Growing Impacts:
Cannabis and Instream Flows

37th Annual Salmonid Restoration Conference

April 24, 2019

9:00am – 5:00pm

Session Coordinators:

Elijah Portugal, CDFW

Eli Asarian, Riverbend Sciences

Similar to other forms of agriculture, the commercial production of cannabis has the potential to cause environmental impacts, both hydrological and biological. The history of illegality of the cannabis industry has focused production primarily in small headwater tributaries in northern California and Oregon where threatened and endangered aquatic and terrestrial species overlap with a high density of cannabis cultivation. In many cases, decades of aquatic habitat restoration primarily intended to benefit salmonids has occurred in many of these same watersheds. Many entities have made considerable effort to understand and reduce the negative impacts resulting from the dramatic increase in the scale of the cannabis industry over the past decade. Through a combination of presentations and discussions with diverse representation from state agency staff, academic researchers, private consultants and NGOs, this workshop will explore the impacts of large-scale cannabis agriculture on rivers and streams, with a focus on hydrology. Specific topics will include: 1) quantifying the recent expansion of cannabis production, 2) hydrological and ecological effects of cannabis production, 3) diverse perspectives on California's system for regulating the environmental impacts of cannabis production, and 4) opportunities and challenges for improving farming practices.

Growing Impacts: Cannabis and Instream Flows

The green rush is real: quantifying the rapid expansion of cannabis cultivation in northern California, 2012-2016

Jennifer Carah, The Nature Conservancy; Van Butsic, UC Berkeley; Matthias Baumann, Humboldt University of Berlin; Connor Stephens, UC Berkeley; and Jake Brenner, Ithaca College

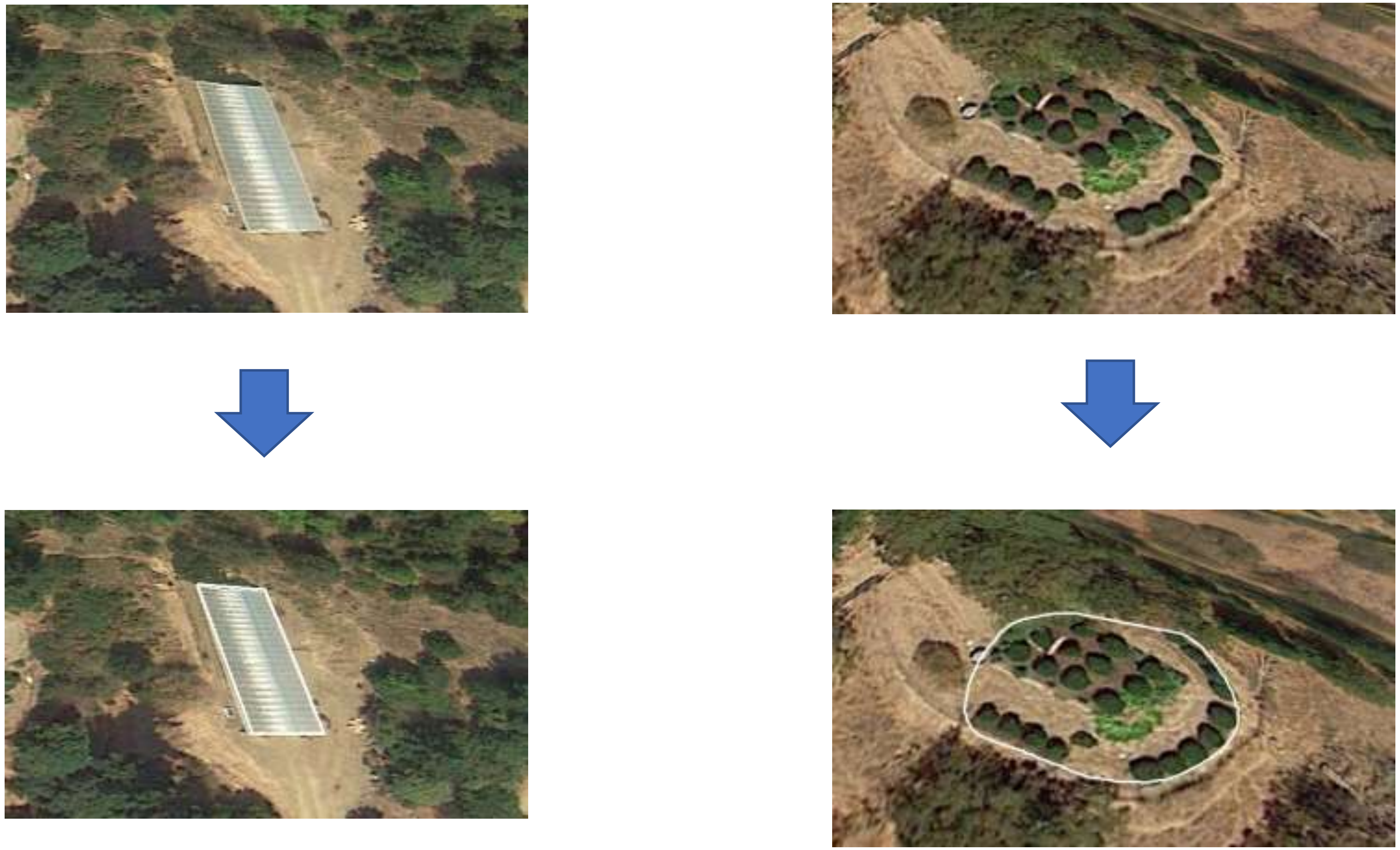
Agricultural frontiers can form where there is an abundance of occupiable land that becomes cultivated when the income from agriculture greatly overcomes the costs of farming and distribution.


Scott Bauer, CDFW

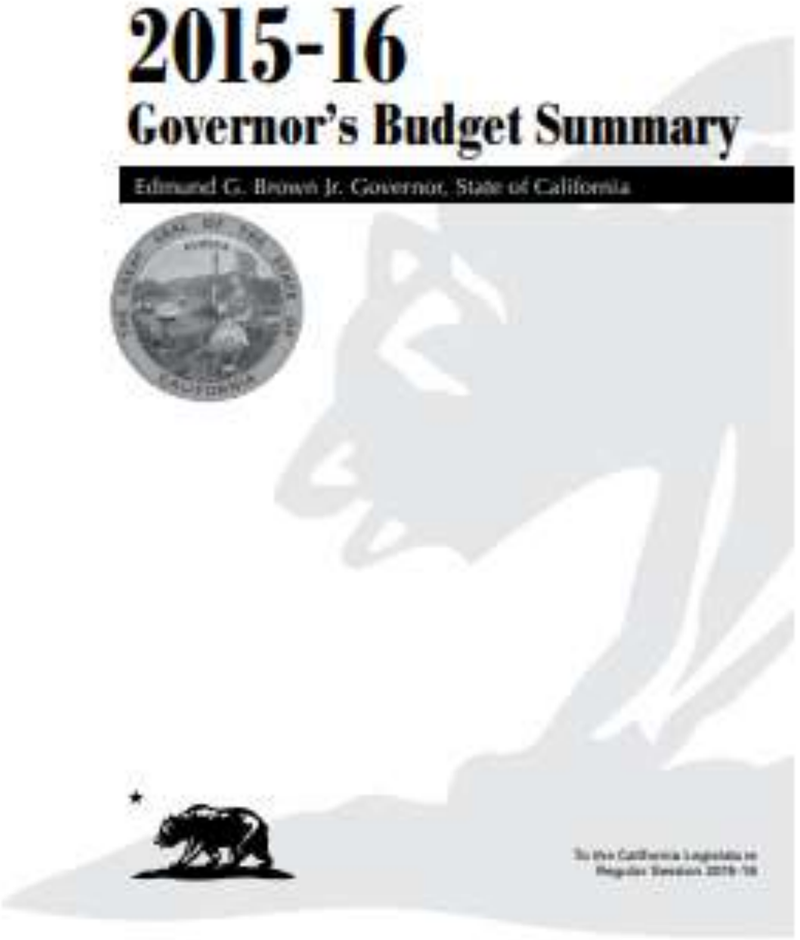
Methods

- 2012 – 2016
- Representative sample – 50% of HUC 12s
- Site count, size, type, number of plants, farm count
- Distance to high quality salmonid habitat
- Distance to paved roads
- Distance to public lands
- Slope

Methods



Methods


2015-16
Governor's Budget Summary
Edmund G. Brown Jr. Governor, State of California

Results

Year	County	# of sites	% increase in sites	Mean # of plants	% increase in # plants per site	Total plants	% increase in # of plants	Greenhouse area (sq. km)	Outdoor area (sq. km)	Total area (sq. km)	% increase in total area
2012	Humboldt	3,763		85		319199		0.21	0.79	1.00	
2016	Humboldt	6,637	76%	119	41%	792788	148%	0.61	1.09	1.70	71%
2012	Mendocino	3,930		53		208685		0.11	0.91	1.02	
2016	Mendocino	6,723	71%	88	65%	590693	183%	0.43	1.63	2.06	102%
2012	Total	7,693		68		524336		0.32	1.69	2.02	
2016	Total	13,360	74%	104	52%	1383481	164%	1.04	2.72	3.76	86%

Results

Year	County	0-500 m of streams	500-1000 m of streams	>1000 m of streams	% increase within 500 m of streams	% of sites within 500 m of streams
2012	Humboldt	3,271	441	51		87%
2016	Humboldt	6,034	591	12	84%	91%
2012	Mendocino	3,316	539	75		84%
2016	Mendocino	5,988	713	22	81%	89%
2012	Total	6,587	980	126		86%
2016	Total	12,022	1,304	34	83%	90%

Results

Year	County	0-500 m of high priority coho habitat	500-1000 m of high priority coho habitat	>1000 m of high priority coho habitat	% increase in sites within 500m of high priority coho habitat	% of sites within 500 m of high priority coho habitat	0-500 m of high priority steelhead habitat	500-1000m of high priority steelhead habitat	>1000 m of high priority steelhead habitat	% increase in sites within 500m of high priority steelhead habitat	% of sites within 500 m of high priority steelhead habitat
2012	Humboldt	429	363	2971		11%	1267	1069	1427		34%
2016	Humboldt	956	834	4847	123%	14%	2318	1845	2474	83%	35%
2012	Mendocino	719	509	2702		18%	1172	1253	1505		30%
2016	Mendocino	1383	874	4466	92%	21%	1993	2047	2683	70%	30%
2012	Total	1148	872	5673		15%	2439	2322	2932		32%
2016	Total	2339	1708	9313	104%	18%	4311	3892	5157	77%	32%

Results

Year	County	0-5 degrees slope	5-15 degrees slope	15-30 degrees	greater than 30 degrees	% increase on slopes 15-30 degrees	% increase on slopes >30 degrees	% on slopes 15-30 degrees	% on slopes >30 degrees
2012	Humboldt	648	1,008	2,086	21			55%	1%
2016	Humboldt	1,380	1,624	3,599	34	73%	62%	54%	1%
2012	Mendocino	1,064	1,182	1,627	57			41%	1%
2016	Mendocino	2,373	1,530	2,744	76	69%	33%	41%	1%
2012	Total	1,712	2,190	3,713	78			48%	1%
2016	Total	3,753	3,154	6,343	110	71%	41%	47%	1%

Results

88% of areas developed for cannabis cultivation were formerly covered in natural vegetation as late as 2006

Results

	Cannabis allocations by fiscal year (U.S. Dollars)					
	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
Dept. of Public Health	461,000	482,000	208,000	138,000	574,000	3,639,000
Dept. of Fish and Wildlife				500,000	503,000	7,655,000
State Water Resources Control Board				1,800,000		5,685,000
Dept. of Pesticide Regulation						700,000
California Dept. of Food and Agriculture						5,355,000
Dept. of Consumer Affairs, Bureau of Medical Marijuana Regulation					1,600,000	3,781,000
Total by fiscal year	461,000	482,000	208,000	2,438,000	2,677,000	26,815,000

Summary

- 74% increase in number of sites
- 164% increase in number of plants
- 86% increase in area under cultivation
- 90% of sites within 500 m of streams
- 18% of sites within 500 m of high priority coho habitat
- 32% of sites within 500m of high priority steelhead habitat
- 88% of sites were formerly covered in natural vegetation as late as 2006
- Until 18 years into medical production, no state funds had been allocated for the regulation of cultivation and production of cannabis

That is so 2016

- How have things changed since then?
  - New work in progress
- Quick comparison
  - Our estimate – 13,274 cultivation sites in Humboldt Co. (2016)
  - Humboldt Co. April 2019 permit application data - ~1,490 active applications or approved applications for licenses
  - How many unlicensed sites persist?

- Open access pdf available on Environmental Research Letter's website at: https://doi.org/10.1088/1748-9326/aaeade
- Acknowledgements: Van Butsic, UC Berkeley; Matthias Baumann, Humboldt University of Berlin; Connor Stephens, UC Berkeley; and Jake Brenner, Ithaca College. Funding from The Nature Conservancy.
- UC Berkeley Cannabis Research Center - https://crc.berkeley.edu/
- jcarah@tnc.org

Year	County	0-500 m to paved roads	500-1000 m to paved roads	>1km to paved roads	% increase at 500-1000 m to paved roads	% increase at > 1km to paved roads	% at 500-1000 m to paved roads	% at > 1km to paved roads
2012	Humboldt	2719	509	535			14%	14%
2016	Humboldt	5181	752	704	48%	32%	11%	11%
2012	Mendocino	3019	435	476			11%	12%
2016	Mendocino	5267	730	726	68%	53%	11%	11%
2012	Total	5738	944	1011			12%	13%
2016	Total	10448	1482	1430	57%	41%	11%	11%

		On public land	0-500m from public land	500-1000m from public land	> than 1km from public land	% increase on public land	% increase on lands withing 500m of public land	% on public land	% within 500 m of public land
2012	Humboldt	36	814	562	2351			1%	22%
2016	Humboldt	73	1634	980	3950	103%	101%	1%	25%
2012	Mendocino	20	525	510	2875			1%	13%
2016	Mendocino	42	925	827	4929	110%	76%	1%	14%
2012	Total	56	1339	1072	5226			1%	17%
2016	Total	115	2559	1807	8879	105%	91%	1%	19%

UC DAVIS
UNIVERSITY OF CALIFORNIA

UtahState University
UTAH WATER RESEARCH LABORATORY

Application of ecologically-based flow metrics for cannabis-impaired streams

Noelle Patterson
Dr. Samuel Sandoval Solis & Dr. Belize Lane
April 2019

Overview

1. Functional Flows Calculator: background and theory
2. Online tool at eFlows.ucdavis.edu
3. Application to a cannabis-impaired reach

Functional Flows Theory

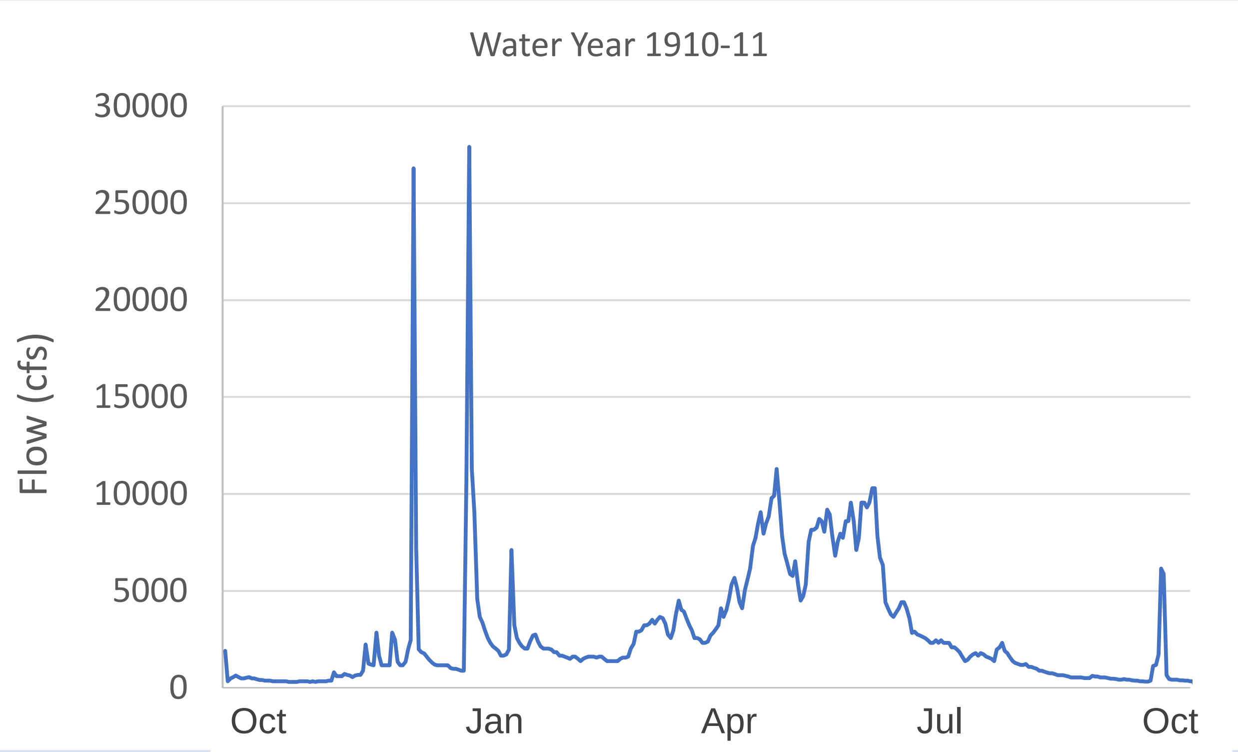
Gualalariver.org

Washington.edu

Flow regime is a "master variable" of river functioning (Poff et al. 1997)

Flow impairment: before and after

☺



USGS gage 11251000, San Joaquin R Below Friant Dam

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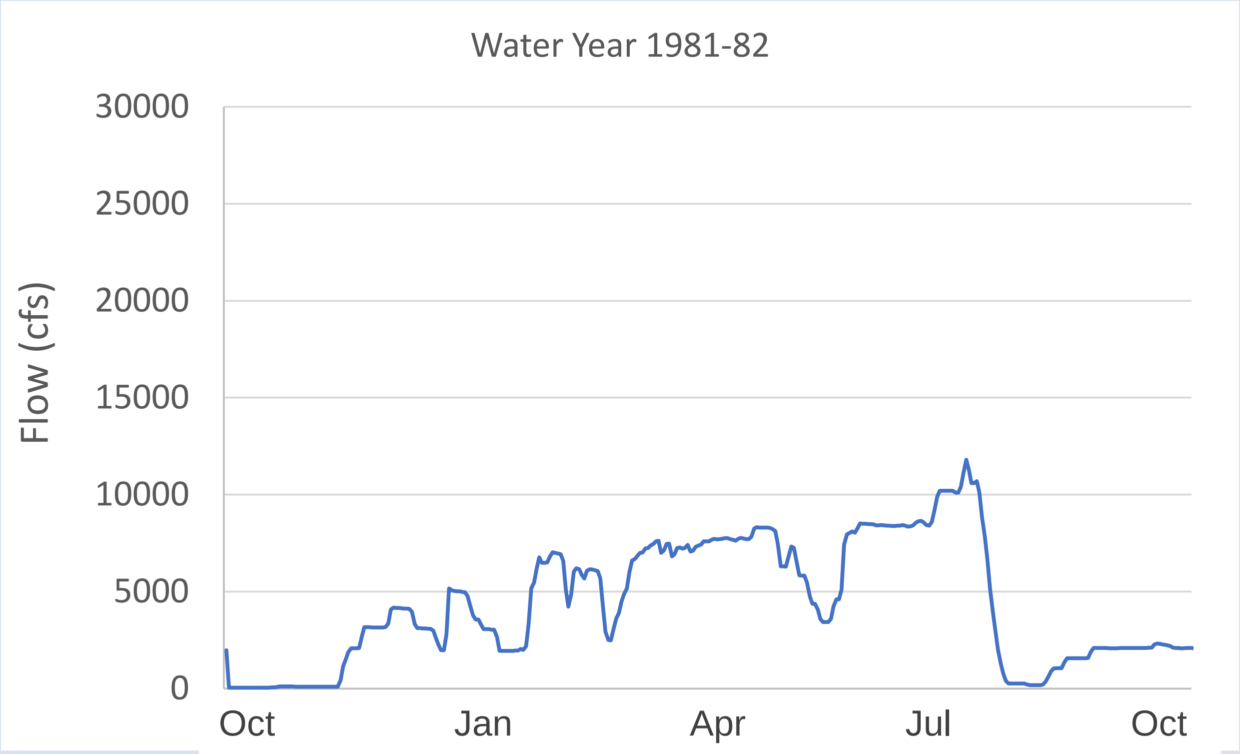
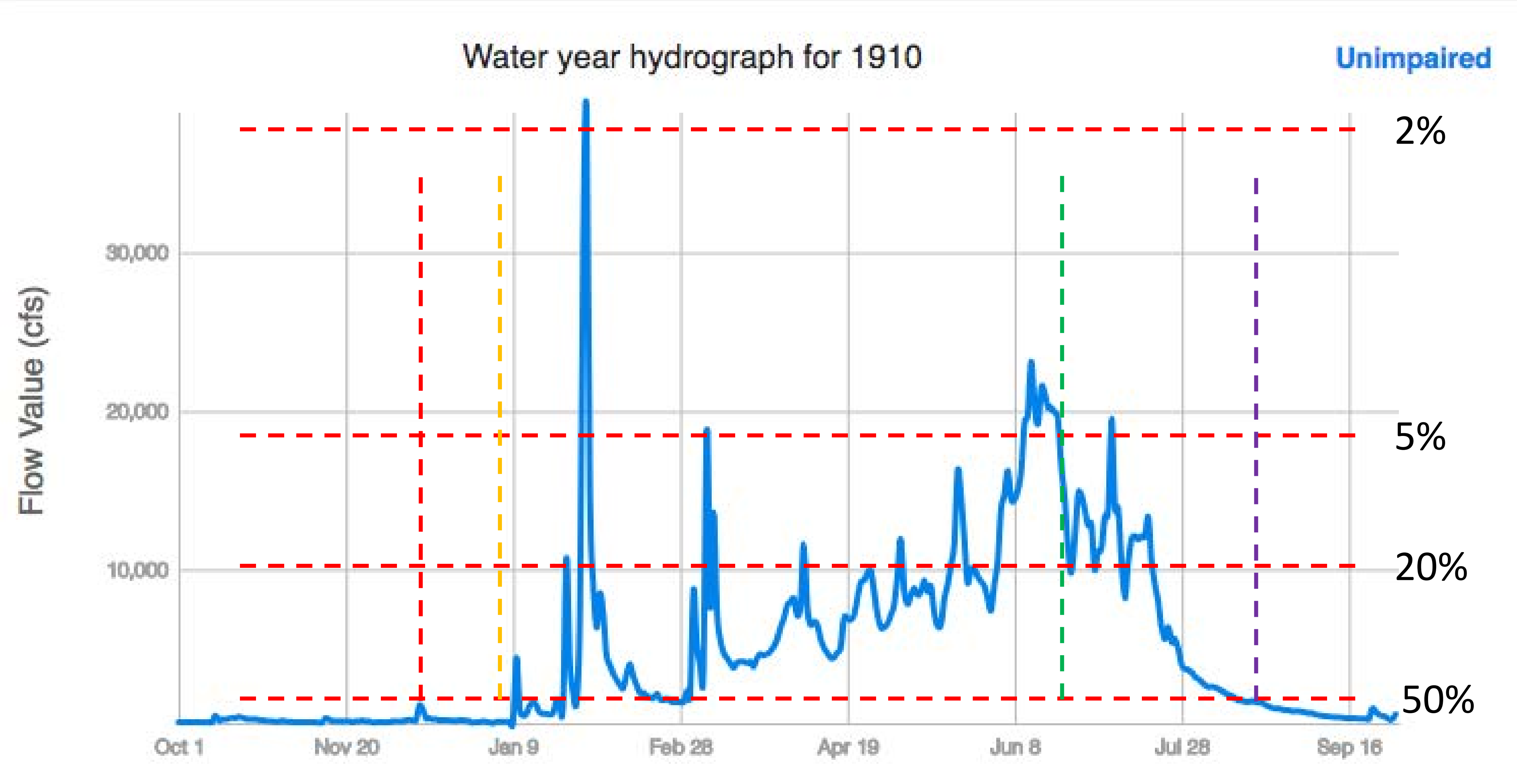


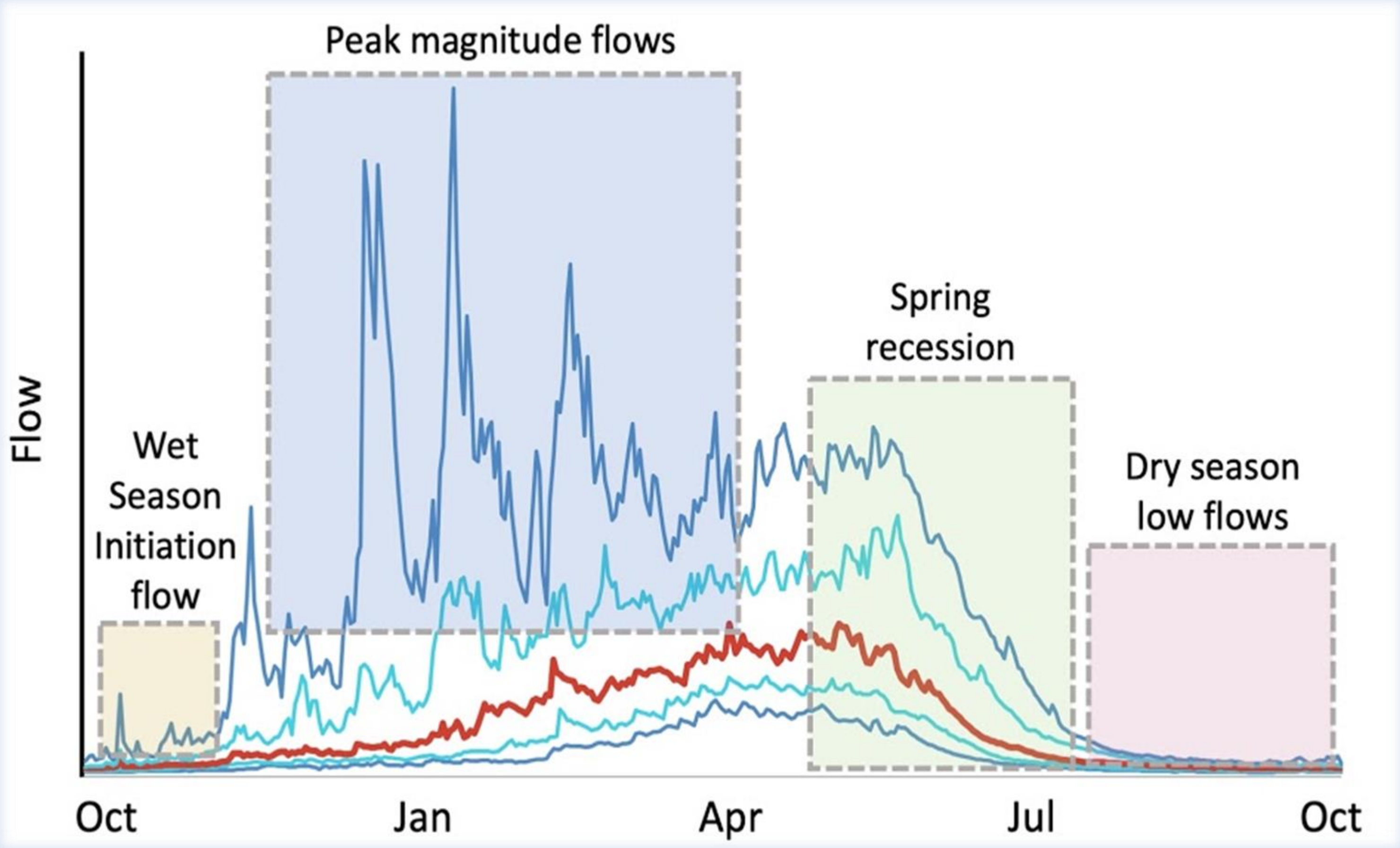
- Magnitude & frequency of peak flows
- Elevation of dry season magnitude
- Rate of change of snowmelt recession


Water year hydrograph for 1910
Unimpaired
Flow Value (cfs)
30,000
20,000
10,000
Oct 1
Nov 20
Jan 9
Feb 28
Apr 19
Jun 8
Jul 28
Sep 16
2%
5%
20%
50%

Functional flow components for CA

4 seasonal flow components:

1. Wet Season Initiation
2. Peak Magnitude Flows
3. Spring Recession
4. Dry Season Low Flows

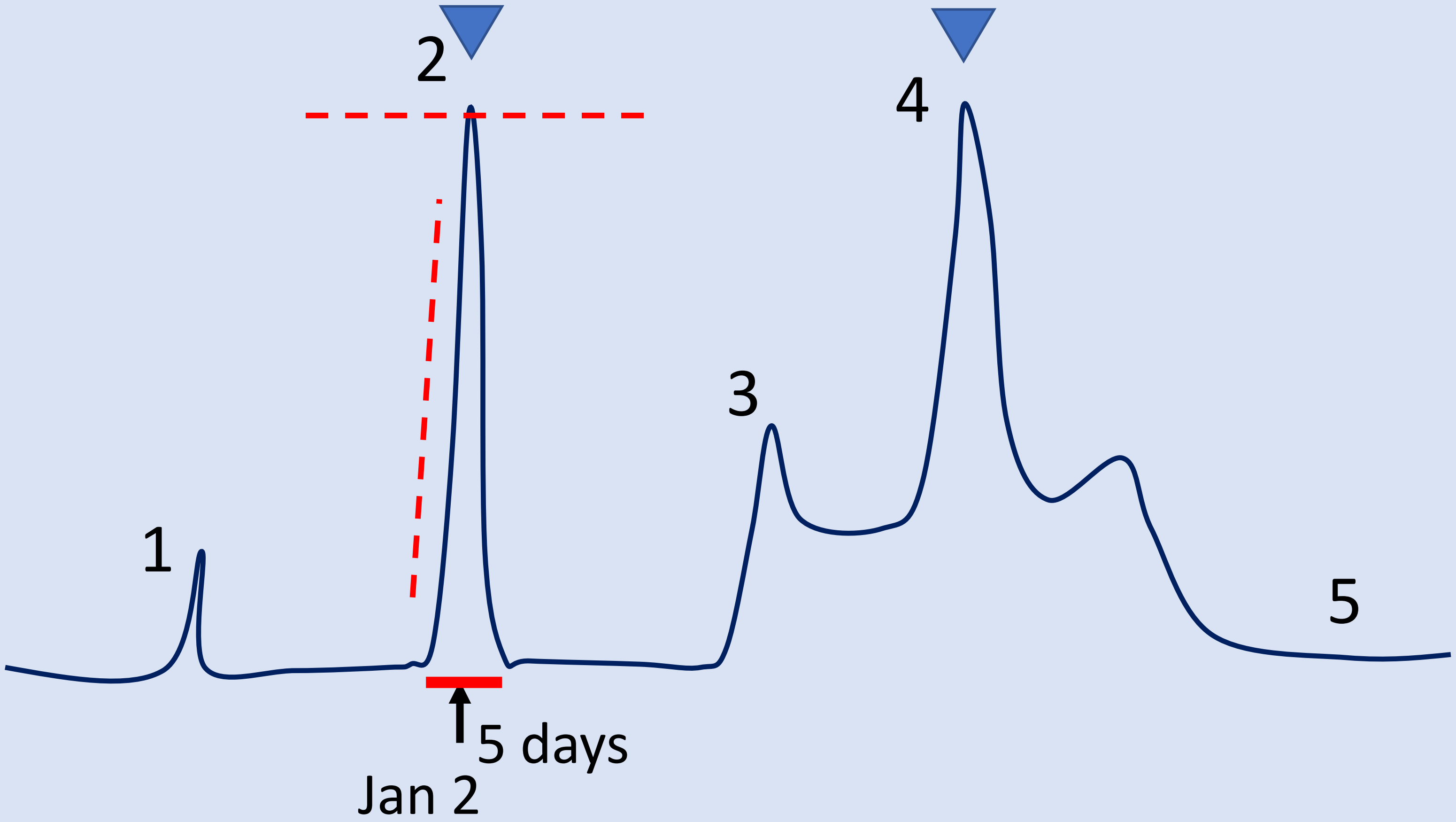


Modified from Yarnell et al. 2015

Flow Characteristics

- Magnitude
- Timing
- Duration
- Frequency
- Rate of Change

(Poff et al. 1997)



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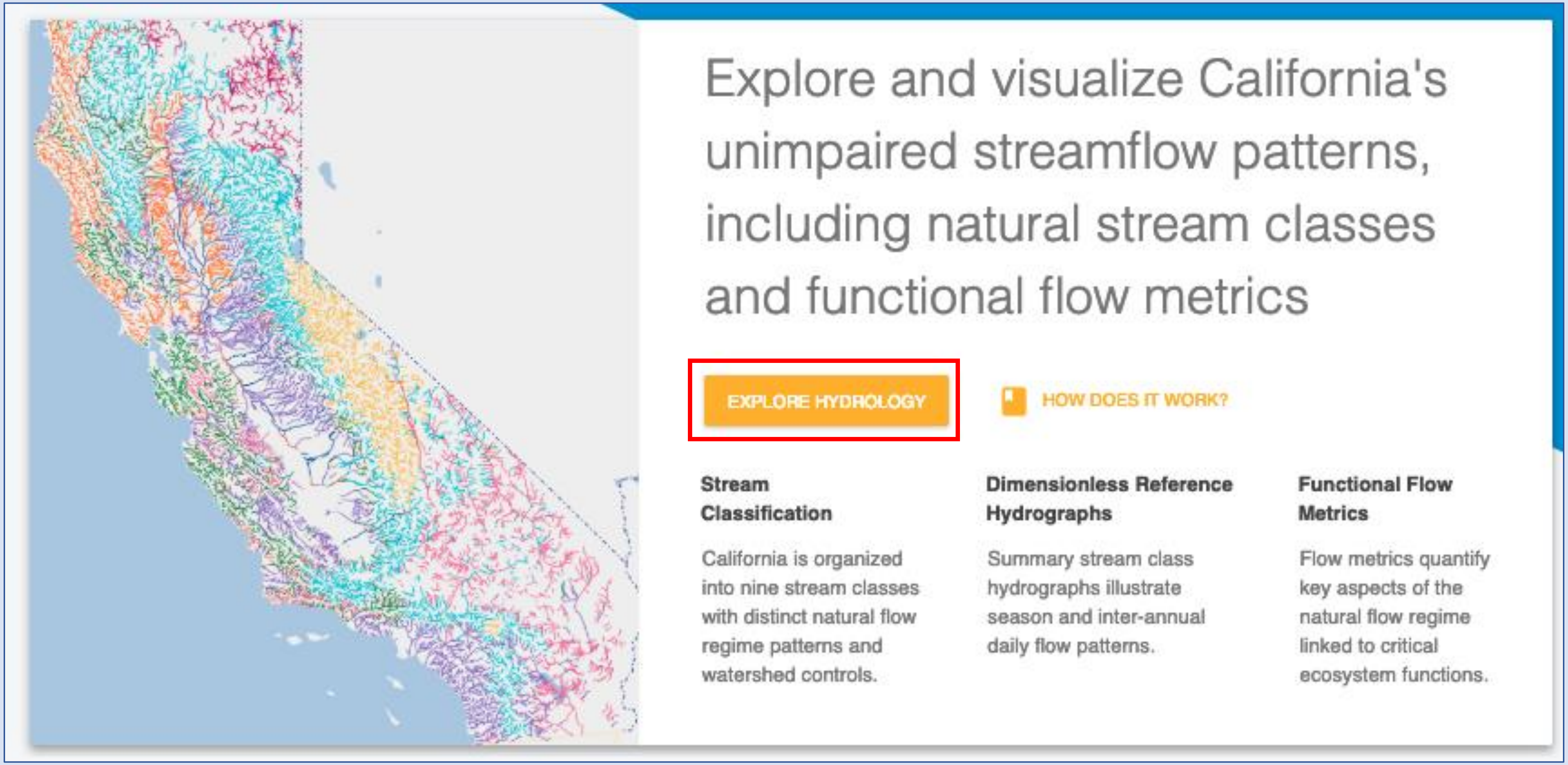
eFlows Website Tour

eFlows beta-v2.20

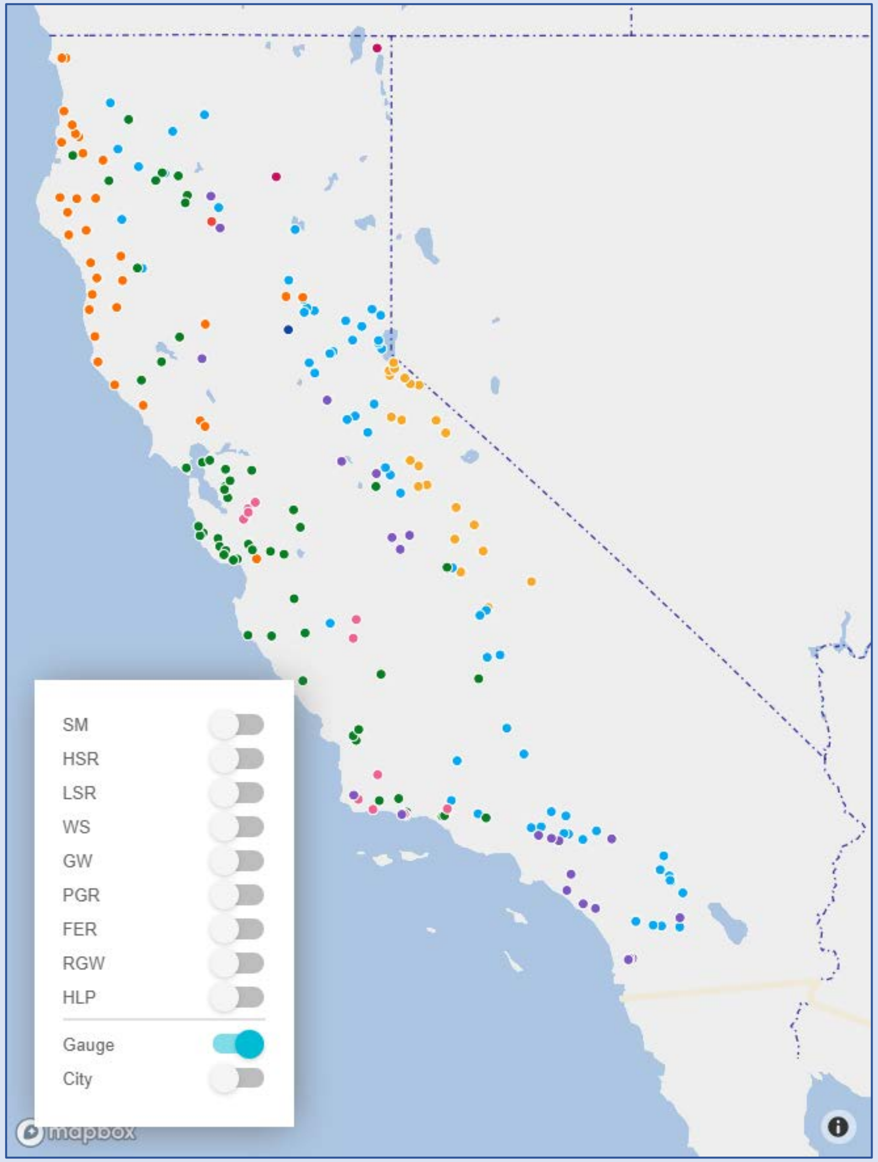
eFlows.ucdavis.edu:

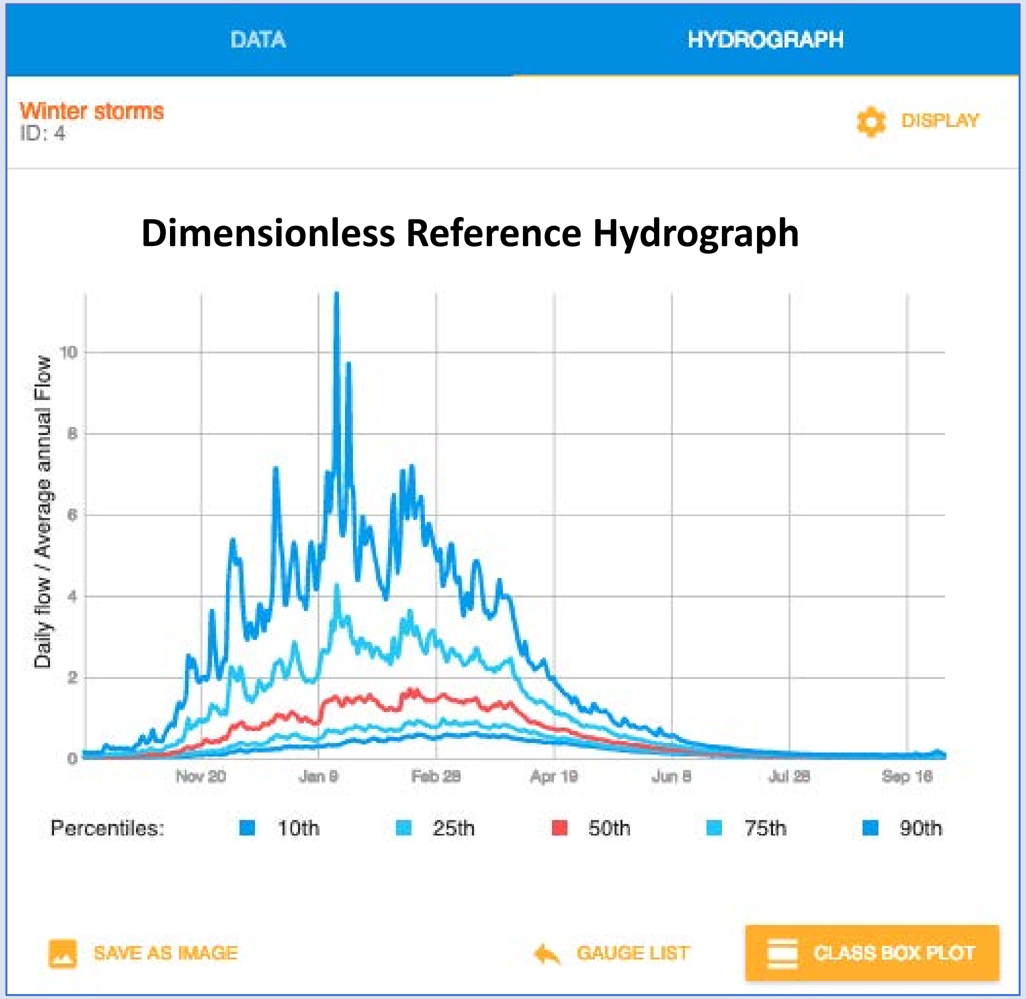


eFlows Website Tour

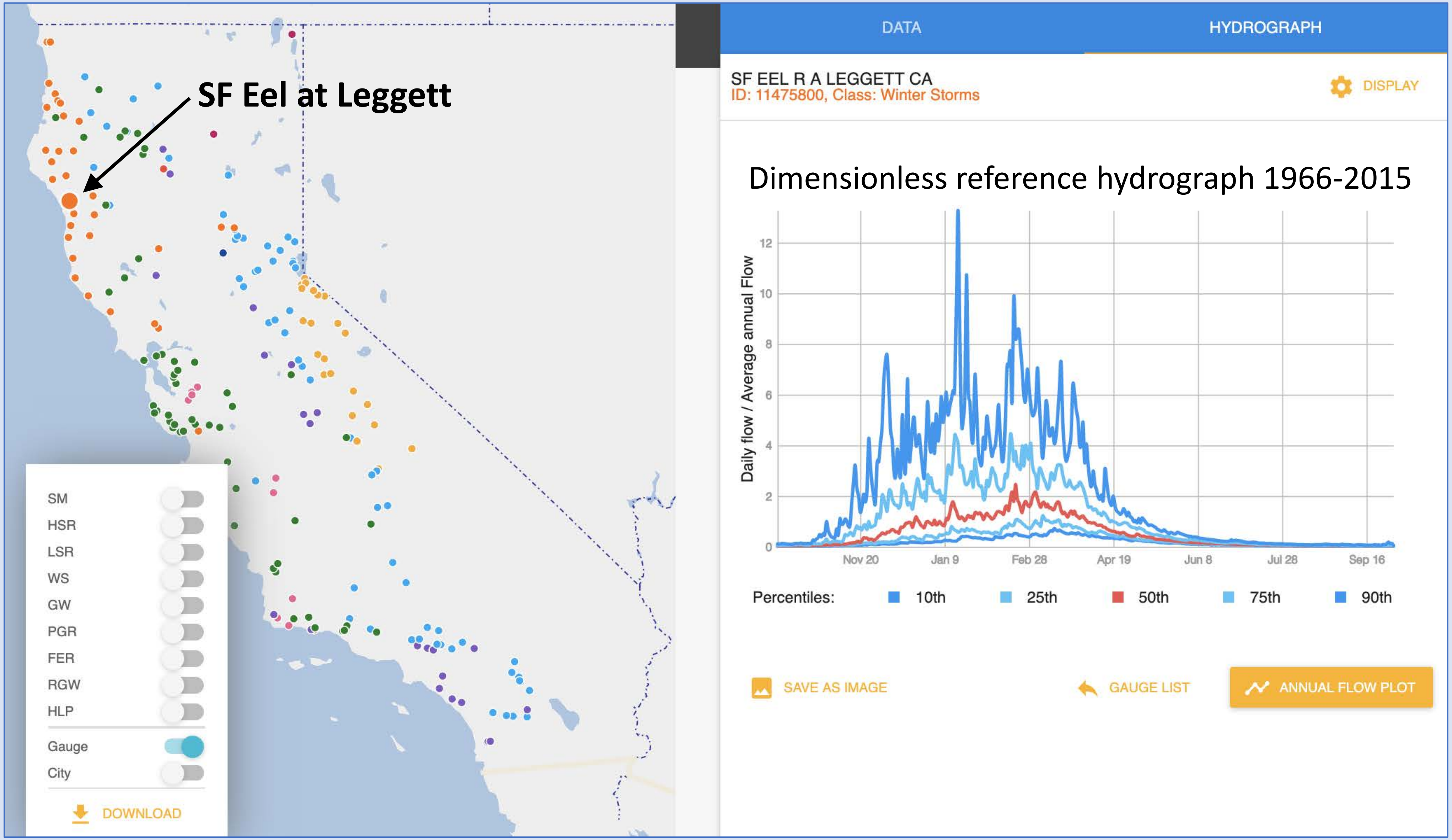
223 Reference Gauges
Poff & Zimmerman 2010

9 Natural stream classes
Lane et al. 2017





eFlows Website Tour



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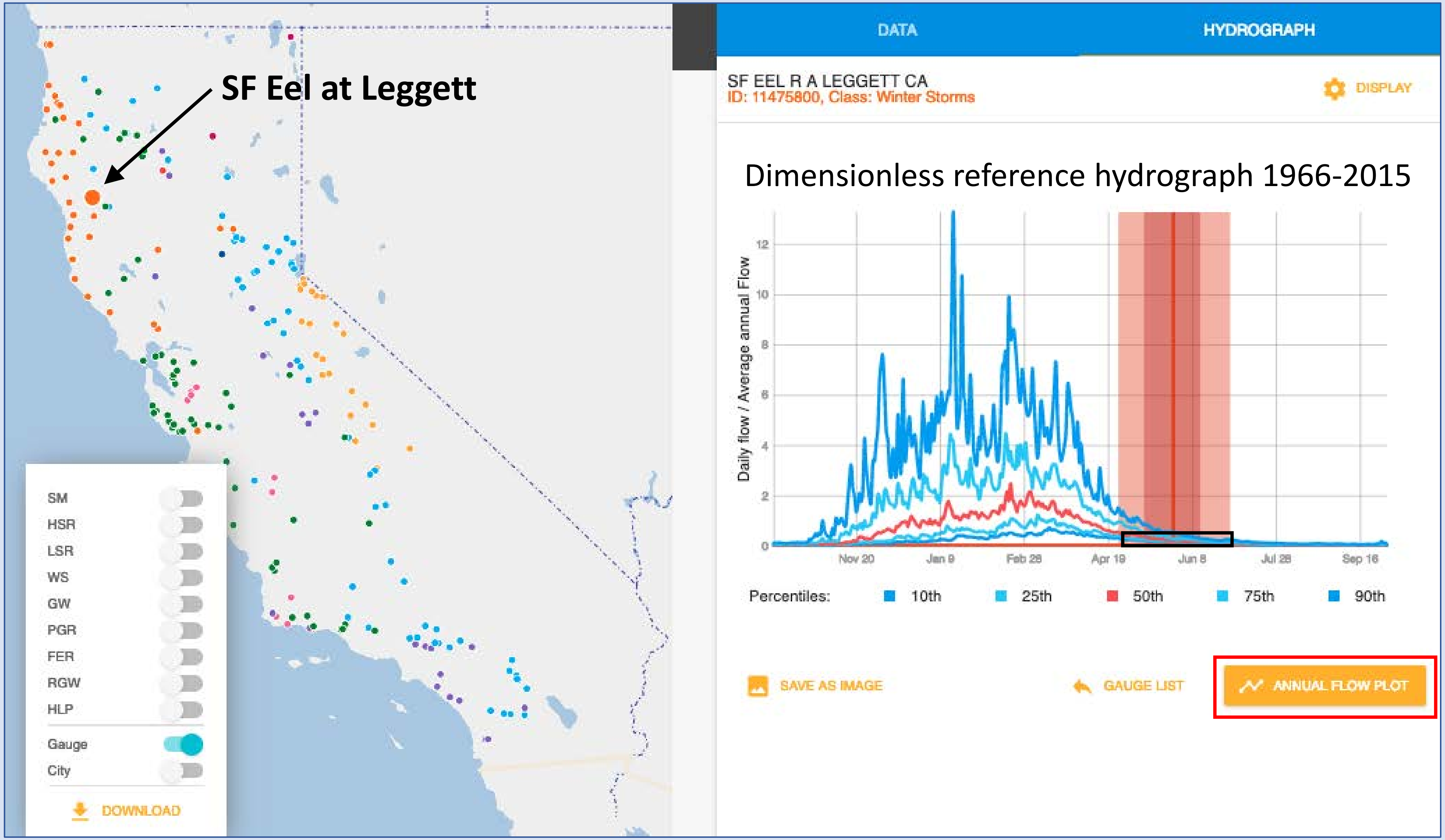
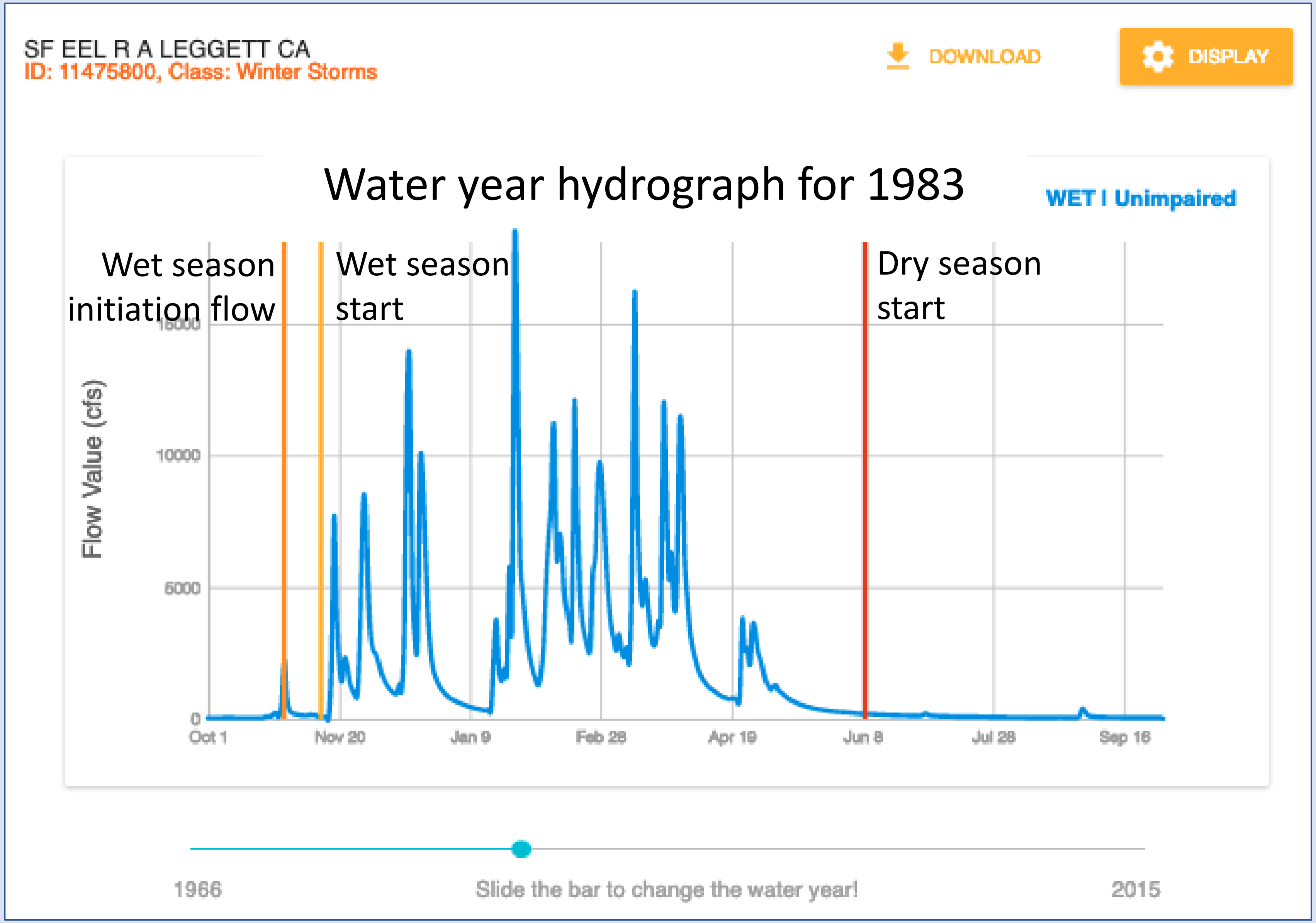
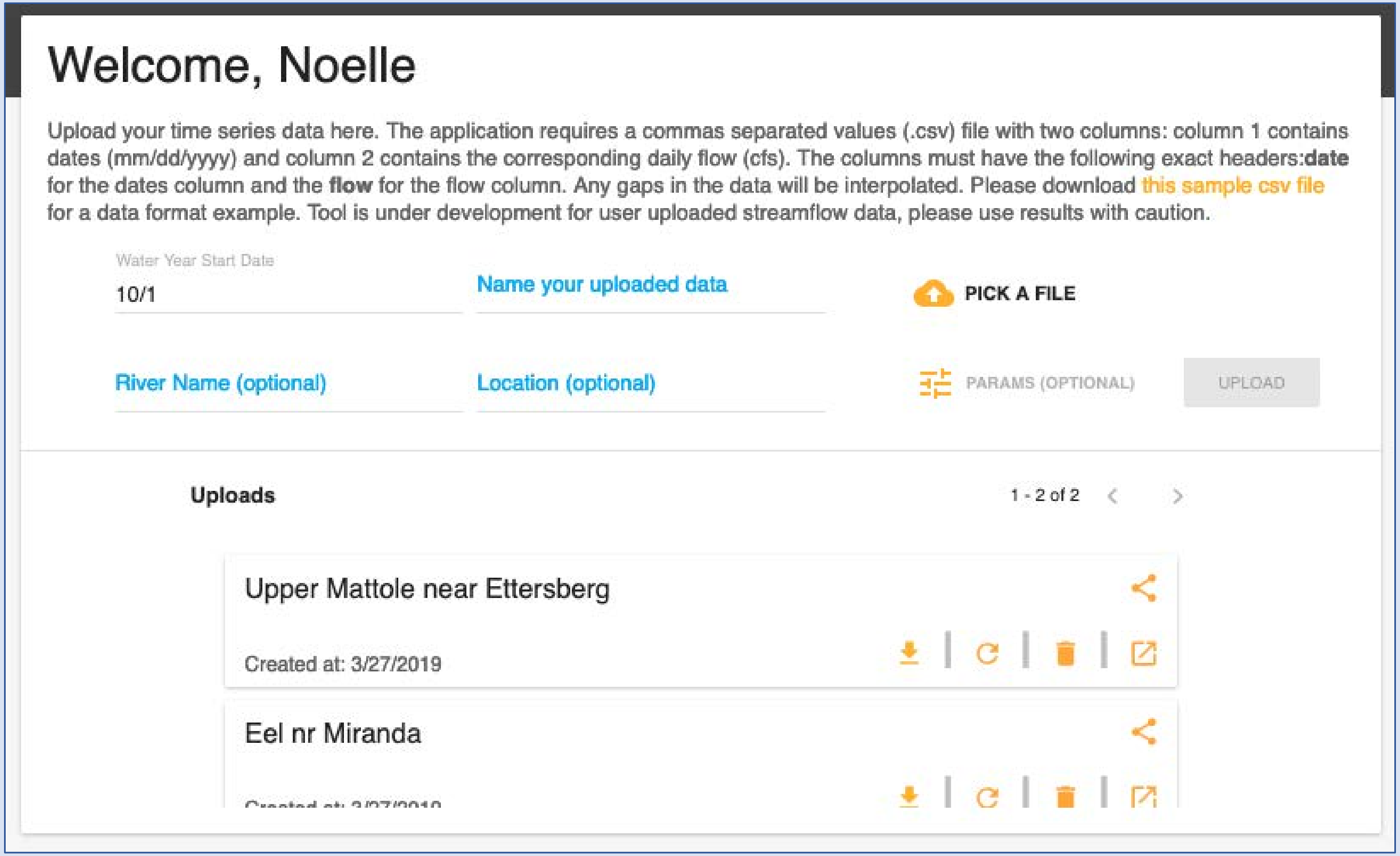


eFlows Website Tour



eFlows Website Tour

User uploads: input flow time series data for functional flow analysis



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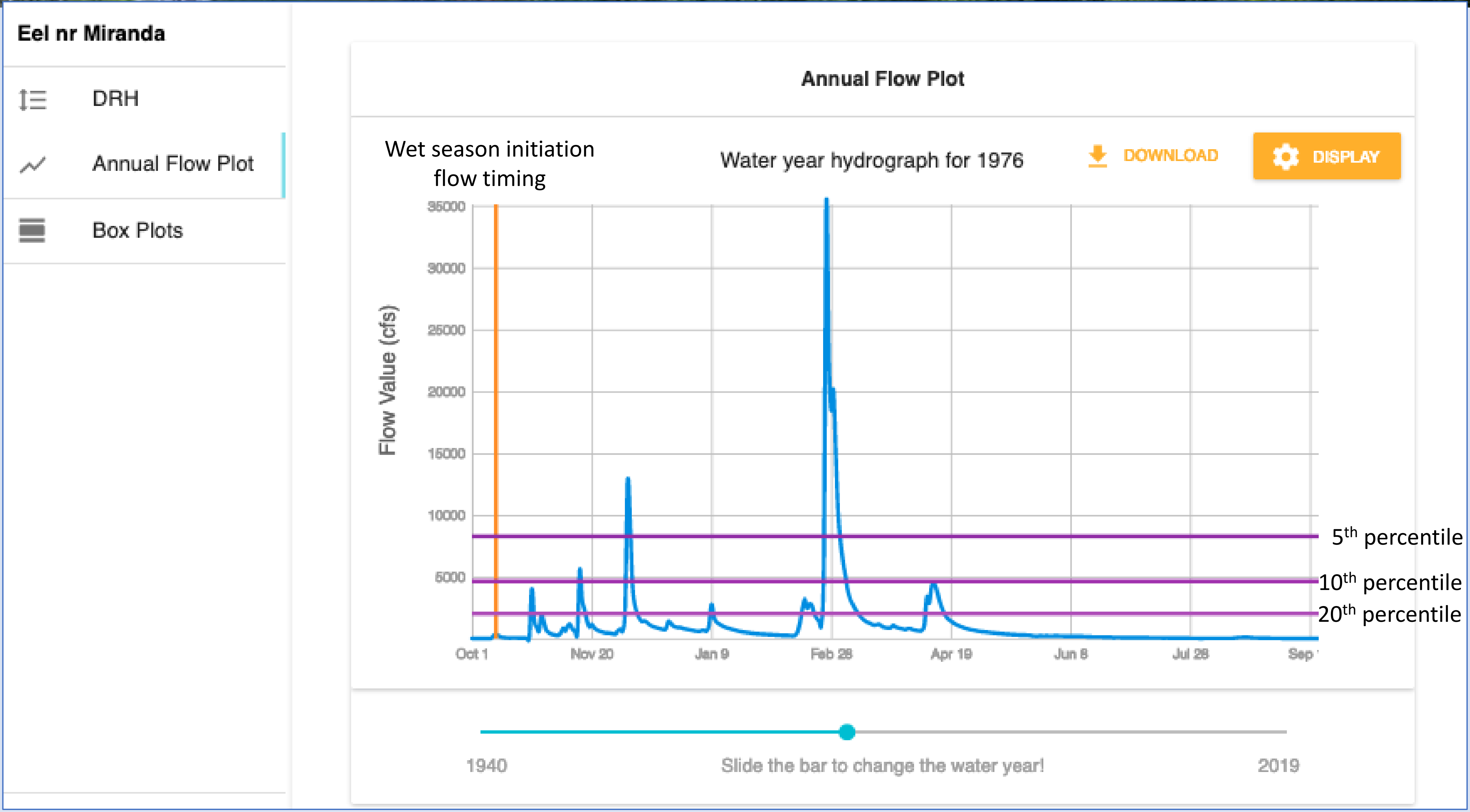
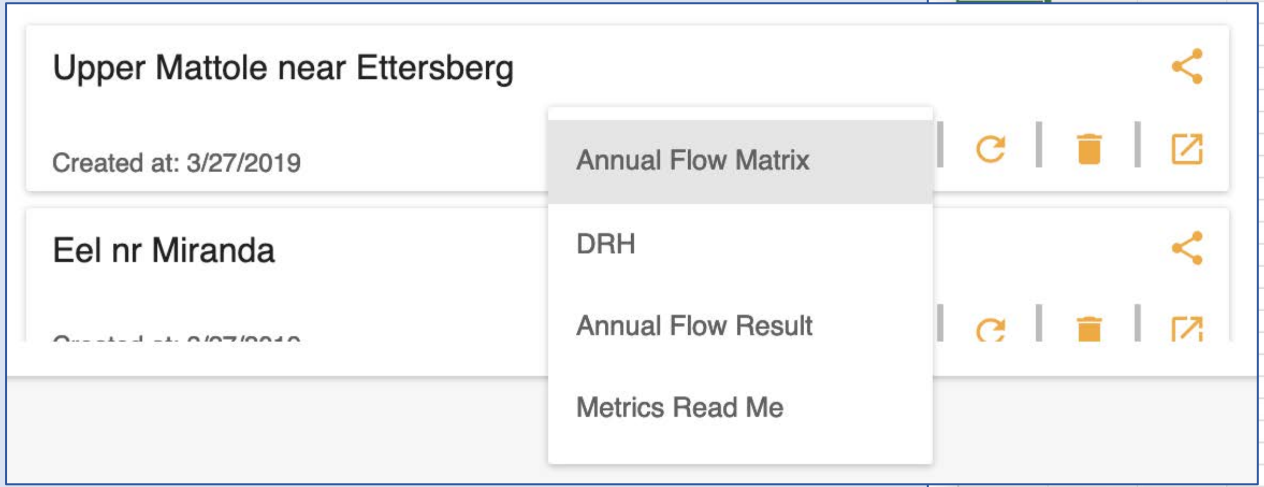
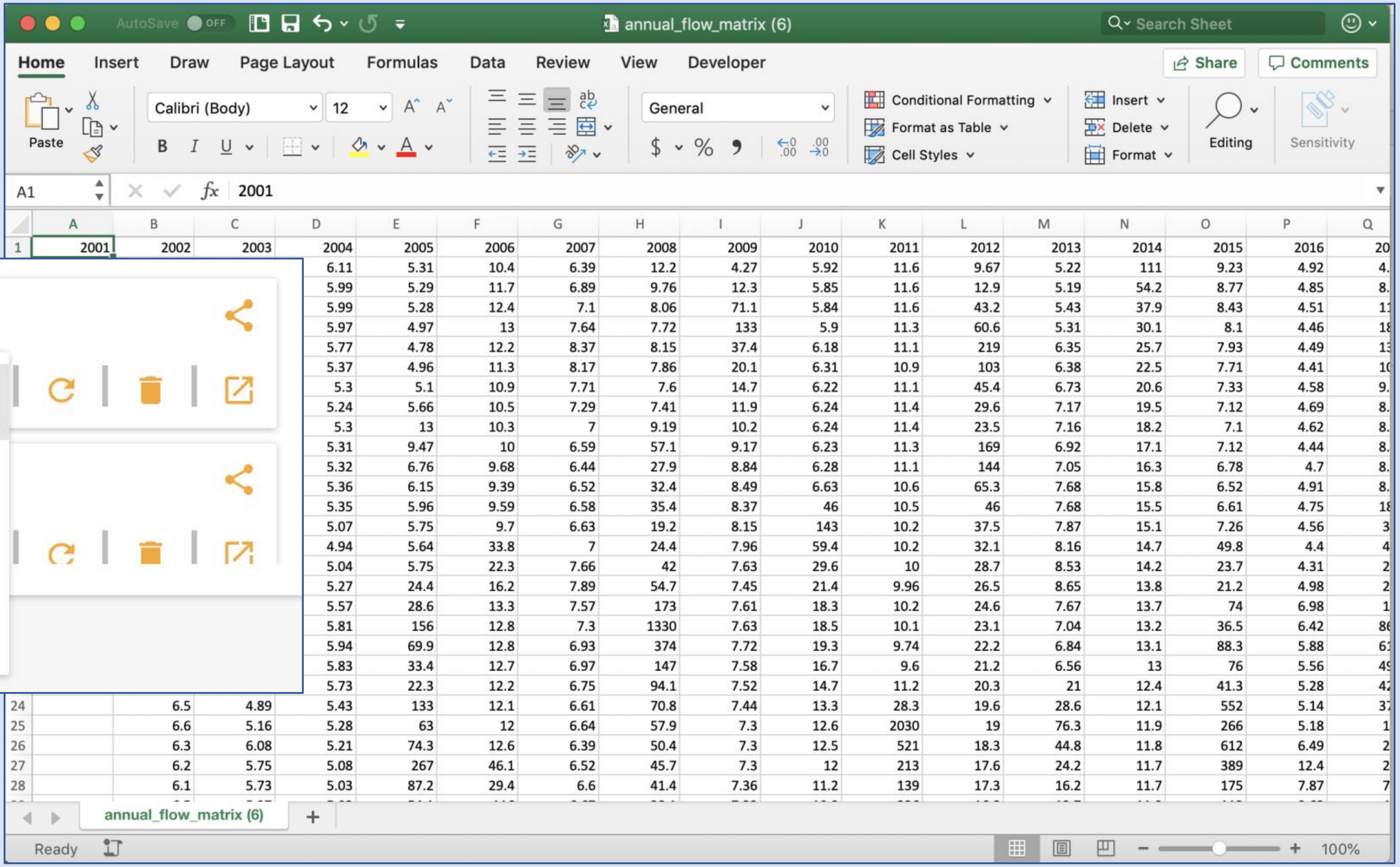


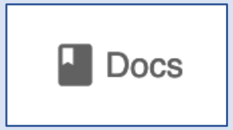
eFlows Website Tour

eFlows.ucdavis.edu:

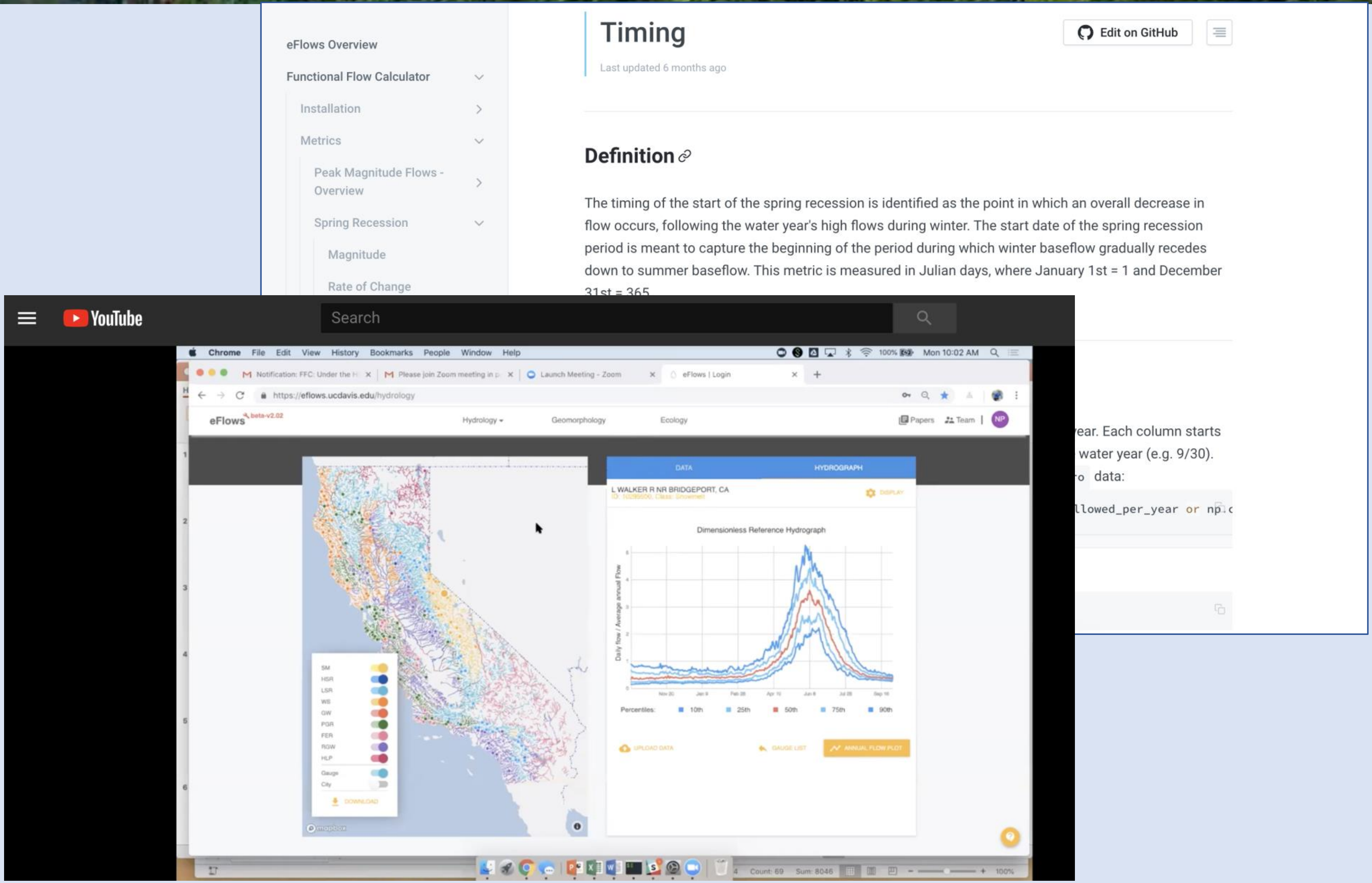




Available Resources



Documentation, source code, and instructional videos



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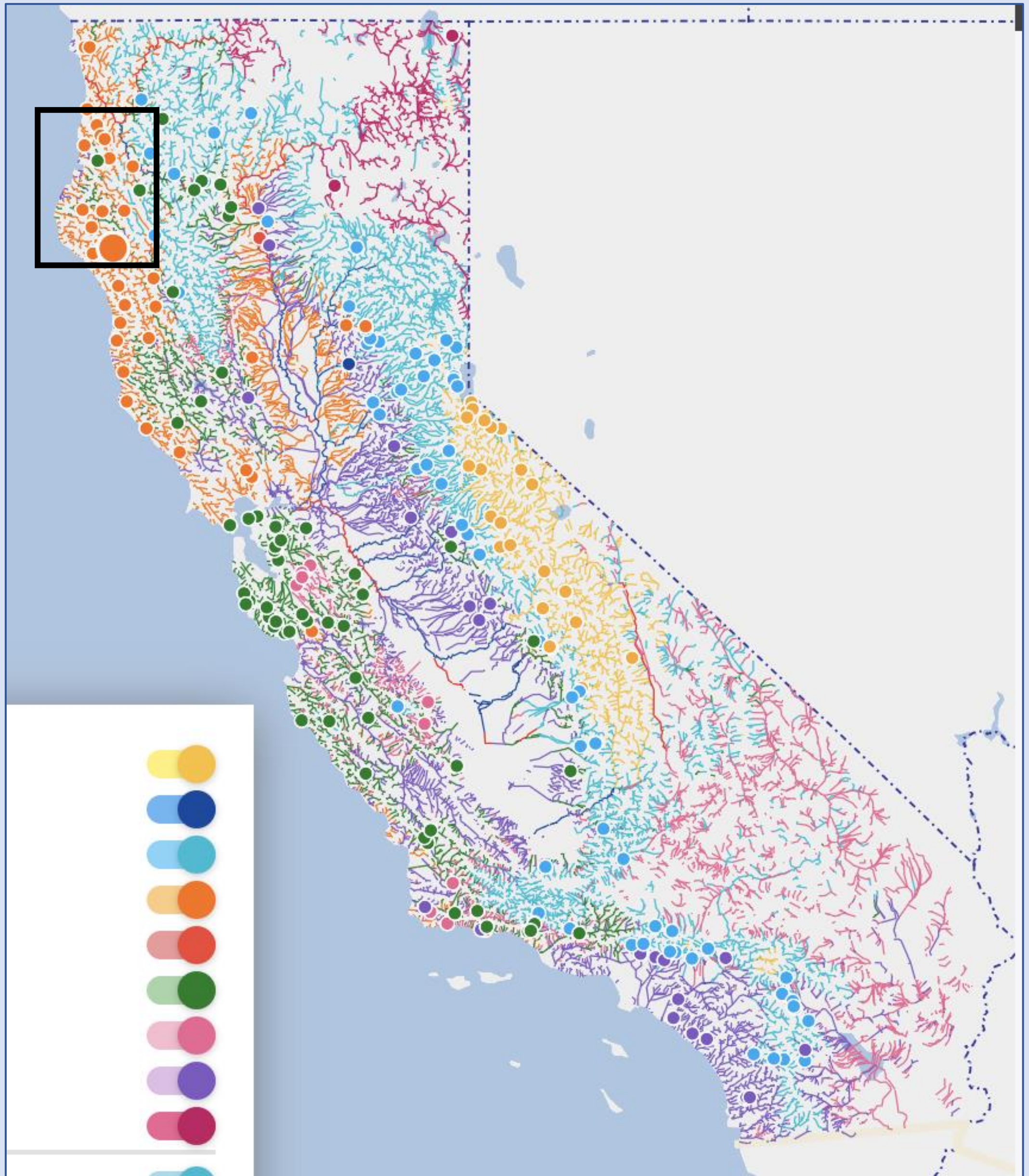
3. Application to a cannabis-impaired reach

Case study: SF Eel River near Miranda



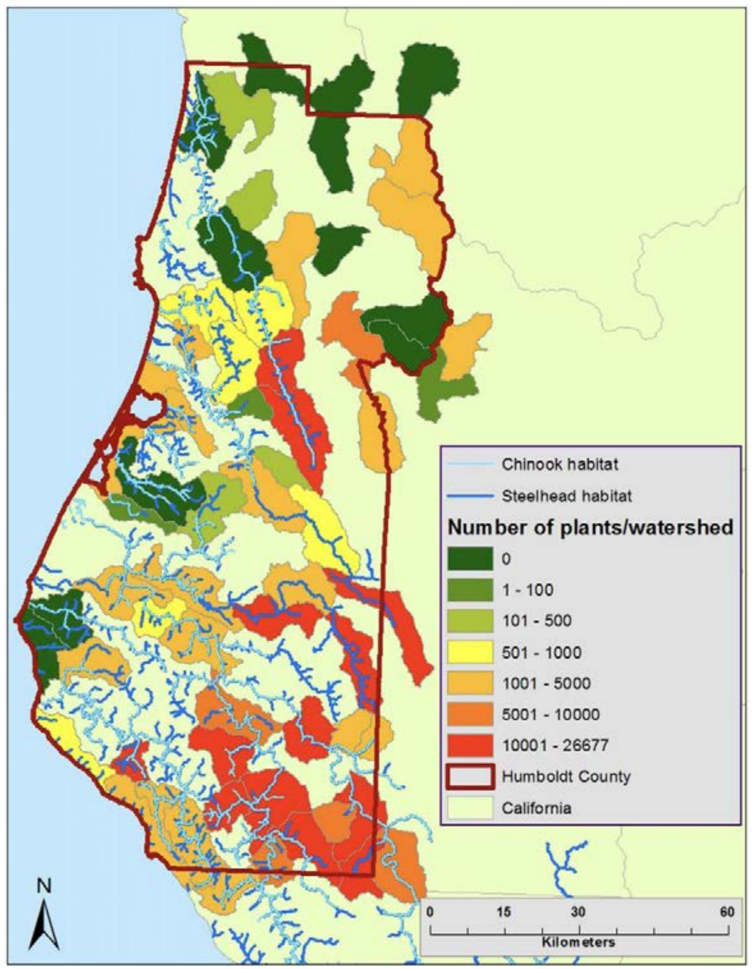


Figure 3. Number of plants per watershed and location of critical habitat for steelhead trout and Chinook salmon.

Van Butsic & Brenner 2016

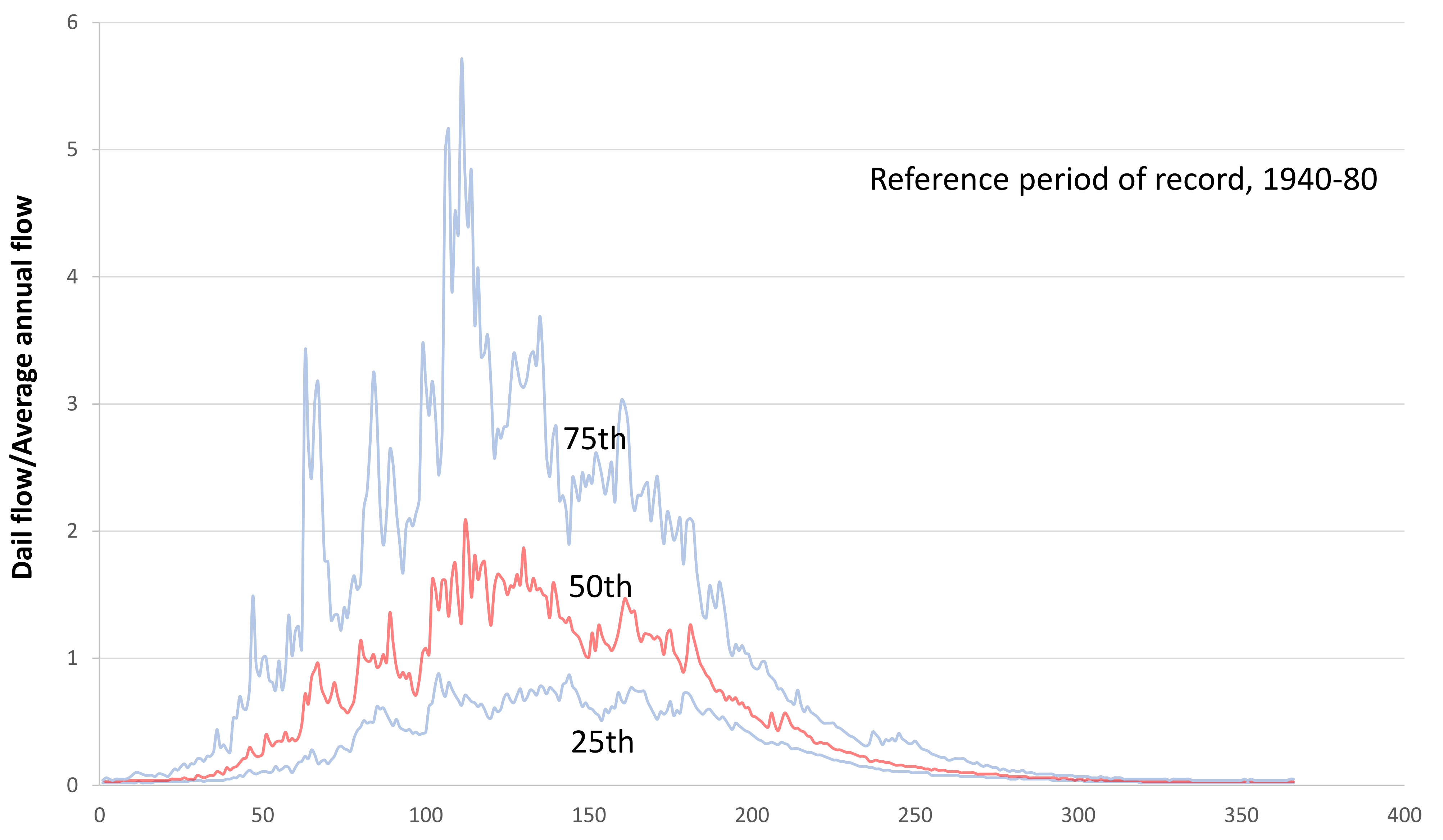
USGS gage:
11476500
(SF Eel near Miranda)

Reference period:
1940-80

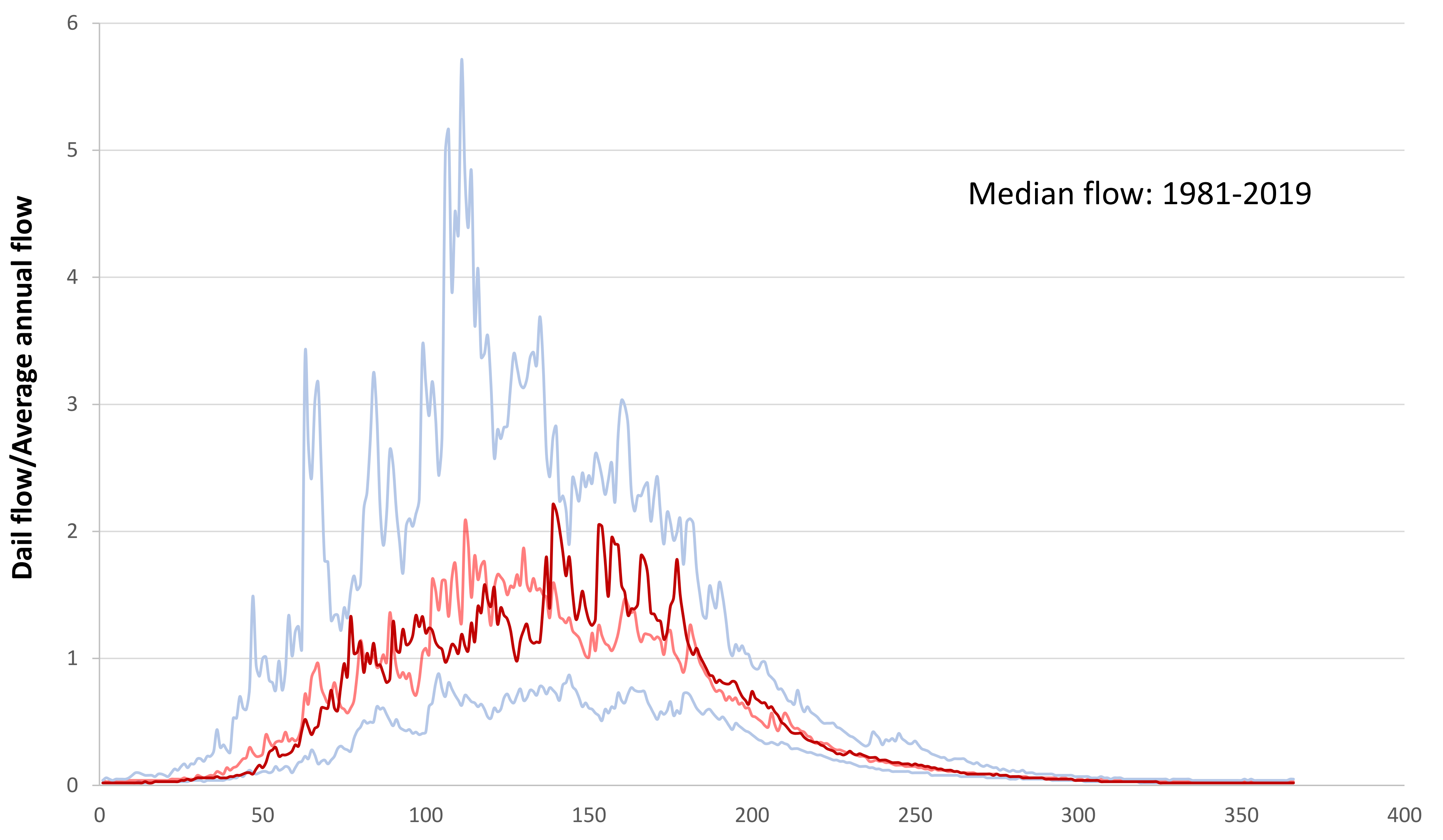
Post-impairment:
1981-2019

(determined by Poff & Zimmerman 2010)

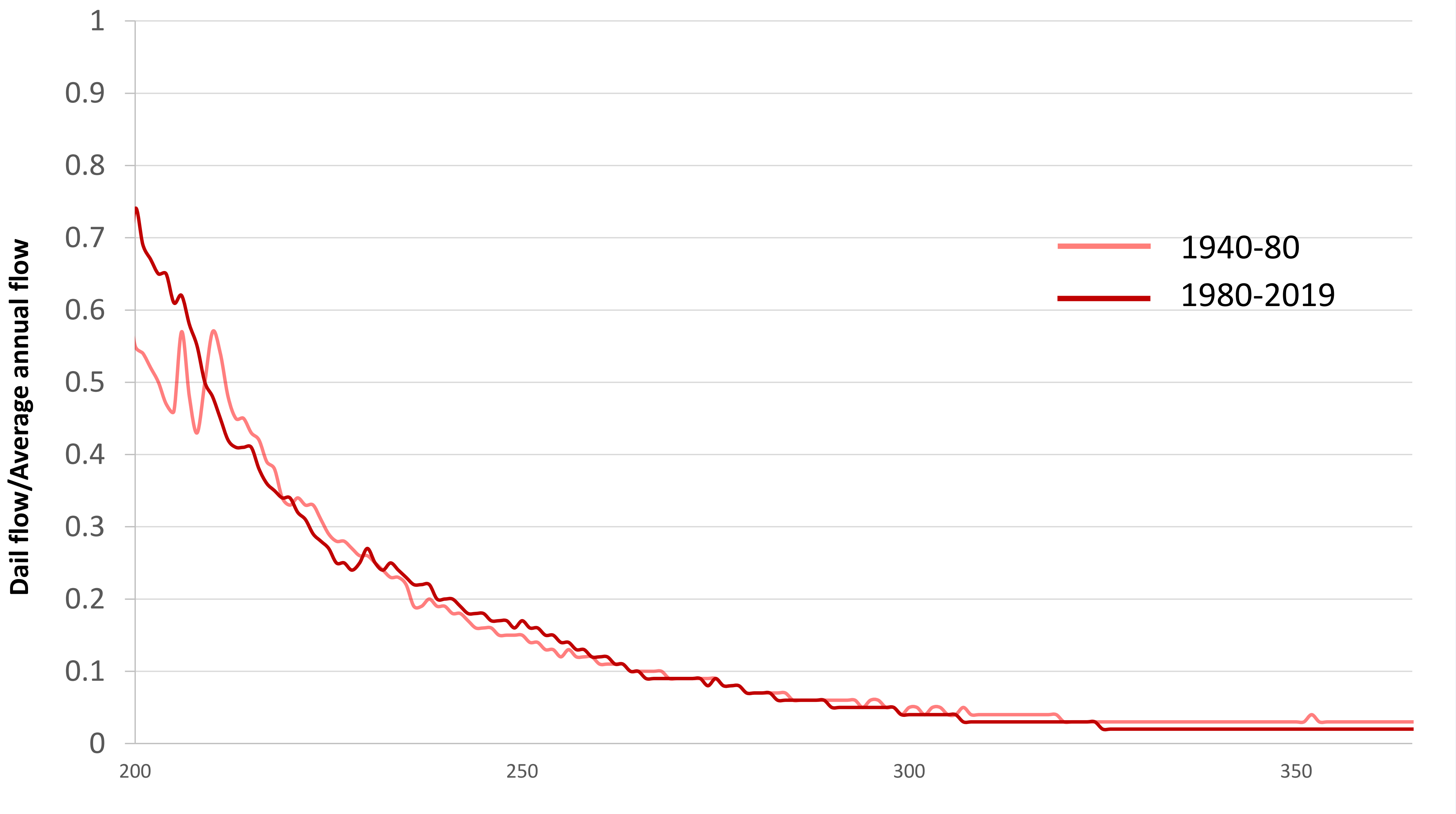
Case study: SF Eel River near Miranda



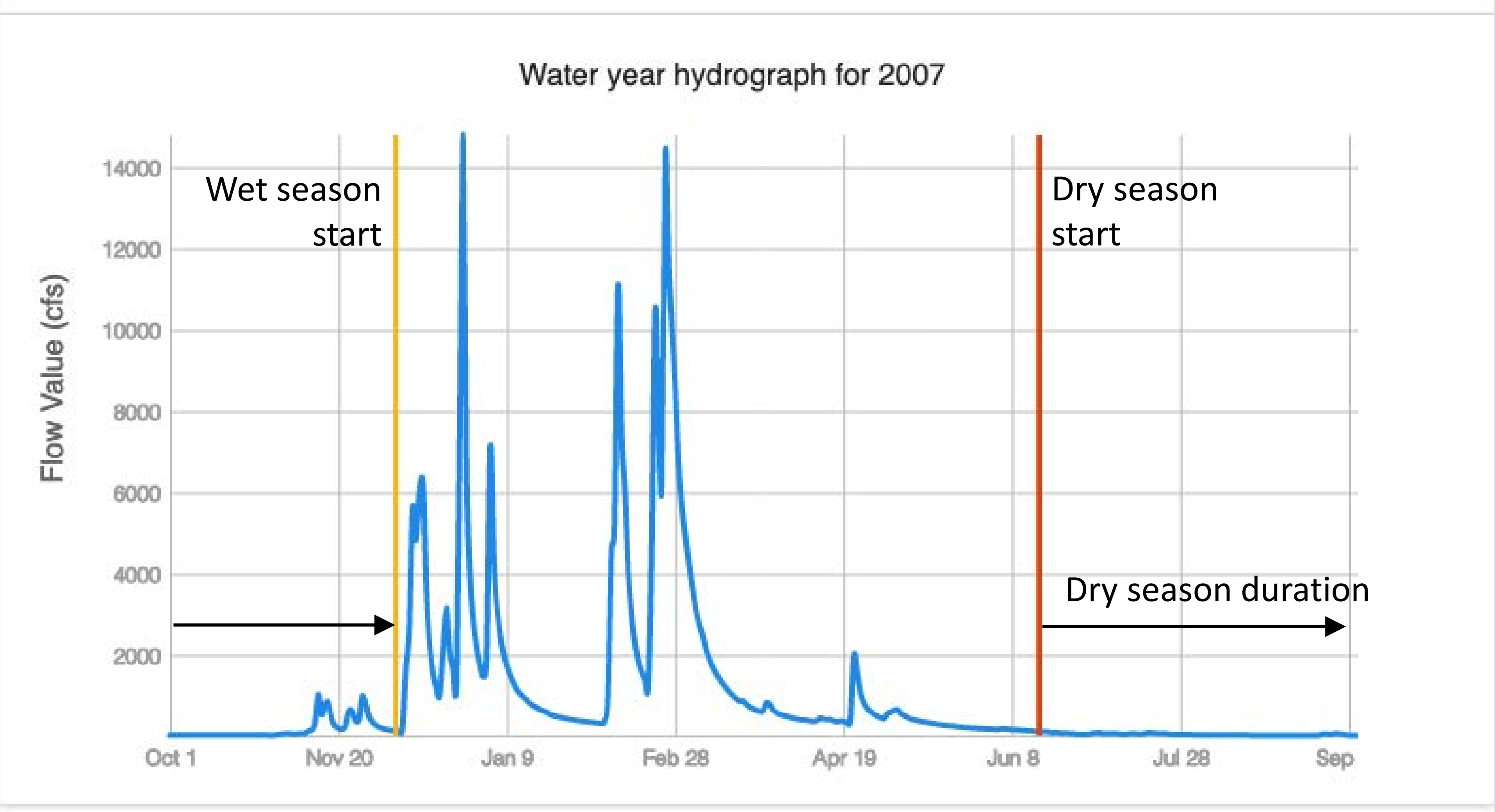
Case study: SF Eel River near Miranda



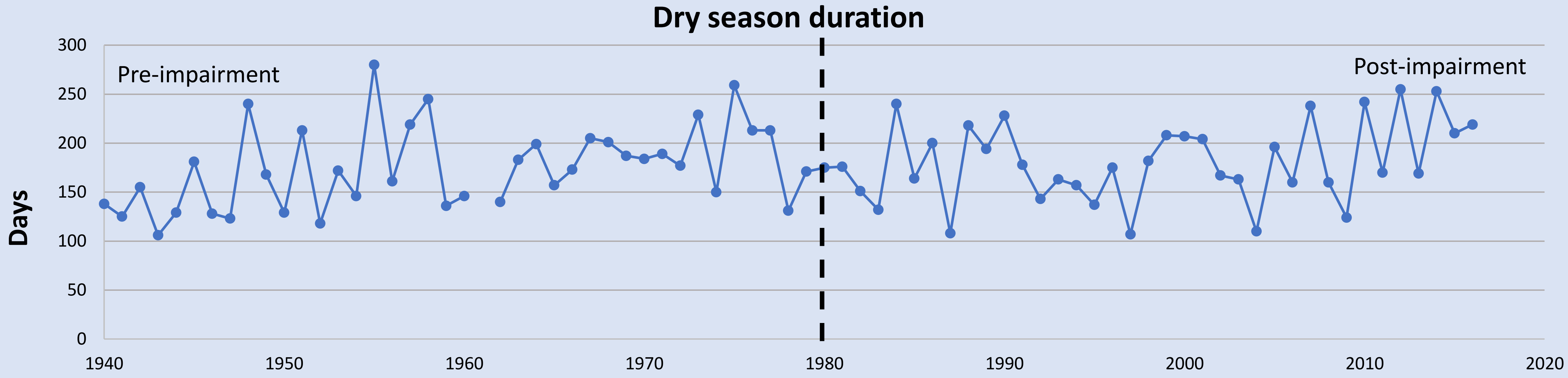
Dry season flows: pre and post impairment

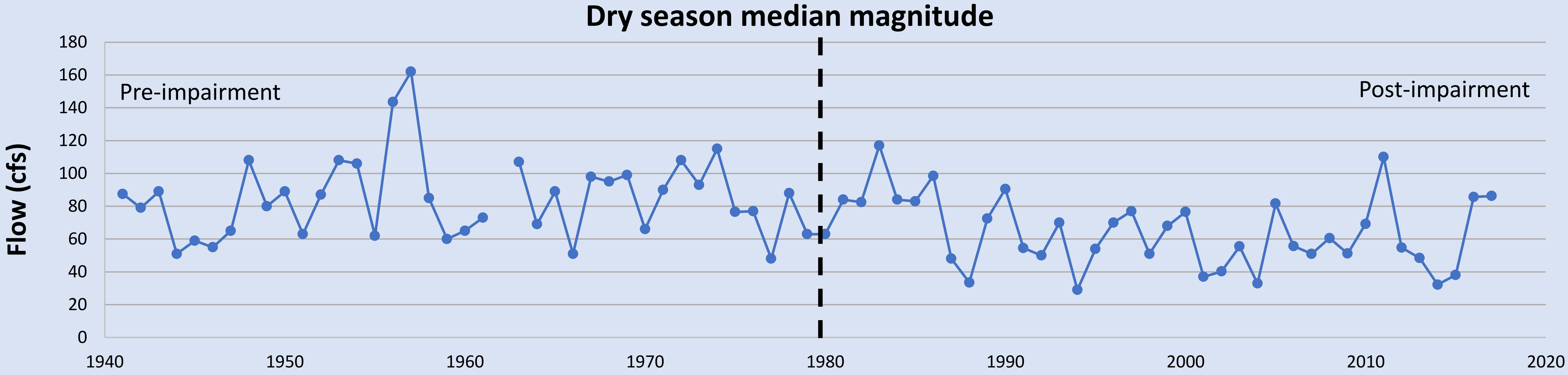


Dry season metric calculations



Dry season metric results





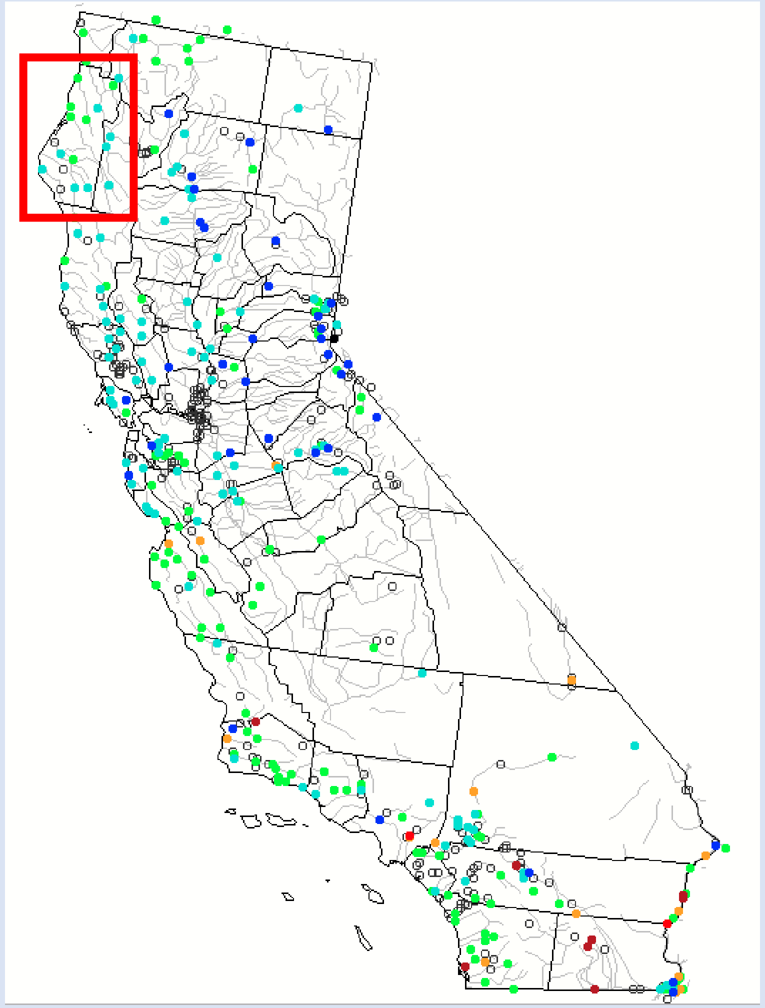
Data needs for FFC Analysis

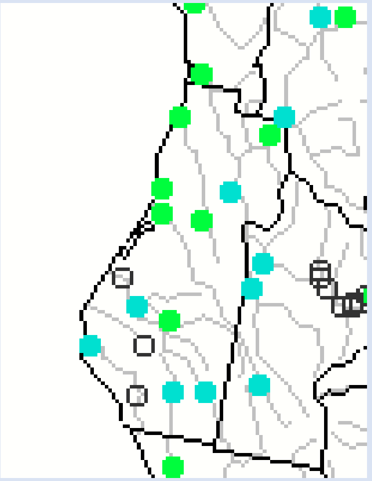
Spatial

- Proximity to source of impairment
- Relative impact on tributaries vs. mainstem river

Timing

- Long-term time series: natural or simulated

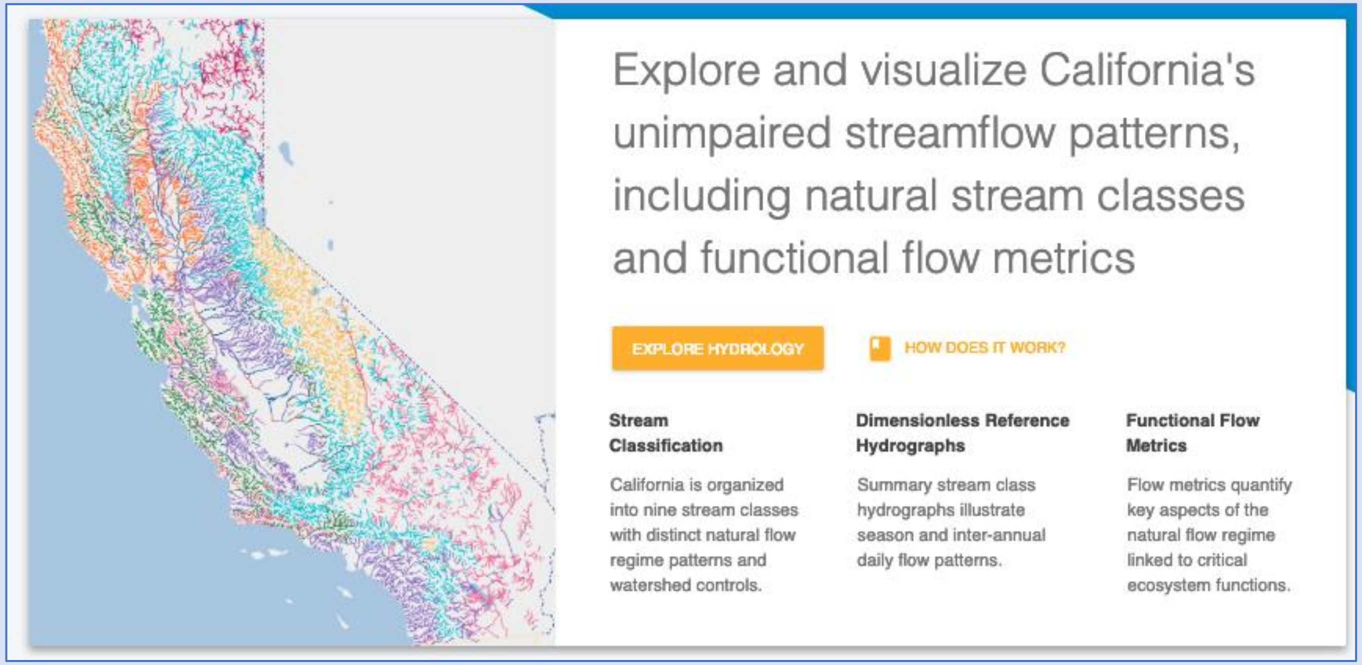




Conclusions

Functional Flows Calculator:

- New tool for theory-driven characterization of streamflow
- For North Coast cannabis-impacted regions:
  - Flow data needed close to impairment source to detect hydrologic changes



References

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- Butsic, Van, and Jacob C. Brenner. "Cannabis (Cannabis sativa or C. indica) agriculture and the environment: a systematic, spatially-explicit survey and potential impacts." *Environmental Research Letters* 11.4 (2016): 044023.

Thank you!

Noelle Patterson
nkpatterson@ucdavis.edu

University of California 2018 cannabis grower survey

Houston Wilson, Ted Grantham, Jennifer Carah, Kent Daane, Hekia Bodwitch, Van Butsic, Christy Getz

Ted Grantham

24 April 2019

University *of* California
Agriculture and Natural Resources

Berkeley
UNIVERSITY OF CALIFORNIA

Background

Cannabis has an estimated value $10 billion[1], exceeding the state's most valuable agricultural commodities

Little is known about crop production methods because of historically clandestine growing operations and prohibitions on research

Growing demands on state agencies, universities, and extension to address the ecological, economic, and agricultural aspects of cannabis in California

State legalization of medical and recreational cannabis has led to a change in UC policy to allow cannabis research

[1] *University of California. 2017. Economic Costs and Benefits of Proposed Regulations for the Implementation of the Medical Cannabis Regulation and Safety Act (MCRSA).*

2018 Grower Survey

A state-wide online survey was developed by University of California research and extension scientists in 2018

Survey focus was on cultivation techniques, crop prices, pest and disease management, water use, labor practices and regulatory compliance barriers

Survey goal was to provide initial characterization of production practices and grower decision-making to support future research and extension programs

2018 On-Line Grower Survey

What are your disease and pest issues? What are your control methods?

Where do you source your water? How much is water is applied and when?

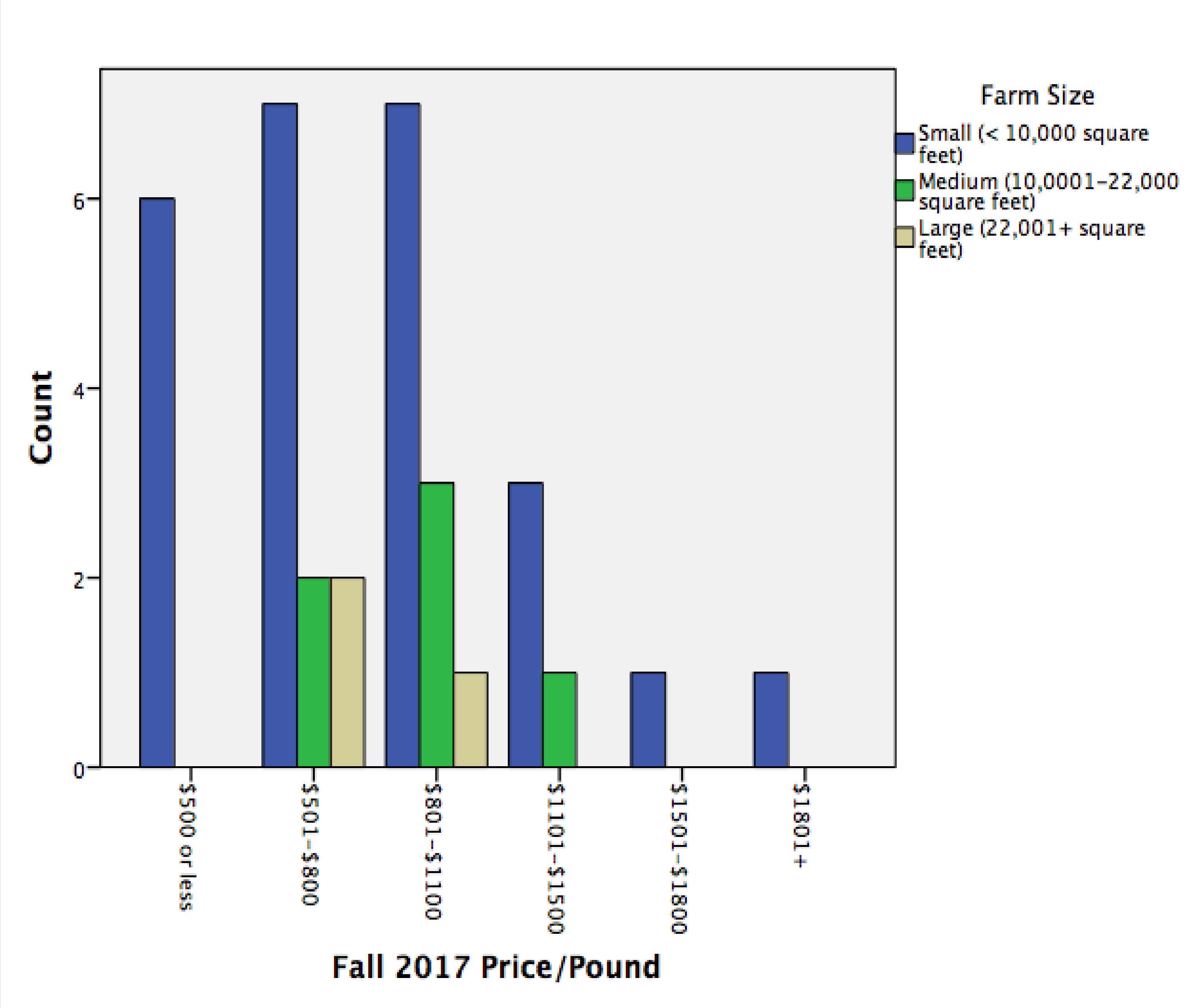
What is your income and production costs from cannabis production?

Have you applied for local/state permits? Why or why not?

Region	Organization
Statewide	California Cannabis Industry Association
	California Growers Association
	Flow Kana
	International Cannabis Farmers Association
Central Coast	Coastal Growers Association
North Coast	Emerald Grown Co-op
	Humboldt's Finest
	Humboldt Sun Growers Guild
	Lake County Cannabis Growers Alliance
	Sonoma County Growers Alliance
	True Humboldt
Sierra Foothills	Inland Cannabis Farmers Association
	Nevada County Cannabis Alliance
	Plumas County Growers Coalition
Southern California	Cultivators Alliance

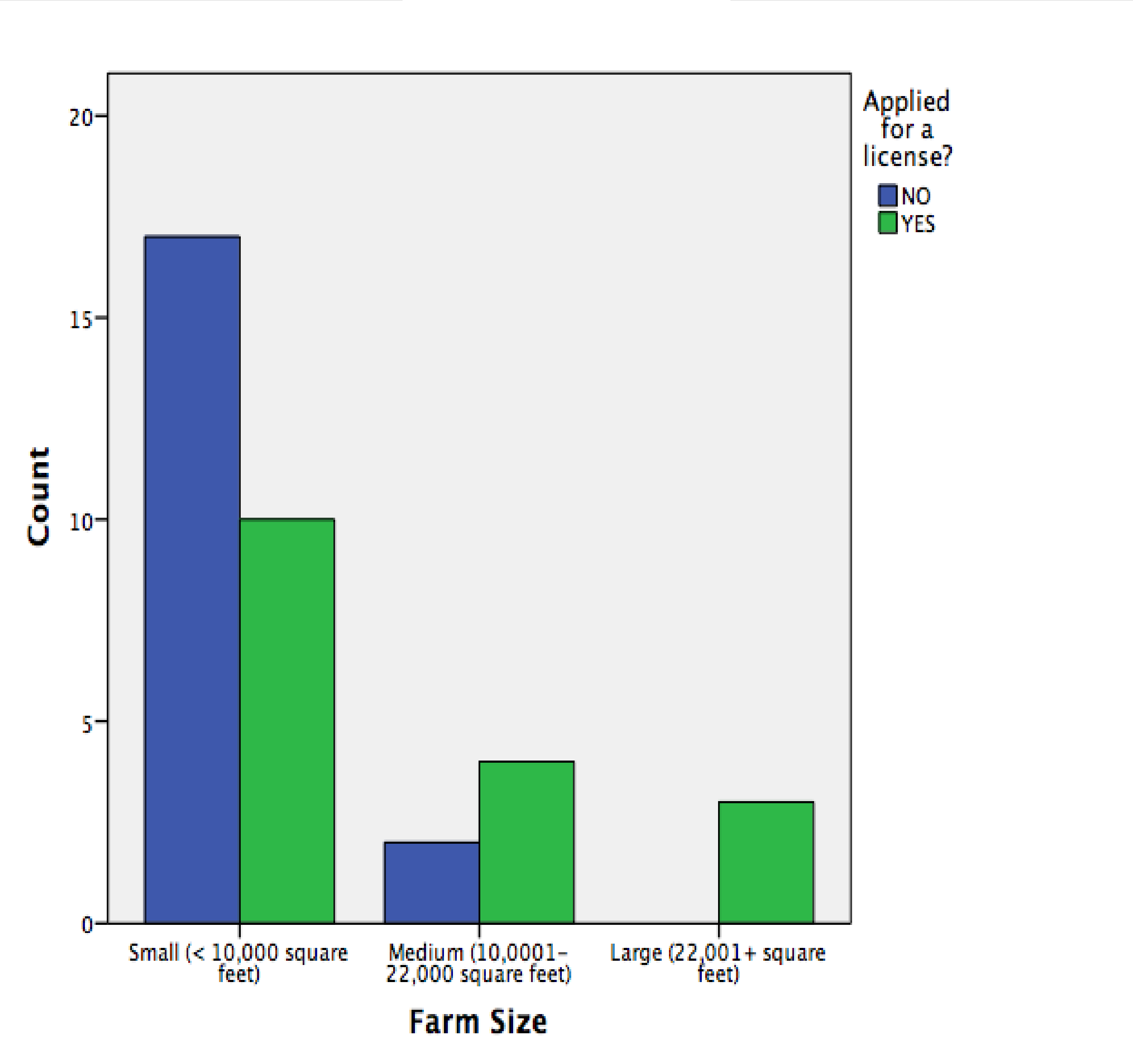
Crop prices (2017)

What was the price/pound you received in 2017?



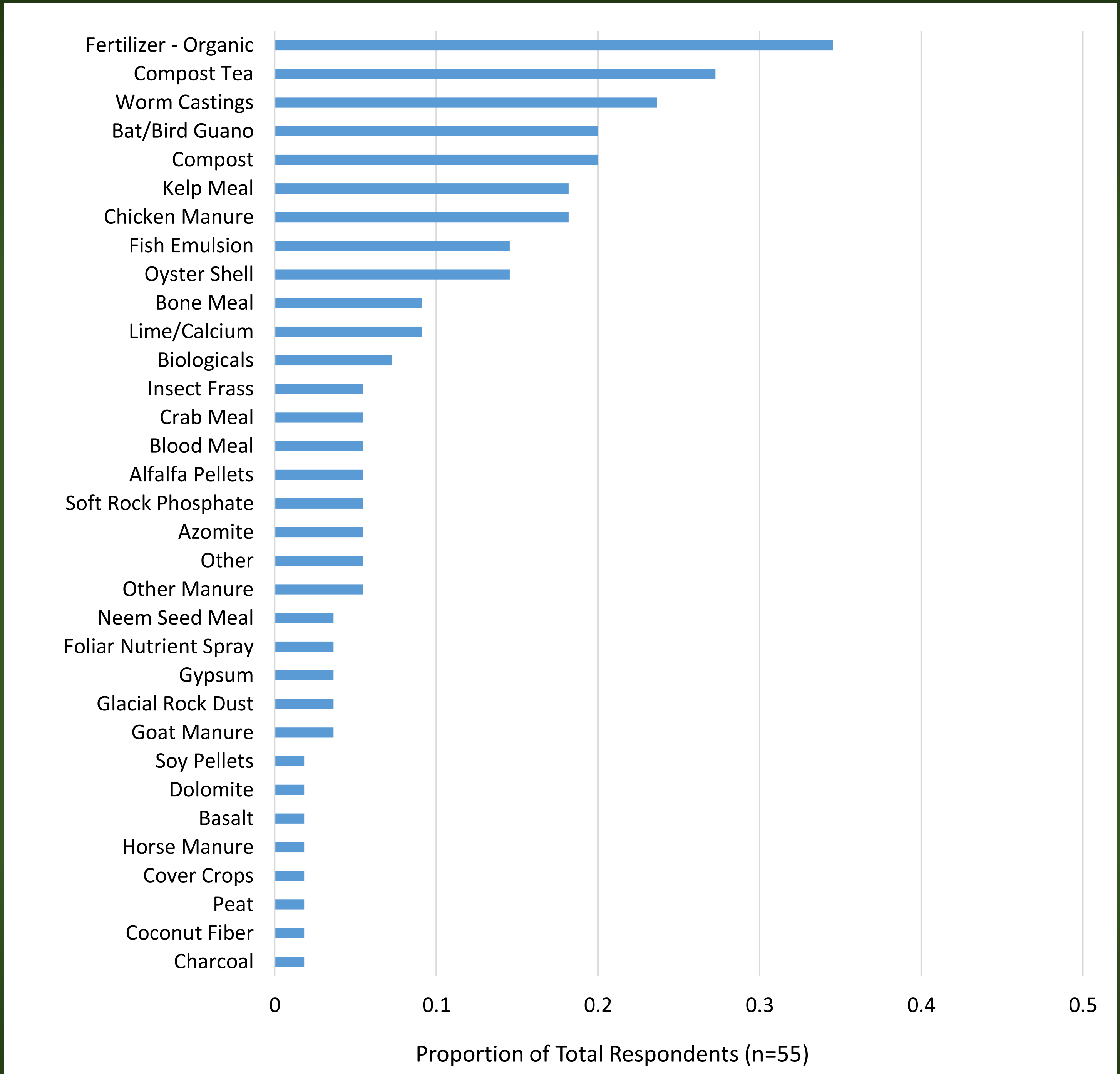
Licensing Status by Farm Size

What is the area under cultivation?



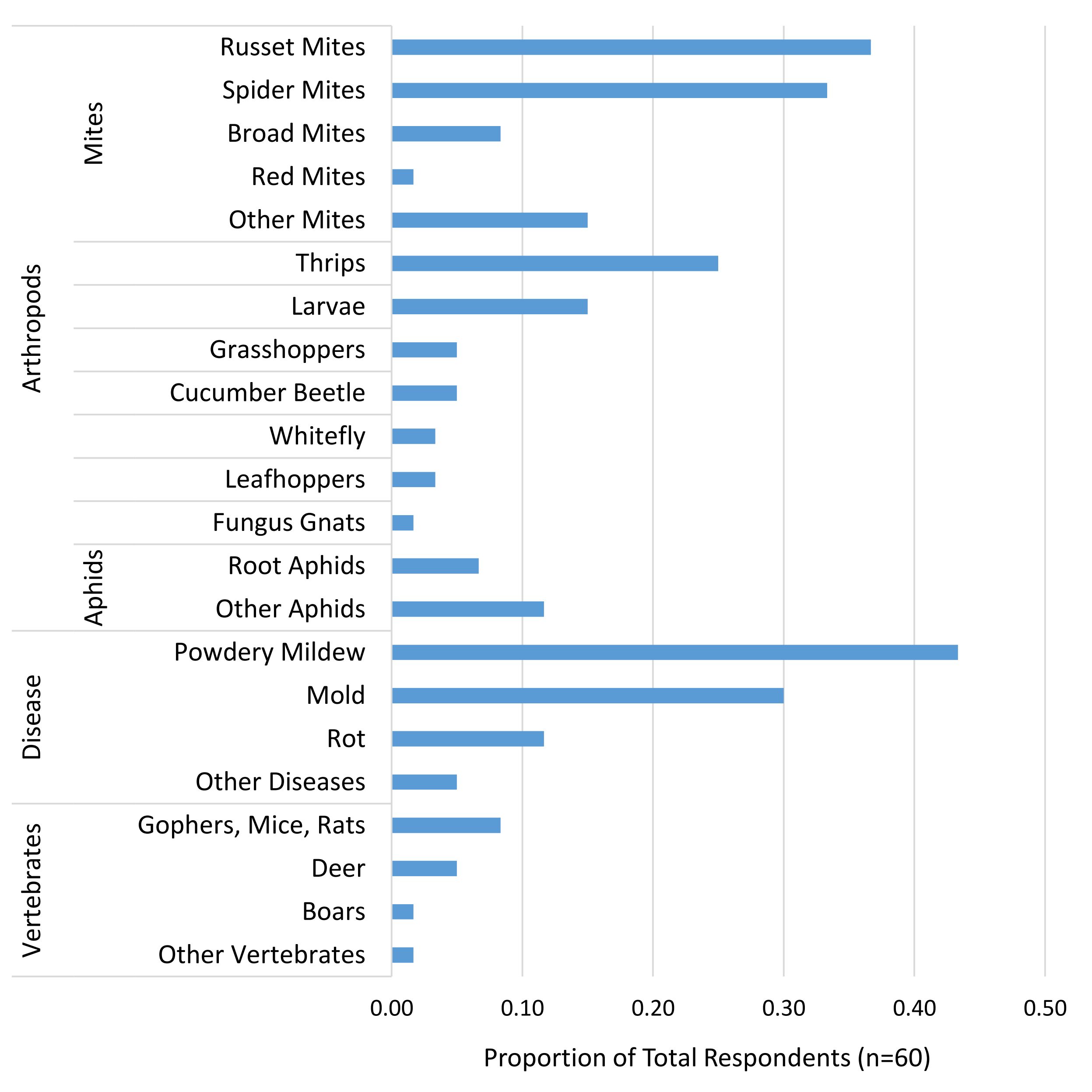
Soil Amendments

What amendments do you use to increase crop yield or quality?



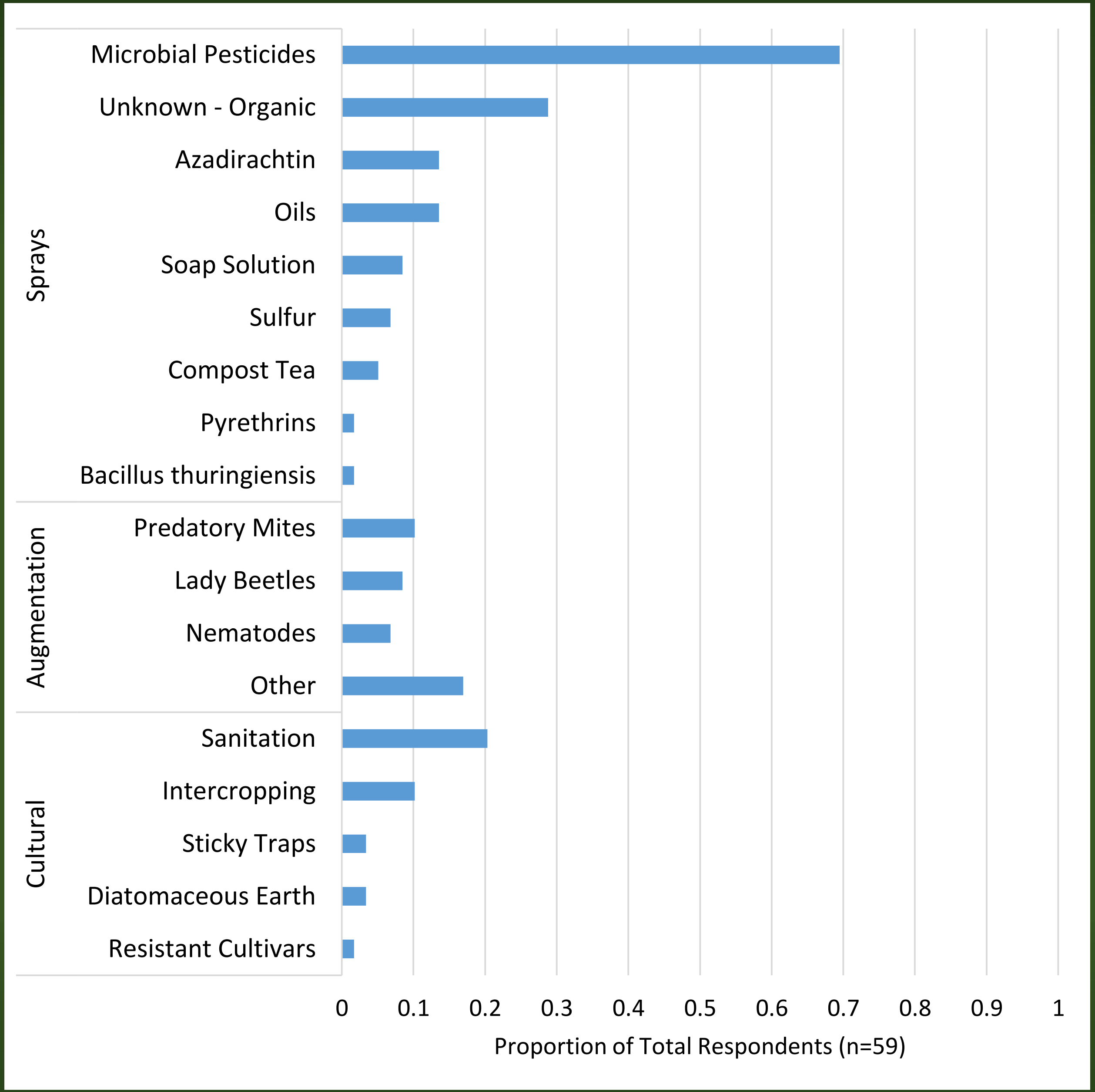
Cannabis Pests

What are your primary pest and disease issues?



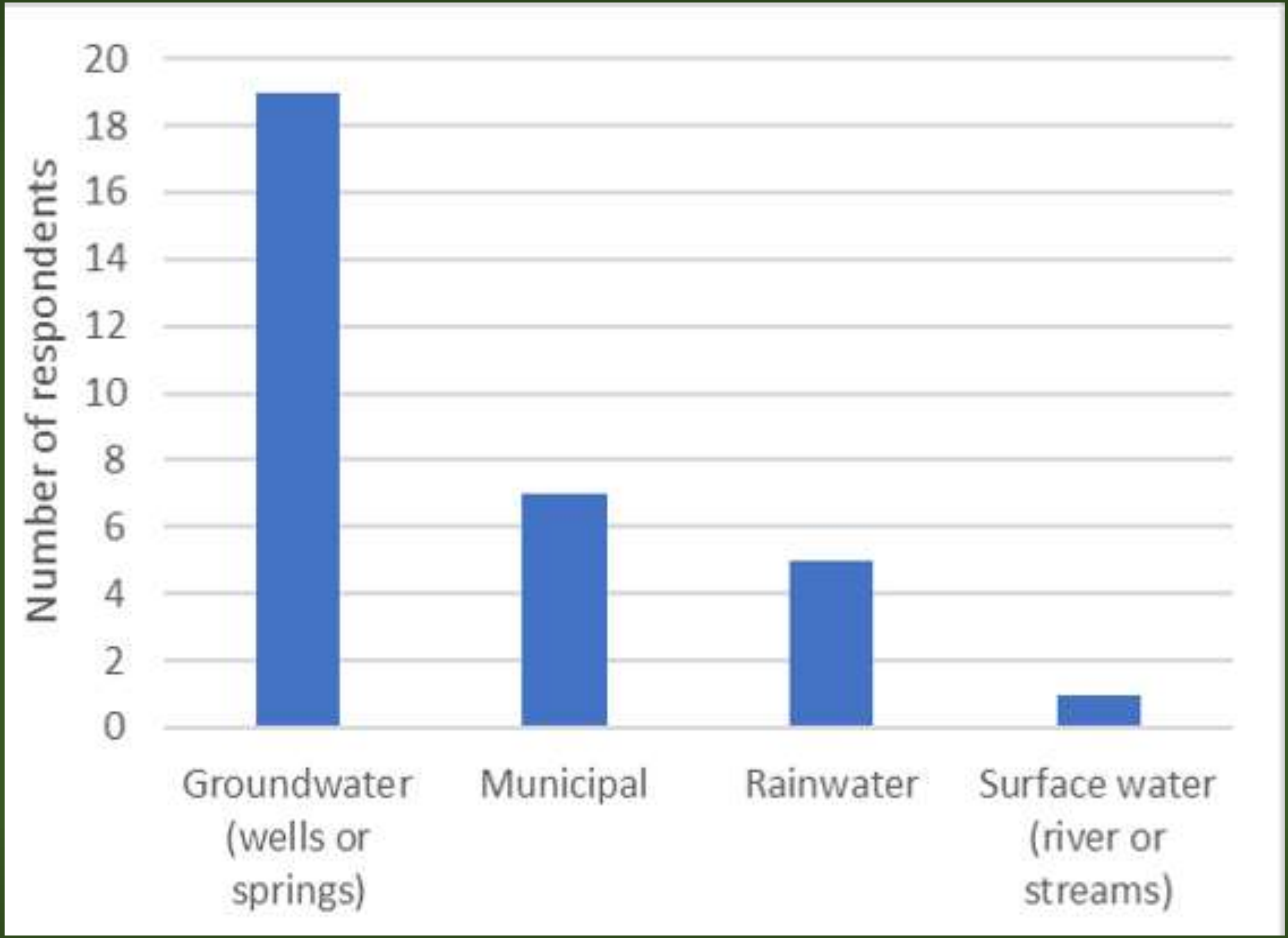
Pest Control Methods

How do you manage or treat plant pests and diseases?



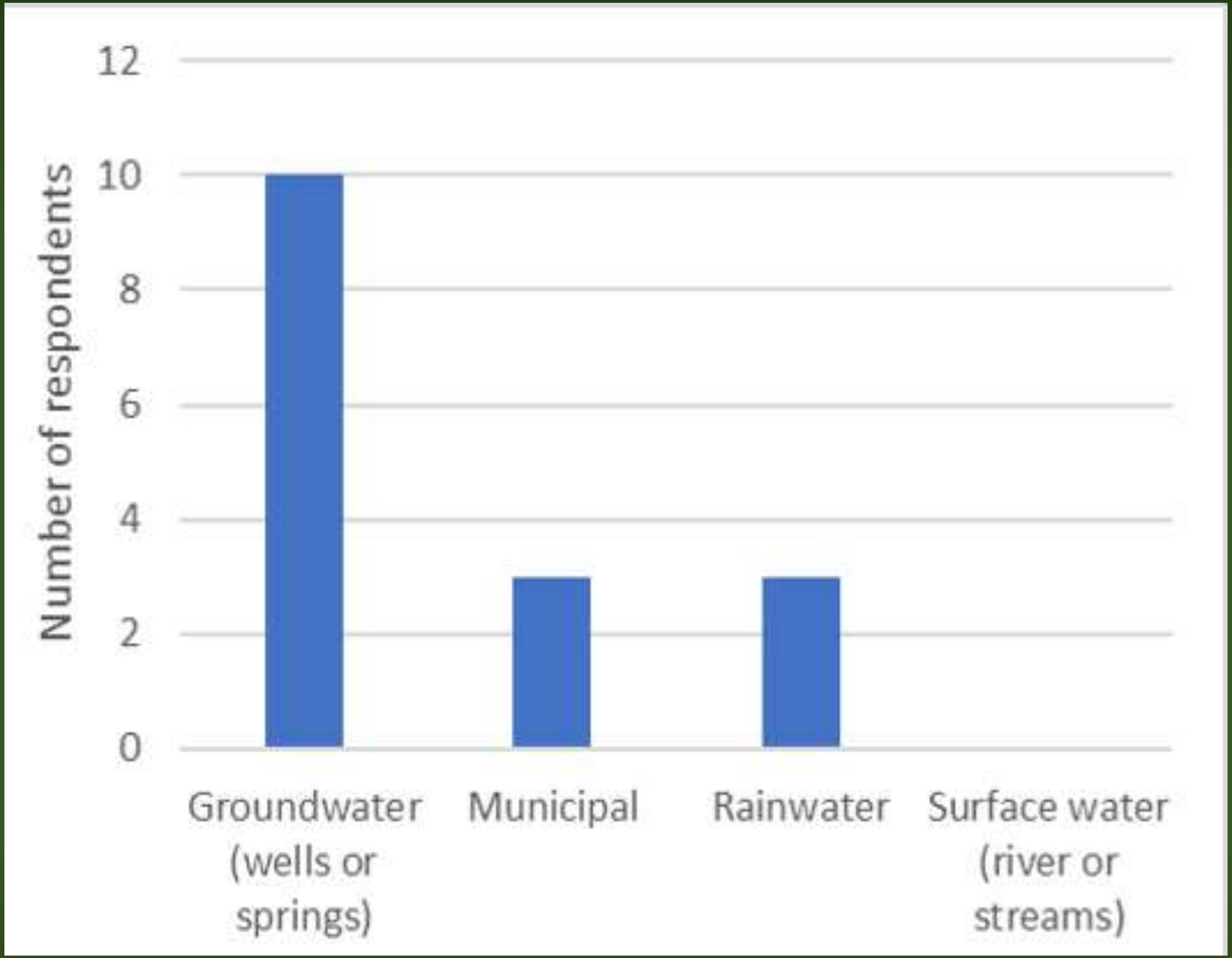
Water Sources

What types of water sources do you rely on for irrigation?



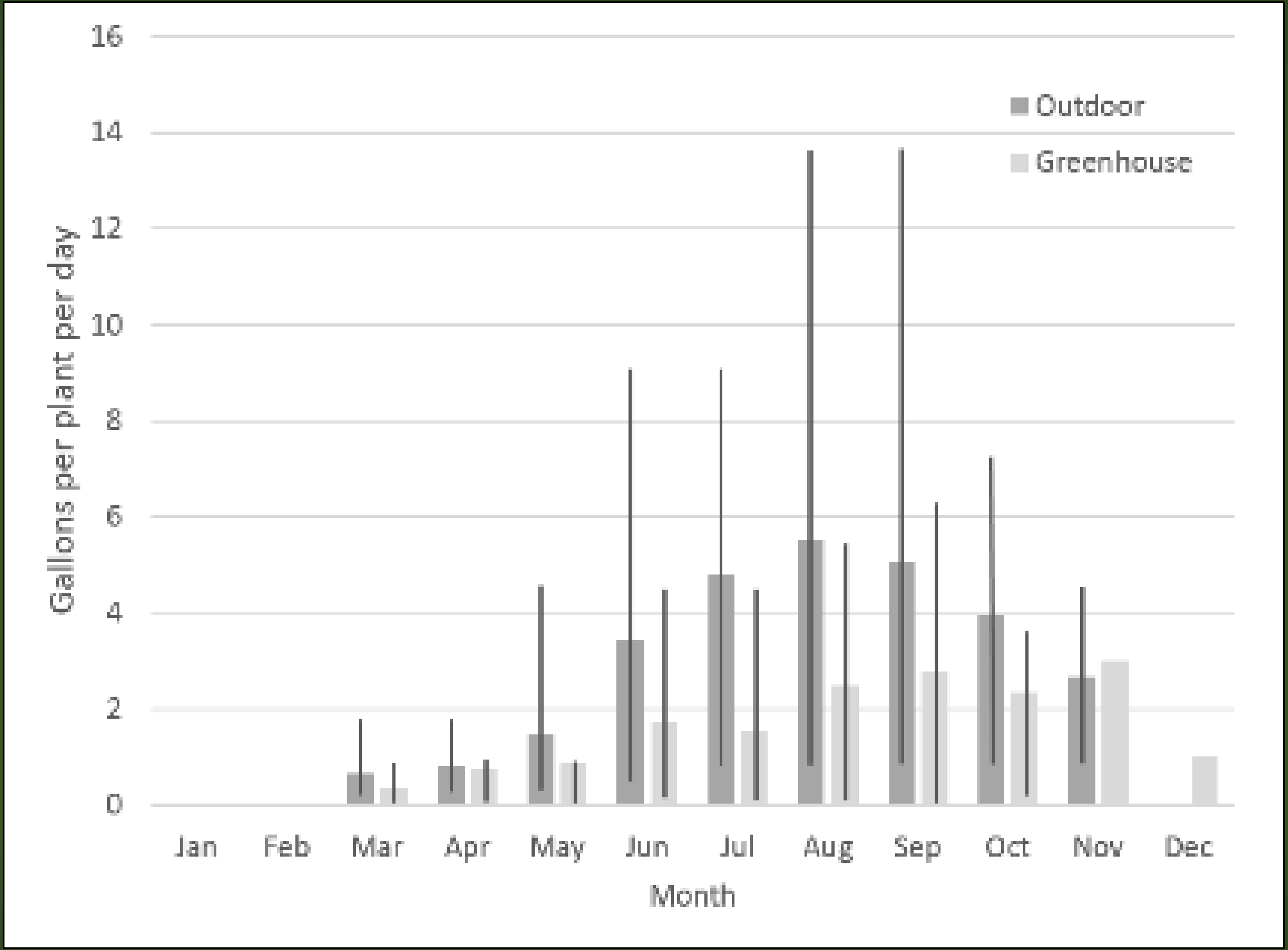
Source of Stored Water

From which water sources do you store water?



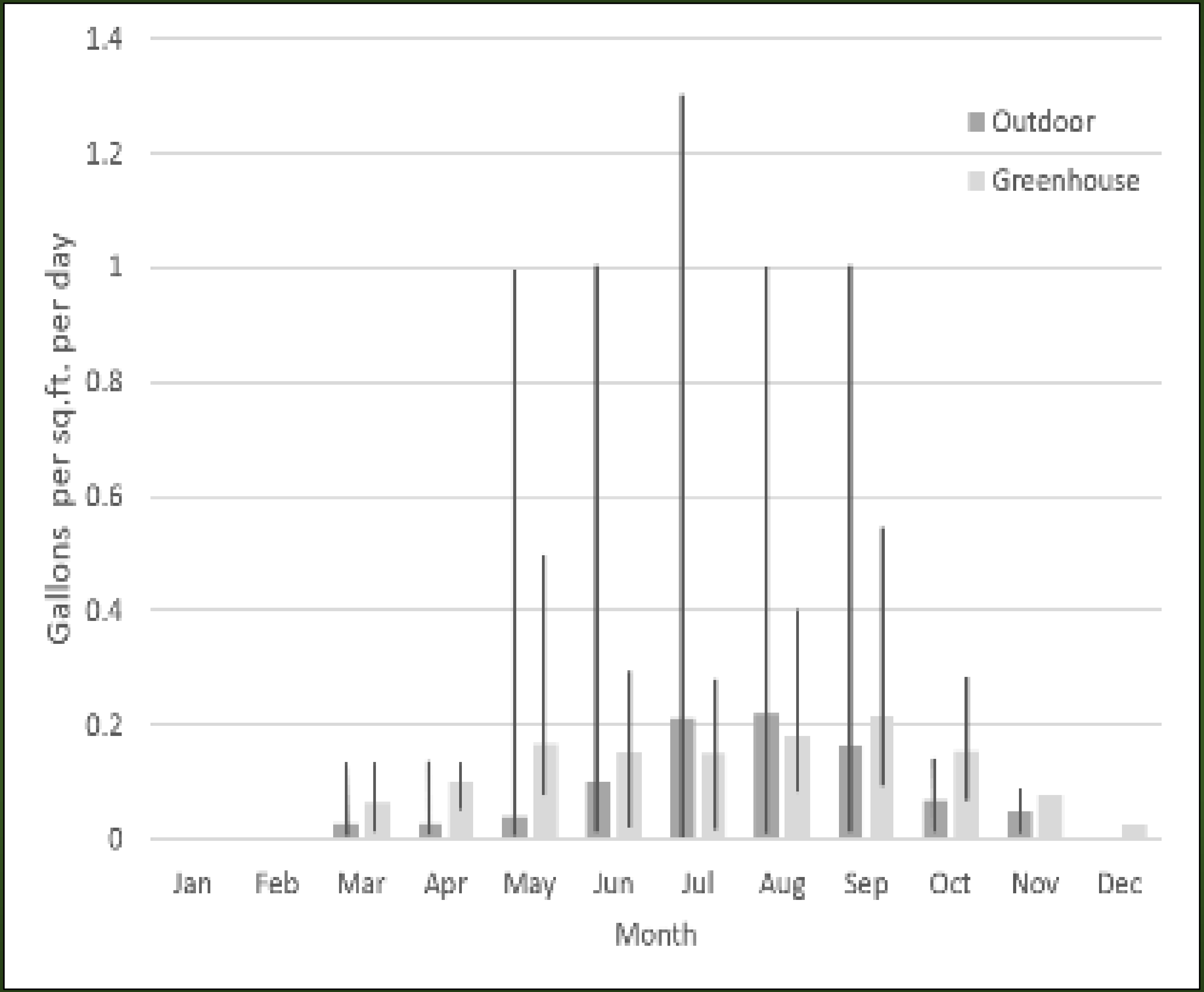
Applied Water
(gal/plant/day)

How much water is applied per plant in each month?



Applied Water
(gal/sq.ft./day)

How much water is applied per square foot of pants each month?



General Comments from Growers

Barriers to compliance – financial cost, inconsistencies between state and county regulations, requirements to adjust production practices

Effects of legalization – small grower exclusion, persistent black market, decrease in local economic activity

Photo credit: www.cannabis-insight.com

Conclusions

Acknowledging the small sample size:

Growers predominantly reported use of microbial or botanically derived insecticides for pest control

Groundwater was the primary source of water, with greatest use in June – Oct

Water application rates were variable across the growing season, peaked in August, and were similar in magnitude for outdoor and greenhouse growers

Some form of storage was commonly reported, but storage capacity needed to satisfy with forbearance requirement may be a significant compliance barrier

Two manuscripts in review at Cal Agriculture

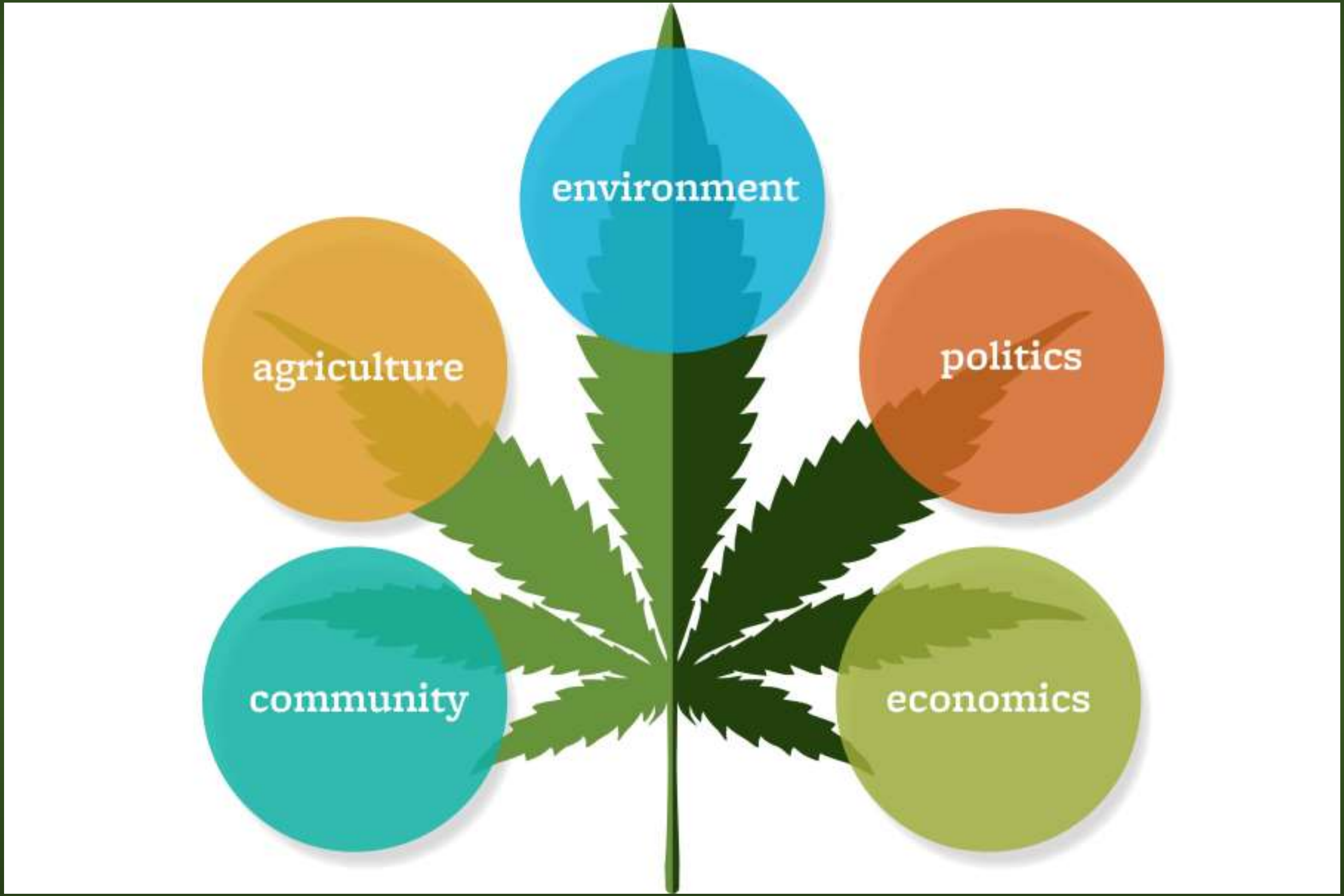
Expanded survey in development and pilot testing underway!

Cannabis Research Center at Berkeley

The CRC promotes interdisciplinary scholarship on the social and environmental dimensions of cannabis production.

Through scientific research and engagement with community, government, and academic entities, we advance understanding of cannabis agriculture in socio-ecological systems at local, national, and global scales.

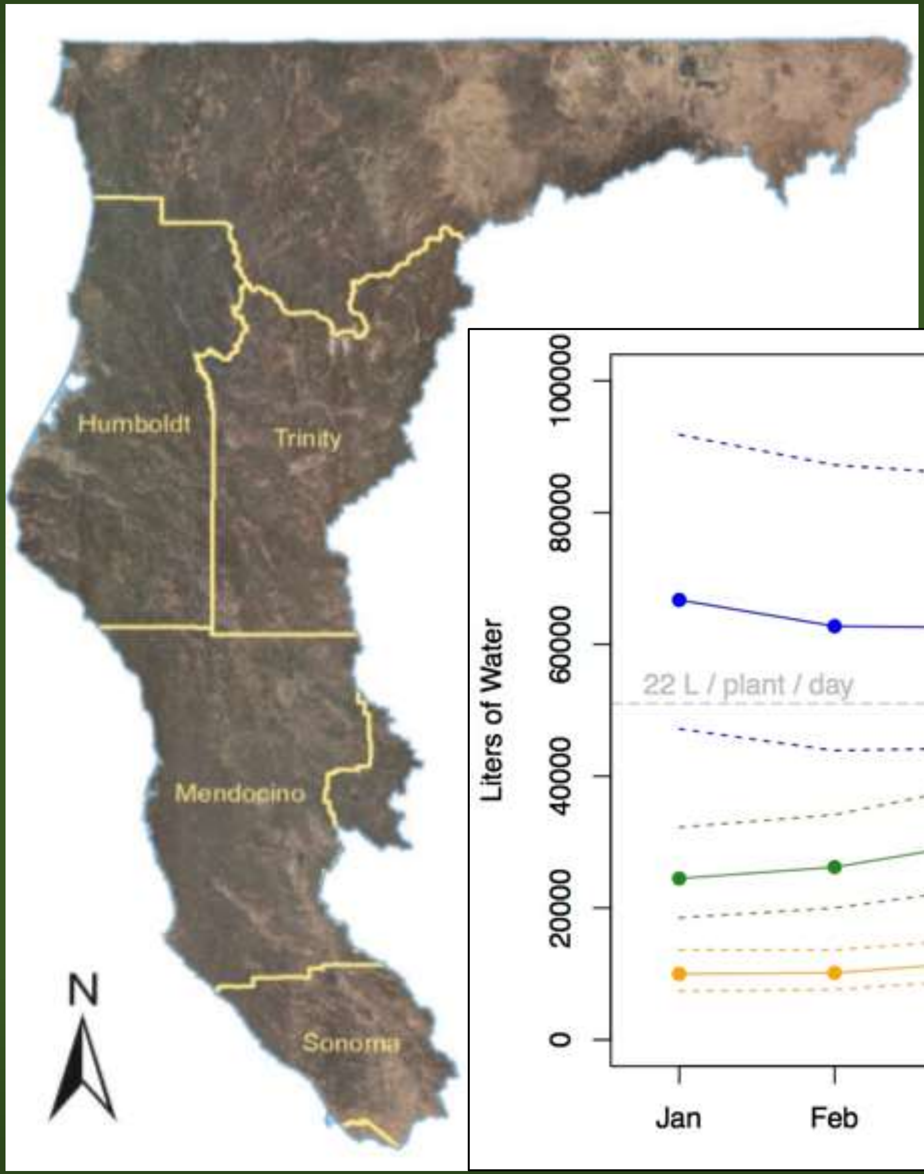
Cannabis Research Center at Berkeley

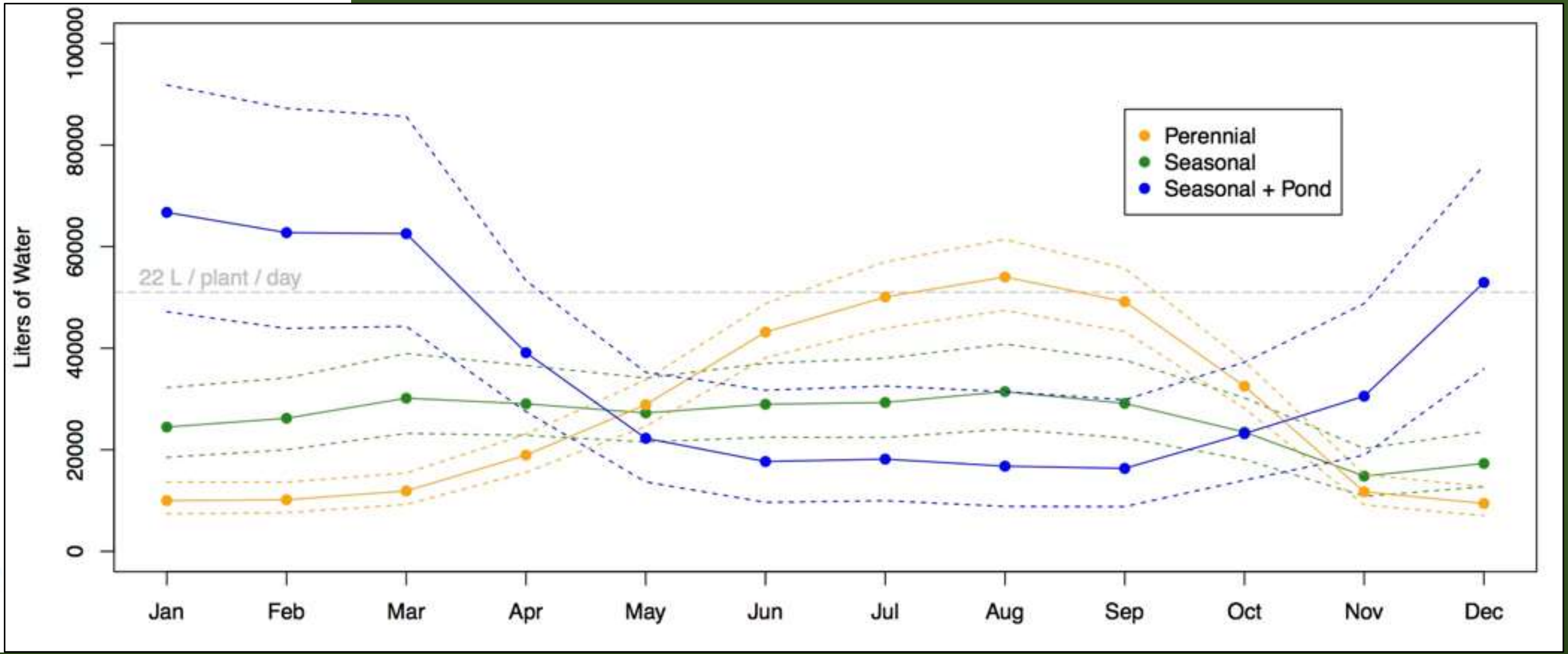


Land Use Change

Source: Google Earth

Water Sourcing, Demands, and Hydrologic Impacts



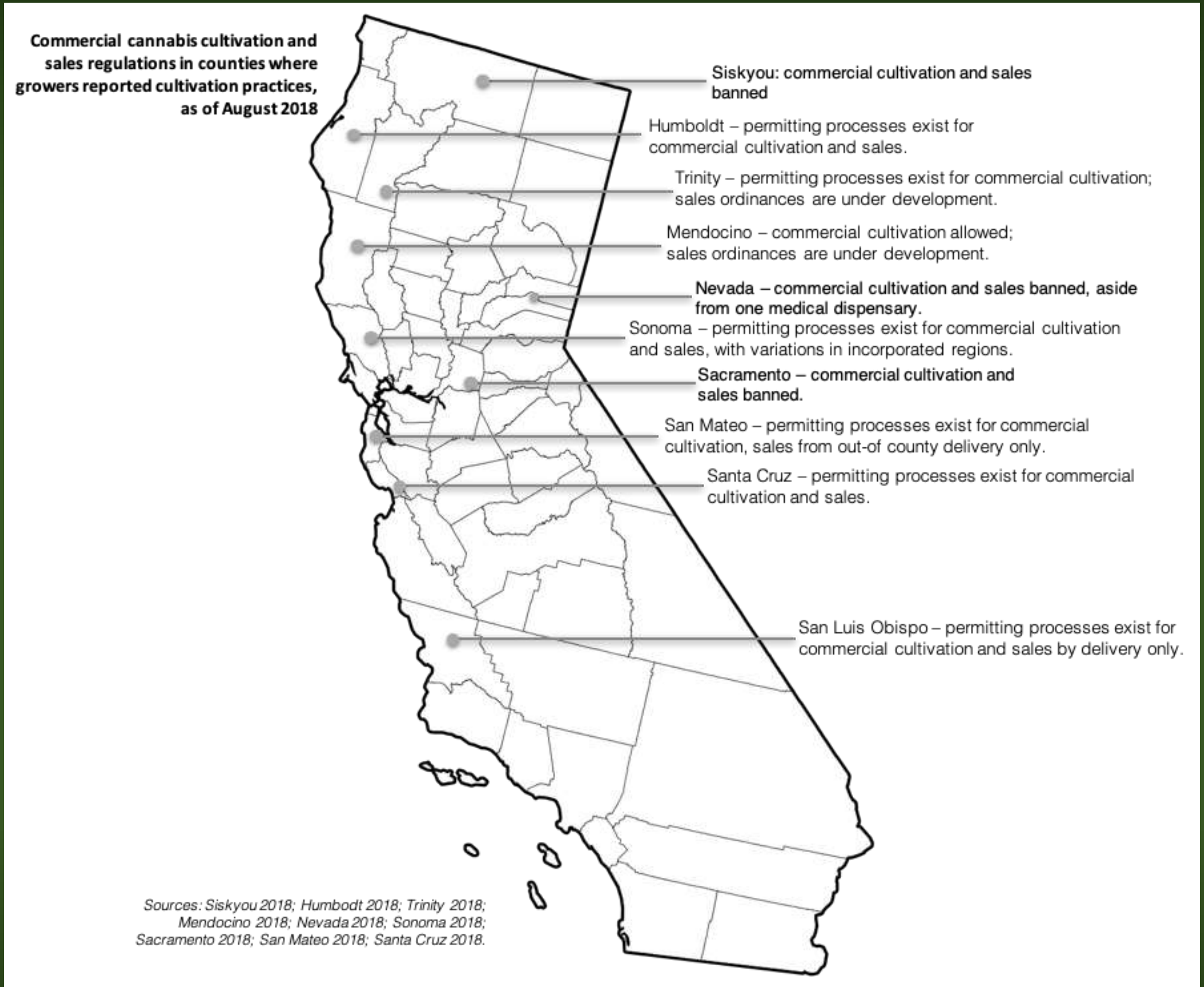


North Coast (Region 1)

Source: Dillis et al. *IN REVIEW*

Fish and Wildlife Impacts

Policy and Regulation



Source: Bodwitch et al. *IN REVIEW*

Who We Are


Van Butsic


Stephanie Carlson


Nathan Sayre


Eric Biber


Mary Power


Michael Polson


Margiana Peterson-Rockney


Ted Grantham


Hekia Bodwitch


Phoebe Parker Shames


Justin Brashares


Jen Carah

Looking ahead…

http://crc.berkeley.edu

Website is live

Research papers forthcoming

Workshops

Collaborative projects

University of California Agriculture and Natural Resources
Berkeley University of California College of Natural Resources
UC Berkeley Social Science Matrix

Water Storage and Cultivation Practices Affect Seasonal Patterns of Water Demand for Cannabis Production in Northern California

Christopher Dillis, PhD
Environmental Scientist

North Coast Regional
Water Quality Control Board

Ted Grantham, PhD
Cooperative Extension Specialist

University of California, Berkeley

California Water Boards

Illegal Water Diversions for Cannabis

Photo credit: California Department of Fish and Wildlife

Photo credit: ChicoER News

Water Boards

Water Storage Systems


Photo credit: Ted Grantham


Photo credit: Rick Fleming

Fundamental Questions

Where do cannabis farms source their water?

How much water is used?

What are the potential impacts to instream flow?

New Data

- Annual reporting: self-reported data on 2017 cultivation year
- First full cultivation season in the program for most enrollees
- Data include:
  - ✓ Size of Cultivation Area
  - ✓ Water input to storage (source and amount)
  - ✓ Water applied to plants (source and amount)
  - ✓ Storage capacity and type
  - ✓ Self-reported compliance with Water Storage and Use Standards

Annual Reports

- Reports analyzed after QA/QC: 901
- Humboldt: 465
- Trinity: 269
- Mendocino: 156
- Sonoma: 11

Fundamental Questions

Where do cannabis farms source their water?

How much water is used?

What are the potential impacts to instream flow?

Water Sources: Seasonal

Surface water

Spring diversion

Water Sources: Seasonal

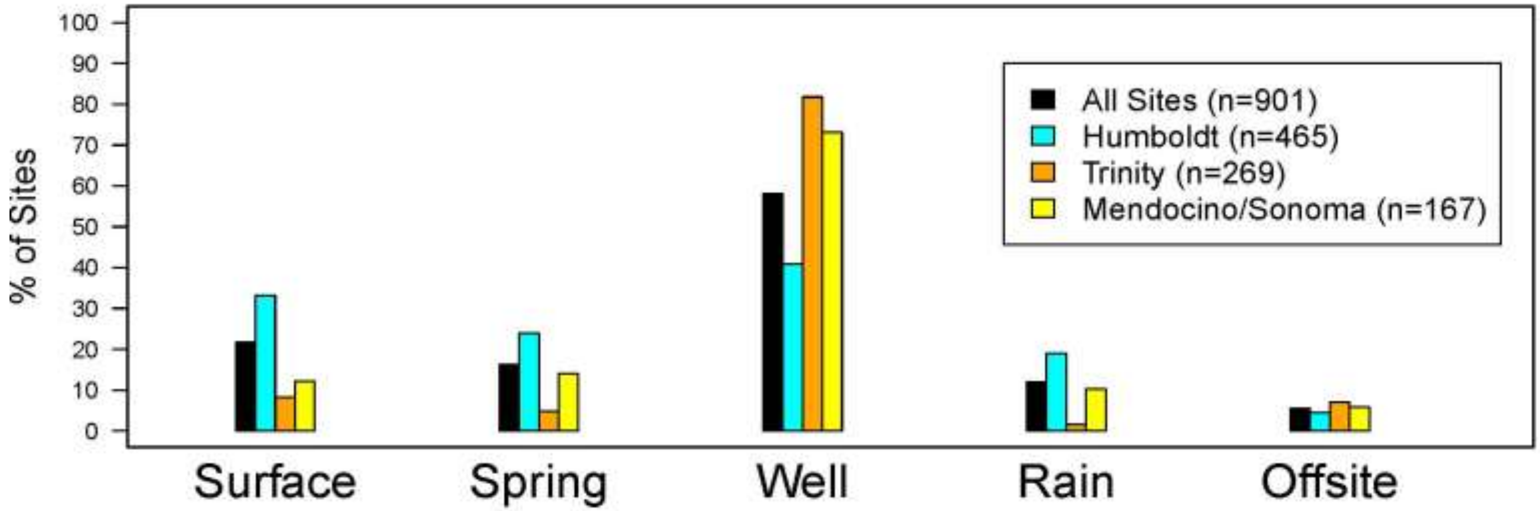
Rainwater catchment systems

Water Sources: Year-round

Groundwater wells

Not pictured: Water delivery, Municipal tap

Water Sources: Results



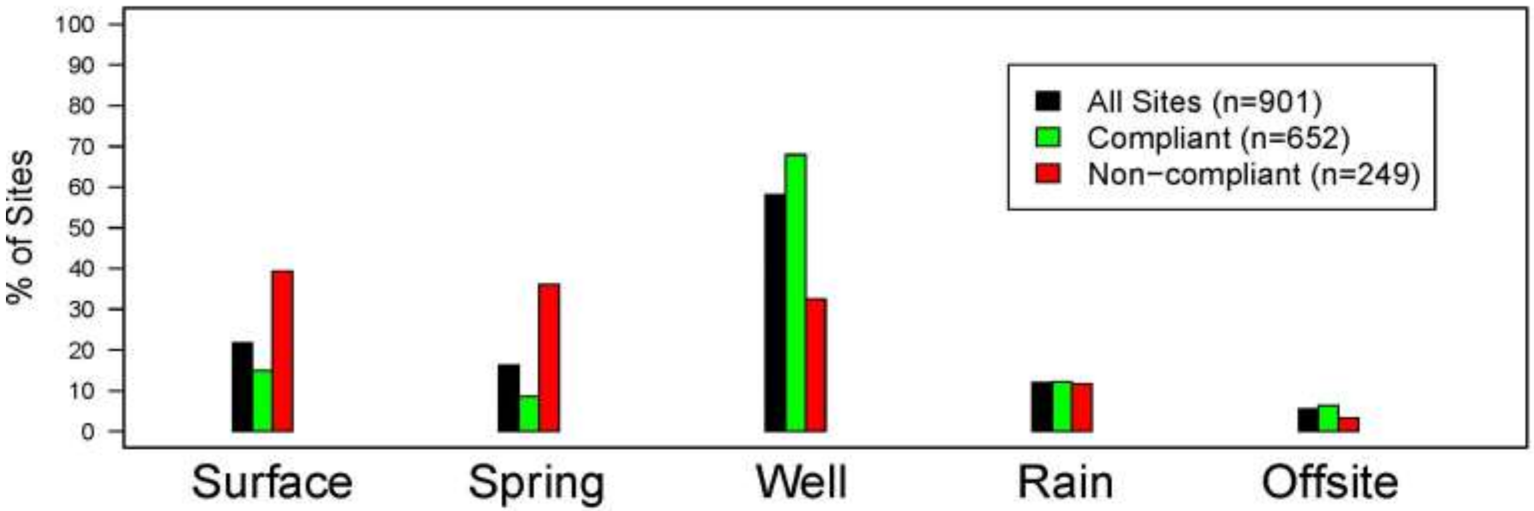
-Wells were the most common water source reported by farms (58%), followed by surface diversions (22%) and spring diversions (16%)

-Rainwater catchment not a common source of water, especially as an exclusive source

-Differences in surface water use (following availability) between counties

Water Boards

Water Sources: Results



-Self-reported compliance with water storage and use standards

-Forbearance requirements (April-October) in 2019 for surface/spring water

-Sites with wells are more likely to meet Water Storage and Use Standards

Water Boards

Water Sources: Findings

- Key findings:
  - ✓ Widespread use of subsurface water in the North Coast
  - ✓ 58% of sites used well, representing 68% of compliant sites
  - ✓ 38% rely on surface and spring water, which are subject to forbearance restrictions in 2019

Water Boards

Forthcoming…

RESEARCH ARTICLE

Watering the Emerald Triangle: Irrigation sources used by cannabis cultivators in Northern California

by Christopher Dillis, Theodore E. Grantham, Connor McIntee, Bryan McFadin and Kason Grady

Accepted to *California Agriculture* (expected publication in summer 2019)

Water Boards

Fundamental Questions

Where do cannabis farms source their water?

How much water is used?

What are the potential impacts to instream flow?

Water Use

- Previous methods for estimating cannabis water use:
  - ✓ Based on expected water demand by a mature cannabis plant during the growing season (Jun-Oct)
  - ✓ Six gallons per plant, per day
  - ✓ Water use = # plants x 6 gpd x 150 days

RESEARCH ARTICLE

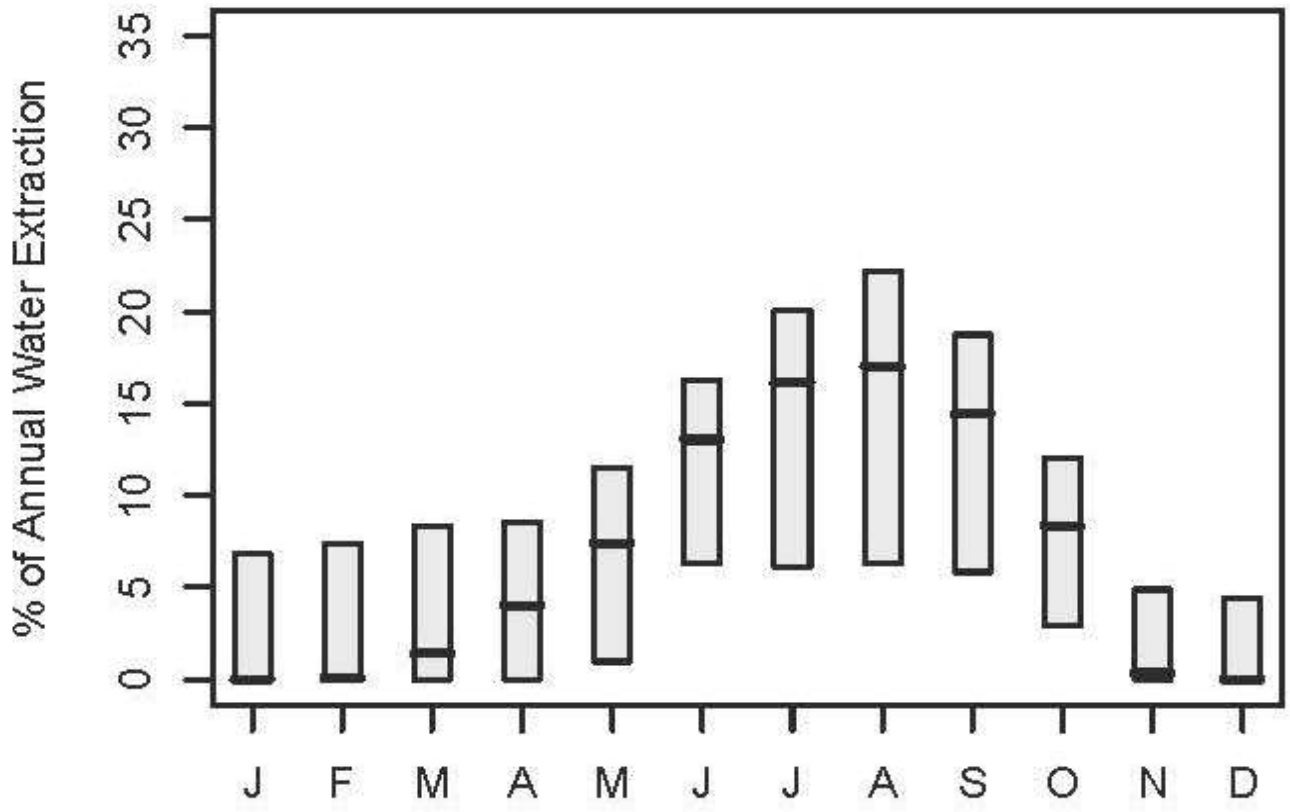
Impacts of Surface Water Diversions for Marijuana Cultivation on Aquatic Habitat in Four Northwestern California Watersheds

Scott Bauer[1*], Jennifer Olson[1*], Adam Cockrill[1], Michael van Hattem[1], Linda Miller[1], Margaret Tauzer[2], Gordon Leppig[1]

Water Use

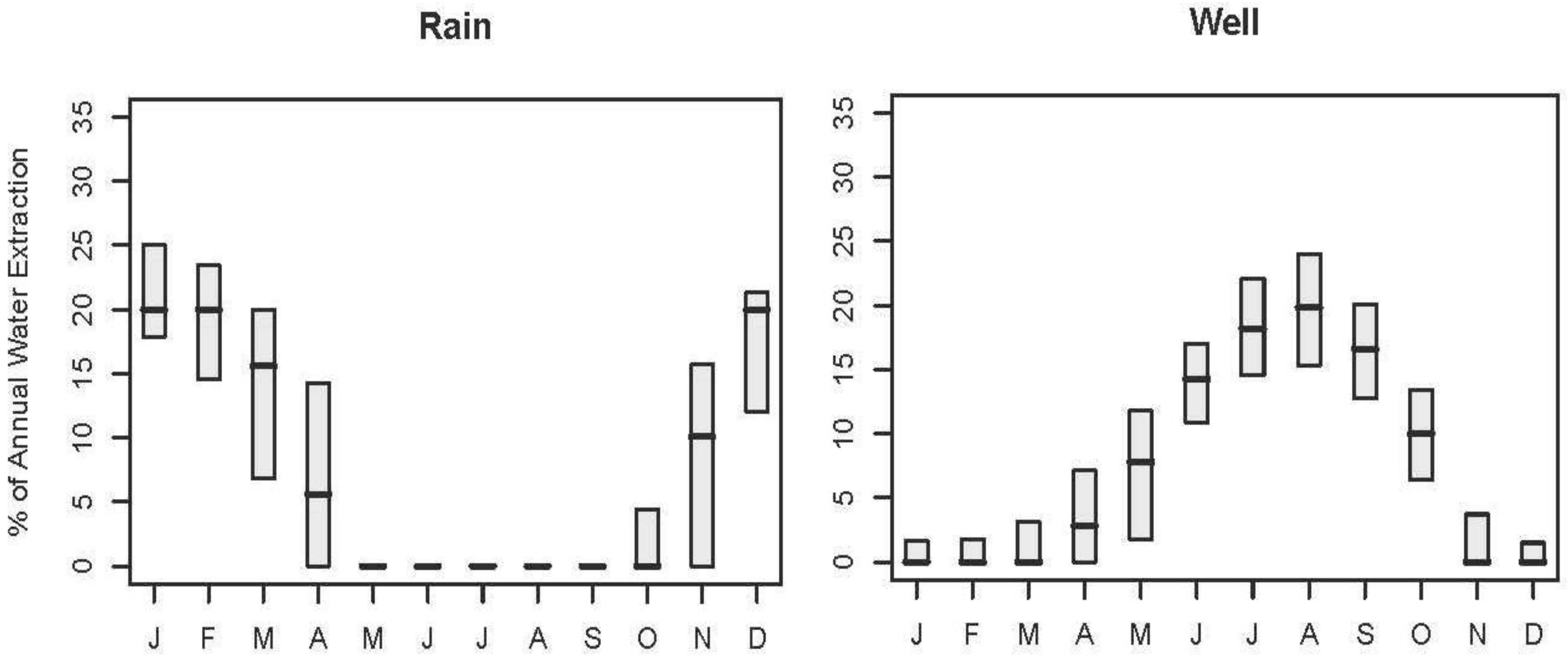
- Limitations of plant-based estimates
  - ✓ Seasonality of water demand
  - ✓ Variability of plant size (outdoor vs. mixed-light operations)
  - ✓ Use of stored water

Water Use Seasonality



Water Boards

Water Use Seasonality By Source



Water Boards

Water Use: importance of storage

Water Use

Vs.

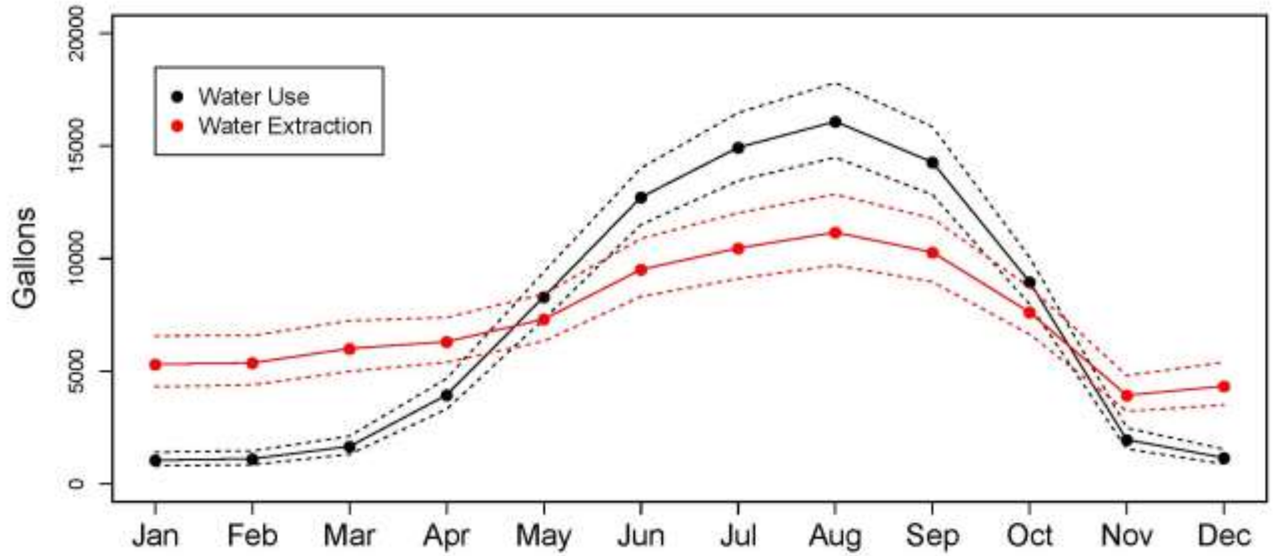
- ✓ Sum of **water applied from storage** and water directly applied from original source
- ✓ Reflects water applied to meet plant demand
- ✓ Previous paradigm

Water Extraction

- ✓ Sum of **water input to storage** and water directly applied from original source
- ✓ Reflects water withdrawn from the watershed
- ✓ More ecologically relevant

Water Boards

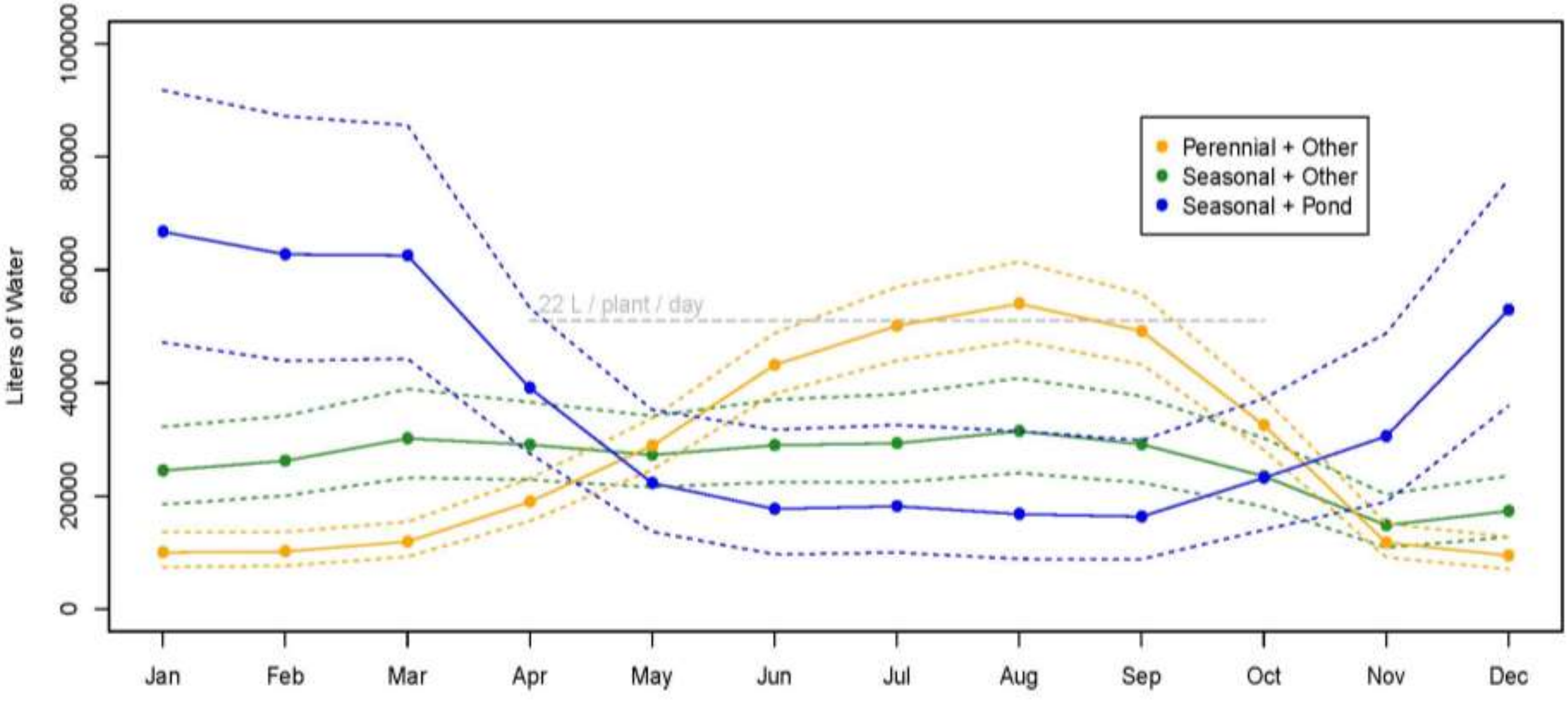
Water Use vs. Water Extraction



*Model predictions made for median size of cultivation area (11,815.5 ft^2)

- Different seasonal patterns of **Water Use** and **Water Extraction**
- Water input to storage reduces extraction during summer months

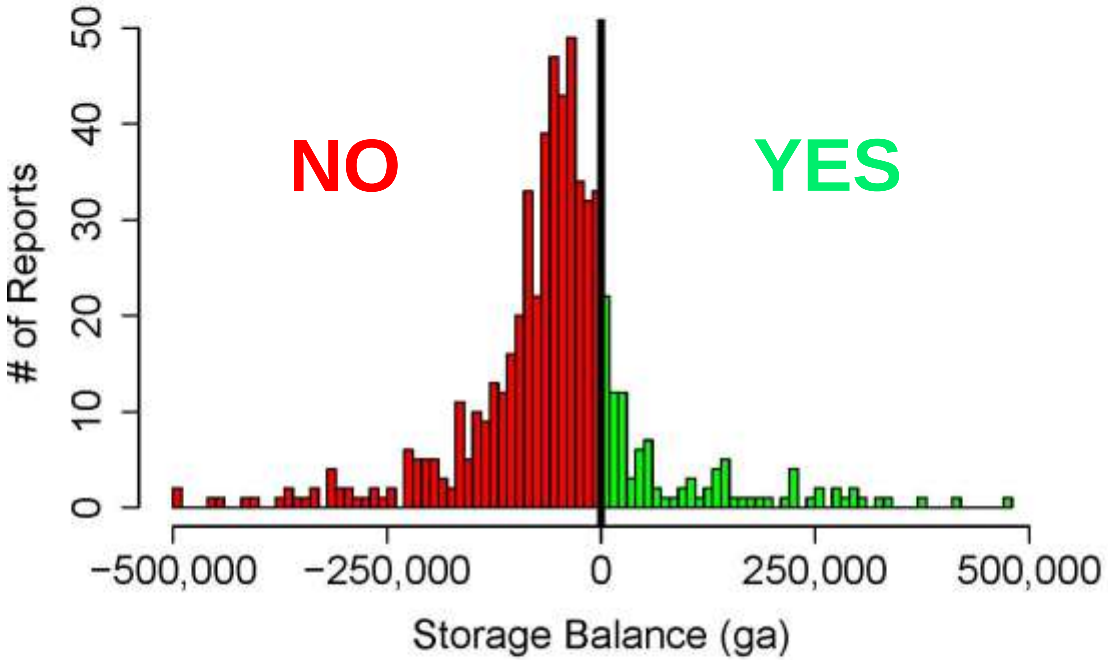
Water Extraction



*Model predictions made for median size of cultivation area (11,815.5 ft^2)

Water Storage

- Storage reduces summer water extraction, *but do farms have enough capacity to forbear Apr-Oct?*

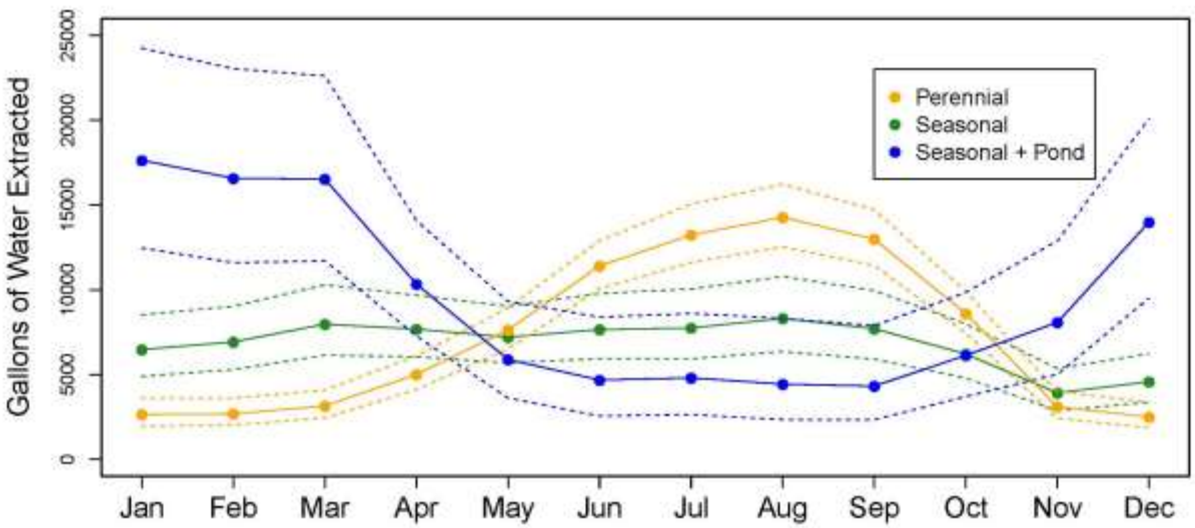


- Storage balance calculated as reported storage capacity minus reported **Water Use** April-October
- In general, farms did not have the storage capacity they would need if required to store water April - October

Water Boards

Water Use: Findings

- Farms with a **perennial water source** do not store much water and therefore extraction follows plant demand
- Farms relying on **seasonal water sources** show a flat curve reflecting both offseason input to storage, yet insufficient storage, resulting in summer extraction
- Farms with **ponds** generally extract most of their water in offseason months



*Model predictions made for median size of cultivation area (11,815.5 ft^2)

Water Boards

In Review…

Water storage and irrigation practices associated with cannabis production drive seasonal patterns of water extraction and use in Northern California watersheds

Christopher Dillis[1*], Connor McIntee[1], Ted Grantham[2], Van Butsic[2], Lance Le[1], Kason Grady[1]

[1]California State Water Resources Control Board, North Coast Region, Santa Rosa, California, United States of America

[2]University of California Berkeley, Berkeley, California, United States of America

Water Boards

Fundamental Questions

Where do cannabis farms source their water?

How much water is used?

What are the potential impacts to instream flow?

Fundamental Questions

Where do cannabis farms source their water?

The majority of reported water used for cannabis cultivation came from wells, with surface water and spring water representing the next most common sources

How much water is used?

What are the potential impacts to instream flow?

Water Boards

Fundamental Questions

Where do cannabis farms source their water?

The majority of reported water used for cannabis cultivation came from wells, with surface water and spring water representing the next most common sources

How much water is ~~used~~ **extracted and when**?

The timing and amount of water extracted for cannabis cultivation depends on where farms source their water and what type (i.e. amount) of water storage is used

What are the potential impacts to instream flow?

Water Boards

Fundamental Questions

Where do cannabis farms source their water?

The majority of reported water used for cannabis cultivation came from wells, with surface water and spring water representing the next most common sources

*How much water is ~~used~~ **extracted and when**?*

The timing and amount of water extracted for cannabis cultivation depends on where farms source their water and what type (i.e. amount) of water storage is used

What are the potential impacts to instream flow?

Water Boards

Potential impacts

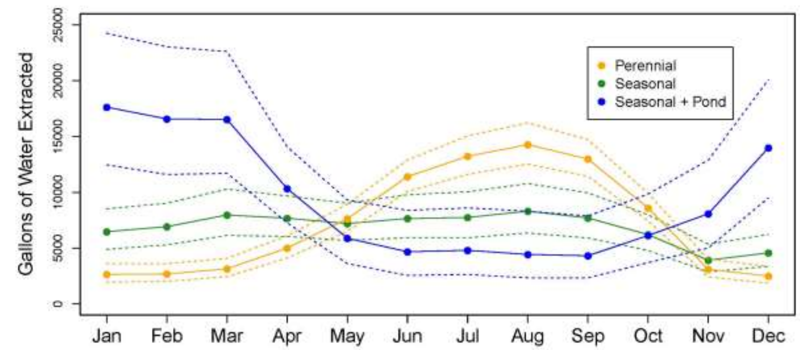
- Overall, extraction patterns are coupled with plant irrigation demands, likely causing dry season flow impacts
- Groundwater use coupled with off-season storage likely moderates summer baseflow impacts
- Potential impacts to instream flow are influenced by the quantity, timing, and location of diversion
  - ✓ Quantity: farm size
  - ✓ Timing: water source and storage capacity
  - ✓ Location: Distance from stream

Water Boards

Next Steps: Cannabis Water Budgets

Cannabis Footprint

Predictive Water Demand Models



Watershed Scale Demand Water Budgets

Water Boards

Thank you!

Instream Flows in Select Trinity River Tributaries and Comparison to Water Use Estimates

April 24, 2019

Salmonid Restoration Federation Conference

Bryan McFadin

Senior Water Resource Control Engineer

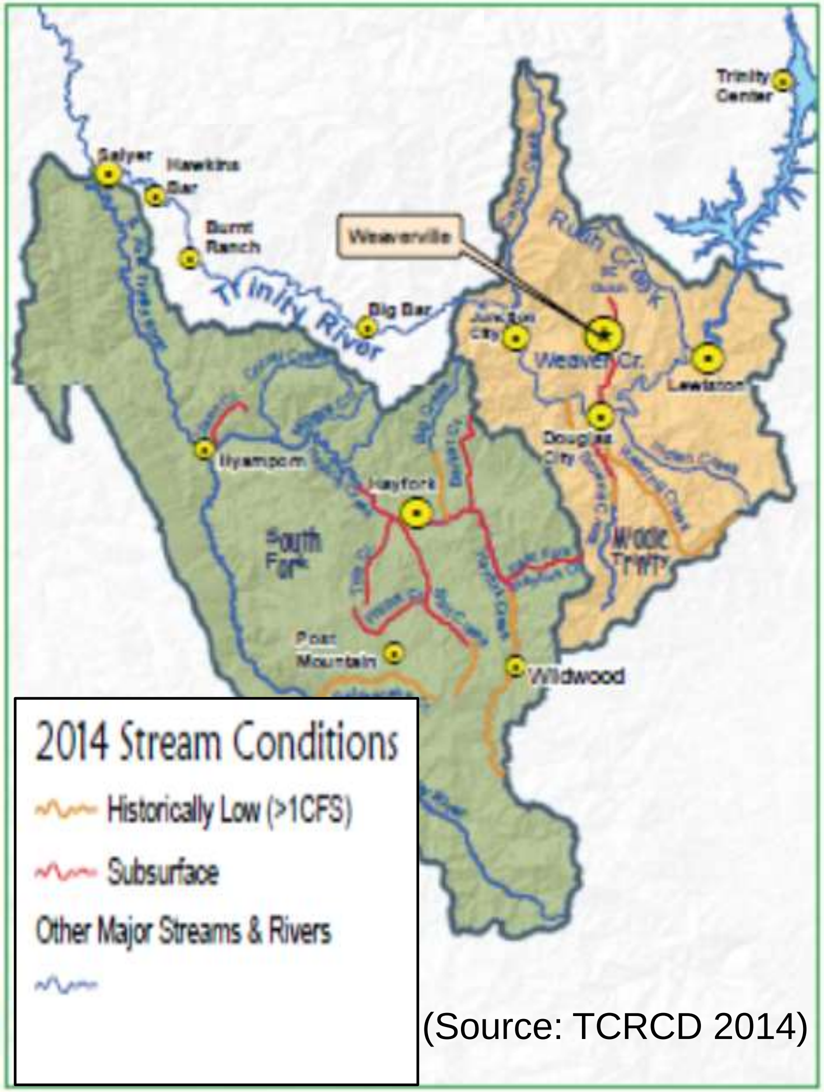
North Coast Regional Water Quality Control Board

CALIFORNIA Water Boards

Acknowledgements

- Josh Smith and Cindy Buxton, WRTC
- Nick Cusick, Callie Grant, Emily McClintock, Cameron Heyvaert, and Katy Abbott, Americorps WSP
- Andy Hill and crew, CDFW
- Galen Andersen, Kyle Hopkins, and Justin Pabich, USFS
- Carrieann Lopez, Connor McIntee, Justin Fitt, Rich Fadness, Stormer Feiler, Shin-Roei Lee

Background



(Source: TCRCD 2014)

- Alarming low flow conditions in drought
- Increased water demands: mostly cannabis
- Local partners

Water Boards

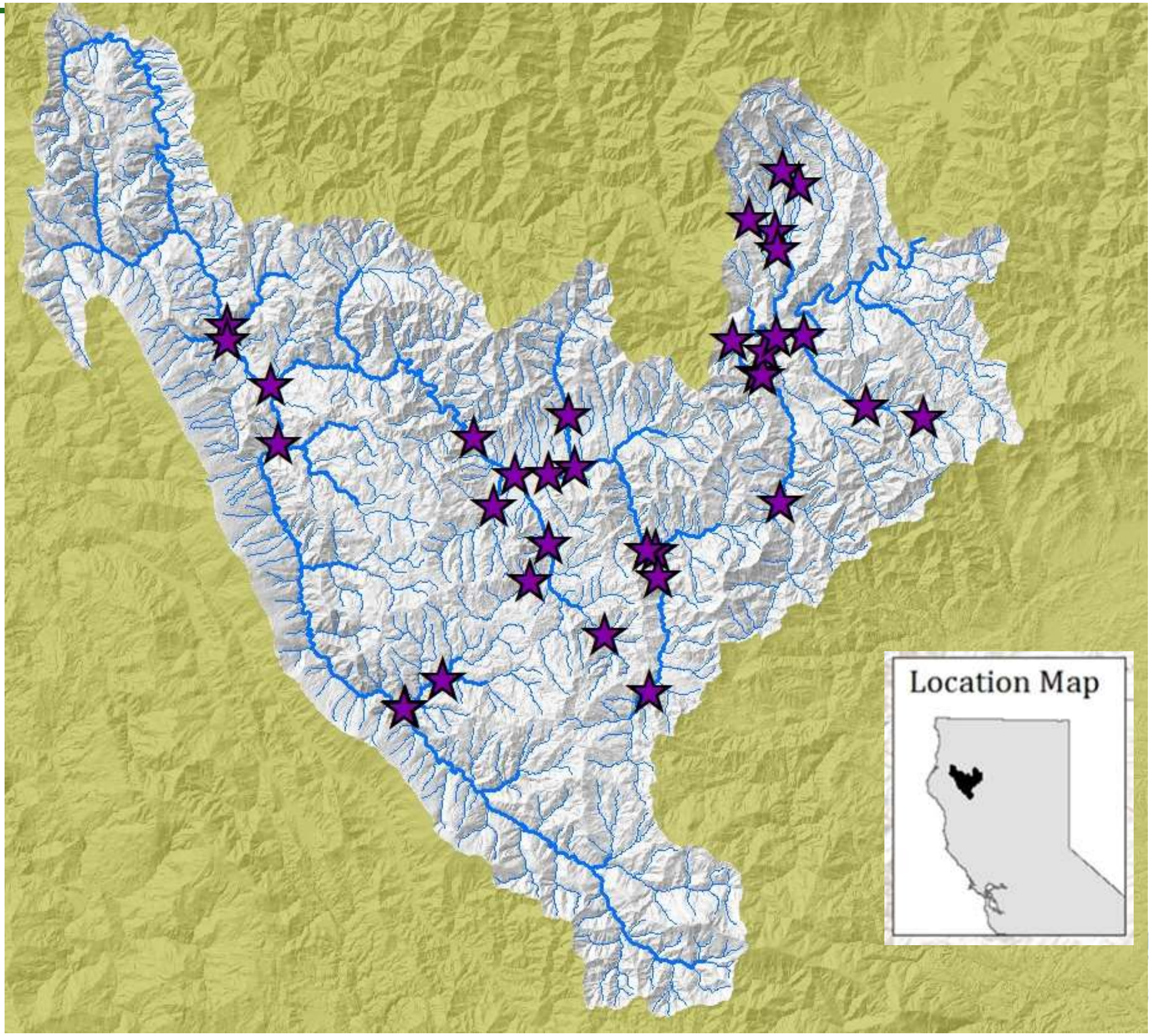
Study Objectives

- Characterize the hydrology of the basins (Weaver, Indian, Reading, Browns, Hayfork, & Rattlesnake Creeks)
- Understand water extraction and impacts
- Establish historical context
- Provide the basis for evaluating the effectiveness of regulations

Water Boards

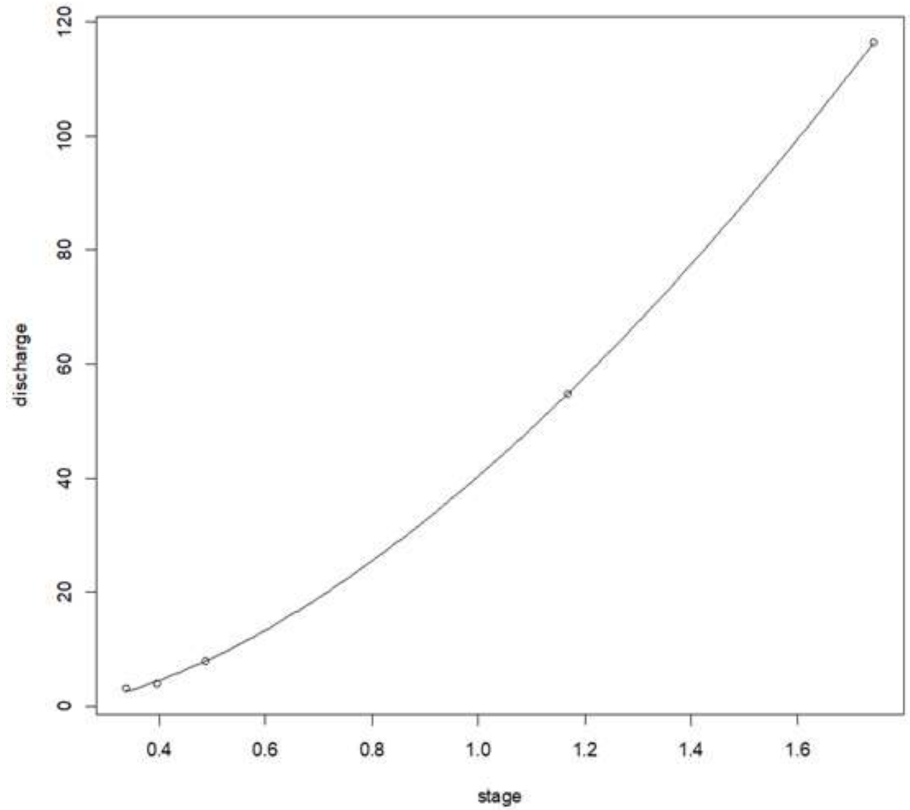
What we did…

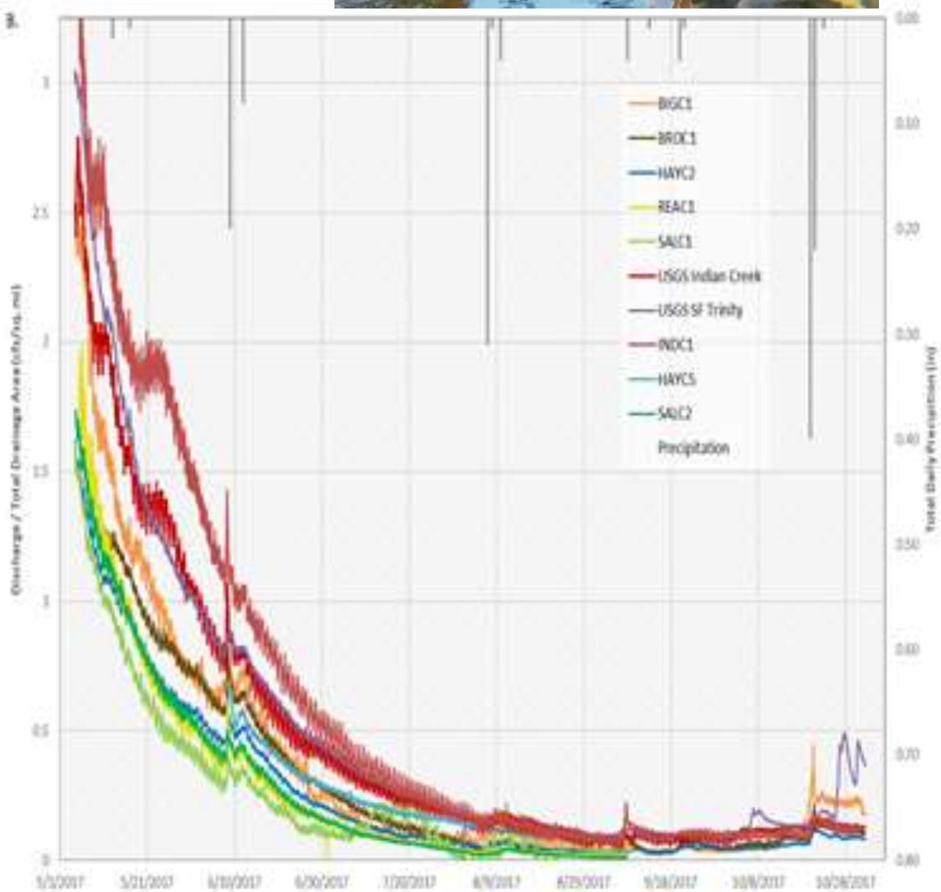
Measured Instream Flows Monthly at 33 locations



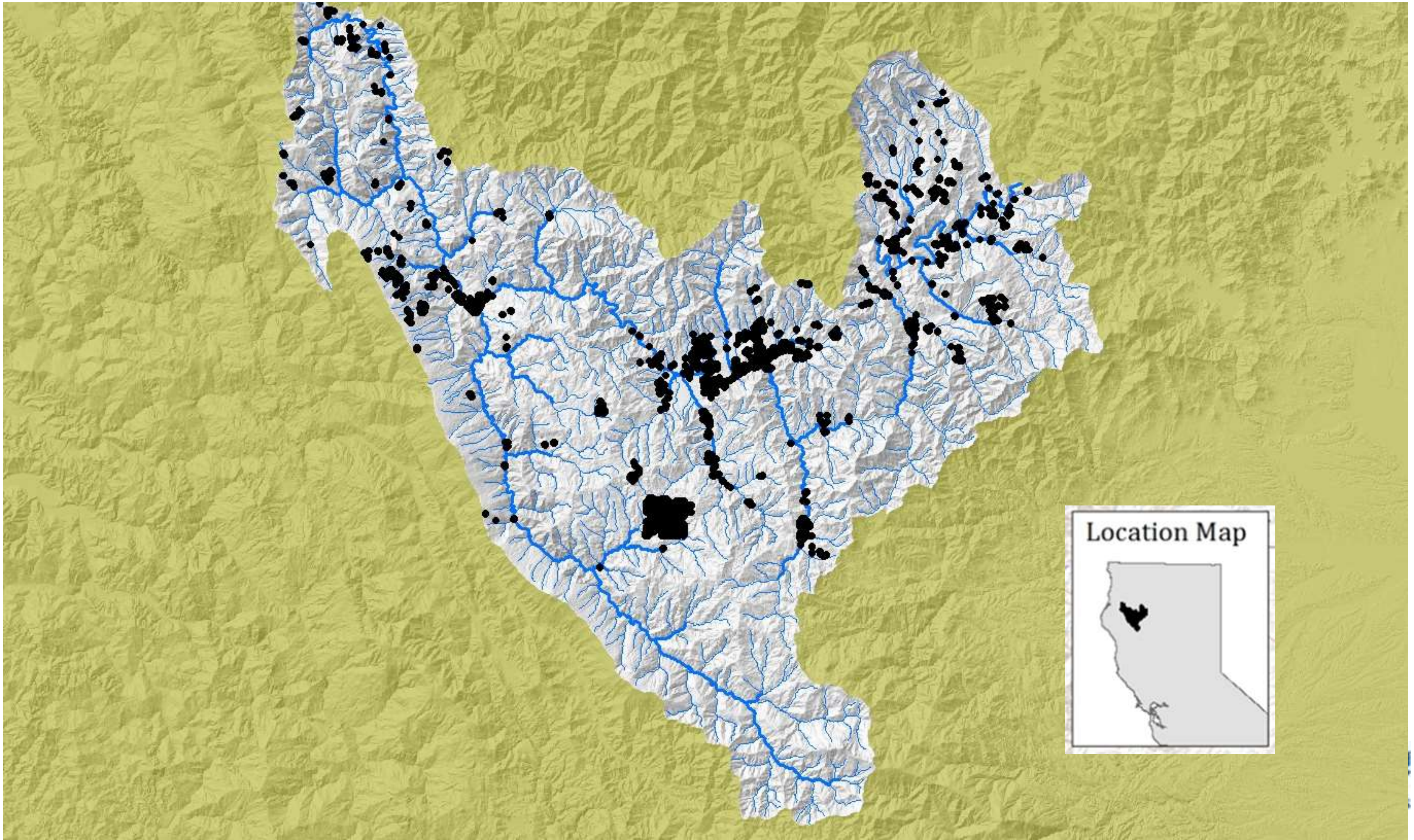
Established Seasonal Gages

- 5 sites in 2016
- 9 sites in 2017





Mapped Cannabis Grows



Estimated Cannabis Water Use

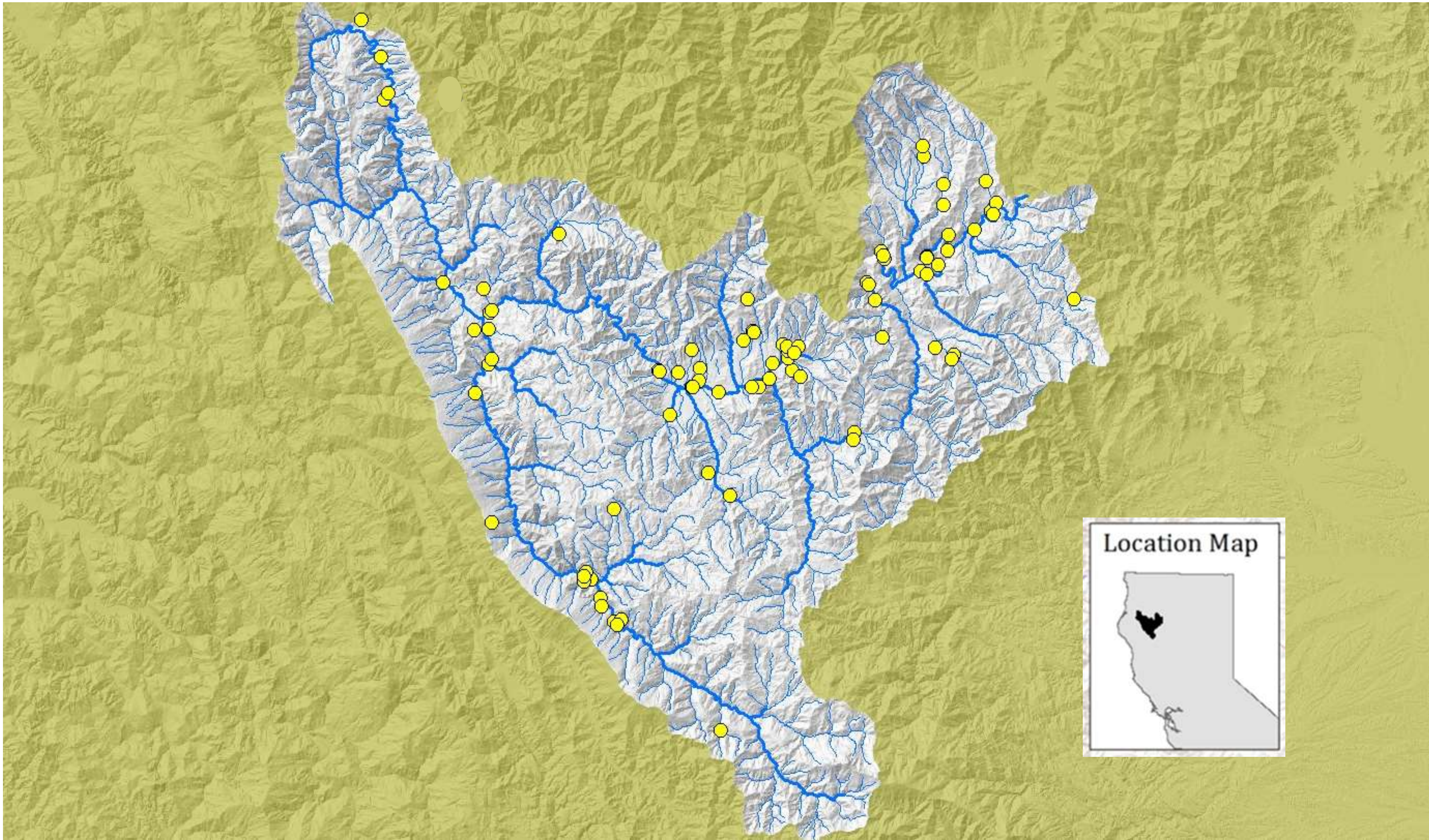
Rate		Area		Volume
Cannabis Monitoring and Reporting Data (CIWQS)	×	Mapped Cannabis Site Area	=	Cannabis-Related Water Use
gallons/ft^2/day		ft^2		gallons/day

Cannabis Water Use Estimates:

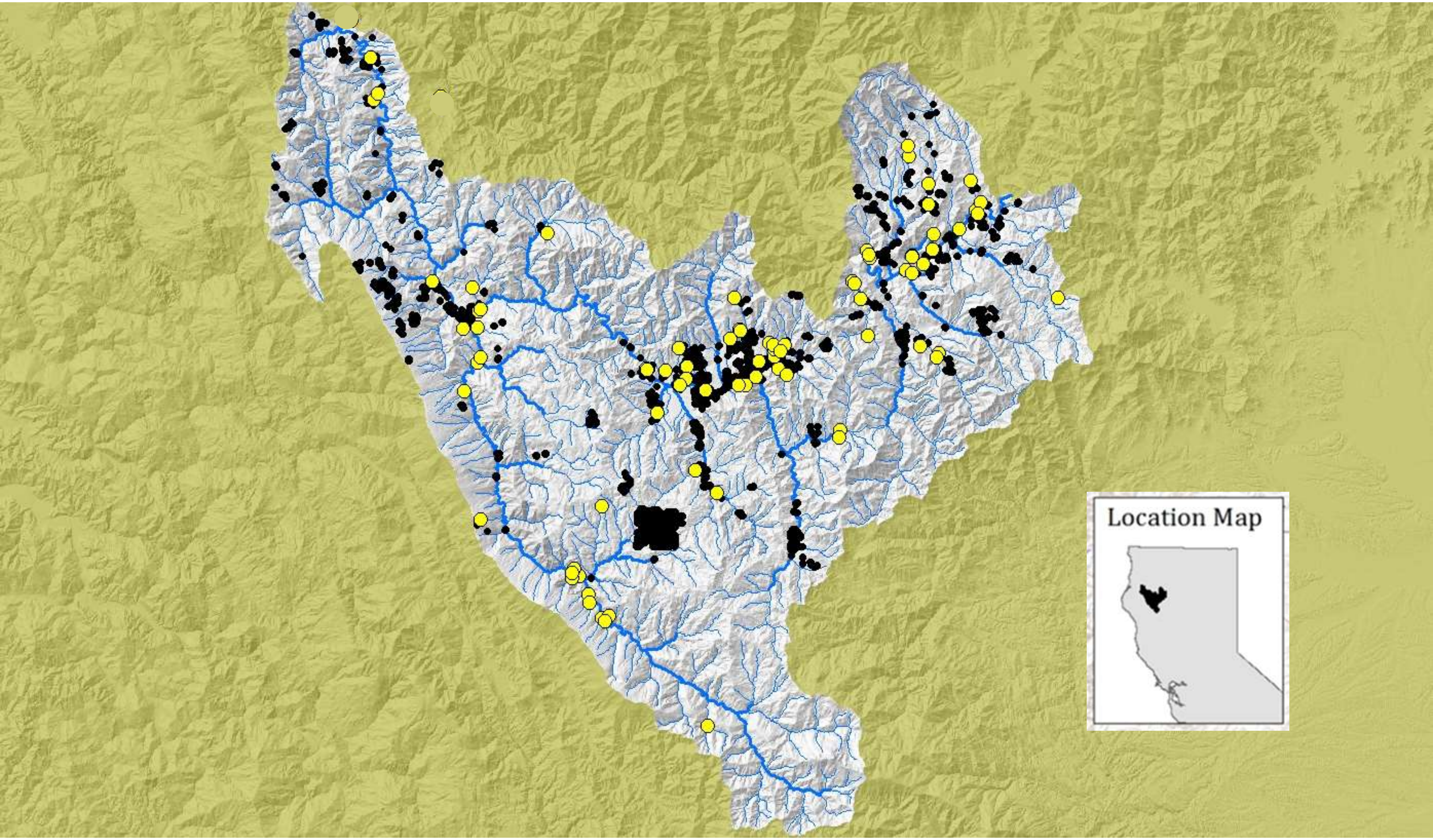
- All cannabis-related water use is assumed to be serviced by direct diversion
- We did not account for storage, groundwater, municipal, and delivered water
- Resulting estimates over-estimate actual flow impacts

Water Boards

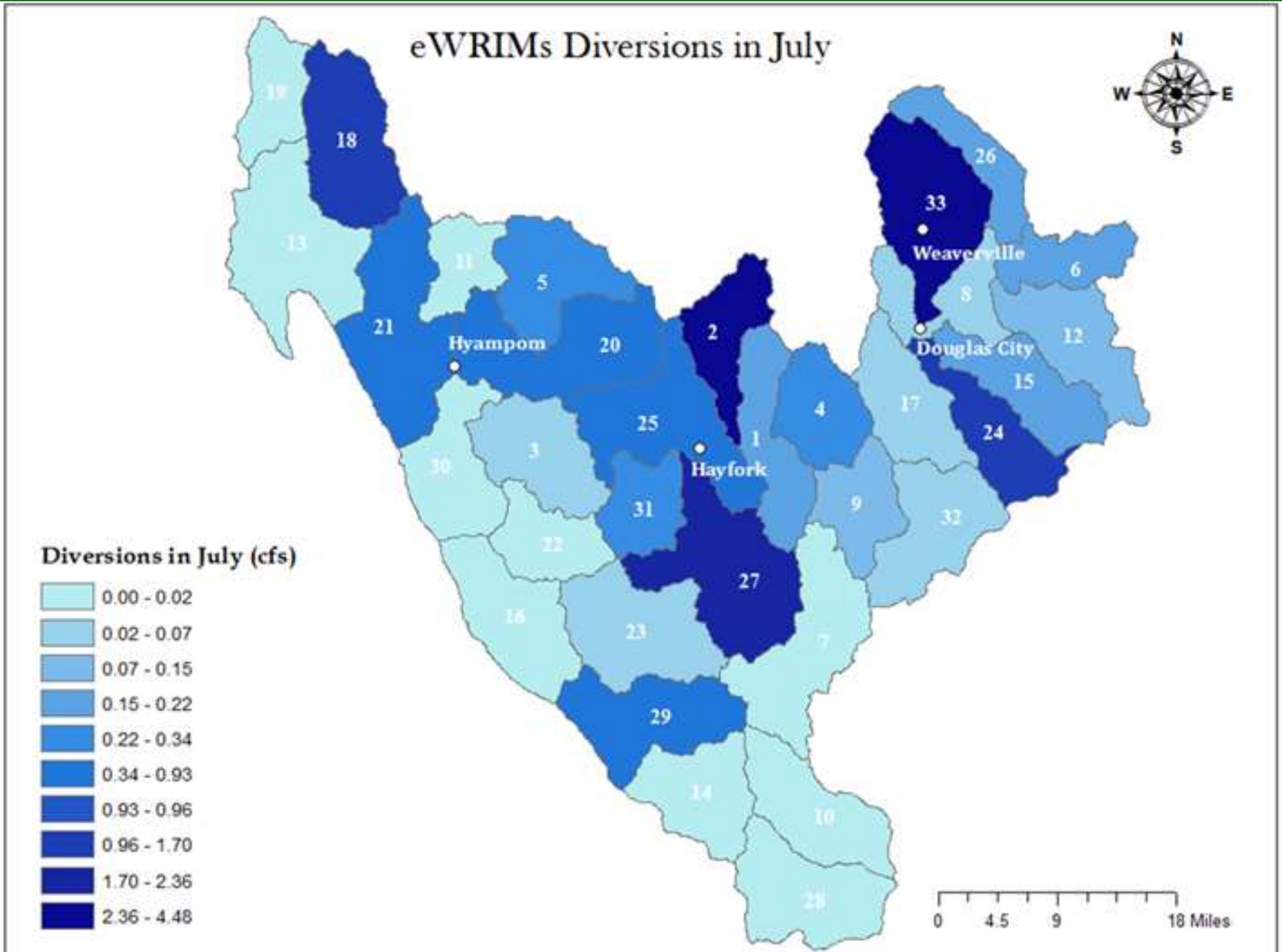
Mapped and Quantified Water Rights



Water Rights and Cannabis

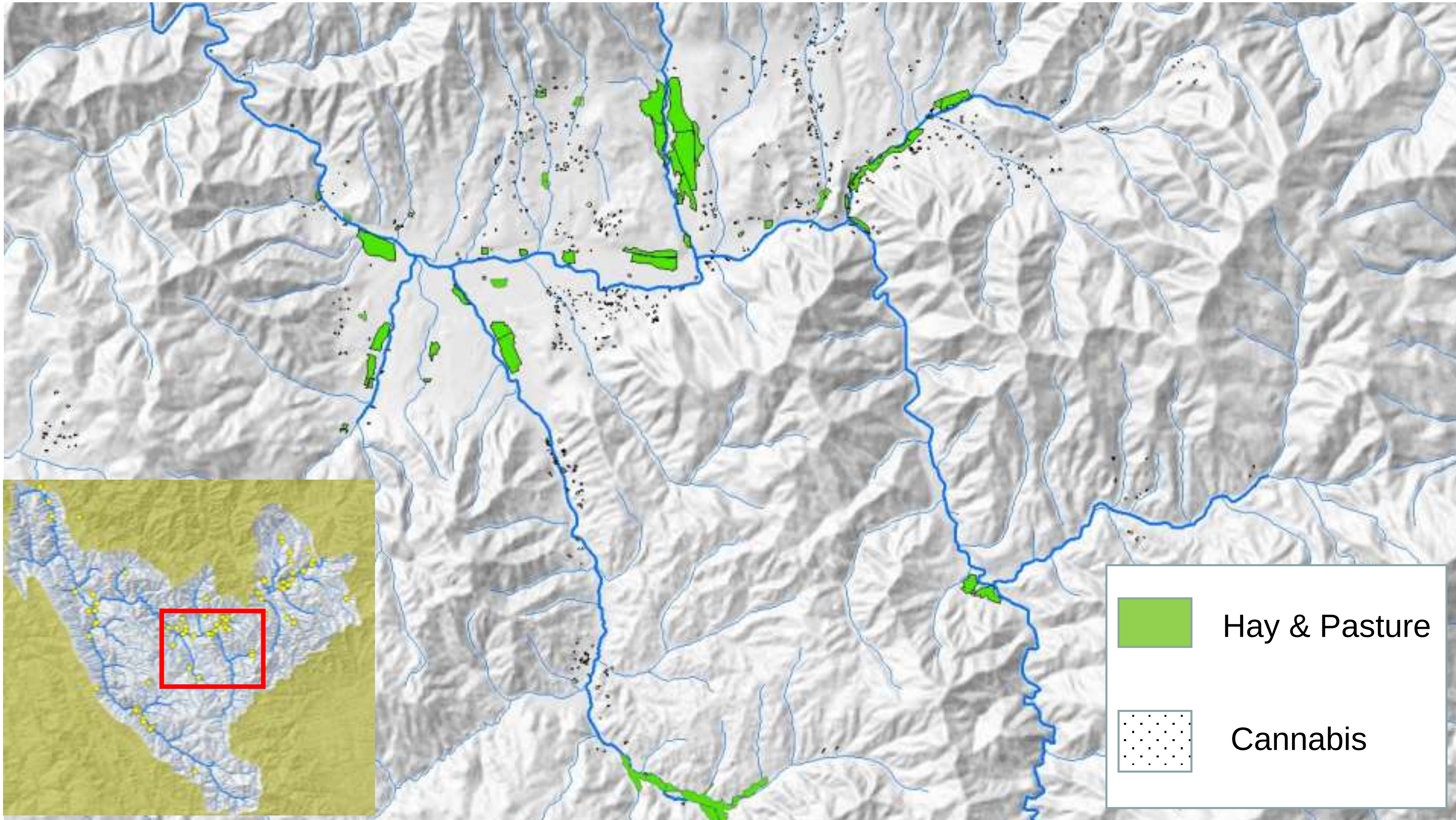


Mapped and Quantified Water Rights



Water Boards

Irrigated Agriculture

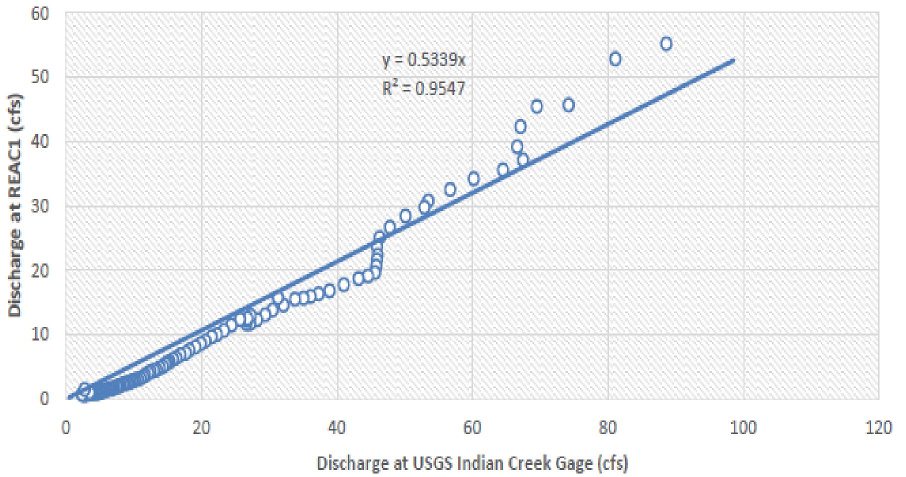


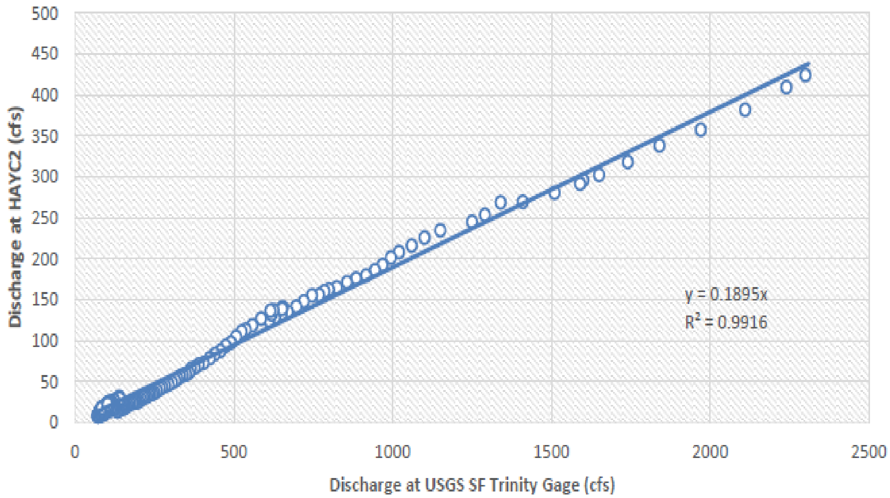
Compared Measured Flows to Long-Term Gage Records

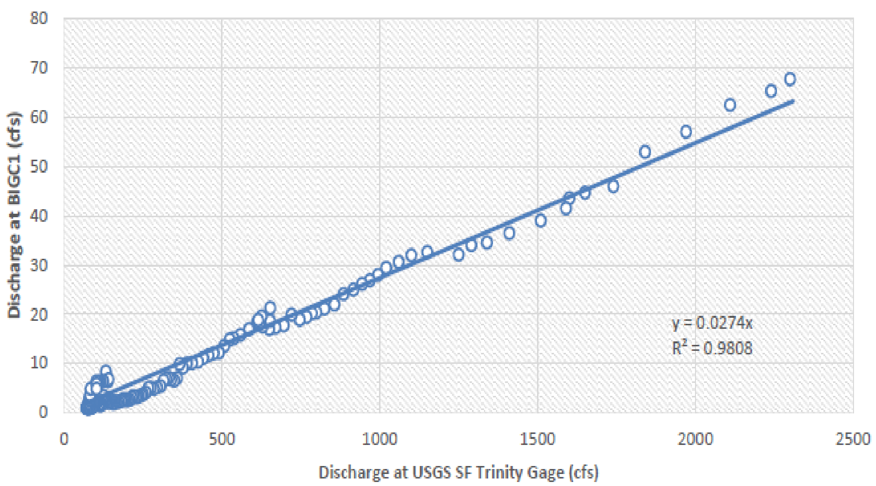
- We related our seasonal gage records to established USGS gages with longer records
- We used the relationships to estimate the historical distribution of flow conditions at our sites, expressed as percentiles

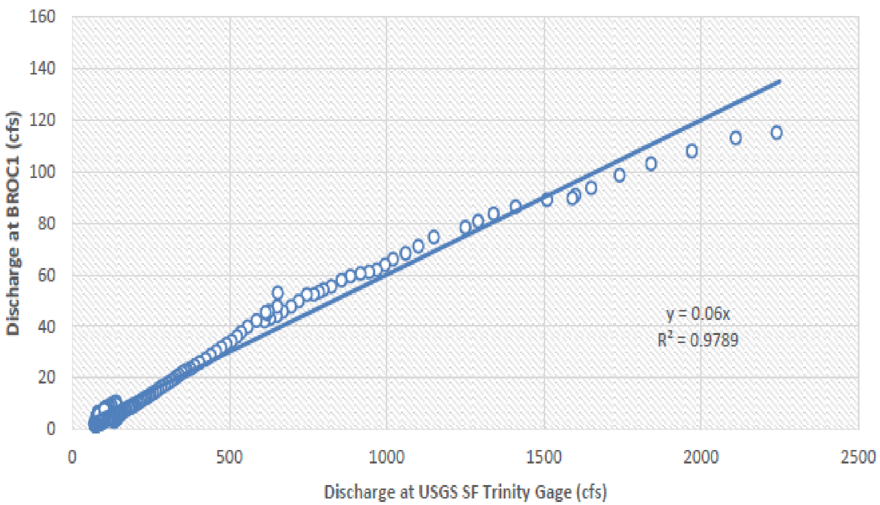
Water Boards

Compared Measured Flows to Long-term Gage Records





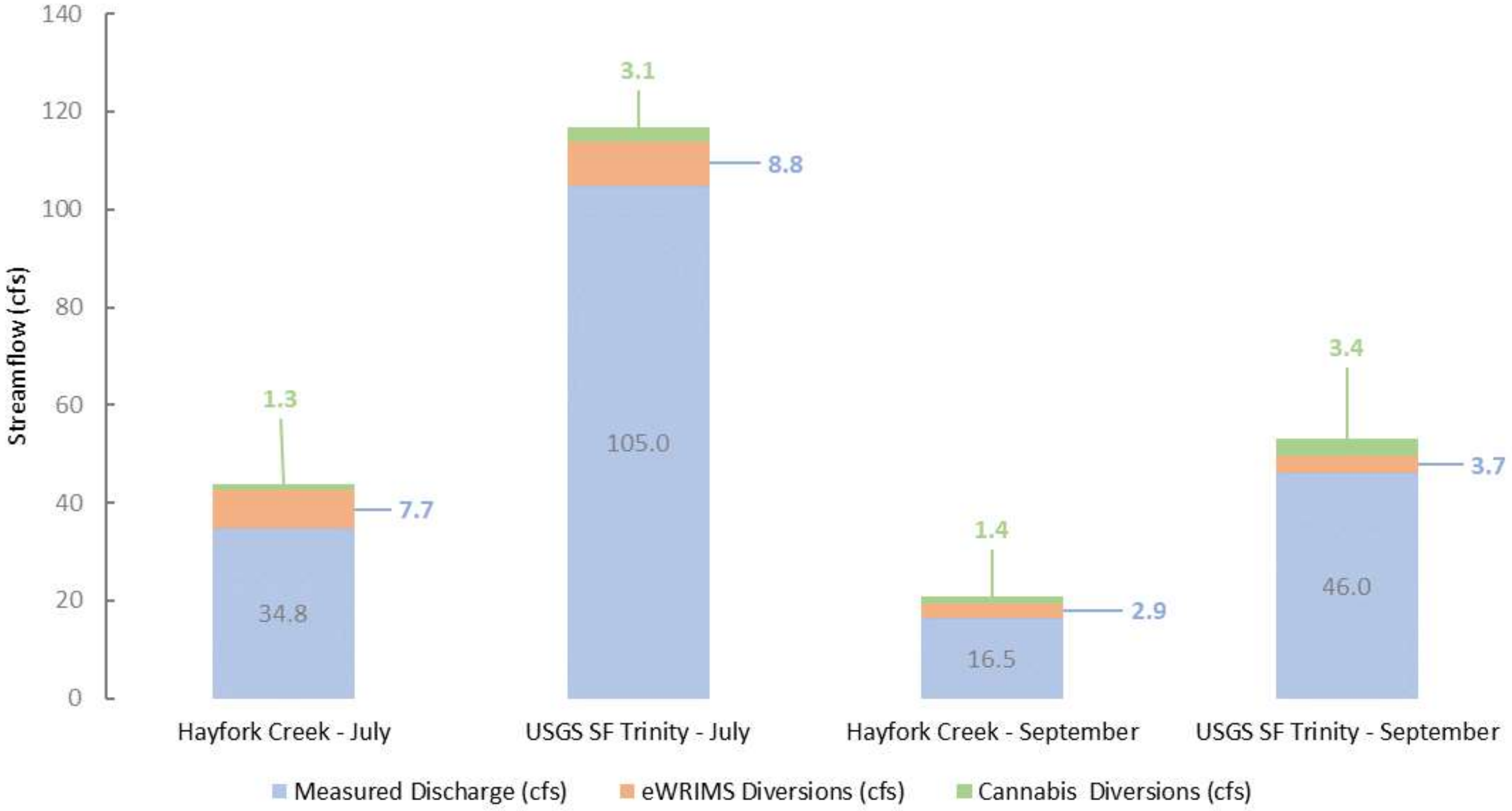




Compared Measured Flows to Long-term Gage Records

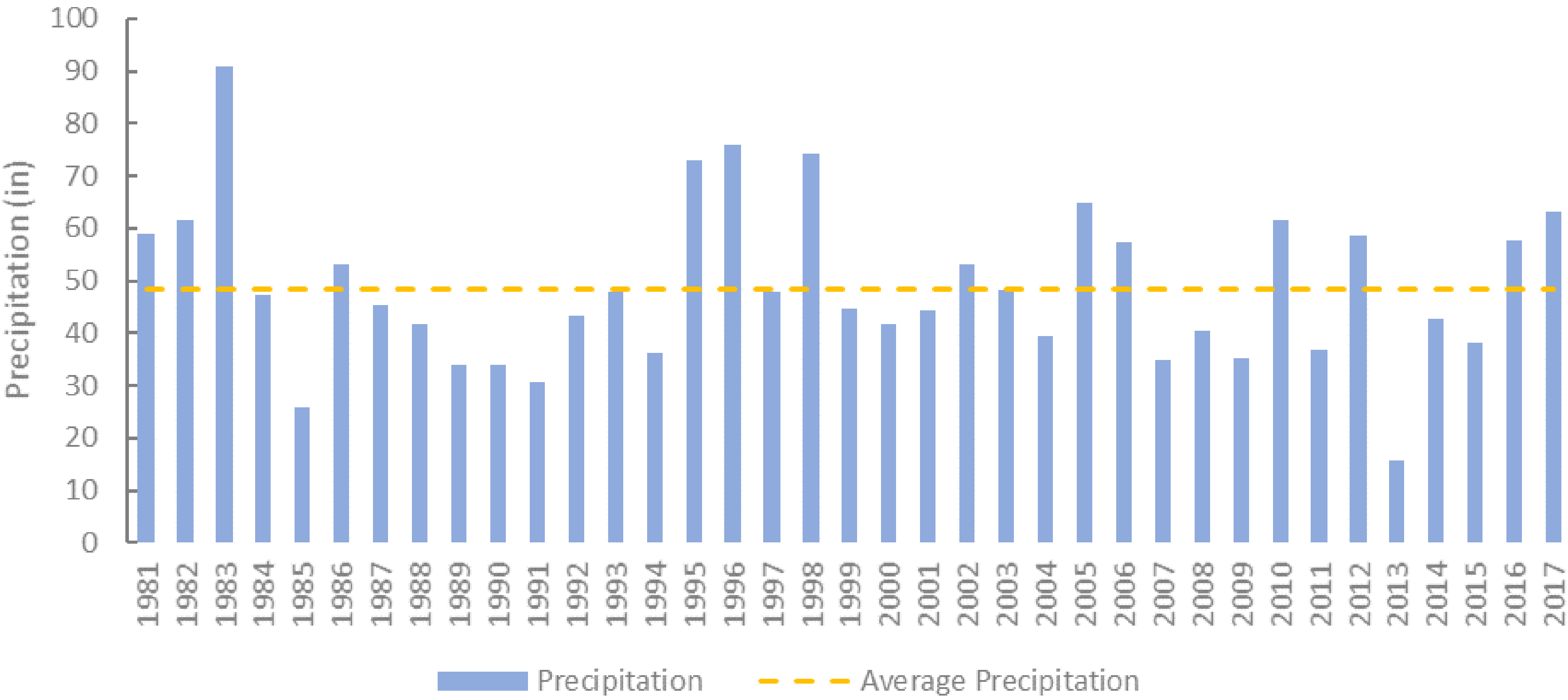
Equation Relating USGS Gages to Seasonal Gages × USGS Gage Daily Flow Statistics = Estimated Daily Statistics at Seasonal Gage Sites

Compared Water Use to Streamflow



Water Boards

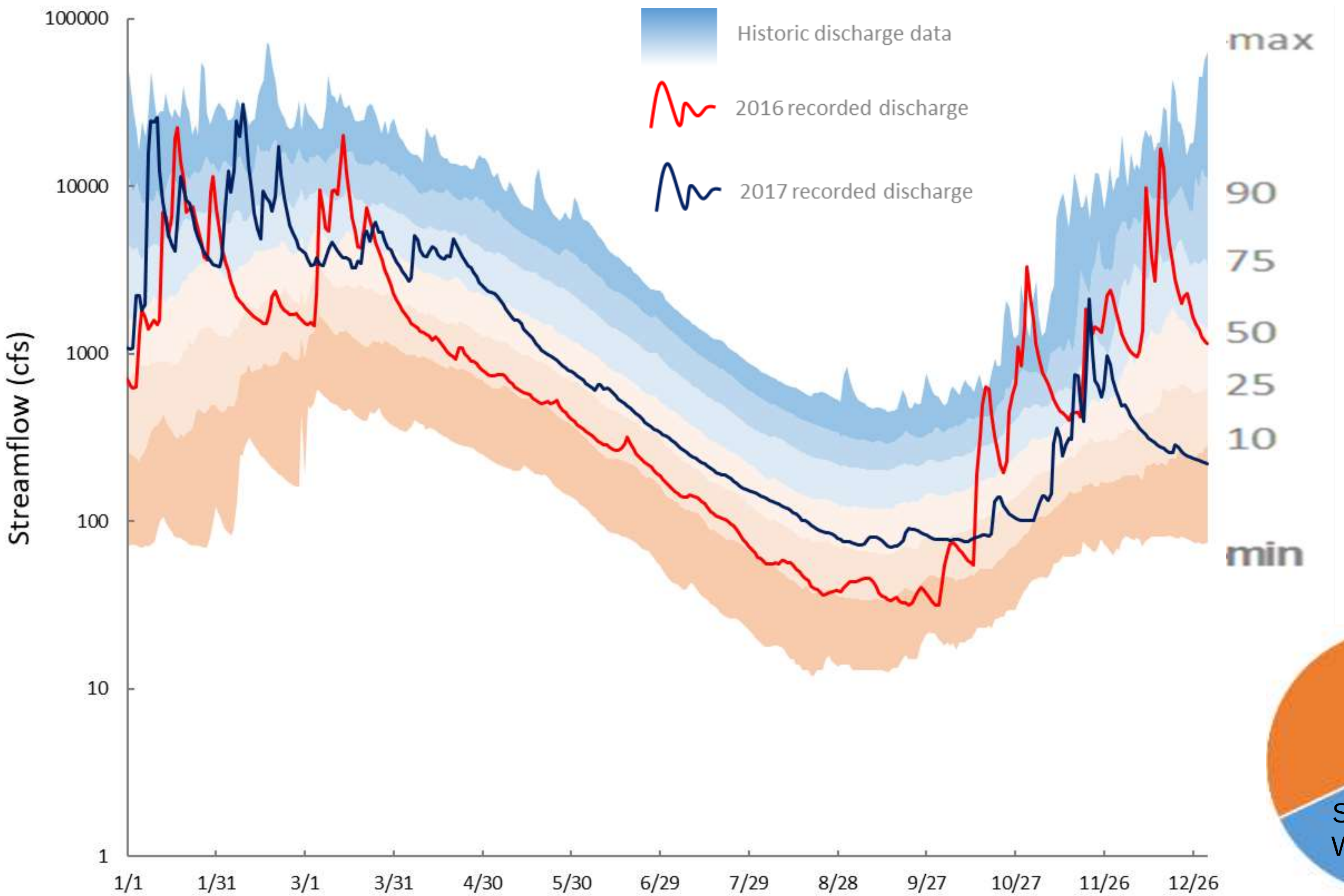
Context: Hydrologic Years 2016 & 2017

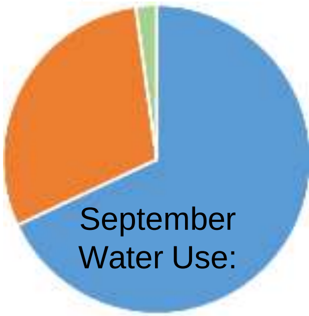


Mean annual precipitation (inches), Hyampom CA.

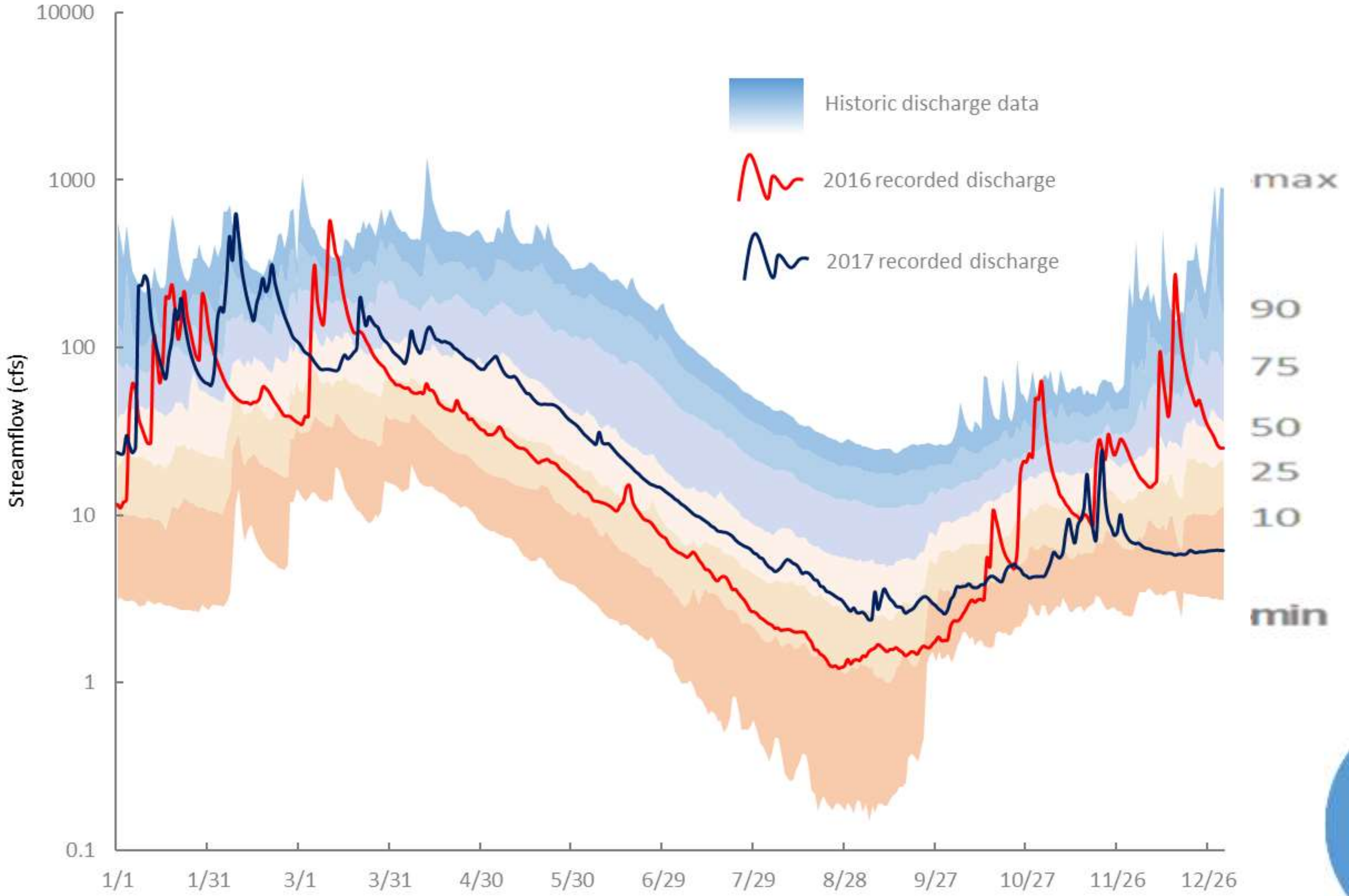
Water Boards

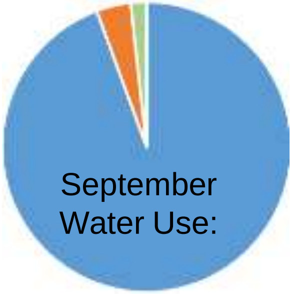
SF Trinity at Hyampom (USGS)





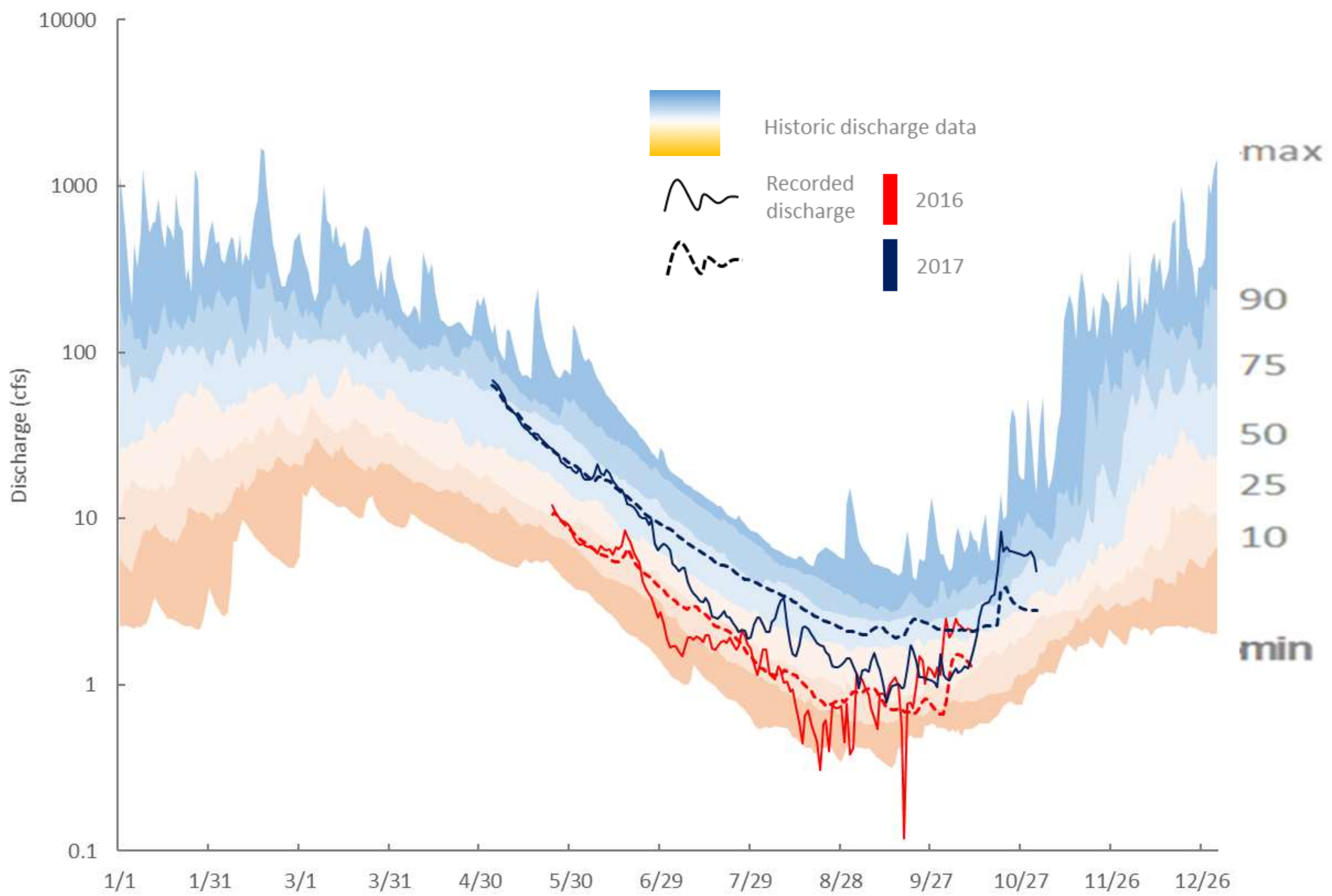
Indian Creek (USGS)





Results

Big Creek


Historic discharge data
Recorded discharge
2016
2017
max
90
75
50
25
10
min
Discharge (cfs)
10000
1000
100
10
1
0.1
1/1
1/31
3/1
3/31
4/30
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6/29
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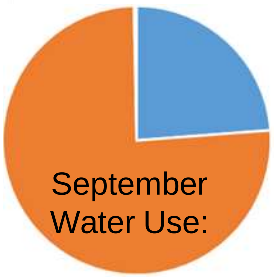
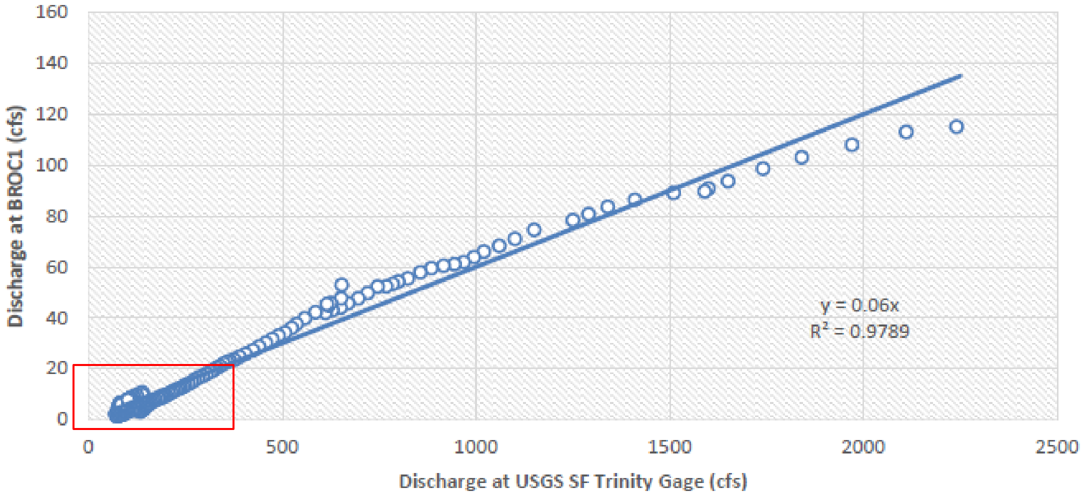
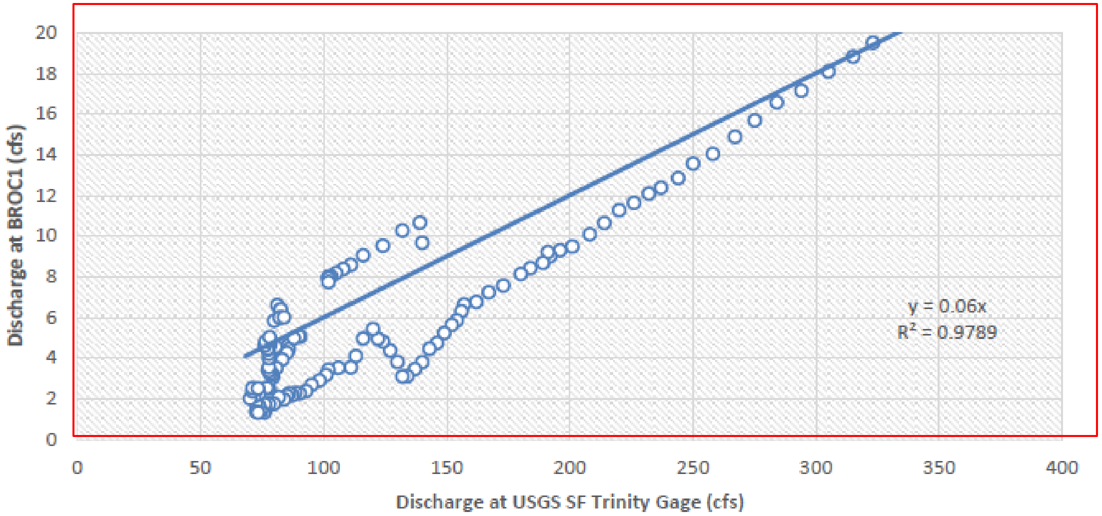
10/27
11/26
12/26


September Water Use:

A caution on interpreting results…

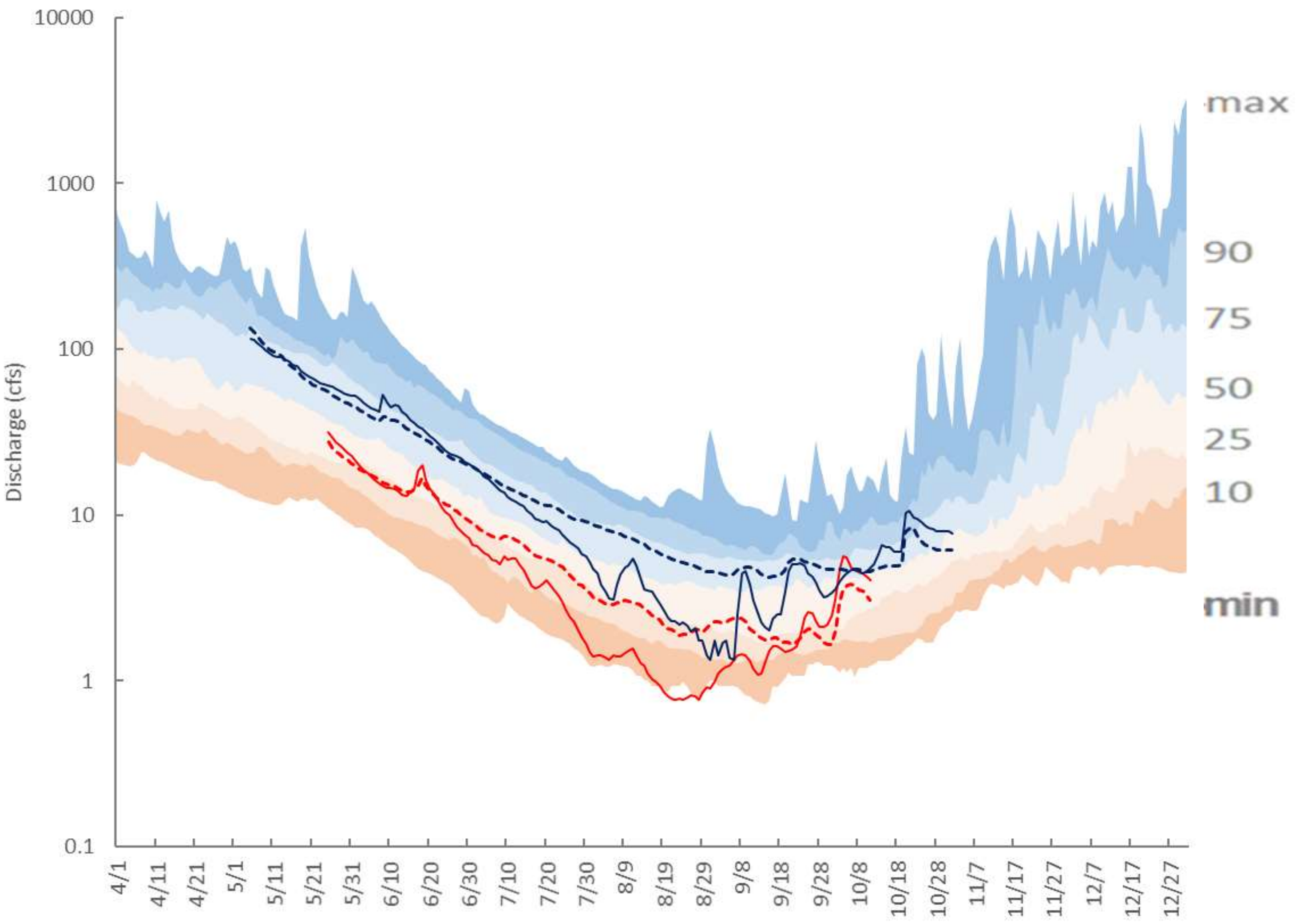


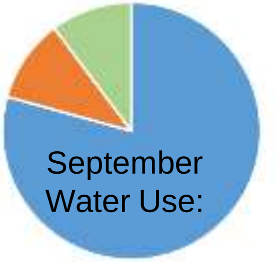


Results reflect the relationship between the USGS and seasonal gages

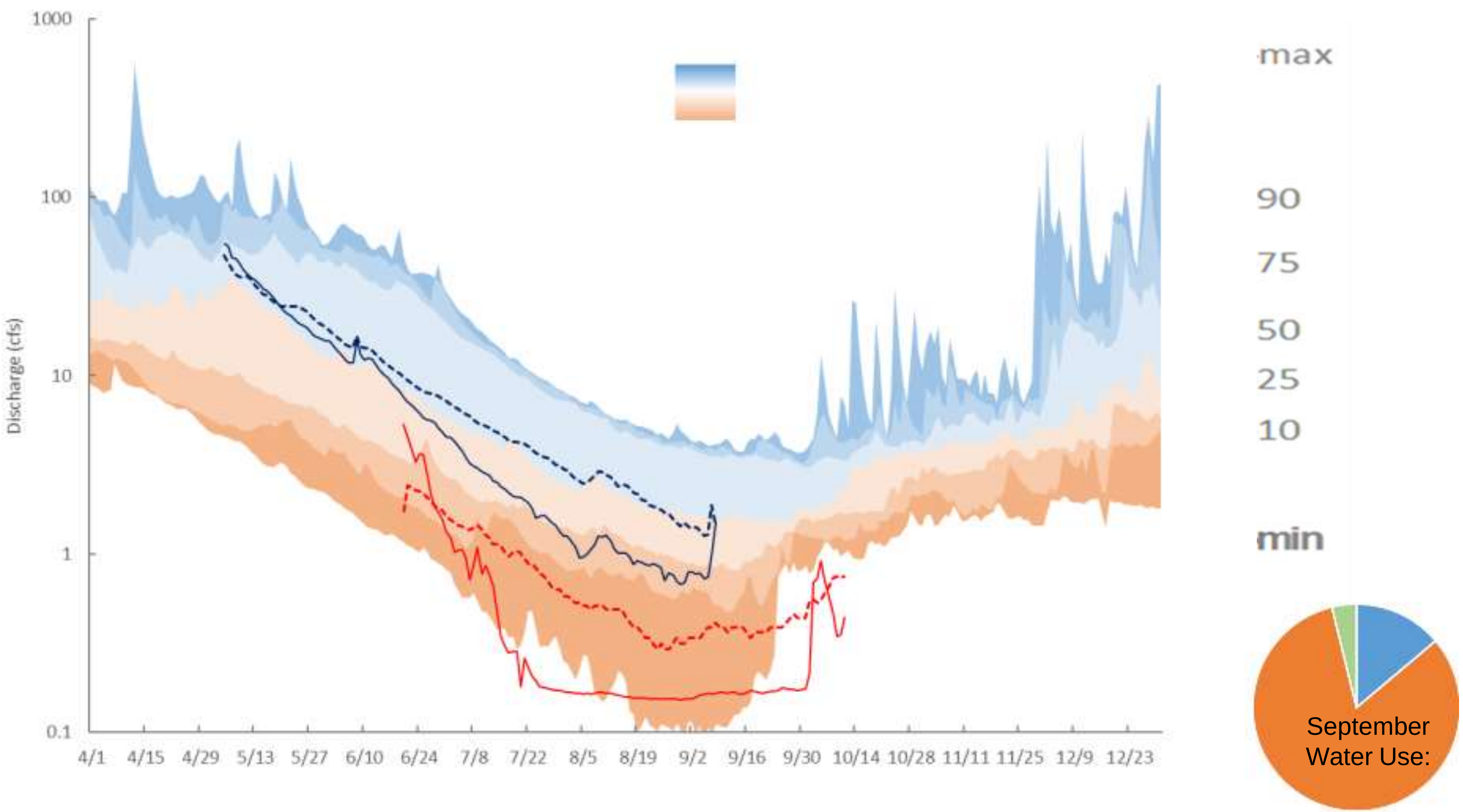
Water Boards

Browns Creek

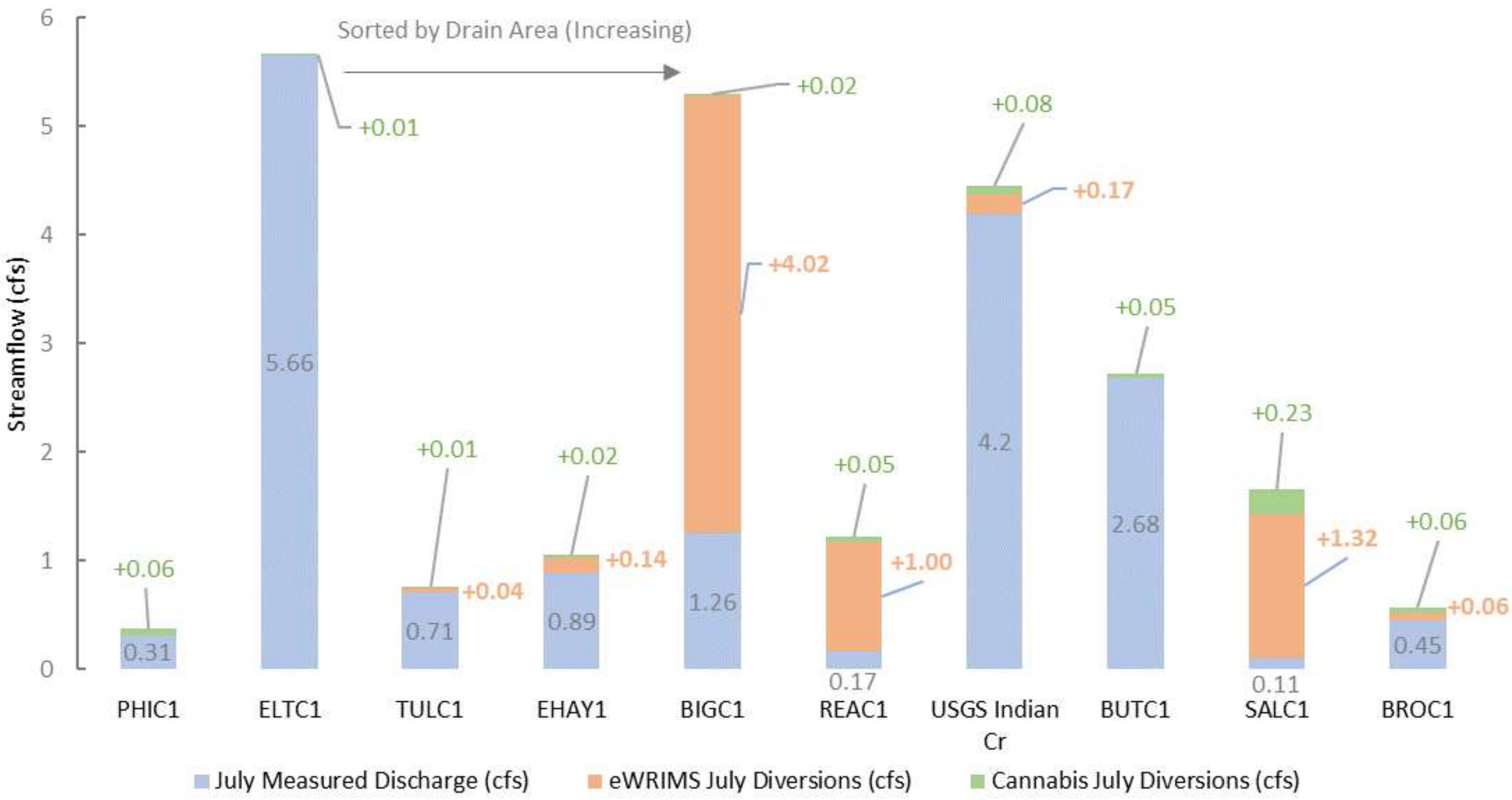




Reading Creek

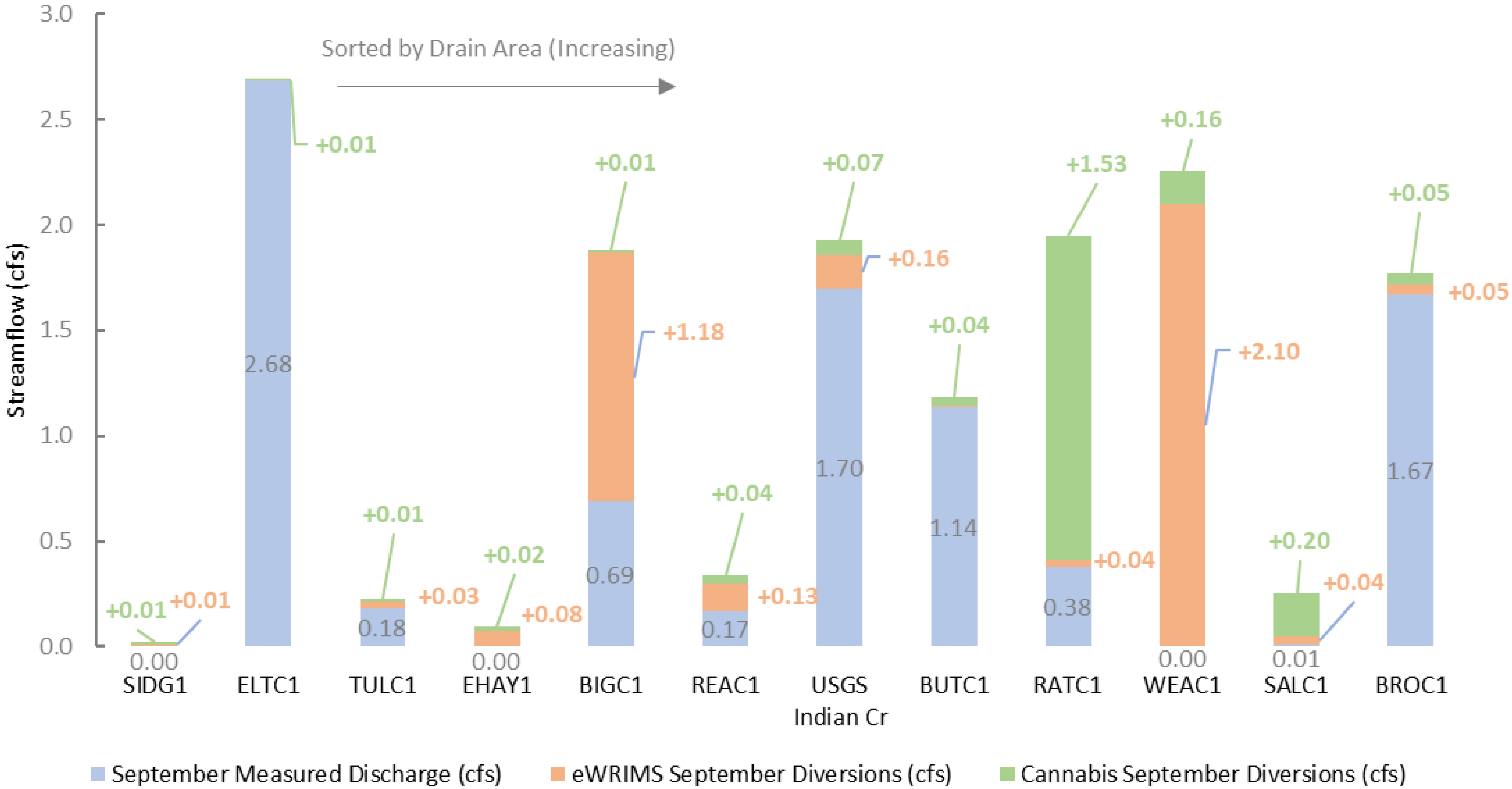


Water Use Compared to Instream Flow: July

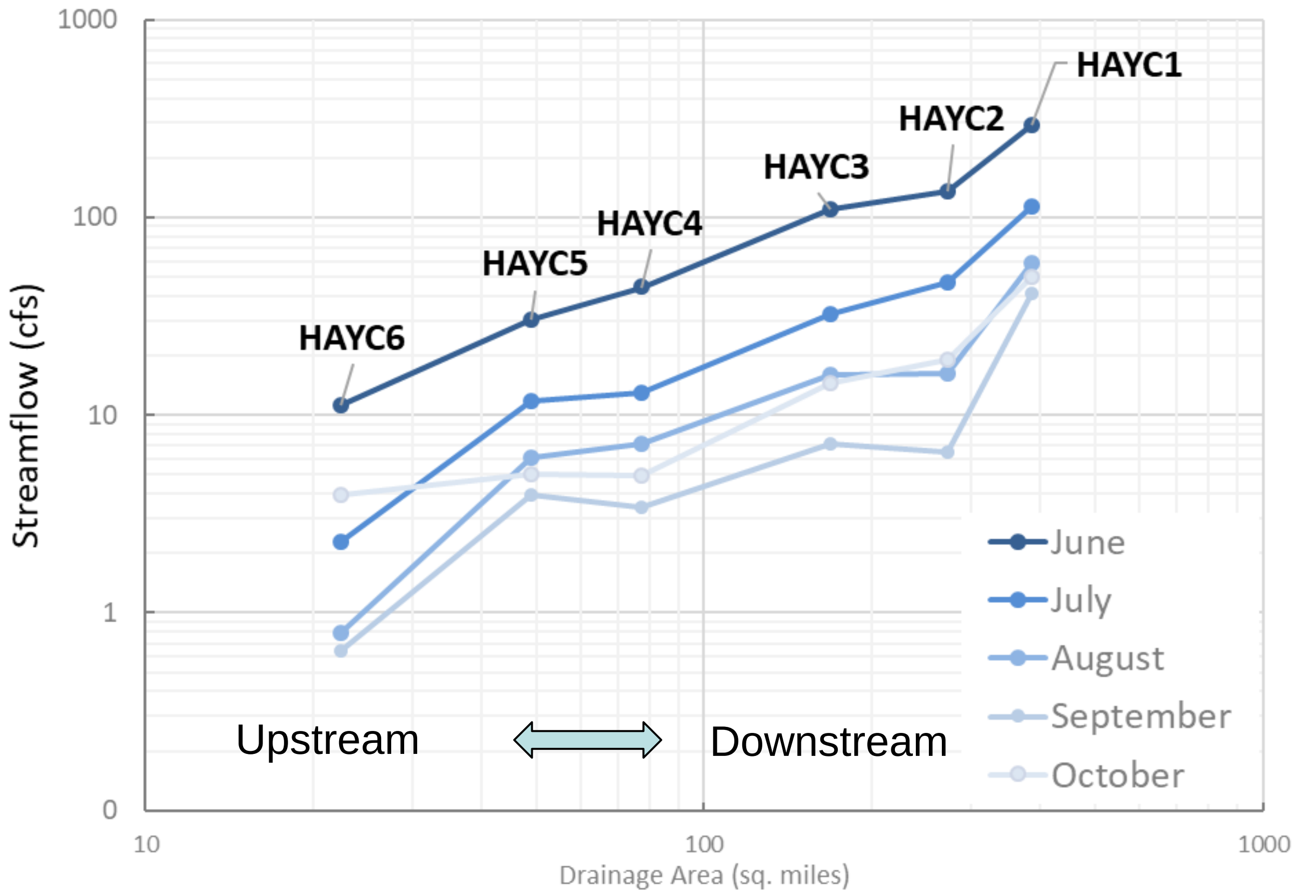


Water Boards

Water Use Compared to Instream Flow: September



Missing Water



- Streams generally increase in the downstream direction
- Loss of flow corresponds with areas of concentrated use and valley areas

Near-Stream Wells

- Near-stream wells are very common
- These wells have similar impacts as riparian diversions, but are basically unregulated

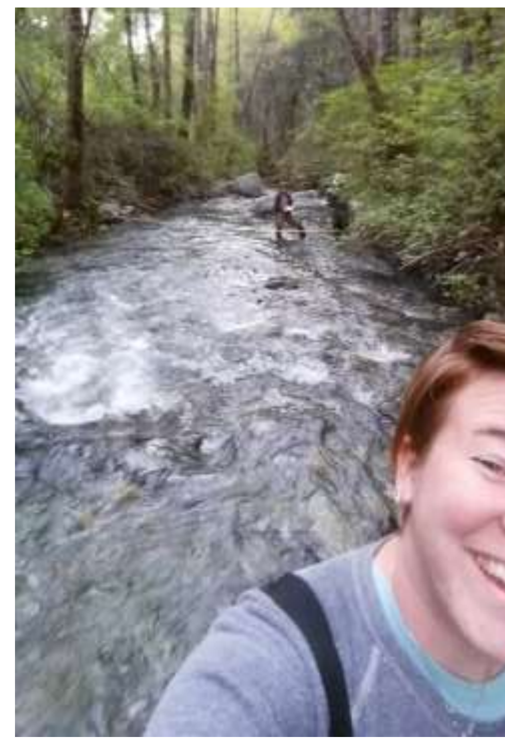
Water Boards

Conclusions

- Streams in study area approached drought condition by the end of the irrigation season, regardless of water year type
- Cannabis water use is relatively small in comparison to traditional water uses in many areas of the study areas
- Diversions for municipal use and flood irrigated pasture have big impacts on the flow of streams in the study area
- Near-stream wells represent a regulatory gap
- Cumulative impacts of combined water uses are significant

Water Boards

AMERICORPS CALIFORNIA



Questions?

Water Boards

Impacts of Marijuana Cultivation on Aquatic Resources, with an Emphasis on Anadromous Fish

Presented by Tricia Bratcher, CA Dept. of Fish and Wildlife

Co-lead Investigators: Tricia Bratcher (CDFW), James Harrington (CDFW) and RWQCB, Redding, CA

What will be covered in this presentation

- Background—Impacts caused by trespass and/or Cartel marijuana growing
- Types of Impacts to the aquatic environment
- Why this study was initiated
- Project Phases
- Sampling methodology
    - Site selection Criteria
    - Sampling Period and Effort: "Marrying" fish life history to potential for contaminant exposure and habitat deterioration
    - Procedures
- Preliminary Study Results



Acknowledgements

Field Staff (Alphabetical):

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Capt. Nate Arnold
Lt. Jess Mitchell
Warden Brian Boyd
Warden Mark Imsdahl
Lt. Frank Imbrie
Warden Brendan Lynch
Lt. Aaron Galwey
Warden Paul Cardoza
Warden Steven Crowl
Lt. DeWayne Little
Tony Magarrell, LE, USFS
Champ
Kilo
Phoebe

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Joe Ferreira, CDFW
Laurie Earley, USFS/FWS
Dr. Greta Wengert, IERC
Dr. Mourad Gabriel, IERC
CDFW Natural Resource Volunteers

Monitoring Committee

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Scott Bauer	CDFW	Angela Montalvo	CDFW
Peter Cafferata	CALFIRE	Peter Ode	CDFW
Jennifer Carah	TNC	Carol Oz	CDFW
Gail Cho	CDFW	Rinderneck, Janna	CDFW
Allison Dowd	Humboldt State University	Trey Sherrell	RWQCB
Laurie Earley	USFS Lassen	Clint Snyder	RWQCB
Mourad Gabriel	IERC	Beckye Stanton	CDFW
Gregory Giusti	UC Agric.& Natural Resources	ME Vasquez	CDFW/UC Davis
Andy Gordus	CDFW	Harvest Vieira	CDFW
Lt. Paul Hamilton	CDFW	Jonathan Warmerdam	SWRCB
Jim Harrington	CDFW	Daniel Whitley	SWRCB
Lt. DeWayne Little	CDFW	Michelle Hladik	USGS
Chris Mayes	USFS	Angela Wilson	RWQCB
Melanie McFarland	USFS	Brad Henderson	CDFW
Stella McMillin	CDFW	Nick Kuntz	SWRCB

The Potential Impacts of Marijuana Cultivation

BACKGROUND:

Central Valley spring-run Chinook salmon (*Oncorhynchus tshawytscha*) ESU is dually listed as Threatened and is currently faced with three primary limiting factors and threats:

(1) loss of most historic spawning habitat;
(2) degradation of the remaining habitat; and
(3) genetic threats from the Feather River Fish Hatchery (FRFH) spring-run Chinook salmon program (NMFS 2009).

Central Valley steelhead, also federally listed as Threatened, is facing similar threats, including impacts from historic and present-day planting efforts.

Locally, Tehama County is particularly known for illegal marijuana cultivation. In August 2010, law enforcement officials on the Lassen National Forest found 27 growing sites. These sites (harvested and burned by law enforcement) contained an estimated 98,000 plants, with a street value of nearly half a billion dollars. Many of these sites were not reclaimed.

Types of Impacts from Trespass Grows

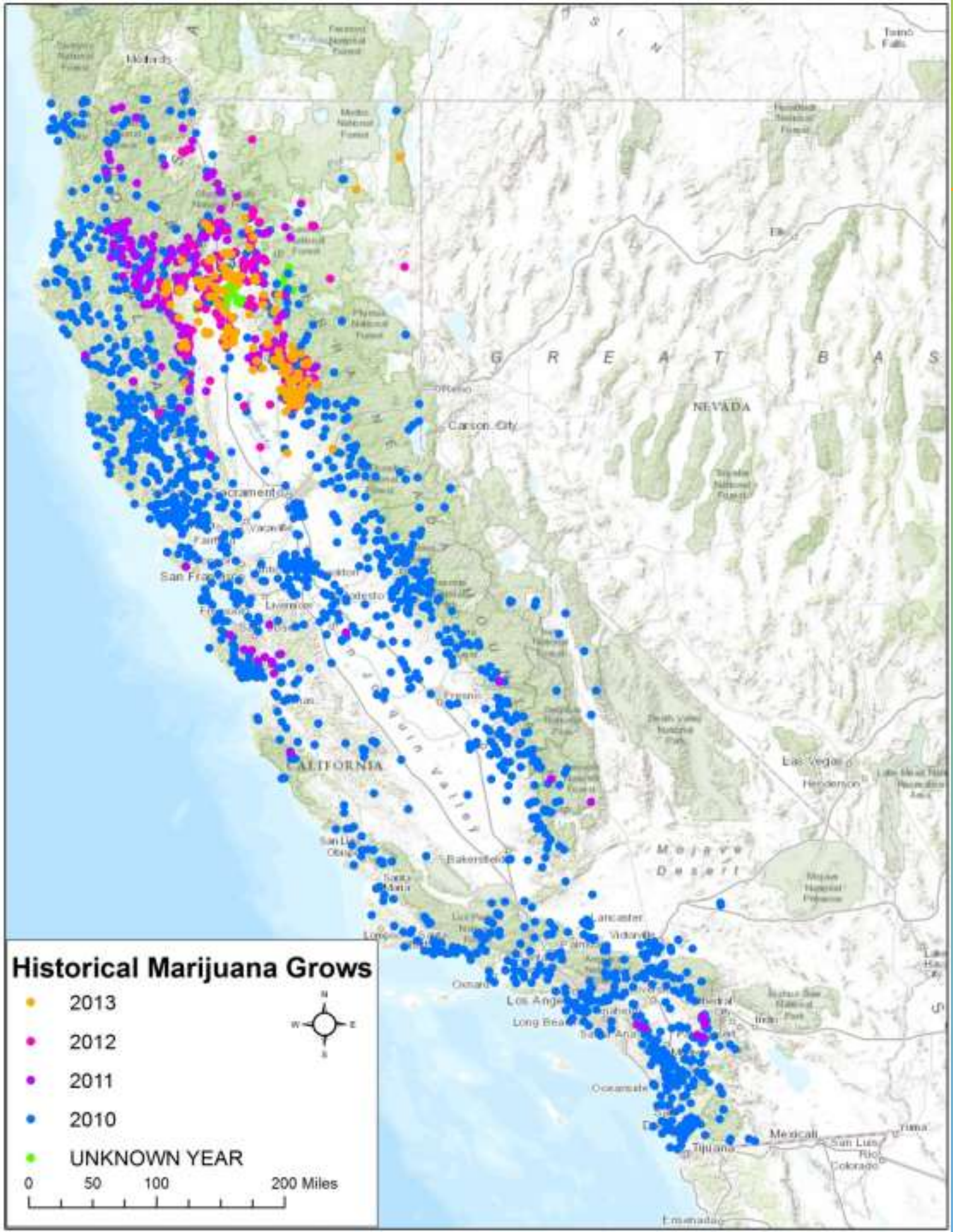
- Refuse/Trash: Human waste/garbage is typically not remediated
- Fertilizer: Up to one pound of fertilizer is used for six marijuana plants throughout the season. Can lead to Eutrophication of streams
- Bioaccumulation: Pesticides like rodenticides keep on killing
- Plant hormones: Can seep into streams/groundwater
- Deforestation
- Non-herbicide Pesticides: Used in large quantities
- Streamcourse Impacts: Riparian loss, Erosion, Siltation
- Water loss due to diversion

Types of Pesticides Found in Trespass Grows

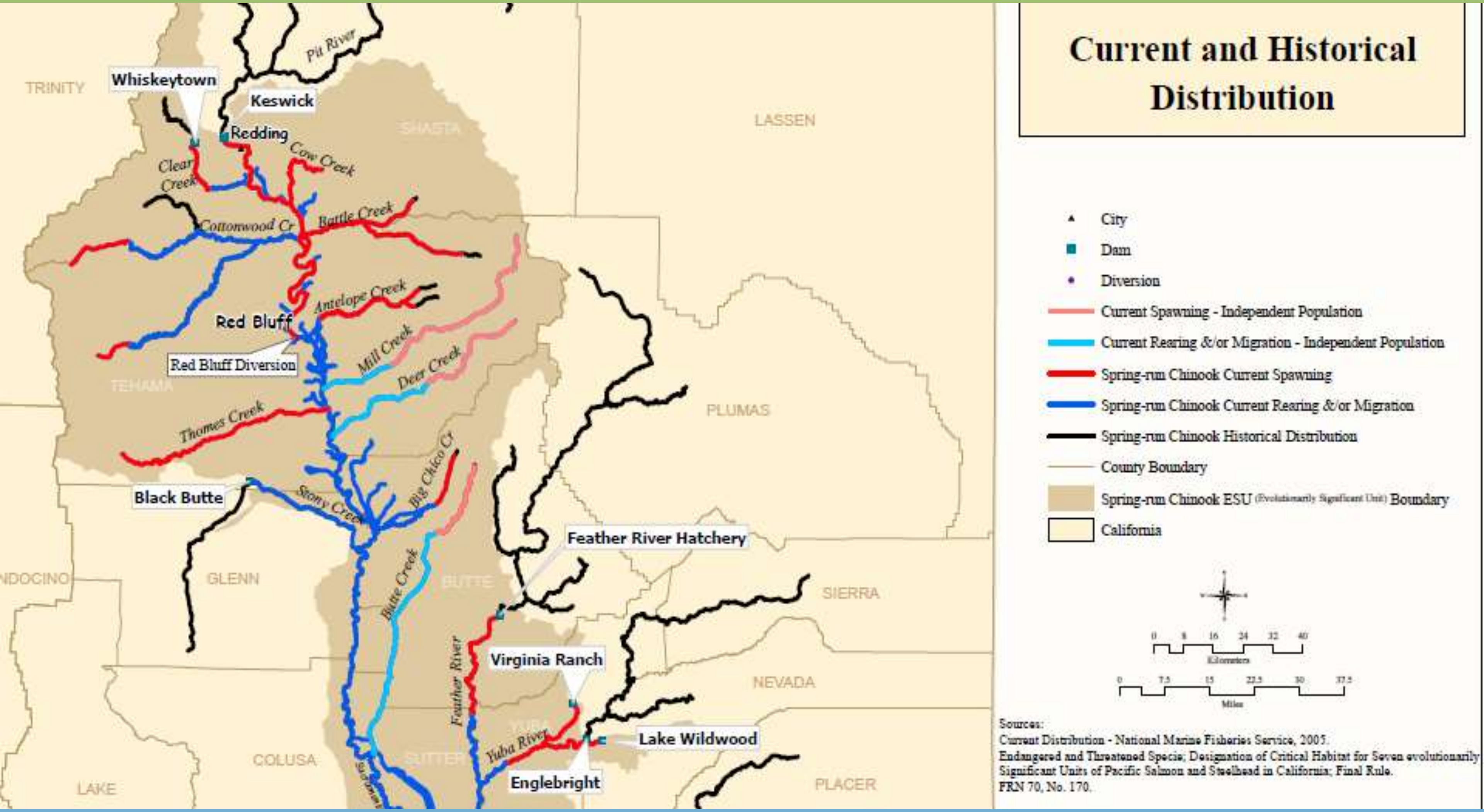
Rodenticides
- Zinc Phosphide (rat/mouse bait)
- Strychnine
  (gopher bait)
- Anticoagulants

Herbicides
- Glyphosate
  (Roundup®)
- 2,4-D
  (Weed B Gon®)

Insecticides
- Organochlorine
  (Lindane, Chlordane, Toxaphene)
- Organophosphate (malathion, diazinon, dursban)
- Carbamate
  (carbofuran, aldicarb, carbaryl)
- Pyrethroid
  (Permethrin)

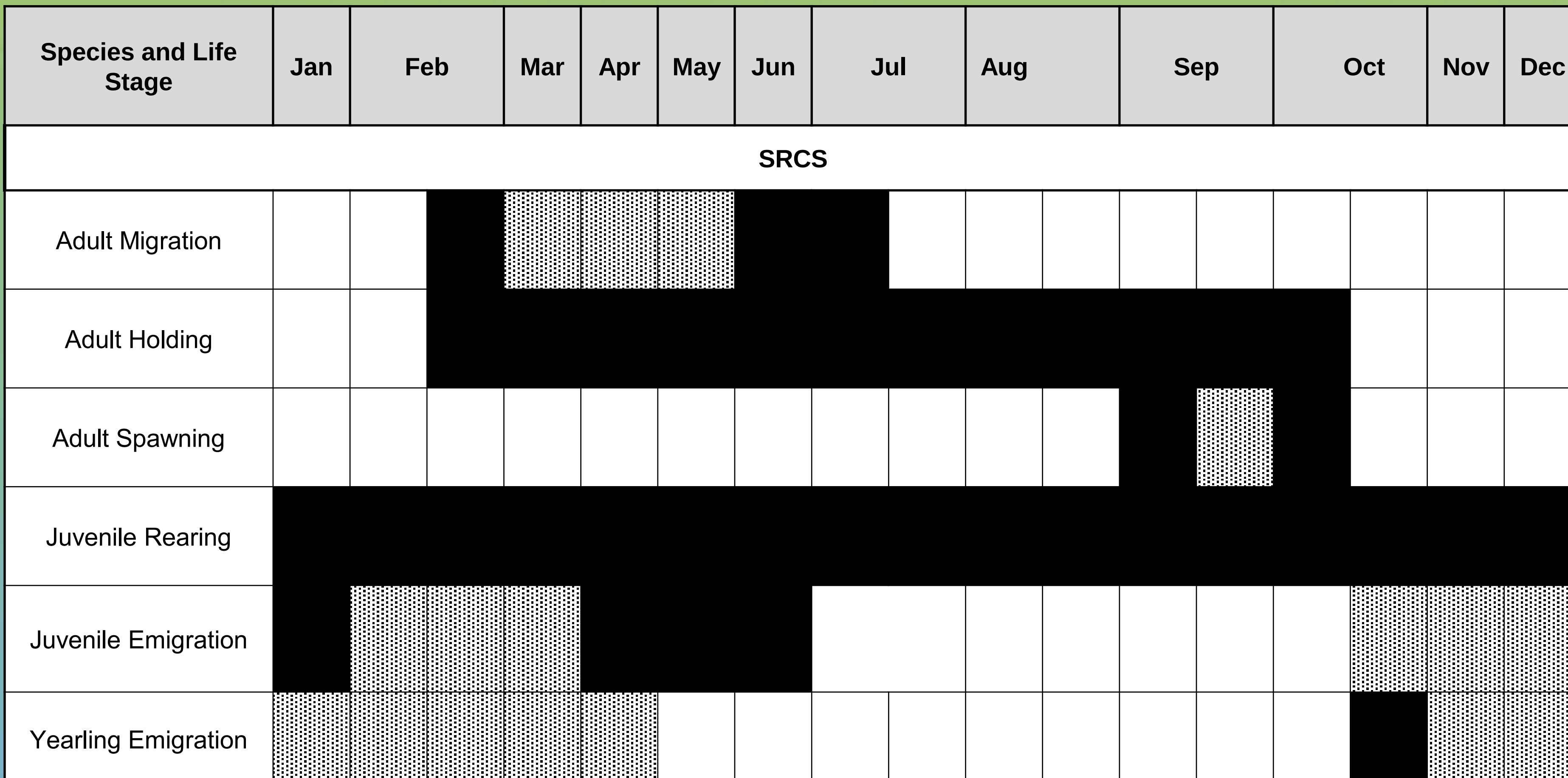

Historical Marijuana Grows
2013
2012
2011
2010
UNKNOWN YEAR
0 50 100 200 Miles
NEVADA
CALIFORNIA
G R E A T B A S
Carson City
Sacramento
San Francisco
Bakersfield
Los Angeles
Long Beach
Oxnard
Lancaster
Victorville
Las Vegas
Henderson
Mexicali
Tijuana
Mojave Desert

Spring-Run Chinook Historic and Current Distribution, Northern Sacramento Valley



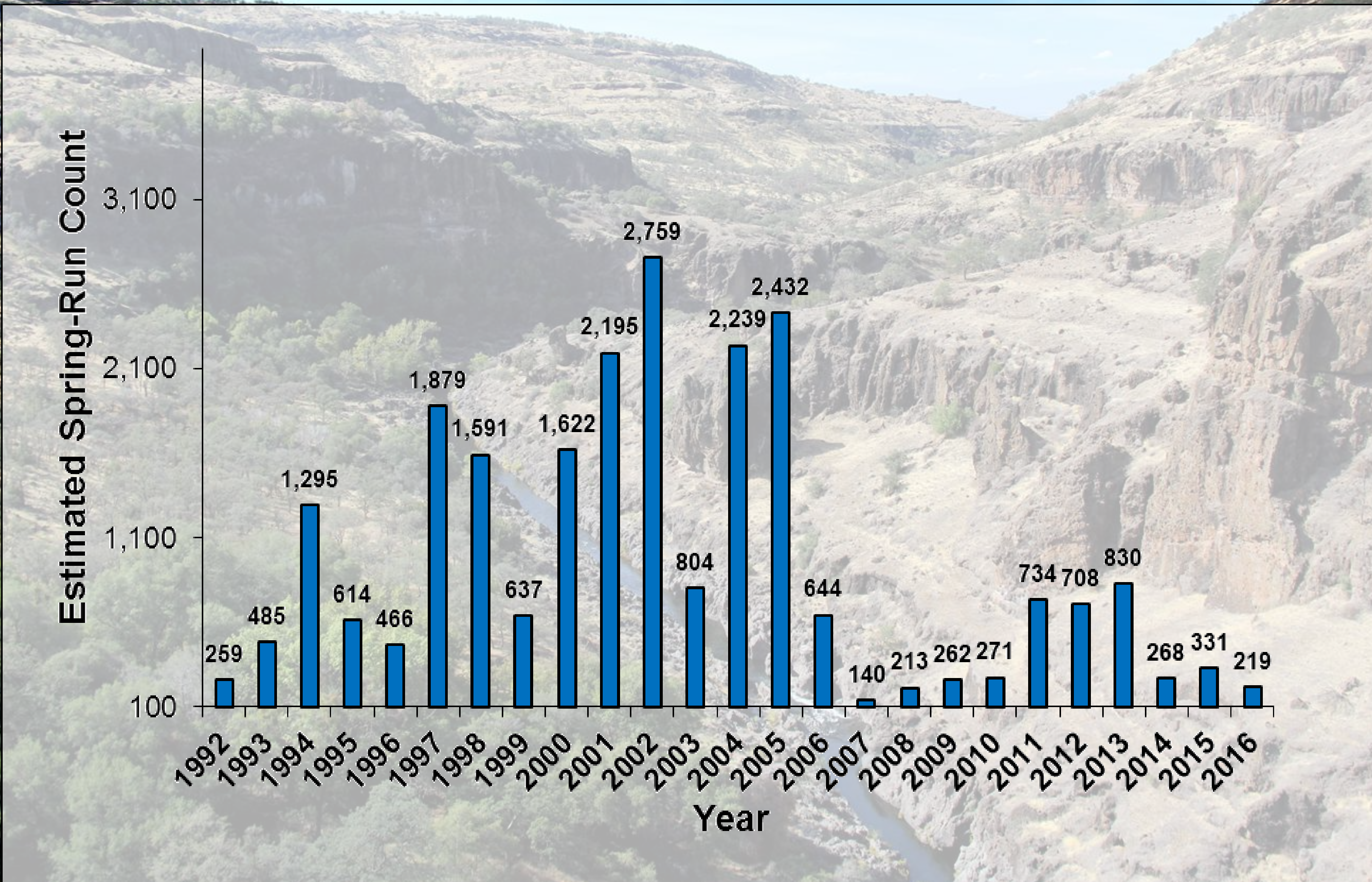
Excerpt, NMFS 2014 Draft Recovery Plan

Spring-Run Chinook Life History



Source: CDFW 1998 and CDFW 2016; M. Johnson pers. comm. 2019

Deer Creek Spring-Run Chinook Escapement, 1992 - 2017



Anadromous Fisheries Restoration Program (AFRP) Study

Concept Proposal submitted to AFRP (a CVPIA Program) as a result of concerns raised by CDFW biologists and law enforcement in **2009.**

What was proposed? Multi-year project to determine impacts to Northern California's aquatic resources posed by marijuana cultivation, specifically to anadromous fish, and to develop tools to use for prosecutorial purposes

Funding: US Fish and Wildlife Service, Central Valley Project Improvement Act, AFRP in 2013

Using a multi-agency and specialist approach in the form of a monitoring committee to help guide monitoring efforts, with extensive coordination with law enforcement

The AFRP-Funded Study

Steps in the study:

- *Step 1. Develop a study plan to address the issue/concern.*
- *Step 2. Conduct monitoring activities following law enforcement activities (grow raids).*
- *Step 3. Develop potential sampling protocols to use for assessing marijuana growing impacts;*
- *Step 4. Reporting the effects; identifying and prioritizing restoration; and determining how to quantify effects. Also, ID potential stressors caused by marijuana production vs. other land management activities using the EPA's Causal Analysis (to be done)*

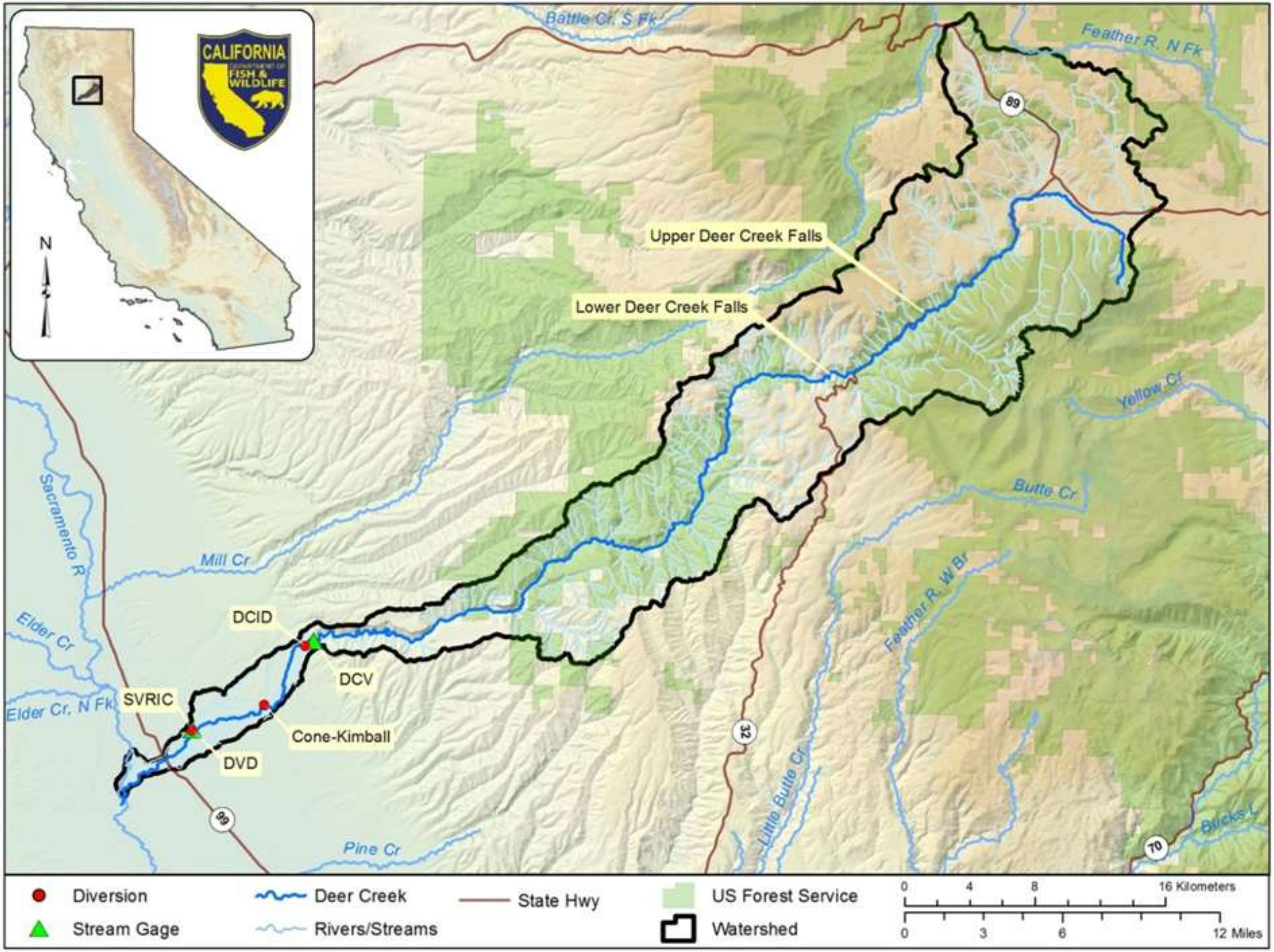
Spring-run Chinook holding, Deer Creek

Hypotheses (developed in 2015):

- Input of water quality-related contaminants from marijuana grows is directly and/or indirectly contributing to a decline in anadromous fish habitat quality, thereby negatively affecting anadromous fish.
  - The observed condition of water quality, instream habitat quality, and the resulting ecological outcomes can be related to differences in land management practices, and the impact of marijuana-cultivation/grow sites can be distinguished from other land management practices.

- The techniques used in the study of the effects of marijuana cultivation on anadromous fish can provide a means by which impacts can be assessed.

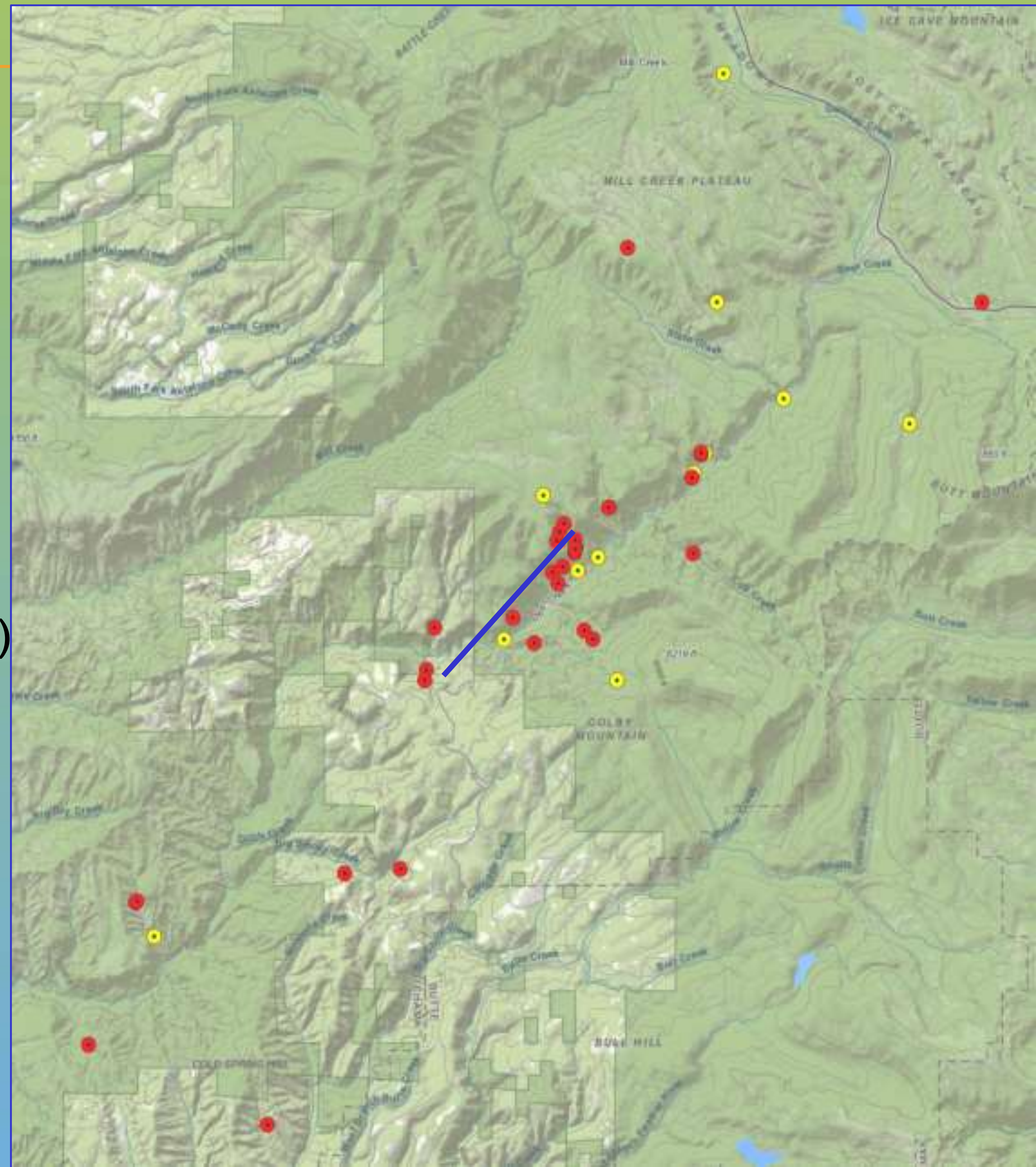
- The impacts from a legacy of marijuana cultivation and of individual marijuana grows on anadromous fish watersheds are measurable and distinguishable relative to other land use practices



CALIFORNIA
FISH & WILDLIFE
N
Battle Cr. S Fk
Feather R. N Fk
89
Upper Deer Creek Falls
Lower Deer Creek Falls
Yellow Cr
Butte Cr
Sacramento R
Mill Cr
Elder Cr
Elder Cr. N Fk
DCID
DCV
SVRIC
Cone-Kimball
DVD
99
32
Little Butte Cr
Feather R. W Br
Pine Cr
Bucks L
70
Diversion
Stream Gage
Deer Creek
Rivers/Streams
State Hwy
US Forest Service
Watershed
0
4
8
16 Kilometers
0
3
6
12 Miles

Site Selection and Timing

- Target was 3 year study (was only able to do 2 years)
- 12 study sites:
  3 Controls, 3 Above Grow, 6 Below Grow; DCID Dam added in late 2017 (valley floor/end of canyon section. Select data)
- Data collected Fall 2016, Spring 2017, Fall 2017, Spring 2018 (DO loggers and flow data gathered to Dec. 2018)



Procedures, or Monitoring Methods

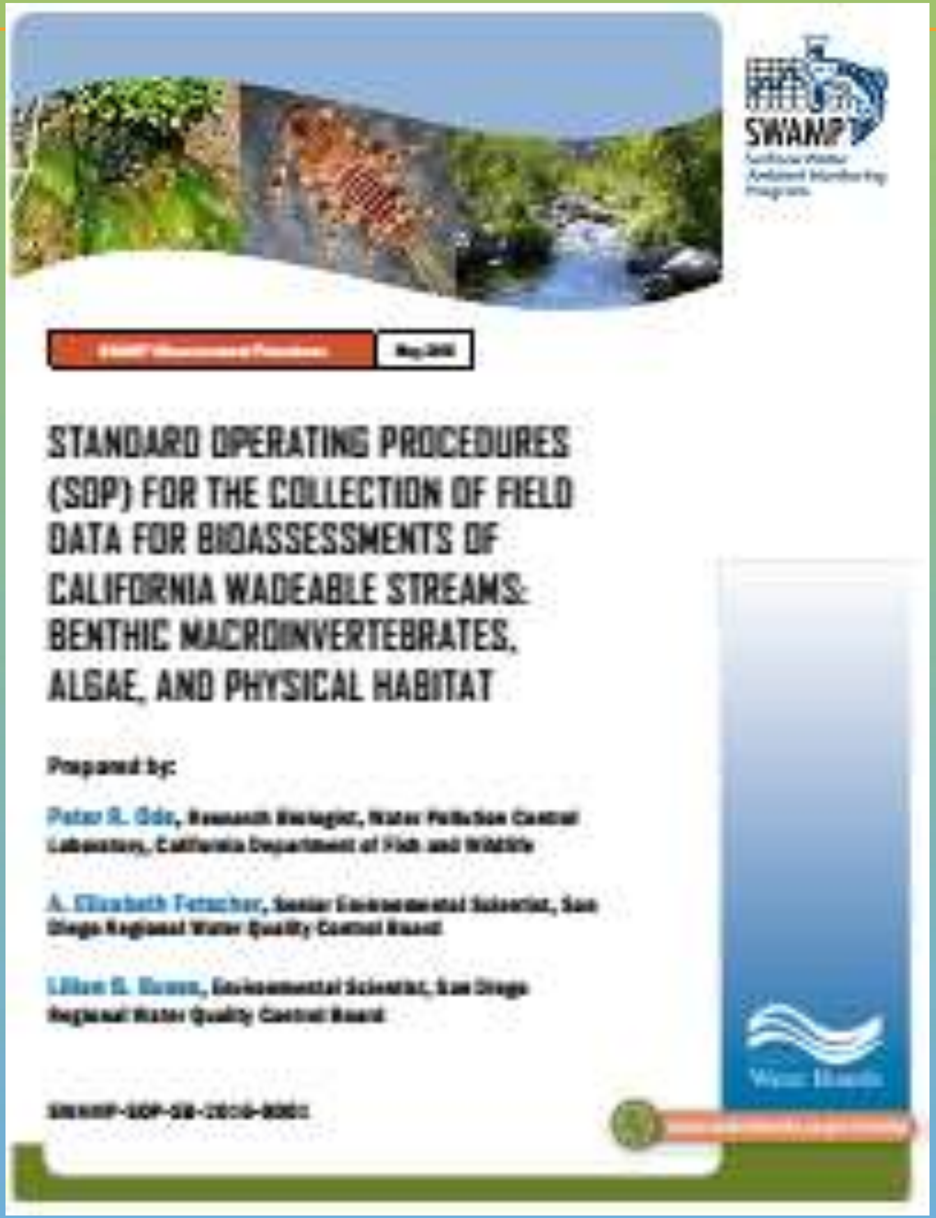
- Surface Water Ambient Monitoring Program (SWAMP) methodology(ies)
- Bioassay; Contaminant-related Monitoring
- Dissolved Oxygen—constant monitoring
- Water Temperature—constant monitoring
- Stream flow/stage

SWAMP Methodology

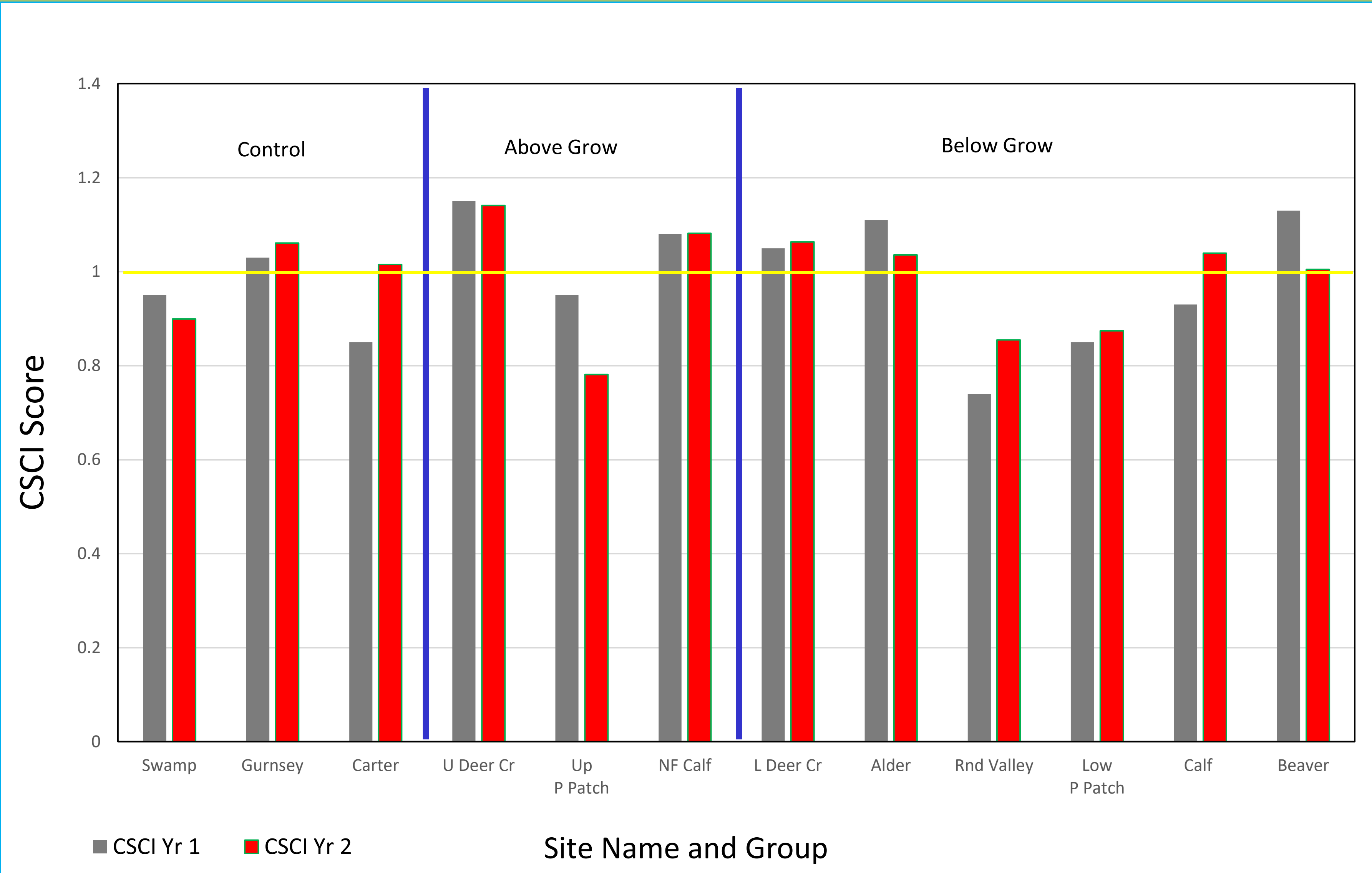
Ode, P.R., A.E., Fetscher, and L.B. Busse. 2016.

Standard Operating Procedures for the Collection of Field Data for Bioassessments of California Wadeable Streams: Benthic Macroinvertebrates, Algae, and Physical Habitat. California State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP) Bioassessment SOP 004

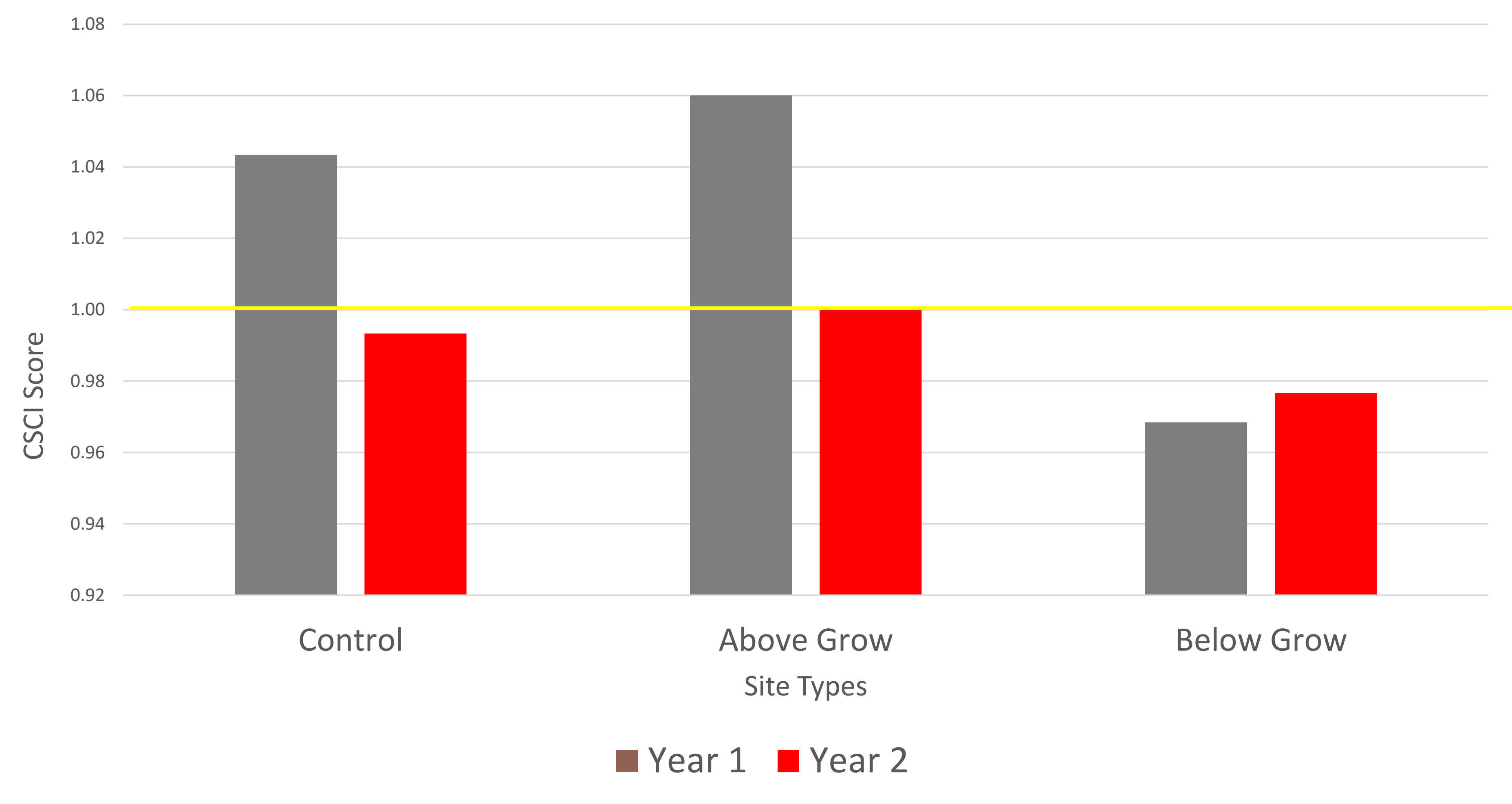
http://www.waterboards.ca.gov/water_issues/programs/swamp/bioassessment/



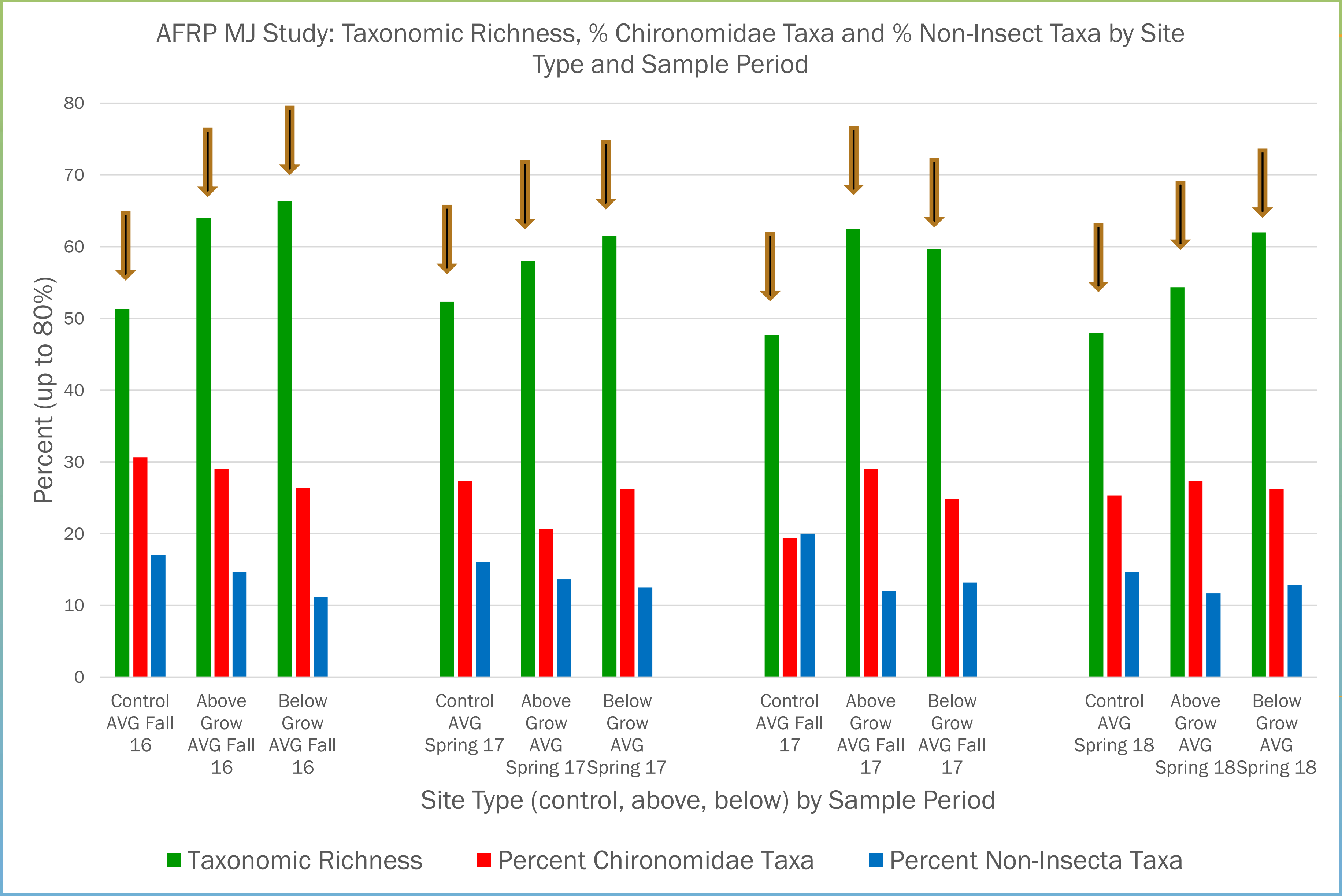
Benthic Macroinvertebrate Results
CA Stream Condition Index (CSCI)



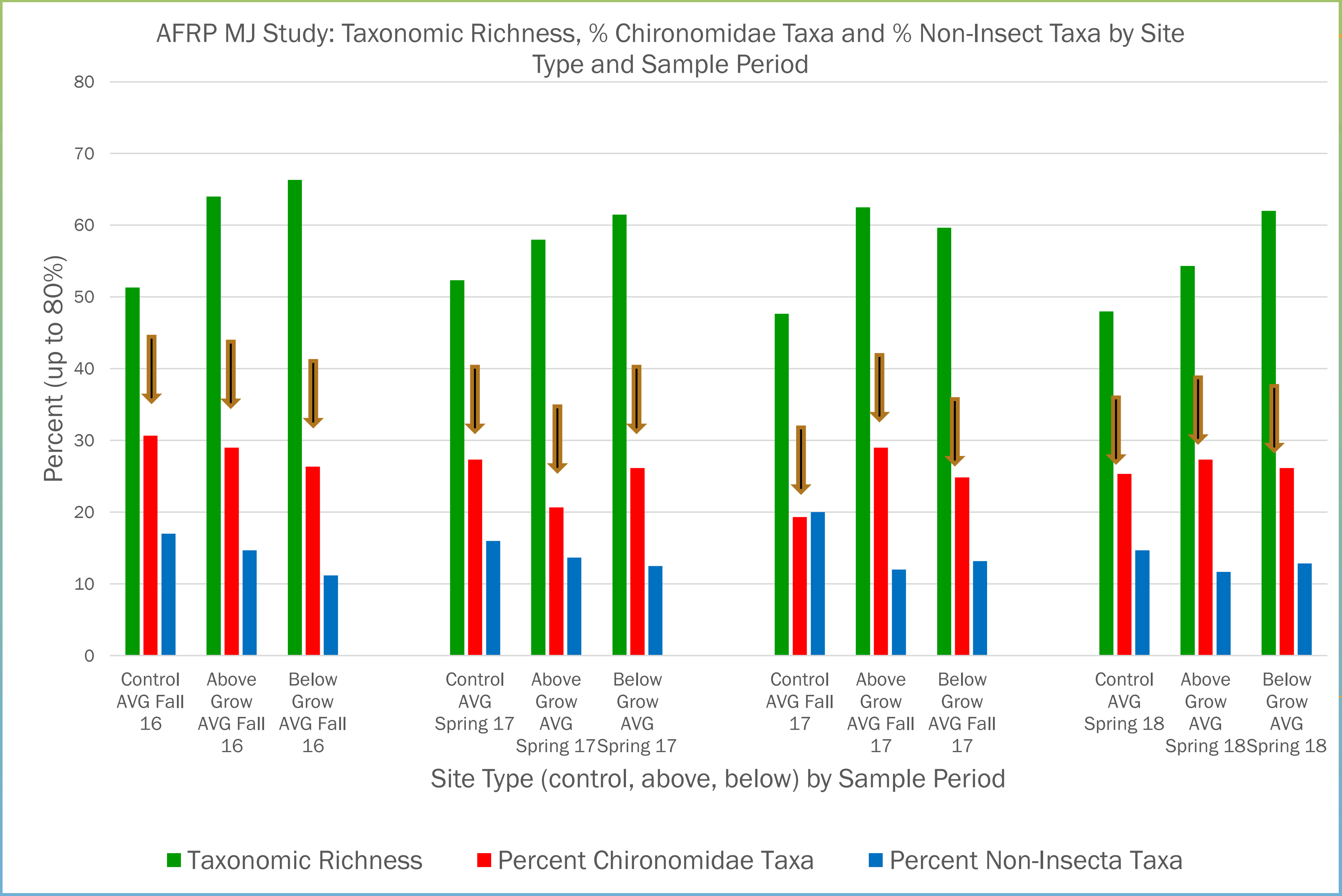
RESULTS: Benthic Macroinvertebrate Results
CA Stream Condition Index (CSCI)



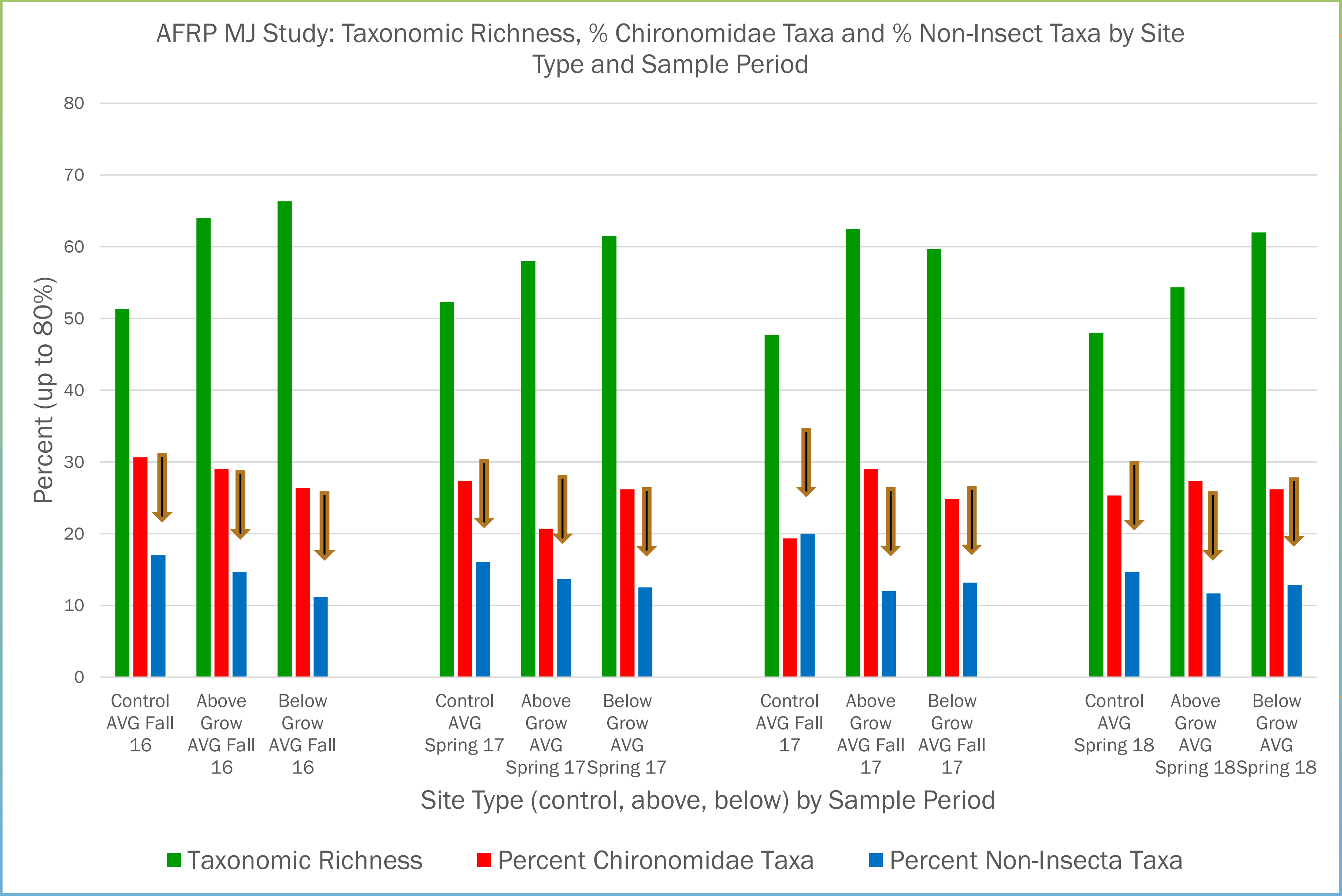
Benthic Macroinvertebrate Results



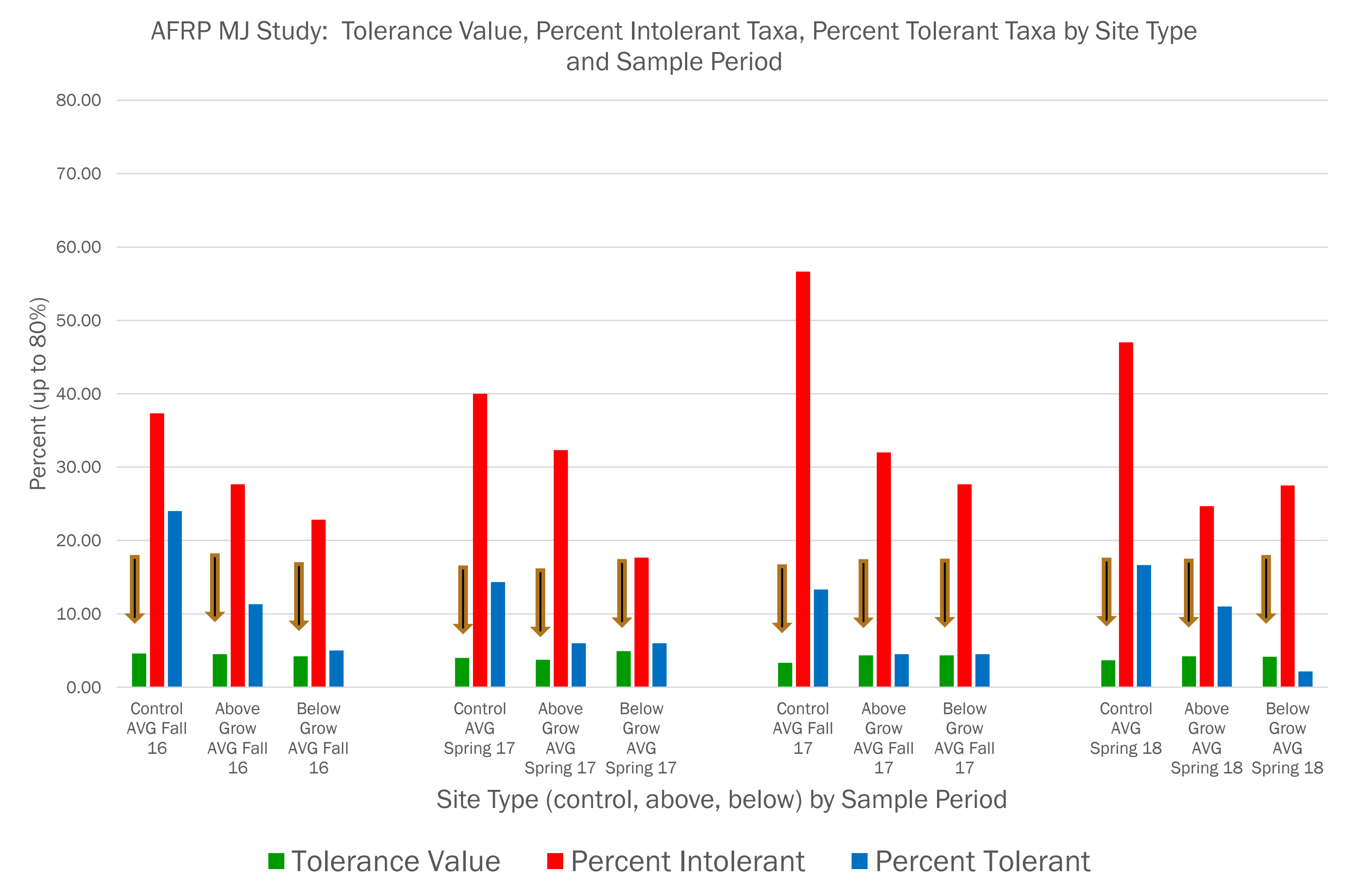
Benthic Macroinvertebrate Results



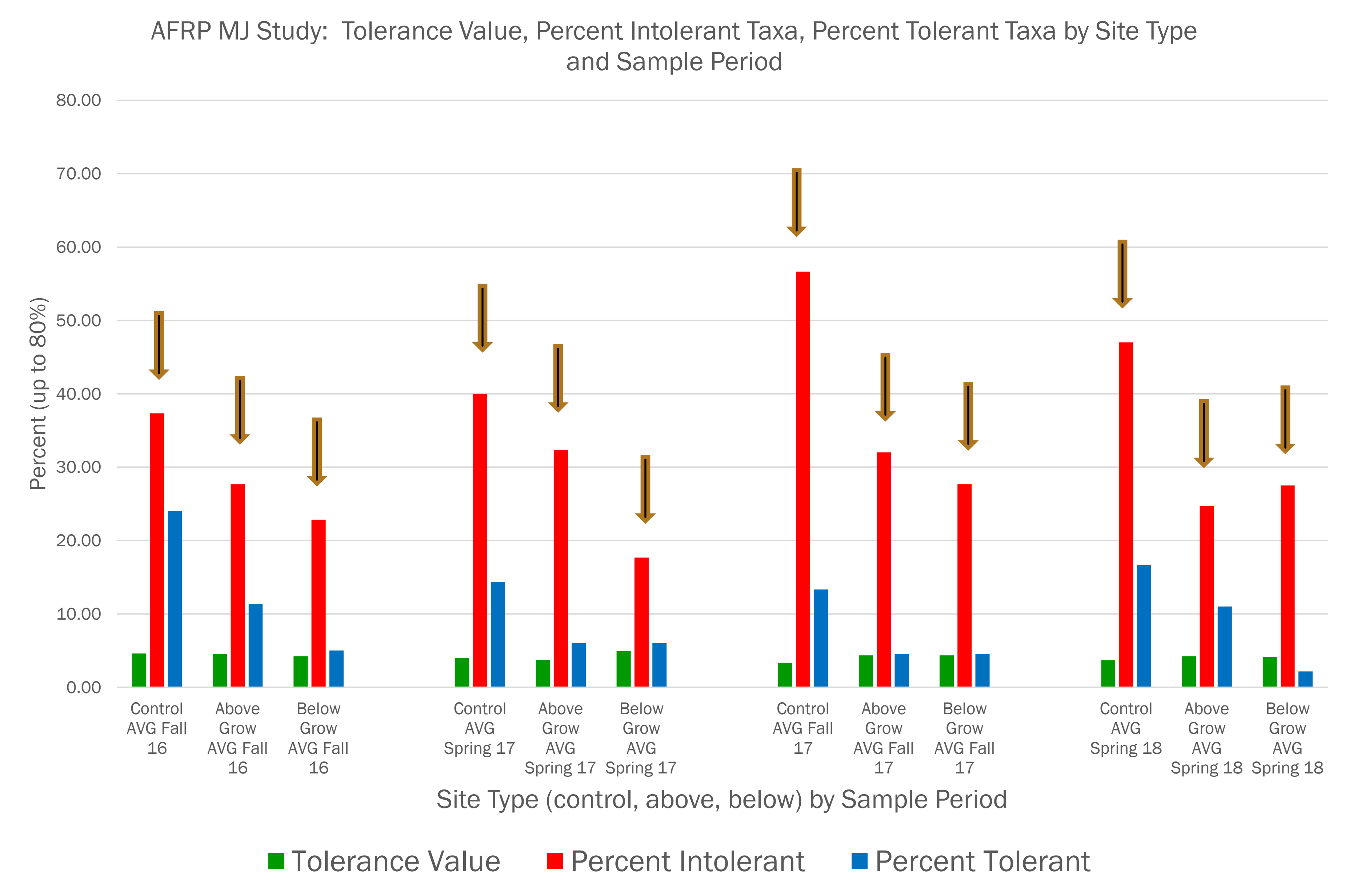
Benthic Macroinvertebrate Results



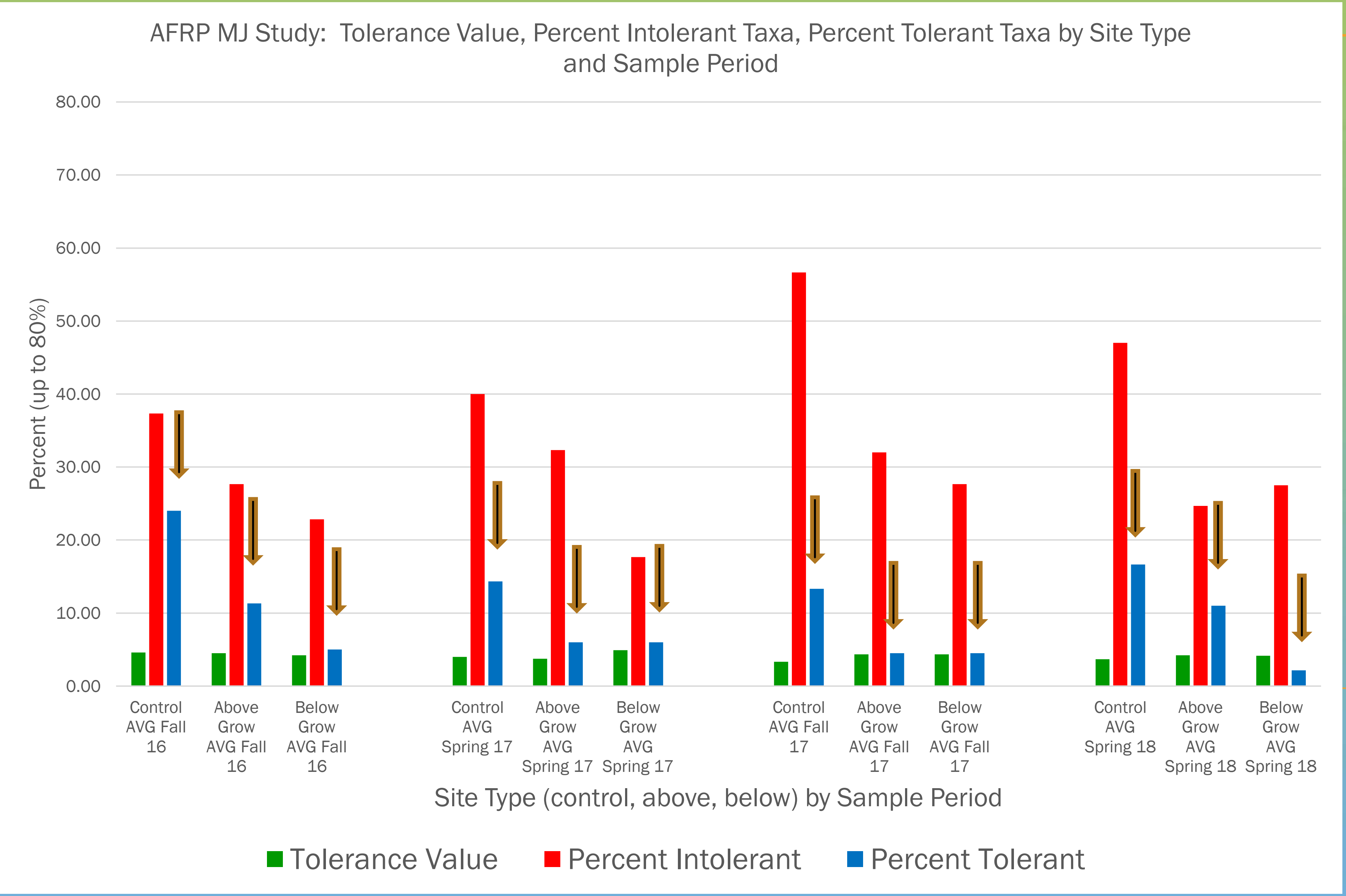
Benthic Macroinvertebrate Results



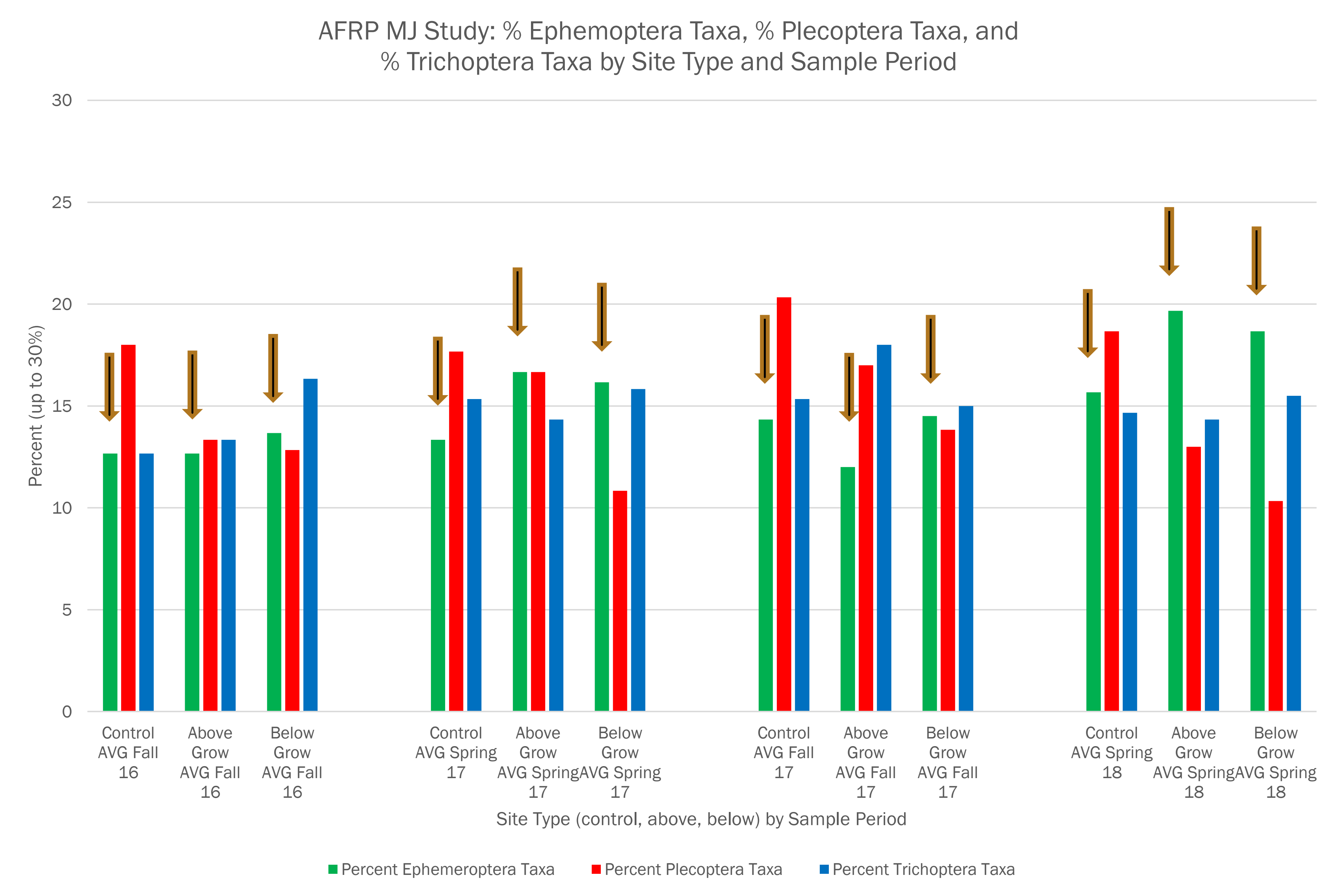
Benthic Macroinvertebrate Results



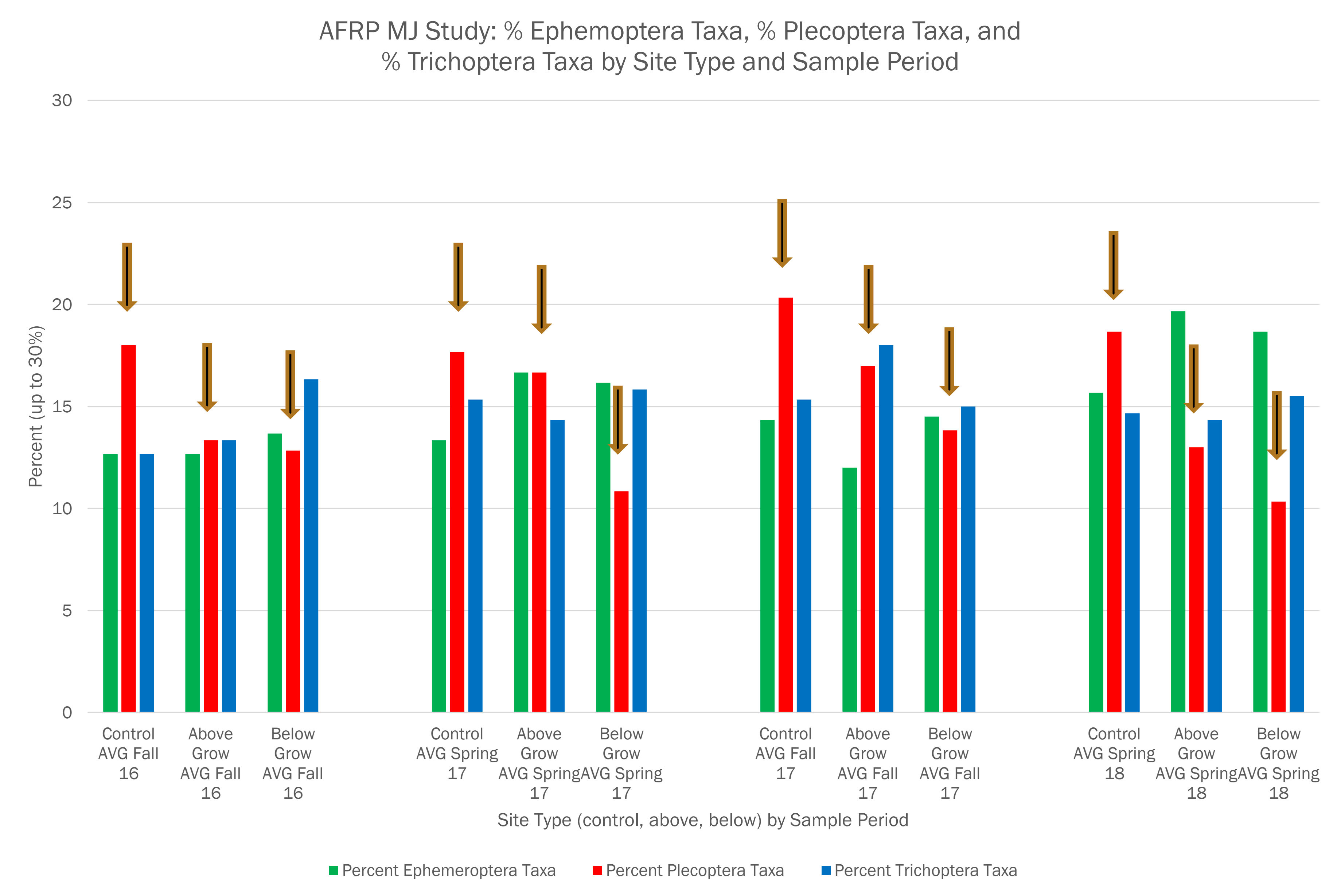
Benthic Macroinvertebrate Results



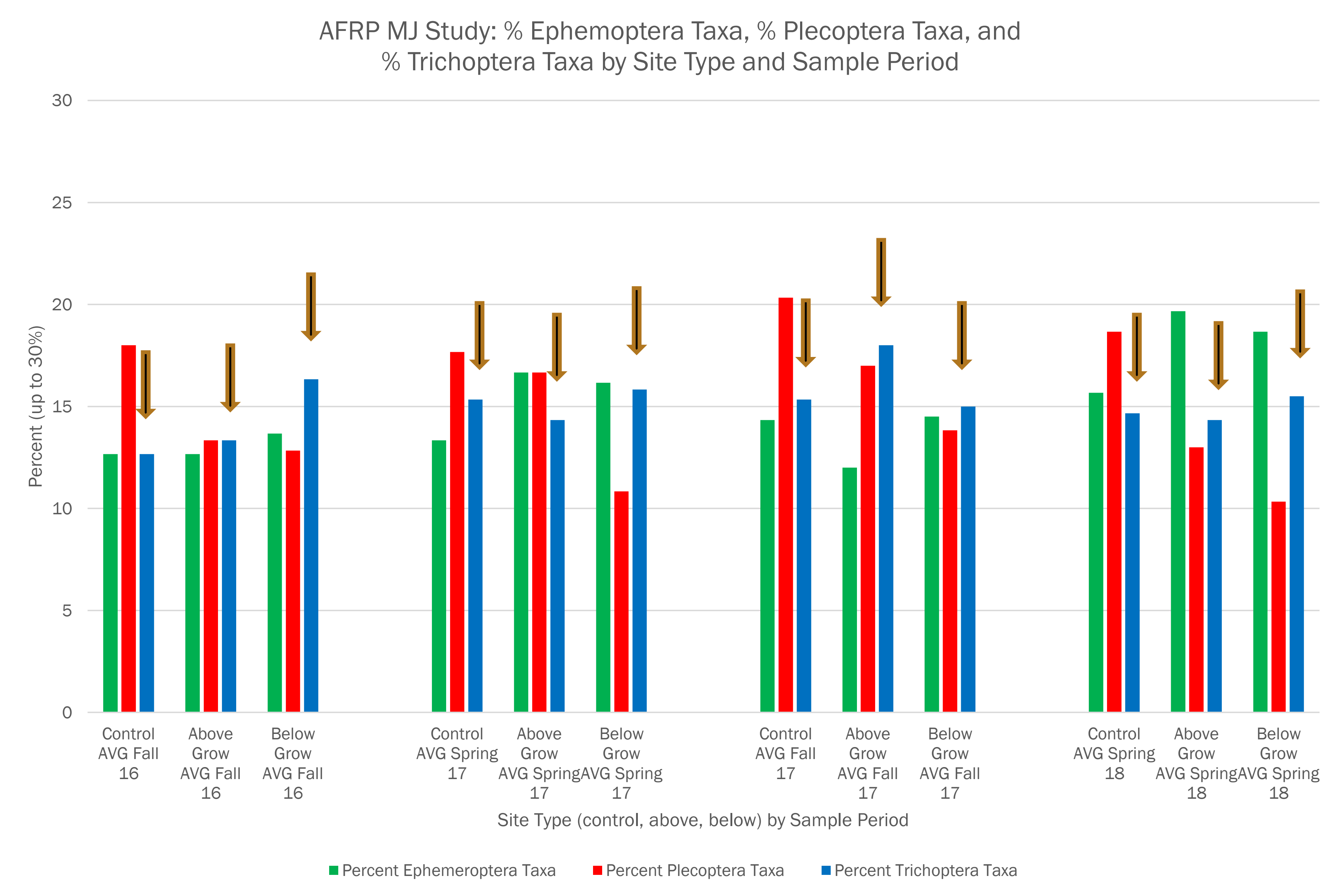
Benthic Macroinvertebrate Results



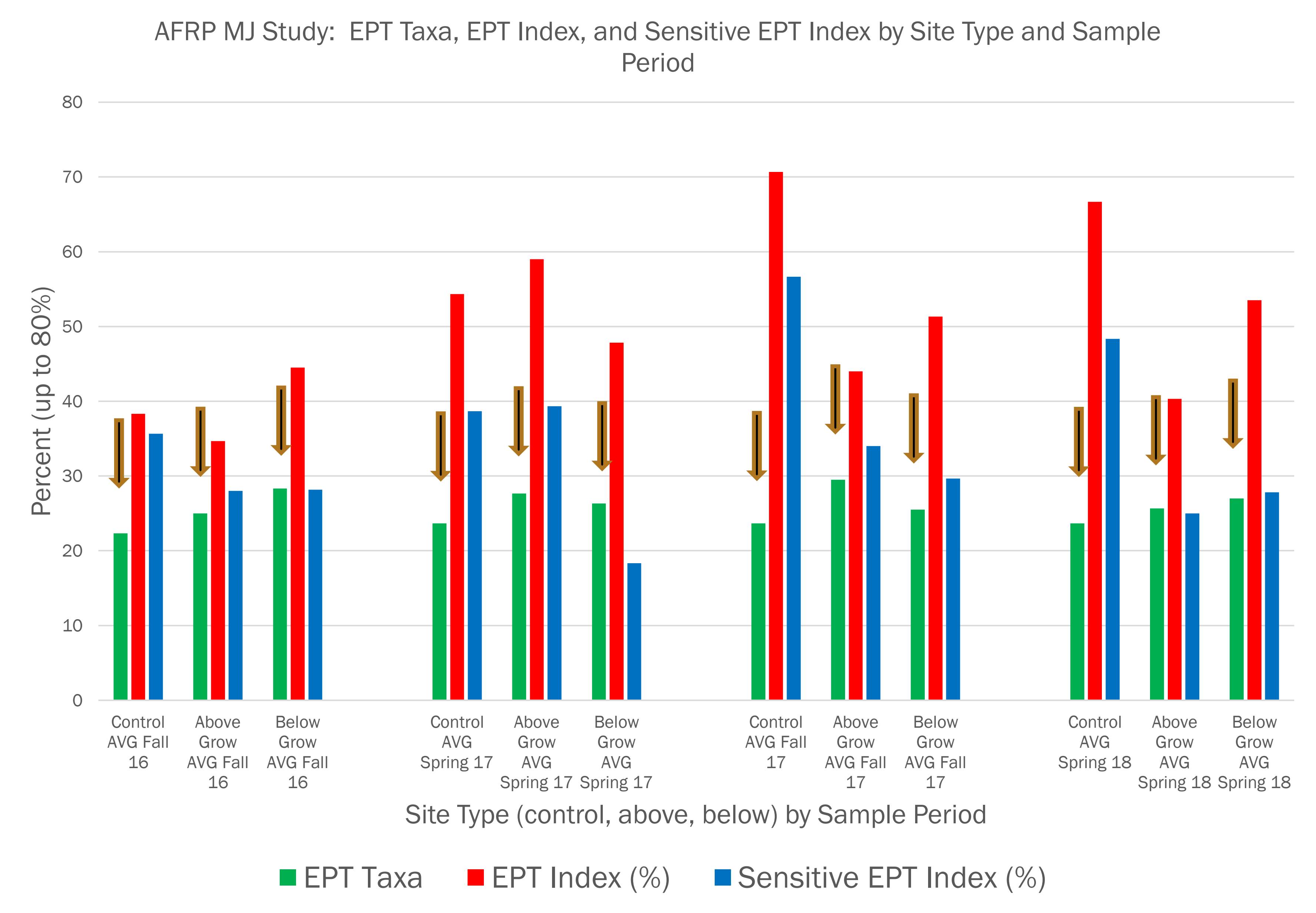
Benthic Macroinvertebrate Results



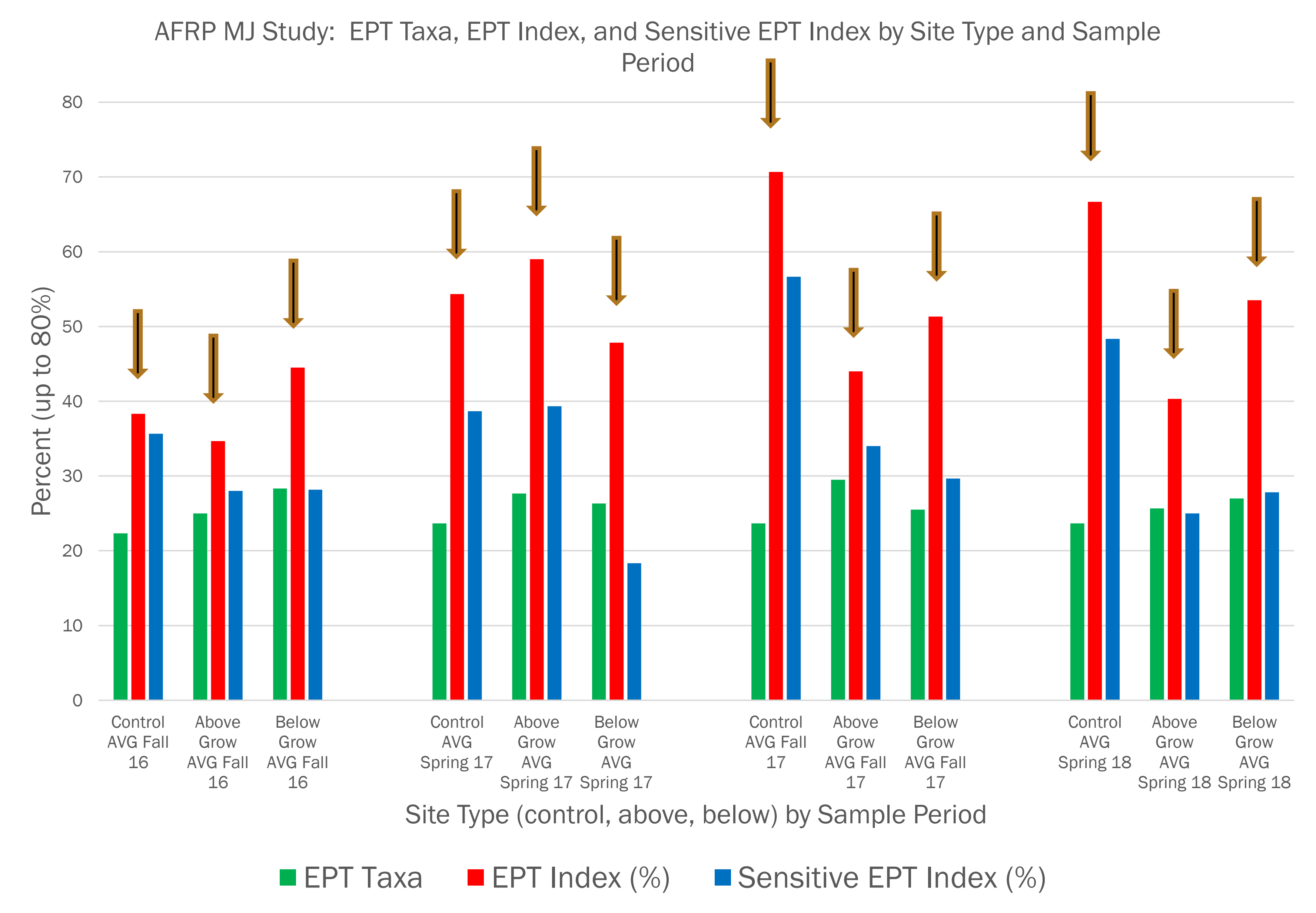
Benthic Macroinvertebrate Results



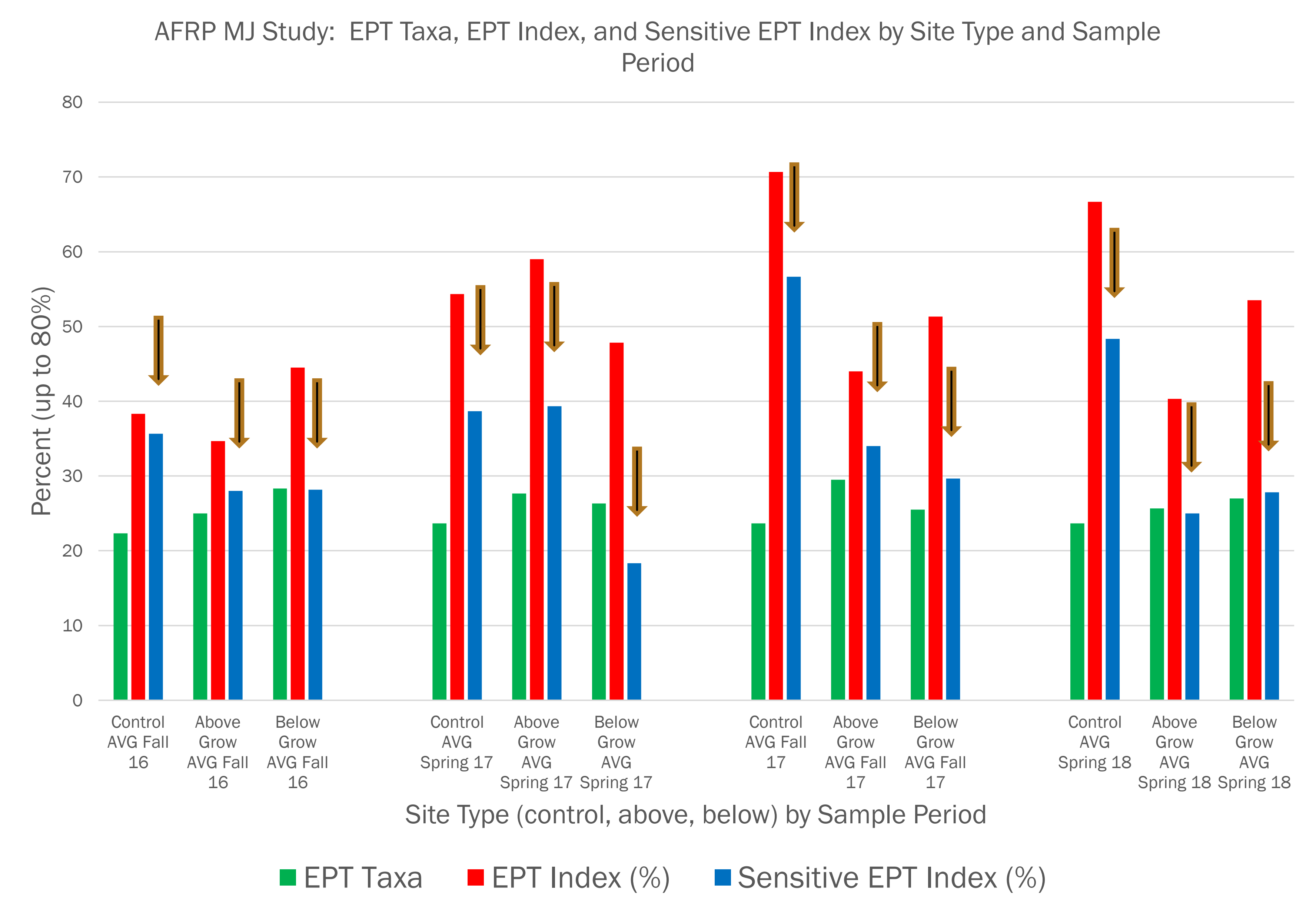
Benthic Macroinvertebrate Results



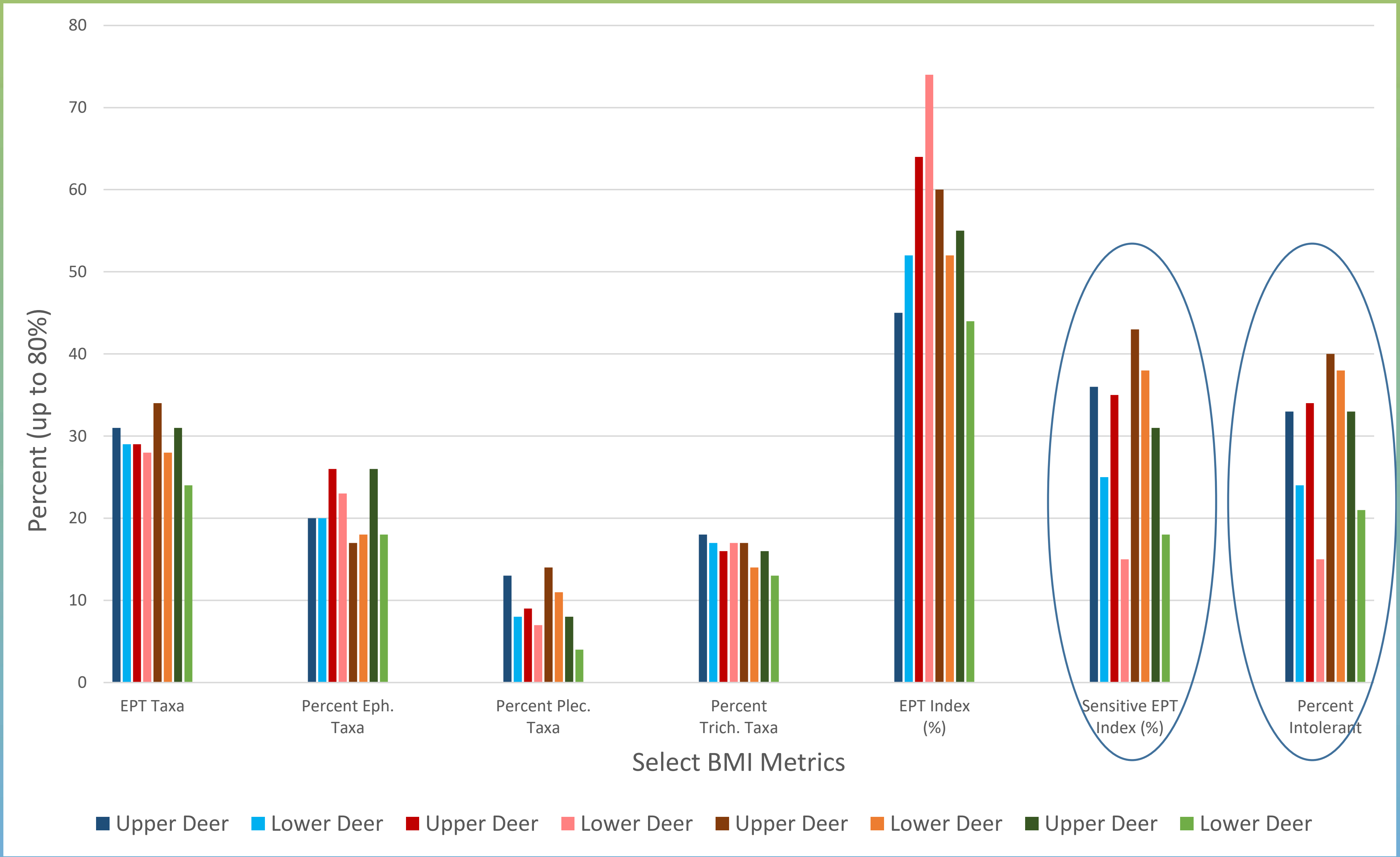
Benthic Macroinvertebrate Results



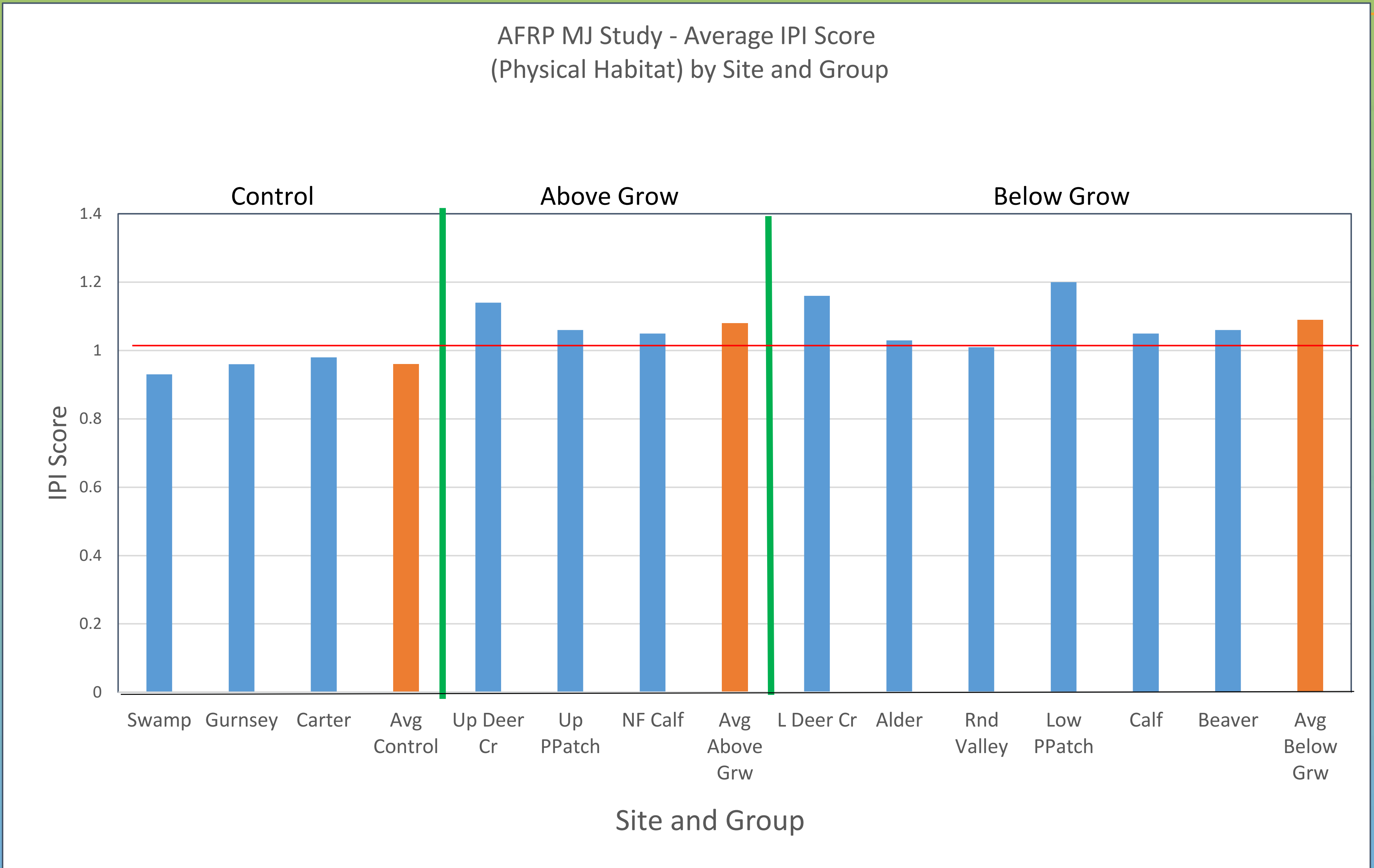
Benthic Macroinvertebrate Results



Comparison: Upper and Lower Deer Creek Sites, Select Metrics

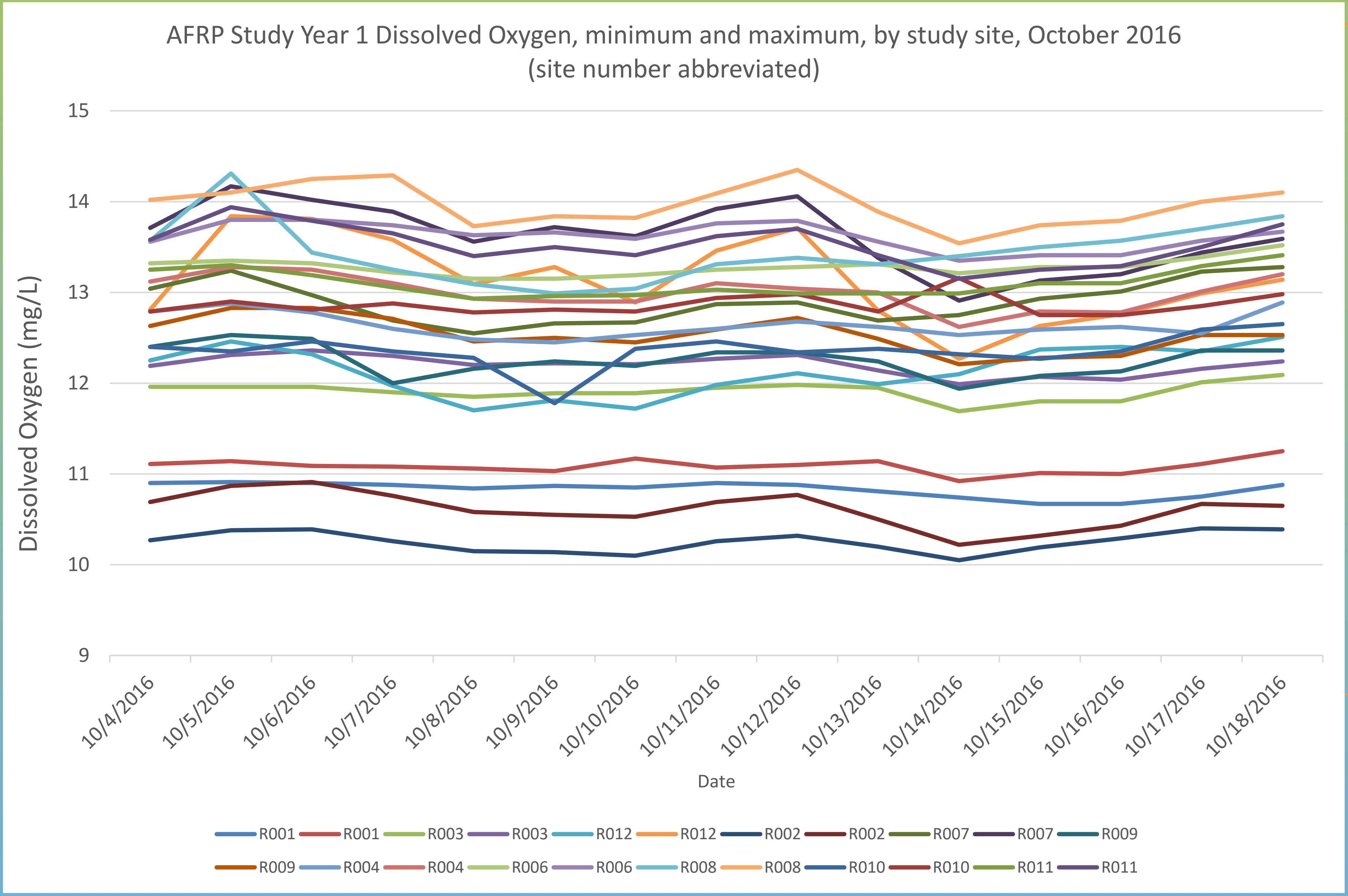


Physical Habitat Analysis and Results, cont'd

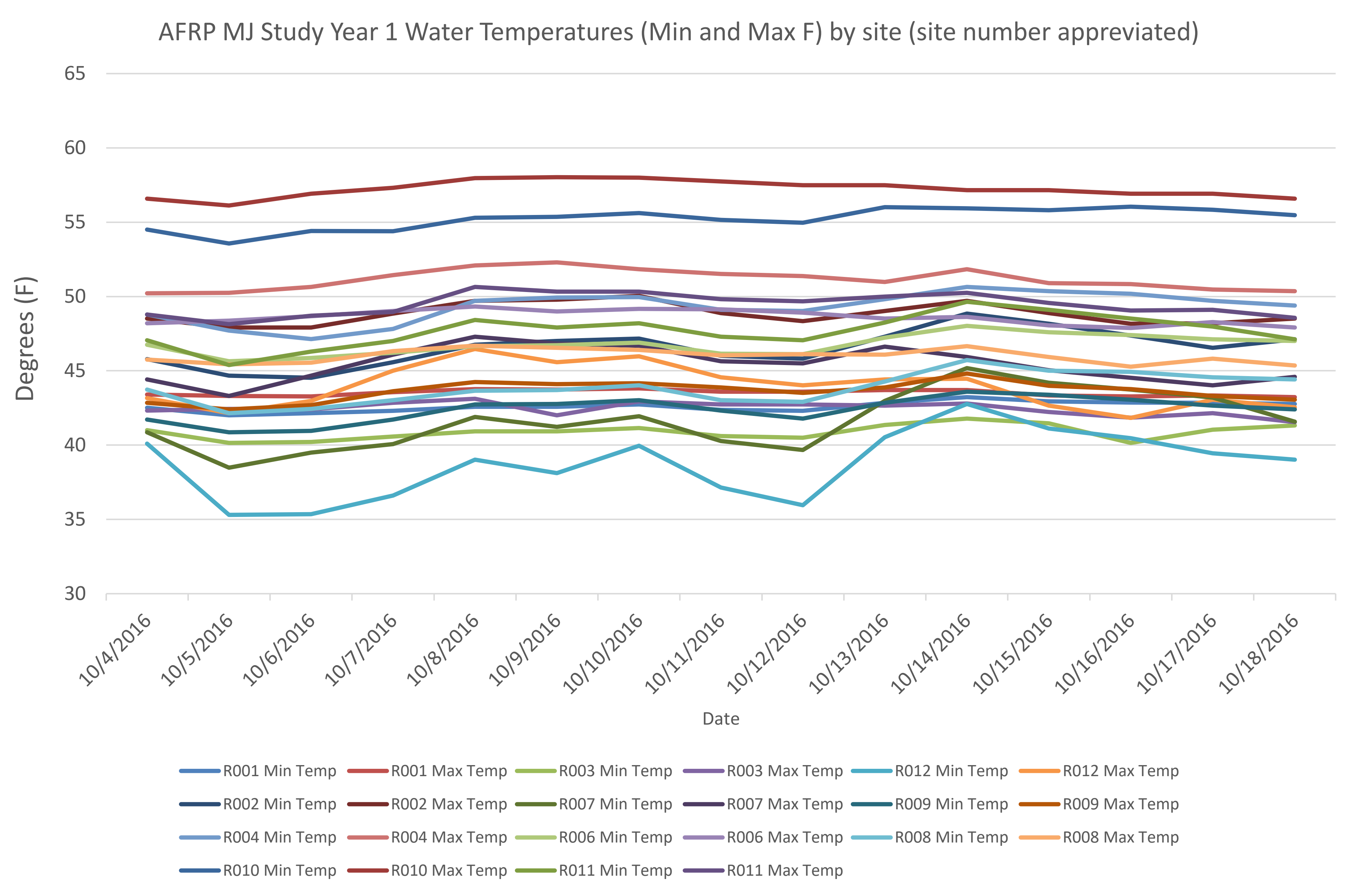


Source: CDFW WPCL

Dissolved Oxygen and Water Temperature

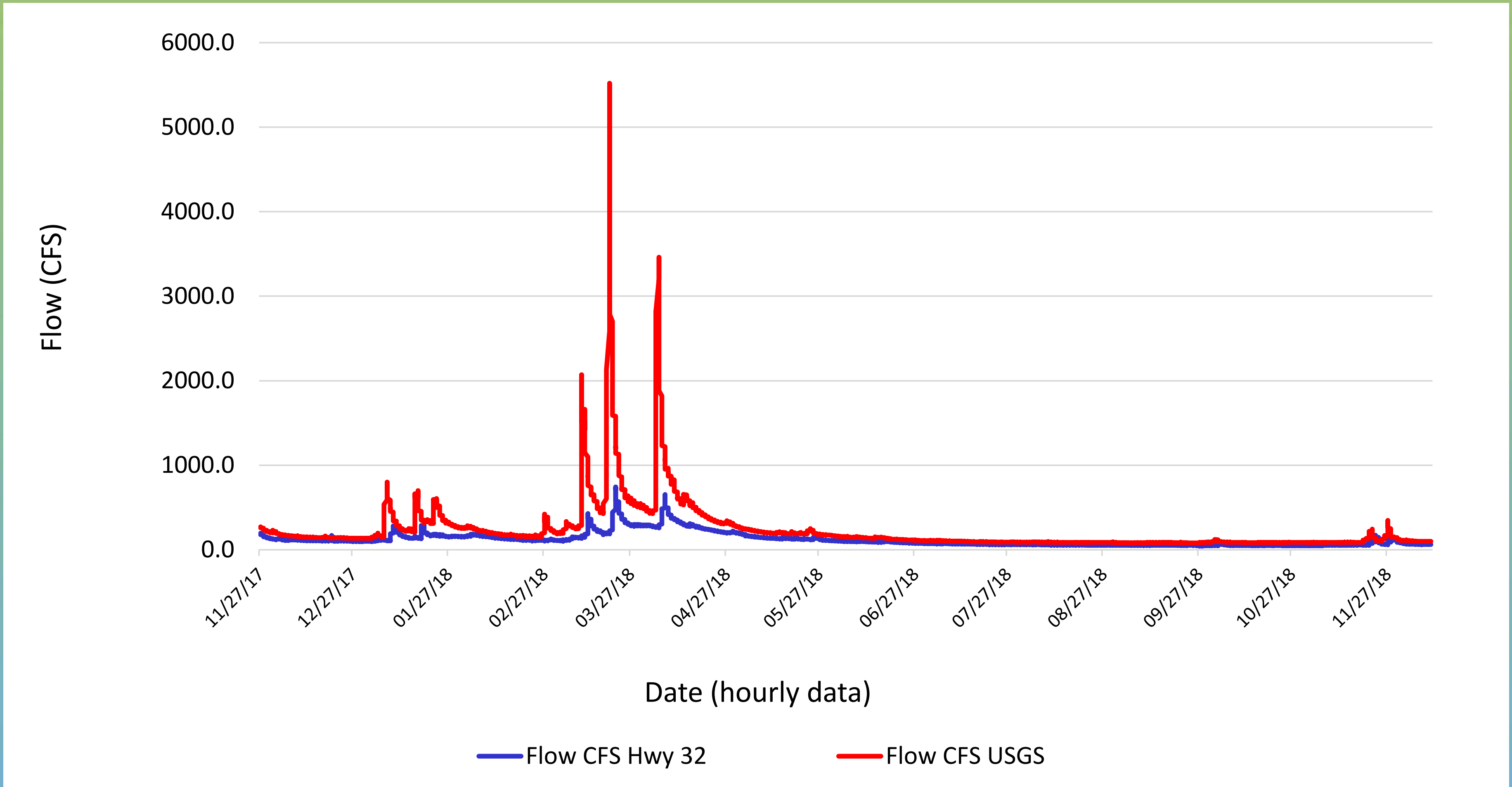


Dissolved Oxygen and Water Temperature, cont'd

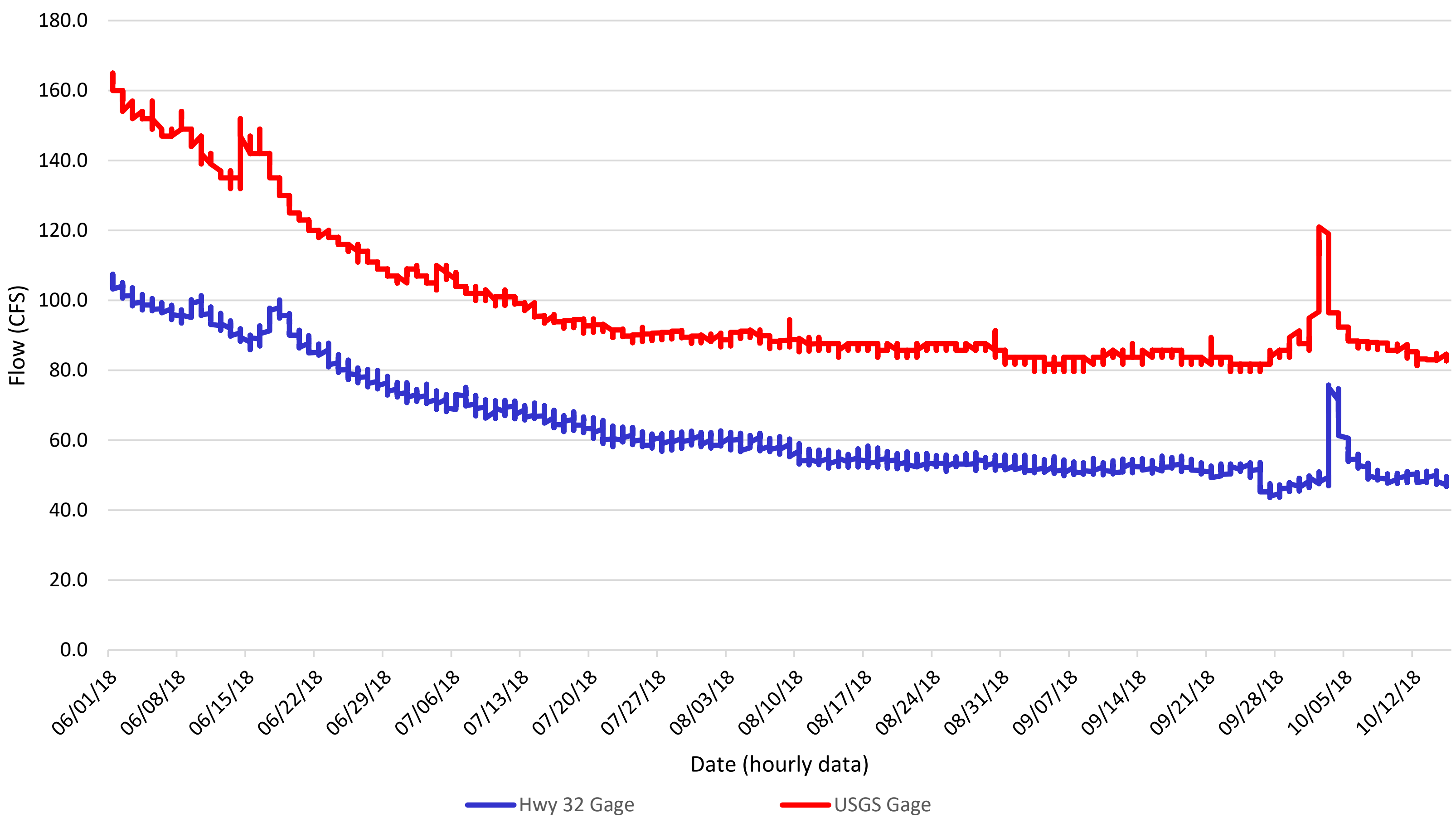


Flow Monitoring Results

Deer Creek Watershed Hwy 32 Gage and USGS Gage Flow Comparison Nov 2017-Dec 2018



Deer Creek Watershed, Hwy 32 Gage and USGS Gage Flow Comparison, Spring-run Chinook Holding and Spawning Period, June-Oct 2018



TO DO: Causal Analysis…

More than just trying to figure out why eating donuts makes you fat

Causal Analysis/Diagnosis Decision Information System, or CADDIS: developed to help scientists and engineers in the Regions, States, and Tribes conduct causal assessments in aquatic systems. Five volumes:

Volume 1: Stressor Identification: step-by-step guide for identifying probable causes of impairment in a particular system, based on the U.S. EPA's Stressor Identification process.

Volume 2: Sources, Stressors & Responses provides background information on many common sources, stressors, and biotic responses in stream ecosystems.

Volume 3: Examples & Applications provides examples illustrating different steps of causal assessments, including completed causal assessment case studies

Volume 4: Data Analysis provides guidance on the use of statistical analysis to support causal assessments.

Volume 5: Causal Databases provides access to literature databases and associated tools for use in causal assessments.

https://www3.epa.gov/caddis/

…AND COMPARISON TO SWAMP REFERENCE SITES IN DEER CREEK

THANK YOU!

My pal Champ, LE Canine Corps

PowerPoint Photo credits: Tricia Bratcher, Matt Johnson, Doug Killam, CDFW Fisheries, SWAMP SOP, Kim Milliron, 2016 Field Crew (site photos), Tricia Parker Hamelberg, Melanie McFarland

Water Quality Impacts of Illegal Marijuana Cultivation on Public Lands, with an Emphasis on Anadromous Fish

Nathan Cullen, Michael Parker, Central Valley Regional Water Quality Control Board, 364 Knollcrest Drive, Suite 205, Redding, CA 96002; nathan.cullen@waterboards.ca.gov; michael.parker@waterboards.ca.gov (Presenters)

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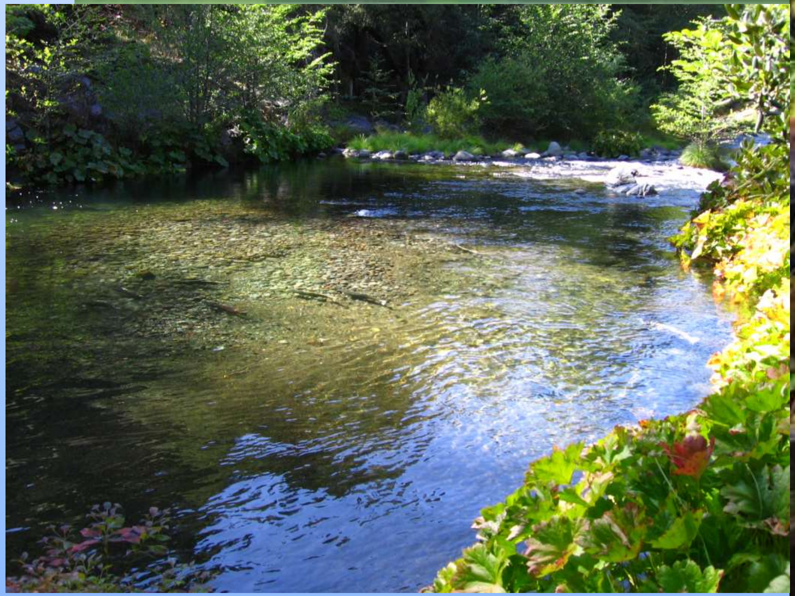
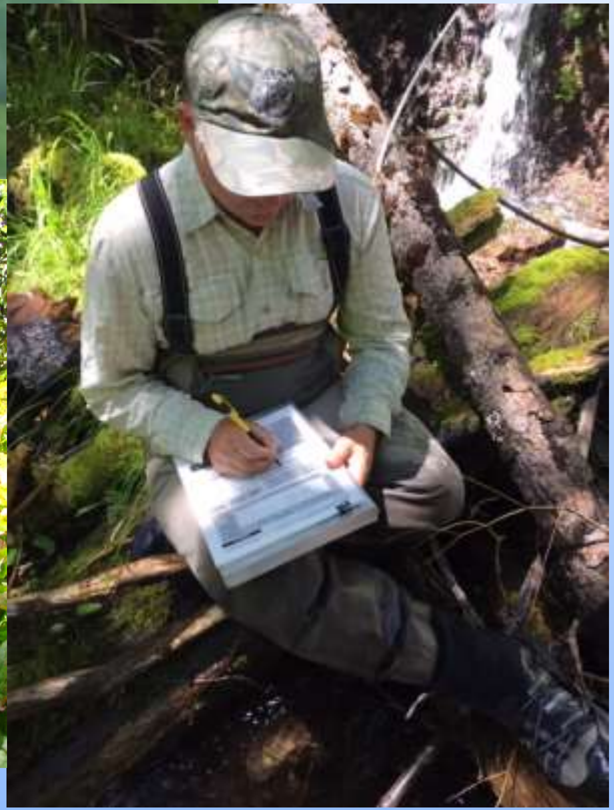
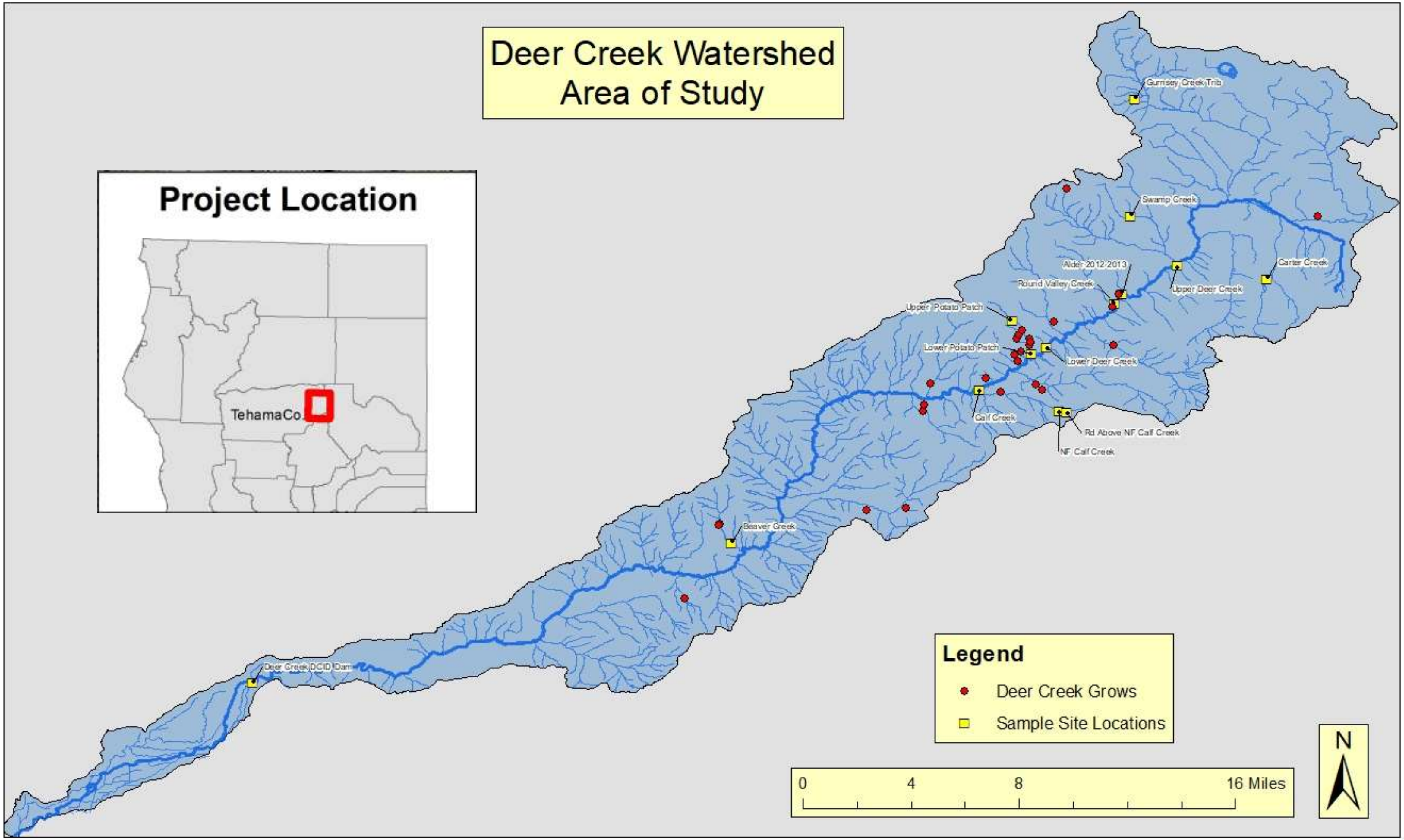
Central Valley Waterboard Role (AFRP Study)

- Led by California Department of Fish & Wildlife (CDFW) the Central Valley Regional Water Quality Control Board (Waterboard) agreed to assist in:
  - Field work collection
  - Analysis of Sediment Toxicity, POCIS detections, and general water chemistry.

- Continued support in analyzing water chemistry and completion of the report.



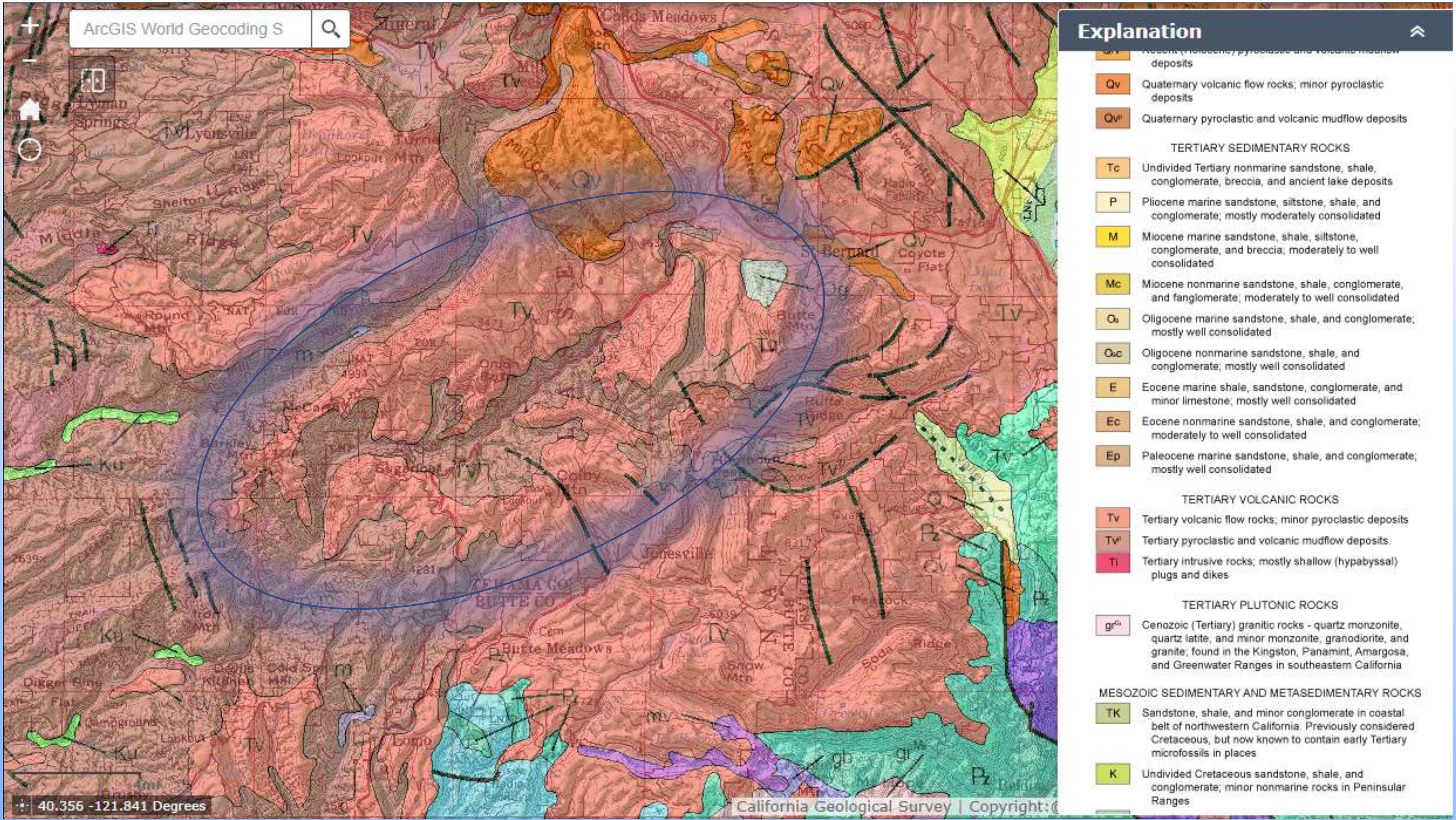


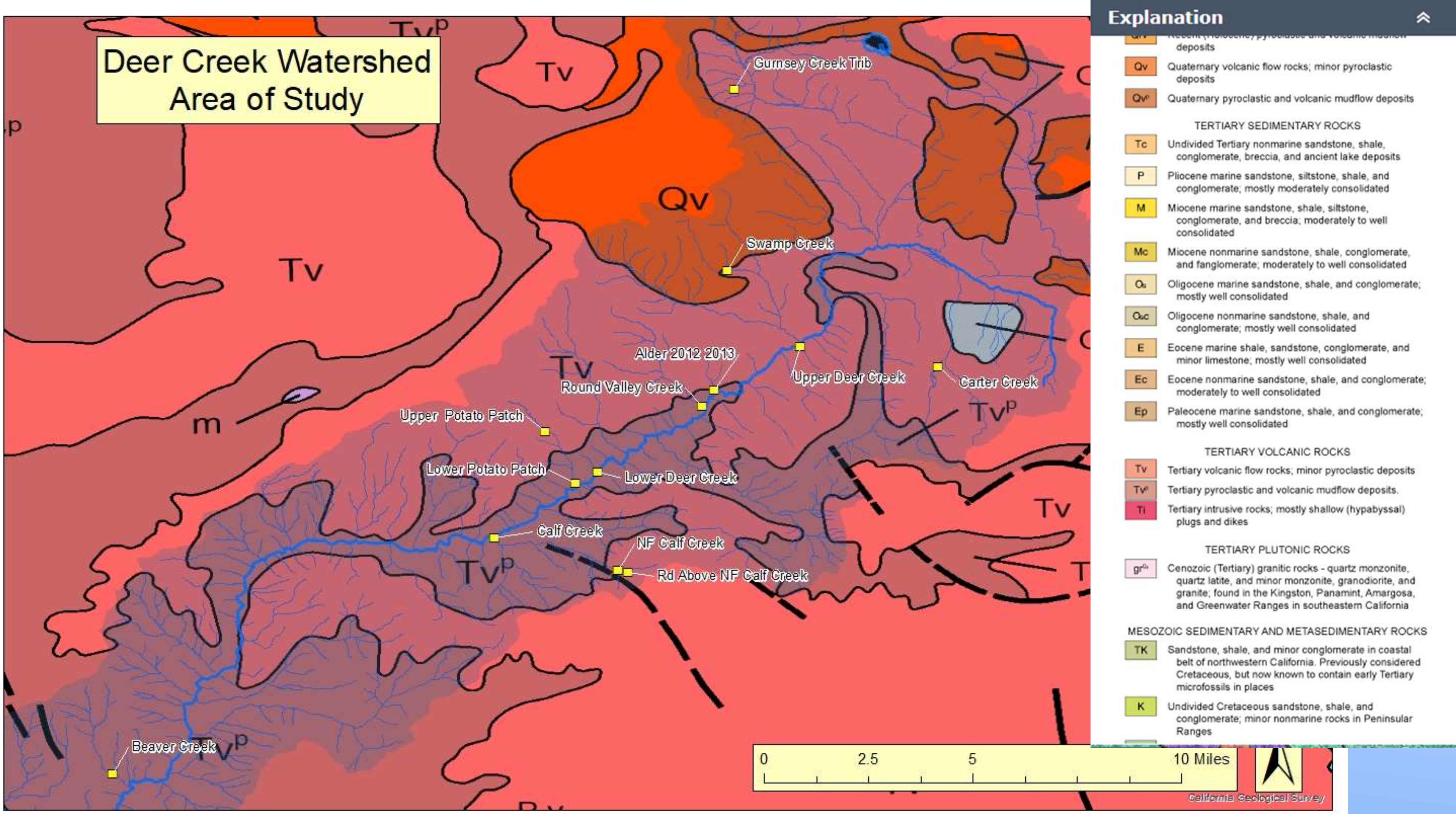

Deer Creek Watershed
Area of Study
Project Location
TehamaCo.
Gurnsey Creek Trib
Swamp Creek
Alder 2012-2013
Round Valley Creek
Upper Deer Creek
Carter Creek
Upper Potato Patch
Lower Potato Patch
Lower Deer Creek
Calf Creek
Rd Above NF Calf Creek
NF Calf Creek
Beaver Creek
Deer Creek DCID Dam
Legend
Deer Creek Grows
Sample Site Locations
0
4
8
16 Miles
N

General Geology of Deer Creek Watershed

- The Deer Creek watershed sits in the cross roads of three major Geomorphic Provenances, the Sierra Nevada Mountains, Cascade Range and the Great Basin.

- Dominated by the Tuscan Formation (Pliocene 2-5ma)
    - Comprised of thick volcanic mudflow deposits (lahars) interbedded with volcanic conglomerates, sandstones and siltstones.
    - Also includes locally derived ash-flow and air-fall tuffs, and lava flows.
    - The higher elevations of the watershed, specifically Mill Creek Plateau, thick rhyolitic lava flows overlay the Tuscan Fm.


ArcGIS World Geocoding S
Explanation
deposits
Qv Quaternary volcanic flow rocks; minor pyroclastic deposits
Qvp Quaternary pyroclastic and volcanic mudflow deposits
TERTIARY SEDIMENTARY ROCKS
Tc Undivided Tertiary nonmarine sandstone, shale, conglomerate, breccia, and ancient lake deposits
P Pliocene marine sandstone, siltstone, shale, and conglomerate; mostly moderately consolidated
M Miocene marine sandstone, shale, siltstone, conglomerate, and breccia; moderately to well consolidated
Mc Miocene nonmarine sandstone, shale, conglomerate, and fanglomerate; moderately to well consolidated
Oligocene marine sandstone, shale, and conglomerate; mostly well consolidated
Oligocene nonmarine sandstone, shale, and conglomerate; mostly well consolidated
E Eocene marine shale, sandstone, conglomerate, and minor limestone; mostly well consolidated
Ec Eocene nonmarine sandstone, shale, and conglomerate; moderately to well consolidated
Ep Paleocene marine sandstone, shale, and conglomerate; mostly well consolidated
TERTIARY VOLCANIC ROCKS
Tv Tertiary volcanic flow rocks; minor pyroclastic deposits
Tvp Tertiary pyroclastic and volcanic mudflow deposits.
Ti Tertiary intrusive rocks; mostly shallow (hypabyssal) plugs and dikes
TERTIARY PLUTONIC ROCKS
Cenozoic (Tertiary) granitic rocks - quartz monzonite, quartz latite, and minor monzonite, granodiorite, and granite; found in the Kingston, Panamint, Amargosa, and Greenwater Ranges in southeastern California
MESOZOIC SEDIMENTARY AND METASEDIMENTARY ROCKS
TK Sandstone, shale, and minor conglomerate in coastal belt of northwestern California. Previously considered Cretaceous, but now known to contain early Tertiary microfossils in places
K Undivided Cretaceous sandstone, shale, and conglomerate; minor nonmarine rocks in Peninsular Ranges
40.356 -121.841 Degrees
California Geological Survey | Copyright:



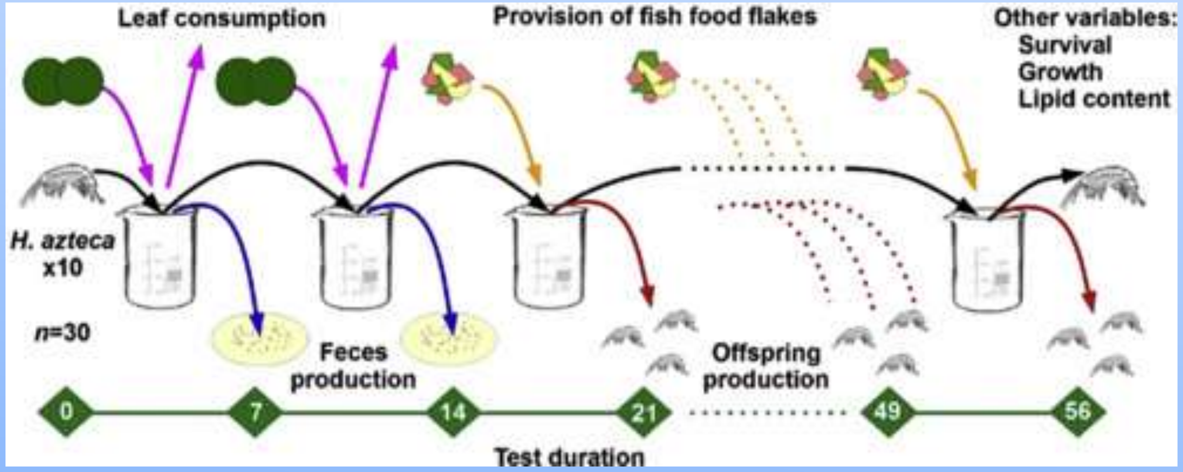
Deer Creek Watershed
Area of Study
Tv
Tv
Tv
Qv
Tv
Tvp
Tvp
Tvp
Tvp
Tv
m
Gurnsey Creek Trib
Swamp Creek
Alder 2012 2013
Round Valley Creek
Upper Deer Creek
Carter Creek
Upper Potato Patch
Lower Potato Patch
Lower Deer Creek
Calf Creek
NF Calf Creek
Rd Above NF Calf Creek
Beaver Creek
0
2.5
5
10 Miles
California Geological Survey
Explanation
deposits
Qv Quaternary volcanic flow rocks; minor pyroclastic deposits
Qvp Quaternary pyroclastic and volcanic mudflow deposits
TERTIARY SEDIMENTARY ROCKS
Tc Undivided Tertiary nonmarine sandstone, shale, conglomerate, breccia, and ancient lake deposits
P Pliocene marine sandstone, siltstone, shale, and conglomerate; mostly moderately consolidated
M Miocene marine sandstone, shale, siltstone, conglomerate, and breccia; moderately to well consolidated
Mc Miocene nonmarine sandstone, shale, conglomerate, and fanglomerate; moderately to well consolidated
Oe Oligocene marine sandstone, shale, and conglomerate; mostly well consolidated
Oec Oligocene nonmarine sandstone, shale, and conglomerate; mostly well consolidated
E Eocene marine shale, sandstone, conglomerate, and minor limestone; mostly well consolidated
Ec Eocene nonmarine sandstone, shale, and conglomerate; moderately to well consolidated
Ep Paleocene marine sandstone, shale, and conglomerate; mostly well consolidated
TERTIARY VOLCANIC ROCKS
Tv Tertiary volcanic flow rocks; minor pyroclastic deposits
Tvp Tertiary pyroclastic and volcanic mudflow deposits.
Ti Tertiary intrusive rocks; mostly shallow (hypabyssal) plugs and dikes
TERTIARY PLUTONIC ROCKS
gr Cenozoic (Tertiary) granitic rocks - quartz monzonite, quartz latite, and minor monzonite, granodiorite, and granite; found in the Kingston, Panamint, Amargosa, and Greenwater Ranges in southeastern California
MESOZOIC SEDIMENTARY AND METASEDIMENTARY ROCKS
TK Sandstone, shale, and minor conglomerate in coastal belt of northwestern California. Previously considered Cretaceous, but now known to contain early Tertiary microfossils in places
K Undivided Cretaceous sandstone, shale, and conglomerate; minor nonmarine rocks in Peninsular Ranges

General Soil Classification Of Deer Creek Watershed

- Dominant soils in the watershed are the Lyonsville and Jiggs association.
  - Lyonsville & Jiggs Association: Generally are gravelly and stoney, moderately deep and well drained.
  - Both soils exhibit erodible properties due to the rhyolitic component.
- Generally the upper watershed is dominated by rhyolitic soils found to be highly erodible on steeper slopes.

Sediment Toxicity Methods

- Sediment was collected and sampled according to SWAMP Bioassessment Procedures from all 12 sites from 2016 to 2018.
  - Collected before first flush in fall of 2016 and after first flush in fall of 2016
  - Collected in Spring of 2017
  - Collected before first flush in fall of 2017 and after first flush in Fall of 2017
  - Collected in Spring of 2018
  - There are four possible outcomes:
    - NSG (Not Significant Greater Similarity)
    - NSL (Not Significant Less Similarity)
    - SG (Significant Greater Similarity)
    - SL (Significant Less Similarity)



Sediment Toxicity Results

- Fall of 2016 (Before First Flush & After First Flush)
  - All results came back NSG (Non Toxic)
- Spring of 2017
  - All results came back as NSG (Non Toxic)
- Fall 2017 (Before First Flush & After First Flush)
  - All results came back as NSG (Non Toxic)
- Spring of 2018
  - Results for 10 of the sites came back as NSG (Non Toxic) except two sites.
  - Carter Creek and Swamp Creek (Both Control Sites) came back as SG (Toxic)

Hyalella azteca (Amphipod)

Polar Organic Chemical Integrative Sampler (POCIS) Deployment Results

- POCIS units were deployed during the fall of 2016 and fall of 2017
  - 2016- Units were deployed until right after first significant rain event.
  - 2017- Different methodology than 2016
    - Units were deployed in September 2017 until right after first significant rain event.
    - After that event, units were replaced and left out for additional 21 days.
    - Fall 2017 a site was added near the DCID dam.
- Constituents analyzed were:
  - Anticoagulants Screen
  - Neonicotinoid Screen
  - Organophosphorus Insecticide Screen
- All samples came back NON-DETECT

Photo: EST Labs, Inc.

http://www.petpoisoncontrol.com/portfolio/anticoagulant-rodenticides/

https://silentsparks.com/2018/04/30/pesticides-fireflies/

https://dir.indiamart.com/impcat/organophosphorus-insecticides.html

Water Chemistry: Instantaneous Grab Sampling

2 consecutive water years: Fall 2016 - Spring 2017, and Fall 2017 - Spring 2018

12 primary sites sampled during each of these four periods

2 more sites added during second year, with limited sampling

(Deer Creek DCID Dam, and Rd Above NF Calf Creek)

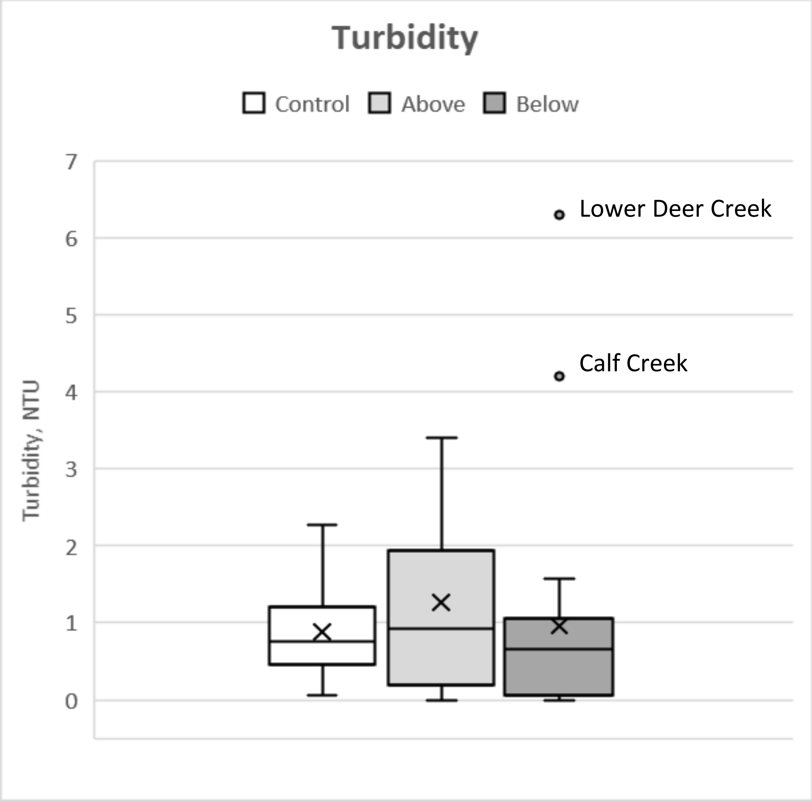
- Temperature
- pH
- Dissolved O2/Saturated O2
- Alkalinity
- Turbidity

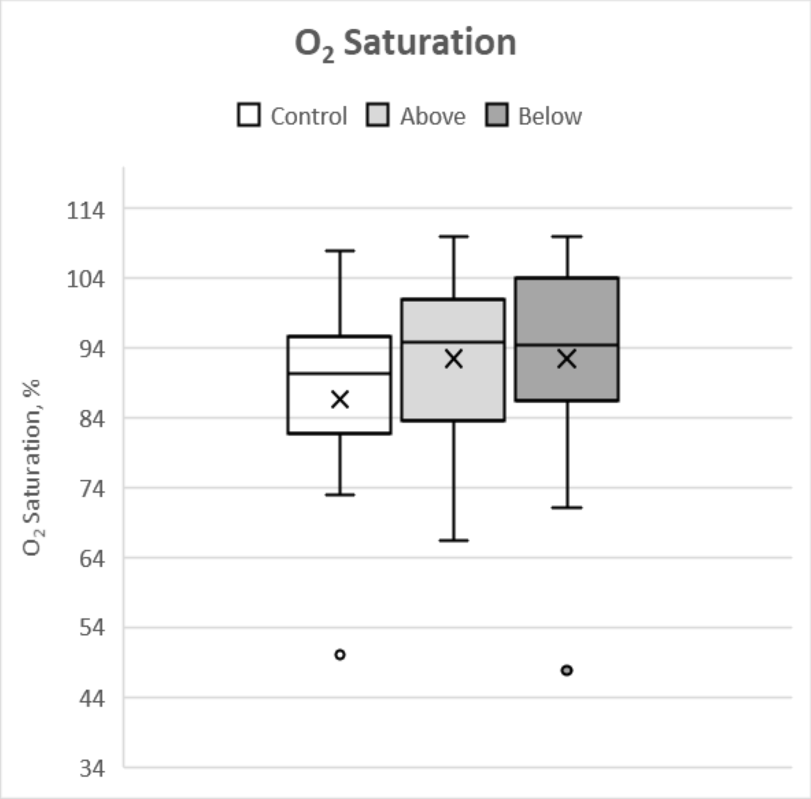
- Ash Free Dry Mass (AFDM)
- Chlorophyll-A
- Nitrate + Nitrite
- Total Nitrogen
- Phosphorous

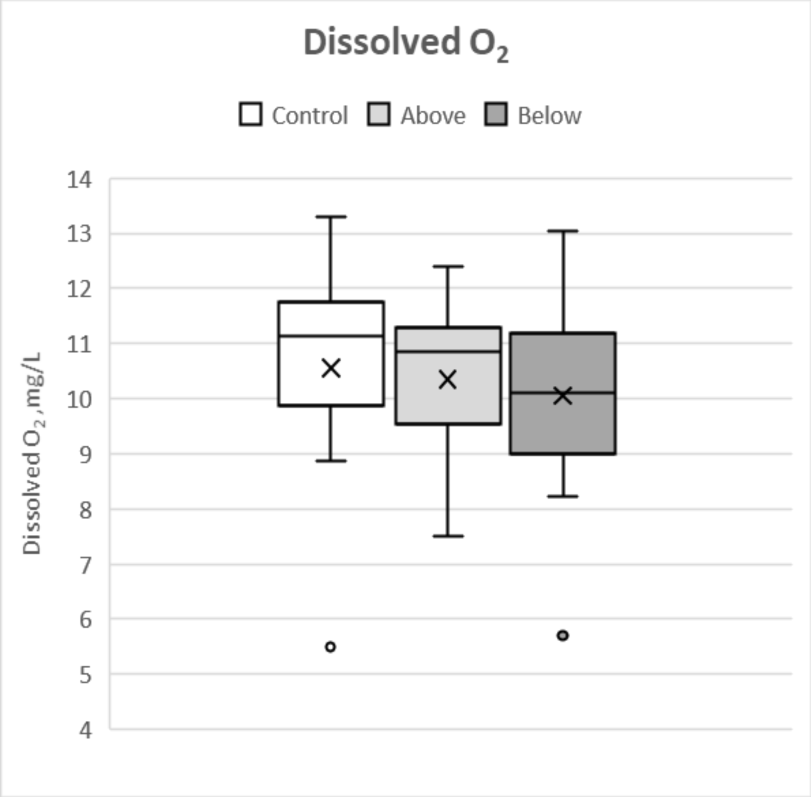
Station ID	Station Name	Type of Site
509MJR001	Swamp Creek	Control
509MJR003	Gurnsey Creek Trib	Control
509MJR012	Carter Creek	Control
509MJR005	Upper Deer Creek	Above MJ Site
509MJR007	Upper Potato Patch	Above MJ Site
509MJR009	NF Calf Creek	Above MJ Site
509MJR002	Lower Deer Creek	Below MJ Site
509MJR006	Alder	Below MJ Site
509MJR011	Round Valley Creek	Below MJ Site
509MJR004	Lower Potato Patch	Below MJ Site
509MJR008	Calf Creek	Below MJ Site
509MJR010	Beaver Creek	Below MJ Site
509MJR013	DCID Dam	Below MJ Site


Deer Creek Watershed
Area of Study
Legend
Sample Site Locations
Gurnsey Creek Trib
Beaver Creek
0
2.5
5
10 Miles
N
There are known knowns; there are things we know that we know.
There are known unknowns; that is to say, there are things that we now know we don't know.
But there are also unknown unknowns – there are things we do not know we don't know.
-Donald Rumsfeld


06/11/2018


Turbidity
Control
Above
Below
Turbidity, NTU
0
1
2
3
4
5
6
7
Lower Deer Creek
Calf Creek


O_2 Saturation
Control
Above
Below
O_2 Saturation, %
34
44
54
64
74
84
94
104
114

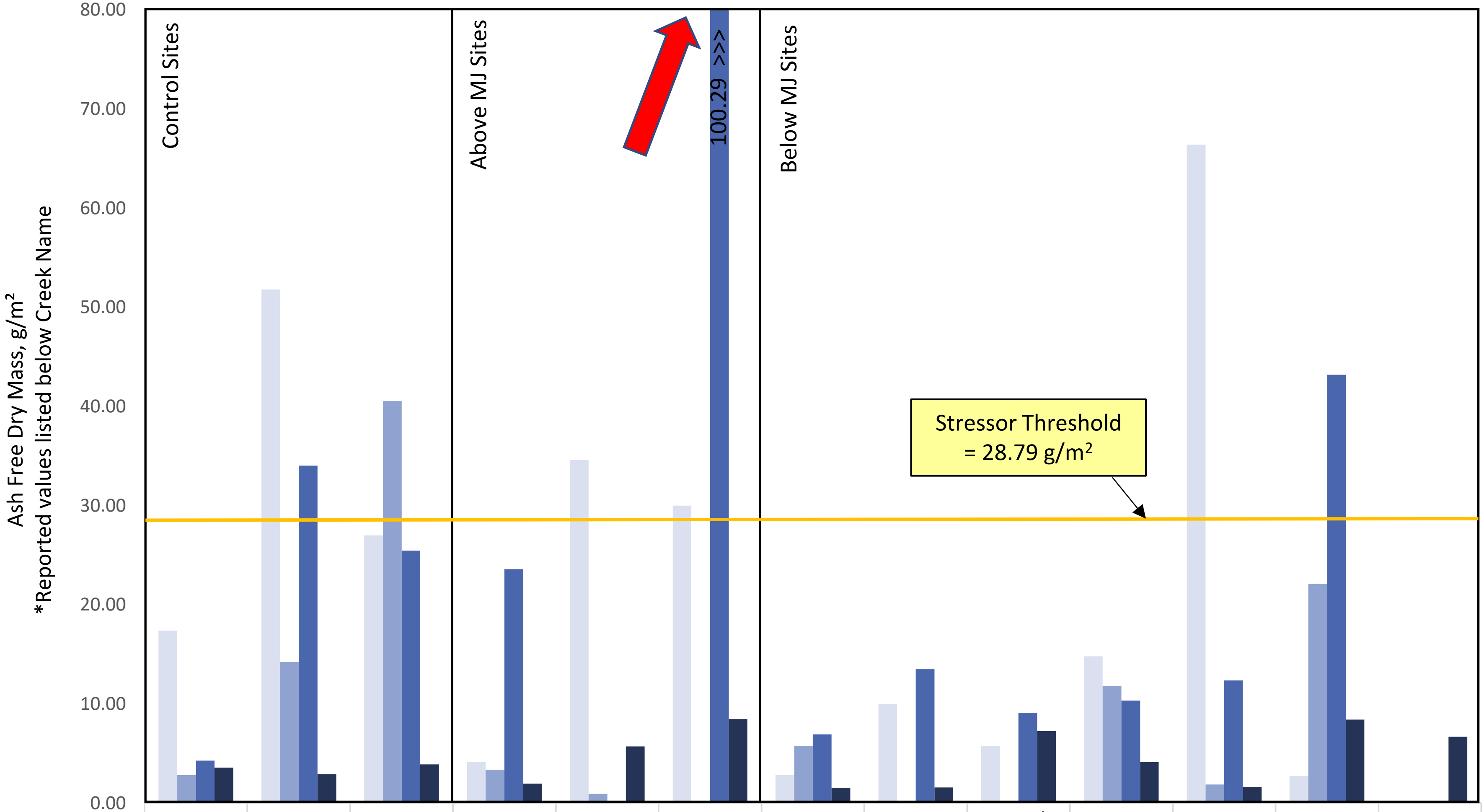

Dissolved O_2
Control
Above
Below
Dissolved O_2, mg/L
4
5
6
7
8
9
10
11
12
13
14

SWAMP Stressor Thresholds

- Surface Water Ambient Monitoring Program (SWAMP), a unifying program created in 2000 that coordinates all water quality monitoring conducted by the State and Regional Water Boards
- Nutrient criteria extrapolated from SWAMP surveys develop stressor thresholds for individual ecoregions.
- Below these stressor thresholds, 90% of surveyed sites were found to be in good biotic condition, per Ode et al. (2011).

Ecoregion	**Total N (mg/L)**	**Total P (mg/L)**	**AFDM (g/m^2)**	**Chlorophyll A (mg/m^2)**
Sierra Nevada	0.171	0.0335	28.79	34.09
Chaparral	0.446	0.143	13.64	25.0

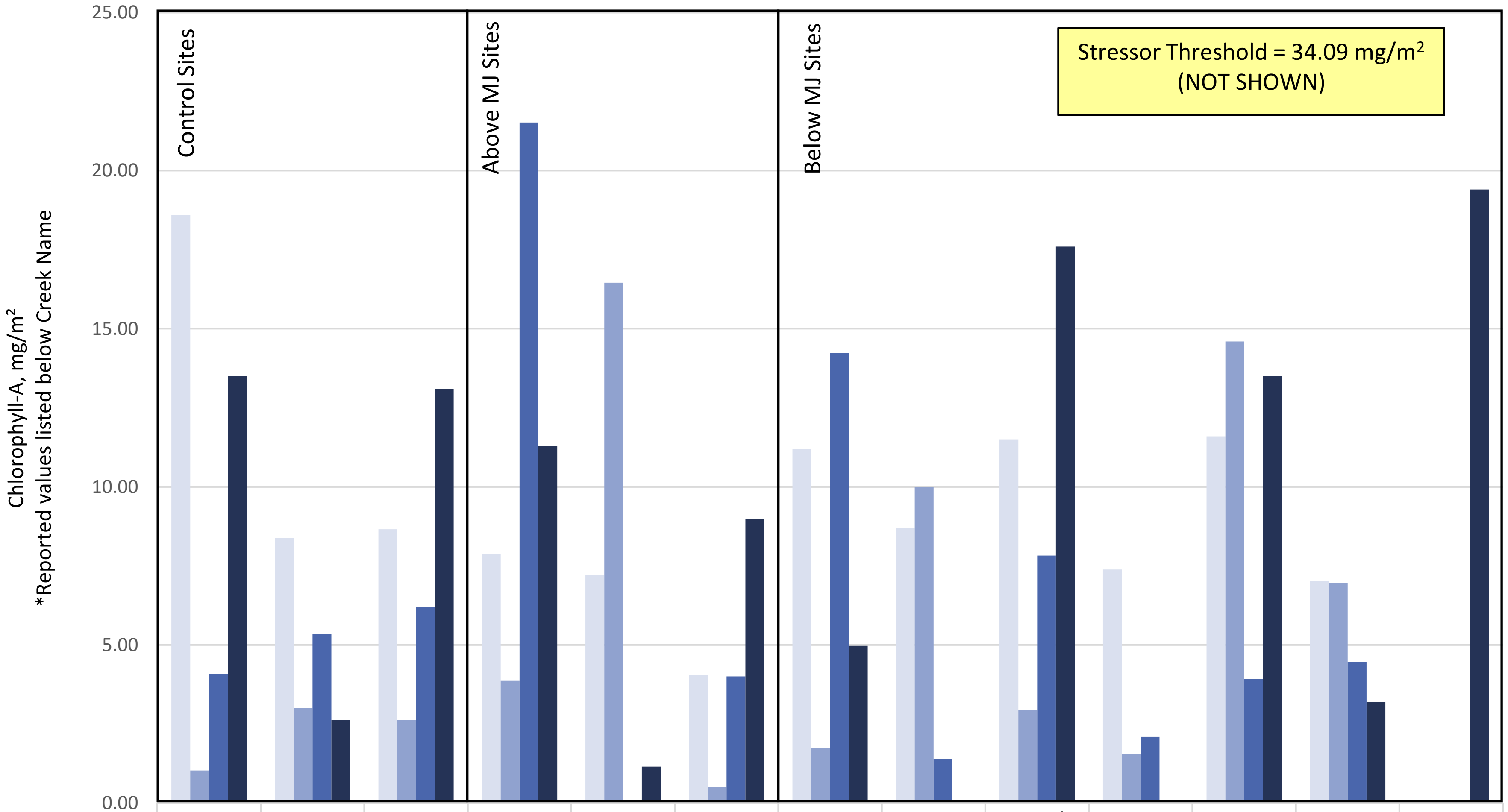
AFDM Year 1 & 2



Blank = No Sample
0 = Non-Detect

	Swamp Creek	Gurnsey Creek Trib	Carter Creek	Upper Deer Creek	Upper Potato Patch	NF Calf Creek	Lower Deer Creek	Alder	Round Valley Creek	Lower Potato Patch	Calf Creek	Beaver Creek	DCID Dam
Fall 2016	17.40	51.80	27.00	4.14	34.60	30.00	2.81	9.95	5.76	14.80	66.40	2.73	
Spring 2017	2.80	14.22	40.55	3.36	0.91		5.76			11.82	1.87	22.10	
Fall 2017	4.27	34.04	25.45	23.58		100.29	6.93	13.51	9.05	10.33	12.36	43.19	
Spring 2018	3.56	2.89	3.89	1.96	5.70	8.46	1.54	1.57	7.24	4.13	1.60	8.41	6.67

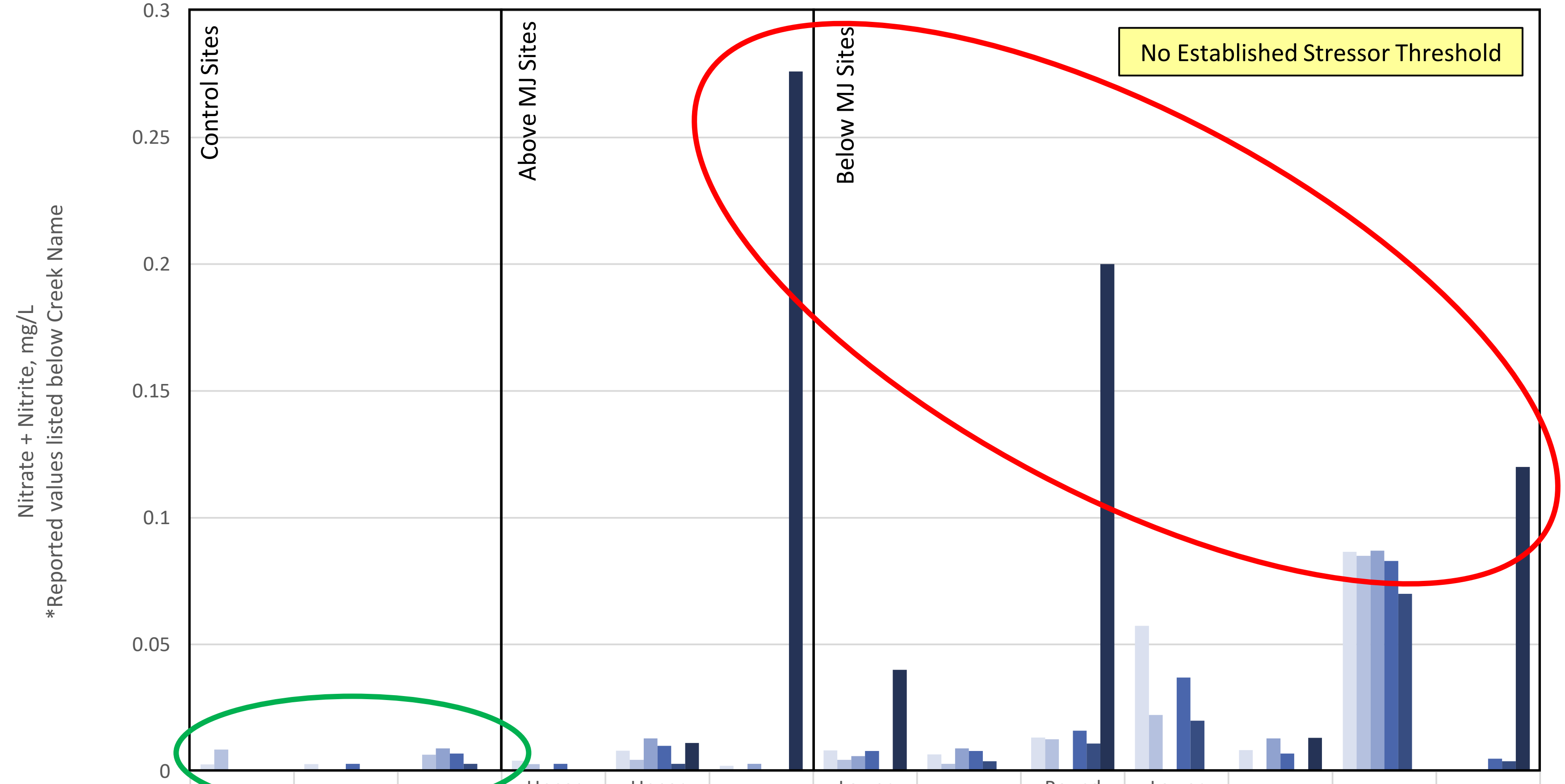
Chlorophyll-A Year 1 & 2



Blank = No Sample
0 = Non-Detect

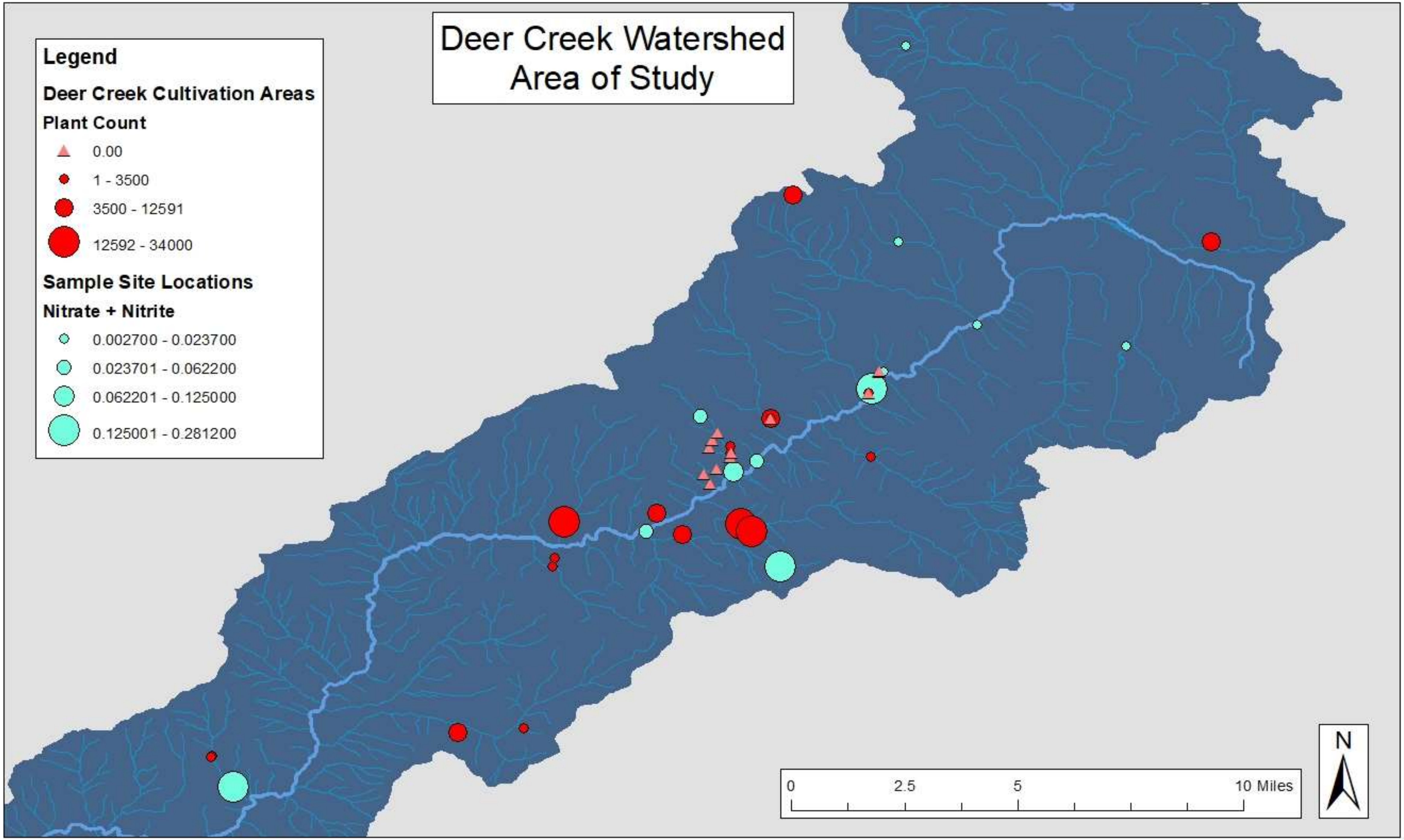
	Swamp Creek	Gurnsey Creek Trib	Carter Creek	Upper Deer Creek	Upper Potato Patch	NF Calf Creek	Lower Deer Creek	Alder	Round Valley Creek	Lower Potato Patch	Calf Creek	Beaver Creek	DCID Dam
Fall 2016	18.60	8.38	8.66	7.89	7.20	4.04	11.20	8.71	11.50	7.39	11.60	7.02	
Spring 2017	1.03	3.01	2.63	3.87	16.45	0.51	1.73	10.00	2.94	1.54	14.59	6.95	
Fall 2017	4.09	5.34	6.19	21.52		4.01	14.22	1.39	7.83	2.09	3.92	4.45	
Spring 2018	13.50	2.63	13.10	11.30	1.15	8.99	4.97	0.00	17.60	0.00	13.50	3.20	19.40

Nitrate + Nitrite Year 1 & 2

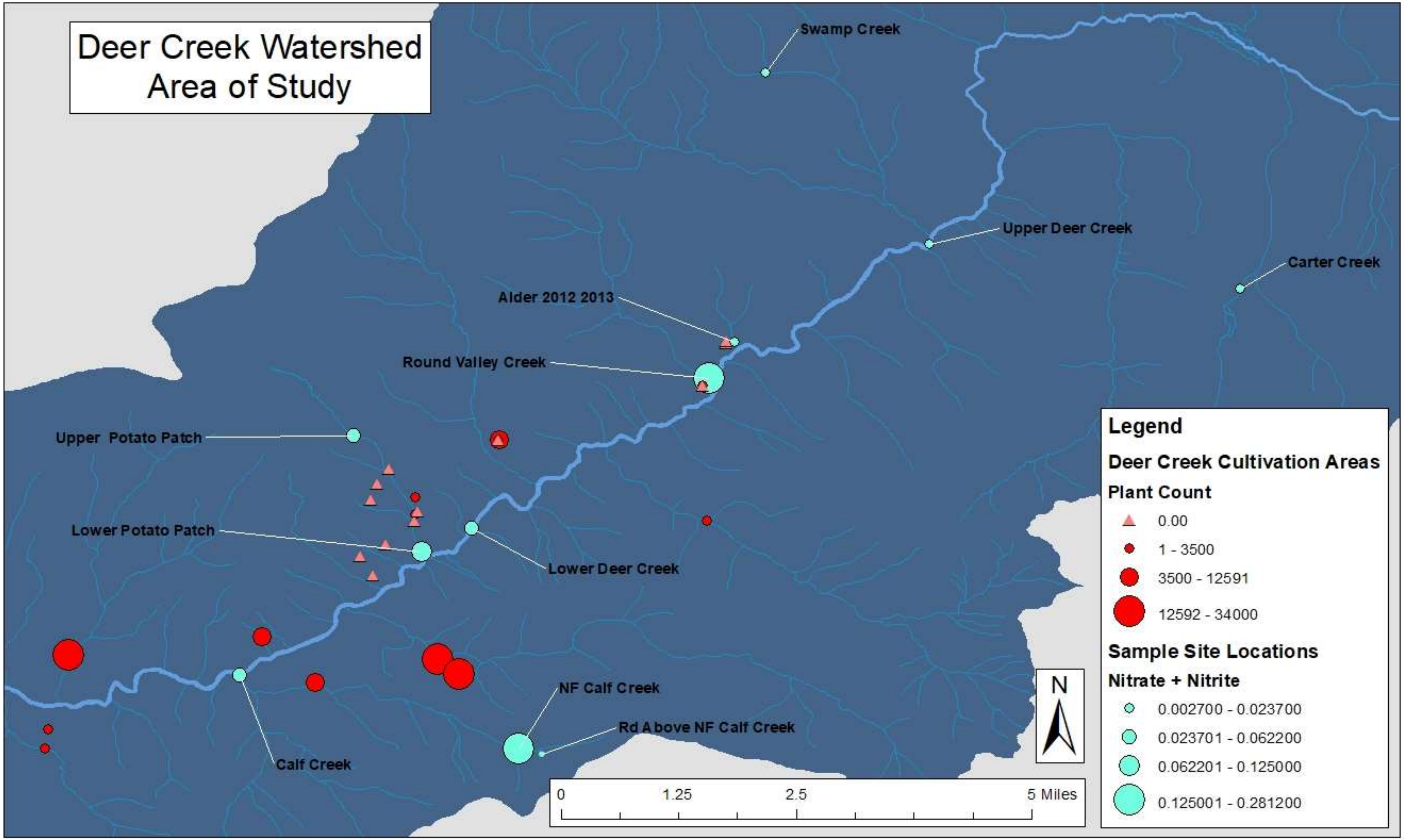


Blank = No Sample
0 = Non-Detect

	Swamp Creek	Gurnsey Creek Trib	Carter Creek	Upper Deer Creek	Upper Potato Patch	NF Calf Creek	Lower Deer Creek	Alder	Round Valley Creek	Lower Potato Patch	Calf Creek	Beaver Creek	DCID Dam
Fall 2016	0.0027	0.0028	0	0.0042	0.0081	0.0022	0.0082	0.0067	0.0133	0.0574	0.0083	0.0866	
Fall Post Storm 2016	0.0086	0	0.0066	0.0028	0.0045	0	0.0045	0.0029	0.0126	0.0222	0	0.0850	
Spring 2017	0	0	0.009	0	0.013	0.003	0.006	0.009	0	0	0.013	0.087	
Fall 2017	0	0.003	0.007	0.003	0.01	0	0.008	0.008	0.016	0.037	0.007	0.083	0.005
Fall 2017 Post Storm	0	0	0.003	0	0.003	0	0	0.004	0.011	0.02	0	0.07	0.004
Spring 2018	0	0	0	0	0.0112	0.276	0.04	0	0.2	0	0.0132	0	0.12

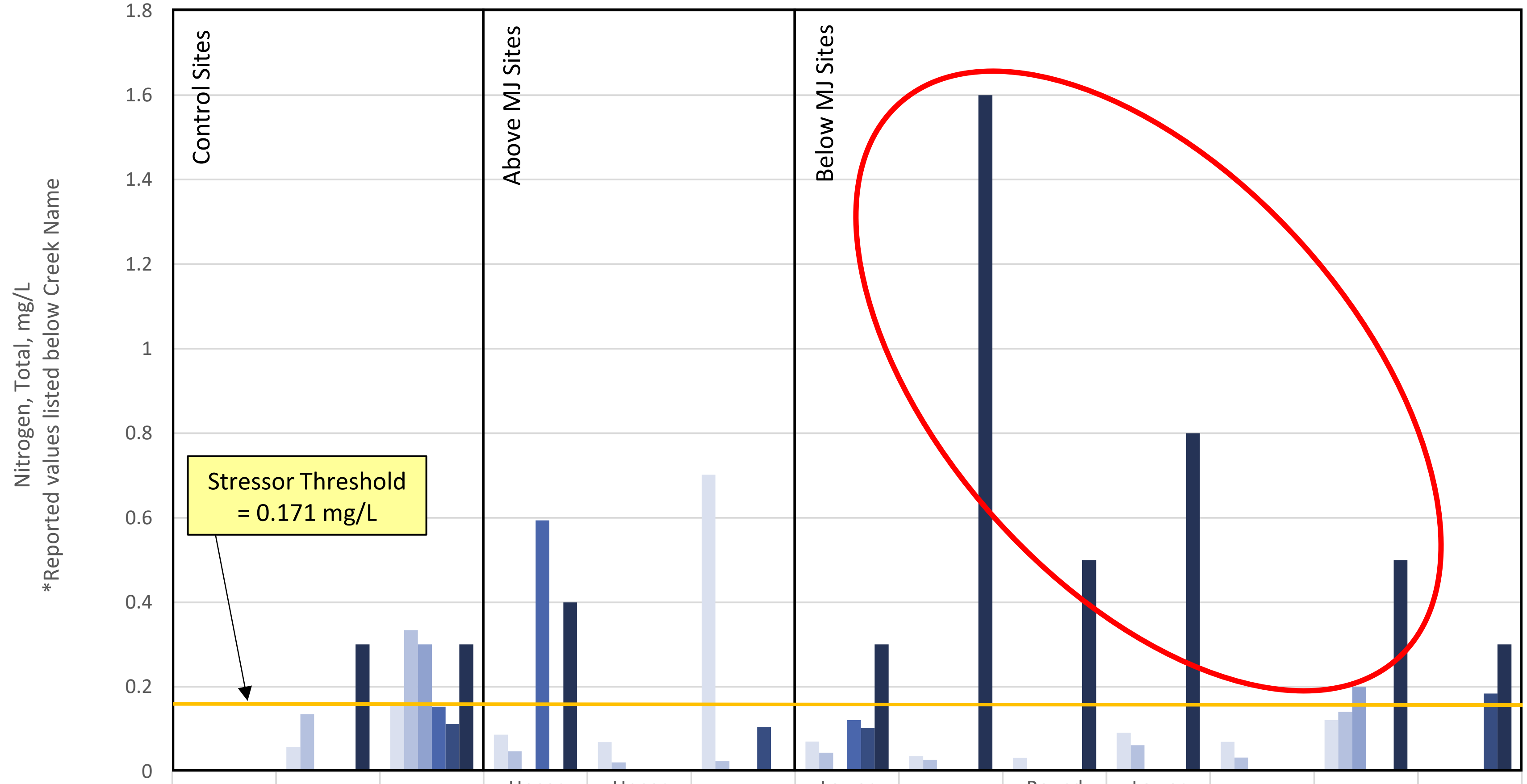


Deer Creek Watershed
Area of Study
Legend
Deer Creek Cultivation Areas
Plant Count
0.00
1 - 3500
3500 - 12591
12592 - 34000
Sample Site Locations
Nitrate + Nitrite
0.002700 - 0.023700
0.023701 - 0.062200
0.062201 - 0.125000
0.125001 - 0.281200
0
2.5
5
10 Miles
N



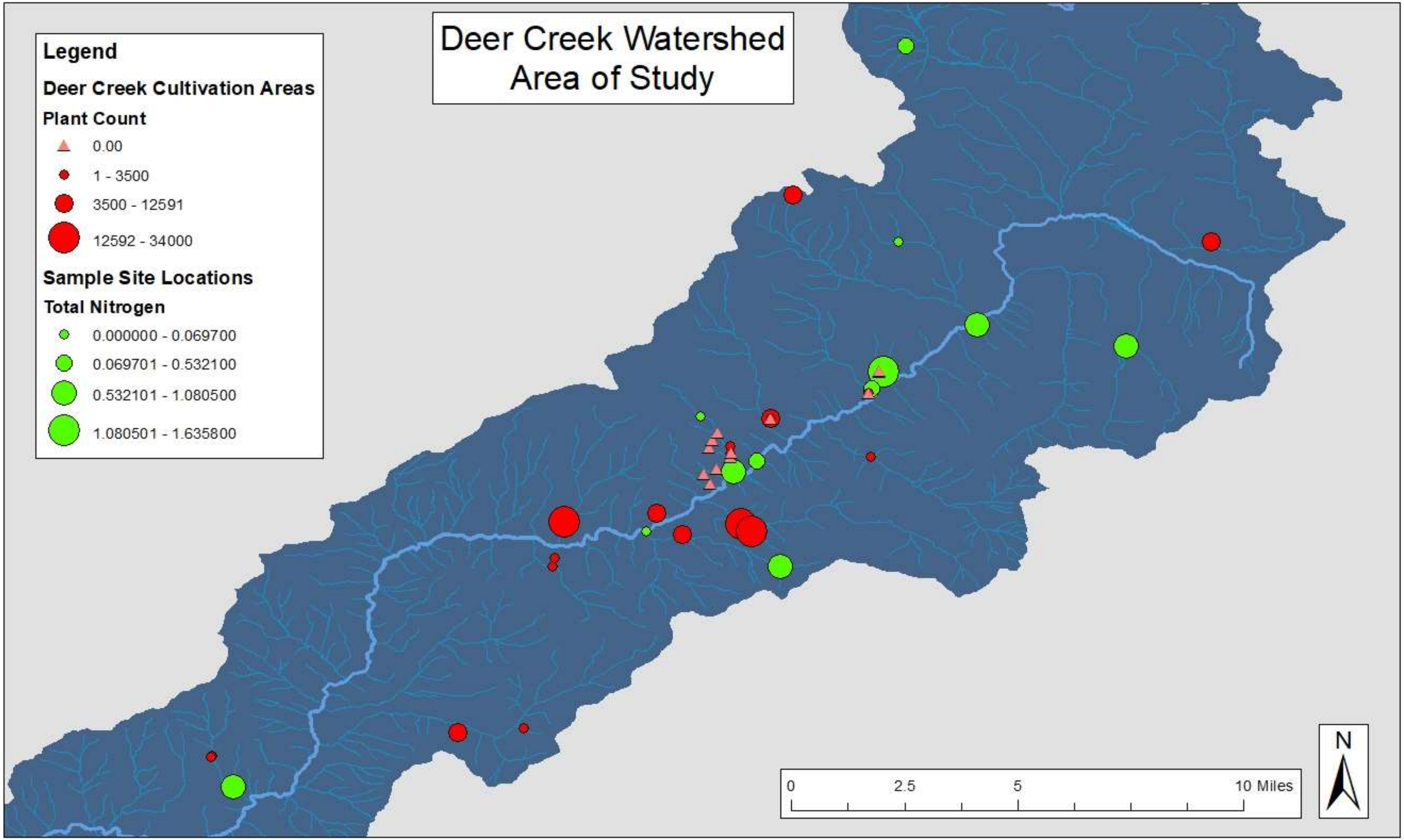
Deer Creek Watershed
Area of Study
Swamp Creek
Upper Deer Creek
Carter Creek
Alder 2012 2013
Round Valley Creek
Upper Potato Patch
Lower Potato Patch
Lower Deer Creek
NF Calf Creek
Rd Above NF Calf Creek
Calf Creek
Legend
Deer Creek Cultivation Areas
Plant Count
0.00
1 - 3500
3500 - 12591
12592 - 34000
Sample Site Locations
Nitrate + Nitrite
0.002700 - 0.023700
0.023701 - 0.062200
0.062201 - 0.125000
0.125001 - 0.281200
N
0
1.25
2.5
5 Miles

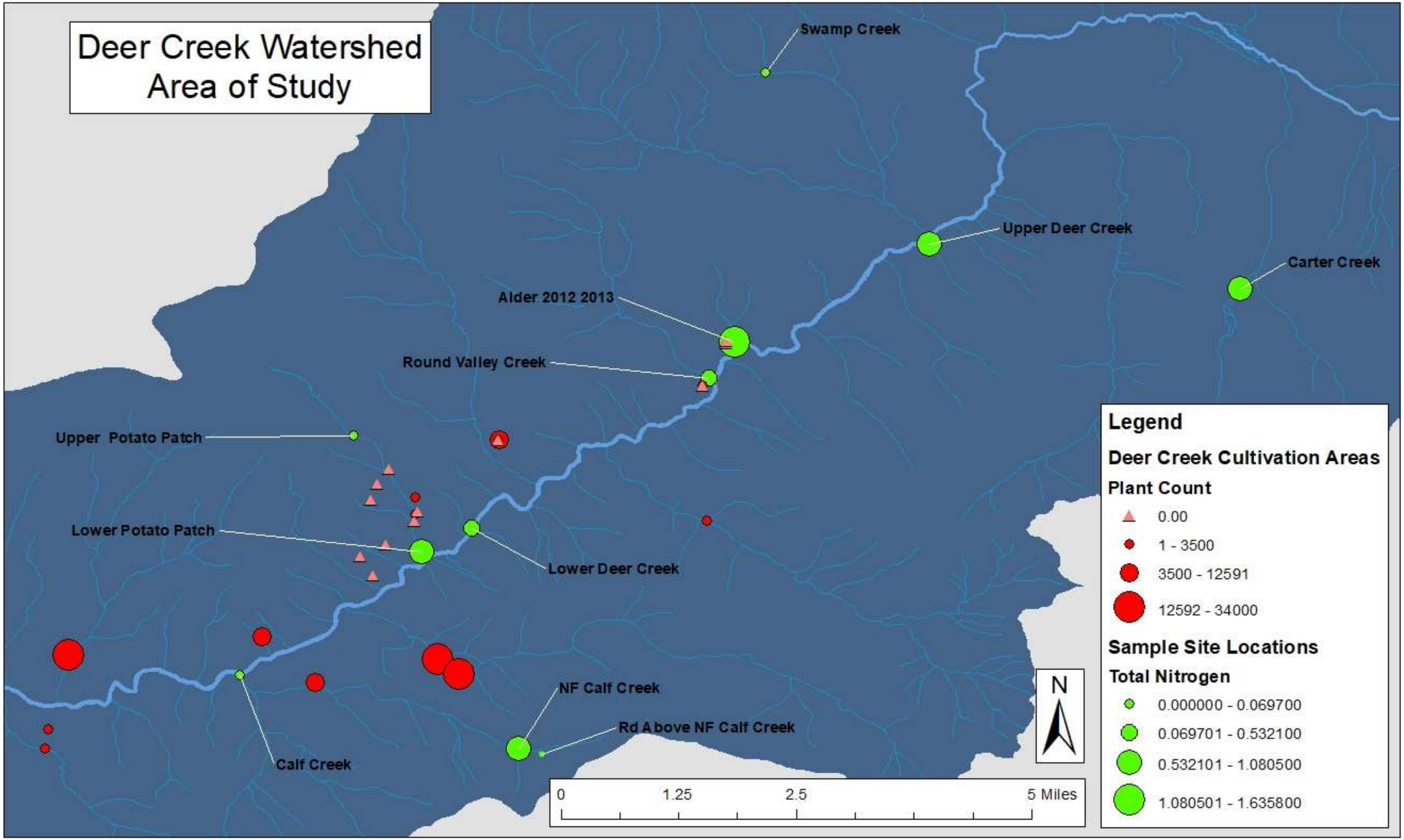
Total Nitrogen Year 1 & 2



Blank = No Sample
0 = Non-Detect

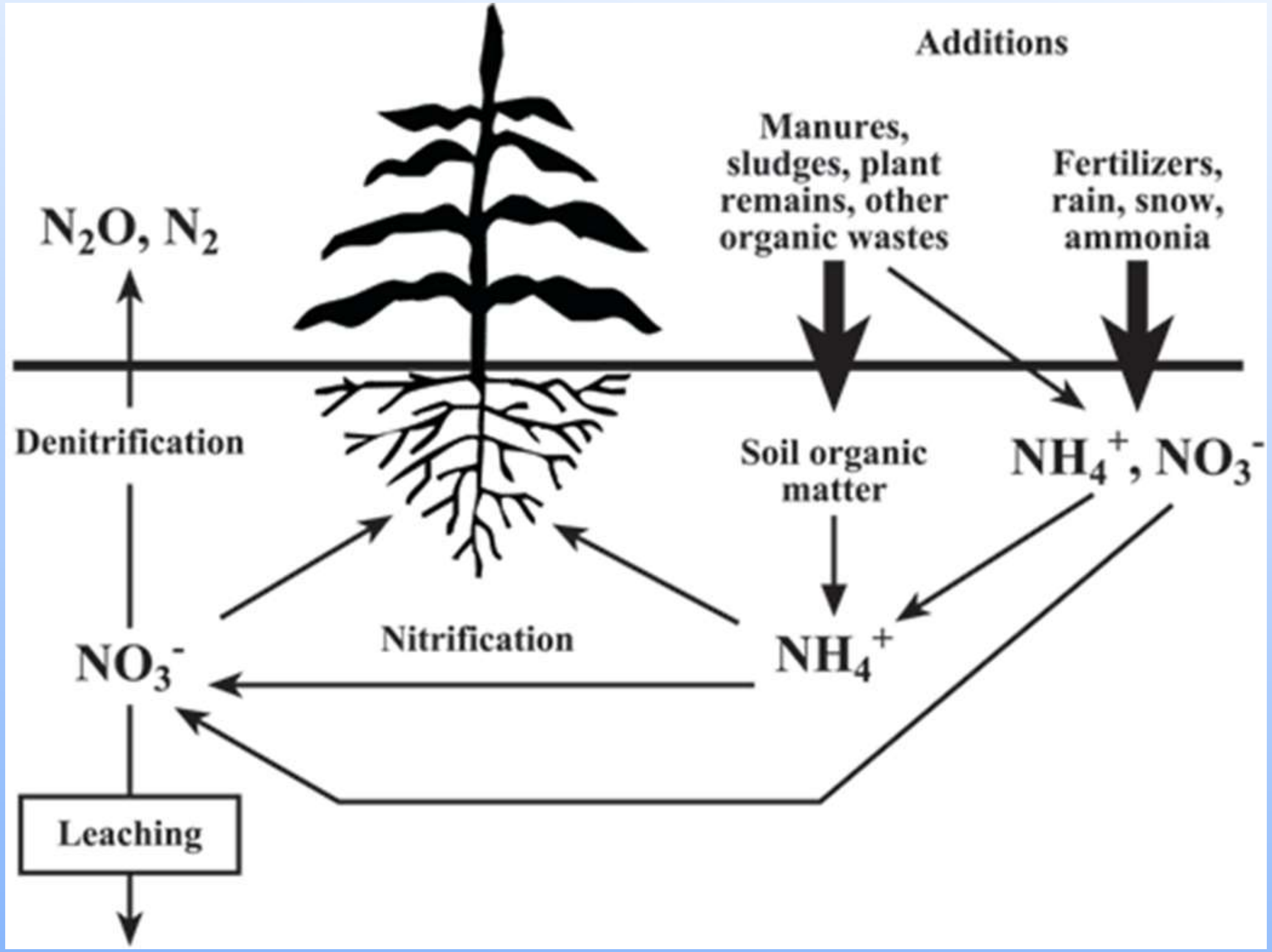
	Swamp Creek	Gurnsey Creek Trib	Carter Creek	Upper Deer Creek	Upper Potato Patch	NF Calf Creek	Lower Deer Creek	Alder	Round Valley Creek	Lower Potato Patch	Calf Creek	Beaver Creek	DCID Dam
Fall 2016	0	0.0575	0.156	0.0865	0.0688	0.702	0.0704	0.0358	0.0321	0.0915	0.0697	0.121	
Fall Post Storm 2016	0	0.135	0.334	0.0472	0.0209	0.0238	0.044	0.0269	0	0.0618	0.0323	0.141	
Spring 2017	0	0	0.3	0	0	0	0	0	0	0	0	0.2	
Fall 2017	0	0	0.153	0.594	0	0	0.121	0	0	0	0	0	0
Fall Post Storm 2017	0	0	0.112	0	0	0.105	0.103	0	0	0	0	0	0.184
Spring 2018	0	0.3	0.3	0.4	0	0	0.3	1.6	0.5	0.8	0	0.5	0.3


Deer Creek Watershed
Area of Study
Legend
Deer Creek Cultivation Areas
Plant Count
0.00
1 - 3500
3500 - 12591
12592 - 34000
Sample Site Locations
Total Nitrogen
0.000000 - 0.069700
0.069701 - 0.532100
0.532101 - 1.080500
1.080501 - 1.635800
0
2.5
5
10 Miles
N



Deer Creek Watershed Area of Study
Swamp Creek
Upper Deer Creek
Carter Creek
Alder 2012 2013
Round Valley Creek
Upper Potato Patch
Lower Potato Patch
Lower Deer Creek
NF Calf Creek
Rd Above NF Calf Creek
Calf Creek
0
1.25
2.5
5 Miles
N
Legend
Deer Creek Cultivation Areas
Plant Count
0.00
1 - 3500
3500 - 12591
12592 - 34000
Sample Site Locations
Total Nitrogen
0.000000 - 0.069700
0.069701 - 0.532100
0.532101 - 1.080500
1.080501 - 1.635800

Nitrogen Cycle



What do we know about Nitrogen used at grows?

TABLE 1. SOME COMMON FORMS OF NITROGEN FERTILIZER

Fertilizer Form	Nitrogen Form				
	Nitrate	Ammonium	Urea	Combination	Organic (1)
Dry	calcium nitrate (15.5-0-0-19(Ca)) (available as solution grade)	ammonium sulfate (21-0-0-24(S)), ammonium phosphate (11-52-0)	urea (46-0-0)	CAN-27	sodium nitrate (mined, 16-0-0)), fish meal, blood meal, bone meal, horn & hoof meal, guano & other manures
Liquid	calcium nitrate (CN-9 (9-0-0-11(Ca))	ammonium thiosulfate (12-0-0-26(S)), ammonium polyphosphate (10-34-0)	NA	CAN-17, UAN-32	fish solubles, hydrolized soy whey
Foliar	potassium nitrate (14-0-46)	NA	low biuret urea (45-0-0)	NA	fish solubles, hydrolized soy whey

1. This list of organic fertilizers containing nitrogen is not comprehensive.

- Most retail nitrogenous fertilizers use <u>calcium nitrate</u>
- Miracle Grow has ammonium phosphate
- Plants can take up both ammonia (NH_4) and nitrate (NO_3)

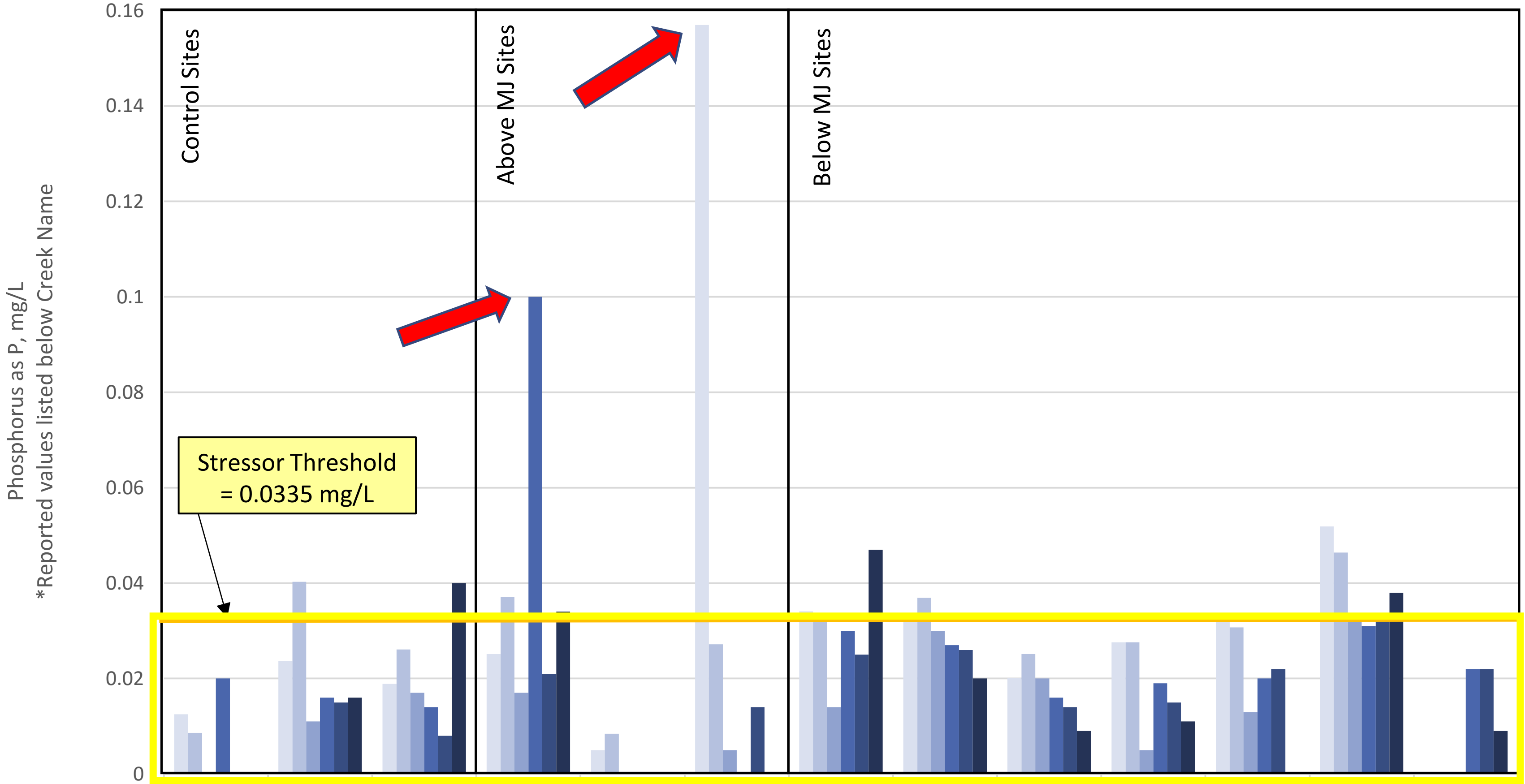
What forms of Nitrogen are we testing for?

- Nitrate plus Nitrite = Nitrate (NO3) + Nitrite (NO2)

- Total Nitrogen = Nitrate (NO3) + Nitrite (NO2) + Ammonia (NH3) + Ammonium (NH4)

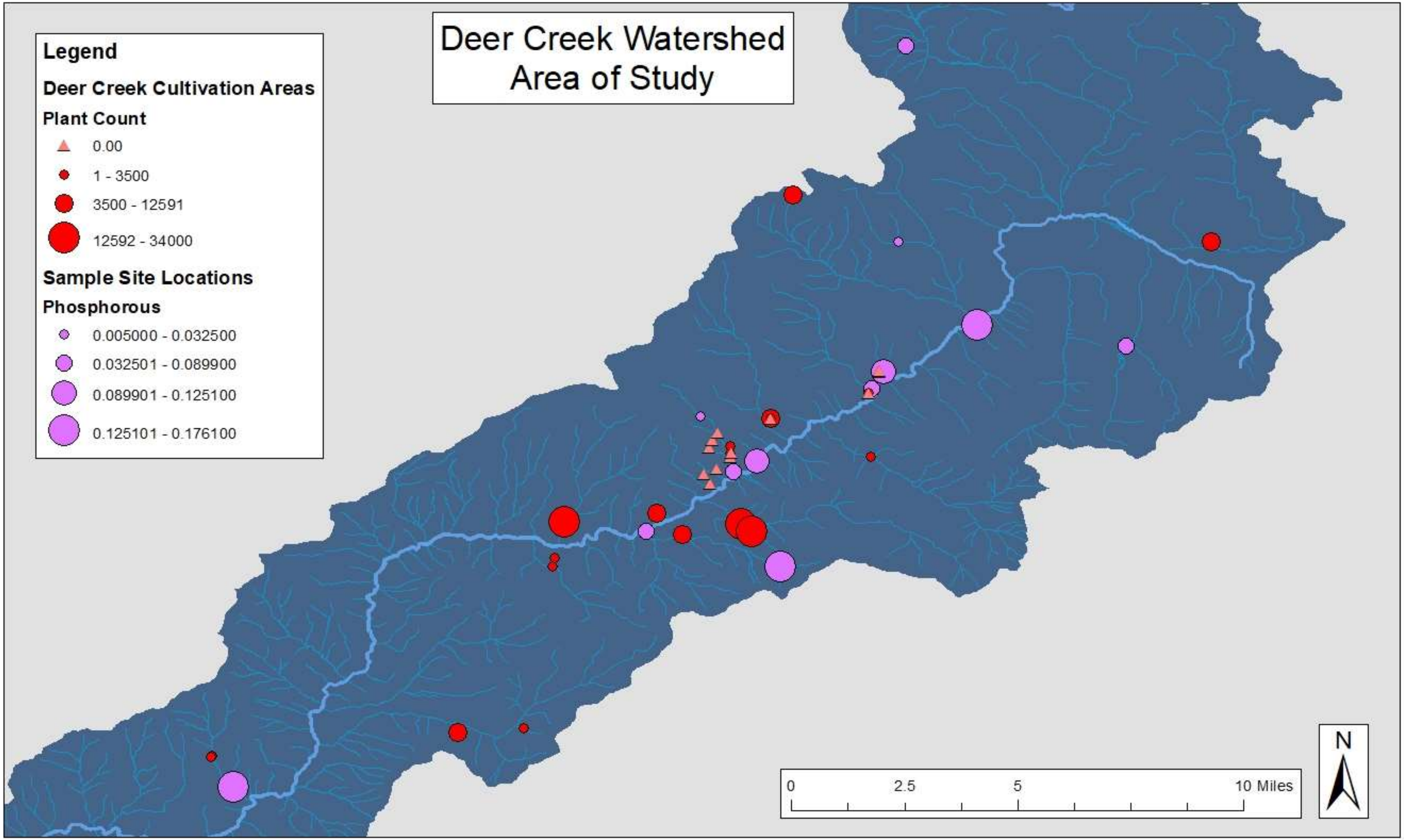
- What about Total Kjeldahl Nitrogen?
  =Ammonia (NH3) + Ammonium (NH4)

Phosphorus Year 1 & 2

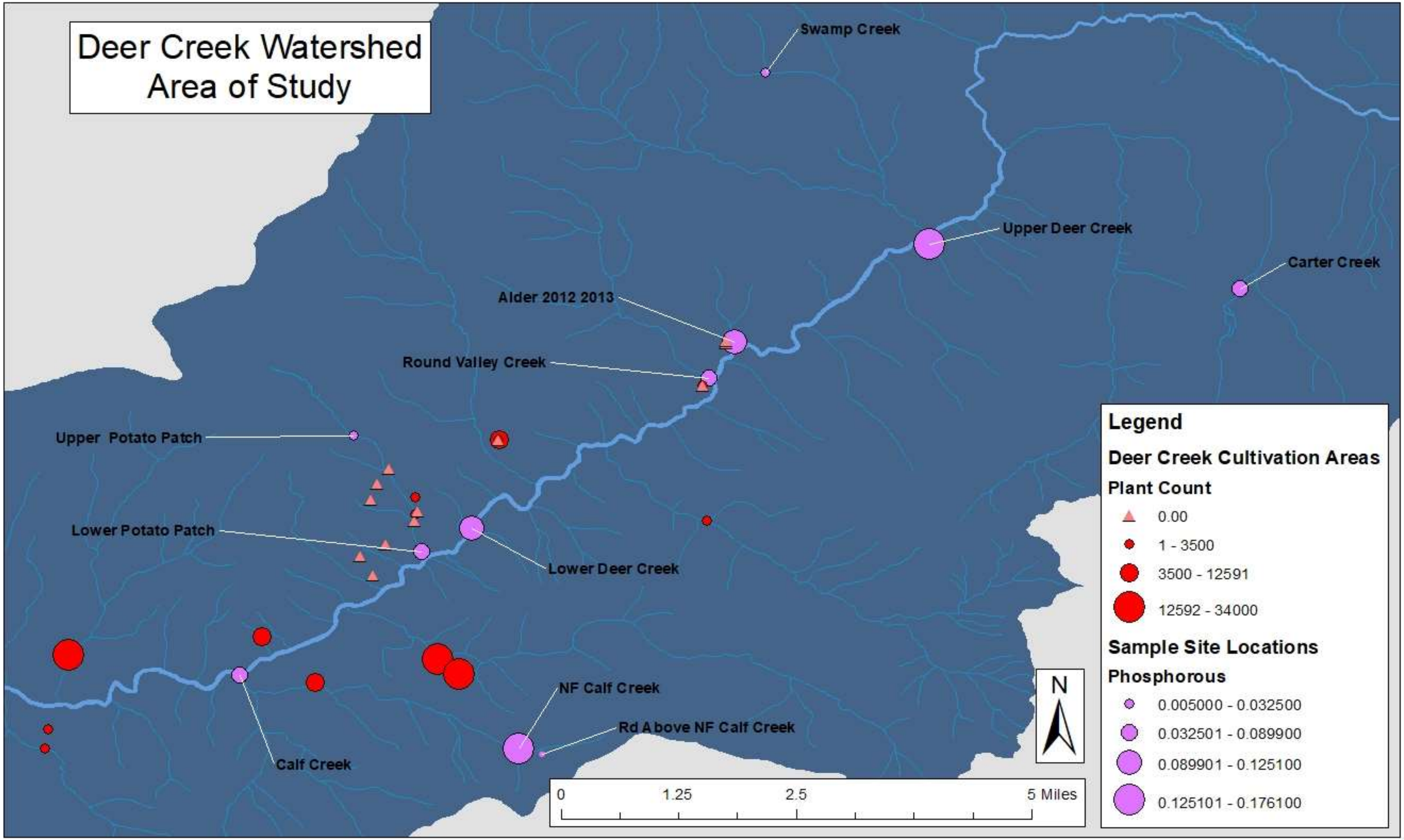


Blank = No Sample
0 = Non-Detect

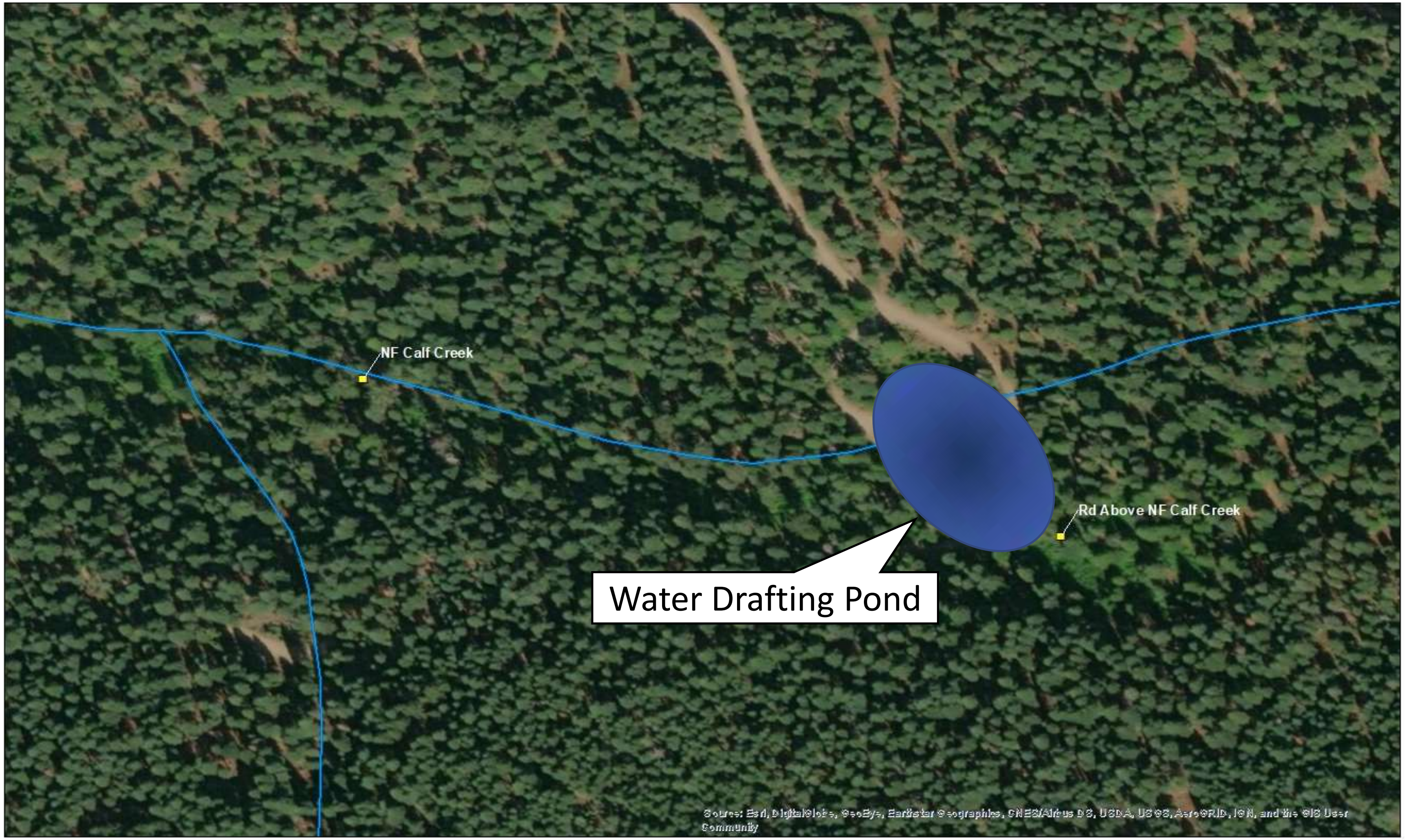
	Swamp Creek	Gurnsey Creek Trib	Carter Creek	Upper Deer Creek	Upper Potato Patch	NF Calf Creek	Lower Deer Creek	Alder	Round Valley Creek	Lower Potato Patch	Calf Creek	Beaver Creek	DCID Dam
Fall 2016	0.0125	0.0237	0.0189	0.0251	0.005	0.157	0.0341	0.0321	0.0201	0.0276	0.033	0.0519	
Fall Post Storm 2016	0.0086	0.0403	0.0261	0.0371	0.0084	0.0272	0.0335	0.0369	0.0251	0.0276	0.0307	0.0464	
Spring 2017	0	0.011	0.017	0.017	0	0.005	0.014	0.030	0.020	0.005	0.013	0.033	
Fall 2017	0.02	0.016	0.014	0.1	0	0	0.03	0.027	0.016	0.019	0.02	0.031	0.022
Fall Post Storm 2017	0	0.015	0.008	0.021	0	0.014	0.025	0.026	0.014	0.015	0.022	0.032	0.022
Spring 2018	0	0.016	0.04	0.034	0	0	0.047	0.02	0.009	0.011	0	0.038	0.009



Deer Creek Watershed
Area of Study
Legend
Deer Creek Cultivation Areas
Plant Count
0.00
1 - 3500
3500 - 12591
12592 - 34000
Sample Site Locations
Phosphorous
0.005000 - 0.032500
0.032501 - 0.089900
0.089901 - 0.125100
0.125101 - 0.176100
0
2.5
5
10 Miles
N

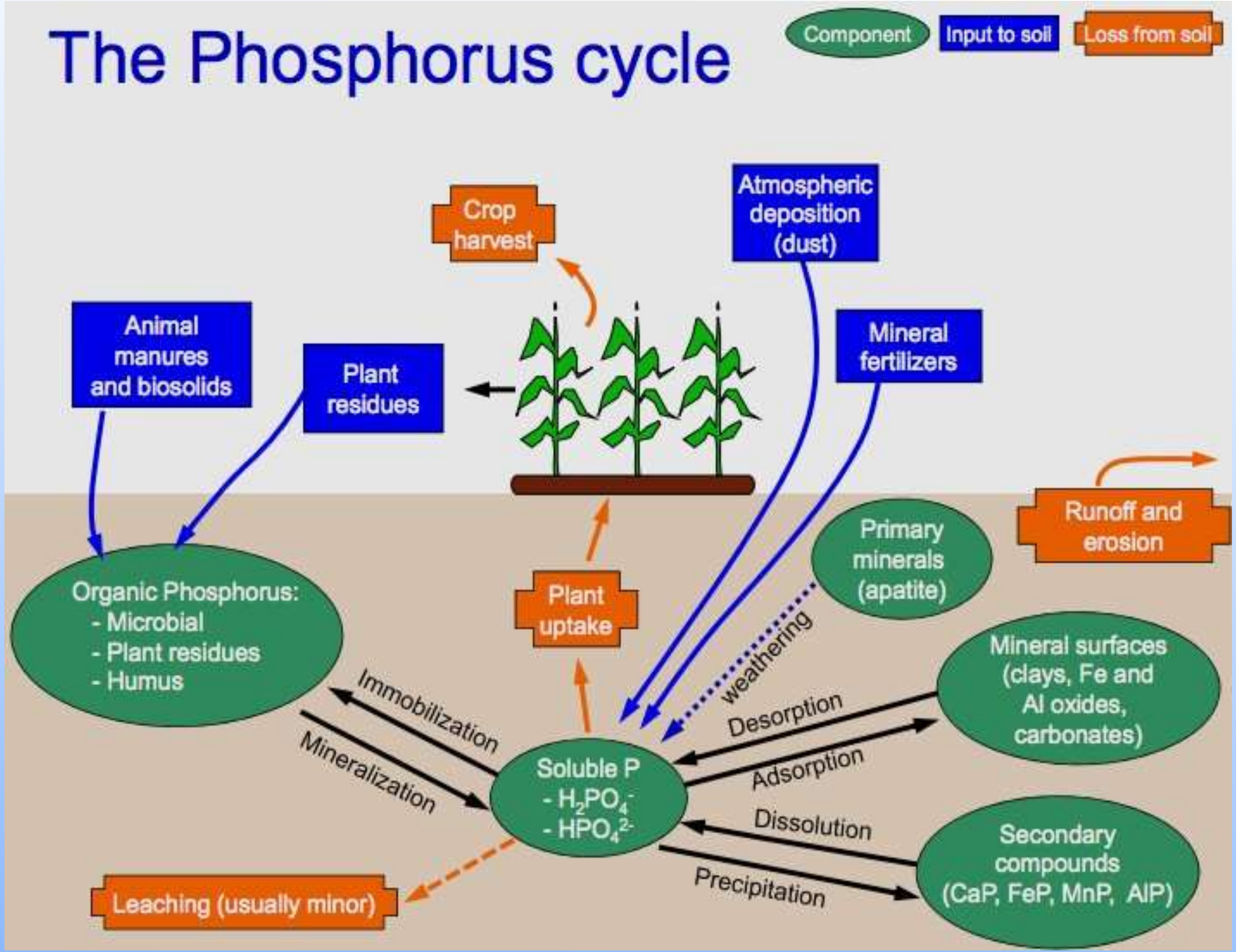

Deer Creek Watershed
Area of Study
Swamp Creek
Upper Deer Creek
Carter Creek
Alder 2012 2013
Round Valley Creek
Upper Potato Patch
Lower Potato Patch
Lower Deer Creek
NF Calf Creek
Rd Above NF Calf Creek
Calf Creek
0
1.25
2.5
5 Miles
N
Legend
Deer Creek Cultivation Areas
Plant Count
0.00
1 - 3500
3500 - 12591
12592 - 34000
Sample Site Locations
Phosphorous
0.005000 - 0.032500
0.032501 - 0.089900
0.089901 - 0.125100
0.125101 - 0.176100

Phosphorous



Phosphorous

- Volcanic soils can contribute
- Levels can increase in acidic environments (e.g. decomposing organics)
- Typically holds onto clays in soil and doesn't transport well, thus localized effects
- In streams, has annual maxima in summer and biannual minima in autumn and spring, Mulholland and Hill (1997).



More Statistics

- High level Omnibus Test to look at likelihood ratio, using an adjusted mean (Tukey method), and a 95% C.I. ($P < 0.05$). A very robust, exploratory tool.
- Does location (Control, Above, Below) have an effect on any of the variables?
- Only showed significance relative to temperature, as expected.
- Not enough evidence to indicate that location has an effect on other variables.
- Statistically speaking: INCONCLUSIVE
- Need more sites! (Go from 12 to 24)

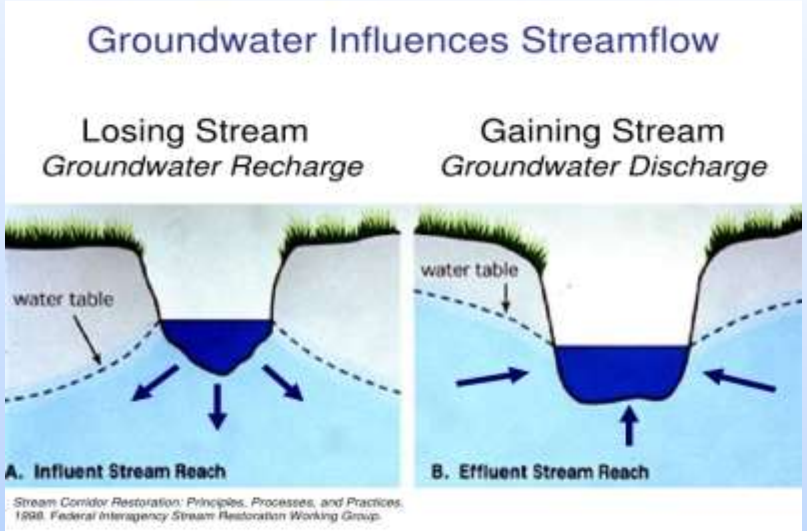
Hypothesis:

- Input of water quality-related contaminants from marijuana grows is directly and/or indirectly contributing to a decl n anadromous fish habitat quality, thereby negatively affecting ous fish.
    - The observed condition of water quality, in t quality, and the resulting ecological outcomes can be related to d land management practices, and the impact of marijuana-cultivat s can be distinguished from other land management practices.
- The techniques used in the e effects of marijuana cultivation on anadromous fish can pr ns by which impacts can be assessed.
- The impacts from a l arijuana cultivation and of individual marijuana grows on ana mous fish watersheds are measurable and distinguishable relative to other land use practices

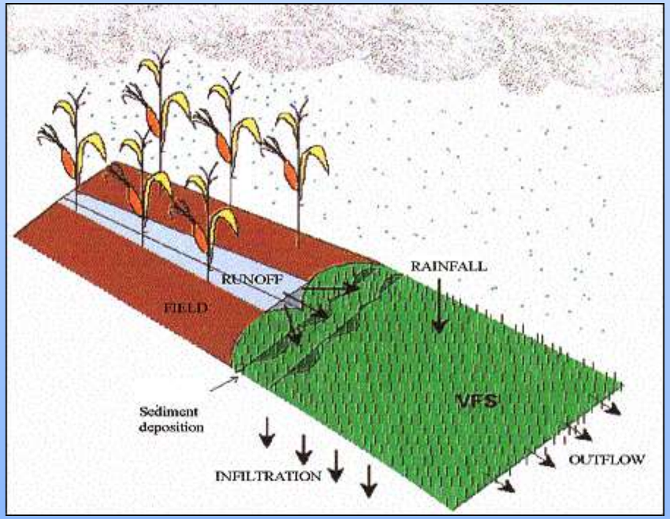
INCONCLUSIVE

Confounding Factors

- Losing vs Gaining Stream
  - Could be different depending on reach
  - Can dig test pits along sides of stream to quantify



- Vegetative Filter Strips/Buffer Strip
  - Reduces discharge of nutrients and pesticides to surface water
  - Effective width of only a few meters, Lerch et. Al. (2017).
  - Dense along riparian corridors



Confounding Factors

- Wildfires
- Anthropogenic effects
  - Commercial timber harvesting
  - Grazing activities
  - Road use
- Time for groundwater to percolate down and enter stream, carrying nutrients/pesticides
  - Could be only 20 feet a year?
  - A grow 300 feet away from the creek would take 15 years to transport
  - Forest trees and vegetation would take up nutrients by then
  - Pesticides break down / bind to soil

Lessons Learned

- Don’t lose your glasses in the field
- Small sample size
- Scale down, narrow focus
- Pesticides could have attached to organics which were removed at the lab prior to testing POCIS
- Lack of negative polarity pesticide collection methodology
- Methodology doesn’t account for interactions of temp/DO/etc.
- Is physical habitat or AFDM/Chlorophyll-A needed?
- Determining instream impacts is difficult
- Non-Point source issues


Where do we go from here?

Where do we go from here?

- More sampling: Frequency, Duration, Number of Sites!
- Type of sampling: More focus towards nutrients and pesticides
- Even more stats!!!
- Begin to quantify distance from upstream grows to surface water
- Consistency with plant counts, and measure area disturbed
- Test for specific constituent when toxic sediment sample found
- Fertilizer pellets often coated in Sulphur, so could test for that

Where do we go from here?

- Continuous in stream sampling with different methodology
- Sample at the cultivation area FIRST… get soil samples to know what you're looking for! THEN do stream stuff.
- Systematic testing along each river mile of Deer Creek
- Put POCIS at confluence of tributaries and Deer Creek
- Test for negative polarity pesticides (POCIS vs Chem Catcher?)
- How to account for unknown grows?

References

- https://pubs.usgs.gov/mf/1983/1340c/report.pdf
- https://pubs.usgs.gov/of/2012/1228/of2012-1228_pamphlet.pdf
- Ode, P.R, T.M. Kincaid, T. Fleming and A.C. Rehn. 2011. Ecological Condition Assessments of California's Perennial Wadeable Streams: Highlights from the Surface Water Ambient Monitoring Program's Perennial Streams Assessment (PSA) (2000-2007). A collaboration between the State Water Resources Control Board's Non-Point Source Pollution Control Program (NPS Program), Surface Water Ambient Monitoring Program (SWAMP), California Department of Fish and Game Aquatic Bioassessment Laboratory, and the U.S. Environmental Protection Agency.
- Mulholland, P. J., and Hill, W. R. (1997), Seasonal patterns in streamwater nutrient and dissolved organic carbon concentrations: Separating catchment flow path and in-stream effects, Water Resour. Res., 33(6), 1297– 1306, doi:10.1029/97WR00490.
- Lerch, R.N., Lin, C.H., Goyne, K.W., Kremer, R.J., and Anderson, S.H., 2017. Vegetative Buffer Strips for Reducing Herbicide Transport in Runoff: Effects of Buffer Width, Vegetation, and Season. Journal of the American Water Resources Association (JAWRA) 53(3): 667– 683. DOI: 10.1111/1752-1688.12526

Questions?

Cannabis Policy and the Continuing Development of Minimum Instream Flows

SALMONID RESTORATION FEDERATION ANNUAL CONFERENCE 2019

CALIFORNIA Water Boards
STATE WATER RESOURCES CONTROL BOARD
REGIONAL WATER QUALITY CONTROL BOARDS

PETER BARNES
Cannabis Instream Flows Unit
State Water Resources Control Board

Presentation Outline

- Brief Overview of Cannabis Policy
- Recent Updates to the Cannabis Policy
- Cannabis Policy Instream Flow Requirements and Online Compliance Tools
- Development of Long Term Principles and Guidelines

Overview of Cannabis Cultivation Policy

State Water Board Responsibilities

Ensure individual and cumulative effects of water diversion and discharge associated with cannabis cultivation do not affect instream flows needed for fish spawning, migration, and rearing, and flows needed to maintain natural flow variability

Business and Professions Code Section 26060.1(b)(1)

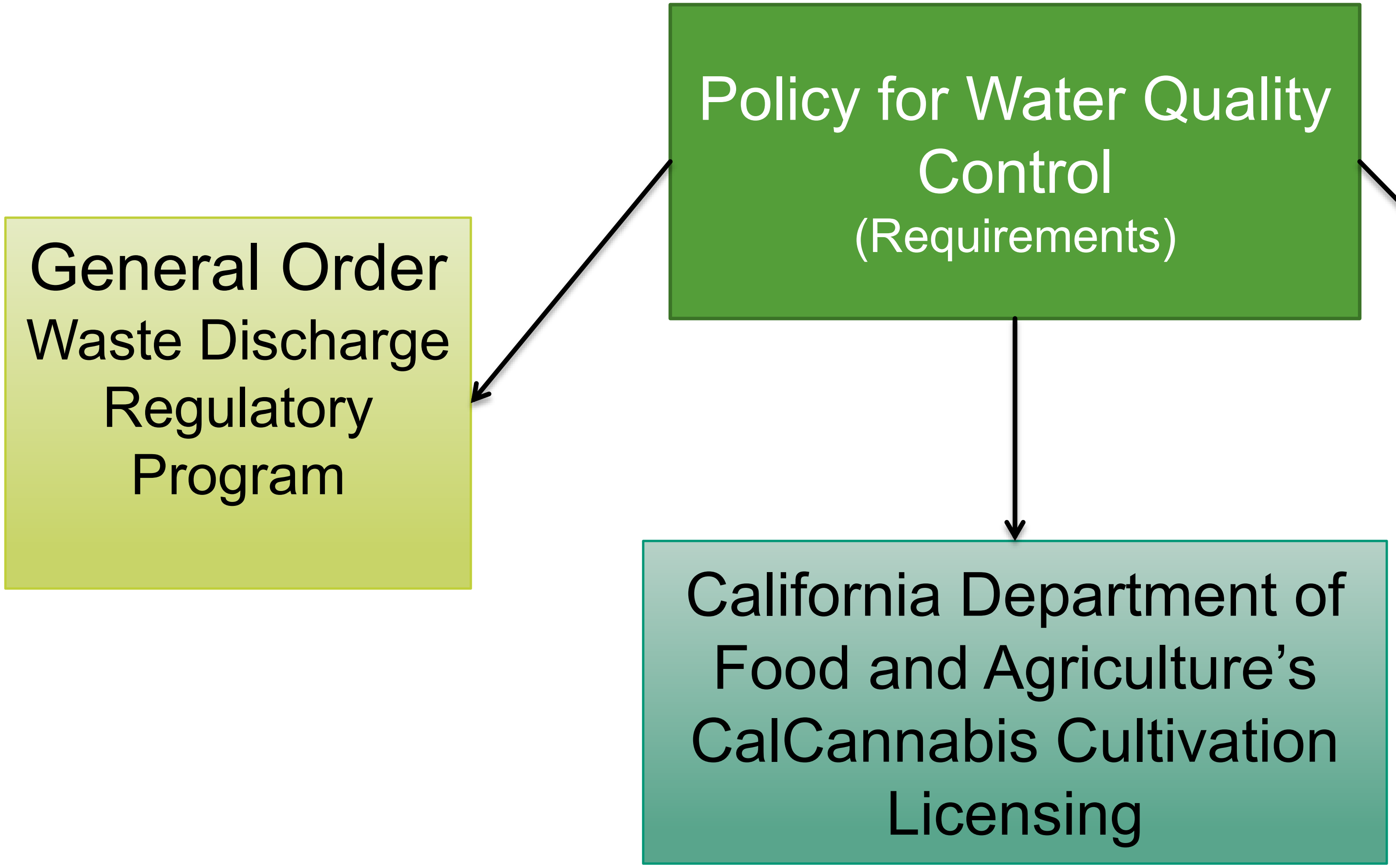


State Water Board Responsibilities
(continued)

- Develop policy for water quality control to establish principles and guidelines (requirements) for cannabis cultivation:
  - Shall include measures to protect springs, wetlands, and aquatic habitat from negative impacts of cannabis cultivation
  - May include requirements for groundwater extractions

Water Code Section 13149(a)(1)(A)

Cannabis Policy Regulatory Flow



Cannabis Cultivation Policy - Principles and Guidelines for Cannabis Cultivation

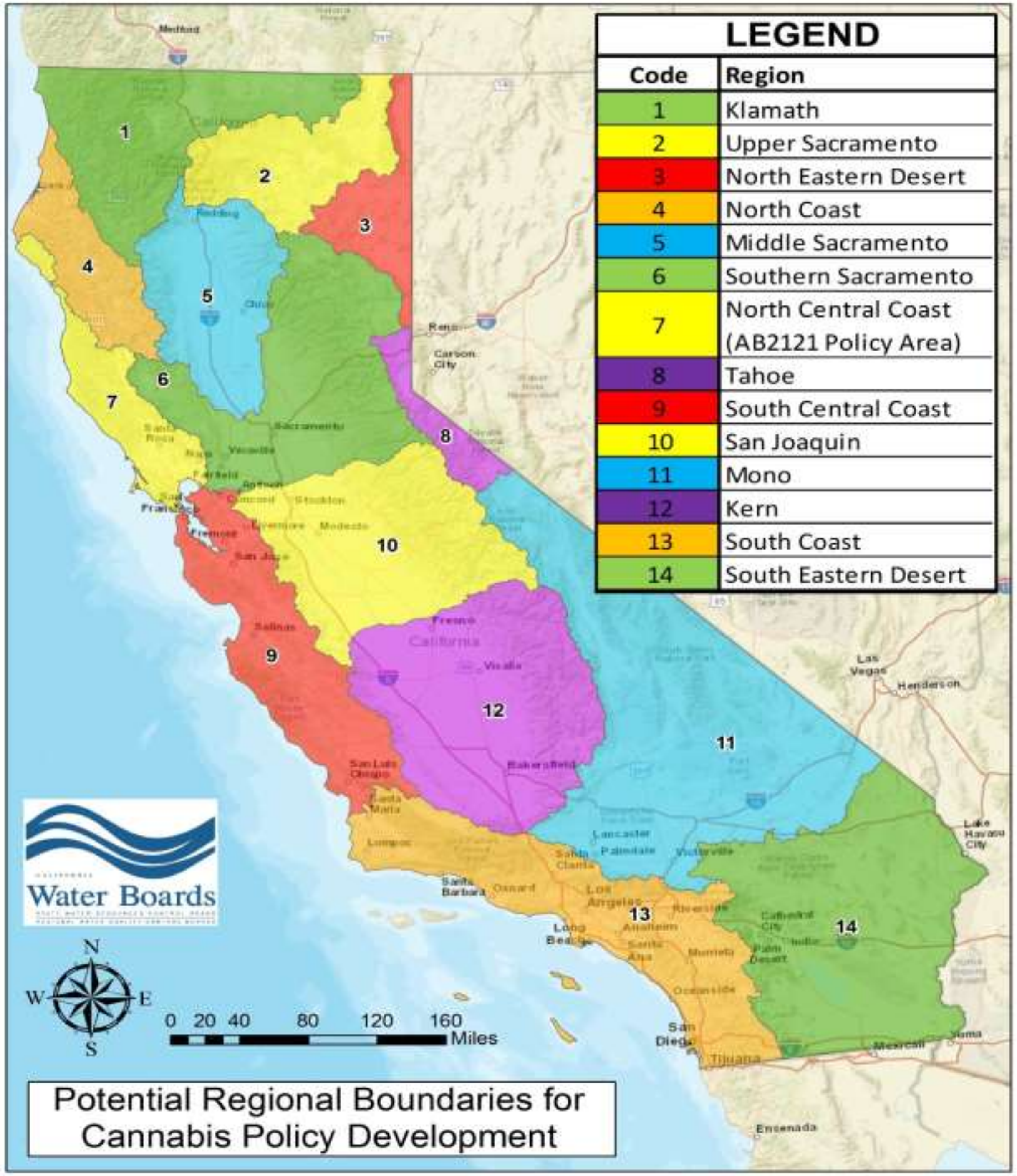
Main Document

- Provides overview of Water Boards' program and context for how it fits with other regulatory programs
- Establishes 14 regions throughout state for instream flow requirements
- Continuing authority to amend Policy
- Describes how Policy is enforced

Attachment A: Cannabis Cultivation Requirements

- Section 1 – Definitions, General Requirements, and Prohibitions
- Section 2 – Requirements for Water Diversion and Waste Discharge (10 subsections)
- Section 3 – Numeric and Narrative Instream Flow Requirements
- Section 4 - Watershed Compliance Gage Assignments
- Section 5 – Planning and Reporting
- Section 6 – Useful Guidance Documents

Map of Regional Boundaries



Cannabis Cultivation Policy – Attachment A

Contains specific requirements for cultivation activities, such as:

- General erosion control measures for entire cultivation site
- Stream crossings and installation, culverts, road development
- Management of fertilizers, pesticides, and petroleum
- Cleanup, restoration, and mitigation on existing sites
- Proper soil, cultivation, and human waste disposal
- Control of irrigation runoff
- Appropriate methods of water diversion and storage
    - Maximum diversion rate: 10 gallon per minute (unless otherwise approved in existing water right)
- Winterization

Attachment A, Section 2

Updates to the Cannabis Policy

Adopted by the State Water Board
February 5, 2019

Approved by the Office of Administrative Law
April 16, 2019

Cannabis Policy and Cannabis Cultivation General Order Update

- Main updates proposed to Cannabis Policy and Cannabis Cultivation General Order are focused on:
  - Tribal Buffers (permission to cultivate on and/or within 600 feet)
  - Requirements for Conditionally Exempt Indoor Cultivation Sites
  - Onstream Reservoirs
  - Winterization Requirements
  - Minor clean up and clarifications based on feedback received during initial implementation efforts
- Broader review and update will be completed in future (anticipated 2022/2023)

Onstream Reservoirs

Cultivators with certain pre-existing onstream reservoirs may obtain a Cannabis Small Irrigation Use Registration (SIUR) if:

- **Reservoir existed prior to October 1, 2016**; and
- Deputy Director for Division of Water Rights ***and*** CDFW determine removal of reservoir or installation of off-stream storage would cause more environmental damage than continuing to use onstream reservoir for diversion and storage.

Onstream Reservoirs (cont'd)

As part of filing for a Cannabis SIUR, cannabis cultivator shall agree to:

- Request a determination of whether removal of reservoir or installation of off-stream storage would cause more environmental damage than continuing to use existing onstream reservoir for diversion and storage
- Accept any conditions imposed to ensure operation of the onstream reservoir are protective of water quality and aquatic resources
- Withdrawal of water from onstream reservoir for cannabis cultivation activities only allowed during surface water diversion forbearance period

Onstream reservoirs that DO NOT qualify for ongoing operation under the SIUR will either need to be <u>removed</u> or otherwise <u>rendered incapable of storing water.</u>

Onstream Reservoir Measurement Requirement

Cannabis cultivators with onstream reservoirs shall install and maintain a measuring device that is:

- ✓ capable of recording date, time, and volume of water diverted at an hourly or more frequent basis, year-round
- ✓ installed and calibrated by a Qualified Professional (including development of area-capacity curve).

Cannabis Cultivators shall maintain hourly depth and volume records.

Cannabis Policy Instream Flow Requirements and Online Compliance Tools

Cannabis Policy – Instream Flow Development Constraints

- Statewide development and implementation
- Transparent
- Consistent
- Limitations
  - Time – Less than one year
  - Resources – Limited staff

Cannabis Cultivation Policy -
Numeric and Narrative Instream Flow Requirements

<u>Narrative Instream Flow Requirements</u>

- 50% of streamflow shall be bypassed past point of diversion
- Surface water forbearance period: April 1 – October 31, possibly later depending on precipitation
  - initial diversion before December 15 may not commence until after seven consecutive days with flow above numeric instream flow

<u>Numeric Instream Flow Requirements</u>

- Diversions can only occur when daily average flow at assigned gage is above minimum instream flow requirement
- Diverters shall measure and record daily water diversion and use

Attachment A, Section 3

Wet Season Flow Requirement Methodology

Wet season flow requirements (surface water diverters)

- Used flow modeling effort conducted by USGS in cooperation with The Nature Conservancy (TNC) and Trout Unlimited (USGS Model)
  - Predicted natural (unaffected by land use or water management) monthly streamflows from 1950 to 2012
  - Available for majority of USGS National Hydrologic Database stream reaches in California
- **Applied the Tessmann Method**

Situation	Minimum Monthly Flow
40% Mean AF > 40% Mean Monthly Flow (MF)	40% Mean AF
40% Mean MF > 40% Mean AF	40% Mean MF

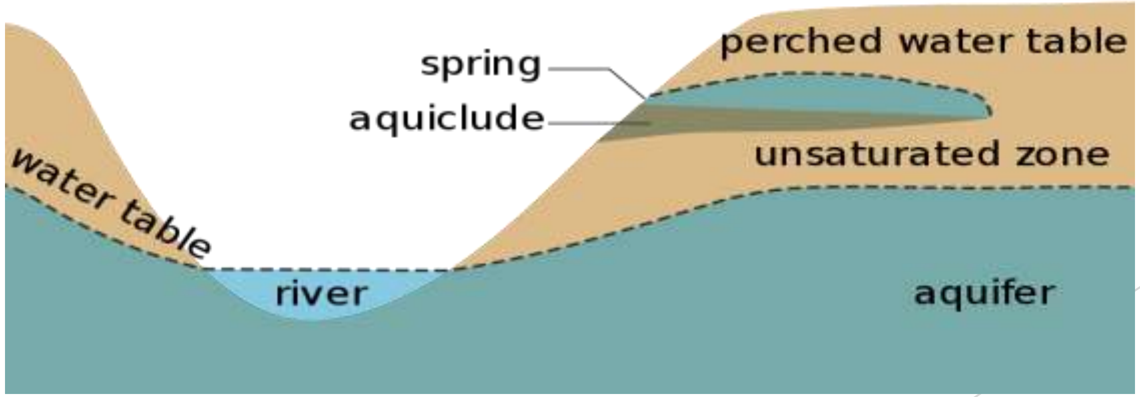
- Flow requirements assigned at compliance gages
  - Ungaged watersheds assigned a paired watershed gage for compliance

Cannabis Cultivation Policy -

Numeric and Narrative Instream Flow Requirements

Groundwater Requirements

- If it is determined that groundwater diversions have potential to significantly affect surface water supply, forbearance periods or other measures may extend to groundwater diverters



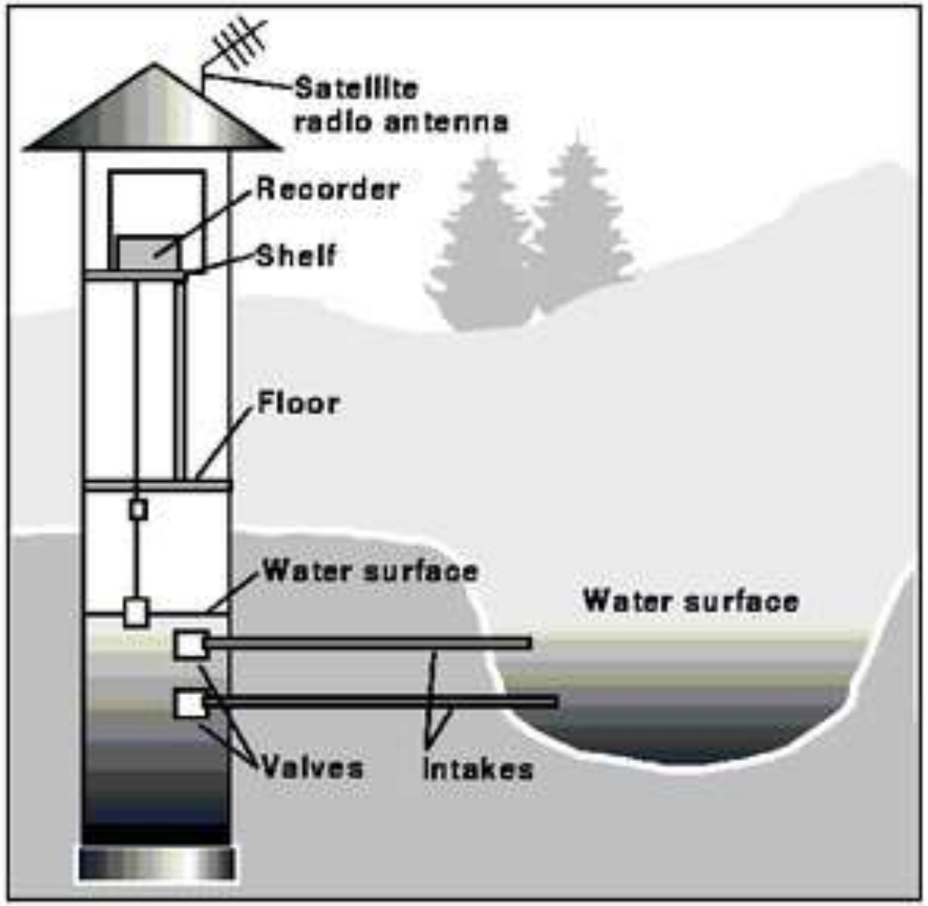
Cannabis Cultivation Policy - Numeric and Narrative Instream Flow Requirements

Groundwater Requirements (cont'd):

- Aquatic base flow thresholds established as one mechanism to help monitor whether groundwater diverters are having a cumulative negative impact on instream flows
- Used predicted natural (unaffected by land use or water management) monthly streamflows from 1950 to 2012 (USGS Model)
- New England Aquatic Base Flow (ABF) Standard methodology (USFWS 1999)
    - ABF for each compliance gage is calculated based on the mean monthly flow of the lowest flowing month from April through October
    - ABF is calculated by taking the median of mean monthly flow (over the predicted historical modeling period) of lowest non-zero flow month that is greater than 1.0 cfs

Attachment A, Section 3

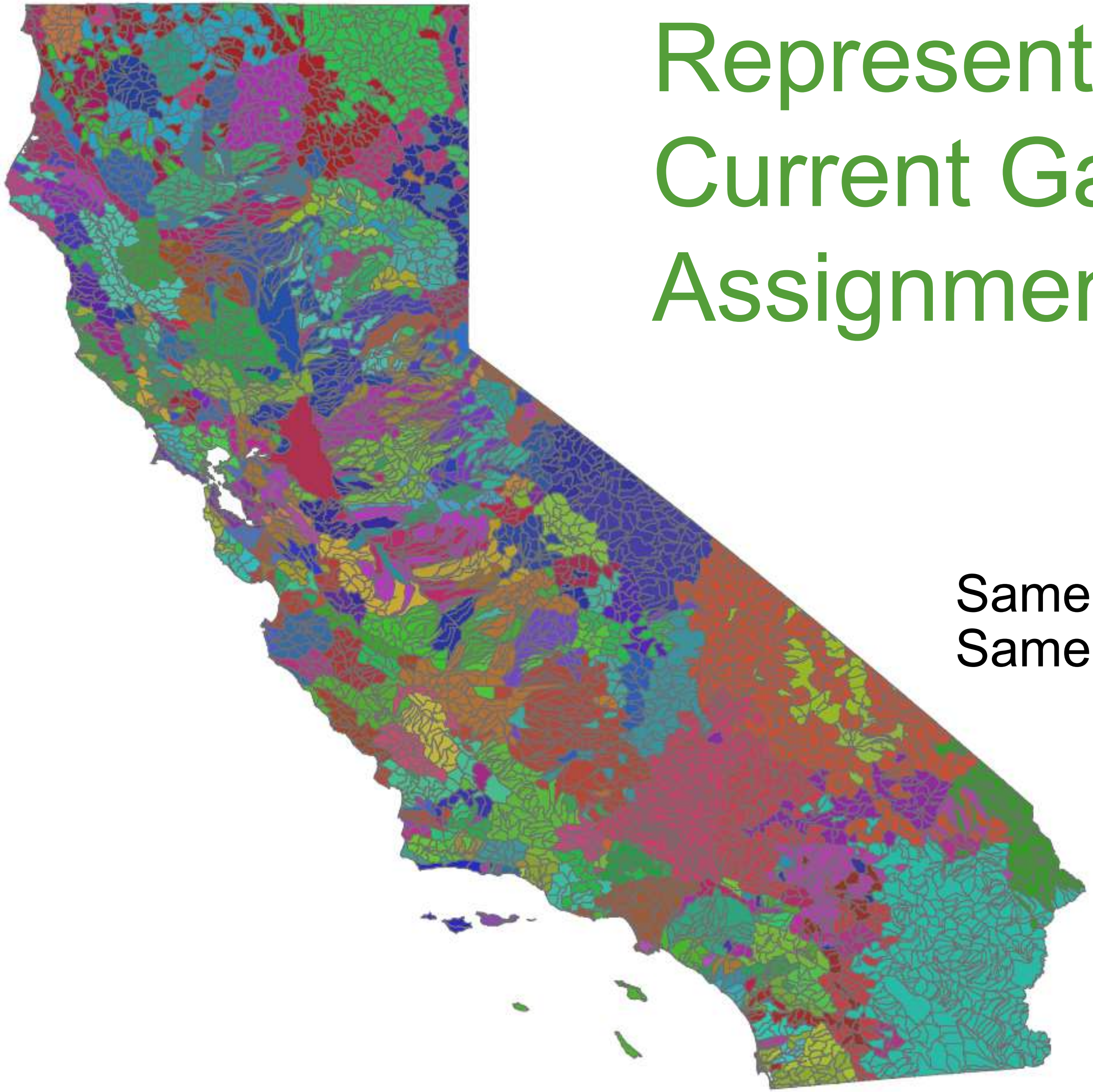
Cannabis Cultivation Policy – Watershed Compliance Gage Assignments



Attachment A, Section 4

- Policy establishes minimum monthly flows at compliance gages
- Watershed areas without existing gages are assigned a compliance gage for a different location in same watershed or a nearby watershed with similar flow characteristics
- Compliance gage assignments may change as more information becomes available
- During diversion season, cannabis cultivators are required to check their compliance gage assignment at least daily and prior to diverting water to ensure water is available to divert at assigned gage

Representation of Current Gage Assignments



Same compliance gage =
Same color watershed

Overview of New Websites and Tools

Map of Existing Flow Requirements	https://www.waterboards.ca.gov/water_issues/programs/cannabis/existing_flow_req.html
Cannabis Compliance Gages	https://www.waterboards.ca.gov/water_issues/programs/cannabis/tessmann_instream_flow_requirements.html
Online Cannabis Compliance Gage Mapping Tool	https://www.waterboards.ca.gov/water_issues/programs/cannabis/online_mapping_tool.html

Existing Flow Requirements

Many rivers in California have existing instream flow requirements through licenses issued by the Federal Energy Regulatory Commission for hydropower projects, Biological Opinions issued by the National Marine Fisheries Service or the United States Fish and Wildlife Service, or water right orders and decisions issued by the State Water Resources Control Board (State Water Board). This webpage provides a comprehensive list of existing instream flow requirements in California, as reflected to the best knowledge of State Water Board staff. While this webpage was developed to assist cannabis cultivators with compliance with the Cannabis Policy, it has utility beyond cannabis cultivation. Cannabis cultivators should refer to the Cannabis Cultivators section below.

The estimated geographic extent of each requirement is represented by a polygon layer in the interactive GIS mapping tool below. Clicking on a polygon will provide an overview of the flow requirement for the applicable stream reach. More information on the existing instream flow requirements is located below the mapping tool and is organized by Cannabis Policy region and stream reach. The associated compliance gages are also included, as applicable.

While the goal of this website is to compile a comprehensive list of existing instream flow requirements in California, the list may be incomplete and the estimated geographic extent of the flow requirements may have been misinterpreted. If you have comments, corrections, or additional information, you are encouraged to contact State Water Board staff by email at CannabisWR@waterboards.ca.gov.

Quick Links to Individual Regions

- Klamath
- Upper Sacramento
- North Eastern Desert
- North Coast
- Middle Sacramento
- Southern Sacramento
- North Central Coast
- Tahoe
- South Central Coast
- San Joaquin
- Mono
- Kern
- South Coast
- South Eastern Desert

Cannabis Cultivators:

Per the Cannabis Policy, cannabis cultivators shall comply with either: (a) existing instream flow requirements (e.g., Biological Opinion or Federal Energy Regulatory Commission license flow requirements); or (b) the Cannabis Policy Tessmann instream flow requirements, whichever is greater. Cannabis cultivators should refer to the Online Cannabis Policy Compliance Gage Mapping Tool (online mapping tool) to determine whether an existing flow requirement may apply to their point of diversion.

Existing Flow Requirement Website (Cont’d)

- Estimated geographic extent of each requirement is represented by yellow layer in GIS mapping tool
- Clicking on layer provides an overview of flow requirement for applicable stream reach

Cannabis Compliance Gages Website

- Provides a current list of Cannabis Policy's active compliance gages and associated instream flow requirements
- Organized by Cannabis Policy Regions
- Not to be used to determine whether or not diversions on a specific day can occur

CALIFORNIA WATER BOARDS State Water Resources Control Board

Board Programs Drinking Water Water Quality

Table 2. Upper Sacramento Region Compliance Gage Numeric Instream Flow Requirements

Gage ID	Gage Name	Source	November (cfs)	December (cfs
11361000	BURNEY C A BURNEY FALLS NR BURNEY CA	USGS	85.6	85.6
HCB	HAT CK BLW HAT CK	CA Dept of Water Resources	86.1	86.1
MCD	MCCLOUD RIVER NEAR MCCLOUD	Pacific Gas & Electric	315.6	365.4
11342000	SACRAMENTO R A DELTA CA	USGS	491.0	644.5
11355500	HAT C NR HAT CREEK CA	USGS	72.7	74.8
PRB	PH-27 PIT RIVER AT BIG BEND	Pacific Gas & Electric	565.8	565.8
P35	PIT RIVER BELOW LAKE BRITTON	Pacific Gas & Electric	469.3	469.3
PMN	PIT RIVER NEAR MONTGOMERY CREEK	US Bureau of Reclamation	719.4	719.4
PR4	PH-30 PIT RIVER BLW PIT NO 4 DAM	Pacific Gas & Electric	518.7	518.7
11355010	PIT R BL PIT NO 1 PH NR FALL RIVER MILLS CA	USGS	377.4	377.4

Online Cannabis Compliance Gage Mapping Tool

Cannabis Policy Compliance Gage Assignments - Mapping Tool Description and Purpose

This webpage is designed to provide cannabis cultivators that divert from surface water with a tool to check whether they may divert for cannabis cultivation on a given day. A summary of some of the main Cannabis Policy's requirements related to diversion of water for cannabis cultivation is available below.

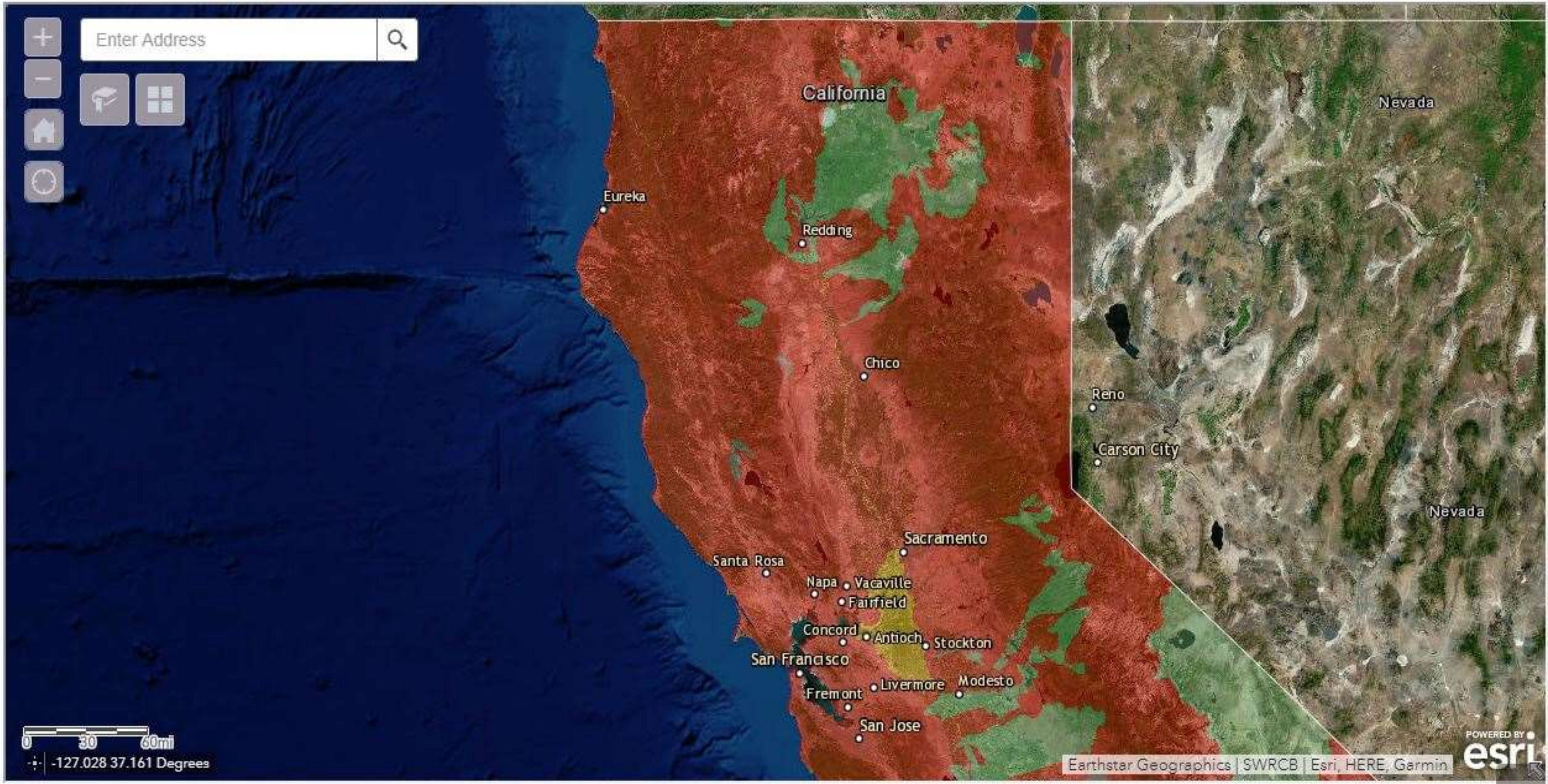
How to Use the Mapping Tool:

1. Navigate to your point of diversion by either entering your address in the search bar or zooming in on the map. (You may need to click on the "OK" box if it's your first time visiting the mapping tool.)
2. Click on the map to identify the location of your point of diversion and a Gage Pop-Up Box will appear with information about whether the **DIVERSION IS AUTHORIZED** or the **DIVERSION IS NOT AUTHORIZED** for that day. Cannabis cultivators are required to check if water is available to divert at their point of diversion (e.g., pump inlet) at least daily, prior to diverting.
3. If you see "**More Information Needed**" in the Gage Pop-Up Box, please refer to the Instructions for Using the Cannabis Compliance Gaging Tool below.
4. If you see "**Contact SWRCB at CannabisWR@Waterboards.ca.gov**" in the Gage Pop-Up Box, please refer to the Instructions for Using the Cannabis Gage Mapping Tool.

For more detailed instructions on how to use the Mapping Tool, see the Instructions for Using the Cannabis Compliance Gage Mapping Tool. For more information about the terms (e.g., DIVERSION AUTHORIZED, etc.), please refer to the Definitions of Pop-Up Box Attributes and Fields.

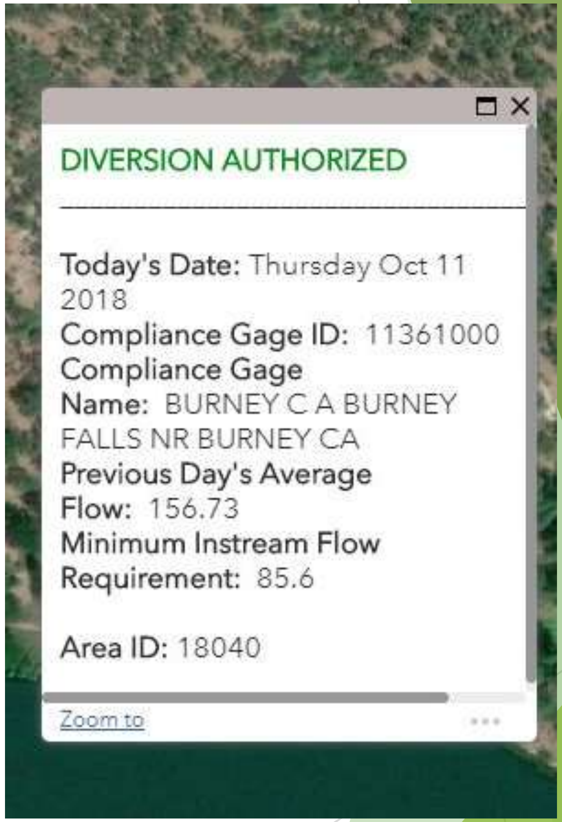
The map below identifies compliance gage assignments for cannabis cultivators with a surface water diversion based on the location of the point of diversion.

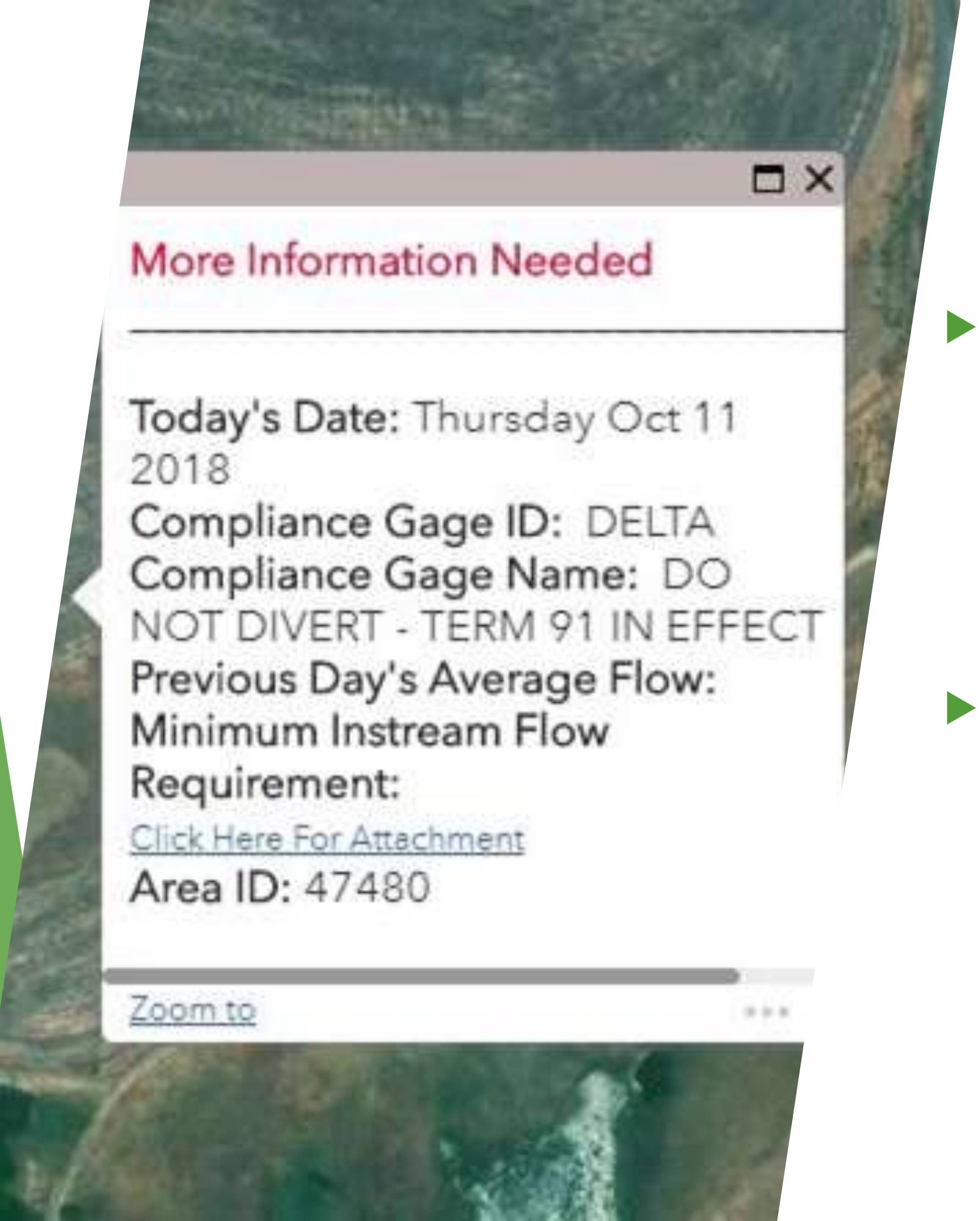
The map below identifies compliance gage assignments for cannabis cultivators with a surface water diversion based on the location of the point of diversion.



Online Mapping Tool (cont'd)

- Click on map to identify location of your point of diversion and a Gage Pop-Up Box will appear with information about whether **DIVERSION IS AUTHORIZED** or **DIVERSION IS NOT AUTHORIZED** for that day
- Cannabis cultivators are required to check if water is available to divert at their point of diversion (e.g., pump inlet) **at least daily**, prior to diverting





Online Mapping Tool (cont'd)

- Indicates that surface water diversion is subject to an existing instream flow requirement that may be more restrictive than what is prescribed by Cannabis Policy
- Cannabis cultivators responsibility to determine whether they are following all instream flow requirements prior to diverting

Online Mapping Tool (cont'd)

Dry Water Year Type			
Month	Existing Flow Requirement*	Cannabis Policy Flow Requirement	**Effective Flow Requirement**
November	70 cfs	124 cfs	**124 cfs**
December	70 cfs	142 cfs	**142 cfs**
January	70 cfs	187 cfs	**187 cfs**
February	70 cfs	195 cfs	**195 cfs**
March	70 cfs	172 cfs	**172 cfs**

Normal Water Year Type			
Month	Existing Flow Requirement*	Cannabis Policy Flow Requirement	**Effective Flow Requirement**
November	95 cfs	124 cfs	**124 cfs**
December	95 cfs	142 cfs	**142 cfs**
January	95 cfs	187 cfs	**187 cfs**
February	95 cfs	195 cfs	**195 cfs**
March	80 cfs	172 cfs	**172 cfs**

*Federal Energy Regulatory Commission has issued a new license to the Pacific Gas and Electric Company for the DeSabla-Centerville Hydroelectric Project, which asserts minimum instream flow requirement at USGS gage 11390000 as summarized in the above table.

Web Link to Water Quality Certification:
Water Quality Certification for the DeSabla-Centerville Hydroelectric Project

Current Enrollment Numbers

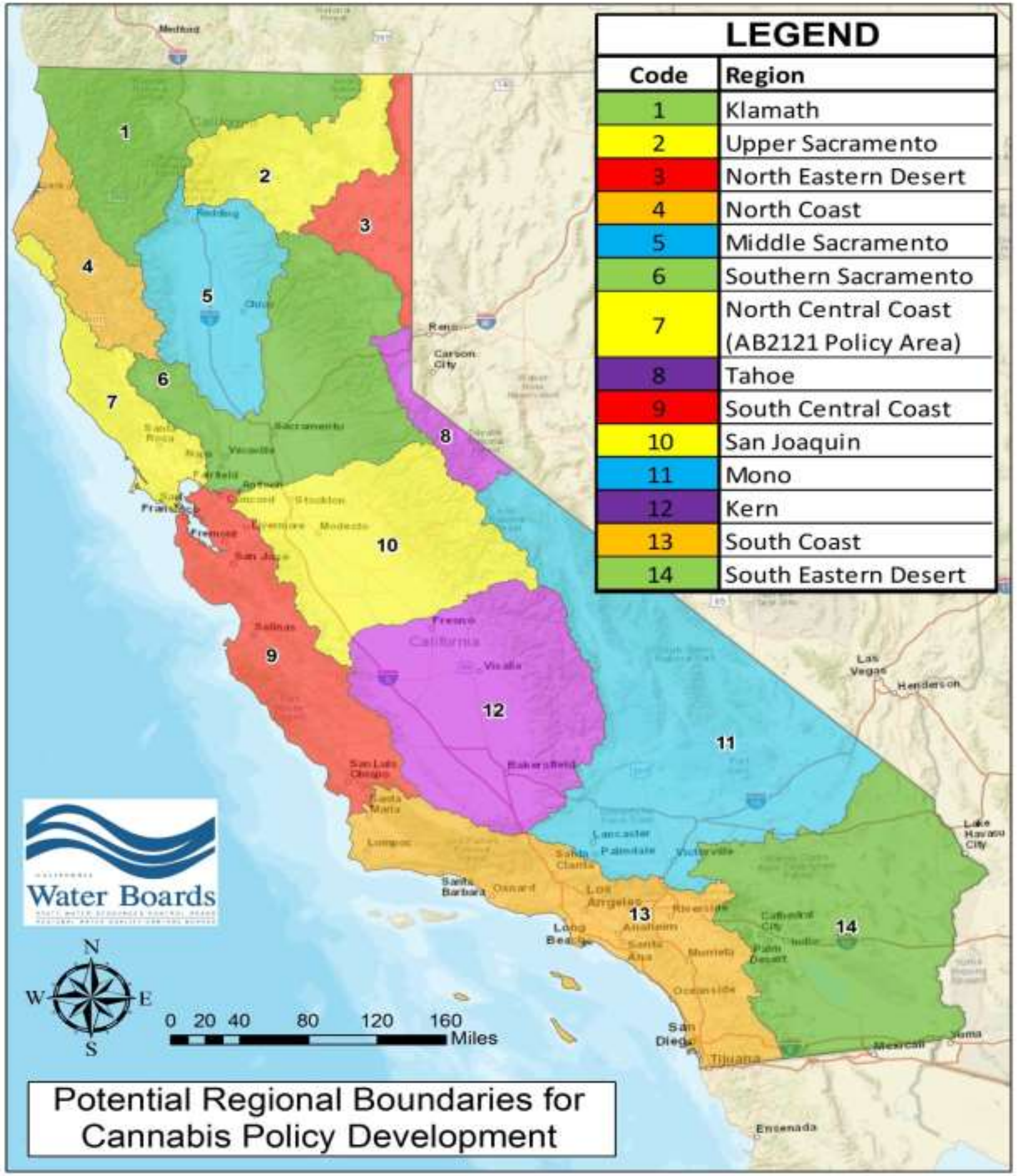
Cannabis Small Irrigation Use Registrations

Total Filings Received	Paid	Rejected / Canceled	Total Issued
627	518	30	430

Cannabis Cultivation General Order (including regional enrollments)

ENROLLEES	NOA ISSUED
2017-0023-DWQ	2598
R1-2015-0023	2699
R5-2015-0113	336
Total:	5633

What’s Next?



Development of Long Term Principles and Guidelines (Long Term Requirements)

Long-term Requirements

- Water Code section 13149 directs the State Water Board to establish interim requirements pending the development of long-term requirements for cannabis cultivation
- Current Policy and associated requirements are considered interim requirements
- Cannabis Policy established 14 regions throughout the state
- Development of long-term requirements at the regional level is currently underway
  - Focus will primarily be on the development of year round regional instream flow requirements

Follow us!

@CAWaterBoardsCultivation

Contact Information

Cannabis Website

- www.waterboards.ca.gov/cannabis

Cannabis Policy Questions

- CannabisWR@waterboards.ca.gov
- 916.341.5363

Cannabis Small Irrigation Use Registration Questions

- CannabisReg@waterboards.ca.gov
- 916.319.9427

Cannabis General Order (WDRs/Waiver) Questions

- DWQ.Cannabis@waterboards.ca.gov
- 916.341.5580

Questions?

Is the Environmental Regulatory Process for Cannabis in CA Working?

Anna Birkas

Village ecosystems

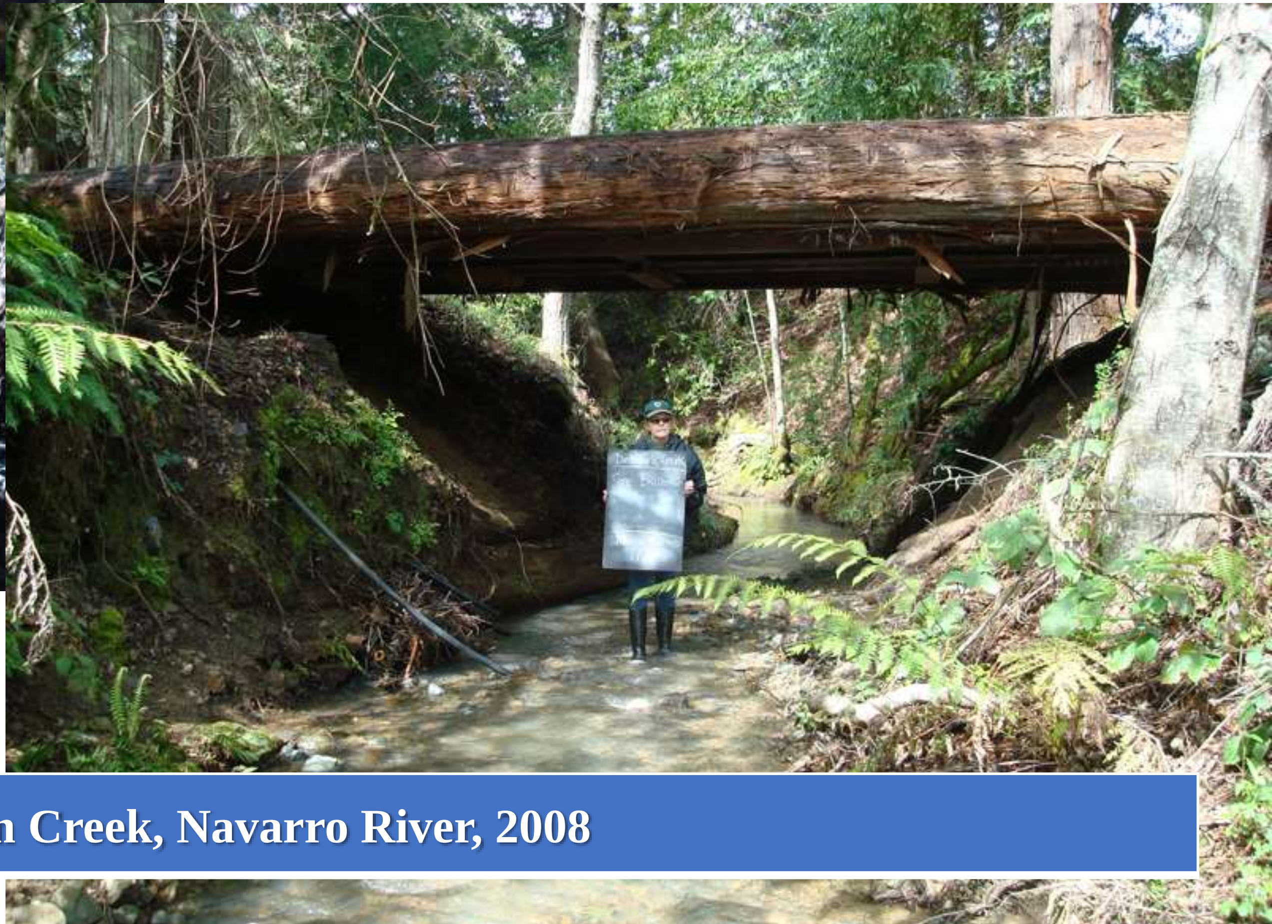
B.S. Environmental Ecology, Humboldt State University

M.S. Forest Hydrology, University of Montana

Presentation for 37th Annual Salmonid Restoration Conference

April 24th, 2019 - Santa Rosa, CA

Bioengineered Bank Stabilization, Russian River, 2011



Bridge Replacement, Robinson Creek, Navarro River, 2008

Good Environmental Goals.
Social and Economic Goals?

- What does “success” for cannabis environmental policies in California look like?
  - Achieving policy goals or benchmarks
  - Wide adoption, participation, enrollment
  - Does not threaten regional economic stability
  - Smooth integration w/ related regional and state policies & agency programs

Two Year Effectiveness Monitoring, 2004 and 2005 (Garcia River and Selby Creek)

Are We Seeing Participation in Regulation?

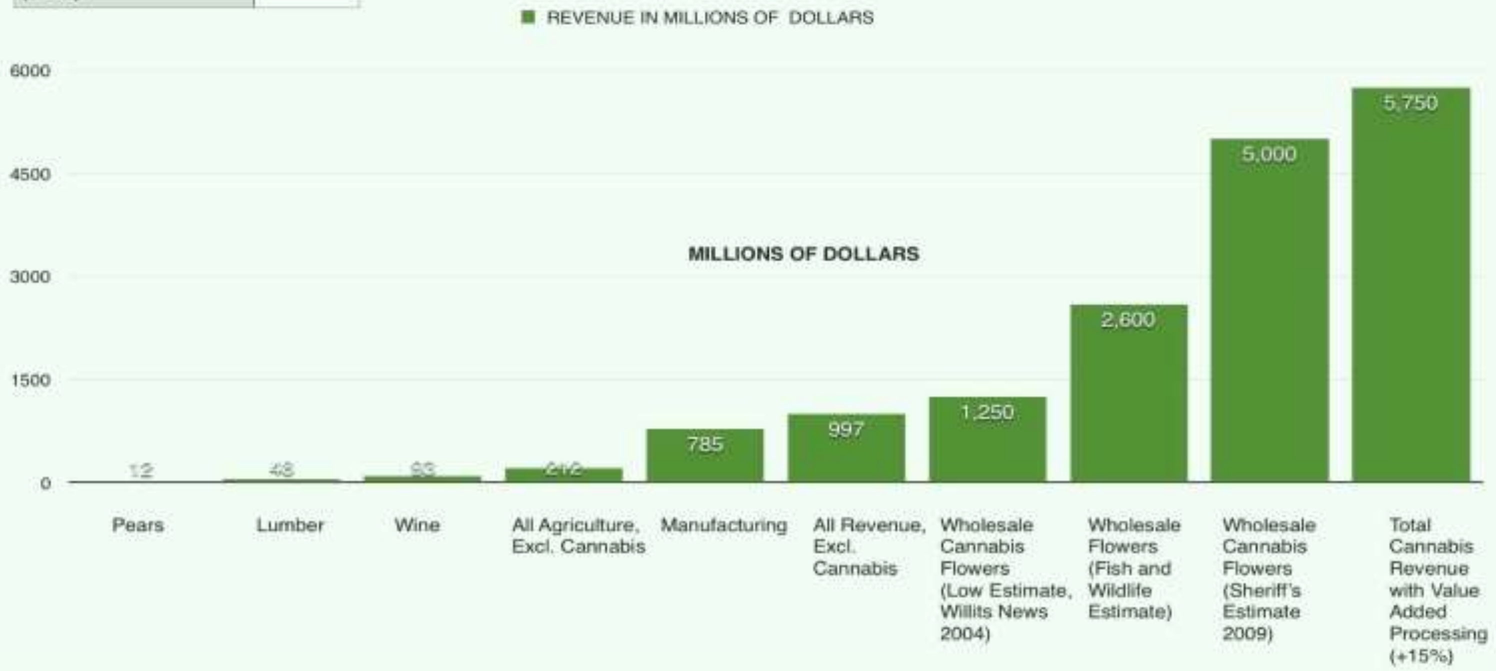
As of March 21, 2019 the Mendocino County Cannabis Program had 1,314 applications.

We estimate that there are 10,000 gardens in Mendocino County and that 50,000 people (about 50% of the population) is employed, at least part time, in the industry. - *Swami Chaitanya*

This suggests that approximate 1.3% of farms in Mendocino Co. have chosen to enroll and seek permits.

Revenue Sources for Mendocino County in 2014

Revenue Source 2014	REVENUE IN MILLIONS OF DOLLARS
PEARS	12
LUMBER	48
WINE	93
ALL AGRICULTURE, EXCLUDING CANNABIS	212
MANUFACTURING	785
ALL REVENUE, EXCLUDING CANNABIS	997
WHOLESALE CANNABIS FLOWERS (LOW ESTIMATE)	1,250
WHOLESALE CANNABIS FLOWERS (FISH AND WILDLIFE ESTIMATE)	2,600
WHOLESALE CANNABIS FLOWERS (SHERIFF'S ESTIMATE)	5,000
TOTAL CANNABIS REVENUE WITH VALUE ADDED PROCESSING (+ 15%)	5,750



Economics of Cannabis in Mendocino County

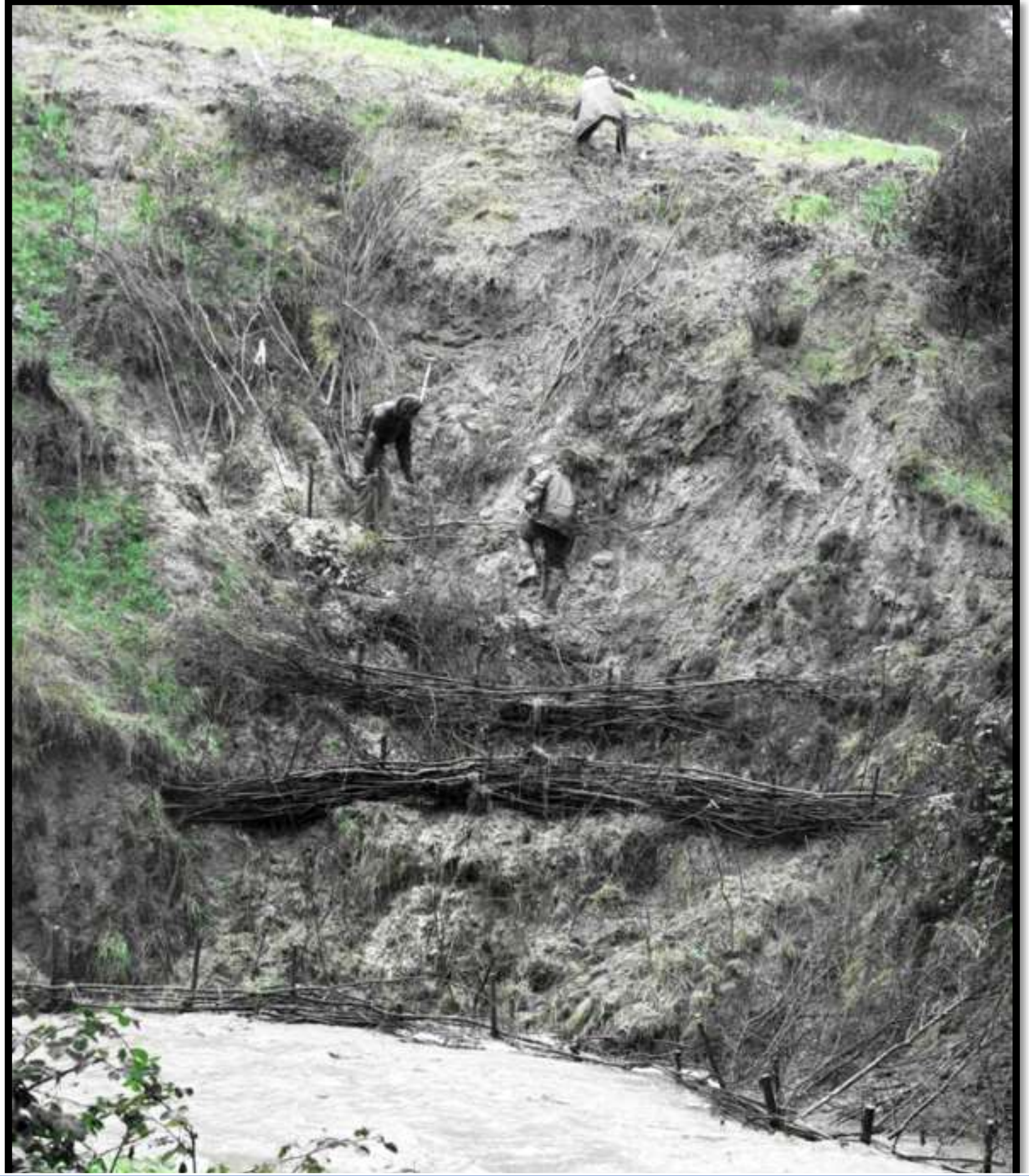
The California Office of Public Affairs - reported taxable sales for the third quarter of 2018 in Mendocino County were $2,364,007.

Approximately $5,000,000 annually in the legal market in 2018.

$2,600,000,000

About 1/500th of the revenue originally earned from cannabis is going through legal means.

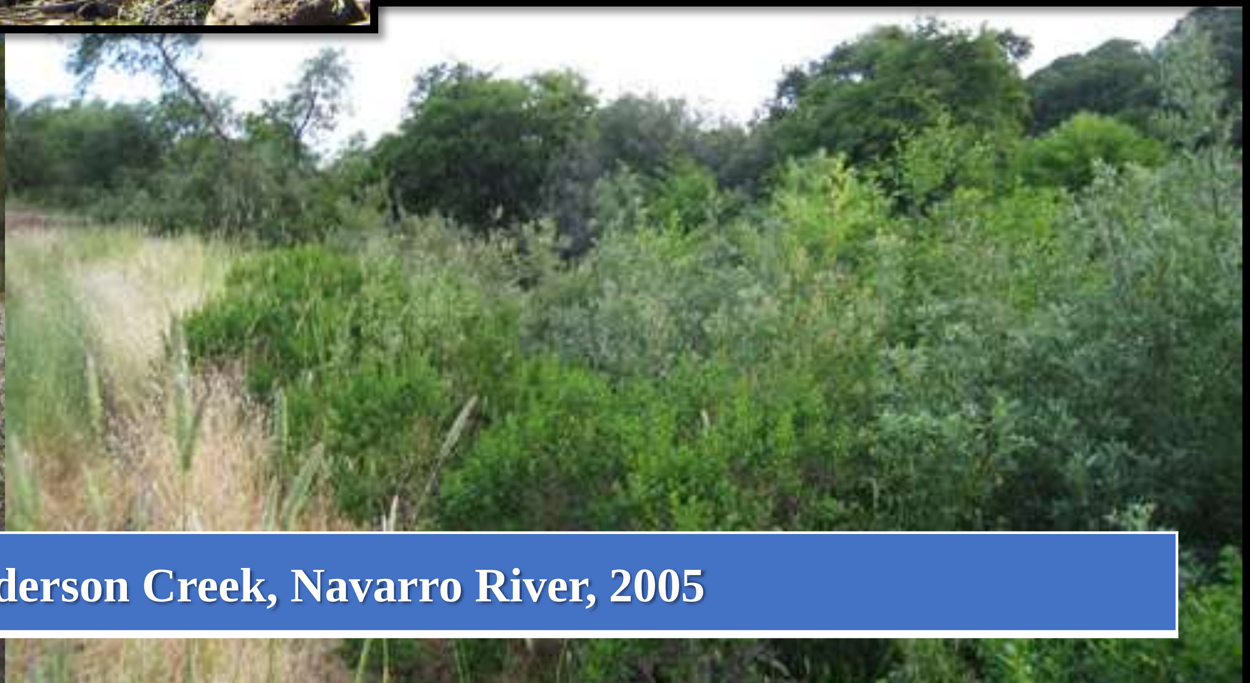
$52,000 average income per person working in cannabis sector



Bioengineered Bank Stabilization, Navarro River, 2006

Do the current cannabis policies promote farm expansion?

- Large scale farms?
  - Initial NCRWQCB R1-2015-0023 pilot policy – Designations:
    - < 2000 square feet – waiver - enrollment not required
    - < 5000 square feet, and
    - < 10,000 square feet
    - >10,000 square feet (their largest designation at that time)
  - The new SWRCB policy has the smallest designation at under 1 acre



Bioengineered Bank Stabilization, Anderson Creek, Navarro River, 2005

Duplications Impacts on Policy Success

- Basic Report Requirements:

Site Management Plan	DFW Project Description
401 Project Description	DFW work compliance report
Site Closure	DFW Project Inspection Report
County Site Plan	

Additional Reports: Erosion and Sediment Control, Disturbed Area Stabilization, Nitrogen Management…

Water use monitoring and reporting to Water Board, Division of Water Rights, Fish and Wildlife

botanical survey, wetland delineation, archeological, geology, geotechnical, disconnected spring, hydrogeologist, Licensed timber operator for forest conversion, biological survey

Coordinated permitting…

CA Cannabis Regulatory Framework

> "Government policies must be carefully formulated so that the individual measures do not undermine one another, or create a rigid and cost-ineffective framework. Overlapping policies result in unnecessary administrative costs, increasing the cost of implementation."

OECD (Organization for Economic Cooperation and Development). "Instrument Mixes for Environmental Policy" (Paris: OECD Publications, 2007) 15–16.

Bioengineered Bank Stabilization, Mill Creek, Navarro River, 2007

Cannabis Policies should be integrated with other Regional Environmental Goals

- Integration with other agencies developing and regulating cannabis
- Policies that relates to regional goals for other resources such as Water, Carbon, etc.

Carbon Footprint of Indoor

Table B-7: Estimates of Total Cannabis Energy Consumption in California

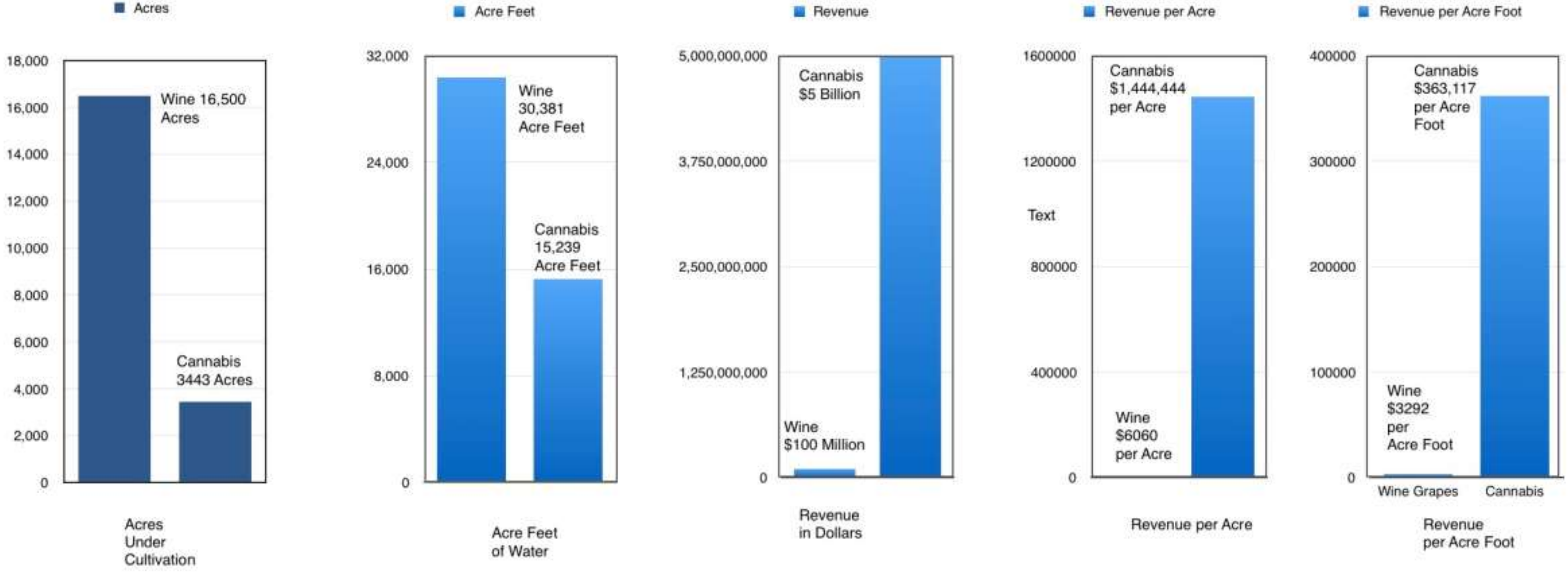
Year	Estimated Indoor Production Including Exports (Metric T ons)	Electricity Used for Indoor Cannabis Production (GWh)	Residential Electricity Demand (GWh)	Ratio of Cannabis to Residential Electricity Demand	T otal Electricity Demand (GWh)	Ratio of Cannabis to Total Electricity Demand
2017	1,070.97	6,506	92,072*	7.1%	285,011*	2.3%

Source: California Energy Commission, Energy Assessments Division, 2017

Bioengineered Bank Stabilization, Selby Creek, 2013

Wine & Cannabis Comparison

Crop	Acres	Acre Feet	Revenue	Revenue per Acre	Revenue per Acre Foot
Wine Grapes	16,500	30,381	100,000,000	6060	3292
Cannabis	3443	15,239	5,000,000,000	1,444,444	362,117



[Swami Chaitanya](https://swamiselect.com/economic-impact-of-cannabis/)
https://swamiselect.com/economic-impact-of-cannabis/

Yountville Veterans Home Source Water Assessment, Rector Reservoir, Napa River, 2008

Existing Body of Literature

- Informs policy
- The questions asked shape the perception of what is happening
- Lack of distinction between:
  - legal and black market grows
  - Environmentally damaging and sensitive farms
- Lack of comparison between cannabis and similar development
  - Compare to rural developments, not undeveloped land
  - Compare with industries that provide a similar revenue
  - Compare with other farming practices, such as orchards and vineyards

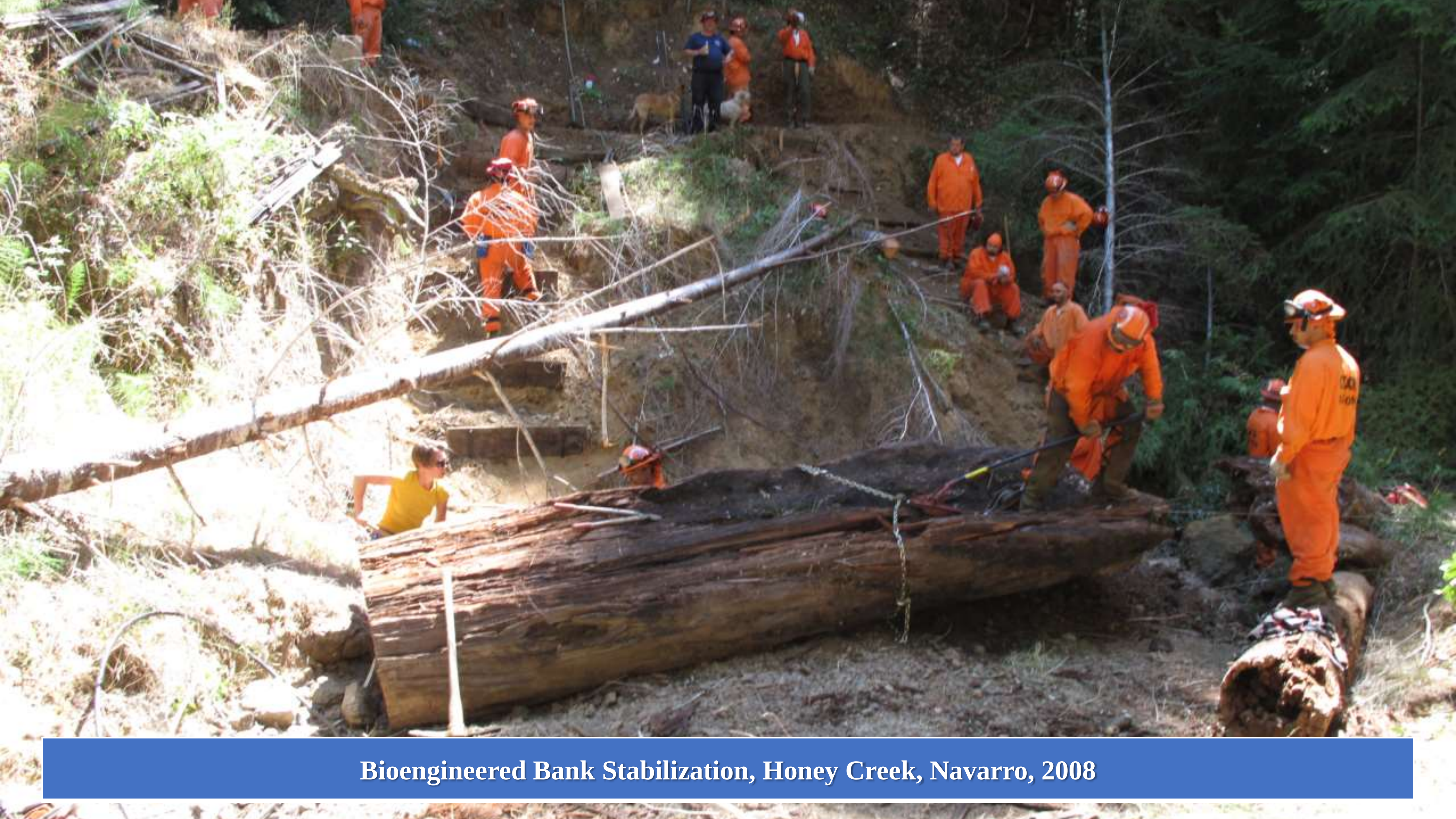
Research that underscores negative environmental impact without distinguishing between different cannabis farming sectors promotes stricter policies for all operators rather than targeted for specific issues.

Bioengineered Bank Stabilization, Anderson Creek, Navarro River, 2005

Research impacts on policy

Stricter policy that do not address underlying social and economic impacts, such that farmers don’t enroll and trust is not built, only contributes to the ineffectiveness of a program that may fail to:

- Be widely adopted,
- Support the viability of a successful economic industry,
- Integrate with other state environmental policies,
- and meet environmental goals.



Bioengineered Bank Stabilization, Honey Creek, Navarro, 2008

Fish Friendly Cannabis Practices: Scale and Opportunities for Environmental Change

Hollie Hall, Ph.D.

- Owner, Hollie Hall & Associates
- Owner, Compliant Farms Certified
- Board Member, International Cannabis Farmers Association
- Member, Humboldt County Fish & Game Advisory Commission
- *Member, Humboldt County* Eel River Valley Groundwater Working Group

Outline

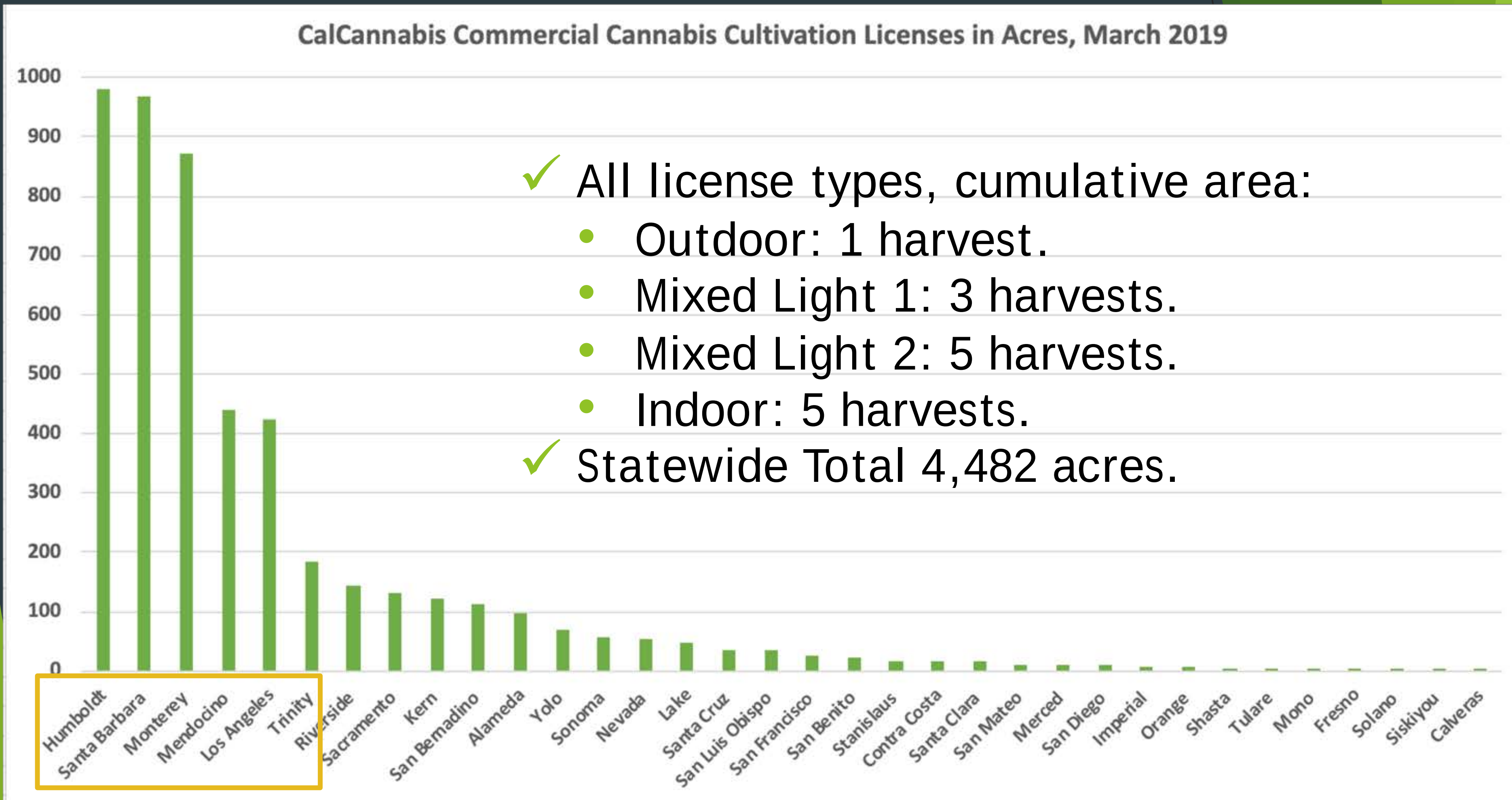
1. Spatial Examination:
   - California's Licensed Cannabis Cultivation.
   - California's Cannabis Small Irrigation Use Registration.

2. Spatial & Volume Comparison:
   - California's Irrigation Water Rights.
   - California's Cannabis Small Irrigation Use Registration.

3. Fish Friendly Cannabis Farming Practices.

4. Cannabis Impacts on the Environment: Pathway Forward.


Licensed Cannabis Cultivation by County



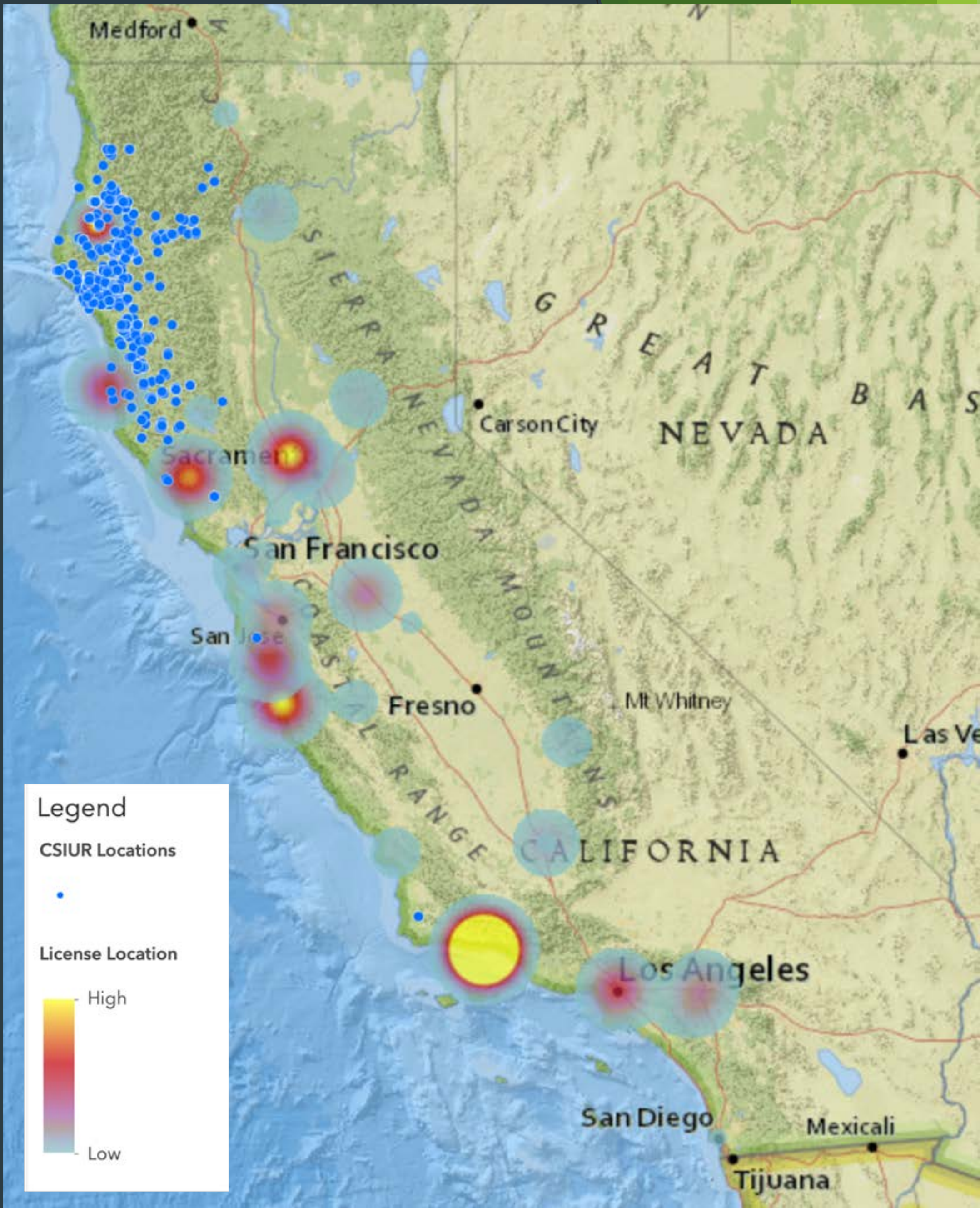
- ✓ All license types, cumulative area:
  - Outdoor: 1 harvest.
  - Mixed Light 1: 3 harvests.
  - Mixed Light 2: 5 harvests.
  - Indoor: 5 harvests.
- ✓ Statewide Total 4,482 acres.

Licensed Cannabis Cultivation vs. Water Use Data

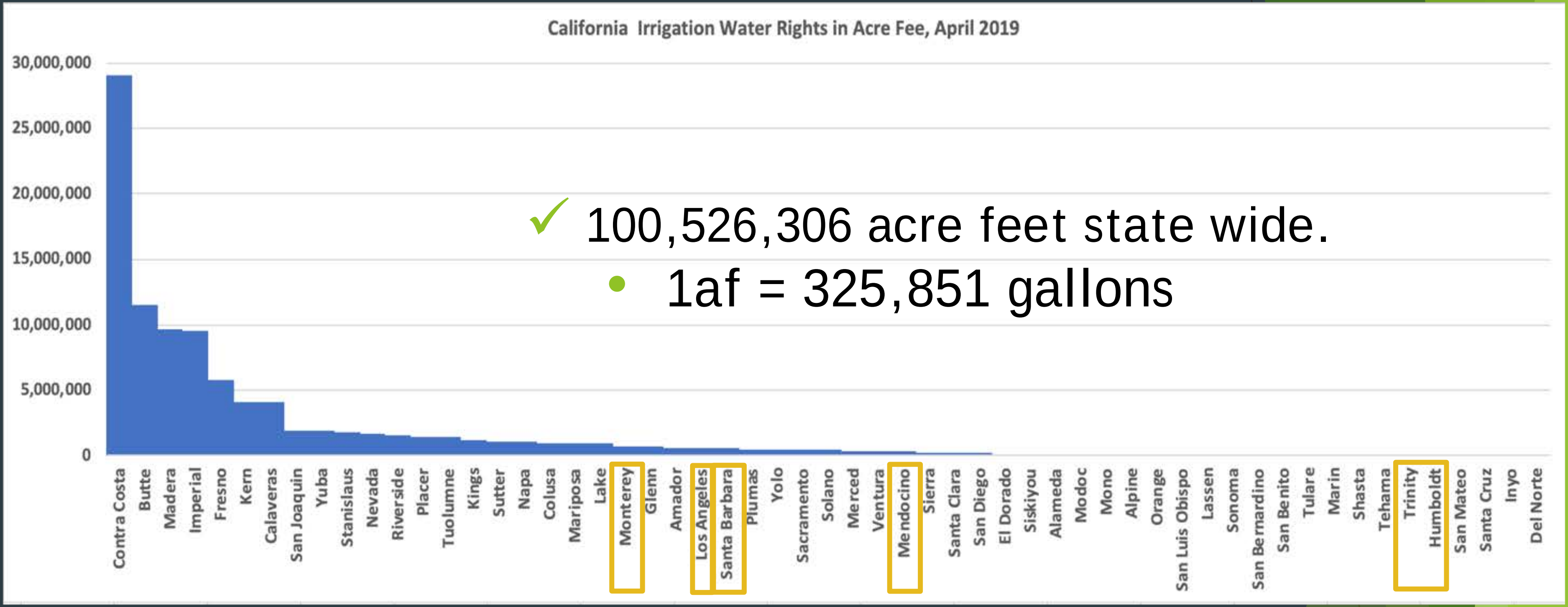
CalCannabis Applications:
- ✓ All license types.
  - ✓ Outdoor
  - ✓ Mixed Light 1
  - ✓ Mixed Light 2
  - ✓ Indoor

✓ CIWQS CSIUR Locations:
- ✓ Surface water use.

✓ Ecological impact data gap.



Irrigation Water Rights by County

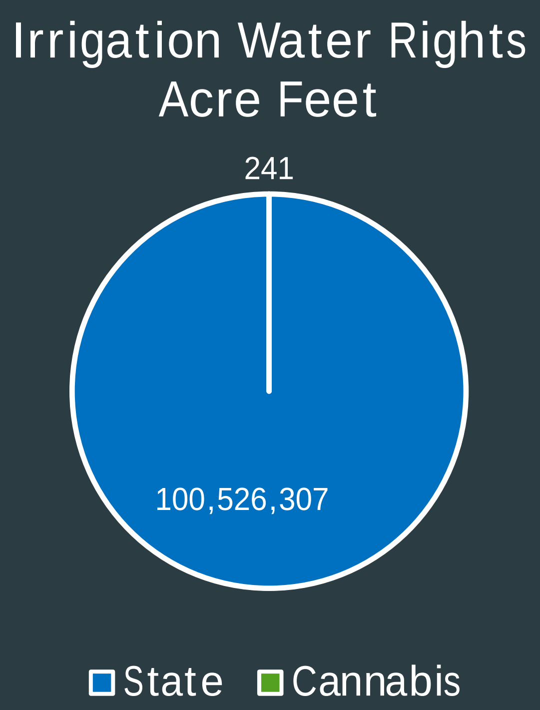


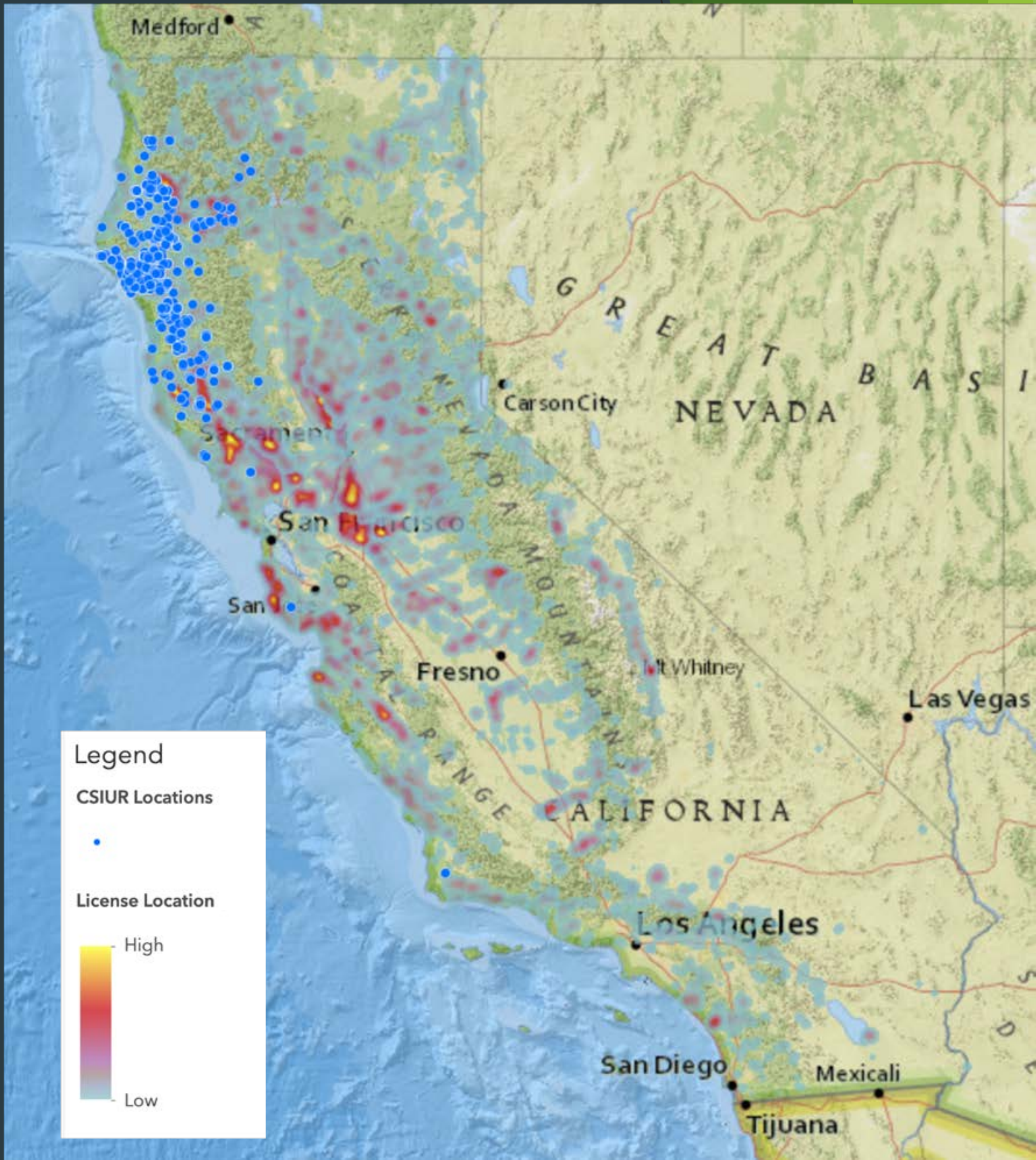
- ✓ 100,526,306 acre feet state wide.
  - 1af = 325,851 gallons

✓Statewide irrigation water rights ≠ Cannabis license locations.

✓ Ecological impact data gap.

California's Irrigation Water Rights

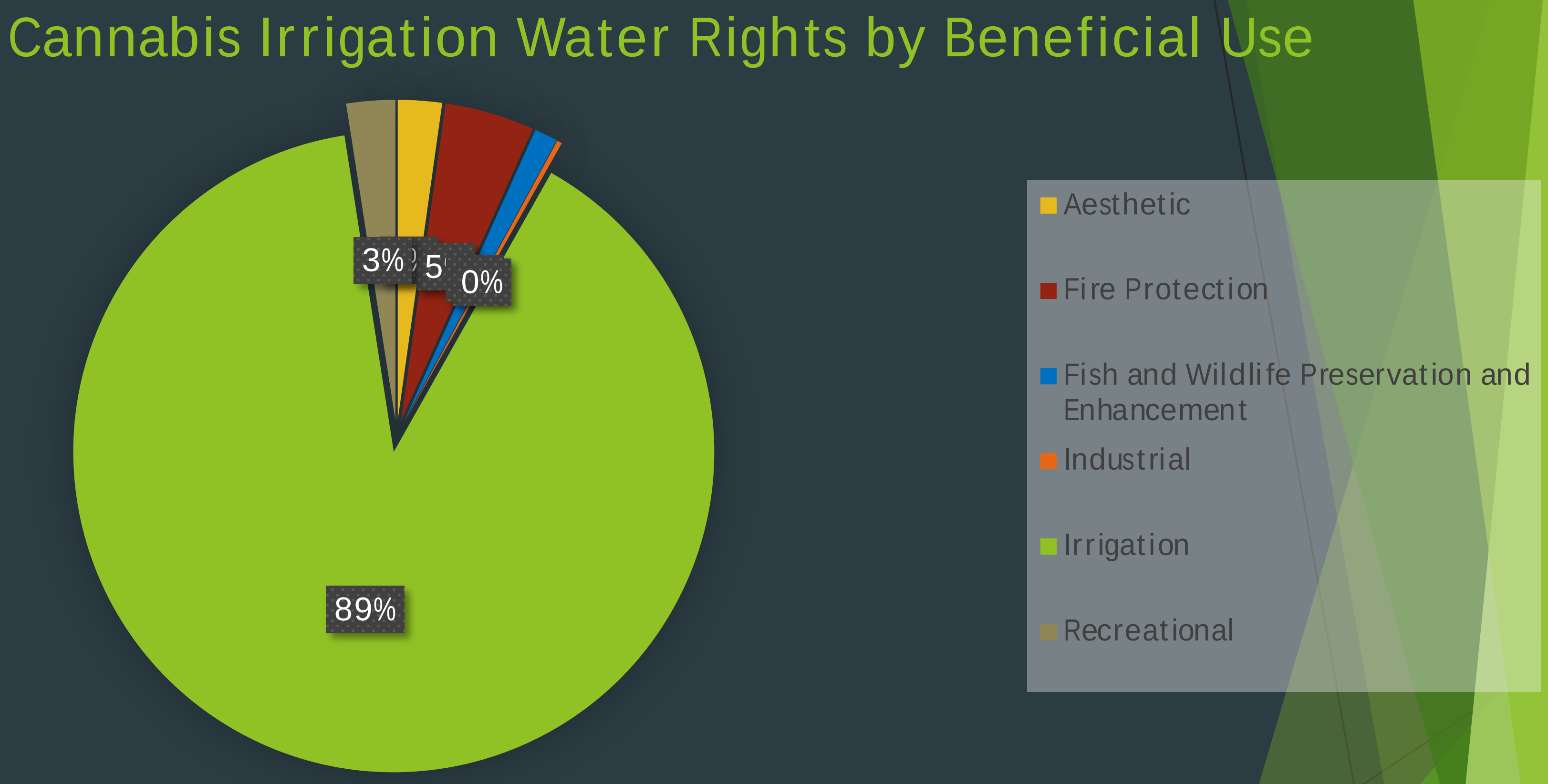




Friendly Cannabis Farming Practices: A Regulatory Driven Paradigm

- Reduced runoff.
- Riparian protections.
- Increased soil infiltration.
- Groundwater recharge.
- Improved water quality.
- Habitat enhancement.

Friendly Cannabis Farming Practices: Water Rights



✓100% of CSUIR is captured during the wet season.

Friendly Cannabis Farming Practices

- ✓ Wet season water capture.
- ✓ Forbearance of dry season pumping.
- ✓ Mulching.
- ✓ Cultivating in the earth.
- ✓ Managing for living soils.
- ✓ Polyculture.
- ✓ Water use monitoring.
- ✓ Conservation irrigation.
- ✓ Riparian corridor setbacks.
- ✓ Integrated Pest Management.

Cannabis Impacts on the Environment: Pathway Forward

- ✓ Improve support compliant cannabis farmers in efforts to steward watershed ecosystems: tax incentives, grant funds, training.

- ✓ Quantify positive impacts of compliant farming activities on indicators of ecosystem health: riparian corridors, stormwater infiltration, dry season stream flow enhancements, habitat.

- ✓ Broaden focus to include landscape scale issues: forest management, non-cannabis irrigation, groundwater supplies.

- ✓ Research ‘organic’ cannabis pest and disease methods: Marrone Bio Innovations Venerate, Grandevo and Regalia in particular.

THANK YOU!

Contact Info:

- HollieRHall@gmail.com
- www.holliehall.com
- www.compliantfarms.com

Data sources & analysis:
- Water Boards CIWQS, April 2019.
- CDFA CalCannabis, March 2019.
- Hollie Hall, Hollie Hall & Associates.
- Kristin Nevedal, International Cannabis Farmers Association.
- Holly Carter, Oxalis Integrative Services.

Coho Salmon: Gauging Cannabis Production Impacts to Summer Rearing Habitat

Corinne Gray
Senior Environmental Scientist Supervisor

Watershed Enforcement Team
California Department of Fish and Wildlife

Fish Need Water

Objectives and Scope

Fish

- Very brief discussion of coho life history

Need

- Discussion of limitations on summer rearing flows
- Comparison of Cannabis Policy using USGS Gauge Sites

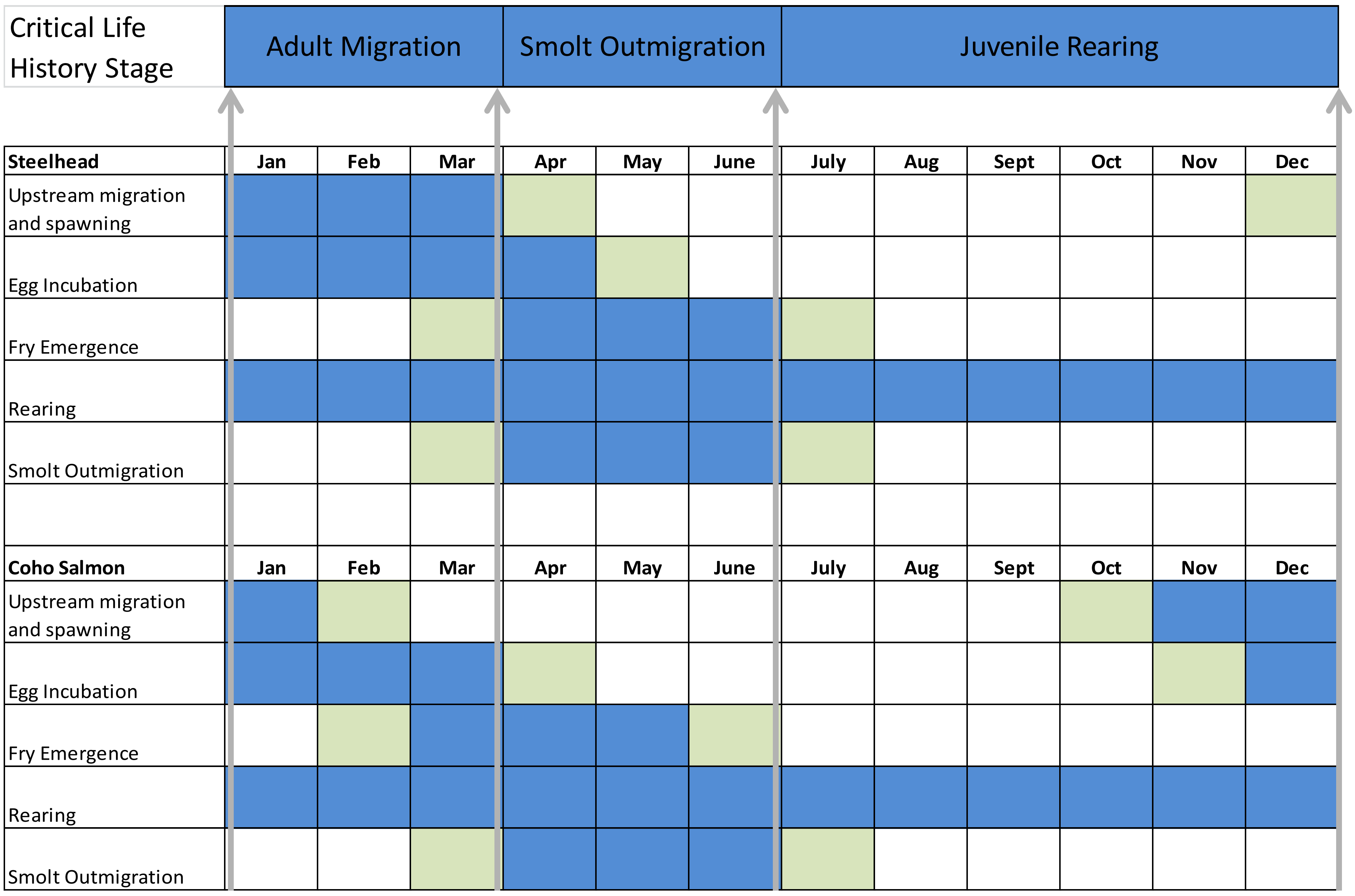
Water

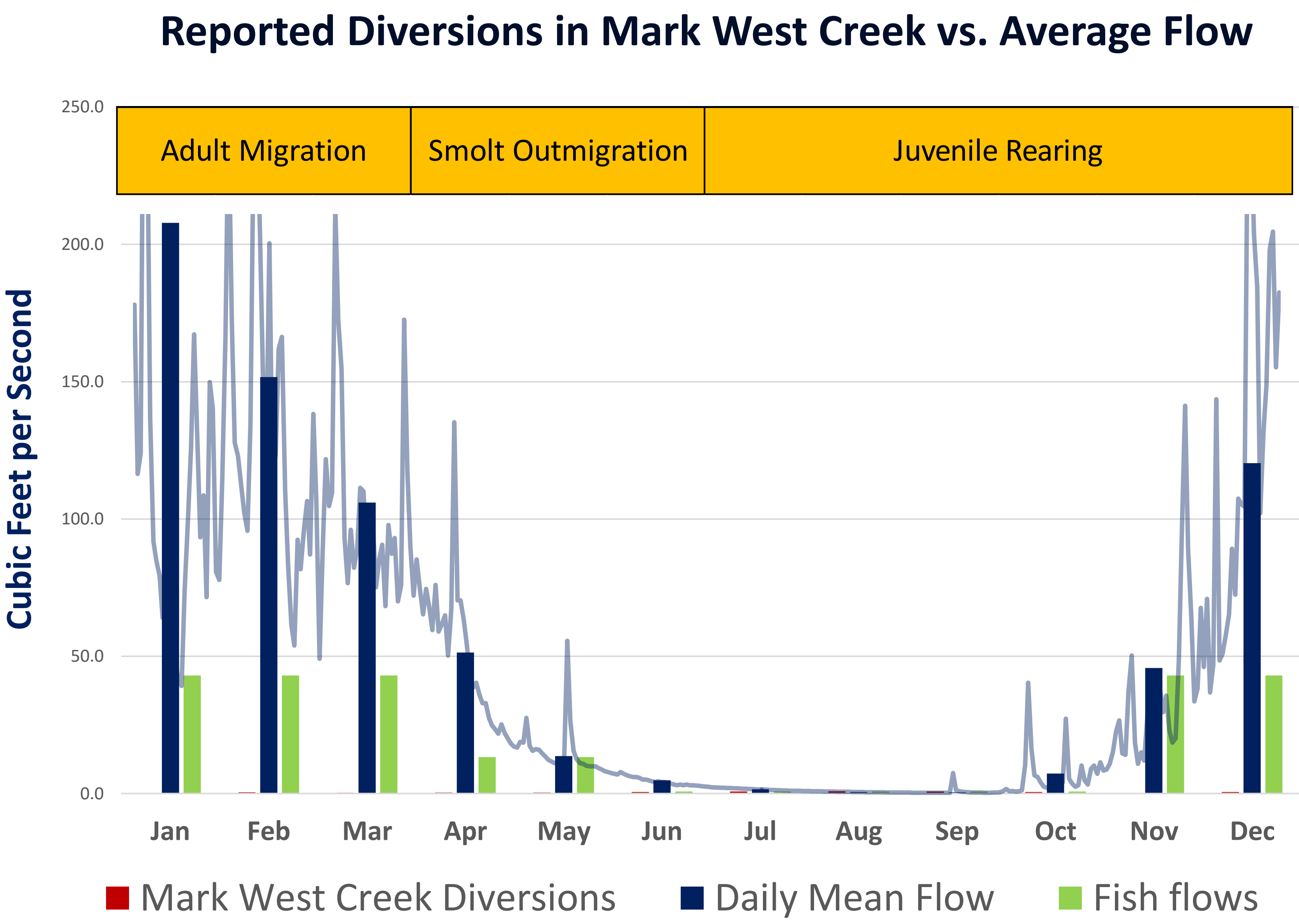
- Mark West Creek case study

Russian River Salmonid Periodicity

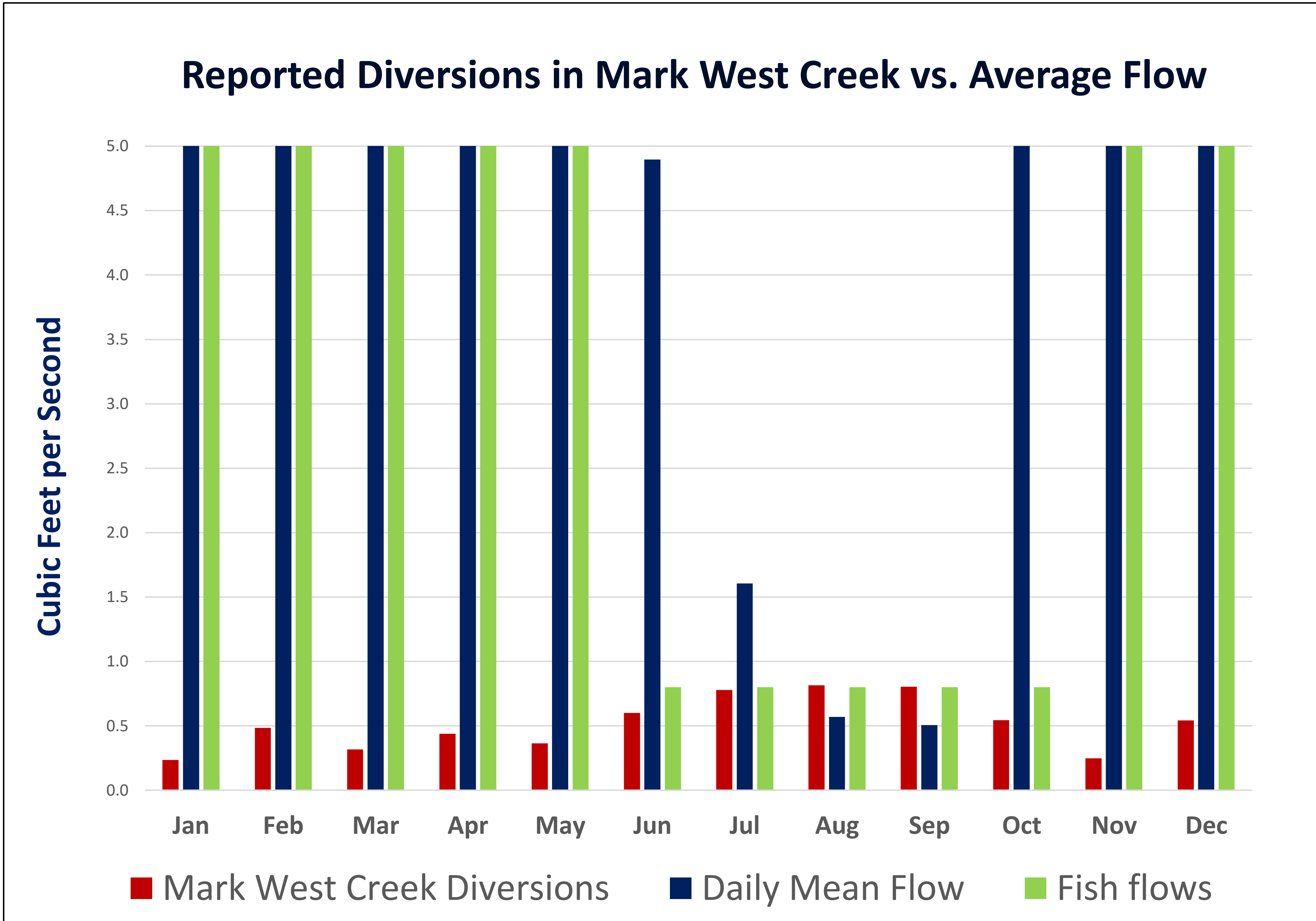
Steelhead	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Upstream migration and spawning												
Egg Incubation												
Fry Emergence												
Rearing												
Smolt Outmigration												

Coho Salmon	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Upstream migration and spawning												
Egg Incubation												
Fry Emergence												
Rearing												
Smolt Outmigration												


Critical Life History Stage
Adult Migration
Smolt Outmigration
Juvenile Rearing
Steelhead
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Upstream migration and spawning
Egg Incubation
Fry Emergence
Rearing
Smolt Outmigration
Coho Salmon
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Upstream migration and spawning
Egg Incubation
Fry Emergence
Rearing
Smolt Outmigration



Reported Diversions in Mark West Creek vs. Average Flow
Adult Migration
Smolt Outmigration
Juvenile Rearing
Cubic Feet per Second
250.0
200.0
150.0
100.0
50.0
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Mark West Creek Diversions
Daily Mean Flow
Fish flows


Reported Diversions in Mark West Creek vs. Average Flow
Cubic Feet per Second
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Mark West Creek Diversions
Daily Mean Flow
Fish flows

How much water does a fish need?

SWRCB Cannabis Policy

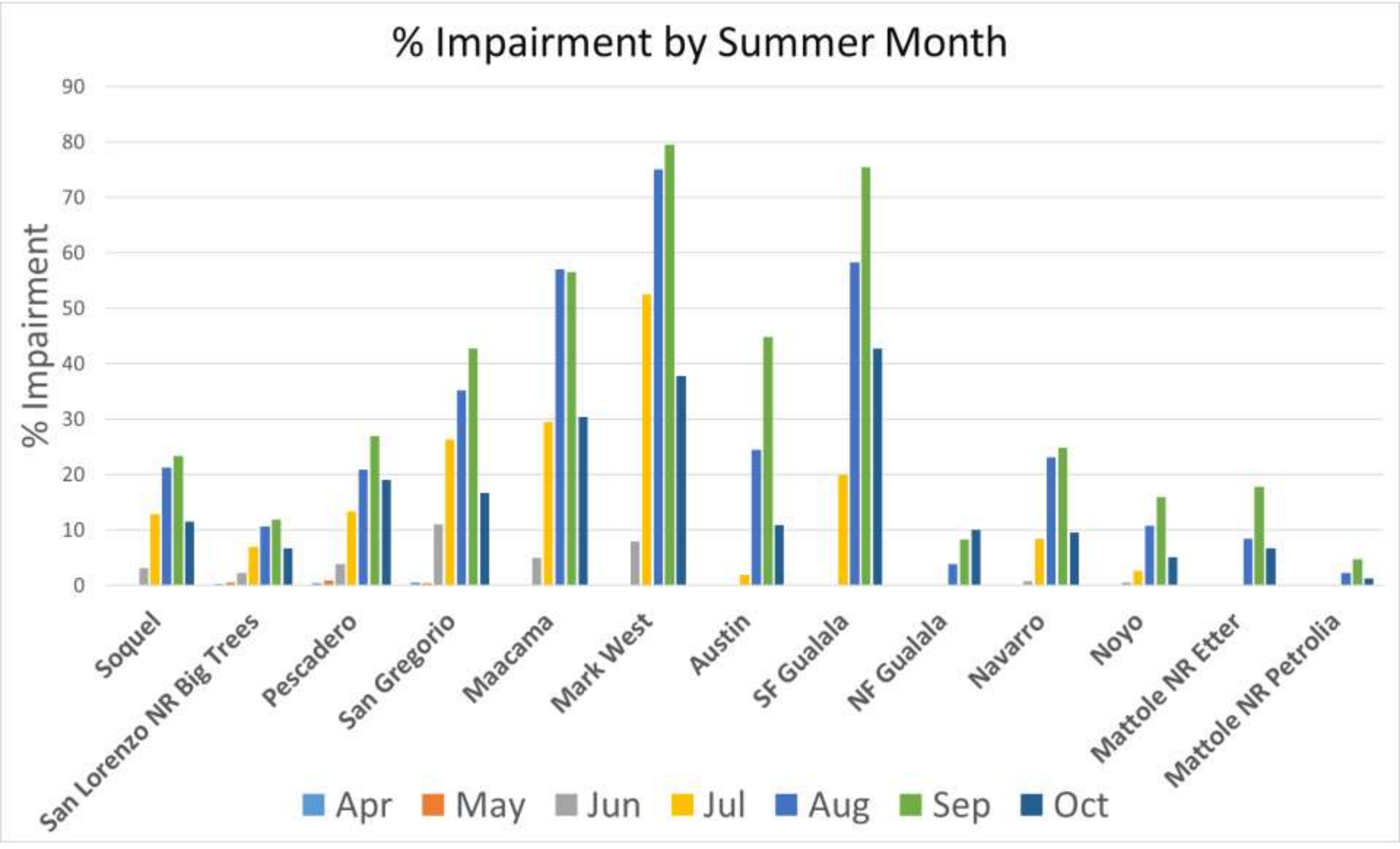
Table 7. North Central Coast Region Compliance Gage Numeric Instream Flow Requirements

Gage Number	Gage Name	Source	November (cfs)	December (cfs)	January (cfs)	February (cfs)	March (cfs)	Aquatic Base Flow (cfs)
11456000	NAPA R NR ST HELENA CA	USGS	52	88	153	159	110	1.6
11458000	NAPA R NR NAPA CA	USGS	109	172	335	342	229	3.5
11458500	SONOMA C A AGUA CALIENTE CA	USGS	38	65	110	117	76	3.7
11459500	NOVATO C A NOVATO CA	USGS	7.5	13	23	24	15	1.1
11460000	CORTE MADERA C A ROSS CA	USGS	10	20	32	32	20	1
11460151	REDWOOD C A HWY 1 BRIDGE A MUIR BEACH CA	USGS	4.6	8.2	13	11	7.3	1.5
11461000	RUSSIAN R NR UKIAH CA	USGS	69	138	197	189	143	3.8
11463000	RUSSIAN R NR CLOVERDALE CA	USGS	324	606	940	935	677	8.9
11463200	BIG SULPHUR C NR CLOVERDALE CA	USGS	63	115	181	190	128	2.9
11463900	MAACAMA C NR KELLOGG CA	USGS	35	61	103	103	73	1.4
11464000	RUSSIAN R NR HEALDSBURG CA	USGS	521	972	1,522	1,539	1,082	14
11465200	DRY C NR GEYSERVILLE CA	USGS	131	253	391	379	253	6.7
11465750	LAGUNA DE SANTA ROSA C NR SEBASTOPOL CA	USGS	33	53	103	101	66	3.8
11466320	SANTA ROSA C A WILLOWSIDE RD NR SANTA ROSA CA	USGS	44	76	132	135	89	2
11466800	MARK WEST C NR MIRABEL HEIGHTS CA	USGS	134	226	407	412	273	7.2
11467000	RUSSIAN R NR GUERNEVILLE CA	USGS	878	1,645	2,585	2,592	1,829	26

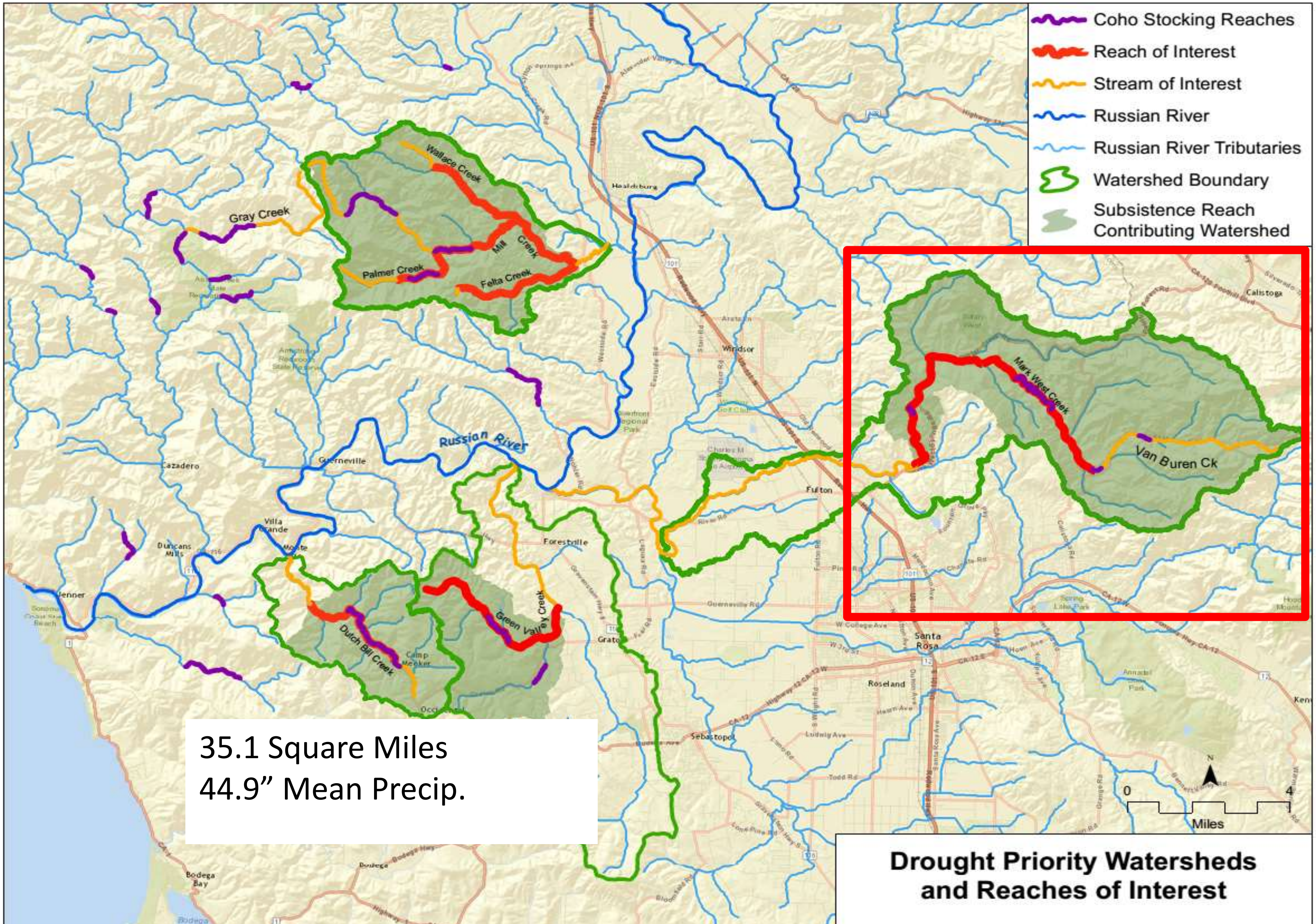
Flows Below Aquatic Base Flow by Month

Gage Name	Aquatic Base Flow (cfs)	2012	2013	2014	2015	2016	2017	2018
MATTOLE R NR PETROLIA CA	27.2	August	August	July	July	July	August	August
MATTOLE R NR ETTERSBURG CA	7.8	September	September	July	July	July	August	August
NOYO R NR FORT BRAGG CA	5.5	August	July	July	June	August	MET	August
NAVARRO R NR NAVARRO CA	8.4	July	July	June	June	July	August	July
NF GUALALA R NR GUALALA CA	3.9	September	August	August	July	September	MET	August
SF GUALALA R NR SEA RANCH	4.9	August	July	July	July	August	August	July
AUSTIN C NR CAZADERO CA	1.3	September	August	August	July	August	September	August
MARK WEST C NR MIRABEL	7.2	July	July	June	June	July	July	June
MAACAMA C NR KELLOGG CA	1.4	ND	July	June	June	August	August	July
SAN GREGORIO C	1	August	July	May	June	MET	MET	July
PESCADERO C NR PESCADERO	2.5	August	July	May	June	MET	MET	July
SAN LORENZO R A BIG TREES CA	15.9	September	July	May	June	August	MET	August
SOQUEL C A SOQUEL CA	2.3	September	July	May	June	August	MET	August

Watershed Impairment



Mark West Creek

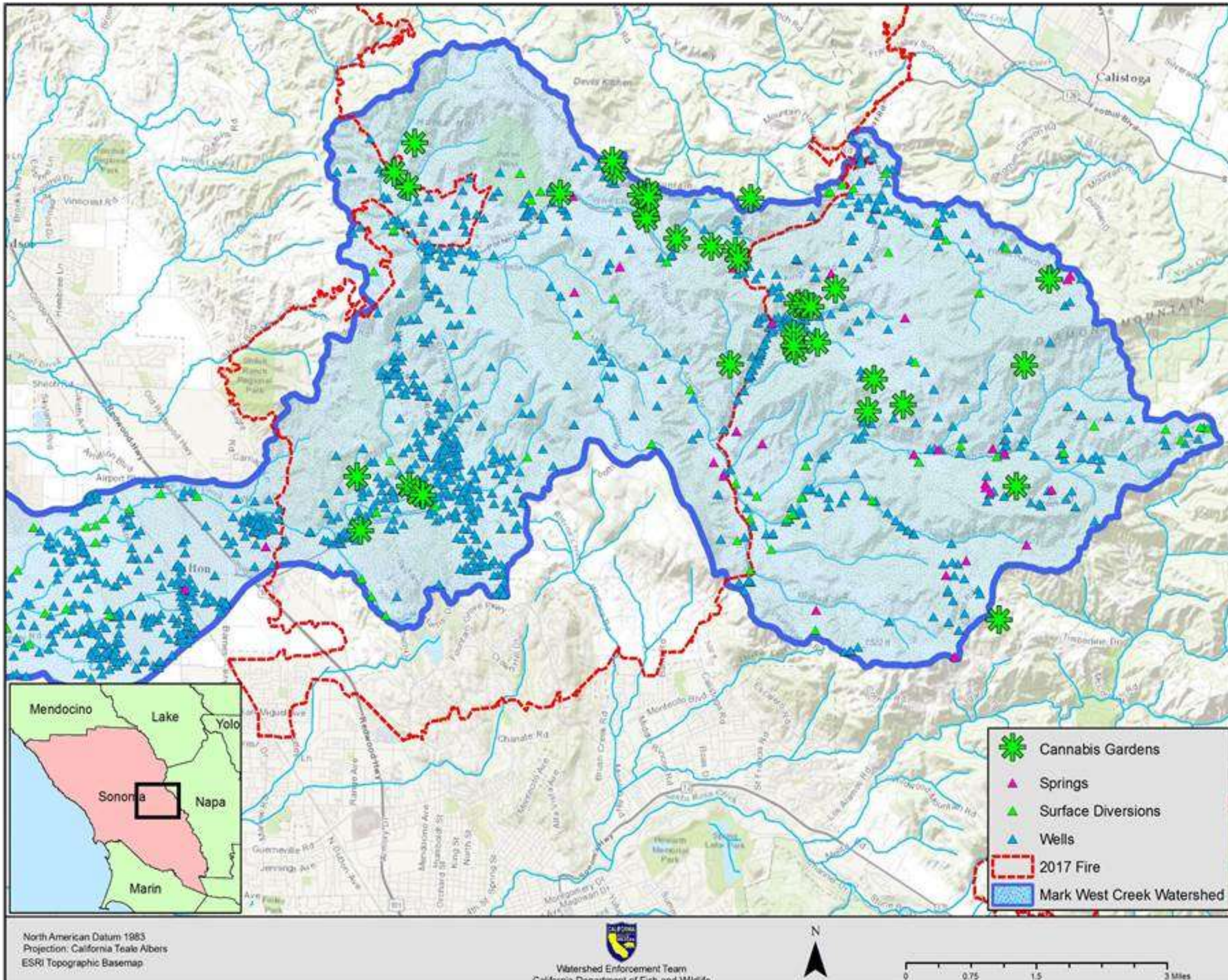

Coho Stocking Reaches
Reach of Interest
Stream of Interest
Russian River
Russian River Tributaries
Watershed Boundary
Subsistence Reach
Contributing Watershed
Wallace Creek
Mill Creek
Felta Creek
Palmer Creek
Gray Creek
Russian River
Healdsburg
Guerneville
Windsor
Fulton
Mark West Creek
Van Buren Ck
Calistoga
Green Valley Creek
Dutch Bill Creek
Forestville
Cazadero
Jenner
Santa Rosa
Roseland
Sebastopol
Bodega Bay
0
4
Miles
35.1 Square Miles
44.9” Mean Precip.
Drought Priority Watersheds
and Reaches of Interest

Drought!

- On January 17, 2014, Governor Brown proclaimed a drought State of Emergency

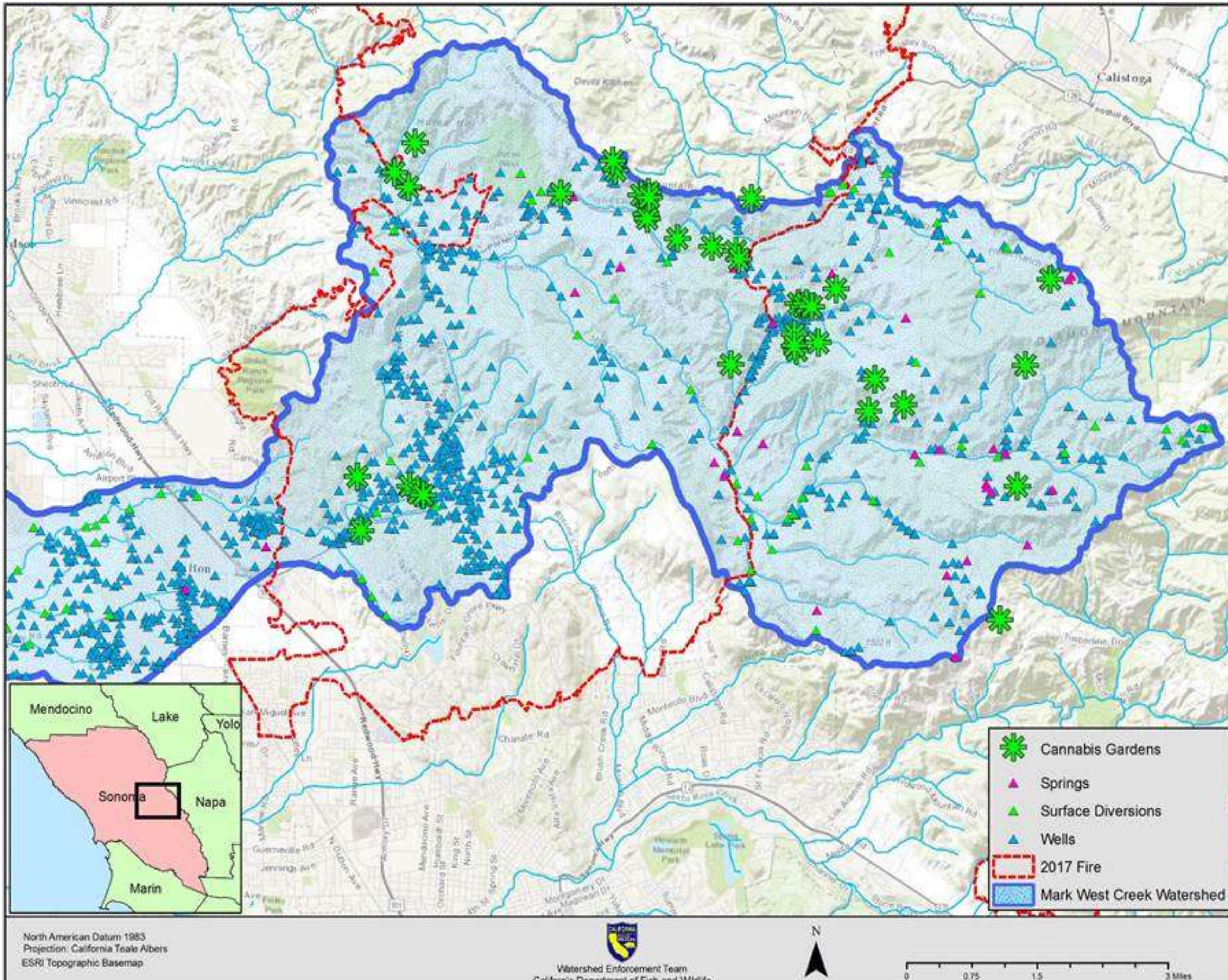
- On May 5, 2015, the SWRCB adopted a mandatory 25% statewide reduction in potable urban water use.

- The Emergency Drought Regulation in Russian River tributaries required all landowners to disclose their water source and usage to SWRCB.

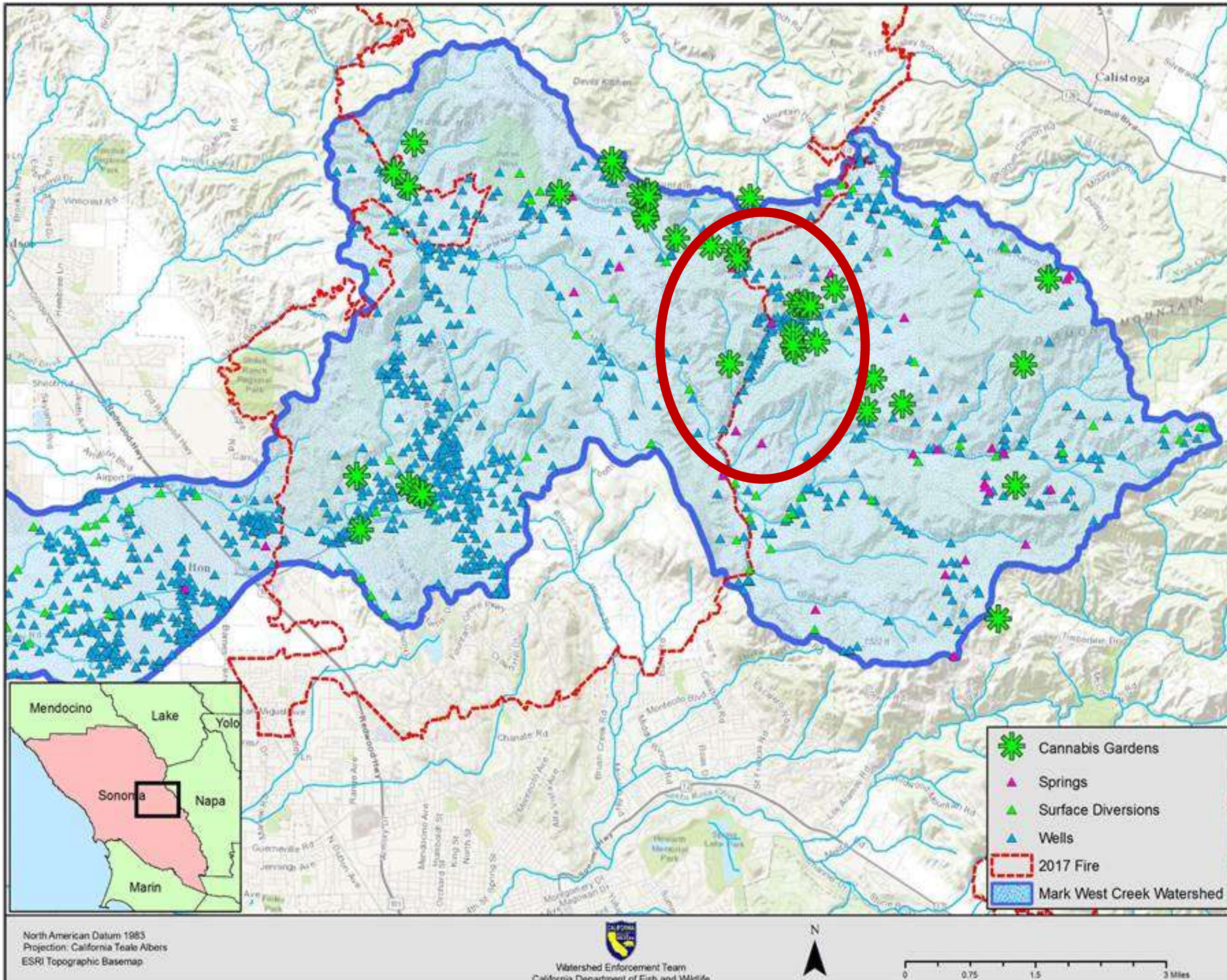

Calistoga
Mendocino
Lake
Yolo
Sonoma
Napa
Marin
Cannabis Gardens
Springs
Surface Diversions
Wells
2017 Fire
Mark West Creek Watershed
North American Datum 1983
Projection: California Teale Albers
ESRI Topographic Basemap
Watershed Enforcement Team
California Department of Fish and Wildlife
N
0
0.75
1.5
3 Miles

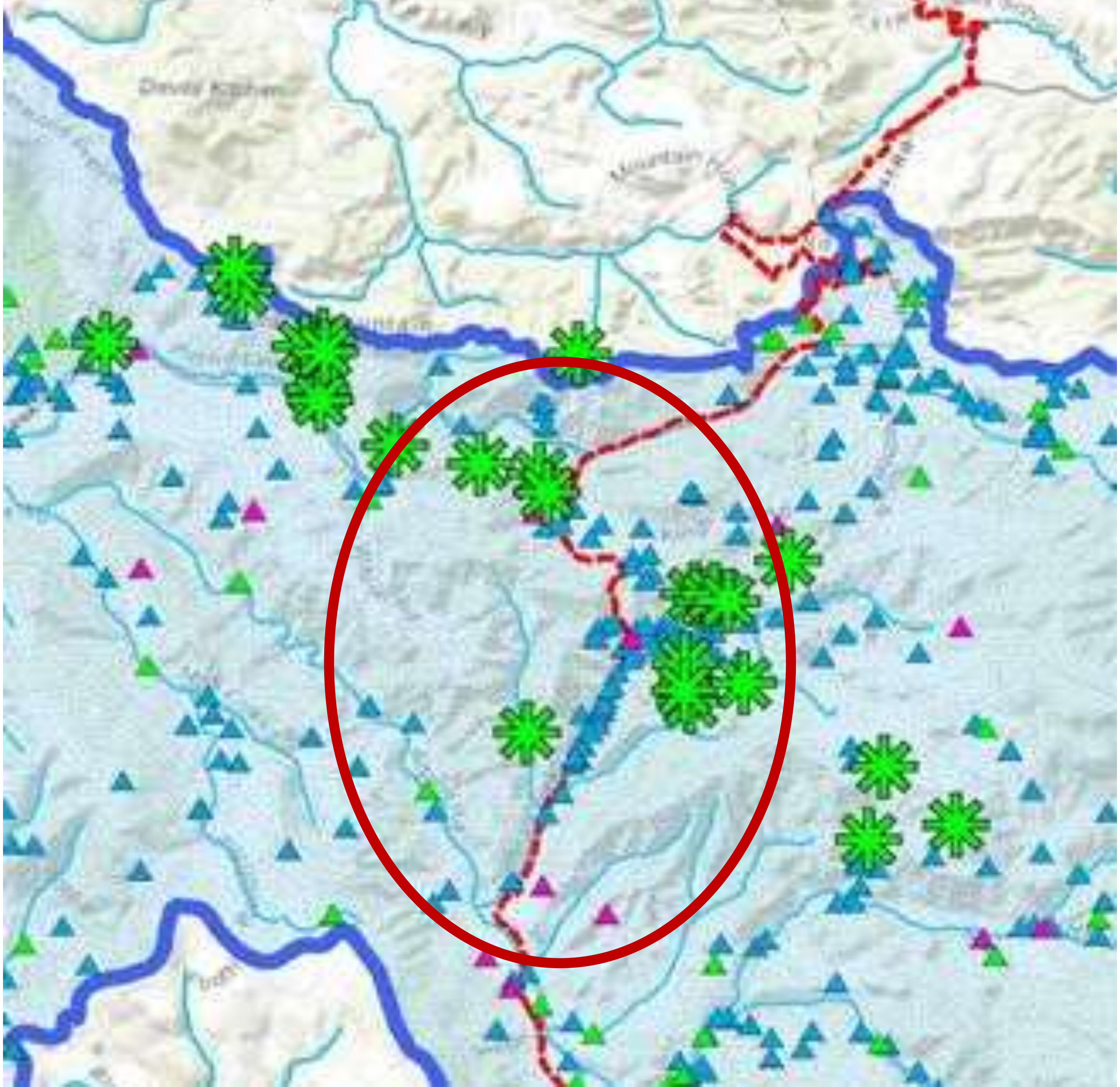
Upper Mark West Creek

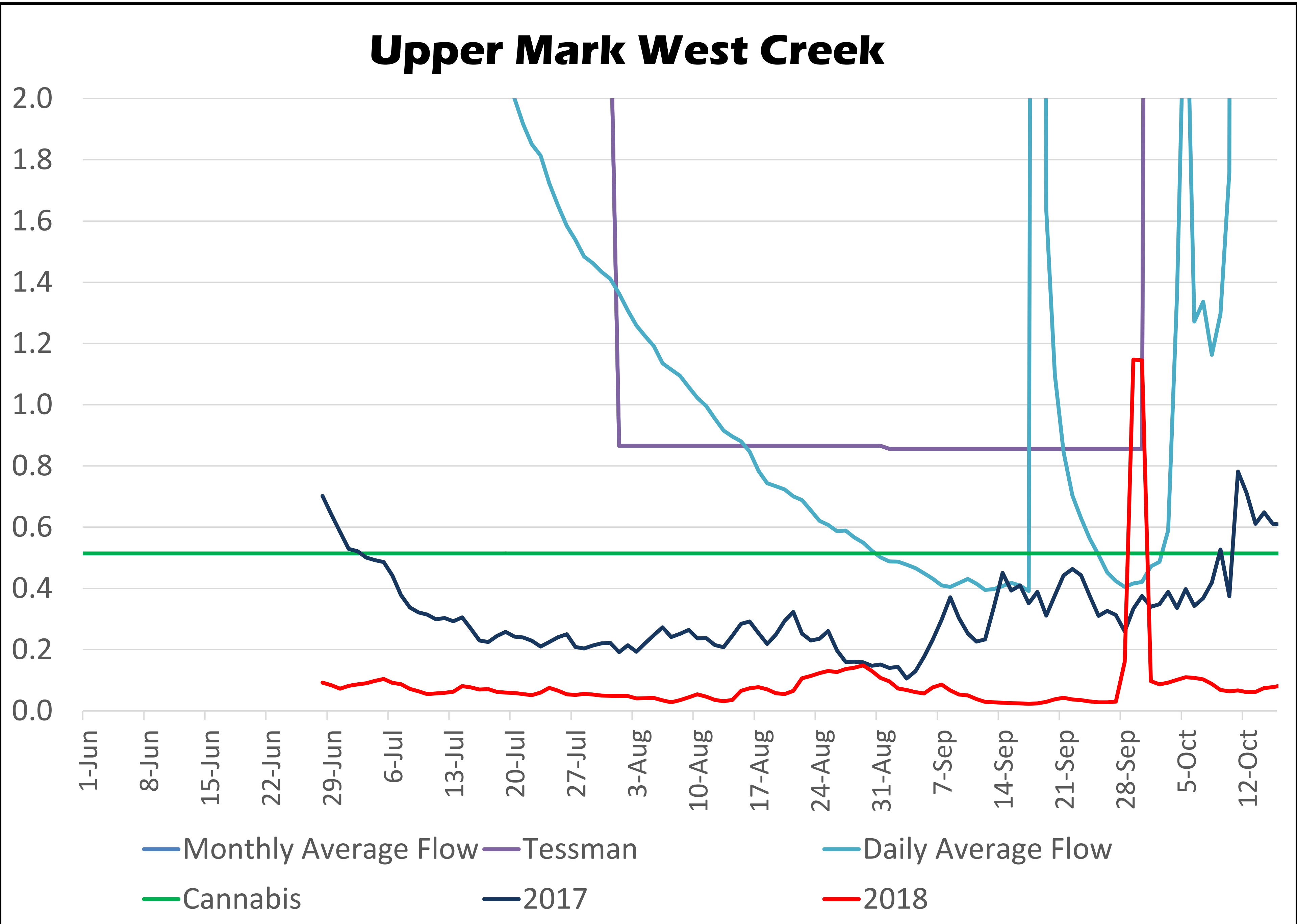
- Over 400 wells reported in Information order
- 47 surface diversions
- 27 springs
- 40+ grows were mapped in 2017
- 10 projects are moving forward with Permits
- All but one are diverting from a well
- All wells were determined to be affecting streamflow

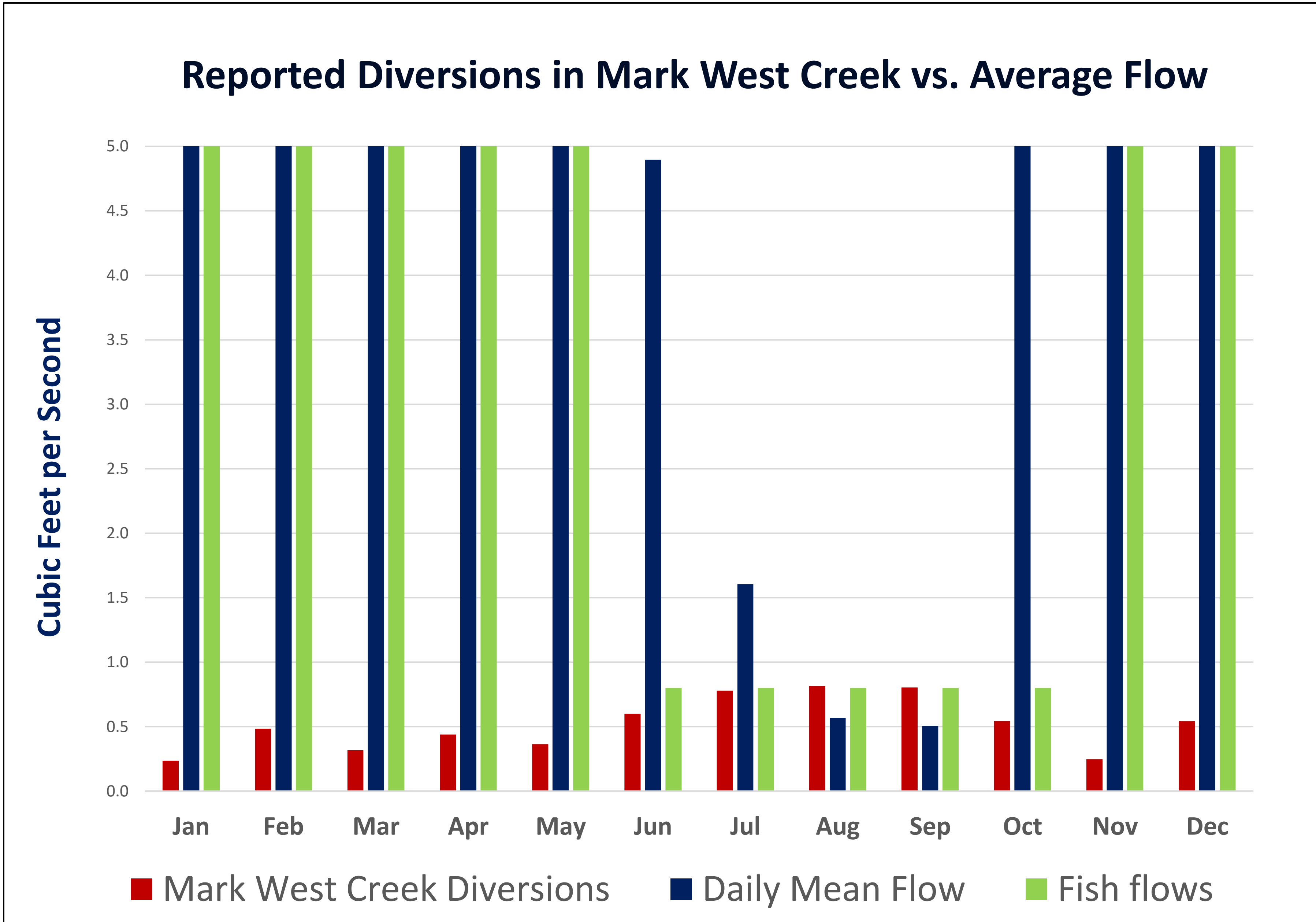


Calistoga
Mendocino
Lake
Yolo
Sonoma
Napa
Marin
Cannabis Gardens
Springs
Surface Diversions
Wells
2017 Fire
Mark West Creek Watershed
North American Datum 1983
Projection: California Teale Albers
ESRI Topographic Basemap
Watershed Enforcement Team
California Department of Fish and Wildlife
N
0
0.75
1.5
3 Miles


Calistoga
Mendocino
Lake
Yolo
Sonoma
Napa
Marin
Cannabis Gardens
Springs
Surface Diversions
Wells
2017 Fire
Mark West Creek Watershed
North American Datum 1983
Projection: California Teale Albers
ESRI Topographic Basemap
Watershed Enforcement Team
California Department of Fish and Wildlife
N
0
0.75
1.5
3 Miles




Upper Mark West Creek
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1-Jun
8-Jun
15-Jun
22-Jun
29-Jun
6-Jul
13-Jul
20-Jul
27-Jul
3-Aug
10-Aug
17-Aug
24-Aug
31-Aug
7-Sep
14-Sep
21-Sep
28-Sep
5-Oct
12-Oct
Monthly Average Flow
Tessman
Daily Average Flow
Cannabis
2017
2018


Reported Diversions in Mark West Creek vs. Average Flow
Cubic Feet per Second
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Mark West Creek Diversions
Daily Mean Flow
Fish flows

What can we do now?

- Outreach and education
- More gauging
- Site specific well forbearance requirements

Questions?