

Wrangling Ridiculous River Data

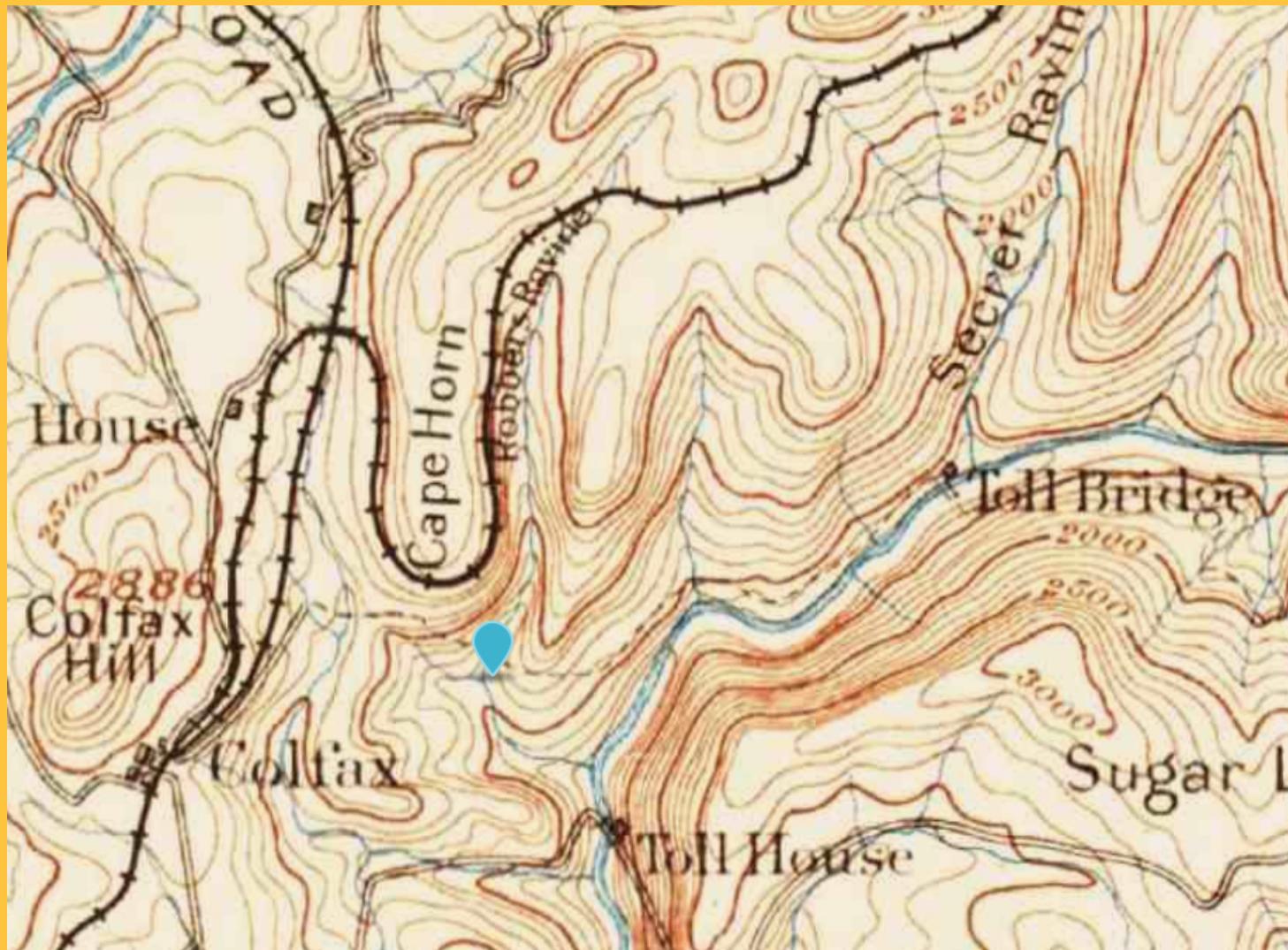
Linking Biological Stream Condition with Flow Alteration



Ryan Peek | 2022 Feb 10

riverpeek

A winding path to data science (who am I)

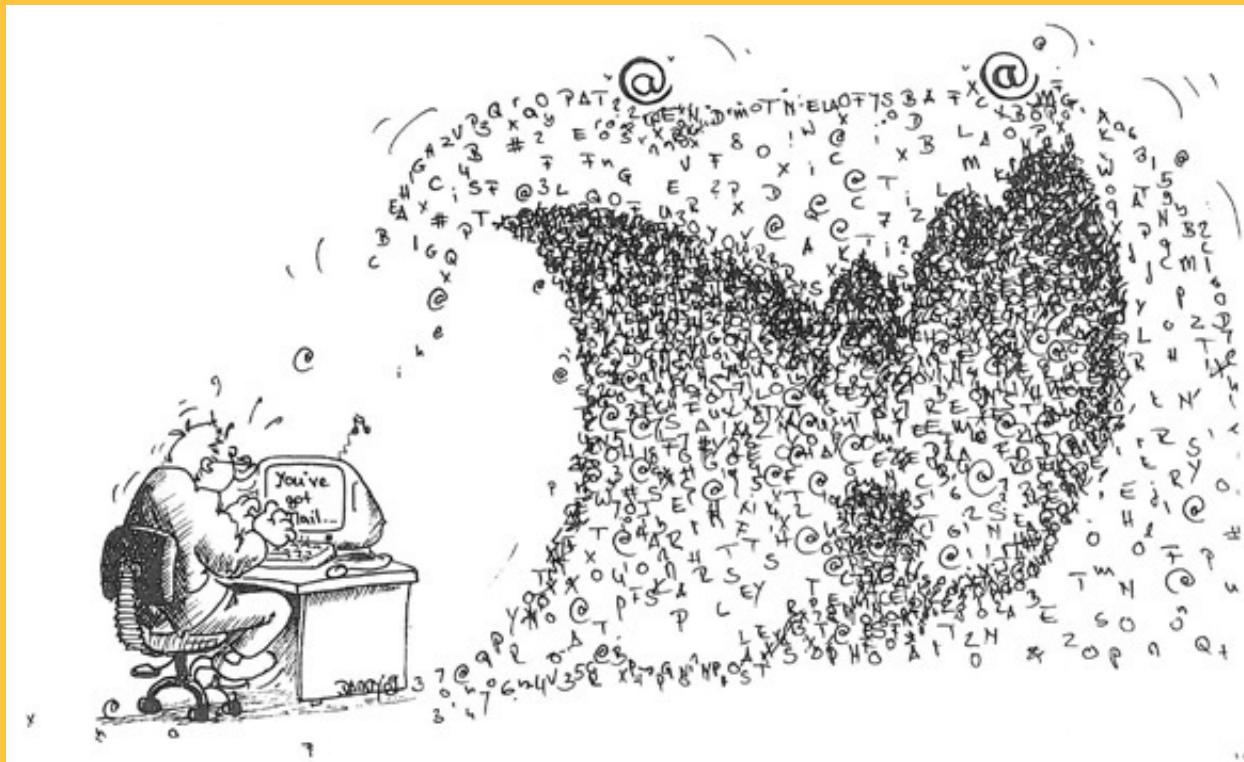


What I work on now

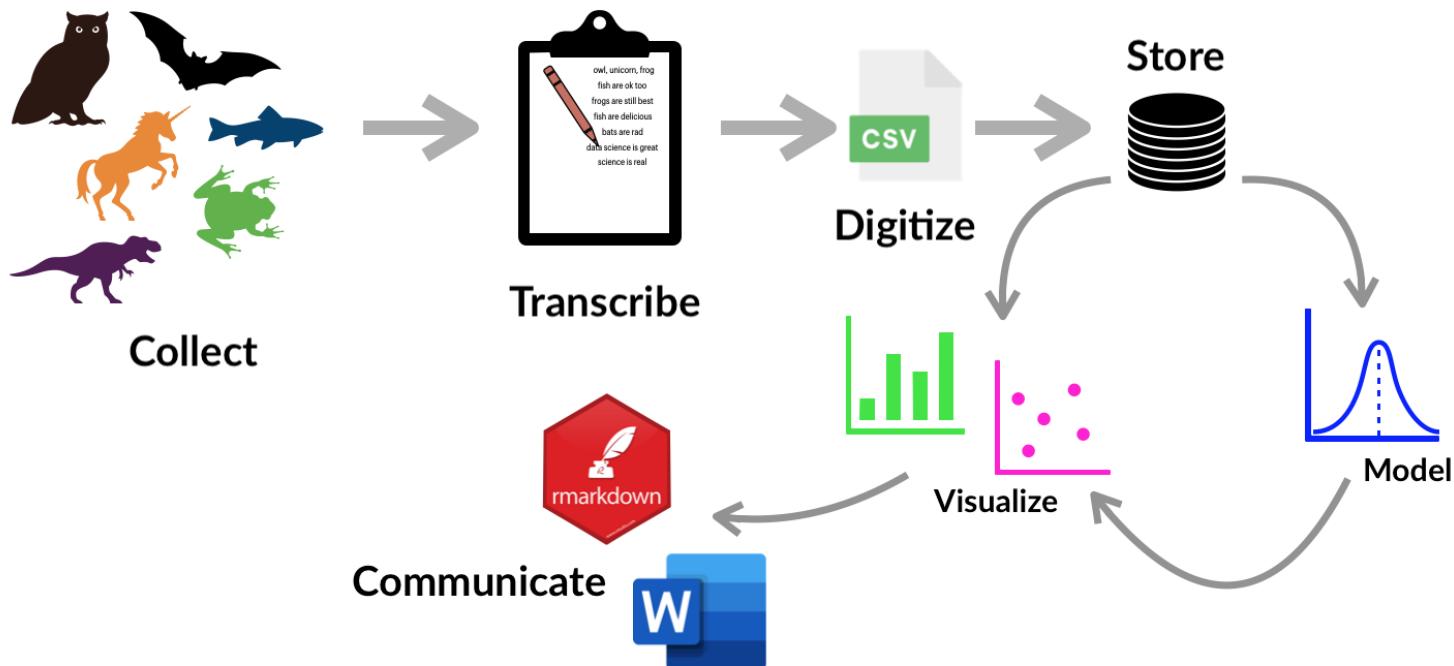
- Conservation Genomics (lots of bioinformatics!)
- Environmental Flows & Altered Rivers
- Meadows & Restoration
- Delta Foodweb Connectivity
-  Davis R Users Group
- R4WRDS
- Carpentries workshops
- Life!

Data in California

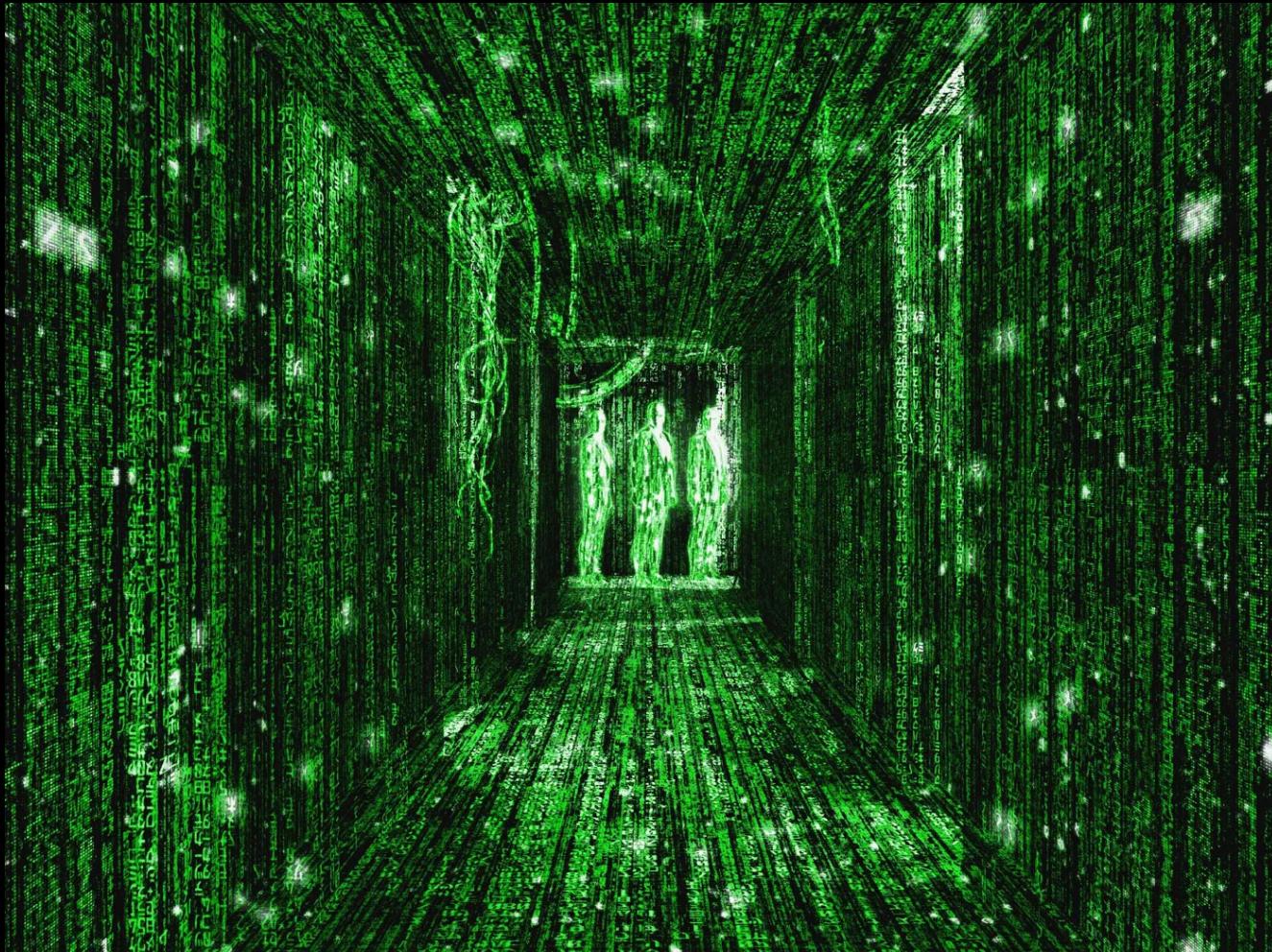
an ever-present wave



So how can we use it for good?



People think Data Science is...

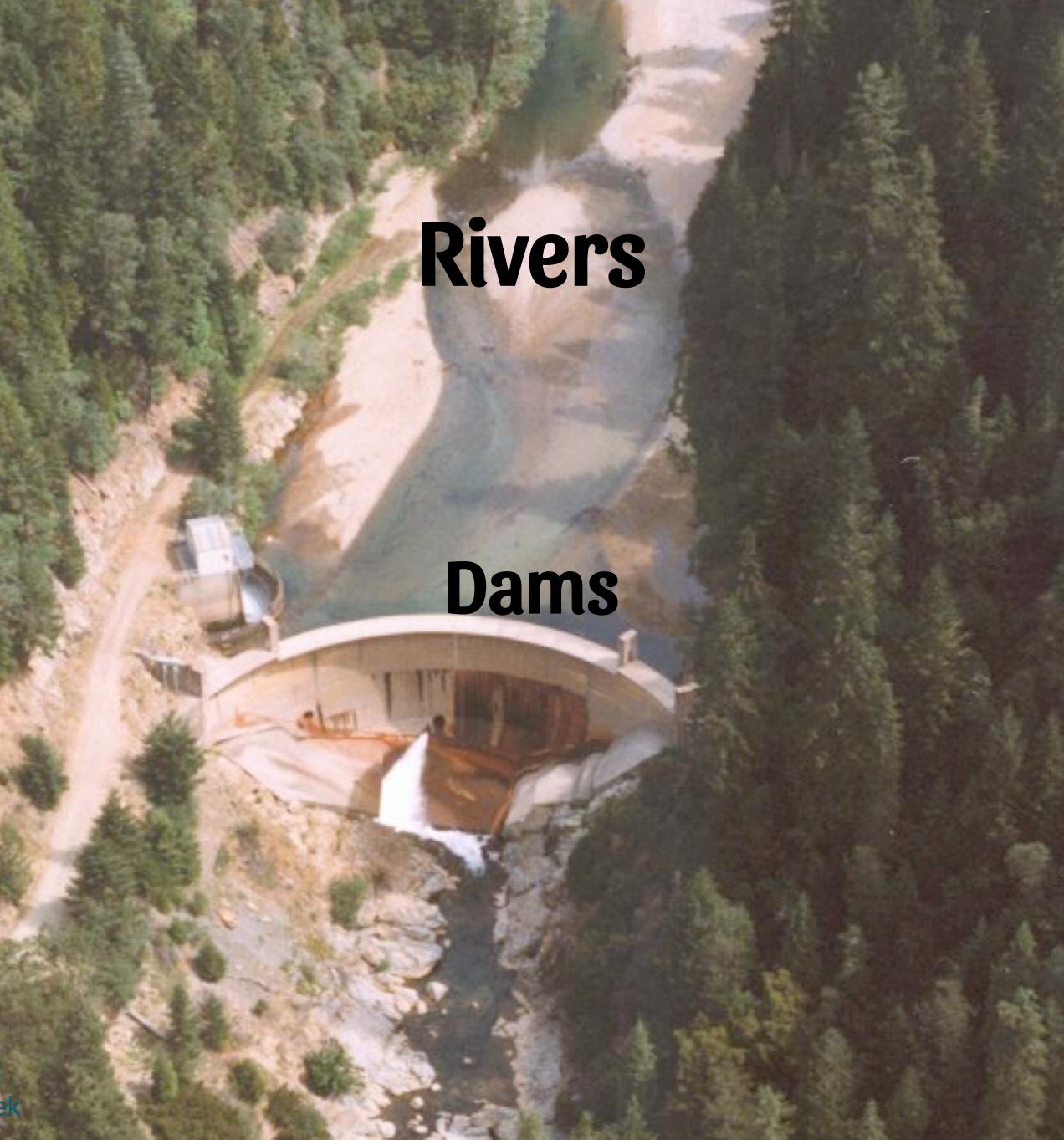


Actual Data Science is this...



Illustration by @allison_horst, from Hadley Wickham's talk 'The Joy of Functional Programming (for Data Science)'"

- *see great visualization of same data 25 ways!*

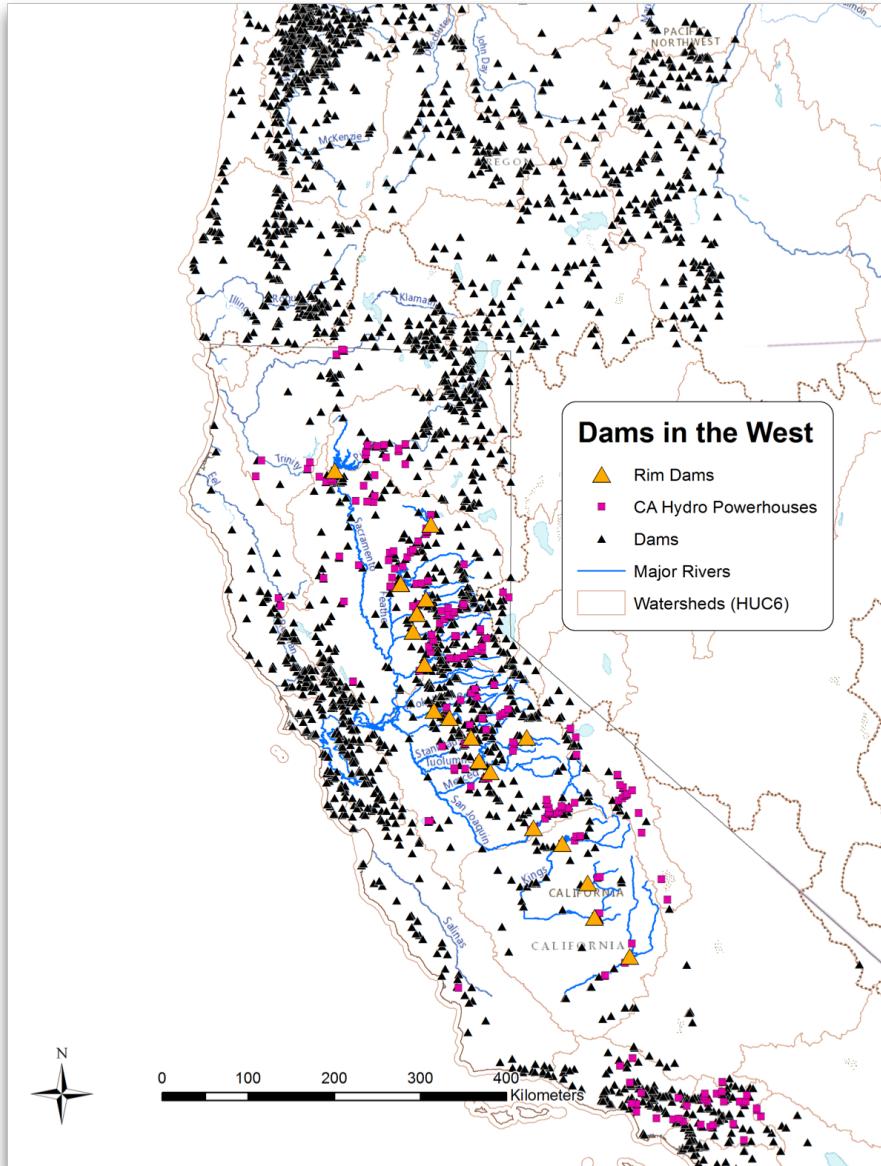
An aerial photograph of a dam in a mountainous, forested area. The dam is a large, curved concrete structure spanning a narrow valley. Water flows over the top of the dam, creating a white, turbulent wake. The surrounding landscape is densely covered in tall evergreen trees. In the foreground, a dirt road leads towards the dam, and a small building is visible near the water's edge.

Rivers

Dams

Over 1,400 large dams in CA

- 95% of streams of have altered flows (depleted or inflated)
- competing demands for energy, agriculture, ecology

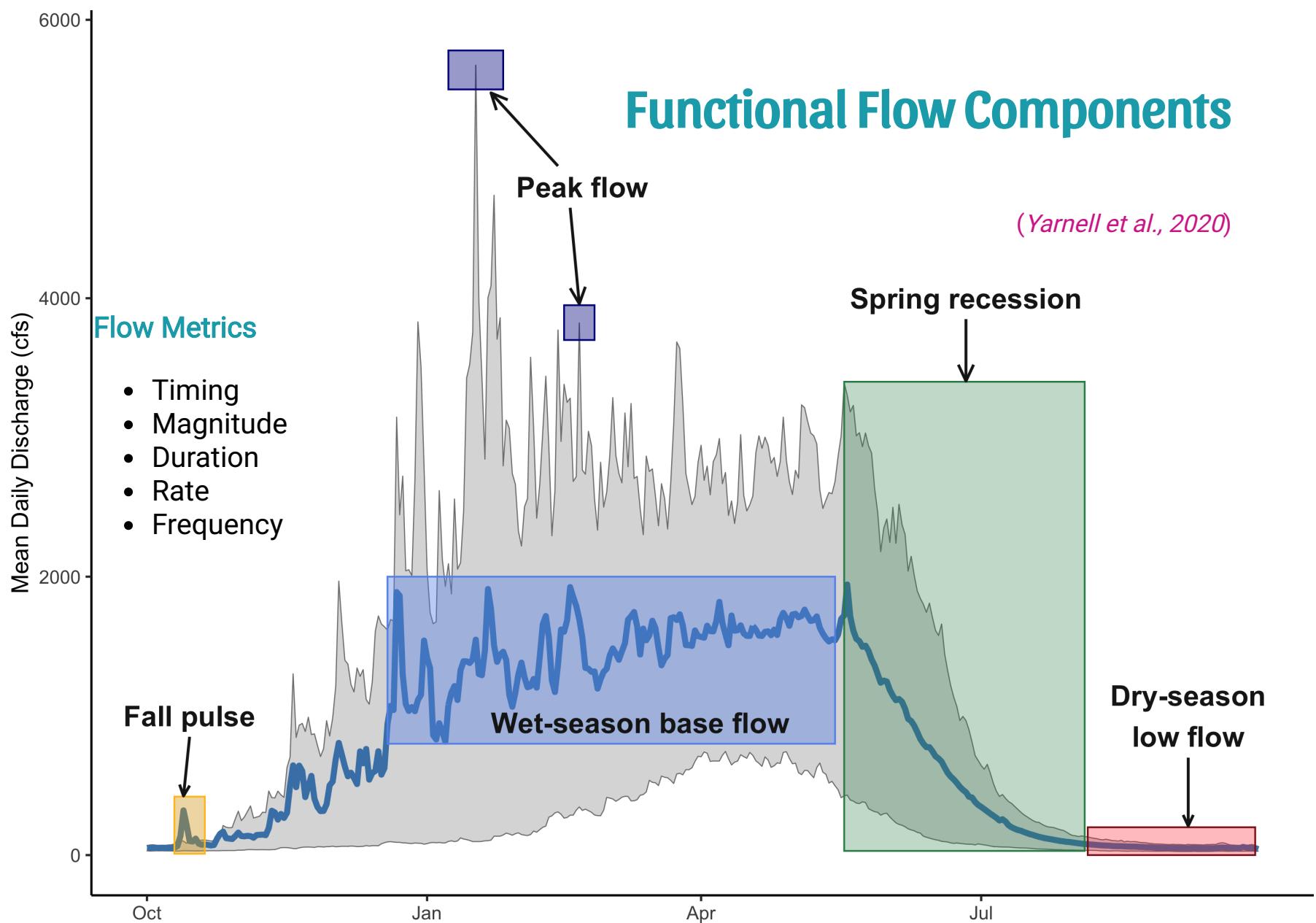


Environmental Flows

- Many programs are attempting to set environmental flows...
- CA is physically diverse & management needs vary
- Coordination & sharing information between groups is challenging!
- **Uncertainty** in most appropriate method
- **Balancing ecological flow needs & other demands is hard**

Functional Flow Components

(Yarnell et al., 2020)



Can calculate quantitative metrics based on hydrograph!

These are biologically relevant

Flow component	Flow characteristic	Flow metric	BMI	Fish	Riparian
Fall pulse flow	Magnitude	Peak of flushing flow		X	
	Timing	Start date	X	X	
	Duration	# days (start-end)			
Wet season baseflow	Magnitude	10th, 90th percentile of daily flow within wet season		X	
	Timing	Start date			
	Duration	# days (start-end)			
Peak flow	Magnitude	2-, 5-, and 10-year recurrence interval peak flow	X	X	X
	Duration	Cumulative # of days 2-, 5-, and 10-year peak flows are exceeded in a year	X	X	
	Frequency	# of times 2-, 5-, and 10-year peak flows are exceeded in a year	X	X	X
Spring recession flow	Magnitude	Flow at start of spring recession	X	X	X
	Timing	Start date	X	X	X
	Duration	# days (start-end)	X	X	X
	Rate of change	Percent decrease in flow per day over spring duration	X	X	X
Dry season baseflow	Magnitude	50th, 90th percentile of daily flow within dry season	X	X	
	Timing	Start date		X	
	Duration	# days (start-end)	X	X	
	Rate of change	cv. of daily flow, flashiness index	X		

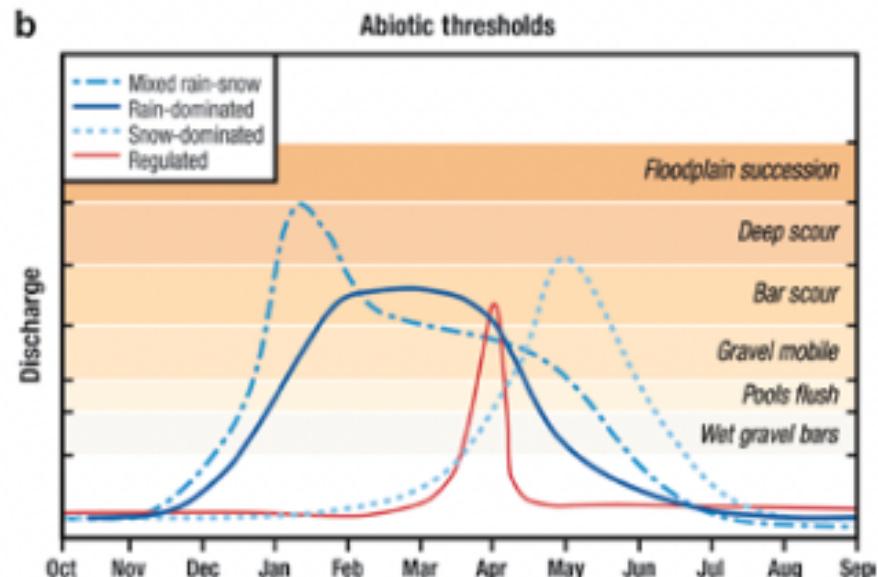
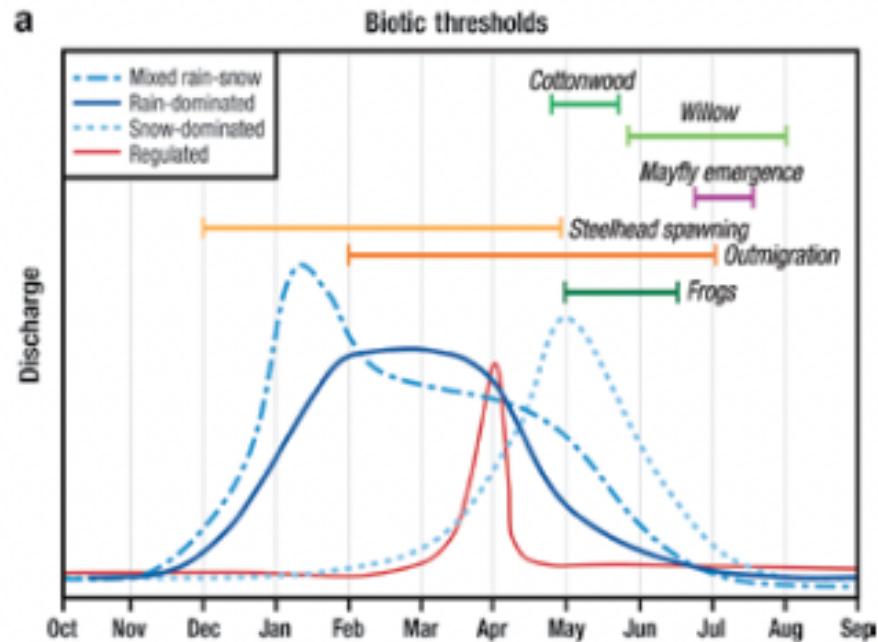
A photograph of a river scene. In the foreground, the river flows from the bottom right towards the center, with clear, shallow water showing the rocky bed. The middle ground shows a wide, sandy beach with many small, light-colored pebbles. In the background, there are large, dark, jagged rocks and a dense forest of green trees and shrubs covering a hillside.

Spring Recession!

Seasonality of Flows

(Yarnell et al., 2020)

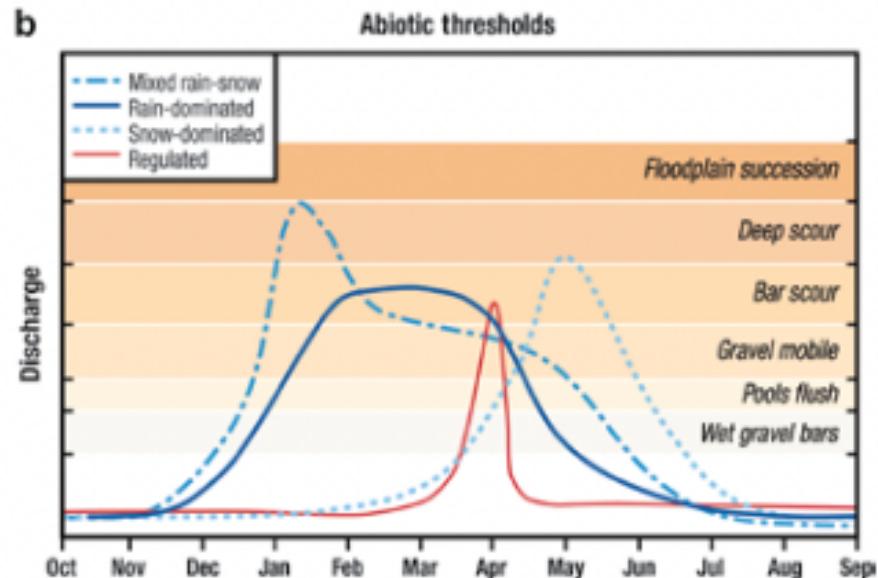
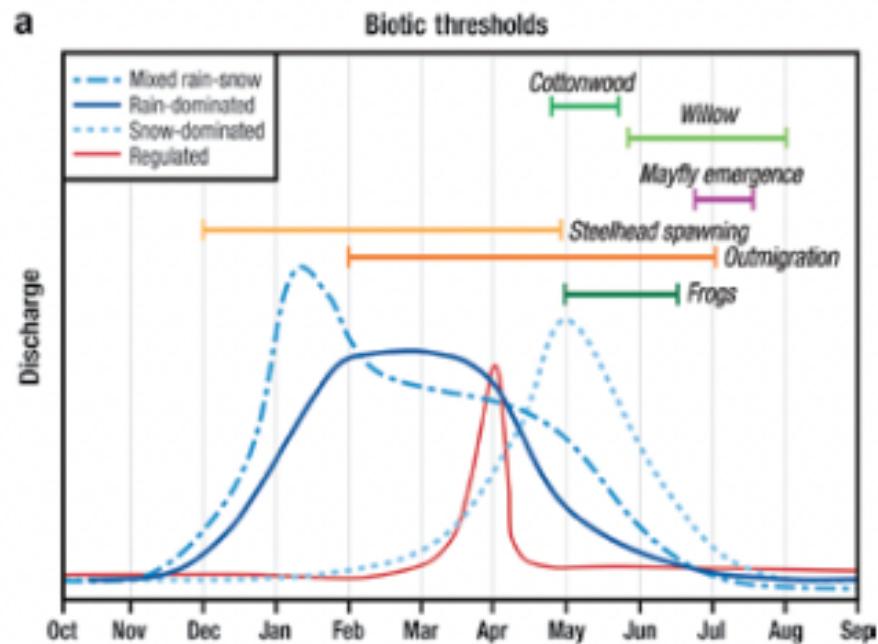
- Important *function* relates to biotic and abiotic change

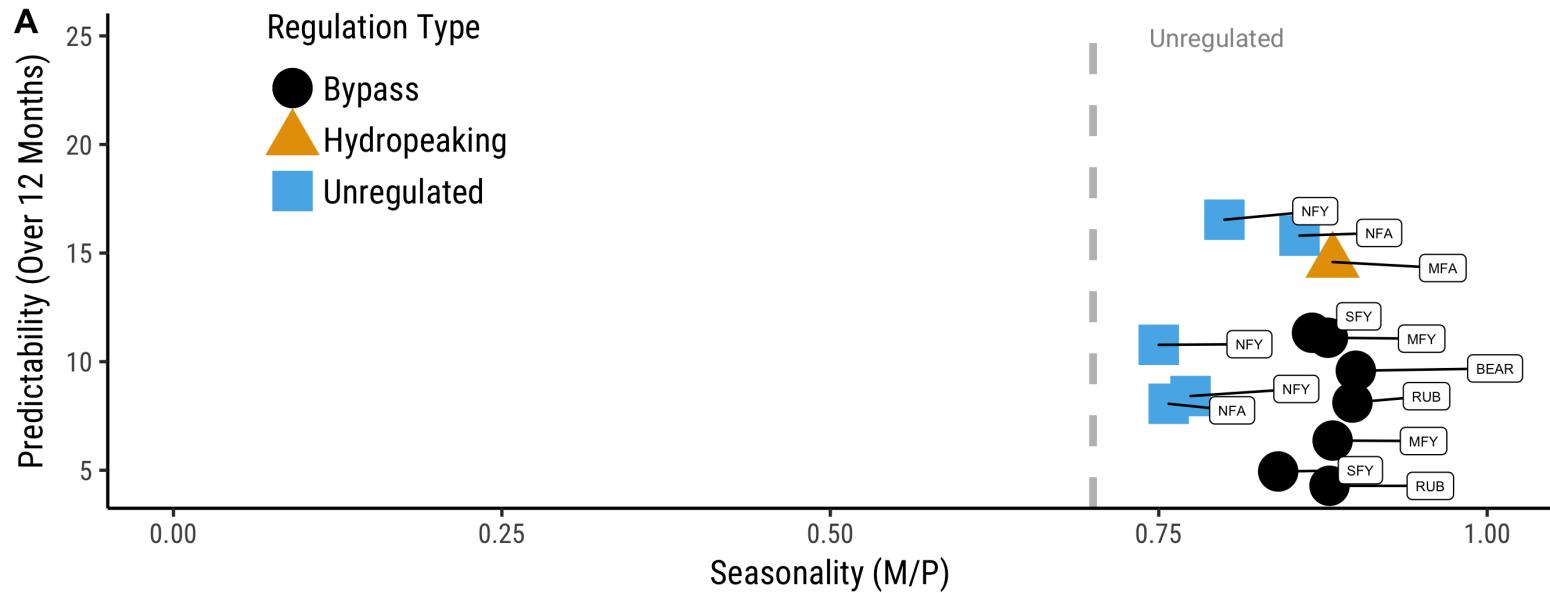


Seasonality of Flows

(Yarnell et al., 2020)

- Important *function* relates to biotic and abiotic change
- **Variability** is really important!





Now: Large & Messy Datasets



Functional Flow Calculator

- Available at eflow.ucdavis.edu
- R FFC Calculator: https://ceff-tech.github.io/ffc_api_client/
- TNC Rivers for Nature

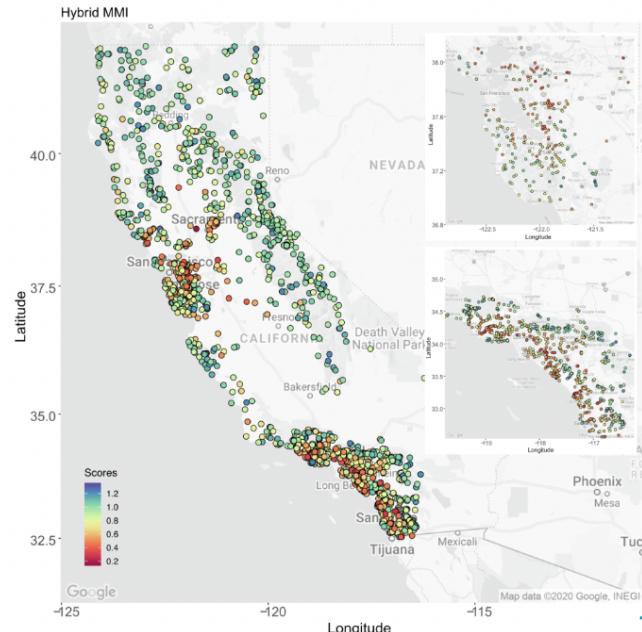
Biological Stream Condition Data

CSCI (California Stream Condition Index)

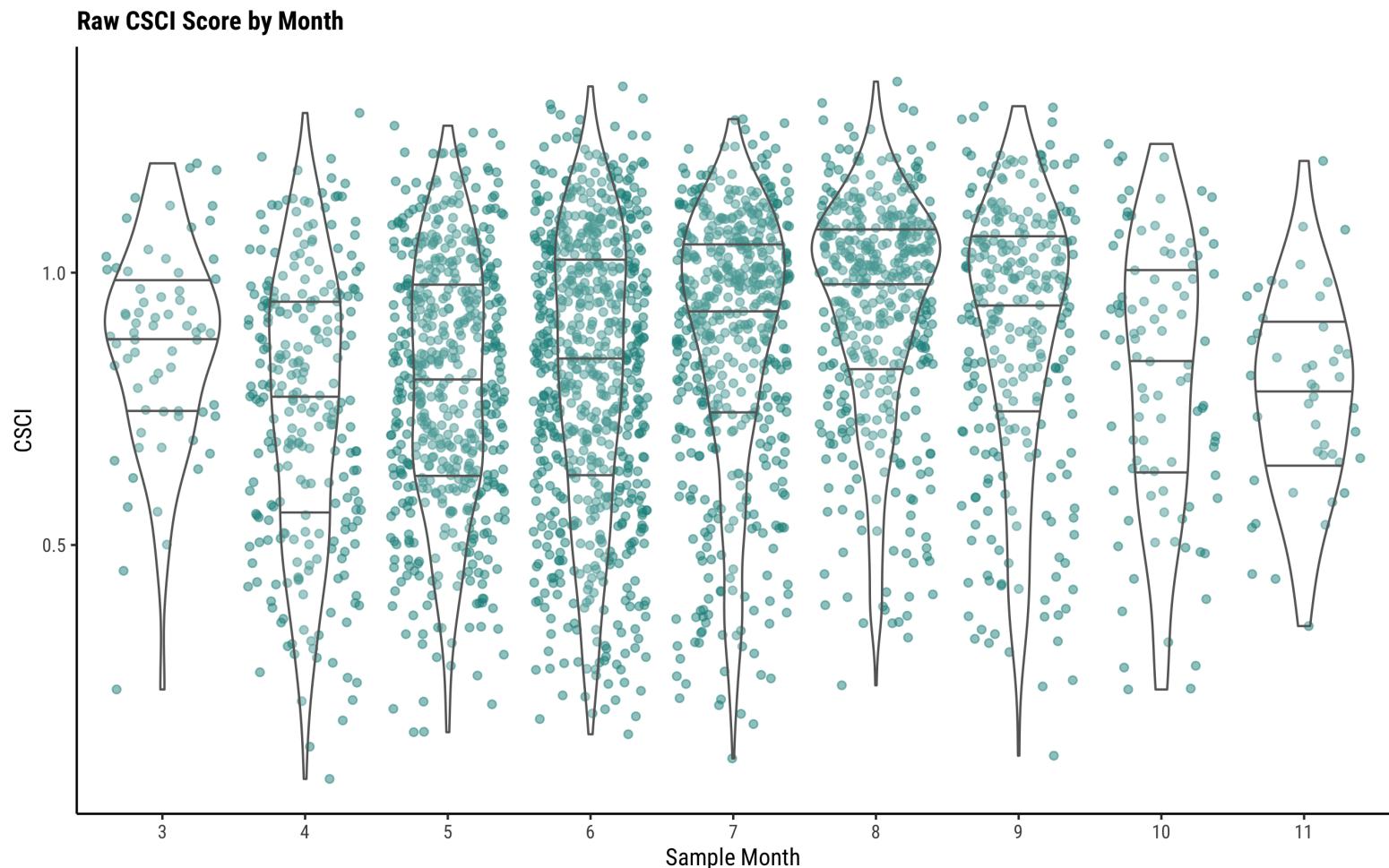
- over 300,000 samples from 1994-2018
- many stations across the state
- Mazor et al., 2016

ASCI (Algal Stream Condition Index)

- Theroux et al., 2020



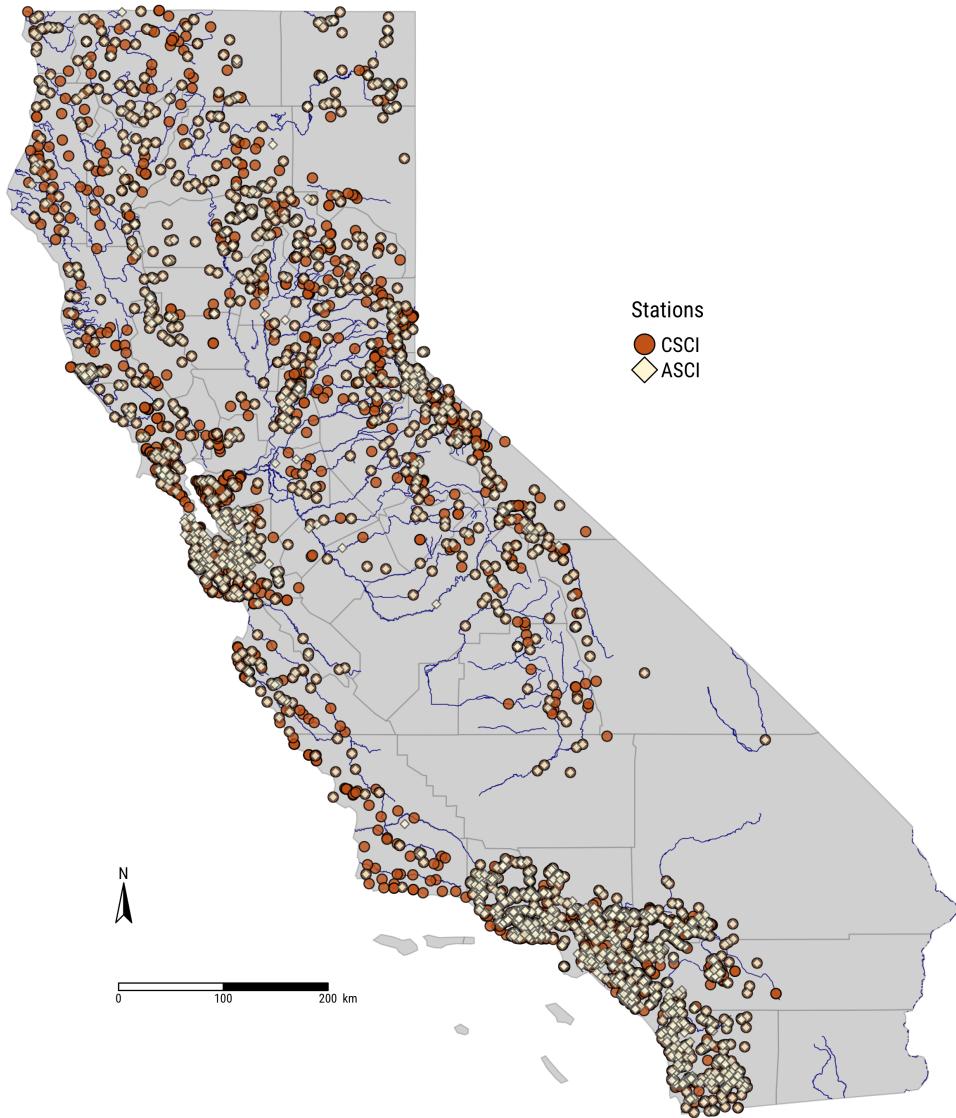
CSCI Scores Variable by site and season



Data from SCCWRP & SWAMP
<www.waterboards.ca.gov/water_issues/programs/swamp>

Biological Sites

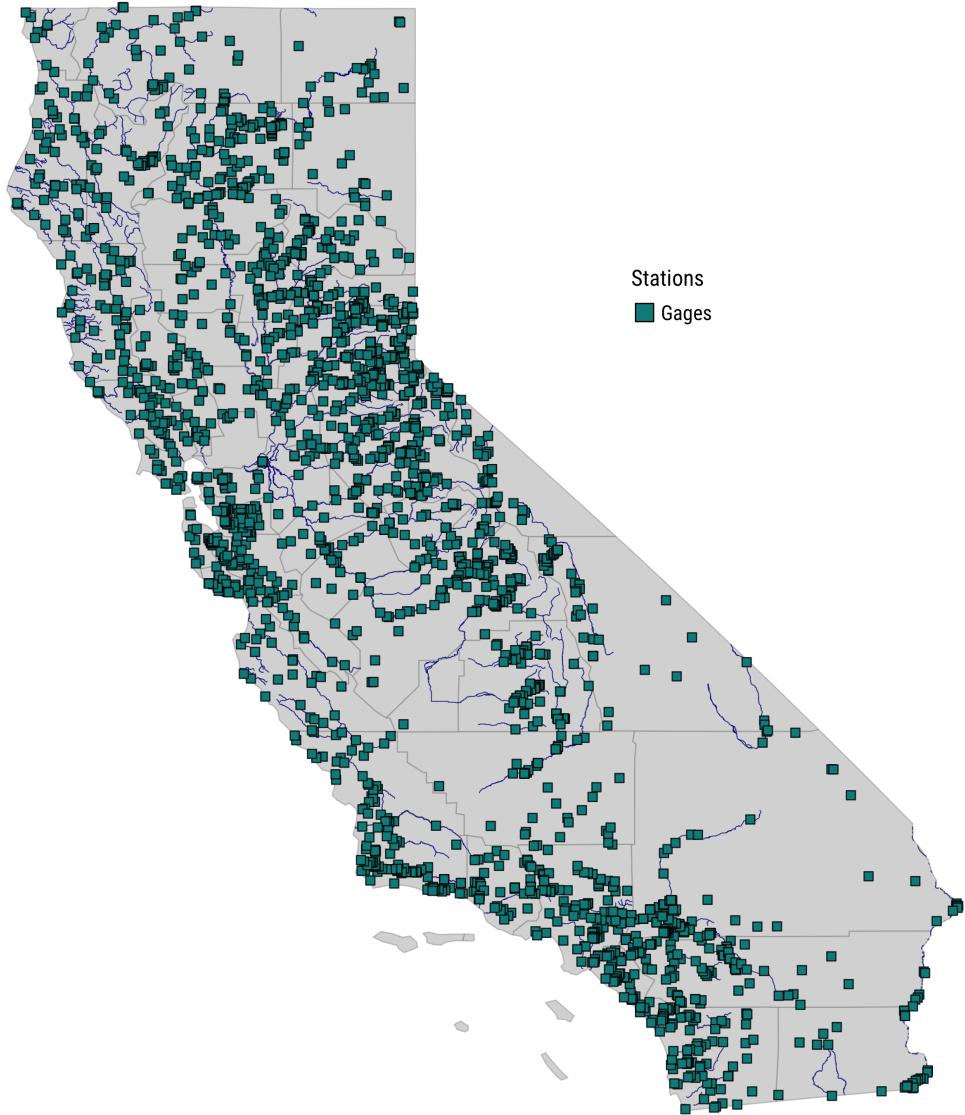
Many sites, but not all
overlapped!



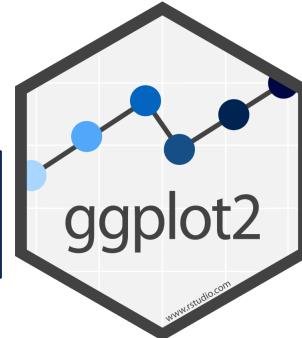
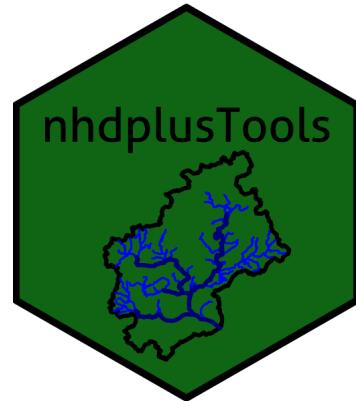
USGS gages across California

Variable data intervals

Different date ranges



Helpful bits (but many many more!)

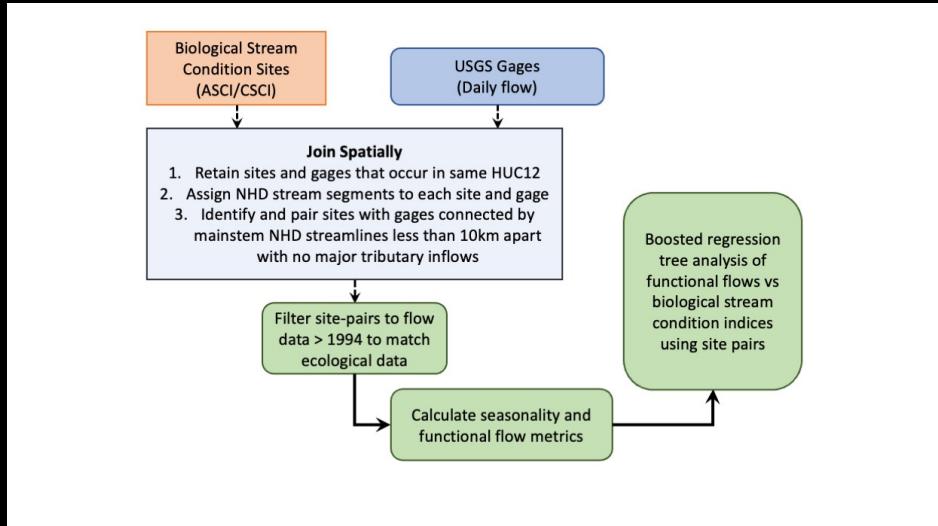


Real Life:

Merging datasets...is messy



General Approach: Write Steps



Lots of waiting and iteration though!



Mapview: Map of Sites

Open map here

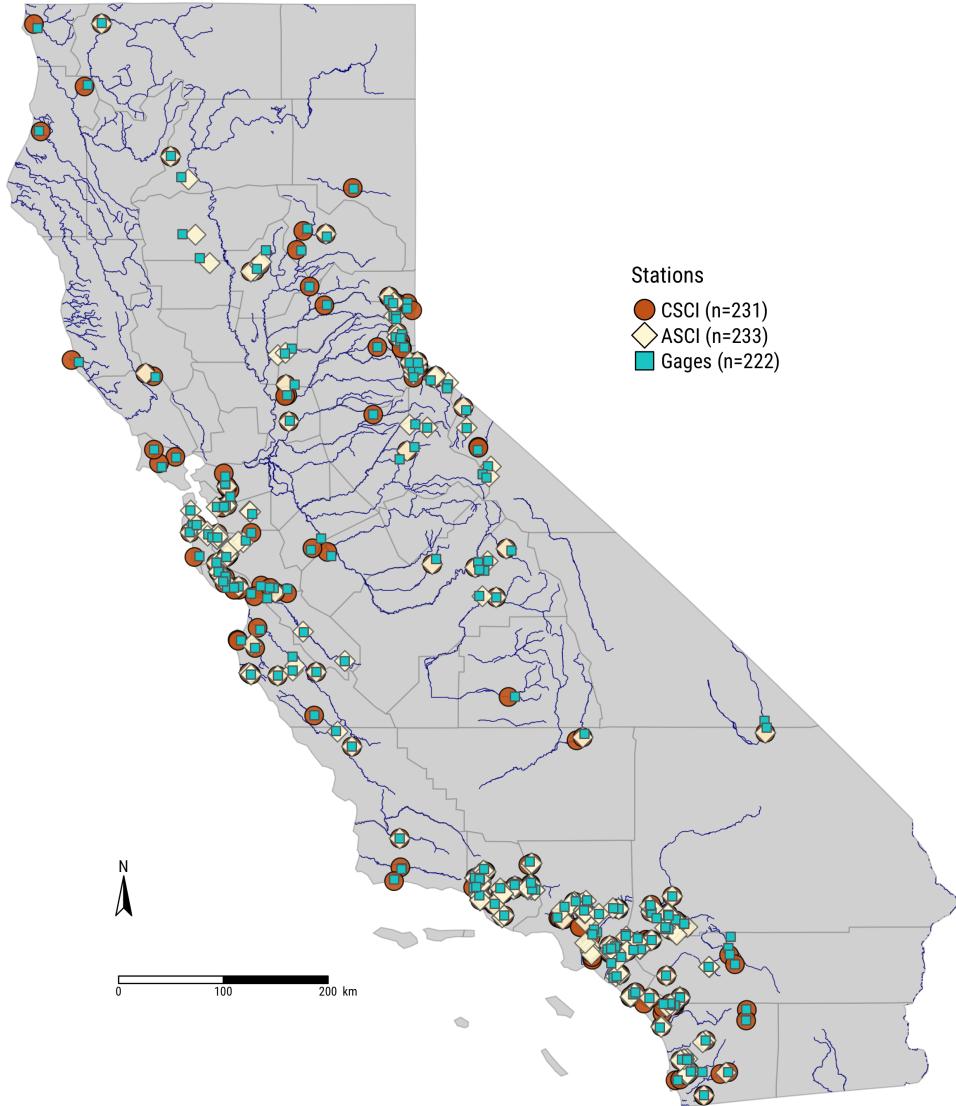
```
library(mapview)
library(dplyr)

# set background basemaps:
basemapsList <- c("Esri.WorldTopoMap", "Esri.WorldImagery", "Esri.NatGeoWorldMap", "OpenTopoMap", "OpenStreetMap", "CartoDB.Positron")
mapviewOptions(basemaps=basemapsList, fgb=FALSE)

# map
m3 <- mapview(bmi_final_dat, cex=6, col.regions="orange", layer.name="Selected_BMI")
mapview(mainstems_all %>% filter(from_gage=="UM"), color="forestgreen")
mapview(mainstems_distinct, color="steelblue", cex=3, layer.name="NHD")
mapview(gages_selected_v2, col.regions="skyblue", cex=7, color="blue2")
# these are all bmi or gages in same H12 but not selected
mapview(gages_not_selected_v2, col.regions="slateblue", color="gray20")
mapview(bmi_not_selected_v2, col.regions="gold", color="gray20", cex=3)
mapview(hucs_selected_v2, col.regions="orange3", alpha.region=0.1, color="black")
mapview(hucs_not_selected_v2, col.regions="dodgerblue", alpha.region=0.1)
```

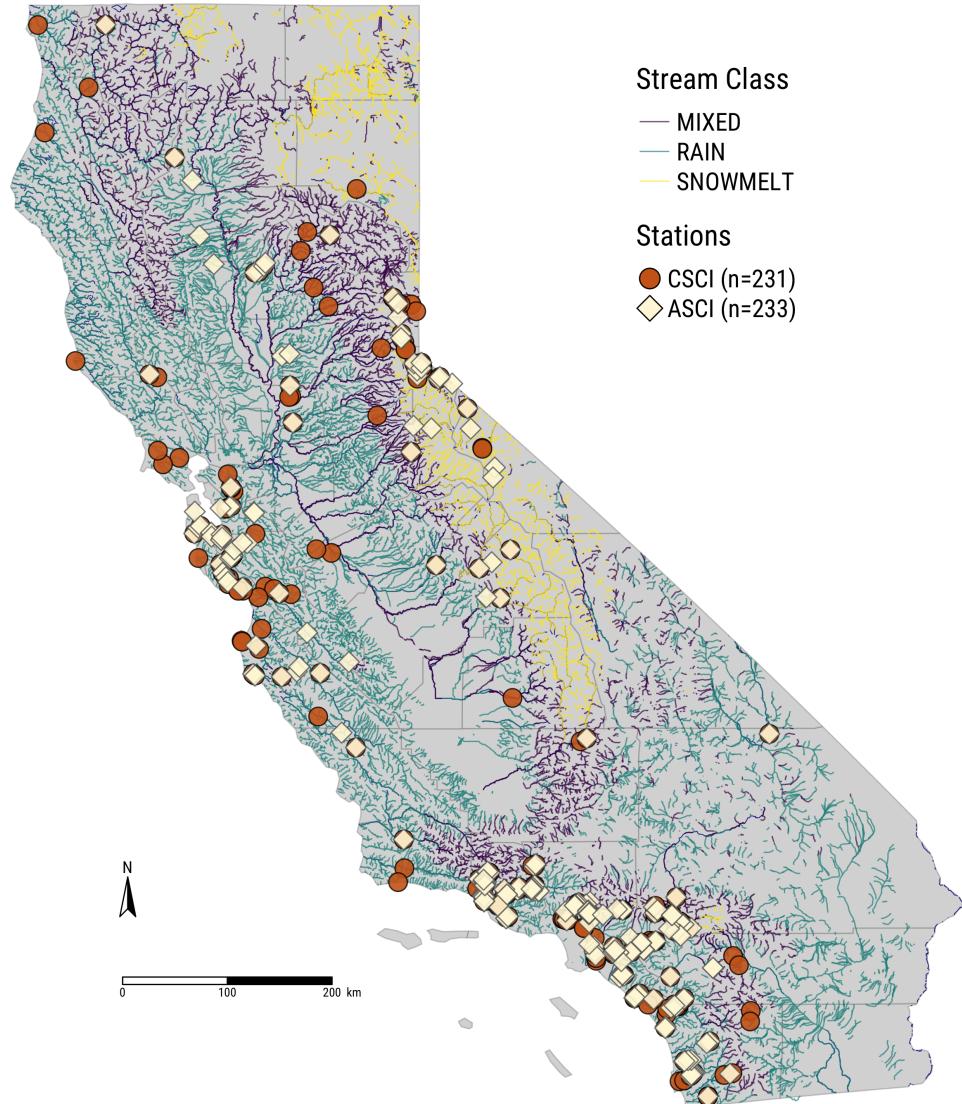
Final Sites

- represent multiple regions
- but meager in some places



Stream Classes

- Collapsed to 3 (based on Patterson et al. 2020)
- Spatial Joins are amazing



Results!



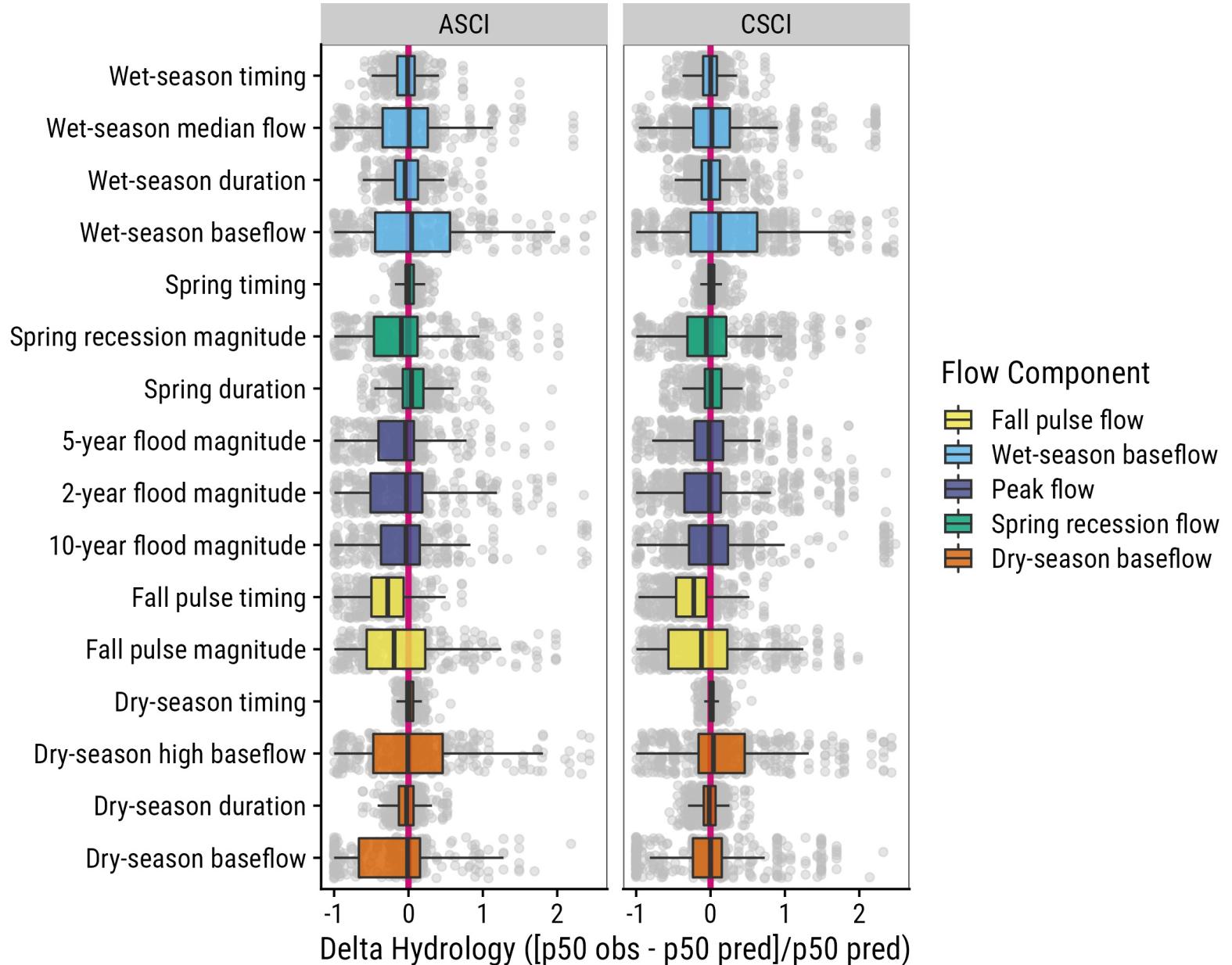
Results

- seasonality one of strongest factors
- as was Fall Pulse and Dry Season Baseflows
- published some stuff

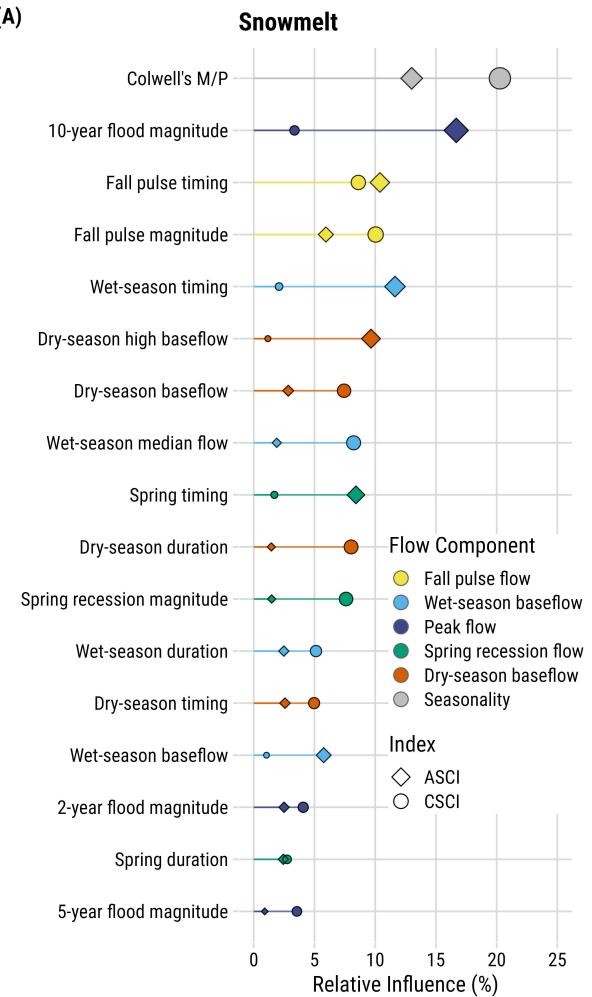
Identifying Functional Flow Linkages Between Stream Alteration and Biological Stream Condition Indices Across California

Ryan Peek^{1}, Katie Irving², Sarah M. Yarnell¹, Rob Lusardi^{1,3}, Eric D. Stein² and
Raphael Mazor²*

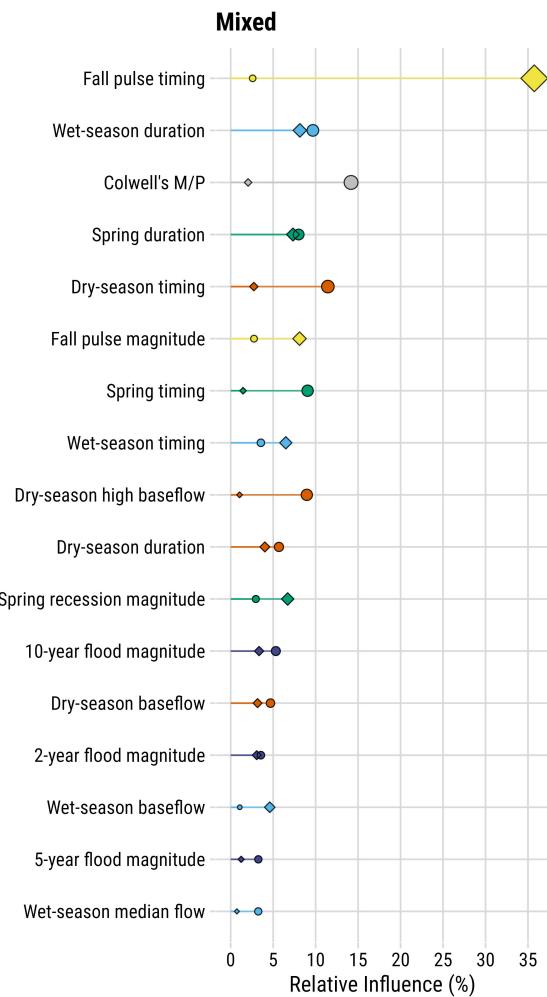
¹Center for Watershed Sciences, University of California, Davis, Davis, CA, United States, ²Southern California Coastal Water Research Project, Costa Mesa, CA, United States, ³Department of Wildlife, Fish, and Conservation Biology, University of California, Davis, Davis, CA, United States



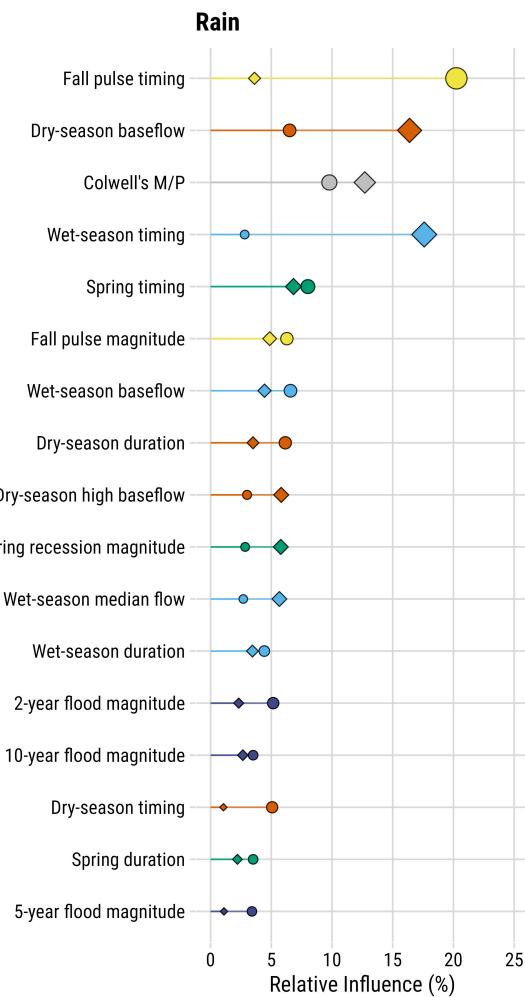
(A)



(B)



(C)



Thanks!