Climate Change: Effective Restoration for a Warming World

A Conference Session at the 34th Annual Salmonid Restoration Conference held in Fortuna, CA from April 6-9, 2016.

Session Overview

- Session Coordinator:
  - Joshua Strange, Stillwater Sciences

Accelerating climate change is consistently outpacing modeled predictions, the scale and speed of which effects all aspects of salmon conservation and restoration. Successfully accounting for climate change in restoration planning and implementation requires, in part, 1) accurately anticipating climatic changes resulting impacts at sufficient resolution; and, 2) having effective compensating and mitigating tactics and techniques. The degree to which restoration practitioners can understand and incorporate such information will have a strong influence on the long term performance of projects and the productivity of salmon populations. This session will inform practitioners on up-to-date anticipated impacts of climate change and provide examples of effective tactics through analysis or implementation.

Presentations

(Slide 4) When It Rains It Pours, But Not Very Often; Implications for Climate Change Considerations for Southern California Steelhead Restoration
Stacie Fejtek Smith, NOAA Restoration Center

(Slide 44) Spatial and Temporal Variability in Baseflow Magnitude and Dry Stream Channels in the Mattole River Headwaters: Implications for Salmonids and Restoration
Nathan Queener, Mattole Salmon Group

(Slide 74) Availability of Thermal Stratification and Refugia in the Middle San Joaquin River System
Nathaniel L. Butler, Ph.D., University of California, Berkeley

(Slide 121) Use of GIS Technology to Prioritize the Restoration and Protection of Anchor Habitat Riparian Areas in the Rogue River Basin
Eugene Wier, The Freshwater Trust

(Slide 142) Thinking Like Planet Water for Rehydrative Resilience in a Time of Global Weirding
Brock Dolman, Occidental Arts and Ecology Center WATER Institute

(Slide 217) Survive, Thrive, or Die? Adapting California's Water Infrastructure to Help Salmon in the Face of Extreme Climate Change
Joshua Strange, Ph.D., Stillwater Sciences

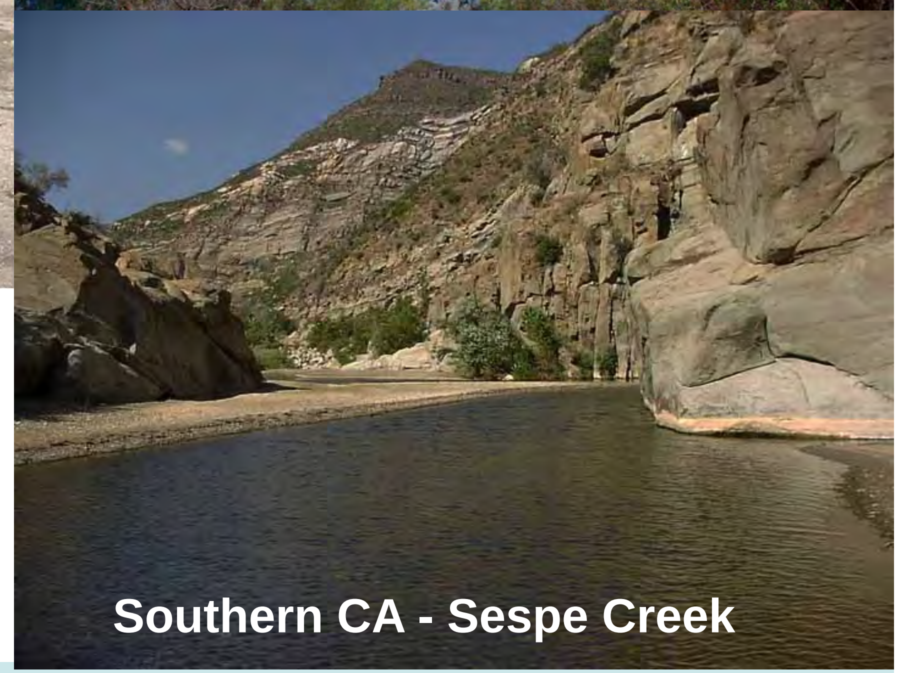
When it Rains it Pours, But Not Very Often; Implications for Climate Change Considerations for Southern California Steelhead Restoration

Stacie Fejtek Smith

NOAA: Bob Pagliuco , Mark Capelli,
UCLA: Rich Ambrose, Glen MacDonald, Dave Jacobs, Mark Gold

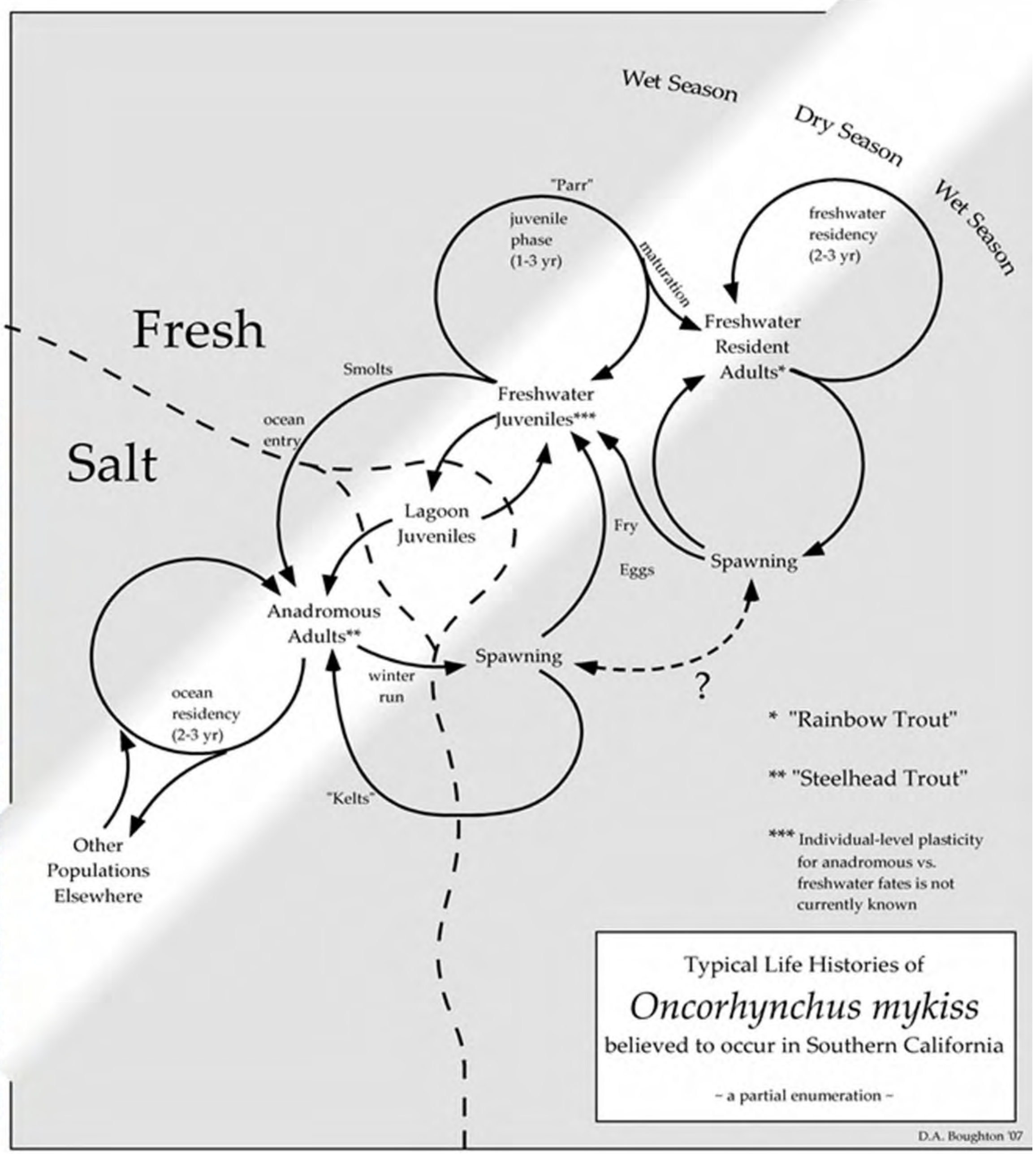
April 9, 2016

Southern California is Already Very Different…

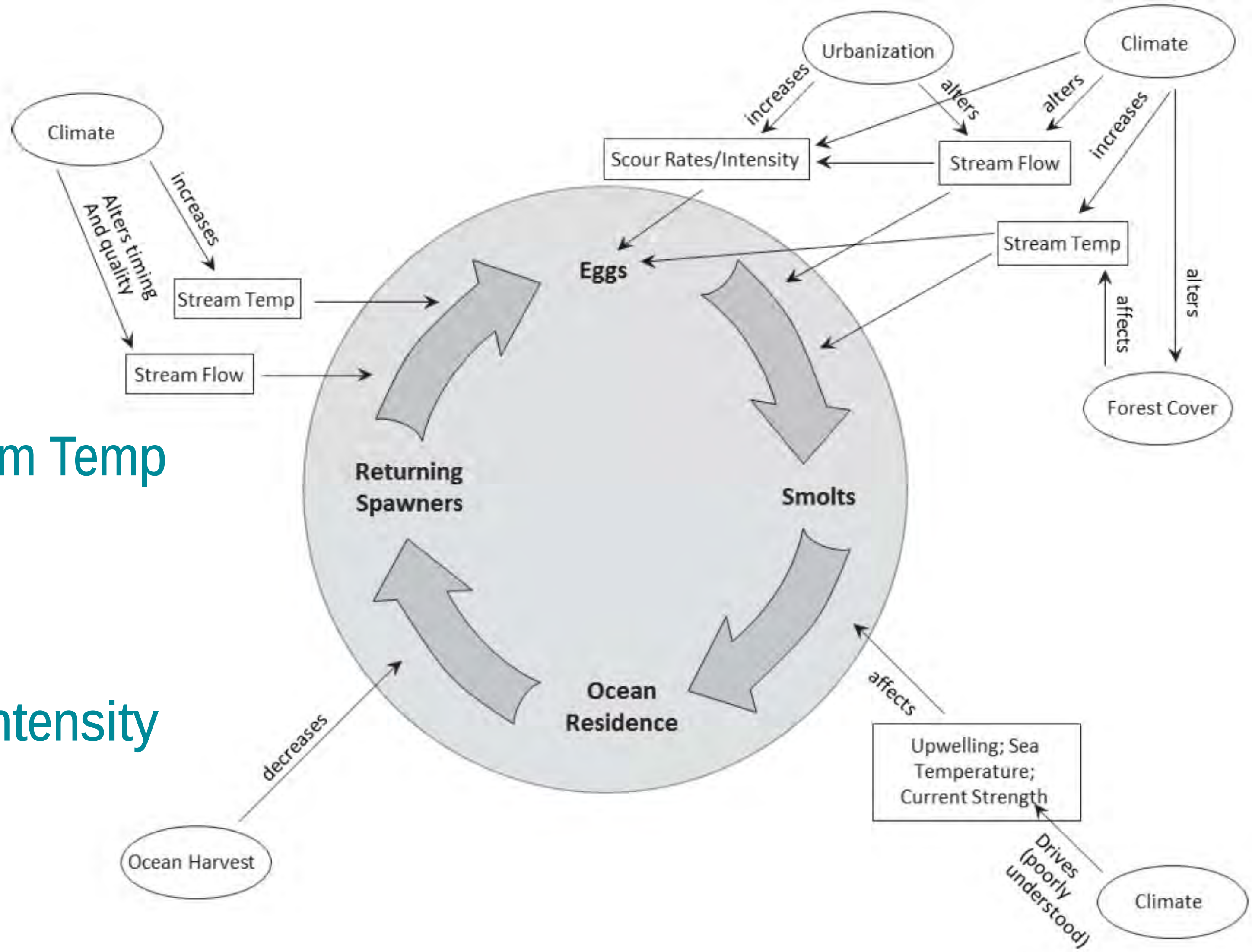


More Changes to Come with Climate Change

Steelhead – Adapted Like No Other



Climate change impacts to steelhead



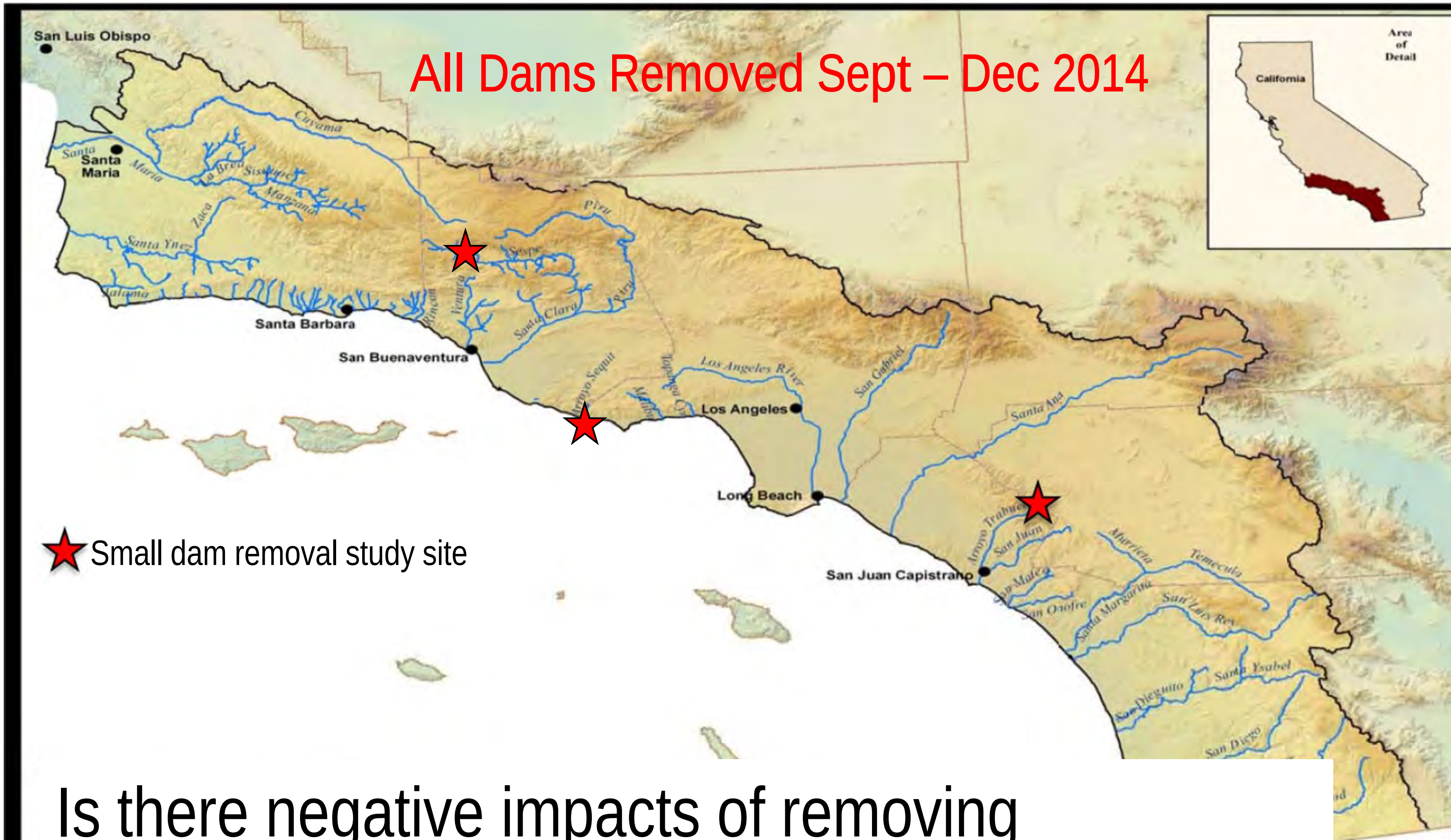
Increased Stream Temp

Altered

- Stream Flow,
- Scour Rate Intensity
- Forest Cover

Small Dam Removal Study

All Dams Removed Sept – Dec 2014



★ Small dam removal study site

Is there negative impacts of removing small dams under persistent drought conditions?

NOAA RESTORATION CENTER

COMMUNITY-BASED RESTORATION PROGRAM

Lion Creek Fish Passage Project, Ventura River Watershed

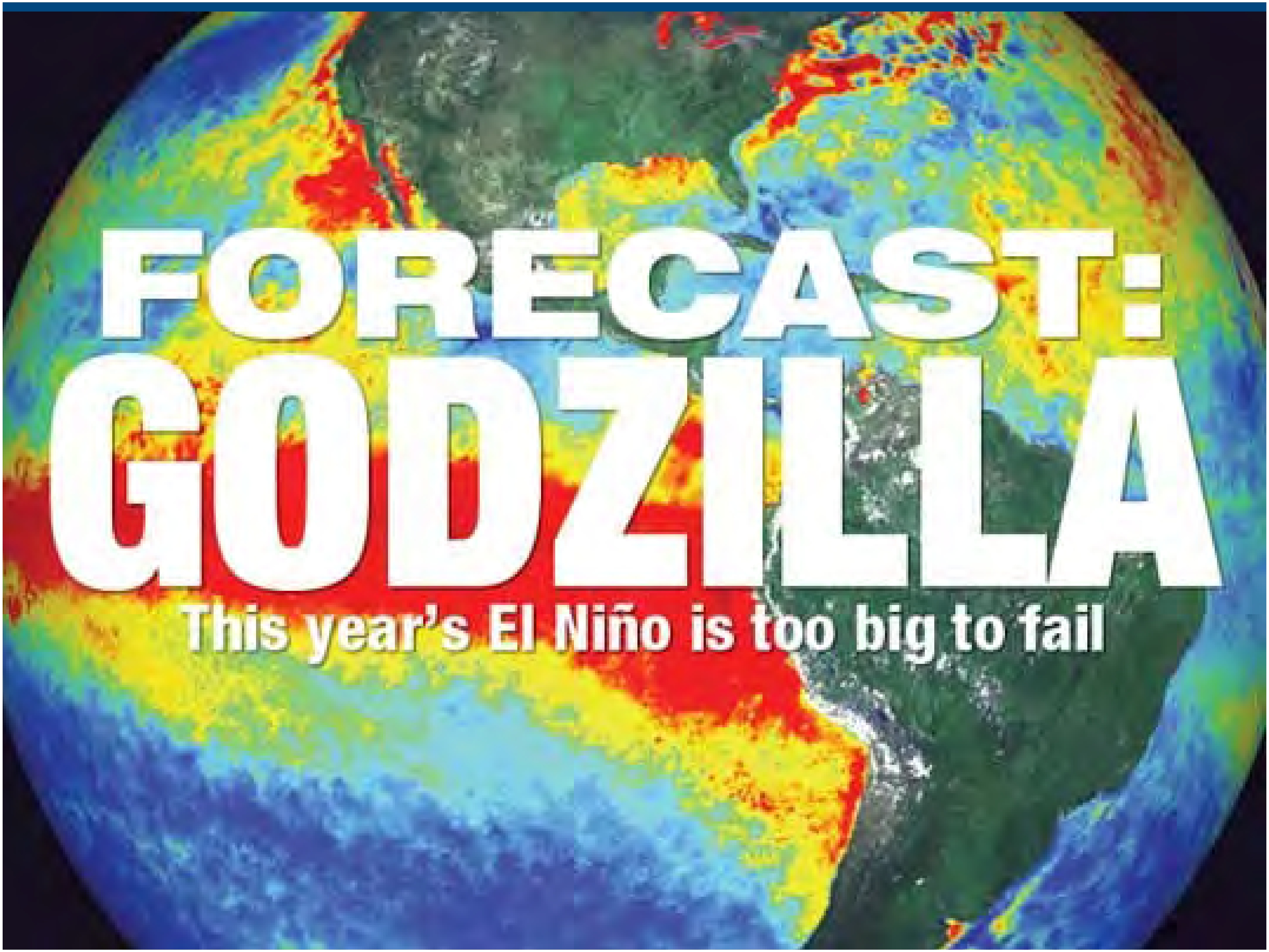
Creative Ways to Monitor Restoration

NOAA/CCC Veteran Corps

Vet CorpsTrainings

- Dive training
- Spawner surveys
- Downstream Migrant Trapping
- Habitat Survey Training
- PIT Tagging and Recovery
- FRGP grant writing seminar
- Excel and Access Database Entry
- Minnow trapping
- Seining
- Collection of tissues, scales and otoliths
- LWD assessment
- Excel and Access database
- Chainsaw Safety Training
- Leave no Trace Training

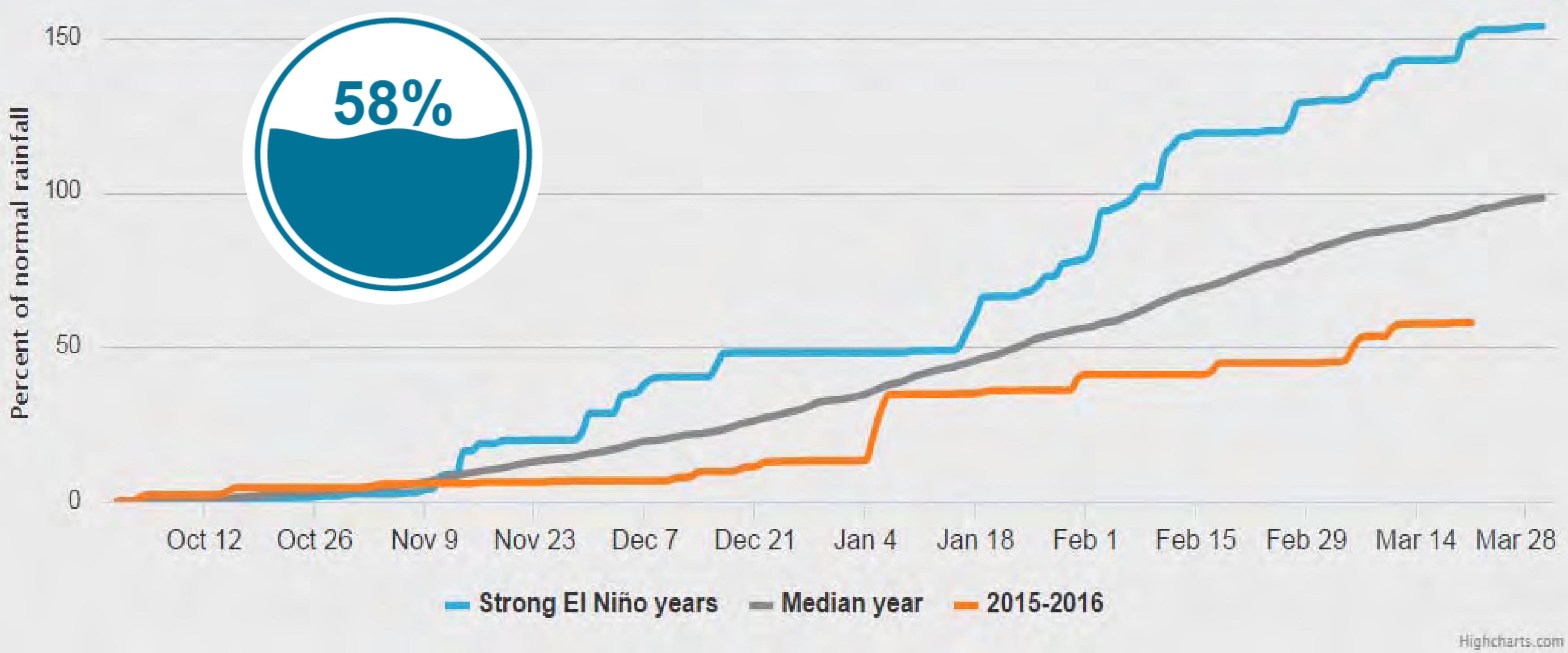
- Whitewater Safety and Snorkeling Techniques
- Instream Flow Monitoring
- Radio and Vehicle Usage
- Adult and Juvenile Identification
- Fish passage/refugia assessments
- Fisheries habitat assessments
- Fish Passage Inventory
- Instream flow and temperature monitoring
- Flood Fighting Techniques
- Pesticide/Herbicide Training
- Adult Trapping Training
- Firefighting Training


FORECAST:
GODZILLA
This year's El Niño is too big to fail

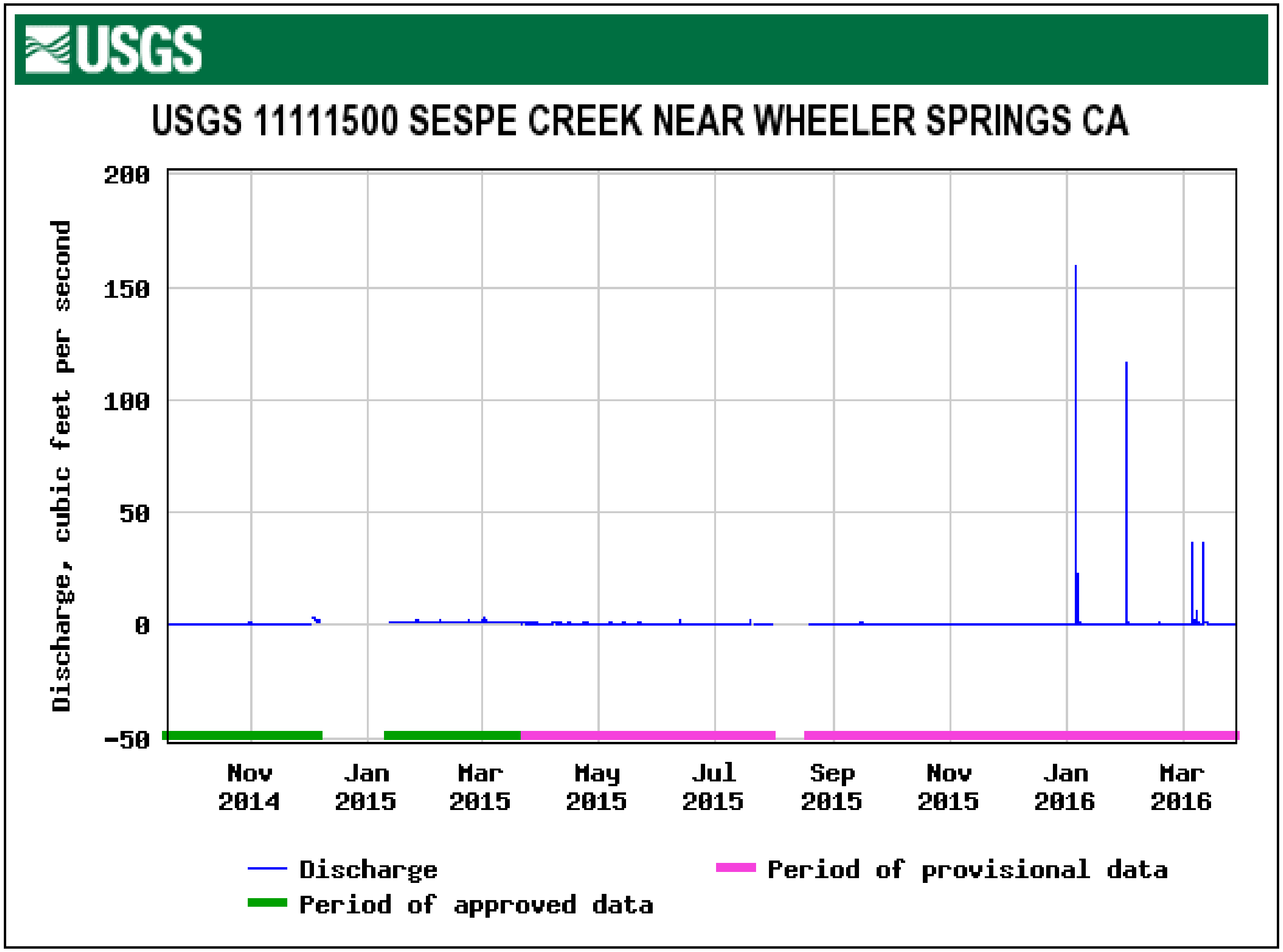
EL NIÑO

How does this year's rainfall in SoCal stack up?

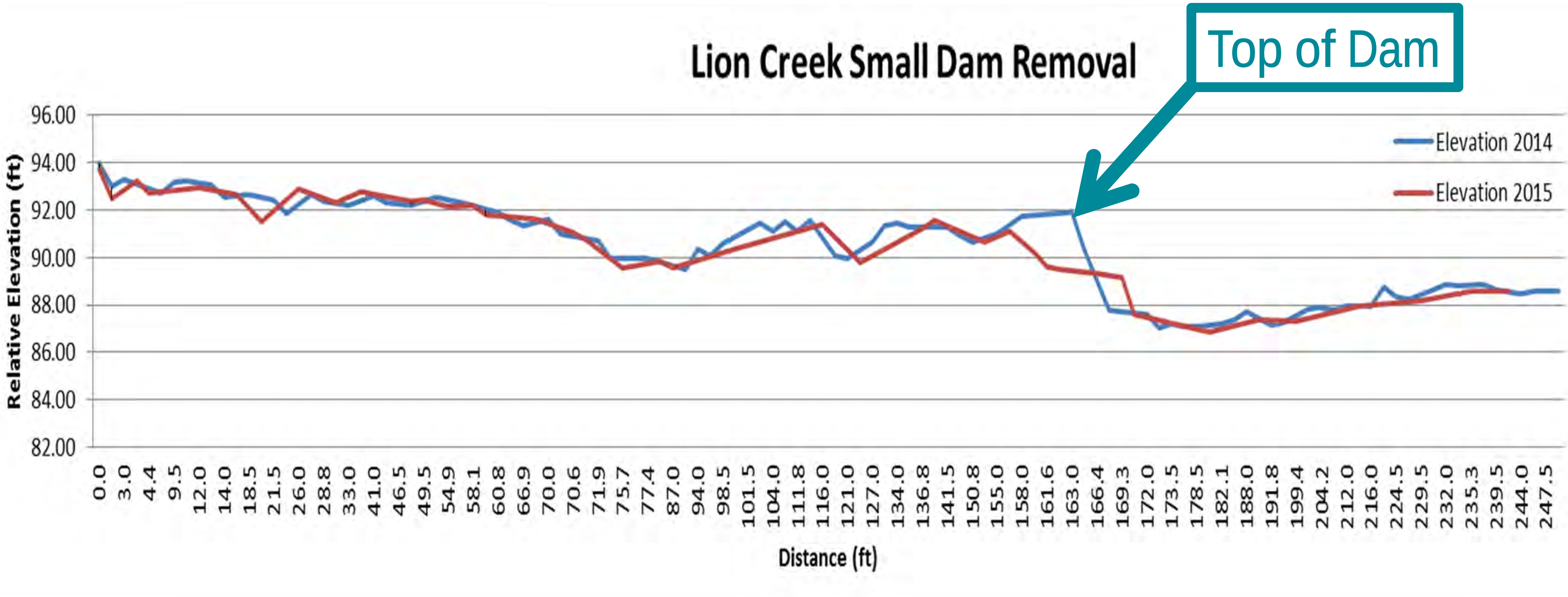
About | Sources | Read more



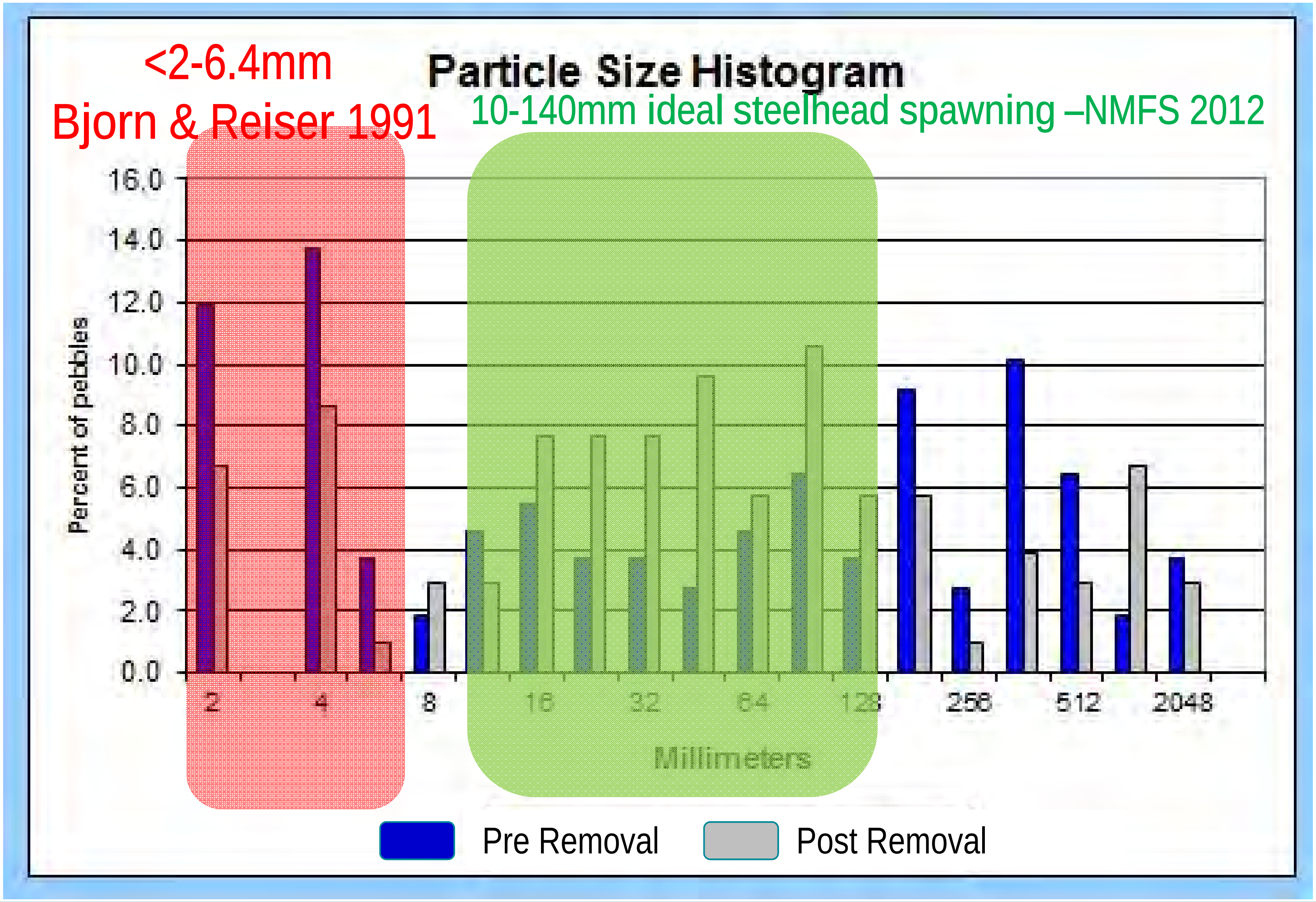
Discharge in Sespe Since Dam Removal



Long Profile for Lion Creek- Pre and Post Dam Removal



Cross-section 2 – Downstream of Dam Removal



UCLA Institute of the Environment and Sustainability

Environmental Science and Engineering, D. Env.

Best Practices for Southern California Coastal Wetland Restoration and Management in the Face of Climate Change

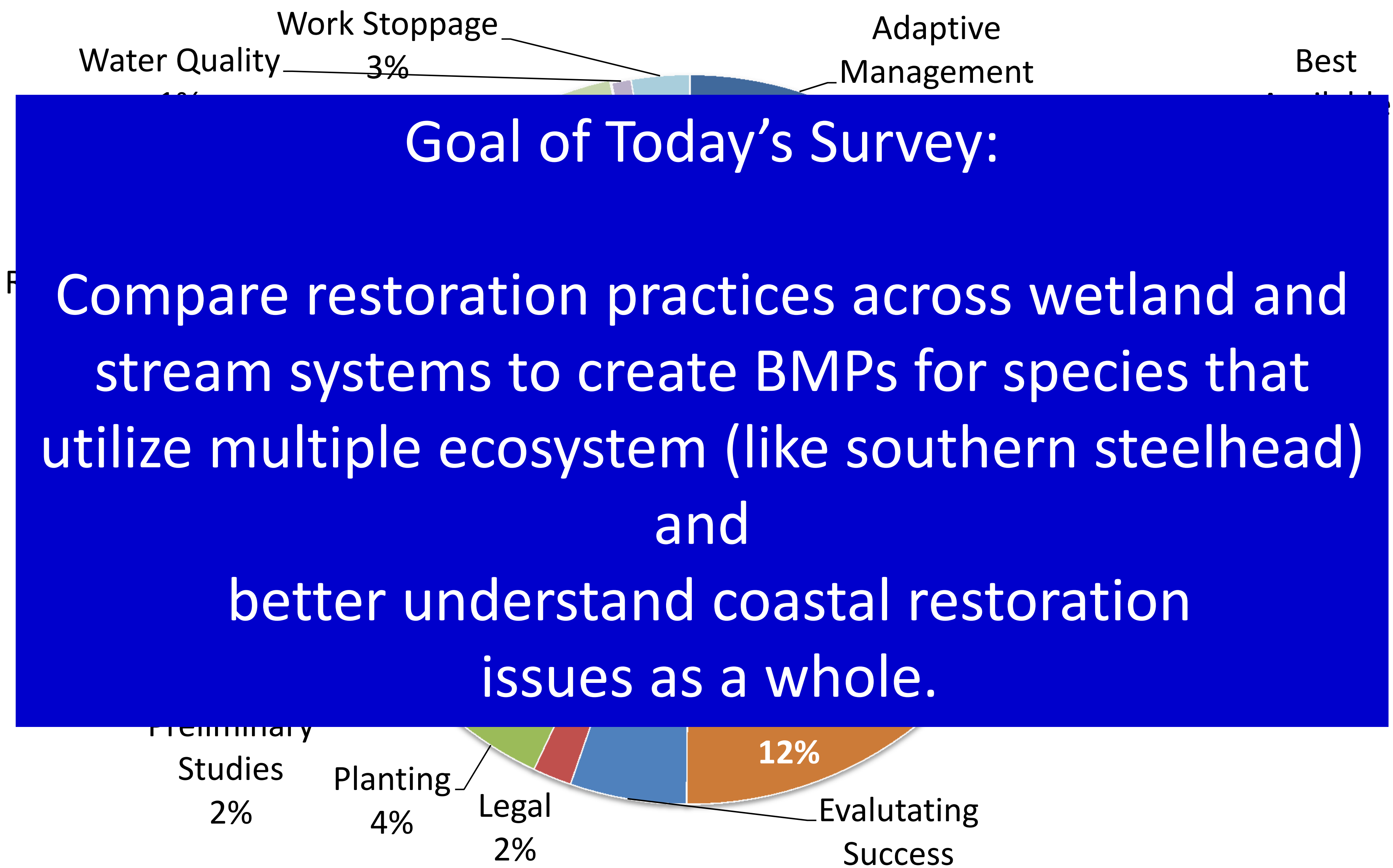
Stacie M. Fejtek[1], Mark Gold[1], Glen M. MacDonald[1,2], Dave K. Jacobs[3], Richard F. Ambrose*[1,4]

Wetland to Stream BMP Development

- Compiled a list of wetlands managers and agencies with range of expertise
- A 10 question interview: Planning, Construction, Management
- Responses used to create a list of recommendations and BMPs

Planning	Construction	Management

349 Recommendations➔ 17 Themes of Restoration Issues



Goal of Today's Survey:

Compare restoration practices across wetland and stream systems to create BMPs for species that utilize multiple ecosystem (like southern steelhead) and better understand coastal restoration issues as a whole.

Survey Logistics

- Survey results will be anonymous
- Contact information will only be viewed by Stacie and used to further develop BMPs
- Organizations will be acknowledged
- Please indicate the type of organization you are affiliated with (private, non-profit, government)
- If you would like to fill out the survey online you can be 100% anonymous - https://www.surveymonkey.com/r/StreamBMP
- Disclaimer: While the authors appreciate the support and advice from the participants, the primary authors are solely responsible for the content. This document does not necessarily reflect the official position of the agencies and project partners. Any errors should be attributed to the primary authors.

1. What southern California stream restoration projects have you worked on that benefit southern steelhead?

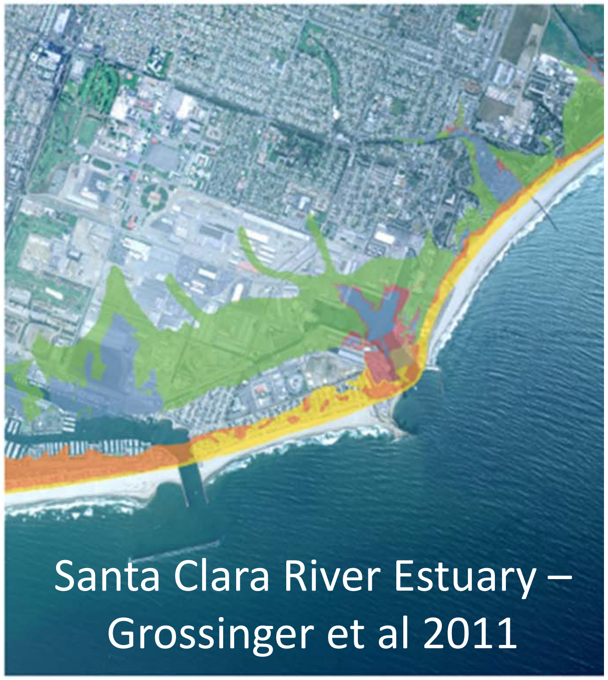
If numerous please give an approximate number of projects highlighting a few examples which you were involved throughout the restoration process.

Have you worked on projects with steelhead benefits in wetlands?

If you have not worked in southern California, but have worked on other salmonid species restorations projects please identify target species and general regional (Northern, Central, South-Central, Central Valley) context of projects.

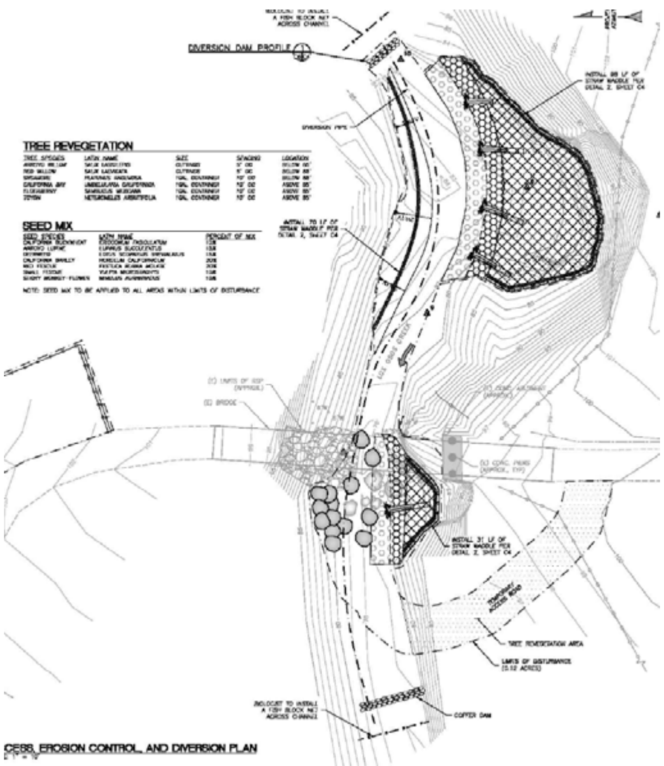
Planning

2. How much consideration was placed on historical, current, and future conditions in development of restoration goals?



Planning

3. What technical, physical, and societal factors slowed or enhanced the planning process?



Planning

4. What recommendations would aid in the planning process and minimize conflict/frustration/failure for restoration projects?

Planning

5. Have you worked on projects that have utilized an adaptive management plan?

Was the adaptive management plan developed as part of the planning process?

If so how was it developed?

Planning

6. How was climate change considered in prior restoration projects?

What climate change considerations should be taken for future projects?

What do you believe are the current gaps in knowledge for coastal stream restoration?

Construction

7. What factors (hydrological, biological, and or engineering) have enhanced or slowed the restoration construction process?

Construction

8. What recommendations would aid in the restoration/construction process for future restorations in general and also in the light of climate change?

Post Construction Restoration Management

9. What were some of the anticipated maintenance requirements projects you have worked on have faced?

Did actual maintenance requirements match the expected maintenance requirements?

What were the unanticipated maintenance requirements?

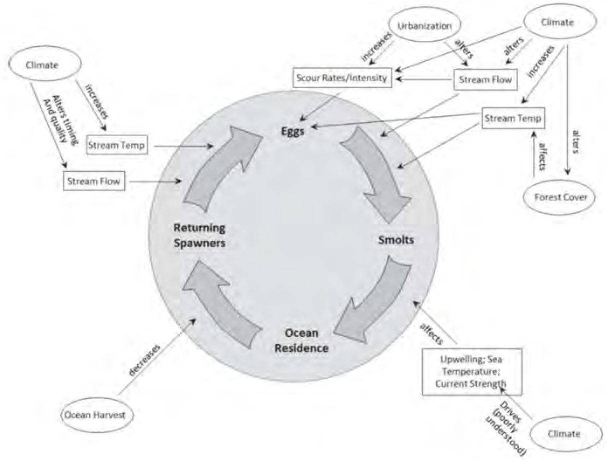
Post Construction Restoration Management

10. Will climate change alter the way projects are managed in the future?

How can climate change be incorporated into post construction management?

Increased Stream Temp

Altered...
Stream Flow, Scour Rate Intensity& Forest Cover



THANK YOU!!!!

Contact/Questions/Submitting Surveys

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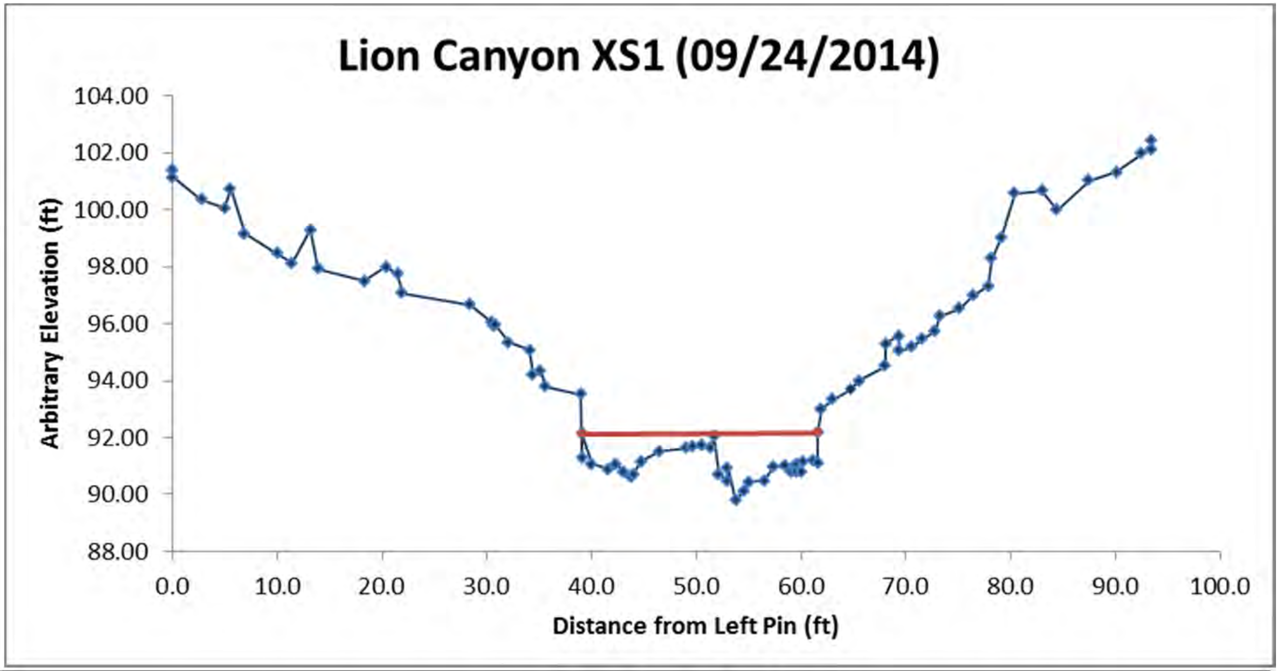
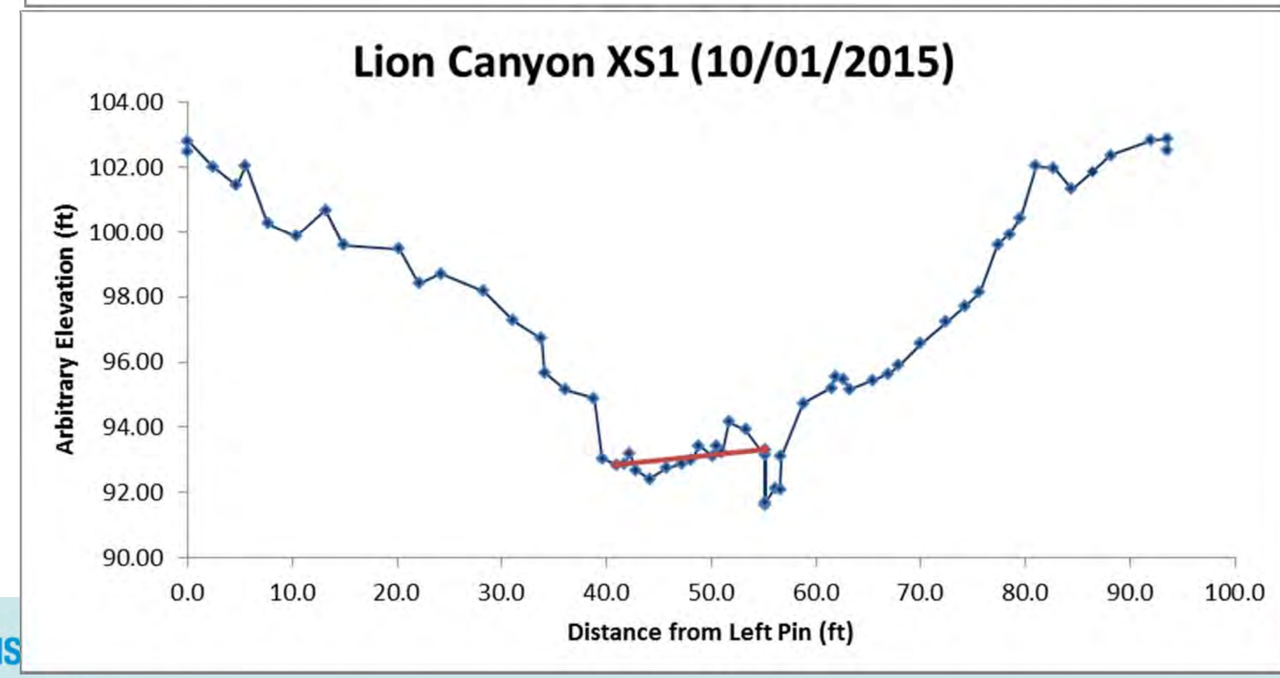
Long Beach, CA 90802


Lion Canyon XS1 (09/24/2014)
Arbitrary Elevation (ft)
Distance from Left Pin (ft)
104.00
102.00
100.00
98.00
96.00
94.00
92.00
90.00
88.00
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0


Lion Canyon XS1 (10/01/2015)
Arbitrary Elevation (ft)
Distance from Left Pin (ft)
104.00
102.00
100.00
98.00
96.00
94.00
92.00
90.00
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
100.0

Cross Section 1 – Upstream of Dam Removal

2mm

	<	> or =	Total
Reference	21	102	123
Study	10	98	108
Total	31	200	231

Reference <	Study <	Average <	Average >=
17.1%	9.3%	13.4%	86.6%

p-value 0.0612

4 mm

	<	> or =	Total
Reference	25	98	123
Study	19	89	108
Total	44	187	231

Reference <	Study <	Average <	Average >=
20.3%	17.6%	19.0%	81.0%

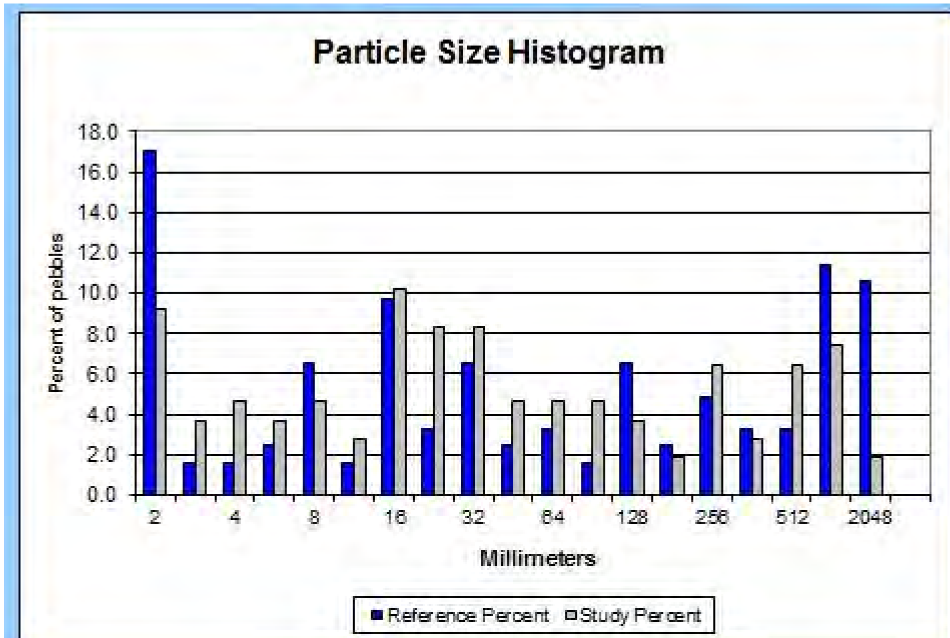
p-value 0.3595

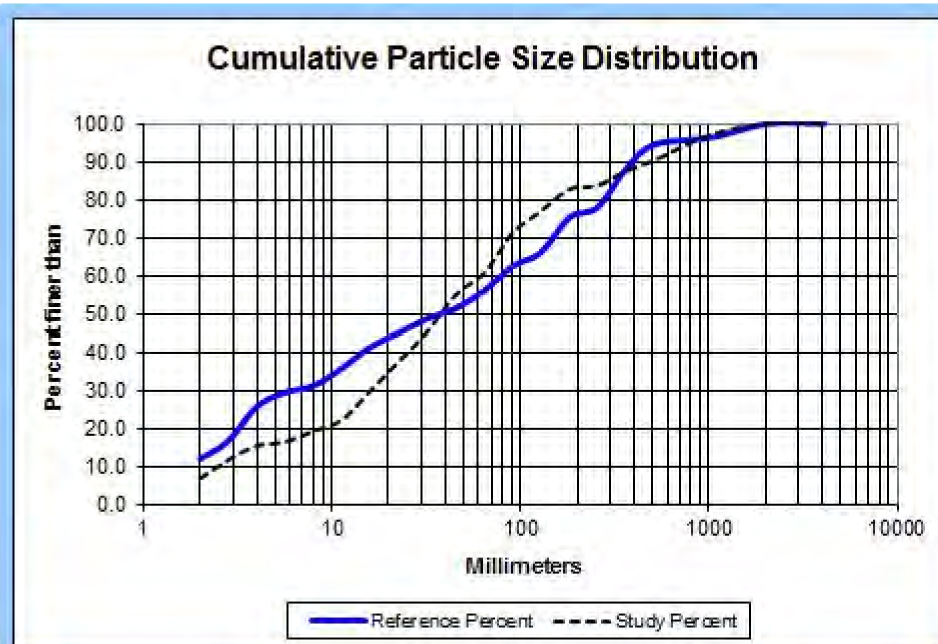
8 mm

	<	> or =	Total
Reference	36	87	123
Study	28	80	108
Total	64	167	231

Reference <	Study <	Average <	Average >=
29.3%	25.9%	27.7%	72.3%

p-value 0.3376





Cross-section 2 – Downstream of Dam Removal

2mm	<	> or =	Total
Reference	13	96	109
Study	7	97	104
Total	20	193	213

Reference <	Study <	Average <	Average >=
11.9%	6.7%	9.4%	90.6%

p-value	0.1435

4 mm	<	> or =	Total
Reference	28	81	109
Study	16	88	104
Total	44	169	213

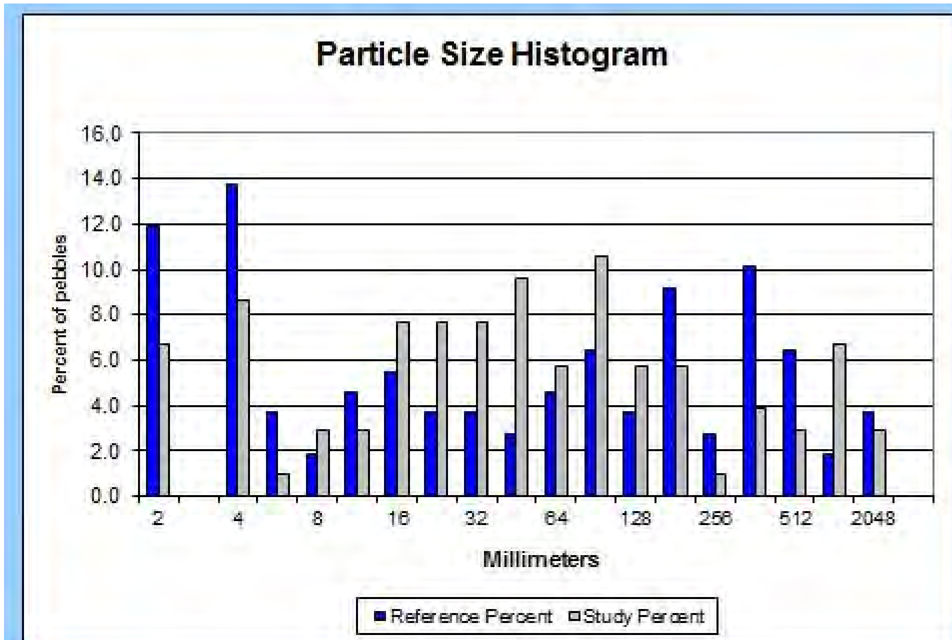
Reference <	Study <	Average <	Average >=
25.7%	15.4%	20.7%	79.3%

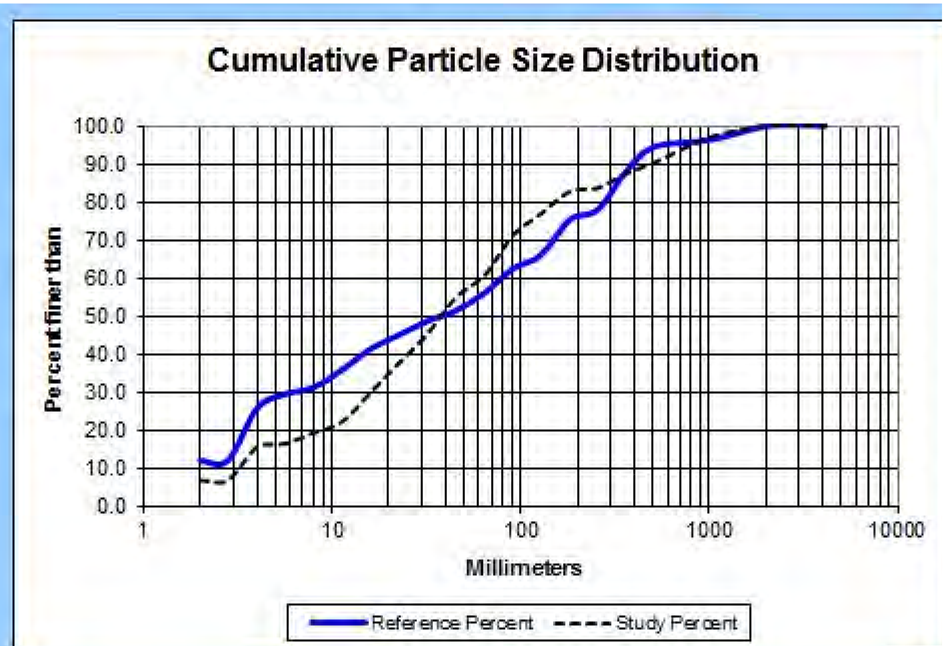
p-value	0.0458

8 mm	<	> or =	Total
Reference	34	75	109
Study	20	84	104
Total	54	159	213

Reference <	Study <	Average <	Average >=
31.2%	19.2%	25.4%	74.6%

p-value	0.0323





NMFS Technical Recovery Team Recommendations

- *Identify and commit to a core set of populations in five biogeographic regions on which to focus recovery efforts.*
- *Secure the extant parts of the large inland populations.*
- *Identify and maintain sustainable refugia against severe droughts and heat waves.*
- *Protect and restore habitats to support all life-history forms*
- *Secure and improve estuarine/lagoon habitat*

Steelhead Recovery Plan Recommendations – for Steelhead and Climate Change

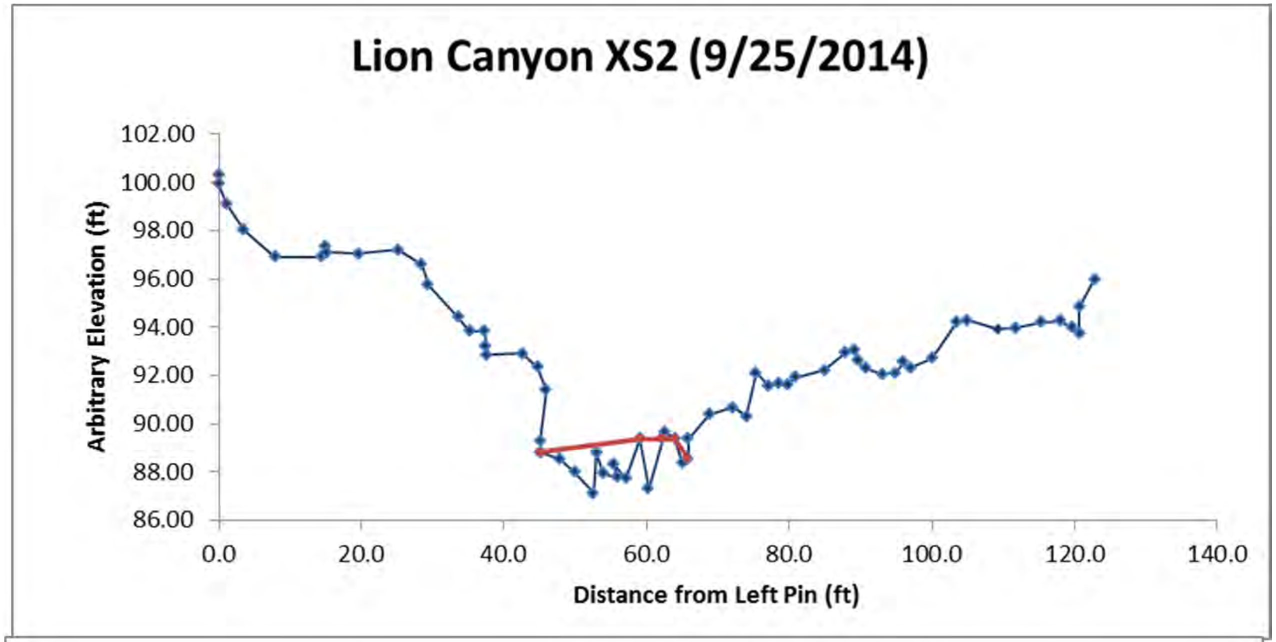
High Priority Recovery Actions :

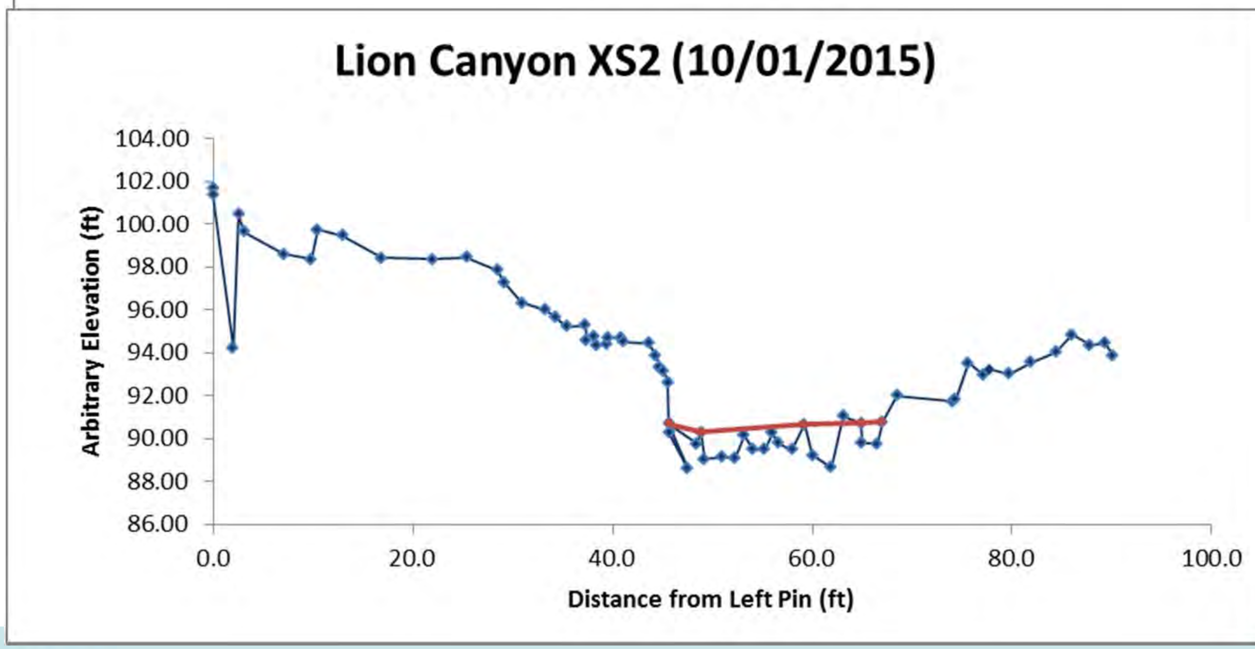
Fish Passage, Flow Management, Estuary Restoration

Recovery Strategy

- *Mimics the Steelhead Evolutionary Strategy*
- *Anticipates Climate Change*

Southern California's
Highly Variable Seasonal Environments


Lion Canyon XS2 (9/25/2014)
Arbitrary Elevation (ft)
102.00
100.00
98.00
96.00
94.00
92.00
90.00
88.00
86.00
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
Distance from Left Pin (ft)


Lion Canyon XS2 (10/01/2015)
Arbitrary Elevation (ft)
104.00
102.00
100.00
98.00
96.00
94.00
92.00
90.00
88.00
86.00
0.0
20.0
40.0
60.0
80.0
100.0
Distance from Left Pin (ft)

Arroyo Sequit

NOAA FISHERIES

Trabuco Creek



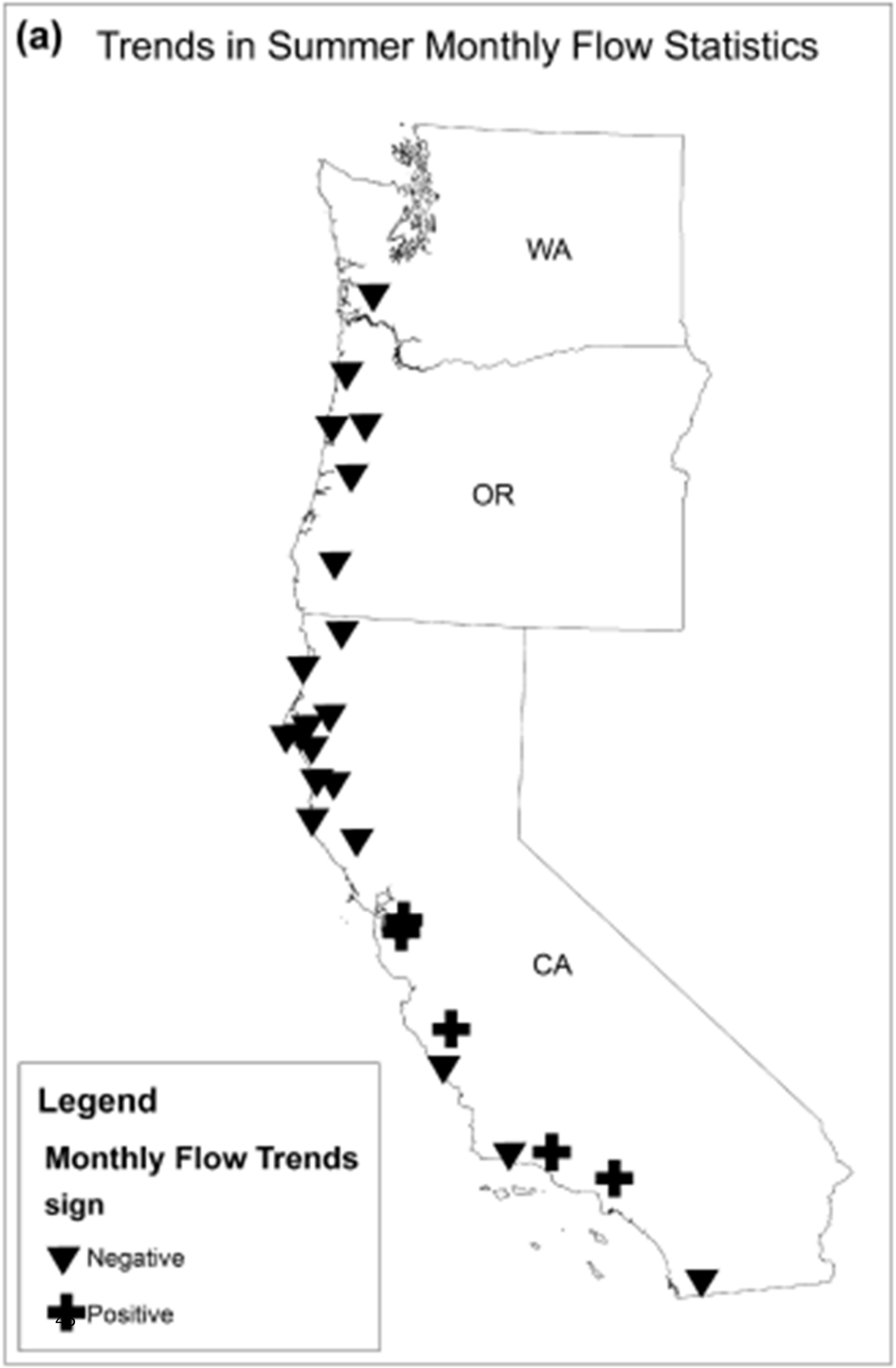

Spatial and Temporal Variability in Baseflow and Stream Drying in the Mattole River Headwaters: Implications for Salmonids and Restoration

Mattole Salmon Group

Nathan Queener[1,2]
Andrew Stubblefield[1]

HUMBOLDT STATE UNIVERSITY

Humboldt State University Department of Forestry and Wildland Resources[1], and Mattole Salmon Group[2]



In rain-dominated watersheds from San Francisco Bay north, dominant trend is declining summer flow.

From Sawaske and Freyberg 2014

Where on (or under) the landscape does dry-season baseflow come from?

Methods – Study Area

- Southern 85 sq km of Mattole River watershed
- Concern about flows since early 2000s
- Primary coho spawning and rearing in Mattole

Methods – Data Collection

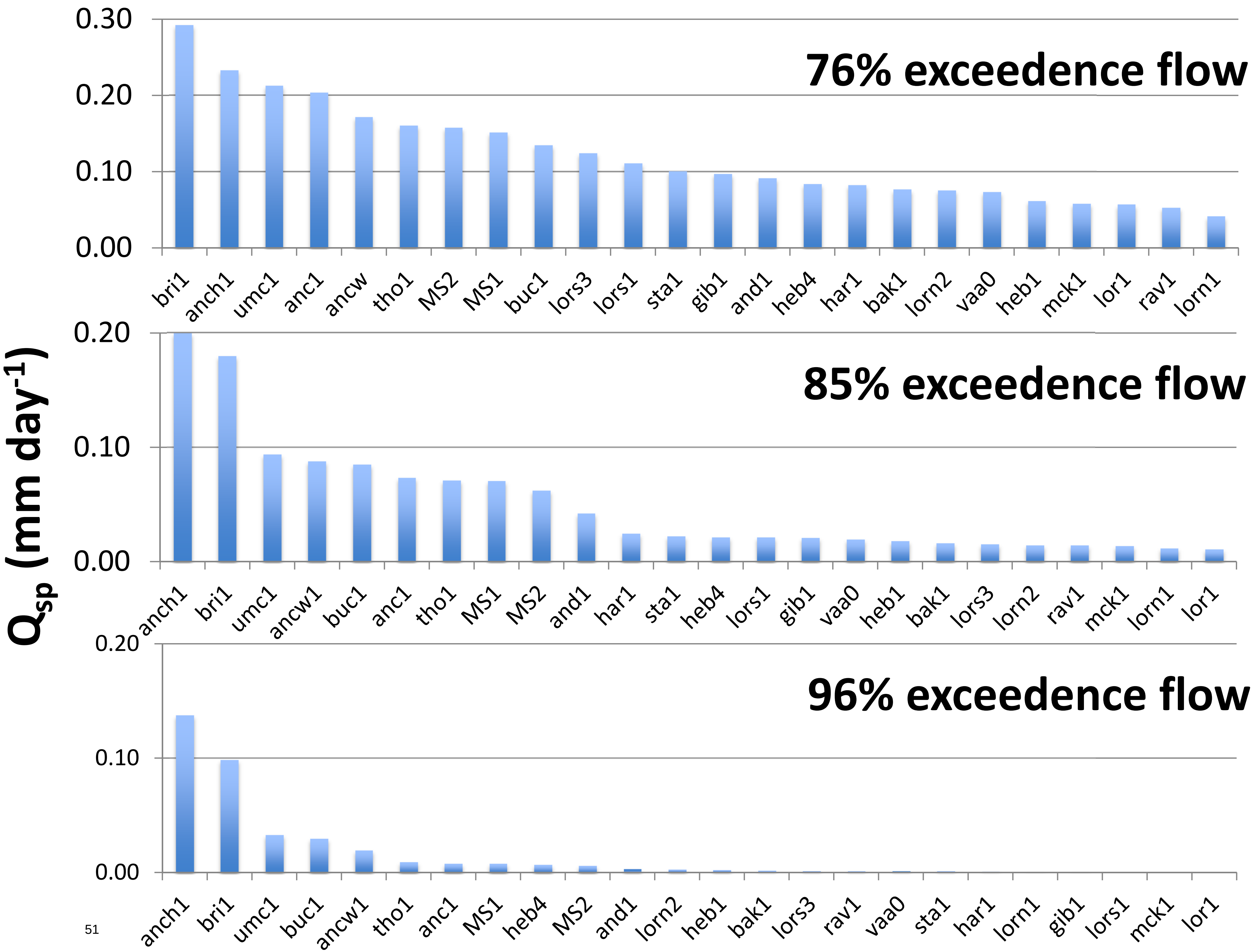
- Mapped distribution of dry and wet channel 2011-2012
  - 9 reaches, 300-2000 m long
- Synoptic streamflow measurements, 2005-2013
  - 35 sites with Sanctuary Forest data
  - Basins 0.17 to 11 sq km
  - Span range of dry season streamflow and human water demand

Methods – Data Analysis

- Convert discharge to unit-area discharge (Q_{sp})
- Use USGS gage on Mattole River at Ettersburg as index gage
- Calculated Spearman correlation coefficients between tributary Q_{sp} at 76%, 85%, and 96% exceedence flow at the Ettersburg gage, and GIS-derived basin characteristics

Methods – Data Analysis

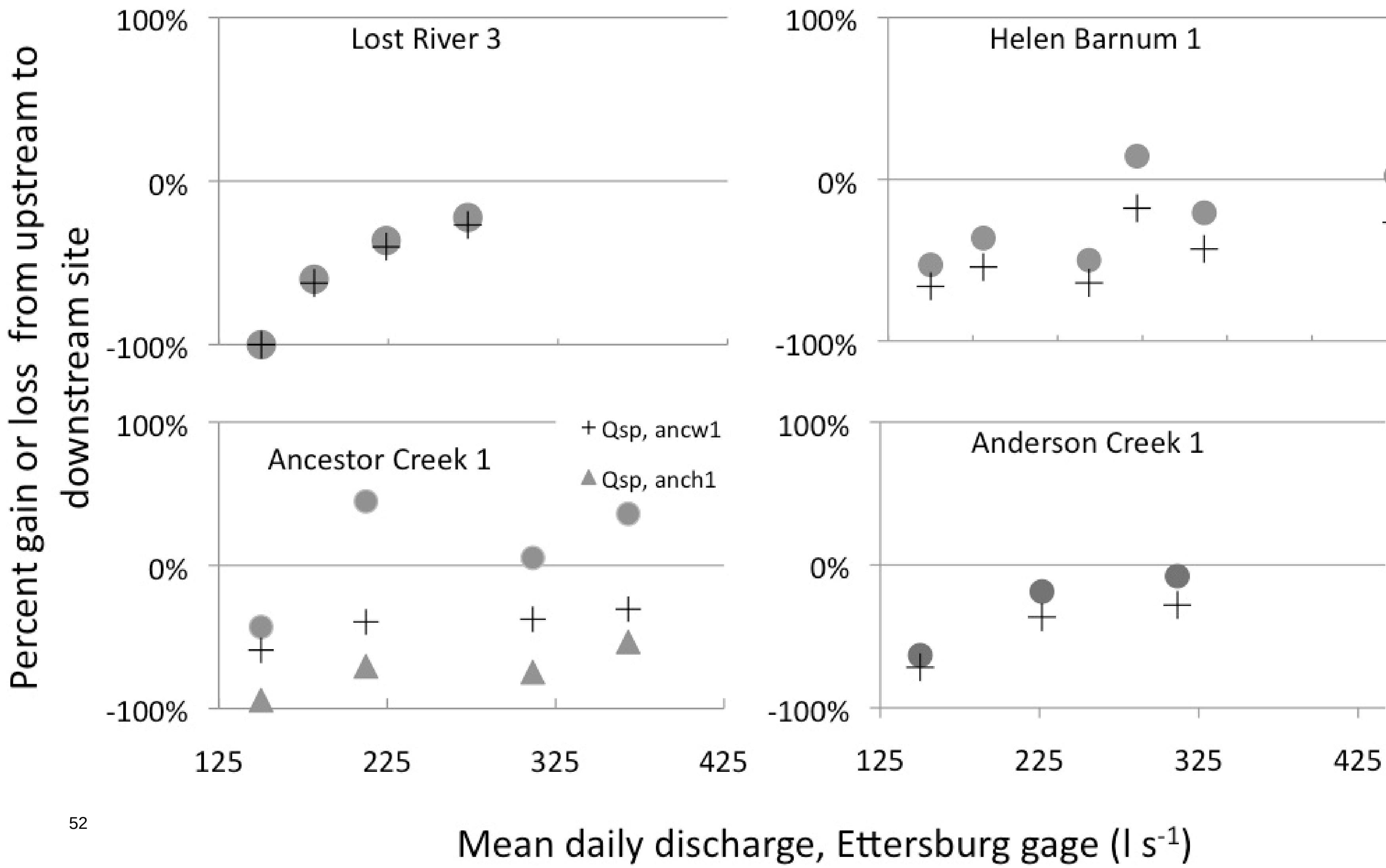
- 92 basin characteristics describe:
  - Aspect
  - Channel network
  - Weather/climate
  - Geology
  - Basin morphometry/topography
  - Riparian/valley character
  - Vegetation
  - Human water use

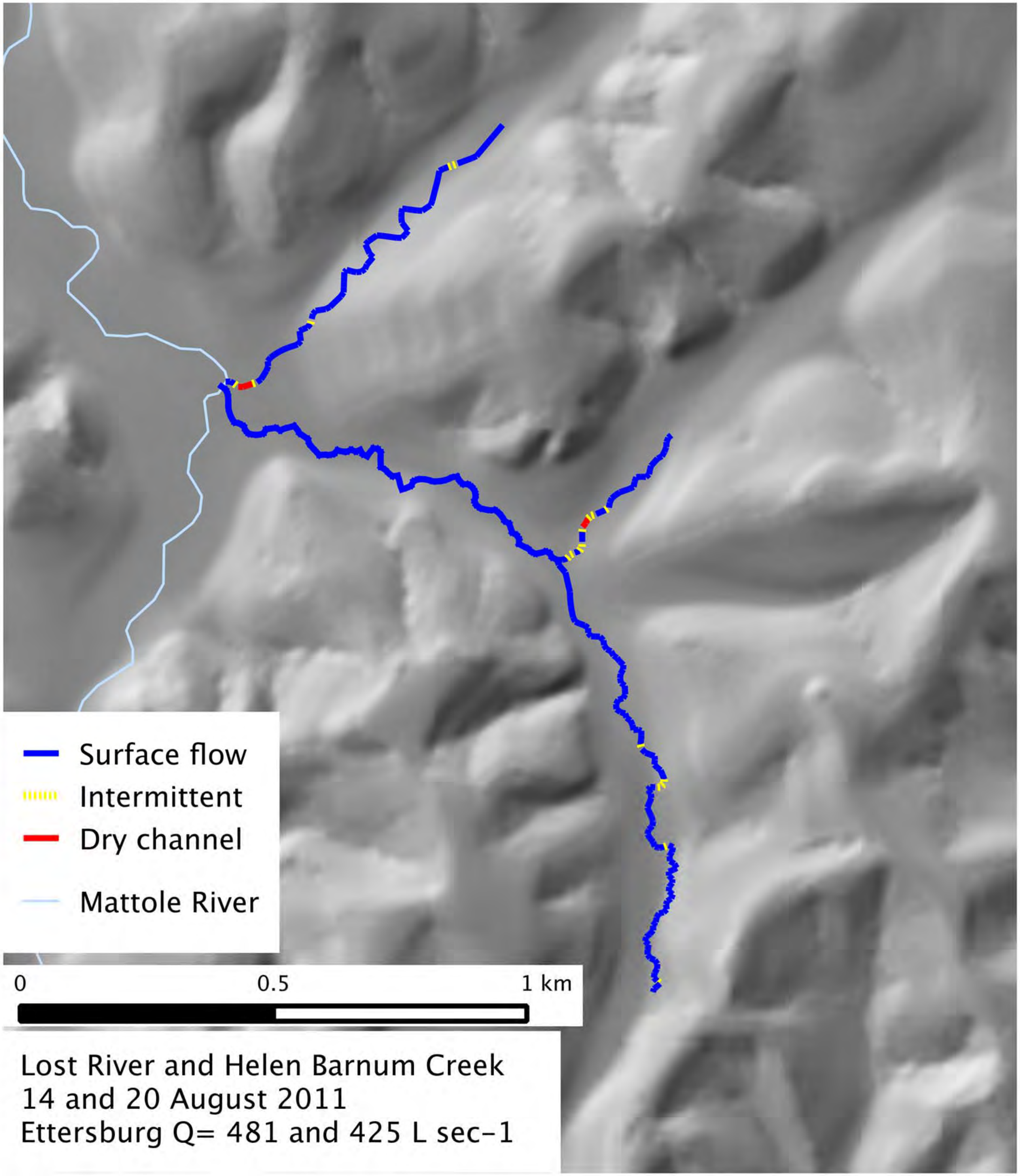


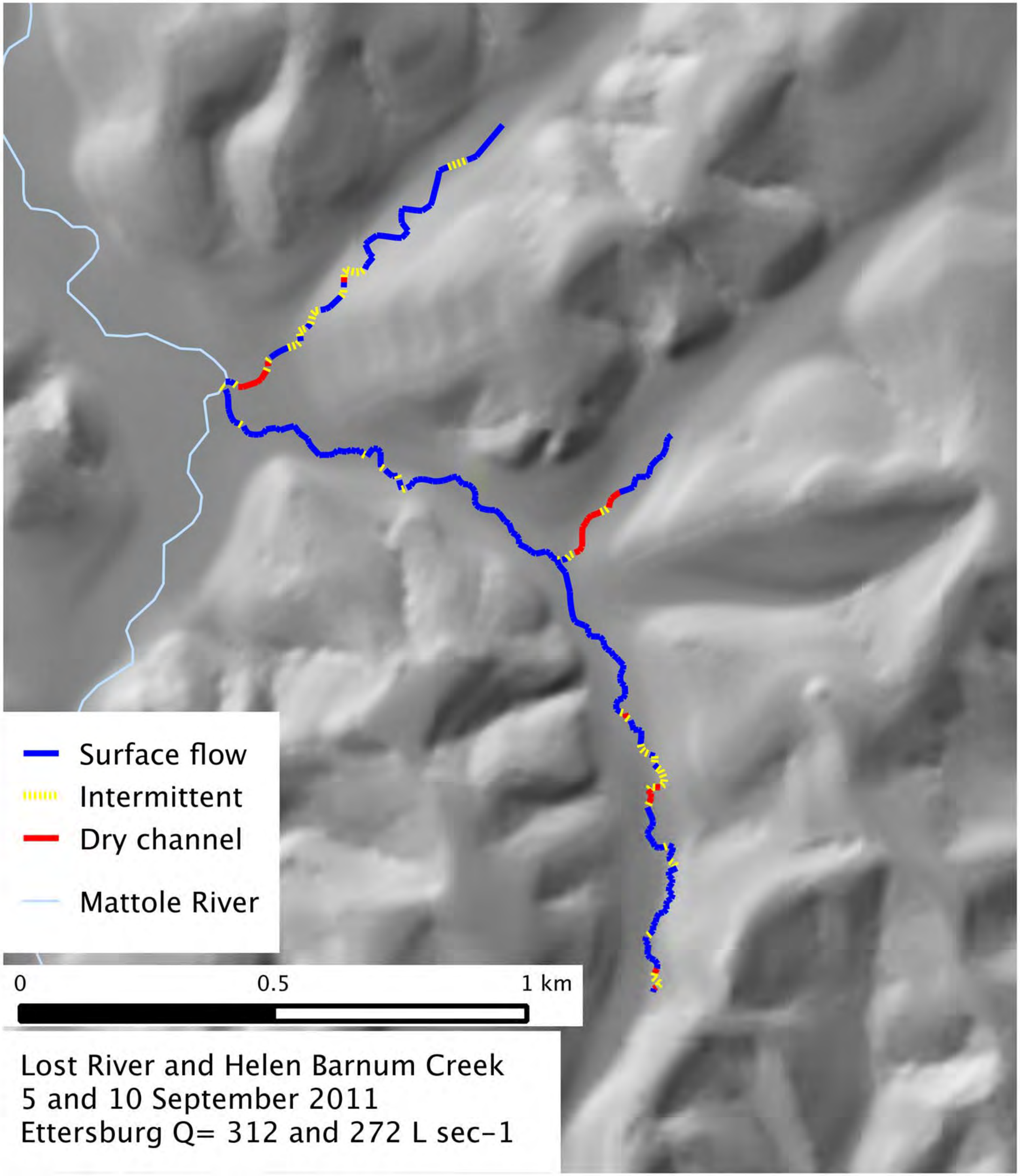
76% exceedence flow
85% exceedence flow
96% exceedence flow
Qsp (mm day-1)
0.30
0.20
0.10
0.00
bri1 anch1 umc1 anc1 ancw tho1 MS2 MS1 buc1 lors3 lors1 sta1 gib1 and1 heb4 har1 bak1 lorn2 vaa0 heb1 mck1 lor1 rav1 lorn1
anch1 bri1 umc1 ancw1 buc1 anc1 tho1 MS1 MS2 and1 har1 sta1 heb4 lors1 gib1 vaa0 heb1 bak1 lors3 lorn2 rav1 mck1 lorn1 lor1
anch1 bri1 umc1 buc1 ancw1 tho1 anc1 MS1 heb4 MS2 and1 lorn2 heb1 bak1 lors3 rav1 vaa0 sta1 har1 lorn1 gib1 lors1 mck1 lor1

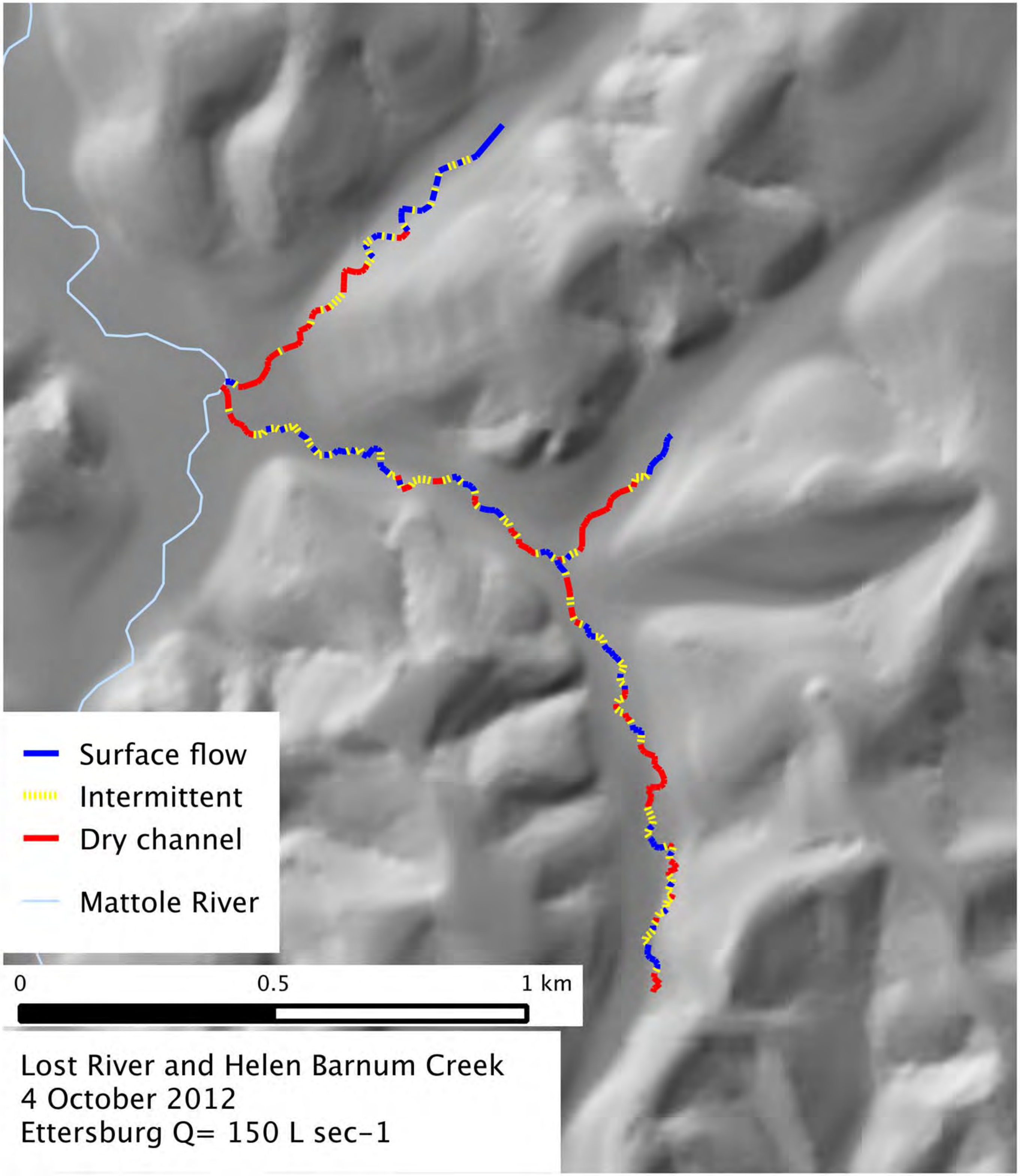
Declining Downstream Flow

Paired upstream-downstream sites




Surface flow
Intermittent
Dry channel
Mattole River
0
0.5
1 km
Lost River and Helen Barnum Creek
14 and 20 August 2011
Ettersburg Q= 481 and 425 L sec-1


Surface flow
Intermittent
Dry channel
Mattole River
0
0.5
1 km
Lost River and Helen Barnum Creek
5 and 10 September 2011
Ettersburg Q= 312 and 272 L sec-1

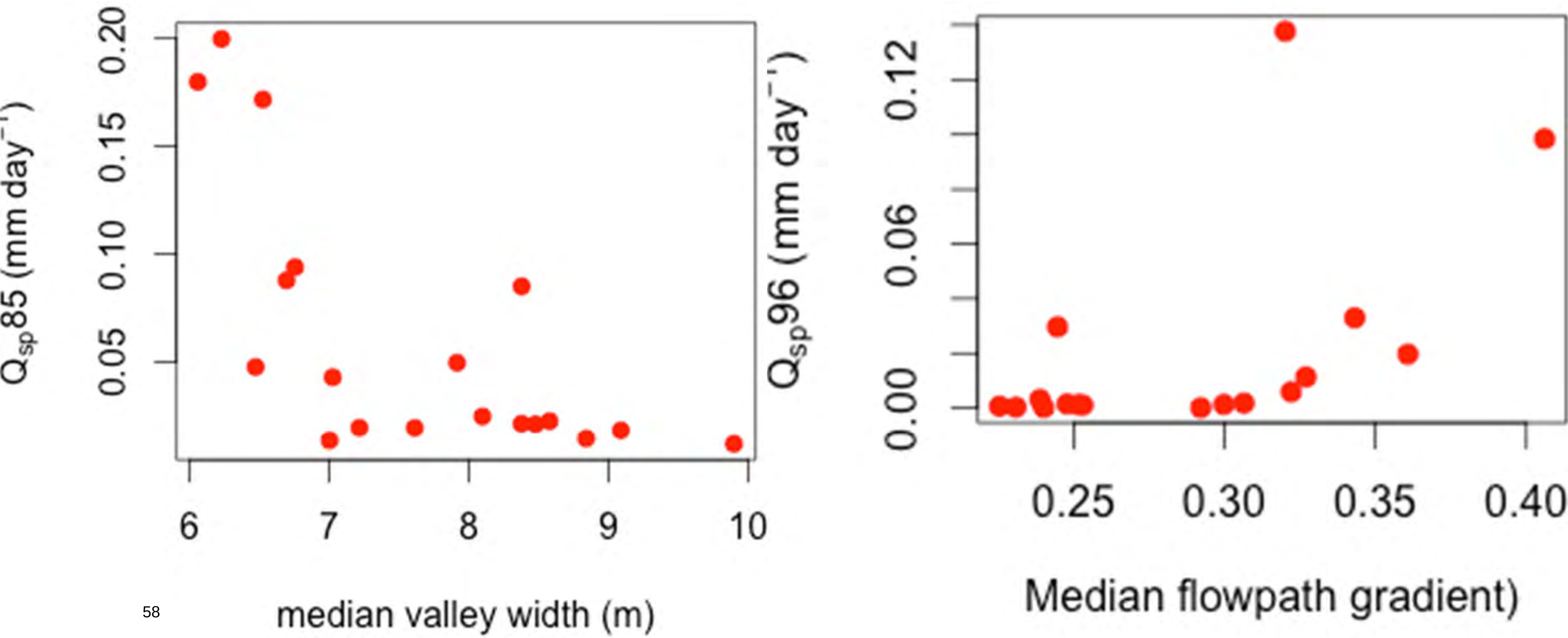

Surface flow
Intermittent
Dry channel
Mattole River
0
0.5
1 km
Lost River and Helen Barnum Creek
4 October 2012
Ettersburg Q= 150 L sec-1

Correlation of Basin Characteristics and Low Flow Metrics

- Many of the 92 basin characteristics were redundant and strongly correlated
- Only considered correlation significant if $p<0.01$

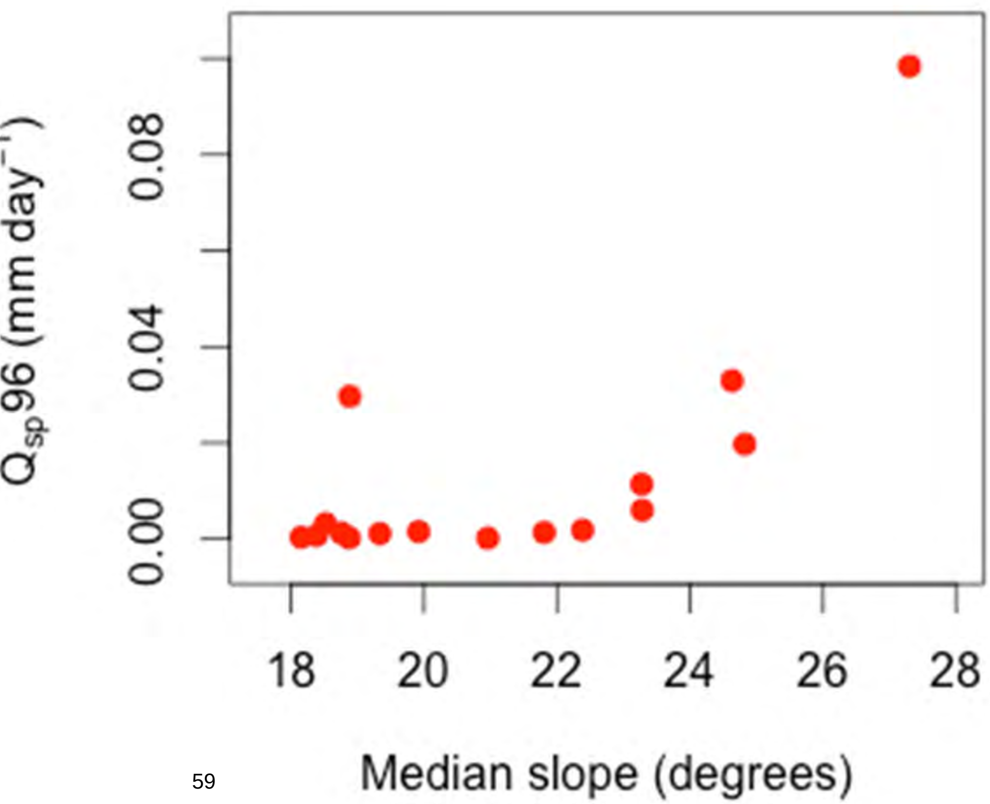
Correlation of Basin Characteristics and Low Flow Metrics

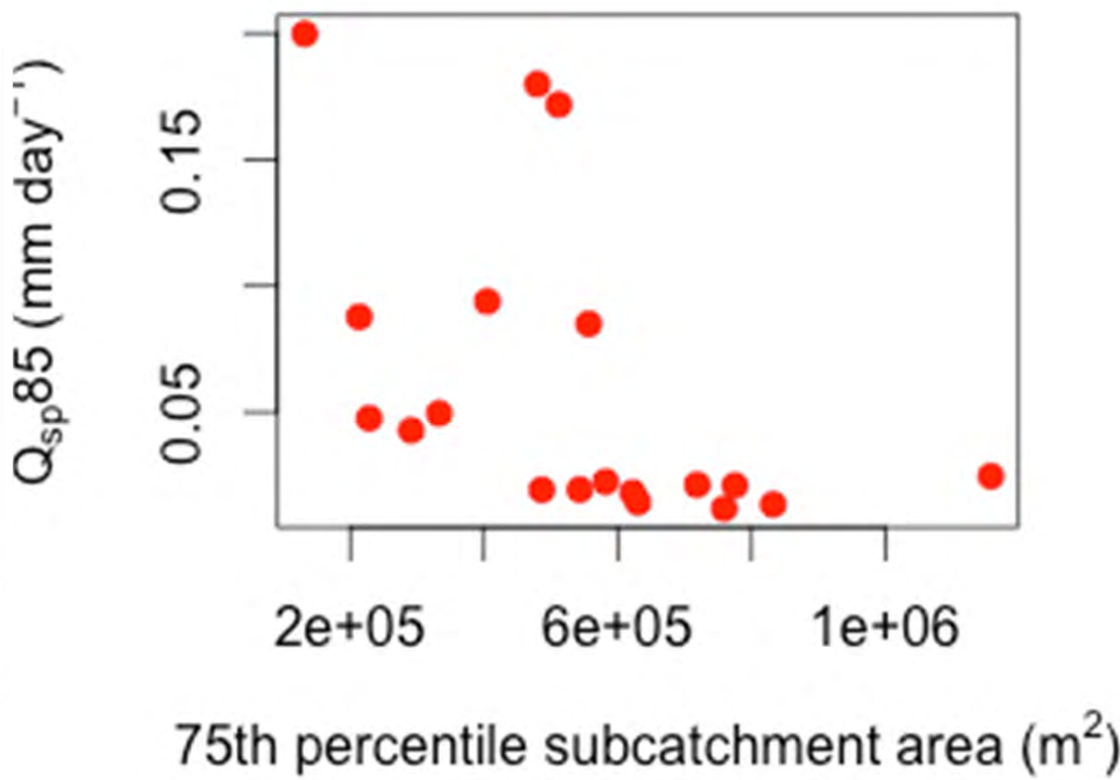
- Basins with narrower valleys, less riparian area, and steeper channels had more summer flow.



Correlation of Basin Characteristics and Low Flow Metrics

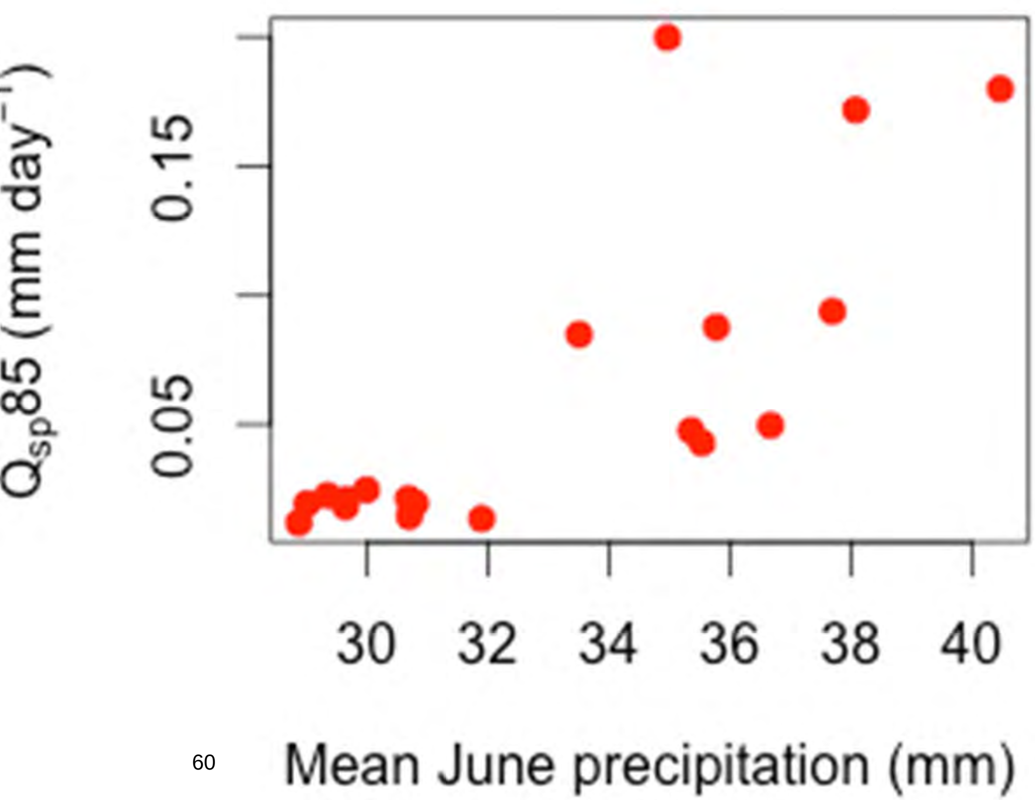
- Steeper basins with more dissected topography and greater drainage density had more summer flow.

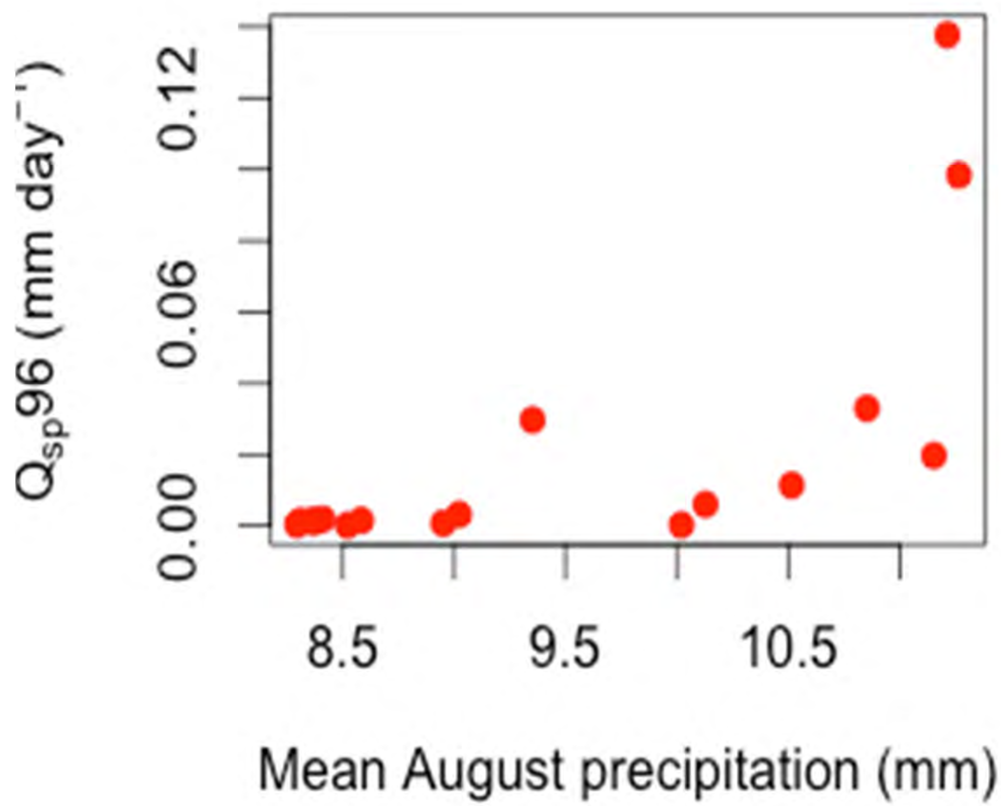




Correlation of Basin Characteristics and Low Flow Metrics

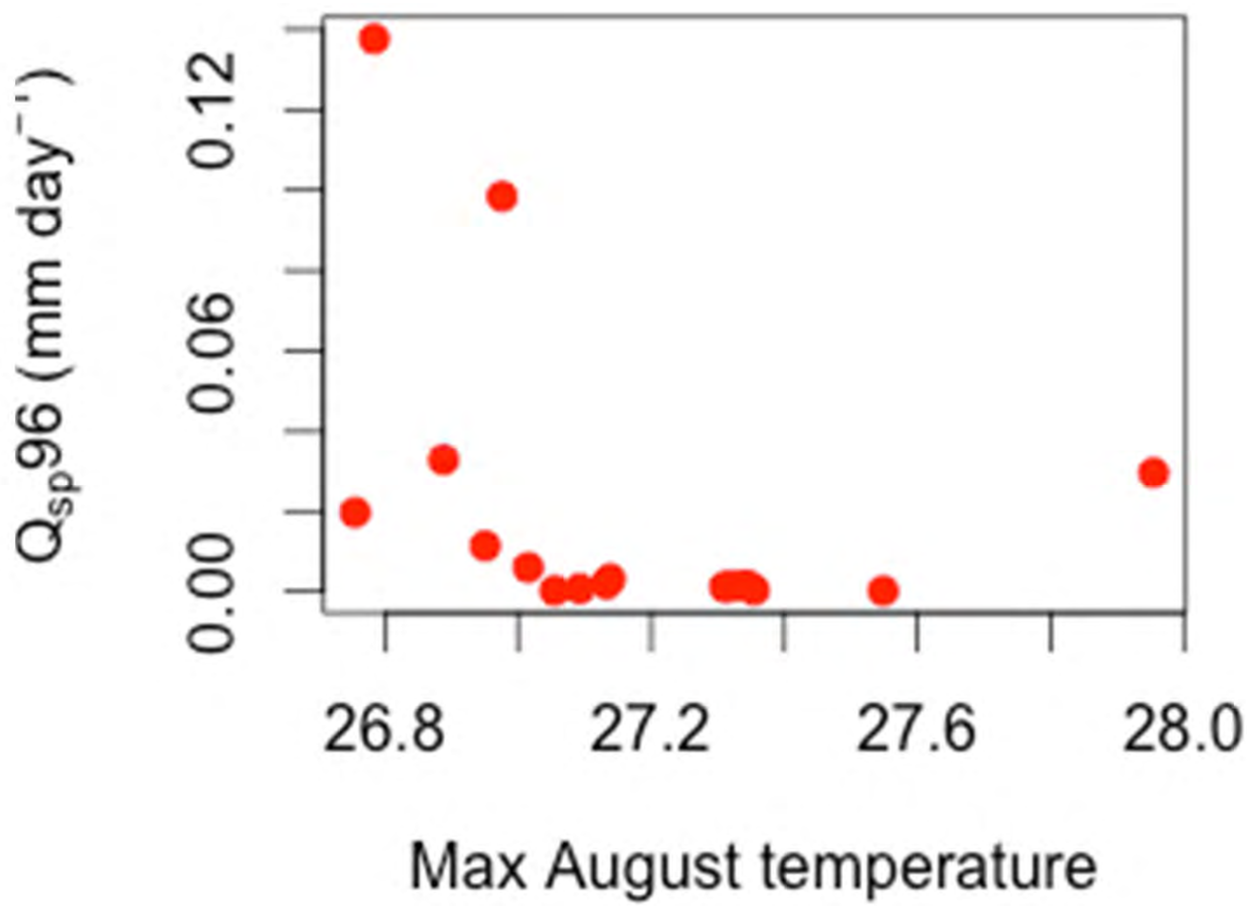
- Unsurprisingly, basins with greater summer precipitation had more summer flow.



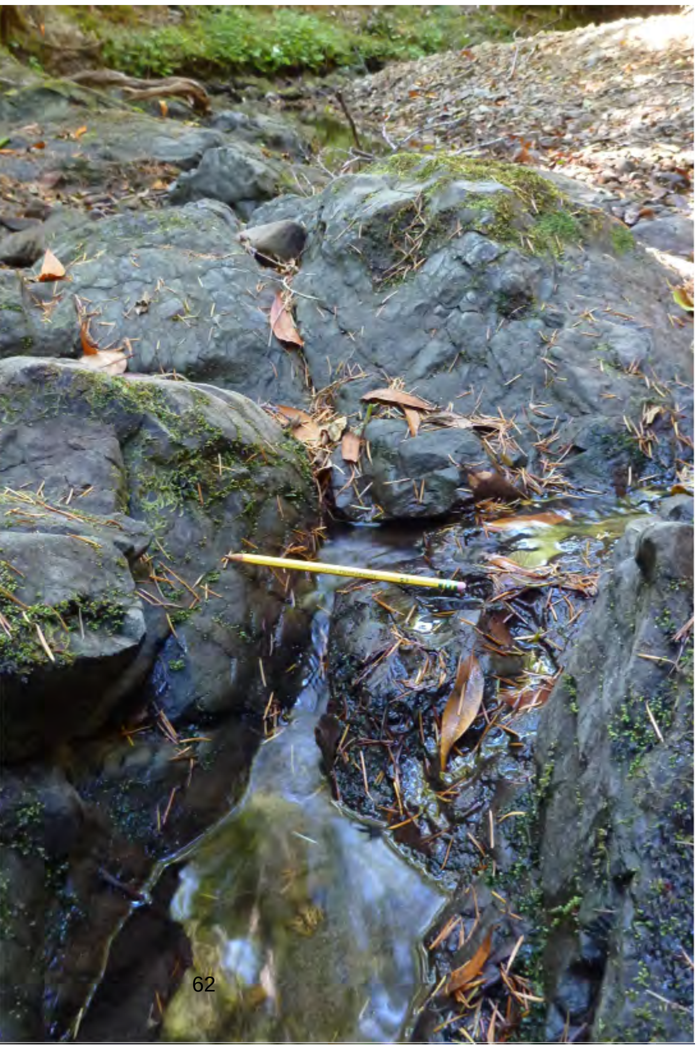


Correlation of Basin Characteristics and Low Flow Metrics

- Unsurprisingly, basins with lower maximum temperatures had more summer flow.



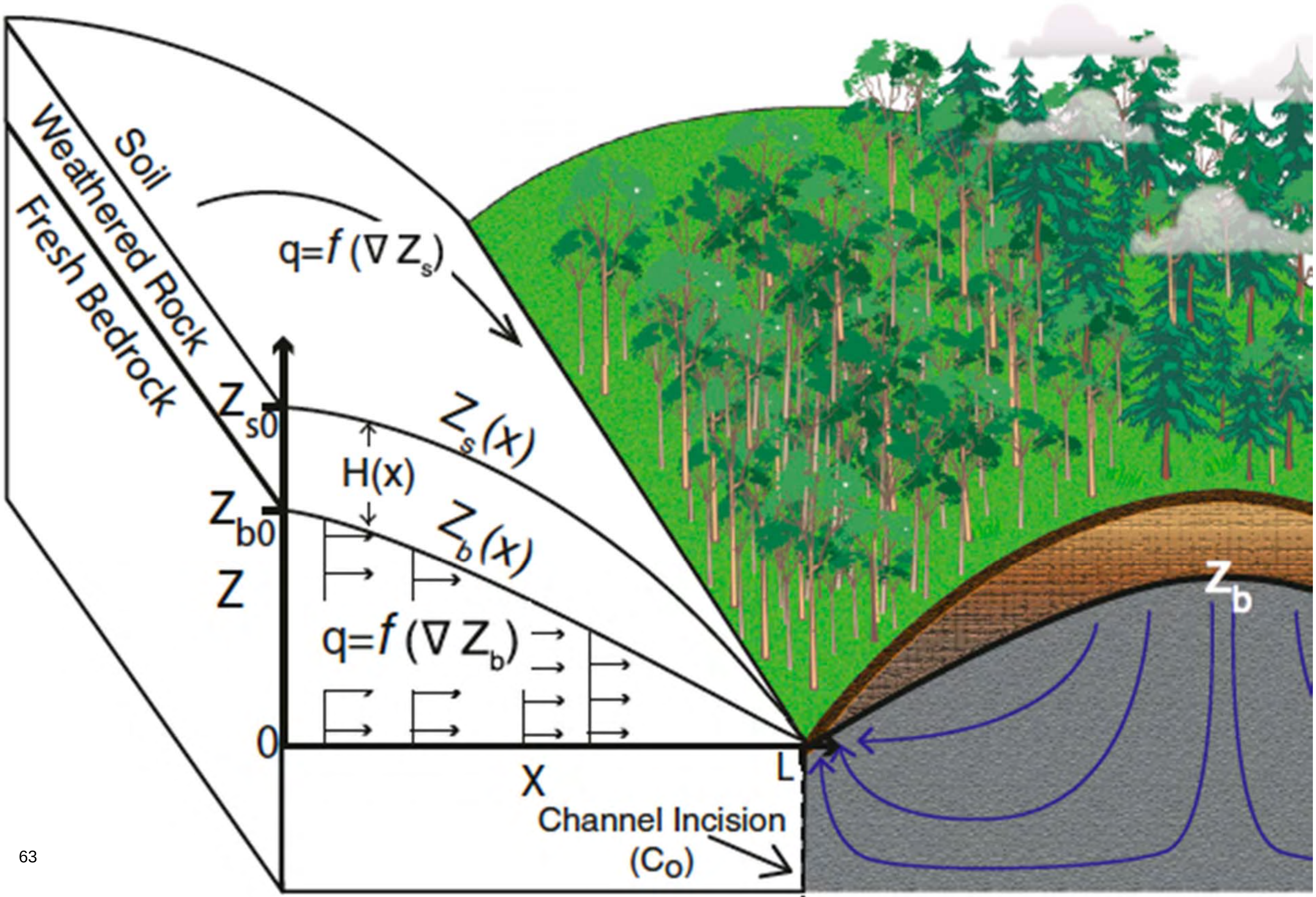
- Basins with greater dry-season flow are:
  - Steeper with narrower valleys
  - More dissected with higher drainage density
  - Cooler and receive more precipitation



- Difference in flow much greater than difference in precipitation and temperature among basins

- Precip/temp differences contribute to flow differences, but aren’t the primary driver?

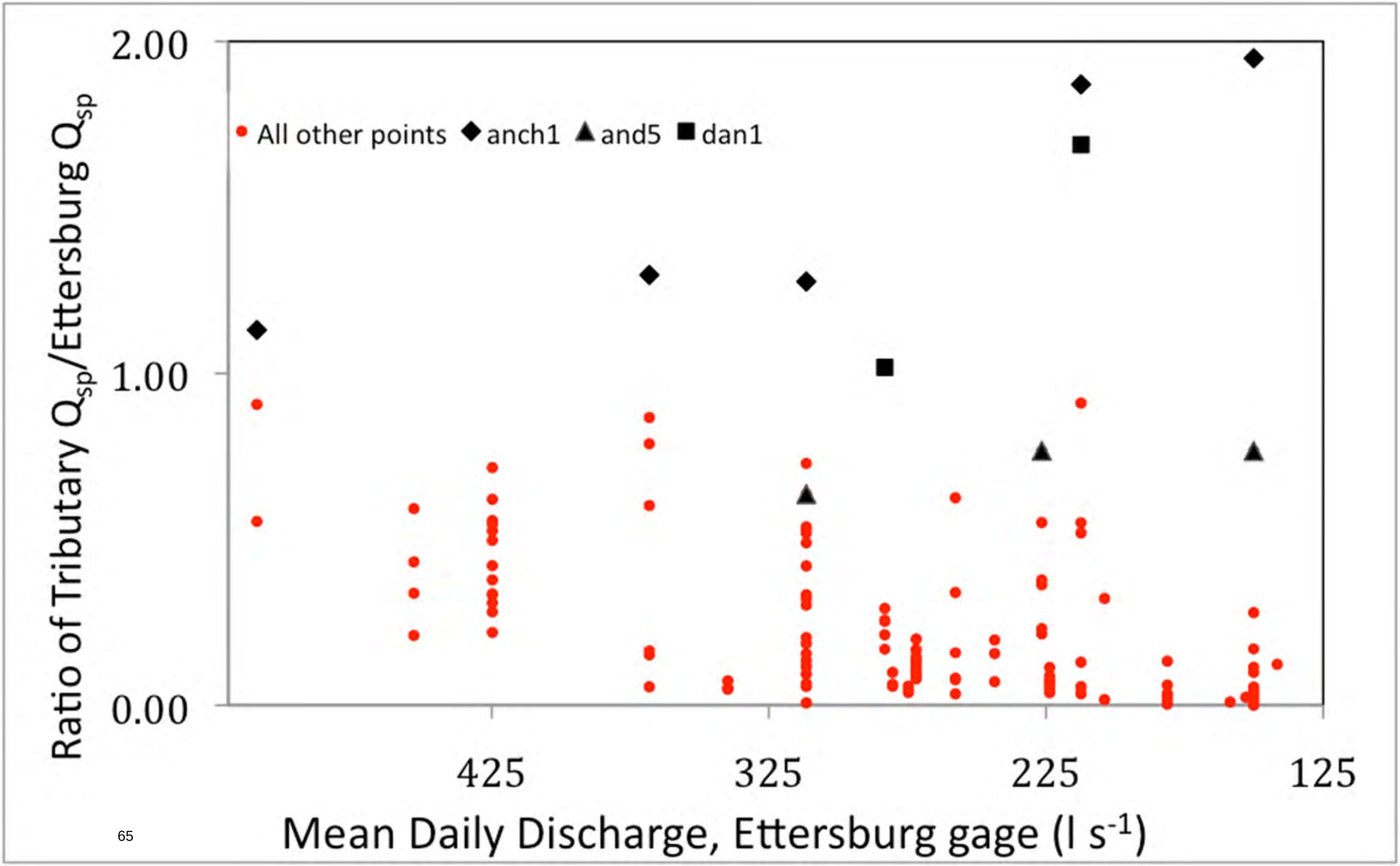
- Q: Do steeper basins store more water?
- A: Yes, if they have deep weathered bedrock



From Rempe and Dietrich 2014

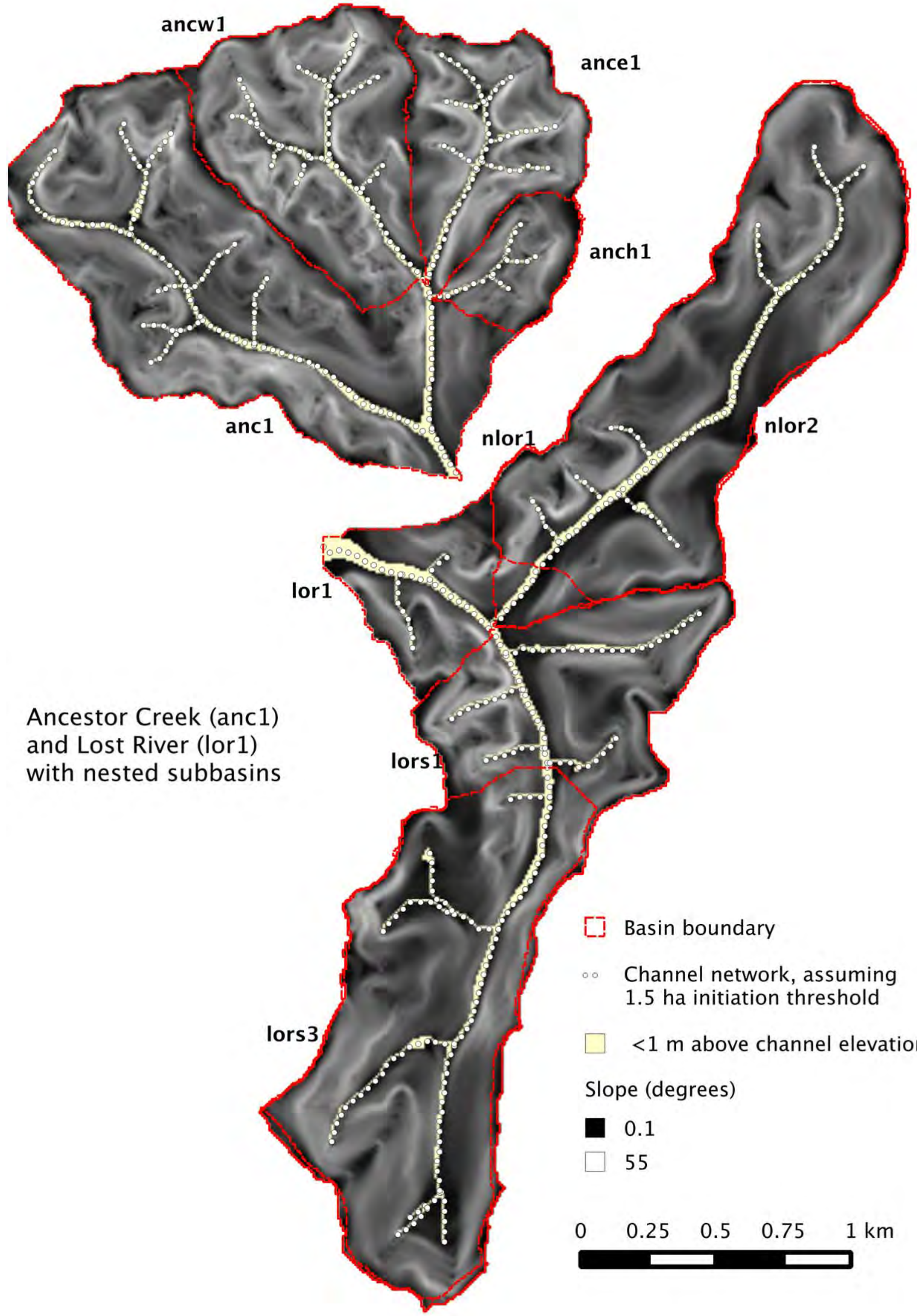
Example of weathered bedrock in the Mattole River watershed. Layer exposed in roadcut is at least 4 m thick.

Unit-area discharge at all but two tributary sites was less than at the Ettersburg gage



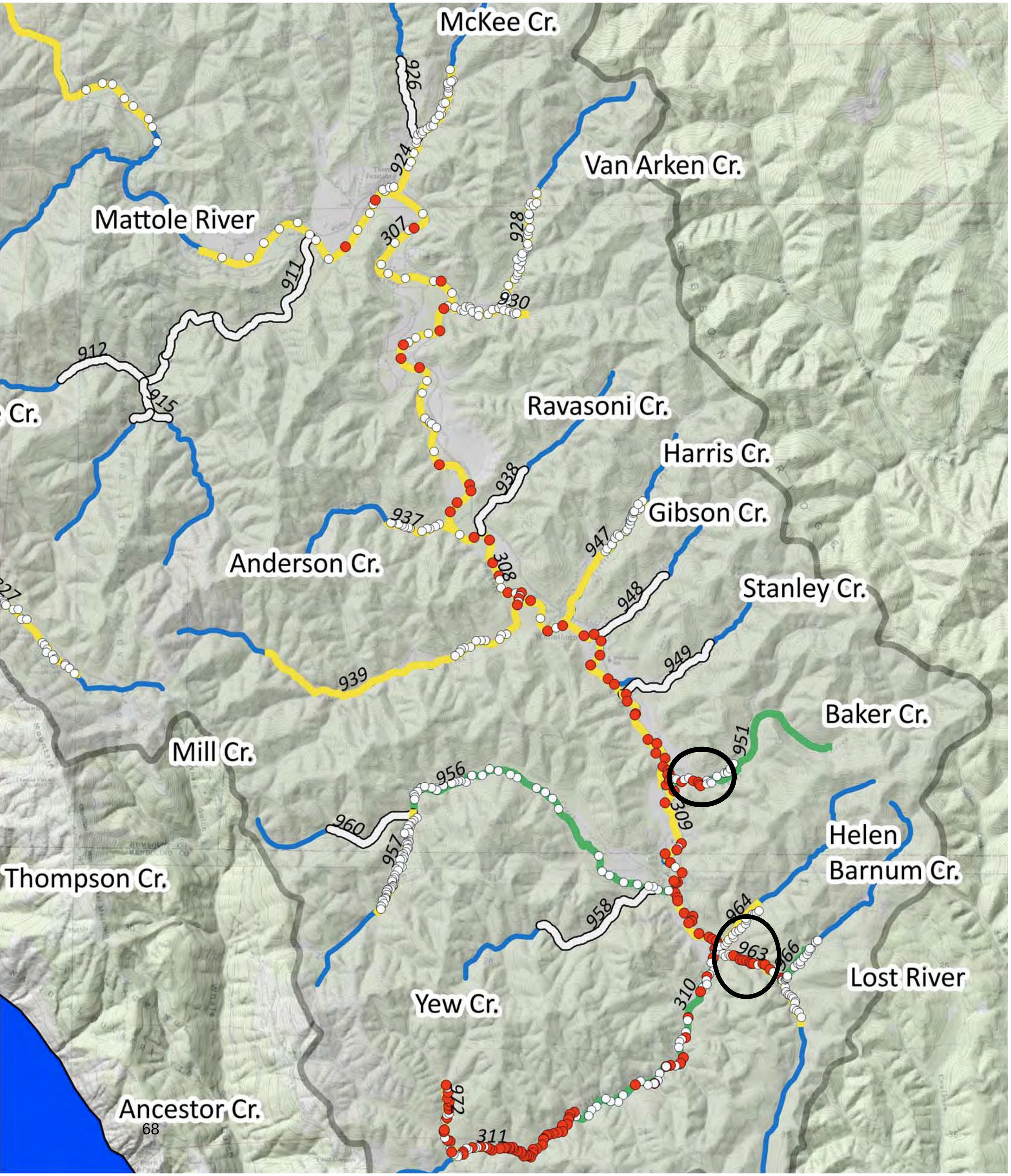
- Observed downstream declines due to topography of basins near stream mouth?
  - Gentler slopes
  - Wider valleys

- Is the valley floor a groundwater gauntlet?



Implications for Salmon and Steelhead Summer Rearing

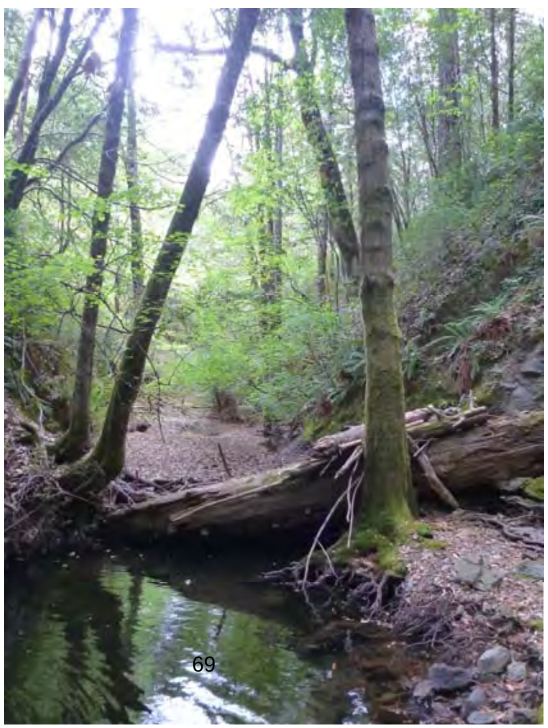
- Juvenile salmon over-summering in intermittent streams is not uncommon
- Small changes in flow can lead to large changes in habitat availability
- Early drying downstream leaves fish with few options as streamflow decreases
- Lower-gradient streams, essential for coho salmon, may be most prone to drying



- Even at very low abundance, Coho keep choosing streams with low flow and up to 95% of channel dry in late summer

Management and Restoration Implications

- Extreme variability in summer baseflow can occur independent of diversions and consumptive water use.
- Differences in internal plumbing within basins likely sets limits on their potential for baseflow increases.



- Efforts to reconnect channels with floodplains for groundwater recharge might focus on areas with hillslope inputs.
- Some streams are more sensitive to water diversion than others.

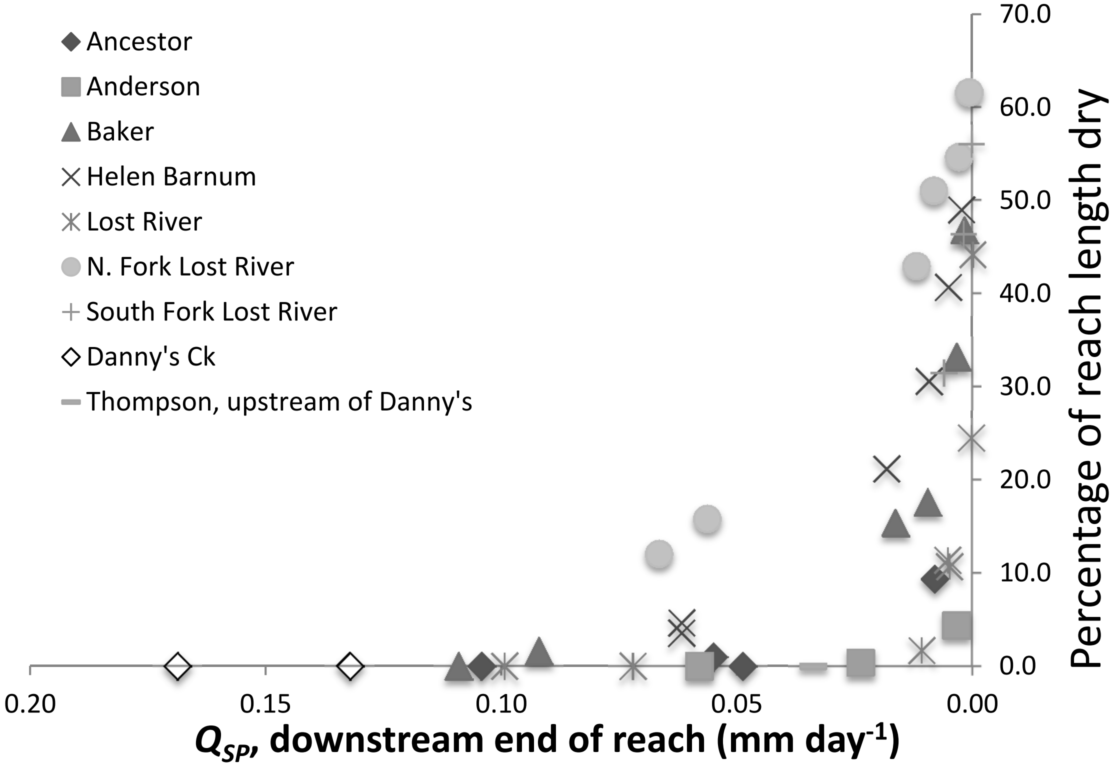
Thanks to:

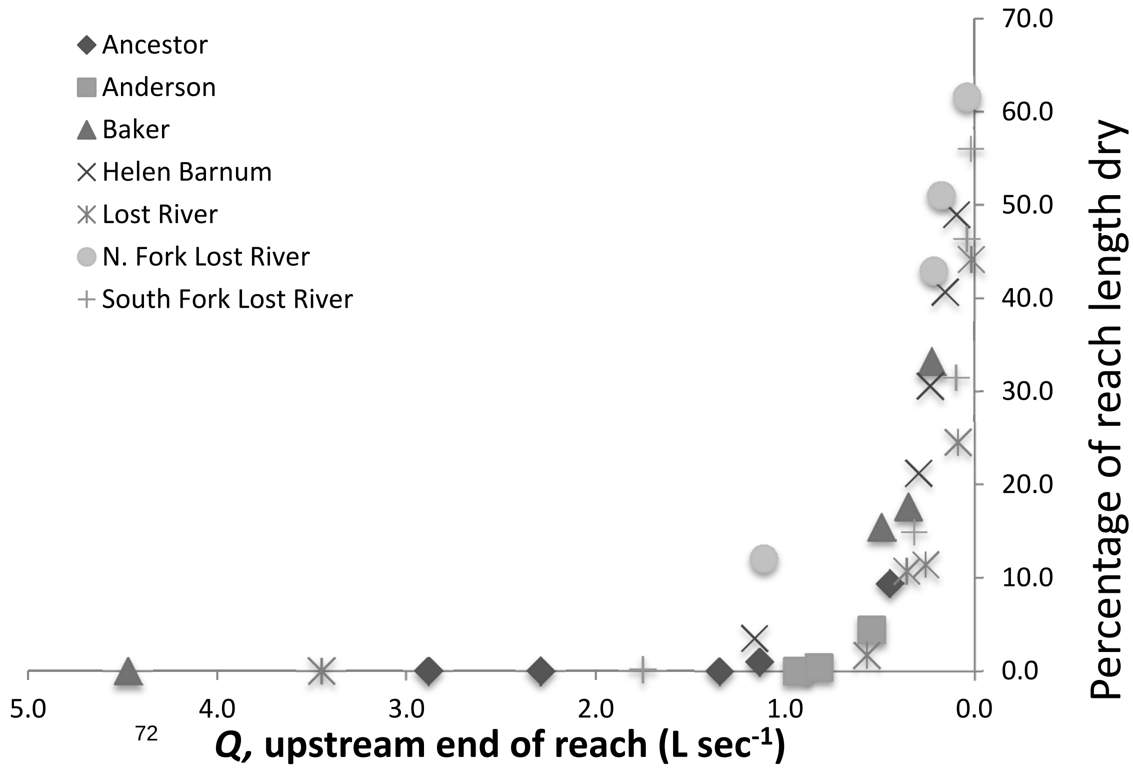
- Committee members Dr Andrew Stubllefield, Dr. Andre Lehre and Dr. Conor Shea

- Sanctuary Forest, Inc. for access to streamflow data

- Tasha McKee, Sam Flanagan, Brad Job, John Williams, Katrina Nystrom, Tony Fair, and Campbell Thompson for discussions that helped inform my understanding of Mattole River hydrology

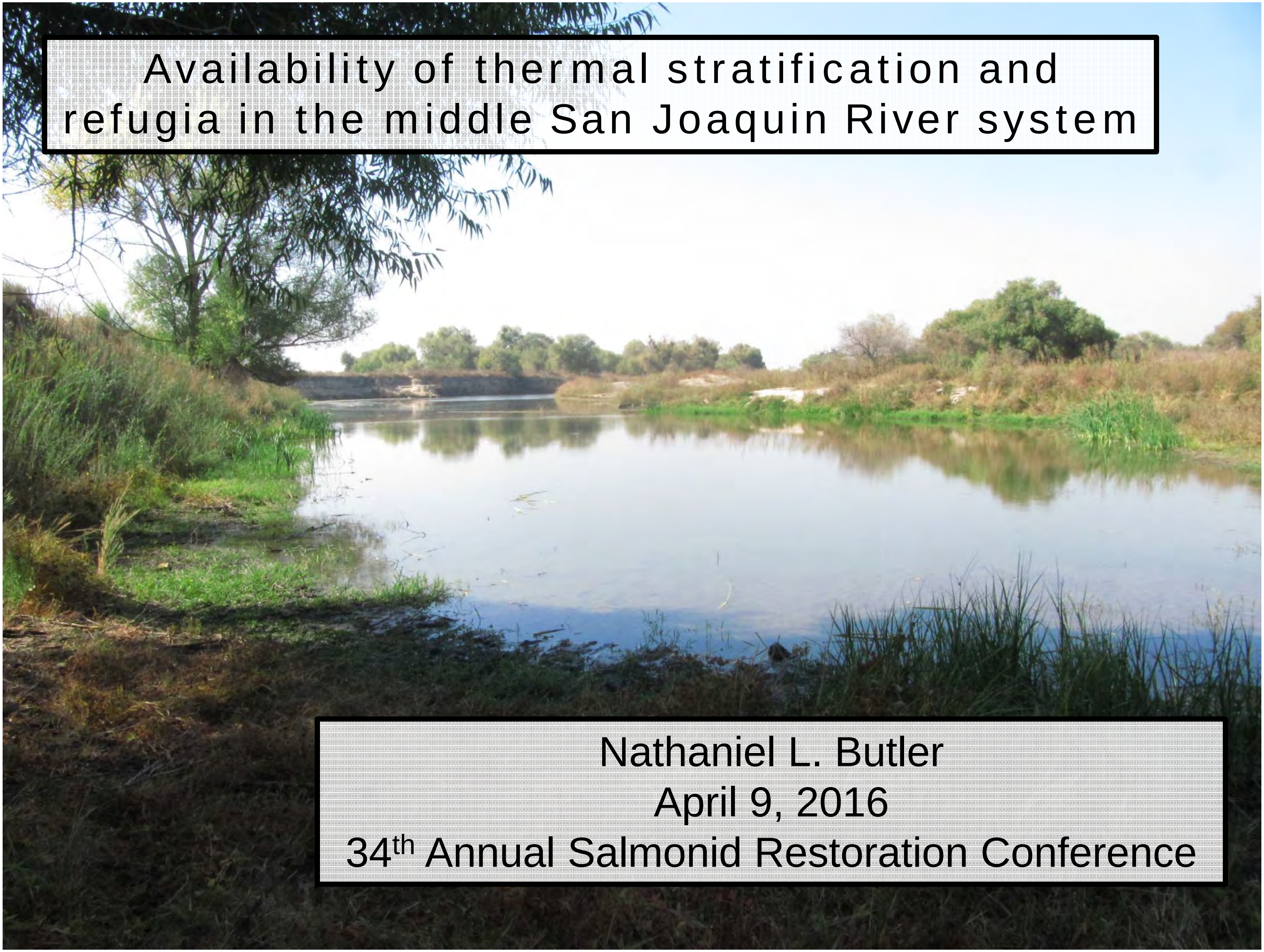
Flow and Dry Channels





- Flow at upstream end of reach best predictor of dry channel
- Less variability in relationship between Q and dry channel than Q_{sp}


0 2 4 6 8 10 km


Availability of thermal stratification and refugia in the middle San Joaquin River system
Nathaniel L. Butler
April 9, 2016
34th Annual Salmonid Restoration Conference

Acknowledgements

Thank you especially to those involved in field work: Karl Stromayer, Bob Parris, Ted Baker, Matt Bigelow, Jessica Fontaine, Jeff Galman, Stephen Lee, David Moreno, Kristi Seabrook, and Michael Wolf.

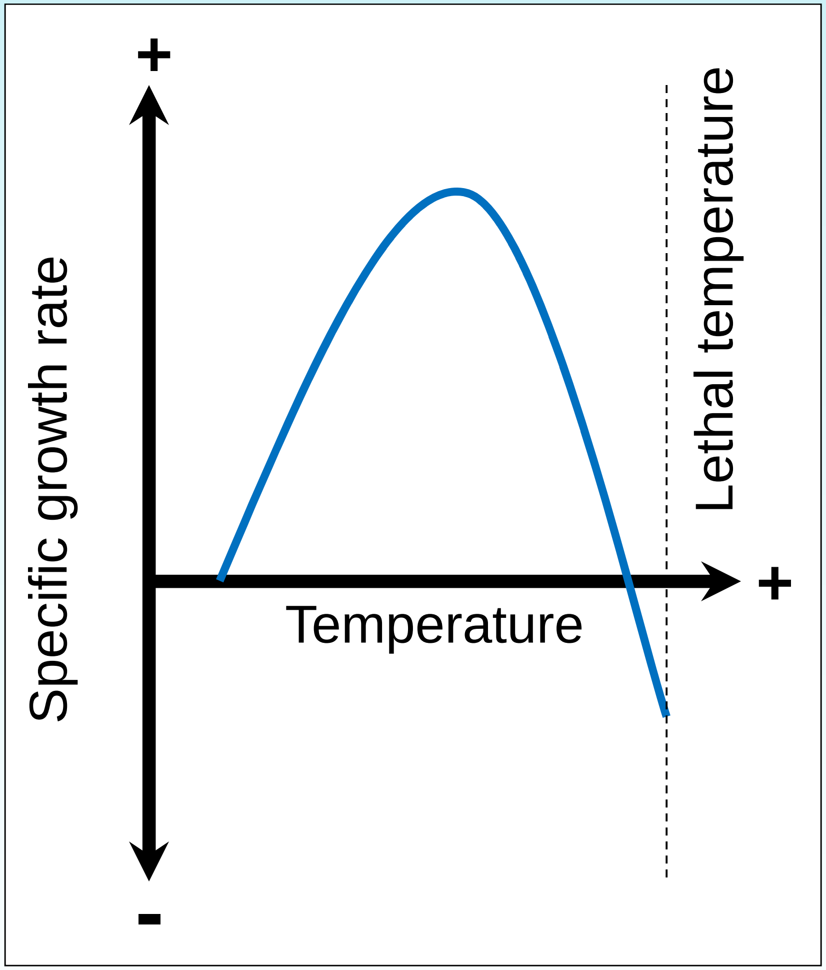
Overview

- Motivation & Objectives
- Background on Thermal Refugia
- Study Location
- Methodology
- Results – Data
- Results – Analysis
- Take Home Messages

Motivation


photo credit: Alan Sorum, Alaska Chinook Salmon Research Initiative

Motivation



- Water temperature influences growth and overall survival for Chinook salmon.
- High stream temperature creates thermal barriers that fragment habitat.
- Cold water habitat or thermal refugia is recognized as potentially enabling passage through warmer reaches of the San Joaquin River historically.

Sullivan et al., 2000; McBain and Trush Inc., 2002; SJRRP FMWG, 2009

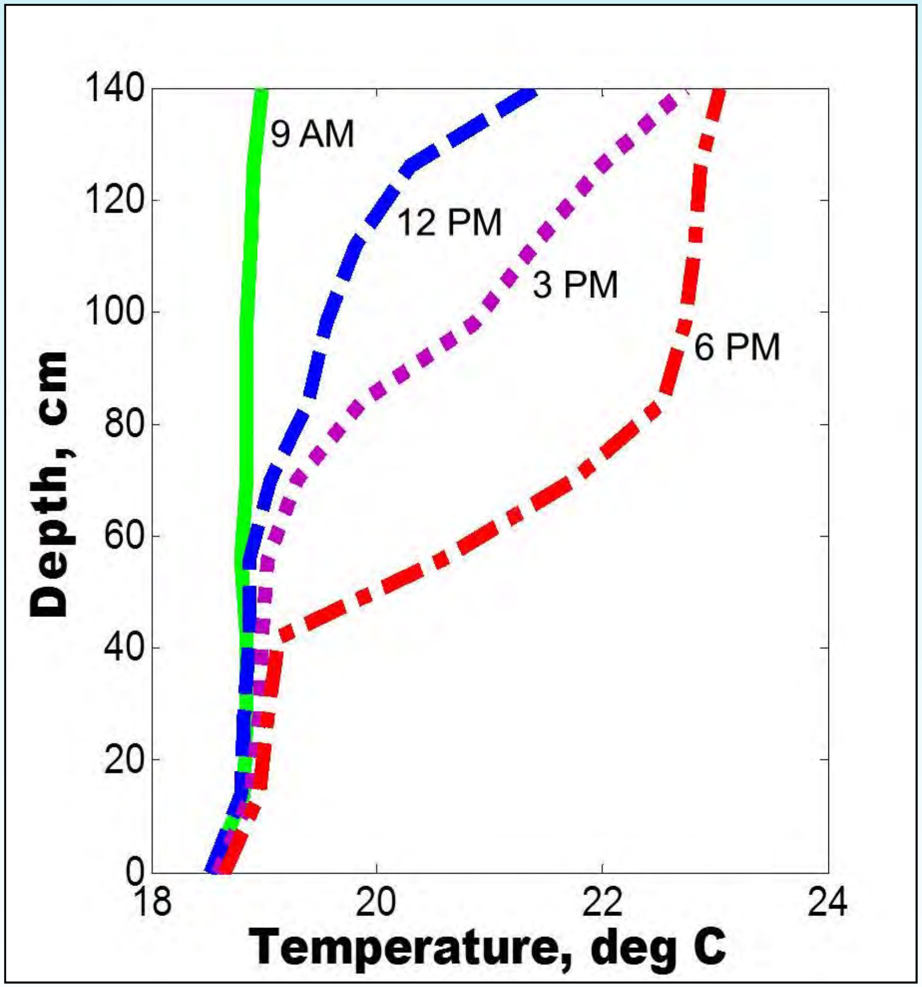
Objectives

- Assess water temperature conditions in the middle San Joaquin River system
- Determine frequency of thermal stratification and if it can provide thermal refugia for Chinook
- Identify the main cause(s) of thermal refugia

Background

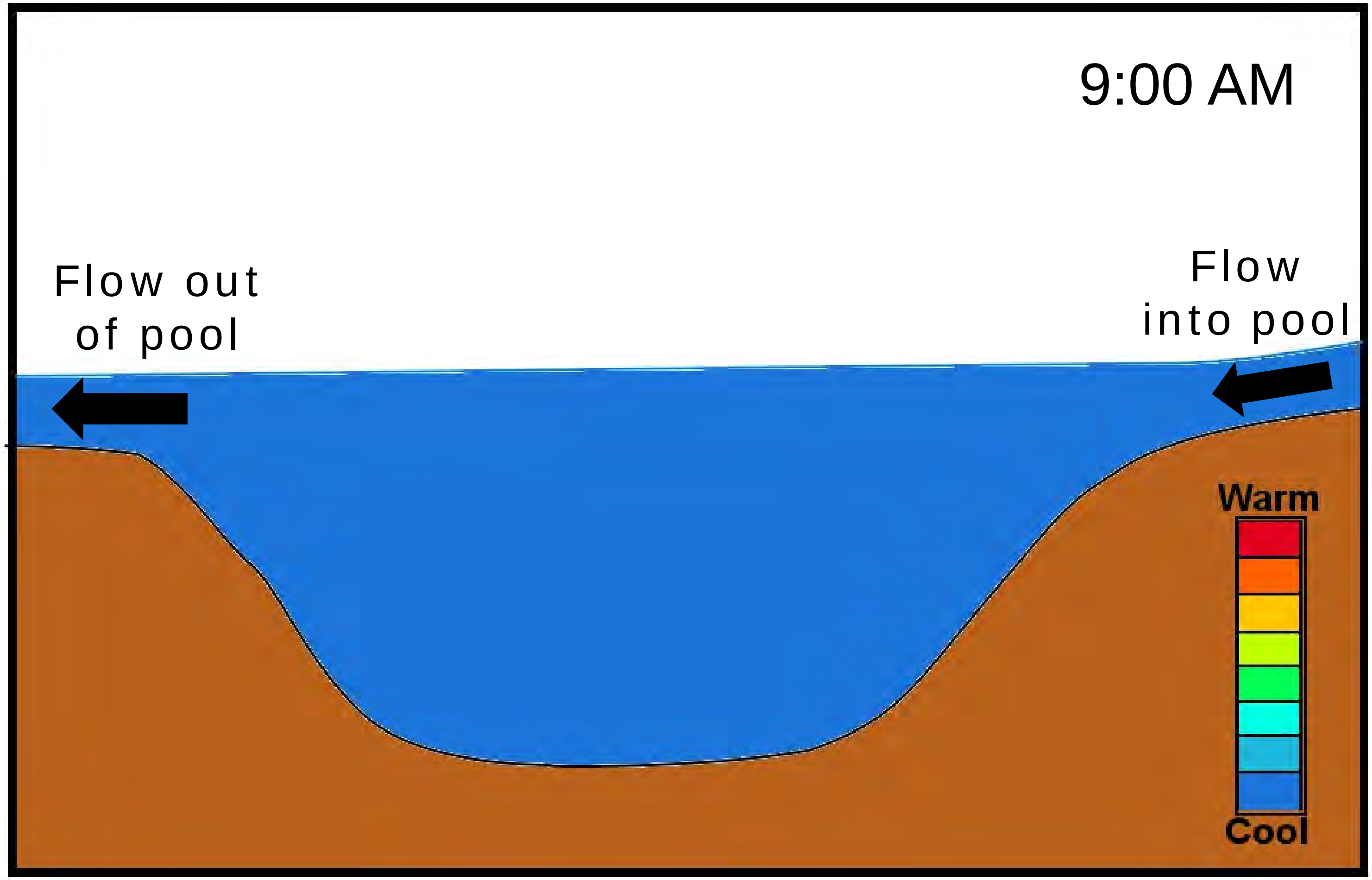
- Thermal stratification is a temperature difference in the vertical water column

- Thermal refugia is the section of the pool below salmon temperature tolerances



Background

Thermal Stratification



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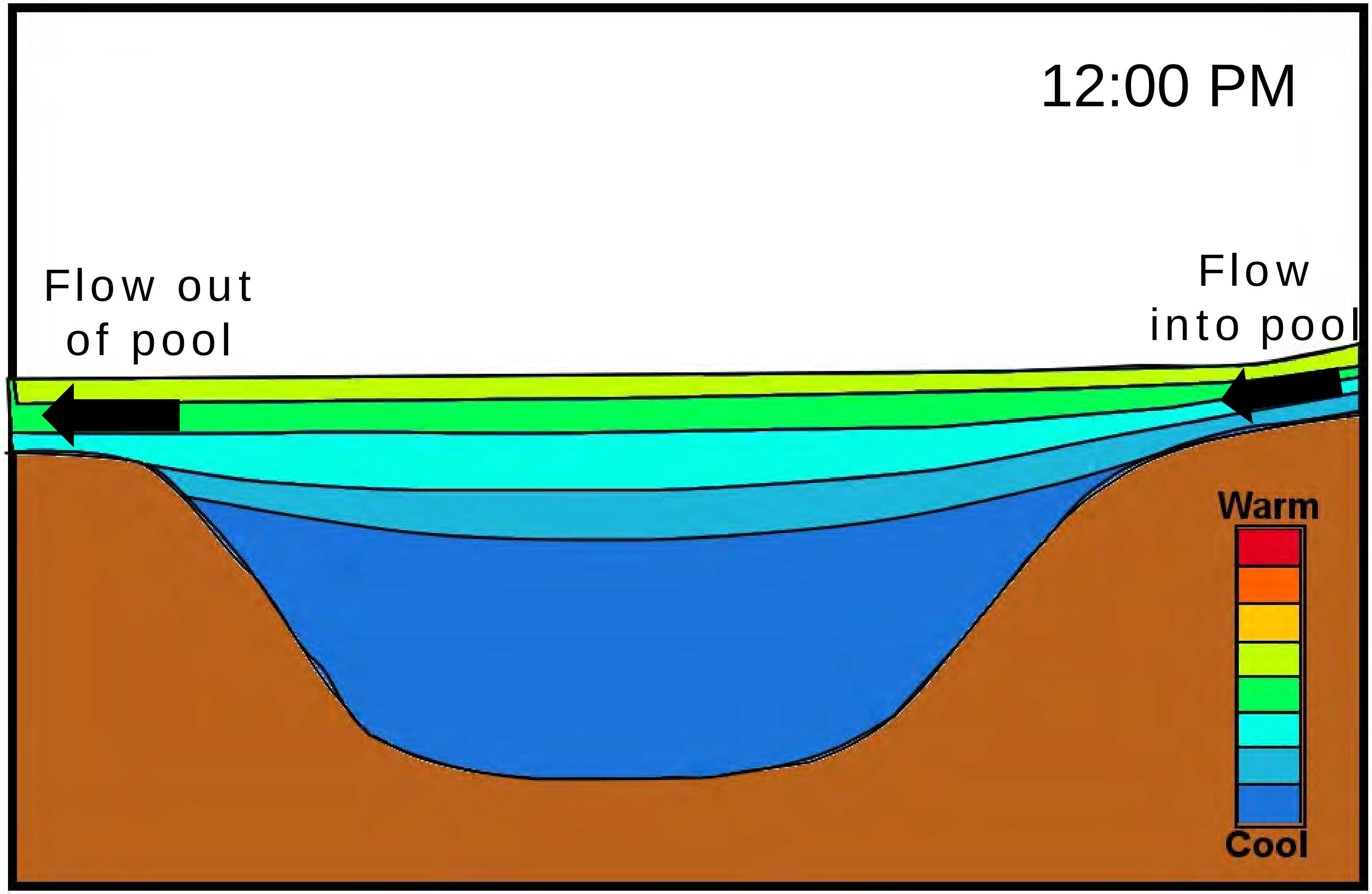
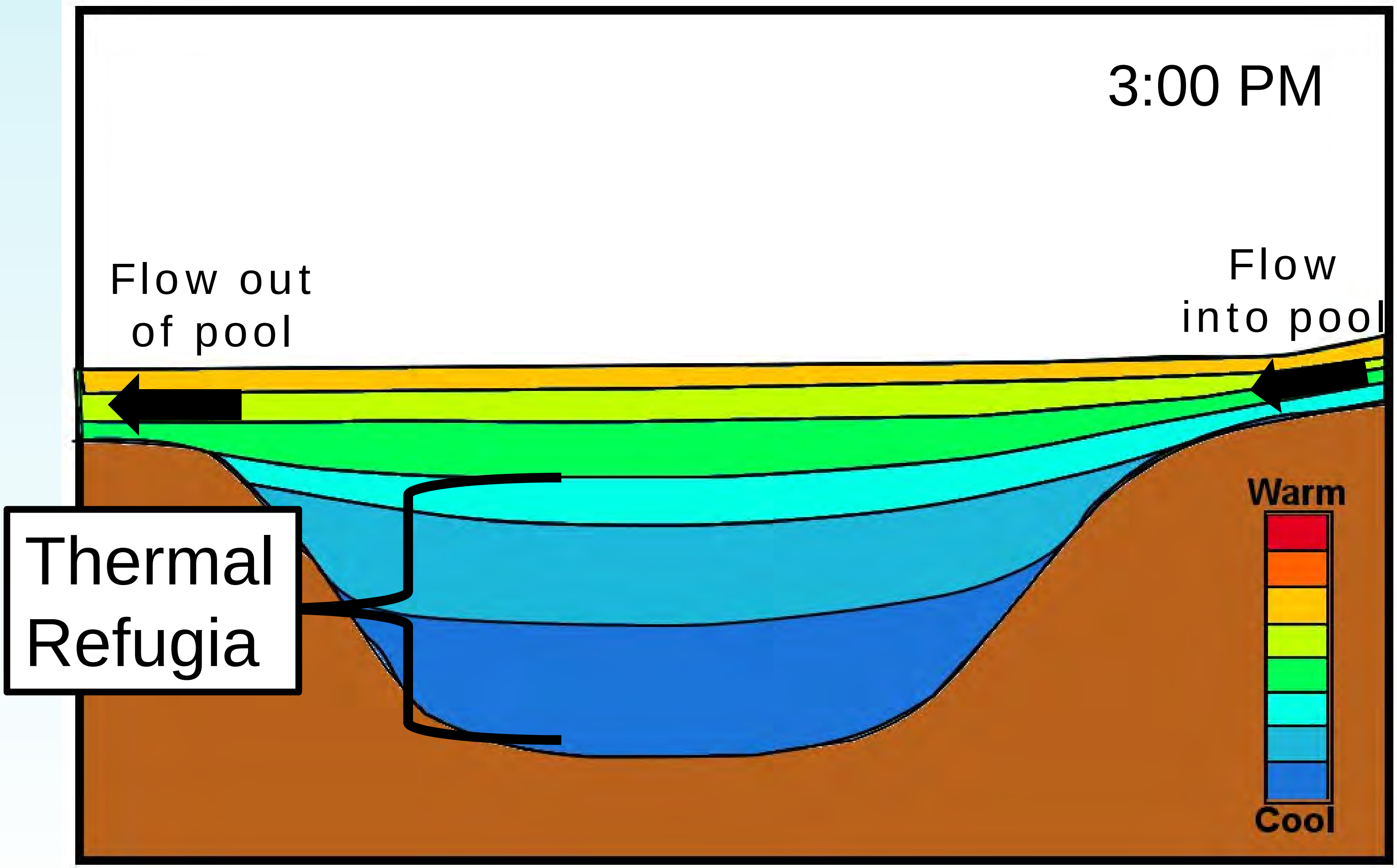
Background

Thermal Stratification



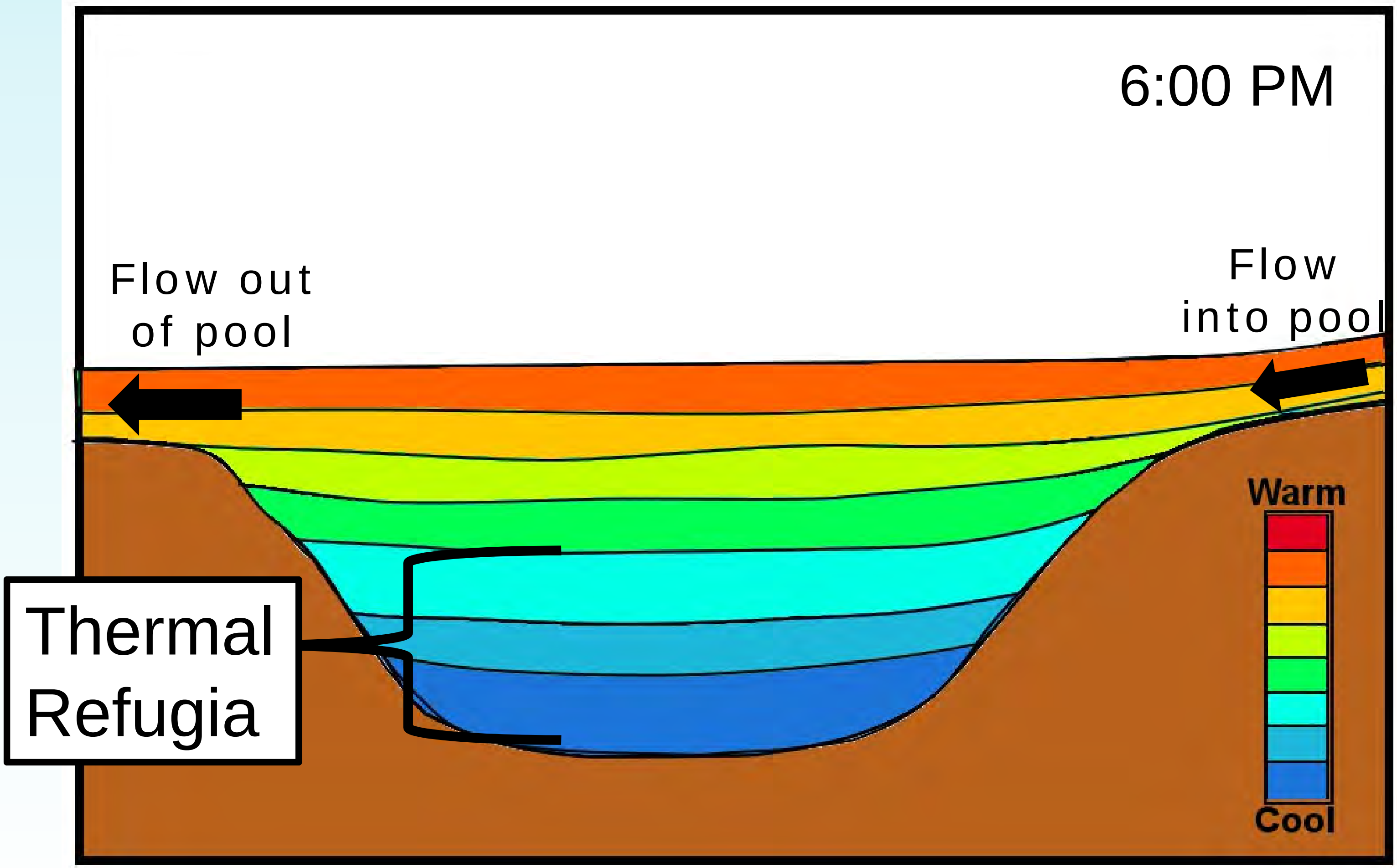
Background

Thermal Stratification



Background

Thermal Stratification



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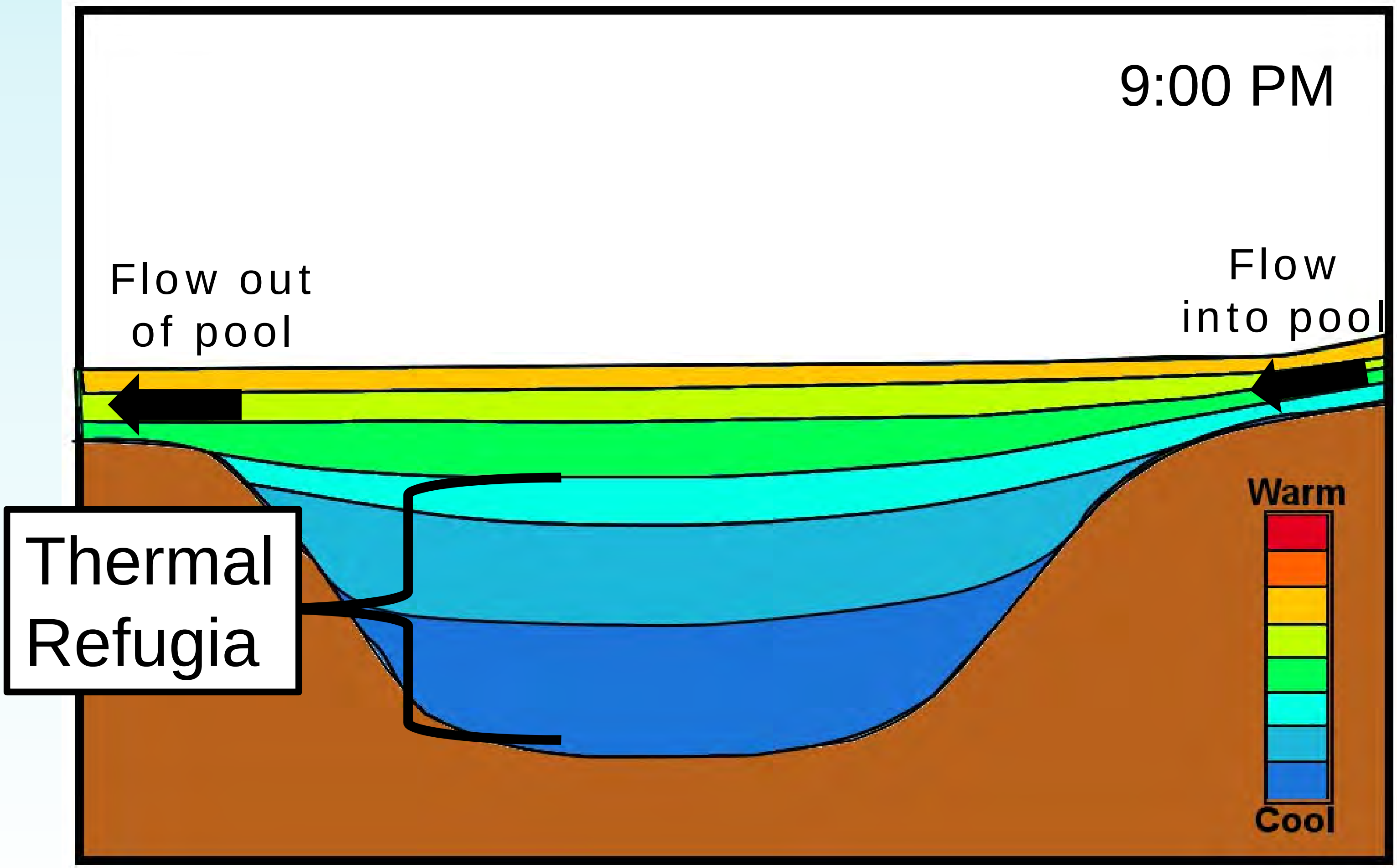
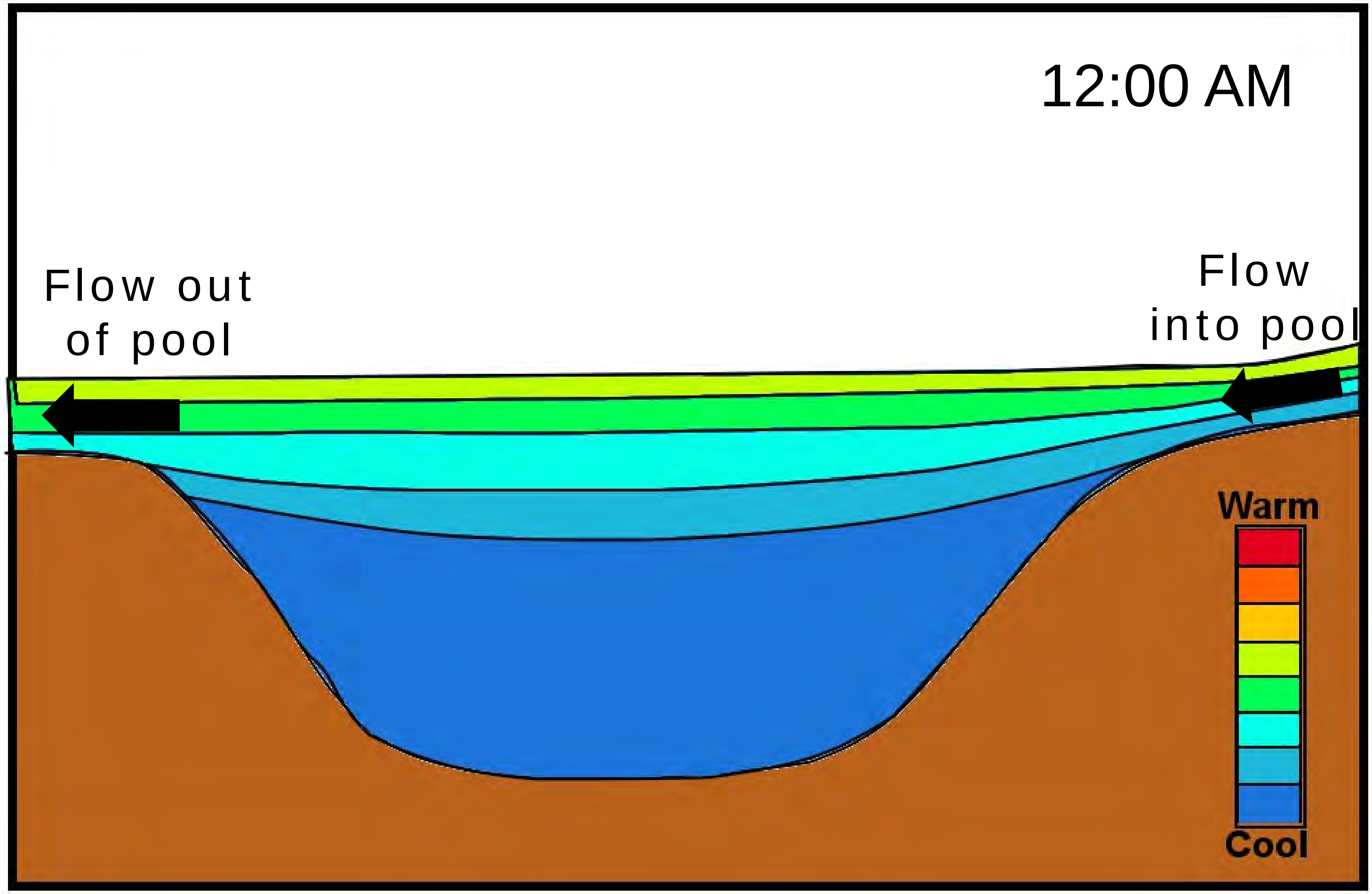
Thermal Stratification



Background

Thermal Stratification



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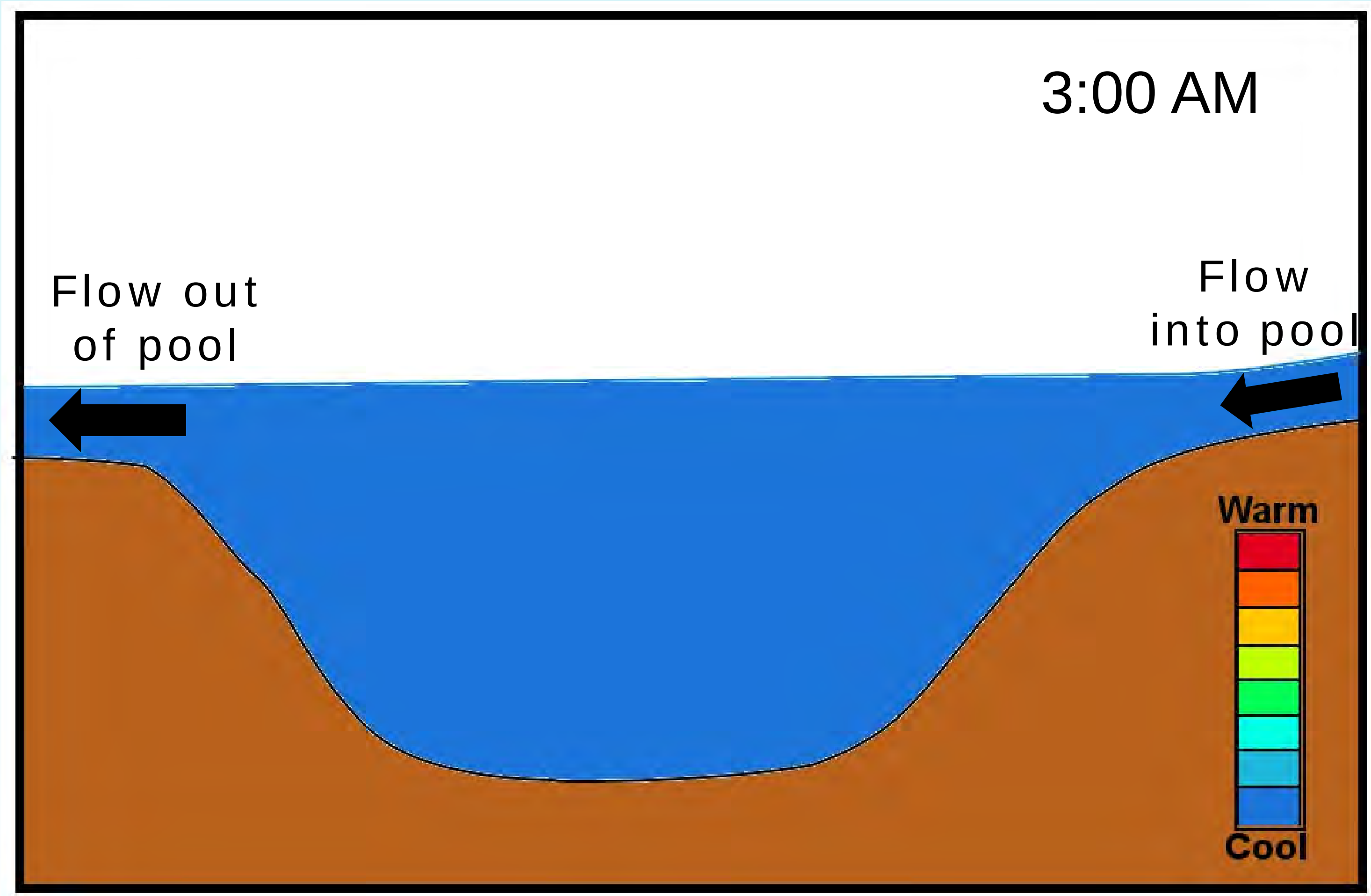
Background

Thermal Stratification



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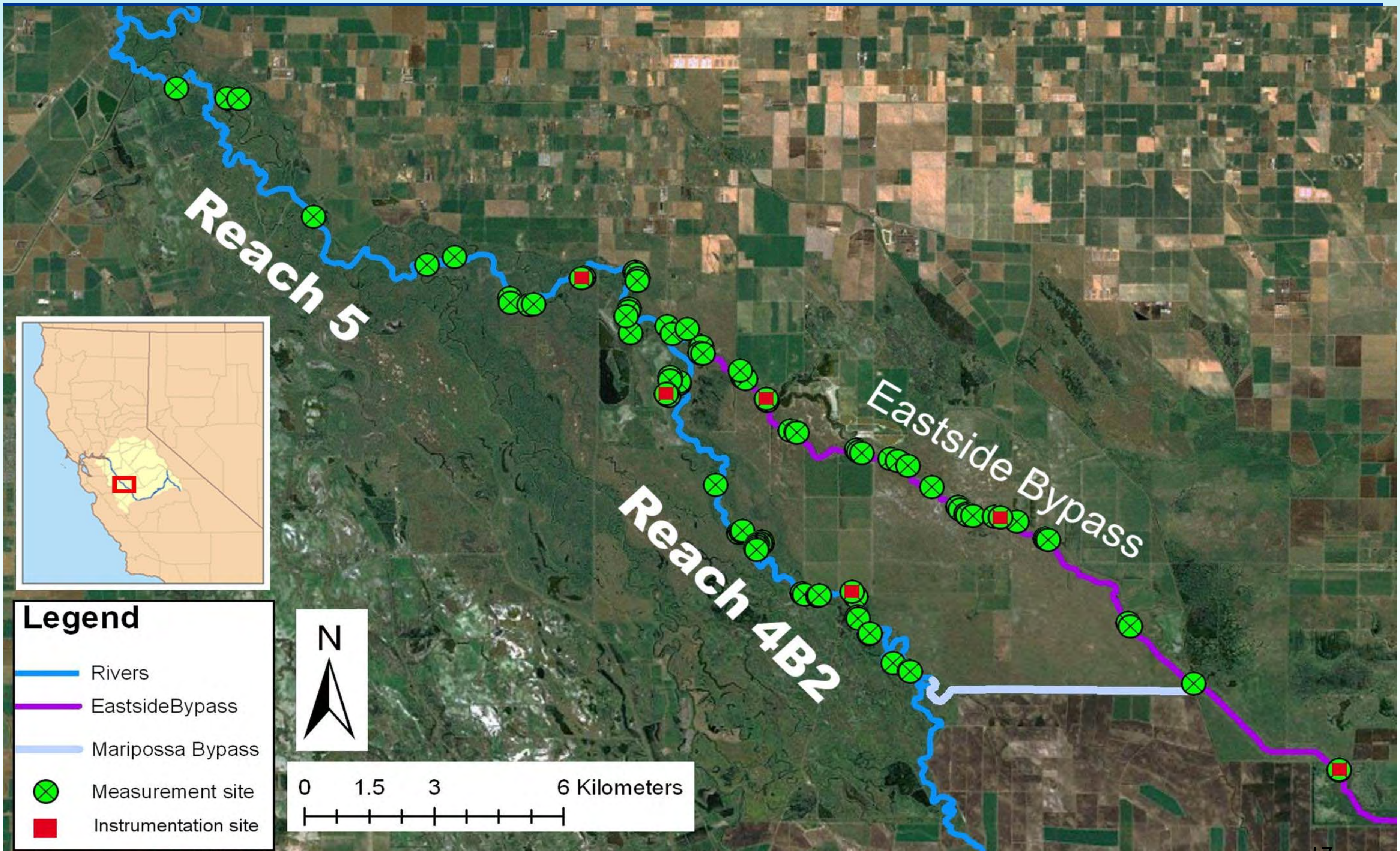
Study Location

SAN JOAQUIN RIVER RESTORATION PROGRAM

Study Location

SAN JOAQUIN RIVER RESTORATION PROGRAM

Study Location



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Methodology

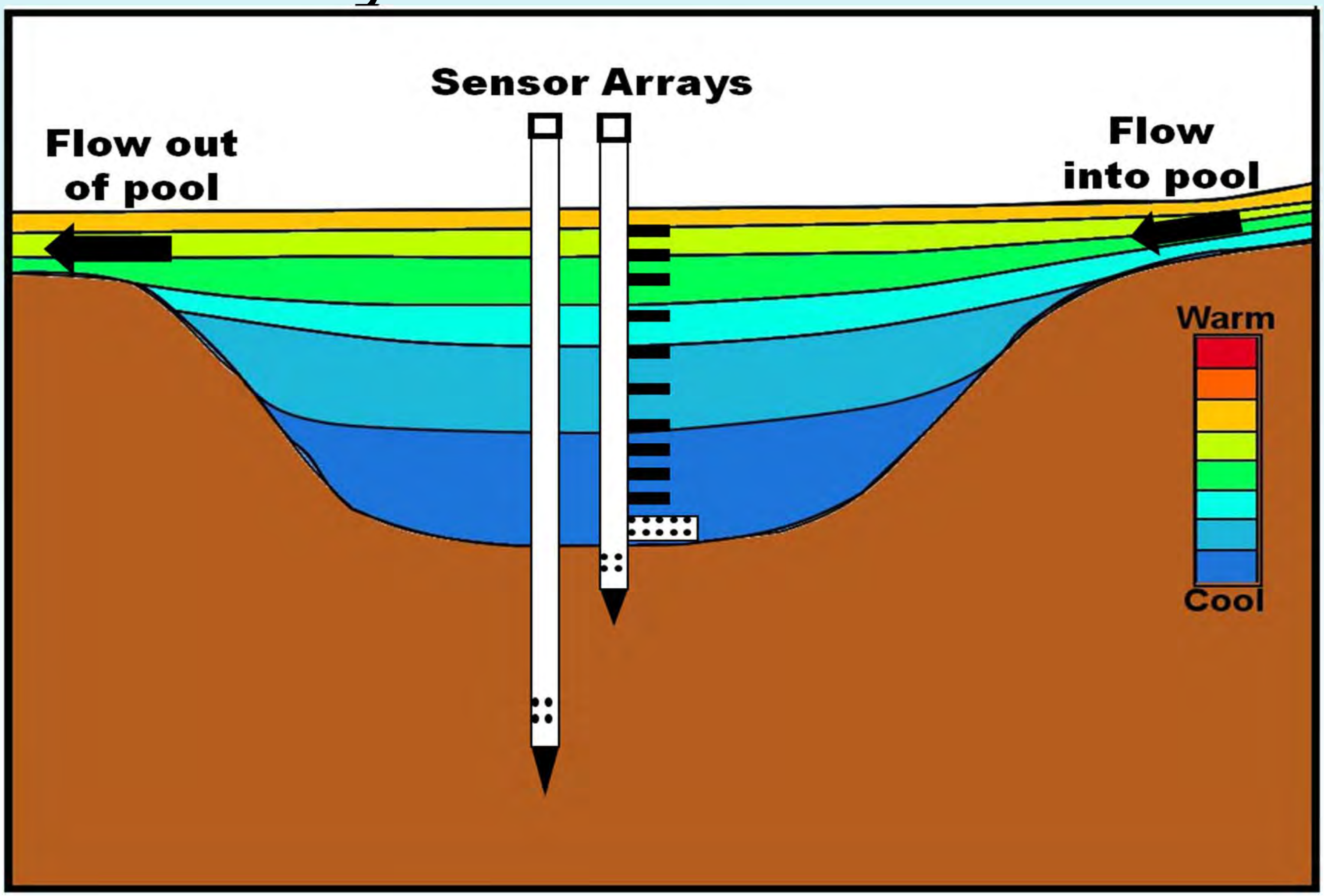
Methodology

Fall Thermal Refugia Site Study

- Pools instrumented with sensor arrays that measured
  - Water temperature
    - In the pool
    - In the ground below the pool
  - Pressure (water depth)
- Sensors recorded every 15 minutes for 2 weeks
- Sensors checked for consistency and data quality

Methodology

Sensor Array Placement



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Methodology

Methodology

SAN JOAQUIN RIVER
RESTORATION PROGRAM

Methodology

SAN JOAQUIN RIVER RESTORATION PROGRAM

Methodology

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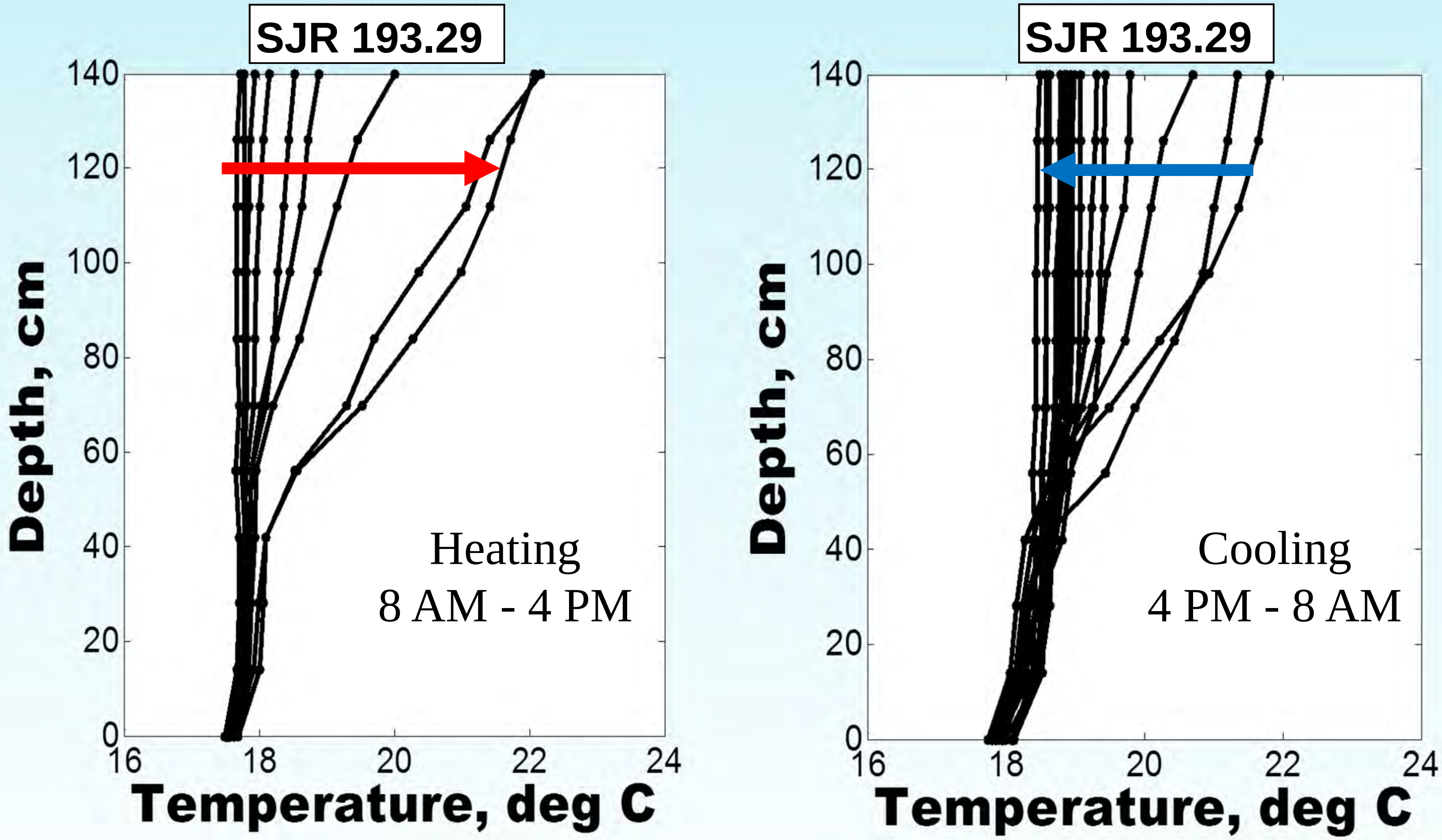
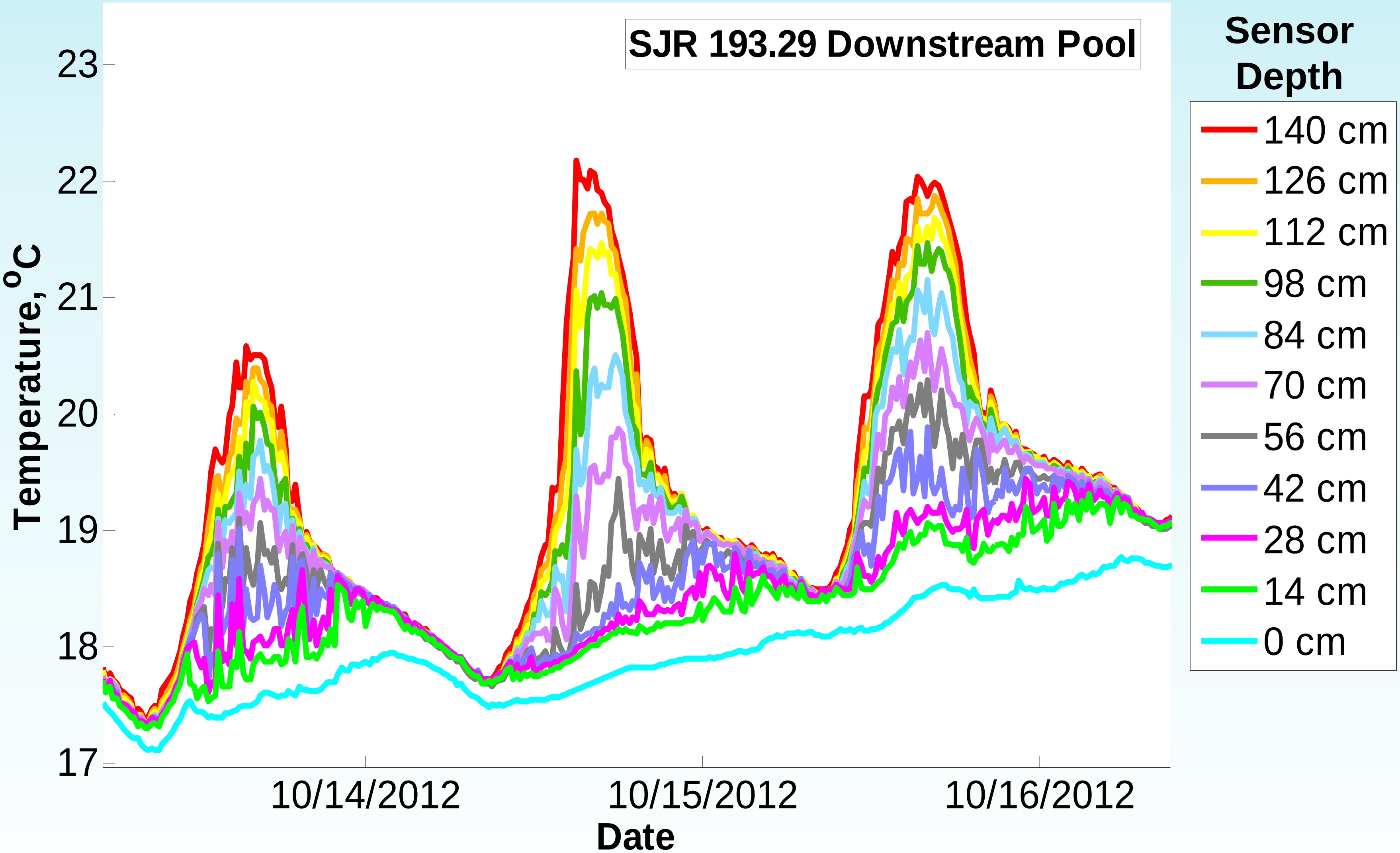
Fall Thermal Refugia Results

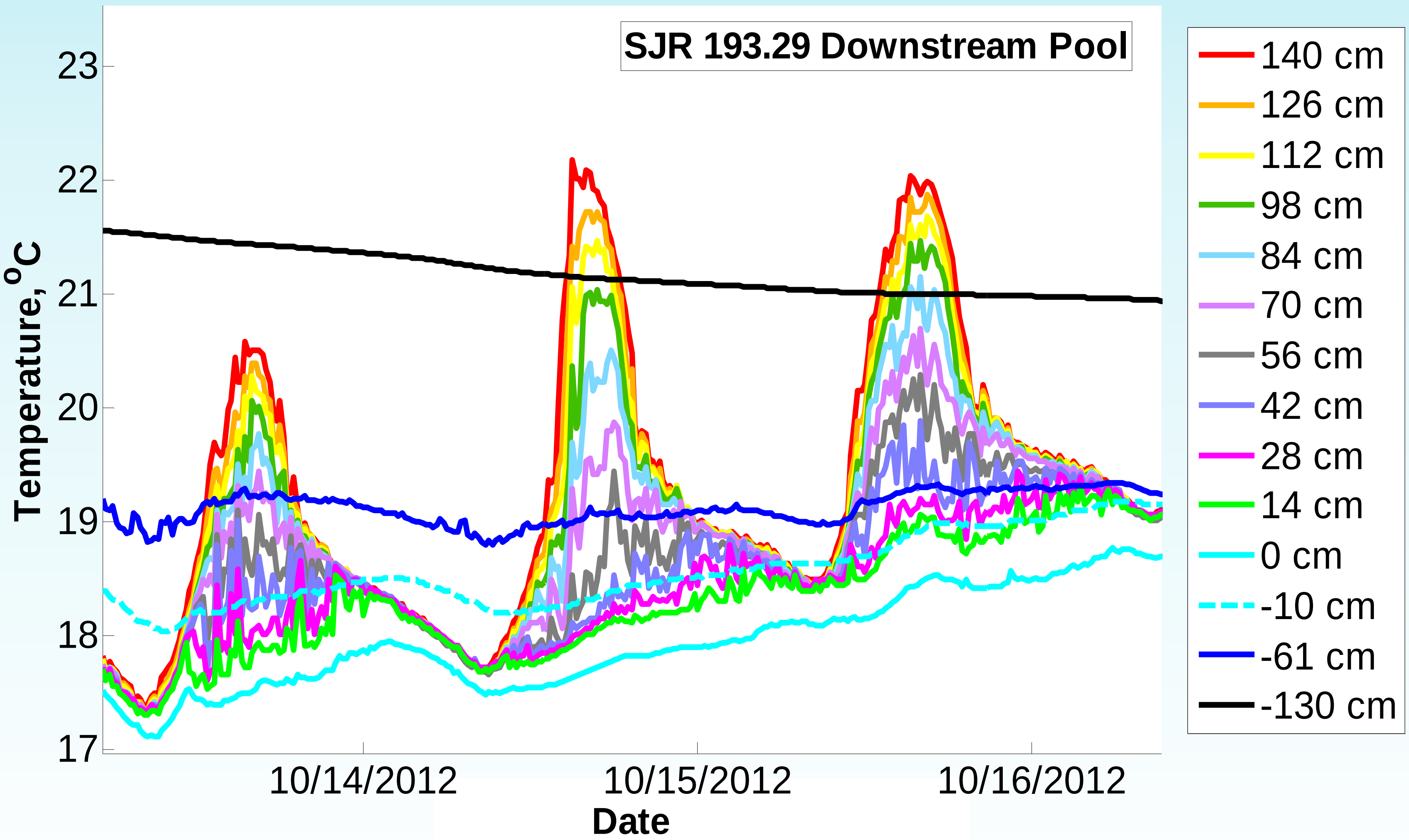
Fall Thermal Refugia Results



Fall Thermal Refugia Results



Fall Thermal Refugia Results



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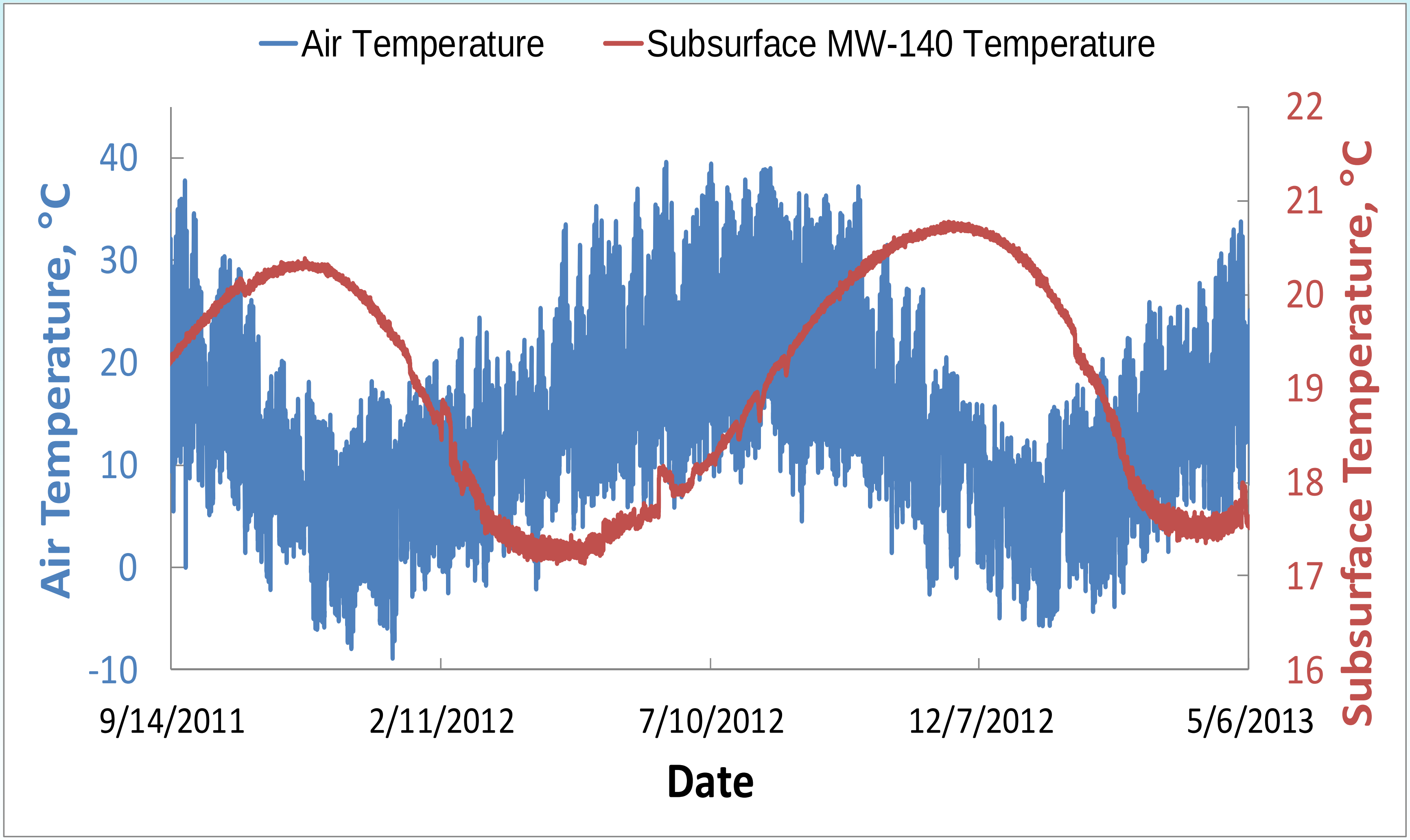
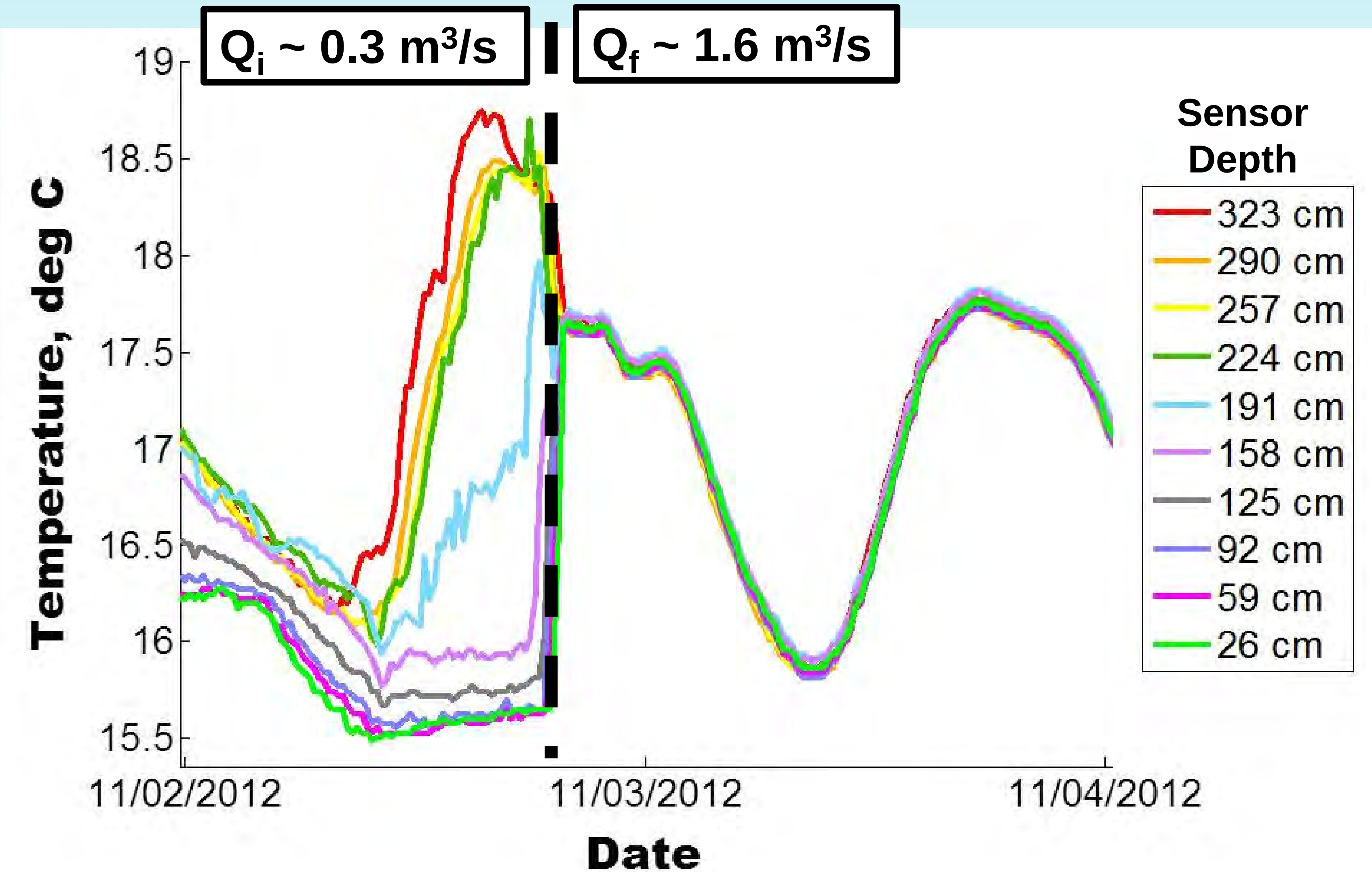
Fall Thermal Refugia Results



Fall Thermal Refugia Results

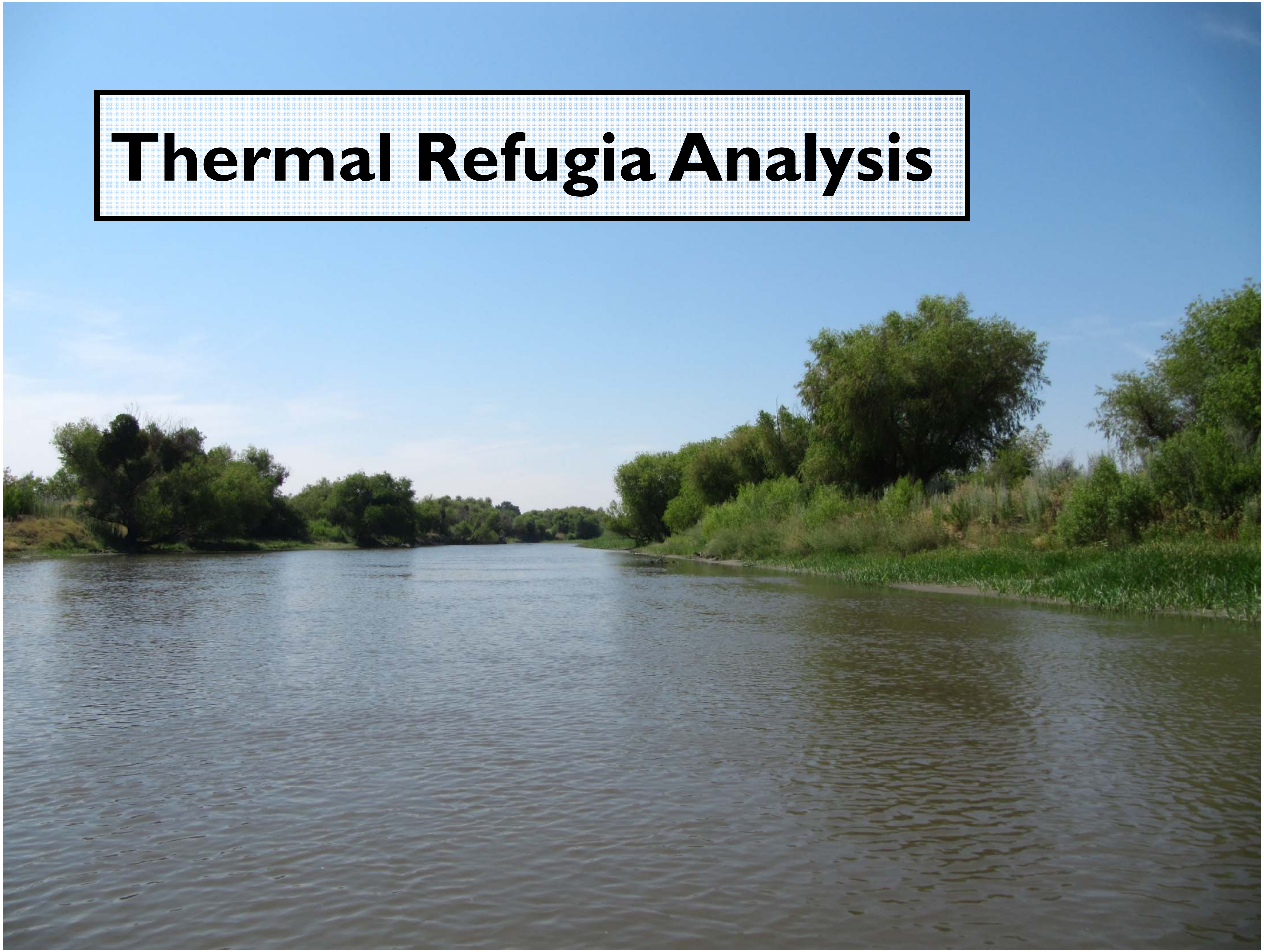


Fall Thermal Refugia Results

Key Data Observations

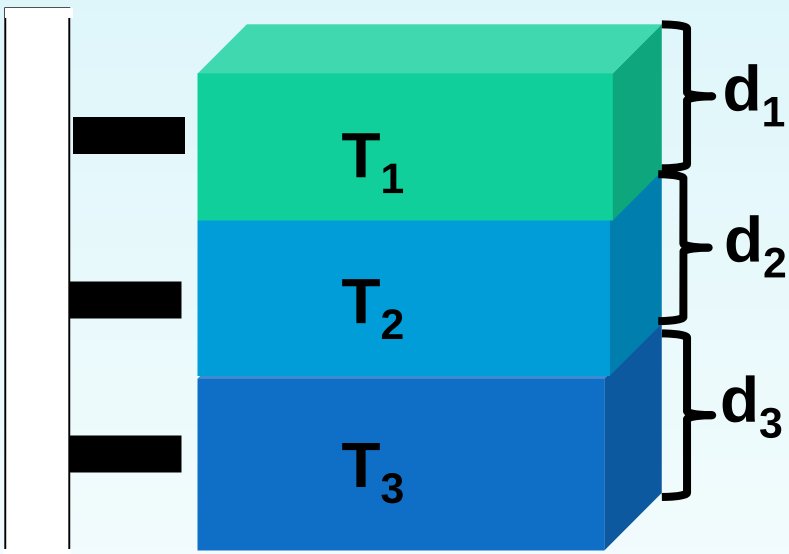
- Pool stratification develops each day then mixes overnight.
- Degree of stratification varies from day to day.
- Pool stratification ***can*** provide thermal refugia.
- Not all pools stratify.
- Subsurface temperature is variable, but is frequently warmer than the pool surface water temperature.
- Surface flow influences presence of thermal stratification.

Thermal Refugia Analysis



Thermal Refugia Analysis

Calculate the total pool heat using pool water temperature and bathymetry data.



$$H_1 = \rho_w C_p T_1 A_{surface} d_1$$

$$H_2 = \rho_w C_p T_2 A_{surface} d_2$$

$$H_3 = \rho_w C_p T_3 A_{surface} d_3$$

$$H_{total} = \sum_{i=1}^{n} H_i$$

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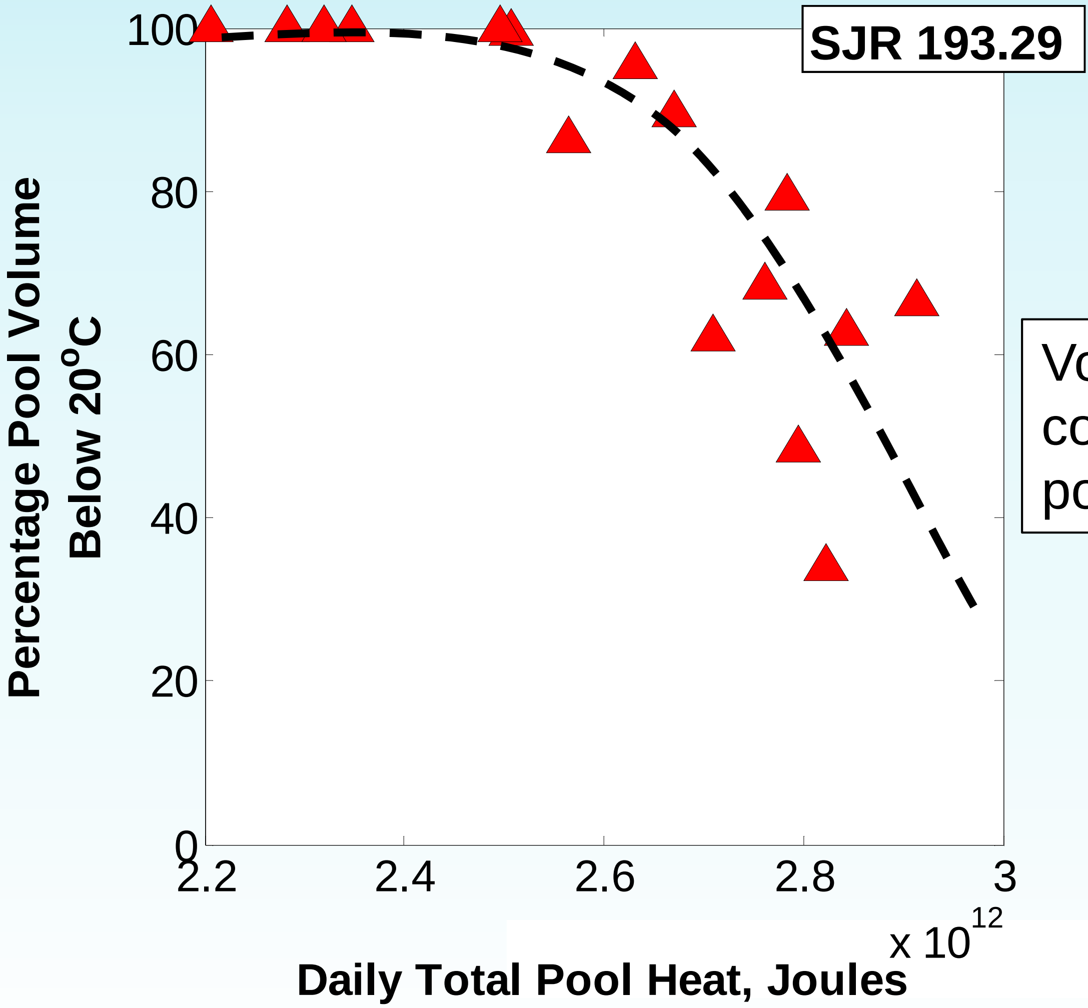
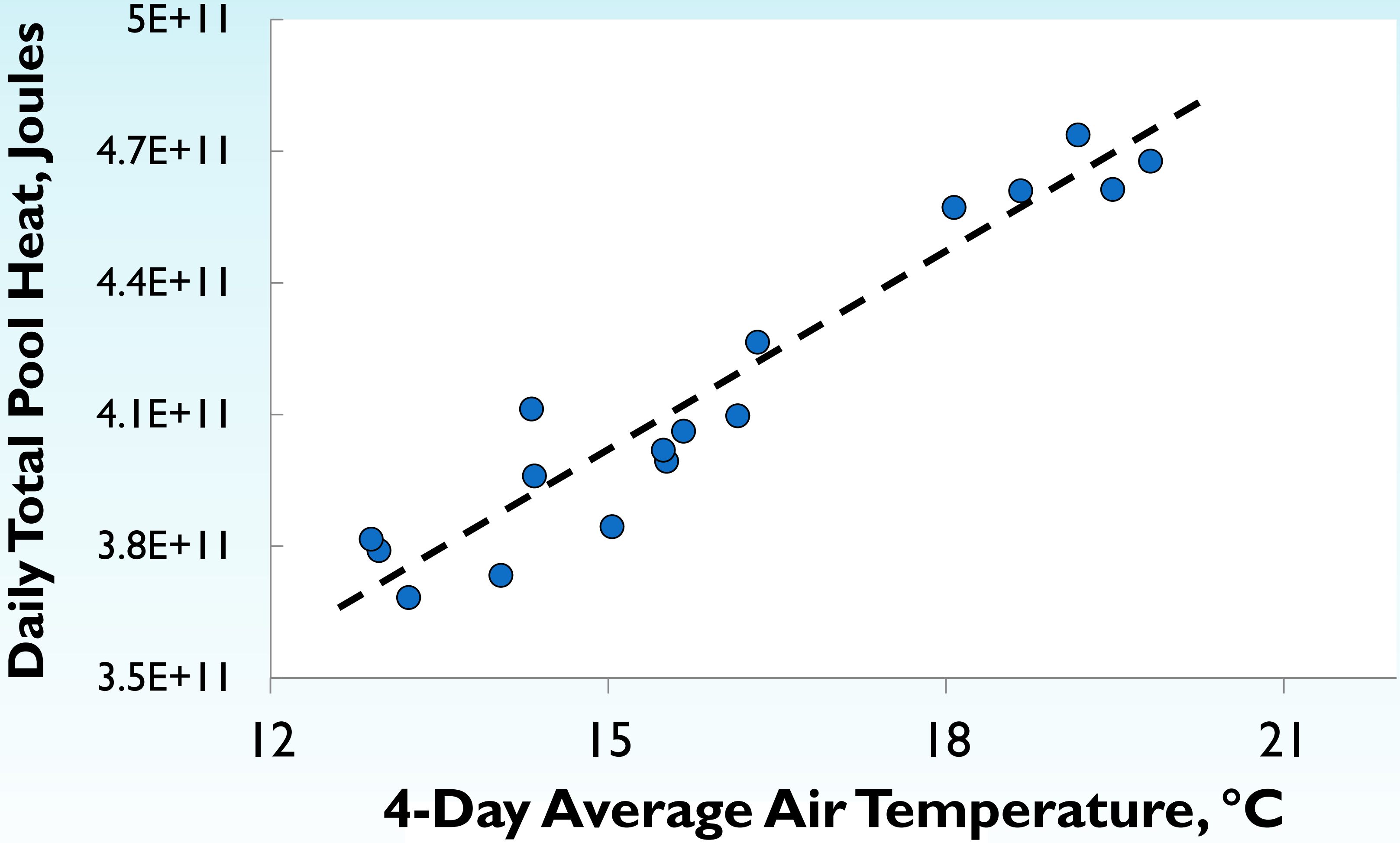
Thermal Refugia Analysis

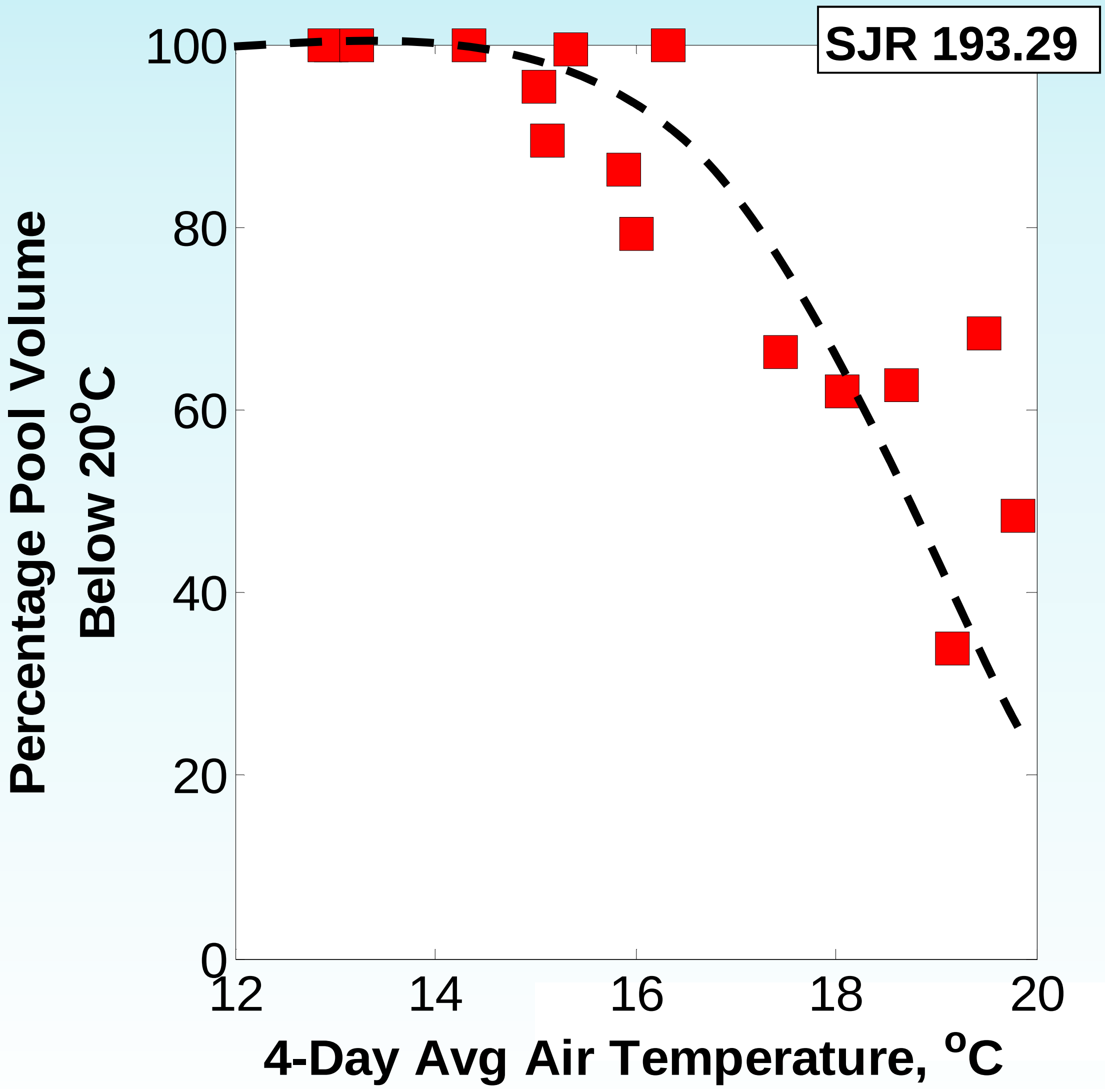


Volume of thermal refugia correlates with the daily total pool heat.

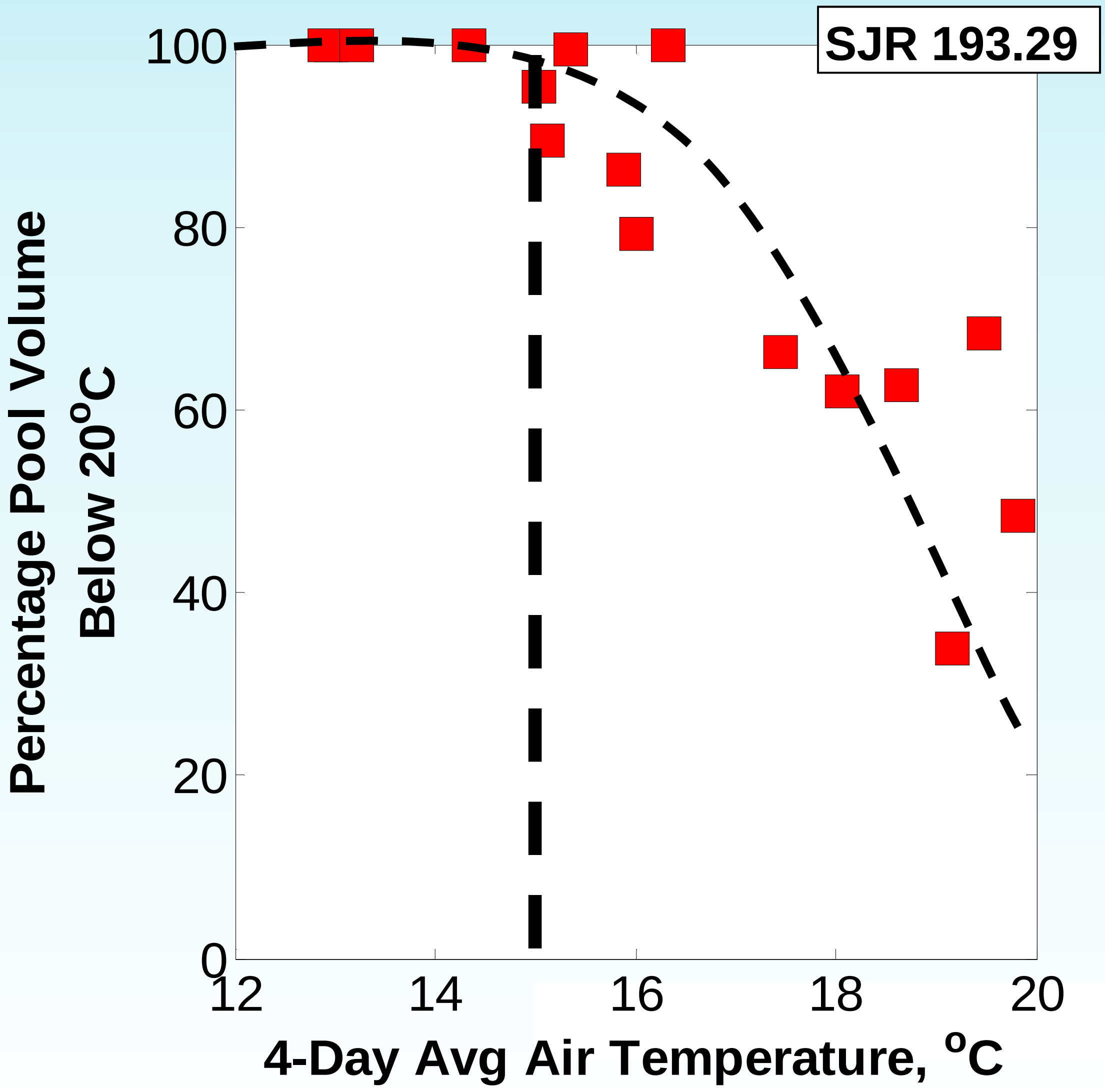
Thermal Refugia Analysis



Thermal Refugia Analysis

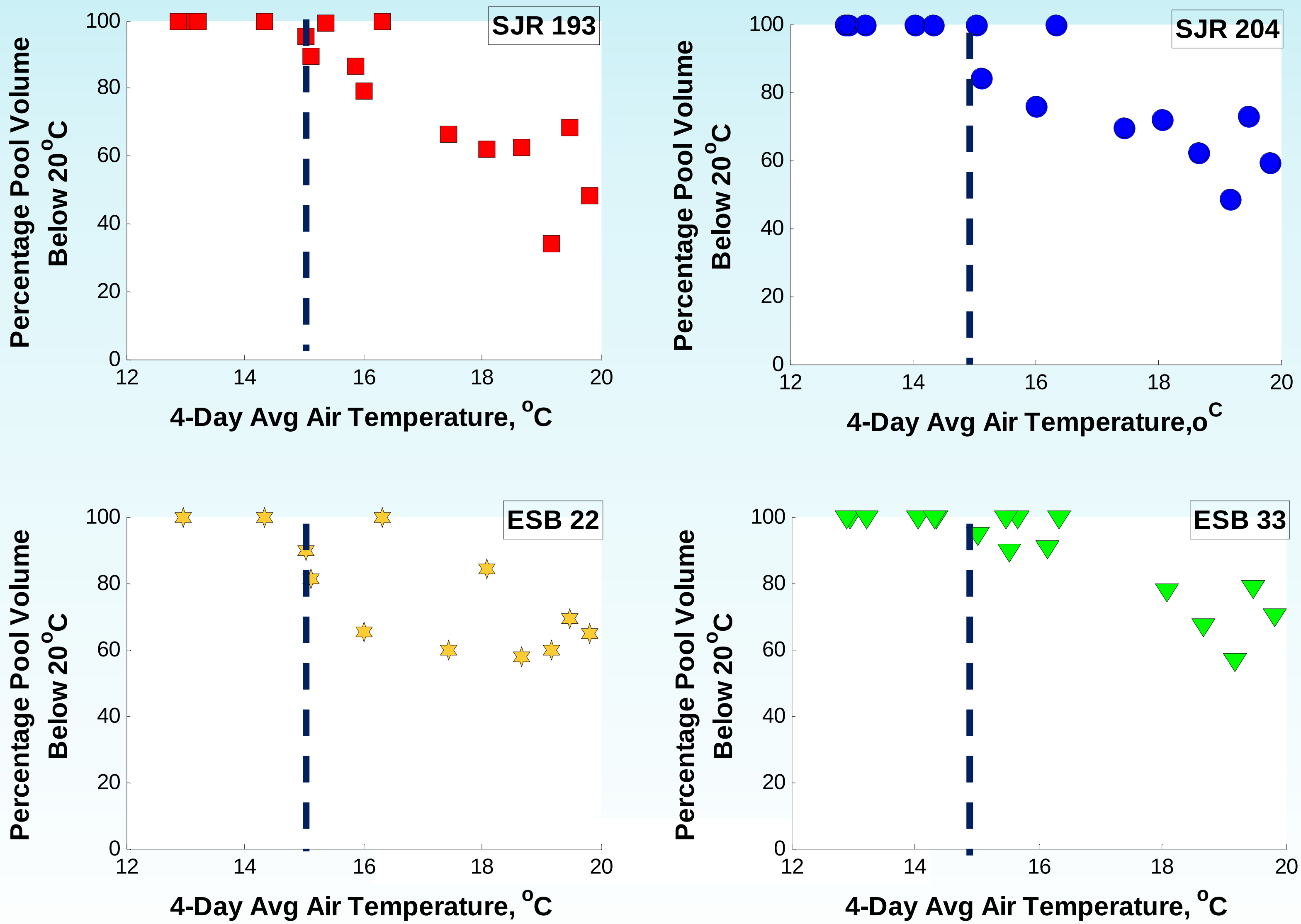


Thermal Refugia Analysis



When $\overline{T}_{air}$ >15°C, the volume of thermal refuge below 20°C decreases.

Thermal Refugia Analysis



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Fall Thermal Refugia Results

Take home messages

Thermal stratification created thermal refugia in pools in the Eastside Bypass, Reach 4B2, and Reach 5.

Air temperature was a dominant influence on water temperature in this section of the San Joaquin River.

Volume of thermal refugia below temperature thresholds can be estimated from 4-day average air temperature.

Availability of thermal refugia is also dependent on pool mixing conditions with increased flow observed to collapse thermal stratification in one pool.

Questions?

Full report

http://www.restoresjr.net/download/data-reporting/data-reporting-2013/SJRRP-Thermal-Refugia-Report-FINAL.pdf

or

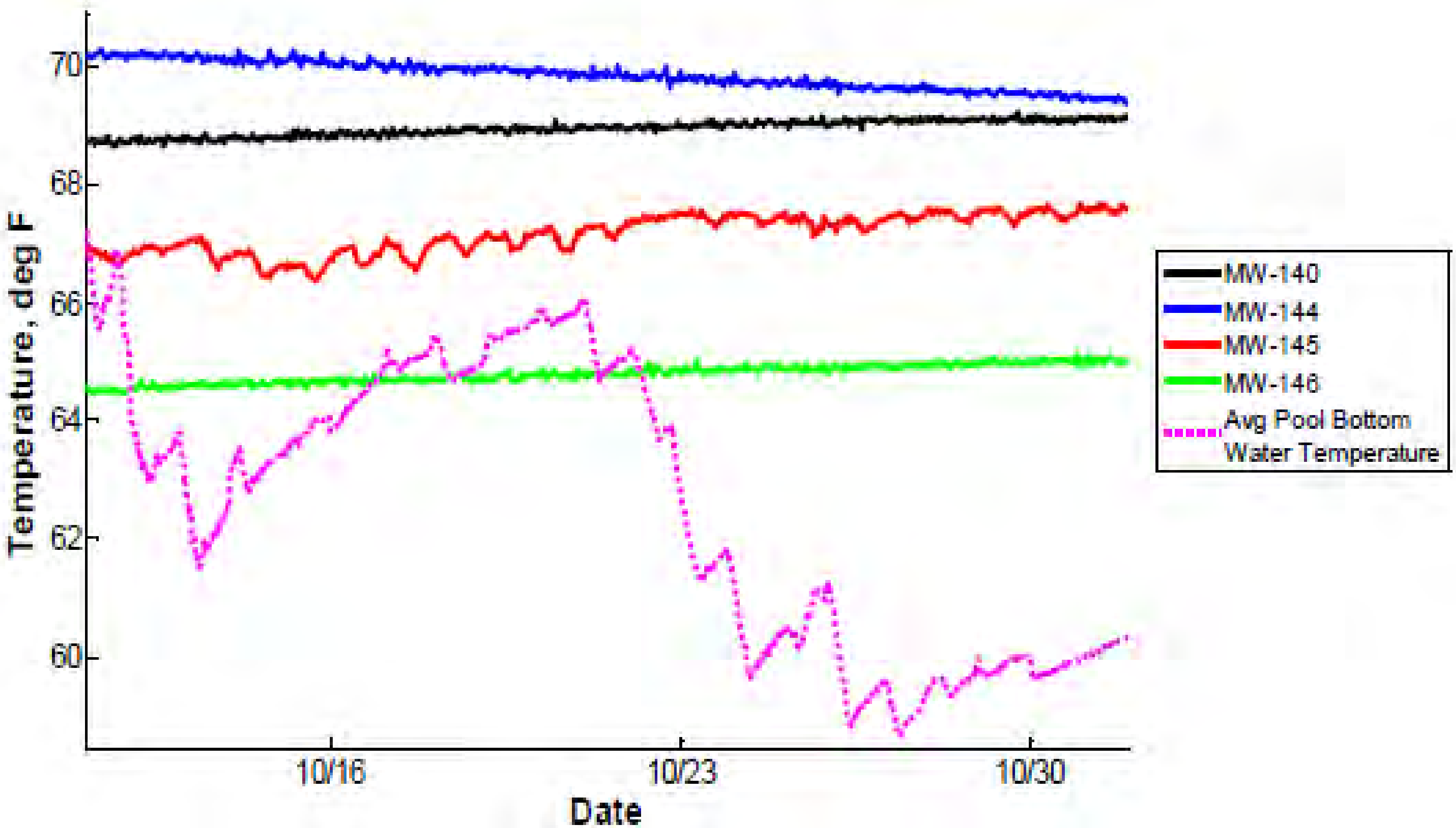
http://tinyurl.com/pwkrye7

Contact

Nathaniel L. Butler

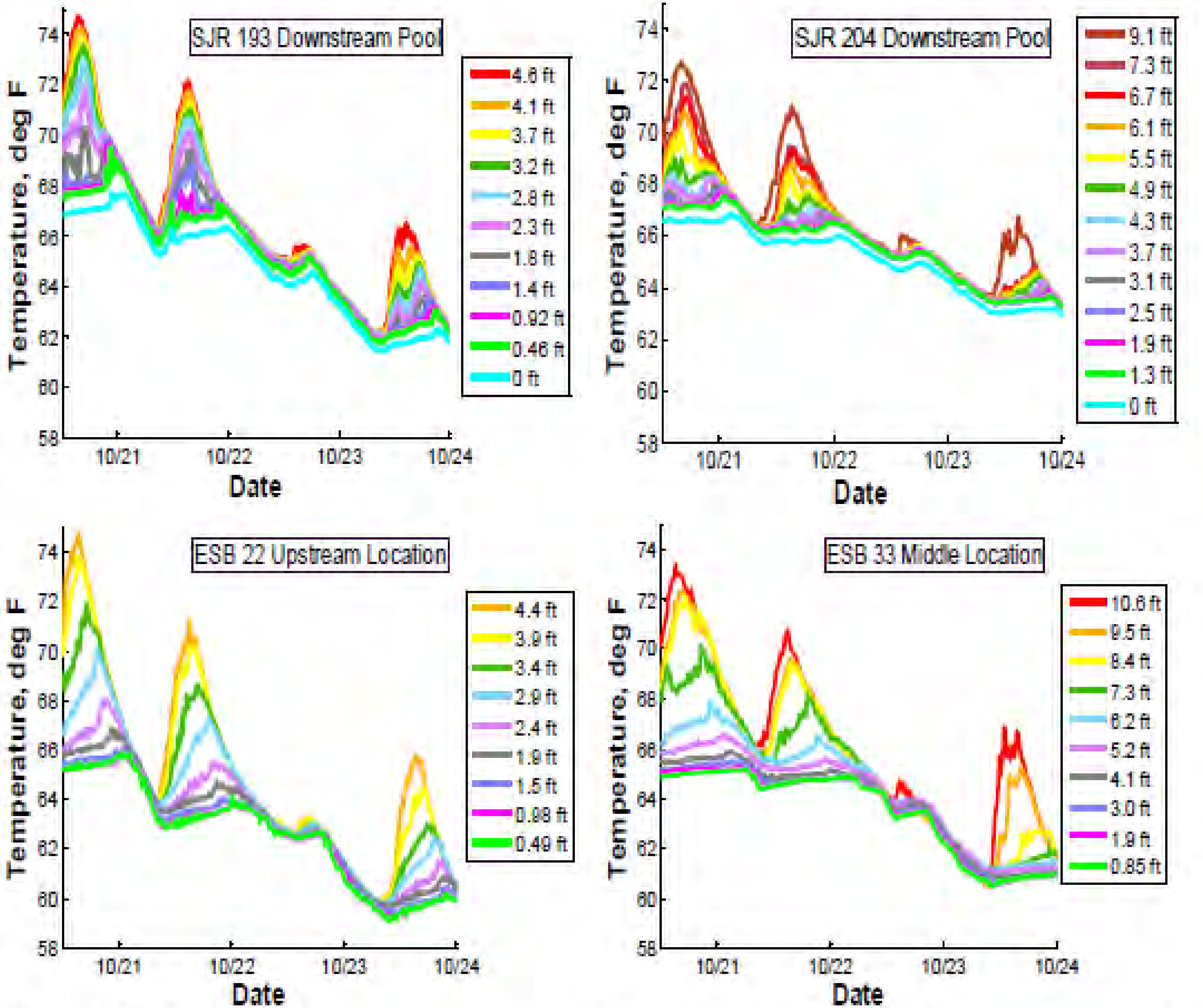
BUTLER.NATHANIEL.L@gmail.com

Fall Thermal Refugia Results



Preliminary draft – subject to change

SAN J


SJR 193 Downstream Pool
4.6 ft
4.1 ft
3.7 ft
3.2 ft
2.8 ft
2.3 ft
1.8 ft
1.4 ft
0.92 ft
0.46 ft
0 ft
Temperature, deg F
Date
10/21
10/22
10/23
10/24
SJR 204 Downstream Pool
9.1 ft
7.3 ft
6.7 ft
6.1 ft
5.5 ft
4.9 ft
4.3 ft
3.7 ft
3.1 ft
2.5 ft
1.9 ft
1.3 ft
0 ft
ESB 22 Upstream Location
4.4 ft
3.9 ft
3.4 ft
2.9 ft
2.4 ft
1.9 ft
1.5 ft
0.98 ft
0.49 ft
ESB 33 Middle Location
10.6 ft
9.5 ft
8.4 ft
7.3 ft
6.2 ft
5.2 ft
4.1 ft
3.0 ft
1.9 ft
0.85 ft
58
60
62
64
66
68
70
72
74

3

Fall Thermal Refugia Results

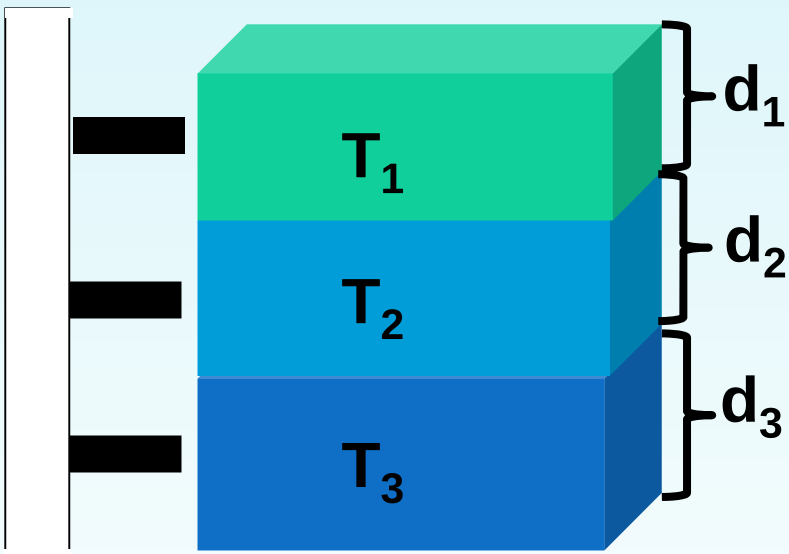
Calculate the total pool heat using pool water temperature and bathymetry data

$$H_{total} = \rho_w C_p T_w A_{surface} d$$

H_{total} = total pool heat [Joules]
ρ_w = density of water [kg/m^3]
C_p = heat capacity of water [Joules/kg °C]
T_w = water temperature [°C]
$A_{surface}$ = surface area of pool [m^2]
d = depth of pool [m]

Fall Thermal Refugia Results

Calculate the total pool heat using pool water temperature and bathymetry data



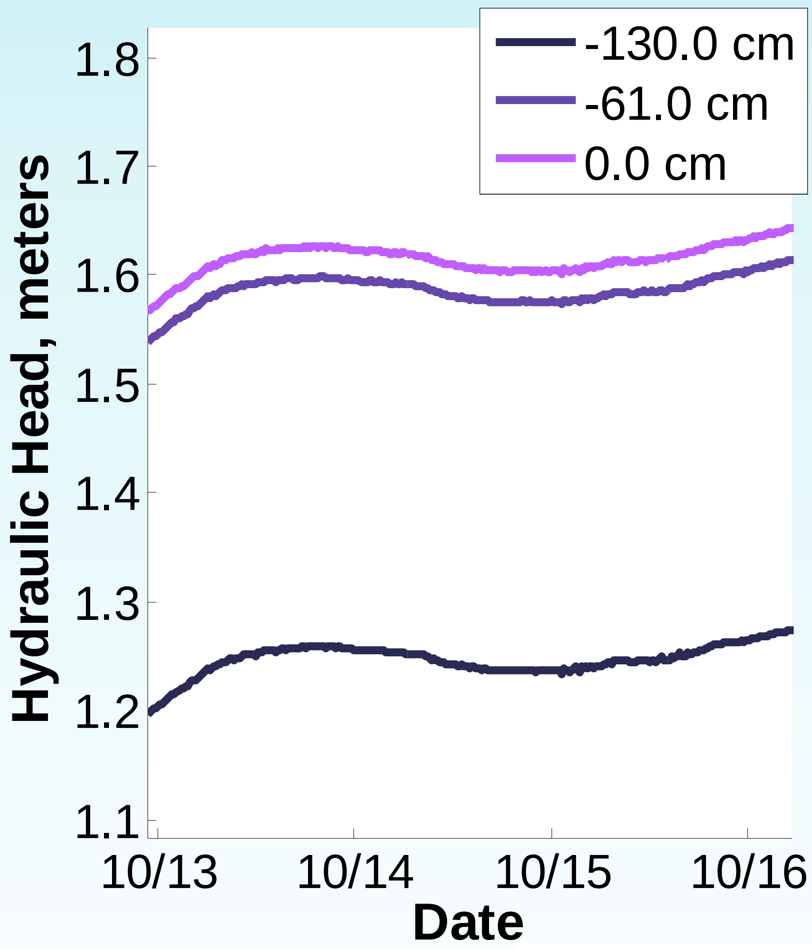
$$H_1 = \rho_w C_p T_1 A_{surface} d_1$$

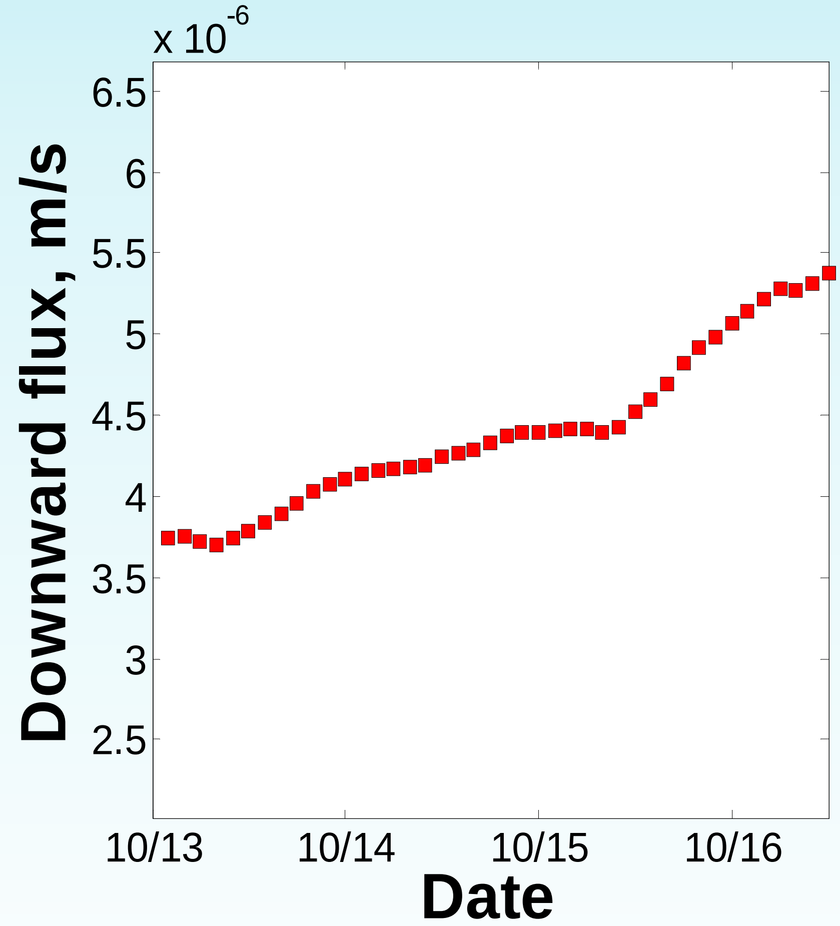
$$H_2 = \rho_w C_p T_2 A_{surface} d_2$$

$$H_3 = \rho_w C_p T_3 A_{surface} d_3$$

$$H_{total} = \sum_{i=1}^{n} H_i$$

Fall Thermal Refugia Results

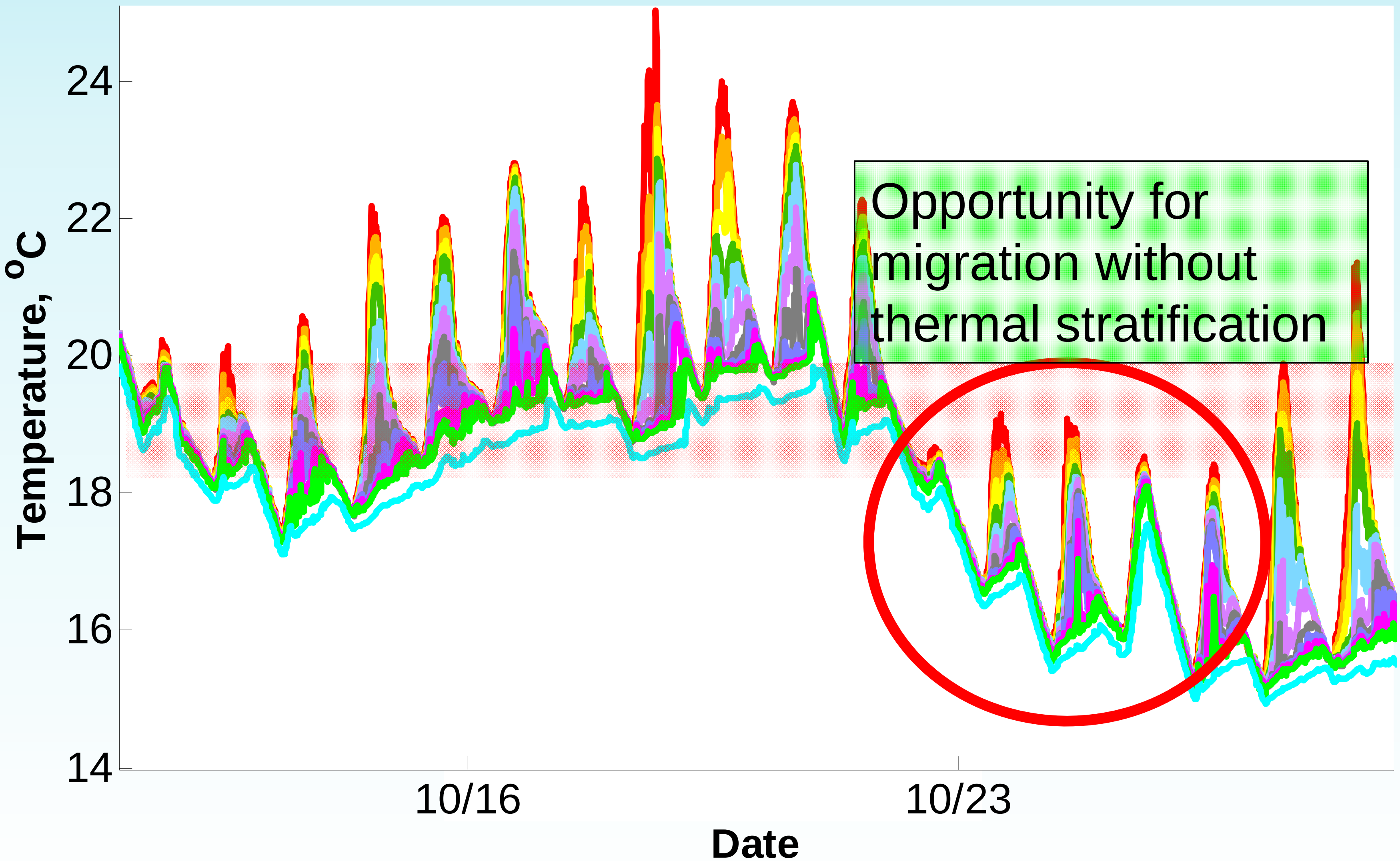




Preliminary draft – subject to change

SAN JOAQUIN RIVER RESTORATION PROGRAM

Fall Thermal Refugia



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Use of GIS Technology to Prioritize the Restoration and Protection of Anchor Habitat Riparian Areas in the Rogue River Basin.
Salmonid Restoration Conference 2016
Eugene Wier
Restoration Project Manager
Rogue-Klamath Lead
The Freshwater Trust
eugene@thefreshwatertrust.org
The Freshwater Trust

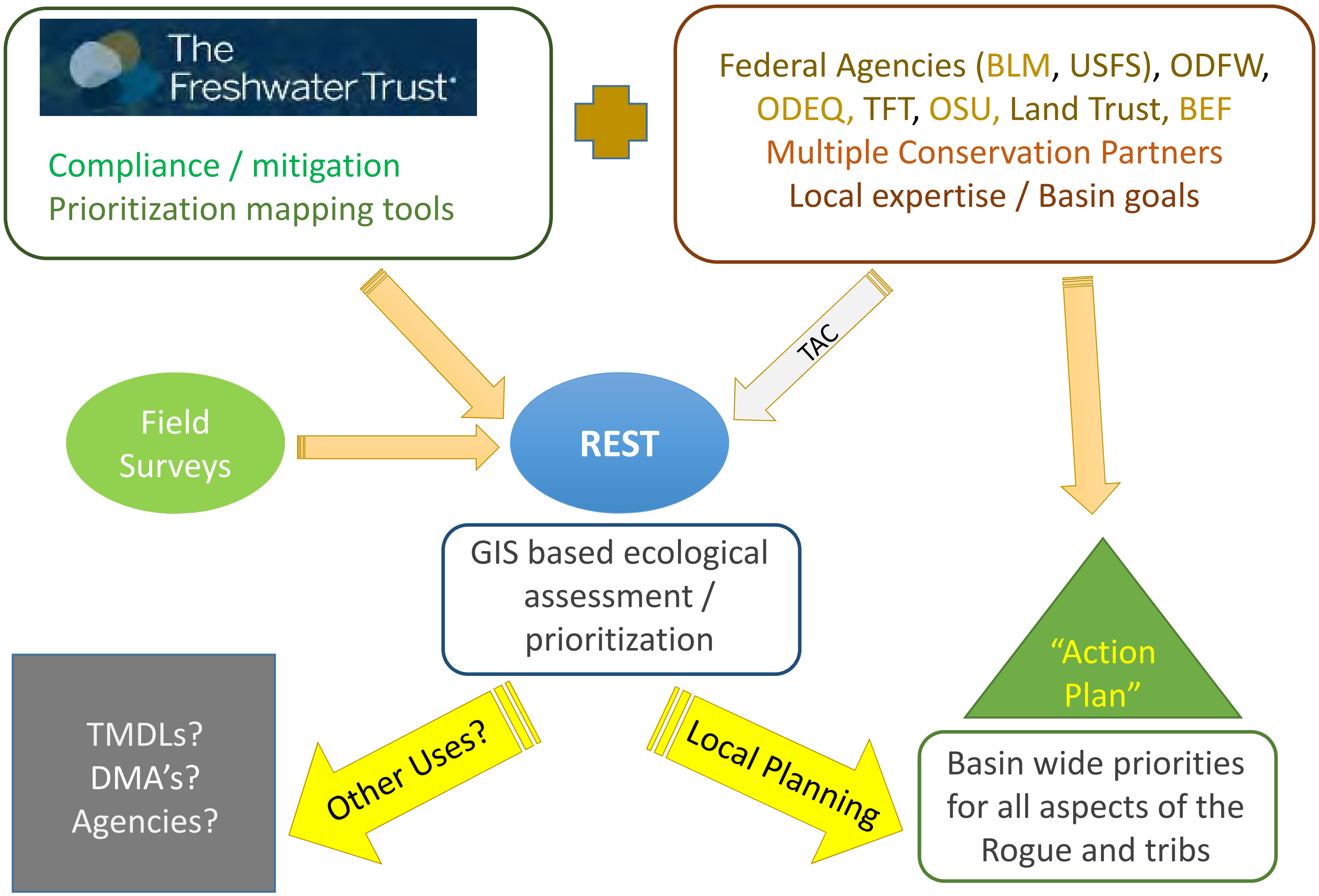
Riparian Extent Status Tool

What it is

What it can do

How it can help

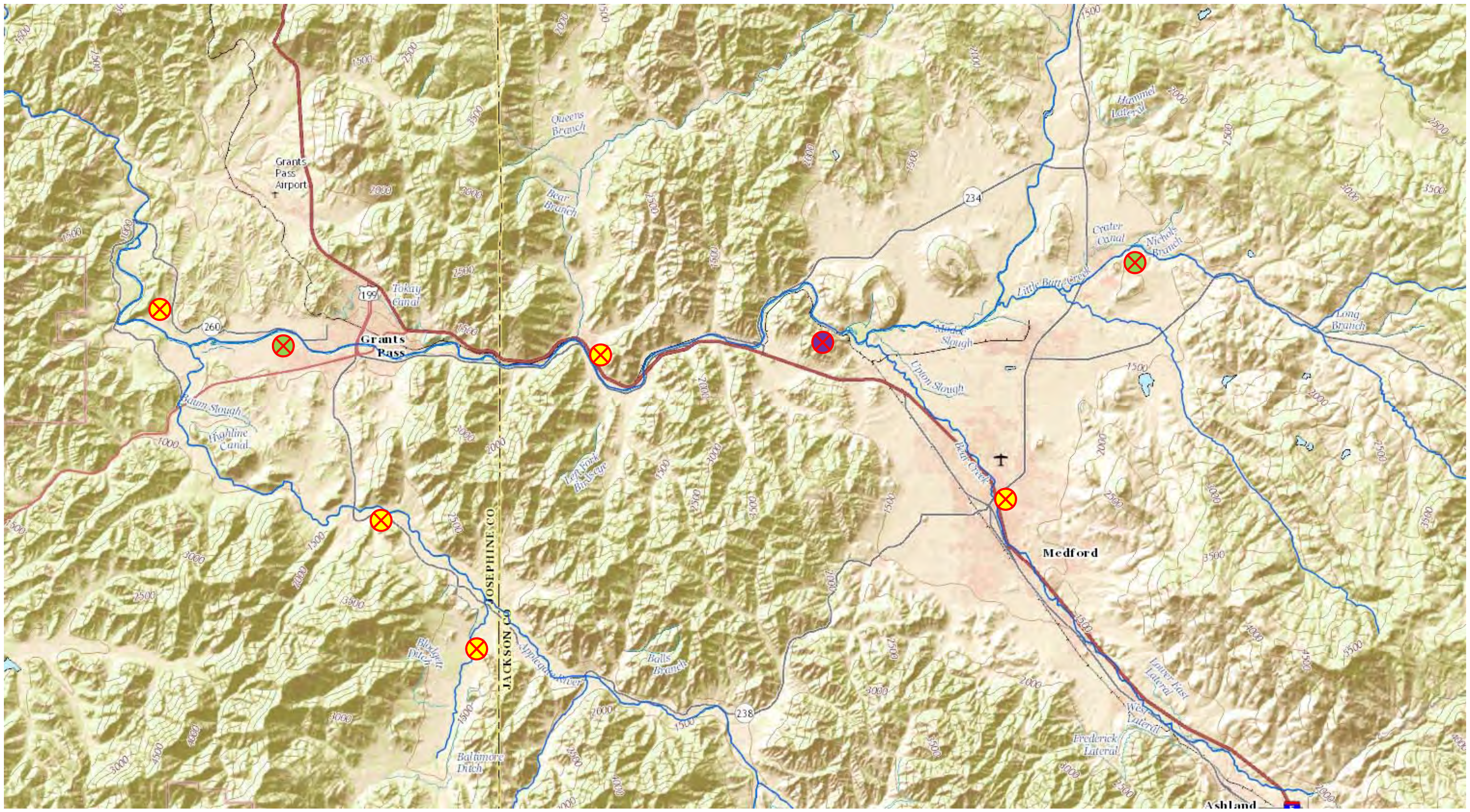
Rogue Basin Technical Assistance Grant for Riparian Site Prioritization:



REST

Background

“Traditional Approach”: scatter shot, opportunistic

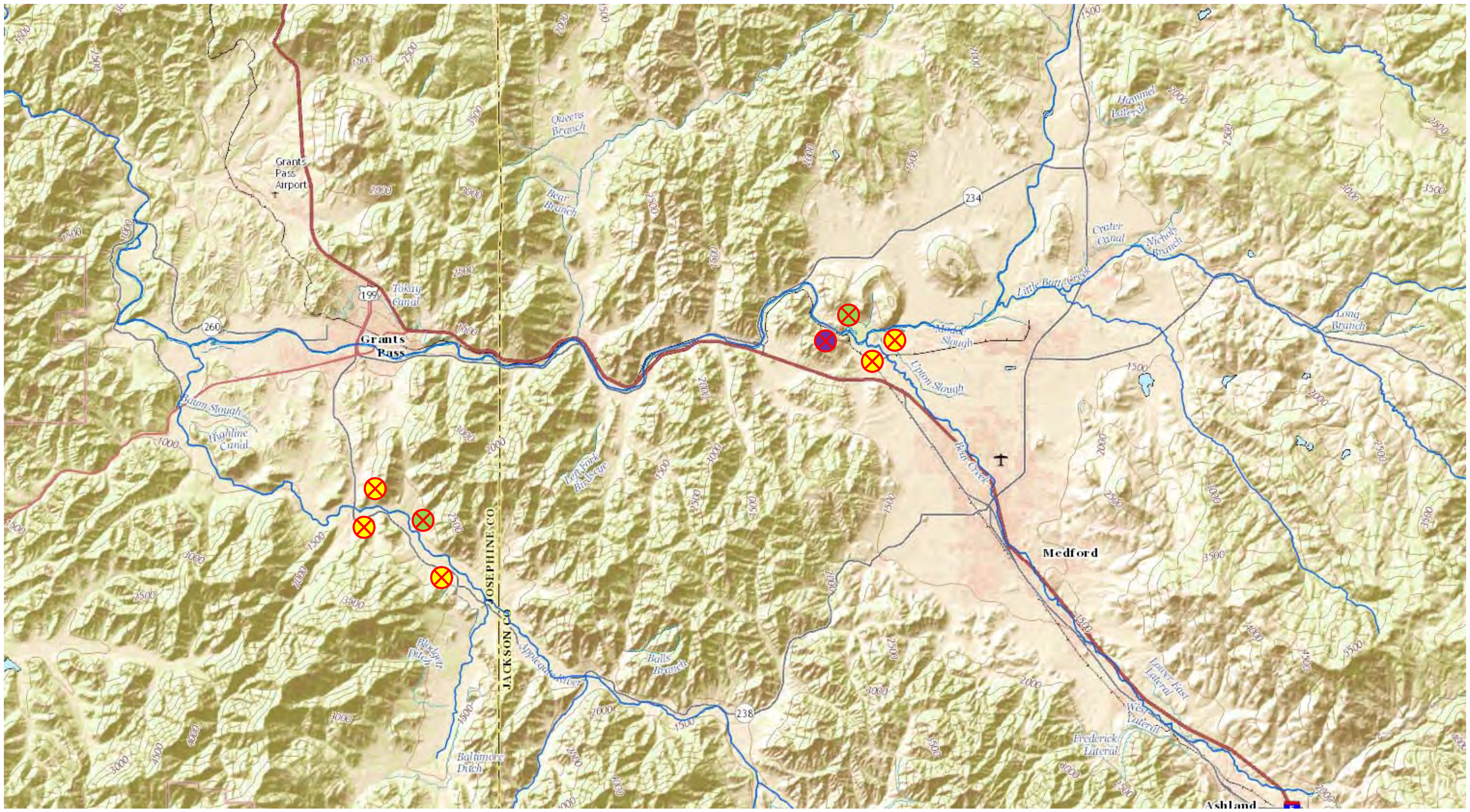


REST

Objective

Prioritized Approach: coordinated, **targeted**

REST

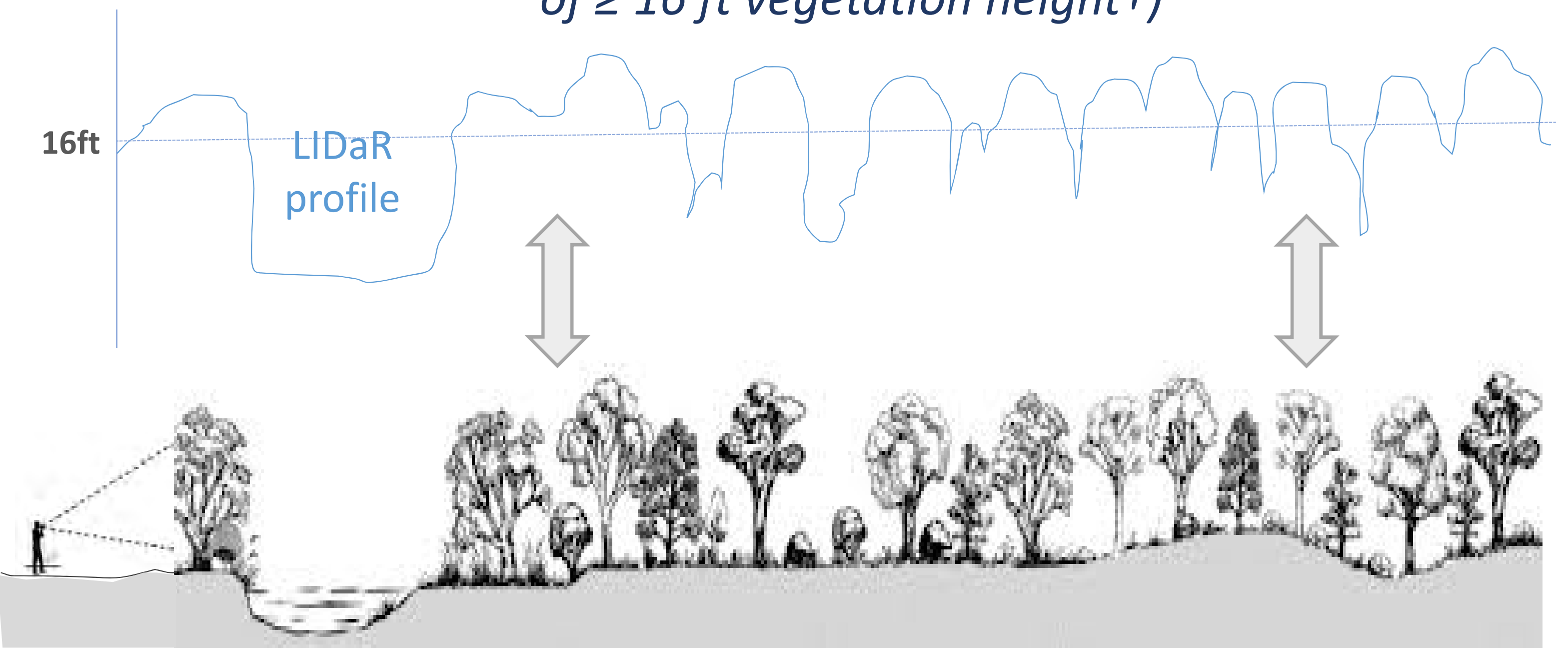


Objective

Use of LIDaR for ***Disturbance*** scoring:

REST

f(riparian forest ≥ 40% cover of ≥ 16 ft vegetation height†)*



Definitions

Field surveys "gut checked" REST scores (about 50 sites)

**NLCD2011 – National Land Cover Database ("forest" definition)*
†USDA-NRCS National Plants Database ("tree" definition)

Less obvious (Geomorphology):

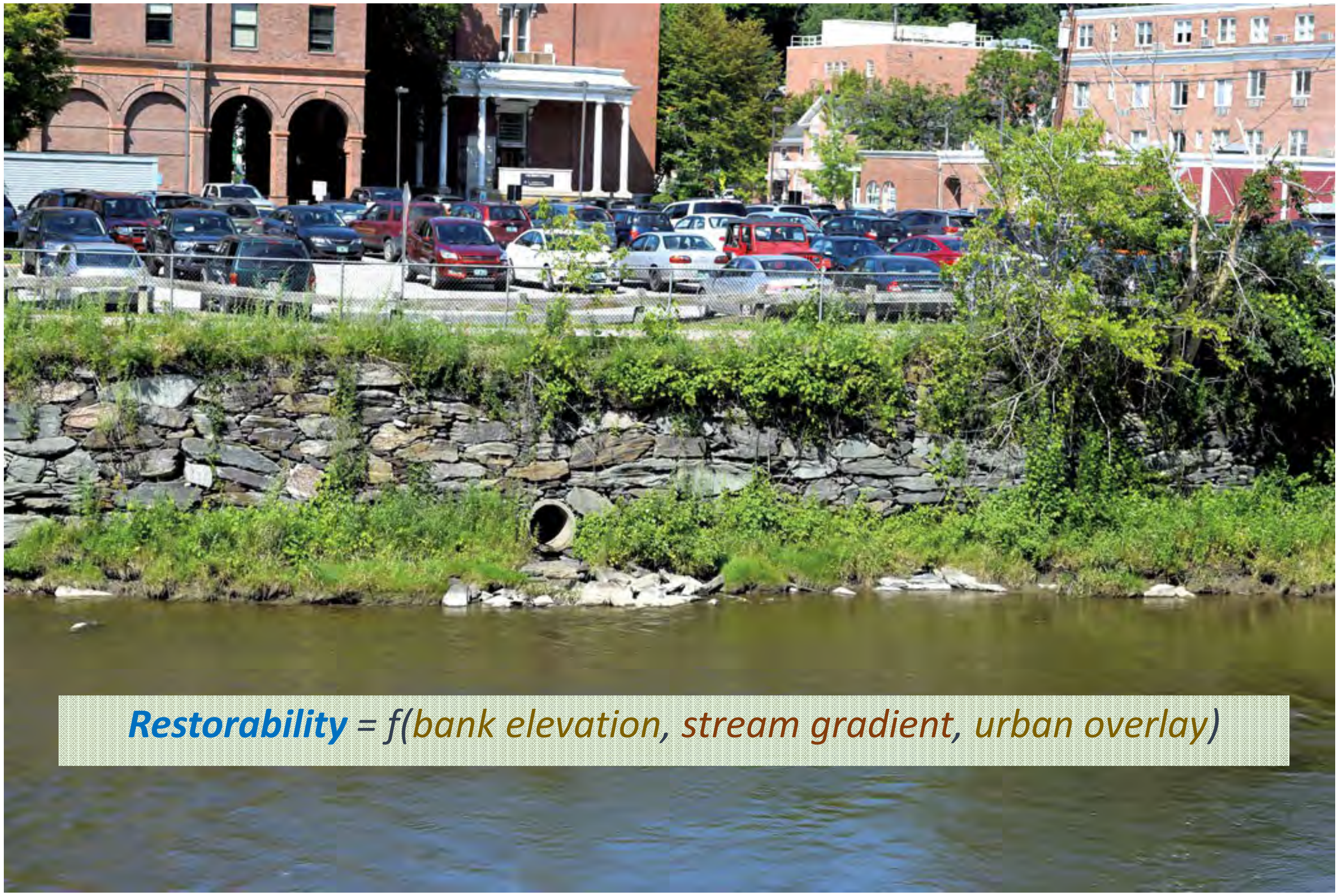
REST

Definitions
(Restorability)

Steep inhospitable banks

Pronounced stream gradient.
Usually associated with unplantable bedrock.

More obvious (urban encroachment):

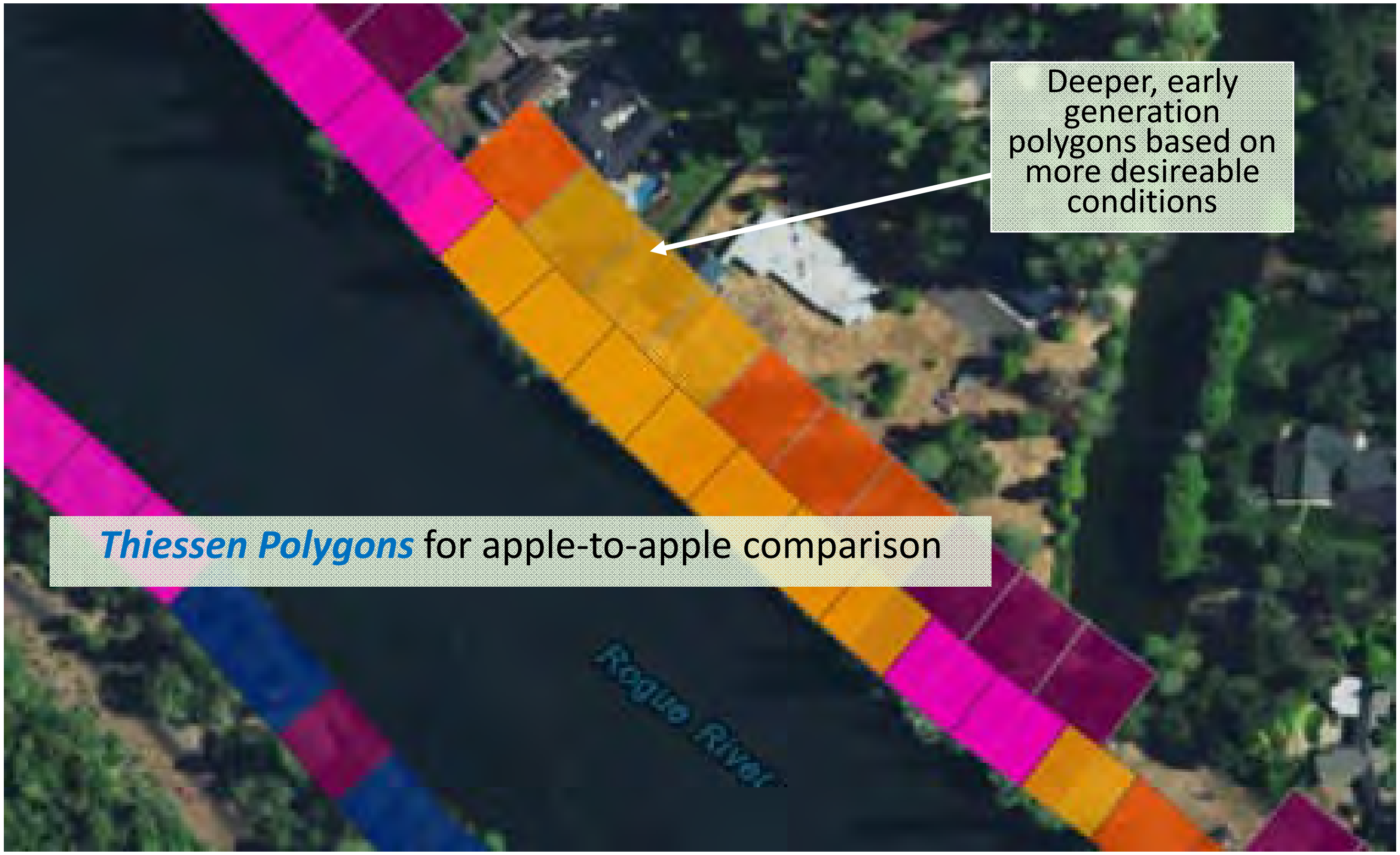


REST

Definitions

Urban layers obtained from County planning departments.

Riparian Assessment Unit (RAU):



REST

Basis

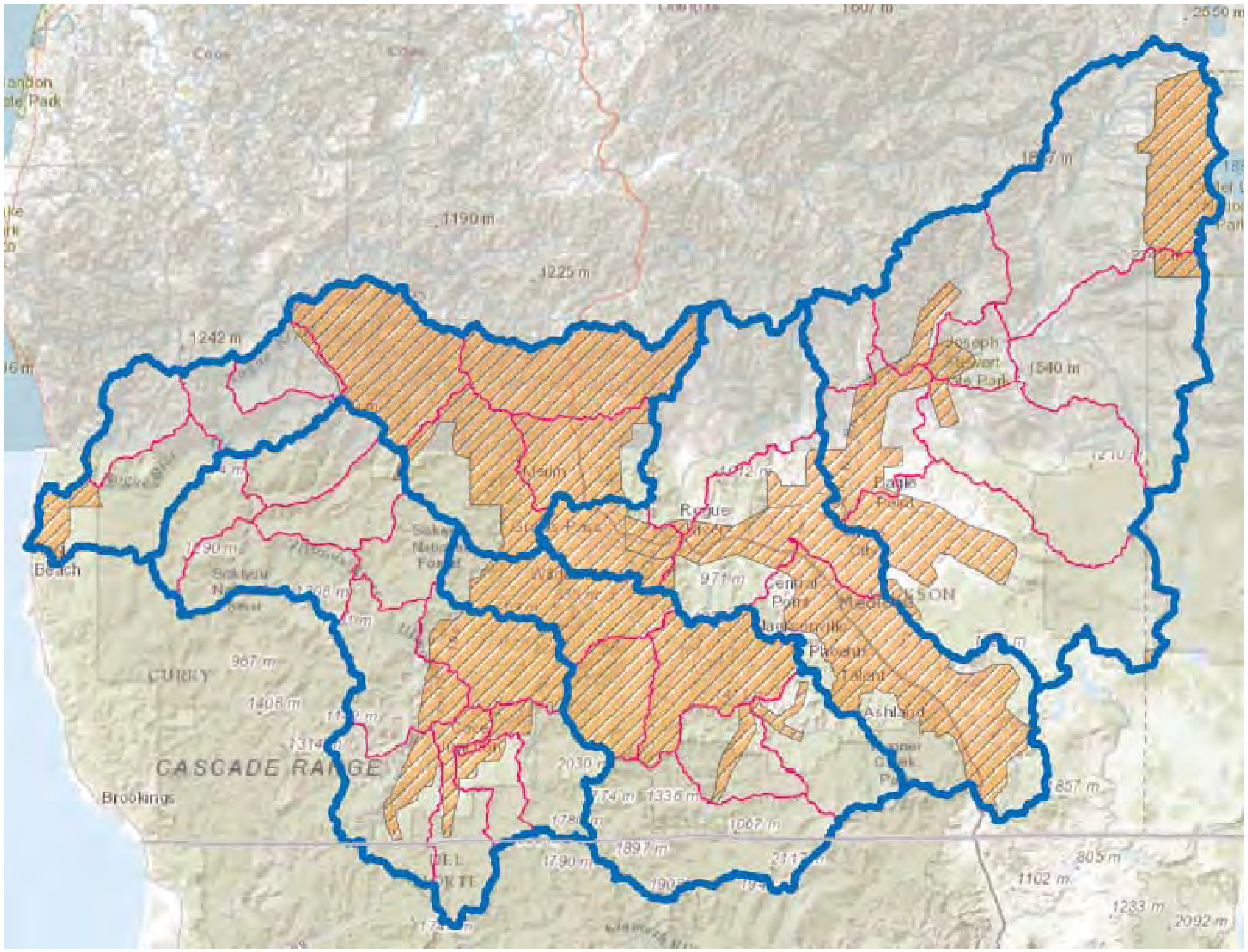
25 m centerlines

75 ft buffer on mainstem

50 ft buffer on tributaries

Focus on area of implementation.

LIDaR availability in the Rogue Basin:



REST

Coverage ~60,000 acres

Mainstem Rogue, Bear Creek, Little Butte Creek, Big Butte Creek, Applegate River, Elk Creek, Evans Creek (2017).

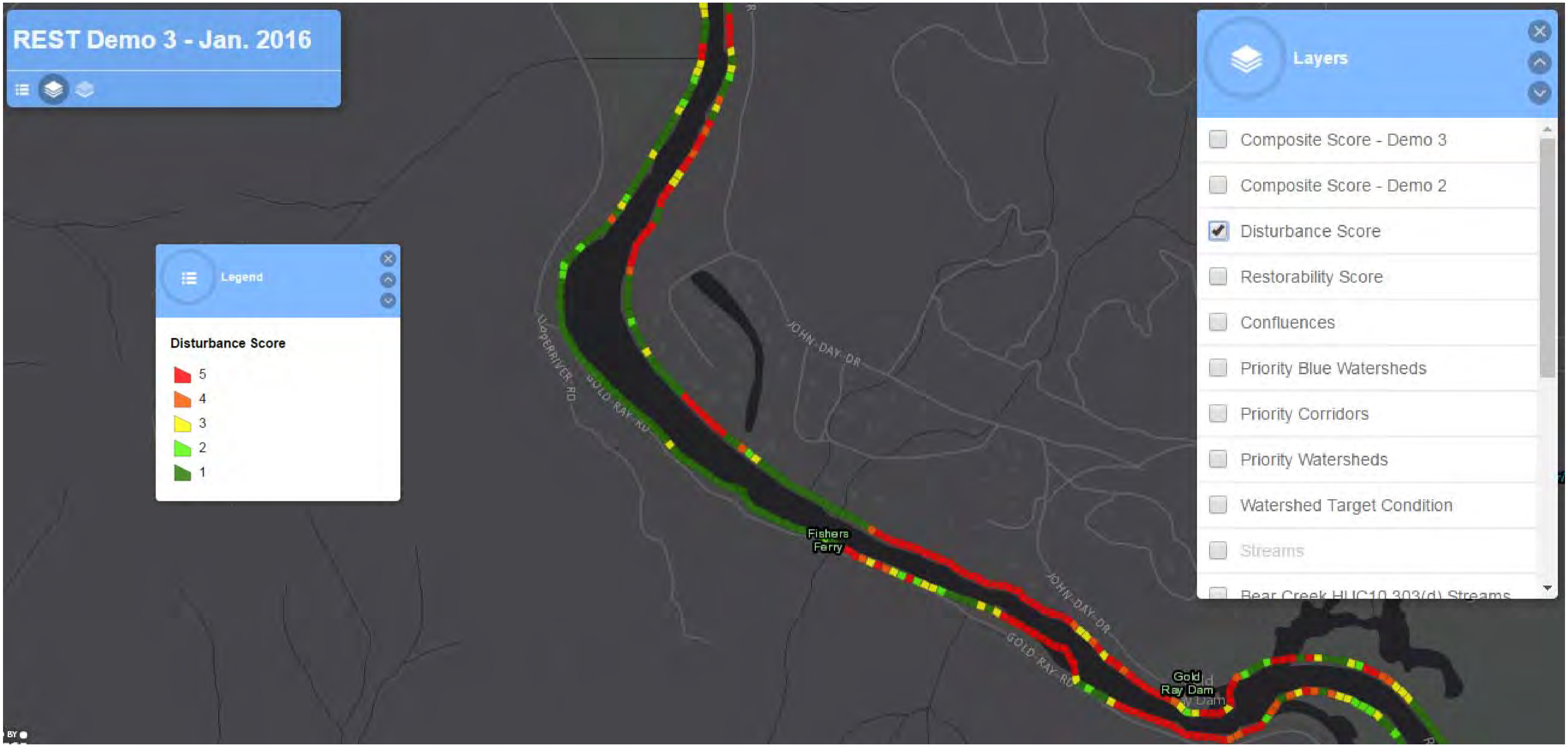
REST

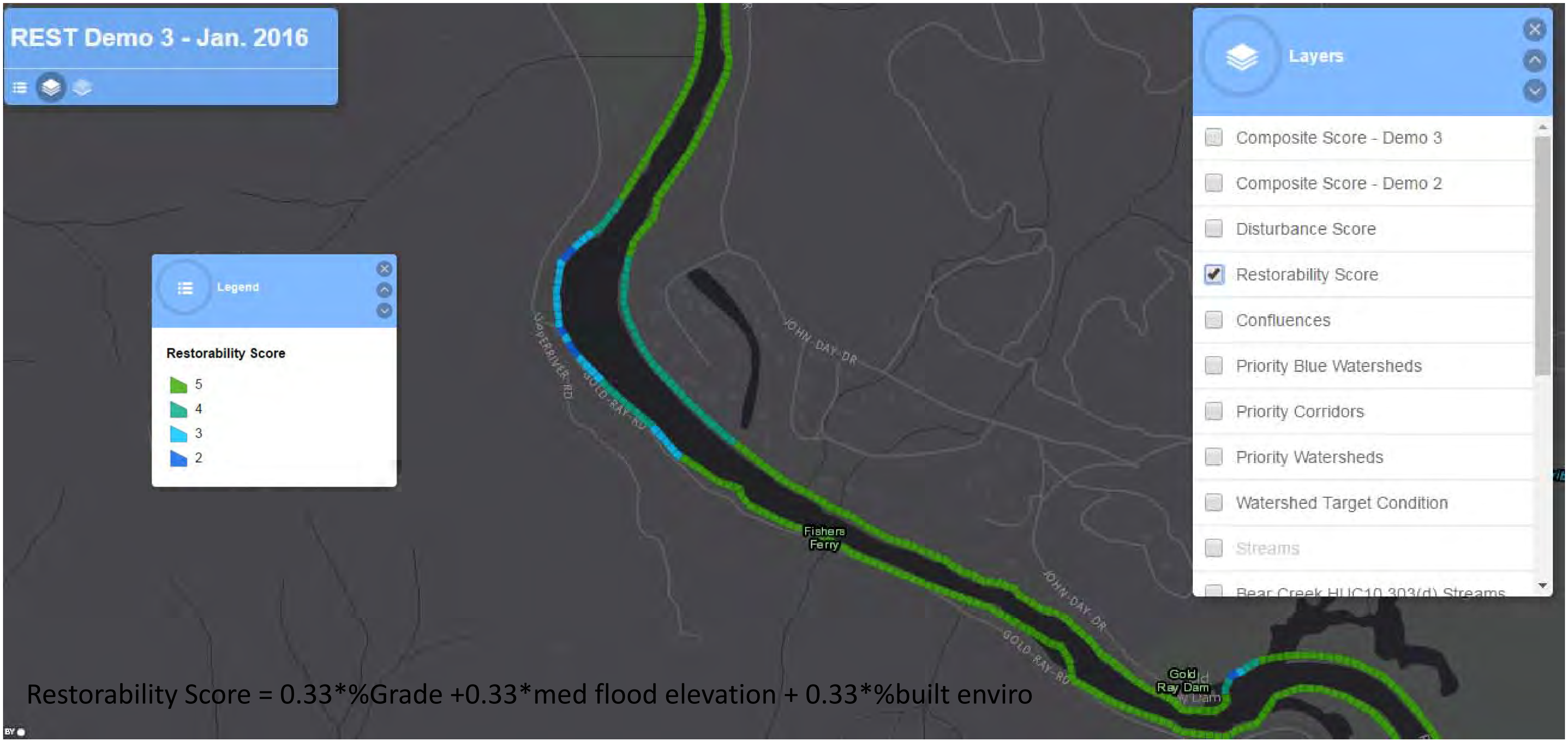
Example

Mainstem Rogue

Between Bear Creek and Gold Hill

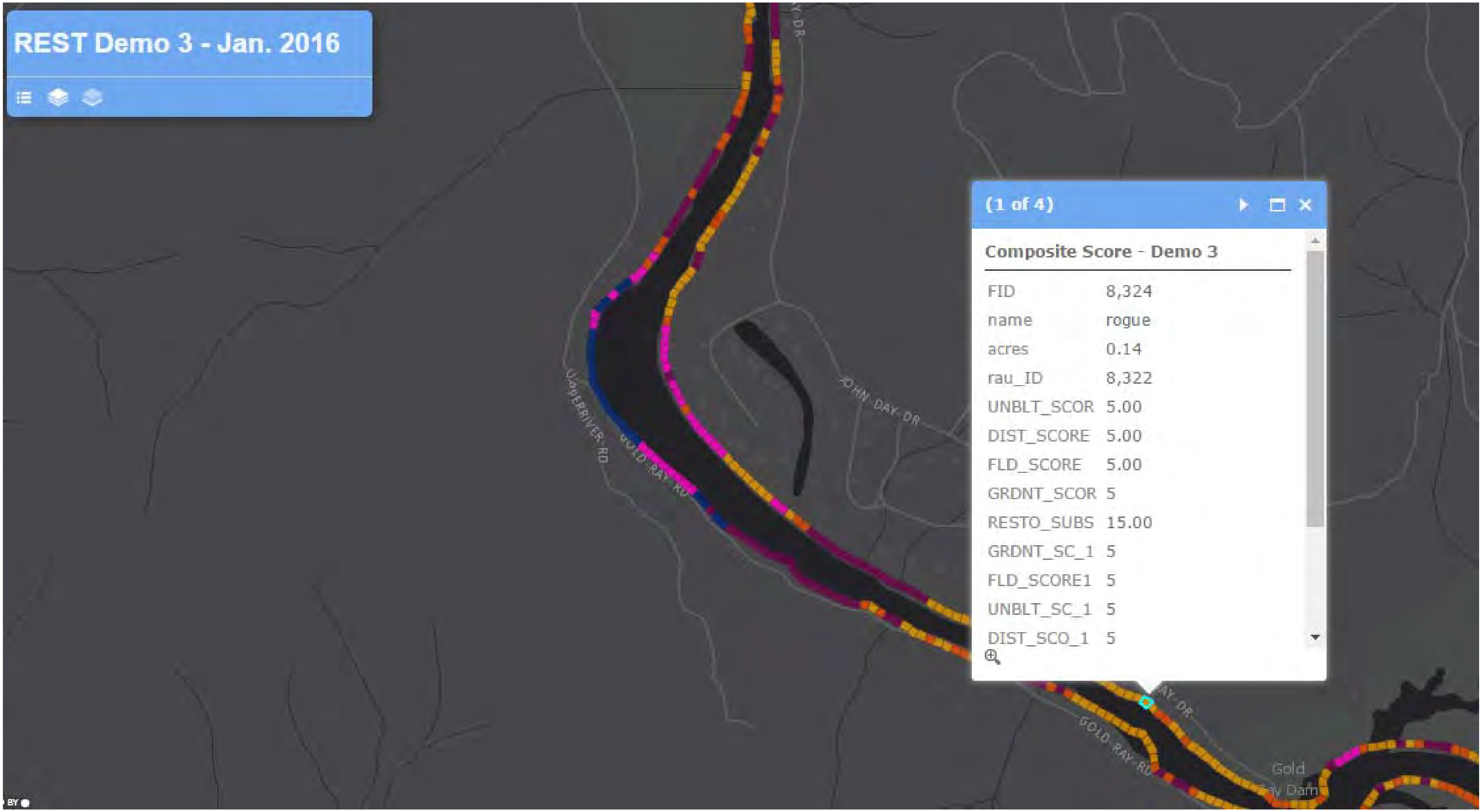
Old Gold Ray Dam site

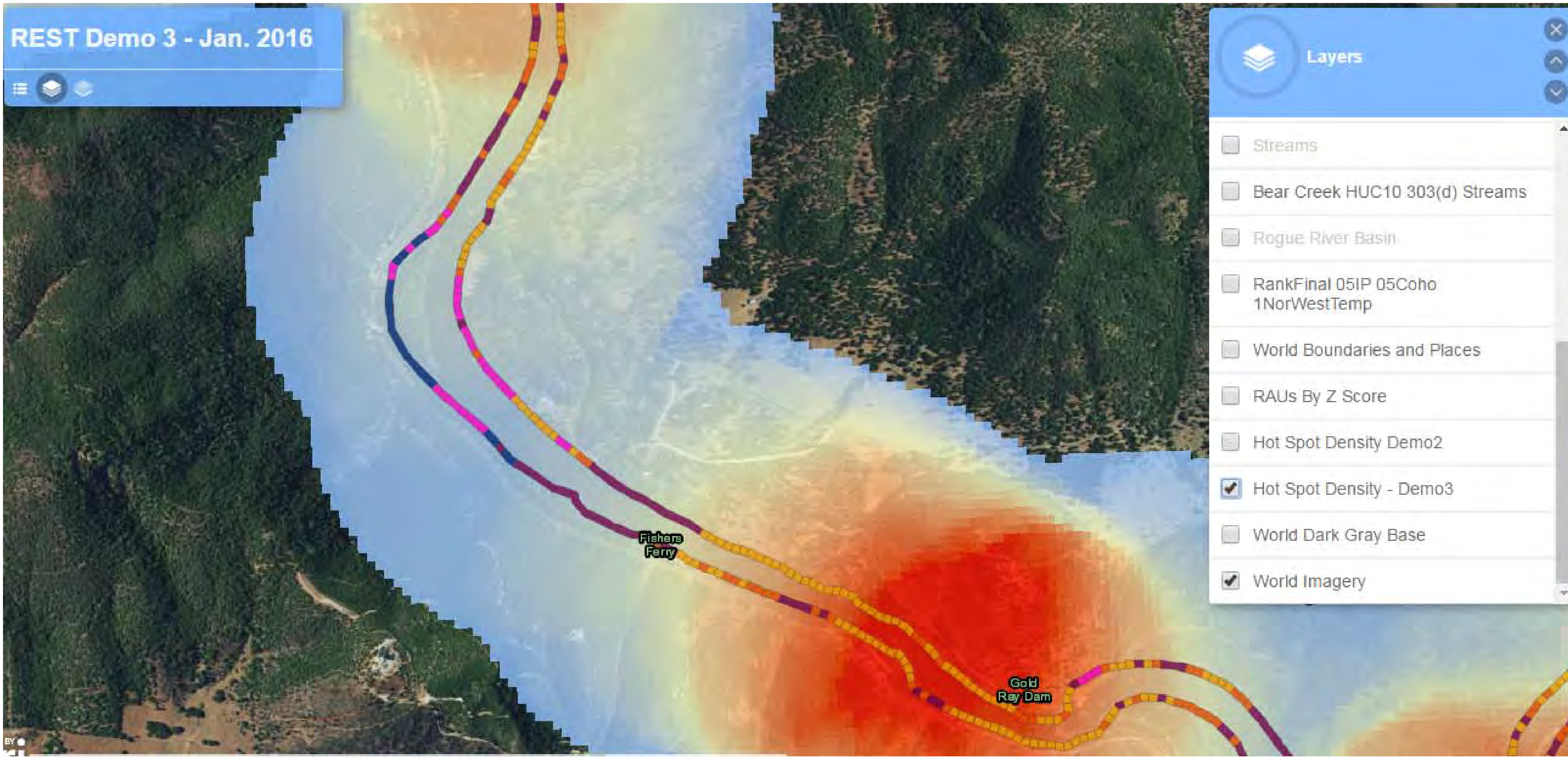

REST Demo 3 - Jan. 2016
Legend
Disturbance Score
5
4
3
2
1
Layers
Composite Score - Demo 3
Composite Score - Demo 2
Disturbance Score
Restorability Score
Confluences
Priority Blue Watersheds
Priority Corridors
Priority Watersheds
Watershed Target Condition
Streams
JOHN DAY DR
GOLD RAY RD
Fishers Ferry
Gold Ray Dam



Restorability Score = 0.33*%Grade +0.33*med flood elevation + 0.33*%built enviro

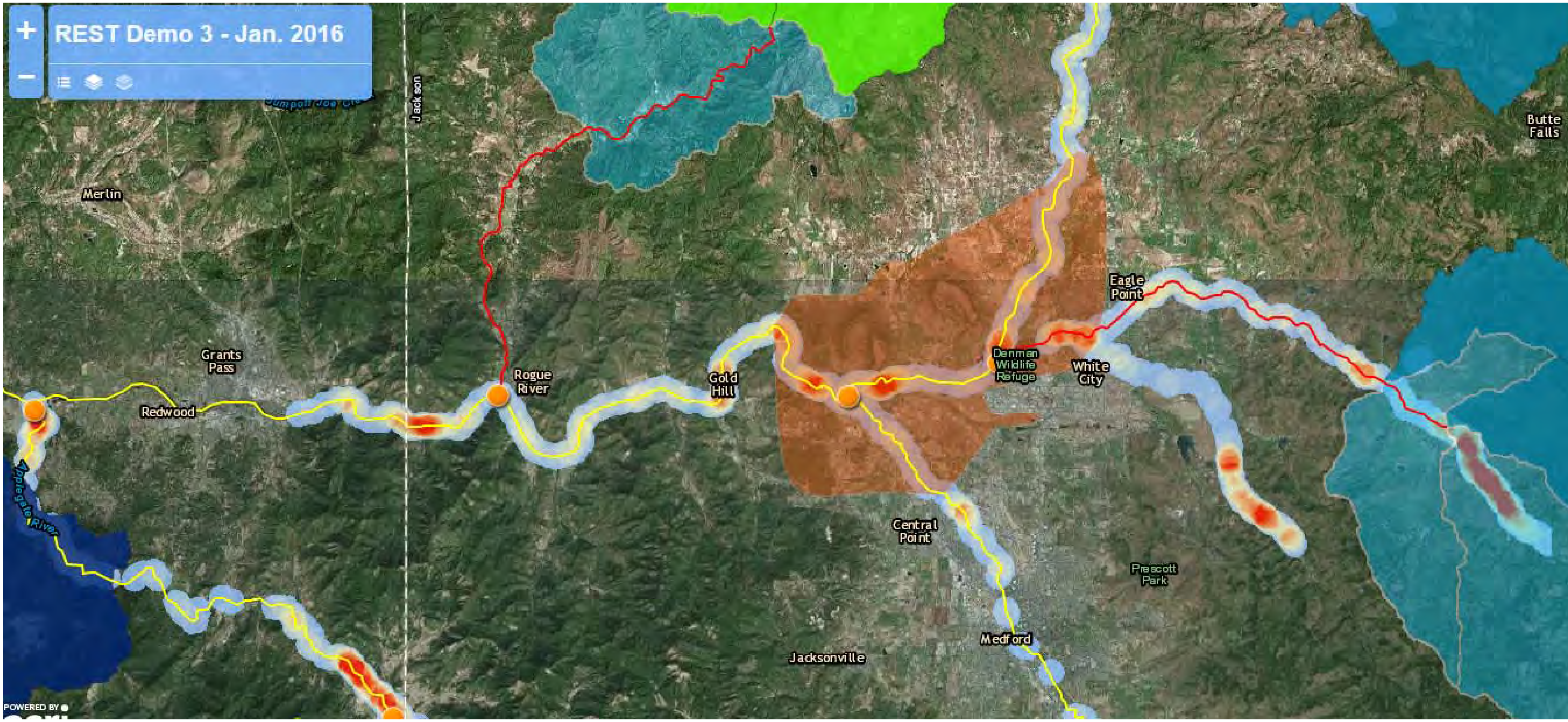
Composite = Disturbance score + Restorability Score


REST Demo 3 - Jan. 2016
(1 of 4)
Composite Score - Demo 3
FID 8,324
name rogue
acres 0.14
rau_ID 8,322
UNBLT_SCOR 5.00
DIST_SCORE 5.00
FLD_SCORE 5.00
GRDNT_SCOR 5
RESTO_SUBS 15.00
GRDNT_SC_1 5
FLD_SCORE1 5
UNBLT_SC_1 5
DIST_SCO_1 5
UPPERRIVER RD
GOLD RAY RD
JOHN DAY DR
Gold

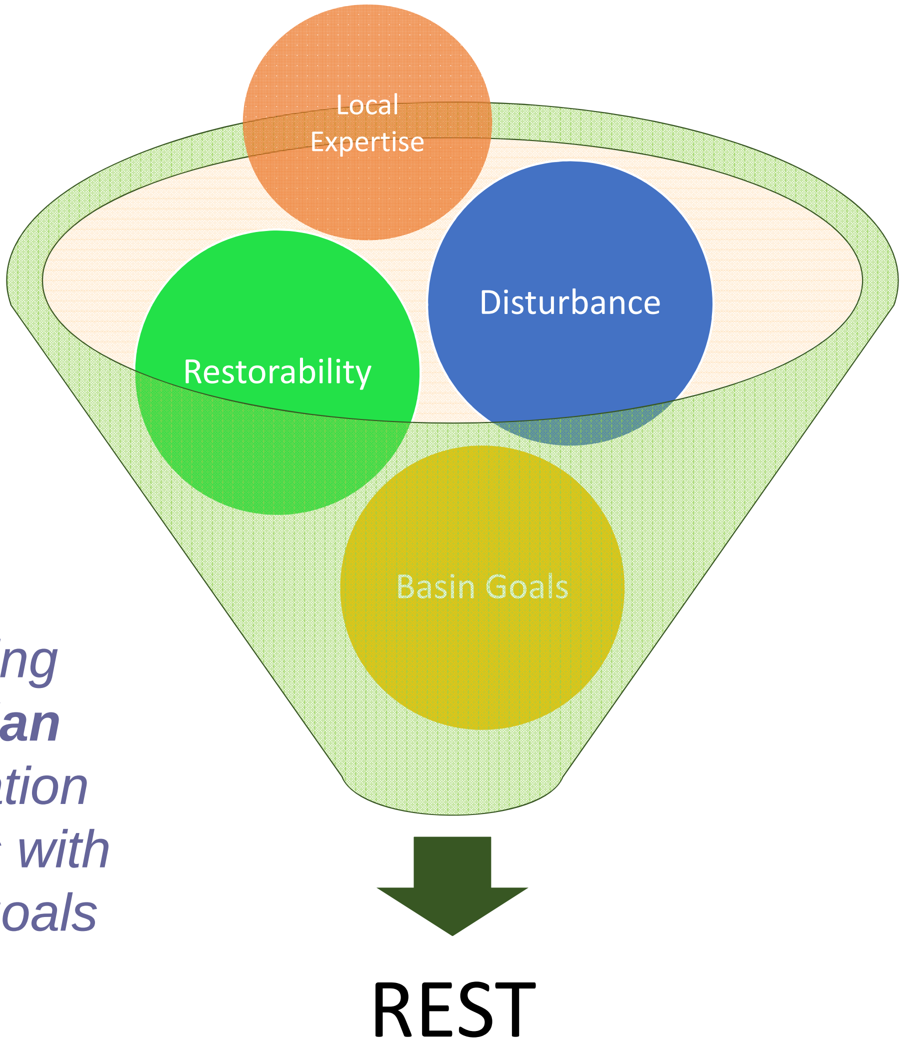

REST Demo 3 - Jan. 2016
Layers
Streams
Bear Creek HUC10 303(d) Streams
Rogue River Basin
RankFinal 05IP 05Coho
1NorWestTemp
World Boundaries and Places
RAUs By Z Score
Hot Spot Density Demo2
Hot Spot Density - Demo3
World Dark Gray Base
World Imagery
Fishers
Ferry
Gold
Ray Dam

REST Demo 3 - Jan. 2016
Jackson
Butte Falls
Merlin
Grants Pass
Redwood
Rogue River
Gold Hill
Eagle Point
Denman Wildlife Refuge
White City
Applegate River
Central Point
Prescott Park
Medford
Jacksonville
POWERED BY


REST Demo 3 - Jan. 2016
Jackson
Merlin
Grants Pass
Redwood
Rogue River
Gold Hill
Eagle Point
Denman Wildlife Refuge
White City
Butte Falls
Central Point
Prescott Park
Medford
Jacksonville
Applegate River
POWERED BY


REST Demo 3 - Jan. 2016
Jackson
Merlin
Grants Pass
Redwood
Rogue River
Gold Hill
Denman Wildlife Refuge
Eagle Point
White City
Butte Falls
Central Point
Prescott Park
Medford
Jacksonville
Applegate River
POWERED BY

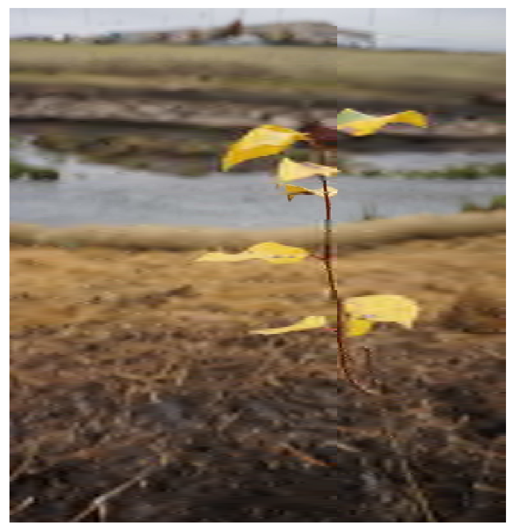
REST for Riparian Site Prioritization:



Aligning ***riparian*** *restoration projects with basin goals*

REST

Overview



REST

Questions

Thinking Like Planet Water Rehydrative Resilience in a Time of Global Weirding

Brock Dolman

Occidental Arts and Ecology Center WATER Institute Director

WATER INSTITUTE

OCCIDENTAL ARTS & ECOLOGY CENTER

3 year old rice paddy tadpole hunter
Okinawa, Japan June 1968

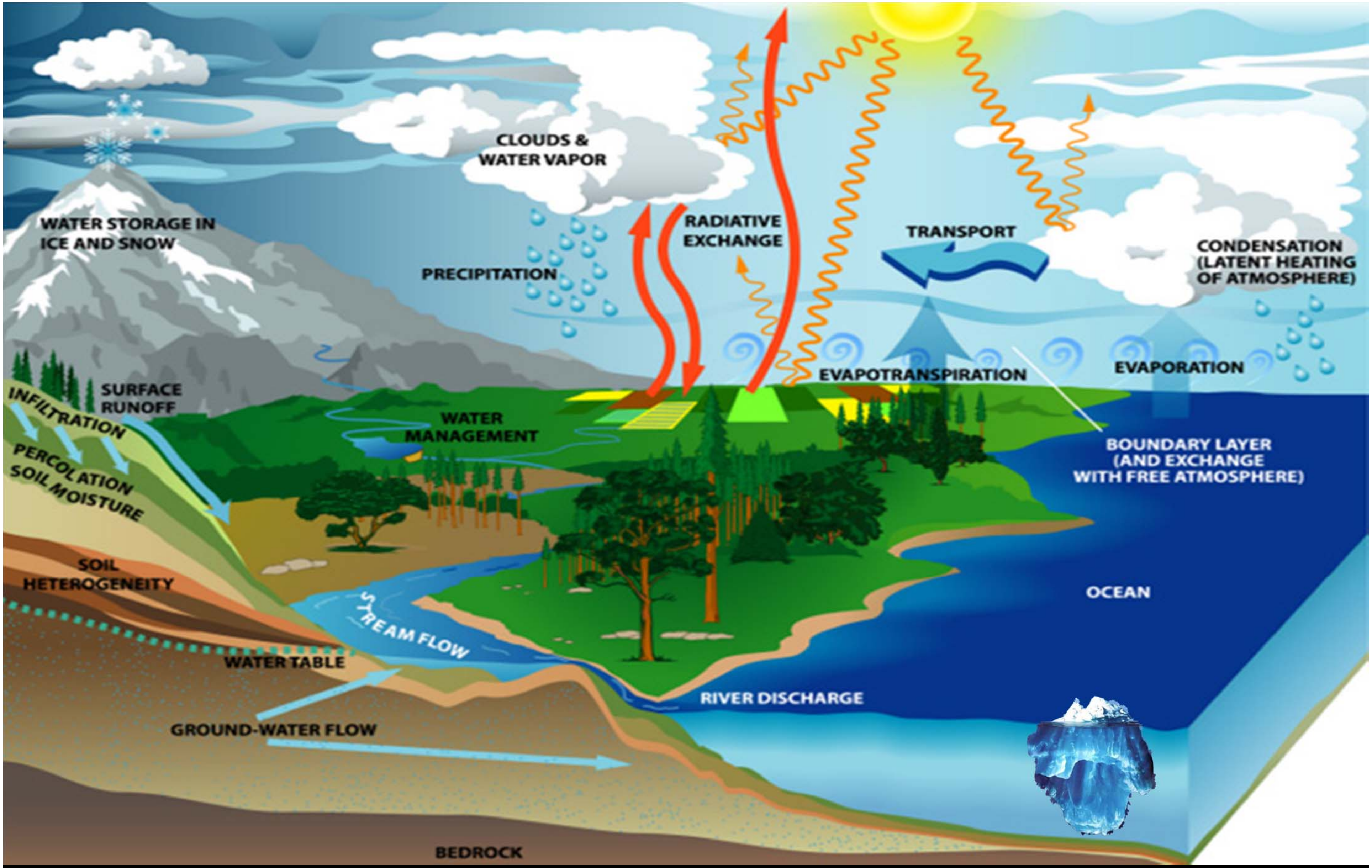
Pro-Life!

Anti-Bio … b-Biotic?

"It is not the strongest
of the species that survives,
nor the most intelligent,
but the one
most responsive to change"
Charles Darwin (1809-1882)


Welcome to Planet Water!
Only Place in the Known Universe Where…
LIFE IS ENDEMIC!

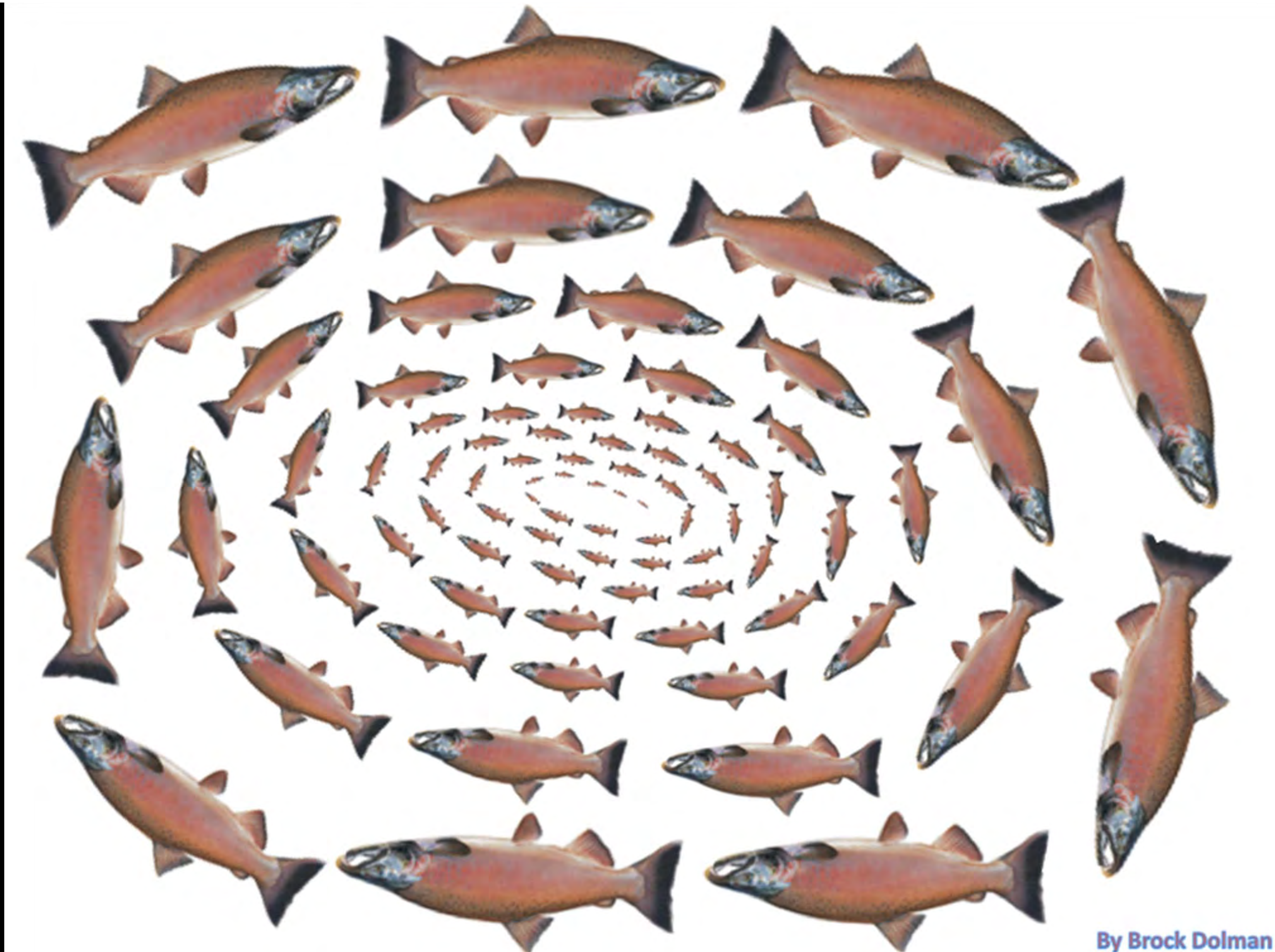

$6CO_2 + 6H_2O$
light energy
chlorophyll
$C_6H_{12}O_6 + 6O_2$



Noun is Finite Verb is Infinite!

Water Cycle and Life Cycle are one!

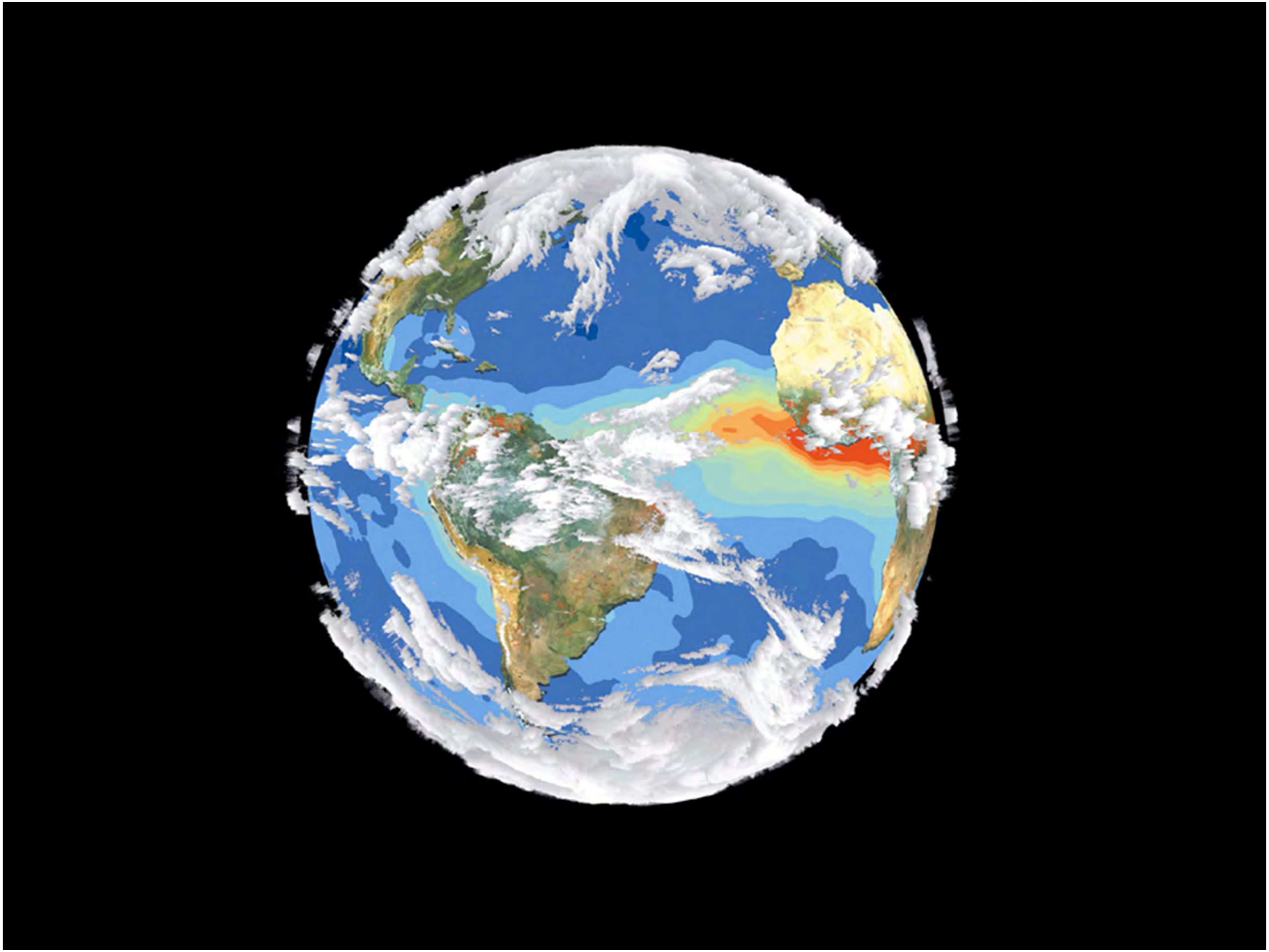

Fishing on
Eel River, 301 Salmon
Humboldt Co. Cal

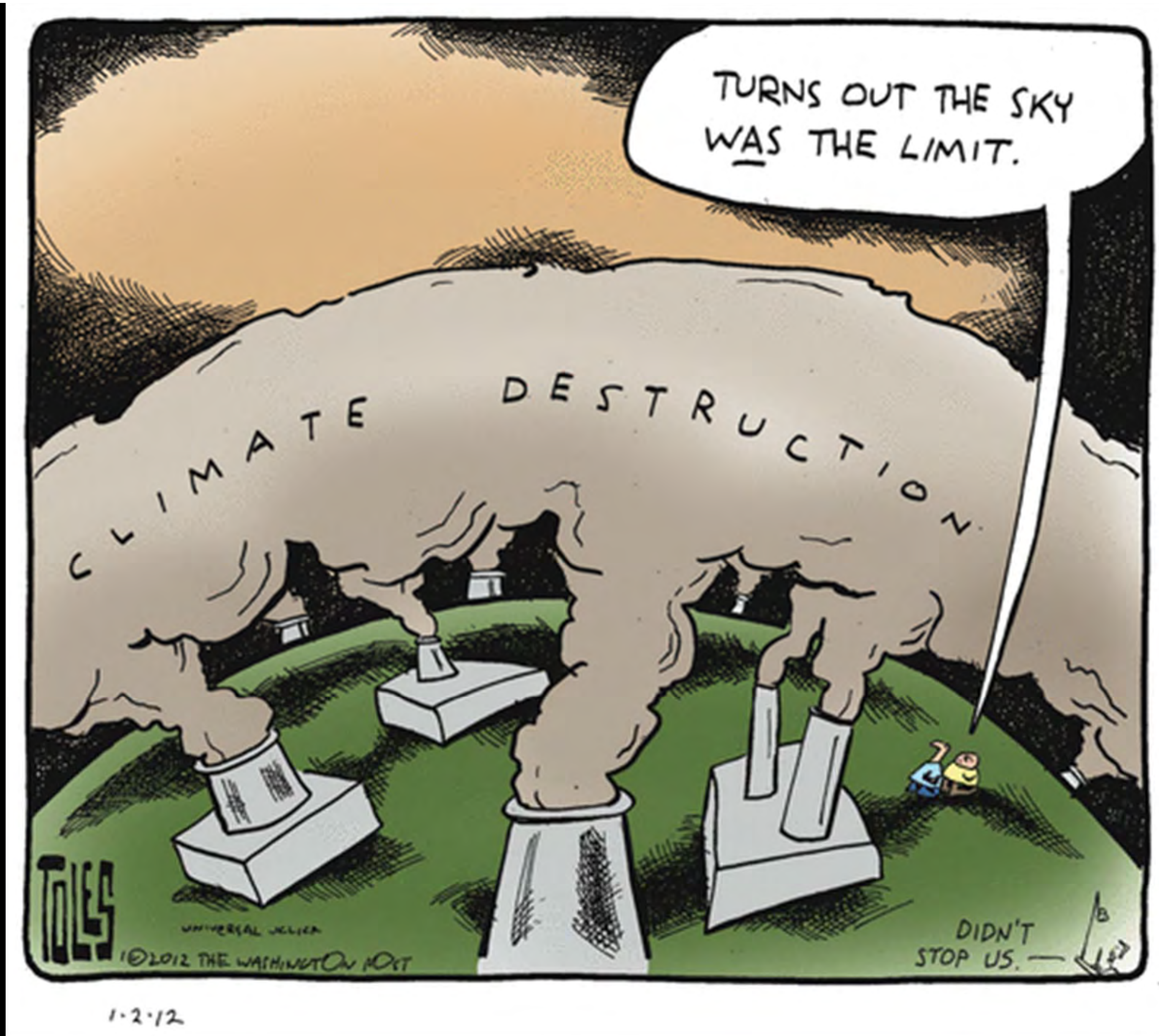


"We are in an extinction vortex. The species is collapsing." Charlotte Ambrose NMFS 2010

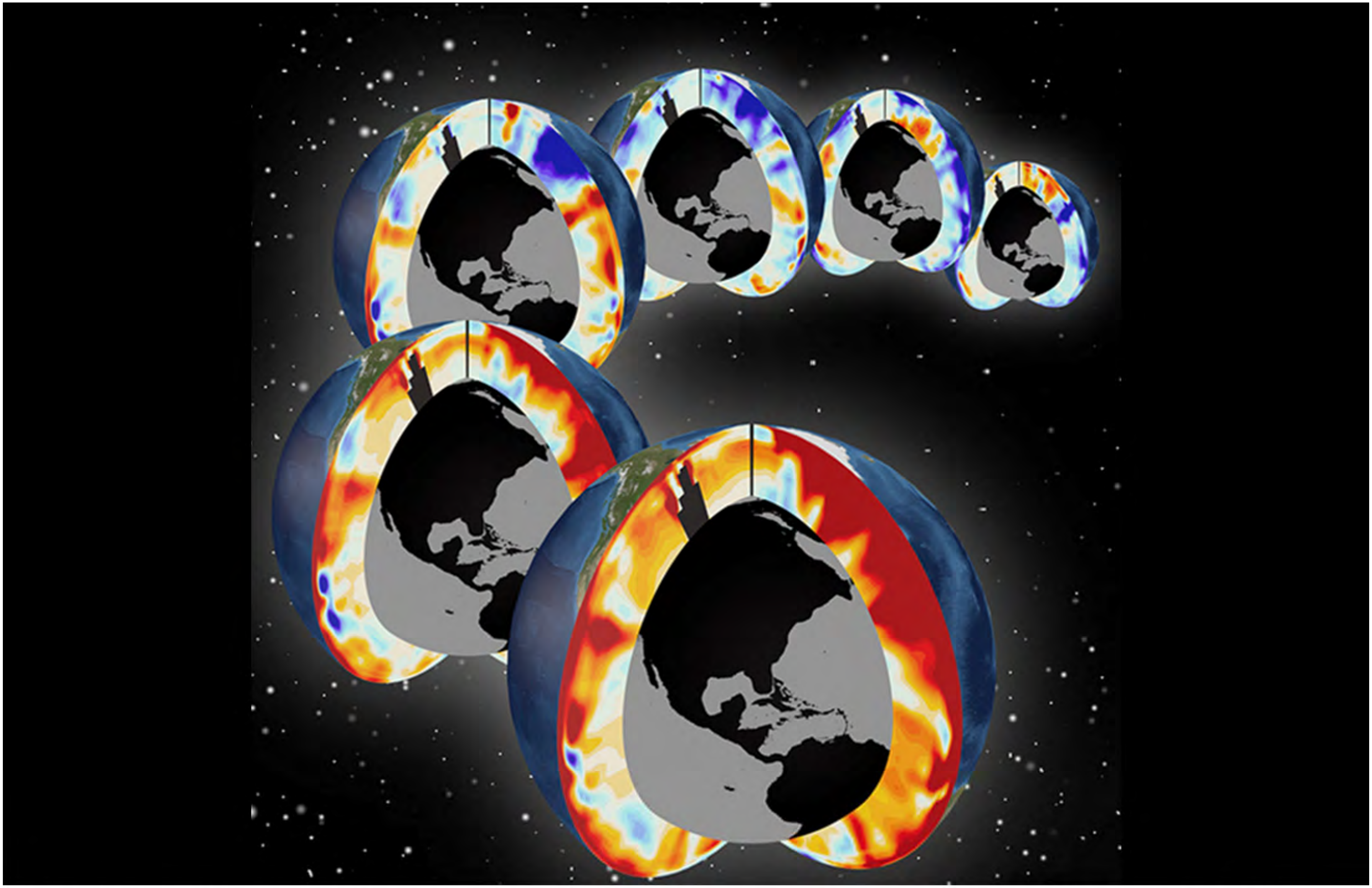
“The health of our waters is the principal measure of how we live on the land"

Luna Leopold



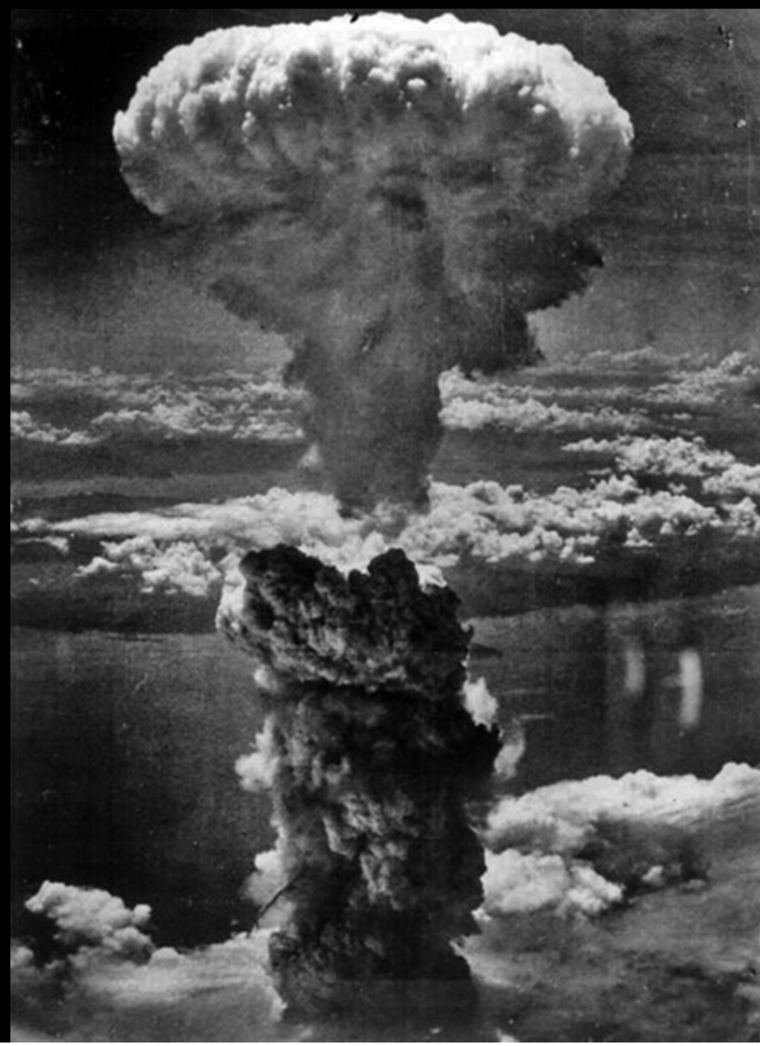


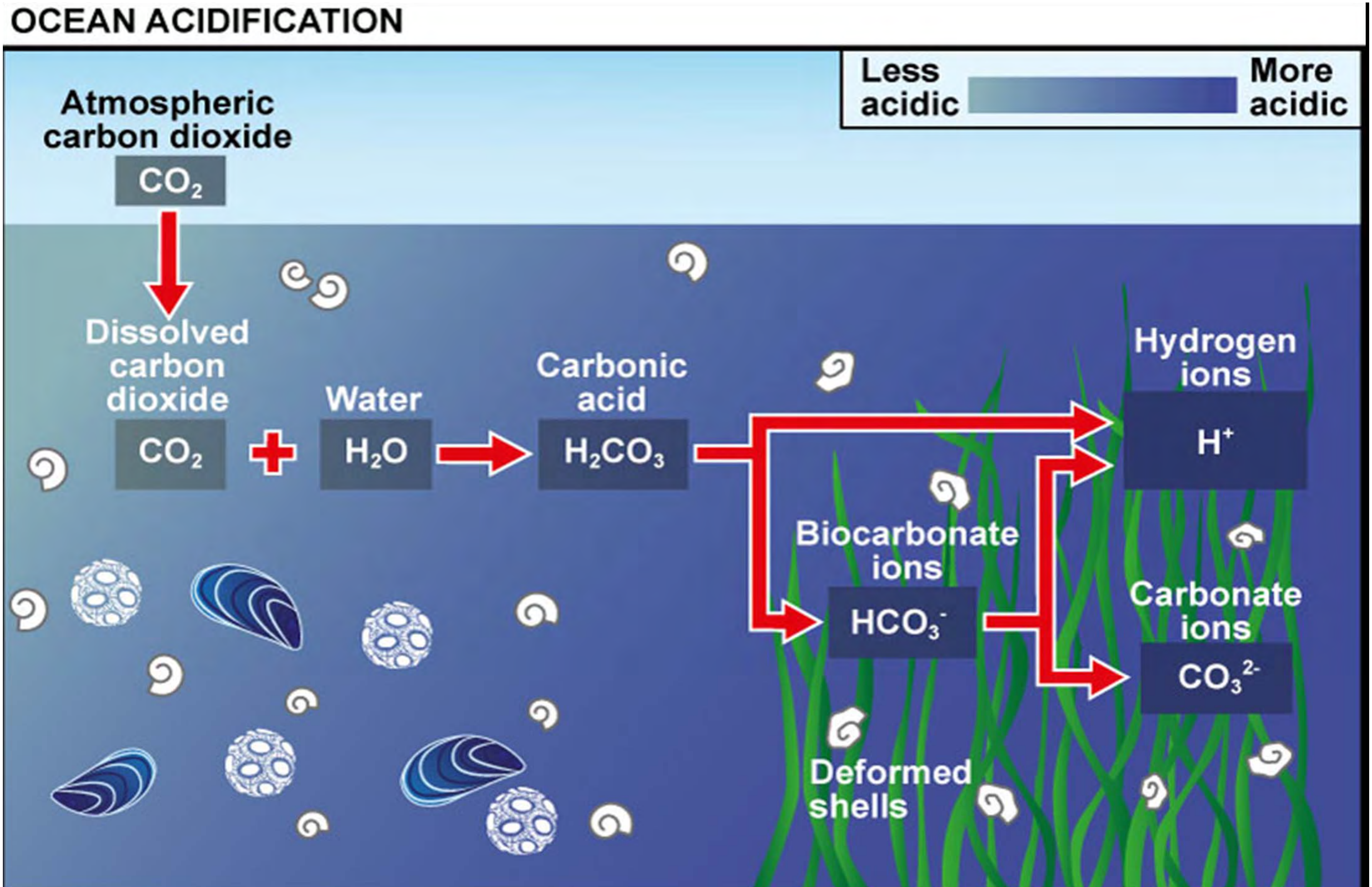
Where is Away?



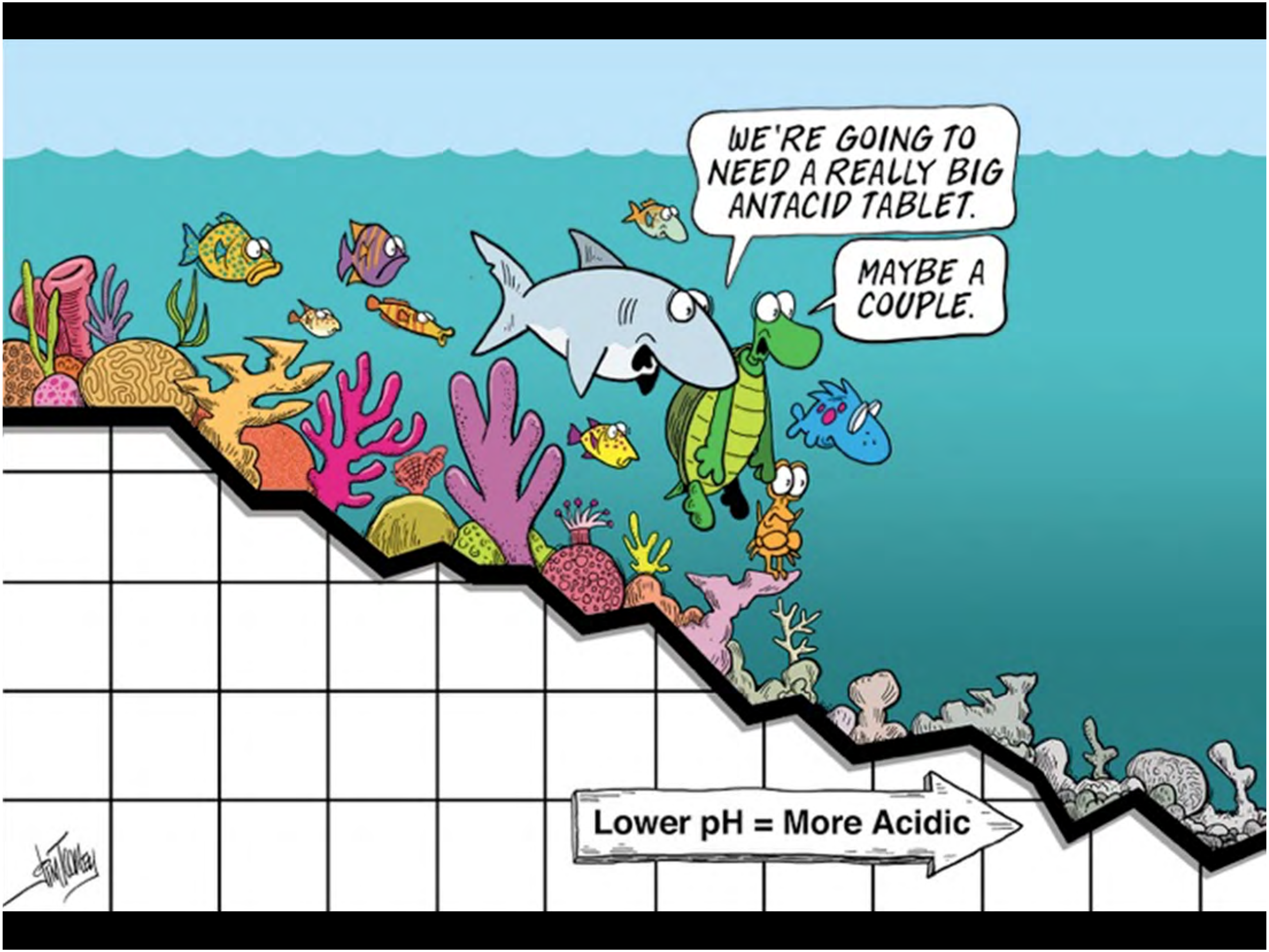
This image provided by Lawrence Livermore National Laboratory shows Pacific and Atlantic meridional sections showing upper-ocean warming for the past six decades (1955-2011). Red colors indicate a warming (positive) anomaly and blue colors indicate a cooling (negative) anomaly.

Man-made heat put into the world's oceans has doubled since 1997!
The amount of energy absorbed is equivalent to an atomic
Hiroshima bomb being exploded every second for 75 years!
Lawrence Livermore National Laboratory - January 2016



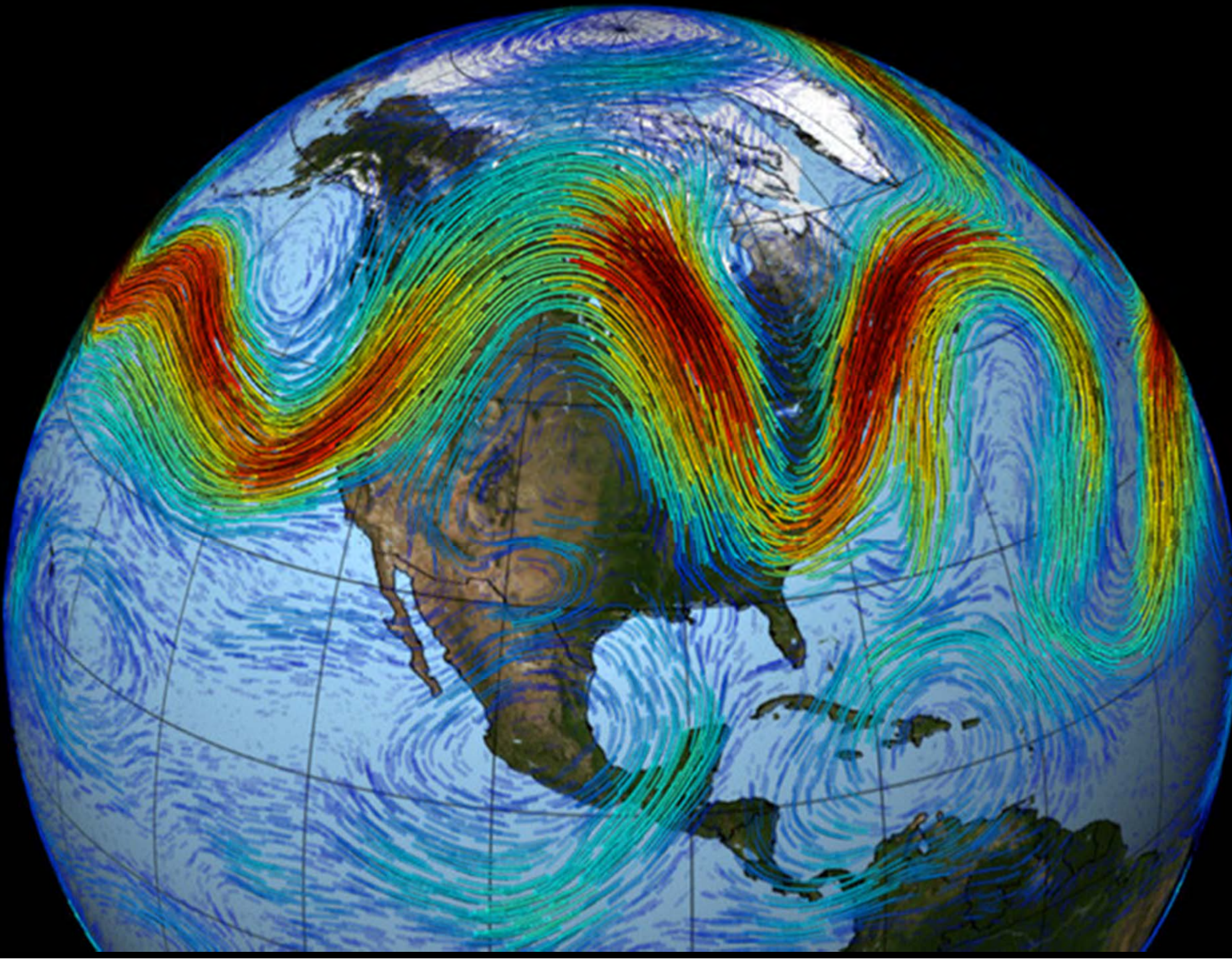


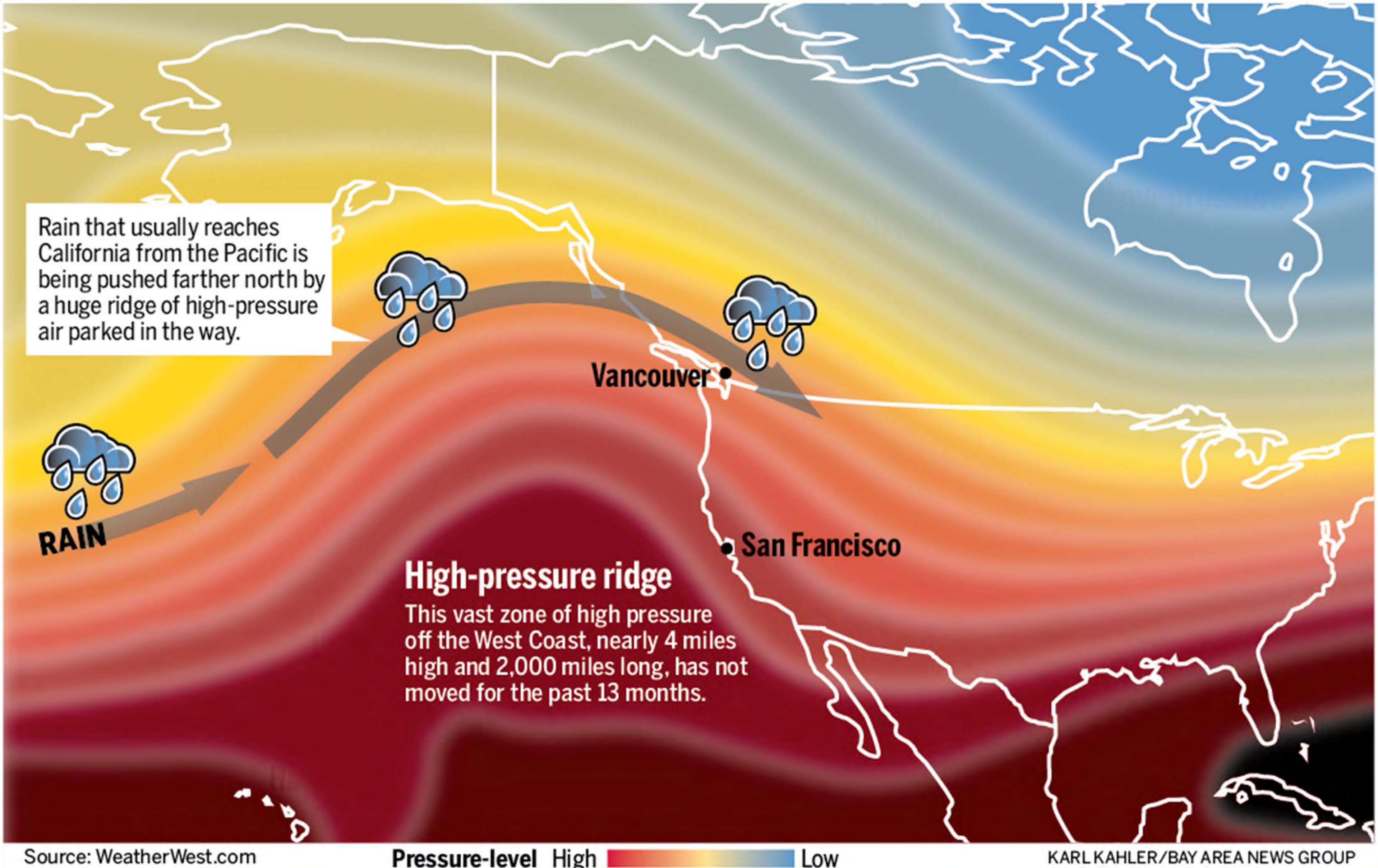
http://www.oceanacidification.org.uk/


WE'RE GOING TO NEED A REALLY BIG ANTACID TABLET.
MAYBE A COUPLE.
Lower pH = More Acidic

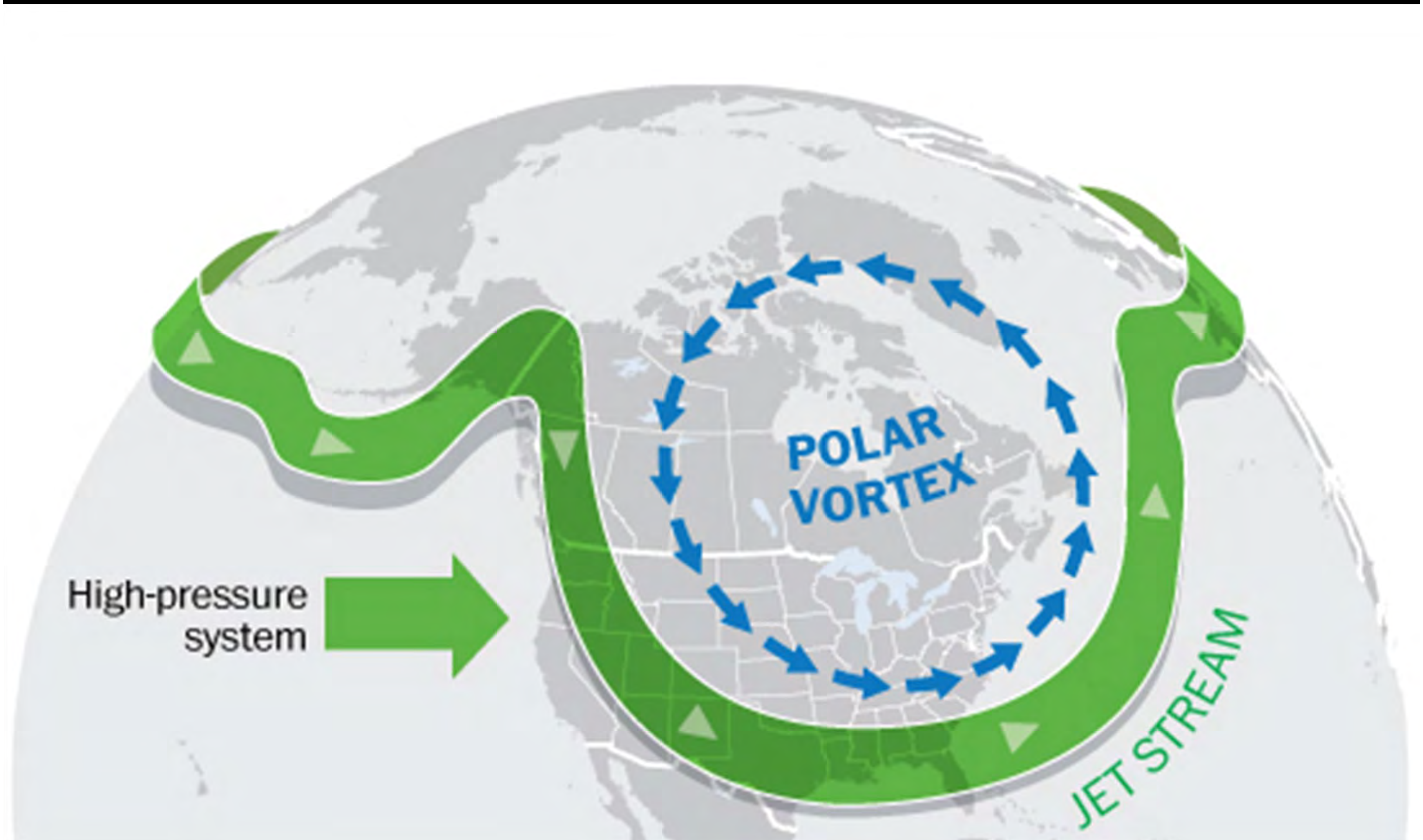
Evidence linking Arctic amplification to extreme weather in mid-latitudes

Jennifer A. Francis and Stephen J. Vavrus 2012



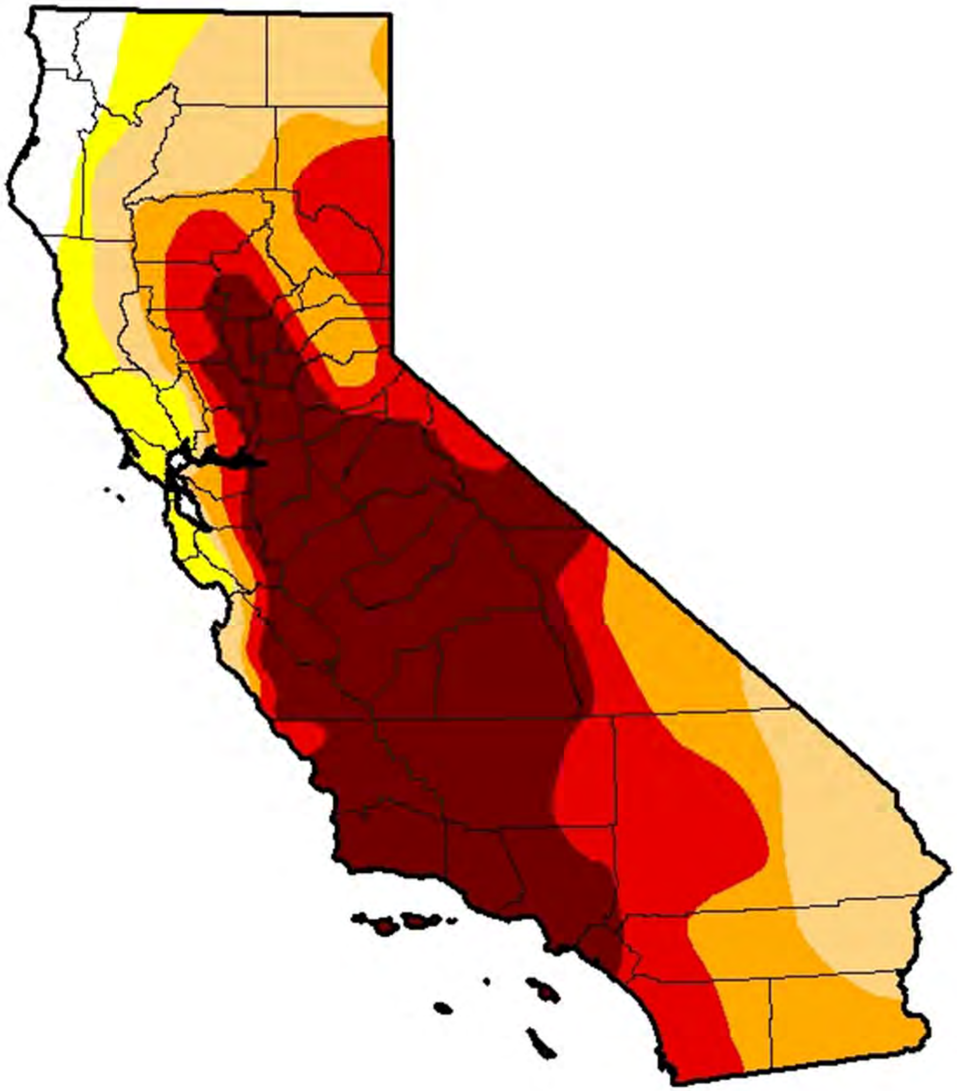


"Ridiculously Resilient Ridge"!


POLAR
VORTEX
High-pressure
system
JET STREAM

U.S. Drought Monitor

California



March 29, 2016

(Released Thursday, Mar. 31, 2016)

Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	3.55	96.45	90.58	72.82	55.25	34.74
Last Week 3/22/2016	1.16	98.84	91.55	72.86	55.31	34.74
3 Months Ago 12/29/2015	0.00	100.00	97.33	87.55	69.07	44.84
Start of Calendar Year 12/29/2015	0.00	100.00	97.33	87.55	69.07	44.84
Start of Water Year 9/29/2015	0.14	99.86	97.33	92.36	71.08	46.00
One Year Ago 3/31/2015	0.15	99.85	98.11	93.44	66.60	41.41

Intensity:

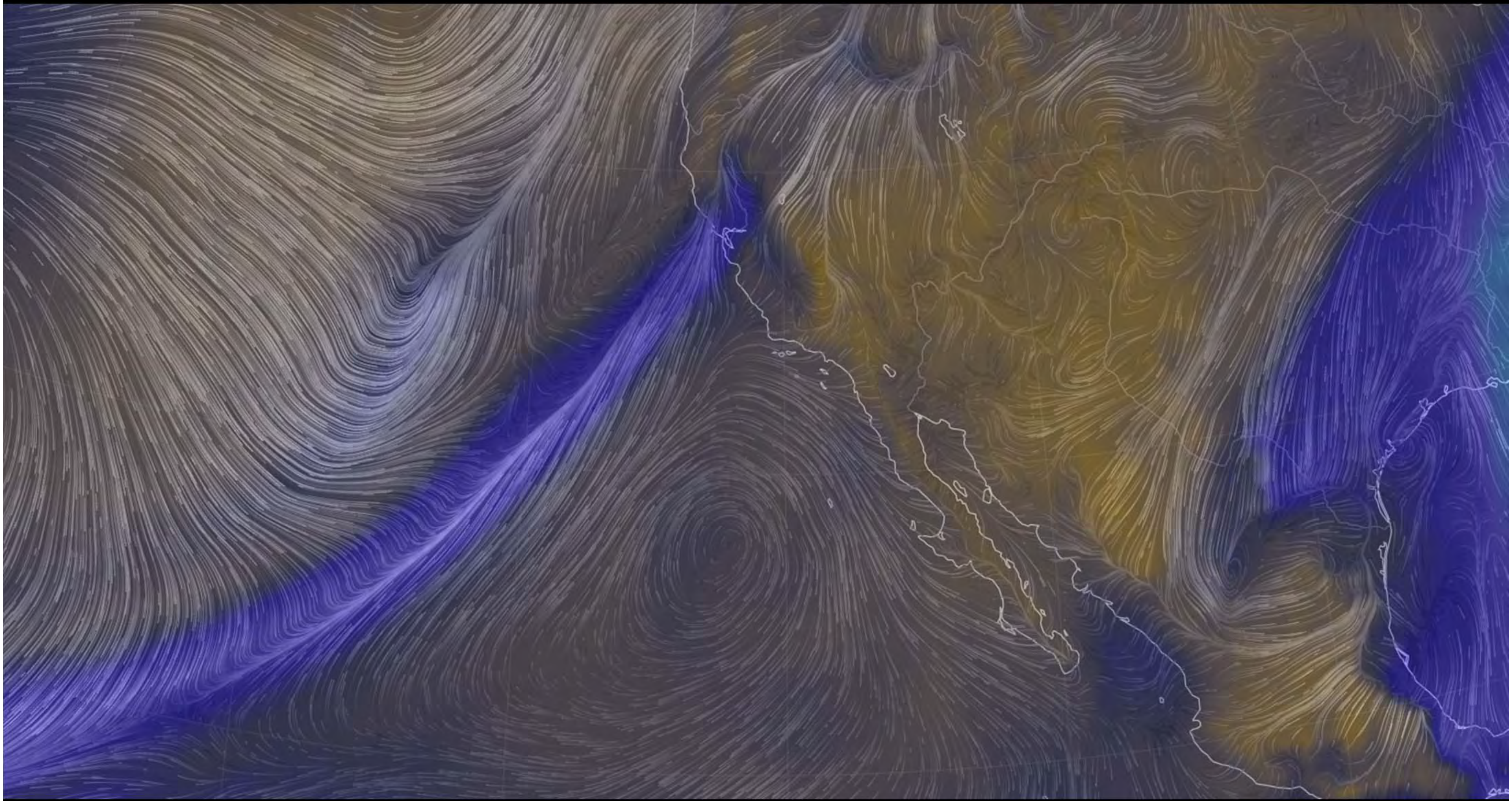
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

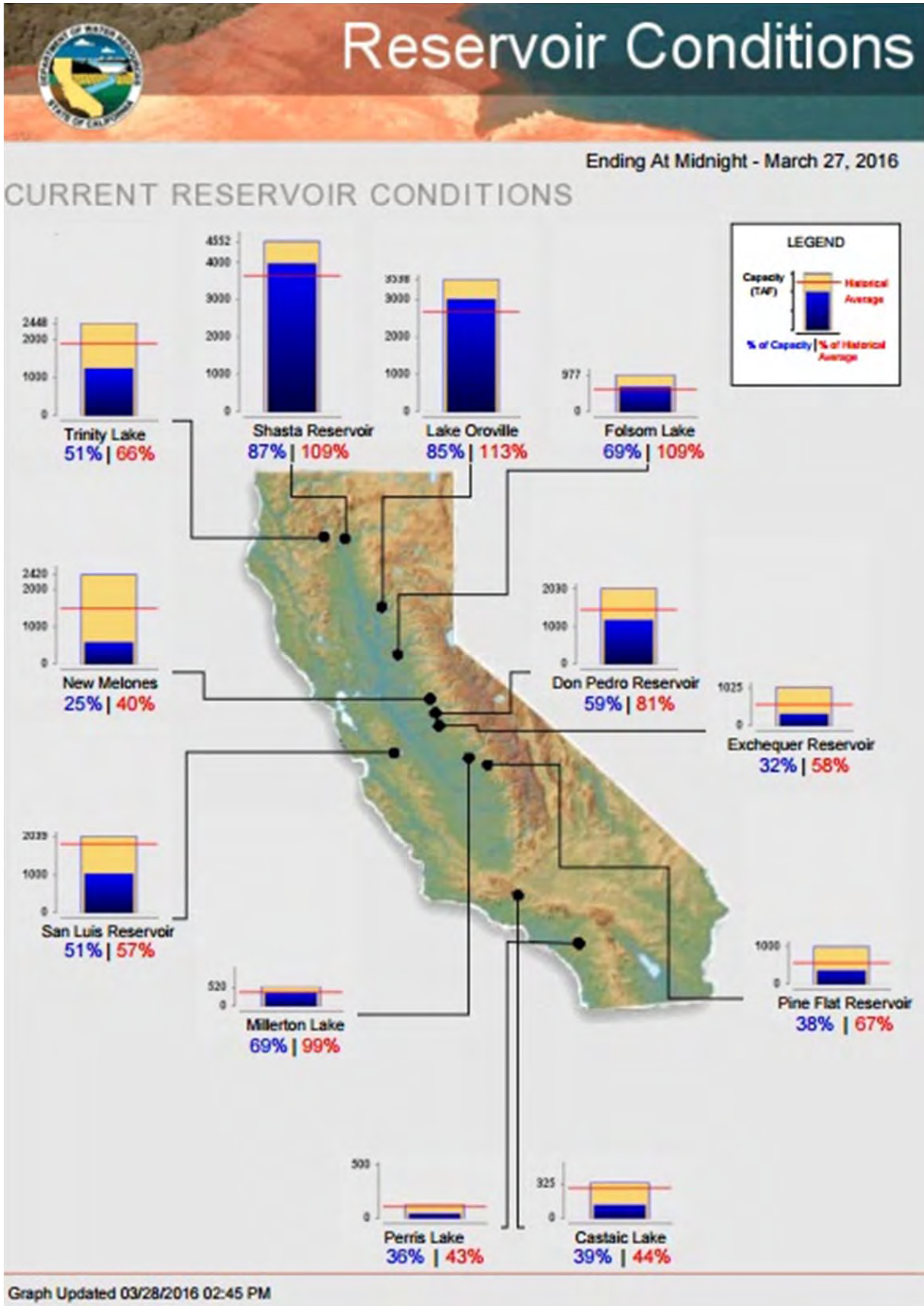
Author:
Brad Rippey
U.S. Department of Agriculture

http://droughtmonitor.unl.edu/

Atmospheric River



March 10, 2016



We need collective clarity on the difference between Pipesheds and Watersheds!

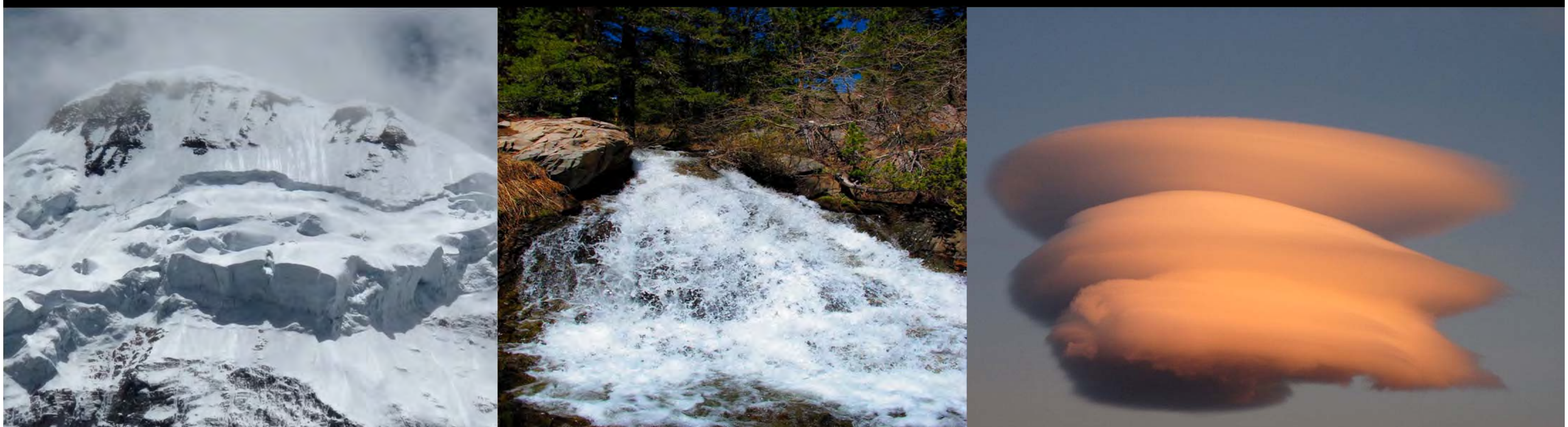
GLOBAL WEIRDING?

Planet Water is primarily responding to Global Warming by changing the Phase States of Water!

Heat Energy Absorbed (Cooling)

Melting → **Evaporation**

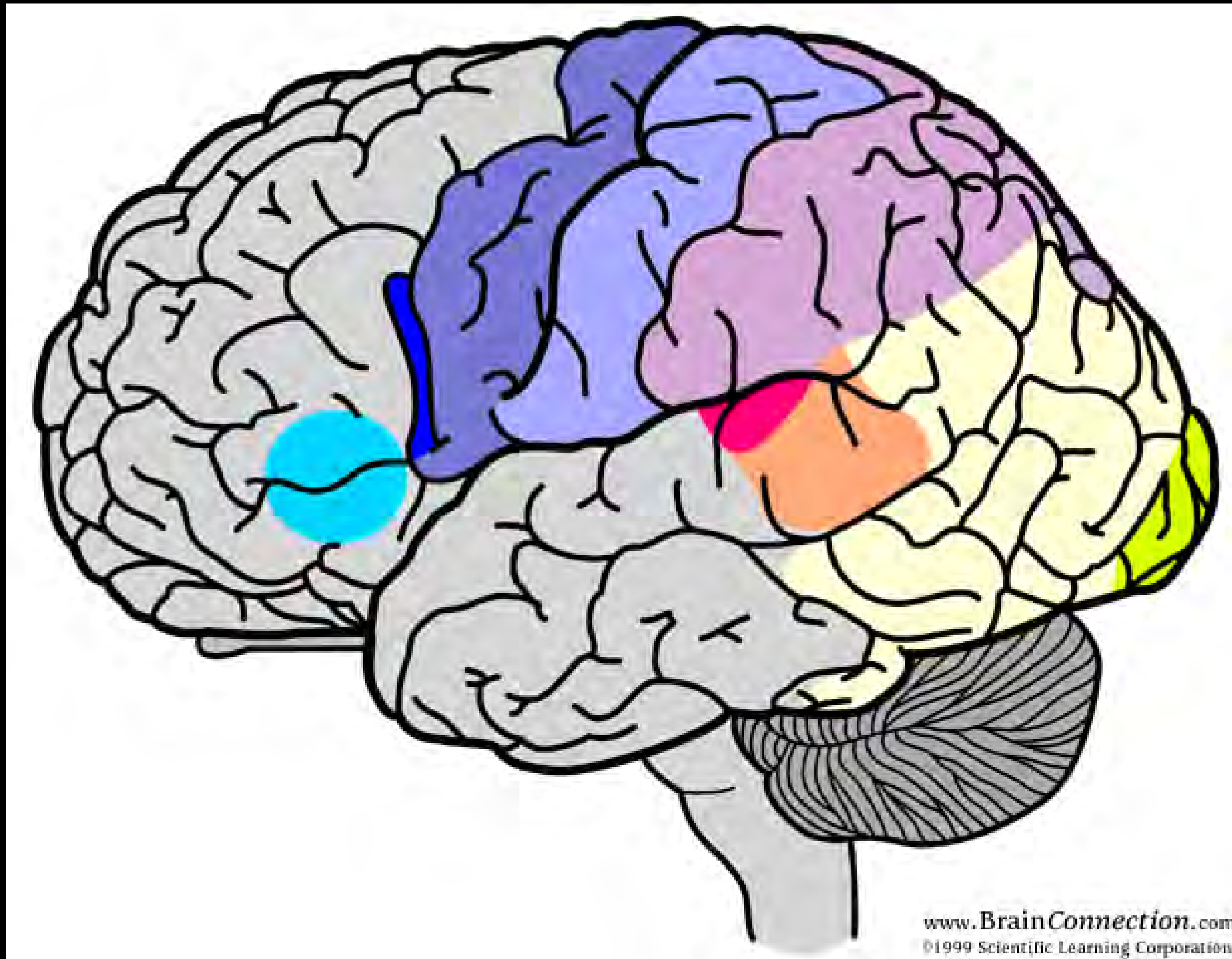
80 Calories — 600 Calories



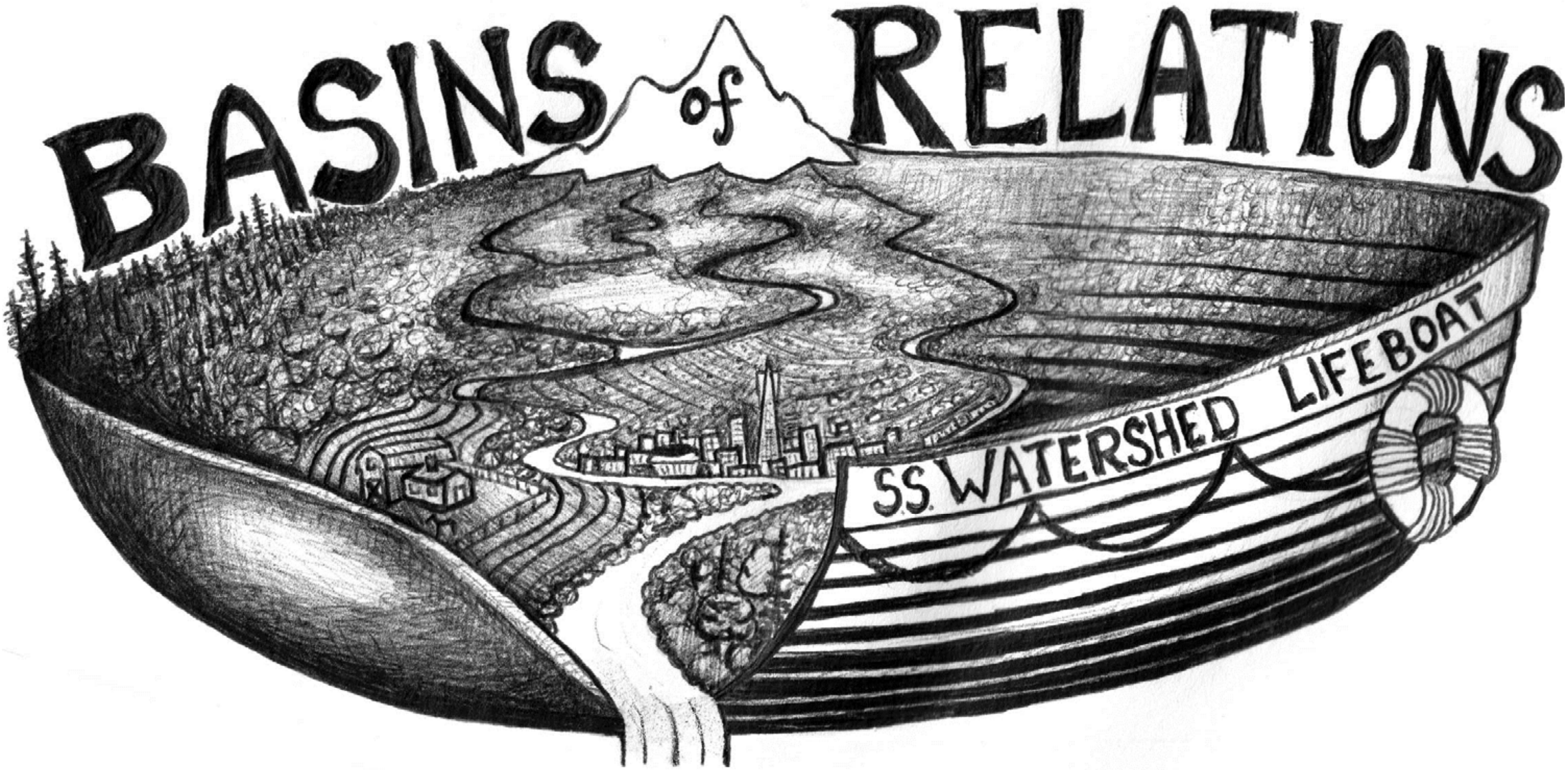
Solid Water ⟷ Liquid Water ⟷ Water Vapor

← **Freezing** ← **Condensation**

Heat Energy Released (Warming)



The critical Head-Waters in need of Ego-System Re-Storyation!



By Jim Coleman

OCCUPY Your Living Lifeboat!

BASINS OF RELATIONS

A Citizen's Guide to
Protecting and Restoring Our Watersheds

WATER INSTITUTE
WATERSHED · ADVOCACY · TRAINING
EDUCATION · RESEARCH

DO YOU KNOW WHERE YOUR WATERSHED IS TONIGHT?

What watershed do you live in? What watershed supplies your water?
Are they the same? What do you use water for?
How safe do you believe your water supply to be?
Where do you get your drinking water?
How long have you been dependent on bottled water?
Would you like to restore your own local drinking water supply?

For more information and additional copies of this publication please contact:

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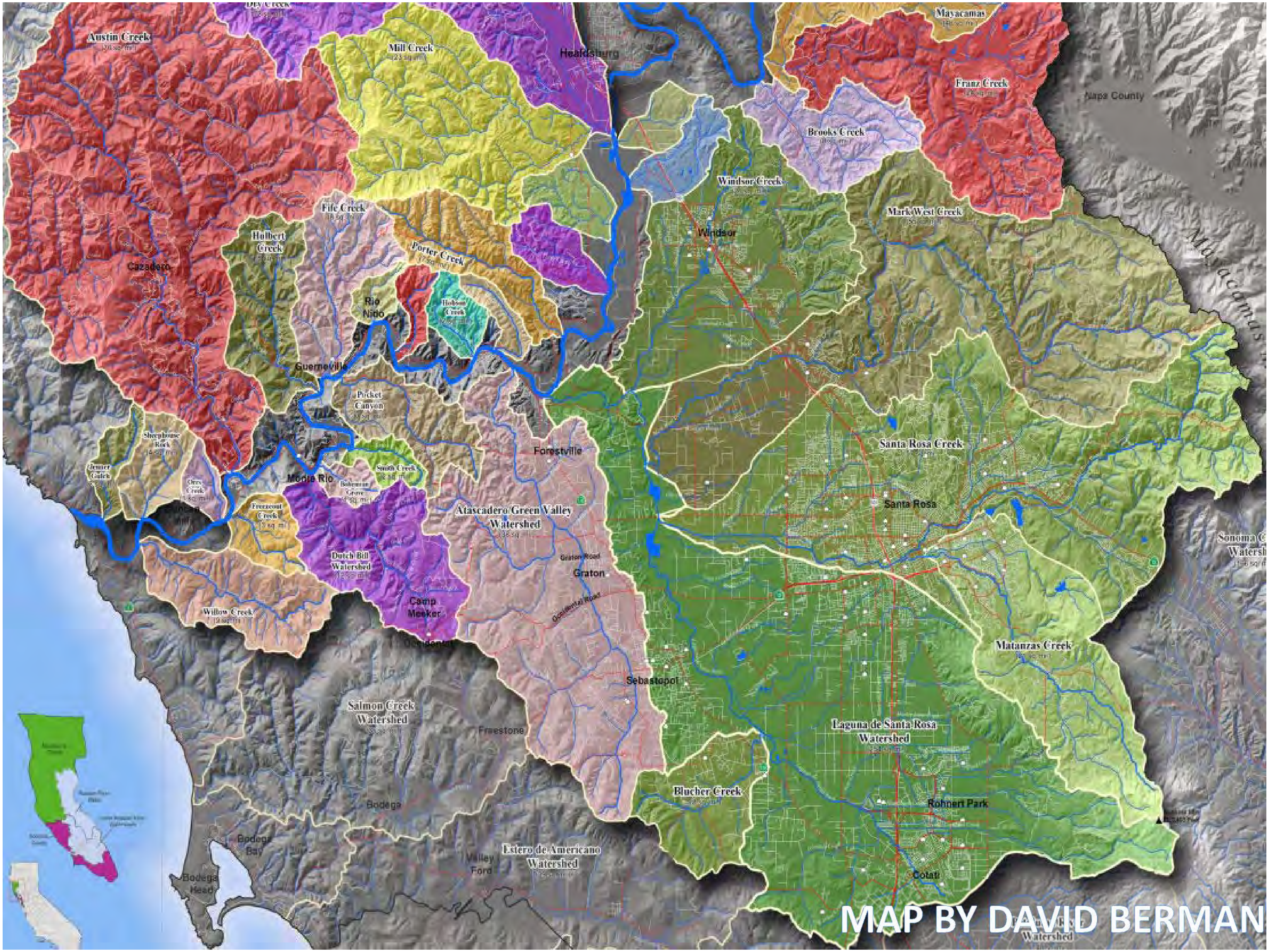
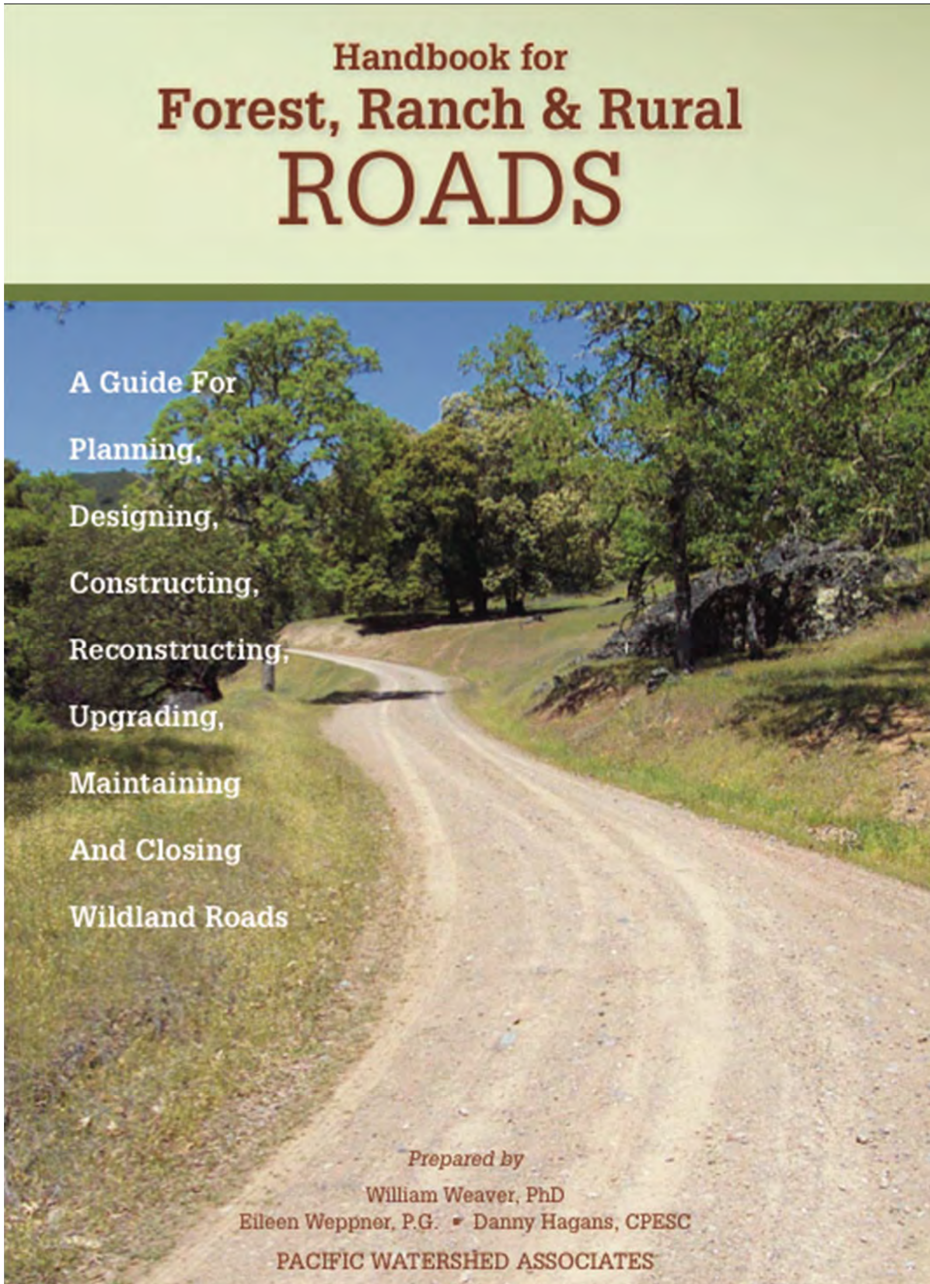
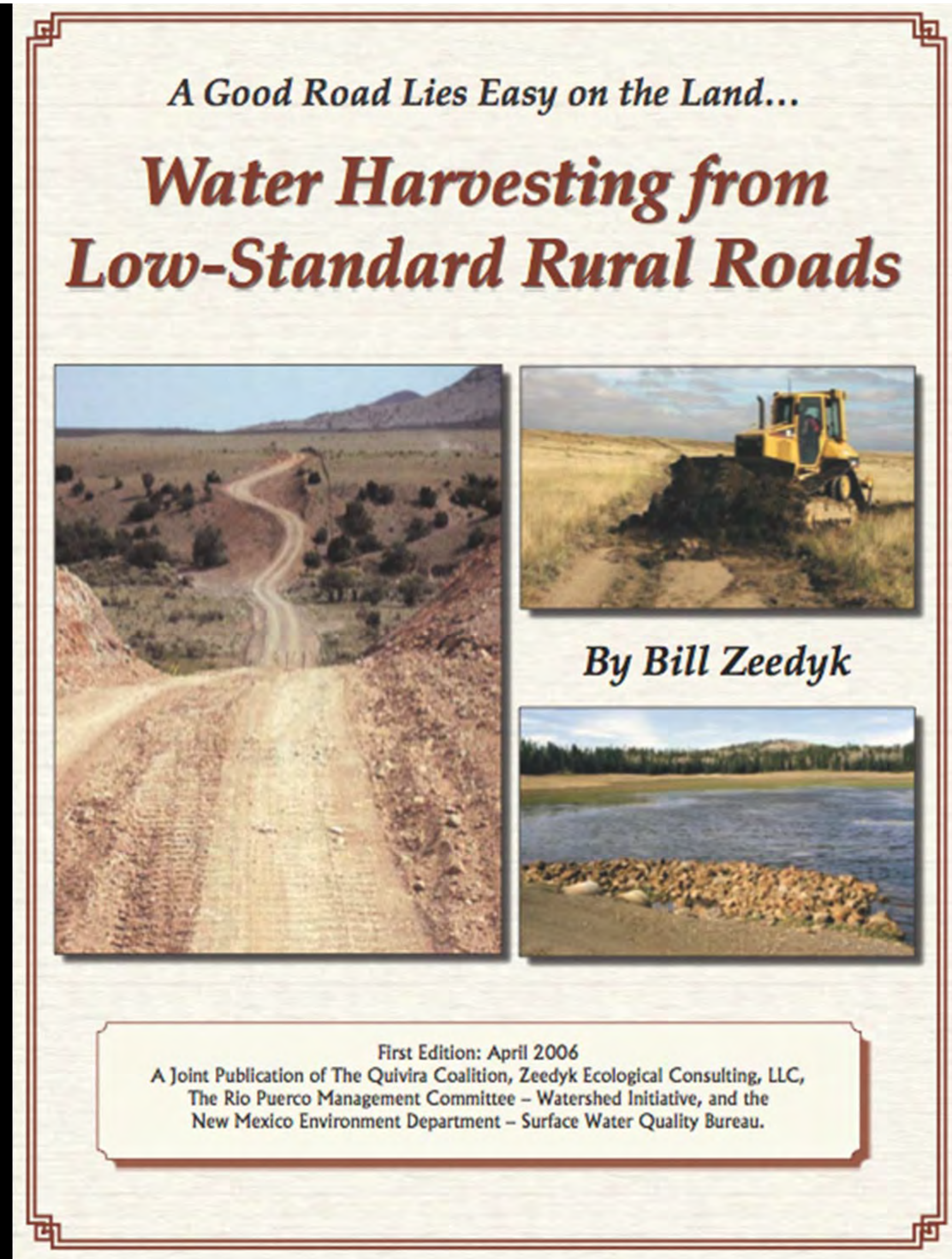
15290 Coleman Valley Road, Occidental CA 95465
(707) 874-1557 ext. 206 • www.oaecwater.org

$5.00


Dry Creek
Austin Creek
Mill Creek
Healdsburg
Mayacamas
Franz Creek
Napa County
Brooks Creek
Windsor Creek
Mark West Creek
Windsor
Fife Creek
Hulbert Creek
Cazadero
Porter Creek
Rio Nido
Hobson Creek
Guerneville
Pocket Canyon
Sheephouse Rock
Jenner Gulch
Orrs Creek
Monte Rio
Smith Creek
Bohemian Grove
Forestville
Santa Rosa Creek
Santa Rosa
Freezeout Creek
Atascadero Green Valley Watershed
Dutch Bill Watershed
Graton Road
Graton
Occidental Road
Willow Creek
Camp Meeker
Occidental
Matanzas Creek
Sebastopol
Salmon Creek Watershed
Freestone
Laguna de Santa Rosa Watershed
Blucher Creek
Rohnert Park
Bodega
Bodega Bay
Bodega Head
Valley Ford
Estero de Americano Watershed
Cotati
Watershed
MAP BY DAVID BERMAN

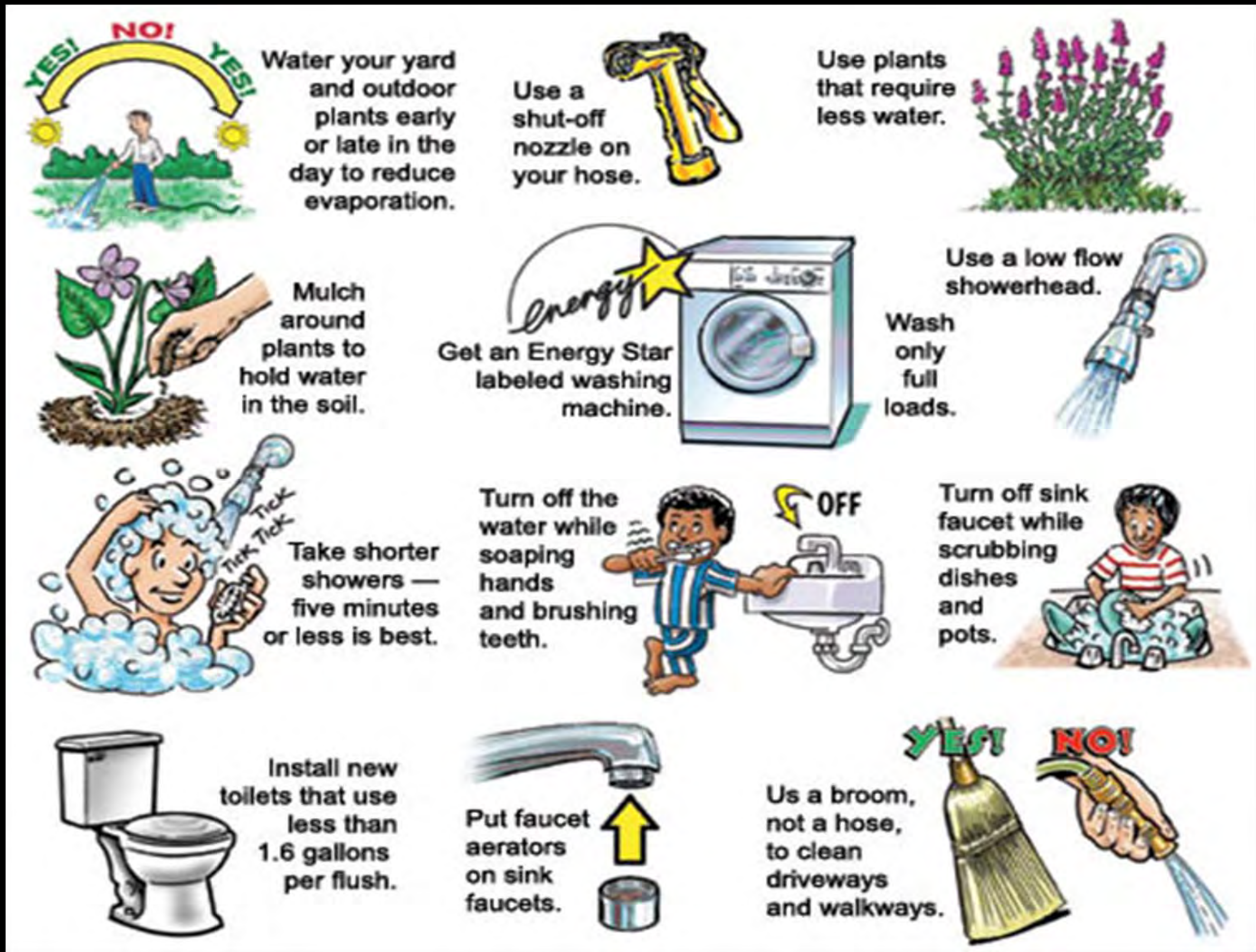




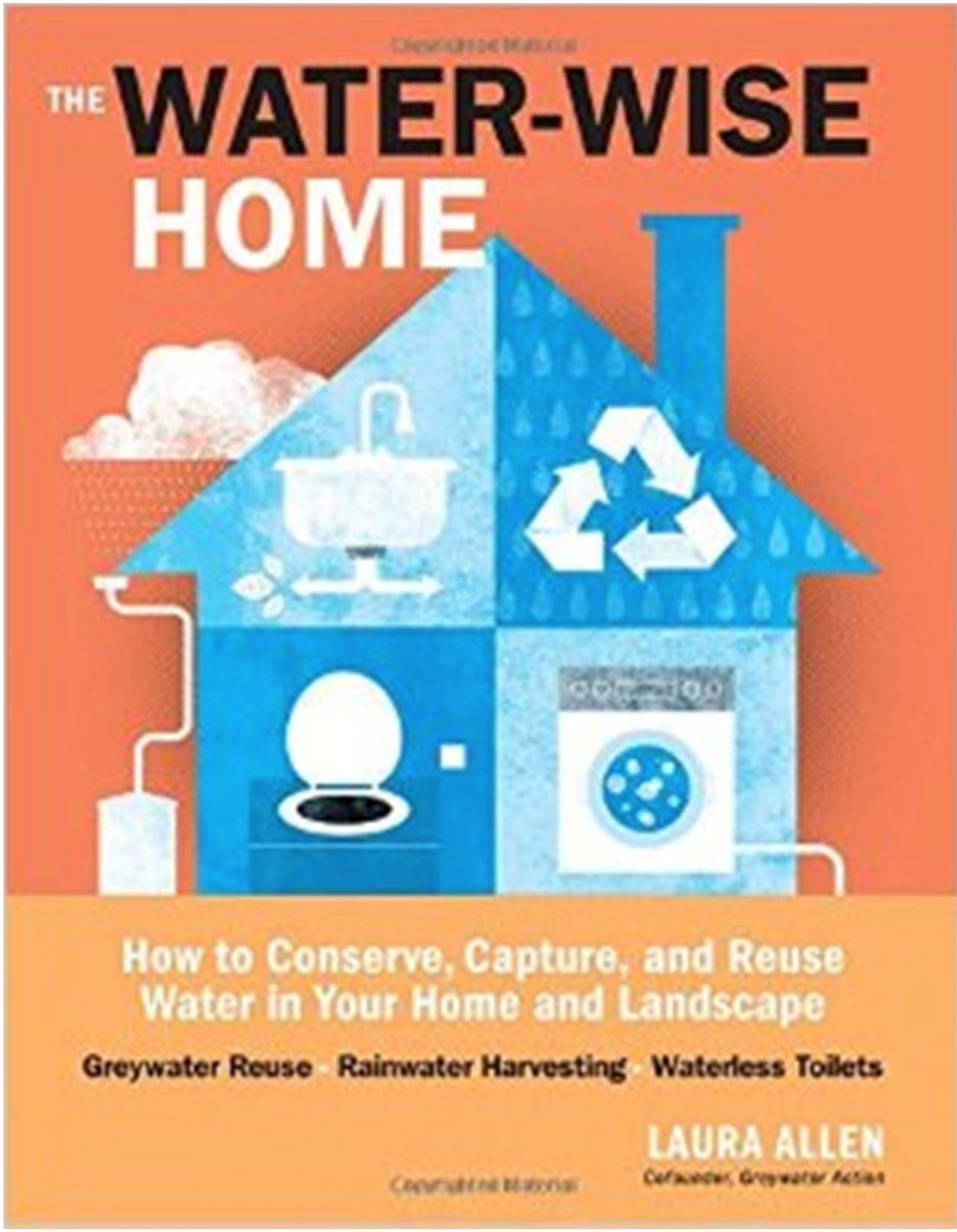
"Nothing in nature mimics a road" Danny Hagans


MONTEREY BAY FRIENDLY
LANDSCAPING
BAY-FRIENDLY
LANDSCAPING & GARDENING COALITION
RIVER-FRIENDLY
LANDSCAPING
OCEAN
FRIENDLY GARDEN
CONSERVATION
of water, energy and habitat
PERMEABILITY
of soil and surfaces lets water slow down and sink
RETENTION
of rainwater and prevention of wet weather runoff
OCEAN
SURFRIDER
FOUNDATION
WWW.OCEANFRIENDLYGARDENS.ORG

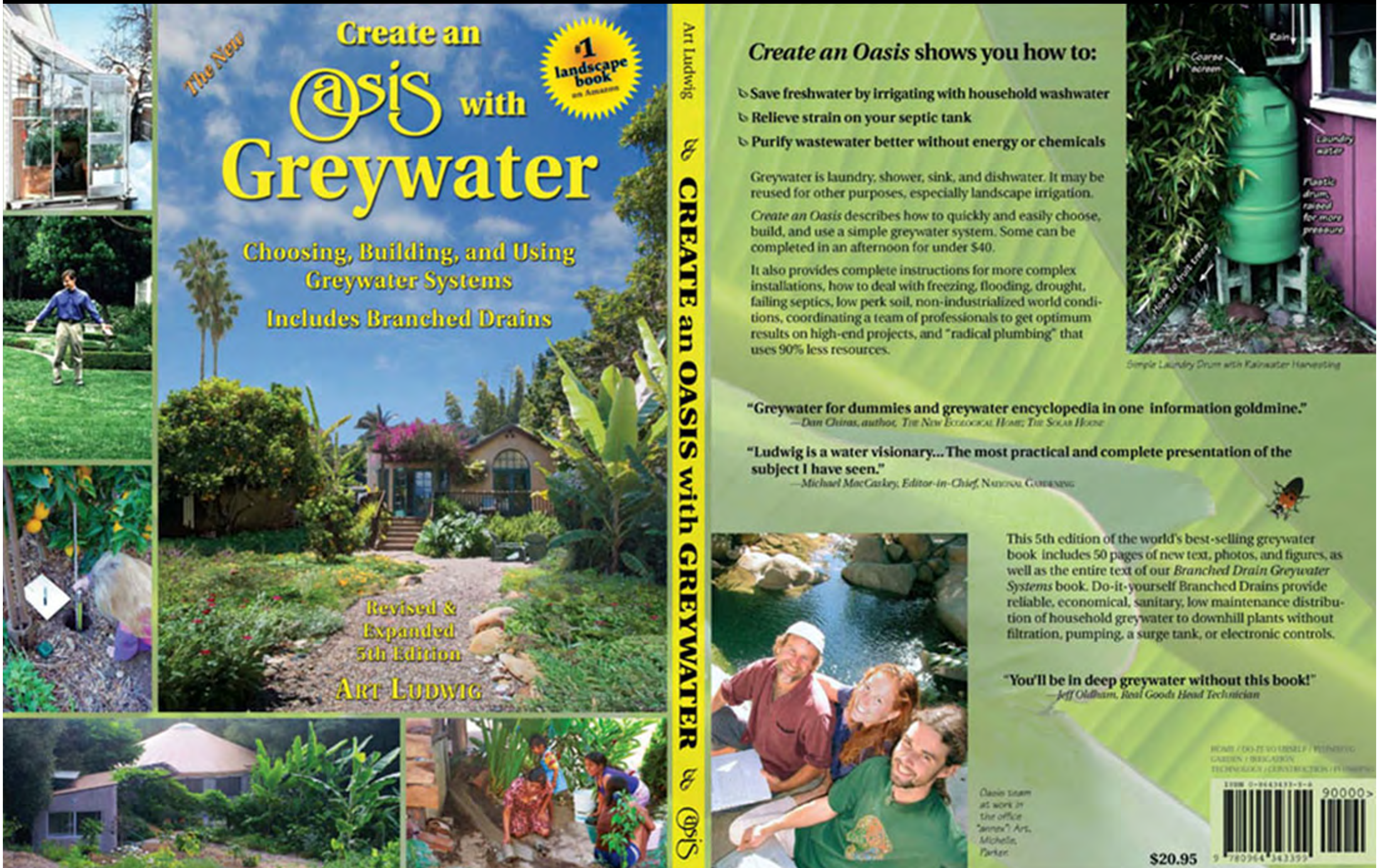
Choose not to use!



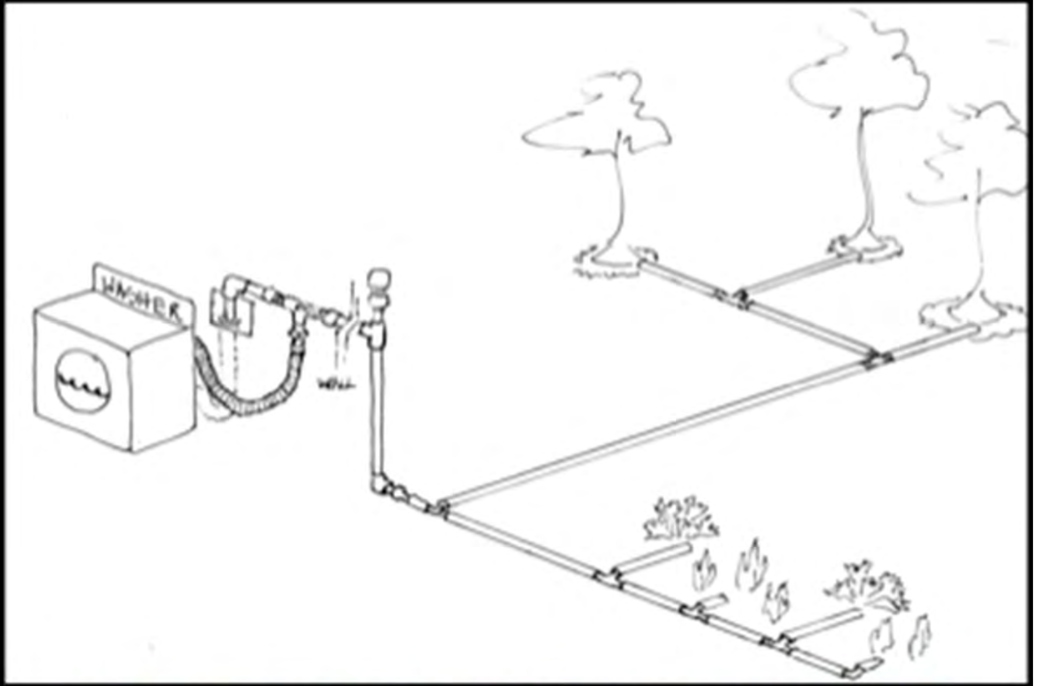
Less is more when you re-use!



© Steve Sanford from The Water-Wise Home


The New
Create an
Oasis with
Greywater
#1 landscape book on Amazon
Choosing, Building, and Using
Greywater Systems
Includes Branched Drains
Revised &
Expanded
5th Edition
Art Ludwig
Art Ludwig
CREATE an OASIS with GREYWATER
Create an Oasis shows you how to:
Save freshwater by irrigating with household washwater
Relieve strain on your septic tank
Purify wastewater better without energy or chemicals
Greywater is laundry, shower, sink, and dishwater. It may be reused for other purposes, especially landscape irrigation.
Create an Oasis describes how to quickly and easily choose, build, and use a simple greywater system. Some can be completed in an afternoon for under $40.
It also provides complete instructions for more complex installations, how to deal with freezing, flooding, drought, failing septics, low perk soil, non-industrialized world conditions, coordinating a team of professionals to get optimum results on high-end projects, and "radical plumbing" that uses 90% less resources.
Rain
Coarse screen
Laundry water
Plastic drum, raised for more pressure
Hose to fruit trees
Simple Laundry Drum with Rainwater Harvesting
"Greywater for dummies and greywater encyclopedia in one information goldmine."
—Dan Chiras, author, The New Ecological Home; The Solar House
"Ludwig is a water visionary...The most practical and complete presentation of the subject I have seen."
—Michael MacCaskey, Editor-in-Chief, National Gardening
This 5th edition of the world's best-selling greywater book includes 50 pages of new text, photos, and figures, as well as the entire text of our Branched Drain Greywater Systems book. Do-it-yourself Branched Drains provide reliable, economical, sanitary, low maintenance distribution of household greywater to downhill plants without filtration, pumping, a surge tank, or electronic controls.
"You'll be in deep greywater without this book!"
—Jeff Oldham, Real Goods Head Technician
Oasis team at work in the office "annex": Art, Michelle, Parker.
$20.95
90000>

Laundry to Landscape Graywater

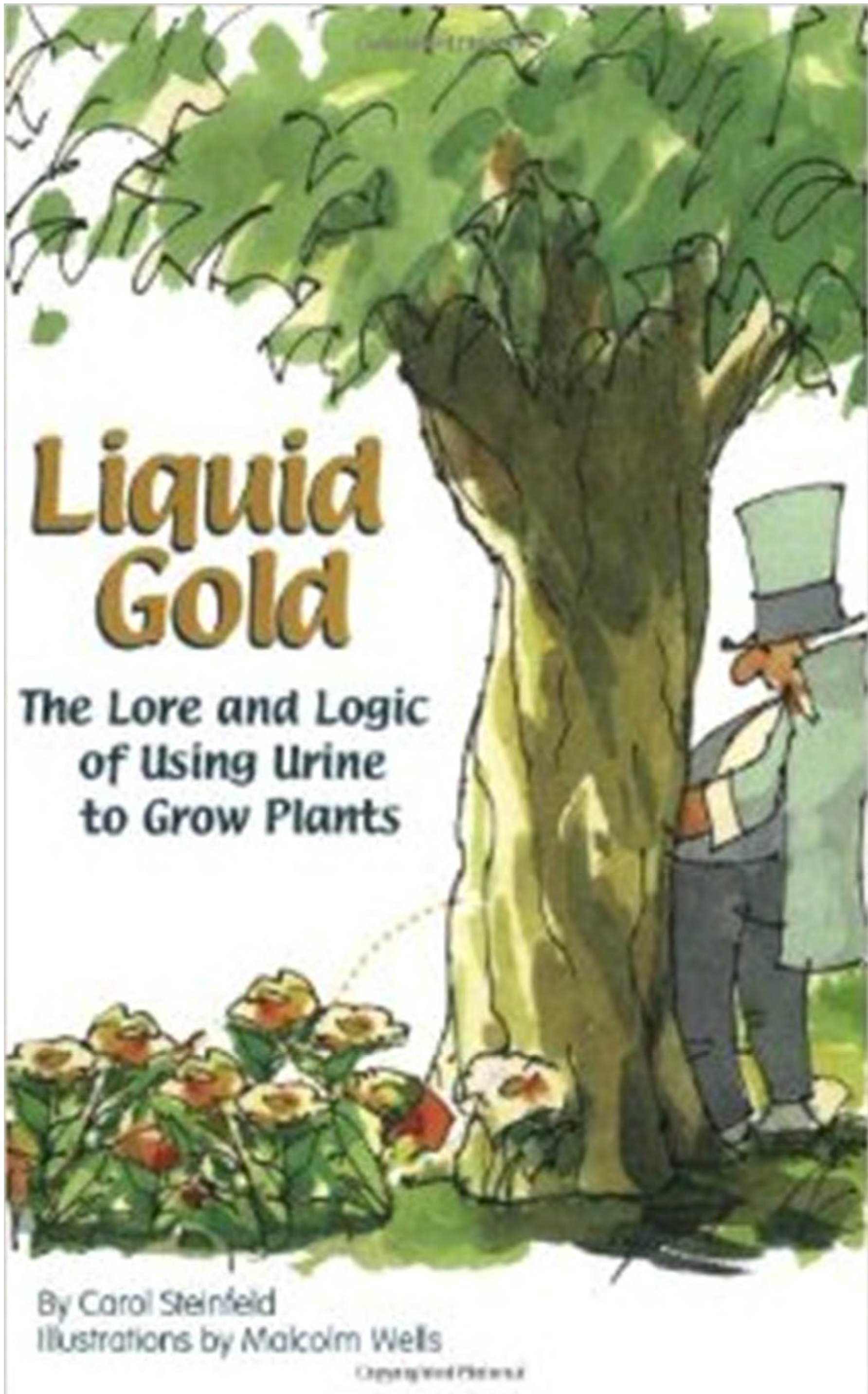


OAEC's Compost Toilet Research Project

phoenix
composting toilets

Phoenix R-200

ecotech
Innovations for Clean Water


Liquid Gold
The Lore and Logic of Using Urine to Grow Plants
By Carol Steinfeld
Illustrations by Malcolm Wells

California Decentralized Water Policy Council

Water Working Groups:

Blackwater

Greywater

Rain & Stormwater

Surface & Groundwater

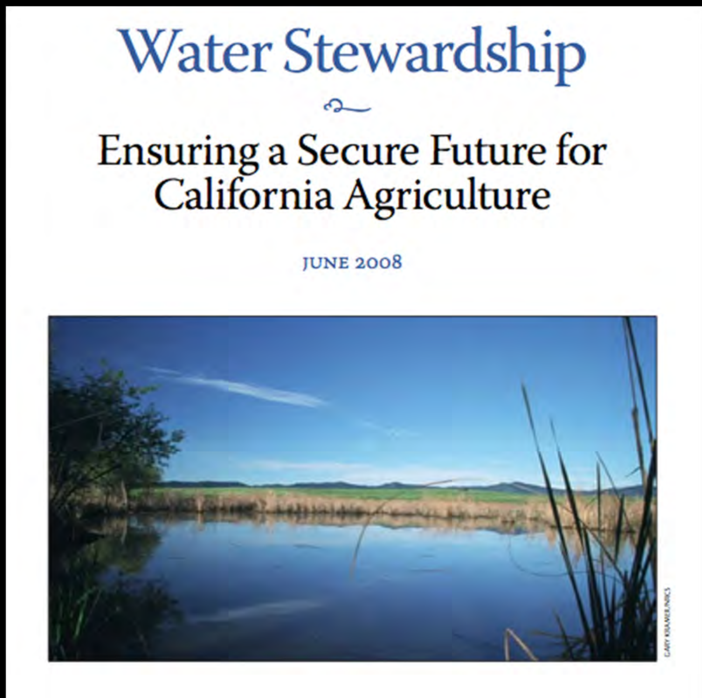
Compost Toilets

OCCIDENTAL ARTS & ECOLOGY CENTER

COWA

The California Onsite Wastewater Association promotes environmentally and economically sound onsite wastewater technology and management practices.

The California Agricultural Water Stewardship Initiative



- On-farm ponds
- Keyline design
- Water recycling
- Soil management
- Dry farming
- Irrigation scheduling

& efficiency

www.agwaterstewards.org

From Storage to Retention:
Expanding California's Options for Meeting Its Water Needs

California Roundtable on Water and Food Supply | November 2012

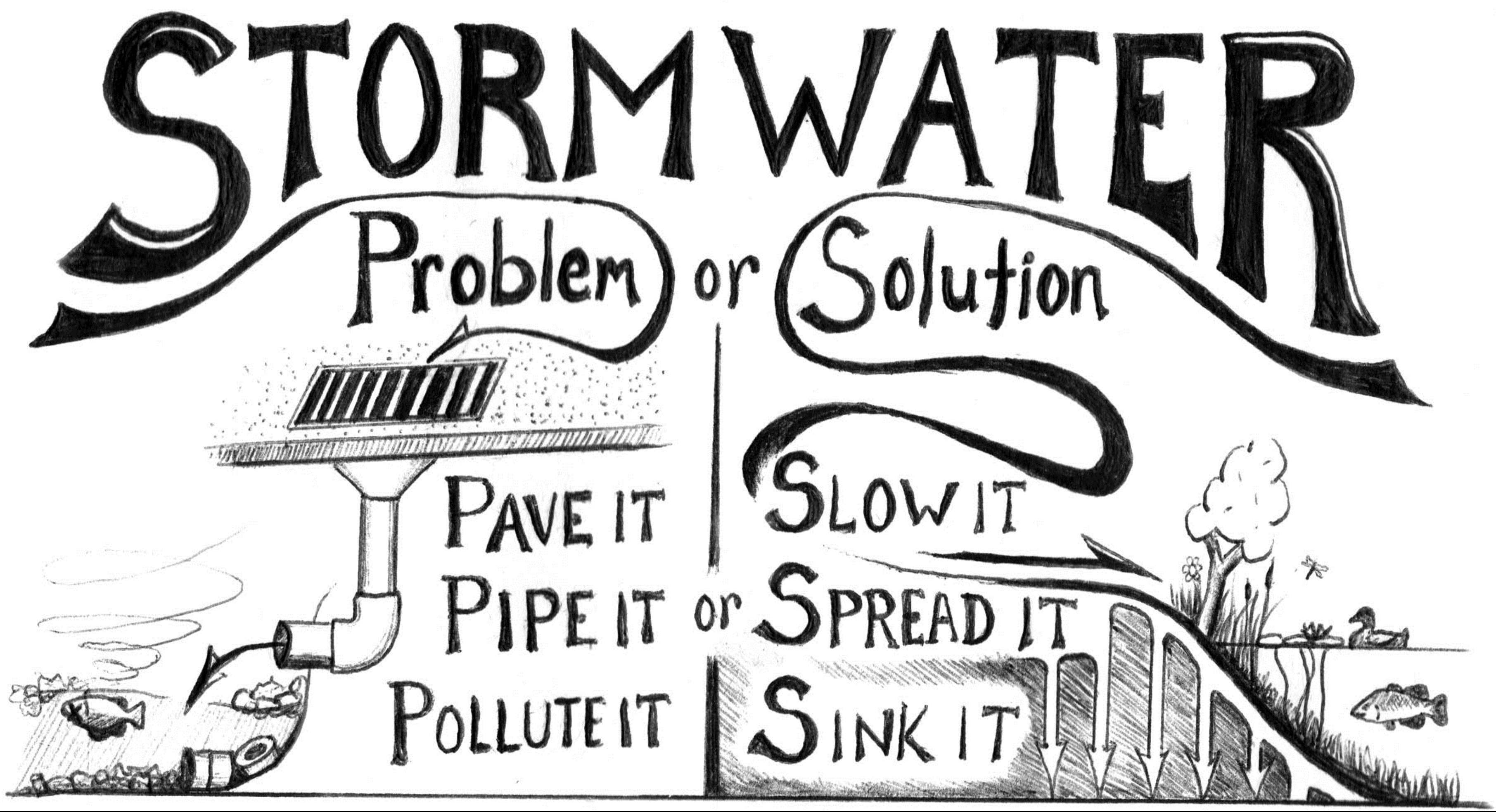
FROM CRISIS TO CONNECTIVITY
Renewed Thinking About Managing California's Water & Food Supply

Ag Innovations Network

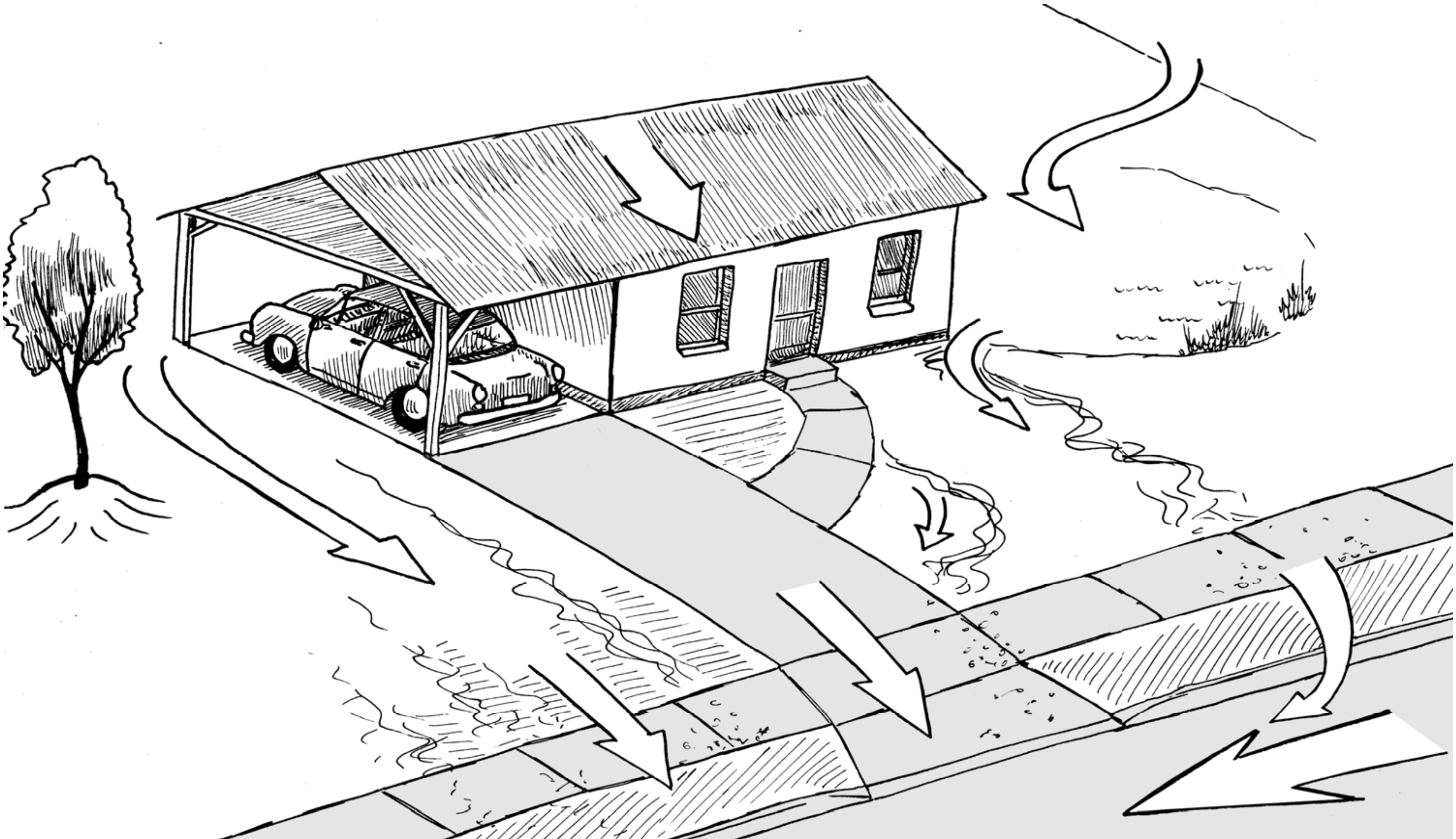
APRIL 2014

WATERSHED BEST MANAGEMENT PRACTICES
for
CANNABIS GROWERS
and other
RURAL GARDENERS

Mendocino County Resource Conservation District

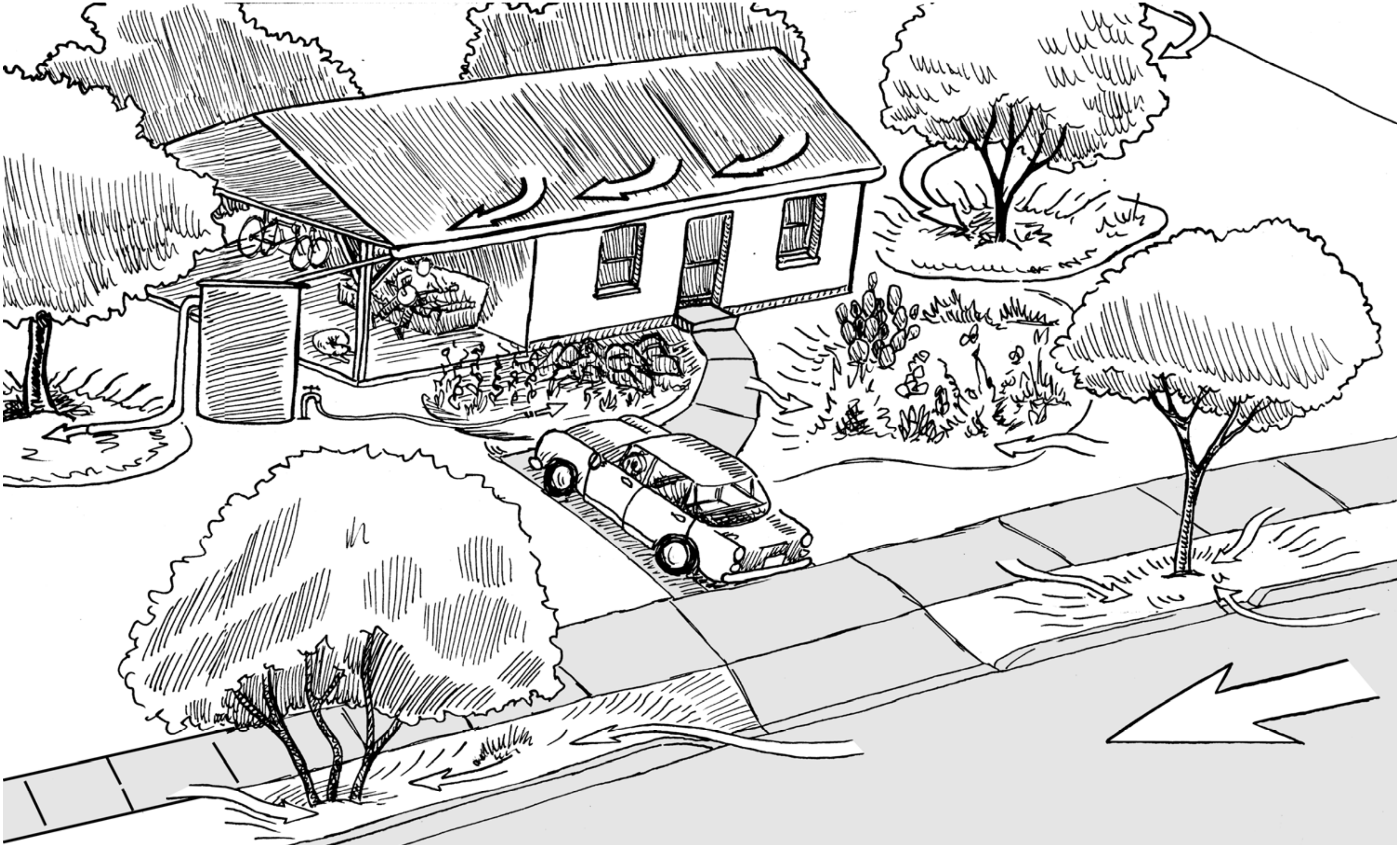


By Jim Coleman
OAEC WATER Institute



Drain-Age?

From: Rainwater Harvesting for Drylands
By Brad Lancaster



Retain-Age!

From: Rainwater Harvesting for Drylands
By Brad Lancaster

SALMON CREEK WATER LEVEL

LOW

- ✓ *Stop all non - essential water use*
- ✓ *Stop drawing water from the creek*
- ✓ *Use stored rainwater*

Learn how at

salmoncreekwater.org

Funded by the State Coastal Conservancy

IT'S DRY SEASON

IN SALMON CREEK WATERSHED

Help the steelhead & coho salmon growing in our creeks!

- ✓ *Conserve water: Install low-use fixtures*
- ✓ *Practice low flow gardening*
- ✓ *Leave downed wood in the streams*
- ✓ *Don't dump toxic materials*

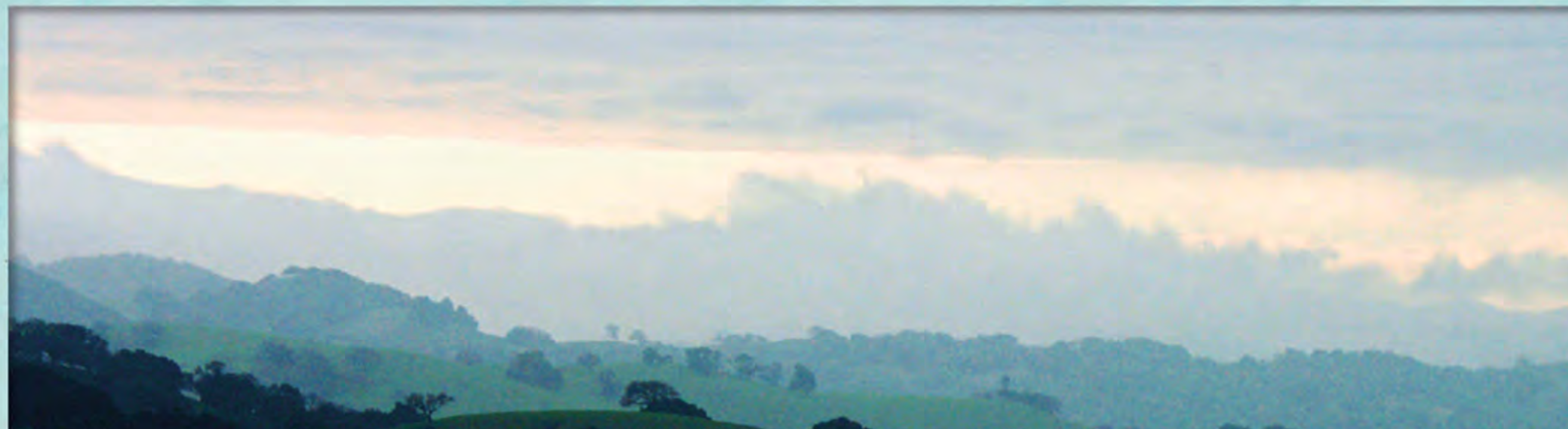
Learn how at

salmoncreekwater.org

Funded by the State Coastal Conservancy

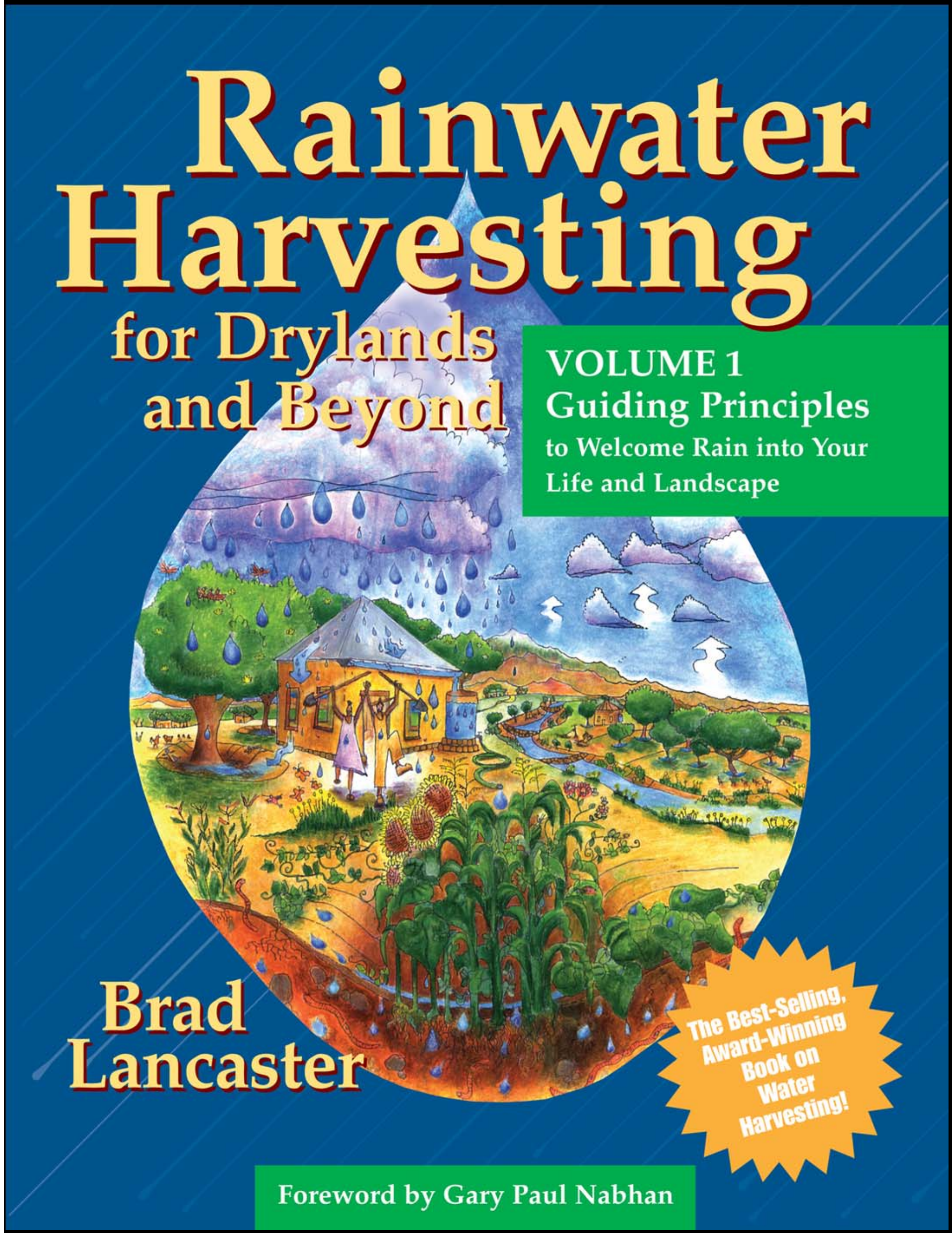
“We do not live in a Water Scarce Area!

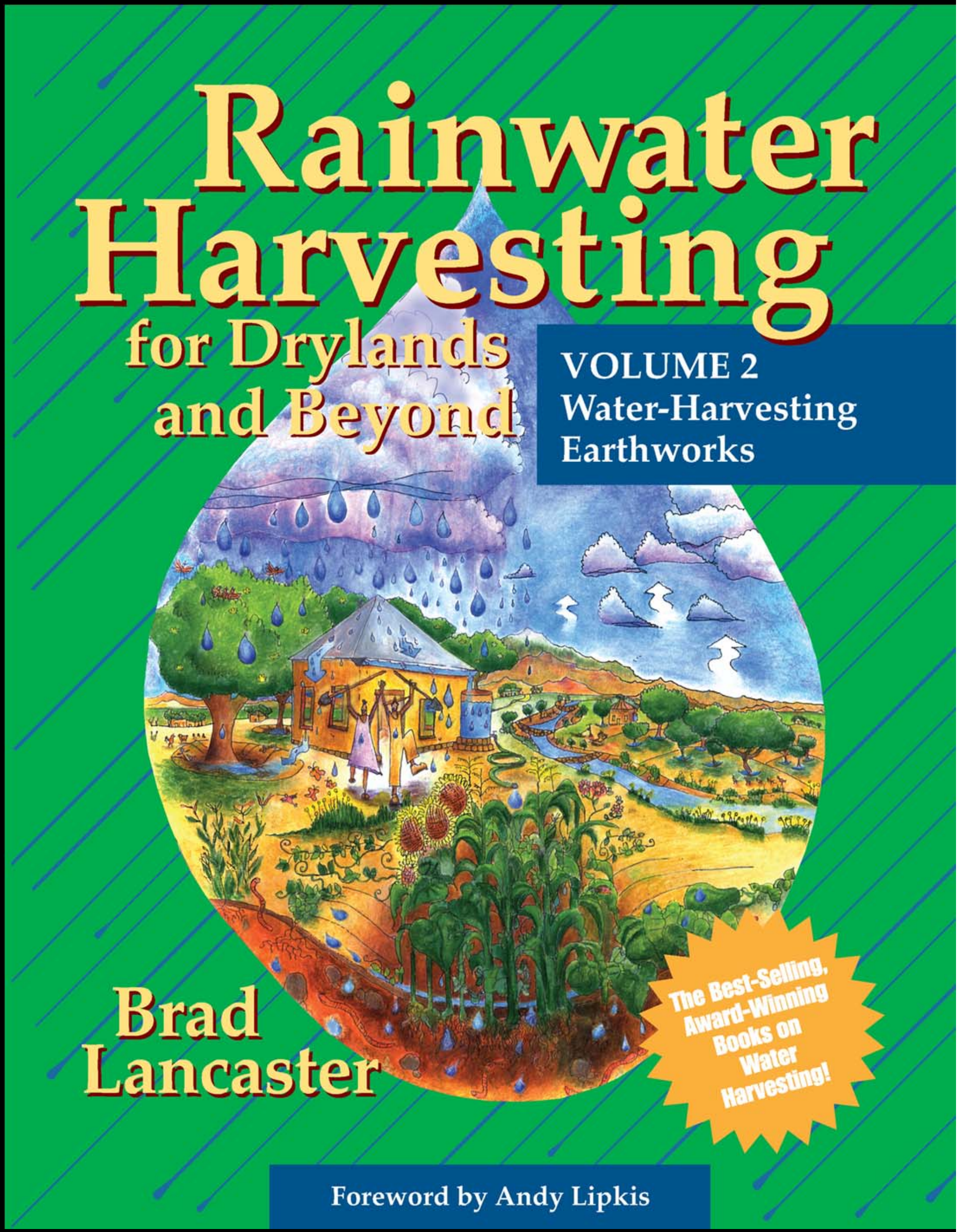
We Live in a Water Storage Scarce Area!!”



Slow it. Spread it. Sink it. Store it!

Guide to Beneficial Stormwater Management and Water Conservation Strategies


Rainwater Harvesting
for Drylands and Beyond
VOLUME 1
Guiding Principles
to Welcome Rain into Your Life and Landscape
Brad Lancaster
The Best-Selling, Award-Winning Book on Water Harvesting!
Foreword by Gary Paul Nabhan


Rainwater Harvesting
for Drylands and Beyond
VOLUME 2
Water-Harvesting Earthworks
Brad Lancaster
The Best-Selling, Award-Winning Books on Water Harvesting!
Foreword by Andy Lipkis

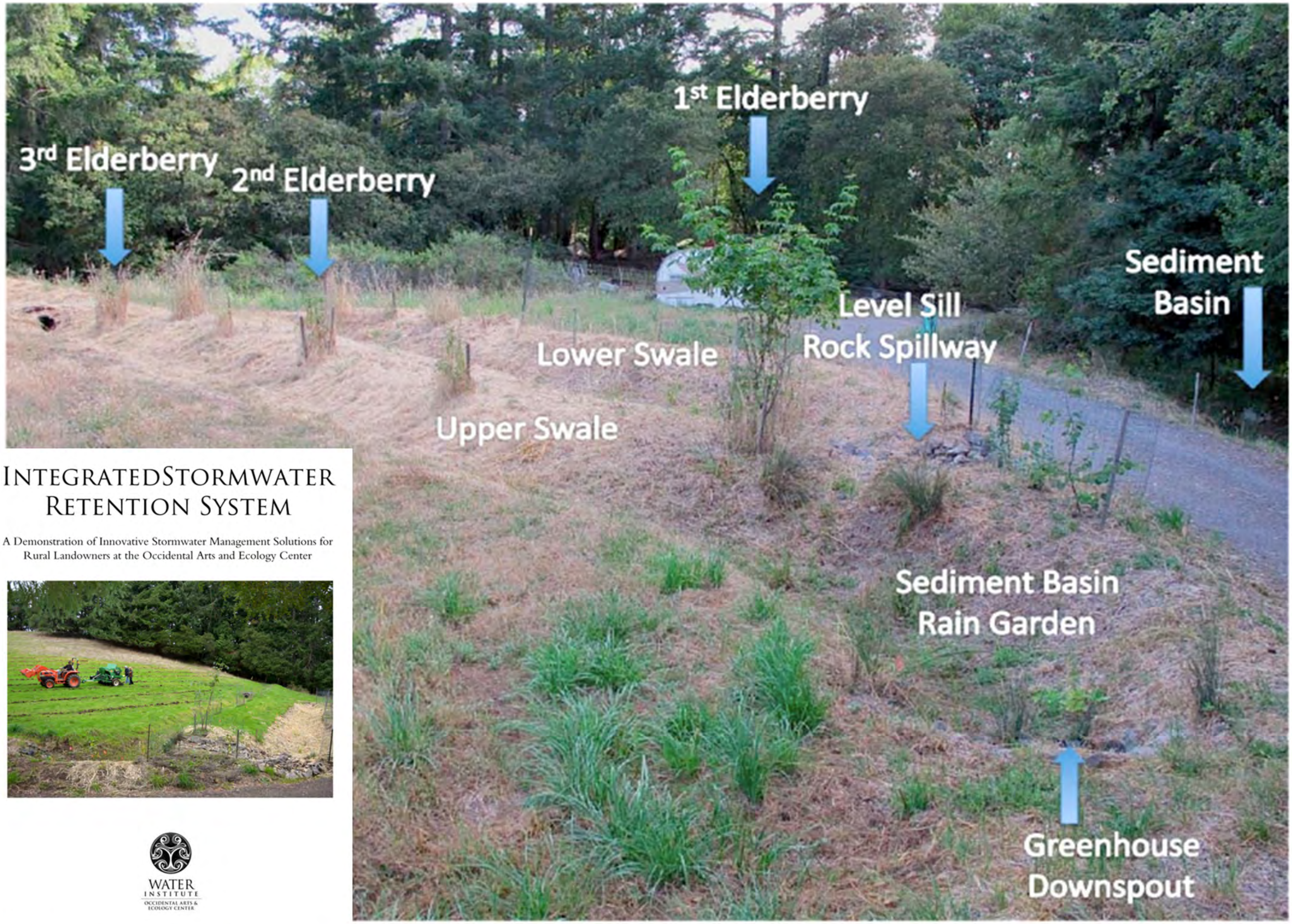
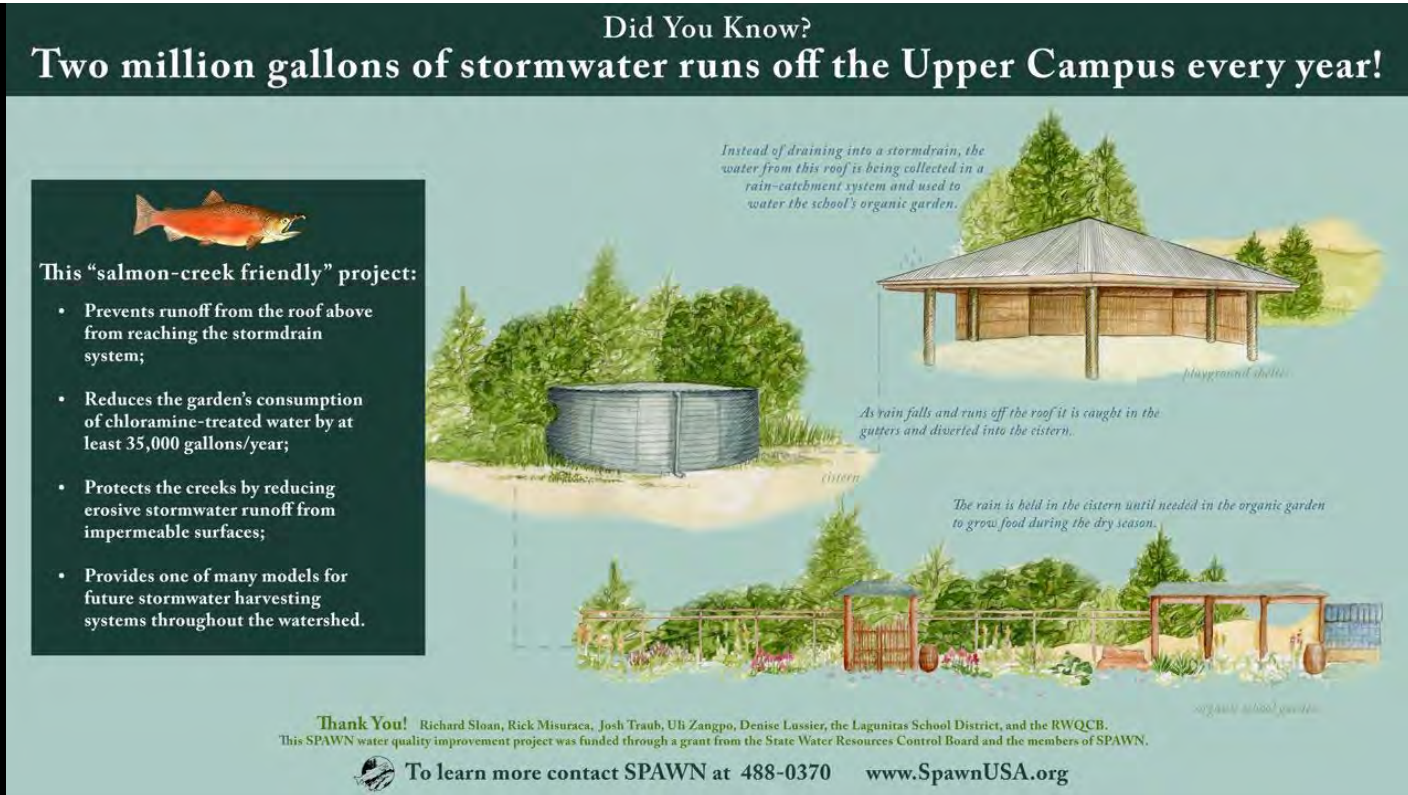


Figure 2. Image of the sediment basins and swales planted with California natives as of July 2012

Low Cost Roofwater System For Agricultural Supply

A Demonstration of our Flexible "Wonder Gutter" System
at the Occidental Arts and Ecology Center

WATER
INSTITUTE
OCCIDENTAL ARTS &
ECOLOGY CENTER


Did You Know?
Two million gallons of stormwater runs off the Upper Campus every year!
This "salmon-creek friendly" project:
• Prevents runoff from the roof above from reaching the stormdrain system;
• Reduces the garden's consumption of chloramine-treated water by at least 35,000 gallons/year;
• Protects the creeks by reducing erosive stormwater runoff from impermeable surfaces;
• Provides one of many models for future stormwater harvesting systems throughout the watershed.
Instead of draining into a stormdrain, the water from this roof is being collected in a rain-catchment system and used to water the school's organic garden.
As rain falls and runs off the roof it is caught in the gutters and diverted into the cistern.
cistern
The rain is held in the cistern until needed in the organic garden to grow food during the dry season.
Thank You! Richard Sloan, Rick Misuraca, Josh Traub, Uli Zangpo, Denise Lussier, the Lagunitas School District, and the RWQCB.
This SPAWN water quality improvement project was funded through a grant from the State Water Resources Control Board and the members of SPAWN.
To learn more contact SPAWN at 488-0370 www.SpawnUSA.org

Bodega Valley Rainwater Catchment & Alternative Water Supply Program

AG INNOVATIONS NETWORK | DECEMBER 2013

The estuary study found that "...opportunities for synergy and cooperation among the many active groups in the watershed abound."

Innovative solutions require an understanding of the habitat, climate, and history that contributed to the initial problems.

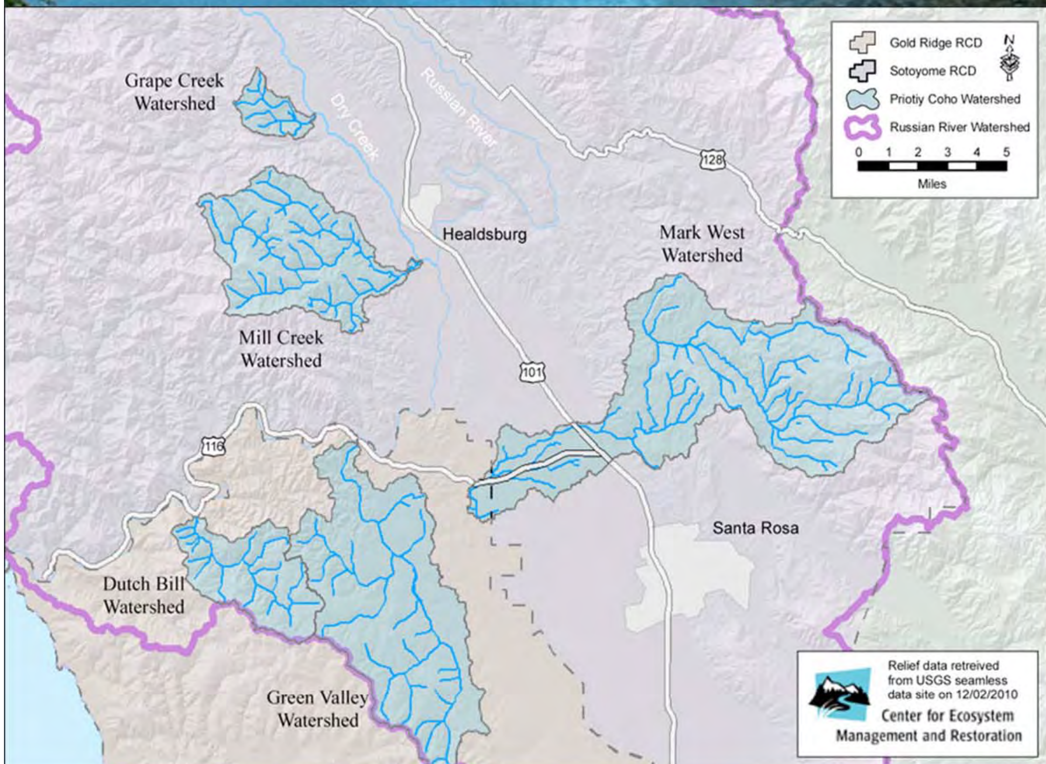
ROOFWATER HARVESTING IN CALIFORNIA:

OBSTACLES AND OPPORTUNITIES

Supporting statewide adoption of this valuable water conservation strategy to increase community water security and stream flows for salmonid recovery

Russian River Coho Water Resources Partnership

Russian River (SCWA)



SONOMA RESOURCE CONSERVATION DISTRICT

TROUT UNLIMITED

cemar rehabilitating California coastal streams

WATER INSTITUTE OCCIDENTAL ARTS & ECOLOGY CENTER

Sea Grant California

Gold Ridge Resource Conservation District

SONOMA COUNTY WATER AGENCY

National Fish and Wildlife Foundation

Formed 2009

The Press Democrat

Water added to Camp Meeker's Dutch Bill Creek a 'lifesaver' for young fish

September 7, 2015,

Coho Monitoring
Flow Monitoring
Irrigation Efficiency
Frost Fans
Offstream Storage
Roofwater Harvesting
Stream Augmentation

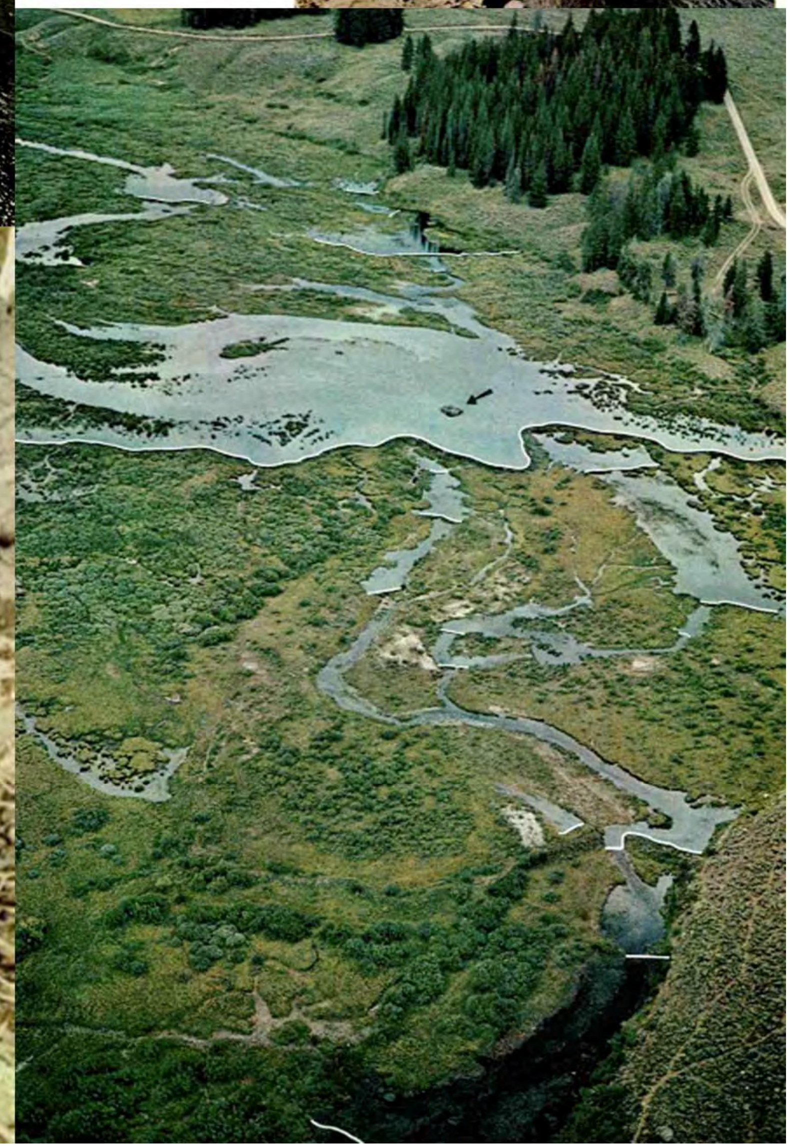
NATURE'S AQUATIC ENGINEERS

Beavers

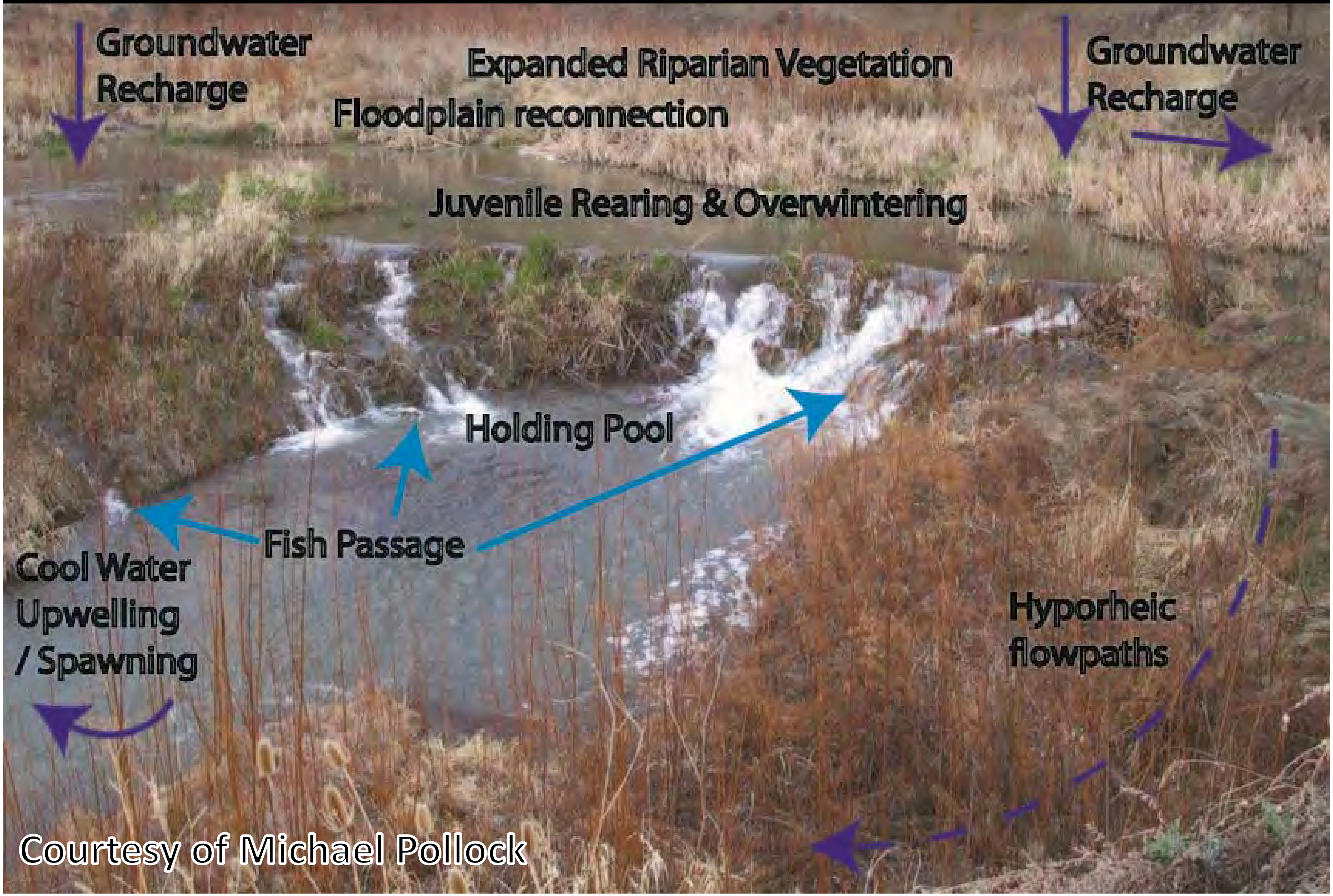
Article and photographs by
DES AND JEN BARTLETT

National Geographic, May 1974

Lumberman,
architect,
engineer

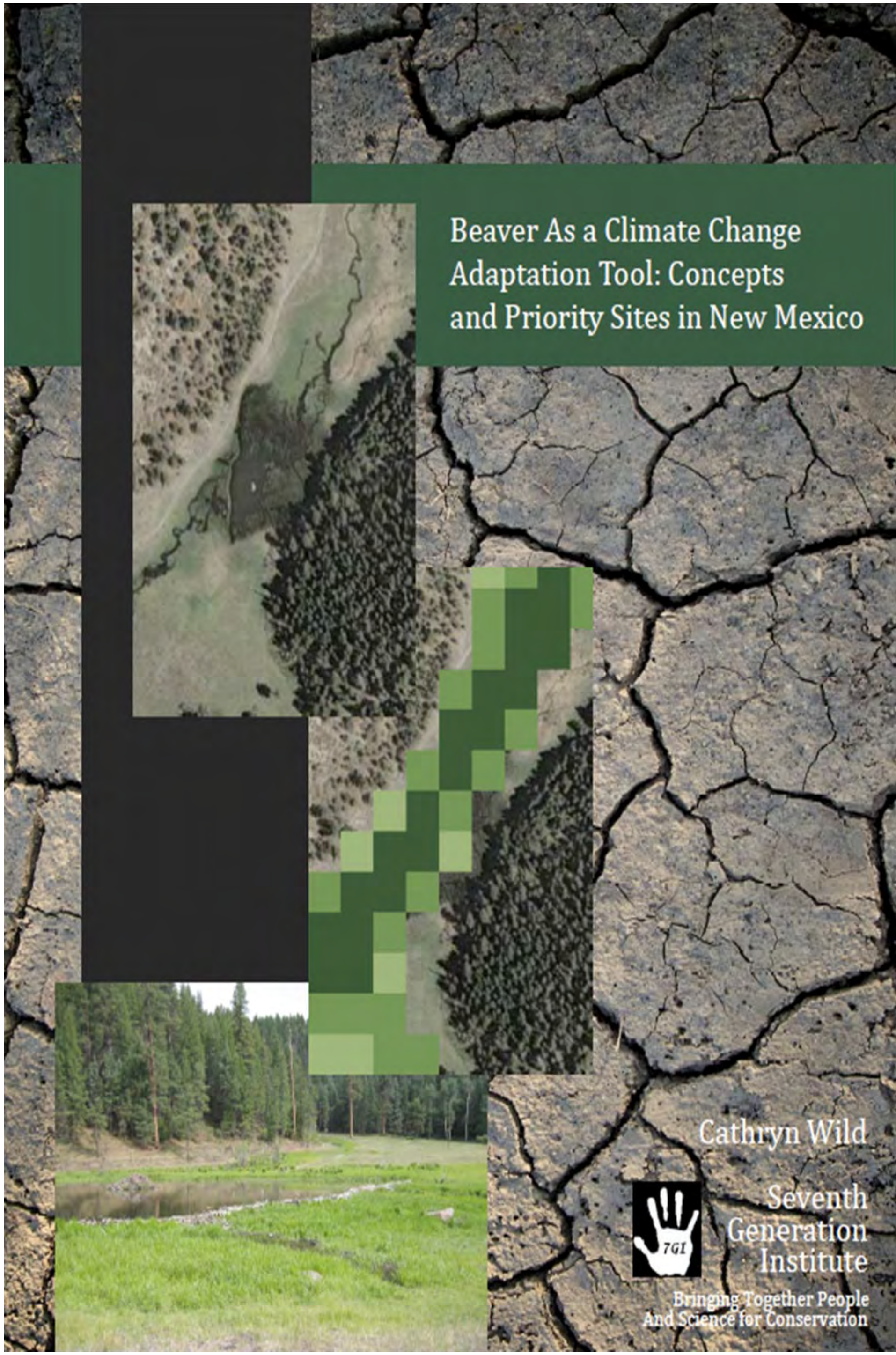


Beaver dams provide many benefits



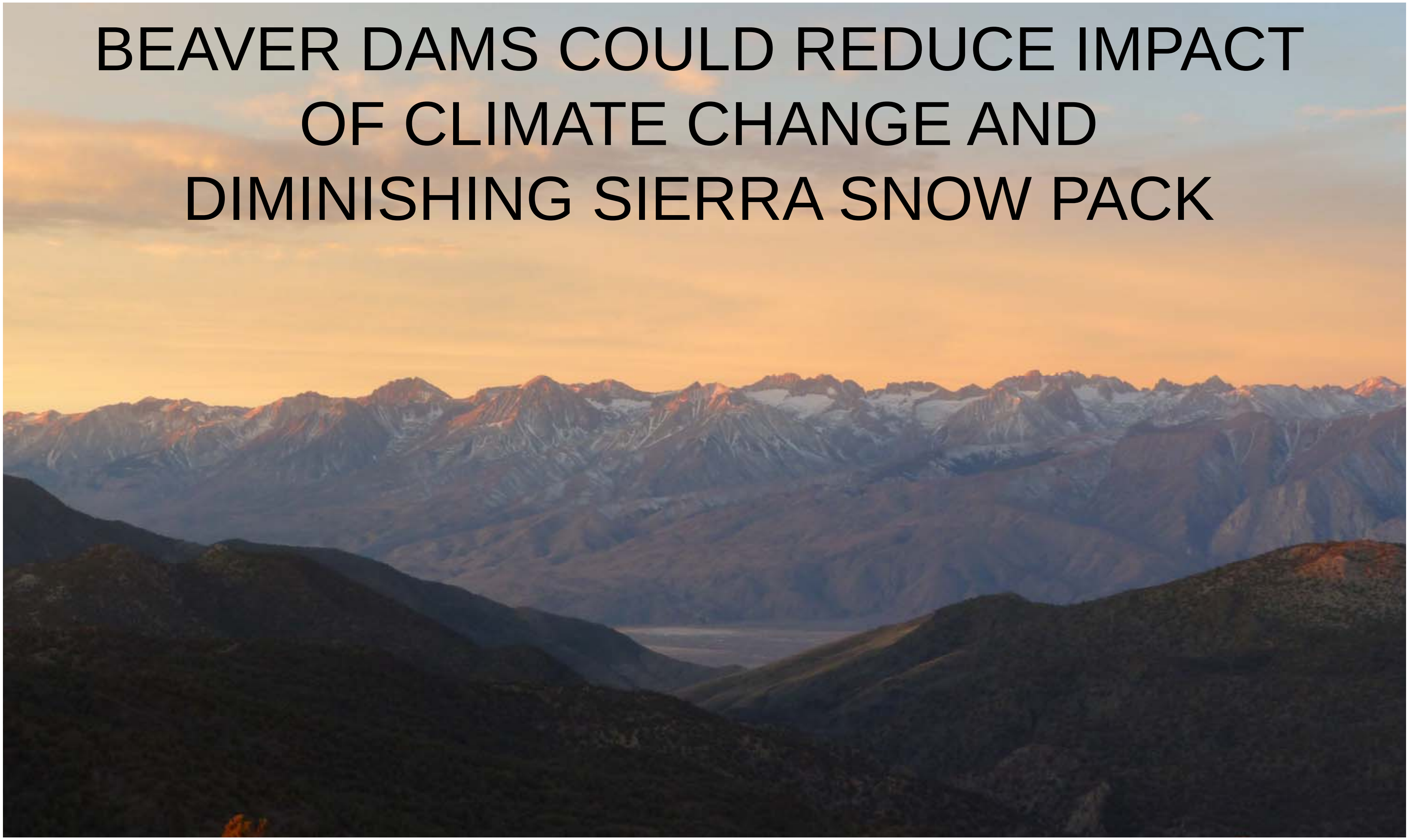

Fight Incision
with Incisors!


"Beaver Taught Salmon How to Jump" Haida saying


Beaver As a Climate Change Adaptation Tool: Concepts and Priority Sites in New Mexico
Cathryn Wild
7GI
Seventh Generation Institute
Bringing Together People And Science for Conservation


Beaver and Climate Change Adaptation in North America
A Simple, Cost-Effective Strategy
WildEarth Guardians
Grand Canyon Trust
The Lands Council
A Report from
WildEarth Guardians
SEPTEMBER 2011

BEAVER DAMS COULD REDUCE IMPACT OF CLIMATE CHANGE AND DIMINISHING SIERRA SNOW PACK

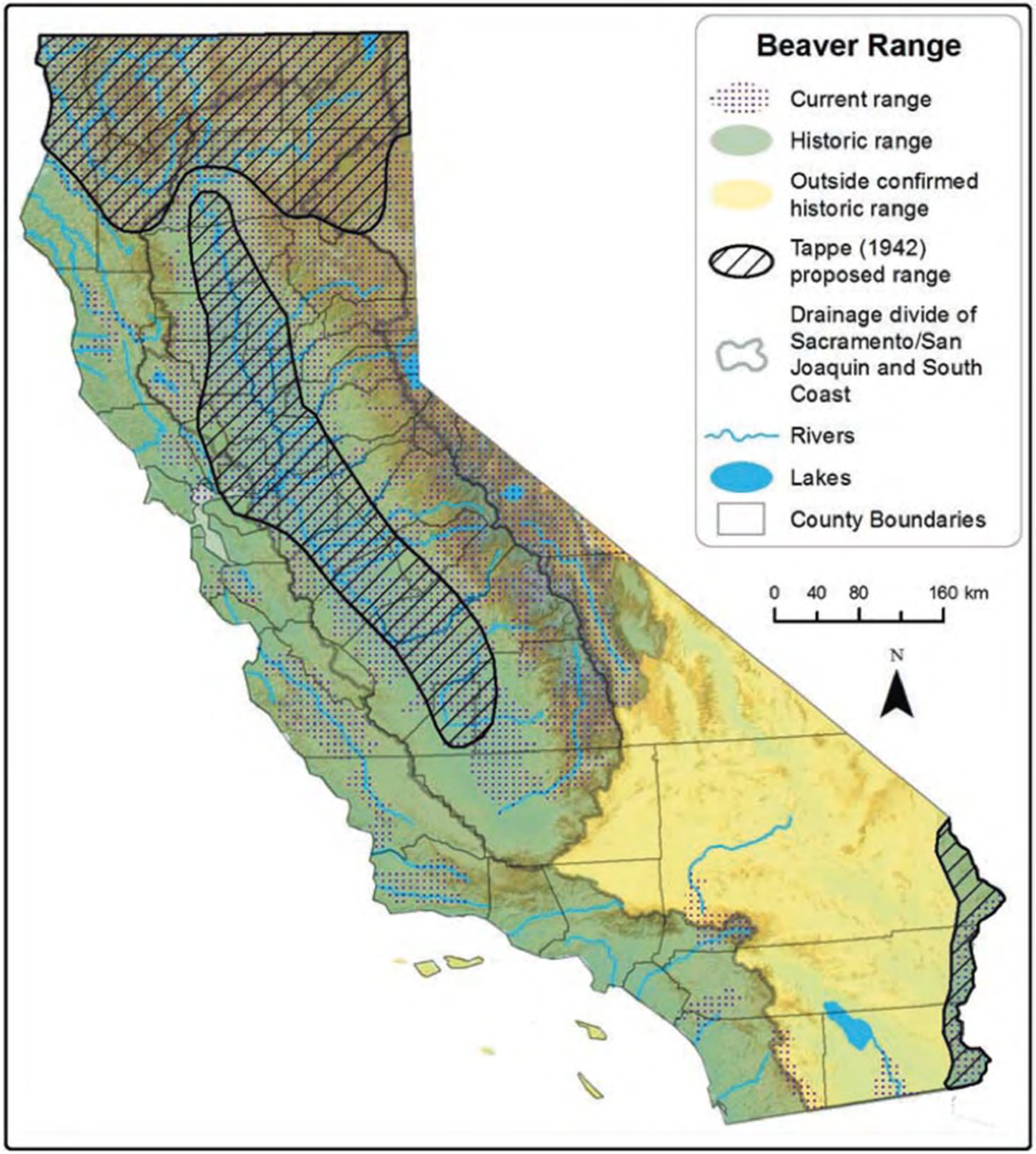


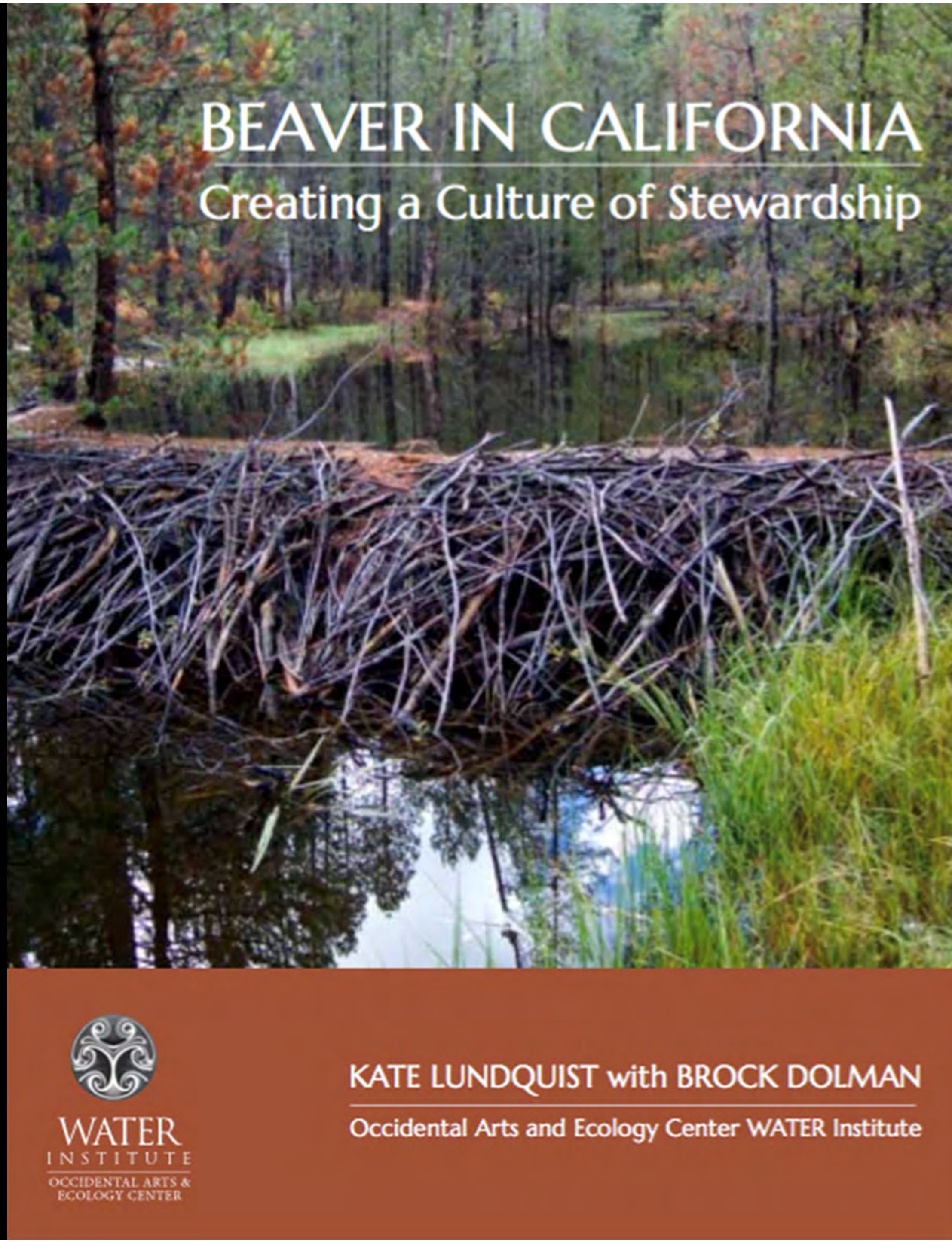
GEOPHYSICAL RESEARCH LETTERS, VOL. 40, 1–6, doi:10.1002/grl.50710, 2013

Landscape-scale carbon storage associated with beaver dams

Ellen Wohl[1]


"TAKE TWO ASPEN, AND CALL ME IN THE MORNING...."
BILL SUDDICK
Guest Cartoonist for a travelling Tak Bui
M.D.
SUDDICK
11-21

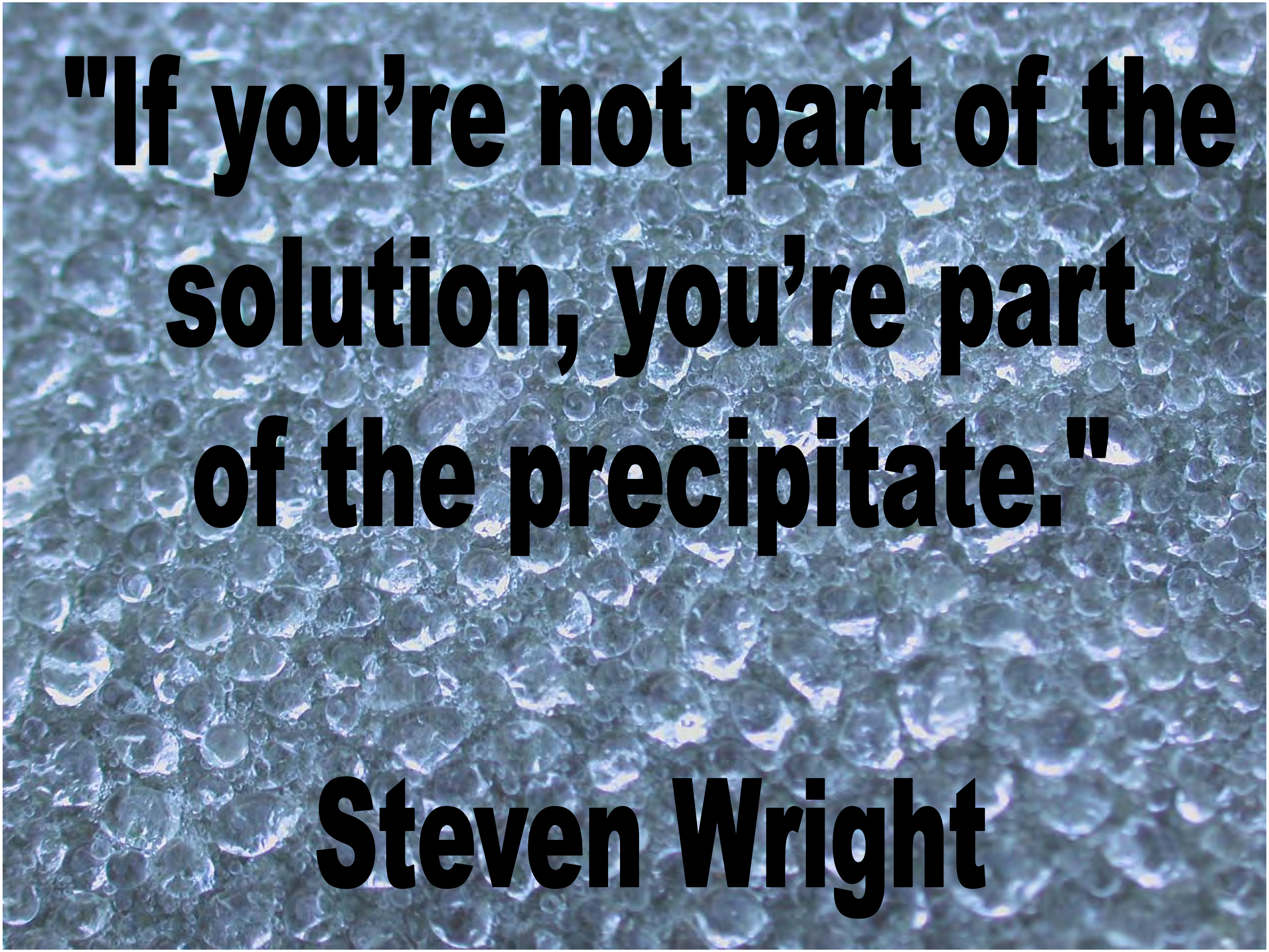

Beaver Range
Current range
Historic range
Outside confirmed historic range
Tappe (1942) proposed range
Drainage divide of Sacramento/San Joaquin and South Coast
Rivers
Lakes
County Boundaries
0 40 80 160 km
N

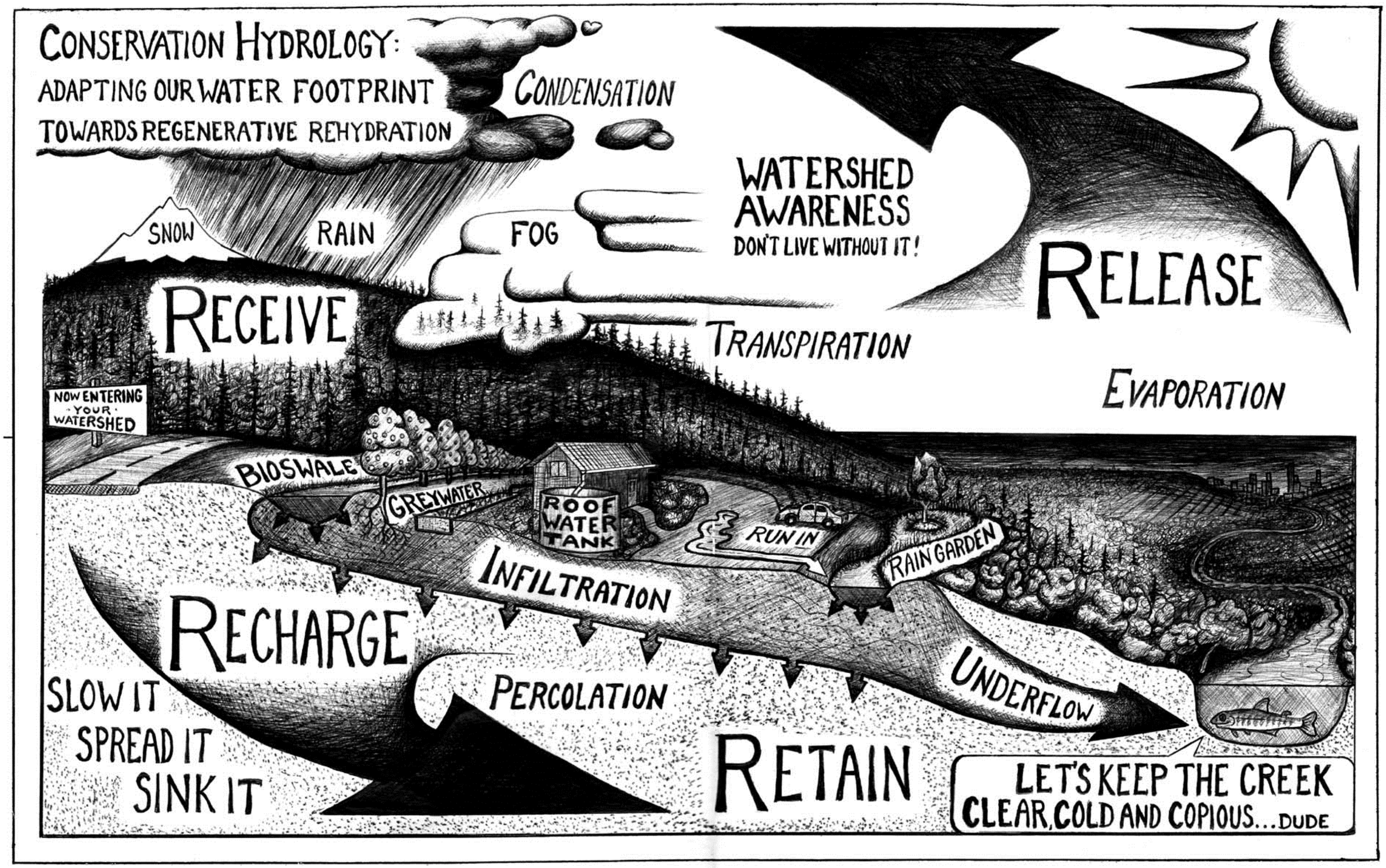


BEAVER IN CALIFORNIA
Creating a Culture of Stewardship
WATER
INSTITUTE
OCCIDENTAL ARTS &
ECOLOGY CENTER
KATE LUNDQUIST with BROCK DOLMAN
Occidental Arts and Ecology Center WATER Institute

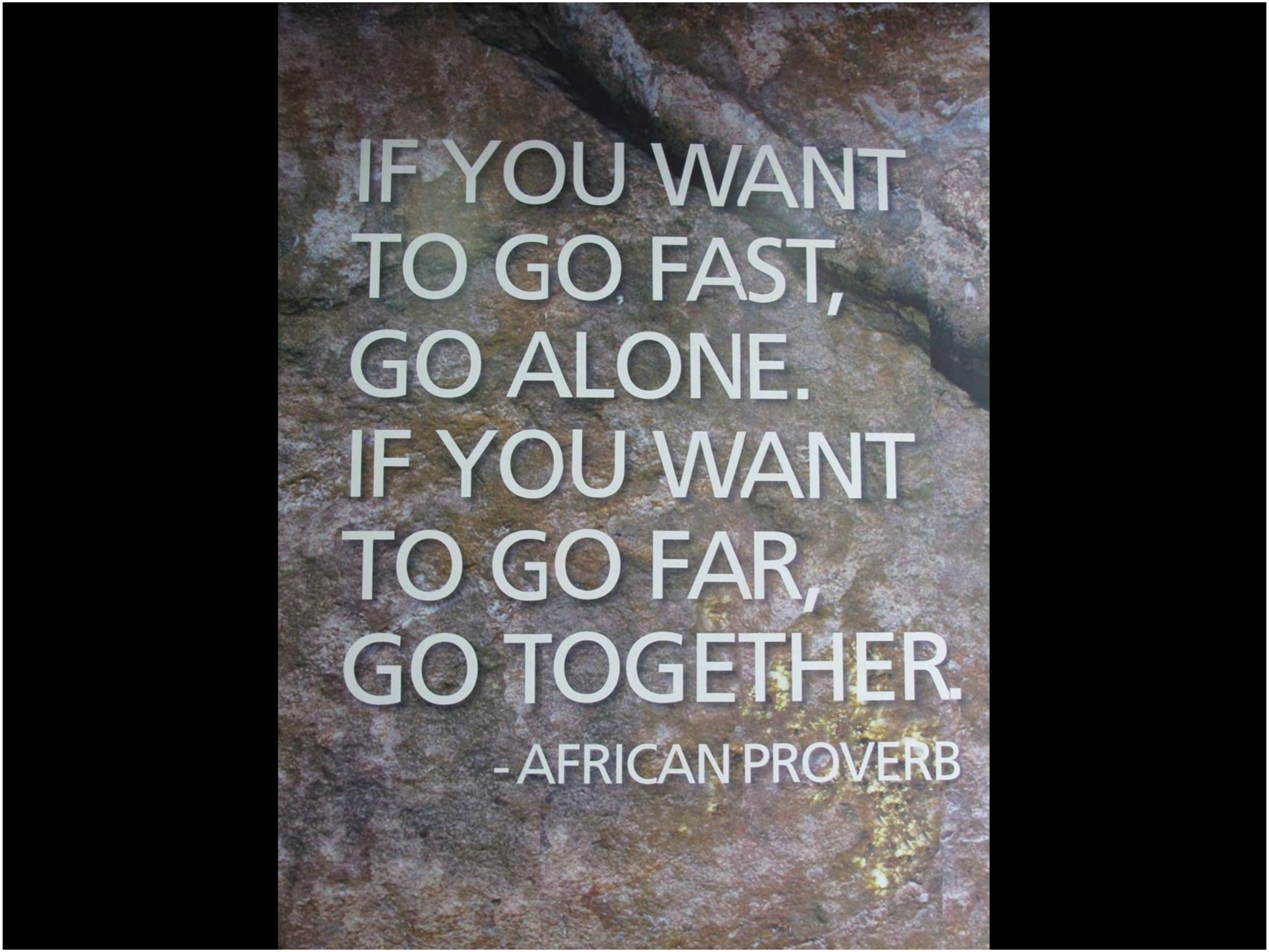

CALIFORNIA REPUBLIC
Bring Back the Beaver
OAEC.org/beaver

Photo by: Jim Coleman


"If you're not part of the solution, you're part of the precipitate."
Steven Wright



By Jim Coleman


IF YOU WANT
TO GO FAST,
GO ALONE.
IF YOU WANT
TO GO FAR,
GO TOGETHER.
- AFRICAN PROVERB

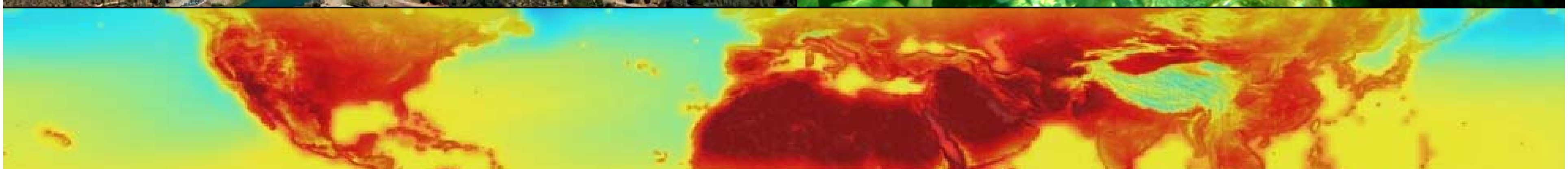
WATER
INSTITUTE

OCCIDENTAL ARTS &
ECOLOGY CENTER

Thank You!!

www.oaec.org

Survive, Thrive, or Die?
Adapting Water Infrastructure to Help Salmon in the Face of Extreme Climate Change



Joshua Strange, Ph.D.
Stillwater Sciences

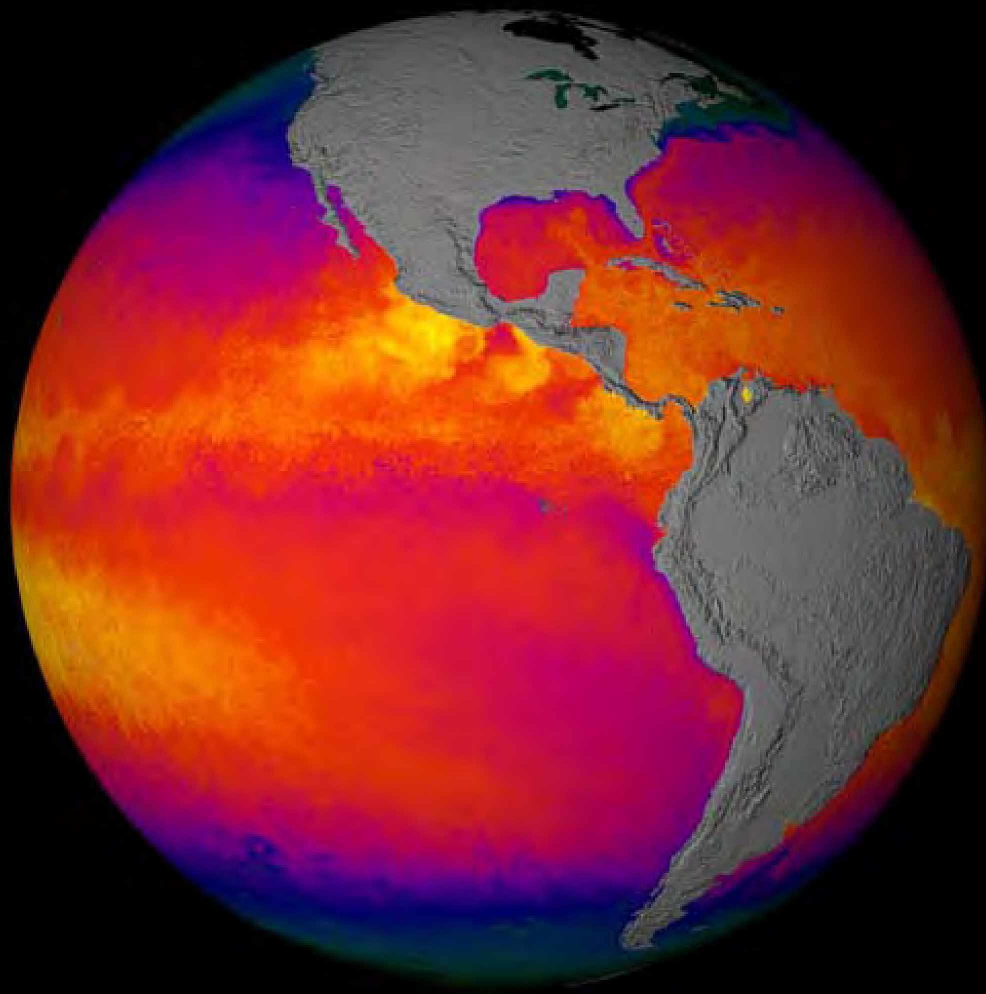
34th Annual Salmonid Restoration Federation Conference


Photo: Jamie Holt

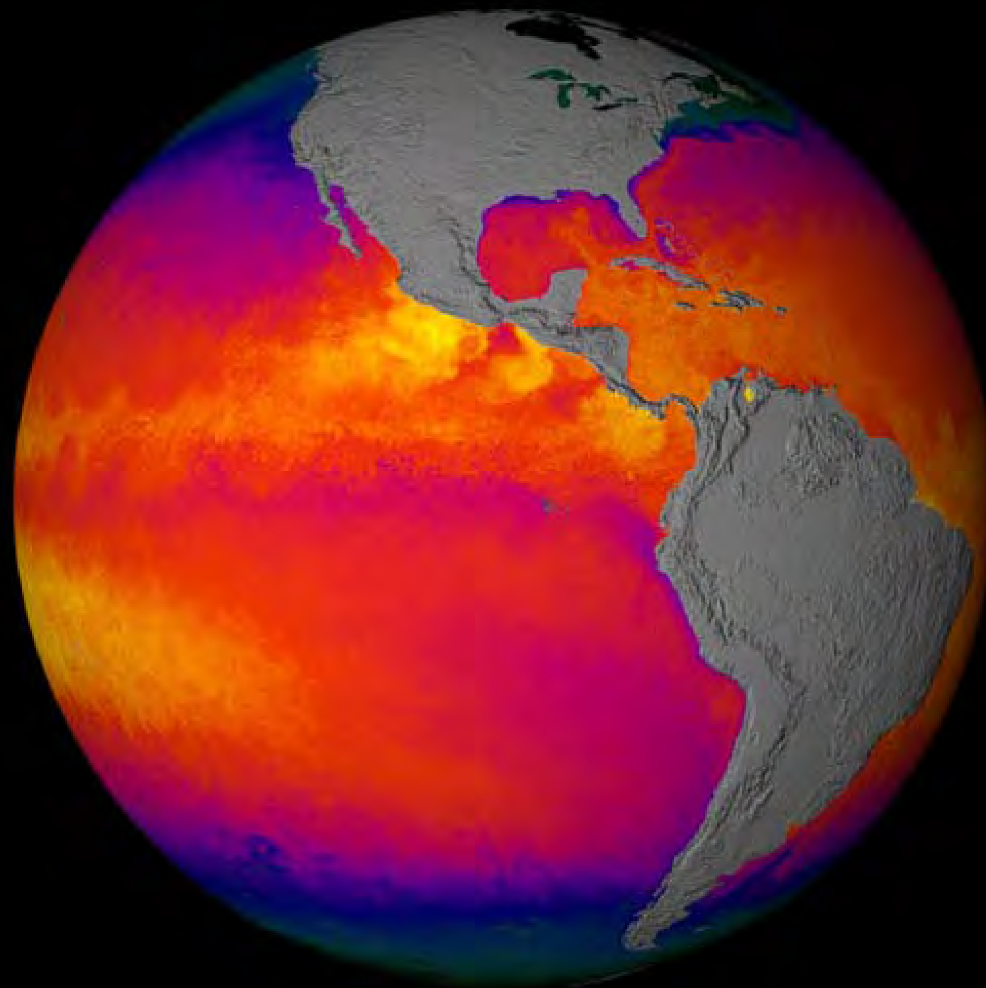
1) Accurately anticipating climatic change impacts;

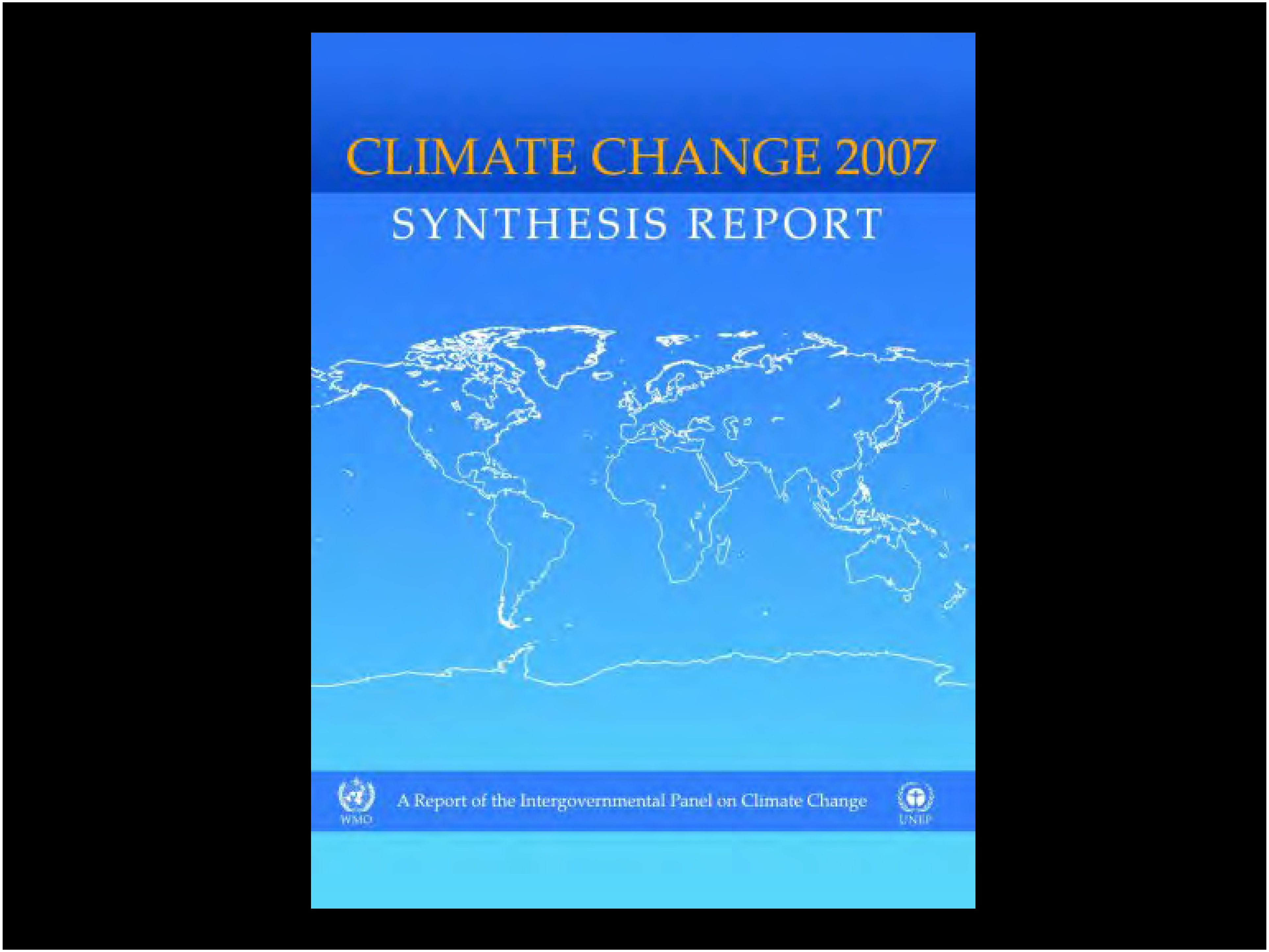
2) Having effective compensating and mitigating tactics and techniques; and,

3) Functional political process that produces policies to implement such tactics and techniques within window of biologic and economic opportunity.

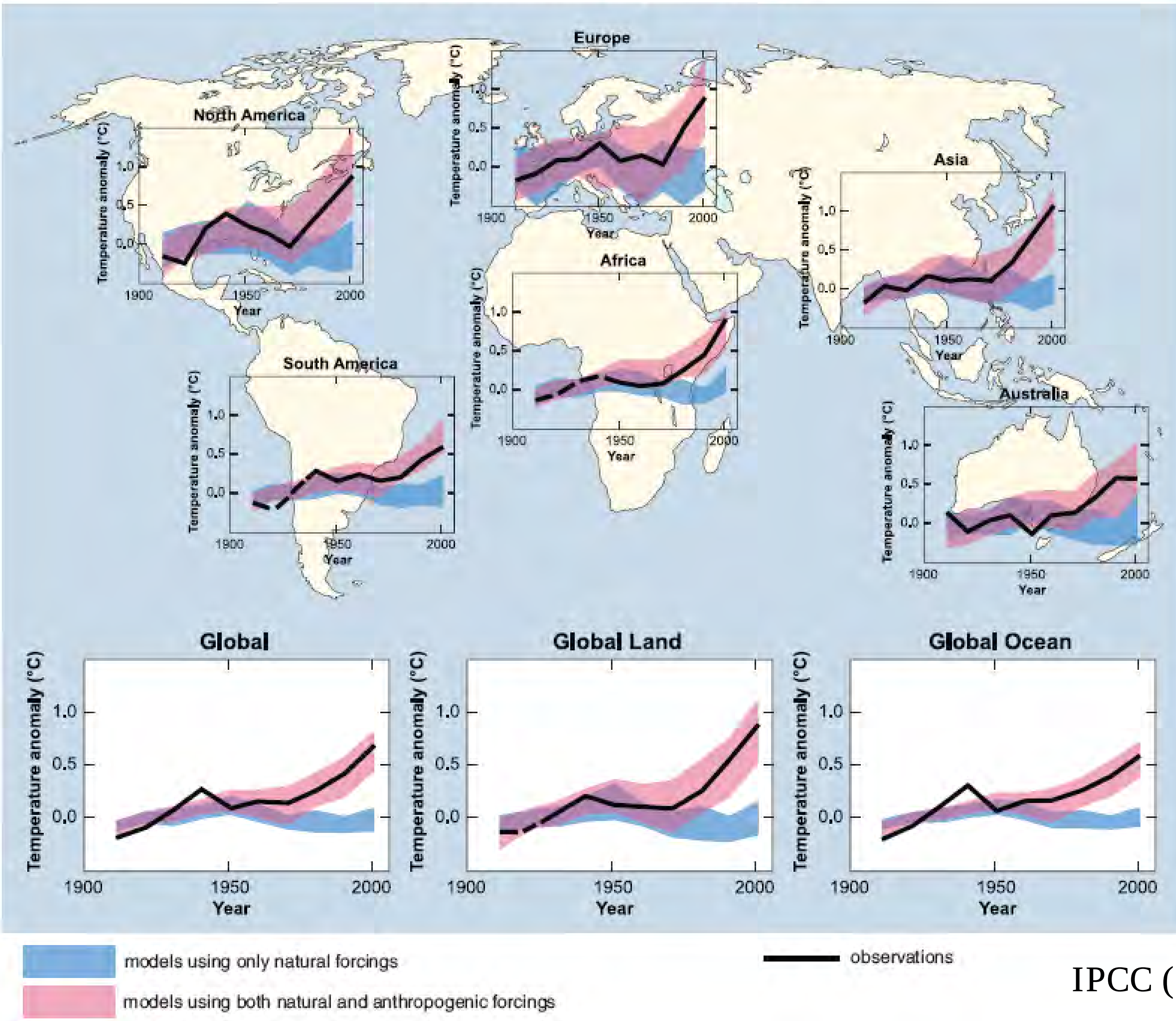


1) Accurately anticipating climatic change impacts;

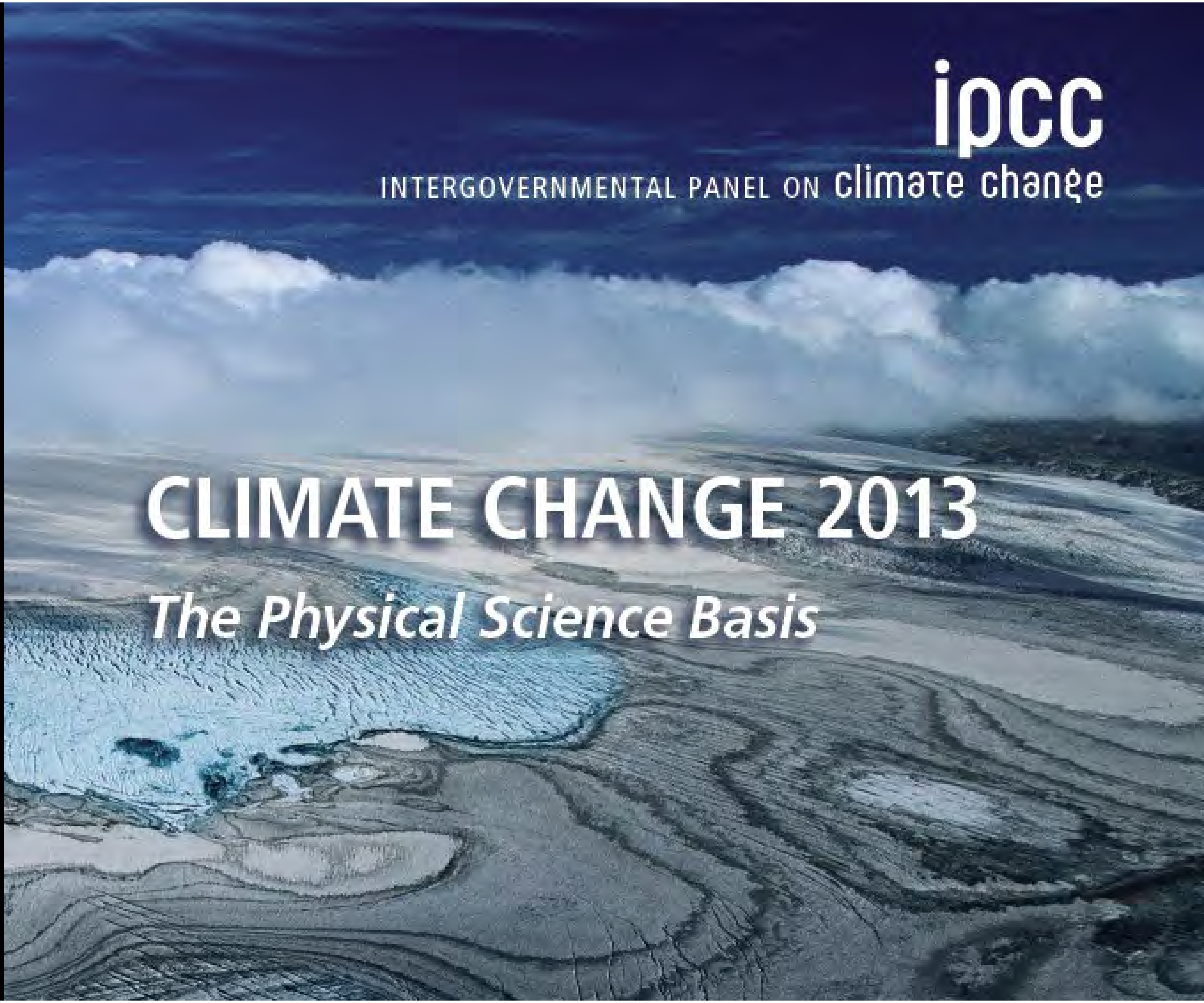



CLIMATE CHANGE 2007
SYNTHESIS REPORT
WMO
A Report of the Intergovernmental Panel on Climate Change
UNEP

Global and continental temperature change



IPCC (2007)


ipcc
INTERGOVERNMENTAL PANEL ON climate change
CLIMATE CHANGE 2013
The Physical Science Basis


119
116
110

nature geoscience

ARTICLES

PUBLISHED ONLINE: 21 MARCH 2016 | DOI: 10.1038/NGEO2681

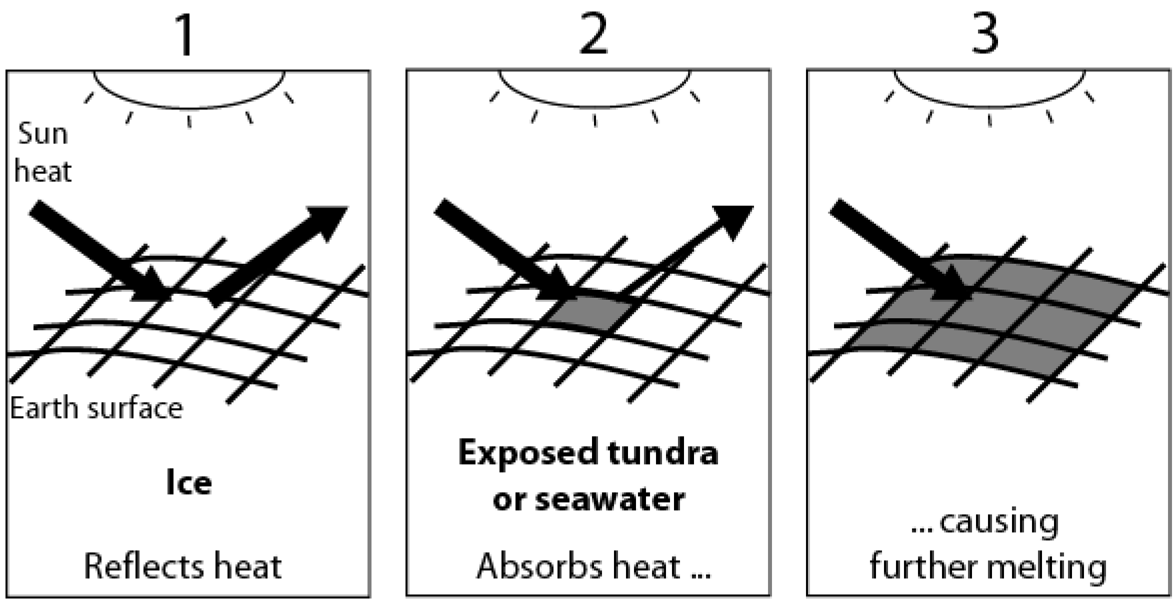
Anthropogenic carbon release rate unprecedented during the past 66 million years

Richard E. Zeebe[1]*, Andy Ridgwell[2,3] and James C. Zachos[4]

Carbon release rates from anthropogenic sources reached a record high of ~10 Pg C yr^{-1} in 2014. Geologic analogues from past transient climate changes could provide invaluable constraints on the response of the climate system to such perturbations, but only if the associated carbon release rates can be reliably reconstructed. The Palaeocene–Eocene Thermal Maximum (PETM) is known at present to have the highest carbon release rates of the past 66 million years, but robust estimates of the initial rate and onset duration are hindered by uncertainties in age models. Here we introduce a new method to extract rates of change from a sedimentary record based on the relative timing of climate and carbon cycle changes, without the need for an age model. We apply this method to stable carbon and oxygen isotope records from the New Jersey shelf using time-series analysis and carbon cycle–climate modelling. We calculate that the initial carbon release during the onset of the PETM occurred over at least 4,000 years. This constrains the maximum sustained PETM carbon release rate to less than 1.1 Pg C yr^{-1}. We conclude that, given currently available records, the present anthropogenic carbon release rate is unprecedented during the past 66 million years. We suggest that such a 'no-analogue' state represents a fundamental challenge in constraining future climate projections. Also, future ecosystem disruptions are likely to exceed the relatively limited extinctions observed at the PETM.

Geological context

Positive feedback mechanisms accelerate change



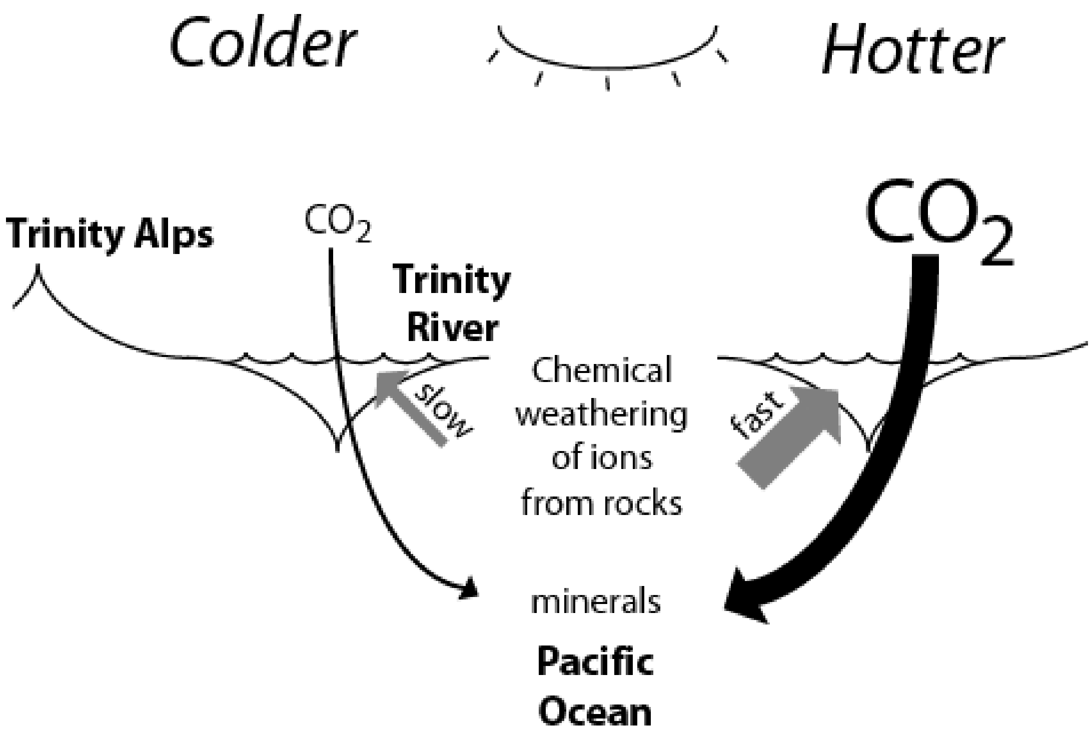
Examples:

• Ice-albedo feedback

• Carbonate dissolution-ocean acidification

Geological context

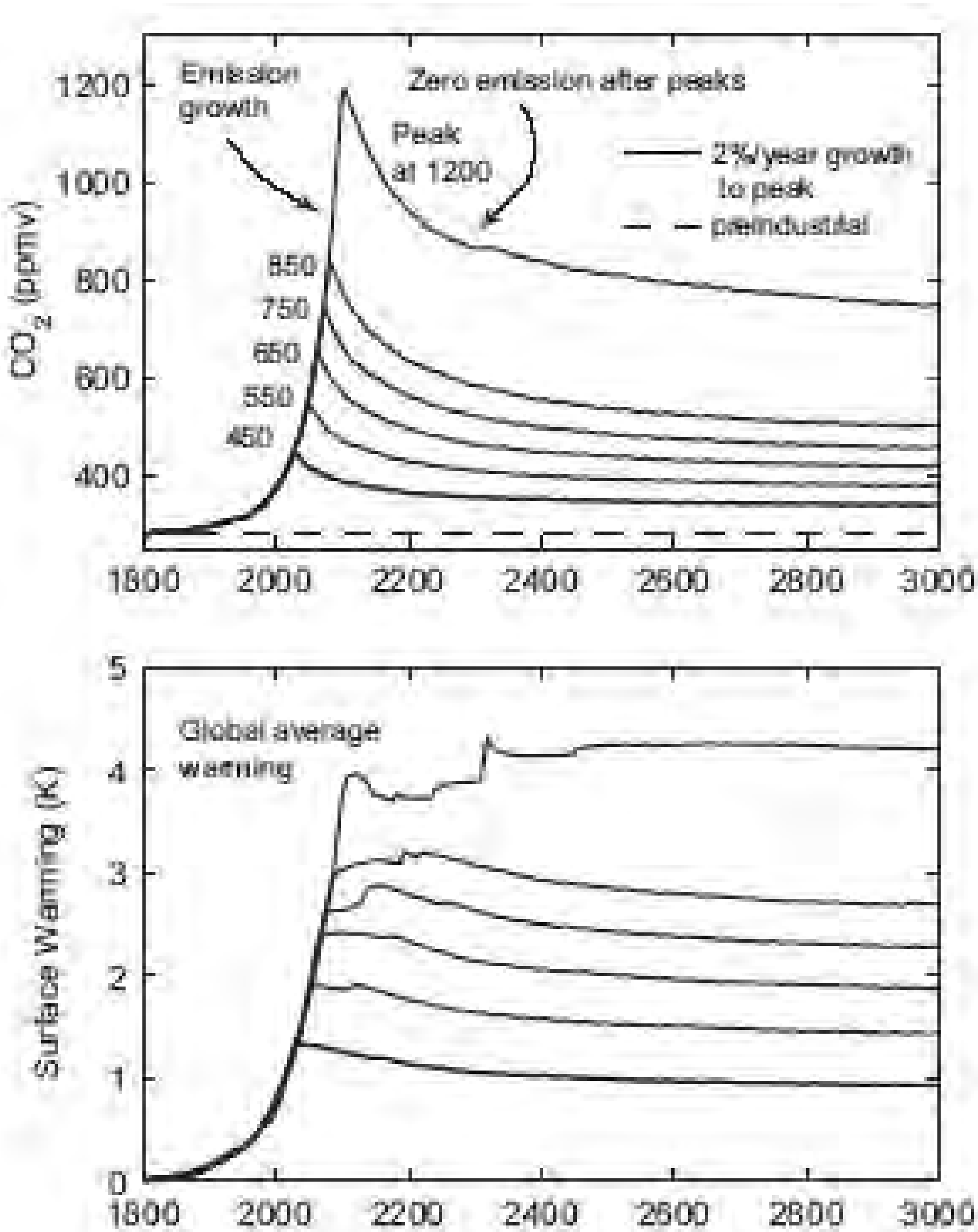
Negative feedback mechanisms limit change



1° Example:

- Calc-silicate feedback cycle

Post-hydrocarbon decay of CO2 and temperatures will be slow



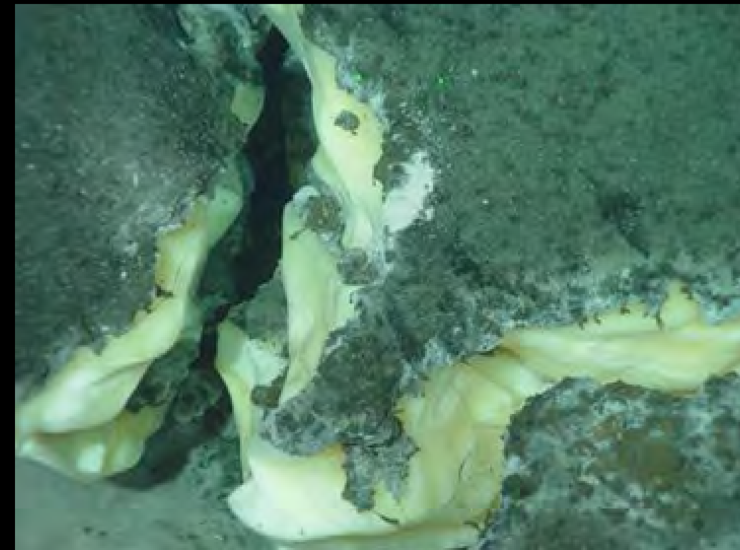
Solomon (2009)

The New York Times

Climate Models May Overstate Clouds' Cooling Power, Research Says

By JOHN SCHWARTZ APRIL 7, 2016


September 16, 2012

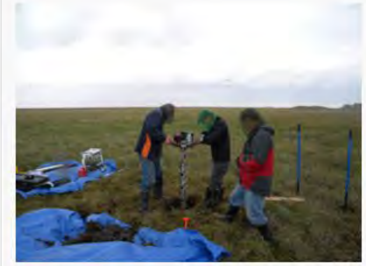



Oct. 31
2013
pm
IASI methane readings
1950+ ppb in yellow
(unified layers)
Tectonic plate
bounderies and
earthquake data
by USGS.gov on
Google earth map
Created by
Sam Carana with
methanetracker.org for
Arctic-news.blogspot.com

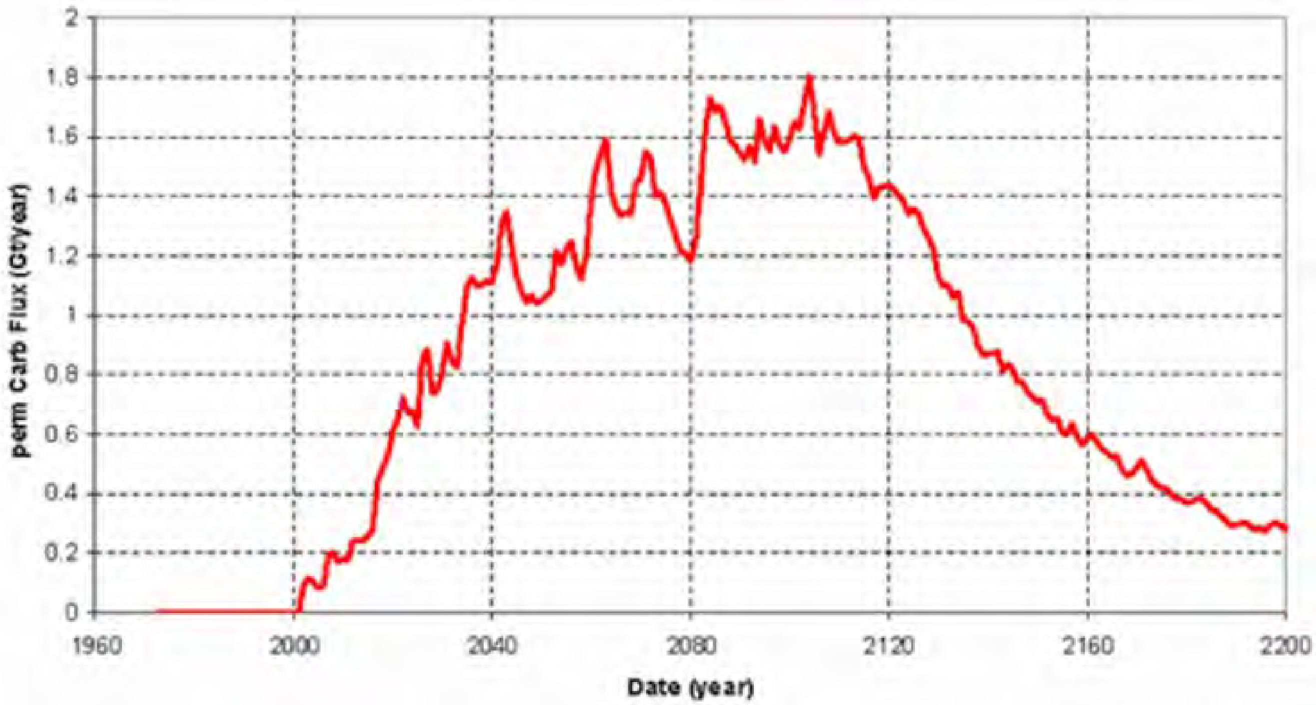
Tellus
SERIES B
CHEMICAL
AND PHYSICAL
METEOROLOGY
PUBLISHED BY THE INTERNATIONAL METEOROLOGICAL INSTITUTE IN STOCKHOLM
Explore this journal >

Amount and timing of permafrost carbon release in response to climate warming

KEVIN SCHAEFER, TINGJUN ZHANG, LORI BRUHWILER, ANDREW P. BARRETT



Kevin Schaefer's research team drills permafrost cores on Alaska's North Slope. New findings by the researchers indicate permafrost in Earth's frozen regions is readying to release vast quantities of carbon into the atmosphere, increasing carbon dioxide levels.
—Credit: Kevin Schaefer, NSIDC/University of Colorado at Boulder



Ice melt, sea level rise and superstorms: evidence from paleoclimate data, climate modeling, and modern observations that 2 °C global warming could be dangerous

James Hansen[1], Makiko Sato[1], Paul Hearty[2], Reto Ruedy[3,4], Maxwell Kelley[3,4], Valerie Masson-Delmotte[5], Gary Russell[4], George Tselioudis[4], Junji Cao[6], Eric Rignot[7,8], Isabella Velicogna[7,8], Blair Tormey[9], Bailey Donovan[10], Evgeniya Kandiano[11], Karina von Schuckmann[12], Pushker Kharecha[1,4], Allegra N. Legrande[4], Michael Bauer[4,13], and Kwok-Wai Lo[3,4]

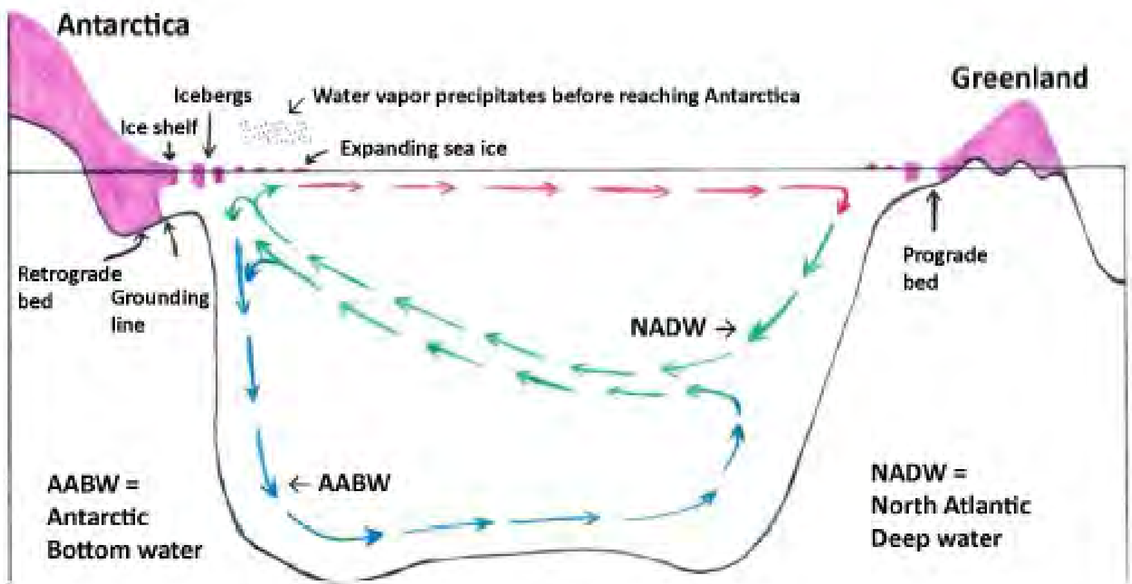


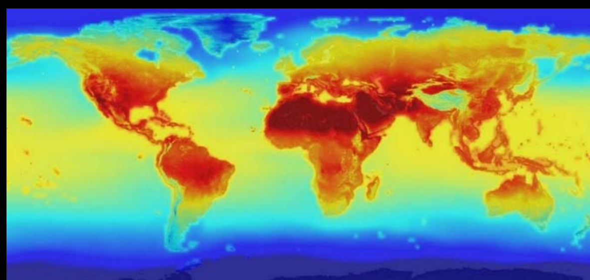
Figure 18. Schematic of stratification and precipitation amplifying feedbacks. Stratification: increased freshwater flux reduces surface water density, thus reducing AABW formation, trapping NADW heat, and increasing ice shelf melt. Precipitation: increased freshwater flux cools ocean mixed layer, increases sea ice area, causing precipitation to fall before it reaches Antarctica, reducing ice sheet growth and increasing ocean surface freshening. Ice in West Antarctica and the Wilkes Basin, East Antarctica, is most vulnerable because of the instability of retrograde beds.

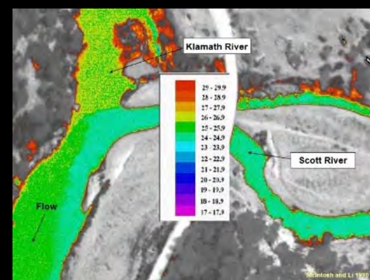
IF ALL THE ICE MELTED

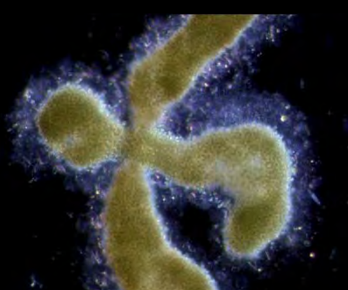
Explore the world's new coastlines if sea level rises 216 feet.

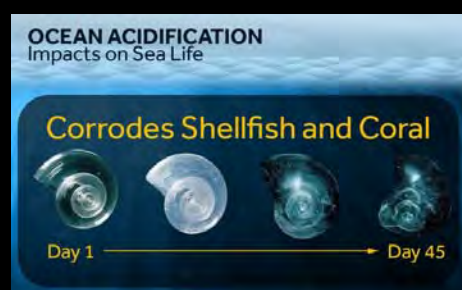
North America

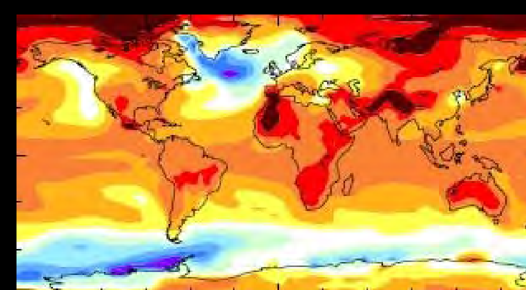
The entire Atlantic seaboard would vanish, along with Florida and the Gulf Coast. In California, San Francisco's hills would become a cluster of islands and the Central Valley a giant bay. The Gulf of California would stretch north past the latitude of San Diego—not that there'd be a San Diego.




Klamath River
Scott River
Flow




OCEAN ACIDIFICATION
Impacts on Sea Life
Corrodes Shellfish and Coral
Day 1
Day 45



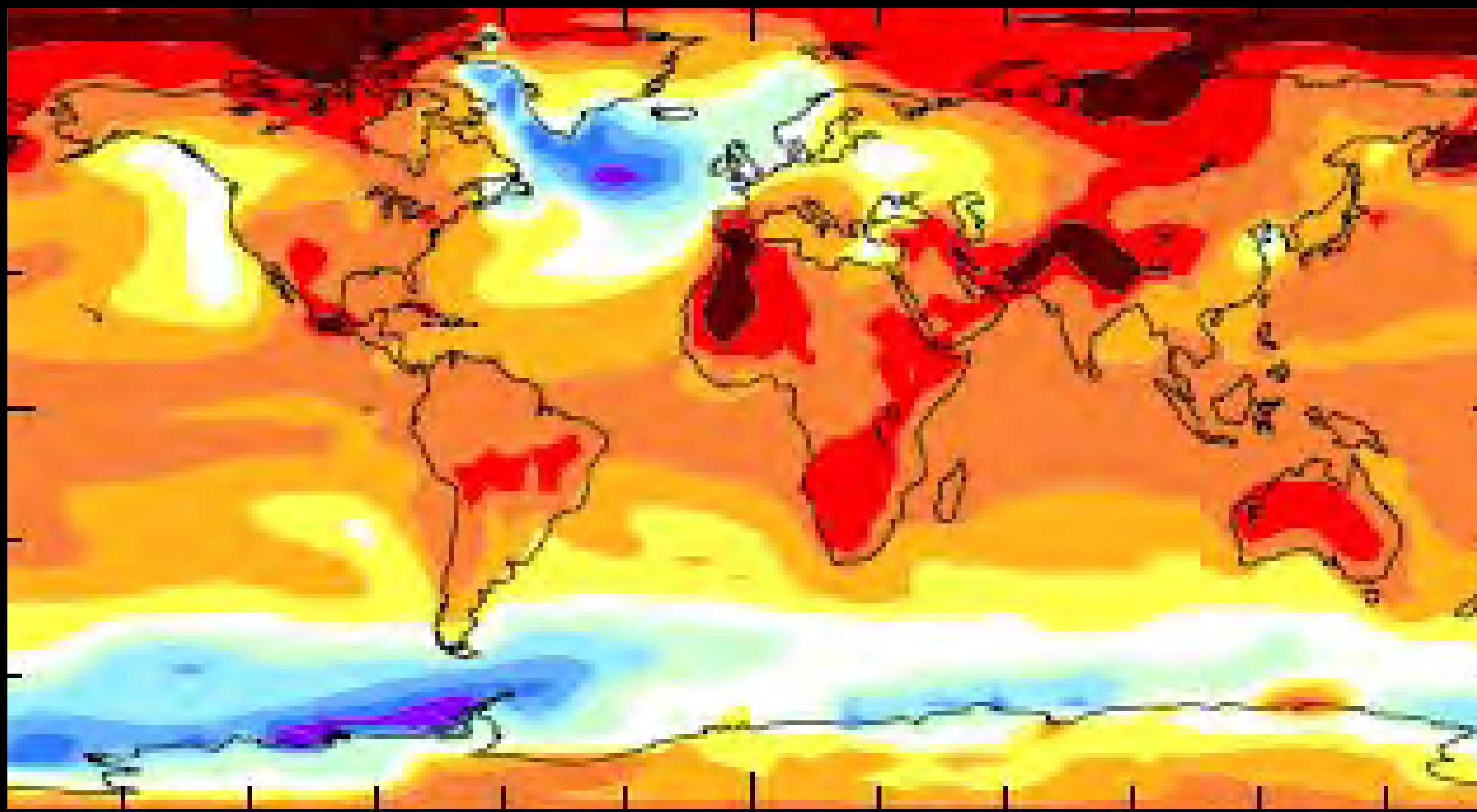
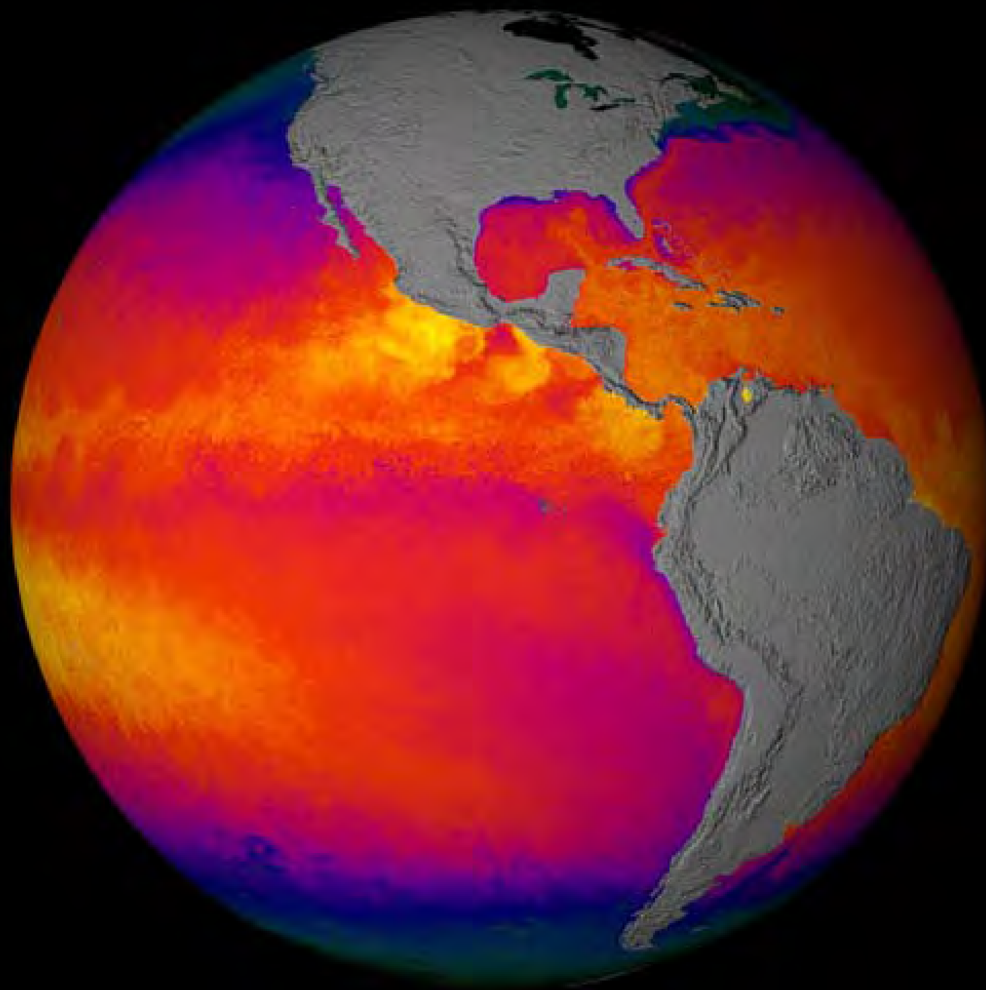



Photo: Jamie Holt

1) *Accurately anticipating climatic change impacts;*

2) Having effective compensating and mitigating tactics and techniques; and,




Redding
Sacramento
San Francisco
Fresno
Los Angeles
San Diego

California's Drought Could Upend America's Entire Food System

BY NATASHA GEILING MAY 5, 2015 8:00 AM

A need to modernize state's water infrastructure

By Mike Mielke and Michael Theriault | July 27, 2015 | Updated: July 27, 2015 4:49pm

After four years of extreme drought conditions across California, there are hopes that an El Niño weather pattern forming in the Pacific Ocean will bring rain this winter. Even the prospect of a wet winter should remind us that we need to update California's water infrastructure to be able to capture, move and store water in wet years so that during future dry years we have a stable water supply.

U.S. | GENERAL NEWS

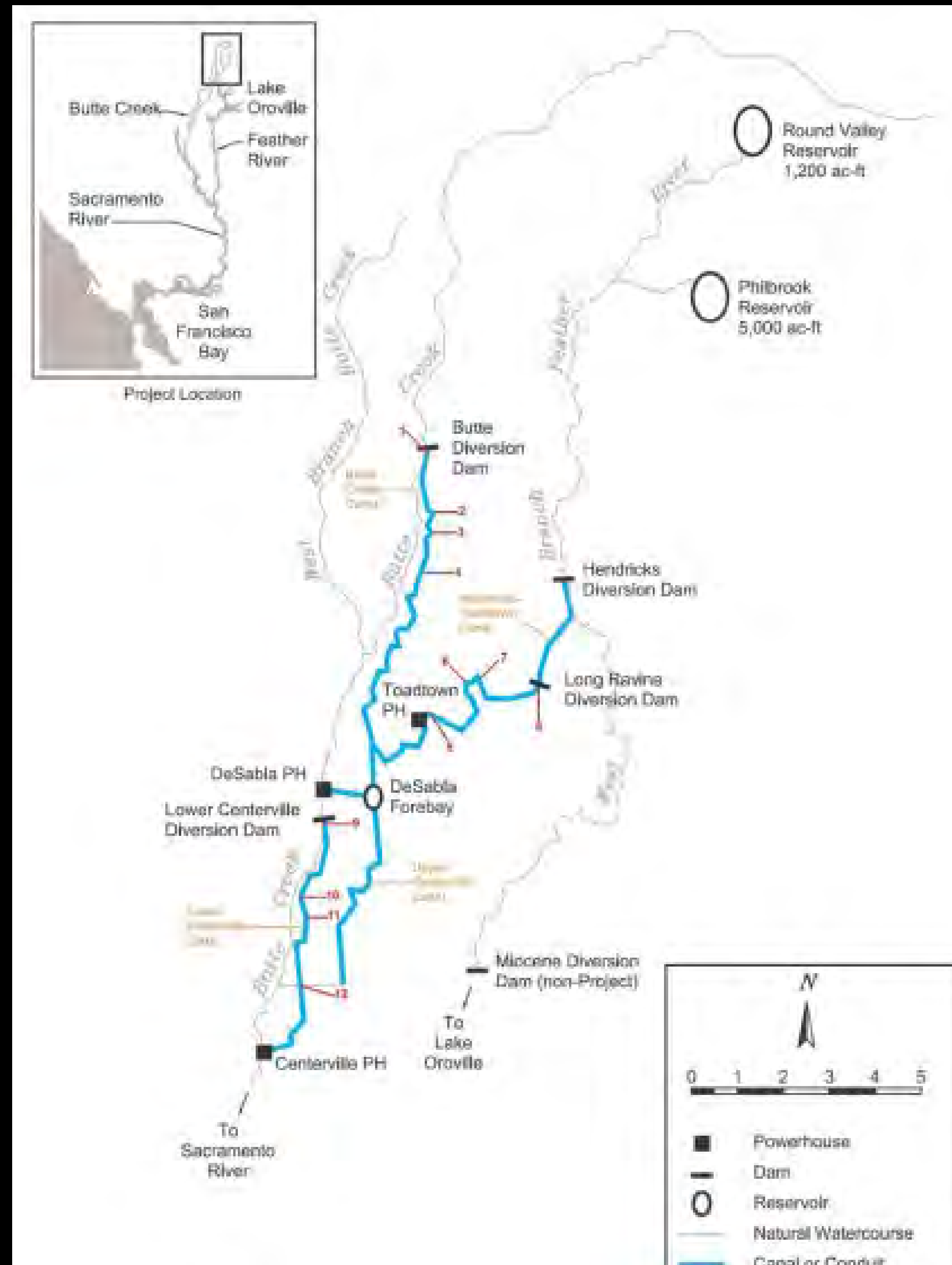
Gov. Brown Signs $1 Billion in Water Infrastructure Bills in a Dry California

Spending will offer some aid to residents hurt by the drought, but much of it will shore up flood-protection structures

Premises

1. Inadequate management and system rules can render optimal infrastructure ineffective

2. Inadequate infrastructure can render optimal management and system rules ineffective



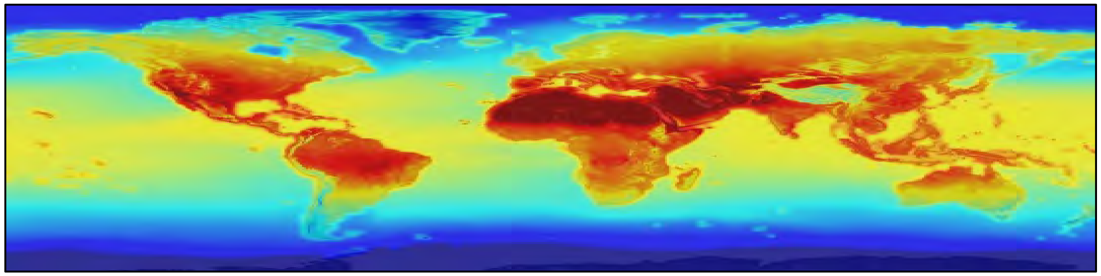
Lake
Oroville
Butte Creek
Feather
River
Sacramento
River
San
Francisco
Bay
Project Location
Round Valley
Reservoir
1,200 ac-ft
Philbrook
Reservoir
5,000 ac-ft
Butte
Diversion
Dam
Hendricks
Diversion Dam
Long Ravine
Diversion Dam
Toadtown
PH
DeSabla PH
DeSabla
Forebay
Lower Centerville
Diversion Dam
Miocene Diversion
Dam (non-Project)
To
Lake
Oroville
Centerville PH
To
Sacramento
River
N
0 1 2 3 4 5
Powerhouse
Dam
Reservoir
Natural Watercourse
Canal or Conduit

Bleak future for spring-run Chinook salmon

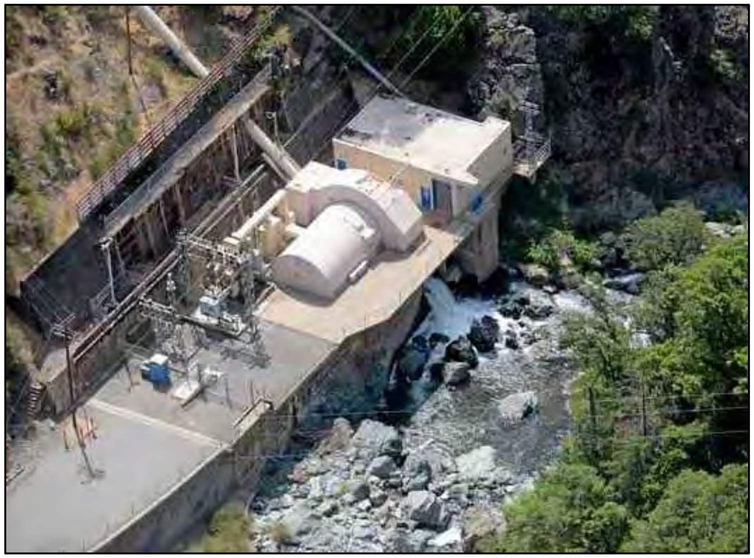
Water Management Adaptations to Prevent Loss of Spring-Run Chinook Salmon in California under Climate Change

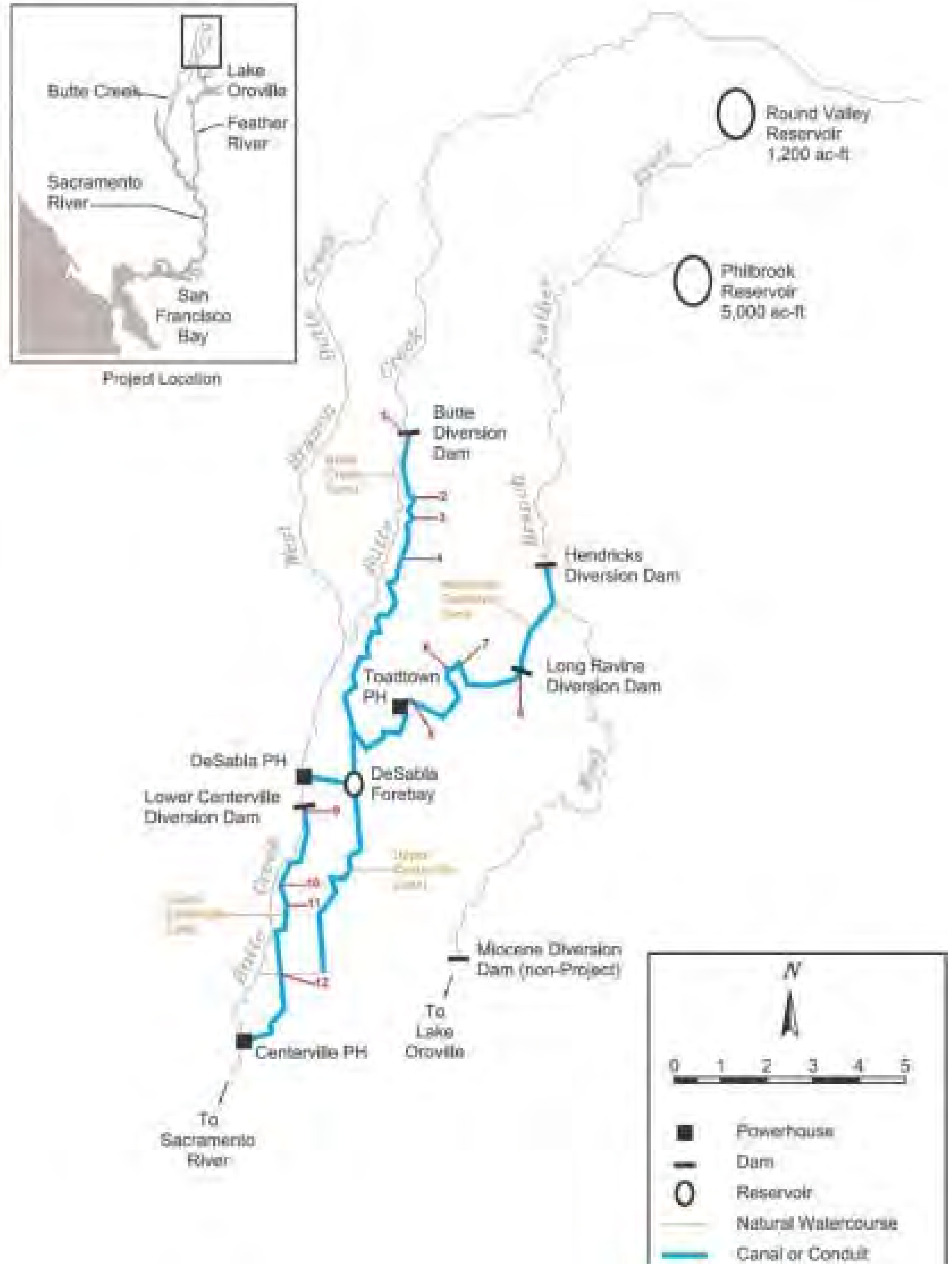
Lisa C. Thompson[1]; Marisa I. Escobar[2]; Christopher M. Mosser[3]; David R. Purkey[4]; David Yates[5]; and Peter B. Moyle[6]

Abstract: Spring-run Chinook salmon (*Oncorhynchus tshawytscha*) are particularly vulnerable to climate change because adults over-summer in freshwater streams before spawning in autumn. We examined streamflow and water temperature regimes that could lead to long-term reductions in spring-run Chinook salmon (SRCS) in a California stream and evaluated management adaptations to ameliorate these impacts. Bias-corrected and spatially downscaled climate data from six general circulation models and two emission scenarios for the period 2010–2099 were used as input to two linked models: a water evaluation and planning (WEAP) model to simulate weekly mean streamflow and water temperature in Butte Creek, California that were used as input to SALMOD, a spatially explicit and size/stage structured model of salmon population dynamics in freshwater systems. For all climate scenarios and model combinations, WEAP yielded lower summer base flows and higher water temperatures relative to historical conditions, while SALMOD yielded increased adult summer thermal mortality and population declines. Of management adaptations tested, only ceasing water diversion for power production from the summer holding reach resulted in cooler water temperatures, more adults surviving to spawn, and extended population survival time, albeit with a significant loss of power production. The most important conclusion of this work is that long-term survival of SRCS in Butte Creek is unlikely in the face of climate change and that simple changes to water operations are not likely to dramatically change vulnerability to extinction.
DOI: 10.1061/(ASCE)WR.1943-5452.0000194.



Resiliency factors in a warming world:

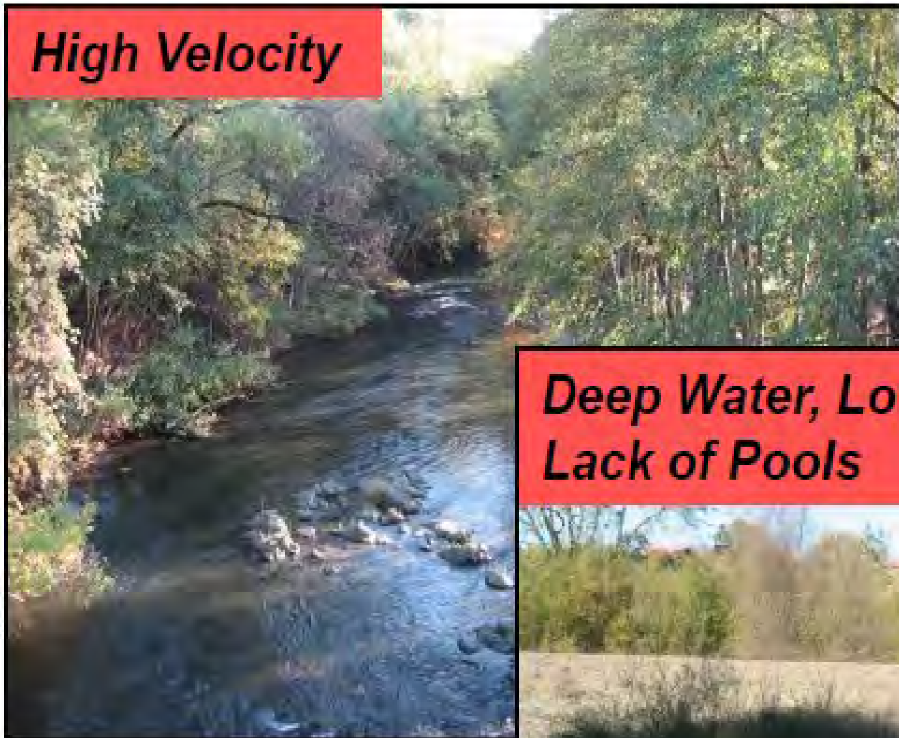




Butte Creek
Lake Oroville
Feather River
Sacramento River
San Francisco Bay
Project Location
Round Valley Reservoir 1,200 ac-ft
Philbrook Reservoir 5,000 ac-ft
Butte Diversion Dam
Hendricks Diversion Dam
Long Ravine Diversion Dam
Toadtown PH
DeSabla PH
DeSabla Forebay
Lower Centerville Diversion Dam
Miocene Diversion Dam (non-Project)
To Lake Oroville
Centerville PH
To Sacramento River
N
0 1 2 3 4 5
Powerhouse
Dam
Reservoir
Natural Watercourse
Canal or Conduit

Photo: Thomas Dunklin





High Velocity


Deep Water, Low Cover,
Lack of Pools

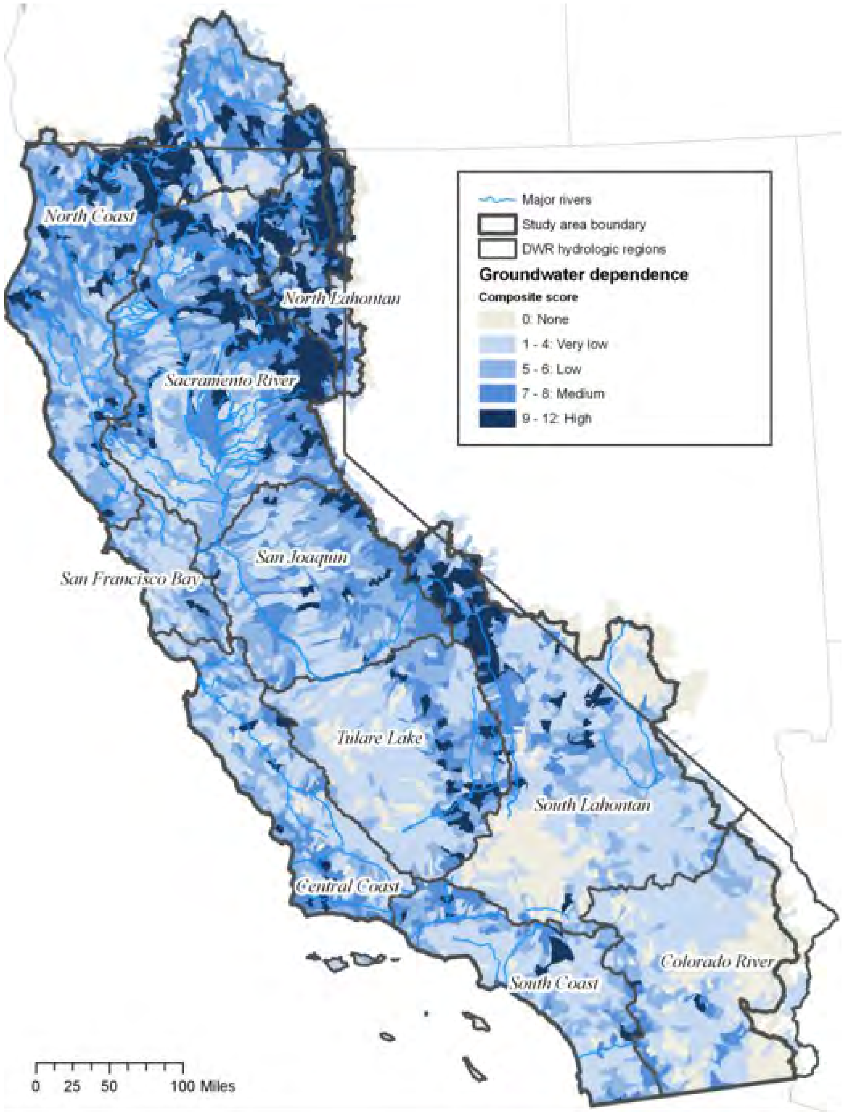

Geomorphic Challenges

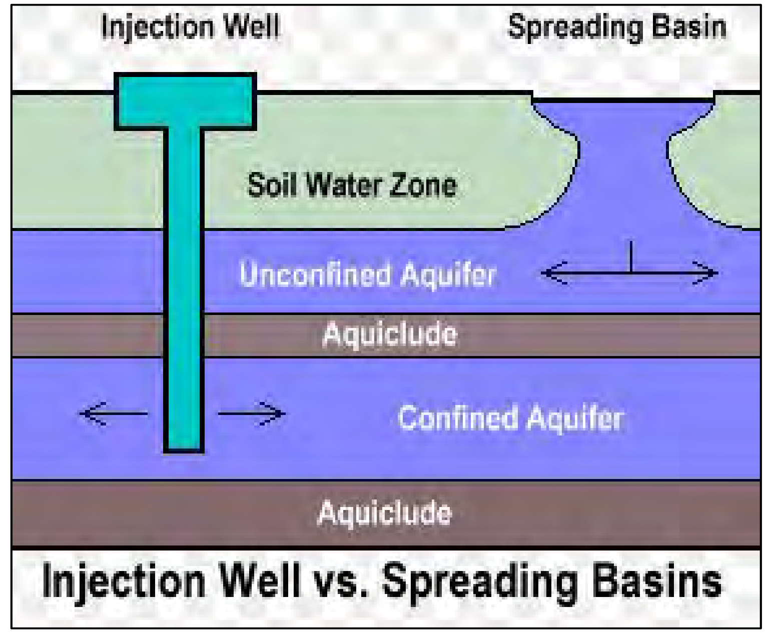

River
Floodplain

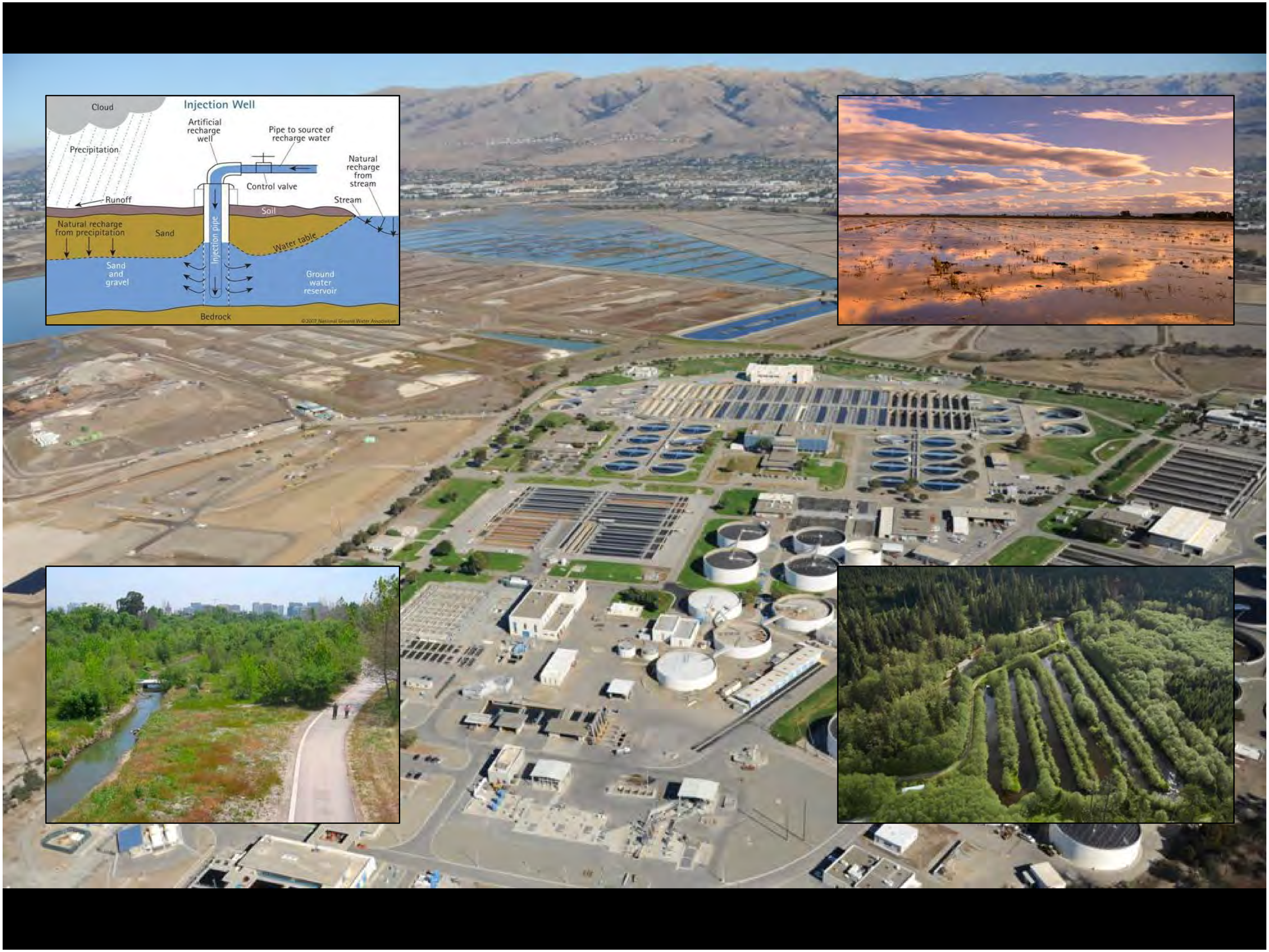

CALIFORNIA TROUT
FISH · WATER · PEOPLE

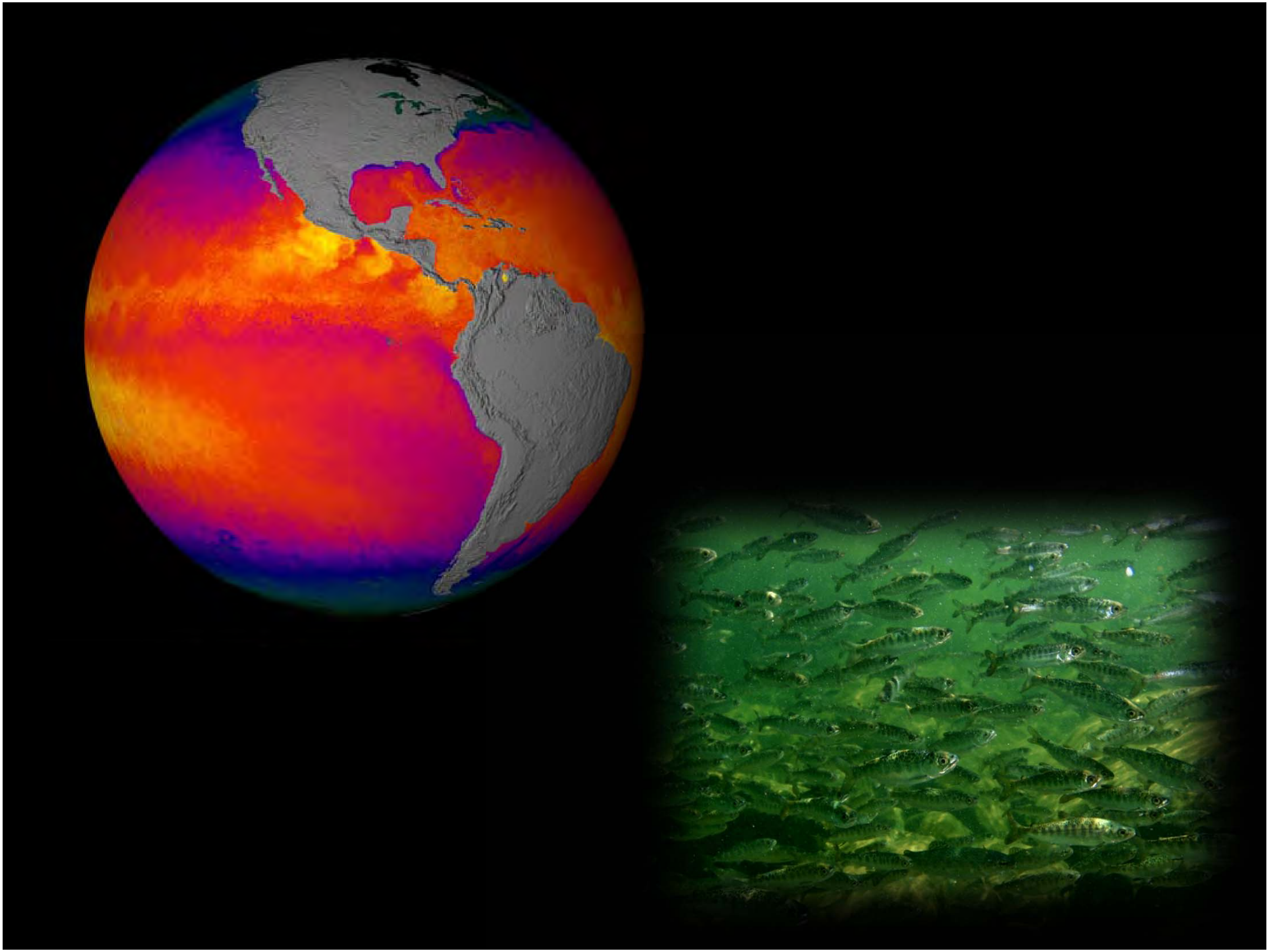

Carson Jeffres




North Coast
North Lahontan
Sacramento River
San Francisco Bay
San Joaquin
Tulare Lake
South Lahontan
Central Coast
South Coast
Colorado River
Major rivers
Study area boundary
DWR hydrologic regions
Groundwater dependence
Composite score
0: None
1 - 4: Very low
5 - 6: Low
7 - 8: Medium
9 - 12: High
0 25 50 100 Miles


Injection Well
Spreading Basin
Soil Water Zone
Unconfined Aquifer
Aquiclude
Confined Aquifer
Aquiclude
Injection Well vs. Spreading Basins


Injection Well
Cloud
Precipitation
Artificial recharge well
Pipe to source of recharge water
Control valve
Natural recharge from stream
Runoff
Stream
Soil
Natural recharge from precipitation
Sand
Injection pipe
Water table
Sand and gravel
Ground water reservoir
Bedrock



[redacted]