Establishing Environmental Flows for California Streams

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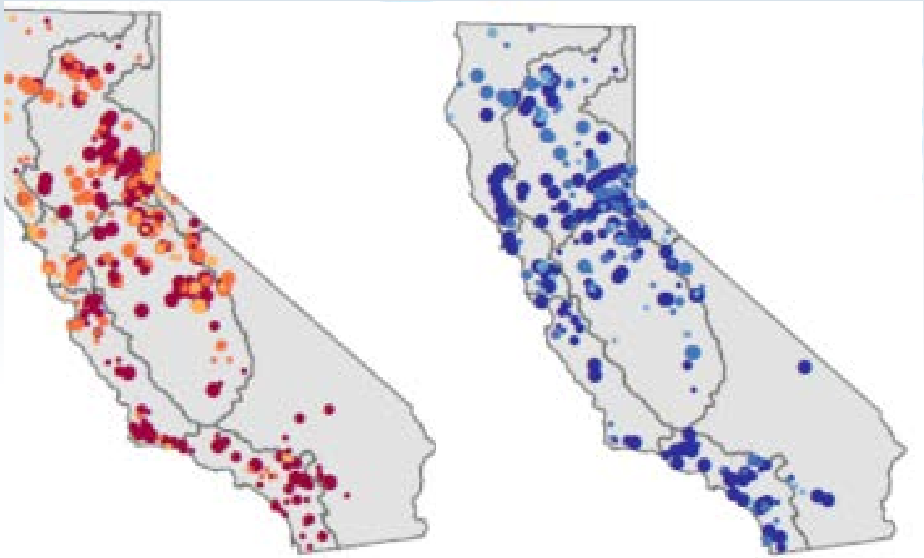
What Do We Know About the Status of Flows Statewide?

- First comprehensive study recently published
  - Statistical analysis of gauged locations
- 95% of gauged locations have at least some altered flows; 11% have pervasive alteration
  - Depletion of high flows
  - Augmentation of low flows
  - Reduction in seasonal variability
- **Results NOT related to any ecological endpoints**



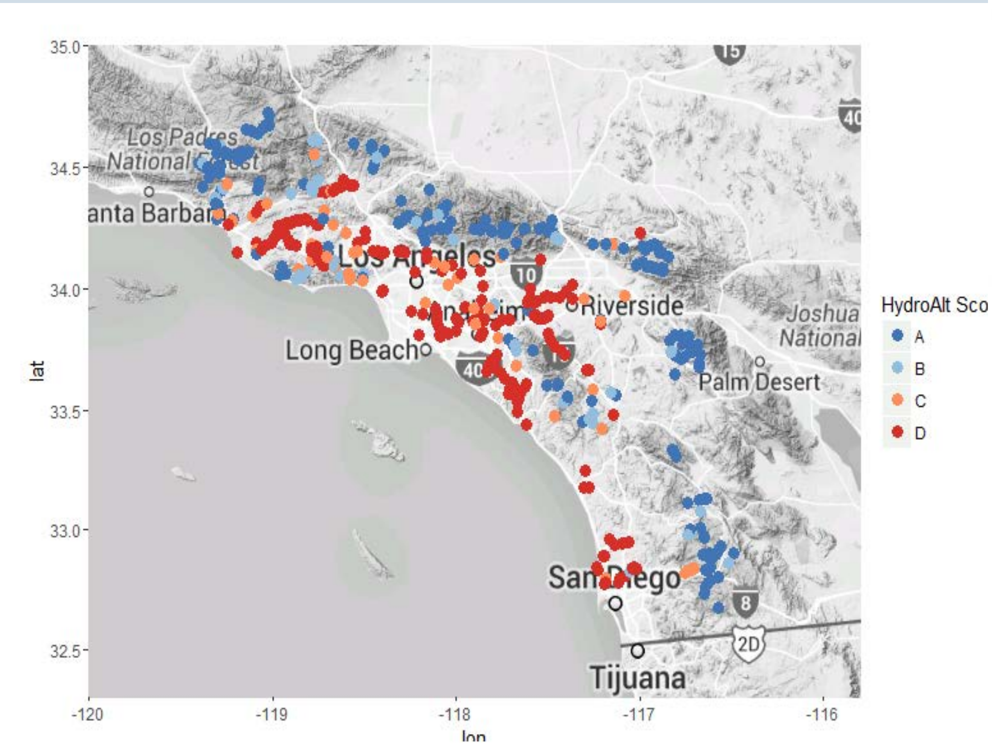
Depletion of high flows Augmentation of low flows

Zimmerman et al. 2018

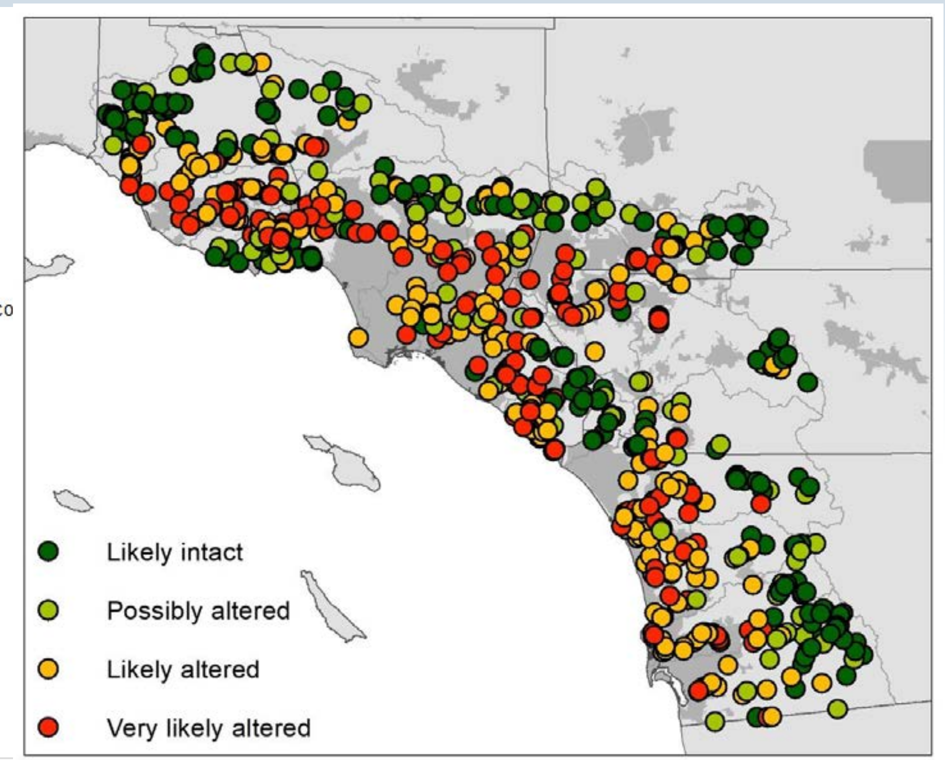
Need an approach to define "flow impairment"

Low Bioassessment Scores Tend to Occur Where Hydrology is Altered

Hydrologic Alteration



Biologic Alteration

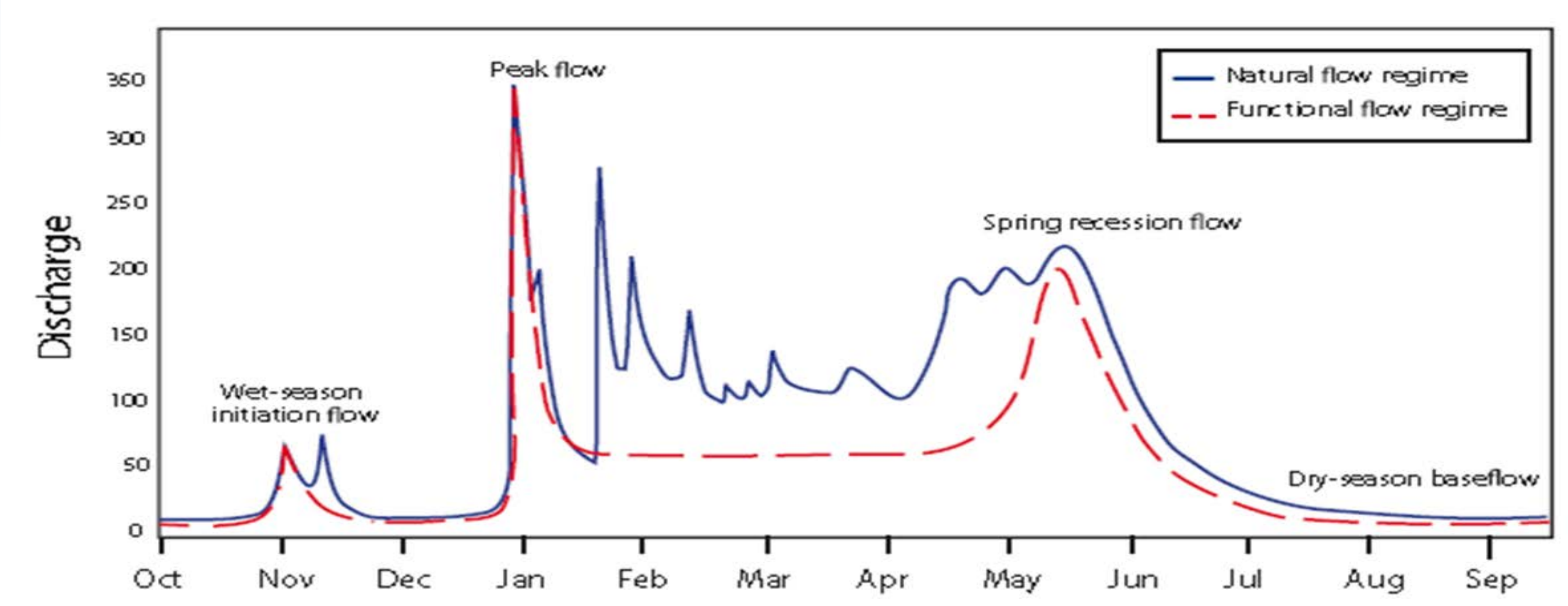


Statewide Needs for Environmental Flows

- Set instream flow standards to protect biological communities
  - Process for selecting appropriate ecological endpoints
- Assess vulnerability of streams to future changes in flow conditions
  - Prioritize areas for restoration/management
- Evaluate/inform management actions
  - e.g., reservoir operations, water withdrawals

What are Environmental Flows?

The magnitude, timing, duration, rate of change, and frequency of flows and associated water levels necessary to sustain the biological composition, ecological function, and habitat processes within a water body and its margins



CA Environmental Flows Workgroup

The mission of the California Environmental Flows Workgroup is to advance the science of environmental flows assessment and its application for supporting management decisions aimed at balancing natural resource needs with consumptive water uses.

Technical Products → **Implementation Products**

Technical Products

- Analytical frameworks
- Classification systems
- Assessment tools
- Modeling approaches and models
- Databases
- Statistical analysis of patterns and relationships

Implementation Products

- Guidance for environmental flow criteria
- Appropriate application of tools, databases and models
- Prioritize knowledge gaps for funding
- Interpretation tools
- Communication approaches
- Ways to reconcile different approaches

CA Environmental Flows Workgroup Members

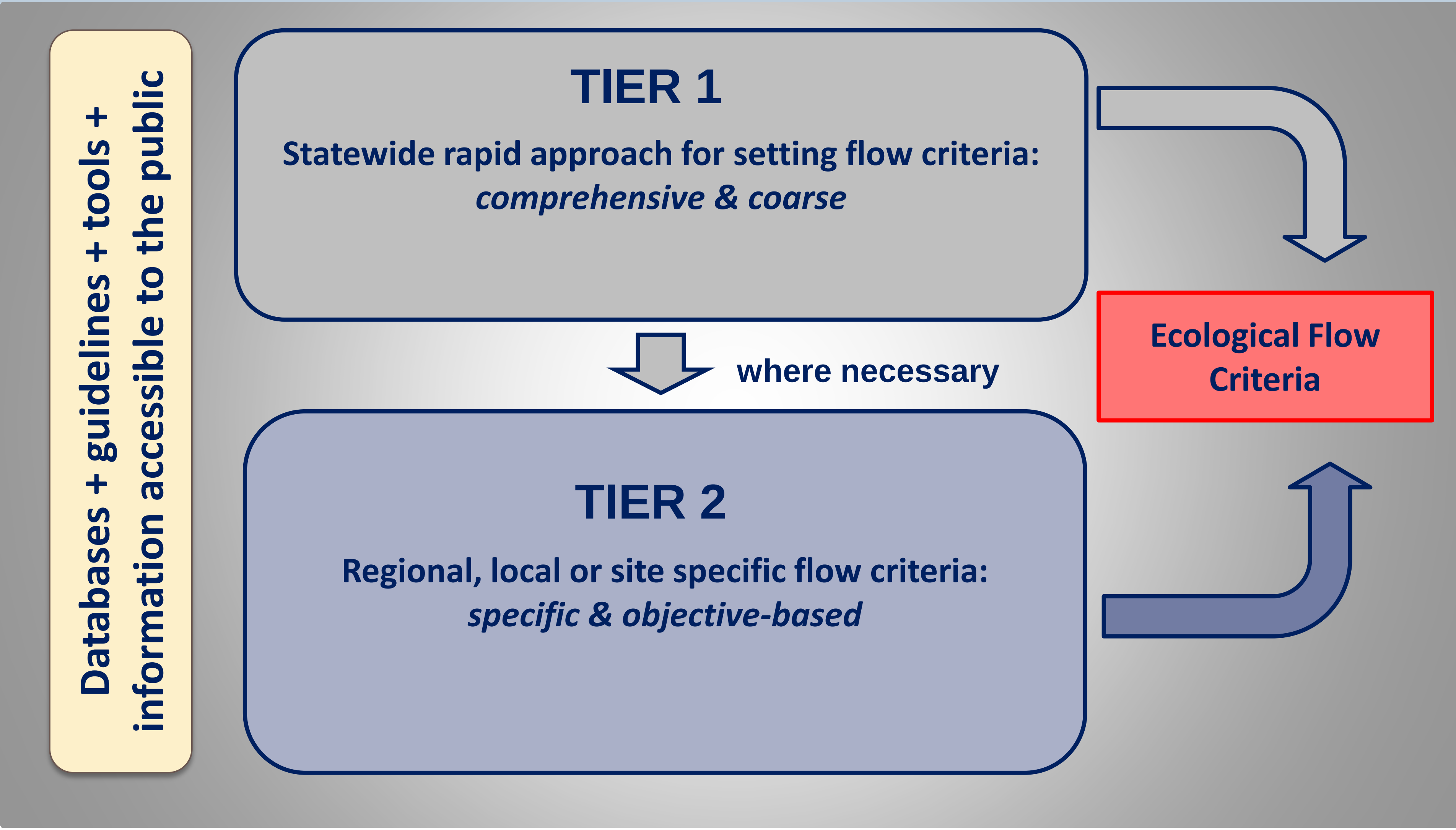
Technical Participants

- University of California, Davis
- University of California, Berkeley
- University of California Agriculture and Natural Resources
- Utah State University
- Southern California Coastal Water Research Project
- The Nature Conservancy
- California Trout
- US Geological Survey

Agency Members

- State Water Board - Water Quality
- State Water Board - Water Rights
- Department of Water Resources
- California Department of Fish and Wildlife
- US Fish and Wildlife Service
- US Forest Service
- US Geological Survey
- Regional Water Quality Control Boards
- Bureau of Reclamation
- NOAA Fisheries

California Environmental Flows Framework (CEEF)



California Environmental Flows Framework (CEEF) – Tier 1

TIER 1

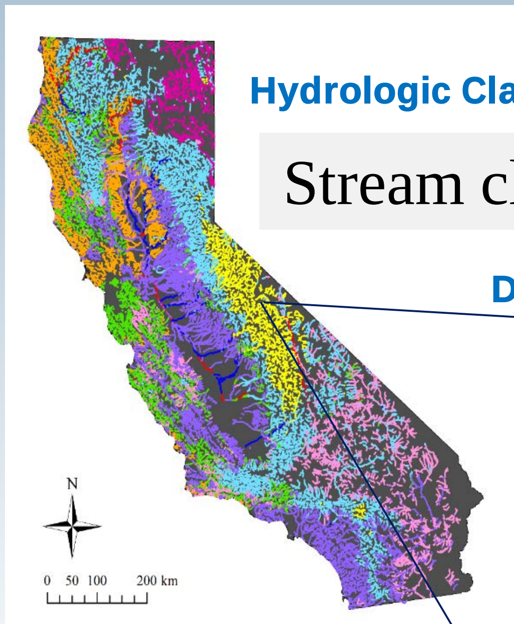
Statewide rapid approach for setting flow criteria:
comprehensive & coarse

Ecological Flow Criteria

Provide tools to establish "flow criteria" ranges for any stream reach in California

- Define a natural stream classification
- Develop dimensionless reference hydrographs
- Estimate functional flow metrics
- Predict flow metrics at all stream segments
- Flow metric ranges at locations of interest

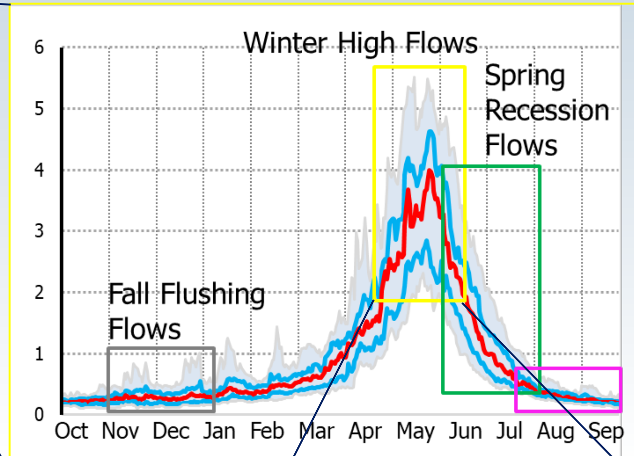
CEFF Tier 1



Hydrologic Classification

Stream classes

Dimensionless Reference Hydrographs



Functional flow components

Functional Flows Calculator

Flow Characteristics	Fall Flush	Winter Floods	Spring Recession	Summer Baseflow
Magnitude	X	X	X	X
Timing	X	X	X	X
Duration		X	X	X
Frequency		X		
Rate of Change			X	X

Functional flow metrics

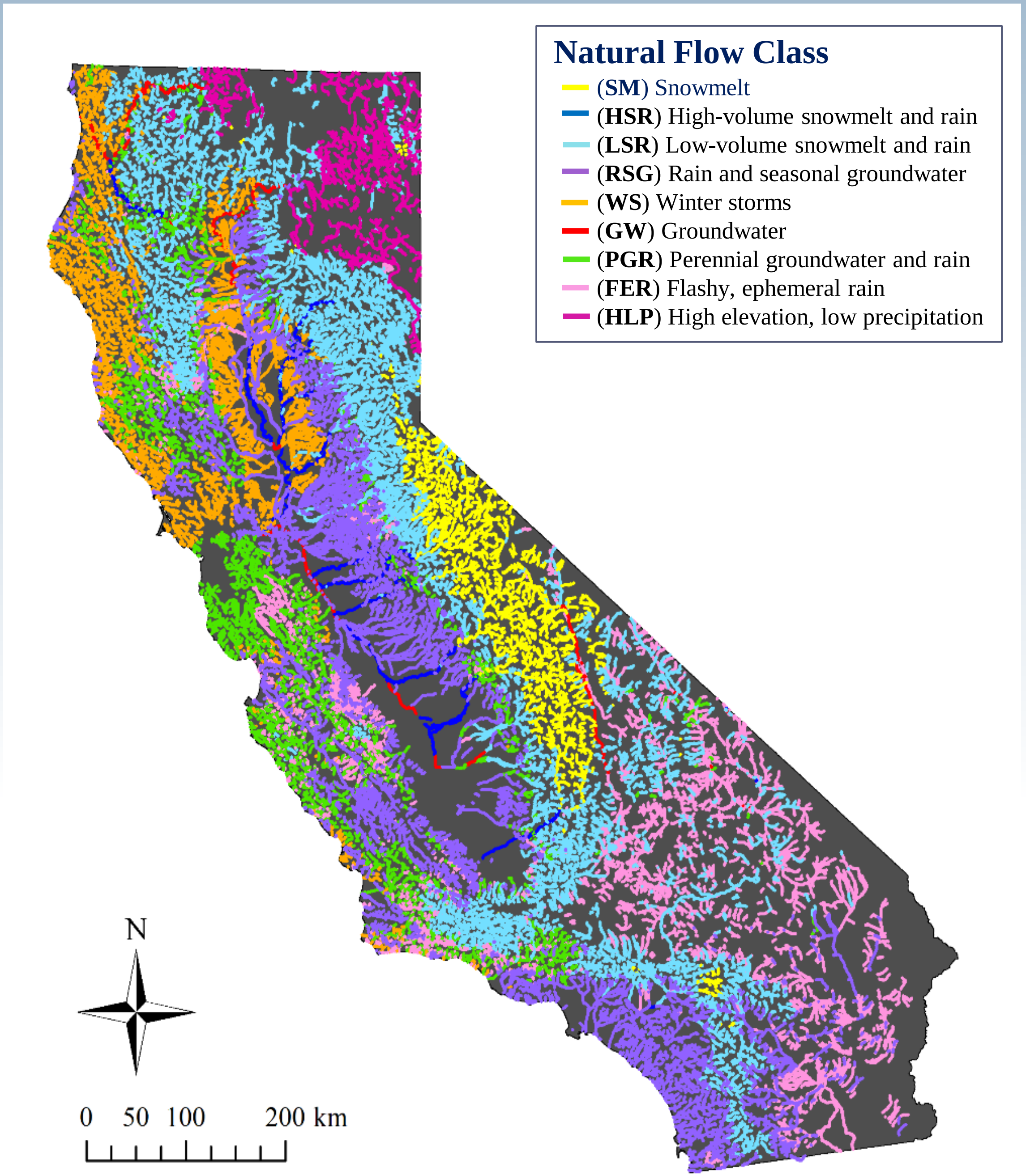
Stream Classification

Catchment Properties

Rainfall Patterns

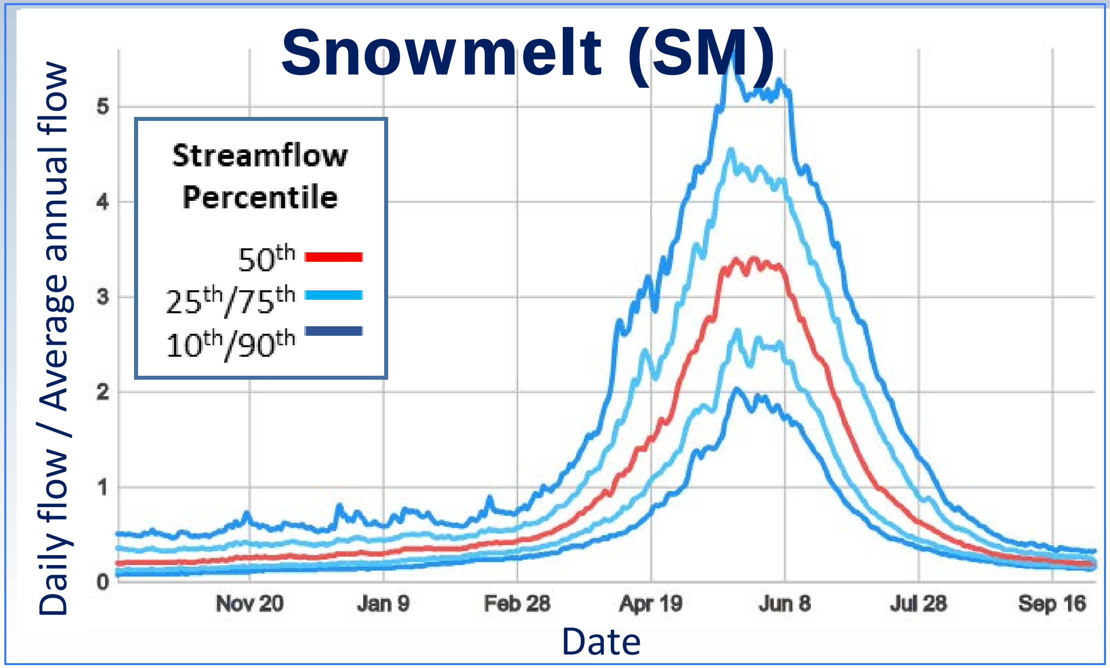
Geology

Soil Properties



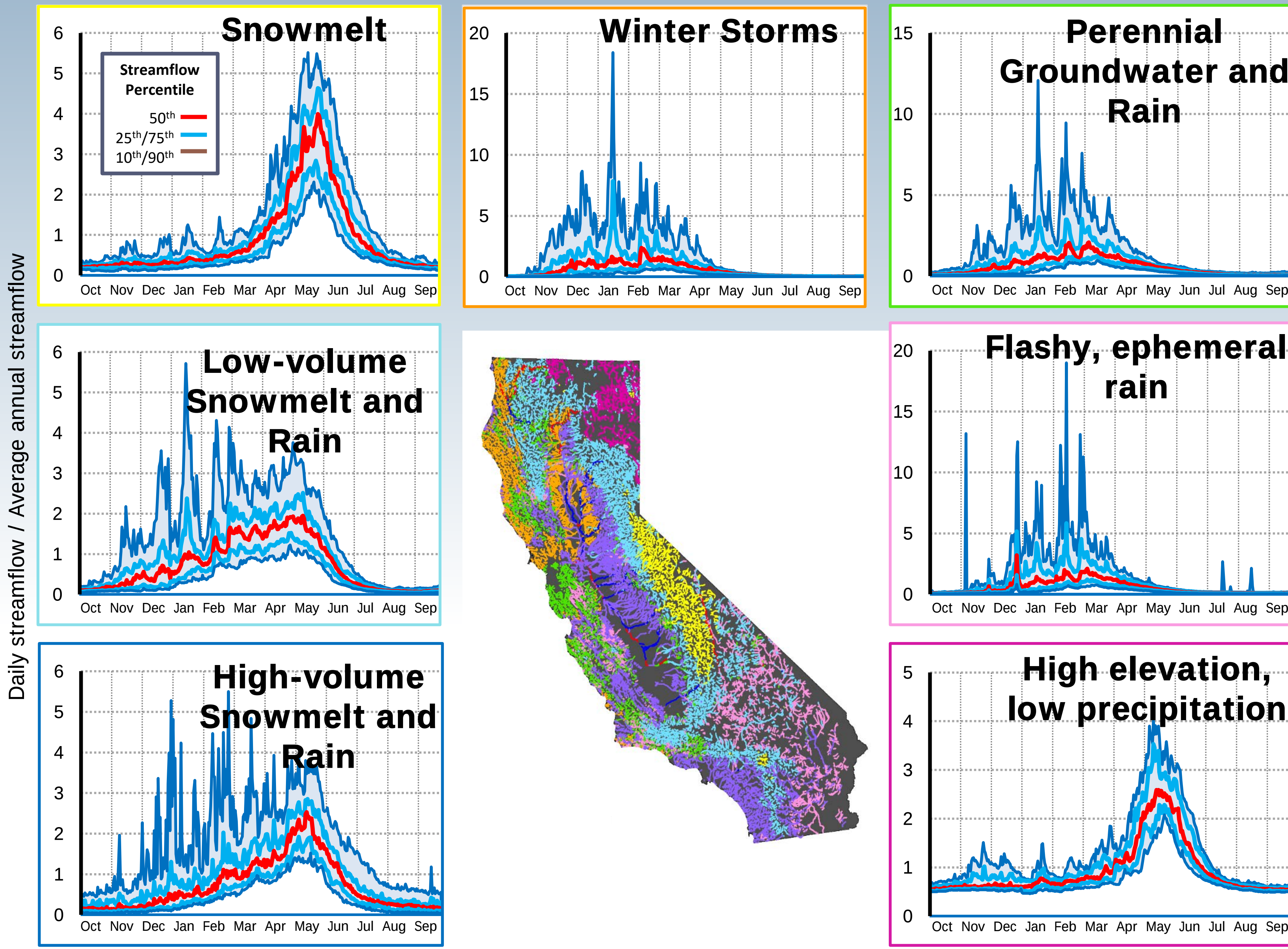
Lane et al., 2018 *in revision*

Dimensionless Reference Hydrographs (DRHs)

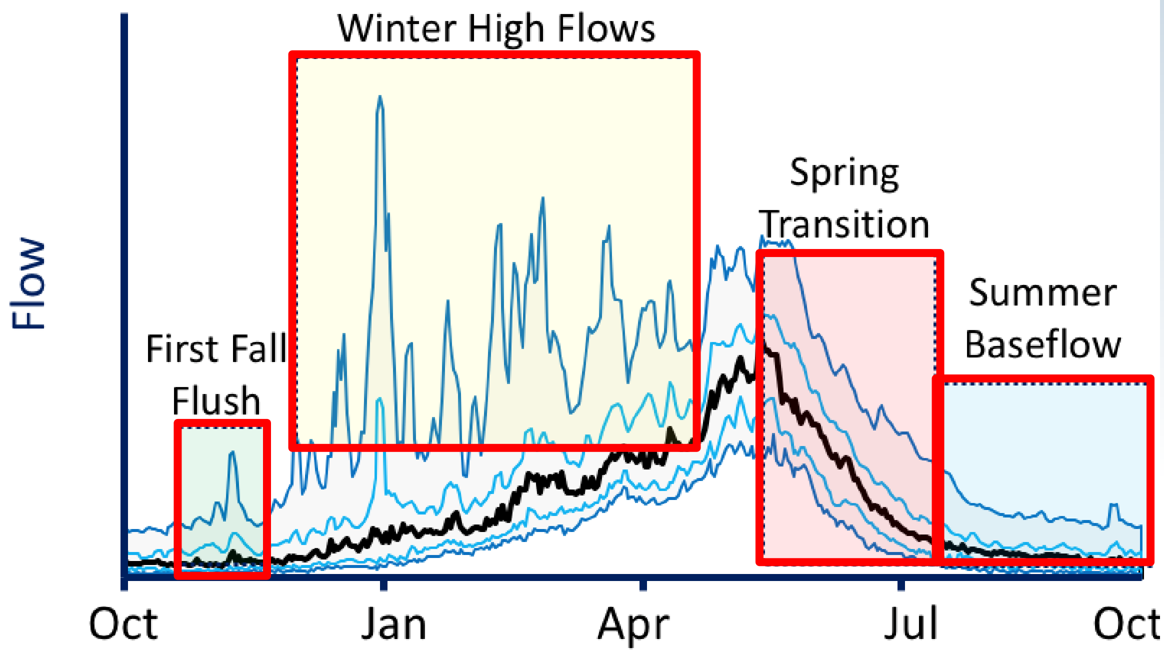


Purpose:
To characterize comparable seasonal and inter-annual flow patterns for each stream class.

Methods:
For each reference gage in a stream class, divide daily flow values by water year average annual flow. Calculate nondimensional flow percentiles for each date across all gauges and years.


Daily streamflow / Average annual streamflow
Snowmelt
Streamflow Percentile
50th
25th/75th
10th/90th
Winter Storms
Perennial Groundwater and Rain
Low-volume Snowmelt and Rain
Flashy, ephemeral rain
High-volume Snowmelt and Rain
High elevation, low precipitation
Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep

Functional Flow Components

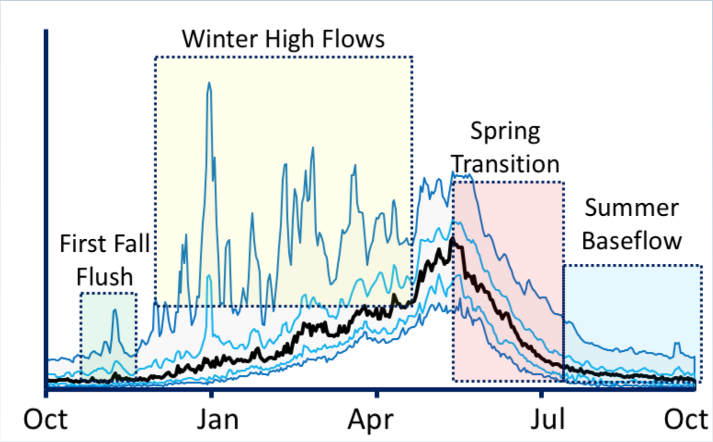


Constrain habitat,
limiting for exotic species

Sub-annual aspects of the natural flow regime expected to support key ecosystem functions

Yarnell et al. 2015

Functional Flow Metrics



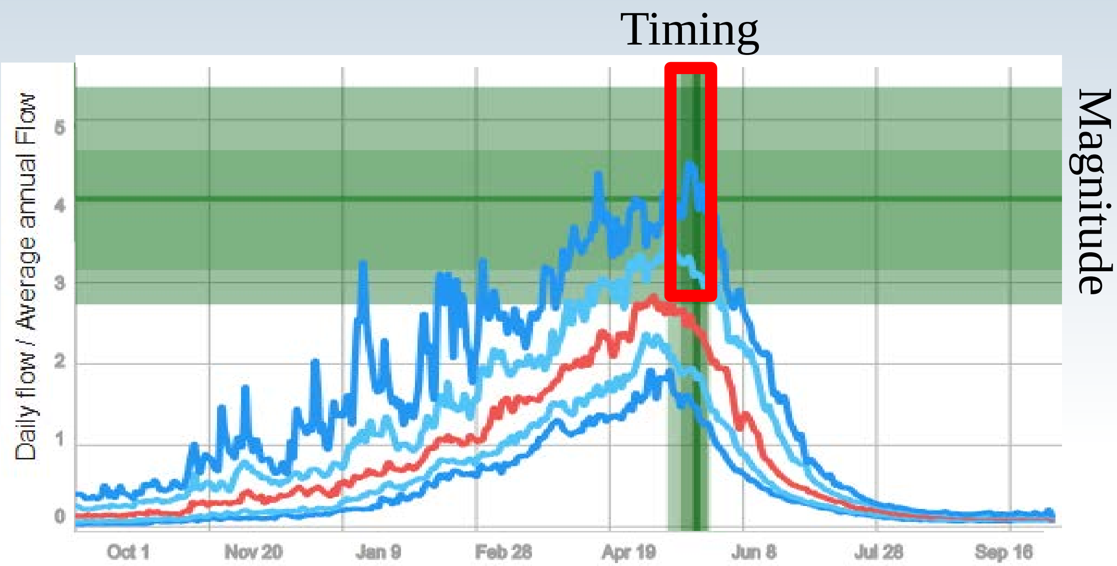
Flow Component	Flow Characteristic	Metric
Annual	Rate of change (%)	coeff. of variation of daily flow
	Average (cfs)	average annual daily flow
First Fall Flush	Magnitude (cfs)	magnitude of first fall flush
	Timing (date)	start date of first fall flush
	Duration (days)	duration of first fall flush
Winter High Flows	Timing (date)	start of wet season
	Magnitude (cfs)	wet season average baseflow
	Magnitude (cfs)	peak magnitude: 2%, 5%, 10%, 20%, 50%
	Timing (date)	start date: 2%, 5%, 10%, 20%, 50%
	Duration (days)	# days: 2%, 5%, 10%, 20%, 50%
	Frequency (#)	# of events in record: 2%, 5%, 10%, 20%, 50%
Spring Transition	Magnitude (cfs)	flow at start (spring peak)
	Rate of change (%)	percent decrease per day
	Timing (date)	start date
	Duration (days)	# days (start-end)
Summer Baseflow	Magnitude (cfs)	baseflow magnitude (10P and 50P)
	Timing (date)	start date of summer
	Duration (days)	# days (start-wet) and (start to first fall flush)
	Frequency (#)	# of no flow days

Metrics not related to any specific organism.

Metrics relate to general health based on *reference conditions*

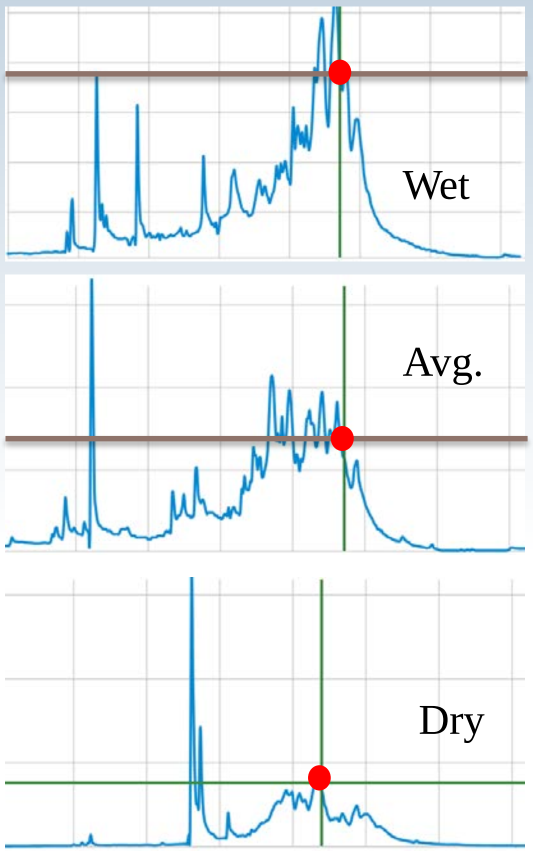
Functional Flows Calculator (FFC)

Stream Class: Low-volume Snowmelt and Rain
Functional Flow Component: Spring Transition
Functional Flow Metrics: Start timing, magnitude



Start Date: May 11 – May 27
Start Magnitude: 2,028 – 4,880 cfs

Water Year Type



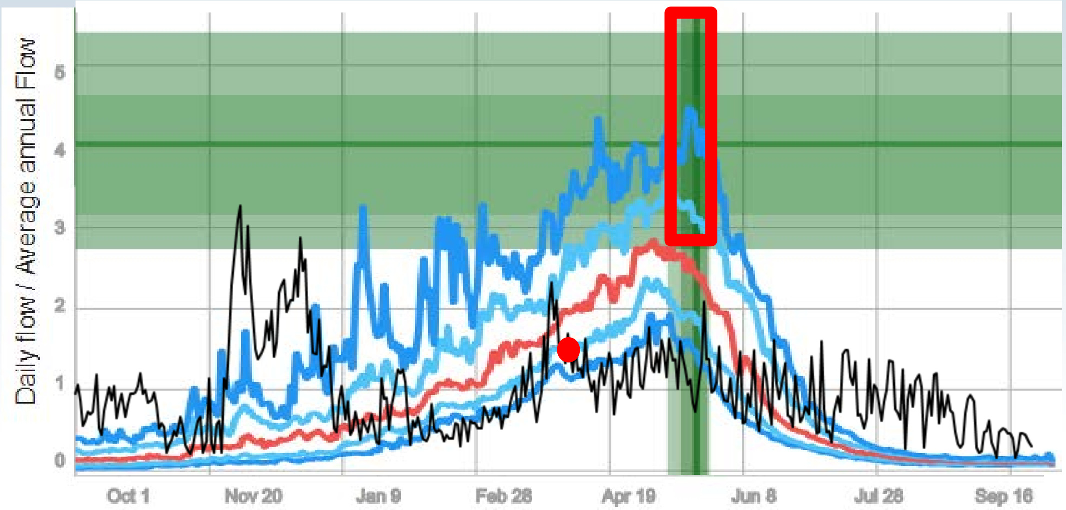
How Do I Use These Numbers?

SF American River

2013 water year

Stream Class: Low-volume Snowmelt and Rain
Functional Flow Component: Spring Transition
Functional Flow Metrics: Start timing, magnitude

Hydropower Effects



Apr 1 << too early

1,250 cfs << too low

Start Date: May 11 – May 27
Start Magnitude: 2,028 – 4,880 cfs

At my site, where do I fall compared to reference ranges?

For this reach in this year, the flows are <u>too low</u> and start <u>too early</u>

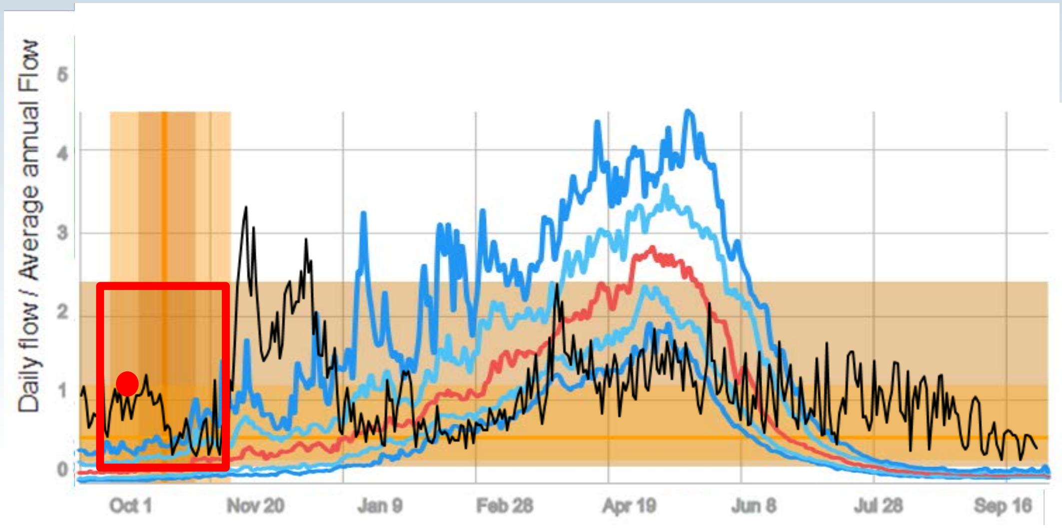
How Do I Use These Numbers?

SF American River

2013 water year

Stream Class: Low-volume Snowmelt and Rain
Functional Flow Component: Fall Flush

Hydropower Effects



Oct 13 == **meets target**

796 cfs == **meets target**

Start Date: Oct 5 – Nov 22
Peak Magnitude: 422 – 857 cfs

At my site, where do I fall compared to reference ranges?

For this reach in this year, the flows achieve functional flow targets

California Environmental Flows Framework (CEEF) – Tier 2

TIER 2

Regional, local or site specific flow criteria:
specific & objective-based

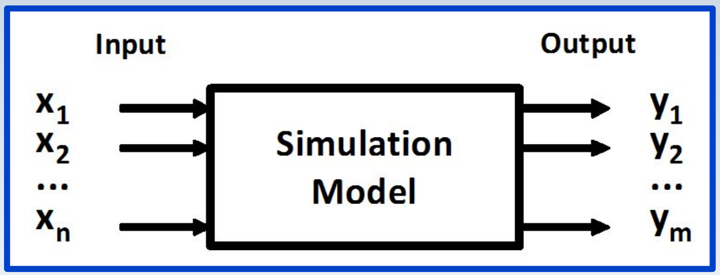
Provide a framework for developing watershed or regional flow criteria based on local needs/issues

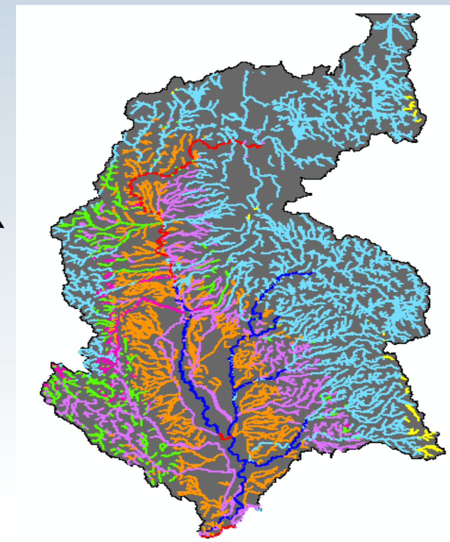
- Define context and objectives:
  spatial-temporal scale, ecological endpoints, hydrologic conditions, water management system
- Characterize and compile data
- Select appropriate E-flow method
- Consider Policy and Management Needs:
  balance objectives, implementation, monitoring, adaptive management

Ecological Flow Criteria

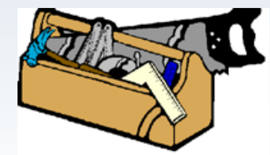
Incorporate Local Data

Hydrology

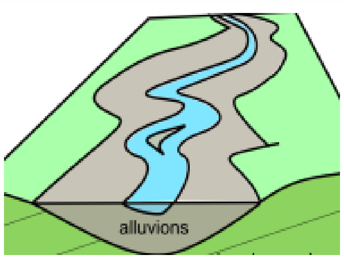




Reach scale environmental flow methods



Geomorphology



Ecology

Flow targets

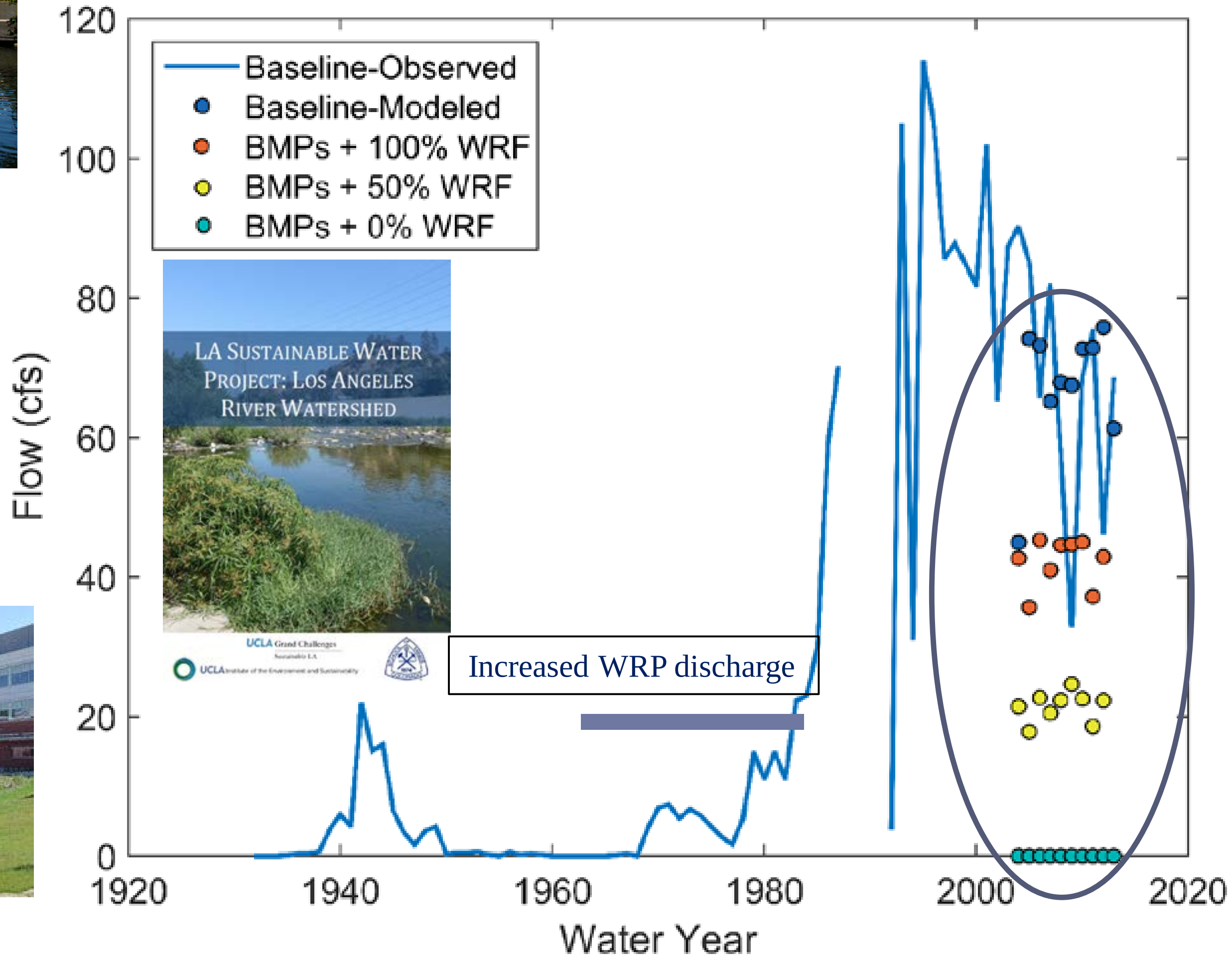
Tier 2 Products
by late 2020

- Baseline characterization of hydrologic alteration
- Geomorphic classification – flow, form function approach
- List of ecological endpoints for each stream class
- Flow-ecology relationships and suggested metrics
  - ***Will NOT produce specific criteria***
- ***Guidance document for how to produce regional or watershed scale flow criteria***
- Case study examples

S. CA (Tier 2) Case Study:

Criteria related to wastewater and stormwater management

Annual minimum flows at Glendale Narrows



LAR Case Study: Overall Objective

Develop and implement an approach to balance reuse of treated wastewater with protecting beneficial uses affected by treated wastewater discharges

- ✓ Prototype for consideration of establishing environmental flows in urban (effluent dominated) systems
- ✓ Case study for implementation of Tier 2 of statewide framework

Potential Participants

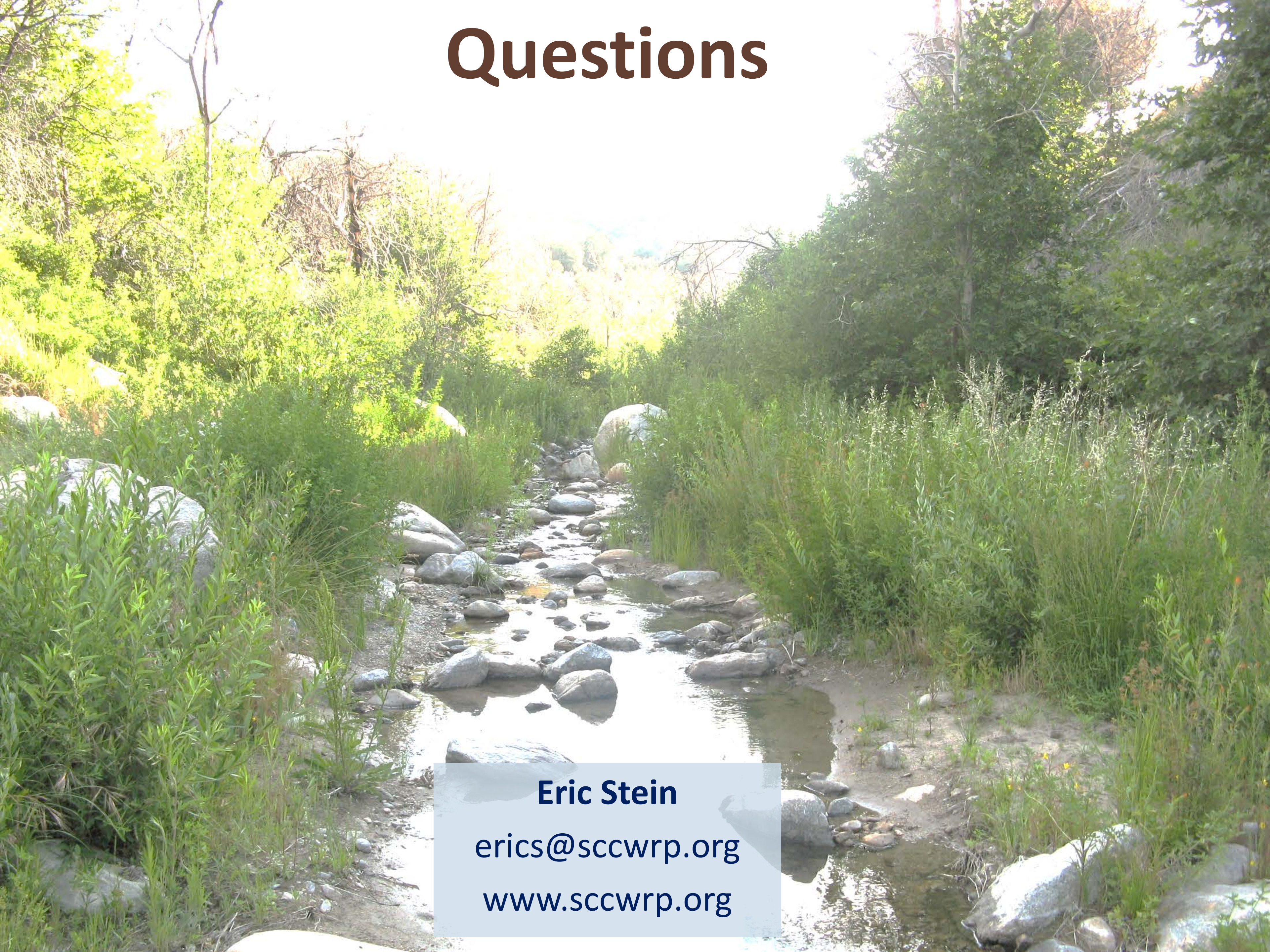
State Water Board
LA Regional Water Board
City of Los Angeles
LA County Public Works
LA County Sanitation Districts
City of Burbank
City of Glendale
UCLA
Colorado School of Mines

Outcomes/Products

- Evaluation of risks & benefits to key ecological endpoints associated with flow modification
- Set of acceptable ranges for flow/depth and wetted area to protect beneficial uses
  - Representative of all ecologically relevant flows
- Process of evaluating tradeoffs in management actions
  - Balance “restoration” vs. “flow management”

These products will provide the information necessary for Division of Water Rights to develop a LA River Instream Flow Policy

Questions



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