

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)

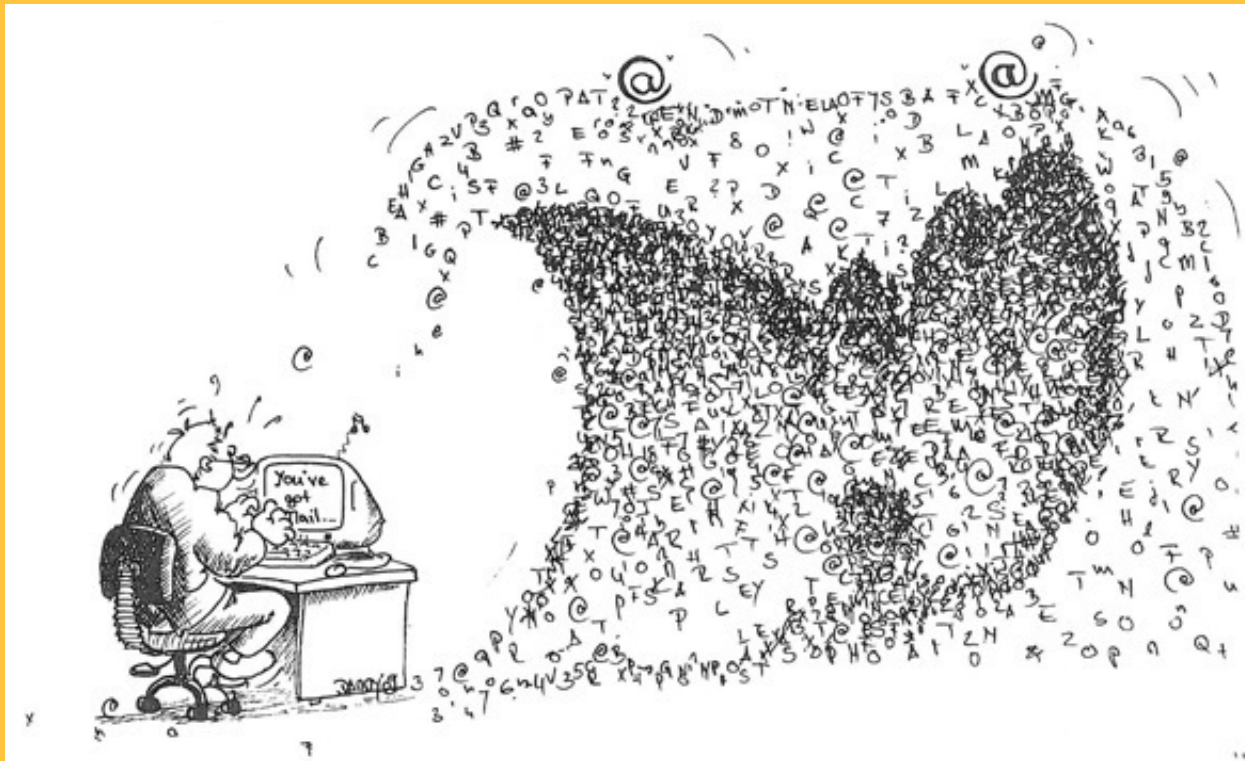


What I work on now

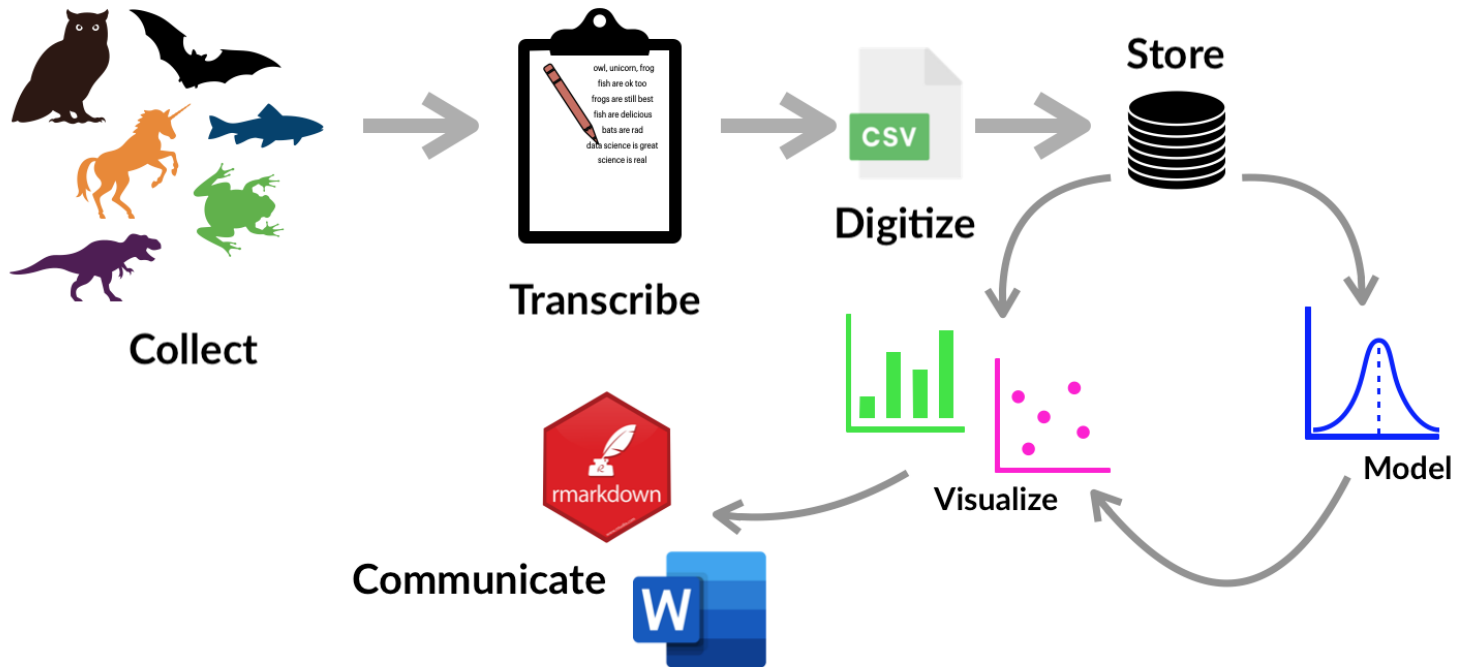
- Conservation Genomics (lots of bioinformatics!)
- Environmental Flows & Altered Rivers
- Meadows & Restoration
- Delta Foodweb Connectivity
-  Davis R Users Group
- R4WRDS
- Carpentries workshops
- Life!

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!*

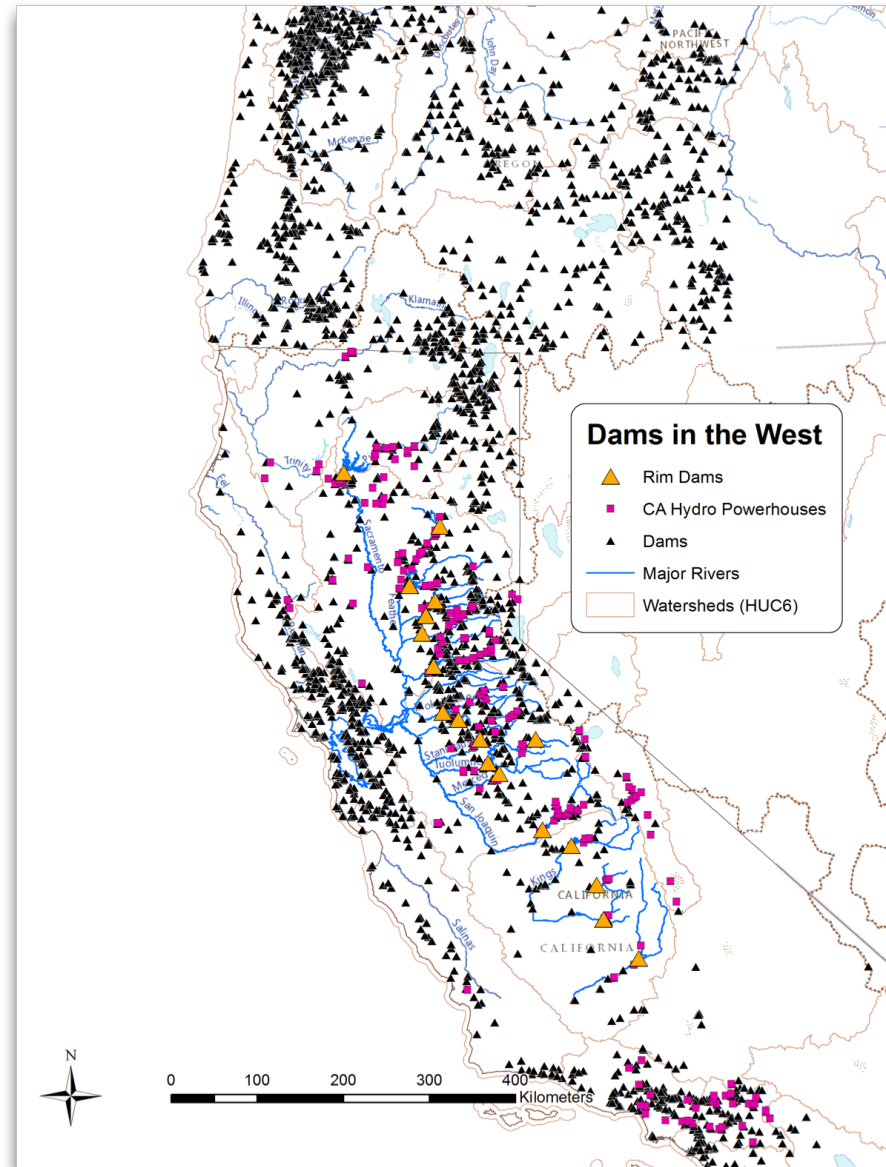
An aerial photograph of a river system. A large reservoir is visible in the upper half of the image, with a dam structure extending across it. Below the dam, the river flows through a rocky channel. The surrounding area is densely forested with green trees. The text 'Rivers' is overlaid in the upper center, and 'Dams' is overlaid in the lower center.

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

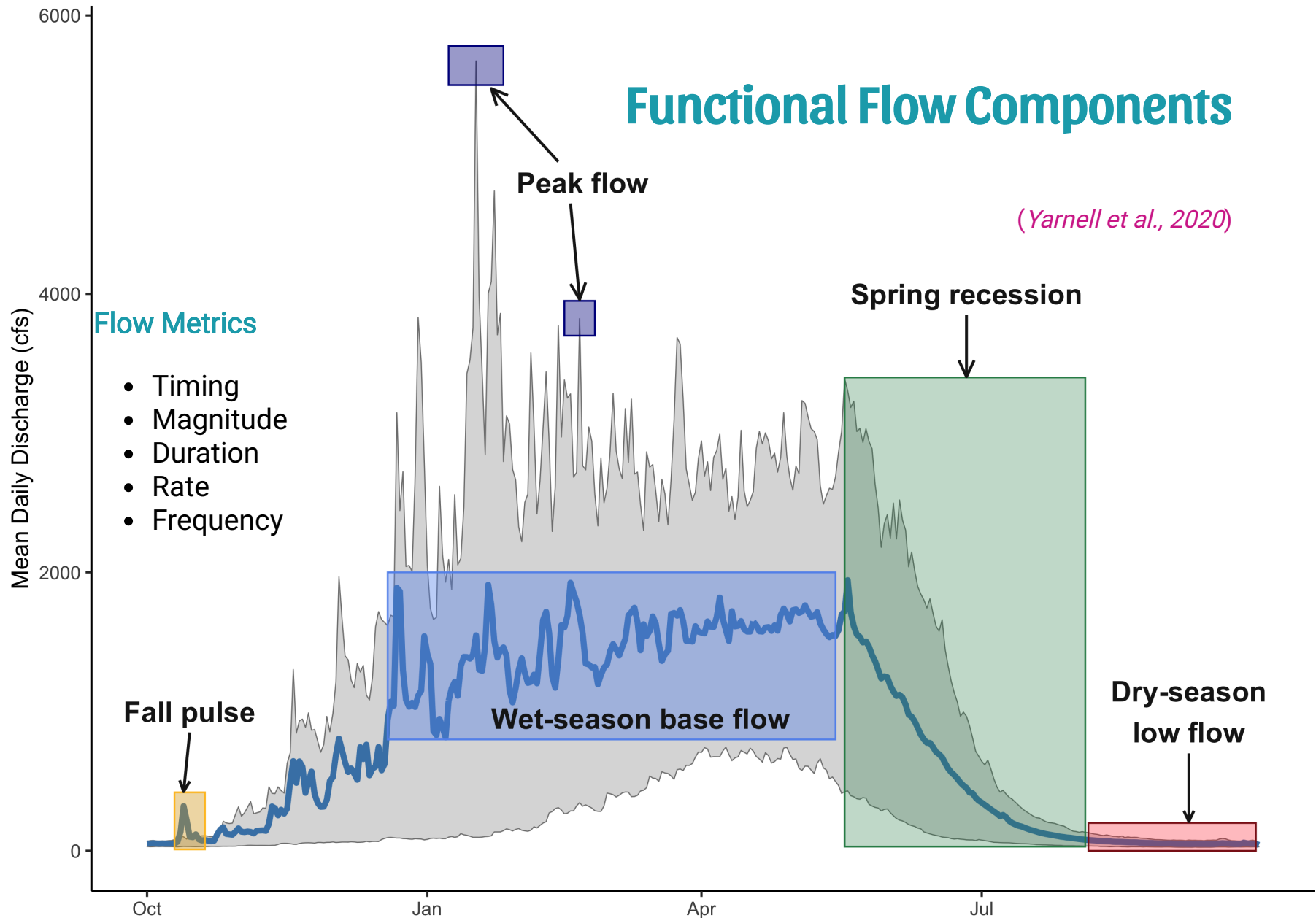


Environmental Flows

- 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)



Flow Metrics

- Timing
- Magnitude
- Duration
- Rate
- Frequency

Can calculate quantitative metrics based on hydrograph!

These are biologically relevant

A fu
flow

Sarah
Rob A
Jeanet

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		

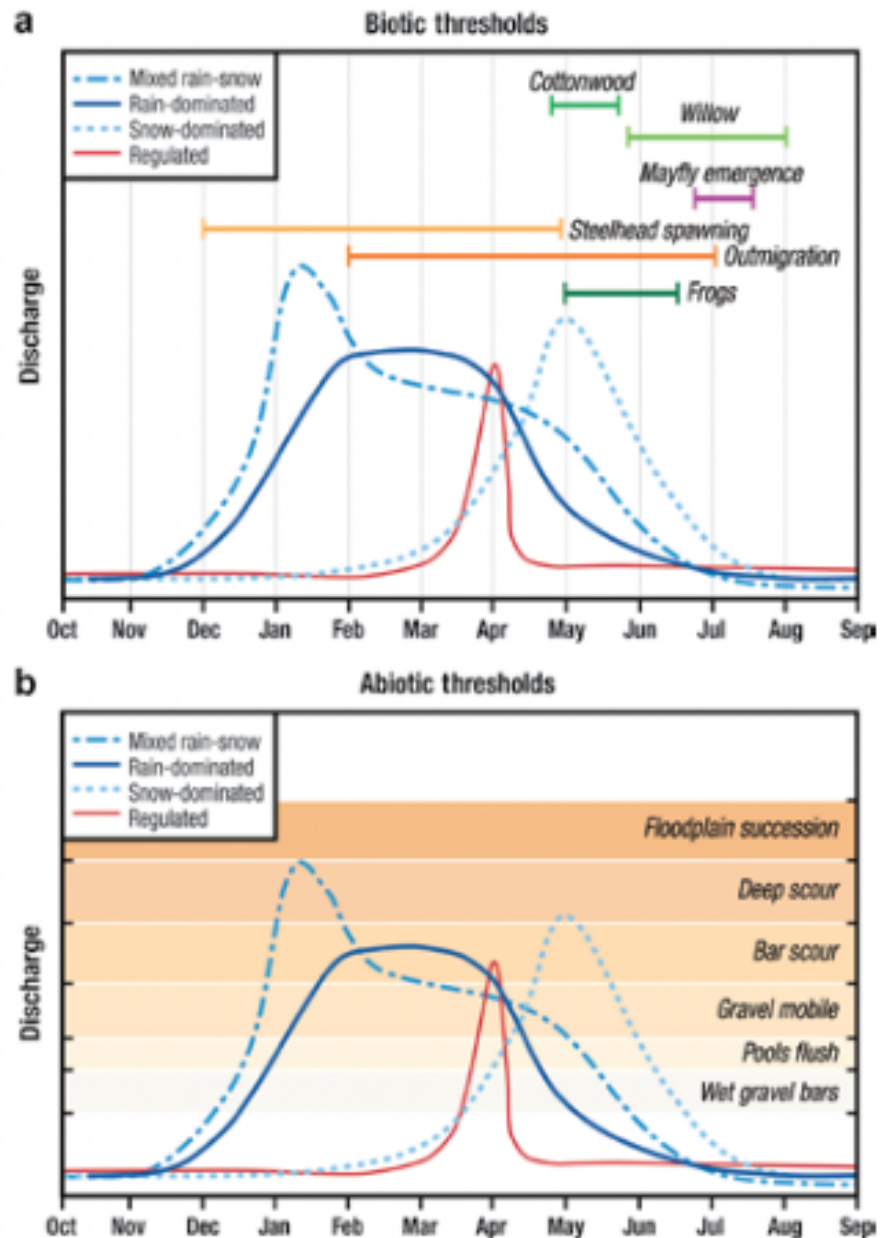


Spring Recession!

Seasonality of Flows

(Yarnell et al., 2020)

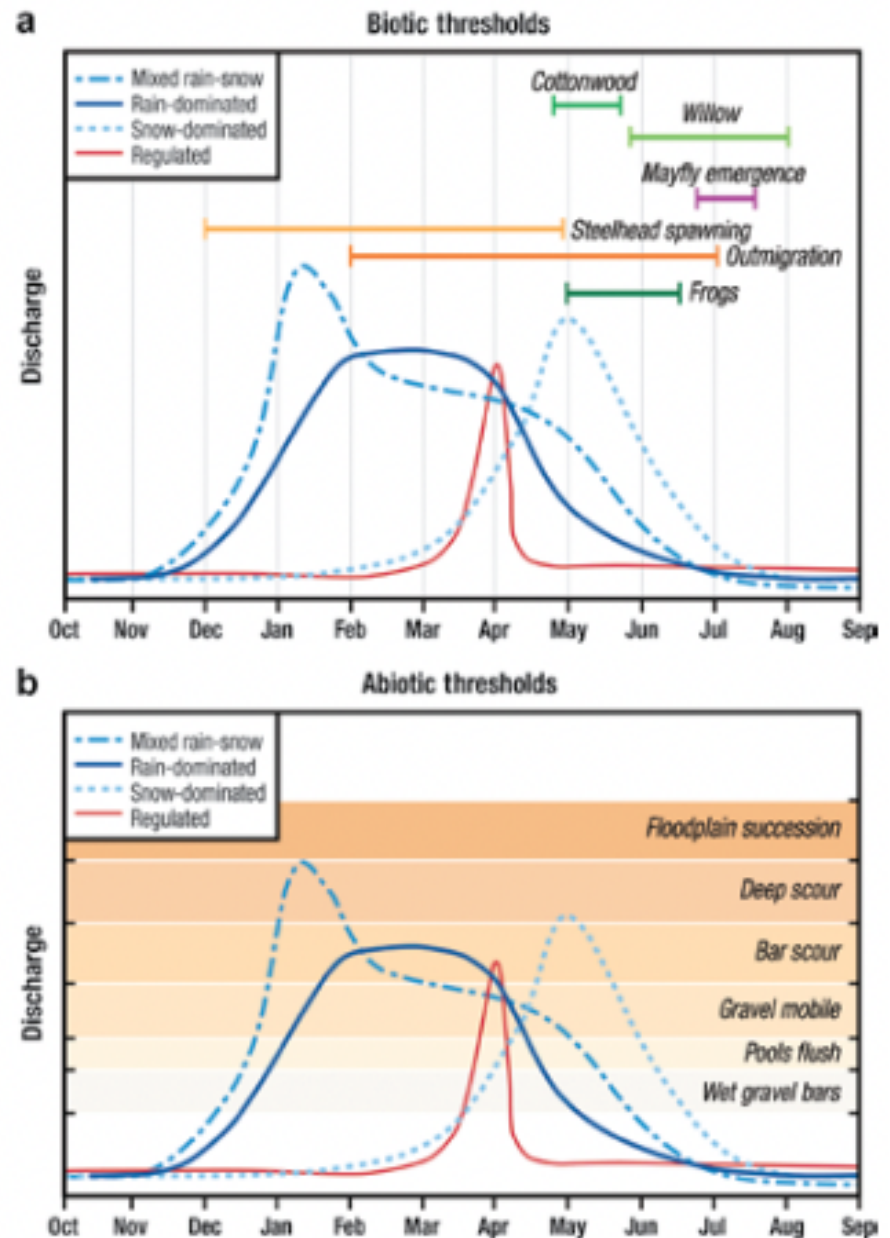
- Important *function* relates to biotic and abiotic change

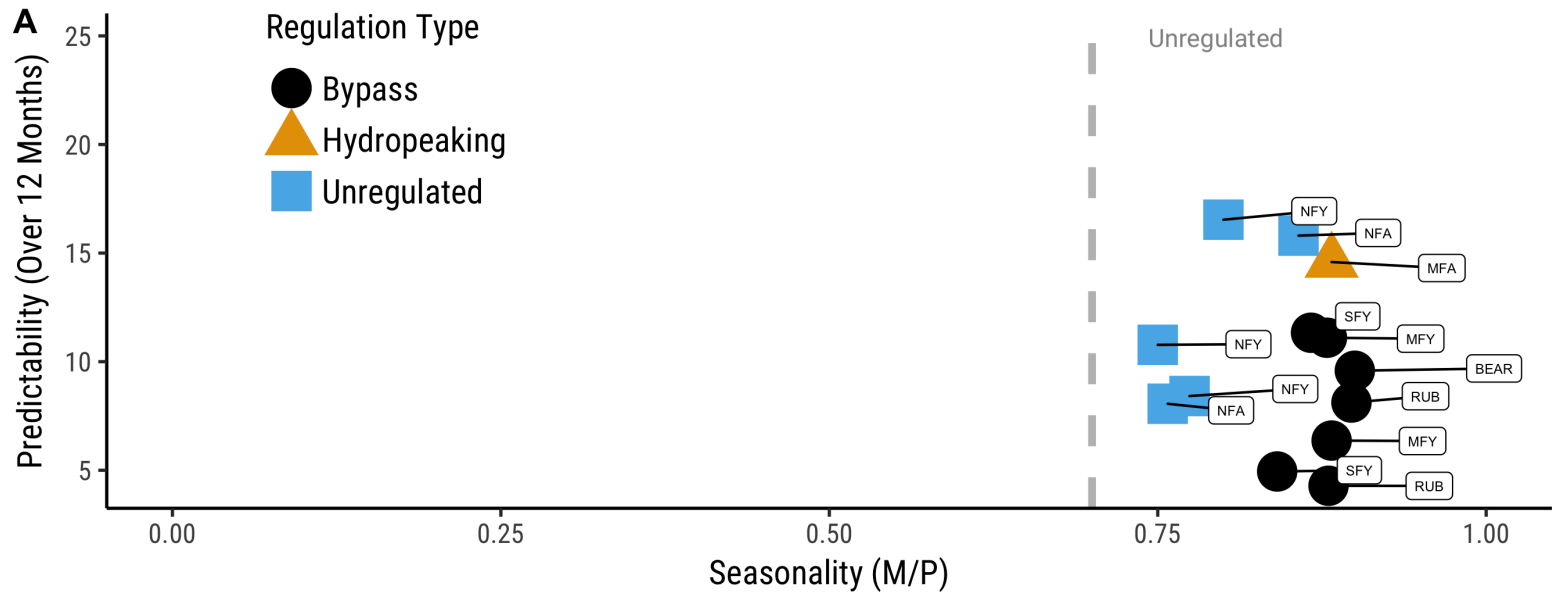


Seasonality of Flows

(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

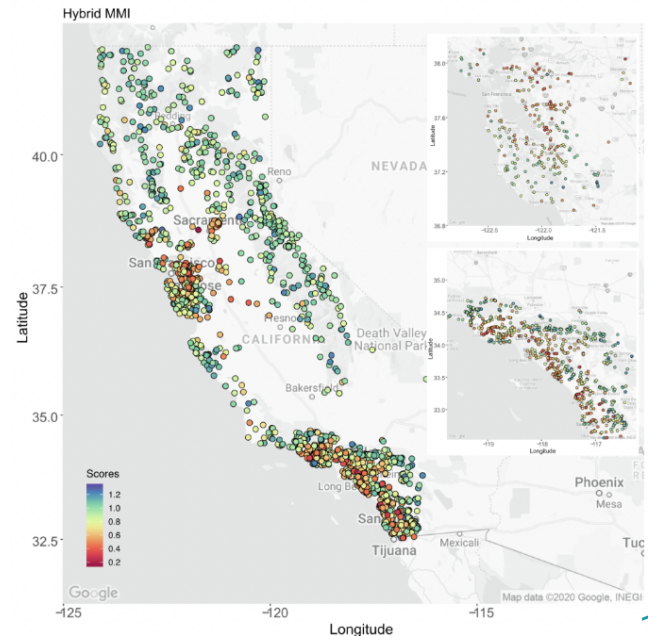
Biological Stream Condition Data

CSCI (California Stream Condition Index)

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

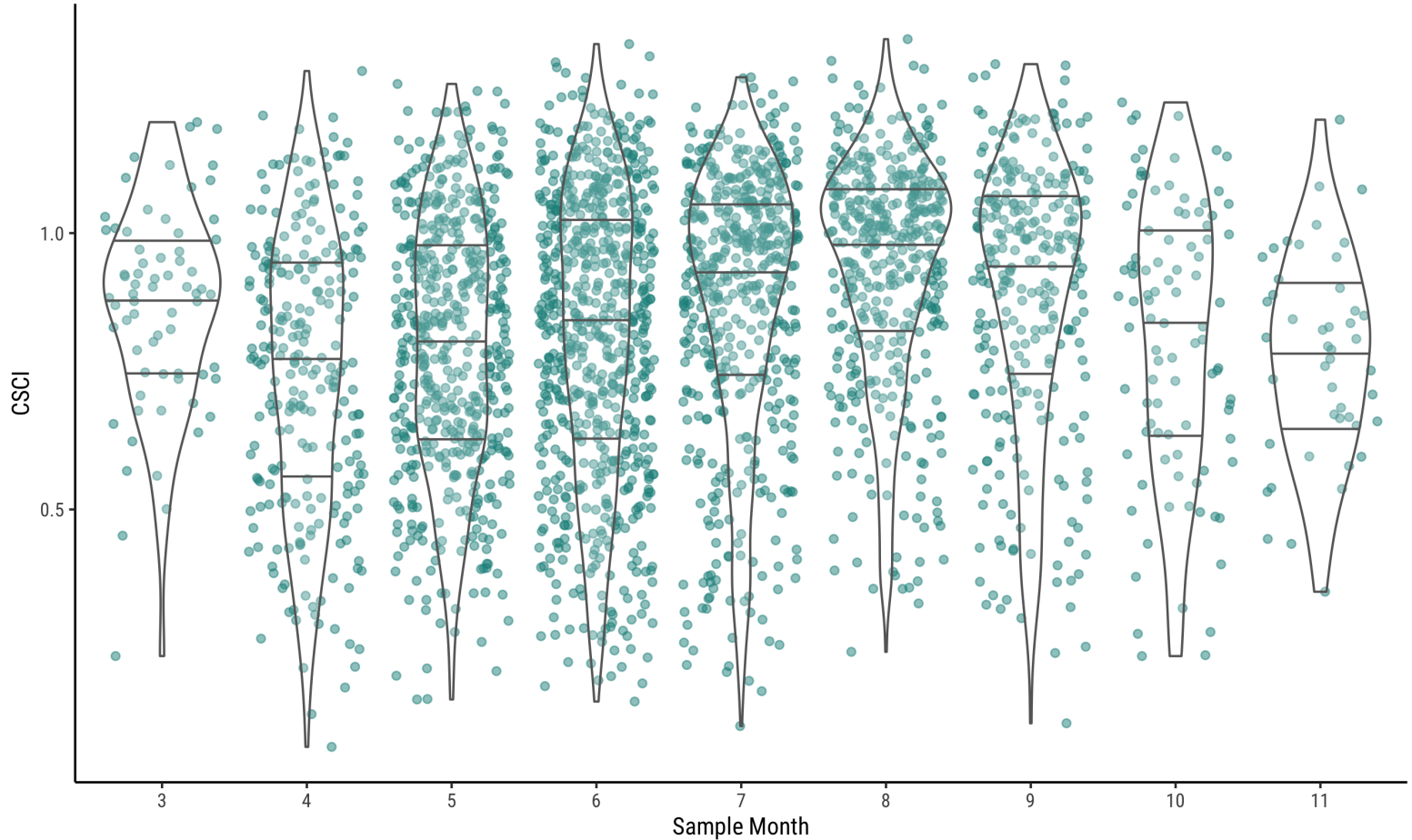
ASCI (Algal Stream Condition Index)

- Theroux et al., 2020



CSCI Scores Variable by site and season

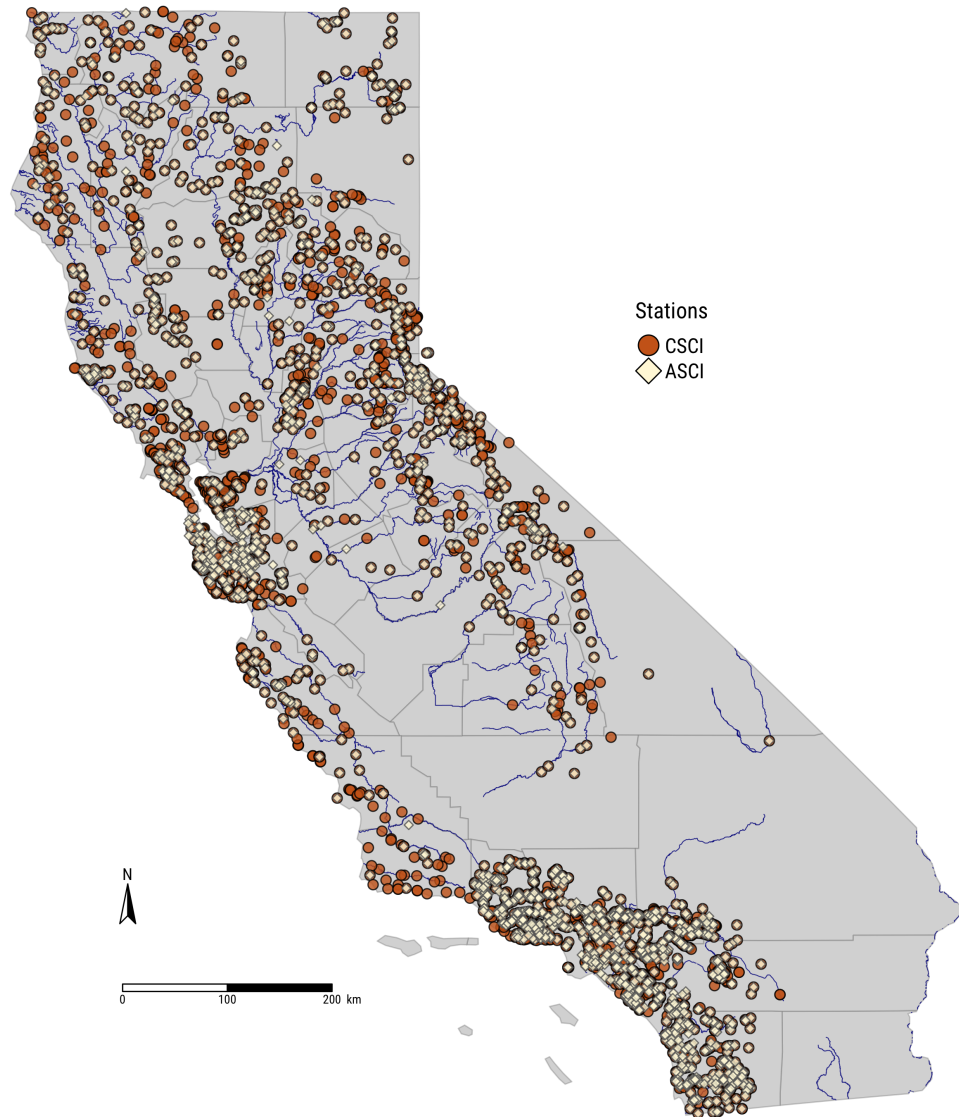
Raw CSCI Score by Month



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

Biological Sites

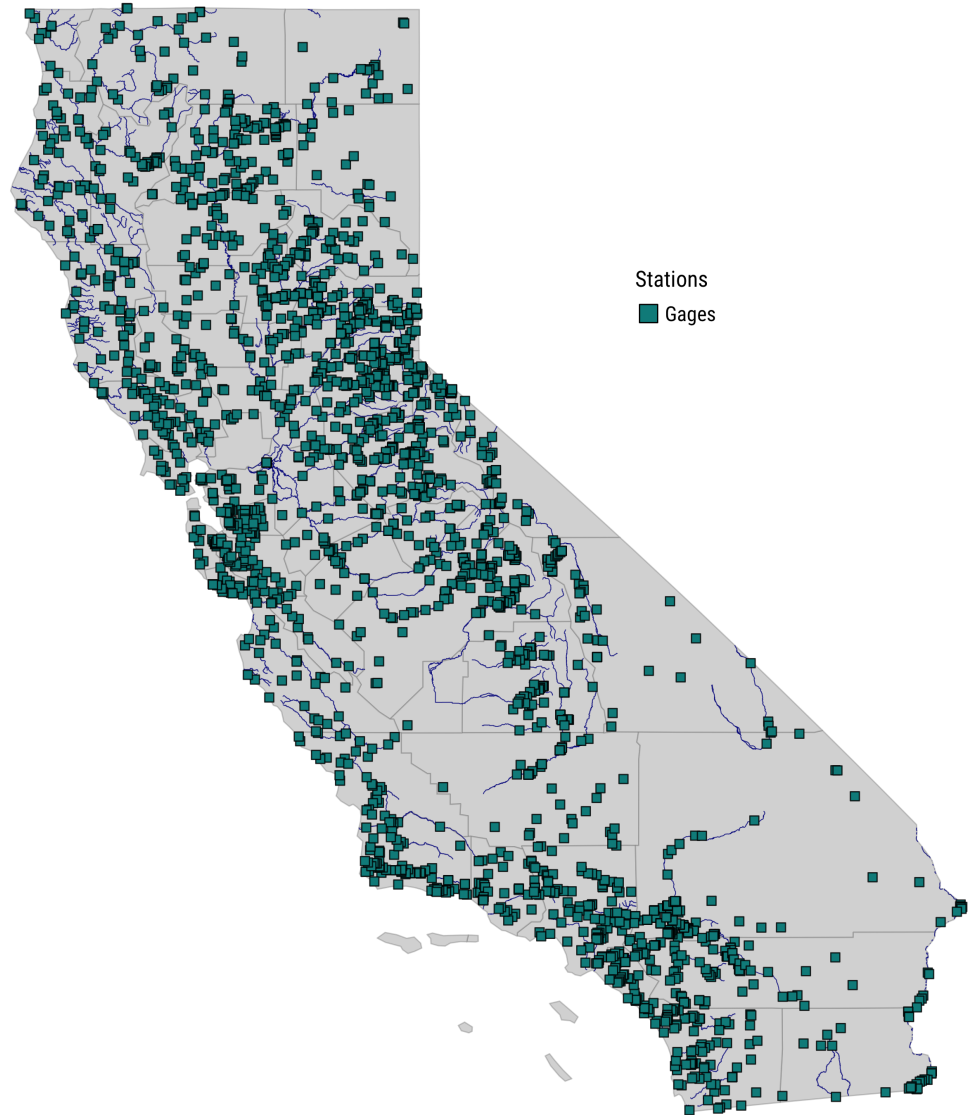
Many sites, but not all overlapped!



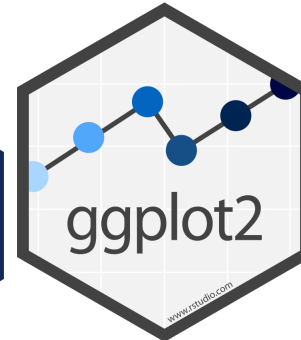
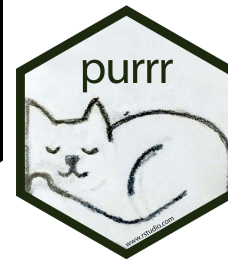
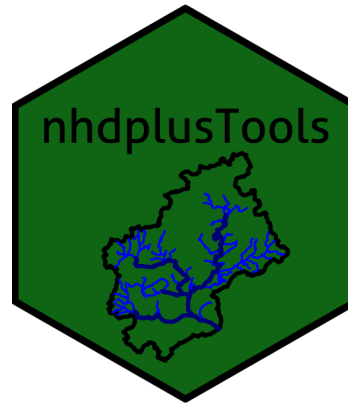
USGS gages across California

Variable data intervals

Different date ranges



Helpful bits (but many many more!)

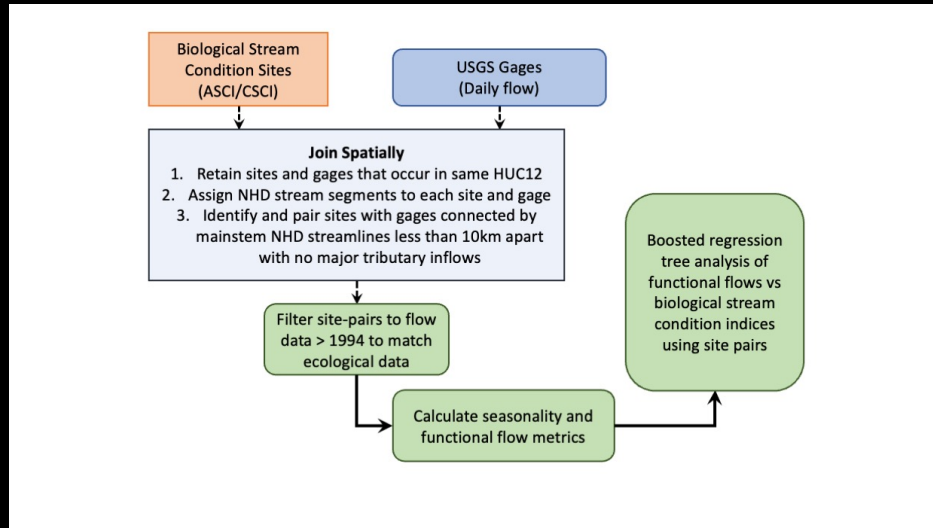


Real Life:

Merging datasets...is messy



General Approach: Write Steps



Lots of waiting and iteration though!



Mapview: Map of Sites

Open map here

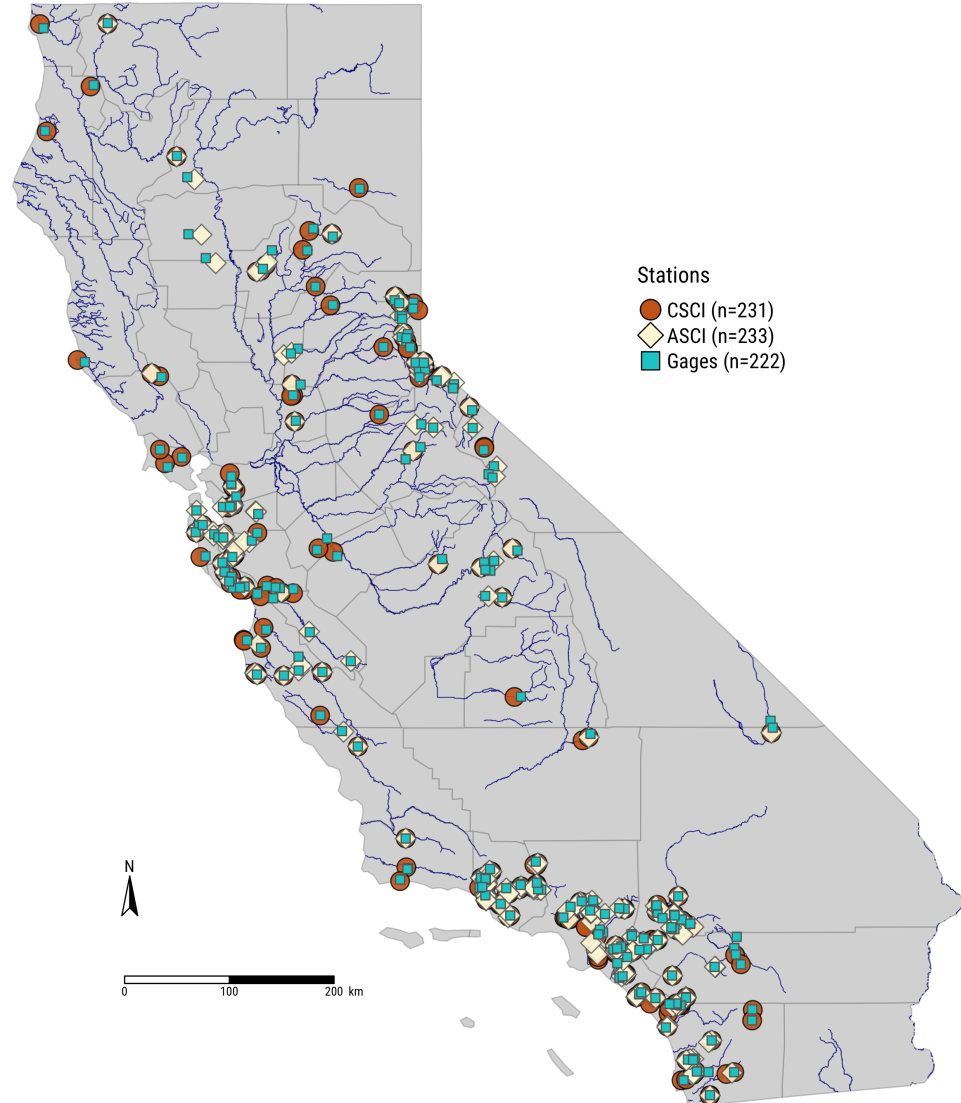
```
library(mapview)
library(dplyr)

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

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

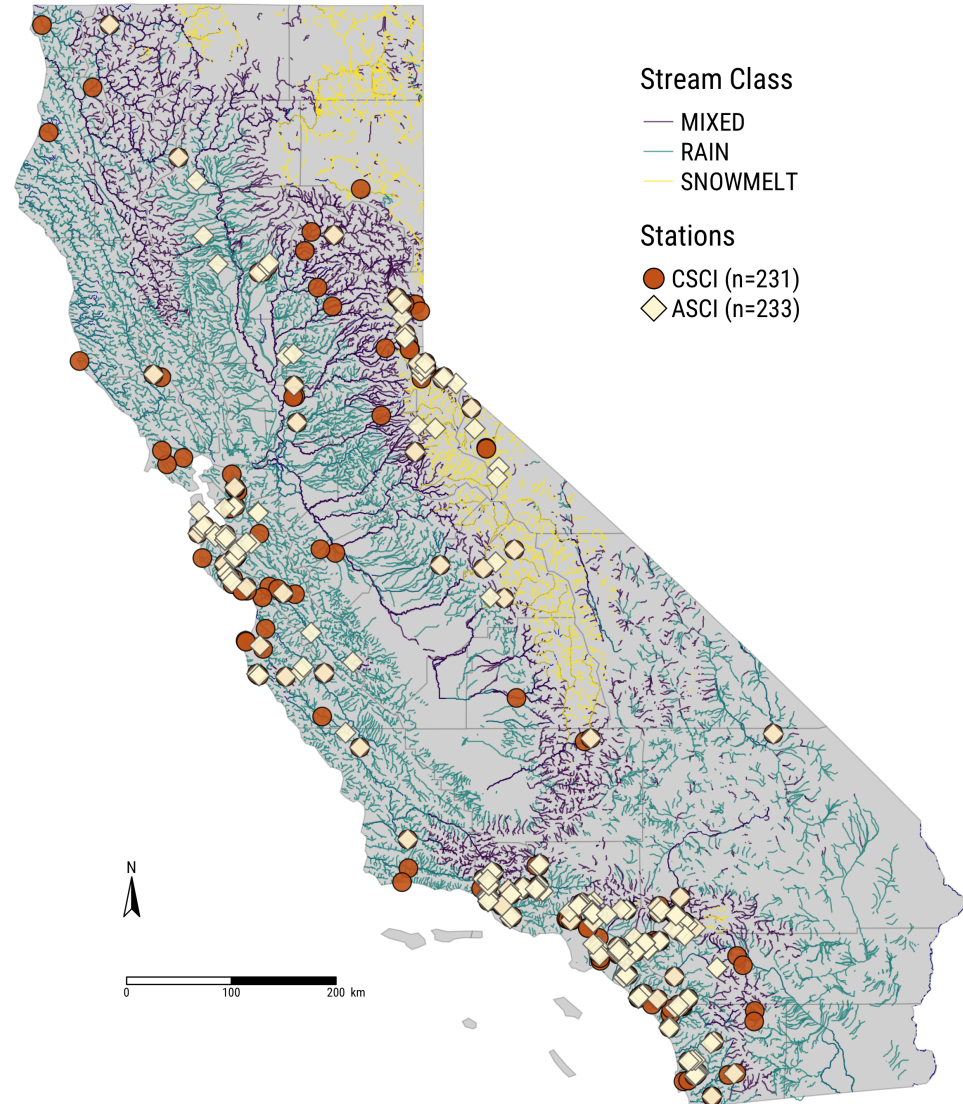
Final Sites

- represent multiple regions
- but meager in some places



Stream Classes

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



Results!



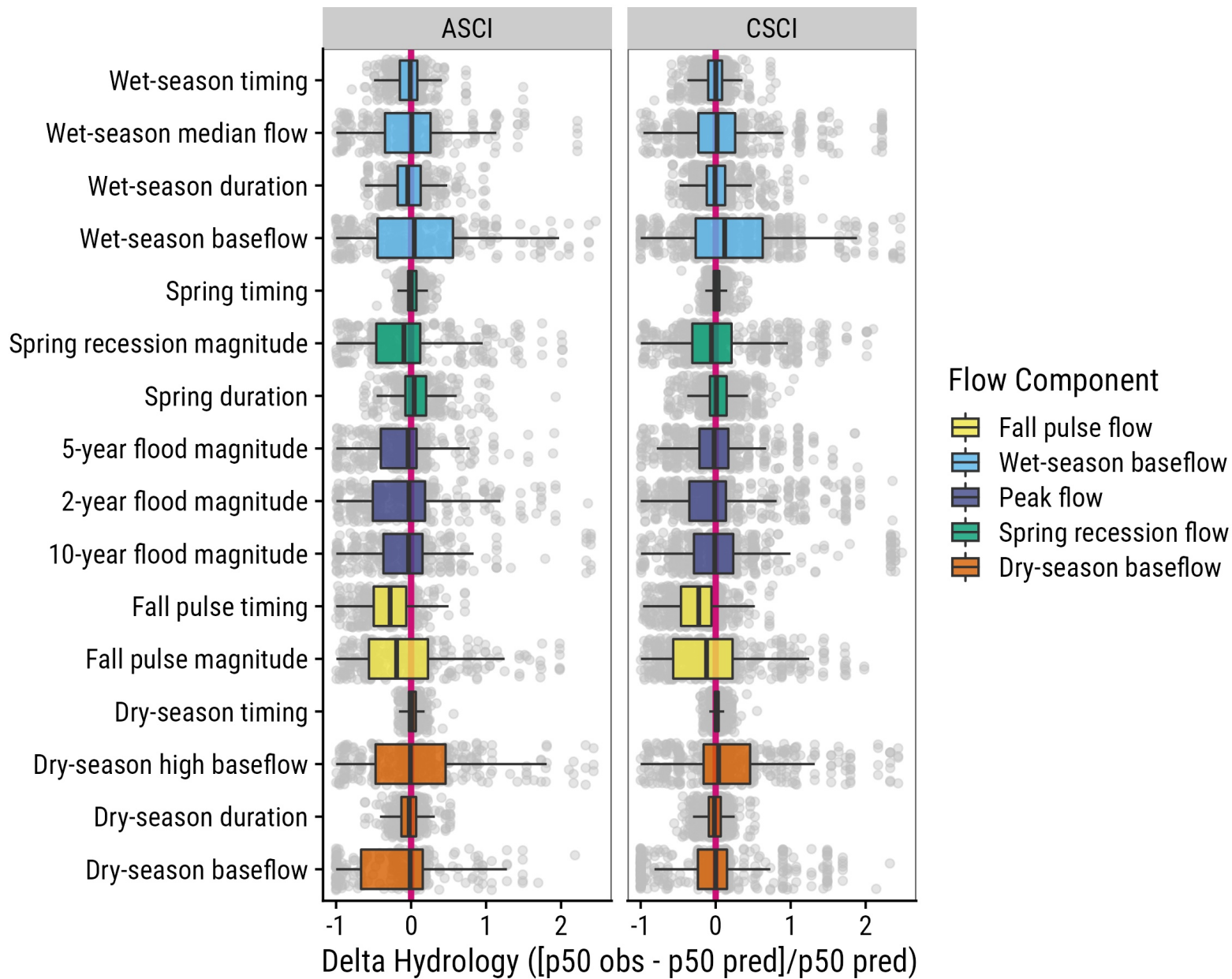
Results

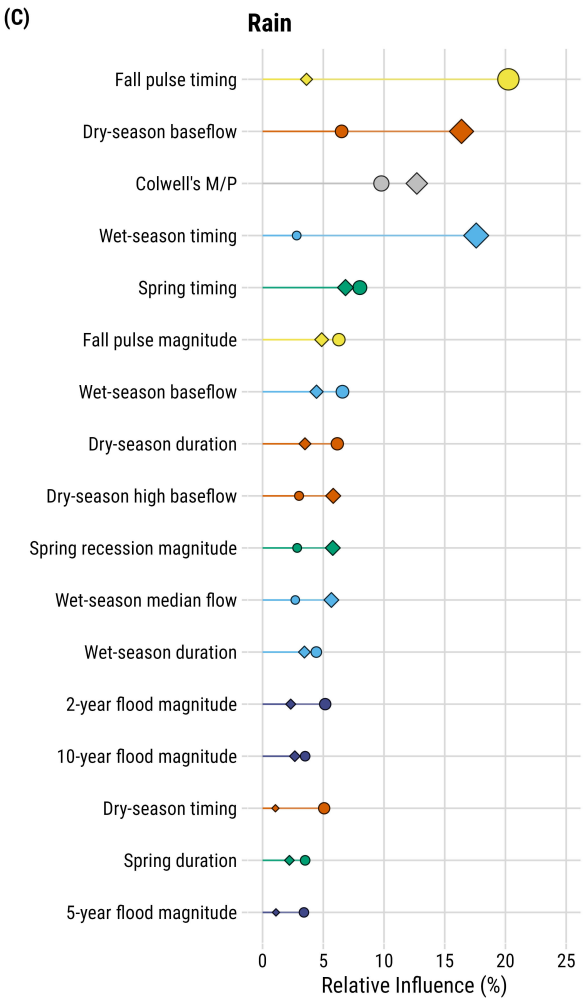
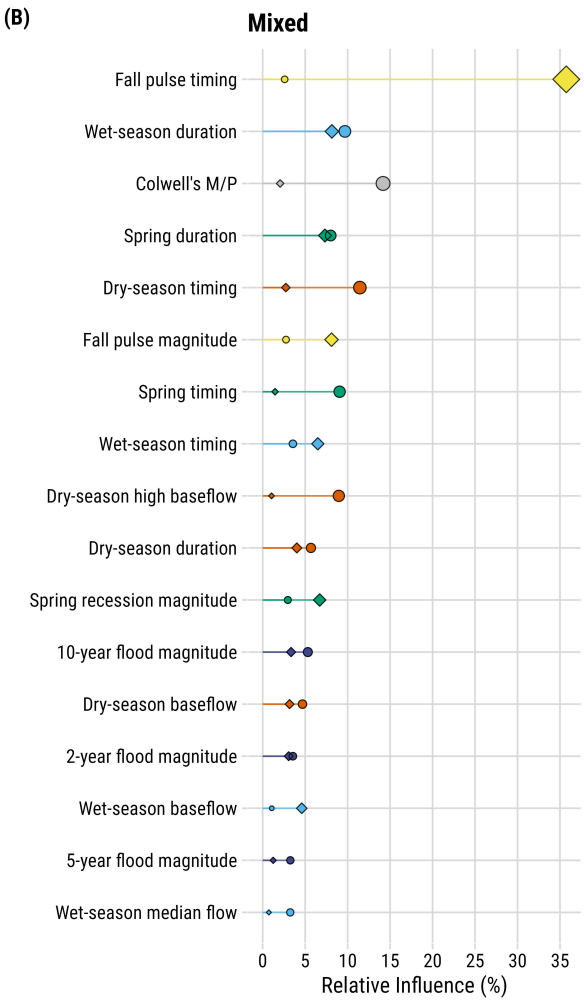
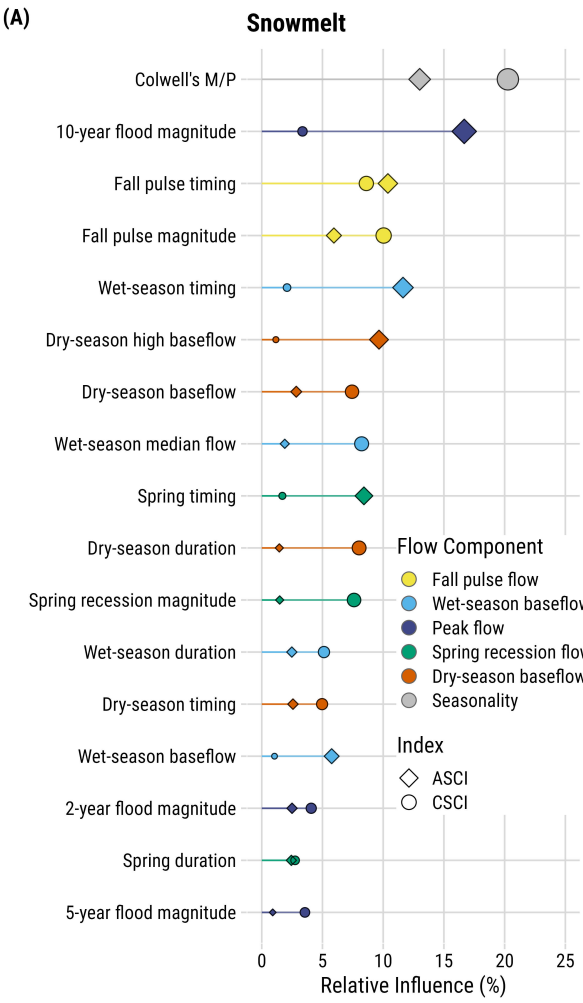
- seasonality one of strongest factors
- as was Fall Pulse and Dry Season Baseflows
- published some stuff

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

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Thanks!