Evolving Policies and Tools to Advance Salmon Restoration: Flows, Cannabis, and Funding Opportunities

A Concurrent Session at the 40th Annual Salmonid Restoration Conference held in Fortuna, California from April 25−28, 2023

Session Coordinators:

- Kelly Souza, California Department of Fish and Wildlife
- Matt Clifford, Trout Unlimited
- Monty Schmitt, The Nature Conservancy

This hybrid session will include presentations about direct and indirect impacts of cannabis cultivation on the environment; advancements in tools and applications that quantify cultivation, species response or water use; and opportunities or partnerships that highlight the remediation and restoration of watersheds affected by cannabis cultivation.

After the break, the session will focus on policy shifts and practical tools to advance the pace and scale of restoration and address water scarcity, groundwater management, and tribal inclusion.

Presentations

- Slide 4, **A Site-Specific Analysis to Understand the Role of Human Influence and Drought on Streamflow Conditions in a Small Humboldt County Watershed,** Kelly Souza, *California Department of Fish and Wildlife*
- Slide 22, **How CDFW's Cannabis Restoration Grant Program Can Contribute to Salmonid Restoration**, Virginia O'Rourke, *California Department of Fish and Wildlife*
- Slide 32, **Modeling Streamflow Depletion from Cannabis Cultivation in California's North Coast Salmon-Bearing Streams**, Philip Georgakakos, Ph.D., *University of California, Berkeley*
- Slide 70, **Efficient Science Tools to Identify Streamflow Objectives to Support Flow Enhancement Project Development and Implementation, and Trigger Management Actions Under Critically Dry Conditions,** Julie Zimmerman, *The Nature Conservancy*
- Slide 95, **Water From Bedrock: Efforts to Condition New Groundwater Wells to Protect Streamflow for Salmon in Sonoma County,** Monty Schmitt, *The Nature Conservancy* and Matt Clifford, *Trout Unlimited*
- Slide 117, **Granting Equity. The Future of CDFW's Granting Programs,** Timothy Chorey, FRGP State Coordinator, *California Department of Fish and Wildlife*

USE OF SATELLITE IMAGERY TO ASSESS HUMAN WATER USE ON HYDROLOGIC CONDITIONS, REDWOOD CREEK

Kelly Souza, CDFW Cannabis Program

April 2024

INTRODUCTION

Background

Why Redwood Creek subwatershed?

Why now?

What does the data and analysis show?

Conditions were at all-time lows

Estimated water needs exceeds that of surface flow

Water-year alone does not explain observed surface flow

Moving forward

BACKGROUND

CULTIVATION

BIODIVERSITY

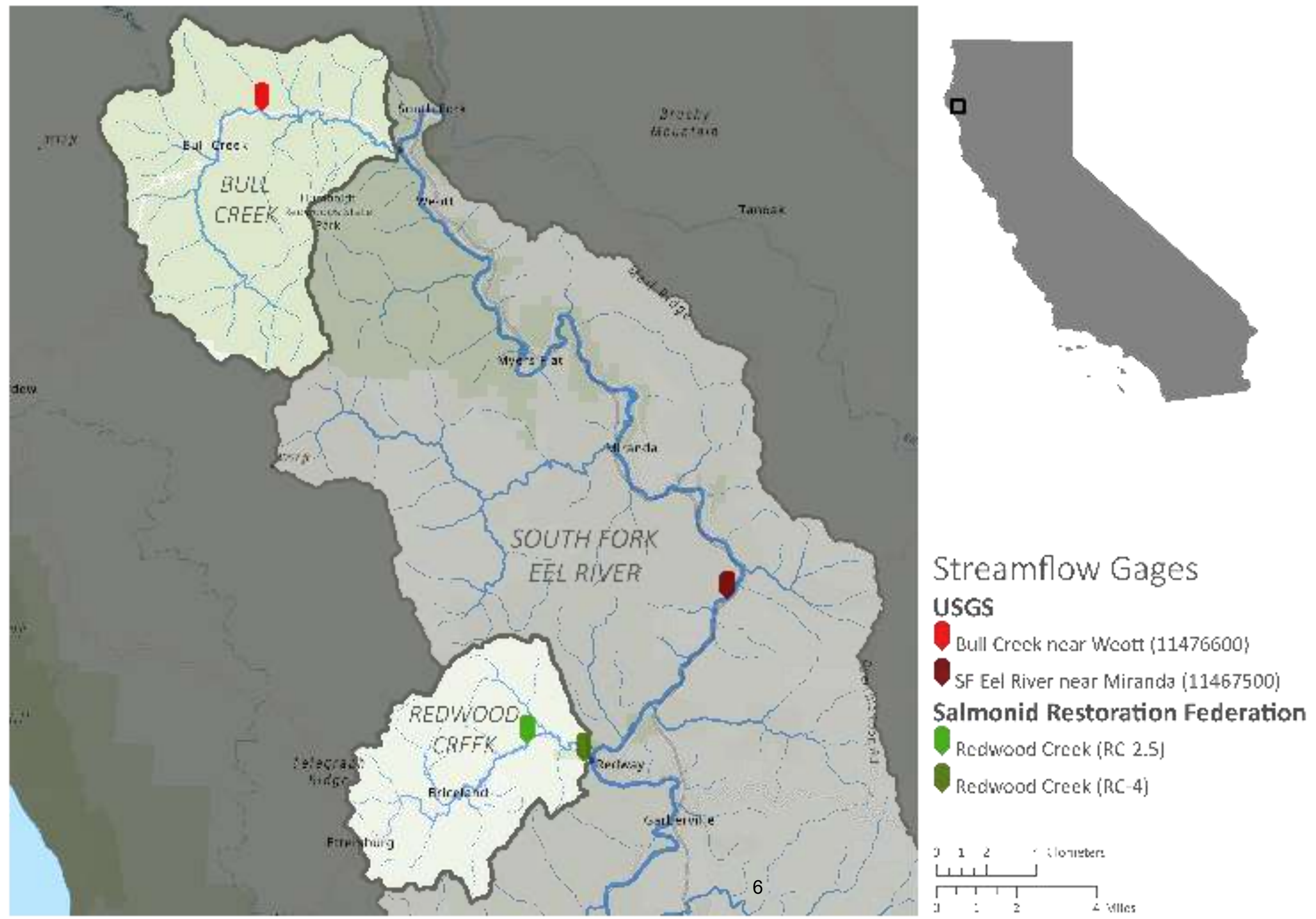
LAND USE

OBSERVED DATA

PAIRING

INVESTMENTS

POTENTIAL

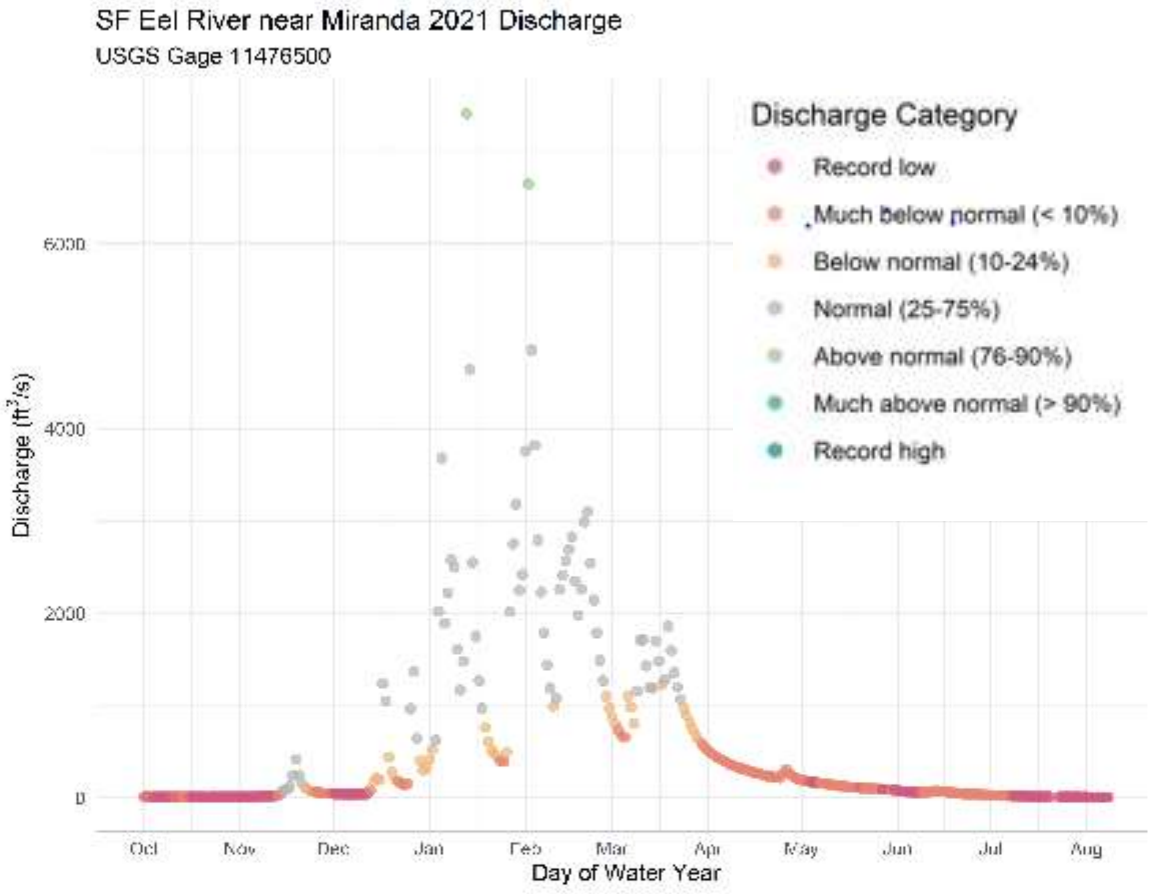


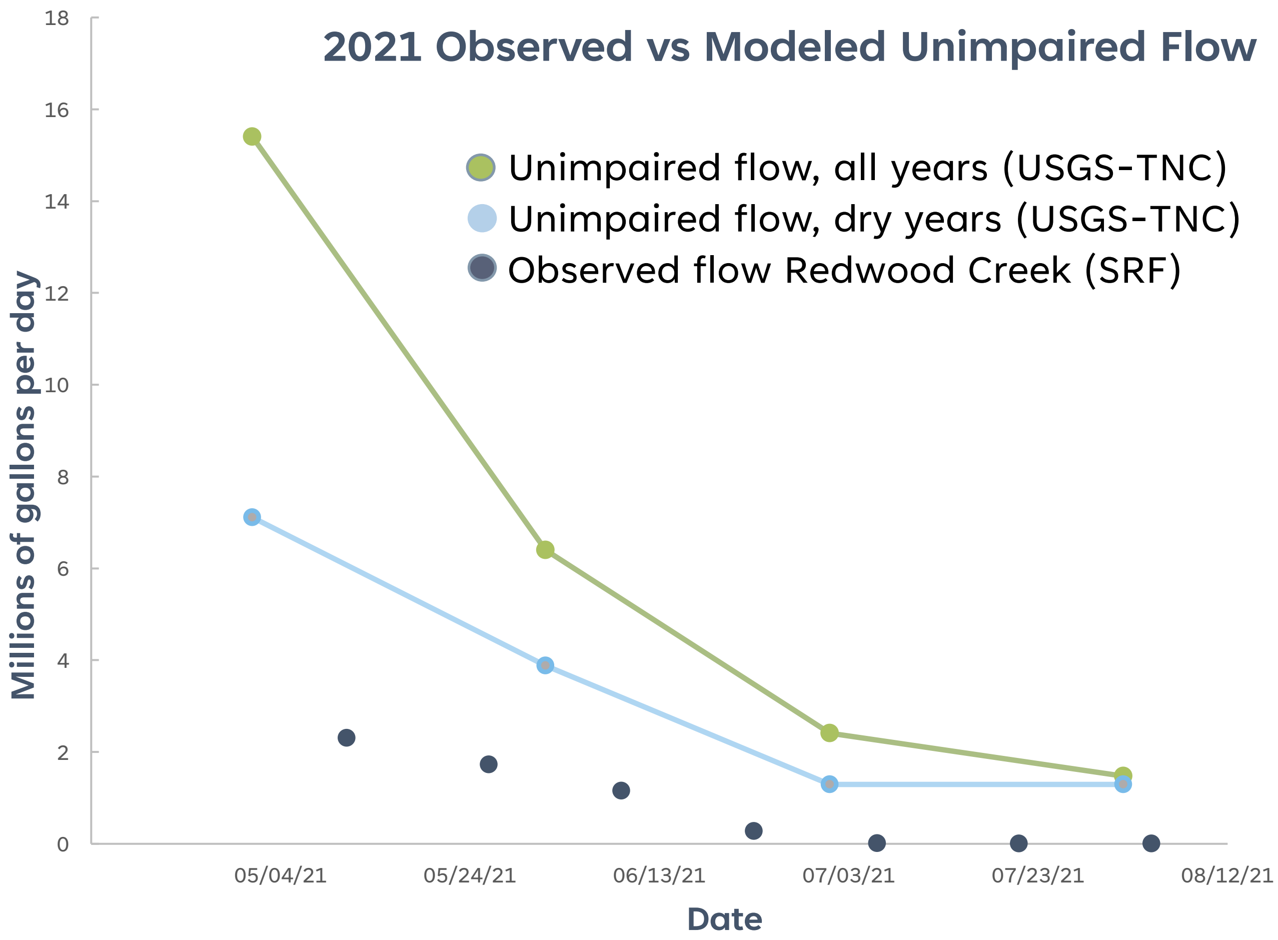
Coho Salmon
Chinook Salmon
Steelhead
Pacific Lamprey
Western Brook Lamprey
Inland Threespine Stickleback

Foothill Yellow-legged Frog
Pacific Giant Salamander
Southern Torrent Salamander
Northern Red-legged Salamander
Tailed Frog
Western Pond Turtle
Boreal Toad

Northern Spotted Owl
White-flowered Rein Orchid

2021 Hydrologic Conditions

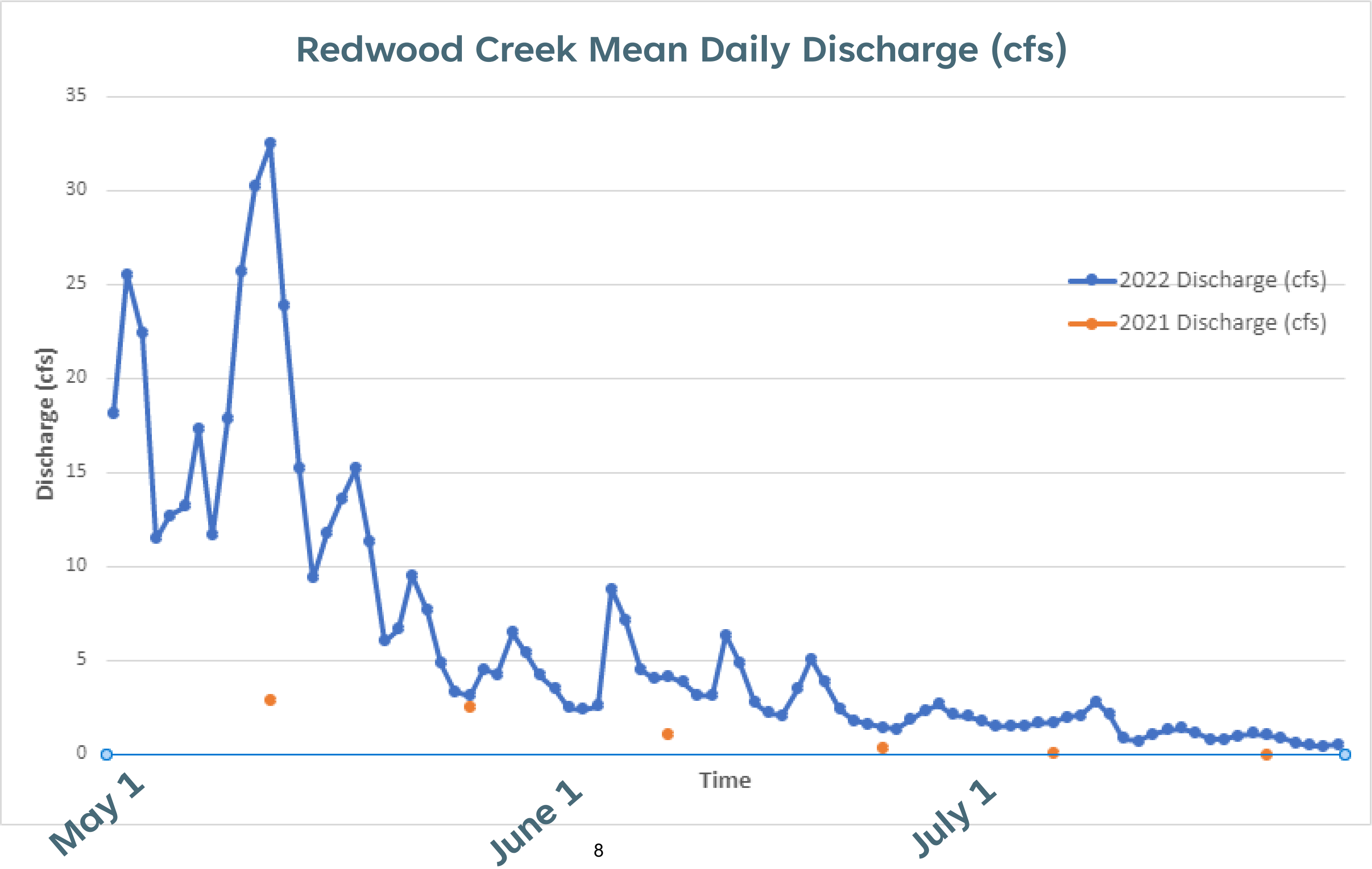




- Regional all-time record low flows, **second consecutive year**

- Redwood Creek **water deficit**

2022 Hydrologic Conditions



Questions

1

What are current regional conditions?

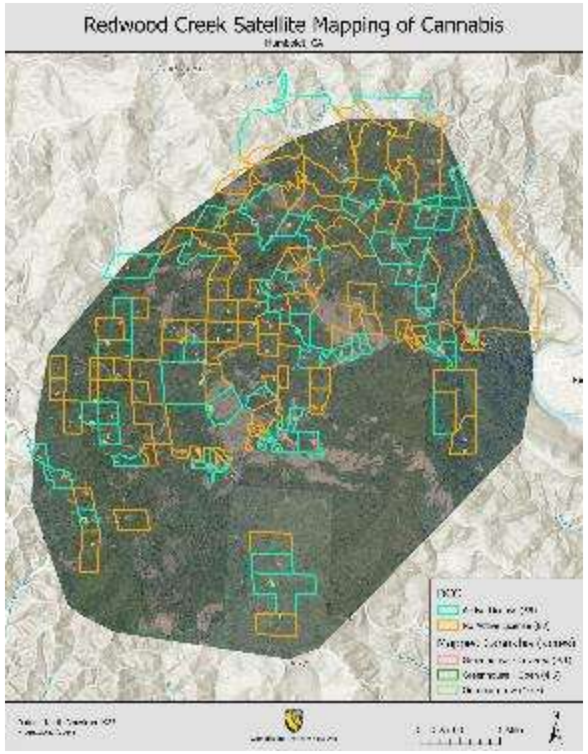
2

What is plant need, storage capacity and water availability?

3

Is site or water year significant?

② 2021 Estimate of Plant Need (mapping) and Storage (SWRCB)

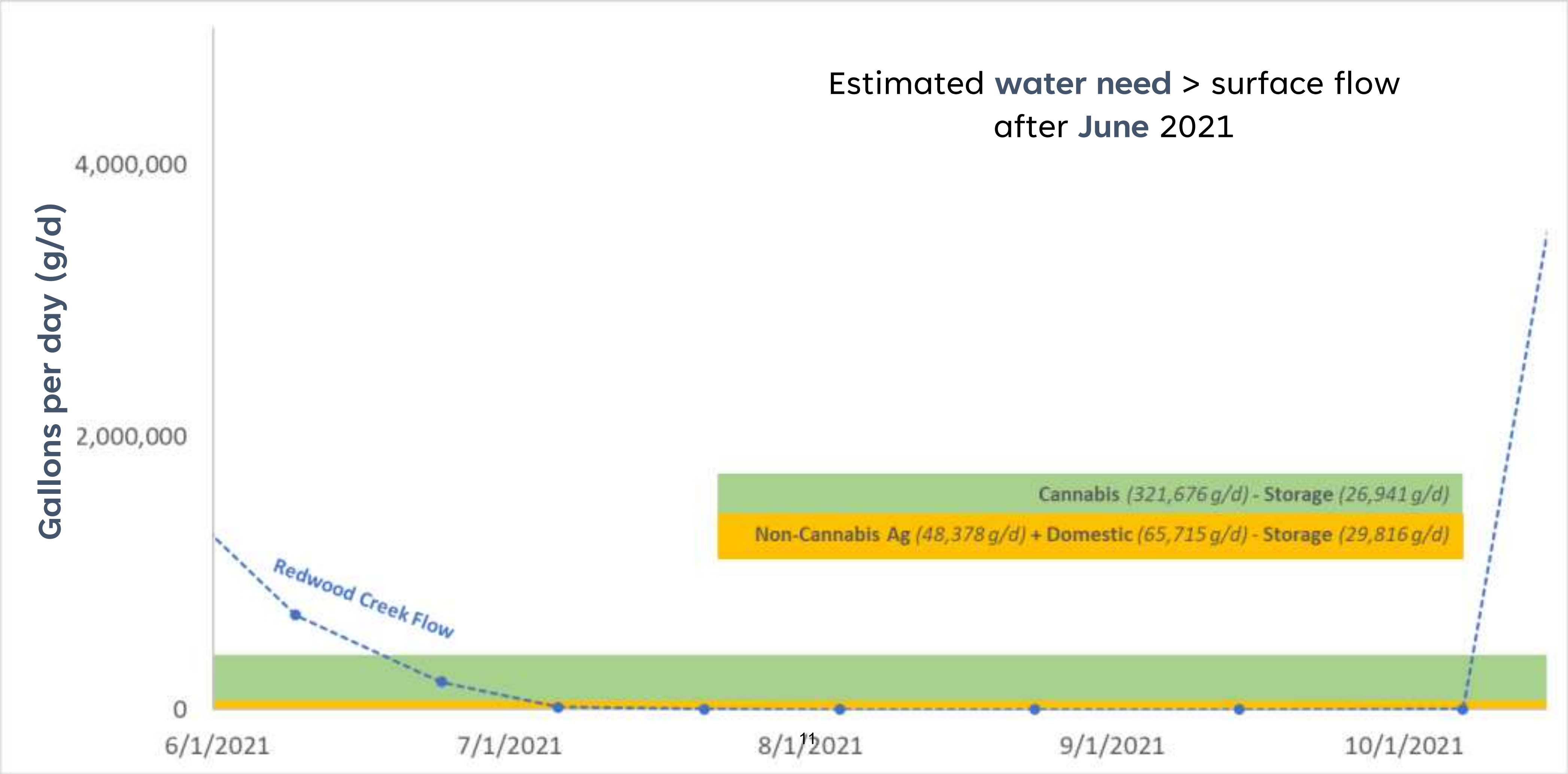


	2021		2022	
	Licensed	Unlicensed	Licensed	Unlicensed
Outdoor (5.5 gpd)	**63,022**	**64,591**	**8,194**	**0**
Greenhouse (2.5 gpd)	**148,394**	**45,670**	**127,611**	**18,404**
Storage (gpd)	**26,941**	**0**	**26,941**	**0**
	184,475	110,261	108,864	18,404

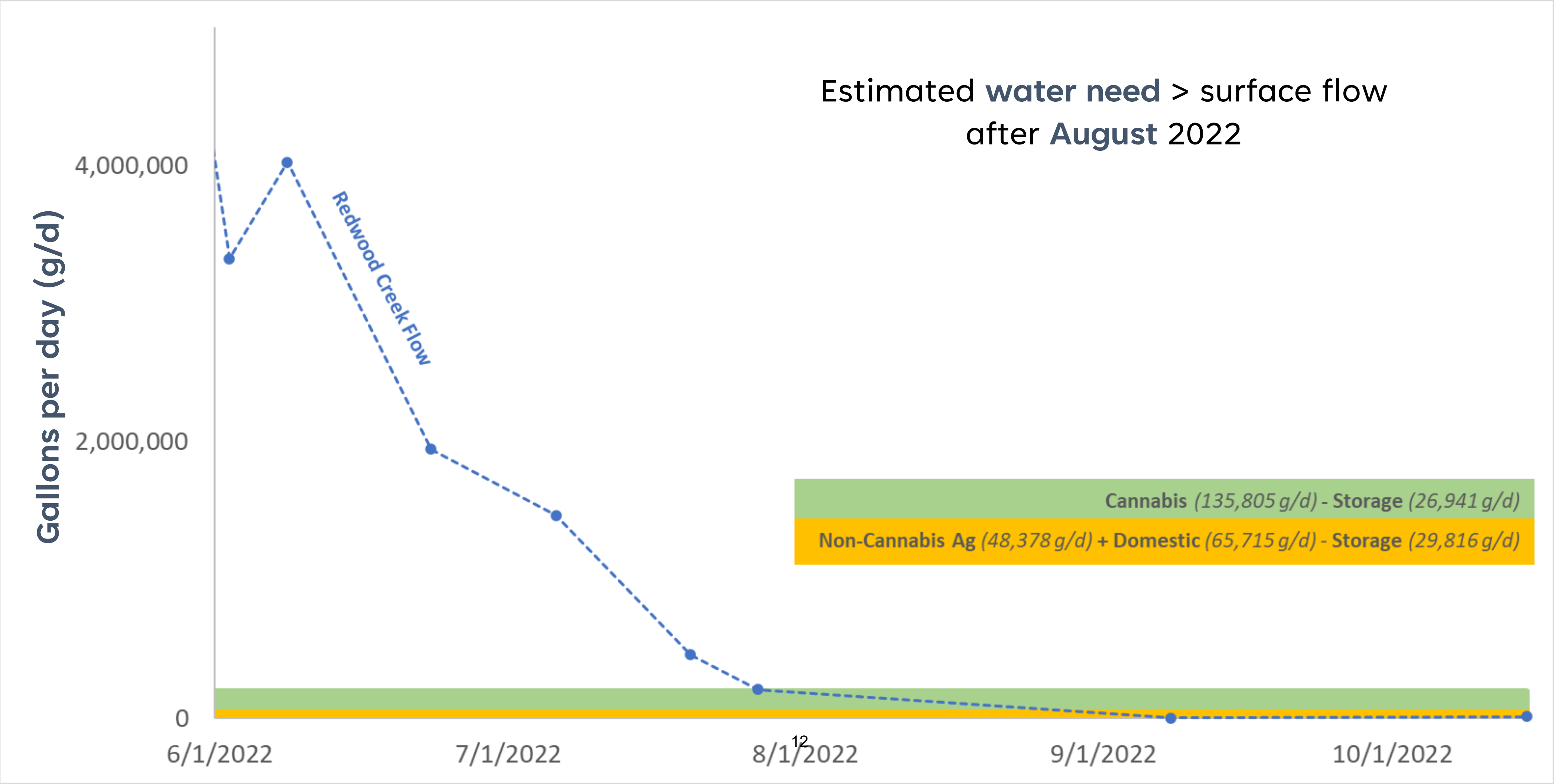
Water use is dominated by the **regulated** community

These are plant-based water need estimates and maximum storage capacity (SWRCB).
Water source an extraction timing are not accounted for here.

② 2021 Water Need vs. Surface Flow



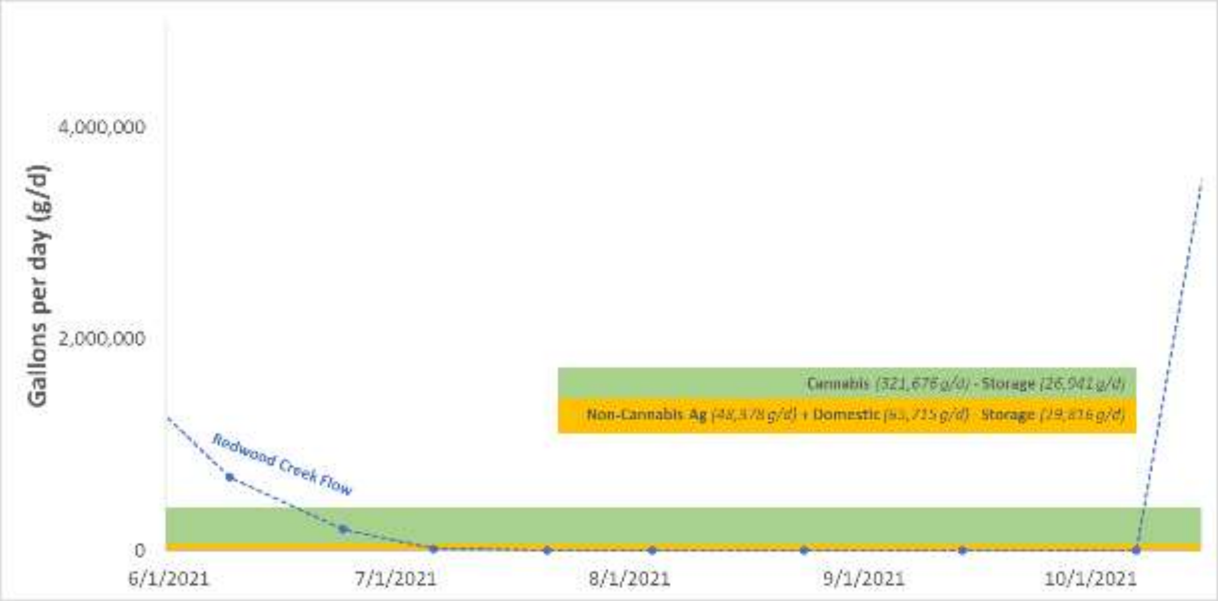
② 2022 Water Need vs. Surface Flow

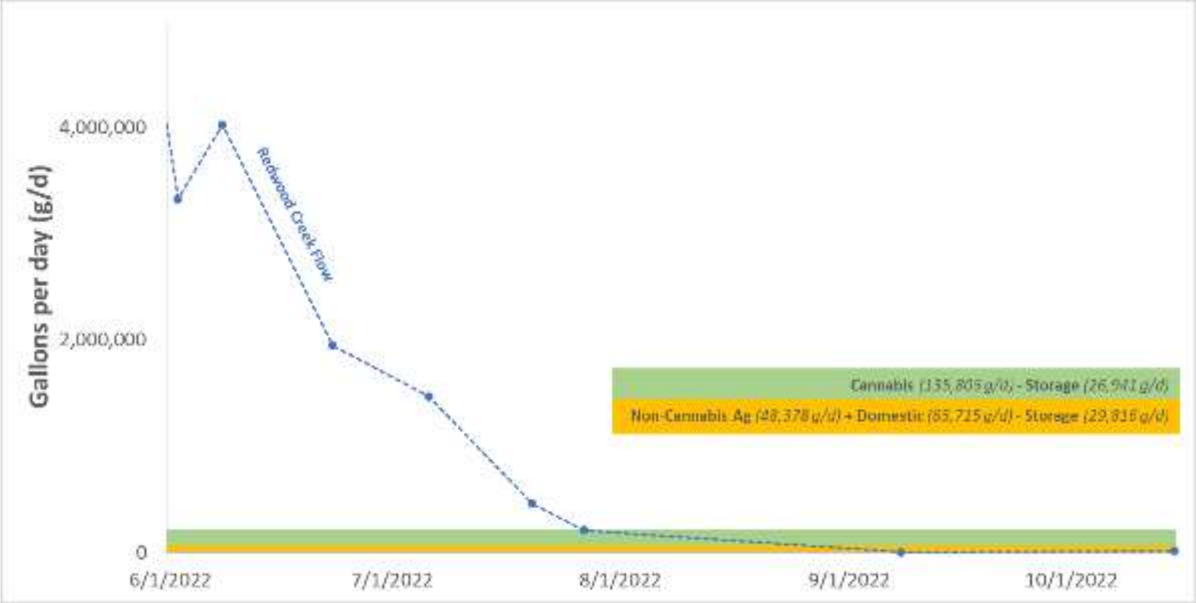


② 2021 and 2022 Water Need vs. Surface Flow

Estimated **water need** > surface flow after **June** 2021

Estimated **water need >** surface flow after **August** 2022





Wetter water year in 2022

Cannabis **water need decreased** from 321,676 g/d → 135,805 g/d

③ Pairing and Scaling

Close proximity

Similar size

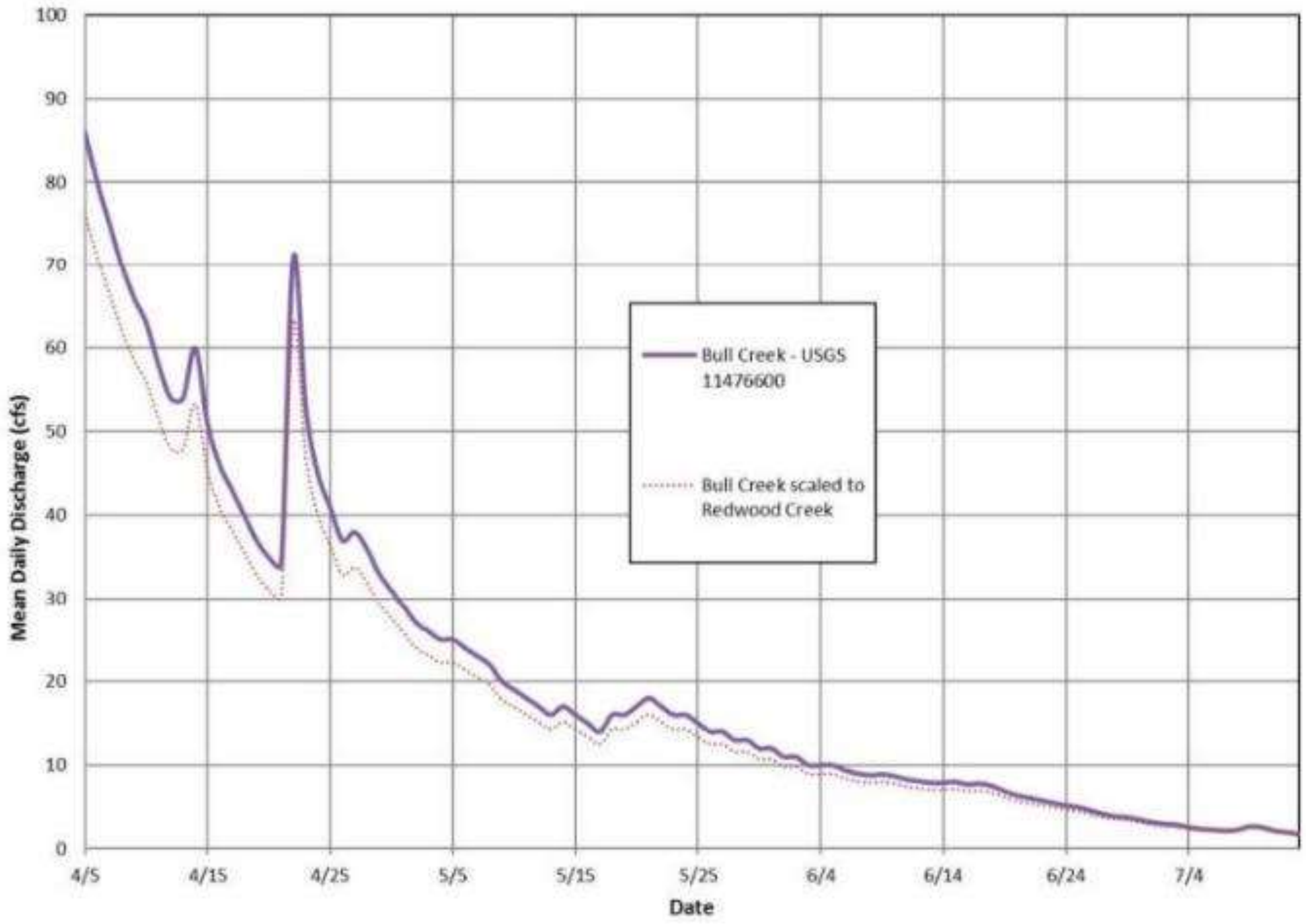
Surface flow record

Mean annual precipitation

Aspect

Gradient

+Lithology/Geology

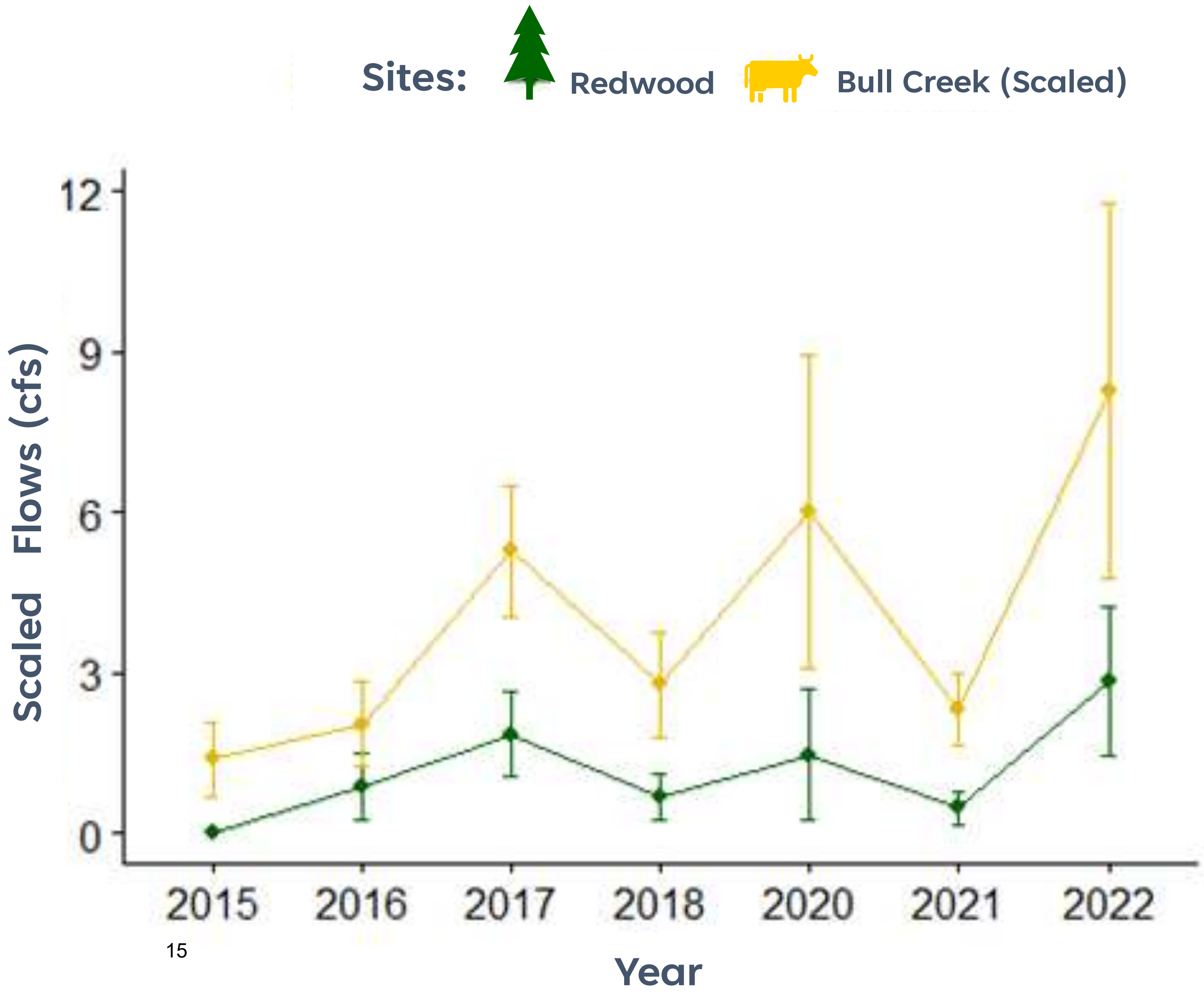


[1]Cowan, W. 2018. Flow Monitoring and Unimpaired Flow Estimation Report for Redwood Creek, Humboldt County. Stream Evaluation Report 18-1. California Department of Fish and Wildlife, Water Branch Instream Flow Program. 33 pp.

③ The Role of Site and Year

Site and year play a significant role in observed flow!

Site; $p < 0.01$
Year; $p < 0.05$



Moving Forward

Outreach

Inspections

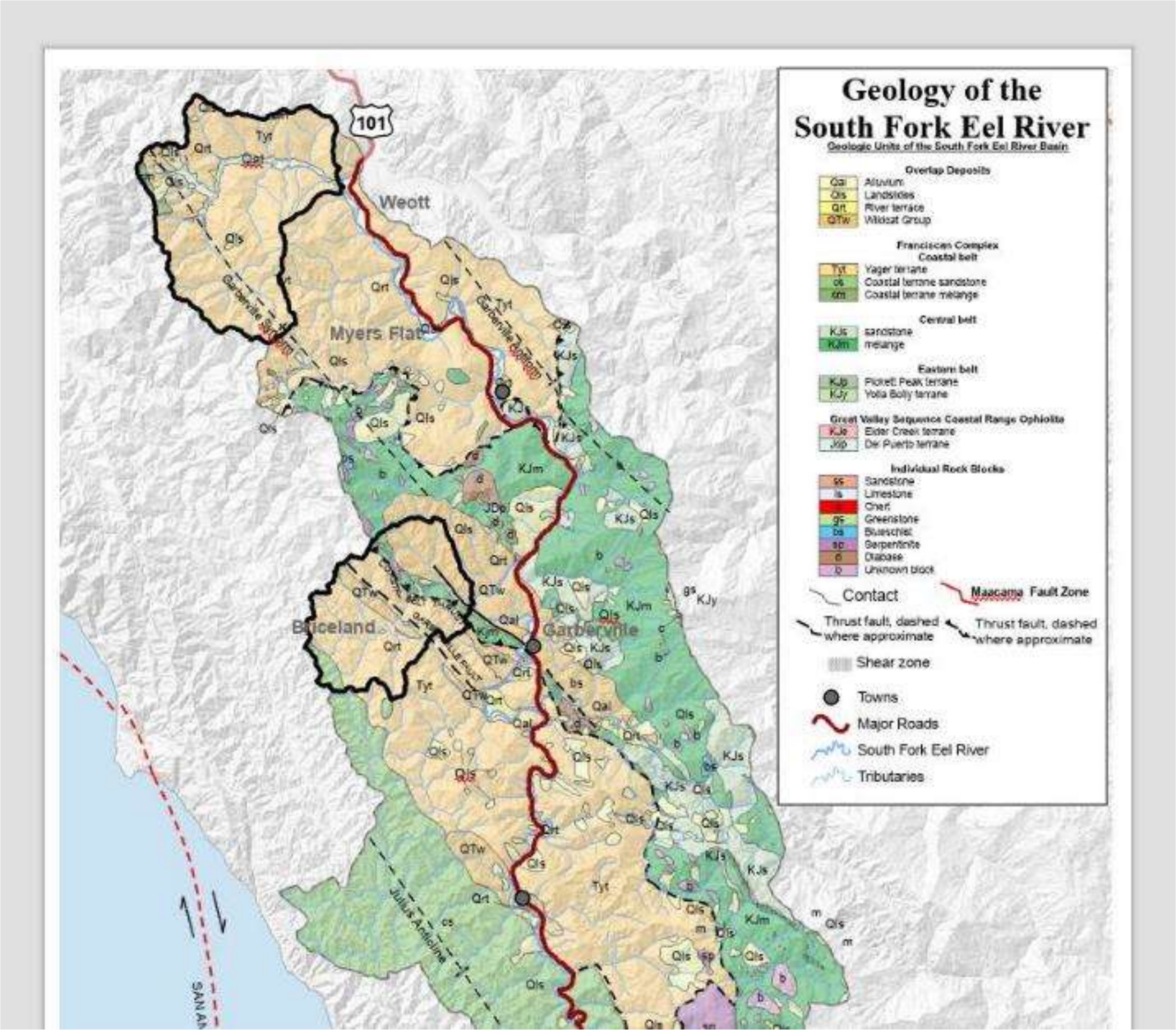
Continued Monitoring

Granting Opportunities

QUESTIONS & DISCUSSION

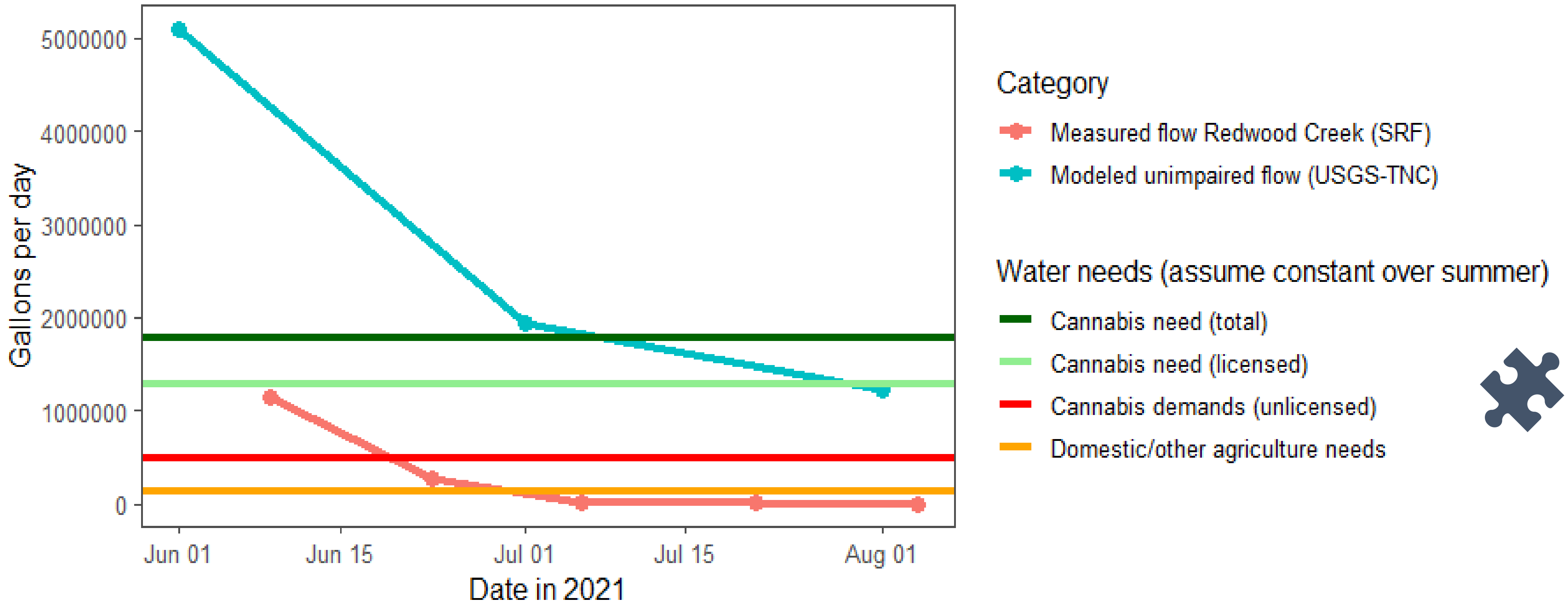
Placeholder for Sara's map

- We need:
  - Bull and Redwood Creek subwatersheds, within SFE, within CA
  - Location of USGS Gages used for analyses
  - Delineated area
  - Location of measured flow locations



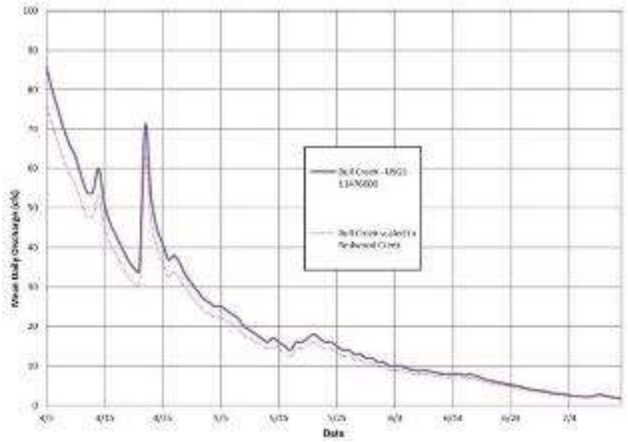
WHAT IS PLANT NEED RELATIVE TO SURFACE FLOW?

Redwood Creek



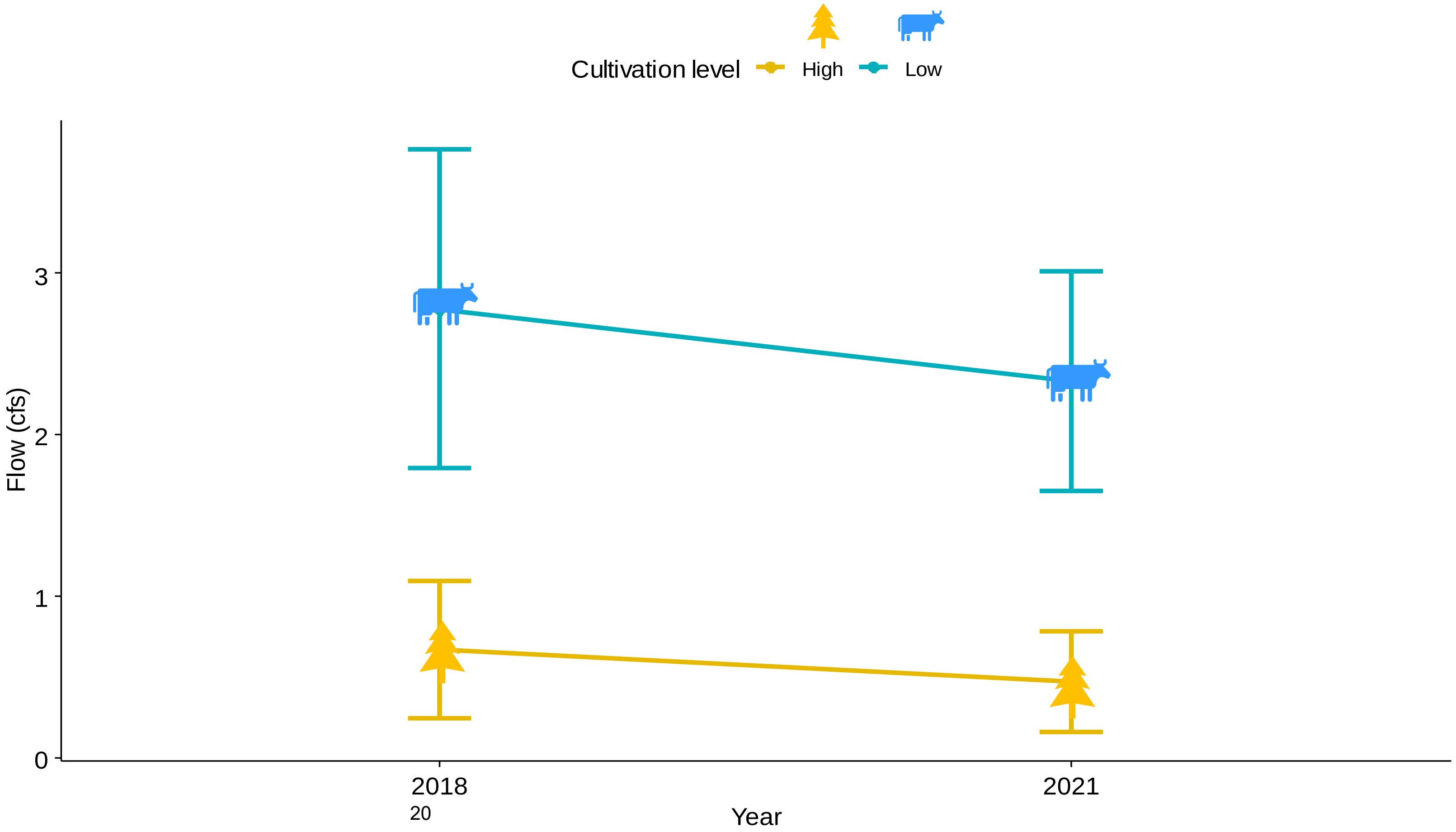
IS OBSERVED SURFACE FLOW DUE TO DROUGHT ALONE?

Comparative analysis



Factor	DF	Sum of Squares	Mean Square	F value	Pr(>F)
Year	1	.31	.31	.25	.63
Cultivation level	1	11.81	11.81	9.22	.01
Interaction (Cultivation level * year)	1	0.04	0.04	.034	.85
Residuals	8	10.24	1.28		

Drought **does not** explain the difference in surface flow between Bull and Redwood Creeks: F = 9.22, df=8, p = 0.01



SOURCES OF UNCERTAINTY

DATA LIMITATIONS

Well use and springs

Storage

Time series

DATA OPPORTUNITIES

Mapping validation

Empirical data

Cannabis and Salmonid Restoration

California Department of Fish and Wildlife
Cannabis Restoration Grant Program

Thursday, April 27, 2023

Presented by California Department of Fish and Wildlife

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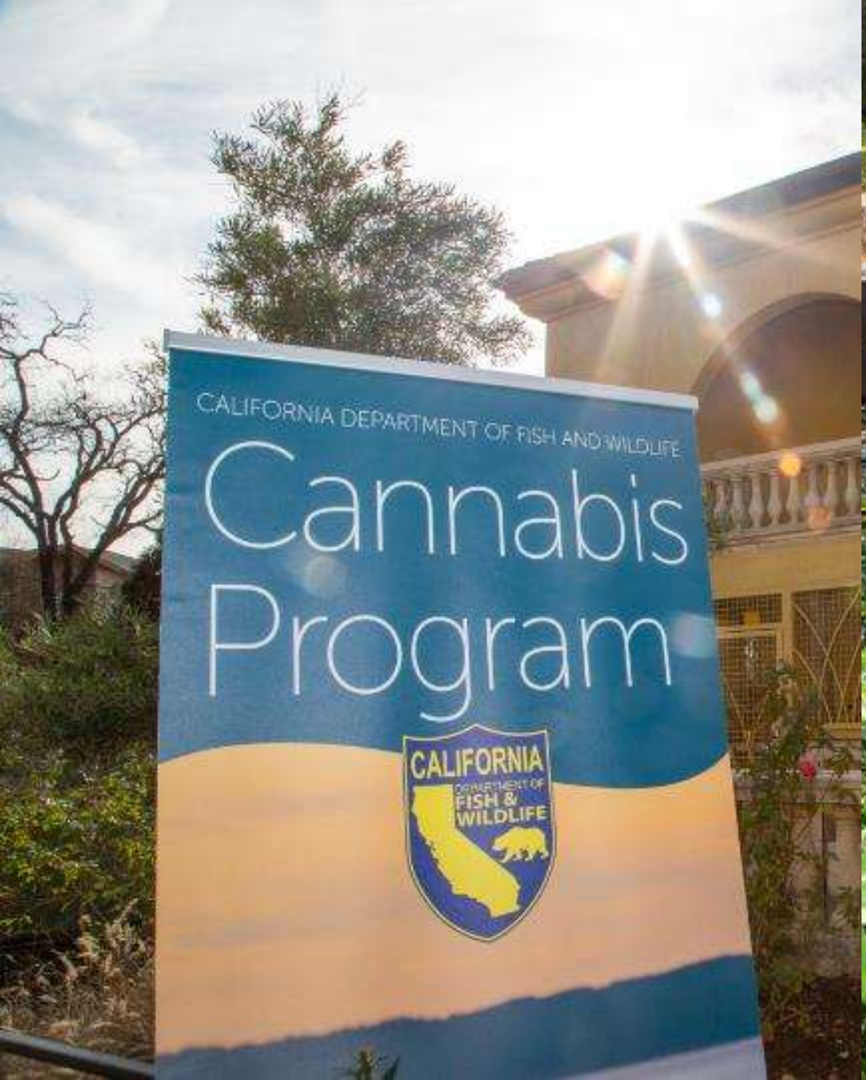

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
Cannabis Program
CALIFORNIA
DEPARTMENT OF
FISH &
WILDLIFE

Funding Opportunities

Cleanup, Remediation, and Watershed Enhancement (CRWE) Funding Opportunity

Project Priorities

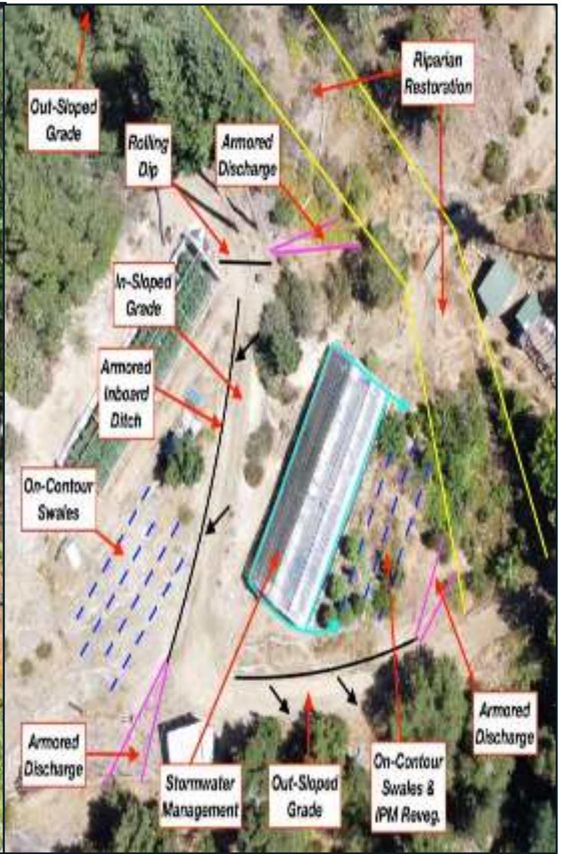
1) Cleanup and Remediation on Qualified Public Land[1]
2) Cleanup and Remediation on Private Land
3) Road Treatments
4) Wildlife and Habitat Enhancements
5) Water Conservation

The CRWE funding opportunity provides opportunities for partnerships that work to clean up, remediate, and restore watersheds impacted by cannabis cultivation, enhance watershed functions, and restore critical wildlife habitat.

CRWE Projects accomplish one or more of the following objectives:

1) Cleanup, remediate, restore, or enhance aquatic, riparian, or upland native species habitat (or habitat connectivity) impacted by cannabis activities
2) Minimize the risk of impacts to fish and wildlife, as well as human exposure, due to toxic materials associated with cannabis activities
3) Alleviate a limiting factor within the impacted environment

Qualified Cultivator Funding Opportunity

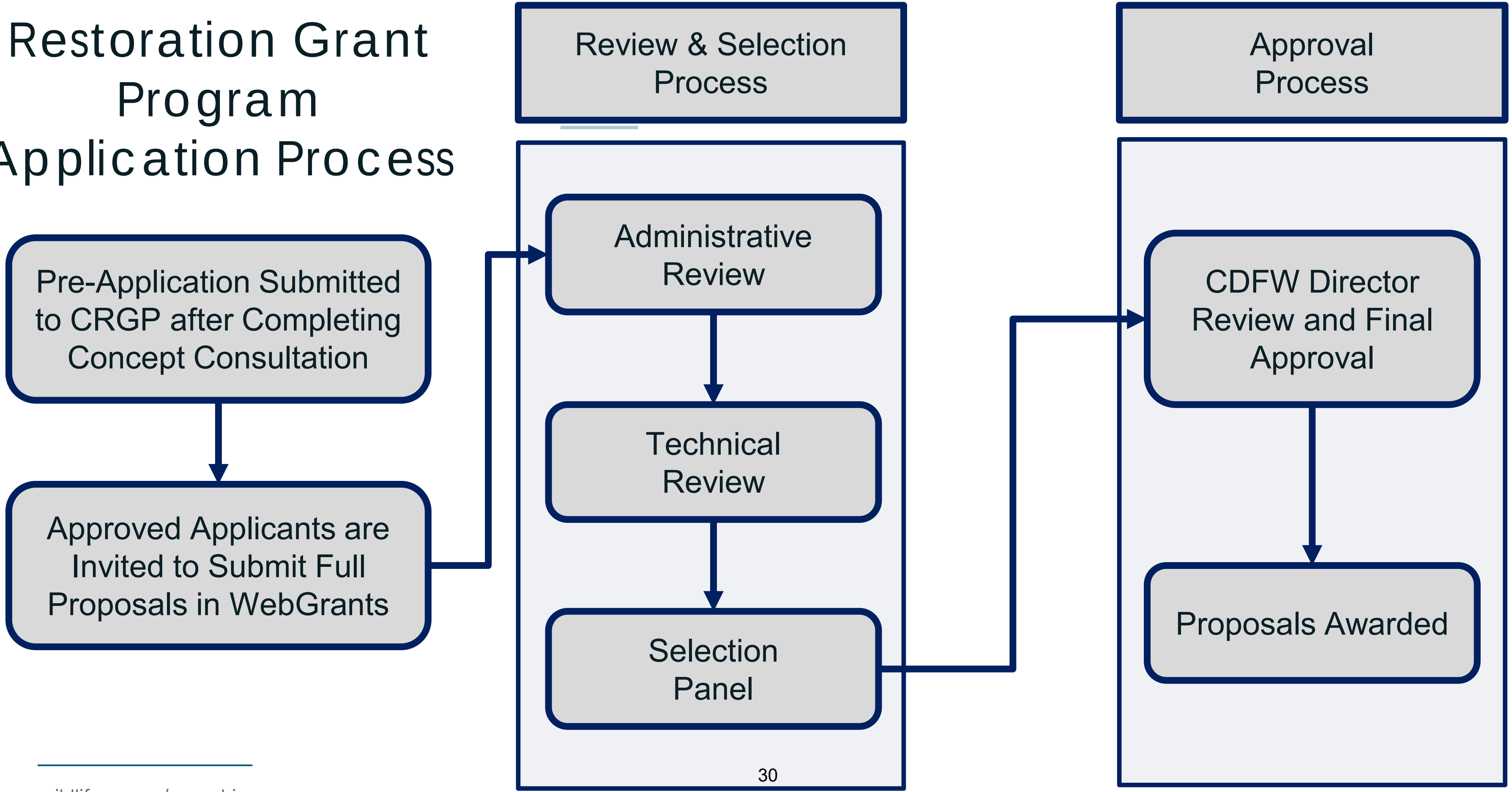


Qualified Cultivator Funding Opportunity

Other qualified cultivator projects implement ecological farming methods:

- Water Conservation
- Irrigation Efficiency
- Healthy Soils
- Integrated Pest Management
- Pollinator Friendly Natives
- Hedge Rows
- Regenerative Practices

Cannabis Restoration Grant Program Application Process



Resources

Grower Profiles

https://wildlife.ca.gov/Conservation/Cannabis/Growers-Corner

CRGP Video Overview

https://www.youtube.com/watch?v=kWkbjOTNvYU

Cannabis Restoration Grant Program (CRGP)

https://wildlife.ca.gov/Conservation/Watersheds/Cannabis-Restoration-Grant

canngrantprogram@wildlife.ca.gov

Virginia O'Rourke

Virginia.O'Rourke@wildlife.ca.gov

California Department of Fish and Wildlife

Modeling streamflow depletion from cannabis cultivation in California's North Coast salmon-bearing streams

Phil Georgakakos, Chris Dillis, David Dralle, Jesse Hahm, Ted Grantham

SRF 2023

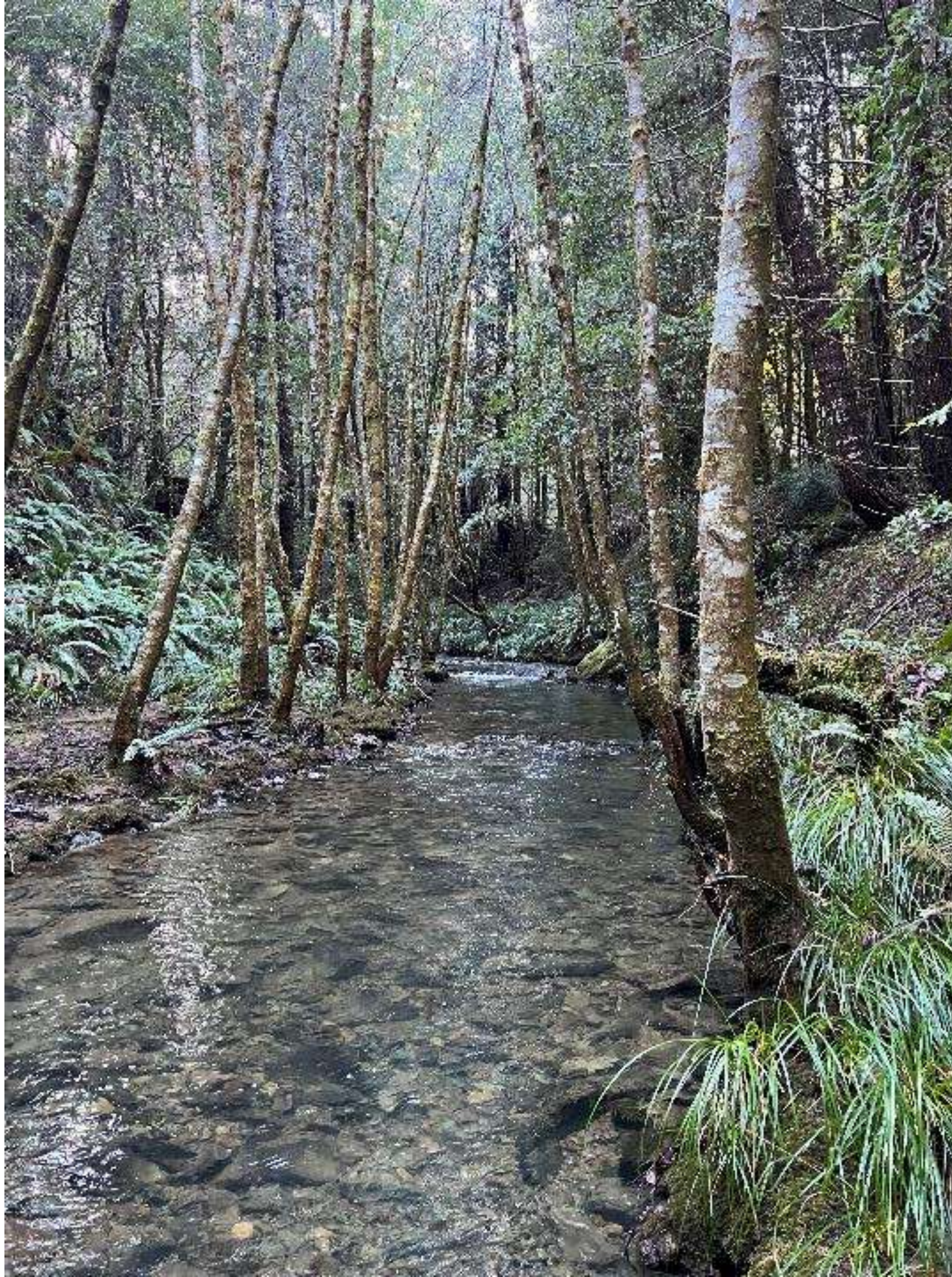
Cannabis agriculture in the North Coast can have negative environmental impacts, particularly on freshwaters (Bauer et al. 2015 ; Carah et al. 2015 ; Butsic et al. 2018; Dillis et al 2019; Zipper et al. 2019).

How do we quantify these impacts in headwater catchments, where most of cannabis cultivation occurs?

Question

How does water extraction for cannabis cultivation influence headwater streamflow?

Why is measuring this hard?



Question

How does water extraction for cannabis cultivation influence streamflow?

Why is measuring this hard?

- Interannual variability

Thousands of acres are underwater in California, and the flood could triple in size this summer

By Bill Weir, CNN Chief Climate Correspondent

Updated 9:47 AM EDT, Sat April 15, 2023

What Will it Take to End the Drought in California?

By Patty Guerra, UC Merced

January 30, 2023

Question

How does water extraction for cannabis cultivation influence streamflow?

Why is measuring this hard?

- Interannual variability

Question

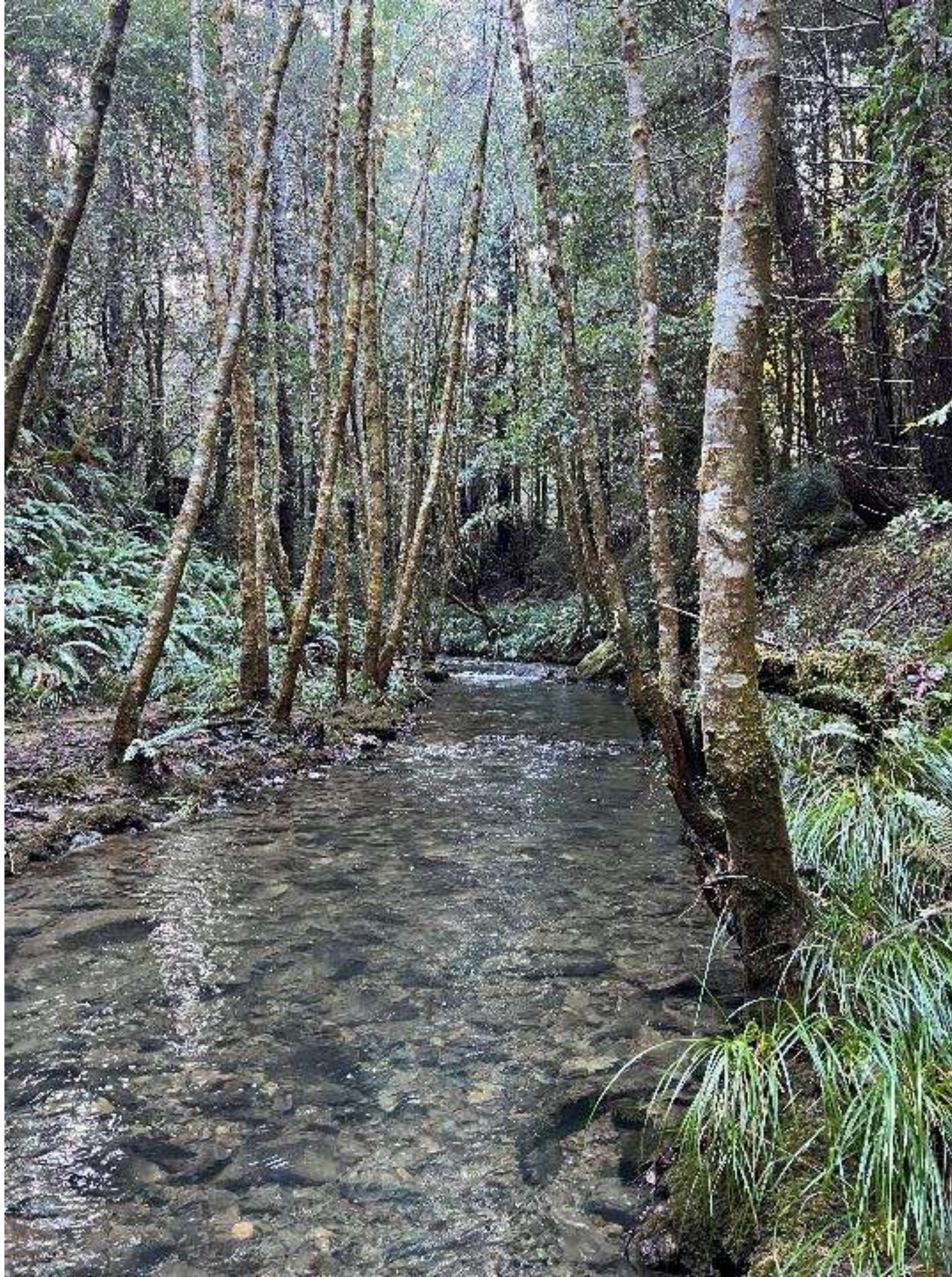
How does water extraction for cannabis cultivation influence streamflow?

Why is measuring this hard?

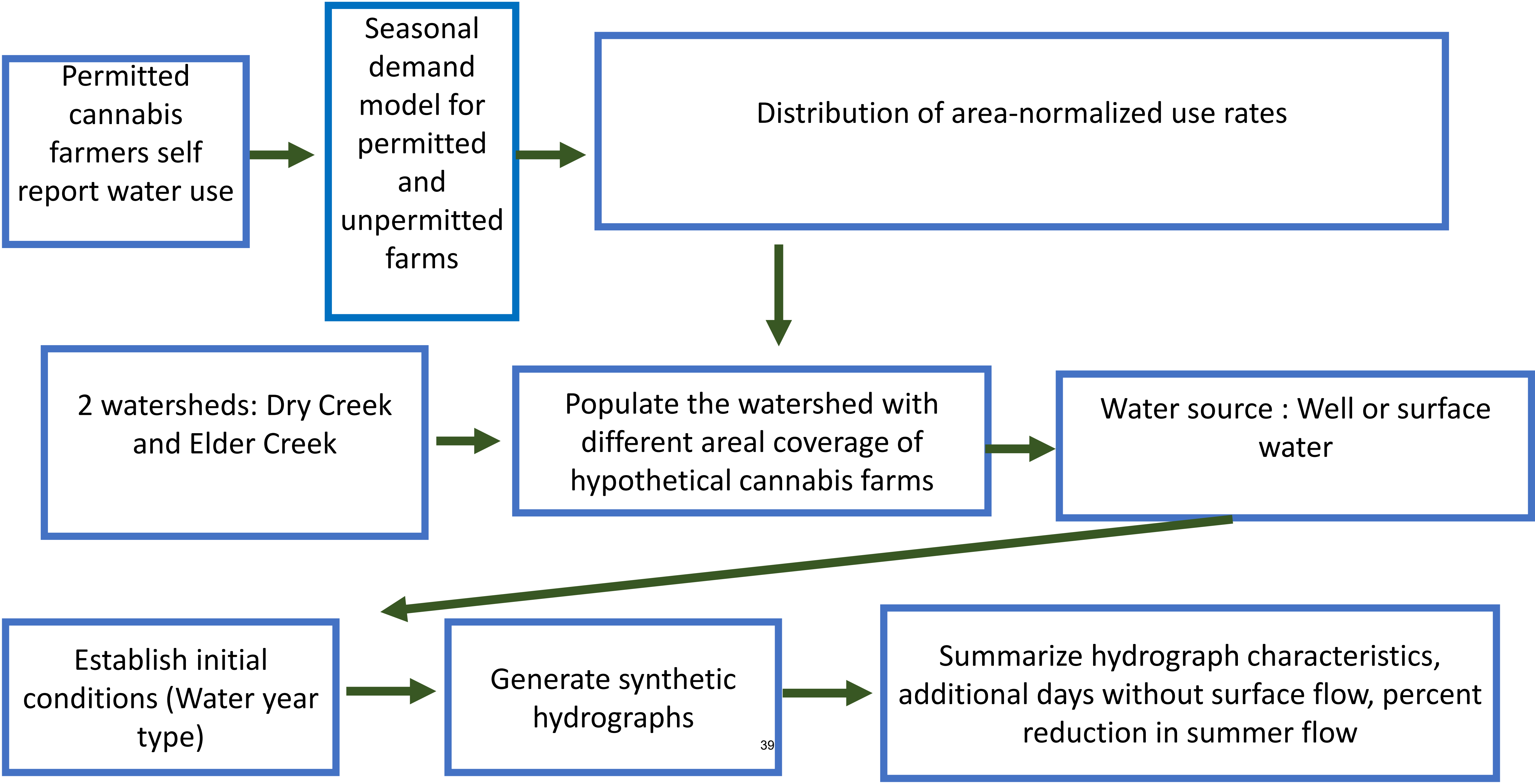
- Interannual variability
- Landscape diversity
- Decentralized extraction networks
- Headwater catchment hydrology

Our approach

- Create scenarios that represent combinations of
  - Water source
  - Irrigation rate
  - Area of cannabis farms
  - Lithologies
  - Water year



Workflow



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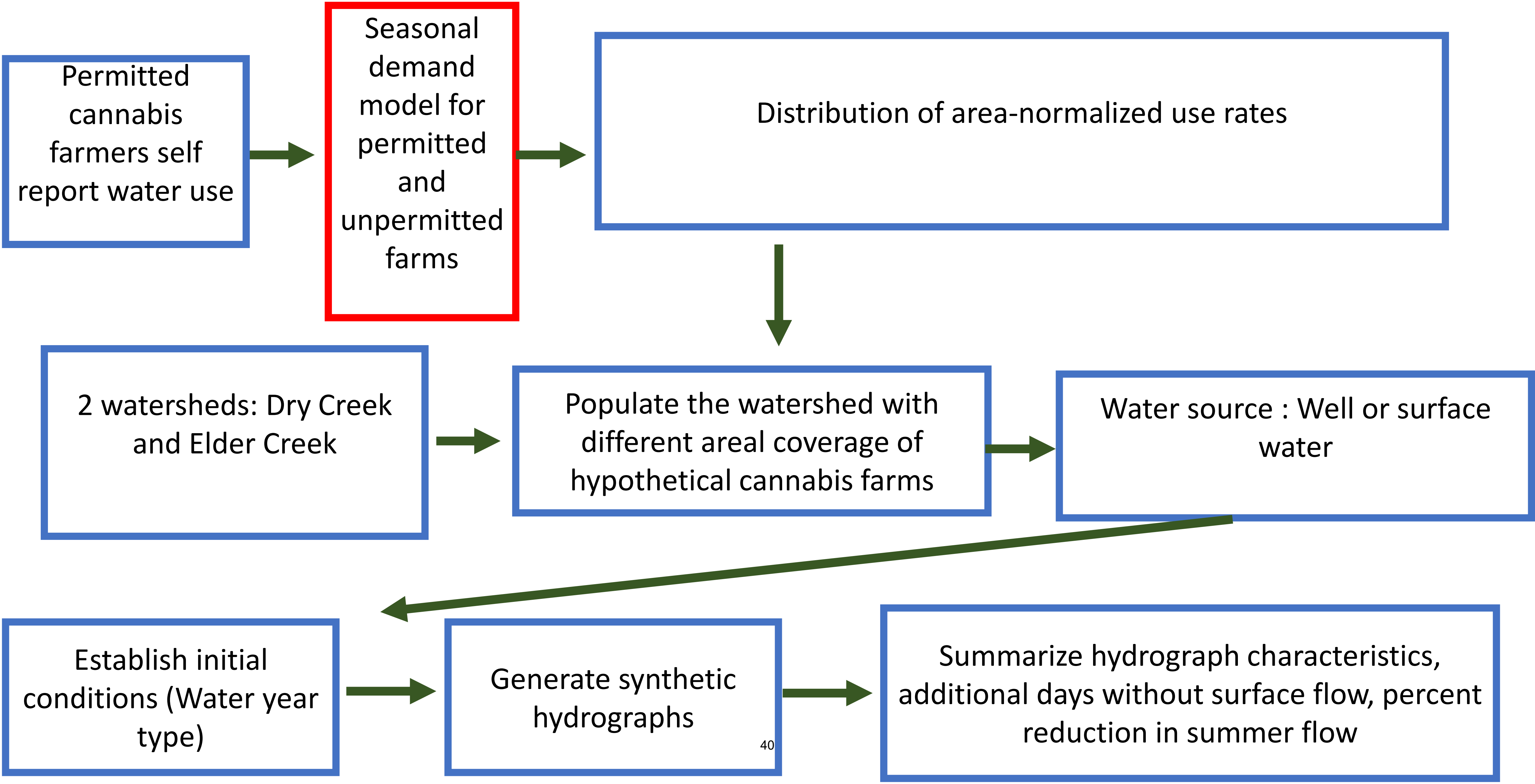
Workflow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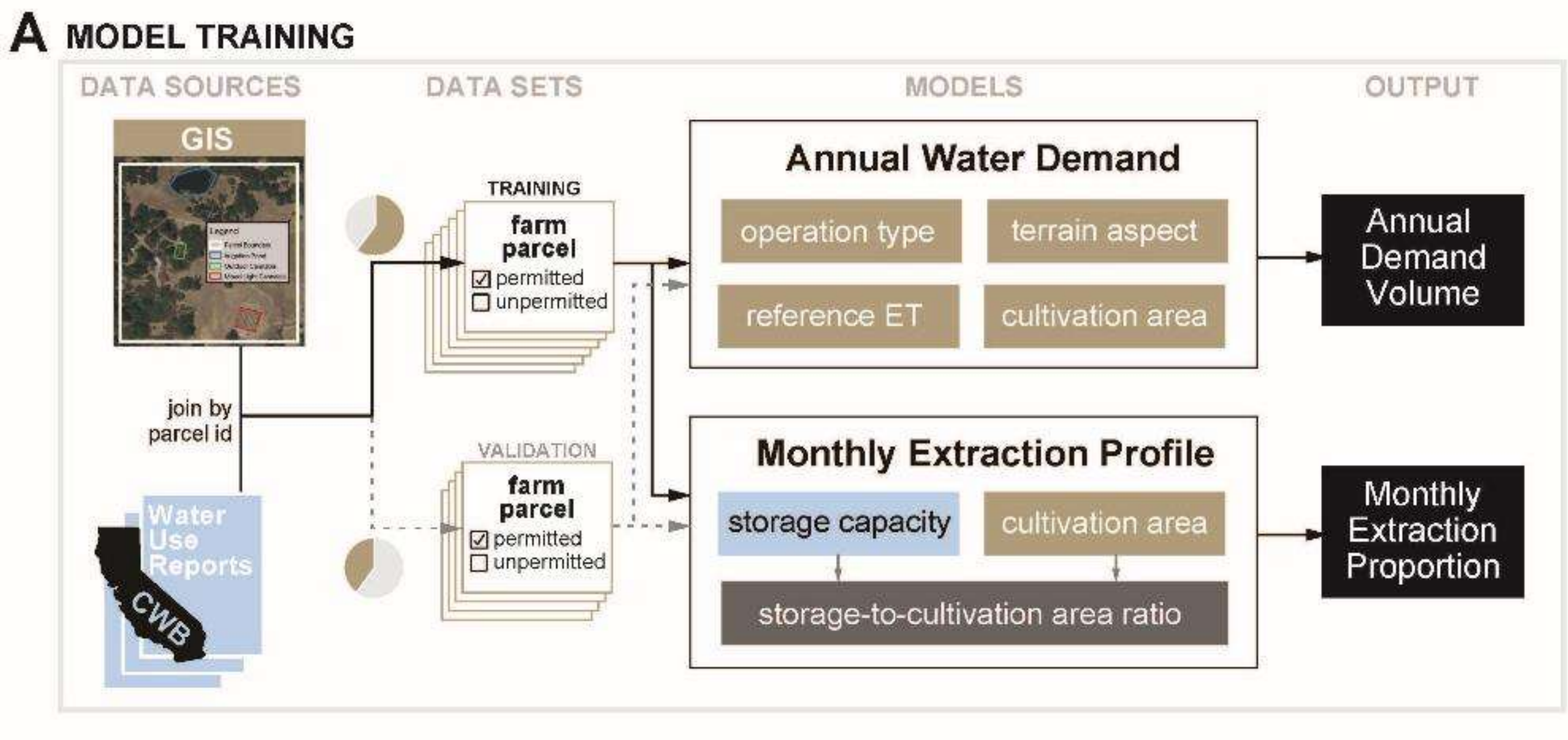
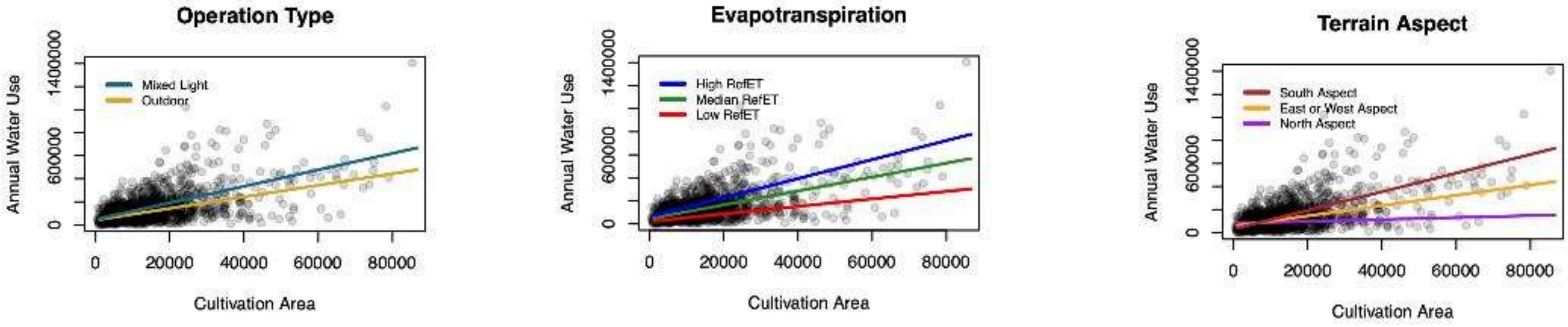
Cannabis water modeling framework



Dillis et al. 2023

Annual water use prediction

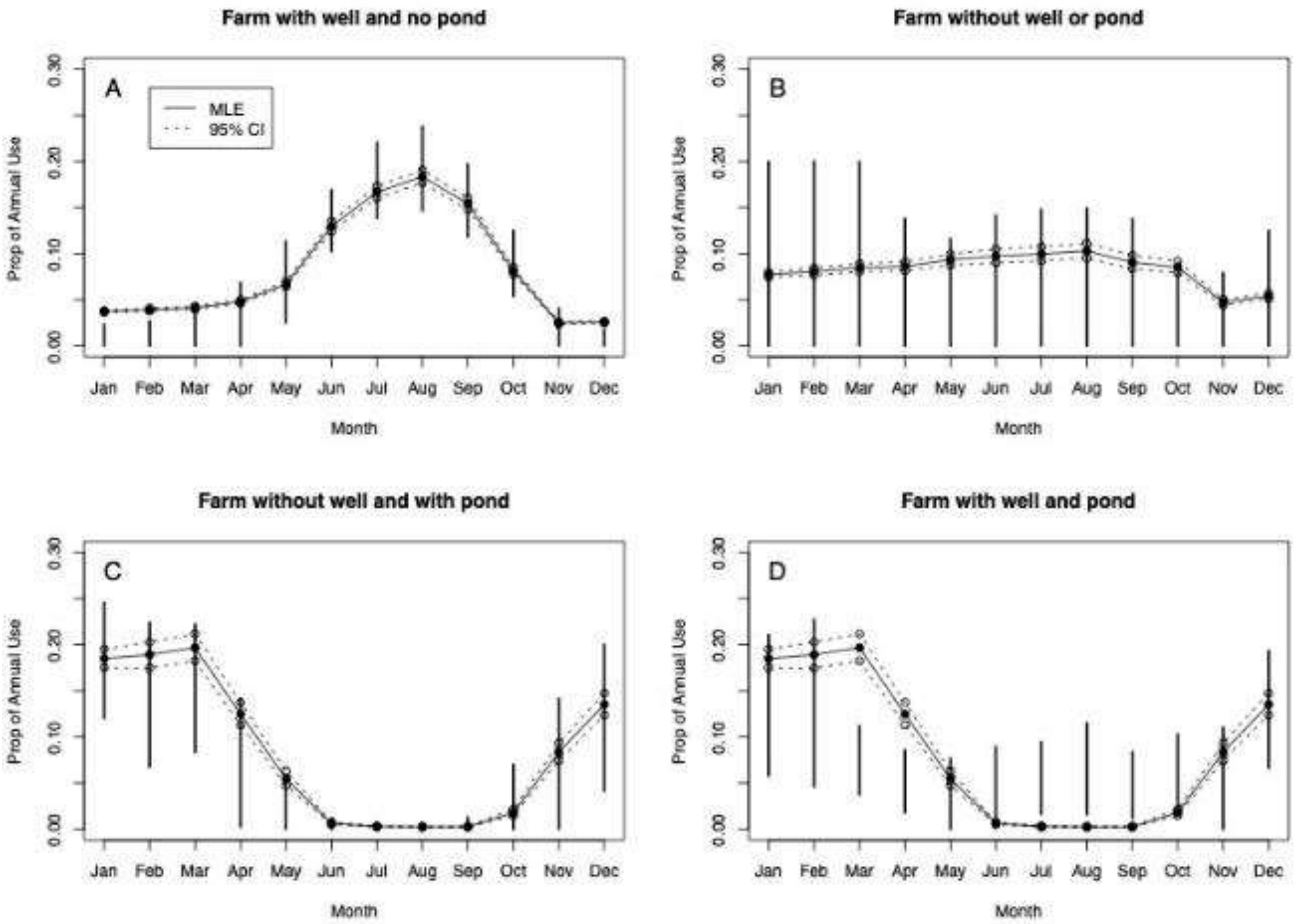
- The annual water use model demonstrated reliable effects of
  - Operation type (full sun outdoor vs mixed light)
  - Evapotranspiration (reference ET)
  - Terrain aspect (direction of slope)



Dillis et al. 2023

Allocating annual use into monthly volumes

- Ratio of water storage capacity to cultivation area (STCA Ratio) accurately predicted monthly water extraction patterns
- STCA Ratios typical of the four characteristic farm types (in terms of storage and water source types) also matched expectations based on previous work



Dillis et al. 2023

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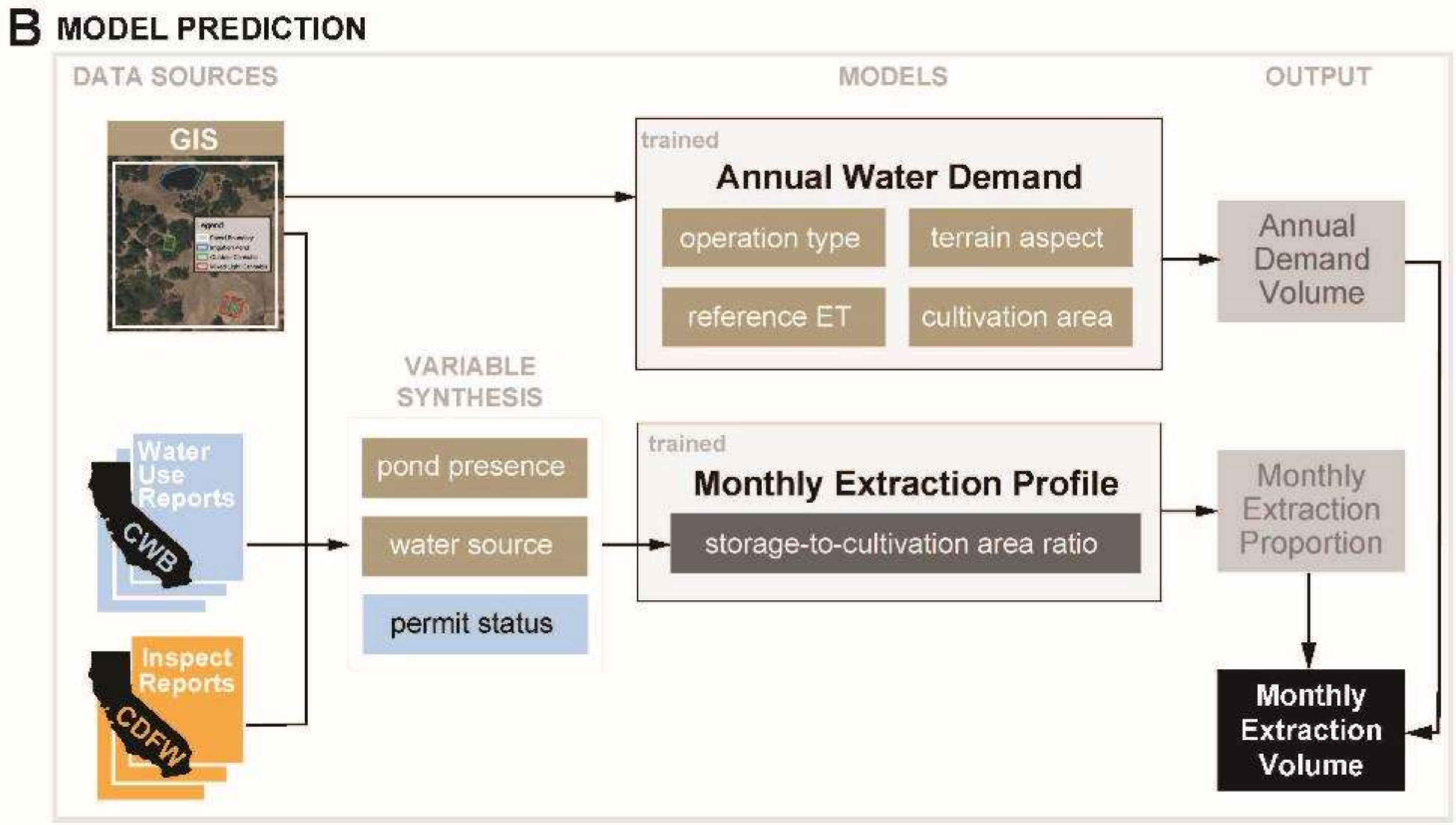
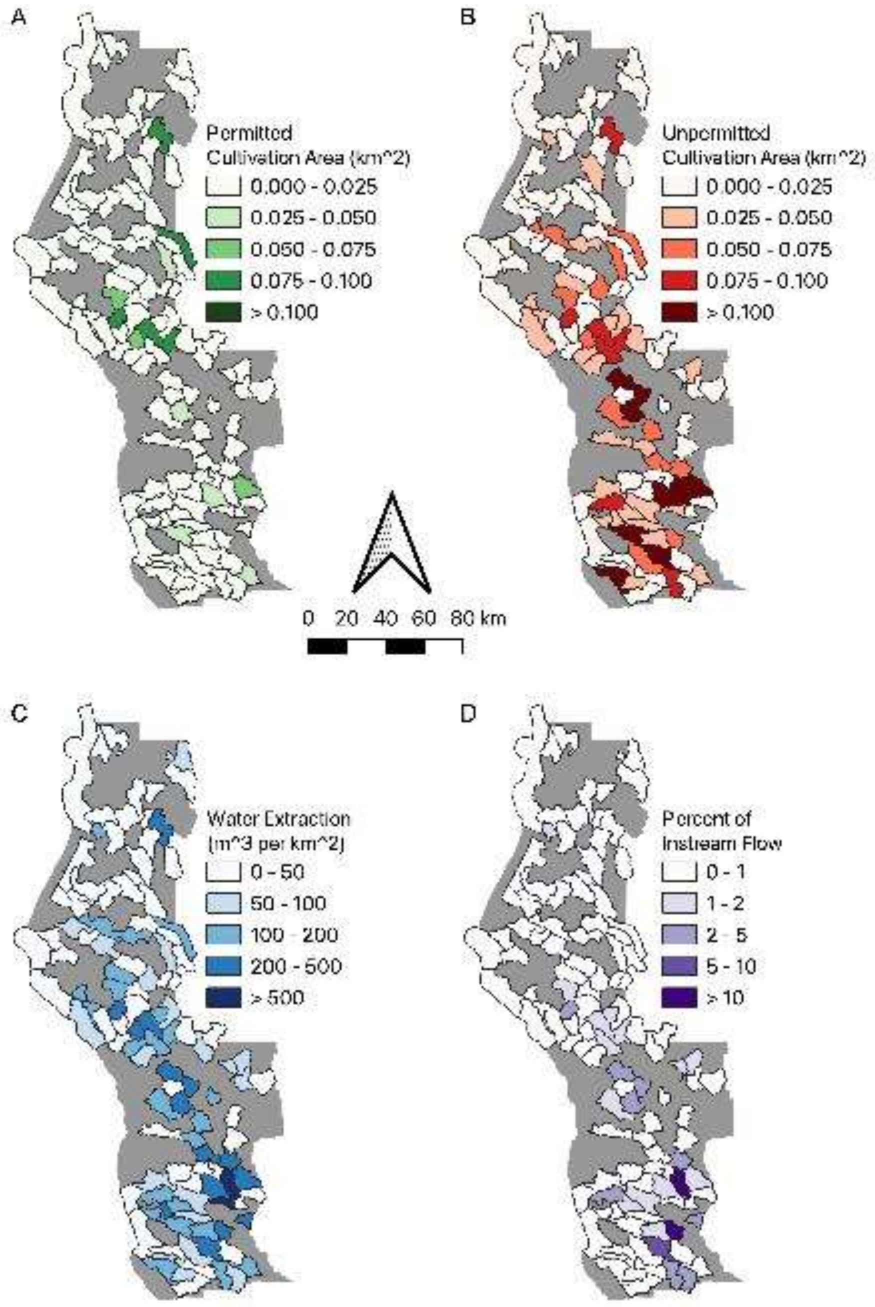


Dillis et al. 2023

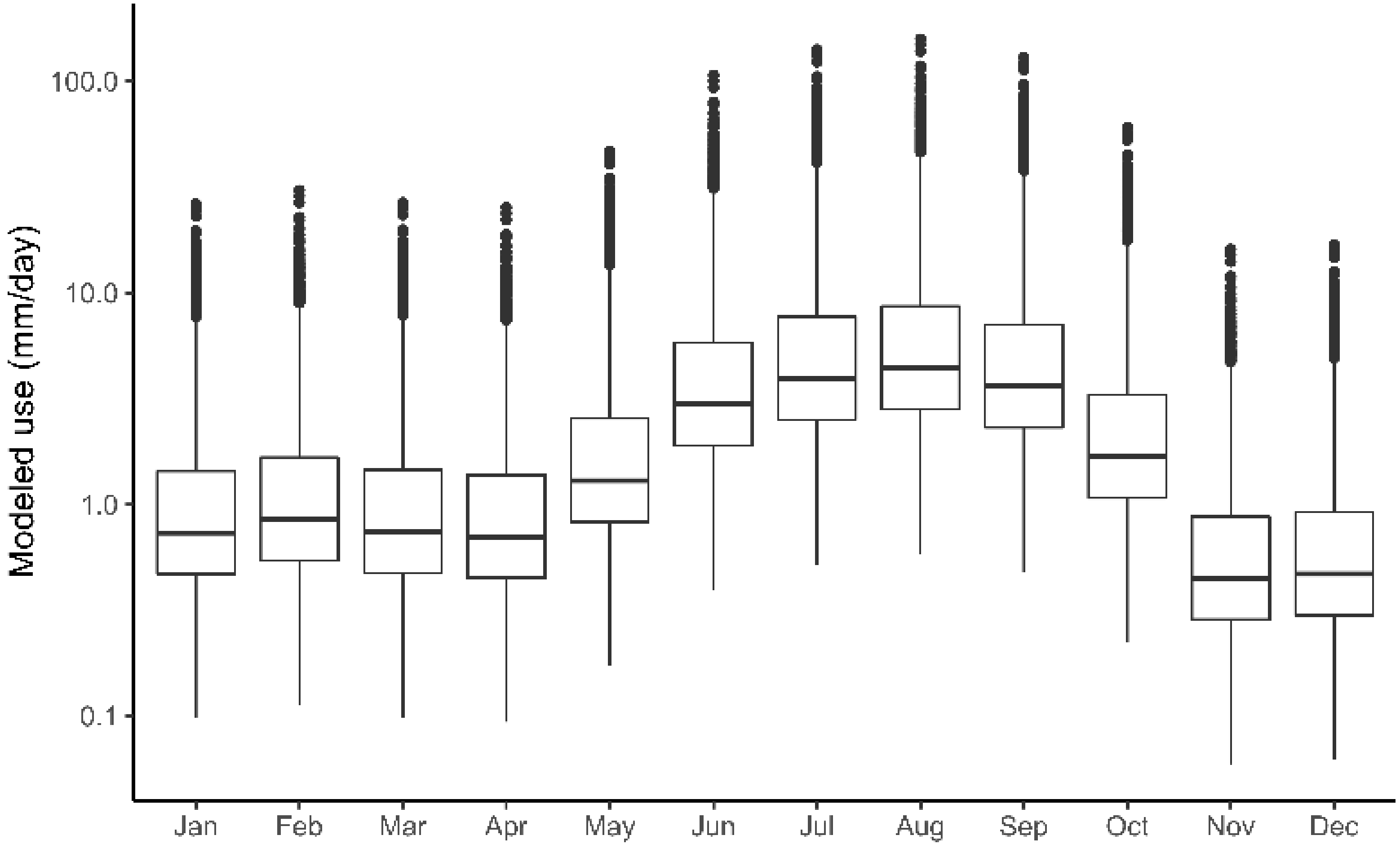
Model Outputs

- Unpermitted cultivation still far outpaces permitted cultivation
- The spatial pattern of dry season water extraction therefore closely follows the distribution of unpermitted cultivation
- The majority of heavy-extraction watersheds are in areas where groundwater is the predominant source of water
- For most watersheds, cannabis only represents a fraction of available unimpaired flow
    - Effects more likely at smaller scales where farm clusters may have bigger impacts locally

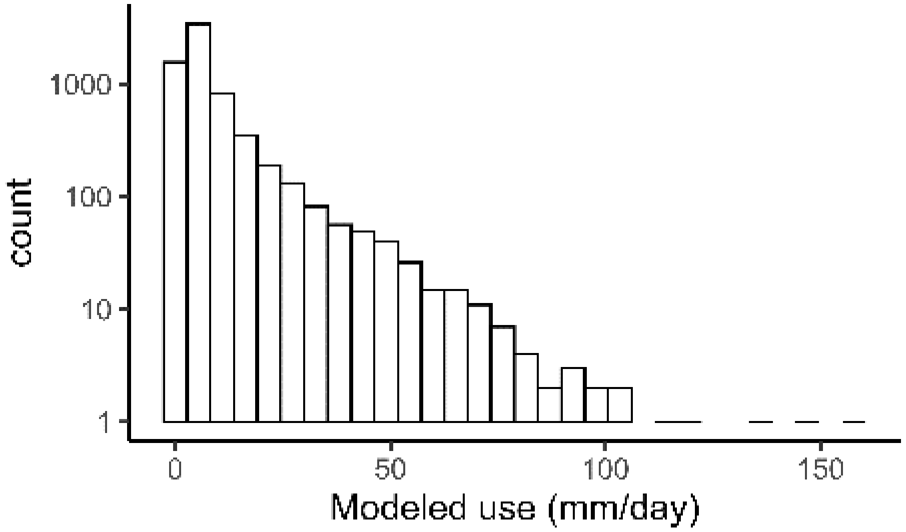


Dillis et al. 2023

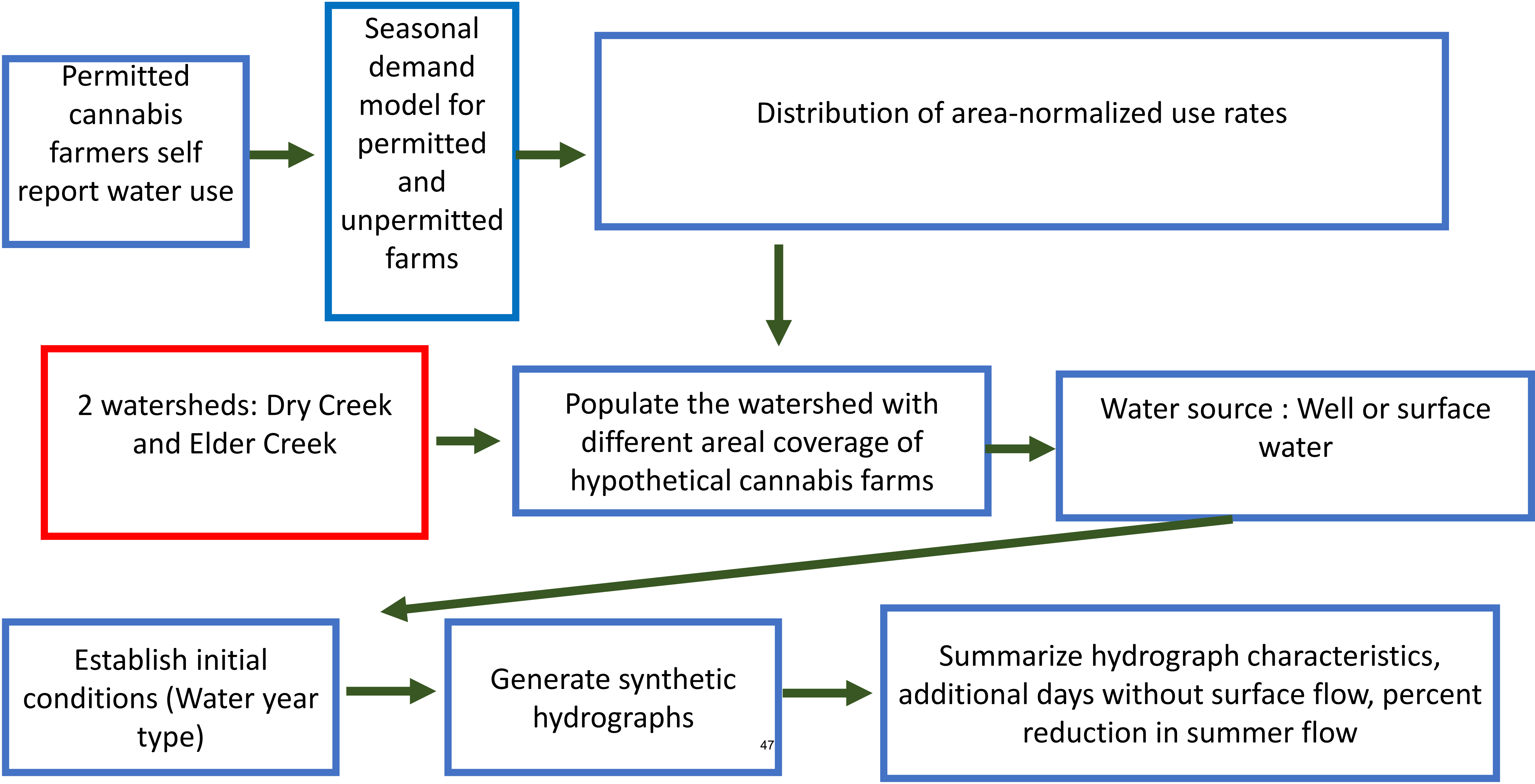
Variation in farm use for permitted and unpermitted farms without onsite storage



Histogram of August farm water use



Workflow



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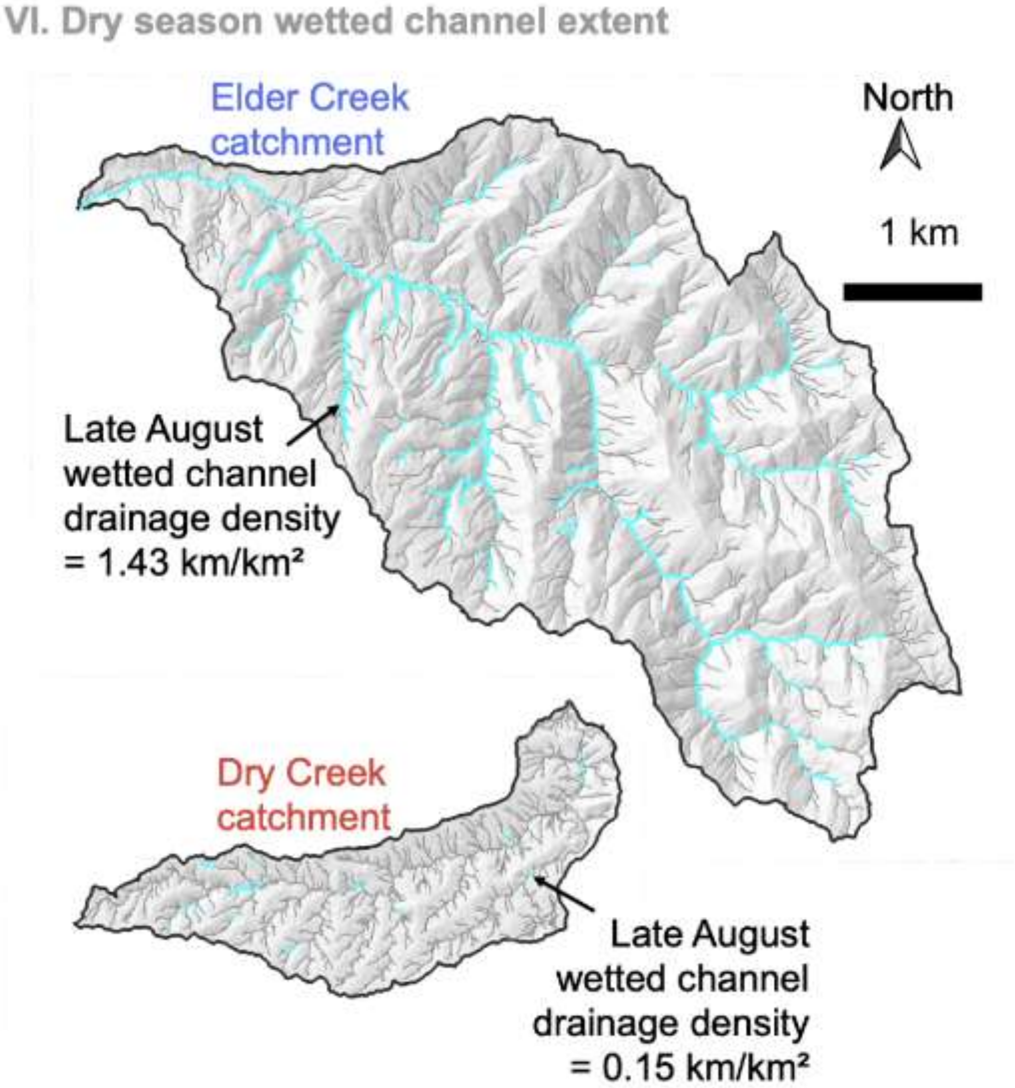
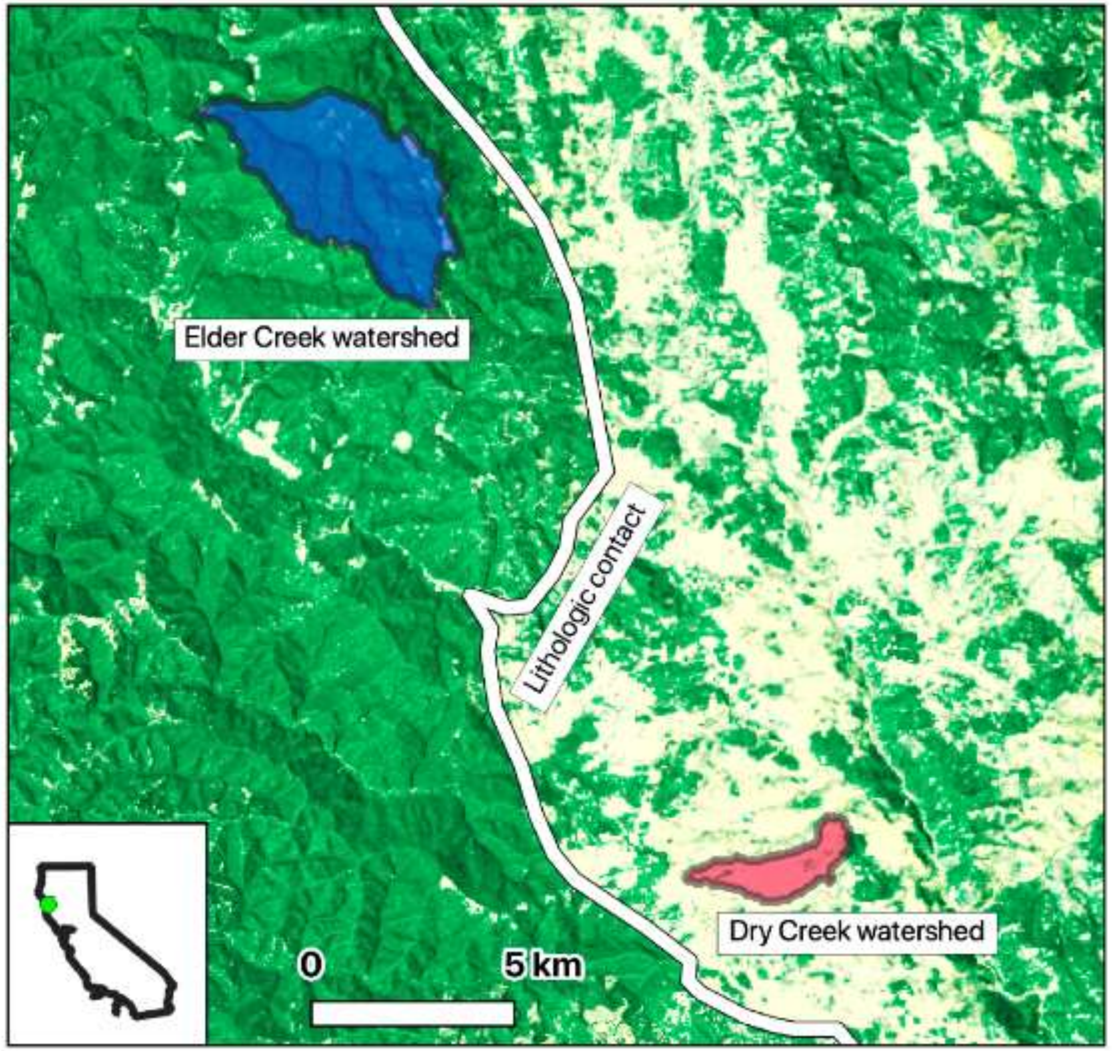
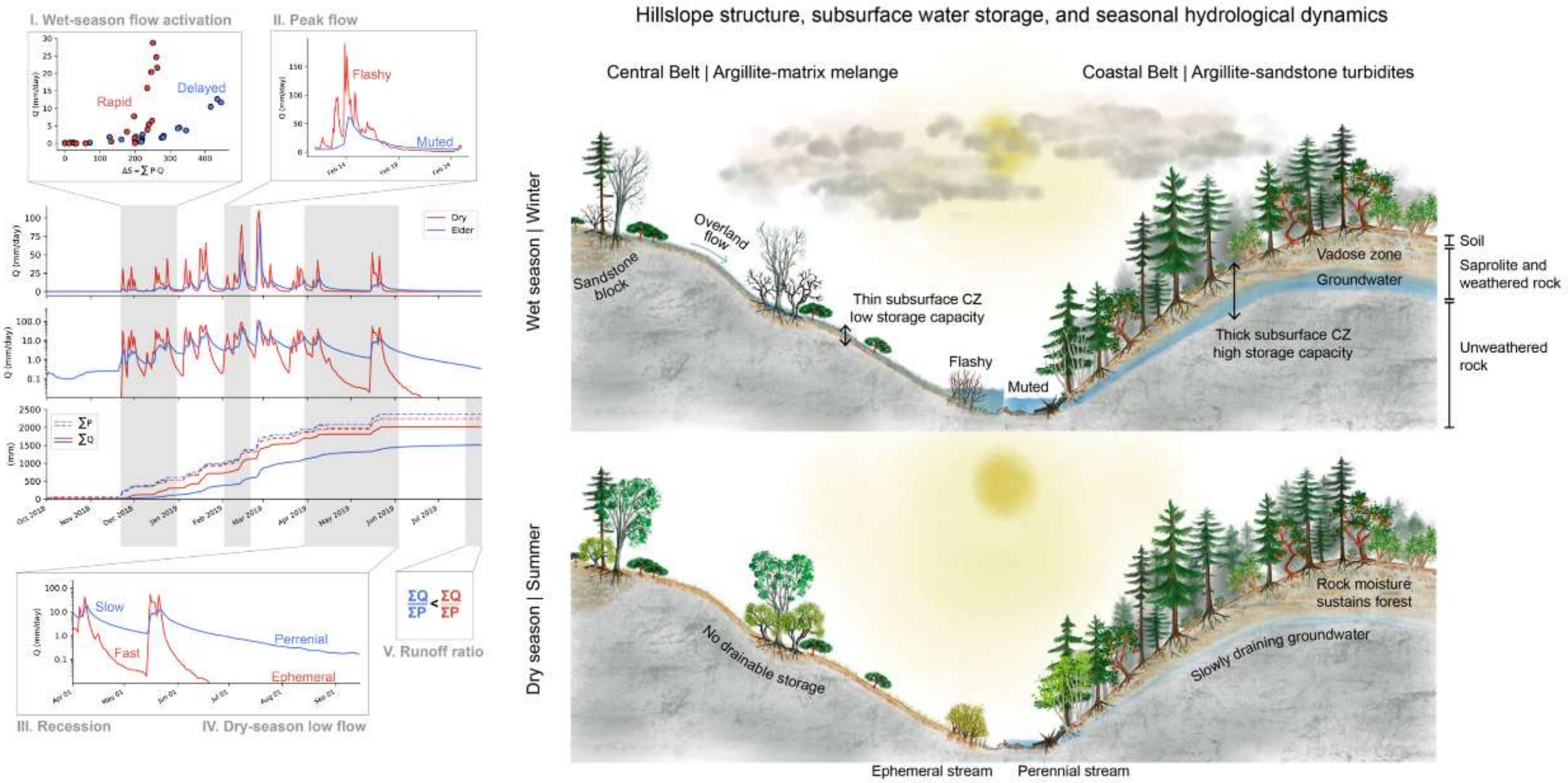
Two different streams





Dralle et al. 2023



Dralle et al. 2023

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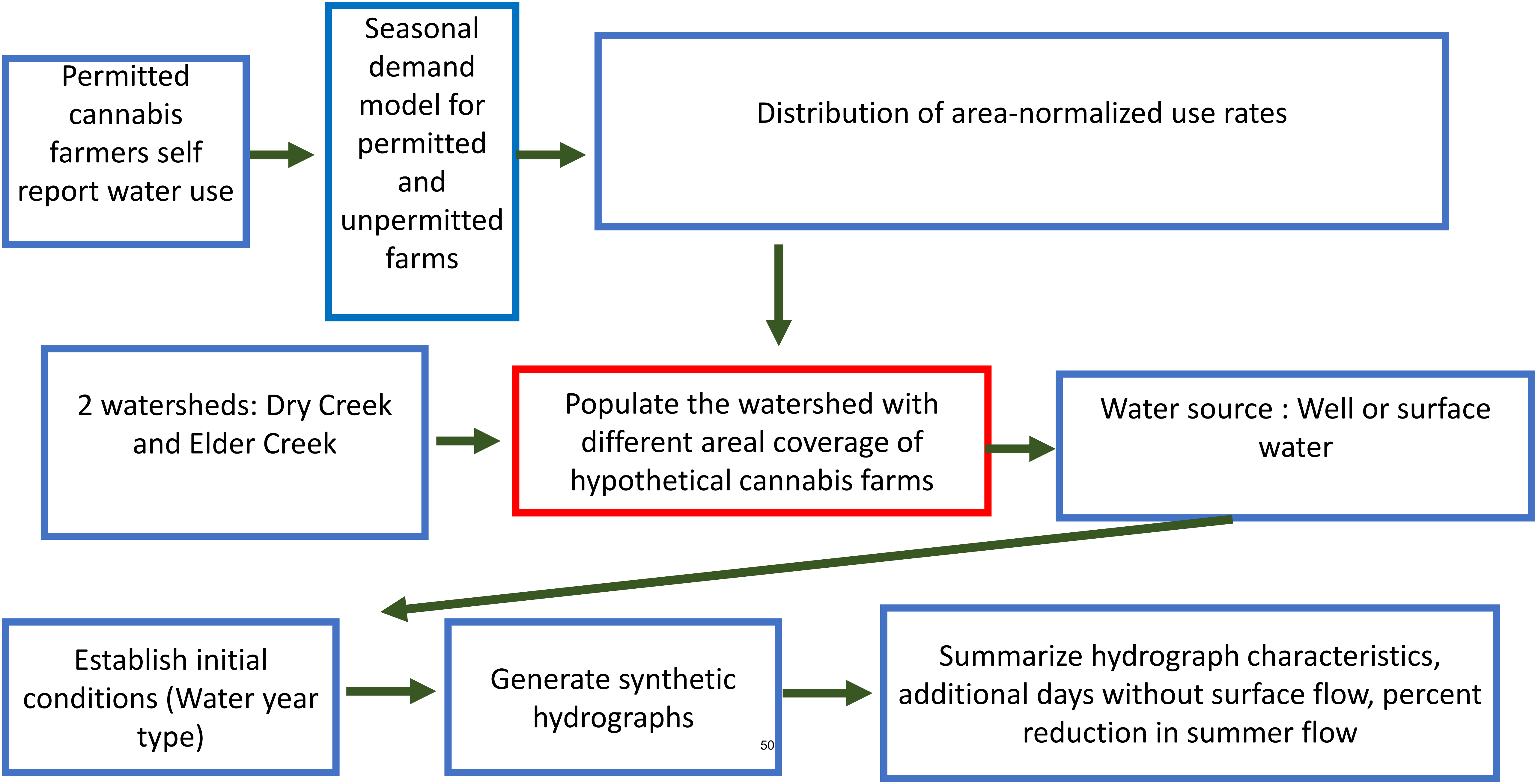
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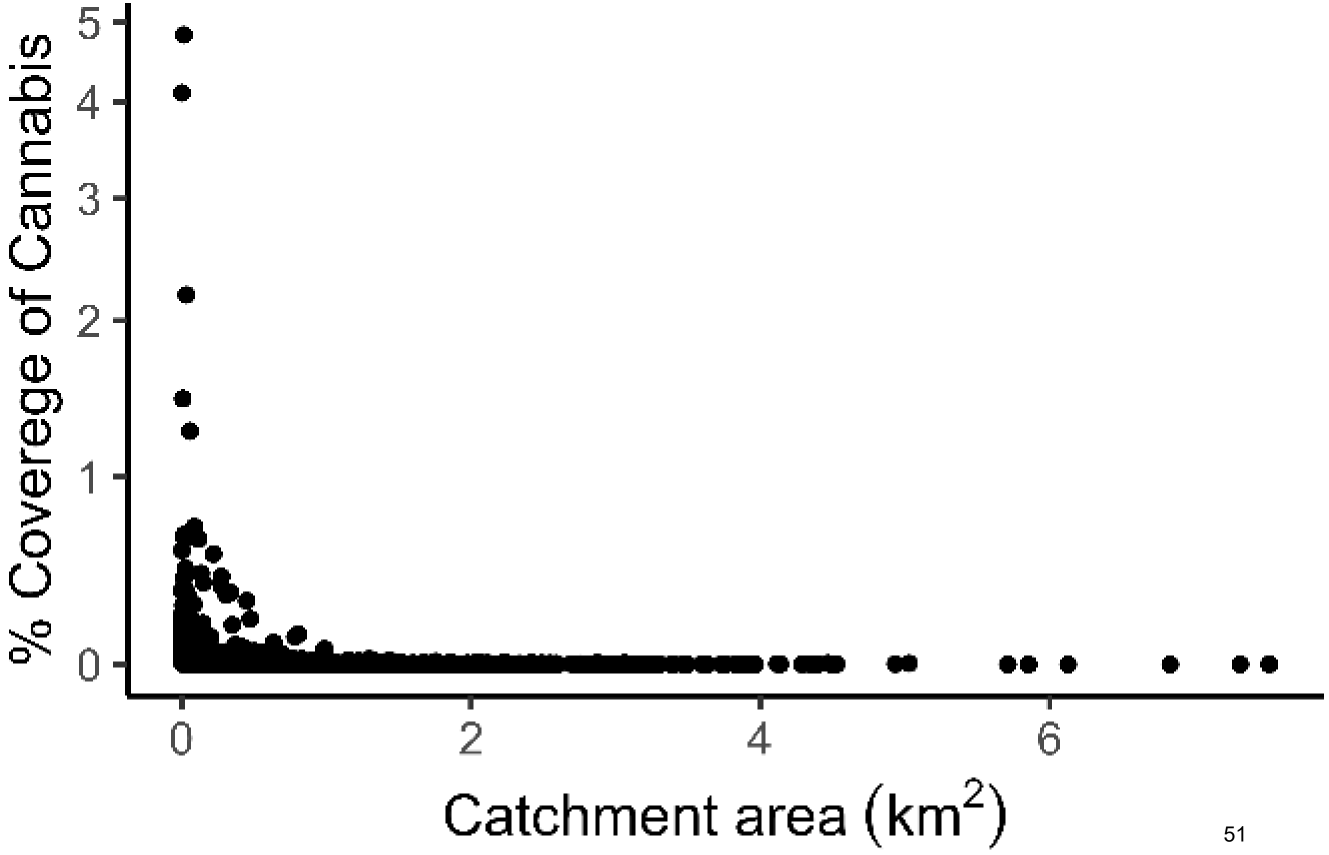
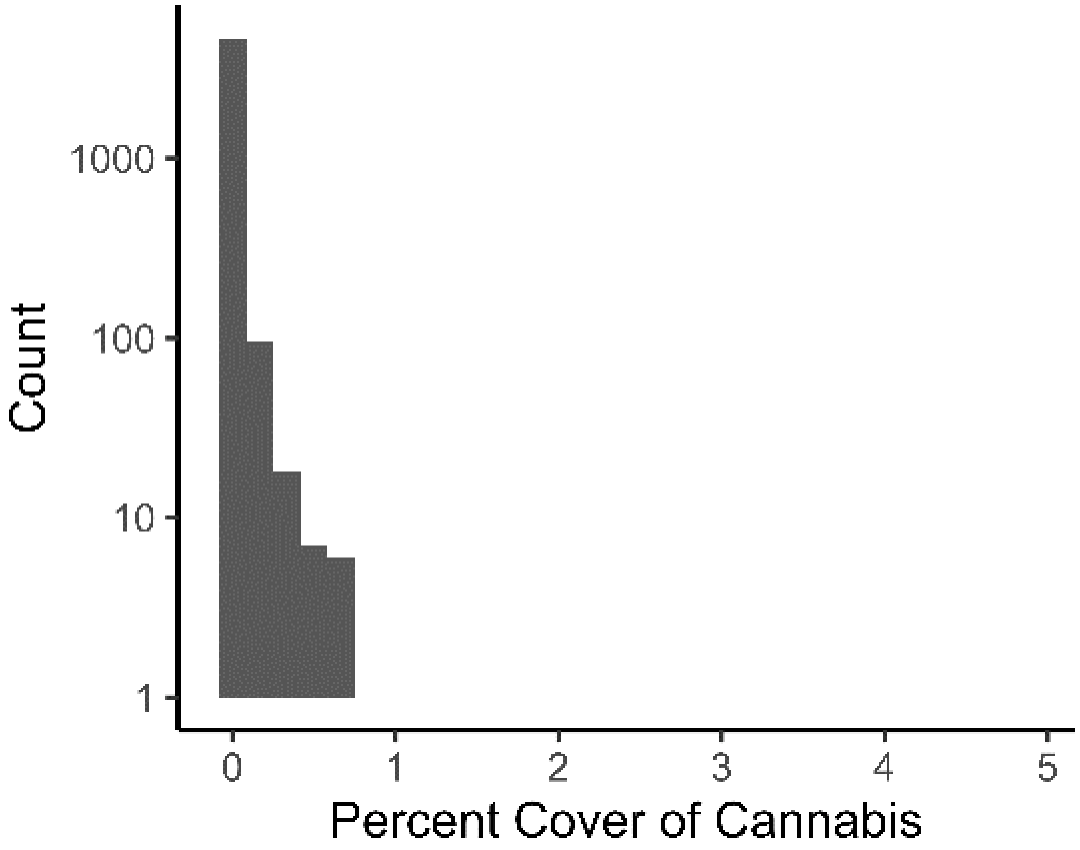
Areal coverage of cannabis on the landscape

Our hypothetical coverage levels 0.25, 1, 2.5, 4.5% cover on the landscape





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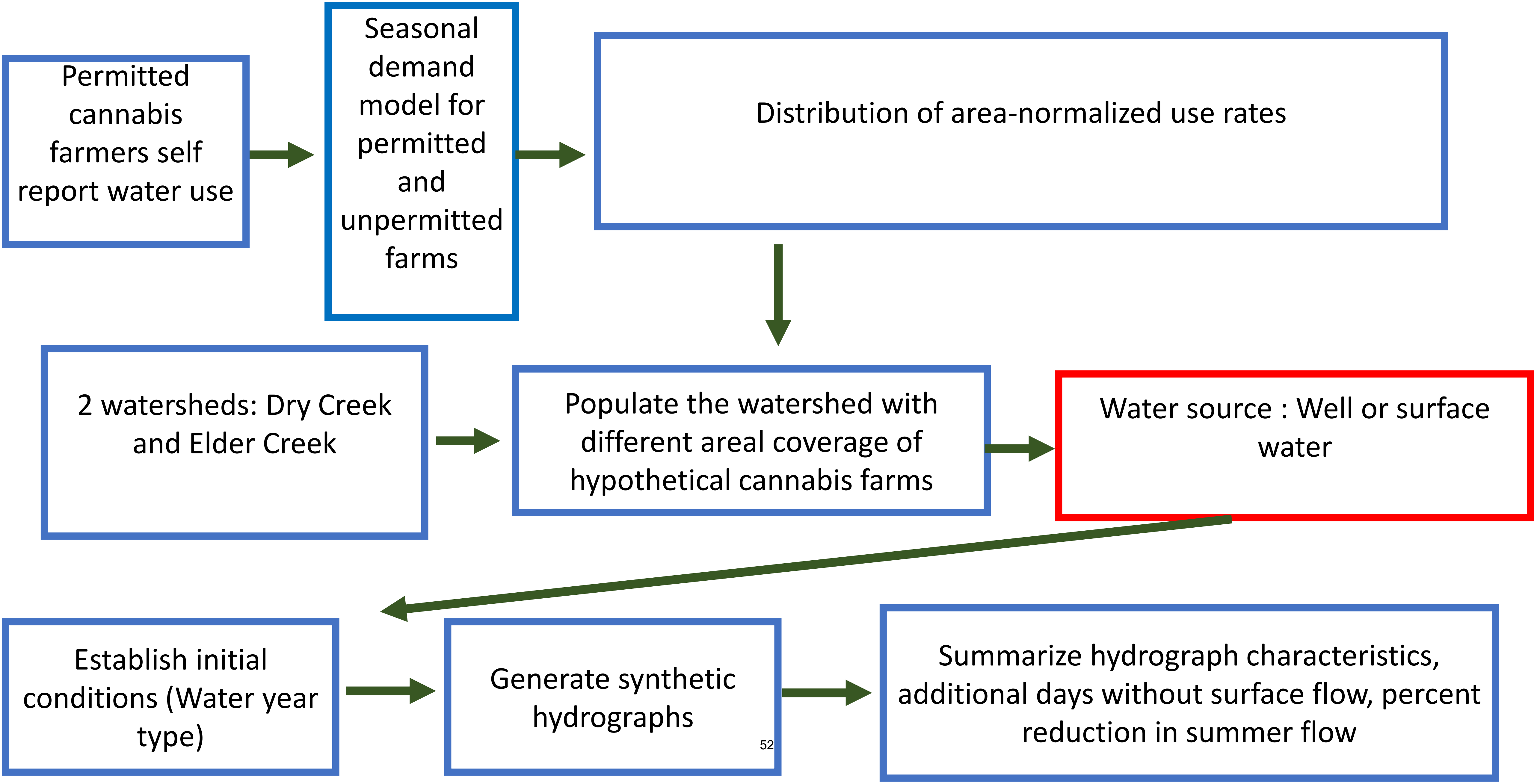
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Effect of groundwater pumping

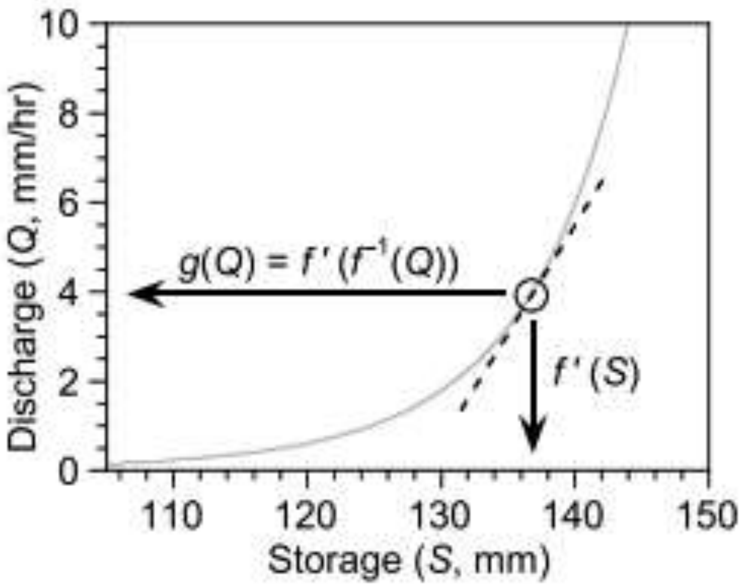


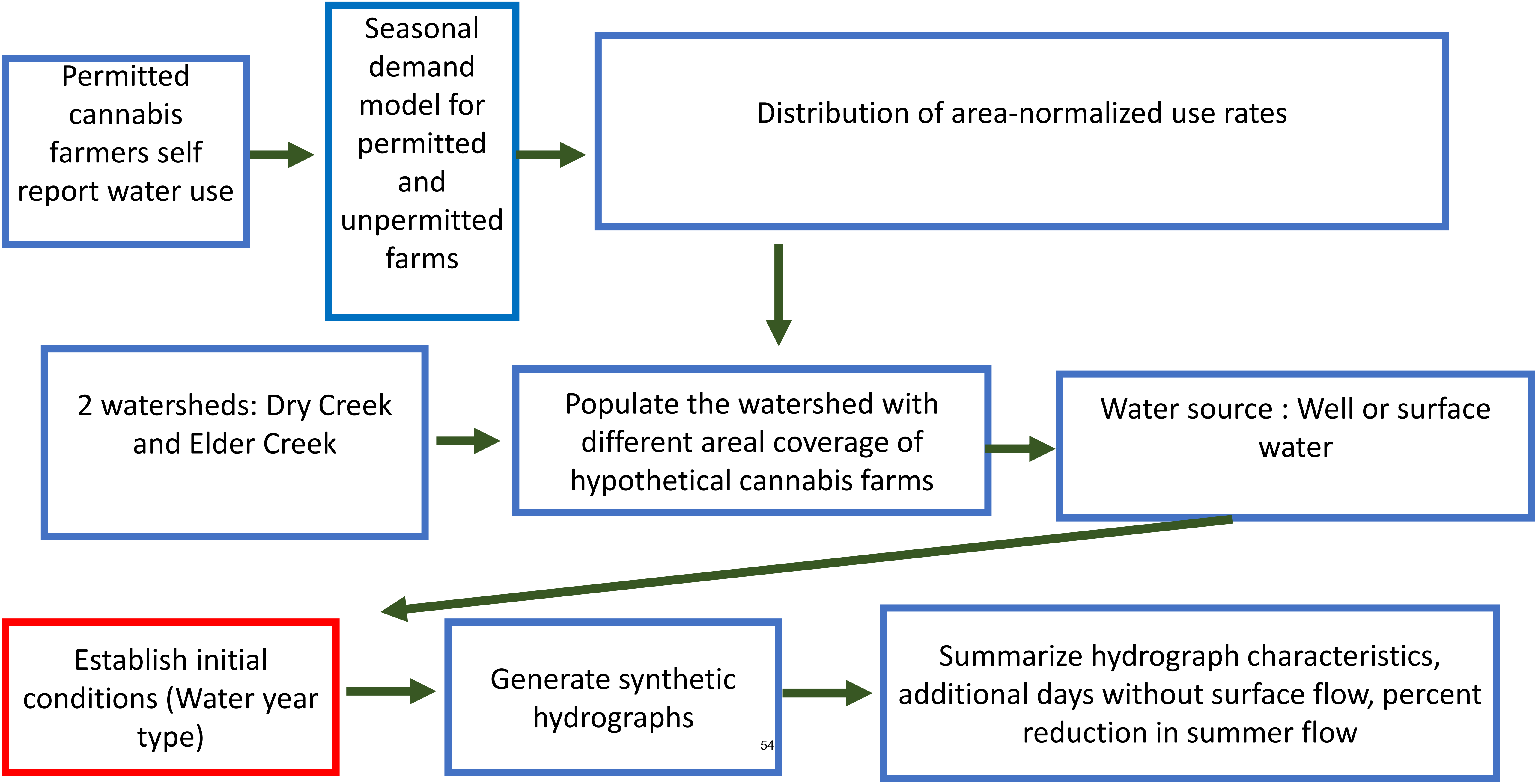
Figure 3, Kirchner 2009

- Surface water diversion
  - basic water balance:

  Q (discharge) = Q $_{unimpaired}$ - Demand
- Well pumping
  - Storage-discharge sensitivity functions (Kirchner 2009)
    - Watershed storage can be quantified by looking at changes in discharge
    - We can back solve these equations for discharge from known storage
    - Water is removed on demand, but this water is removed from the ”storage” within a watershed, which in turn influences streamflow

  Assumes water is removed from watershed storage

Workflow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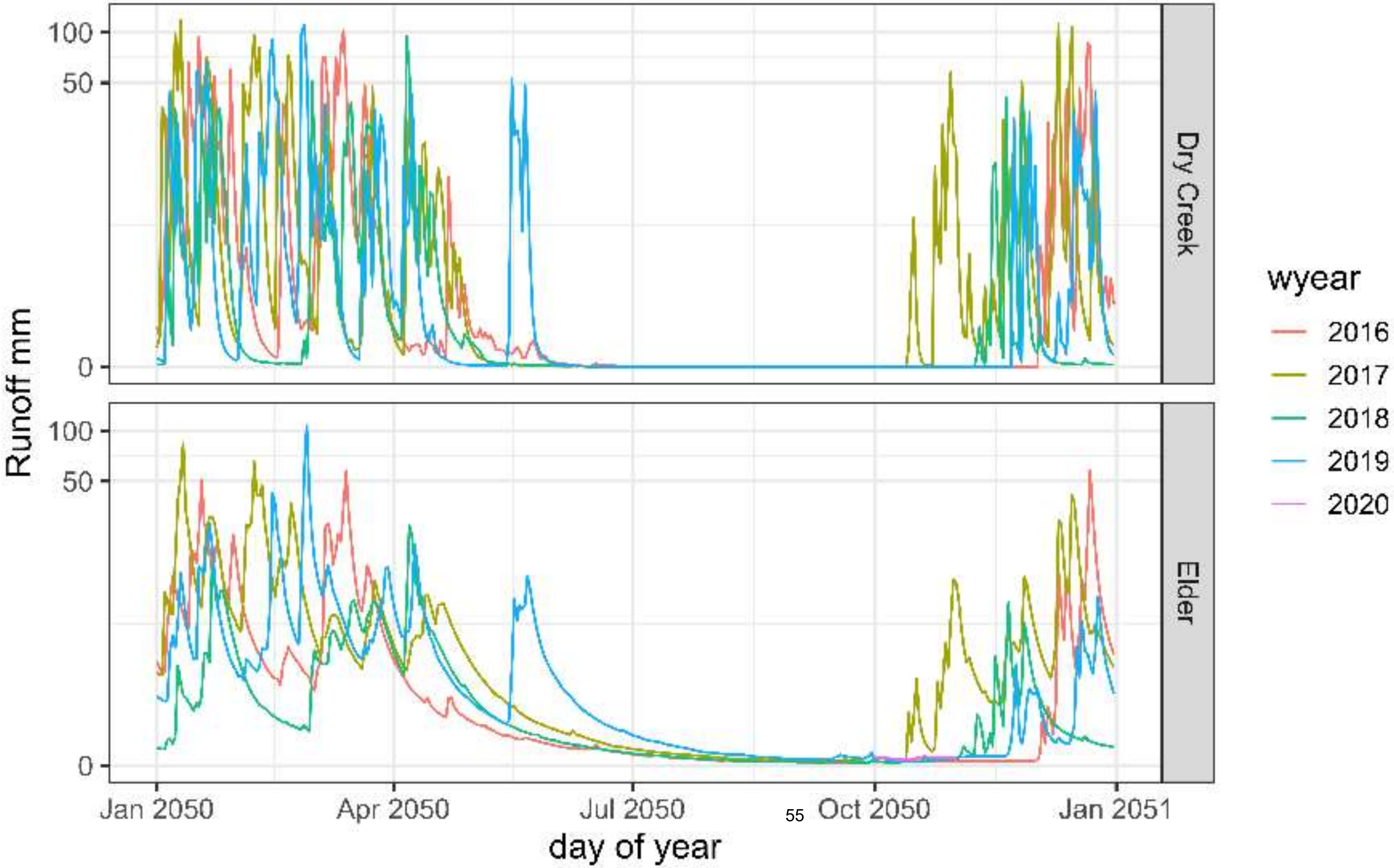
Water year = initial conditions



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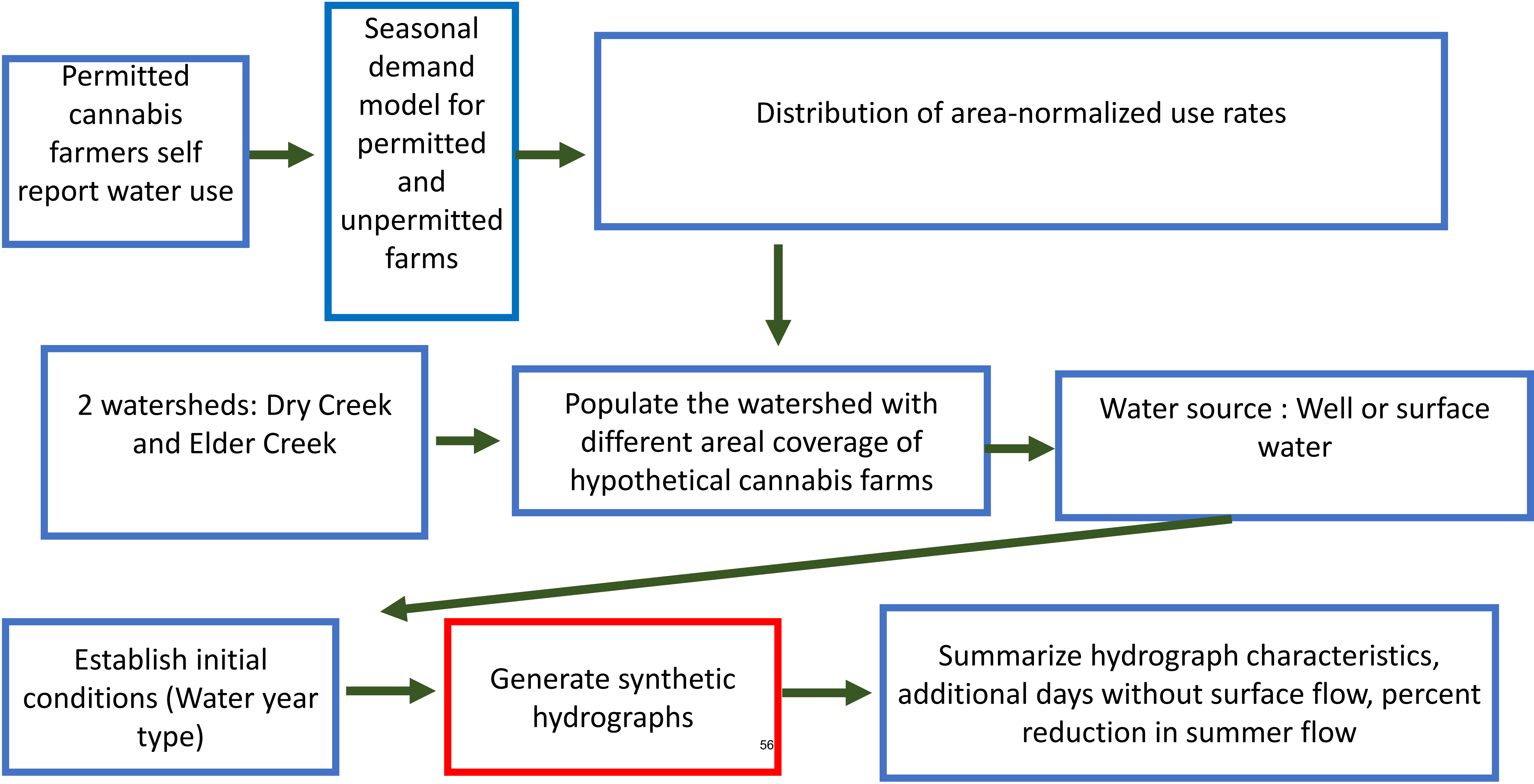
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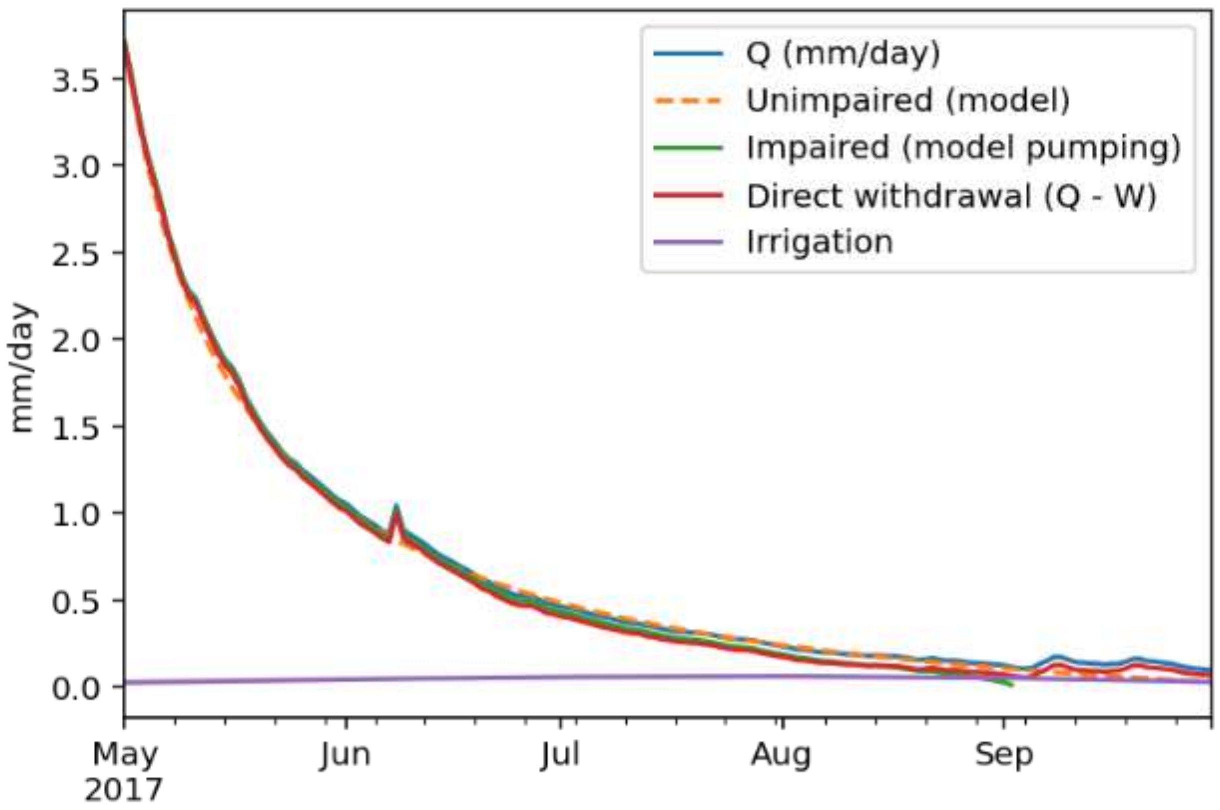
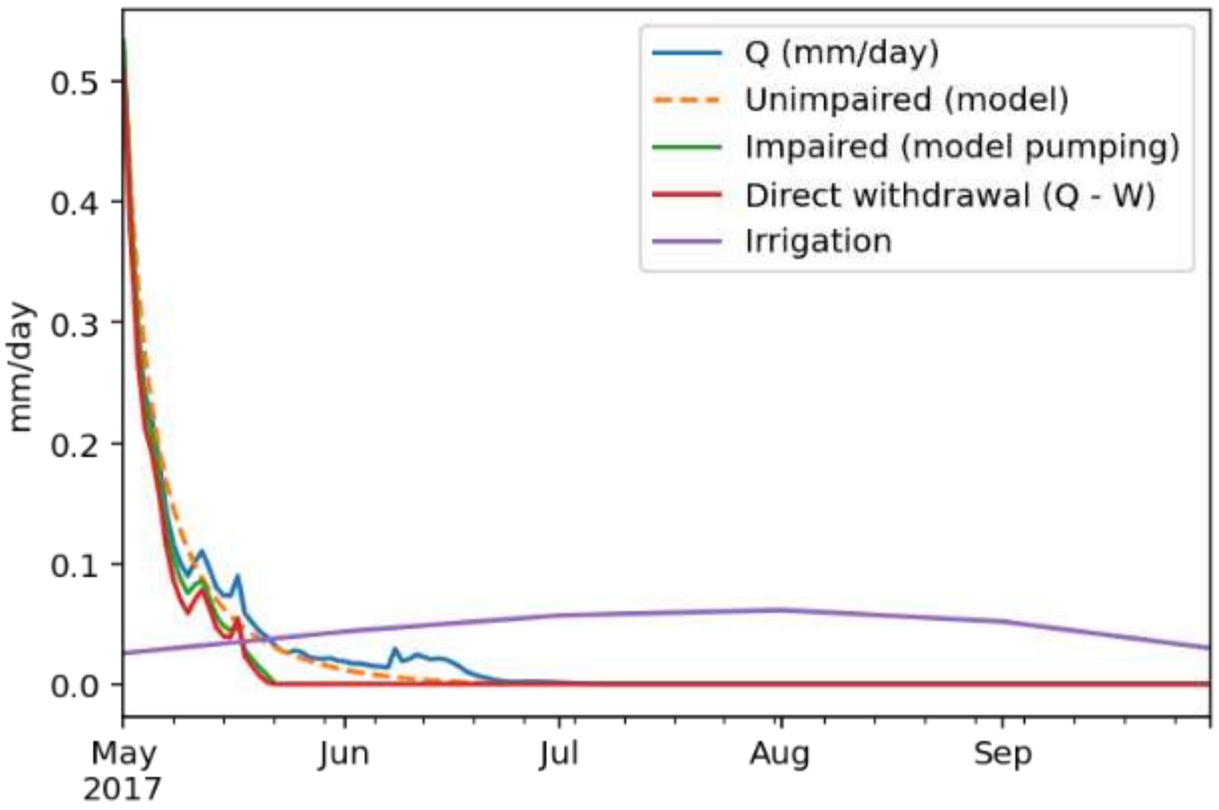
Impacts on Streamflow

2017, median water use rate, 0.25% cover

Elder



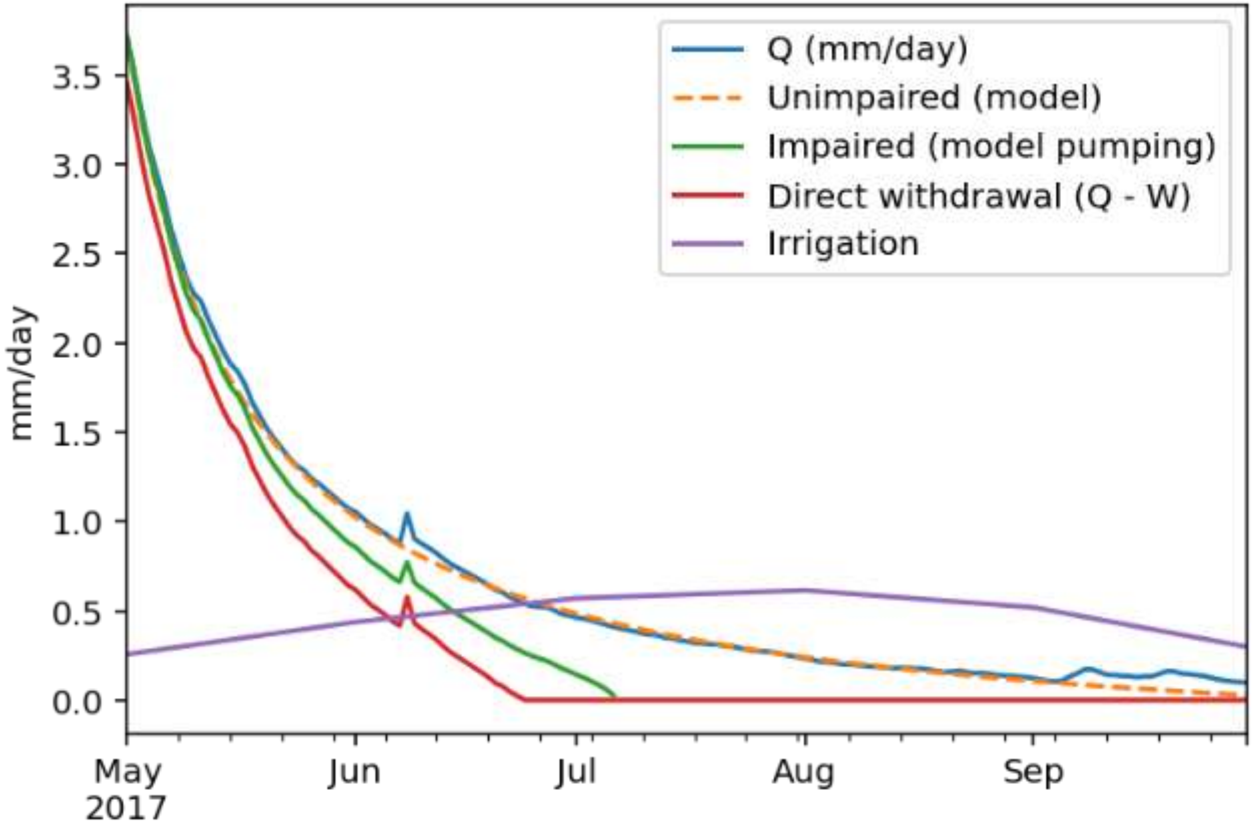
Dry Creek



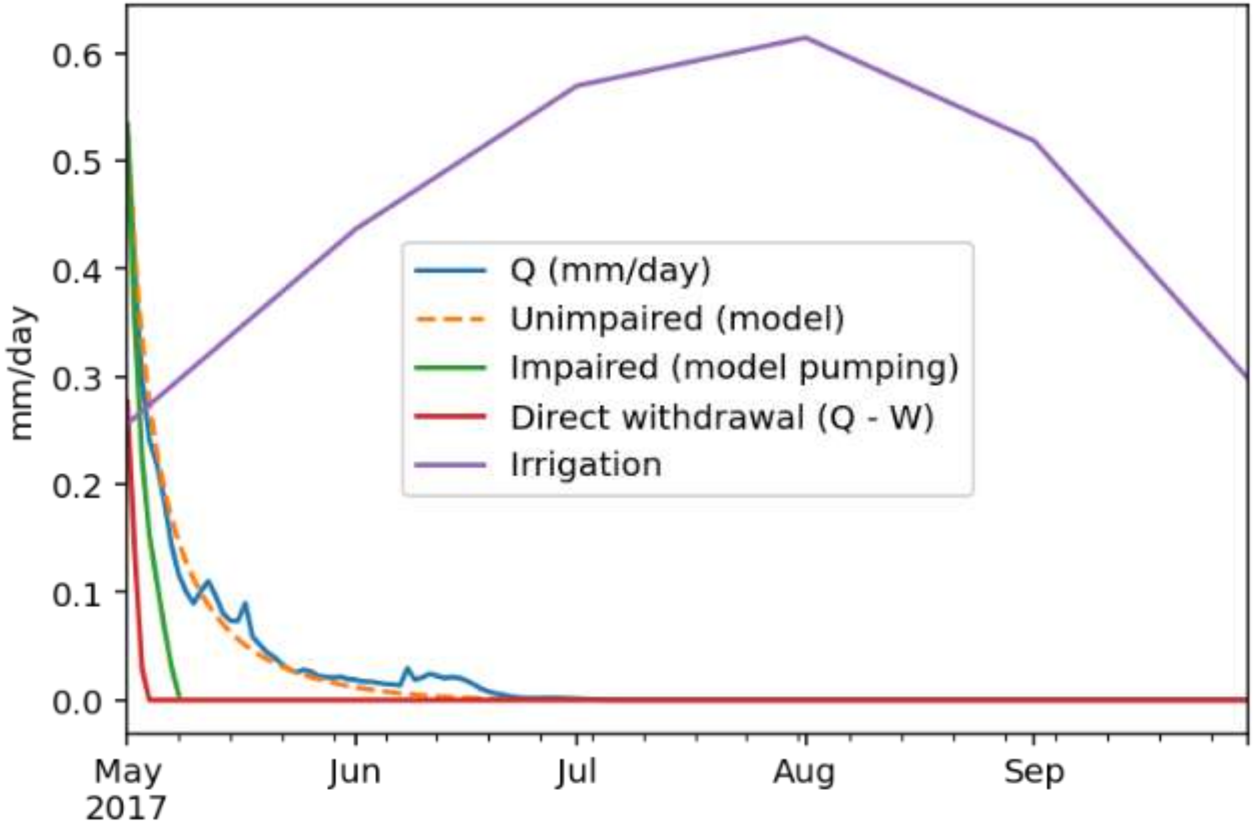
Impacts on Streamflow

2017, median water use rate, 2.5% cover

Elder



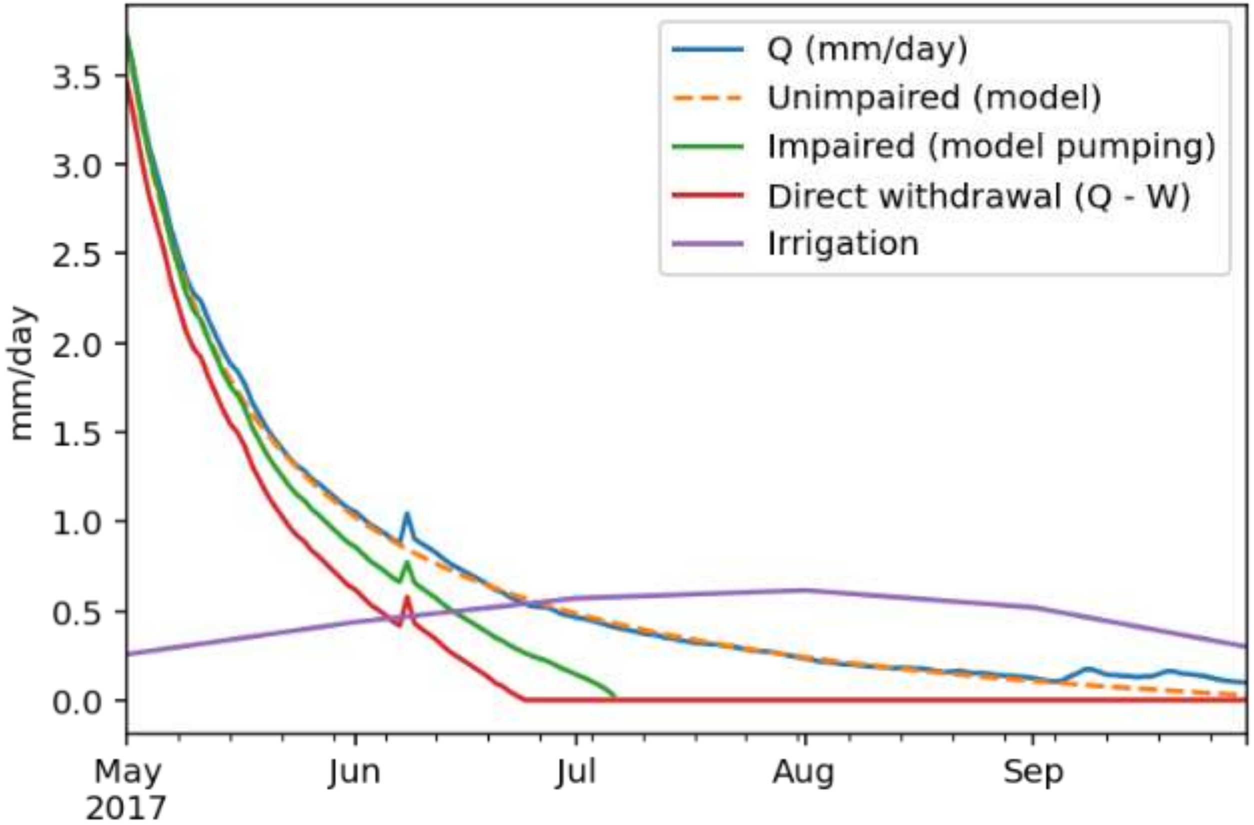
Dry Creek



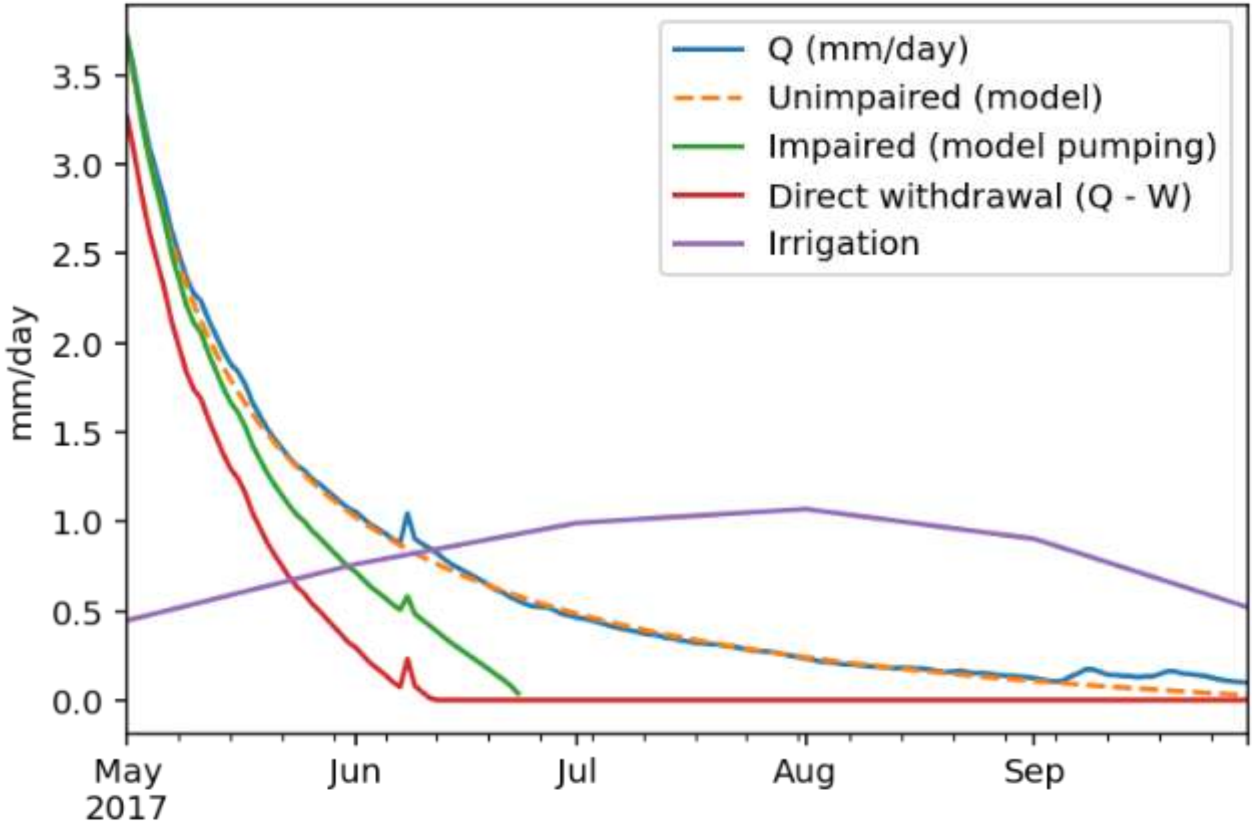
Impacts on Streamflow

2017, water user contrasts, 2.5% cover

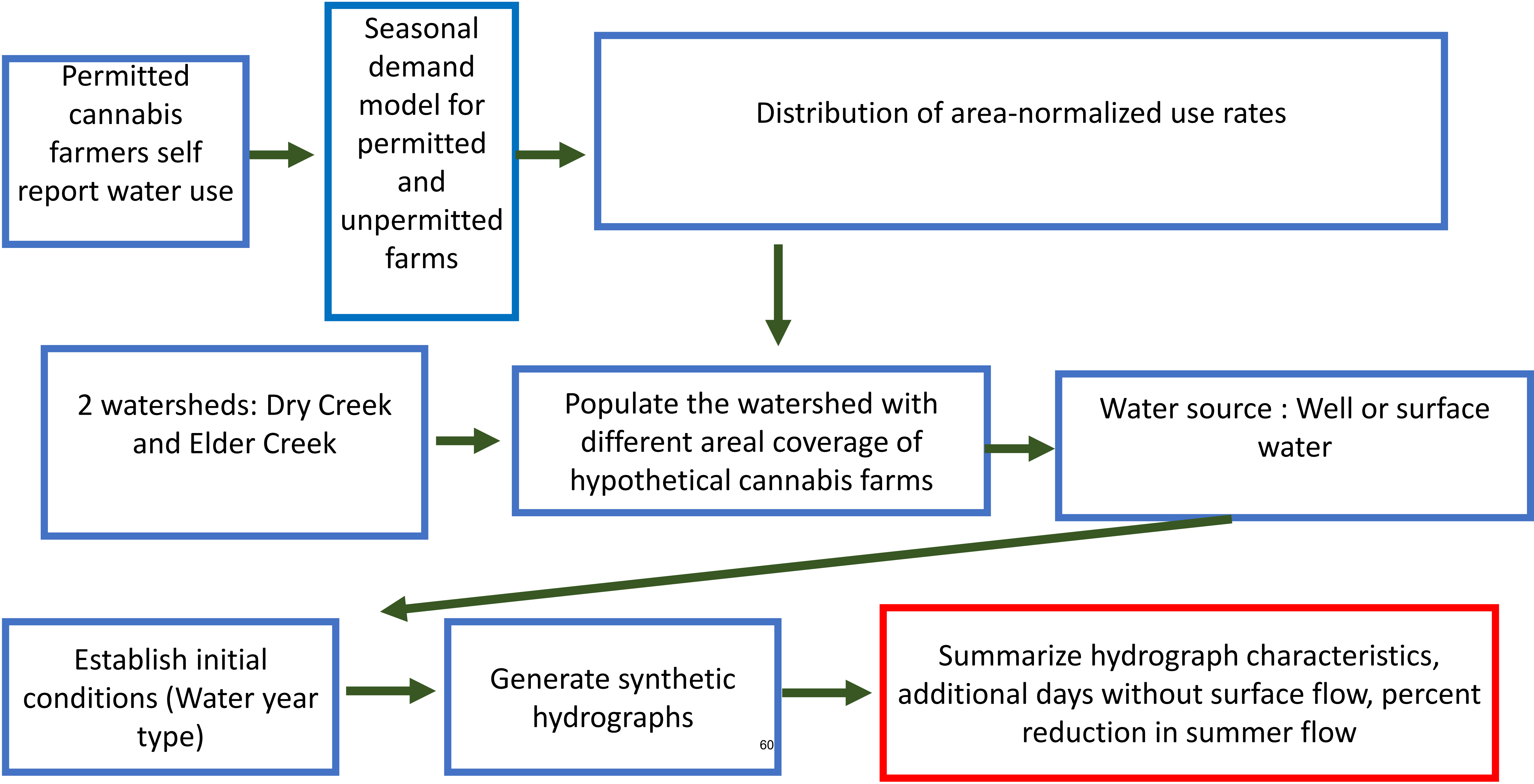
Elder, median user



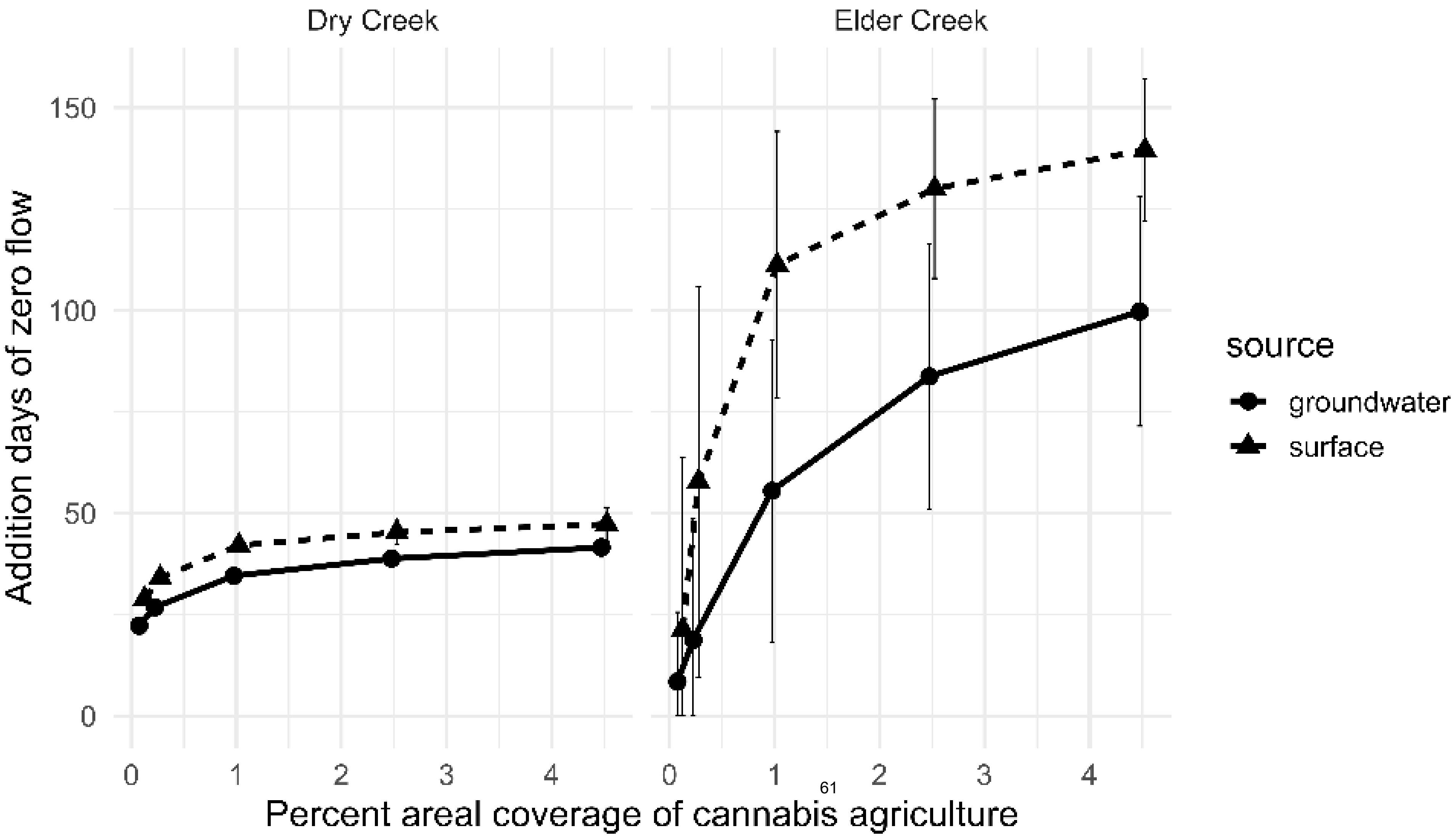
Elder, 95th percentile user



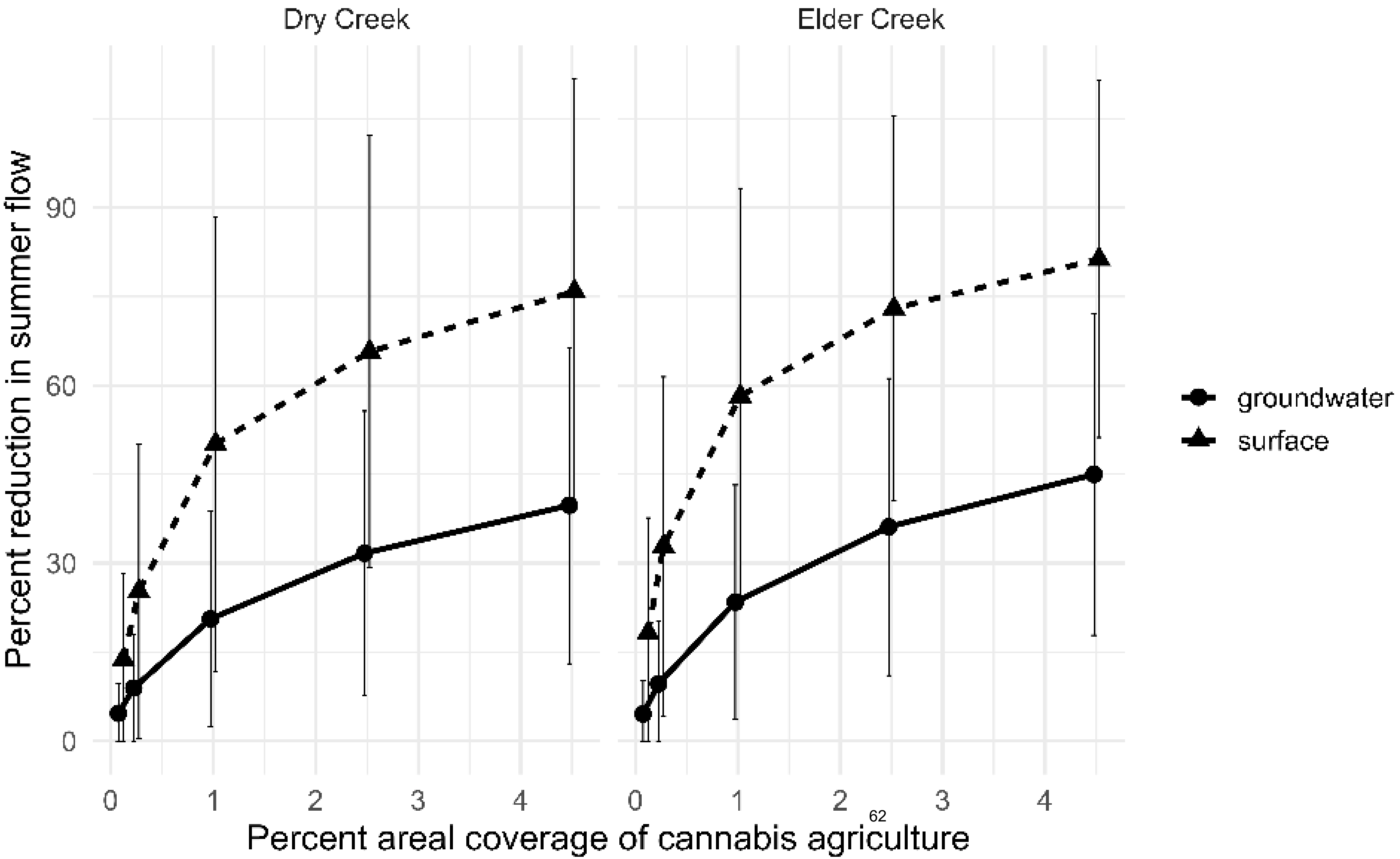
Workflow


Permitted cannabis farmers self report water use
Seasonal demand model for permitted and unpermitted farms
Distribution of area-normalized use rates
2 watersheds: Dry Creek and Elder Creek
Populate the watershed with different areal coverage of hypothetical cannabis farms
Water source : Well or surface water
Establish initial conditions (Water year type)
Generate synthetic hydrographs
Summarize hydrograph characteristics, additional days without surface flow, percent reduction in summer flow

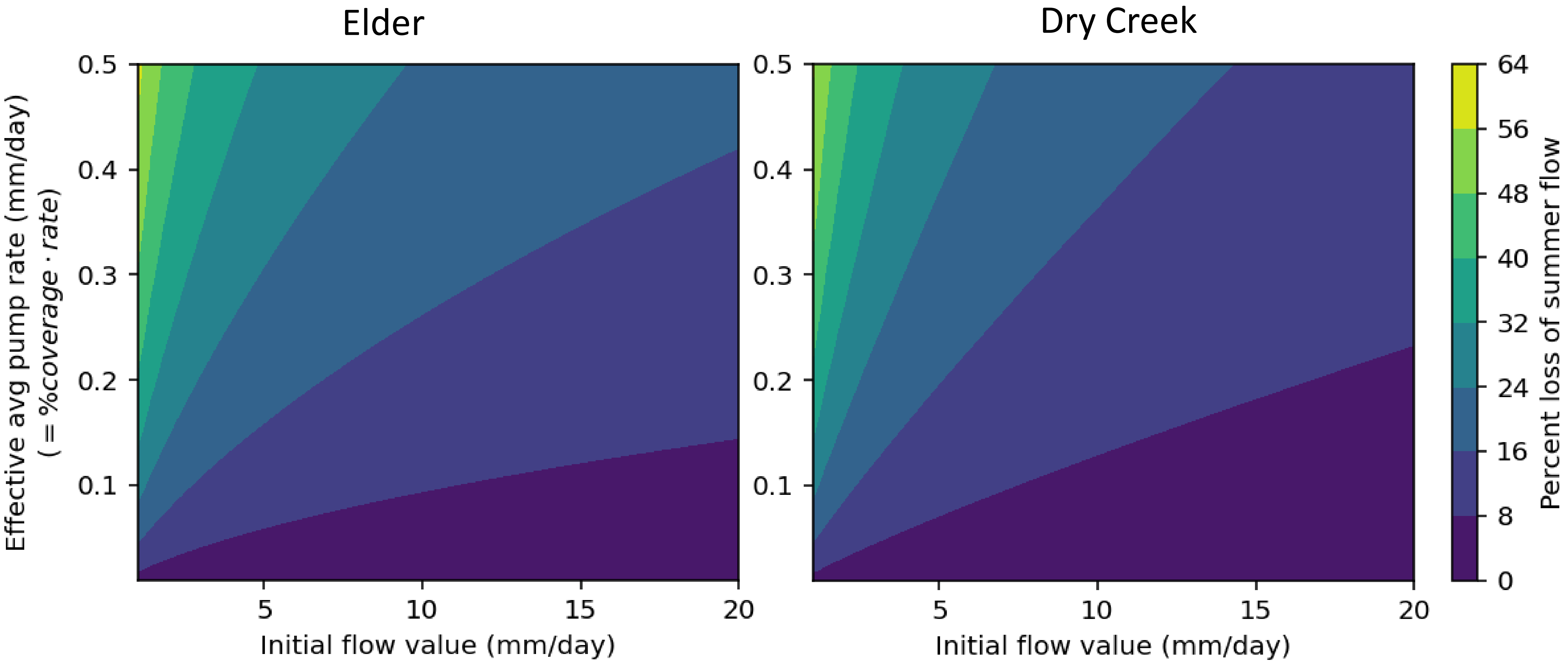
Additional Zero-flow days



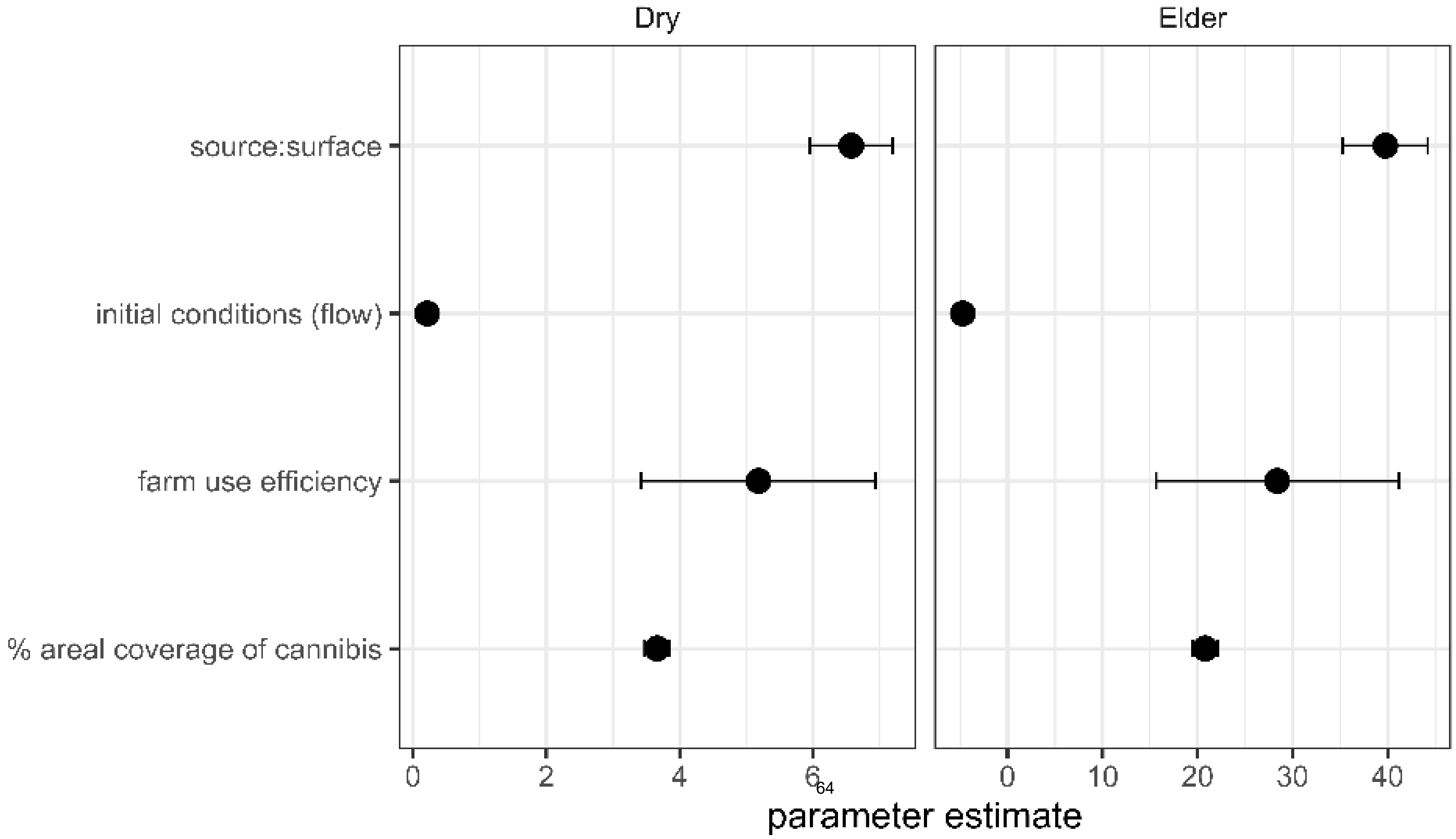
Percent reduction in summer flow



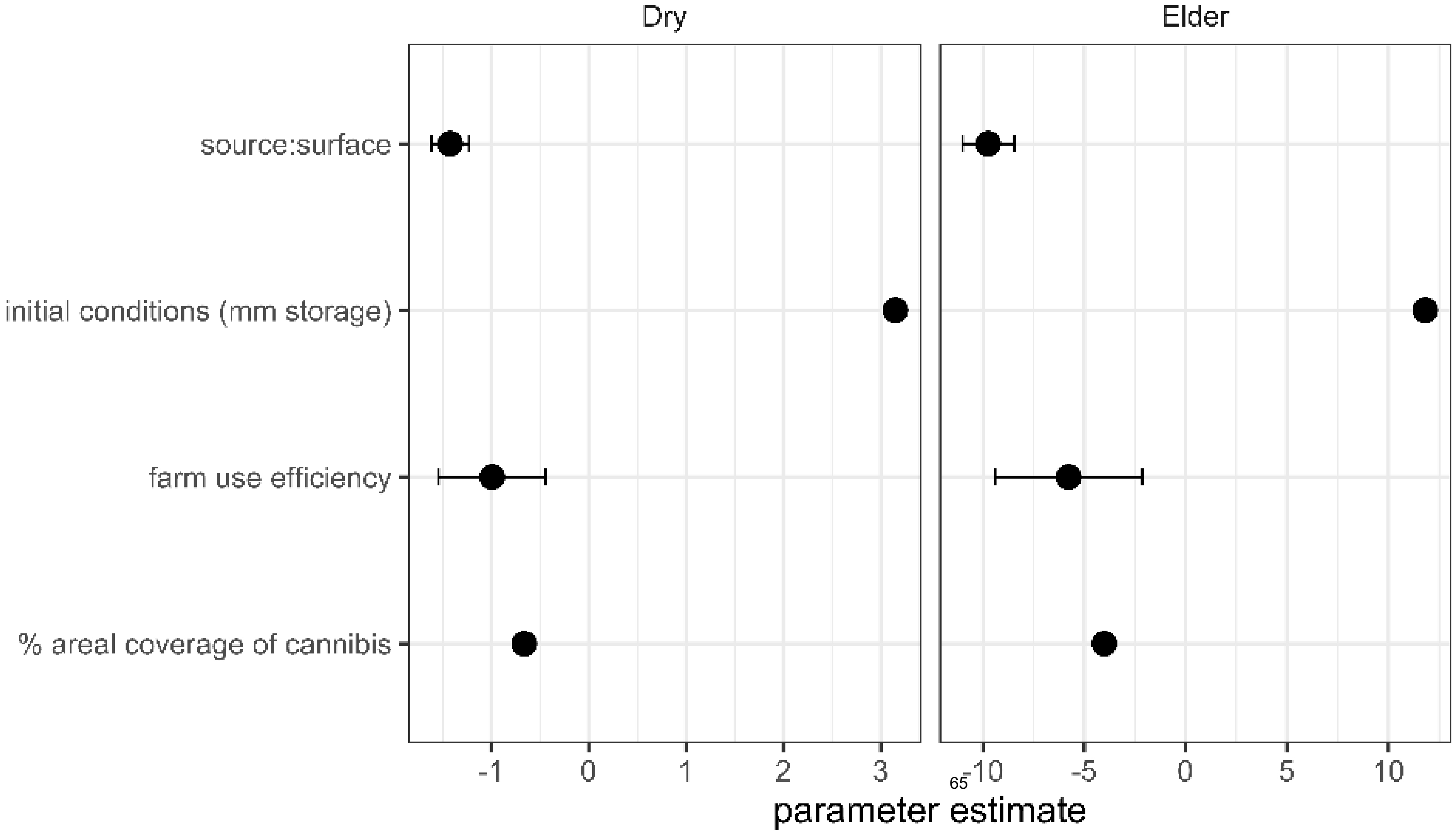
Percent reduction in summer streamflow



Effect sizes of predictor on additional zero-flow days



Effect sizes of predictor on additional zero-flow days

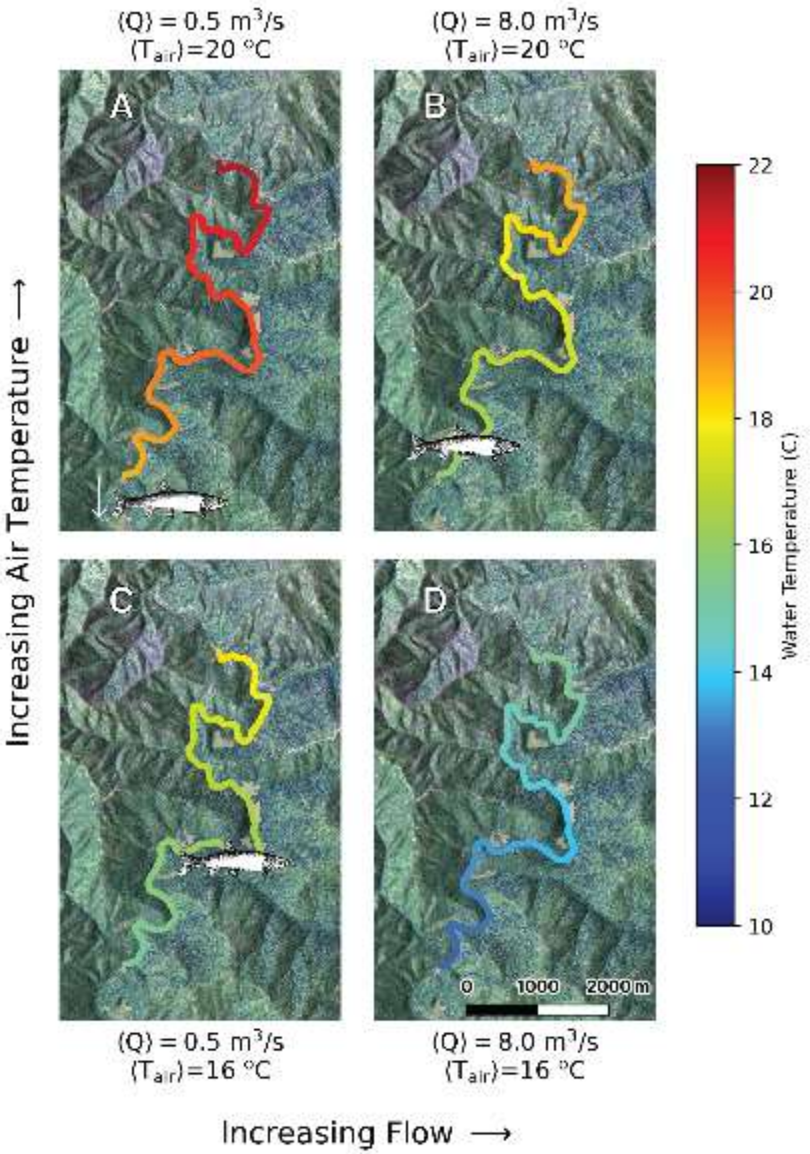


Conclusions

- Storage-discharge sensitivity functions can be useful for estimating effects of groundwater pumping in headwater streams
- Cannabis cover of 0.25% on landscape could de-water a perennial stream and accelerate drying in an intermittent stream
- Mélange streams more sensitive (with regard to discharge) to withdrawal
    - Accelerated drying
    - Greater impact at similar withdrawal rate
- Wide variation in cannabis irrigation rate, more efficient watering and onsite storage could have a large impact
- Pumping’s effect on streamflow is expected to be delayed relative to surface water diversions but can still be substantial.
    - Spatial distribution of farms and wells in a watershed matters

Linking physical impacts to stream ecology

- Hoping to leverage and build on work by this group!
- Georgkakos 2020 : Distribution of native and non-native fishes
  - Timing of pikeminnow movement
  - Invasive vertebrate distribution
- Schaaf et al. 2017
  - Black-spot on steelhead increases with water temperature
- Wang et al. 2020
  - Steelhead use of confluence habitat across seasonal temperature variation



Linking physical impacts to stream ecology

- Georgakakos 2020 : Distribution of native and non-native fishes
  - Timing of pikeminnow movement
  - Invasive vertebrate distribution
- Schaaf et al. 2017
  - Black-spot on steelhead increases with water temperature
- Wang et al. 2020
  - Steelhead use of confluence habitat across seasonal temperature variation

Top: Coho salmon with Black-spot at Jack of Heart's Confluence SF Eel. July, 27 2021
Bottom: Close-up of black-spot on ~12cm Steelhead found dead on SF Eel. August 1, 2021

Questions?

Thanks to the Department of Cannabis Control for funding
Eel River Critical Zone Observatory

Efficient science tools to ID streamflow objectives for flow enhancement and trigger management actions under dry conditions

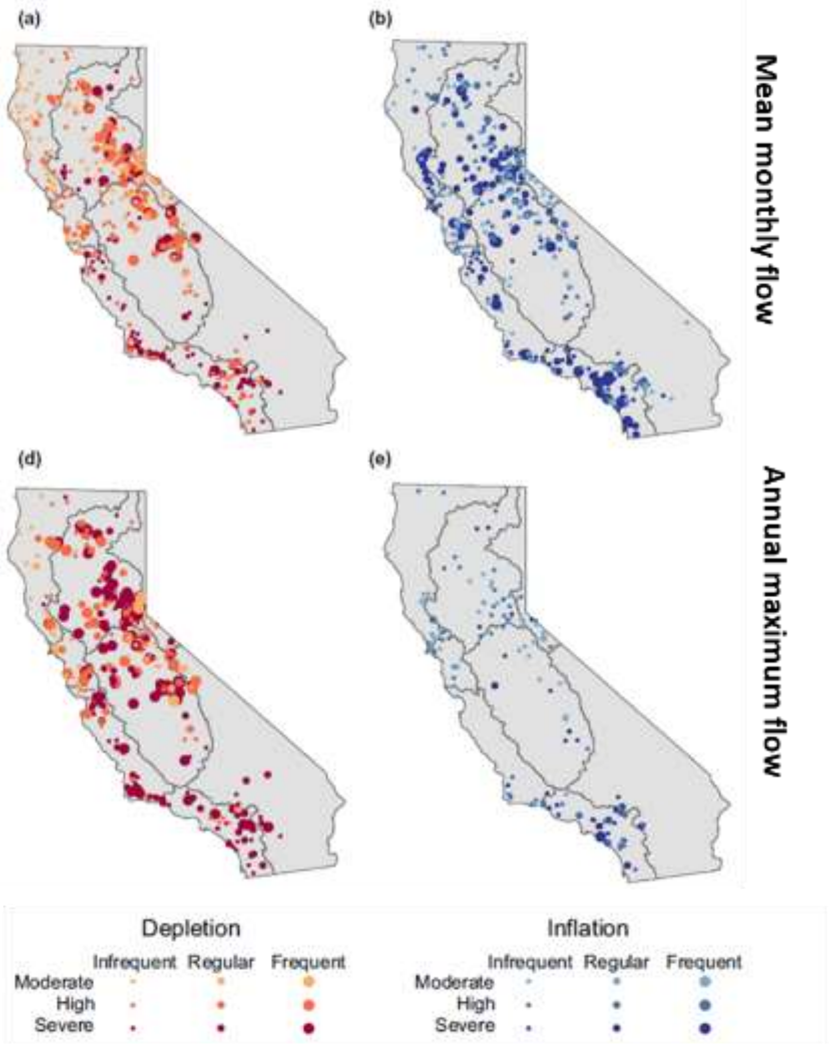
Jennifer Carah, Julie Zimmerman, and Kirk Klausmeyer
The Nature Conservancy

Flow alteration is pervasive

95% of gauged locations have at least
some altered flows; many have pervasive alteration

How much water needs to stay in river to
adequately protect ecosystems?

How do we know when a stream is so dry it will
cause serious stress to freshwater ecosystems?



From Zimmerman et al. 2018, *Freshwater Biology*

Hydrologic (flow)

Hydraulic (flow + stage /velocity)

Habitat-based (physical + biological)

→ Data, time intensive
Expensive
Limited in scope (e.g. portion of flow regime, single species)
Quantitative

Holistic (entire ecosystem)

→ Comprehensive
Less quantitative outputs

California Environmental Flows Framework (CEFF)

Natural Flows Database

Drought Flows Monitor web tool

California Environmental Flows Framework

California Environmental Flows Working Group,
a committee of the California Water Quality Monitoring Council

Funded by:
State Water Resources Control Board, Division of Water Rights

March 2021
Technical Report version 1.0
DRAFT FINAL

CEFF TECHNICAL TEAM

Alyssa Obester – CA Department of Fish and Wildlife

Amber Villalobos - CA Department of Fish and Wildlife

Belize Lane – Utah State University

Bronwen Stanford - CA Department of Fish and Wildlife

Daniel Schultz – State Water Resources Control Board

Eric Stein – Southern CA Coastal Water Research Project

Jeanette Howard – The Nature Conservancy

Julie Zimmerman – The Nature Conservancy

Kris Taniguchi-Quan – S. CA Coastal Water Research Project

Robert Holmes – CA Department of Fish and Wildlife

Rob Lusardi - CalTrout

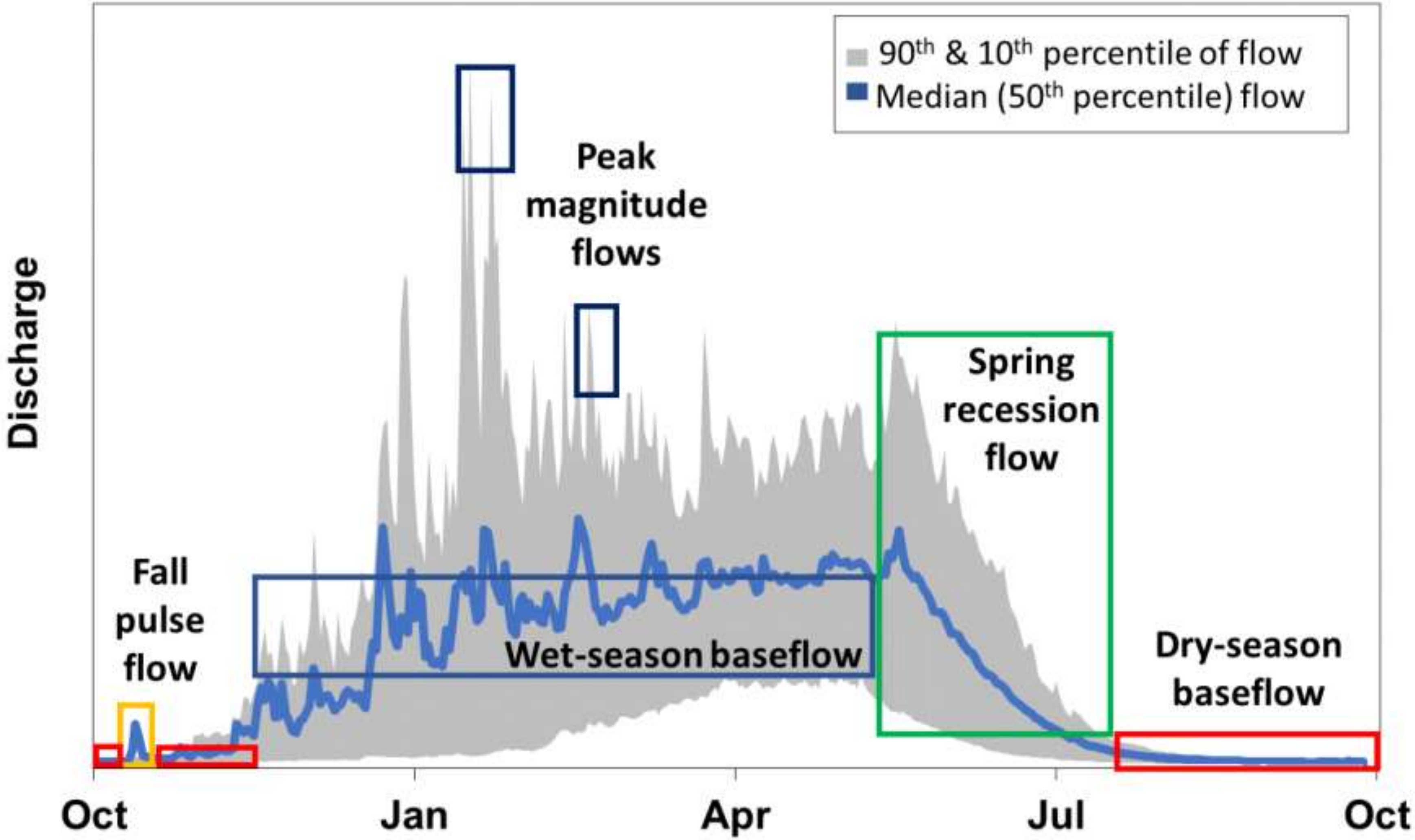
Sam Sandoval-Solis – University of California, Davis

Samuel Cole – State Water Resources Control Board

Sarah Yarnell – University of California, Davis

Ted Grantham – University of California, Berkeley

Functional Flows in California



Yarnell et al. 2020 *River Research and Applications*

Natural flows database

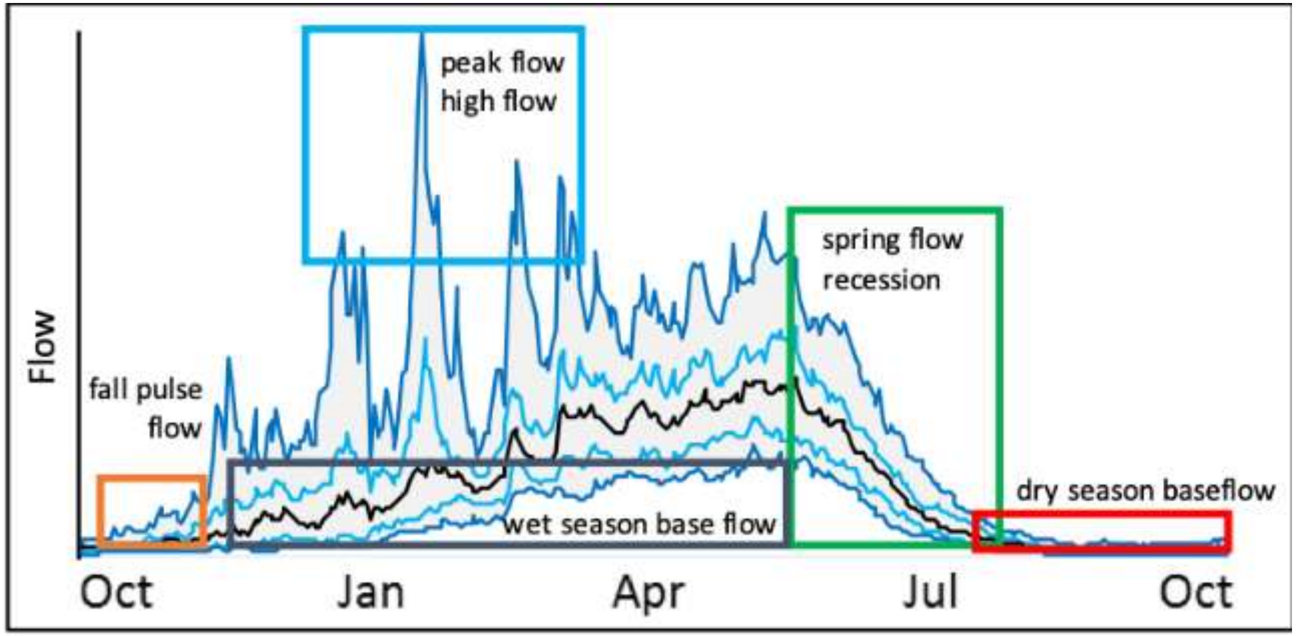
- Partnership between USGS, TNC and UC Berkeley
- Machine learning approach to predict natural monthly flows for every stream reach in CA
- Model was trained with flow data from 250 reference gages in CA, as well as precipitation, air temp, and many physical habitat variables; extensively validated
- Outputs: mean, max, min monthly unimpaired flow estimates, 1950-present
- 1000 model runs for each stream segment – reports average of all runs + 10th and 90th percentile models

Zimmerman et al. 2018 *Freshwater Biology*

Functional Flow Metrics

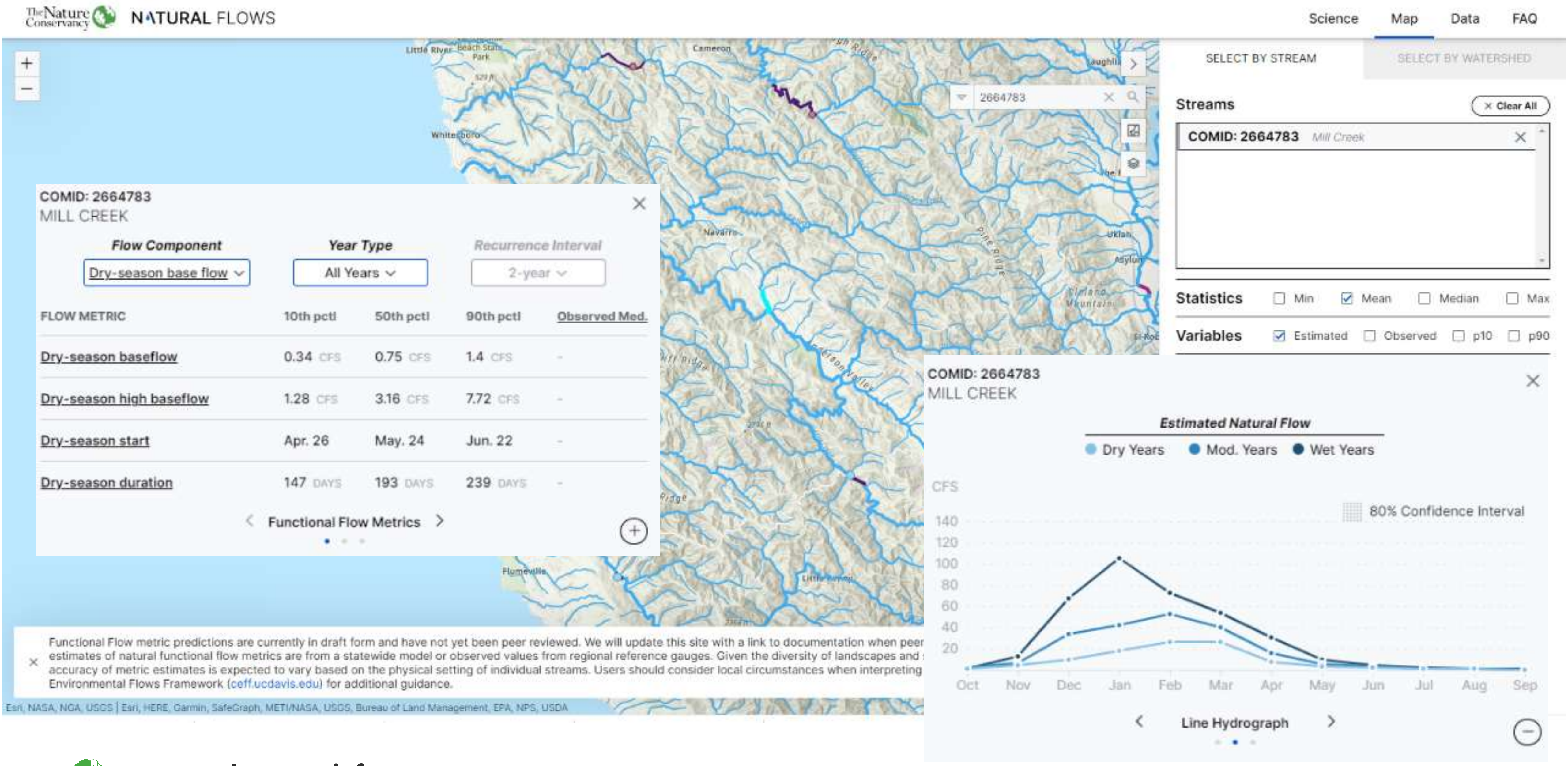
- Developed by the CEFF tech. team
- Uses similar machine learning approach to predict FFMs for every stream reach in CA
- Outputs: predictions of functional flow metrics for each stream segment; provided as median (p50) and a range (p10, p90) to reflect model uncertainty and interannual variation; also validated
- Also, reported in bins: wet, moderate and dry years

Grantham et al. 2022 *Frontiers in Environmental Science*

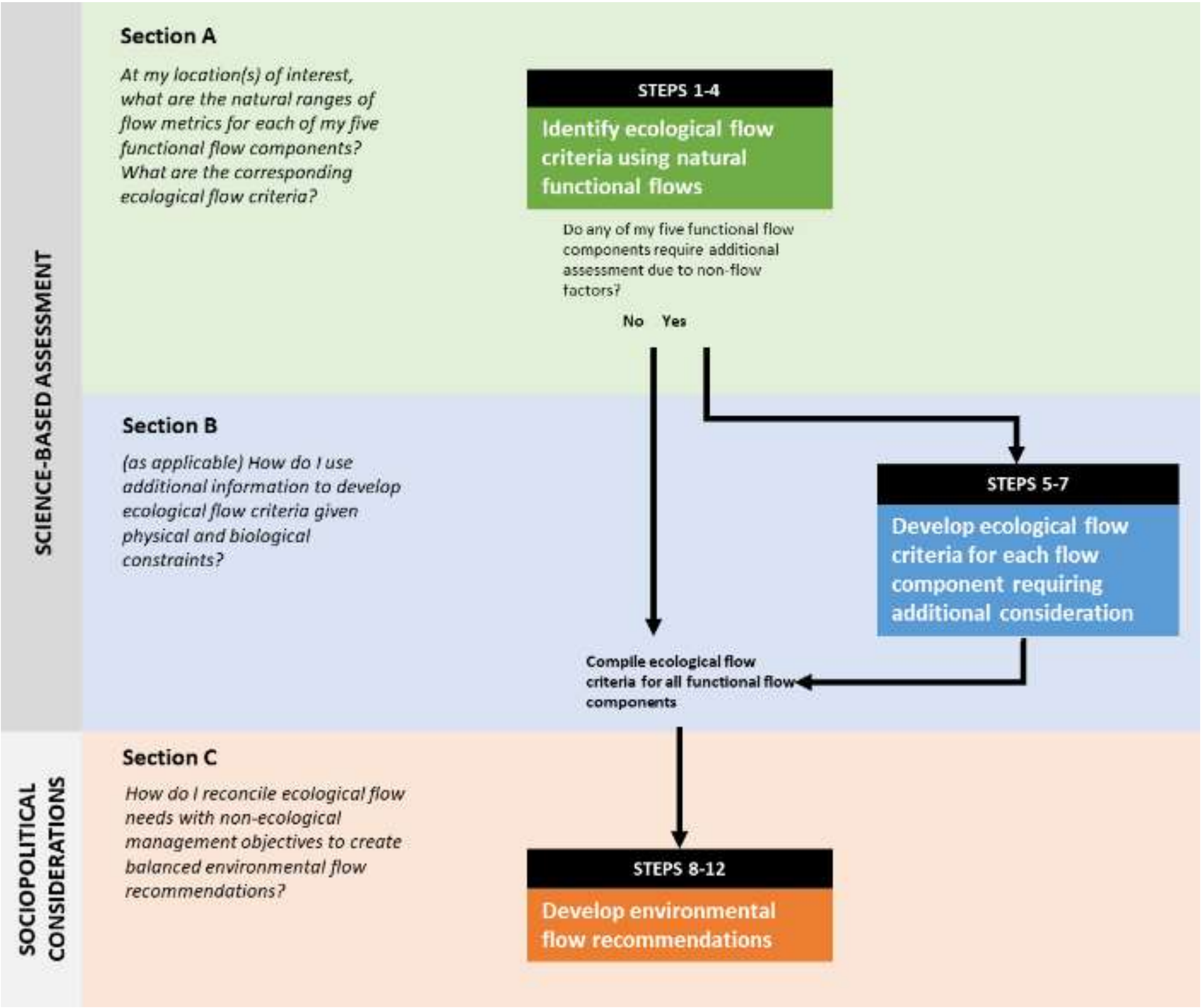


Flow Component	Flow Characteristic
Fall pulse flow	Magnitude (cfs)
	Timing (date)
	Duration (days)
Wet-season base flow	Magnitude (cfs)
	Timing (date)
	Duration (days)
Wet-season peak flow	Magnitude (cfs)
	Duration (days)
	Frequency
Spring recession flow	Magnitude (cfs)
	Timing (date)
	Duration (days)
	Rate of change (%)
Dry-season base flow	Magnitude (cfs)
	Timing (date)
	Duration (days)

Grantham et al. 2022 *Frontiers in Environmental Science*



rivers.codefornature.org



- Ecological flow criteria
- Alteration assessment
- Environmental flow recommendations (via stakeholder process)
- Implementation, monitoring and adaptive management plan

Stein et al. 2021 *Frontiers in Environmental Science*

Flow Component	Flow Metric	Predicted Range at Lower Mill (COMID 2664783); median (10th - 90th percentile)	Predicted Range at Meyer Gulch (COMID 2664715); median (10th - 90th percentile)
Fall pulse flow	Fall pulse magnitude	5.44 (1.78-33) cfs	0.72 (0.21-5.19) cfs
	Fall pulse timing	Oct. 27 (Oct. 9-Nov. 14)	Oct. 29 (Oct. 8-Nov. 20)
	Fall pulse duration	3 (2-6.5) days	No data
Wet season baseflow	(median magnitude)	16.9 (8.38-34) cfs	1.78 (0.86-3.47) cfs
	Wet season start date	Dec. 3 (Nov. 20-Dec. 22)	Dec. 5 (Nov. 13-Dec. 31)
	Wet season duration	117 (74-155) days	111 (67-159) days
Peak flows	5-year flood magnitude	893 (488-1300) cfs	91 (45-149) cfs
	5-year flood duration	2.5 (1-6) days	No data
	5-year flood frequency (number of 5-year floods/year)	1 (1-3) occurrences	No data
Spring recession flows	Spring recession magnitude	88 (22-276) cfs	9.75 (2.55-39.5) cfs
	Spring recession timing	Apr. 2 (Mar. 12-Apr. 28)	Mar. 31 (Mar. 8-May 1)
	Spring recession duration	40 (25-77) days	43 (24-105) days
	Spring recession rate of change	6 (3-10) %	No data
Dry season baseflow	Dry season (median) baseflow	0.75 (0.34-1.4) cfs	0.09 (0.03-0.23) cfs
	Dry season start date	May 24 (Apr. 26-Jun. 22)	May 26 (Apr. 23-Jul. 6)
	Dry season duration	193 (147-239) days	190 (135-242) days

Flow Component	Flow Metric	Alteration ststus at Lower Mill (COMID 2664783)	Alteration status at Meyer Gulch (COMID 2664715)
Fall pulse flow	Fall pulse magnitude	likely unaltered	likely unaltered
	Fall pulse timing	likely unaltered	likely unaltered
	Fall pulse duration	likely unaltered	No data
Wet season baseflow	Wet season baseflow (median magnitude)	unclear if altered*	likely unaltered*
	Wet season start date	unclear if altered	likely unaltered
	Wet season duration	likely unaltered	likely unaltered
Peak flows	5-year flood magnitude	likely altered (low)*	likely altered (low)*
	5-year flood duration	likely unaltered	No data
	5-year flood frequency (number of 5-year floods/year)	likely unaltered	No data
Spring recession flows	Spring recession magnitude	likely unaltered	likely unaltered
	Spring recession timing	unclear if altered	likely altered (early)
	Spring recession duration	likely unaltered	likely unaltered
	Spring recession rate of change	likely unaltered	No data
Dry season baseflow	Dry season (median) baseflow	likely altered (low)	likely altered (low)
	Dry season start date	likely unaltered	likely unaltered
	Dry season duration	likely unaltered	likely unaltered

	July mean monthly flow observed (cfs)	Natural Flows Database mean monthly flow (cfs) - July				August mean monthly flow observed (cfs)	Natural Flows Database mean monthly flow (cfs) - August			
		10th percentile	Dry years	Mod. Years	Wet years		10th percentile	Dry years	Mod. Years	Wet years
Meyer Gulch	no data	0.01	0.1	0.13	0.2	no data	0.00	0.00	0.04	0.09
Lower Mill	0.29	0.52	1	1.39	1.86	0.10	0.23	0.65	0.81	1.02

	Sept. mean monthly flow observed (cfs)	Natural Flows Database mean monthly flow (cfs) - Sept.				October mean monthly flow observed (cfs)	Natural Flows Database mean monthly flow (cfs) - October			
		10th percentile	Dry years	Mod. Years	Wet years		10th percentile	Dry years	Mod. Years	Wet years
Meyer Gulch	no data	0.00	0.00	0.00	0.00	no data	0.02	0.11	0.15	0.17
Lower Mill	0.06	0.07	0.36	0.41	0.55	0.24	0.52	1.12	2.07	1.41

Can we quickly identify critically dry conditions (without stream gages) to inform decision making?

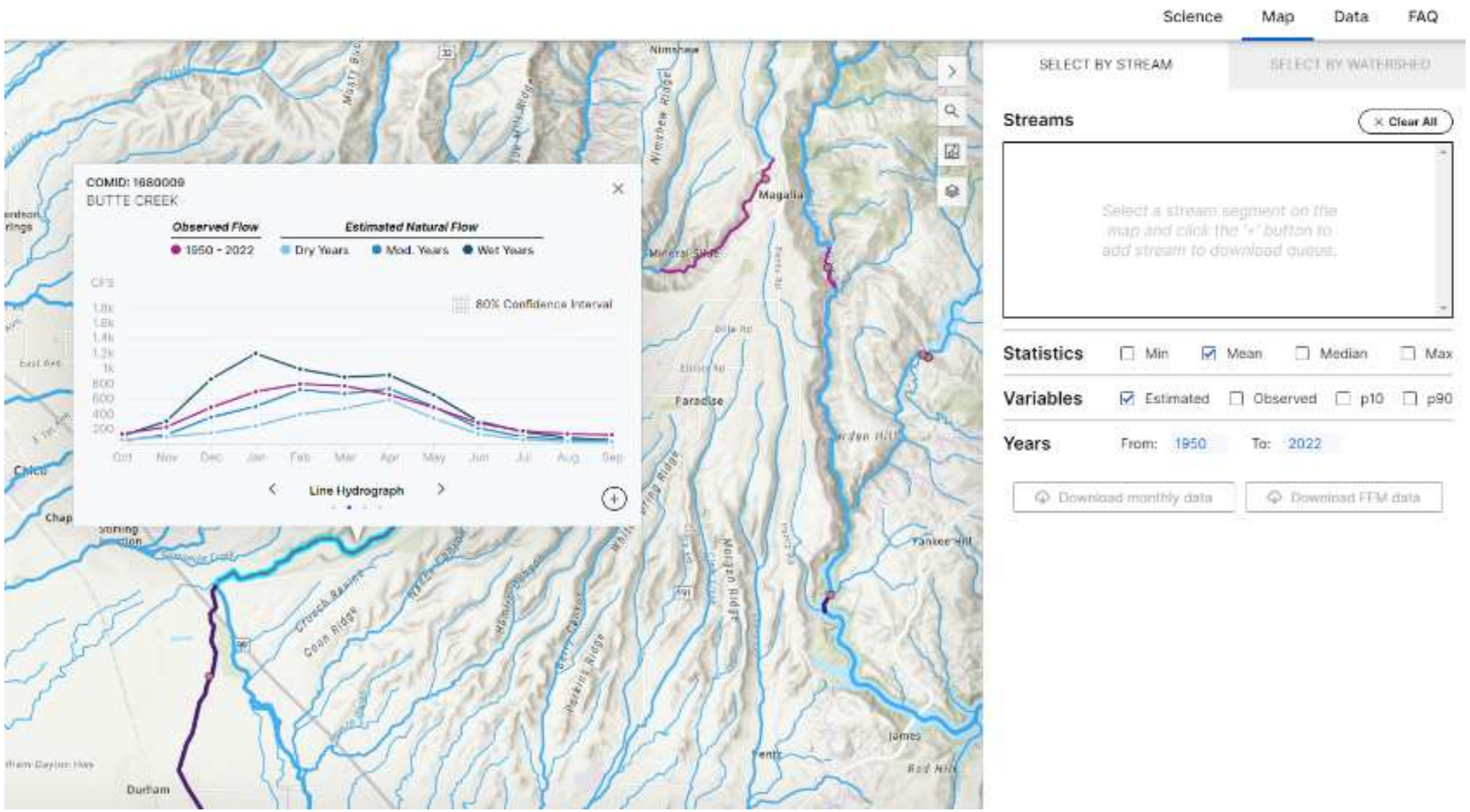
Are there indicators early in a water year that can help flag when and where critically dry conditions are likely in the coming dry season ?

Drought Flows Monitor:
https://rivers.codefornature.org/#/apps

- Goal: guide river management decisions by identifying watersheds with historically low natural flows where ecological risk of human water use is very high

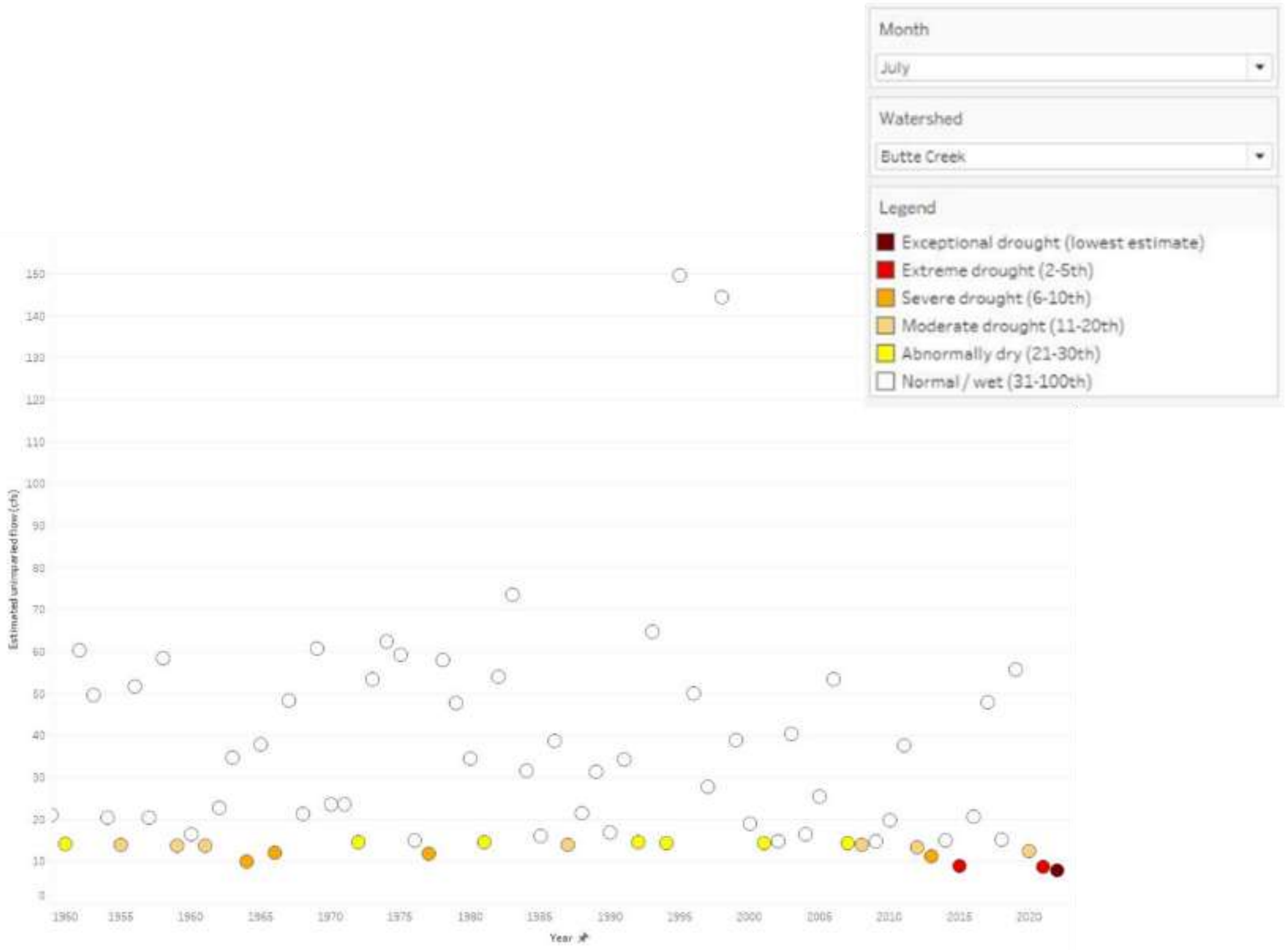
- Natural Flows Database (monthly natural flow predictions, 1950-present)

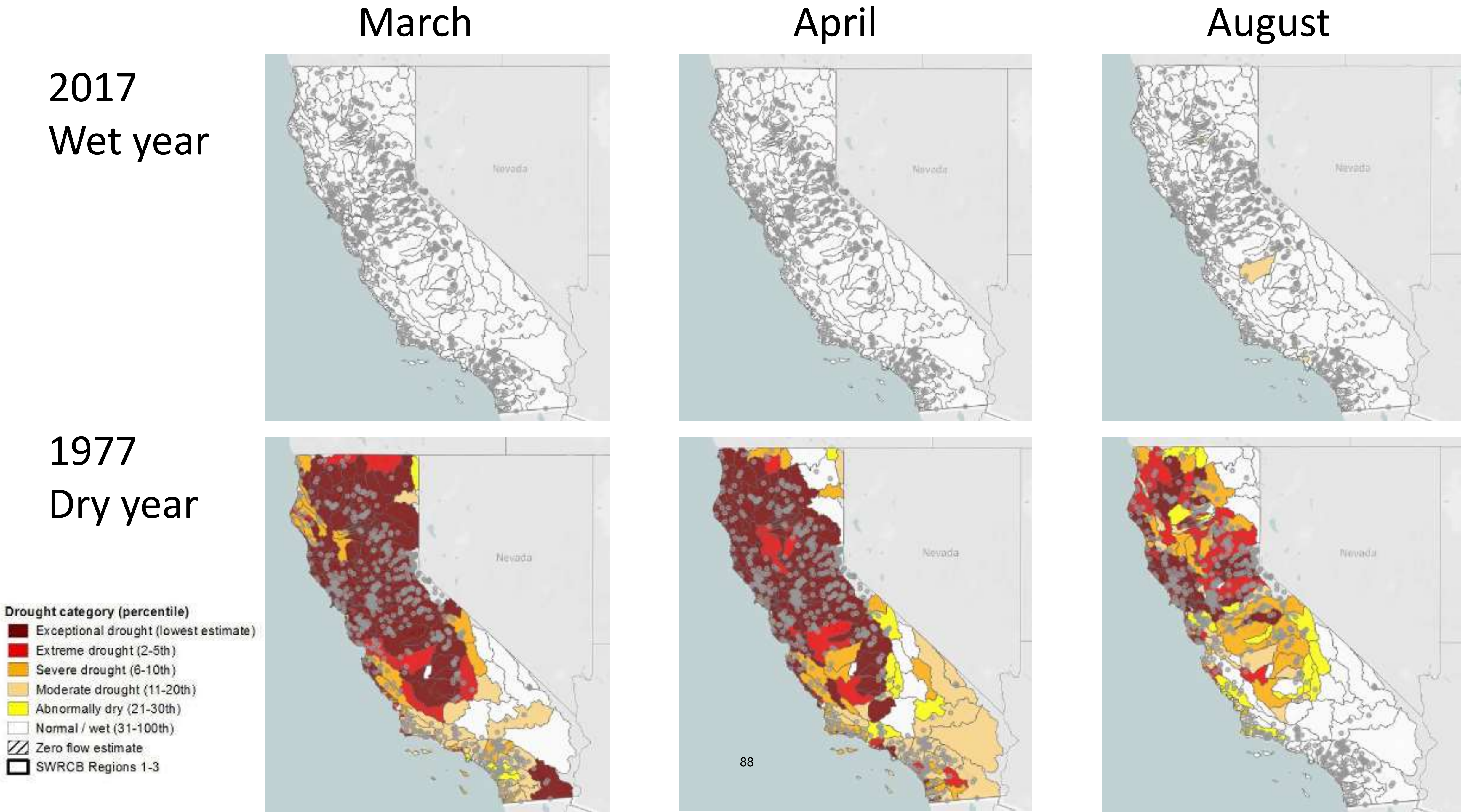
Calculate each monthly prediction as a percentage of the range of predicted flows from 1950-present



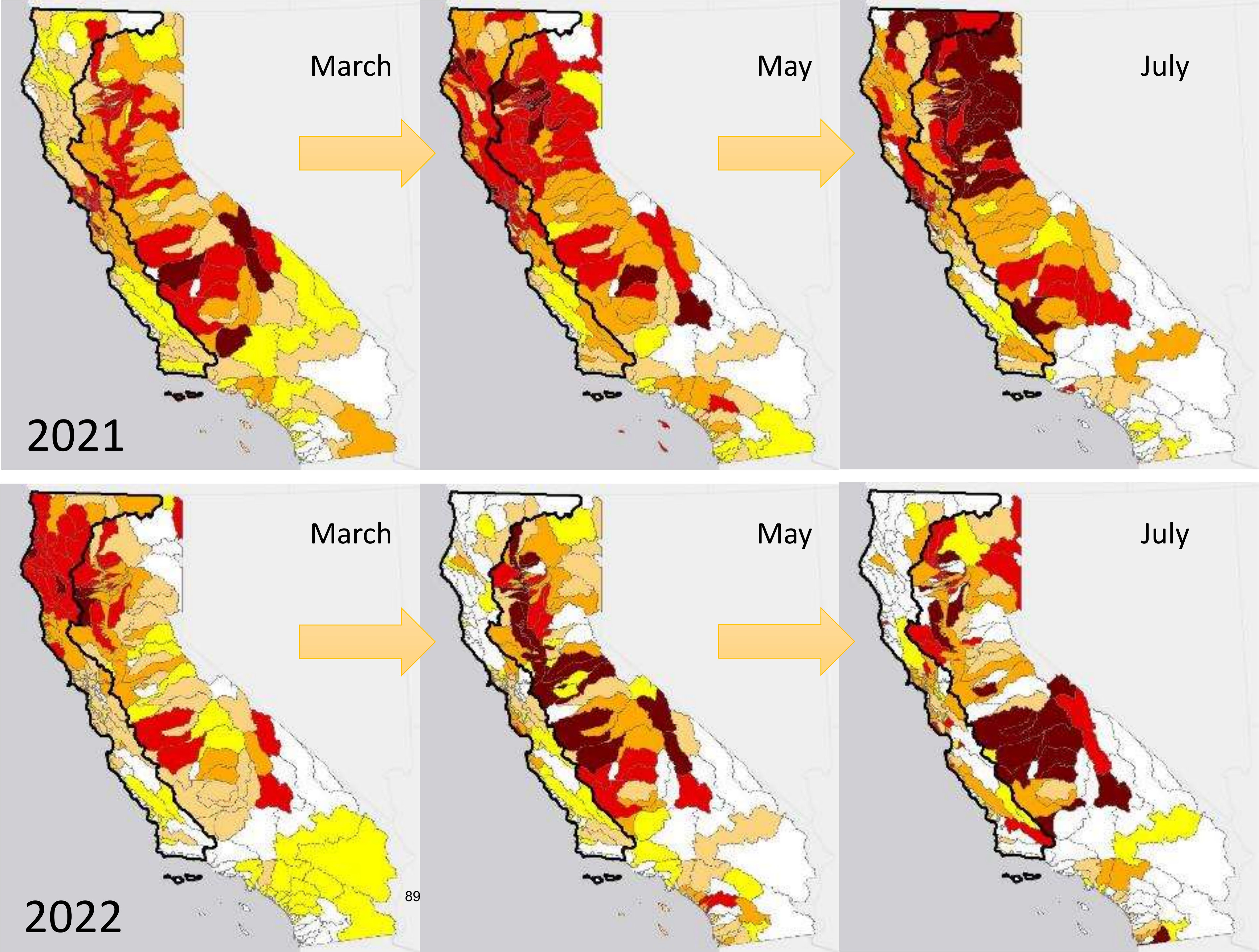
Drought conditions follow US Drought Monitor categories, ≤30th percentile of the distribution of natural flow for the same month

HUC 8/12 watersheds combined by large named streams, most downstream reach of largest river used for summary

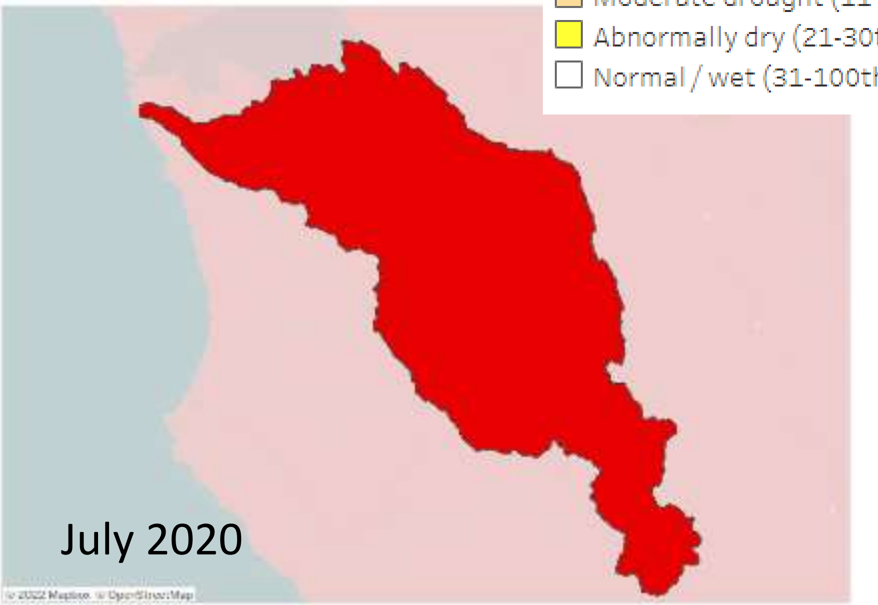


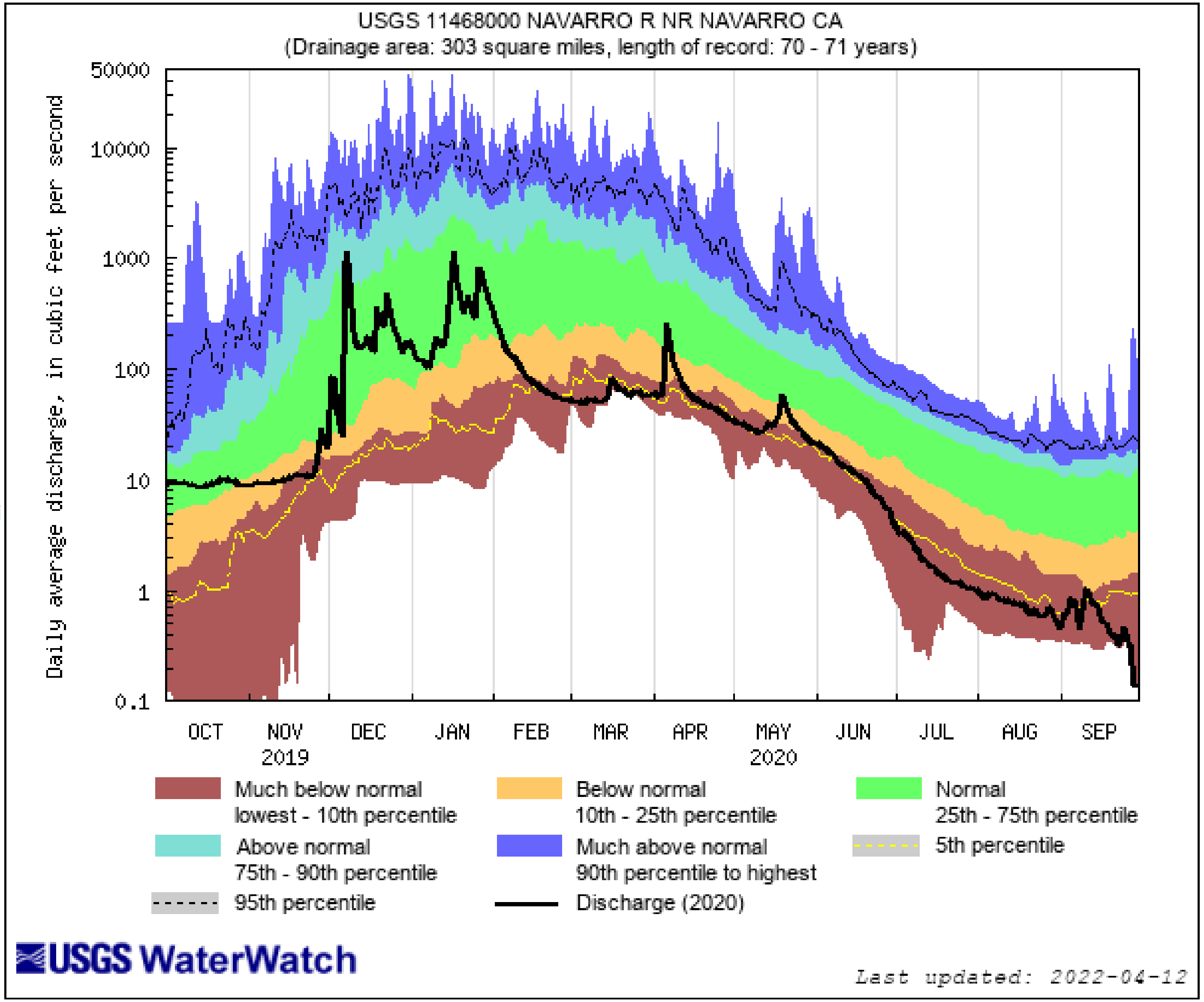

March
April
August
2017
Wet year
1977
Dry year
Nevada
Drought category (percentile)
Exceptional drought (lowest estimate)
Extreme drought (2-5th)
Severe drought (6-10th)
Moderate drought (11-20th)
Abnormally dry (21-30th)
Normal / wet (31-100th)
Zero flow estimate
SWRCB Regions 1-3

These maps show the estimated natural flows for the largest river in each watershed, as a percentile of the range of estimate flows from 1950-2022. For example, a dark red watershed in the July 2021 panel indicates the estimated natural flow for the largest river in that watershed was the lowest estimated in the last 72 years.



Legend
- Exceptional drought (lowest esti
- Extreme drought (2-5th)
- Severe drought (6-10th)
- Moderate drought (11-20th)
- Abnormally dry (21-30th)
- Normal / wet (31-100th)





Insights and real-world application

- Critically dry conditions in late spring are unlikely to improve over the dry season
  - March and April conditions tend to persist – but need to evaluate late season storms.
- Many individual stream reaches go dry by late summer even under normal conditions
  - Summarizing by larger watershed evaluates conditions in perennial streams and is a good indicator of overall watershed condition
  - Many streams don’t have much variation in natural August flows – they’re always dry
- Natural flow conditions that are expected to be critically dry will result in ecosystem stress at any time of year
  - Reducing alteration from human use is warranted

Insights and real-world application

- Valuable tool to quickly ID watersheds statewide likely in need of management change due to critically dry conditions
- Does not require gaging data or site specific data
- Can pair with additional site-specific data (gages, RCT data) to further evaluate drought conditions and impairment if desired
- Has different implications in flow regulated mainstem rivers
- Could summarize information at smaller HUC unit scale or individual reaches for decision making

Example application

- Start tracking critically dry months in March as early indicator that a critically dry season is likely – early warning system for summer low flow months
- Access web tool first week of April to ID watersheds that likely experienced exceptional, extreme or severe drought in March
- Flag watersheds where conditions are likely critically dry (prepare for management changes or actions)
- Verification step - where USGS gages are present, check whether mean daily discharge in early April is approaching the 10th percentile of mean daily discharge for the gage period of record
- In early May, use tool to ID watersheds that likely experienced critically dry conditions in April (and repeat verification step)
- In those watersheds, where additional significant precipitation is not predicted management changes or actions could proceed by early June
- If significant precipitation is predicted in May, tool is consulted again in early June to see if critically dry conditions are still likely

Resources

- CEFF and Natural Flows Database:

https://rivers.codefornature.org/

- Drought Flows Monitor web tool:

https://rivers.codefornature.org/#/apps

Water From Bedrock:

Efforts to Condition New Groundwater Wells to Protect Streamflow for Salmon

Presentation to the

40th Annual Salmonid Restoration Federation Conference

Fortuna, CA
April 27, 2023

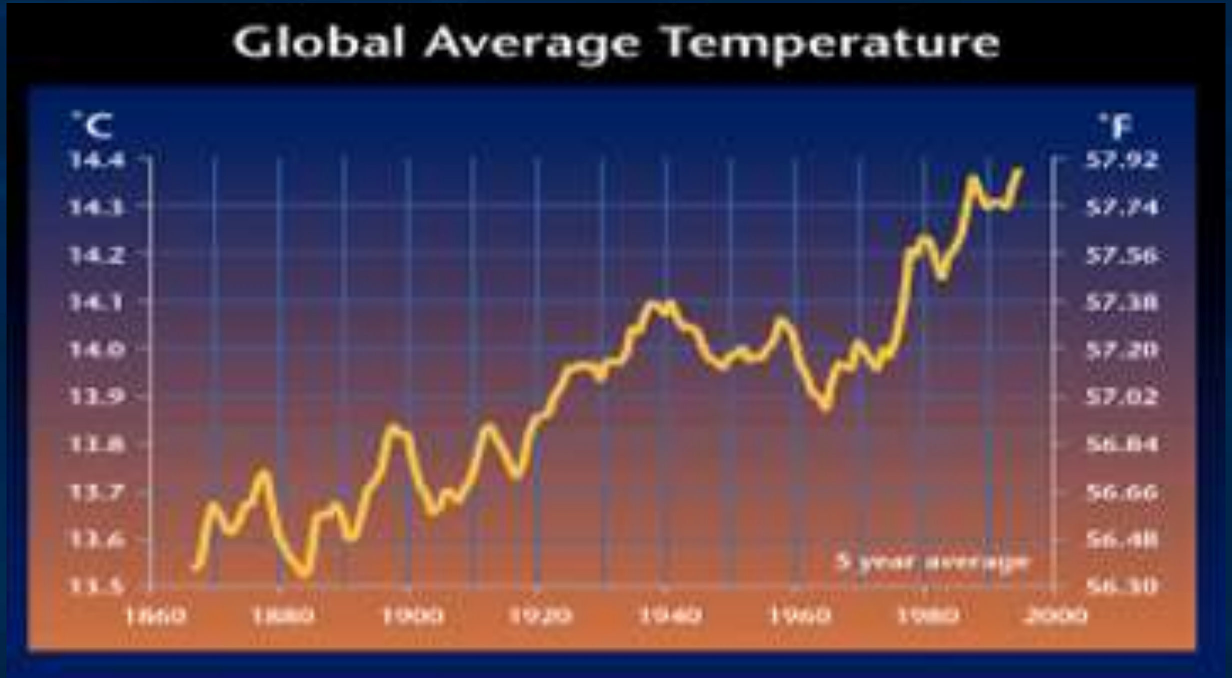
Matt Clifford
Trout Unlimited

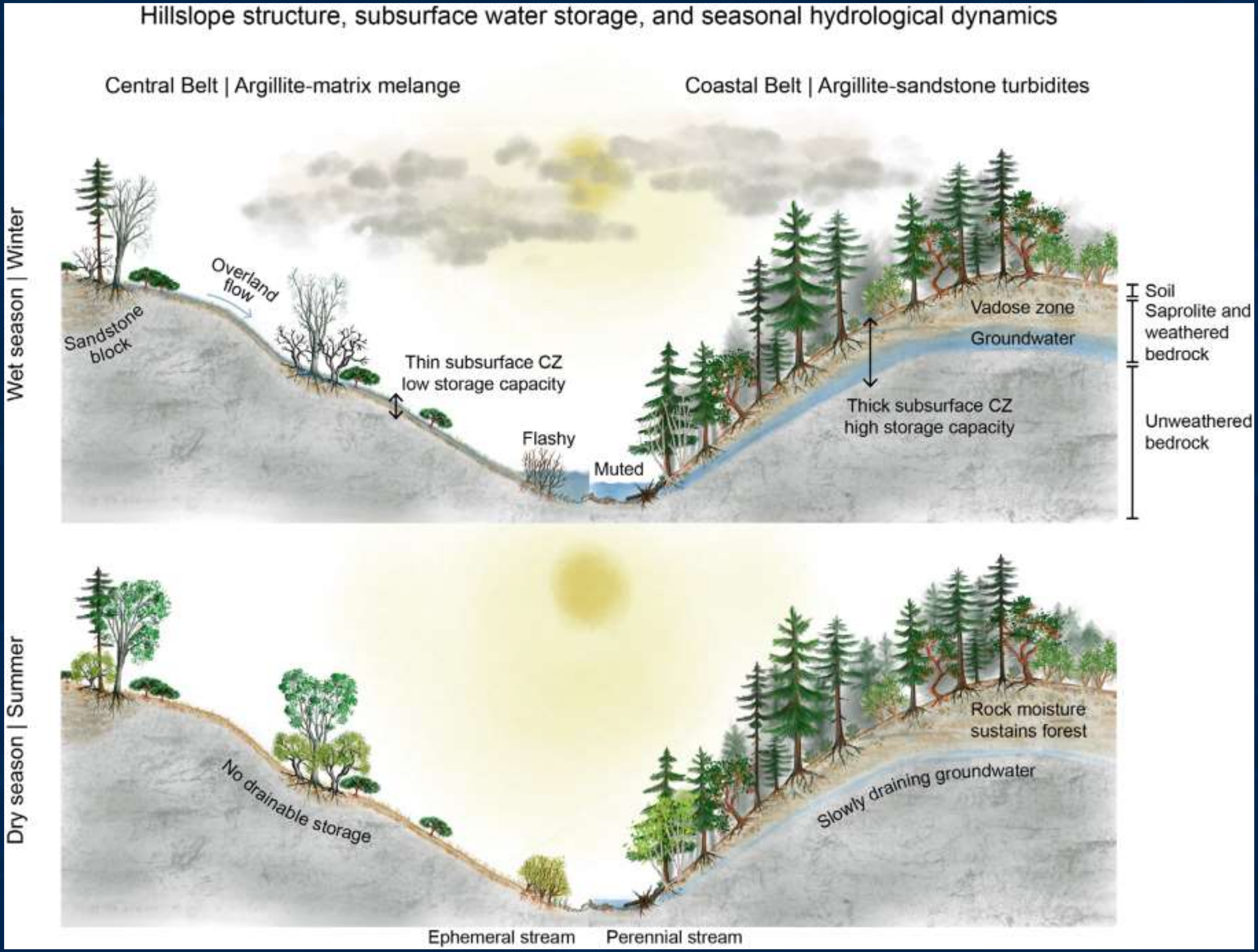
Monty Schmitt
The Nature Conservancy

Overview

- Coastal Watersheds, Salmon and Groundwater
- Groundwater, Wells and the Public Trust Doctrine
- Case Study- Sonoma County Well Ordinance
  - Process
  - Adopted updated well ordinance
  - Next steps
- Considerations for future well ordinances

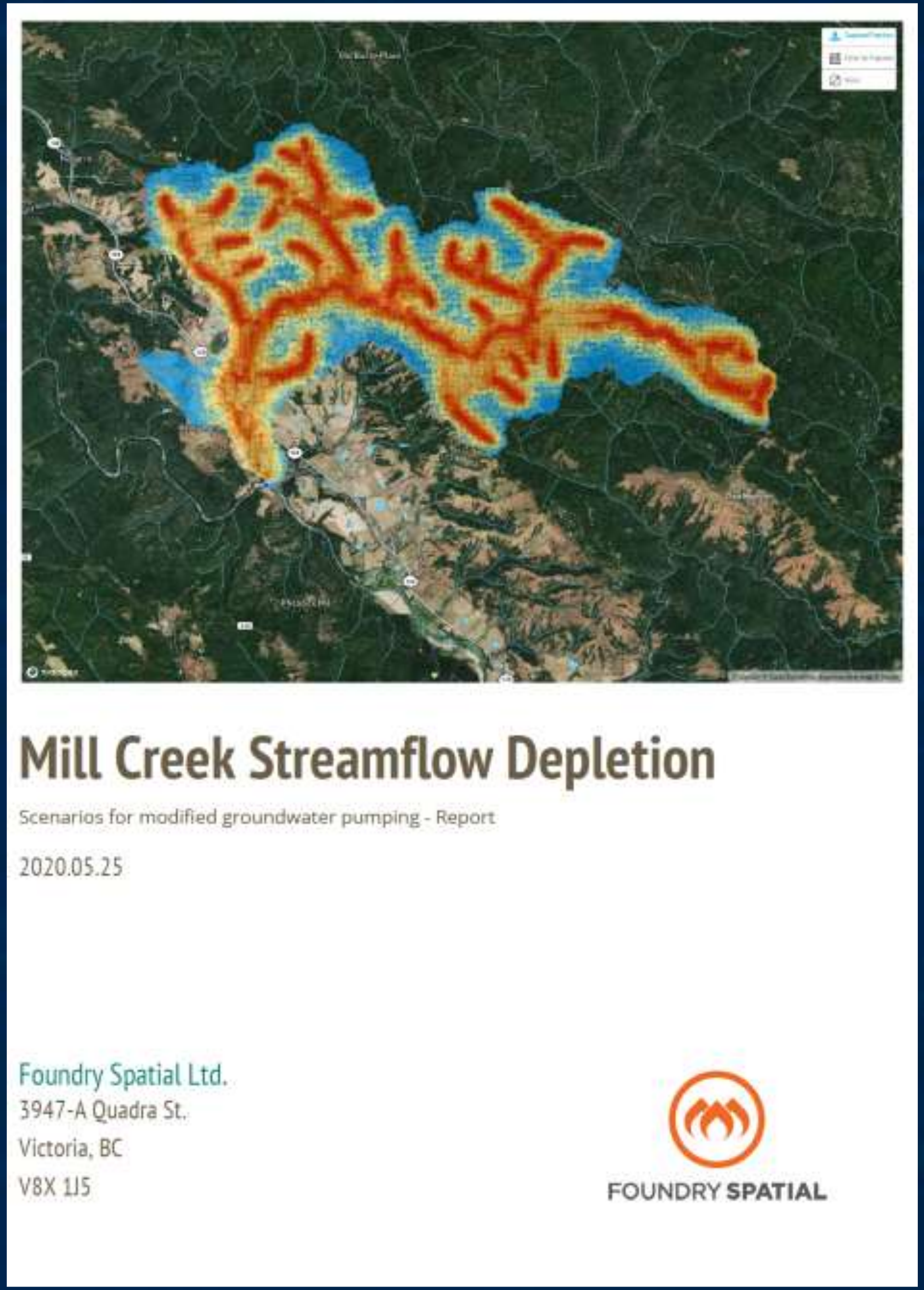
Coastal watershed water management challenges





Credit Drallle.2023

Modeled Streamflow Depletion



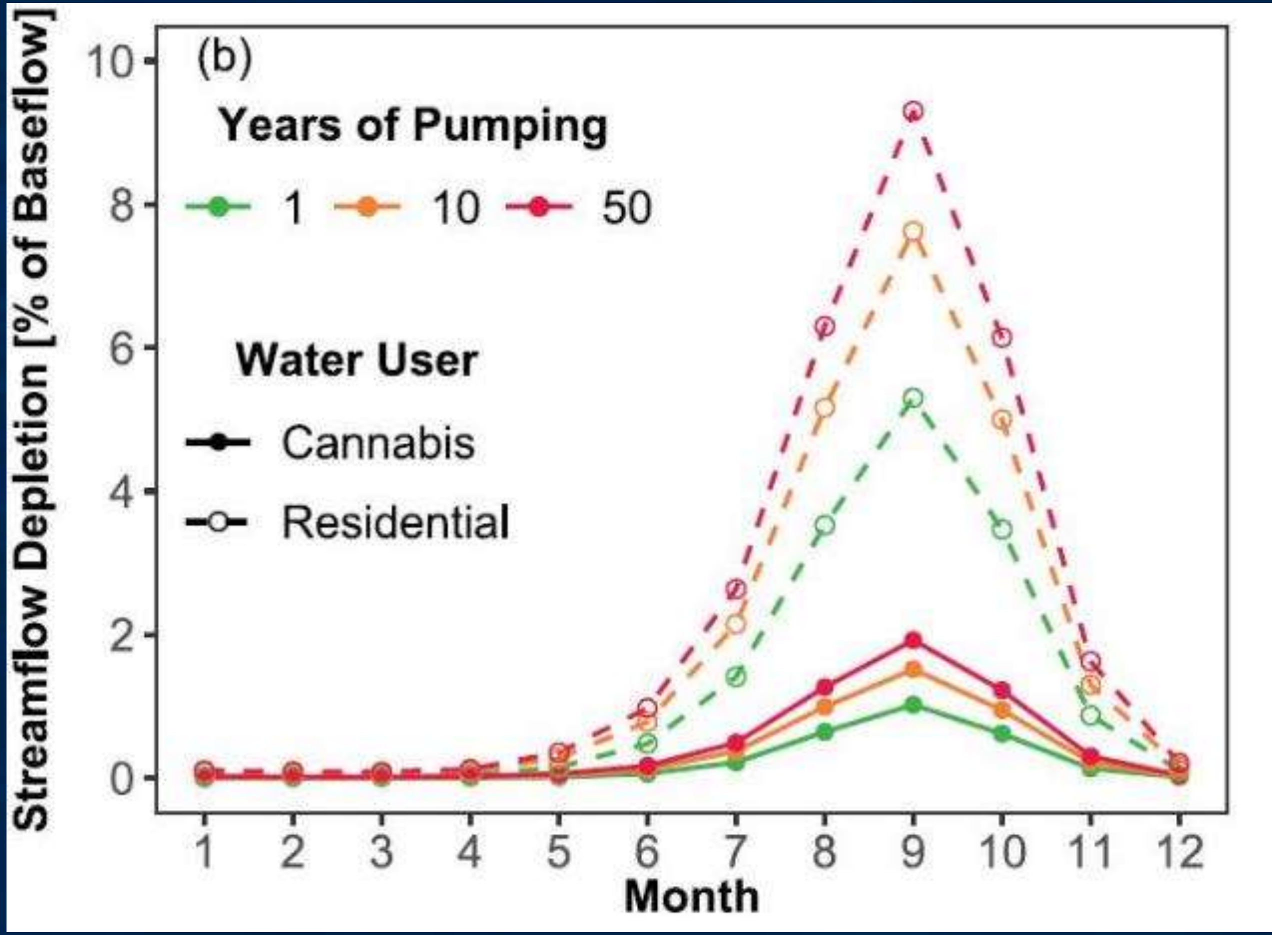
Mill Creek Streamflow Depletion

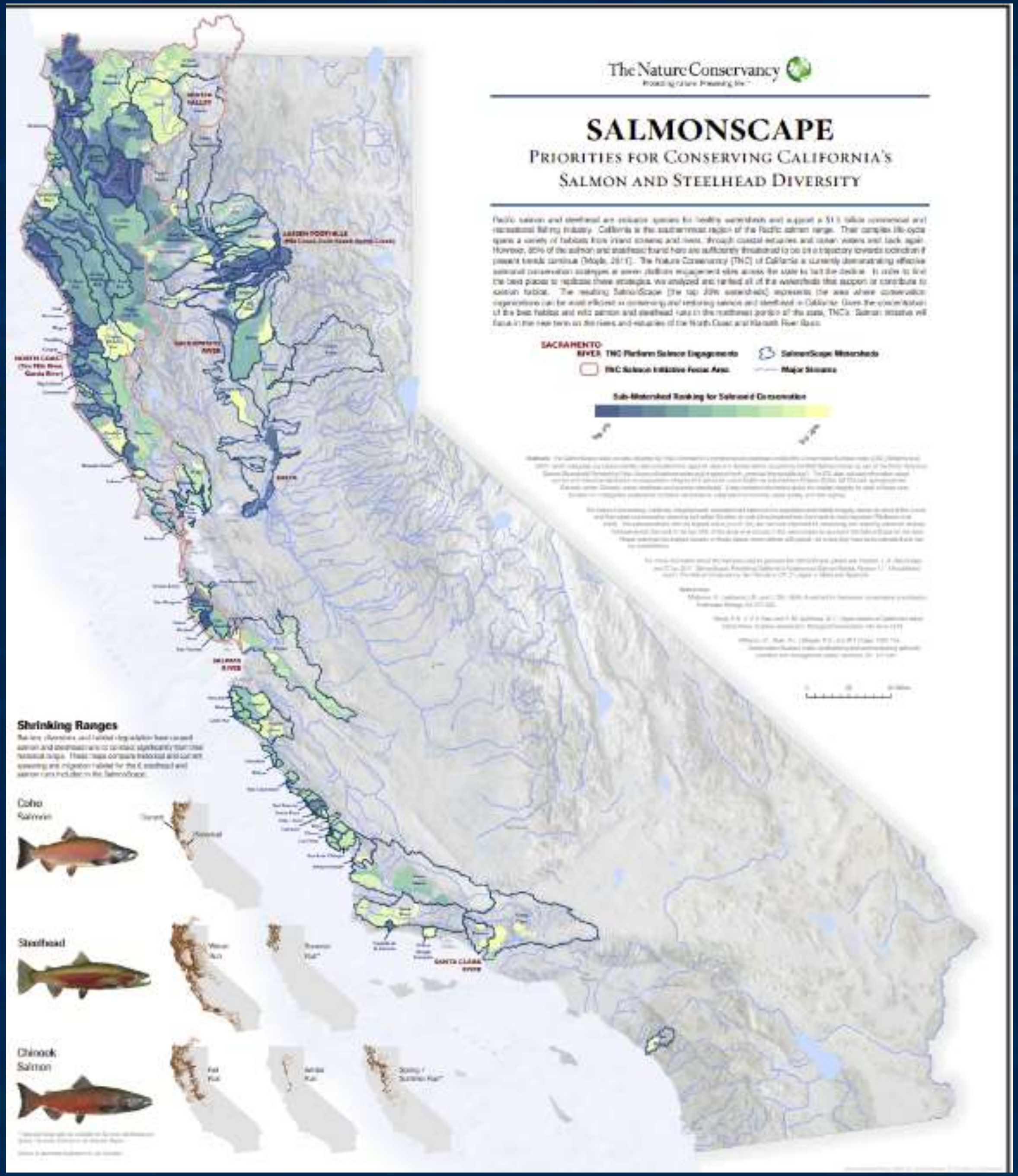
Scenarios for modified groundwater pumping - Report

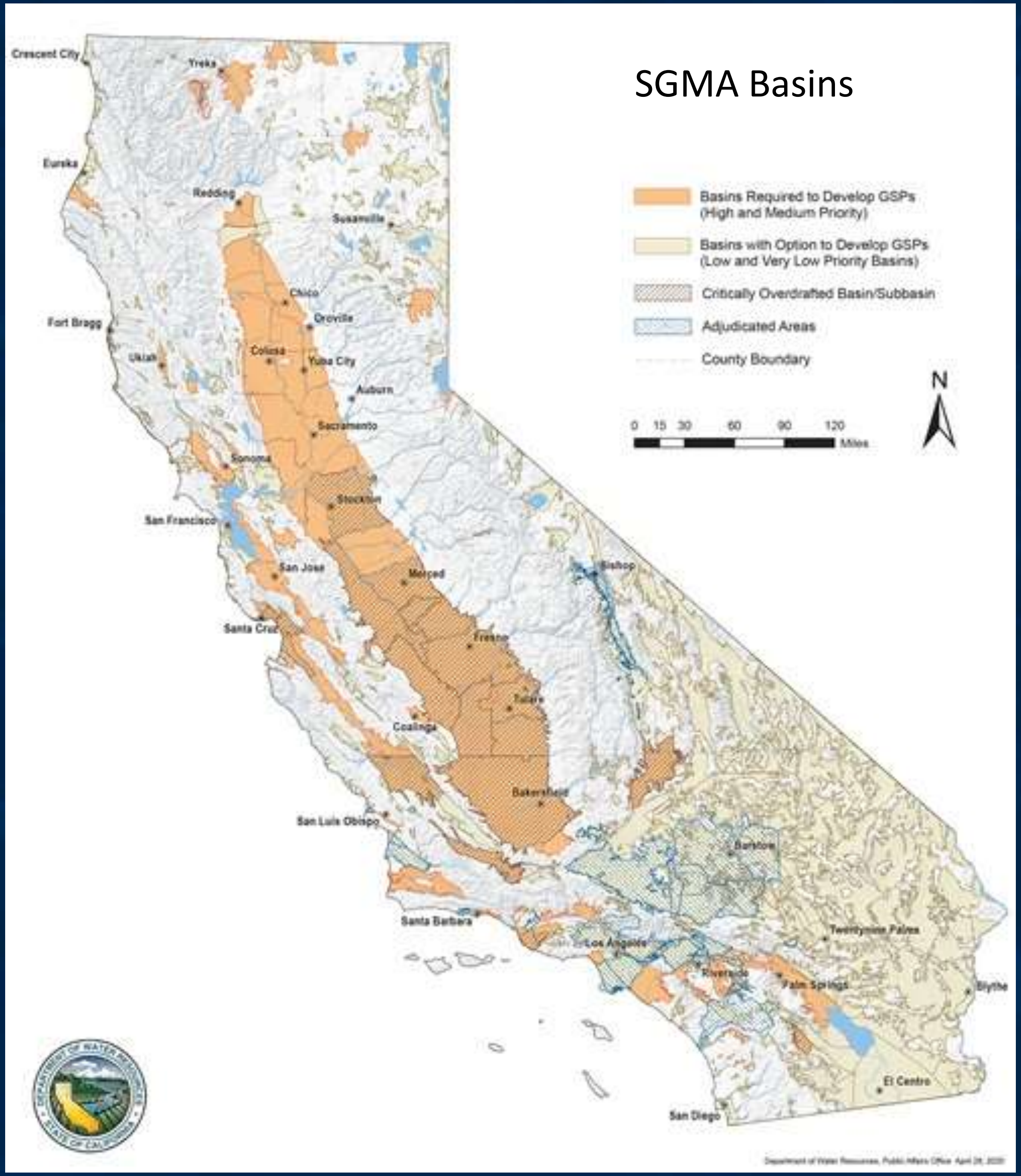
2020.05.25

Foundry Spatial Ltd.
3947-A Quadra St.
Victoria, BC
V8X 1J5

FOUNDRY SPATIAL




The Nature Conservancy
SALMONSCAPE
Priorities for Conserving California's Salmon and Steelhead Diversity
Shrinking Ranges
Coho Salmon
Steelhead
Chinook Salmon


SGMA Basins
Basins Required to Develop GSPs (High and Medium Priority)
Basins with Option to Develop GSPs (Low and Very Low Priority Basins)
Critically Overdrafted Basin/Subbasin
Adjudicated Areas
County Boundary
0 15 30 60 90 120 Miles
N
Crescent City
Yreka
Eureka
Redding
Susanville
Chico
Oroville
Fort Bragg
Ukiah
Colusa
Yuba City
Auburn
Sacramento
Sonoma
Stockton
San Francisco
San Jose
Merced
Bishop
Santa Cruz
Fresno
Tulare
Coalinga
Bakersfield
San Luis Obispo
Barstow
Santa Barbara
Los Angeles
Twentynine Palms
Riverside
Palm Springs
Blythe
El Centro
San Diego

Is this the new normal?

The Public Trust Doctrine

- State holds all **navigable waters** in **trust** for the benefit of the people
- Public trust **uses**: navigation/commerce/ fishing, and in modern times, **ecosystems**
- State decisions affecting navigable waters must consider effects on public trust uses
- Applies to **State Water Board** decisions to issue **water rights**

PTD -- Counties

- ELF v. Siskyou County -- PTD also applies to a **county's** decisions to issue **well drilling permits** (2015)
- 2021: Coastkeeper suit against **Sonoma County**
- 2022: Sonoma County agrees to modify its well permit ordinance to address public trust impacts

Sonoma County Well Ordinance Revision Process timeline

- August 2022 - Draft update to well ordinance
- October 4 – Hearing led to six- month moratorium, established technical and policy working groups to develop recommendations to staff.
- April 4 - Staff proposal to the County Supervisors
- April 18 final vote 3 to 2.
    - Adopted Staff proposed recommendations
    - Commitment to further development
    - Progress report in within a year to 18 months.
    - 1 month extended moratorium until May 18, 2023

- Sonoma County Well Ordinance Update
  - Defining Public Trust Review Area
  - Well Classifications
    - Ministerial VS Discretionary
  - Conservation Measures
  - Metering Monitoring Requirements
  - Reporting and Update to the Board

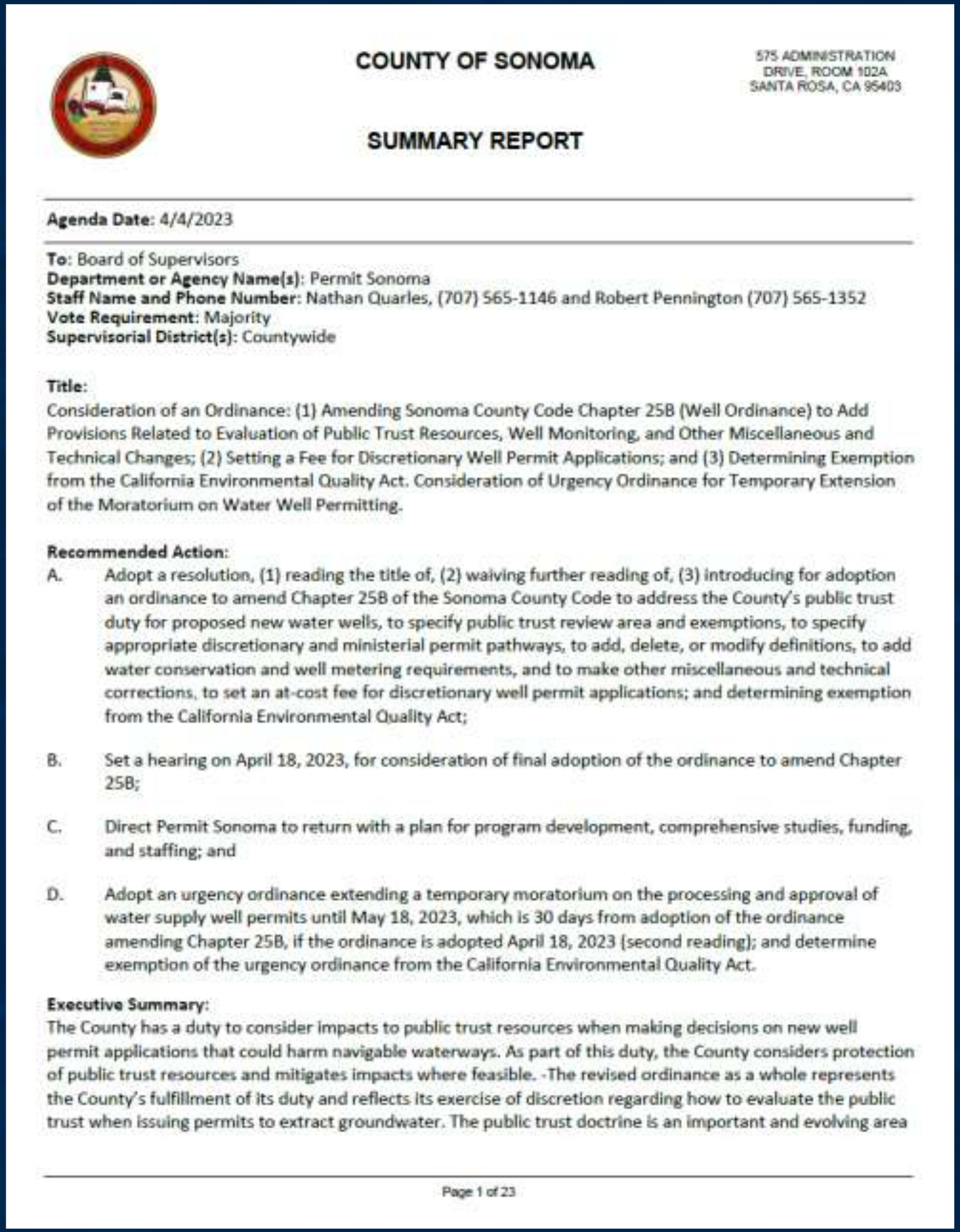
Defining the Public Trust Review Area

1. What waterways require impact analyses under the public trust doctrine?
    1. Navigable Waterways vs waterways that support PTR

2. What public trust resources (uses and habitat) are sensitive to streamflow depletion due to groundwater extraction?

3. What aquifers are interconnected with public trust waterways, and does groundwater extraction from these aquifers have an adverse impact on public trust resources?

Sonoma County approach to defining the Public Trust Review Area



COUNTY OF SONOMA

575 ADMINISTRATION DRIVE, ROOM 102A SANTA ROSA, CA 95403

SUMMARY REPORT

Agenda Date: 4/4/2023

To: Board of Supervisors
Department or Agency Name(s): Permit Sonoma
Staff Name and Phone Number: Nathan Quarles, (707) 565-1146 and Robert Pennington (707) 565-1352
Vote Requirement: Majority
Supervisorial District(s): Countywide

Title:
Consideration of an Ordinance: (1) Amending Sonoma County Code Chapter 25B (Well Ordinance) to Add Provisions Related to Evaluation of Public Trust Resources, Well Monitoring, and Other Miscellaneous and Technical Changes; (2) Setting a Fee for Discretionary Well Permit Applications; and (3) Determining Exemption from the California Environmental Quality Act. Consideration of Urgency Ordinance for Temporary Extension of the Moratorium on Water Well Permitting.

Recommended Action:

A. Adopt a resolution, (1) reading the title of, (2) waiving further reading of, (3) introducing for adoption an ordinance to amend Chapter 25B of the Sonoma County Code to address the County's public trust duty for proposed new water wells, to specify public trust review area and exemptions, to specify appropriate discretionary and ministerial permit pathways, to add, delete, or modify definitions, to add water conservation and well metering requirements, and to make other miscellaneous and technical corrections, to set an at-cost fee for discretionary well permit applications; and determining exemption from the California Environmental Quality Act;

B. Set a hearing on April 18, 2023, for consideration of final adoption of the ordinance to amend Chapter 25B;

C. Direct Permit Sonoma to return with a plan for program development, comprehensive studies, funding, and staffing; and

D. Adopt an urgency ordinance extending a temporary moratorium on the processing and approval of water supply well permits until May 18, 2023, which is 30 days from adoption of the ordinance amending Chapter 25B, if the ordinance is adopted April 18, 2023 (second reading); and determine exemption of the urgency ordinance from the California Environmental Quality Act.

Executive Summary:
The County has a duty to consider impacts to public trust resources when making decisions on new well permit applications that could harm navigable waterways. As part of this duty, the County considers protection of public trust resources and mitigates impacts where feasible. The revised ordinance as a whole represents the County's fulfillment of its duty and reflects its exercise of discretion regarding how to evaluate the public trust when issuing permits to extract groundwater. The public trust doctrine is an important and evolving area

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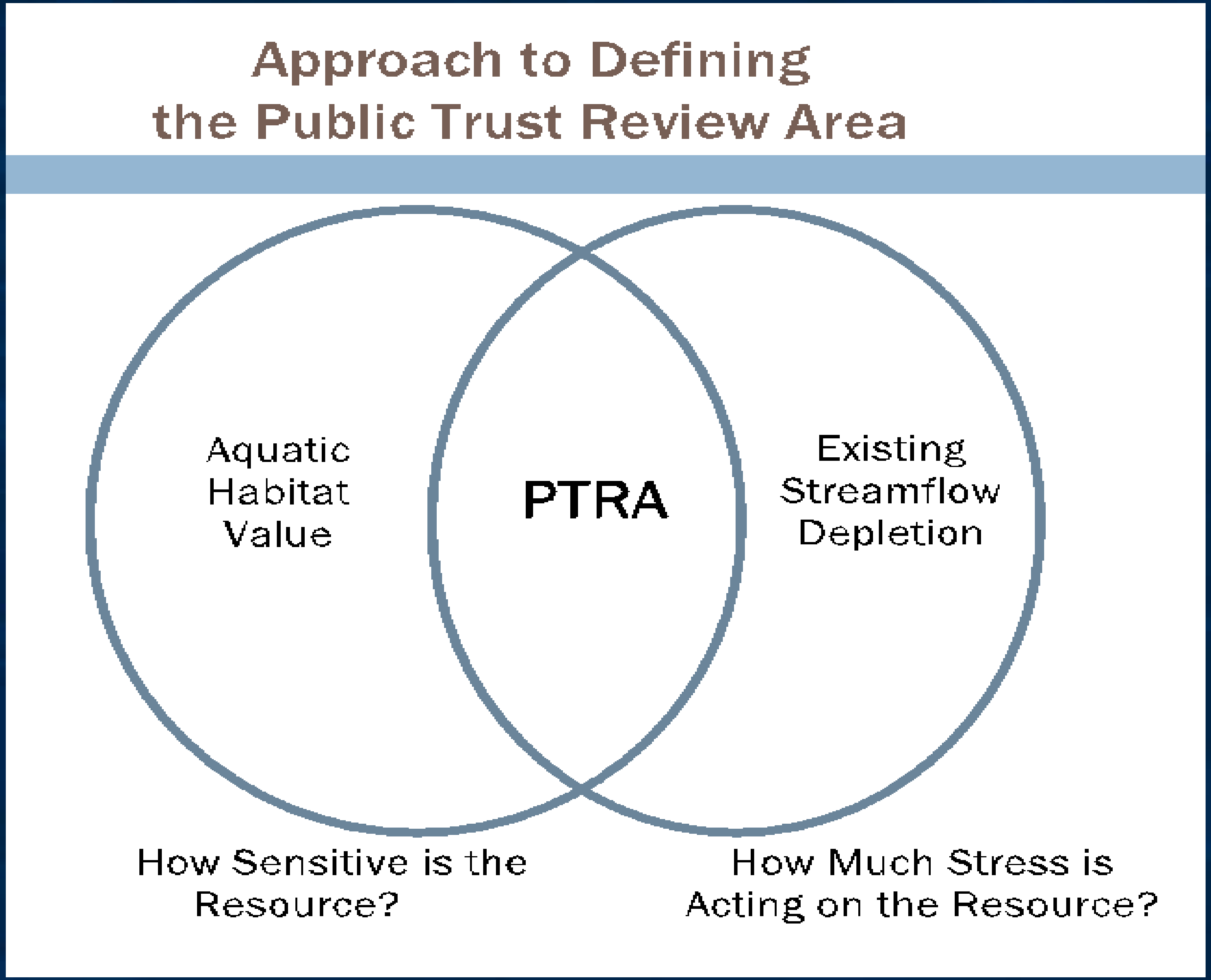

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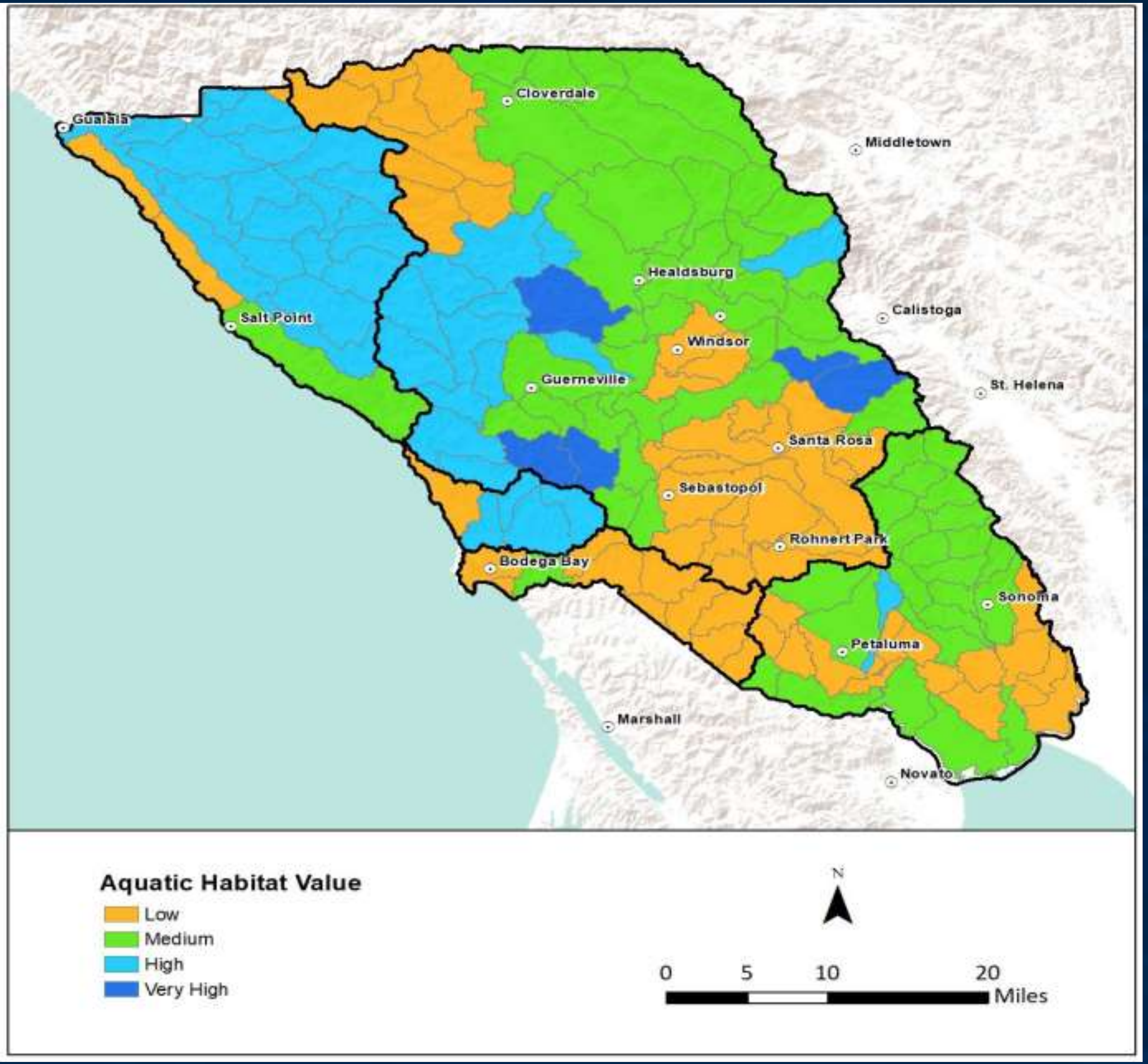
Defining the Public Trust Review Area



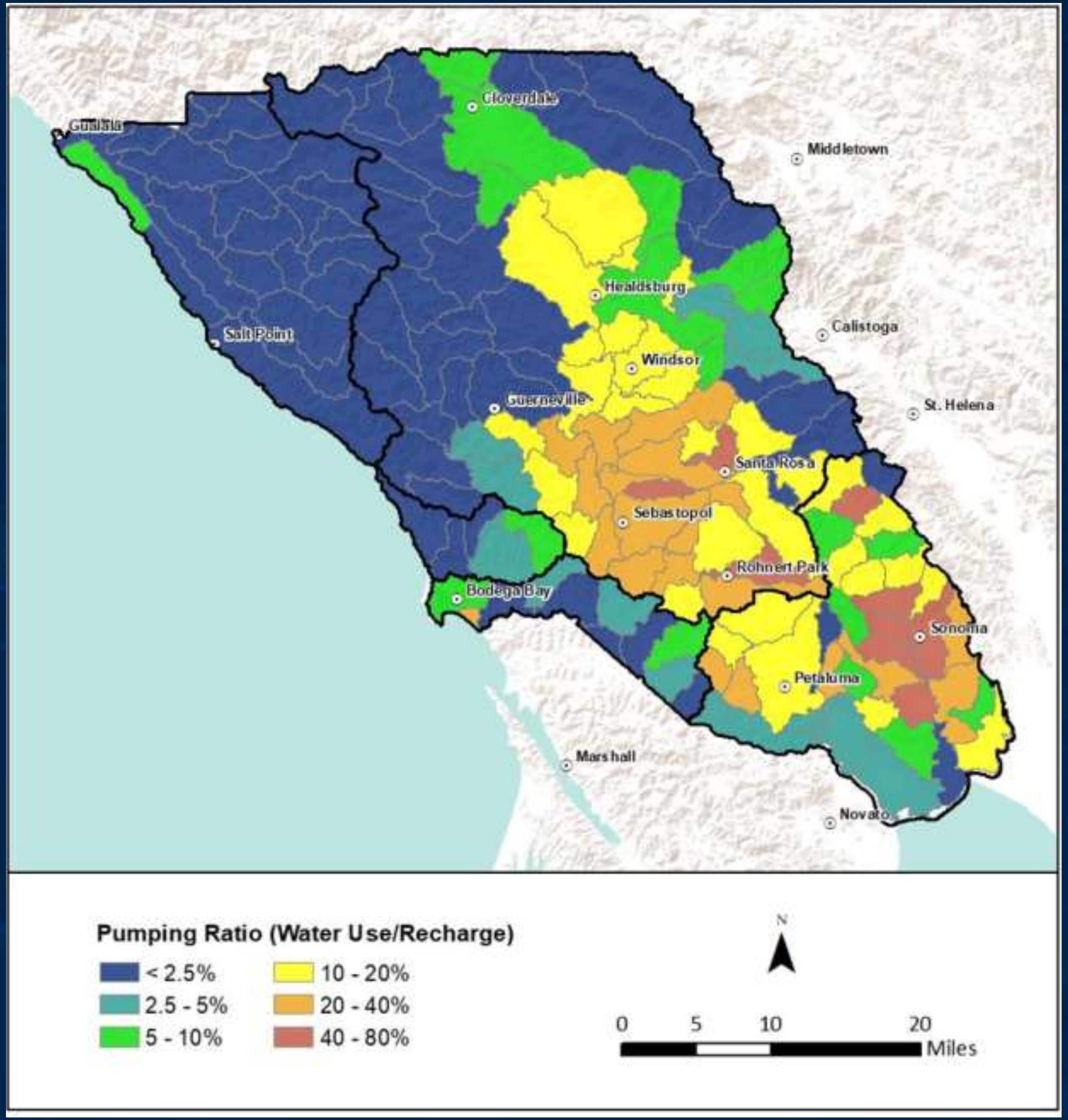
Credit O'Connor Env. Inc.

Aquatic Habitat Value

- Coho and steelhead used as indicator species
- Focused on existing summer rearing habitat and priority recovery habitat for Coho
- Assessment of specific habitat conditions based on input fisheries experts.

Subwatershed resource sensitivity classification based on aquatic habitat value.

Defining the Public Trust Review Area



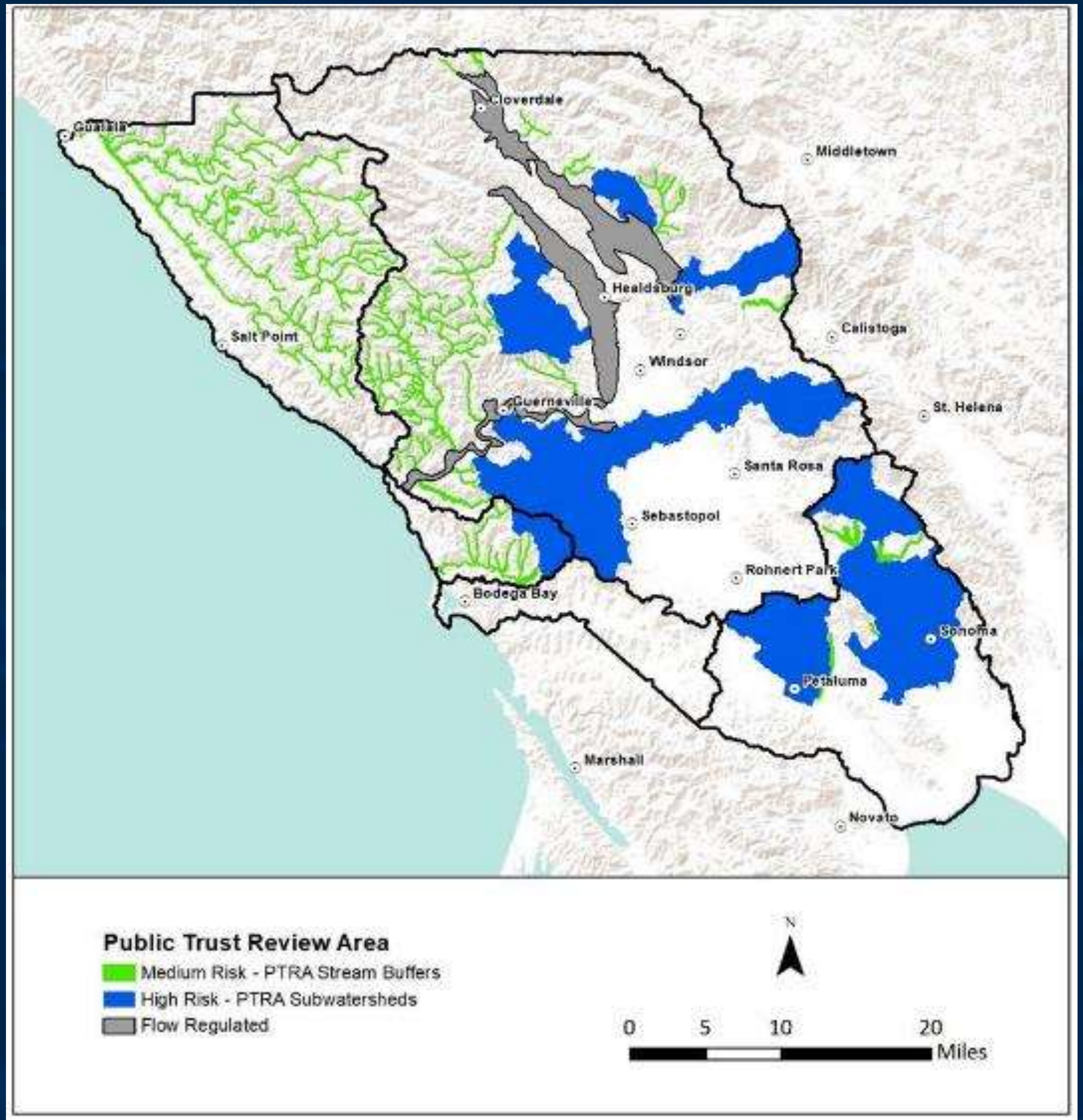
Credit O'Connor Env. Inc.

Groundwater pumping ratio per subwatershed.

Existing Streamflow Depletion

- July, August, and September
- Estimated existing streamflow depletion on a parcel basis
- Developed Streamflow Depletion Factor (SFD) estimated ratio of depletion vs recharge.
- Developed a presumptive standard for environmental flow protection based on Richter (2012)
  - 0-10% Depletion= High level of ecological protection
  - 11-20% = Moderate depletion.
  - > 21%= High level of Streamflow depletion

Defining the Public Trust Review Area



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	Low SFD (0 – 10%)	Medium SFD (10 – 20%)	High SFD (>20%)
Low Habitat Value	Low Risk Area Not included in PTRA	Low Risk Area Not included in PTRA	Low Risk Area Not included in PTRA
Moderate Habitat Value	Low Risk Area Not included in PTRA	Moderate Risk Area Stream buffers	High Risk Area Sub-watershed
High Habitat Value	Moderate Risk Area Stream buffers	High Risk Area Sub-watershed	High Risk Area Sub-watershed
Very High Habitat Value	High Risk Area Sub-watershed	High Risk Area Sub-watershed	High Risk Area Sub-watershed

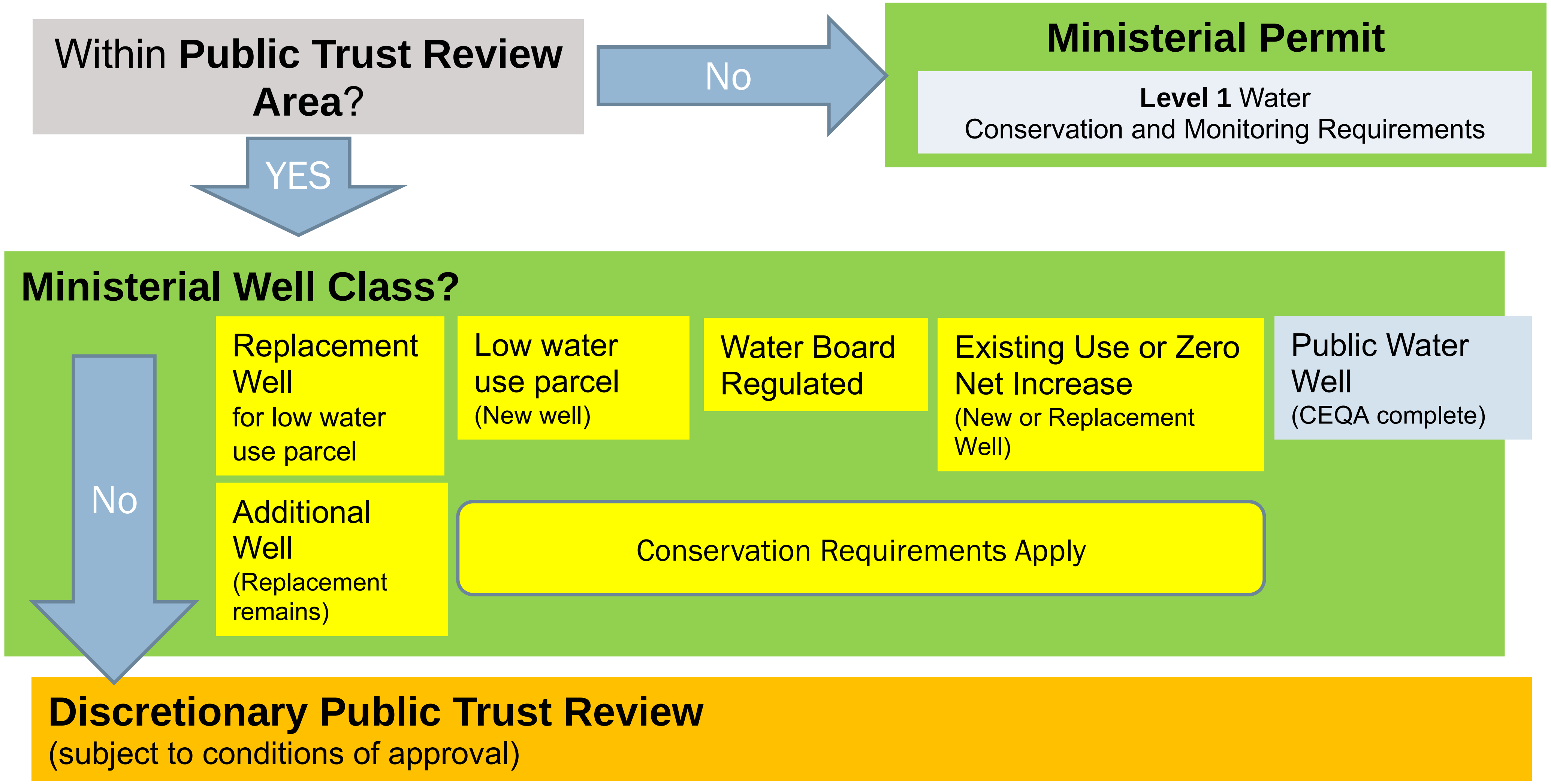
Credit O'Connor Env. Inc.

Stream buffers – Moderate Risk Areas

- Stream Depletion Factor (SDF) was used in defining stream buffer distances
- A relative measure of how rapidly streamflow depletion occurs in response to new pumping
- ~100 ft for the Franciscan Complex, ~250 ft for the Sonoma Volcanics, and ~750 ft for Wilson Grove Formation / alluvial sediments

Permit Screening Flow Chart

(Working Proposal)



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Water Conservation Requirements

Level 1 – *All new wells*

1. Leak and water conservation audit
2. Water efficient faucets and showerheads
3. New landscapes shall comply with County water efficient landscape regulations
4. Limitations and prohibitions on grass lawns unless compliant with Water Efficient Landscape Regulations
5. Compliance with water conservation requirements adopted by a Groundwater Sustainability Agency.

Level 2 – *for "Well for Existing Use" and "Net Zero Groundwater Increase" wells*

1. Water efficient water bathroom fixtures;
2. Water conservation plans for commercial industrial and institutional sites
3. Water conservation plan for agricultural sites
4. Limits on vineyard and orchard irrigation to the existing use or 0.6-acre feet per acre
5. Required frost protection plan for vineyards.

Metering and Monitoring Requirements

- Monthly measurements and annual reporting for wells over 2AF/yr
- Water level monitoring and reporting for wells on using over 5 AF/ yr

Next Steps

- Report and update to the County Supervisors – 12 to 18 months
- Data Collection and potential model refinement

Unresolved Questions and Considerations

TOPICS	Key Discussion Issues / Questions
Public Trust / GW Review Area	What waterways require impacts analysis under the public trust doctrine? What public trust resources and uses are sensitive to streamflow depletion due to groundwater extraction? What aquifers are interconnected with public trust waterways, and what groundwater extraction from these aquifers is likely to have an adverse impact on public trust resources?
Well Classification: Ministerial and Discretionary	What classes or categories of wells receive a ministerial (routine across the counter) permit? What well classes receive a discretionary (more tailored) review? - Replacement domestic wells, public water wells, zero net use, etc.
Well Implementation Requirements – Conservation and other Measures	What water conservation measures should be required of each class of wells? - Water efficient landscape regulations, maximum allowed use, etc. Other measures: groundwater recharge, farm practices, etc.
Adverse Impacts / Impact Definitions	What is a substantial adverse impact? (watershed, waterway, basins) What methods should be employed to evaluate adverse impacts?
Discretionary Review Process	What is the nature of that review? (CEQA, other) What requirements are defined by what anticipated impacts?
Monitoring Requirements	What groundwater monitoring conditions (water meter readings, depth to water measurements, etc.) should be required of specific classes of wells?
Adaptation	What information or discovery will trigger the need to revisit these policies or approaches? What recommended studies and/or data collection activities could the County consider reducing data gaps and improve understanding of impacts to public trust resources?

Credit Permit Sonoma

Additional Observations and Considerations for Future Efforts

- Timeframe – 6 months is not enough.
- Plan for data collection and model development
- Identify quantifiable and verifiable mitigation measures
- Address integration of SGMA and well ordinance

Water From Bedrock:

Efforts to Condition New Groundwater Wells to Protect Streamflow for Salmon

\- Thank You-

Questions?

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Granting Equity

THE FUTURE OF CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE'S GRANTING PROGRAMS.

Goal

- JEDI Definitions
- Understand the future of granting

Overview

- Introduction
- Setting the Stage
  - JEDI Terms
  - CDFW and FRGP History
- Granting Equity
  - Examples
- Next Steps

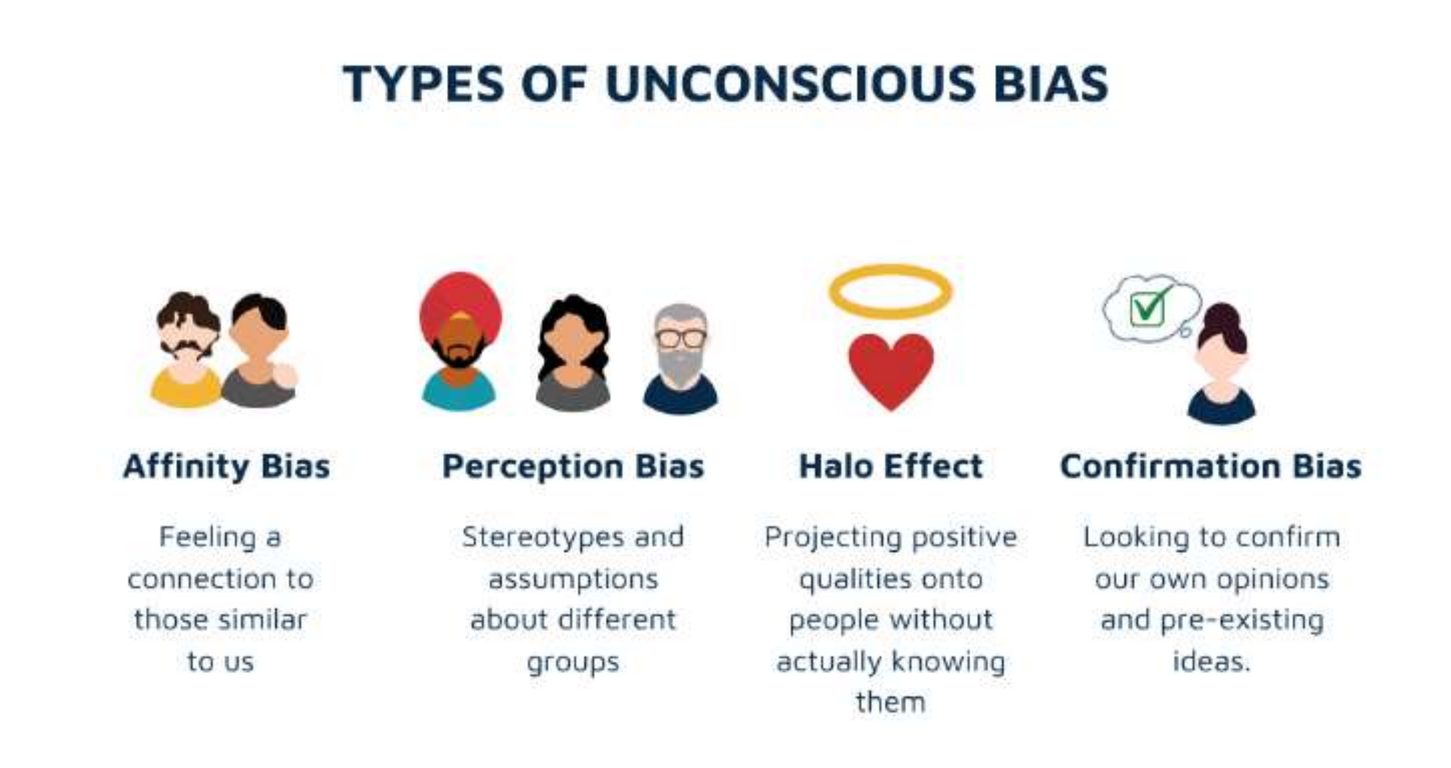
Tim Chorey

- Grew up in Massachusetts.
- Had easy access to the outdoors
- Colorado State University- Watershed Science and Geology
- Worked in Restoration since 2006.
- 2017- CDFW FRGP Statewide Coordinator

JEDI Terms

- Implicit Bias
- Diversity
- Equity
- Justice
- Inclusion

JEDI Terms: Implicit Bias



- Implicit bias is a form of bias that occurs automatically and unintentionally, that nevertheless affects judgments, decisions, and behaviors.

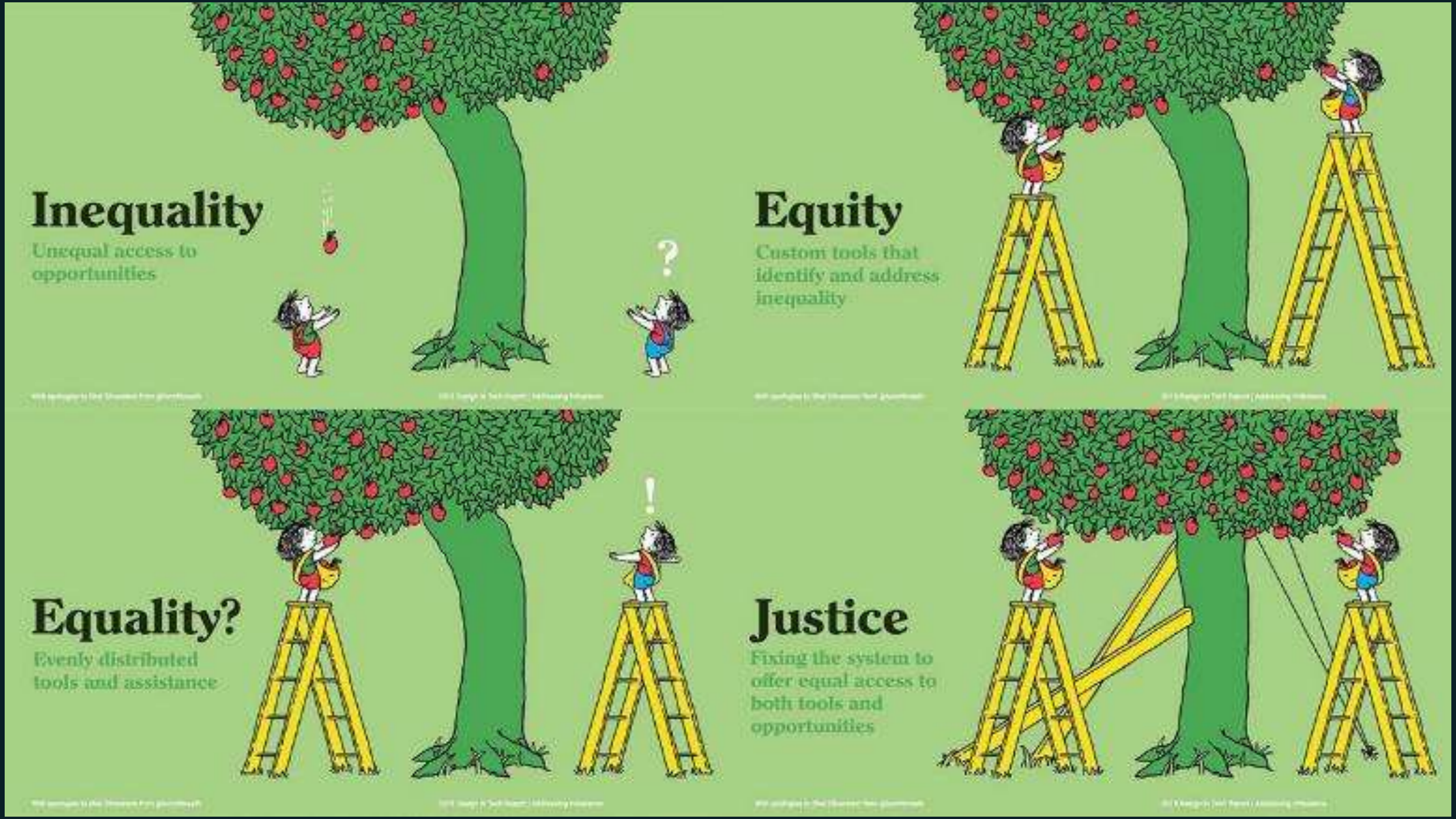
JEDI Terms: Diversity

- The existence of variations of different characteristics in a group of people.
- These characteristics could be everything that makes us unique, (e.g., race, age, gender, religion, sexual orientation, cultural background).

JEDI Terms: Equity

- Everyone gets the support they need.

JEDI Terms: Justice



- Justice is what CDFW is working towards.

> "INCLUSION IS NOT BRINGING PEOPLE INTO WHAT ALREADY EXISTS; IT IS MAKING A NEW SPACE, A BETTER SPACE FOR EVERYONE."
>
> *– George Dei*

JEDI Terms: Inclusion

- The act of being included.

CDFW and FRGP History

- 1851: The first law specifically dealing with fish and game matters.
- CDFW was historically set up to serve white men.
- 1981 FRGP Established to provide grants to improve rivers from logging impacts.
- For 42 years FRGP has provided ~$538 Million for ~6,900 grants.

FRGP's Growth Potential

- Closed outreach loop
- Highly punitive
- Inaccessible staff from project development
- Cumbersome PSN/Guidelines
- Bare minimum tribal engagement
- Reimbursement payments

CDFW’s effort to improve: Outreach

- Expand(ed) outreach
  - Increased distribution
  - Inclusive language
  - Pre-Proposal phase

CDFW's effort to improve: Grace Period

- Be less punitive
- Tested assumptions
- Evaluate the project

CDFW's effort to improve: Tribal Engagement

- Specific PSN instructions
  - Encouraged engagement
  - Recommended funding
  - Instructed how to reach out
- Specific engagement question
- Tracked responses
  - 13 of 50 applicants including tribal funding

Next Steps.

- Dedicated Equitable Granting Group
- Continue to improve relationships and outreach
- Continue to test assumptions
- Build organizational capacity
- Share findings within CDFW programs and broader
- Integrate JEDI issues
- Look for system fixes

Thank you.

- Tim Chorey
- CDFW FRGP Statewide Coordinator
- Timothy.Chorey@Wildlife.ca.gov