Scenario planning resources for climate resilience in the Napa Valley

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Terrestrial Biodiversity Climate Change Collaborative
(TBC3.org)

Napa Watershed Symposium
May 24, 2017

TBC3 Terrestrial Biodiversity Climate Change Collaborative

Pepperwood PRESERVE
Inspiring conservation through science

Agenda

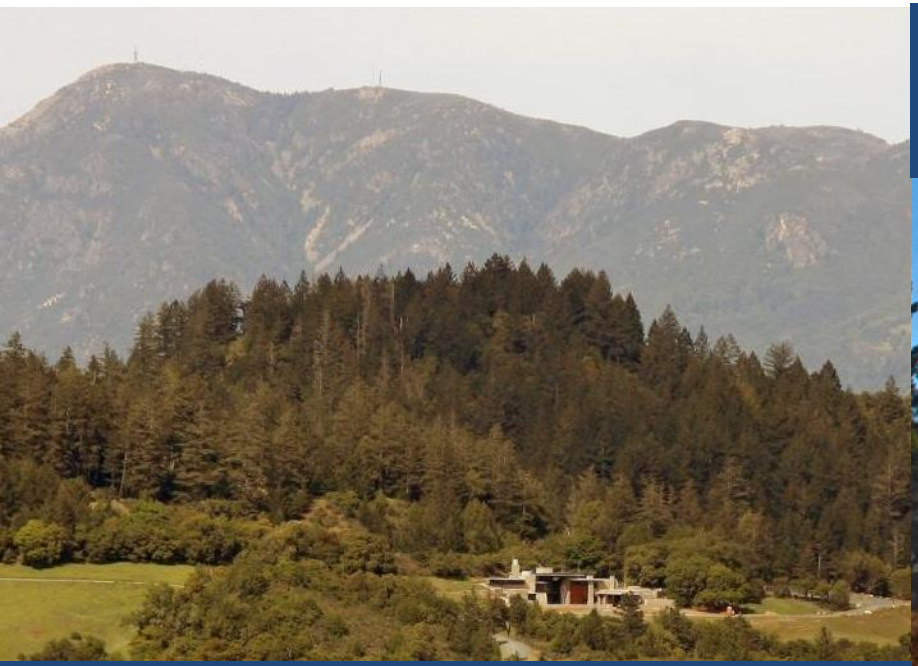
- introduce Pepperwood and TBC3 - north bay climate ready collaboration
- what are local projections for climate change?
- how you can to use scenarios to prepare for climate change?

Pepperwood
PRESERVE
Inspiring conservation through science

Pepperwood Foundation

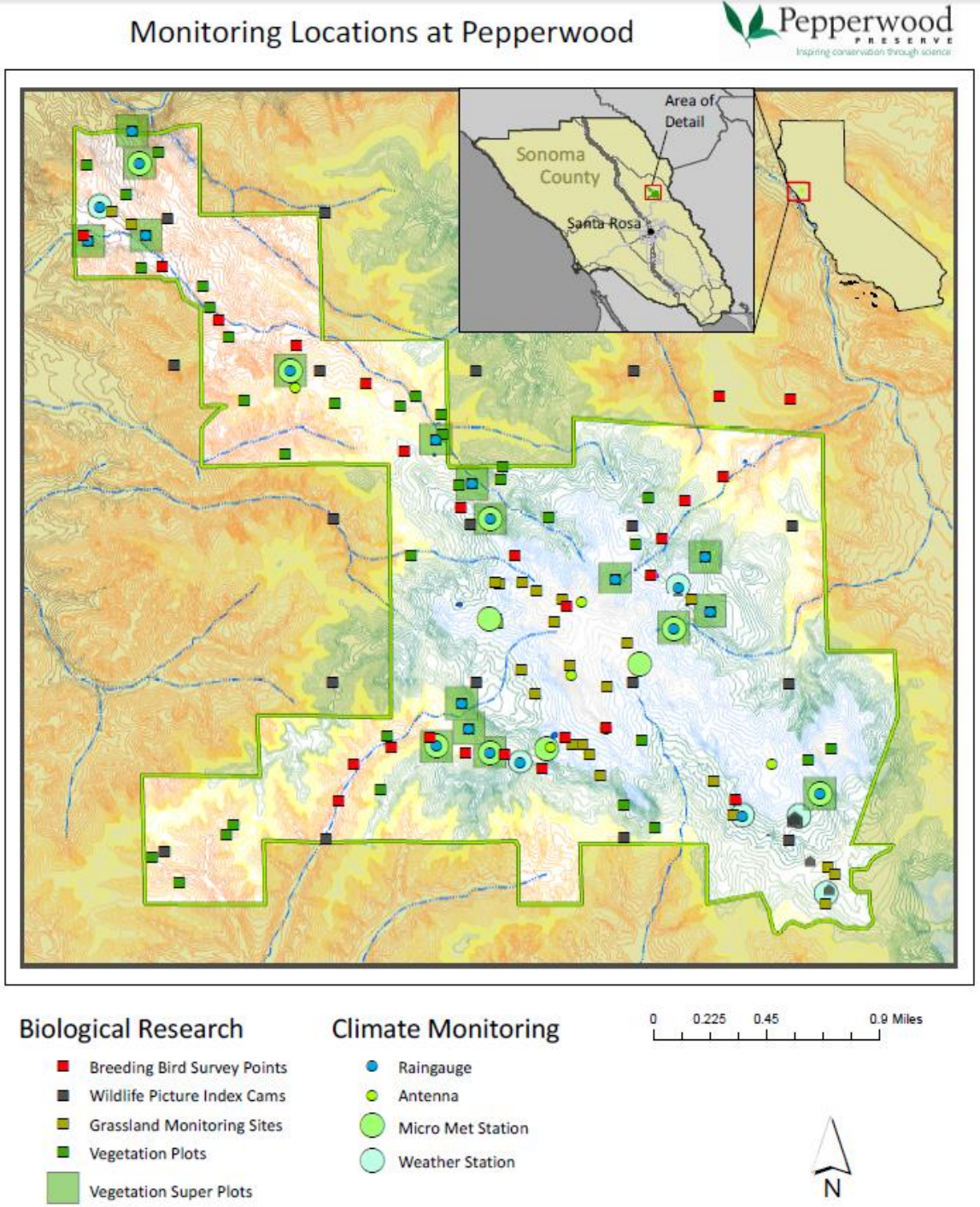
mission

to advance science-based conservation throughout our region and beyond



3200-acre scientific preserve in Sonoma County

The Dwight Center for Conservation Science



got data?

Topo-climate-variability of temp, rainfall and humidity across preserve, an interface of coastal-inland meteorology

Full hydrologic cycle monitoring-fog drip, precipitation, soil moisture, stream flow

Dominant plant communities-forest and grassland long-term stations and plant phenology transect

Wildlife occupancy-complemented by bird, herpetofauna, invertebrate surveys

Terrestrial Biodiversity Climate Change Collaborative (Pepperwood's TBC3)

Berkeley
UNIVERSITY OF CALIFORNIA

USGS
science for a changing world

GORDON AND BETTY MOORE FOUNDATION

SONOMA COUNTY
AGRICULTURAL PRESERVATION AND OPEN SPACE DISTRICT

BAY AREA | OPEN SPACE COUNCIL

Point Blue Conservation Science

Pepperwood
PRESERVE

the question

how will a shifting climate effect the lives and landscapes of Northern California?

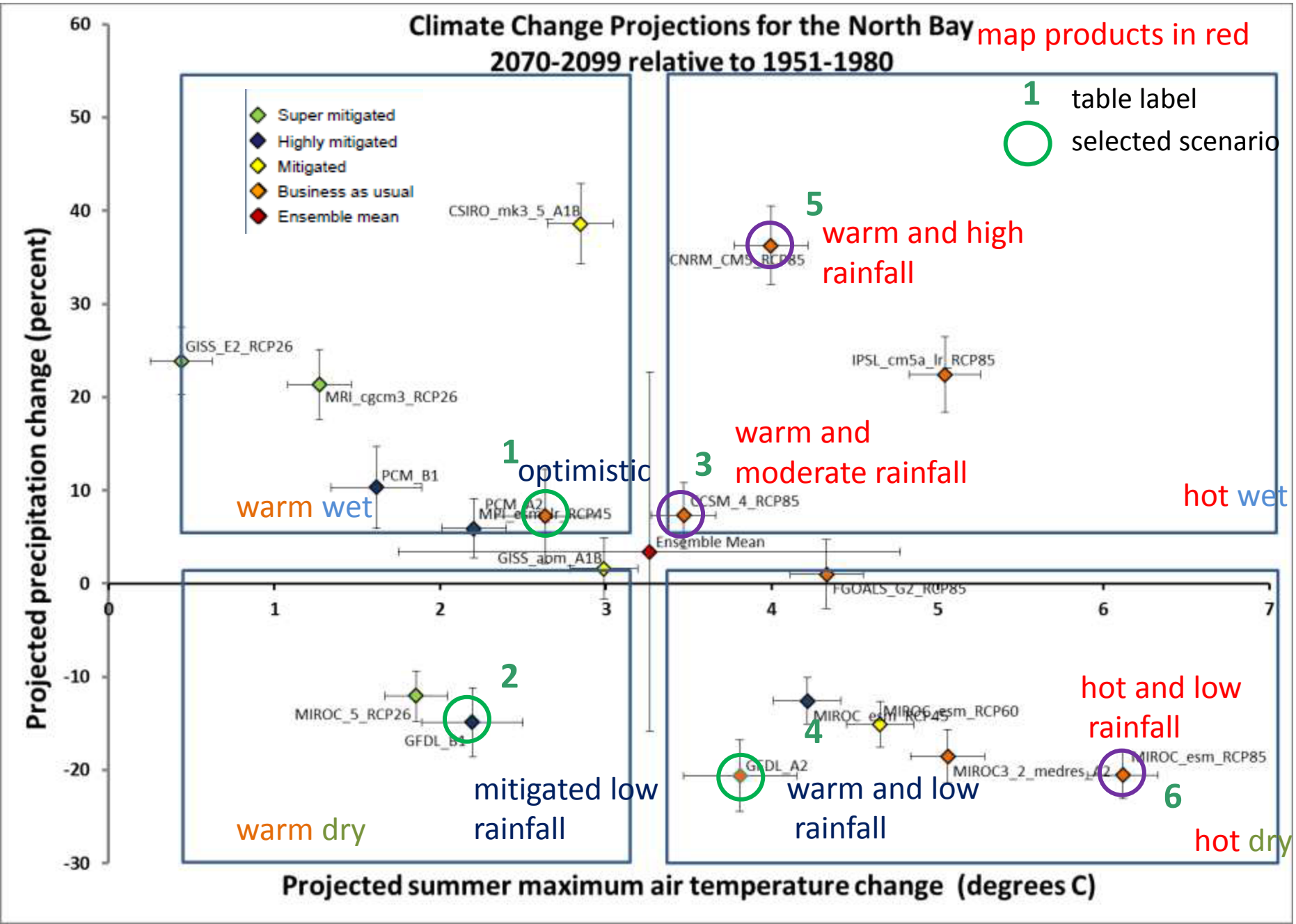
take home message

our region is becoming more arid – and potentially also more fire and flood prone!

the challenge

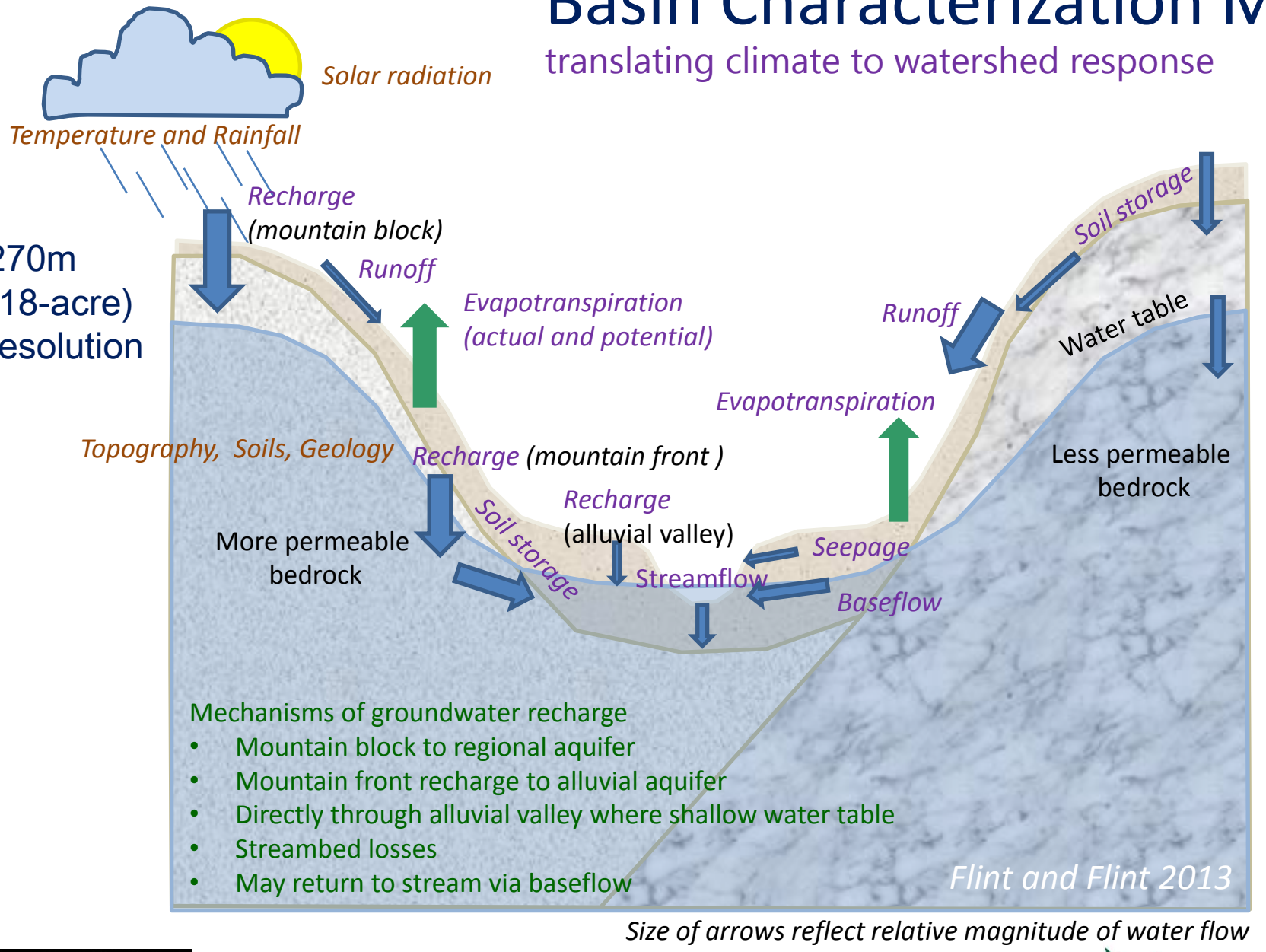
so how can we make our watersheds and working lands more resilient?

Climate Ready North Bay: Selected Futures



Basin Characterization Model

translating climate to watershed response



Size of arrows reflect relative magnitude of water flow

USGS science for a changing world

Brown text is BCM input, Purple text is BCM output

Pepperwood PRESERVE

BCM output

Climatic Water Deficit

annual evaporative demand
that exceeds available water=
drought stress

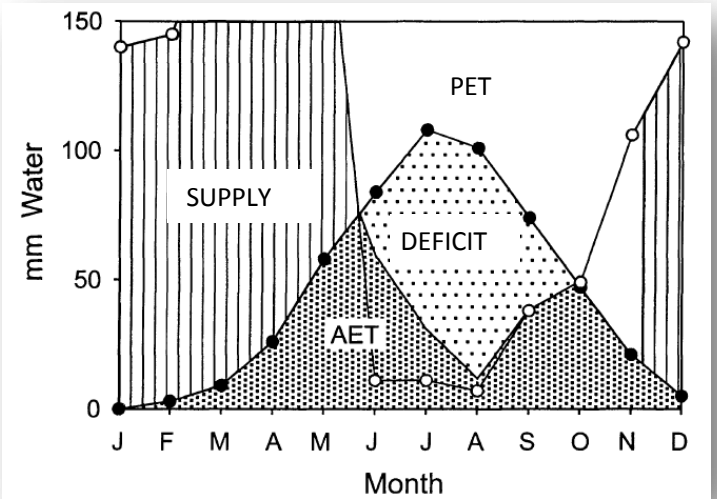
Potential – Actual Evapotranspiration

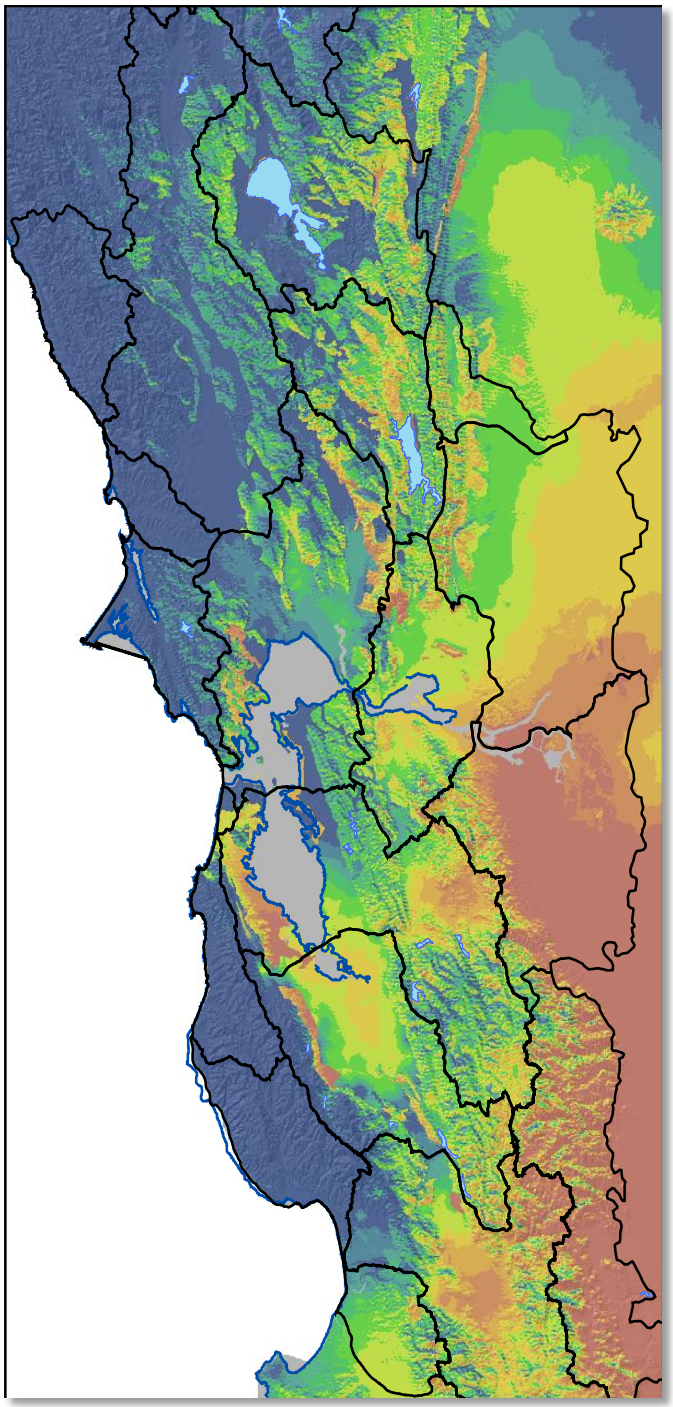
Integrates climate, energy loading, drainage, and available soil moisture

Increases with all future climate scenarios

Surrogate for irrigation demand

Correlates with vegetation and fire risk





BCM methods

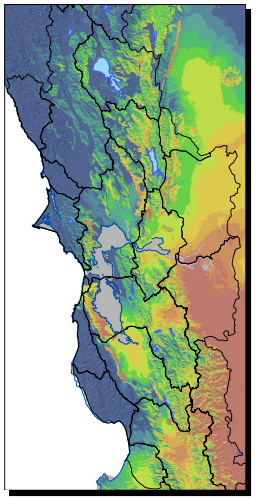
2001
mm/yr

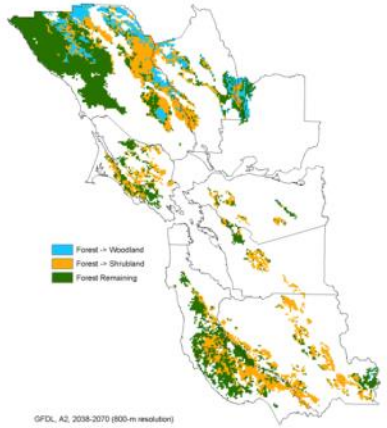
- <775
- 775 - 800
- 800 - 825
- 825 - 850
- 850 - 875
- 875 - 900
- 900 - 925
- 925 - 950
- 950 - 975
- 975 - 1000

TBC3 has built a climate adaptation knowledge base for application to regional conservation

Napa County Climate Ready North Bay Case Study on CA Climate Commons
http://climate.calcommons.org/crnb/home

Climate + Topography ⇨ Watershed Hydrology + Topo-climate ⇨ Vegetation Cover + Fire Risks ⇨ Species Distributions





generating an ensemble of projections for use in scenario planning
NOT predictions

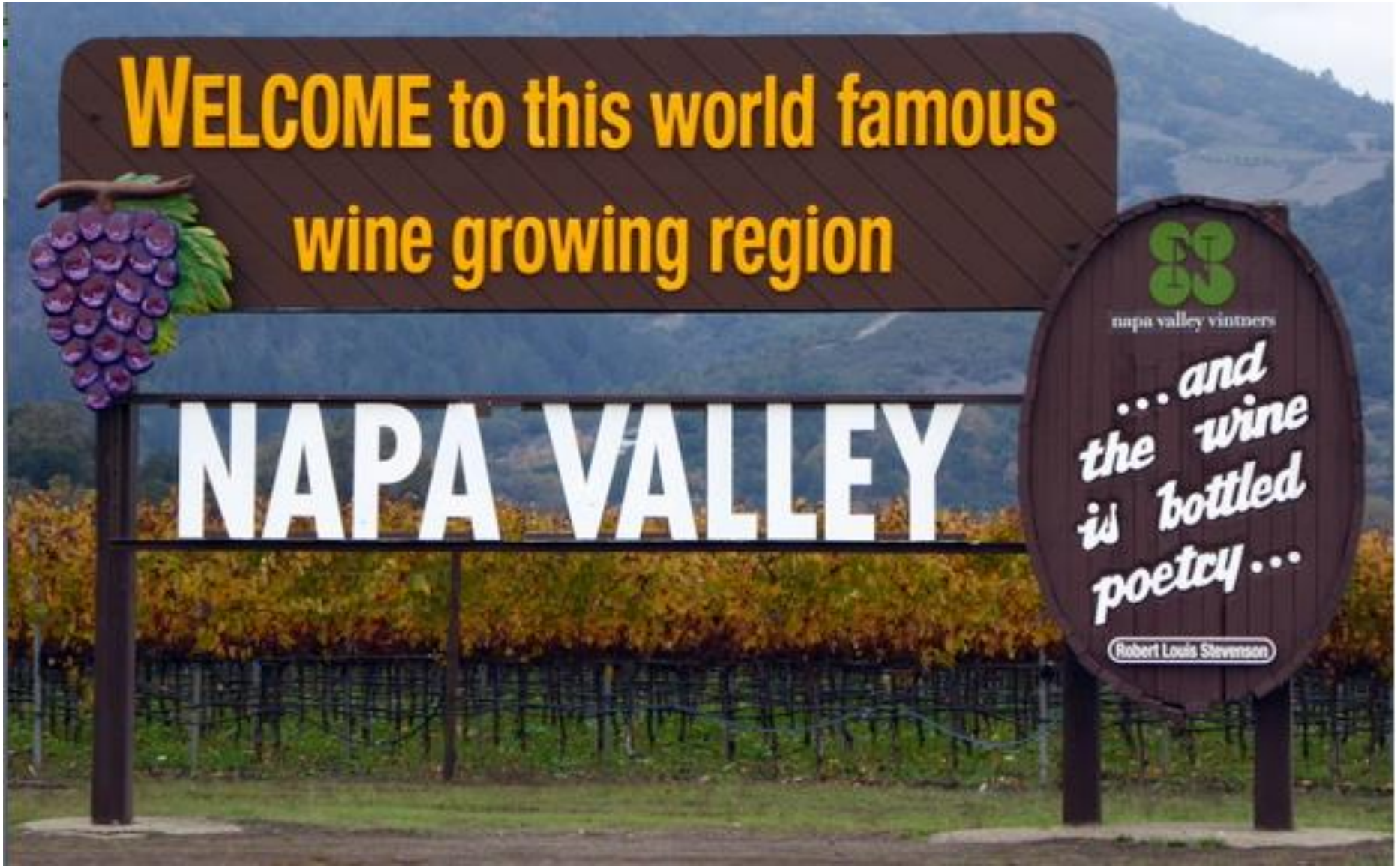
Pepperwood PRESERVE

Management Question

How is climate change projected to impact the variability of regional annual rainfall relative to the historic record?

We don’t know on average whether we will get more or less…but rain is likely to be more variable year to year!

100% more flood years and 60% more drought years on average


WELCOME to this world famous
wine growing region
NAPA VALLEY
napa valley vintners
... and
the wine
is bottled
poetry ...
Robert Louis Stevenson

Basin Characterization Model: Napa Valley Watershed
Trends in 30-year average values, historic-2099

Temperatures increase by 4-7◦F by mid-century
7-12◦F by end-century

				Projected change in temperature (Deg F) and hydrologic indicators (%)					
Variable	**Units**		**Current**	**Moderate Warming, High Rainfall**		**Moderate Warming, Moderate Rainfall**		**Hot, Low Rainfall**	
			1981-2010	***2040-2069***	***2070-2099***	***2040-2069***	***2070-2099***	***2040-2069***	***2070-2099***
Ppt	in		36.4	+23%	+ 34%	-3%	+ 5%	-21%	-24%
Tmn	Deg F		39.4	+ 3.4	+ 6.4	+ 2.1	+ 4.9	+ 4.2	+ 7.3
Tmx	Deg F		86.5	+ 4.4	+ 7.4	+ 4.0	+ 6.6	+ 7.3	+ 11.5
CWD	in		30.6	+ 4%	+ 9%	+ 6%	+ 10%	+ 12%	+ 20%
Rch	in		10.6	+ 27%	+ 27%	-1%	+ 5%	-29%	-27%
Run	in		7.8	+ 67%	+ 107%	-11%	+ 22%	-44%	-51%

VARIABLES: Ppt=precipitation, Tmn=winter minimum temperature, Tmx=summer maximum temperature, CWD=climatic water deficit, Rch=recharge, Run=runoff

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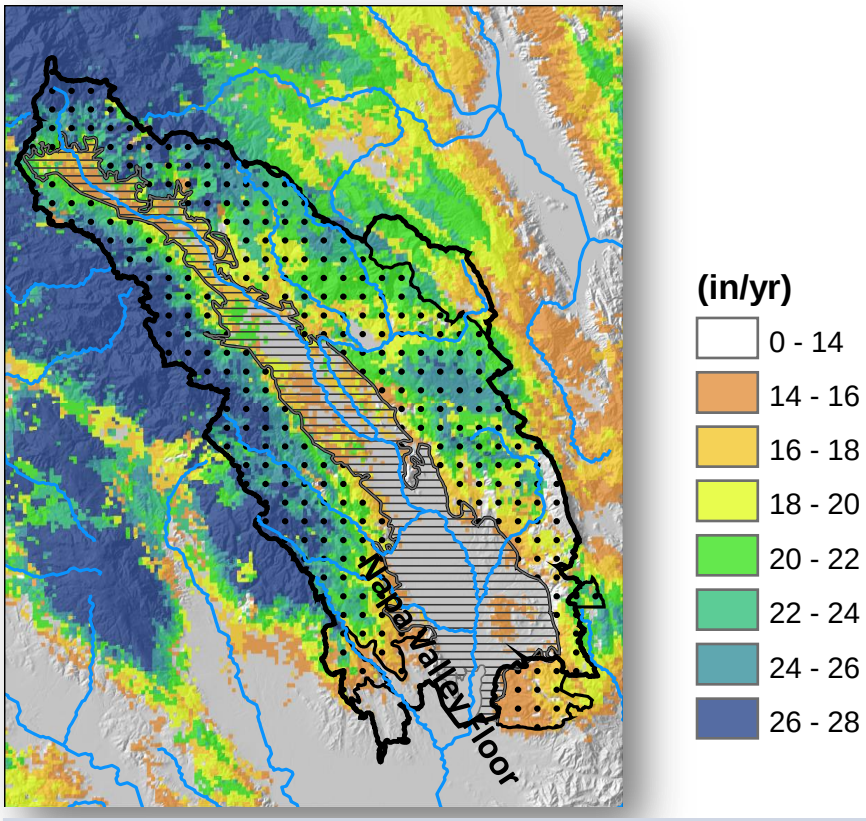
Management Question

How is climate change projected to impact the variability of reservoir supplies?

Water Supply-Recharge + Runoff-projections



30 year averages capture potential trajectories depending on whether we receive more or less rainfall

We have also calculated these trends for every reservoir catchment in basin

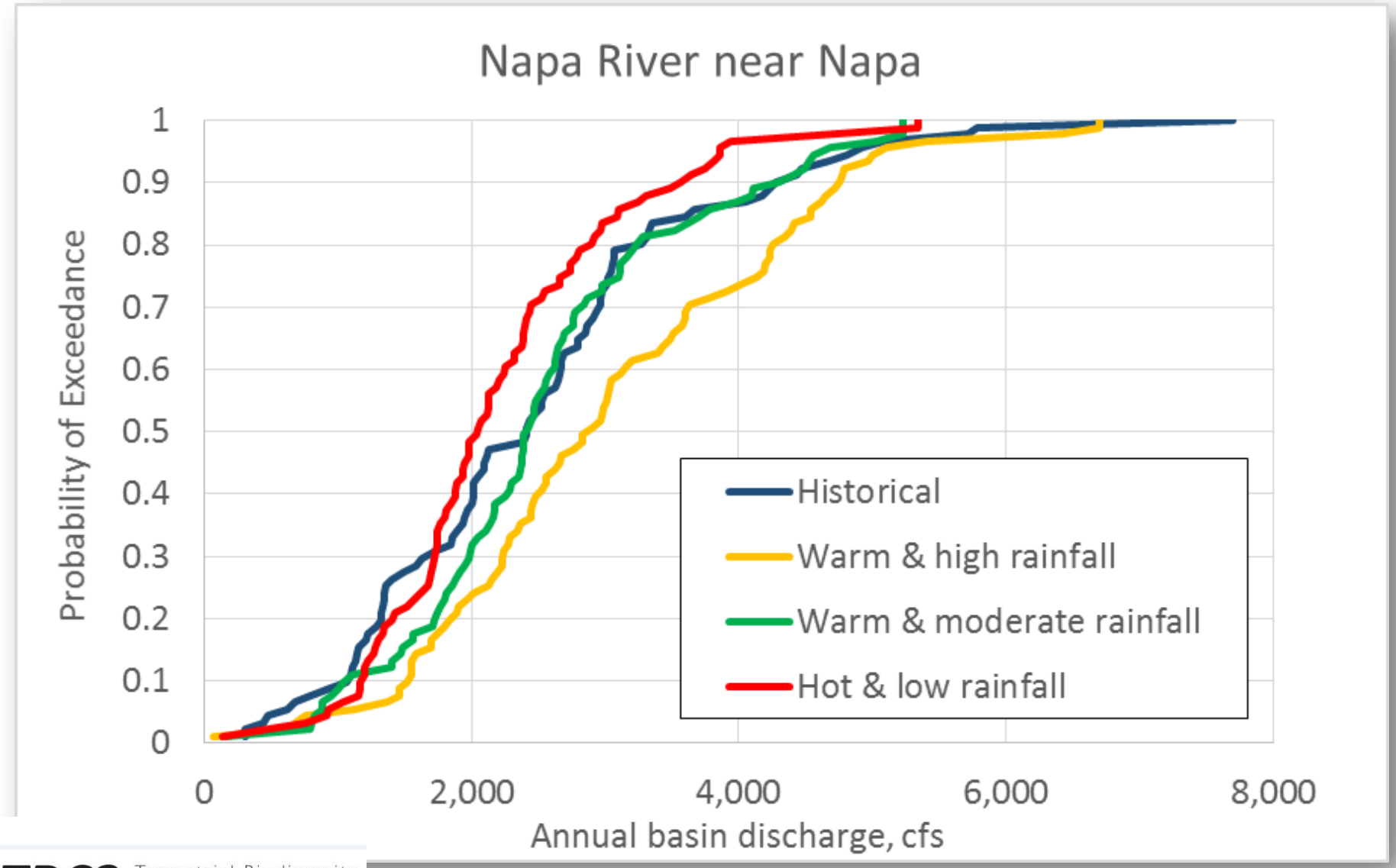
			Current	Moderate Warming, High Rainfall		Moderate Warming, Moderate Rainfall		Hot, Low Rainfall	
Rch+Run (acre-ft)		Area (acres)	1981-2010	2040-2069	2070-2099	2040-2069	2070-2099	2040-2069	2070-2099
Mountains	total	452,476	243,131	344,656	392,444	233,723	272,710	163,522	160,806
	SD		58,769	71,890	76,404	56,910	59,658	45,580	46,690
	% change			42%	61%	-4%	12%	-33%	-34%
Valley floor	total	189,418	59,142	89,894	107,424	53,860	67,413	33,201	31,061
	SD		21,889	28,335	30,616	22,300	23,755	17,066	17,567
	% change			52%	82%	-9%	14%	-44%	-47%

Management Question

How will the flow regime of the Napa River be potentially impacted by climate change?

What are implications for fisheries and riparian zones, and tributaries prone to flooding?

River managers need to design for both unprecedented HIGH and LOW flows



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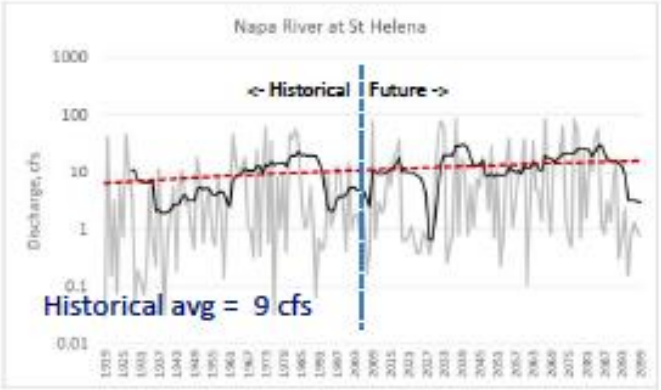
Management Question

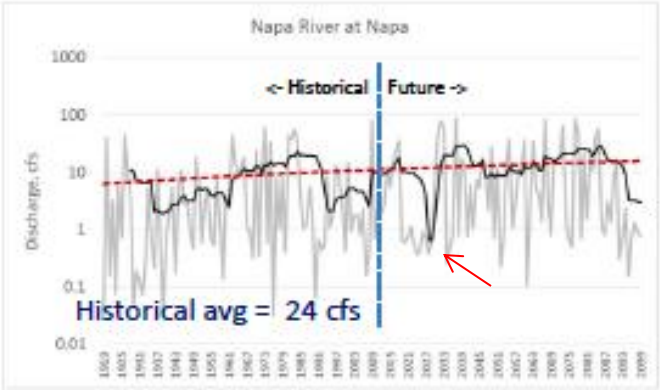
How will the low flow regime of the Napa River and its tributaries (critical to salmonid summer survival) be potentially impacted by climate change?

Napa River: Saint Helena and Napa Gages

Summer low flows (Aug-Sep-Oct)

Warm & High Rainfall

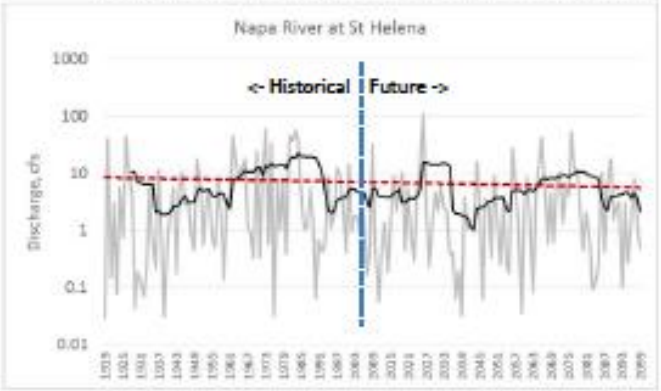


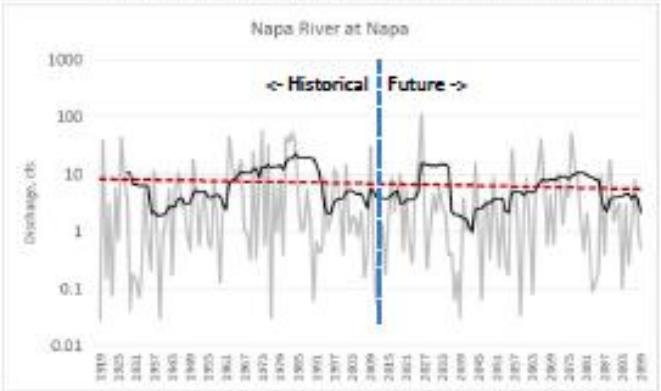


St Helena
Projected = 13 cfs

Napa
Projected = 36 cfs

Warm & Moderate Rainfall

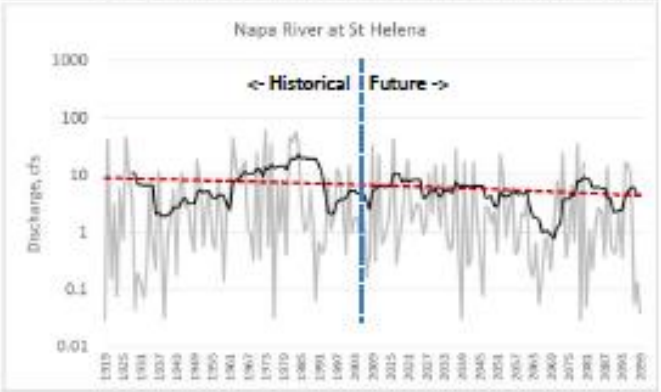


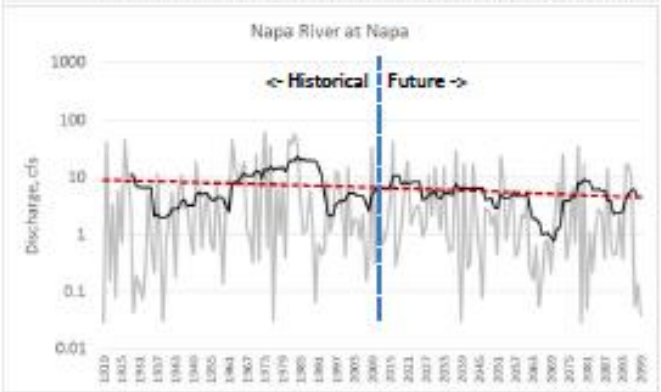


St Helena
Projected = 6 cfs

Napa
Projected= 15 cfs

Hot & Low Rainfall





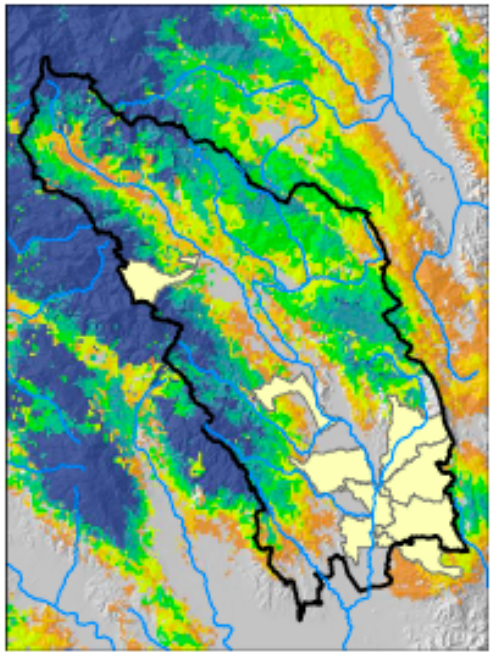
St Helena
Projected = 5 cfs

Napa
Projected= 13 cfs

Management Question

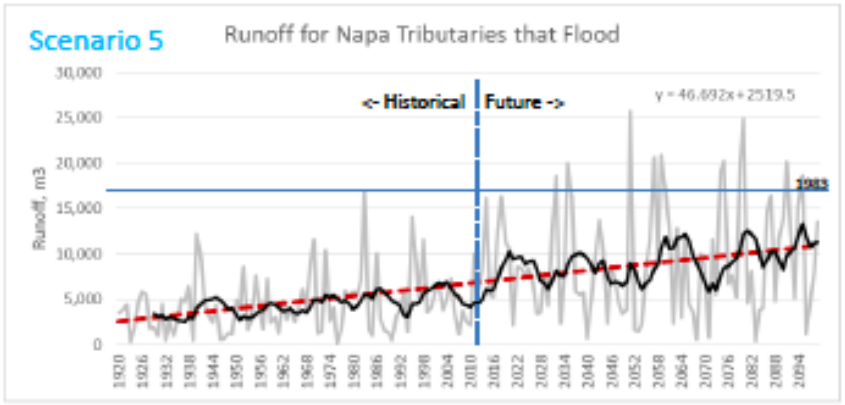
How will climate change impact Napa Valley tributaries prone to flooding?

Napa Tributaries that Flood



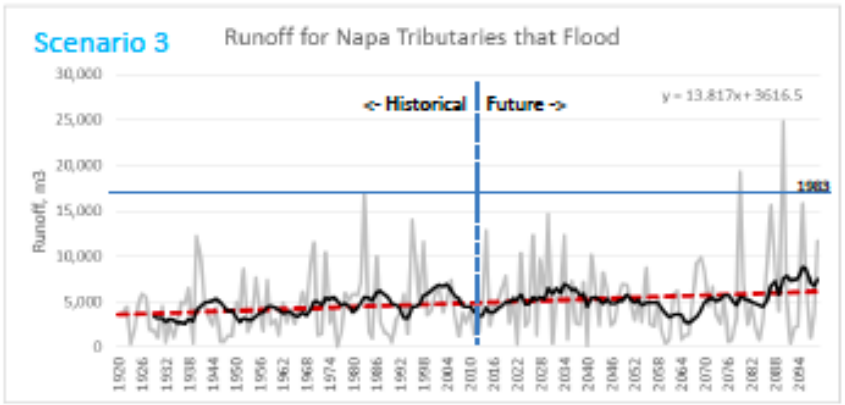
1983 is reference peak "year" of historical record

Warm & High Rainfall



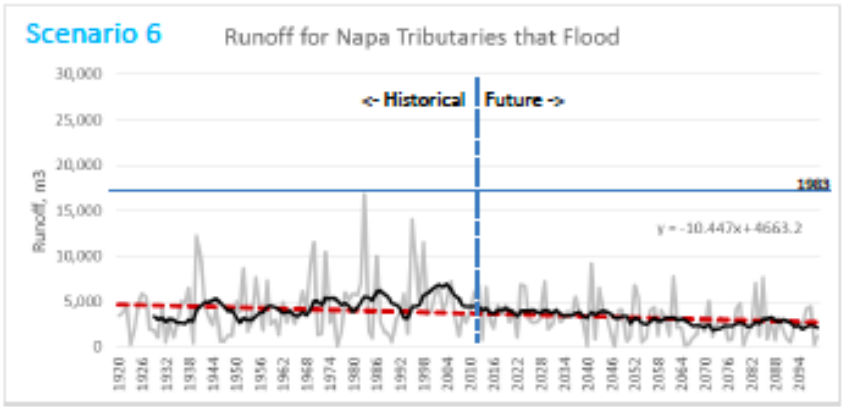
10 years exceeding historical peak threshold in future

Warm & Moderate Rainfall



2 years exceed threshold

Hot & Low Rainfall



None exceed threshold

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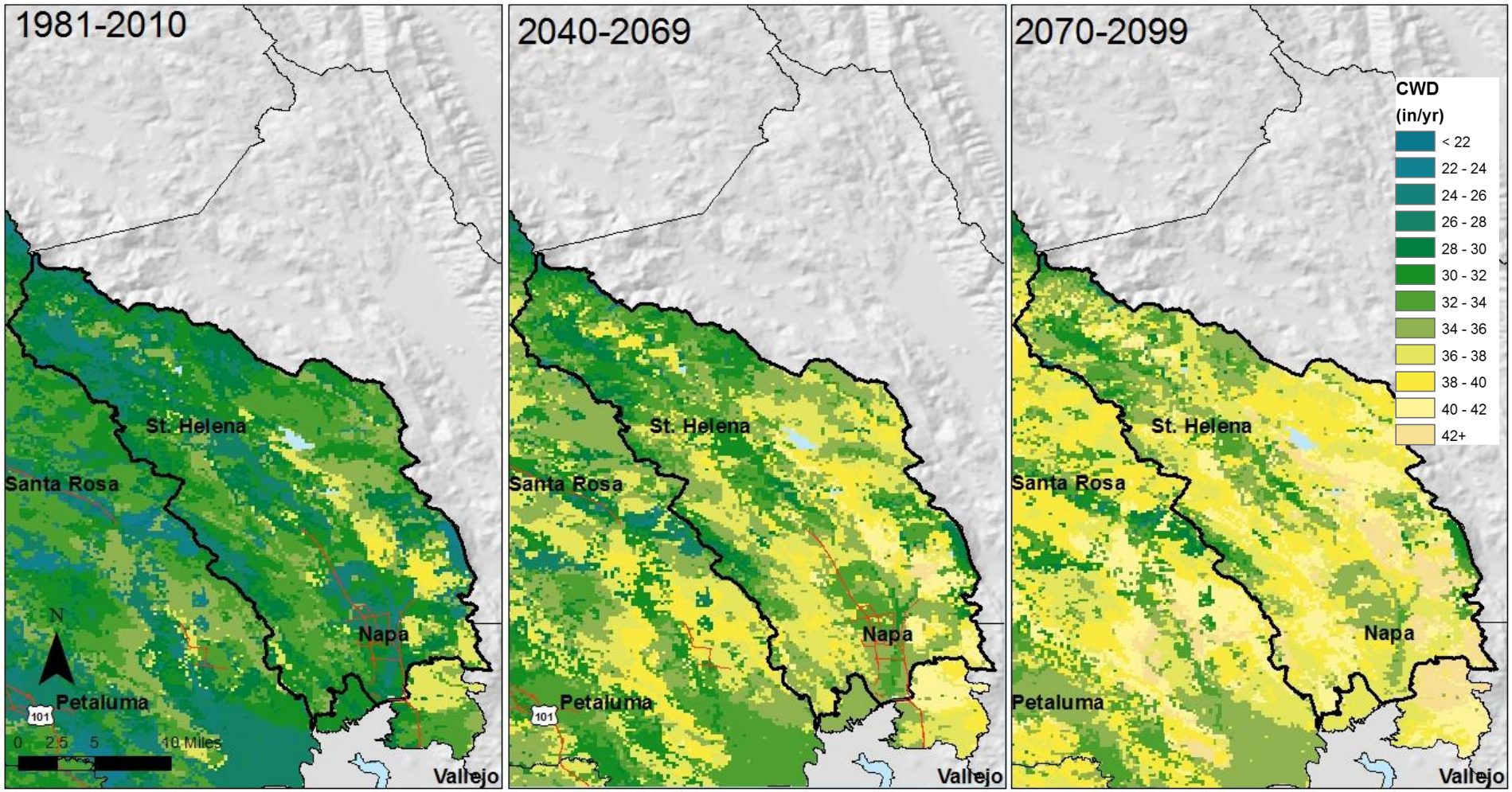
Management Question

How will the agricultural lands of the Napa Valley be potentially impacted and what are the implications for irrigation demand?

Climatic Water Deficit, Hot and Low Rainfall



CWD 31 in/y average

CWD 34 in/y average
(-3 in/y)

CWD 37 in/y average
(-6 in/y)

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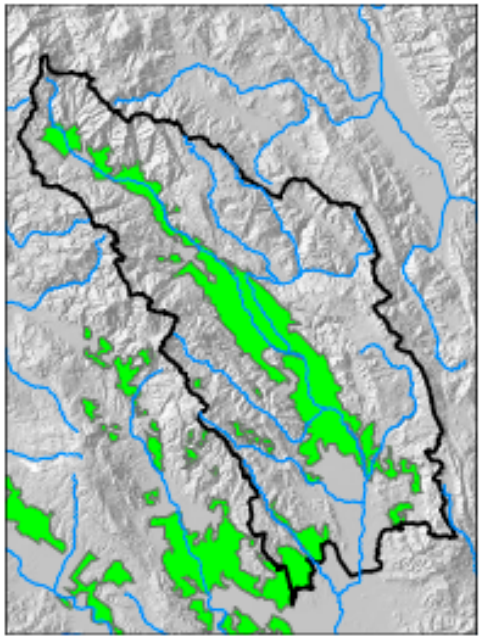
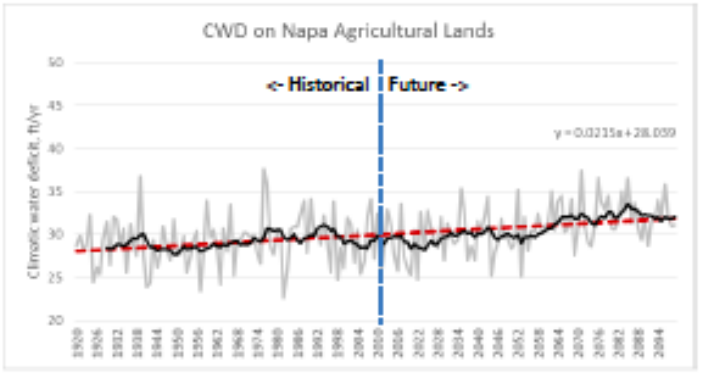


Climatic Water Deficit on Napa Agricultural Lands

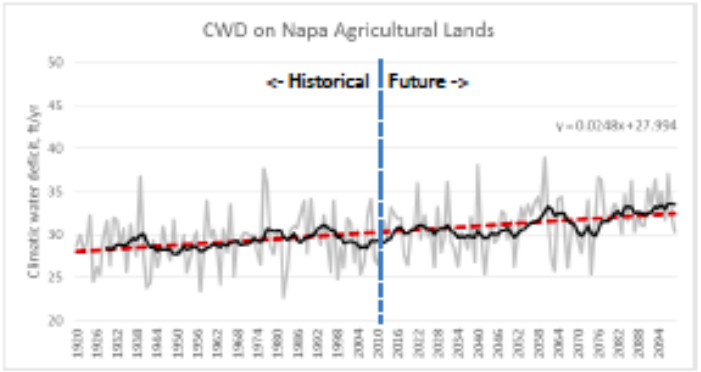
Water deficits increase in even high rainfall scenarios

Scenario 5 Warm & High Rainfall



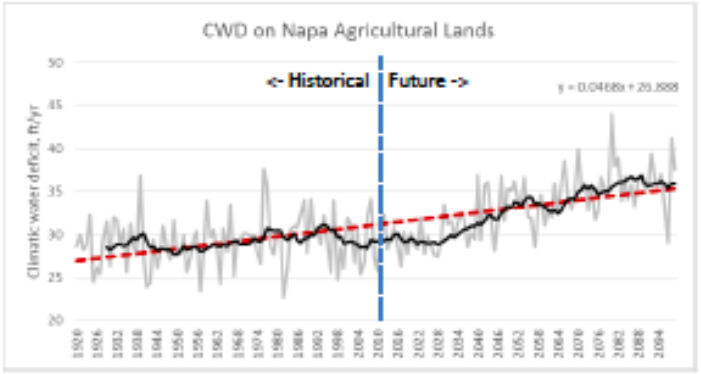
last 30 years 9 % greater deficit

Scenario 3 Warm & Moderate Rainfall



last 30 years 10 % greater deficit

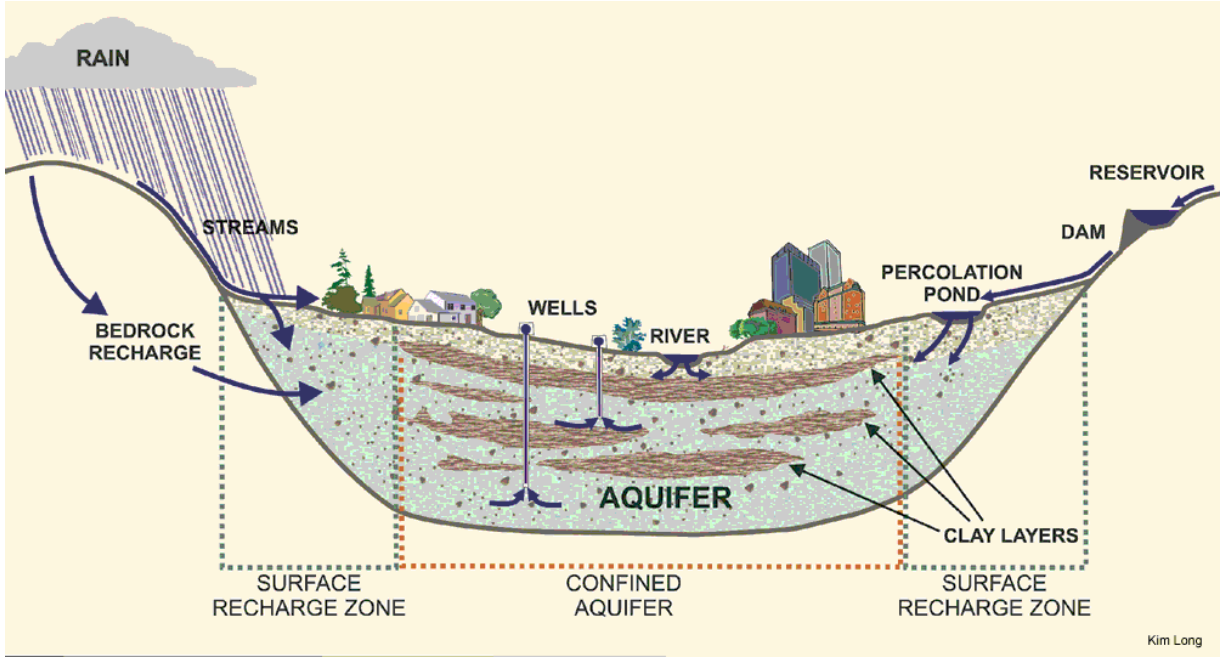
Scenario 6 Hot & Low Rainfall



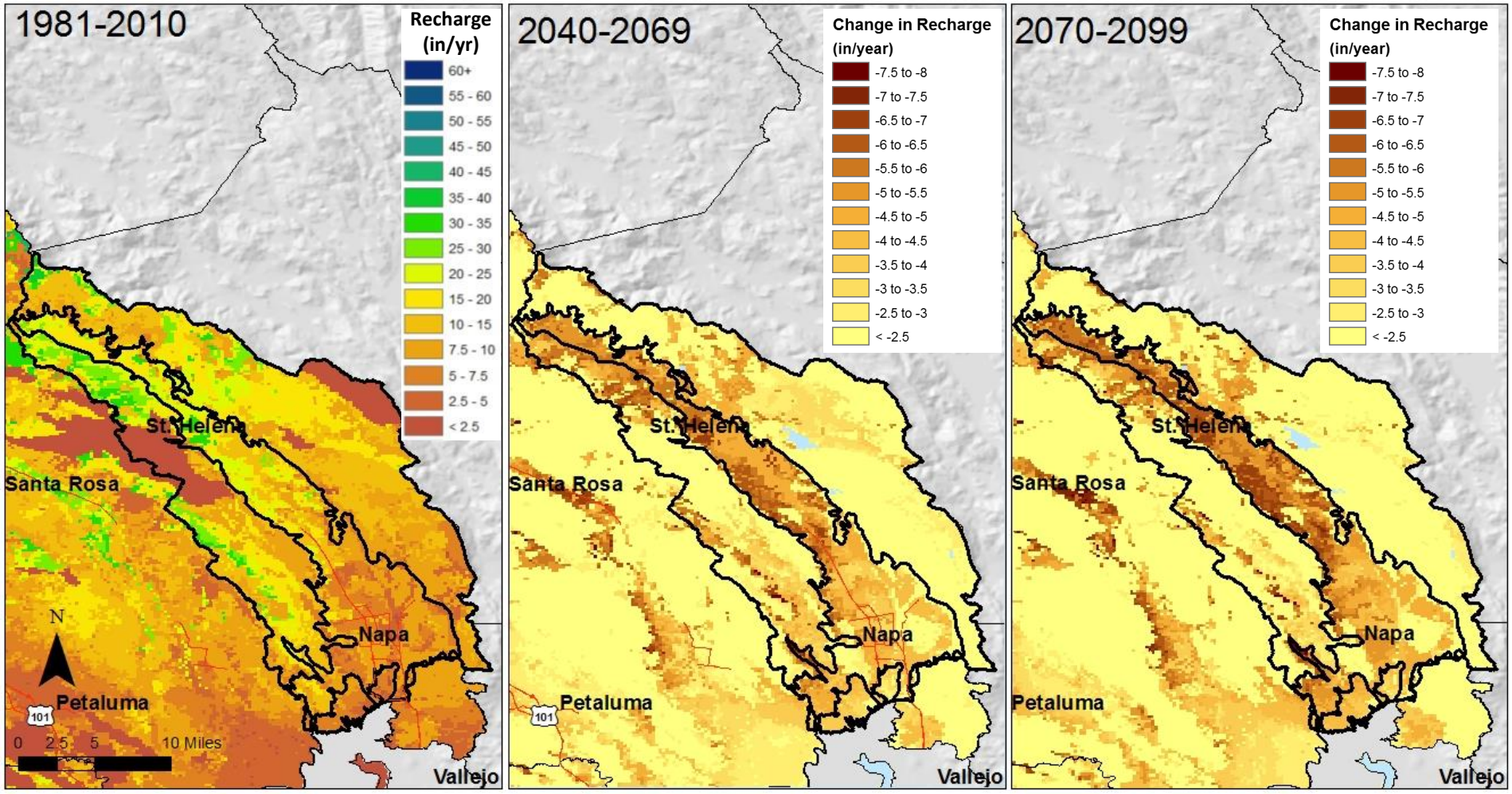
last 30 years 20 % greater deficit

Management Question

How will groundwater resources of the Napa River be potentially impacted by climate change?



Projected Change in Recharge, Hot and Low Rainfall



11 in/y average for valley

29% reduction
to 7.5 in/y average for valley

27% reduction
to 7.8 in/y average for valley

Low rainfall scenario results in losses of 2.5 inches of groundwater recharge per unit area annually

Management Question

How will the seasonality of the hydrologic cycle be potentially impacted by climate change?

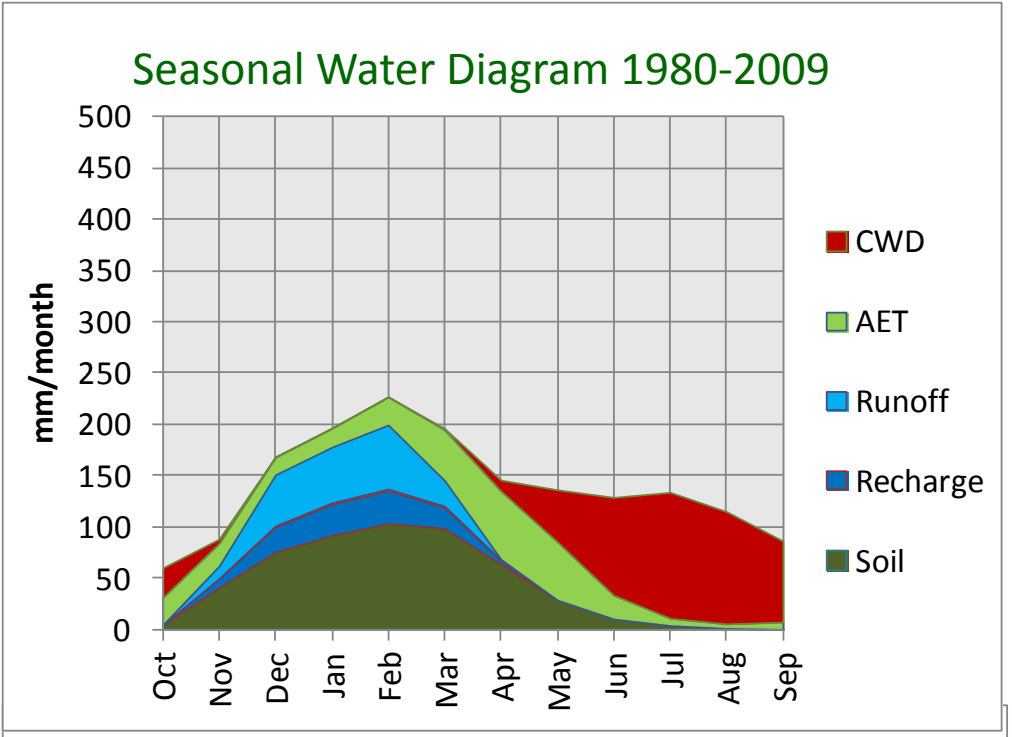
Bud Break in Napa Valley

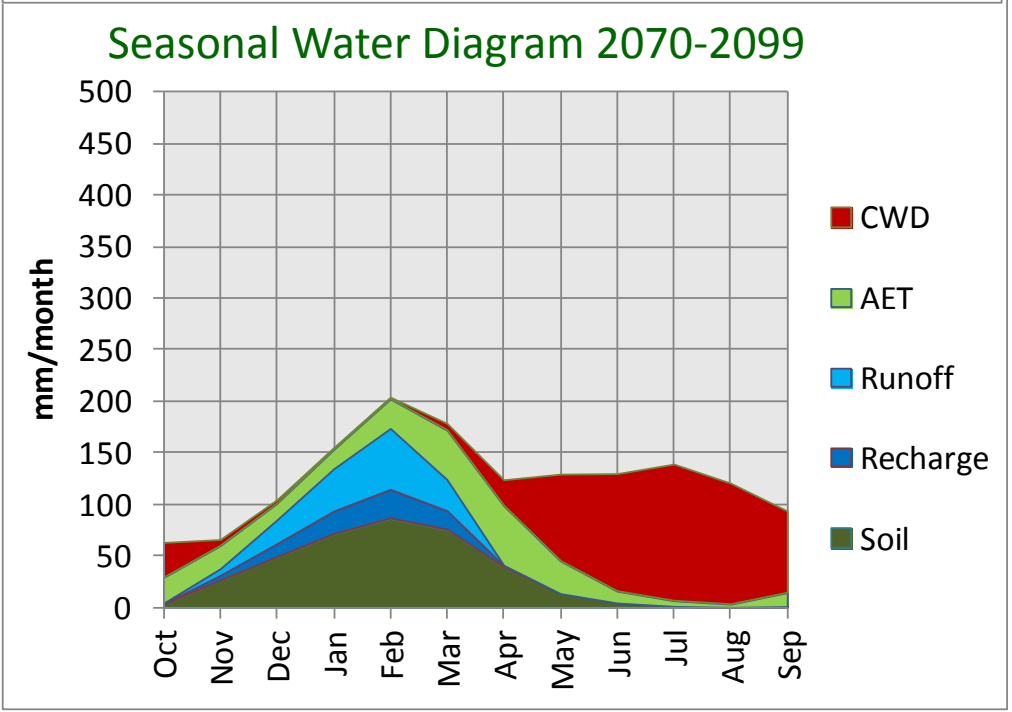
Though it's easy to find reasons to visit Napa Valley at various times throughou
shining, the weather is mild and enjoyable, nature is waking up for another glo
buds in the 400+ vineyards across Napa Valley are beginning to break. Spring
harvest; it's a time of renewal and new beginnings. Clear signs that spring is w
carpets of mustard growing between the vines and the bud break now occurrin
your room at our romantic Bed and Breakfast this spring, and enjoy nature's re

Bud Break Comes Early

Bud break is an exciting time in Napa Valley, and it's ultimately where the great
bud break, the vineyards that have been dormant throughout the winter month
tender buds of the growing season emerge in the early months of spring, growi
clusters of grapes begin to form. Though the Napa Valley is only 30 miles long, bud break and flowering can take up to two m
the differences in both elevation and temperature. The southern Carneros region near San Pablo Bay tends to be cooler whe

This year, bud break in Napa Valley seems to be happening earlier than ever before, thanks in large part to the warmer and





Seasonality of Water Cycle

1980-2009	Annual Average	
PPT	25.9	in
CWD	19.8	in
AET	13.0	in
Runoff	8.2	in
Recharge	4.8	in
Recharge/runoff	0.58	
Tmax	59.2	F
Tmin	41.7	F

2070-2099	Annual Average	
PPT	20.8	in
CWD	23.8	in
AET	11.1	in
Runoff	6.4	in
Recharge	3.4	in
Recharge/runoff	0.53	
Tmax	63.7	F
Tmin	45.5	F

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Management Question

How can I get this annual and seasonal time series BCM data for the Napa Valley and beyond?

BETA now available via the Climate Smart Watershed analyst on California Climate Commons!

calcommons.climate.org/tbc3/ sf-bay-watershed-analyst

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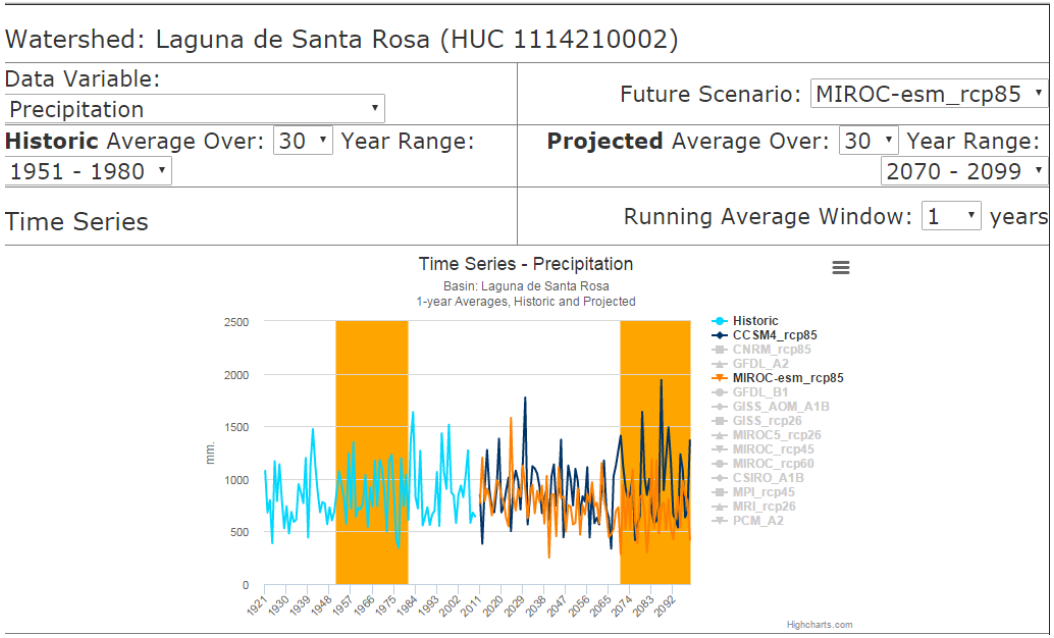
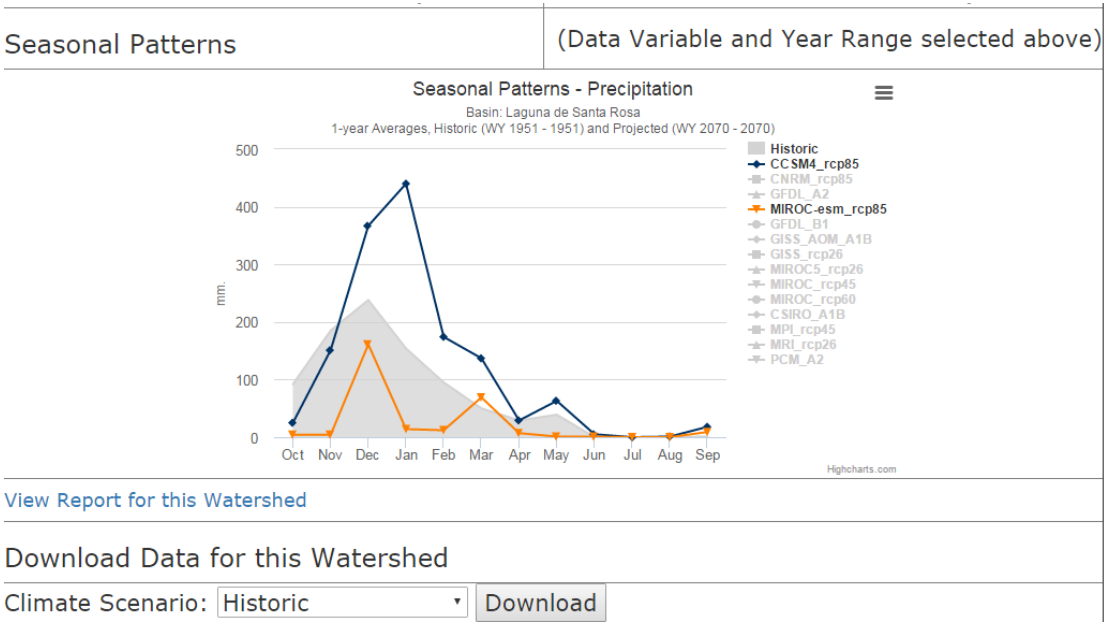


User selects a variable, temporal resolution, running average option, “comparison” windows

Seasonality of selected parameter-one or multi-year records/projections versus reference period



Management Question

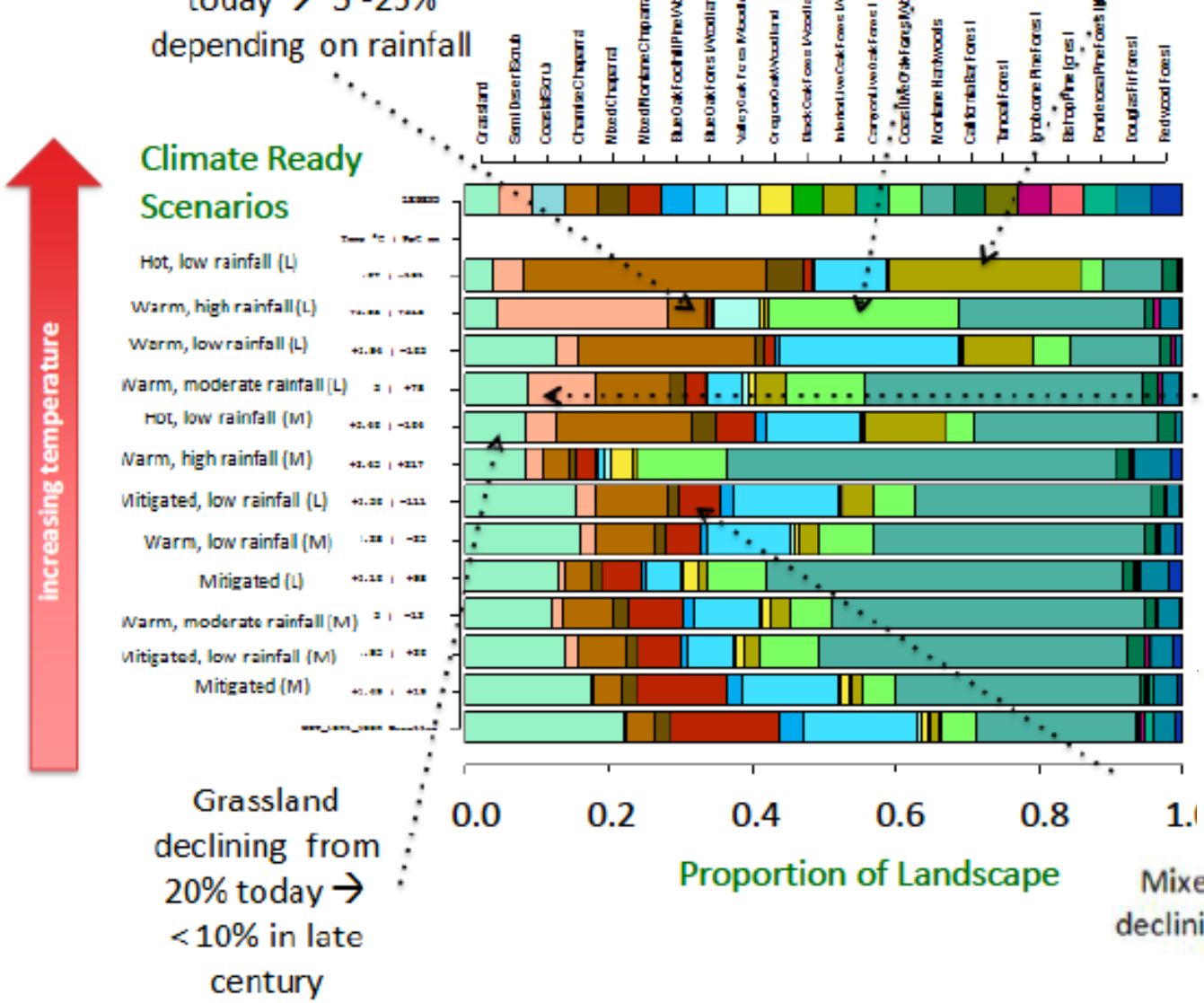
How will the natural vegetation of the Napa Valley be potentially impacted by climate change?

Ackerly et al 2015 - PloSOne

Coast Live Oak and Interior Live Oak increasing from ~ 5% today → 5 - 25% late century, depending on rainfall

Conditions for Chemise Chaparral increasing from ~ 5% today → 5 -25% depending on rainfall

Napa County Vegetation Report Summary



Semi-desert Scrub emerges and becomes common

Grassland declining from 20% today → <10% in late century

Mixed Montane Chaparral declining from ~10% → < 5% by mid century

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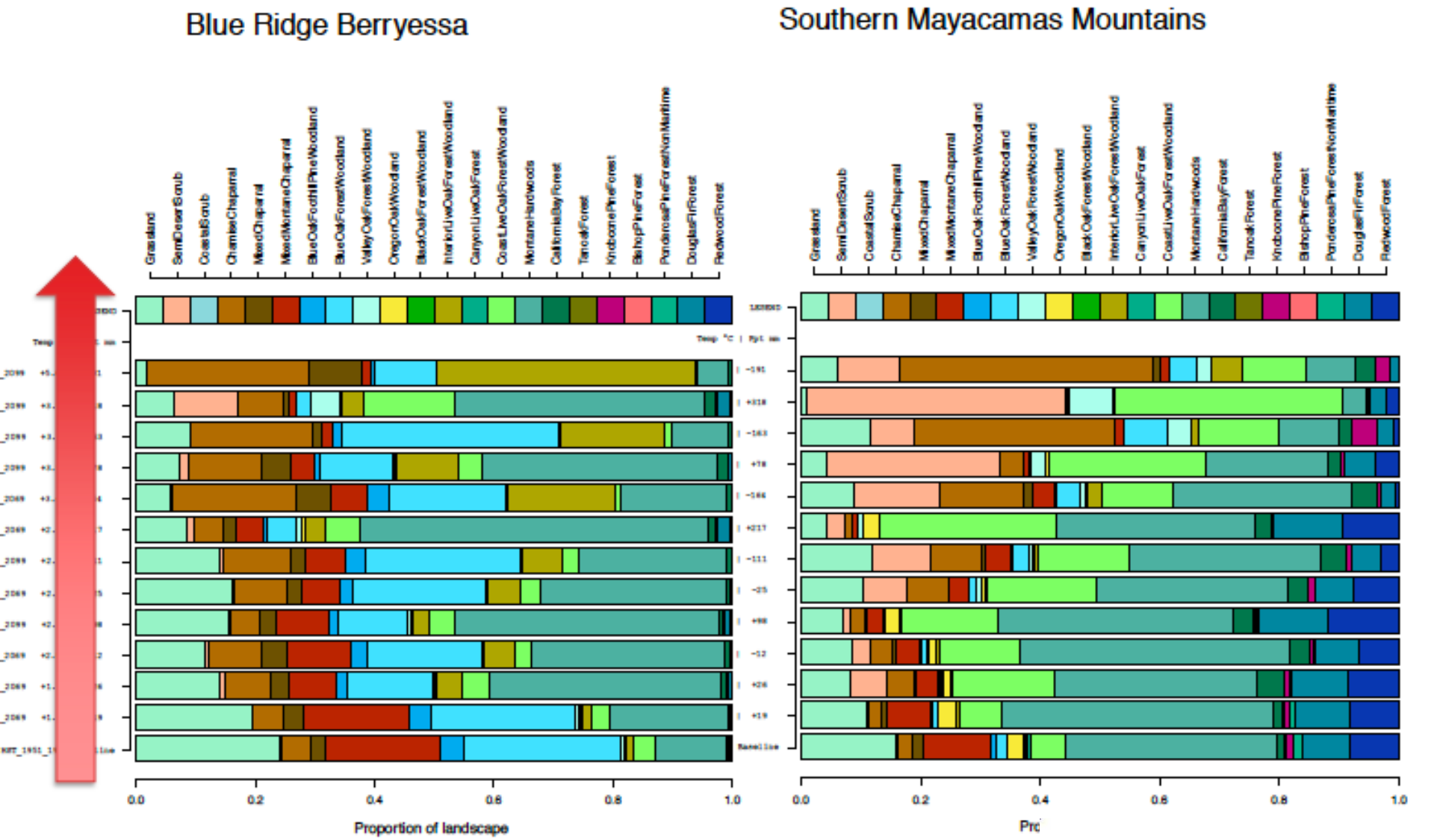


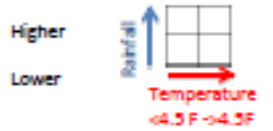
there can be significant differences between landscape units

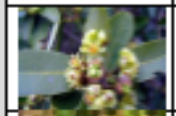
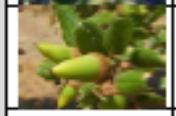
TBC3 Terrestrial Biodiversity Climate Change Collaborative

What are the potential native plant winners and losers for the Southern Mayacamas?

The color shows the projected response of vegetation to future climate.
Red: Dramatic Decline - 25% less than current
Orange: Moderate Decline - 25-75% less than current
Gray: Relative Stability - 75-125% current
Green: Increase - 125% more than current

The four squares summarize different climate futures: warm vs. hot and drier vs. wetter



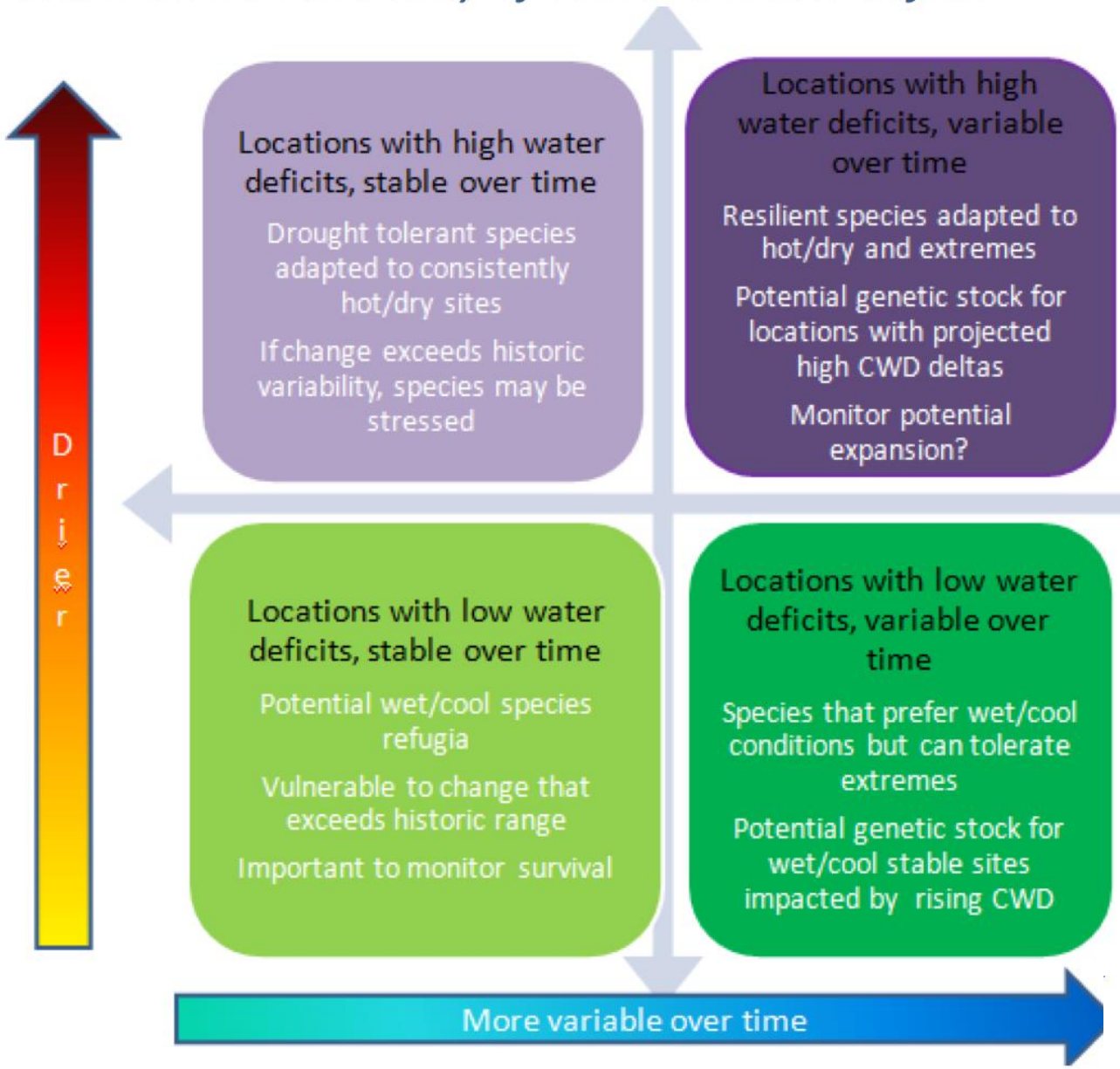
Possibly Expanding		Chamise Chaparral		Occupies hot, dry, steep slopes, and favorable conditions are projected to expand throughout the Bay Area under future climates. Seed dispersal and establishment may limit expansion. For existing chaparral stands, succession to oak woodland can happen over time in the absence of fire.
		Knobcone Pine		Knobcone pine is uncommon in our region, but could expand under hotter and drier conditions.
Likely Stable		Baccharis		Aggressive invader of grasslands in the absence of fire or grazing, and spreads rapidly in wet years. Models project expansion in interior regions of the Bay Area, especially under higher rainfall future scenarios.
		Blue Oak		Models disagree on the fate of Blue Oak. Native range includes very hot and dry locations, but it may be negatively impacted by warmer winters near the coast and loss of groundwater. Recruitment failure has been observed in parts of California, possibly due to competition with grasses and impacts of grazing.
		California Bay		Sensitive to hot, dry summers, but responds positively to warmer winters; the balance of these two makes projections uncertain. Bay regenerates vigorously from seed and seems to be expanding in many North Bay woodlands.
		Coast Live Oak		Reaches its northern range limit in the Bay Area, and may persist or even expand under warmer climates. While it is sensitive to warmer summers, it may be favored by increasing winter temperatures.
		Valley Oak		Endemic to California. Valley Oak is usually dependent on access to groundwater. Recruitment failure has been observed in some populations over the past decades. Models predict some declines under future climates, mainly in response to drier summers and/or warmer winters.
Possibly Declining		Douglas-fir		Establishes in grasslands, shrublands and oak woodlands, and in the absence of fire invades and overtops oak woodlands. It responds positively to modest winter warming, but is sensitive to drier summers and reduced rainfall.
		Oregon Oak		Near the southern limit of distribution along the California coast. Declining suitability is projected under all future climate scenarios, due to drier summers and warmer winters. Recruitment failure has been observed in some populations, though causes are uncertain.

Projected Vegetation Model reports available for North Bay at

http://www.pepperwoodpreserve.org/tbc3/our-work/climate-ready/

Or shortcut to Tbc3.org

Figure X. Conceptual framework for classifying portions of the preserve relative t value and historic variability of climatic water deficit



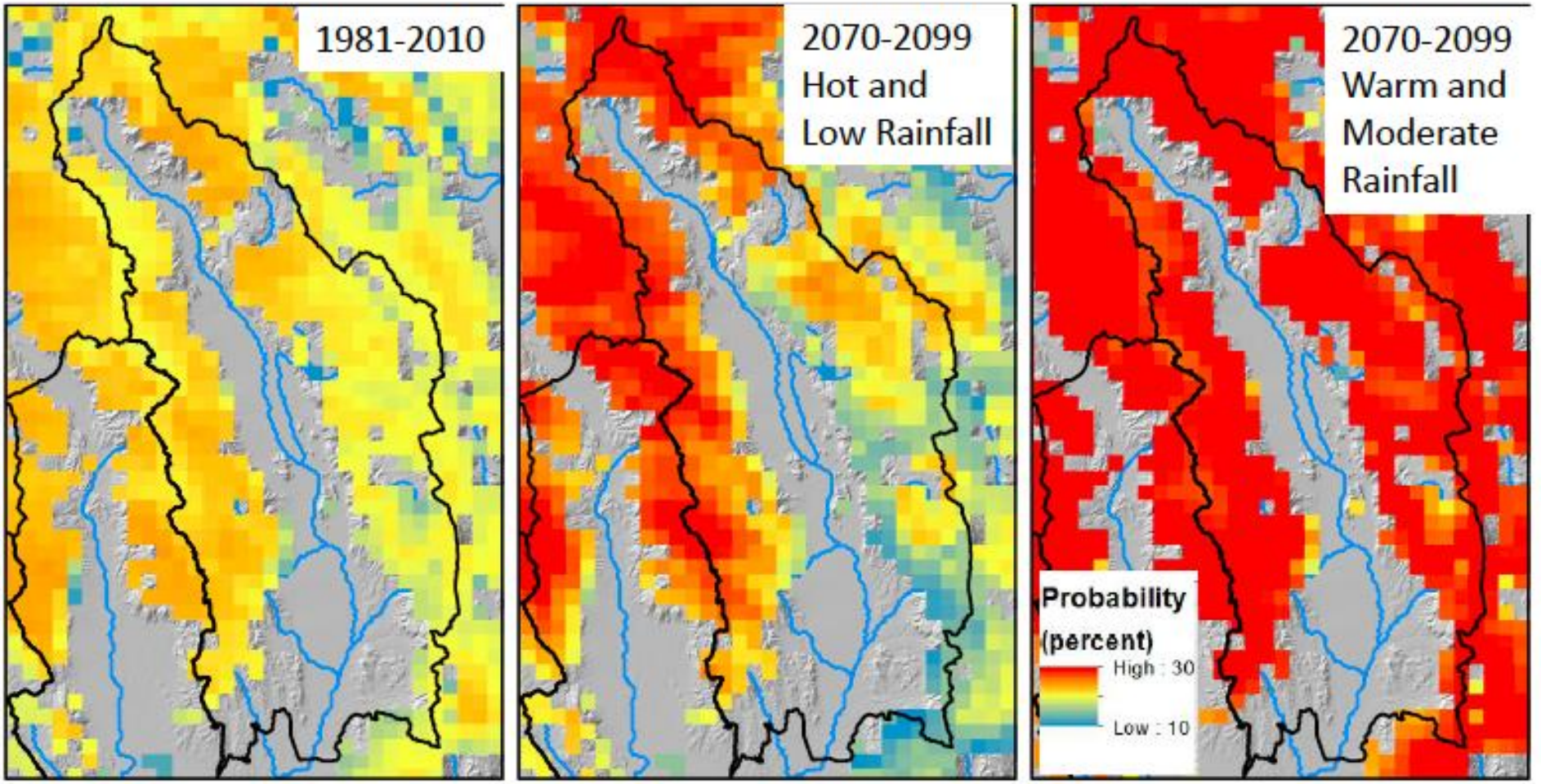
Using climatic water deficit projections to think about parcel-scale stewardship strategies

TBC3 Terrestrial Biodiversity Climate Change Collaborative

Management Question

How will the risk of fire in the Napa Valley be potentially impacted by climate change?

Change in Projected Probability of Burning One or More Times



Probability of fire doubles in some locations

		Current	Hot, Low Rainfall	Moderate Rainfall
Variable	Units	1971-2000	2070-2099	2070-2099
Probability of burning 1	Percent	21%	22%	29%
or more times	SD	2%	5%	3%

Urban and agricultural areas masked out

What kind of long-term agency plans can use this landscape-level data?

In general:

human health energy demand watershed plans
surface water supply fire and hazard mitigation
sustainable groundwater management agricultural
sustainability ecological restoration

TBC3 Terrestrial Biodiversity Climate Change Collaborative

In Napa:

CAP-Climate Action Plan-potential to use projections as local estimate of projected climate change. Increased heat could be used to project increase electrical use and emissions. Starting point for conversation about adaptation

Groundwater Plan: augment groundwater data with model recharge (current and projections). What area do you need to protect to achieve a target (% total?) recharge amount? Can Low Impact Development maintain recharge potential?

Urban water plans: reservoir scenario planning for extreme rainfall years, droughts and floods

Landscape Connectivity for Climate Adaptation

Fall 2016 launch

Continuous wildlife permeability surface e.g. Merenlender et al

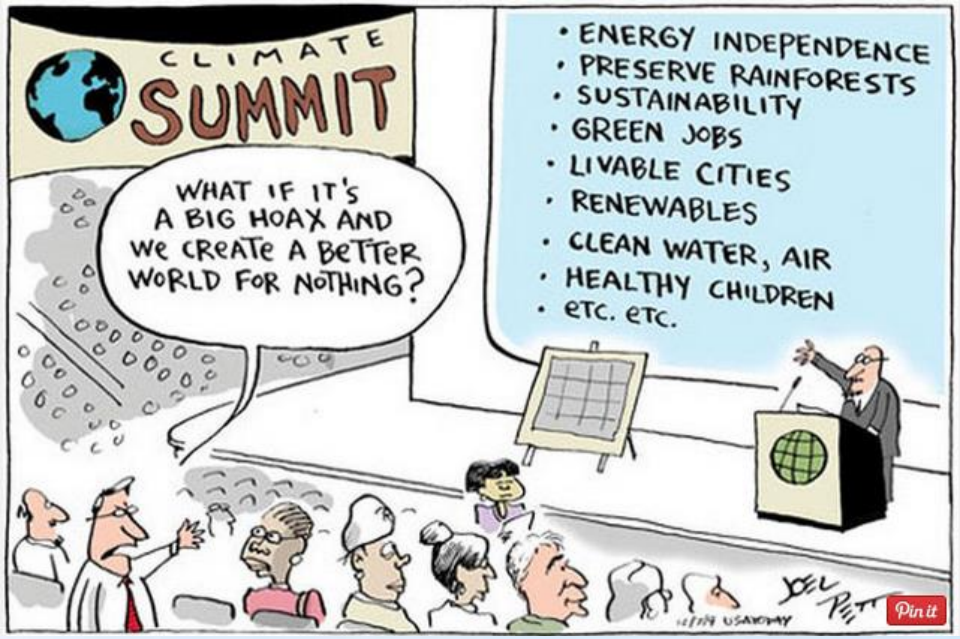
Meaningful consideration of streams and riparian corridors

Assessment of climate adaptation benefits

Pepperwood PRESERVE

Win-win strategies for climate adaptation

Mitigate greenhouse gas emissions.
Protect key watershed functional areas: floodplains, recharge areas, wetlands.
Recycle and conserve water.
Increase soil moisture holding capacity.
Get serious about fuels management.
Identify native species that are likely to be climate “winners”- protect seed sources.
Keep the landscape connected-riparian and terrestrial habitat corridors.
Prepare for more frequent extreme events.



Invest in preparedness-its cheaper than emergency response!

Pepperwood PRESERVE

NBCAI

The Climate Resilience Roadmap Overview

A Climate-Resilient Vision for Sonoma County

Extreme Heat · Frequent Drought · More Wildfires · Warmer Winters · More Floods · Higher Seas

9 CLIMATE RESILIENCE GOALS

1. Promote healthy, safe communities
2. Protect water resources
3. Promote a sustainable, climate-resilient economy
4. Mainstream the use of climate projections
5. Manage buffer zones
6. Promote ag preparedness and food security
7. Protect infrastructure
8. Increase emergency preparedness and prevention
9. Monitor climate and its effects

Process

1 Vulnerable communities' resilience
2 Connect community
3 Use less water
4 Use less water
5 Manage water as one
6 Diversify agriculture
7 Seize opportunities
8 Build resilient supply chain
9 Quantify benefits
10 Make room for water
11 Align plans with hazards
12 Farm carbon, water & diverse crops
13 Subsidize local food
14 Position your business
15 Reduce forest flammability
16 Prepare yourself
17 Invest in radical collaboration
18 Reality check
19 Align investments with values
20 Measure resilience

6 CLIMATE HAZARDS ADDRESSED

COMMUNITY RESOURCES AFFECTED

People and social systems
Built systems
Natural and working lands

TOP 20 ACTIONS

These are the highest priority actions from a longer list in the complete Roadmap document, distilled from over 125 raw actions from dozens of contributors and vetted by NBCAI and other experts.

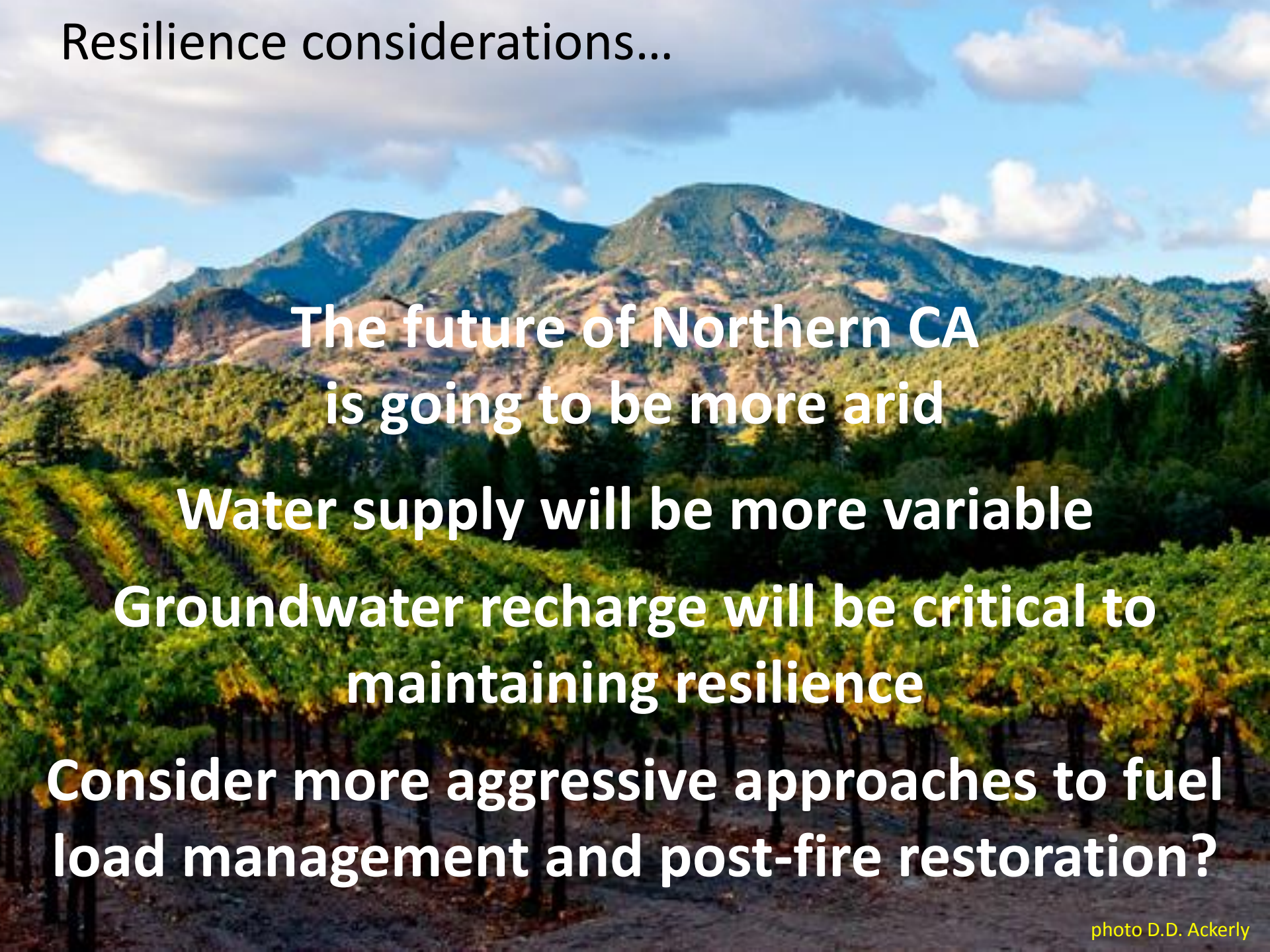
For the full list of actions, see the complete Roadmap at northbayclimate.org.

We must ALL participate for our community to be climate-resilient. Every person (and actor) has a part to play—school child, designer, official, tradesperson, farmer, retiree—to lead us to the resilient future we know is possible.

5 ACTORS

Working Lands Managers
Businesses
Individuals Households
Government
Nonprofits
Faith Community & Philanthropy
Academic Institutions

Resilience considerations…



The future of Northern CA is going to be more arid

Water supply will be more variable

Groundwater recharge will be critical to maintaining resilience

Consider more aggressive approaches to fuel load management and post-fire restoration?

photo D.D. Ackerly

Thank you!

www.pepperwoodpreserve.org