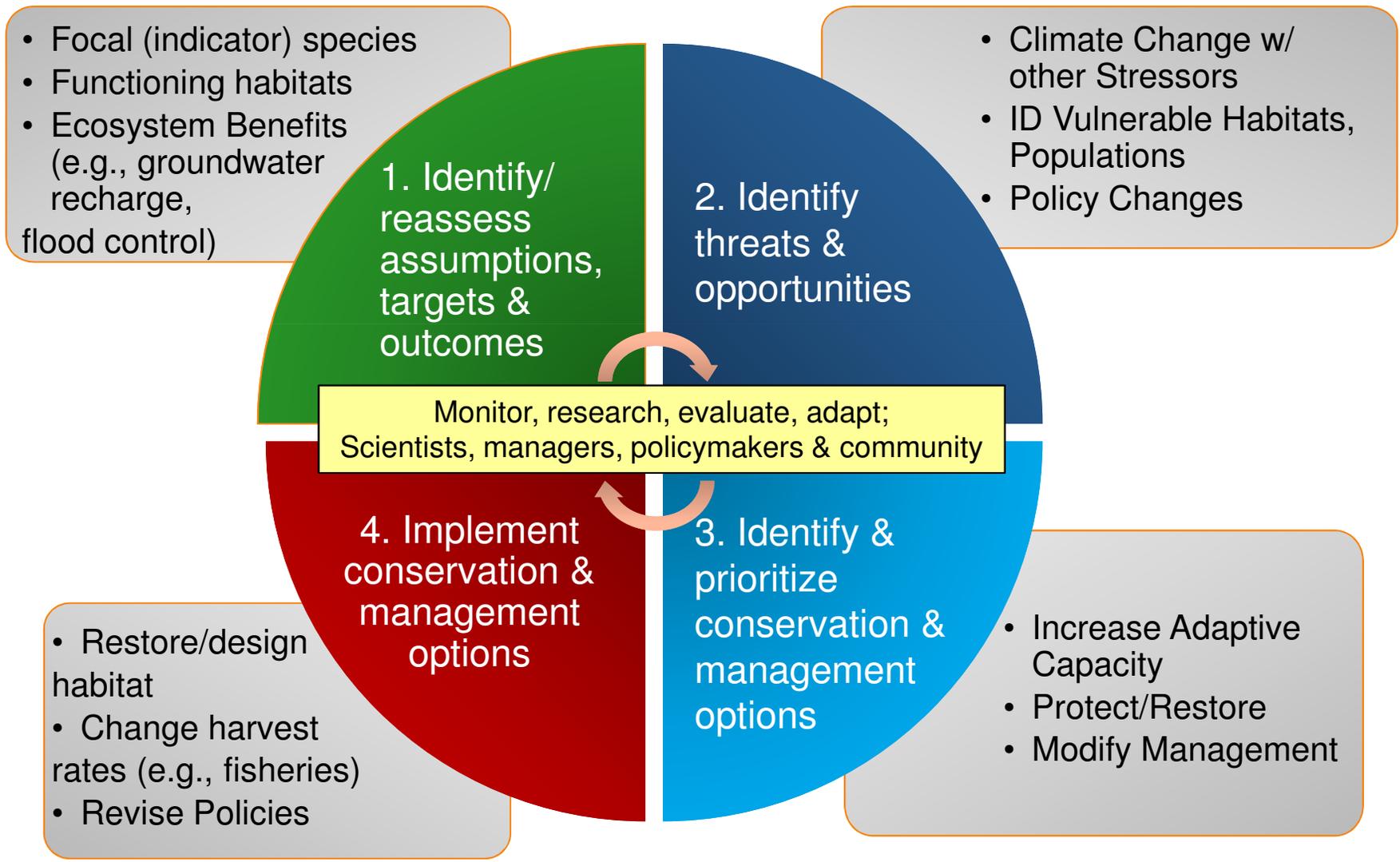
- **Mitigation:** reduce greenhouse gas emissions and enhance carbon sinks



- **Adaptation:** actions to reduce the risks of and to adapt to climate change impacts on the human and **natural environment**



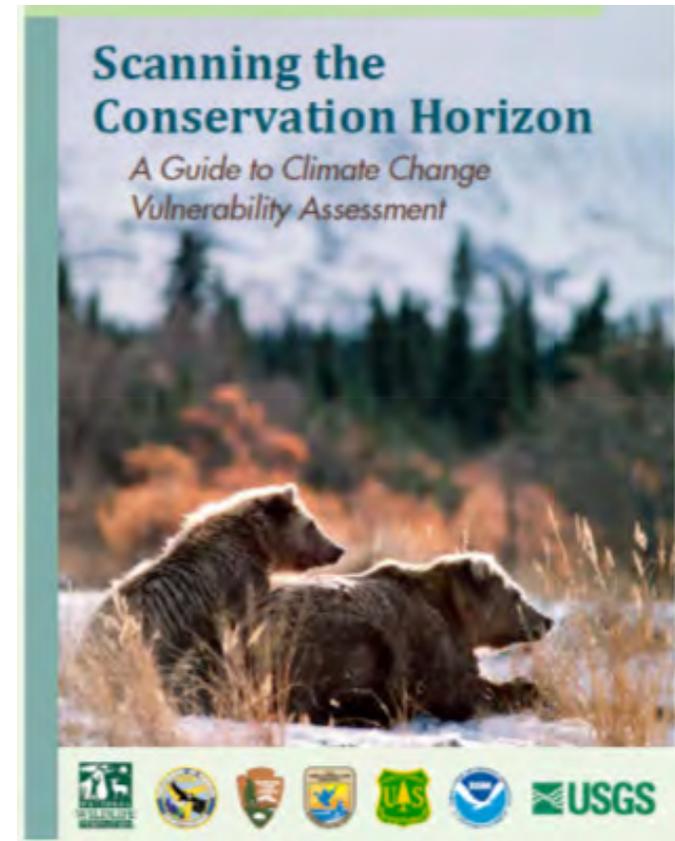
# Climate Smart: Flexible, Adaptive Conservation



# Climate Smart: Assess Vulnerability

[http://dfg.ca.gov/Climate\\_and\\_Energy/vulnerability\\_assessments/](http://dfg.ca.gov/Climate_and_Energy/vulnerability_assessments/)

A Vulnerability Assessment seeks to determine how susceptible-how at risk- a species or a system is to the negative impacts of climate change.



Source: Smit et al. 2000. *Climatic Change* 45  
Williams et al. 2008. *PloS Biology* 6

Glick, et al, 2011 National Wildlife Federation,  
[www.nwf.org/News-and-Magazines/Media-Center/Reports/Archive/2011/Scanning-the-Horizon.aspx](http://www.nwf.org/News-and-Magazines/Media-Center/Reports/Archive/2011/Scanning-the-Horizon.aspx)

# CA Rare Plants- Climate Change Vulnerability Index

## Example: *Brodiaea orcuttii*

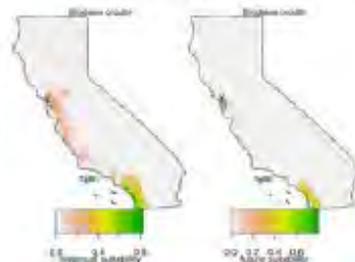
### Preliminary result: highly vulnerable

- Prefers vernal moist grasslands and is dependent on a seasonal flood regime.
- Predicted climate change exposure is + 2.2-2.4 C for half of the *B. orcuttii* occurrences and + 2.5-2.7 C for the other half of the *B. orcuttii* occurrences (Figure 2).
- Anthropogenic barriers: Development and construction are major threats; the majority of its range is surrounded by high density urban interface.
- Renewable energy production within the species range also threatens the species, decreasing its ability to shift range and, therefore; increasing its susceptibility to climate change.



Copyright © 2001 Ellen Friedman & Ted Dunning

Figure 2: Maxent's predicted historical (1951-2006) and future (2080) climate suitability



- Assessed 156 rare plant species
- Found most species vulnerable



© 2004 BonTerra Consulting

# Climate Change Vulnerability of CA's At-Risk Birds

2012 PRBO-CDFG publication-- builds on 2008 Bird Species of Special Concern and 2011 Literature Review of Climate Change Impacts by CA Eco-regions

<http://data.prbo.org/apps/bssc/>

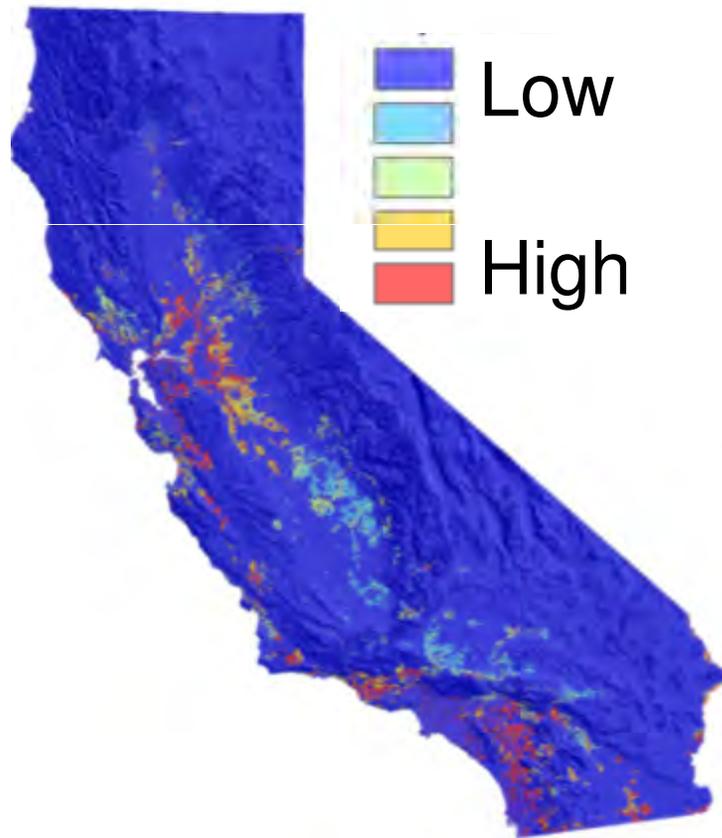
- Ranked 358 at-risk bird species
- Found 128 (38%) vulnerable to climate change (on top of other threats- e.g., development, invasives)
- Most vulnerable in wetlands (e.g., tidal marshes, beaches and rocky shorelines); also marine, arid lands
- Helps guide allocation of scarce conservation dollars



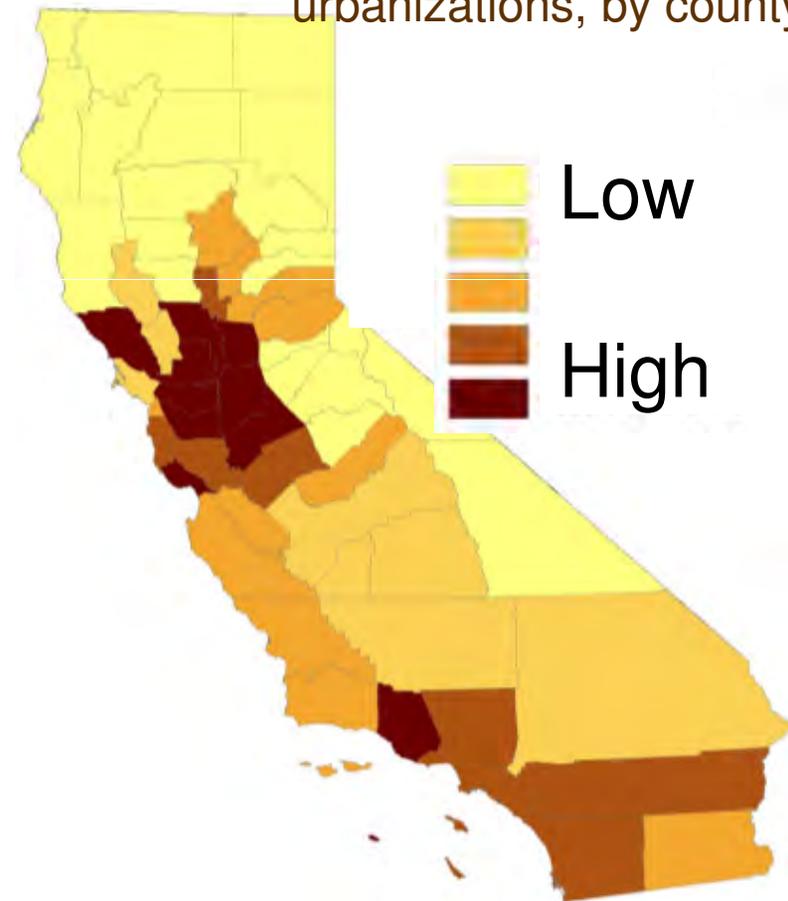
# Climate Smart: Incorporate development; Climate alone

underestimates impacts - *e.g., Climate, housing density & oak woodland birds*

Red = high conservation value & threat from future urbanization

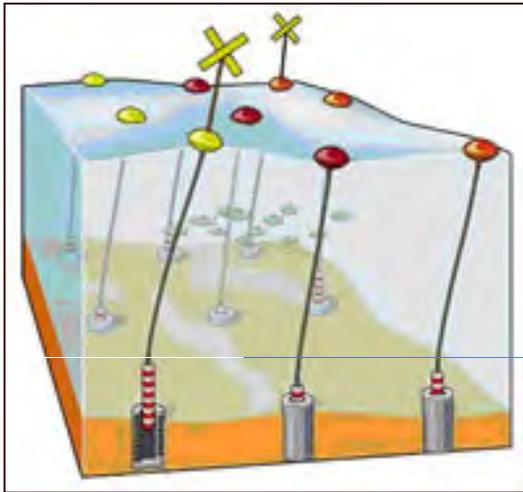


Brown = high conservation value & threat from future urbanizations, by county



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# Renewable Energy Siting: Assess ecological impact, ensure science-based decisions & as eco-friendly as possible



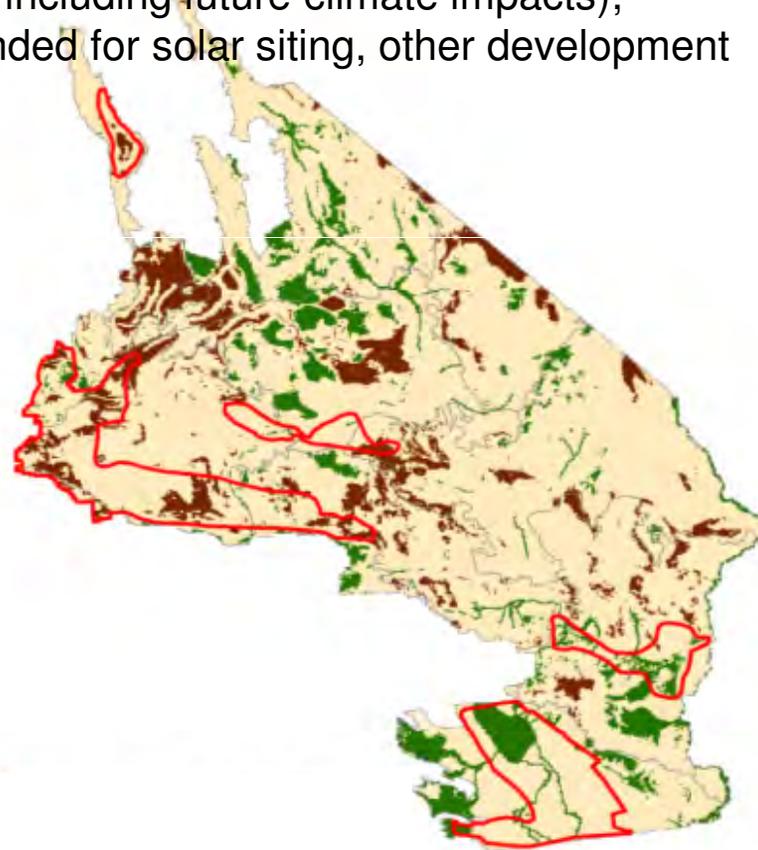
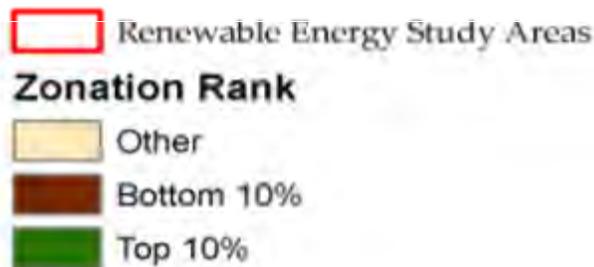
State renewable energy goal -- 33 % of all retail electricity by 2020



# Climate Smart: Ranked top 10% of landscape to avoid disturbance from solar siting

For CA DRECP Planning Area based on breeding land bird focal species

Finding: Every CA desert region (Colorado, Mojave and Sonoran) contains high priority portions valuable to birds (not including future climate impacts);  
Degraded areas recommended for solar siting, other development



PRBO, Howell, et al, 2011  
<http://www.prbo.org/cms/574>  
and to the website with the data layers  
available for download:  
<http://data.prbo.org/apps/drecp/>

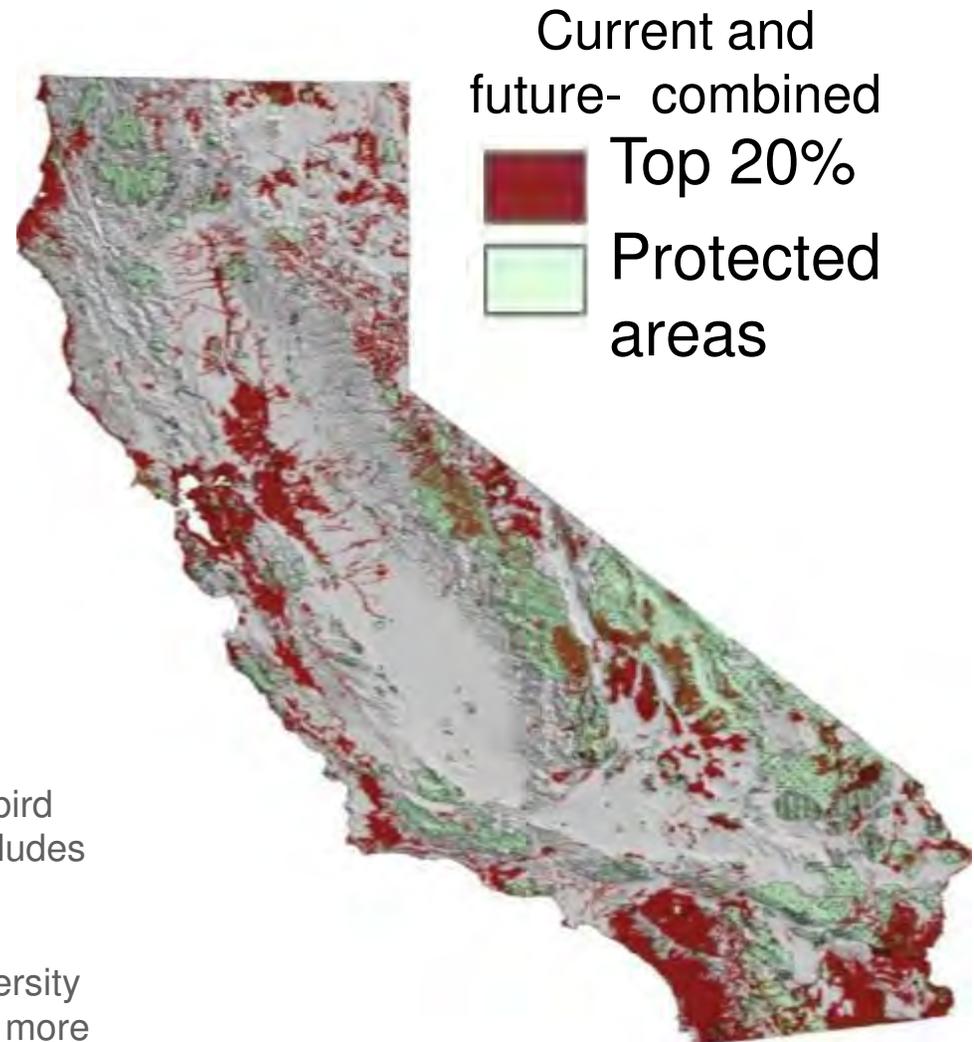
# Climate Smart: Prioritize conservation investments across CA *(based on birds, vegetation)*

~80% of highest priority conservation areas fall outside of today's existing protected areas...

How protect them?

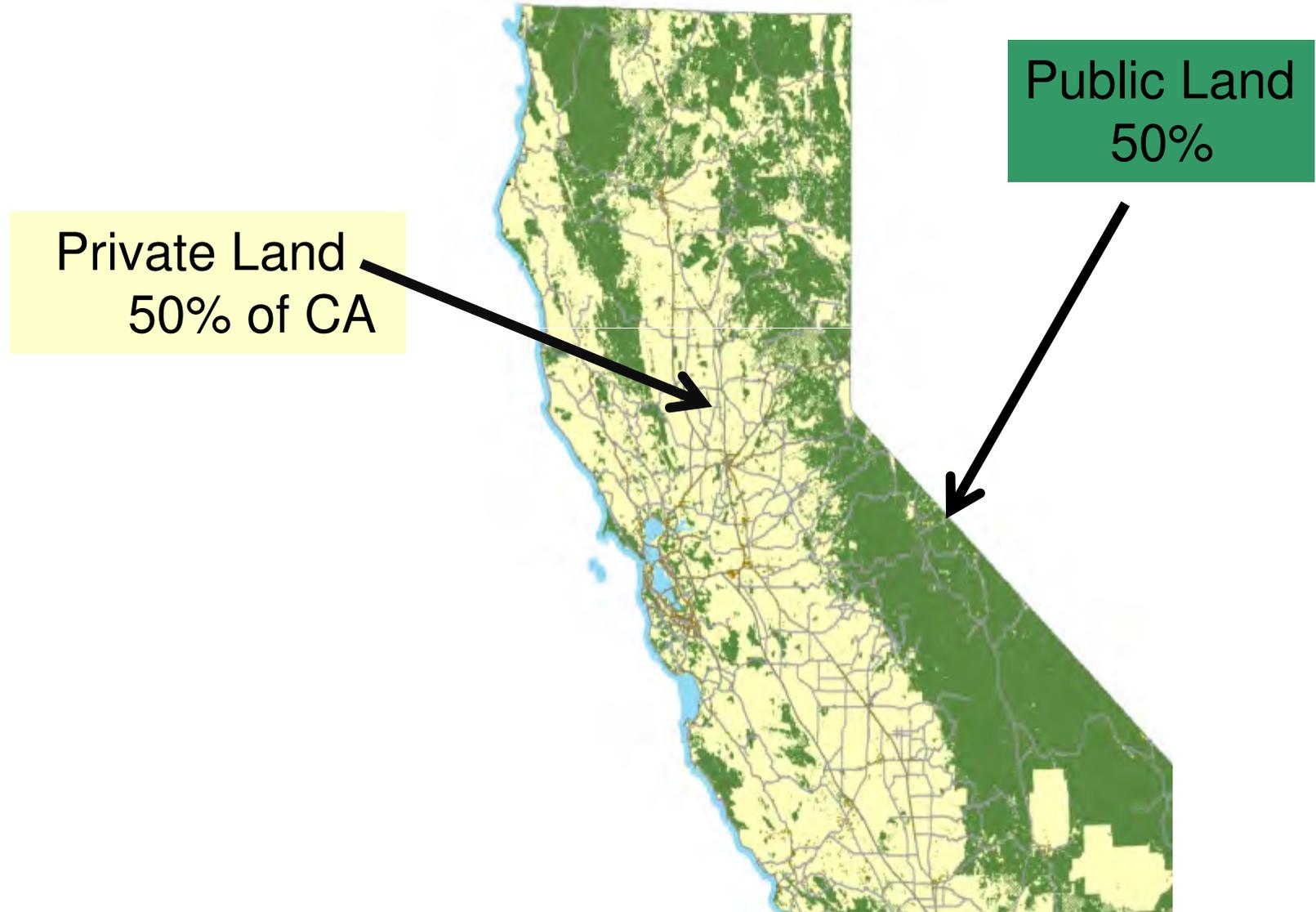
- PRBO statewide **Zonation** analysis of 199 bird species, vegetation, and climate models; includes current and future distributions

- Data from PRBO, KBO, CDFG, Natural Diversity Database, USGS, eBird, Forest Service and more



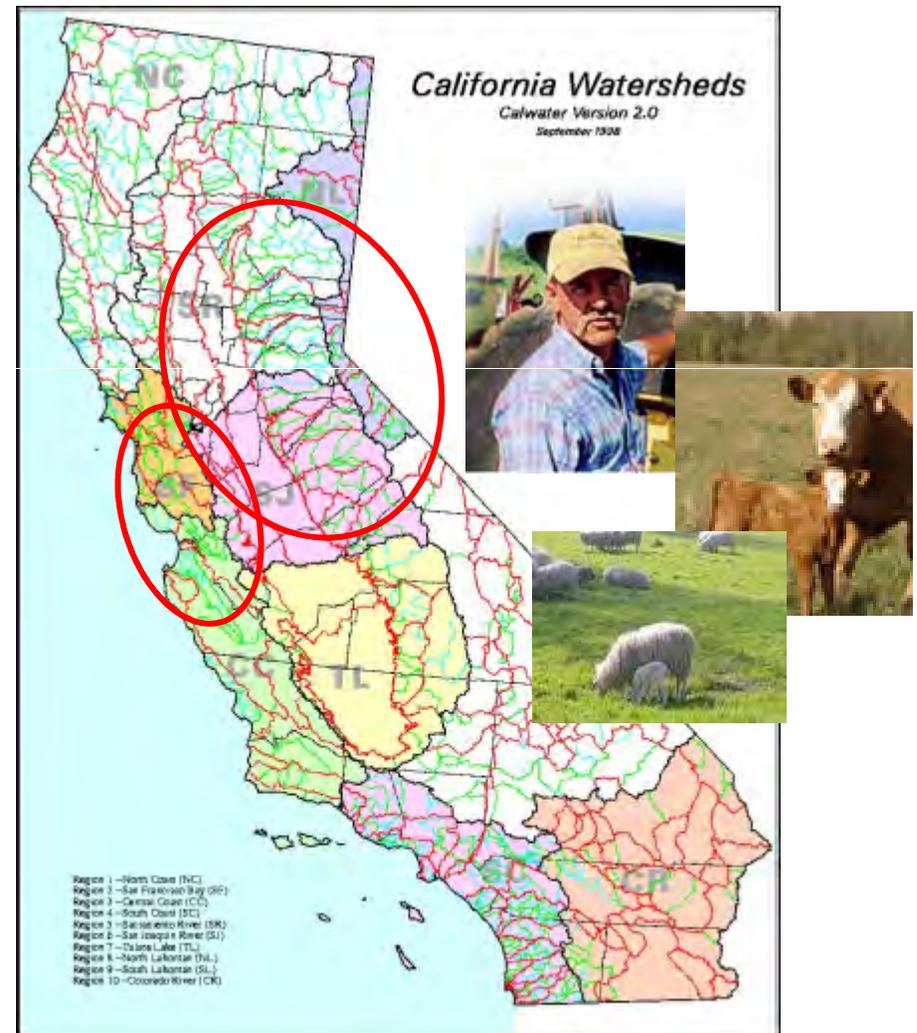
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# Climate Smart: include major private lands efforts to address climate impacts on wildlife— *landscape scale*



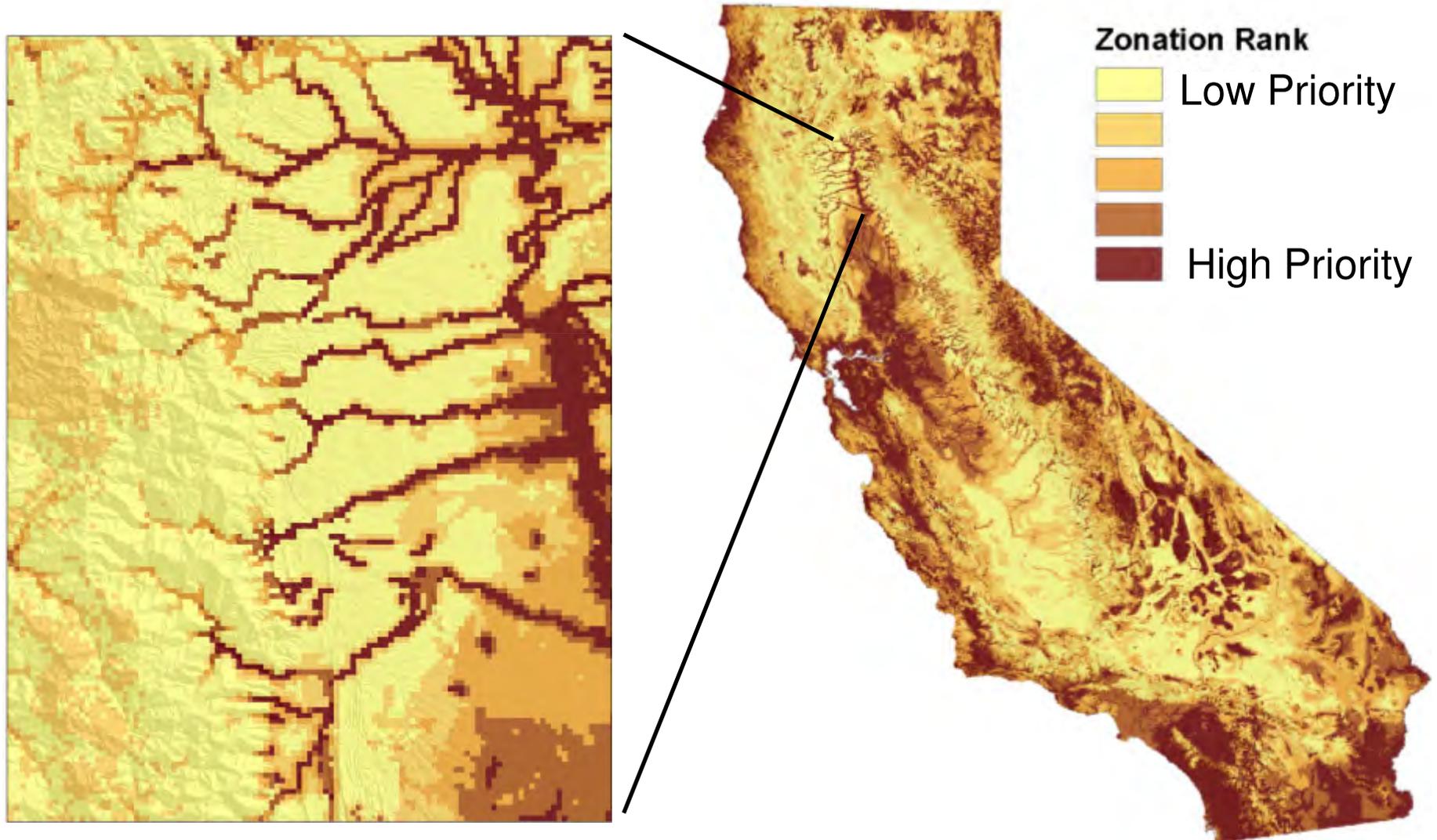
# Climate Smart: Work w/ private landowners to “re-water” foothills through eco-friendly grazing practices

- Leverage Farm Bill funds
- Hire, train 21 partner biologists with NRCS
- Enhance 1 million+ acres on grazing lands in Sac and SJ Valley foothills, and Coastal Watersheds over next 5 years
- Restore water storage & flow = double Hetch-Hetchy
- Ecological, economic benefits



PRBO Conservation Science

# Combined Current/Future Zonation prioritizes riparian areas—*mostly “potential”* – *must be restored*



Source: PRBO, Veloz, et al., manuscript, 2012

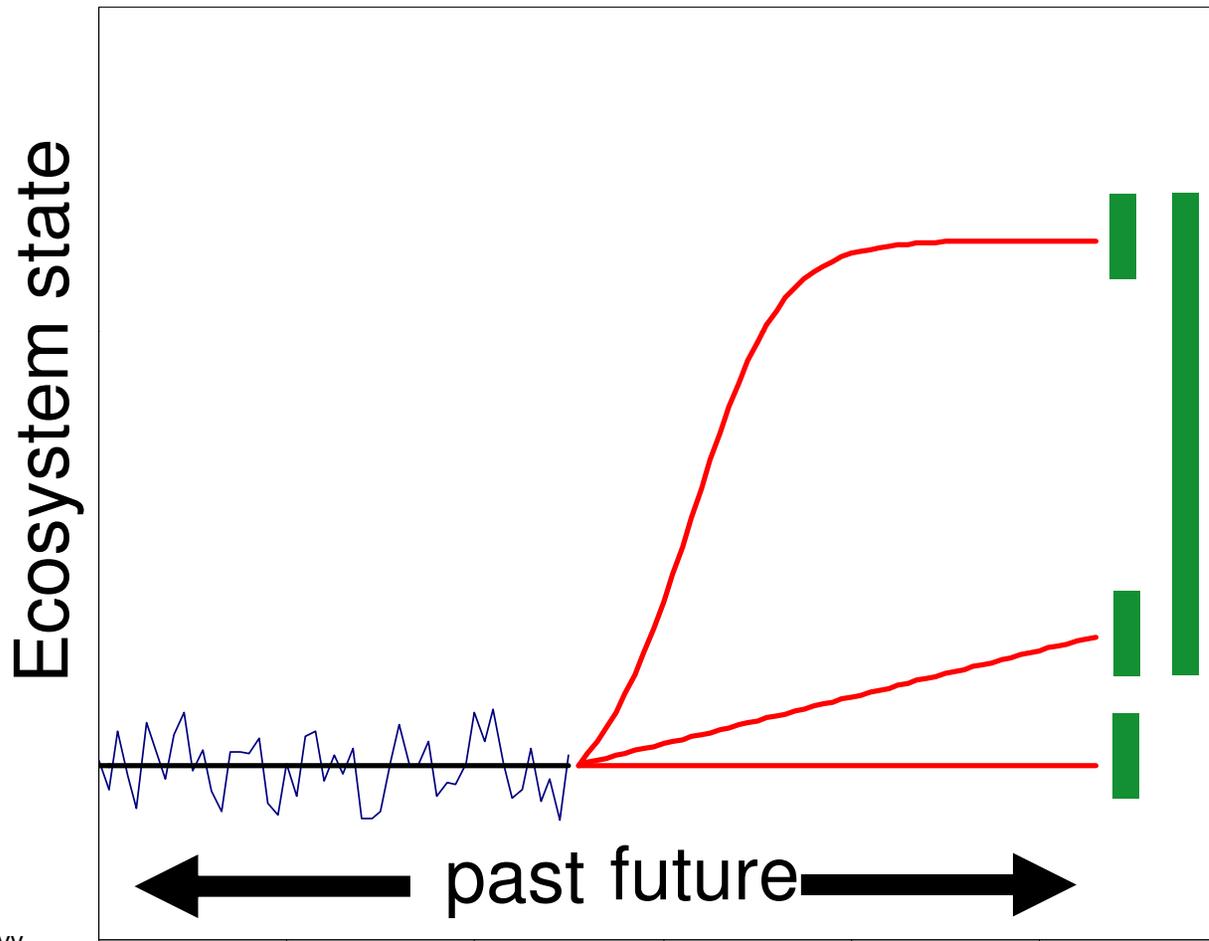
# Climate Smart: Riparian restoration – multiple benefits for wildlife and people

- Reduces drought and flood impacts
- Recharges groundwater
- Provides habitat connectivity
- Creates thermal refugia for wildlife
- Supports fish, birds, other wildlife

[www.PRBO.org](http://www.PRBO.org) Seavy et al., **Why climate change makes riparian restoration more important than ever.** 2009. *Ecological Restoration* Ecol. Rest. v27



# Climate Smart: plan for extremes, wider range of variability to increase adaptive capacity



-- Design restorations to succeed under multiple scenarios

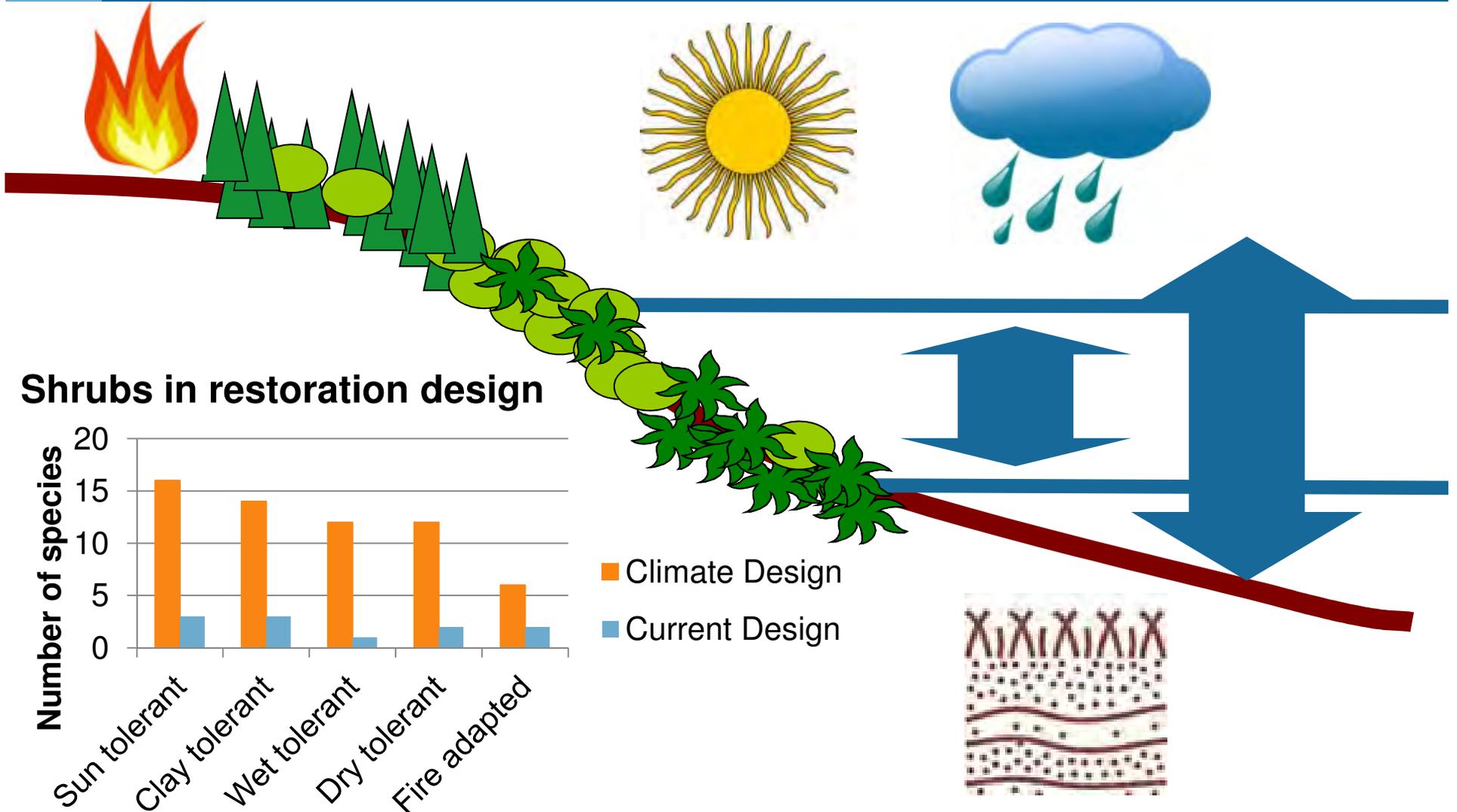
-- Reduce stressors and (e.g., non-native predators, noxious invasives,

-- Protect refugia (e.g., marine food web reserves)

-- Manage for habitat and 'climate space' heterogeneity

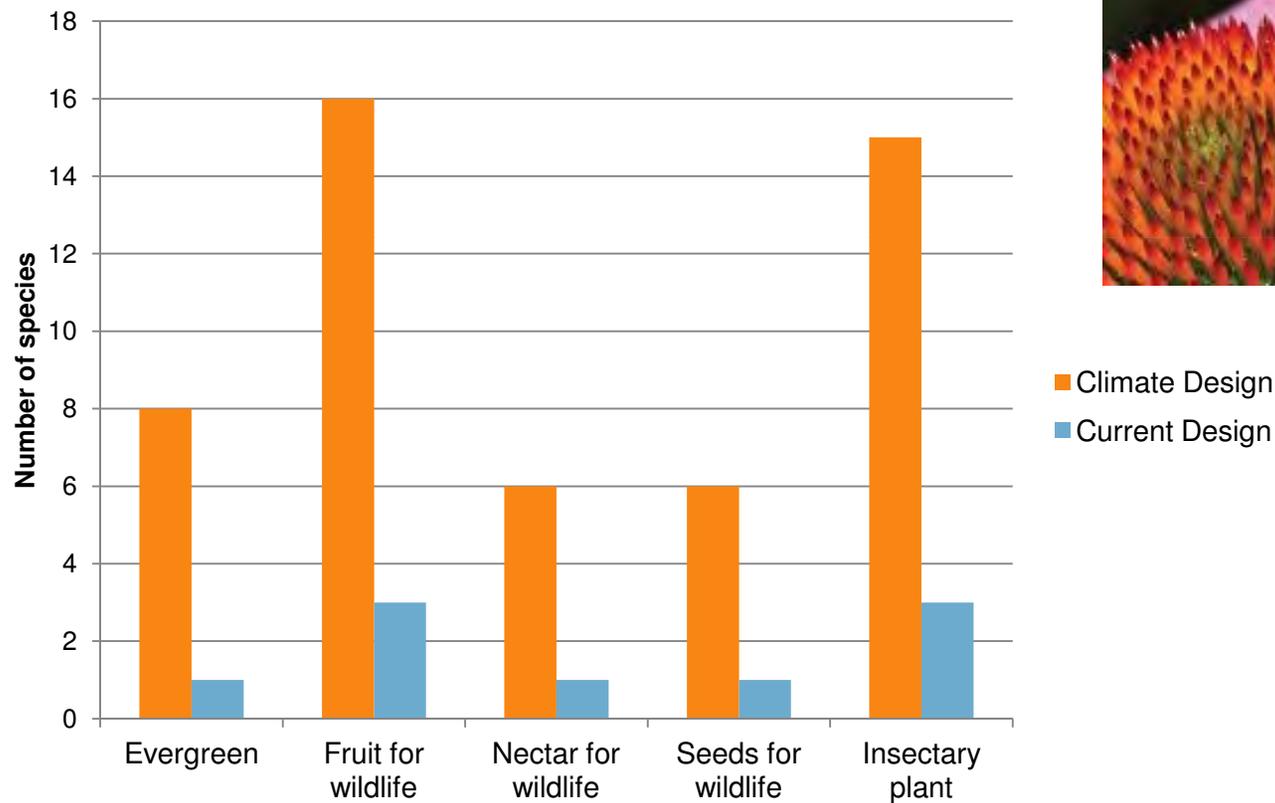
# Climate Smart: Test New Restoration Designs

..... *planting more species tolerant of extremes*



# Climate Smart: Test Restoration Designs- *provide more food resources over longer period for disrupted phenologies*

## Shrubs in restoration design





# Climate Smart: connect Sierra meadows to foothills to valley floor to SF Bay to ocean— for water function, wildlife, people





San Francisco 2010 <http://californiakingtides.org/>

# Climate Smart: Safeguard Tidal Wetlands

## Design to maximize benefits for wildlife and people

Multi-partner approach: SCC, USFWS, CDFG, SFBayJV, NOAA, USGS, SLT...



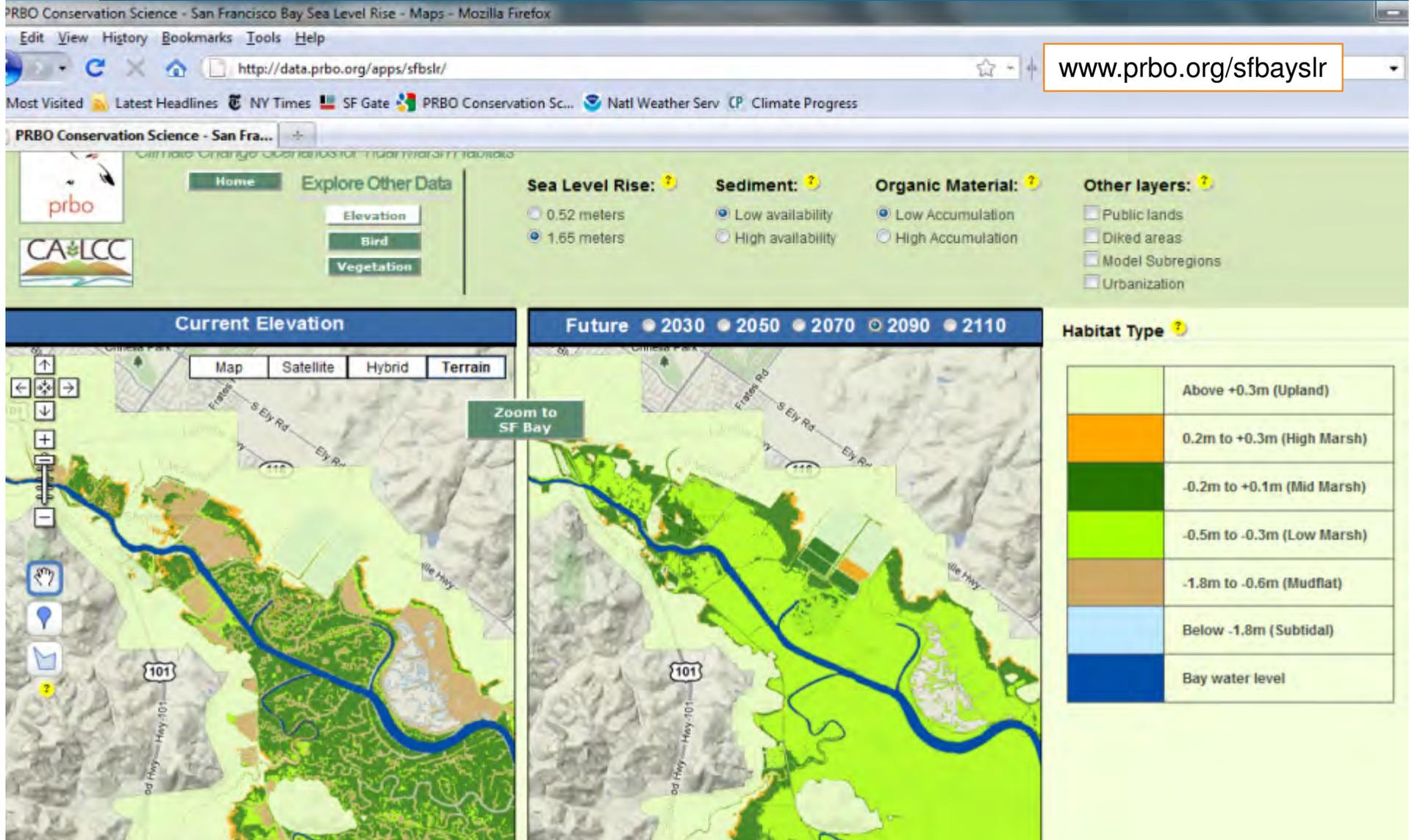
### Ecosystem "services":

- Reduce flood impacts
- Reduce sea level rise impacts
- Sustain biodiversity
- Filter out pollutants
- Replenish ground water
- Sequester carbon
- Protect Human Infrastructure--  
*"living shorelines"*

North SF Bay ~50k Acres of Wetland Restoration  
Napa Sonoma Marsh Restoration, Ponds 2, 2a, 3, Larry Wyckoff, CDFG

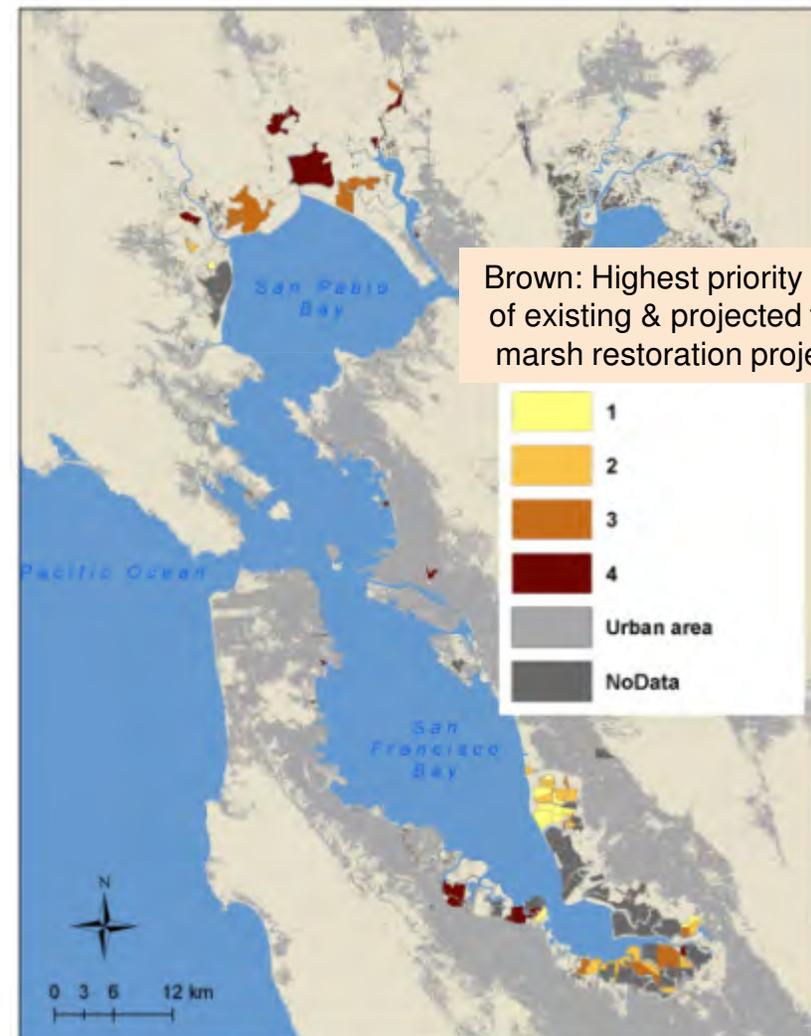
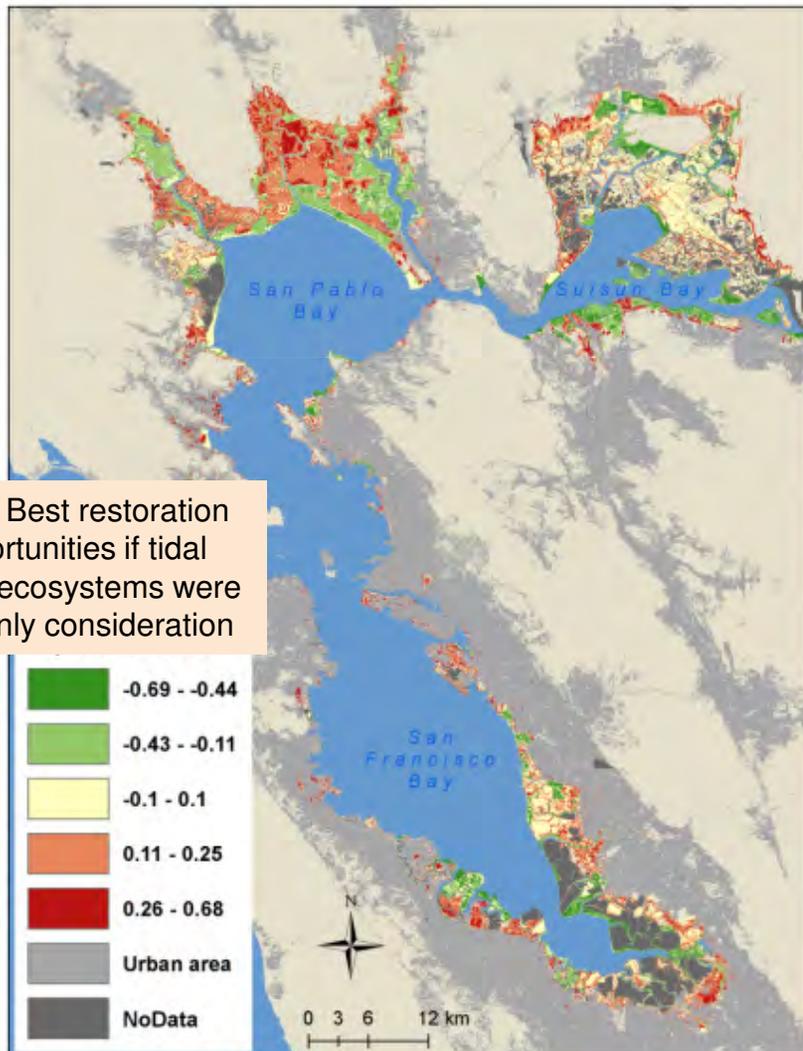
# Climate Smart: Project where future tidal marsh might be

*e.g., Petaluma Tidal Marsh, 1.65 m SLR, Low Sediment by 2090*

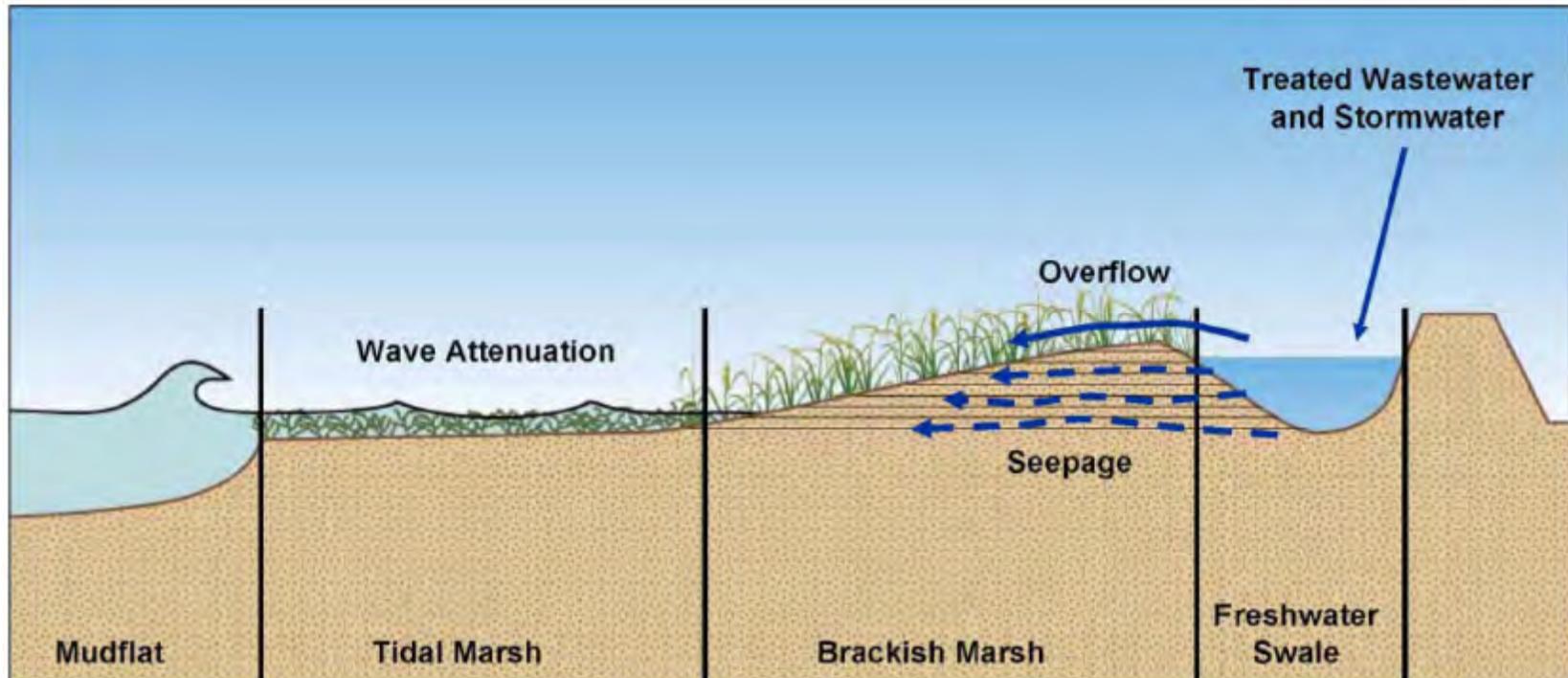


# Climate Smart: Prioritize tidal marsh restoration to guide where invest today for best future outcome

Based on tidal marsh birds, sediment availability, sea level rise scenarios; see [www.prbo.org/sfbayslr](http://www.prbo.org/sfbayslr)



# Climate Smart- Designed Tidal System: reduce sea level rise, storm surge impact on infrastructure *and* create new habitat



ESA PWA tidal marsh restoration design

Hayward Area Shoreline Planning Agency, Hayward, CA (SF Bay)

[http://www.bc3sfbay.org/uploads/5/3/3/9/5339154/haspa\\_executive\\_summary.pdf](http://www.bc3sfbay.org/uploads/5/3/3/9/5339154/haspa_executive_summary.pdf)

# Climate Smart: Surfers' Point Managed Shoreline Retreat Project, Ventura, California -- *adaptation project underway*



## Phase I:

- existing damaged parking lot removed; materials recycled
- Beach widened by 60 ft
- Multi-use bike path relocated inland
- New parking area built north



Partners include: City of Ventura, Ventura County Fairgrounds (Seaside Park), California Coastal Conservancy, California State parks, the State Coastal Commission and the Surfrider Foundation

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# Climate Smart: Sonoma Bayland Restoration, San Pablo Bay

- Installing marsh plants, constructing hundreds of small islands to create wind breaks and filter out sediment from the incoming tides
- Breaching levees to allow tidal waters into marsh area
- Building a new levee to protect the railroad, Highway 37 and adjacent private property



<http://www.sonomalandtrust.org/>

John Burgess / Santa Rosa Press Democrat: Sears Point Ranch Restoration Site

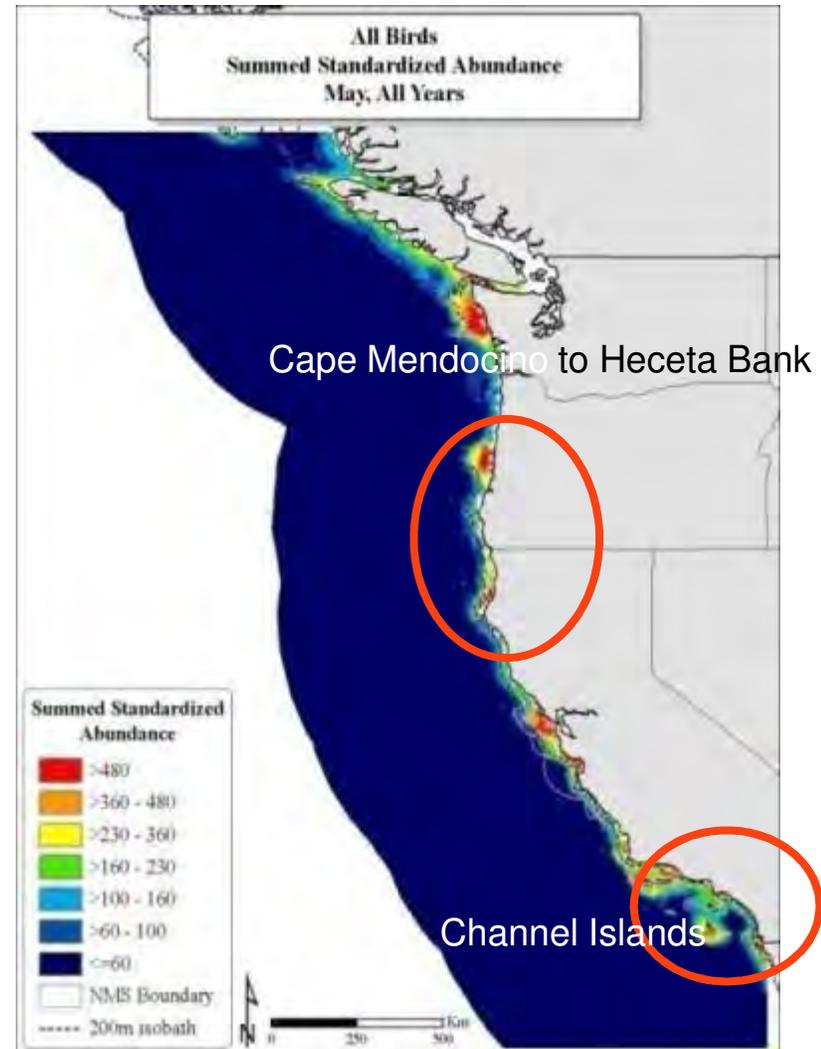
<http://www.pressdemocrat.com/article/20120216/ARTICLES/120219645/1042/opinion?p=2&tc=pq&tc=ar>



# Climate Smart: Protect Marine Food Webs for Fisheries and Wildlife

Cal

- Identified food web “hotspots” in the California Current
- Identified gaps in protection
- Providing science to policy makers to decide:
  - where to establish marine protected zones
  - what types of protection and when





# Climate Smart: Give Time to Sensitive Species to Adapt



- Cassin's Auklets:
- protect from extreme heat
  - control invasive predators to help with adaptation



© Ron LeValley



# Climate Smart: Reduce Human Impacts- Change shipping lanes, speed; employ near-real time assessments



# Climate Smart: Collaborate across traditional barriers

*Example:* Bay Area Ecosystems Climate Change Consortium



or BAECCC [www.baecccc.org](http://www.baecccc.org)

Bringing together scientists,  
natural resource managers  
and planners to sustain  
nature's benefits in the face of  
accelerating climate change

- NOAA Gulf of the Farallones and Cordell Bank National Marine Sanctuaries
- NOAA Coastal Services Center
  - US Fish & Wildlife Service
- PRBO Conservation Science
  - US Geological Survey
  - CA Coastal Conservancy
- CA Dept of Fish and Game
  - National Park Service
  - Bay Conservation and Development Commission
    - SF Bay Joint Venture
    - SF Estuary Partnership
    - Upland Goals Project
- Bay Area Open Space Council

PRBO Conservation Science

# *Project Example: Preparing for SLR & Extreme Storms Along SF Bay Area's Outer Coast & SF Bay*

*Funded by NOAA SARP and NPS*

## Project Leads



- USGS constructing seamless digital elevation model
- PRBO developing web-based tool and interactive maps
- GFNMS managing team and leading stakeholder participation

## Project Objectives

- Assess vulnerabilities to SLR & increased storm intensity and stakeholder information needs from Point San Pedro to Point Reyes.
- Map vulnerabilities at the scale necessary for management.
- Conduct workshops and communicate the findings in accessible, user-friendly formats to apply to local adaptation and response strategies.

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# *Project Example: Climate Change Technical Update of 1999 Baylands Ecosystem Habitat Goals*

*Funded by State Coastal Conservancy*

## **Project Partners include:**



Project Objectives include:

- Provide updated habitat restoration and protection goals for next decade- including sites that can accommodate wetland transgression upslope.
- ID management strategies for more resilient marshes (e.g., improve sedimentation dynamics).
- ID long term science gaps and management needs to implement recommendations.
- Develop recommendations for “living shorelines”- using habitats to reduce shoreline erosion.

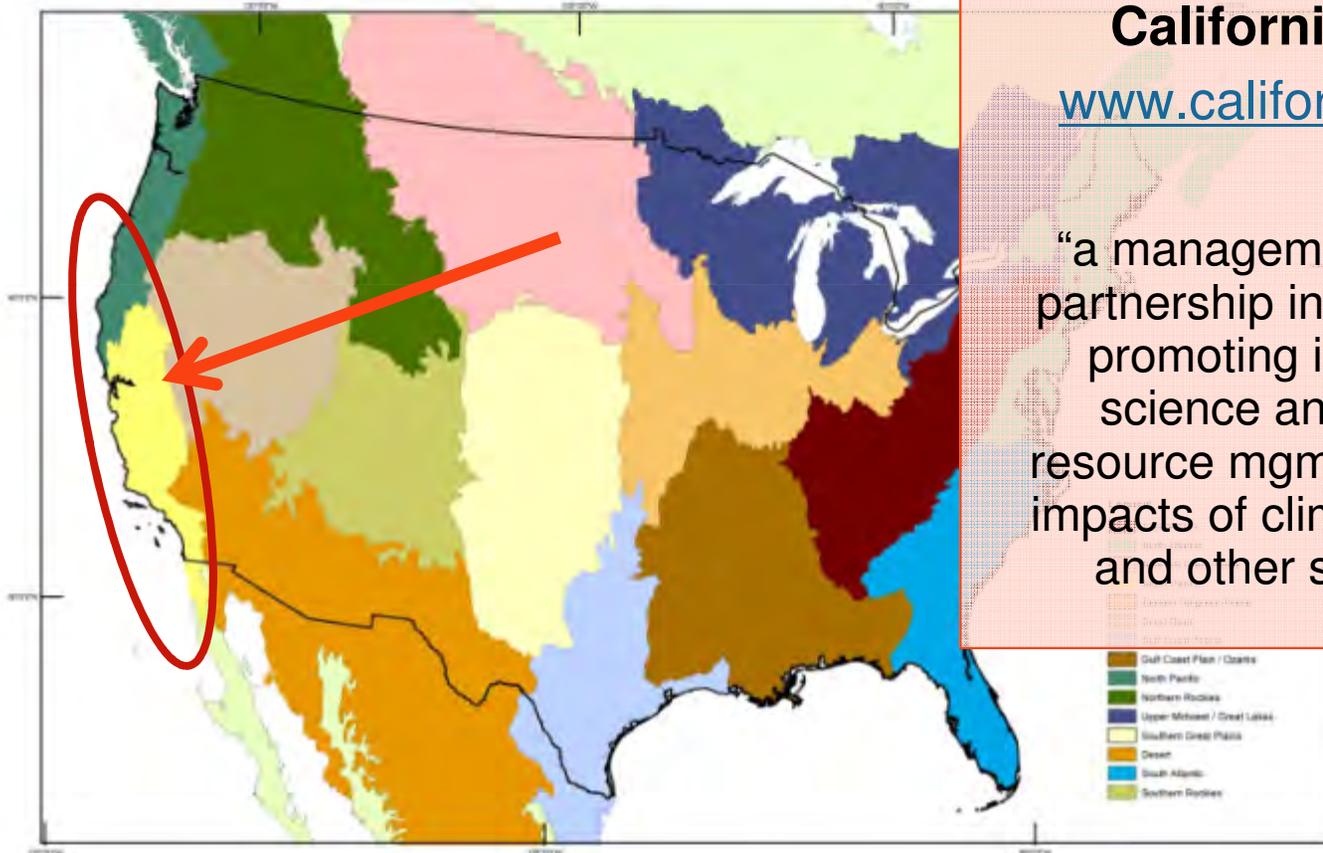
# Climate Smart: Landscape Conservation Cooperatives



U.S. Fish & Wildlife Service

Landscape Conservation Regions  
Conterminous United States

Recommendations from the National Geographic Framework  
Rapid Prototyping Workshop



## California LCC

[www.californialcc.org](http://www.californialcc.org)

“a management-science partnership informing and promoting integrated science and natural resource mgmt to address impacts of climate change and other stressors”

PRODUCED IN THE DIVISION OF REALTY  
ARLINGTON, VA  
MAP DATE: 8/2008  
BASEMAP: ESRI  
MERIDIAN: NAD  
FILE: LCR0a



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How address the economic & ecological challenges of accelerating climate change on top of other stressors?

t h i n k i n g



# Employ Climate Smart Conservation Principles

- Landscape-scale approach, think & link beyond current protected areas
- Focus on future possible conditions- not past
- Requires flexible & informed management
- Takes into account range of possibilities—extremes
- Benefits wildlife & people
- Avoids maladaptation
- Promotes collaboration, open sharing of information
- Minimizes carbon footprint



*Adapted from National Wildlife Federation: Climate Smart Conservation Principles*  
<http://www.nwf.org/Global-Warming/Climate-Smart-Conservation.aspx>

# Climate-Smart: Communicate the Science & Inspire Hope

- **Inspire:** I think I can, I think I can
- **Solution oriented:** confident, hopeful, belief in human ingenuity – people more likely to accept the science than if focus is only on dire consequences, inevitable, catastrophic
- **We have CHOICES** --talk about choices we have!

# Climate Smart: Communicate science terms in ways that have appropriate meaning to public

Terms that have different meanings for scientists and the public		
Scientific term	Public meaning	Better choice
enhance	improve	intensify, increase
aerosol	spray can	tiny atmospheric particle
positive trend	good trend	upward trend
positive feedback	good response, praise	vicious cycle, self-reinforcing cycle
theory	hunch, speculation	scientific understanding
uncertainty	ignorance	range
error	mistake, wrong, incorrect	difference from exact true number
bias	distortion, political motive	offset from an observation
sign	indication, astrological sign	plus or minus sign
values	ethics, monetary value	numbers, quantity
manipulation	illicit tampering	scientific data processing
scheme	devious plot	systematic plan
anomaly	abnormal occurrence	change from long-term average

# Climate Smart: Apply the 10% Rule Every Day



**T** = Test &

**E** = Experiment

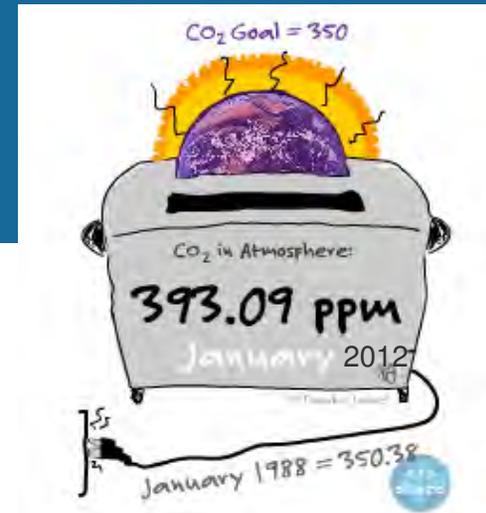
**N** = Now

# No More “Business as Usual”

**Stop greenhouse gas emissions  
and  
make ecosystem conservation  
an equal priority now**



# CO2 Target:



# < 350 ppm

**“To preserve creation, the planet on which civilization developed” – Jim Hansen**

Director, NASA Goddard Institute for Space Studies

*Human-made Climate Change: A Moral, Political and Legal Issue*, Blue Planet Lecture, Tokyo, Japan, October 2010

Ppm = parts per million of CO<sub>2</sub> in the atmosphere

# 350 ppm is possible

## 1. Phase out Coal by 2030

All coal emissions halted in 20 years; no unconventional fossil fuels- tar sands, oil shale, methane hydrates

## 2. Price Carbon Immediately: Fee and Dividend

## 3. Invest in Energy Efficiency & Eco-friendly Renewable Energy- *jobs*

## 4. Secure Nature's Benefits- Eco-friendly Land & Ocean Management

Enriching soil carbon, farming with perennials, climate-friendly livestock production, protecting natural habitats, restoring watersheds and rangelands, protecting ocean biodiversity hotspots

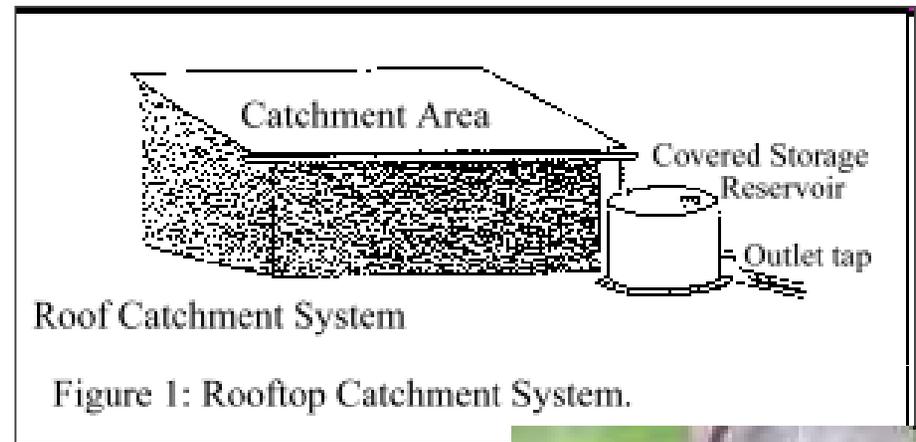


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Climate Smart: prohibit new building at sea level, flood plains; include future costs to society



# Climate Smart: capture roof rainwater, greywater; require permeable streets/surfaces, white roofs/surfaces



The Effects of White Roofs on Urban Temperature in a Global Climate Model; Olson et al *Geophysical Research Letters* <http://www2.ucar.edu/news/1385/computer-model-demonstrates-white-roofs-may-successfully-cool-cities> Jan 28 2011

[www.oaec.org/water-institute/](http://www.oaec.org/water-institute/)  
[www.greywateralliance.org](http://www.greywateralliance.org)  
[www.watersprout.org](http://www.watersprout.org)

# Climate Smart: link back yards, plant more and plant natives, promote open space

- Link and scale up habitats
- Cool micro-climate
- Strengthen water cycle
- Provide habitat for birds, butterflies, other wildlife



Monkey Flower

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# Climate Smart: Engage youth & community in local, hands-on restoration efforts!



PRBO STRAW Project- Students & Teachers Restoring a Watershed [www.prbo.org/straw](http://www.prbo.org/straw)

## In Summary:



1. Climate change impacts are here and accelerating; exacerbates other stressors
2. Make ecosystem conservation an equal priority: *water, carbon, biodiversity*
3. Plan for extremes: drought, fires, floods, heat, variability
4. Actively apply climate smart adaptive management, including monitoring
5. Be climate-smart!
6. Test, experiment now!

Our future?



Courtesy Tom Suchanek, USGS

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# OR...restored watersheds to sustain wildlife and our communities....





.... healthy tidal habitats to protect wildlife and people from sea level rise & extremes...

# And healthy populations of fish, wildlife in the ocean.

Murres on Farallones

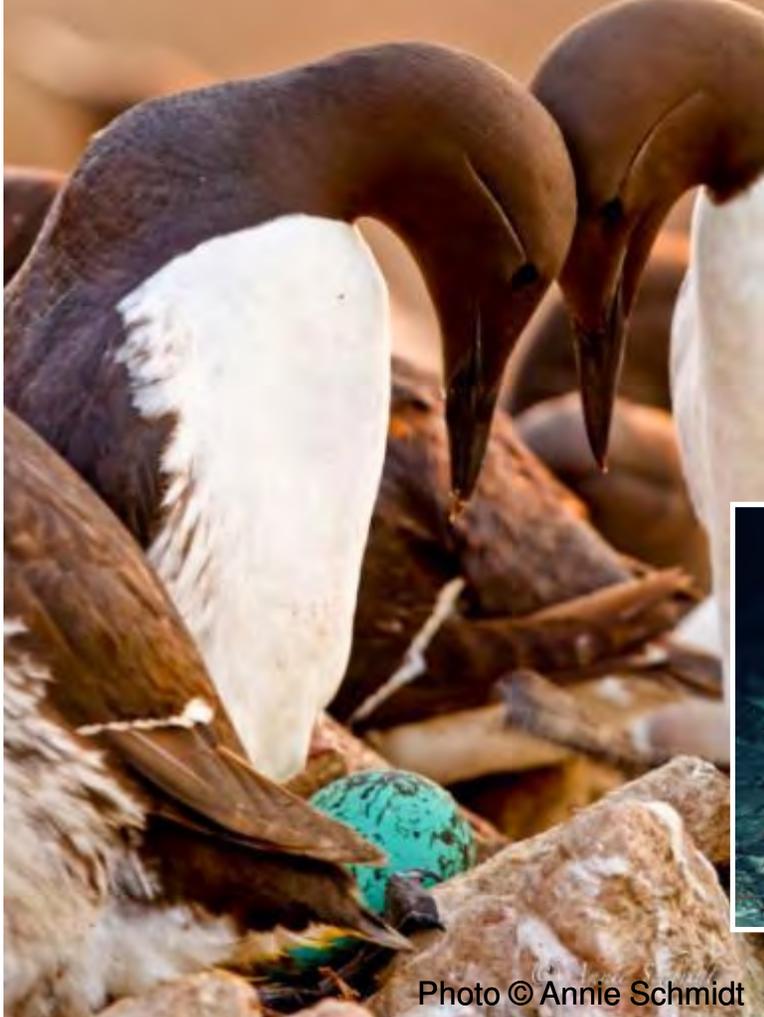


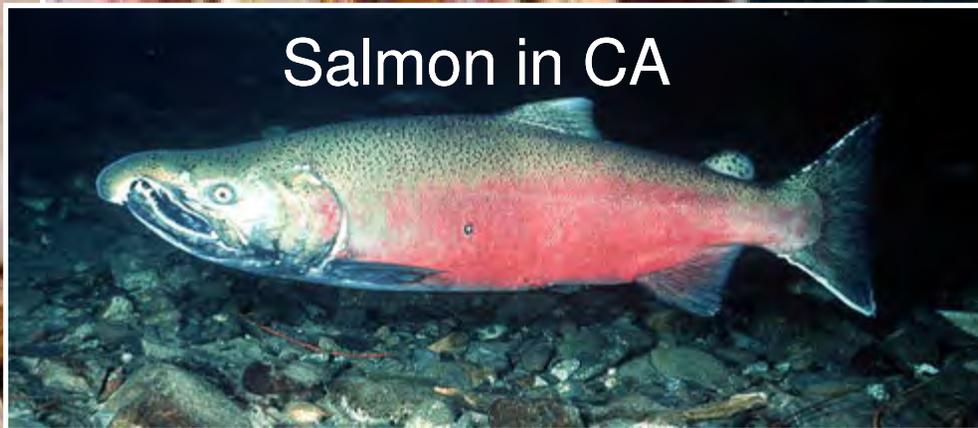
Photo © Annie Schmidt

Juvenile rockfish on Cordell Bank National Marine Sanctuary



Photo © Greg McFall / NOAA / CBNMS

Salmon in CA



How many lightbulbs does it take  
to change an American?

It's no joke:

Climate change is a critical issue  
for all life on Earth. But can the  
actions of one individual really  
make a difference?

Visit [nature.org](http://nature.org) to learn about steps  
you can take to make the world a  
better place for us all.

[nature.org/calculator](http://nature.org/calculator)

The Nature  
Conservancy   
Protecting nature. Preserving life.

Photo © istockphoto.com / Duke of Time

Each of us  
can make a  
difference!

San Diego Airport  
Southwest Airlines  
Terminal Feb 2012

## Adapted from PRBO:

*Because of our work, in 100 years California's diverse habitats will still support resilient ecosystems, thriving wildlife populations and vital ecosystem services for California's residents.*

*California will still be a premier center for nature on Earth—providing unparalleled economic, cultural, and conservation values.*

## Additional Resources

- [www.nwf.org/Global-Warming/Climate-Smart-Conservation.aspx](http://www.nwf.org/Global-Warming/Climate-Smart-Conservation.aspx) *Climate Smart Conservation*
- [www.skepticalscience.com](http://www.skepticalscience.com) *Explaining climate change science & rebutting global warming misinformation*
- [www.realclimate.org](http://www.realclimate.org) *Climate science from climate scientists*
- [www.climatechangecommunication.org](http://www.climatechangecommunication.org) *Center for Climate Communication*
- [www.merchantsofdoubt.org/](http://www.merchantsofdoubt.org/) *how handful of scientists obscured truth from tobacco smoke to global warming*
- <http://blogs.kqed.org/climatewatch/> *climate-related science and policy issues, with a specific focus on California*
- [www.baecc.org](http://www.baecc.org) *list serve- receive weekly biodiversity and climate change news updates*

THANK YOU!



NASA Blue Marble HD 2011

# PRBO Conservation Science Acknowledgements



- Anonymous (2)
- Audubon California
- Bay Area Ecosystems Climate Change Consortium
- S.D. Bechtel, Jr. Foundation
- Bernice Barbour Foundation
- Bureau of Reclamation
- Bureau of Land Management
- California Coastal Conservancy
- California Department of Fish and Game
- California Department of Water Resources
- California Bay Delta Authority
- California Landscape Conservation Cooperative
- Central Valley Joint Venture
- Faucett Family Foundation
- Richard Grand Foundation
- Marin Community Foundation
- Giles Mead Foundation
- Moore Family Foundation
- David and Lucile Packard Foundation
- National Park Service
- National Science Foundation
- NOAA National Marine Sanctuaries
- Natural Resource Conservation Service
- Resources Legacy Fund Foundation
- San Francisco Foundation
- San Francisco Bay Joint Venture
- The Nature Conservancy
- U.S. Fish and Wildlife Service
- USDA Forest Service
- USDA Natural Resources Conservation Service
- US Geological Survey
- and PRBO Board, Members and Staff

