Introducing the

California Environmental Flows Framework

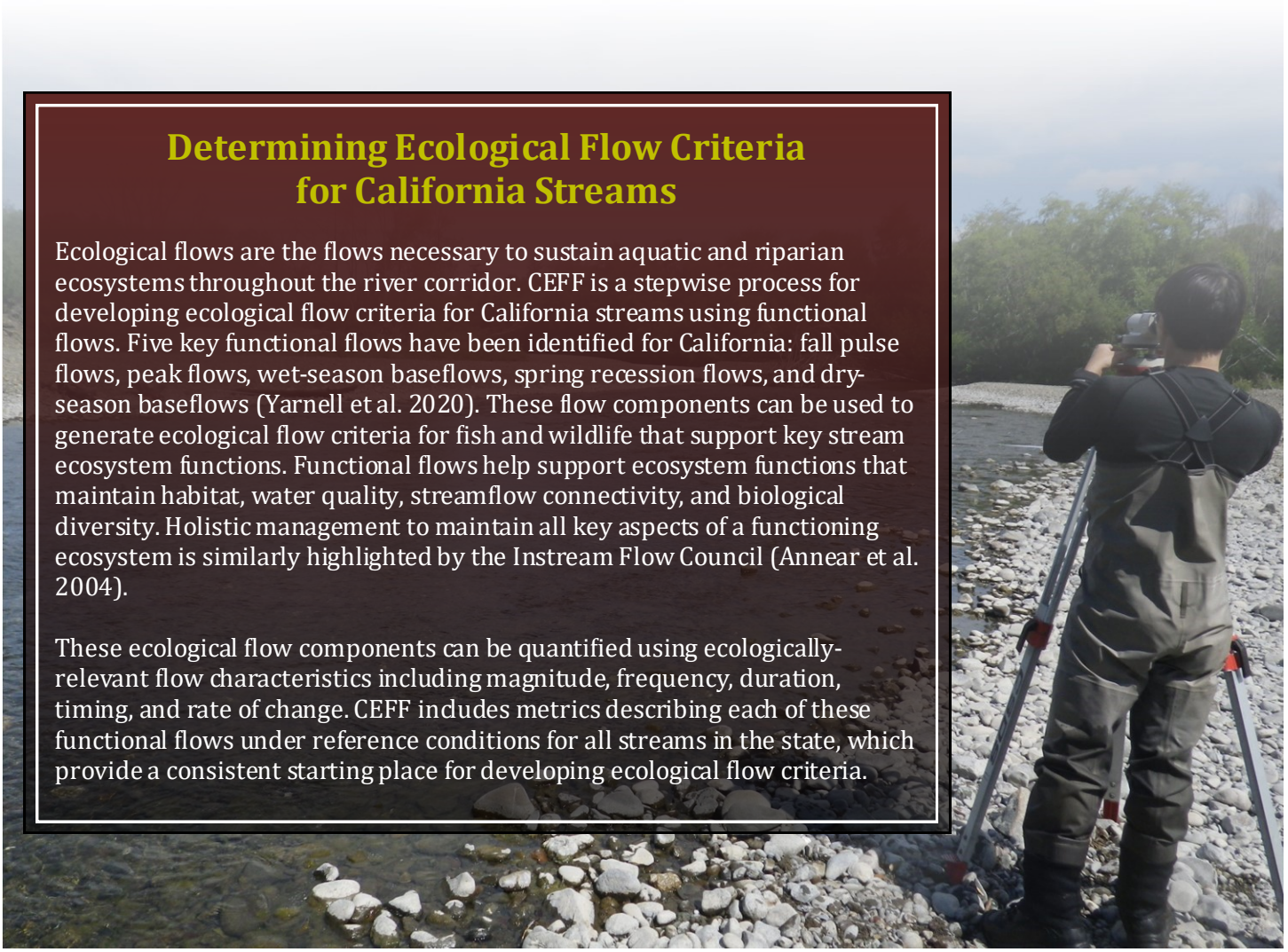
The California Environmental Flows Framework (CEFF) is a statewide approach for determining ecological flow criteria. CEFF provides a consistent and defensible approach to identifying ecological flow needs for California's rivers and streams. CEFF is being developed by the Environmental Flows Technical Workgroup (eFlows TWG), a subgroup of the California Water Quality Monitoring Council. The central goal of the eFlows TWG is improved coordination, collaboration, and data sharing among agencies, nonprofits, and other parties interested in instream flows. The eFlows TWG meets quarterly at the State Water Resources Control Board in Sacramento, California.

CALIFORNIA WATER QUALITY MONITORING COUNCIL

Determining Ecological Flow Criteria for California Streams

Ecological flows are the flows necessary to sustain aquatic and riparian ecosystems throughout the river corridor. CEFF is a stepwise process for developing ecological flow criteria for California streams using functional flows. Five key functional flows have been identified for California: fall pulse flows, peak flows, wet-season baseflows, spring recession flows, and dry-season baseflows (Yarnell et al. 2020). These flow components can be used to generate ecological flow criteria for fish and wildlife that support key stream ecosystem functions. Functional flows help support ecosystem functions that maintain habitat, water quality, streamflow connectivity, and biological diversity. Holistic management to maintain all key aspects of a functioning ecosystem is similarly highlighted by the Instream Flow Council (Annear et al. 2004).

These ecological flow components can be quantified using ecologically-relevant flow characteristics including magnitude, frequency, duration, timing, and rate of change. CEFF includes metrics describing each of these functional flows under reference conditions for all streams in the state, which provide a consistent starting place for developing ecological flow criteria.

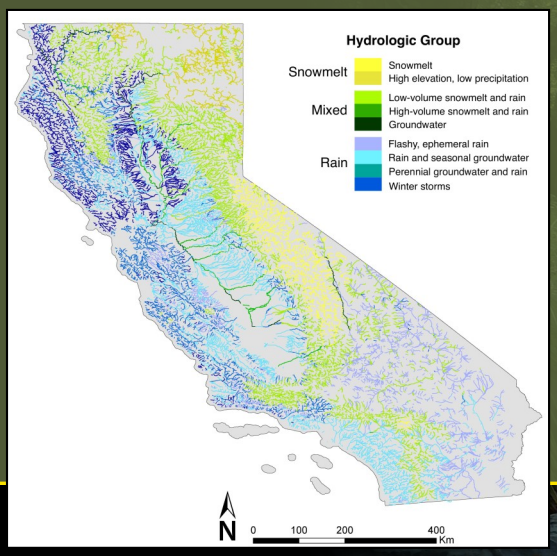


The California Environmental Flows Framework

CEFF uses functional flow components to represent distinct aspects of the natural flow regime that support geomorphic or biogeochemical functions. Natural flow patterns vary across both space and time, creating the regional, intra– and interannual flow variability that native species are adapted to. Once complete, CEFF will provide users with a framework to use for quantifying instream flow needs consistently statewide using tools supported by published literature. The boxes that follow represent tools used in CEFF for developing ecological flow criteria.

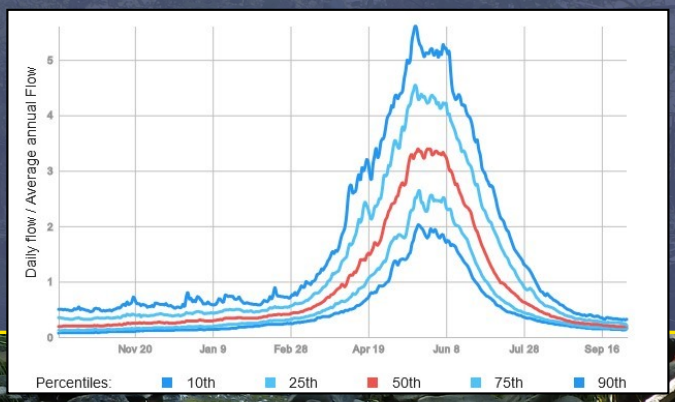
STREAM CLASSIFICATION

(Lane et al. 2018): Nine hydrologically based classes of stream reach types spanning California: snowmelt; high-volume snowmelt and rain; low-volume snowmelt and rain; rain and seasonal groundwater; winter storms; groundwater; perennial groundwater and rain; flashy ephemeral rain; and high elevation low precipitation.



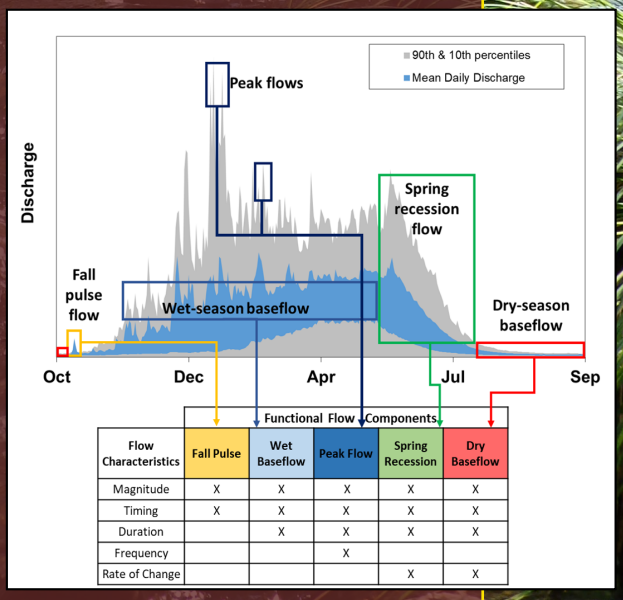
DIMENSIONLESS REFERENCE HYDROGRAPHS

(DRH; Lane et al. 2018): Scalable representations of reference hydrology based on unimpaired streamflow data of 223 reference gages. A DRH graphically shows the flow signature and the intra- and interannual variability of each of the nine stream classes (*Low-volume snowmelt and rain* stream class shown).



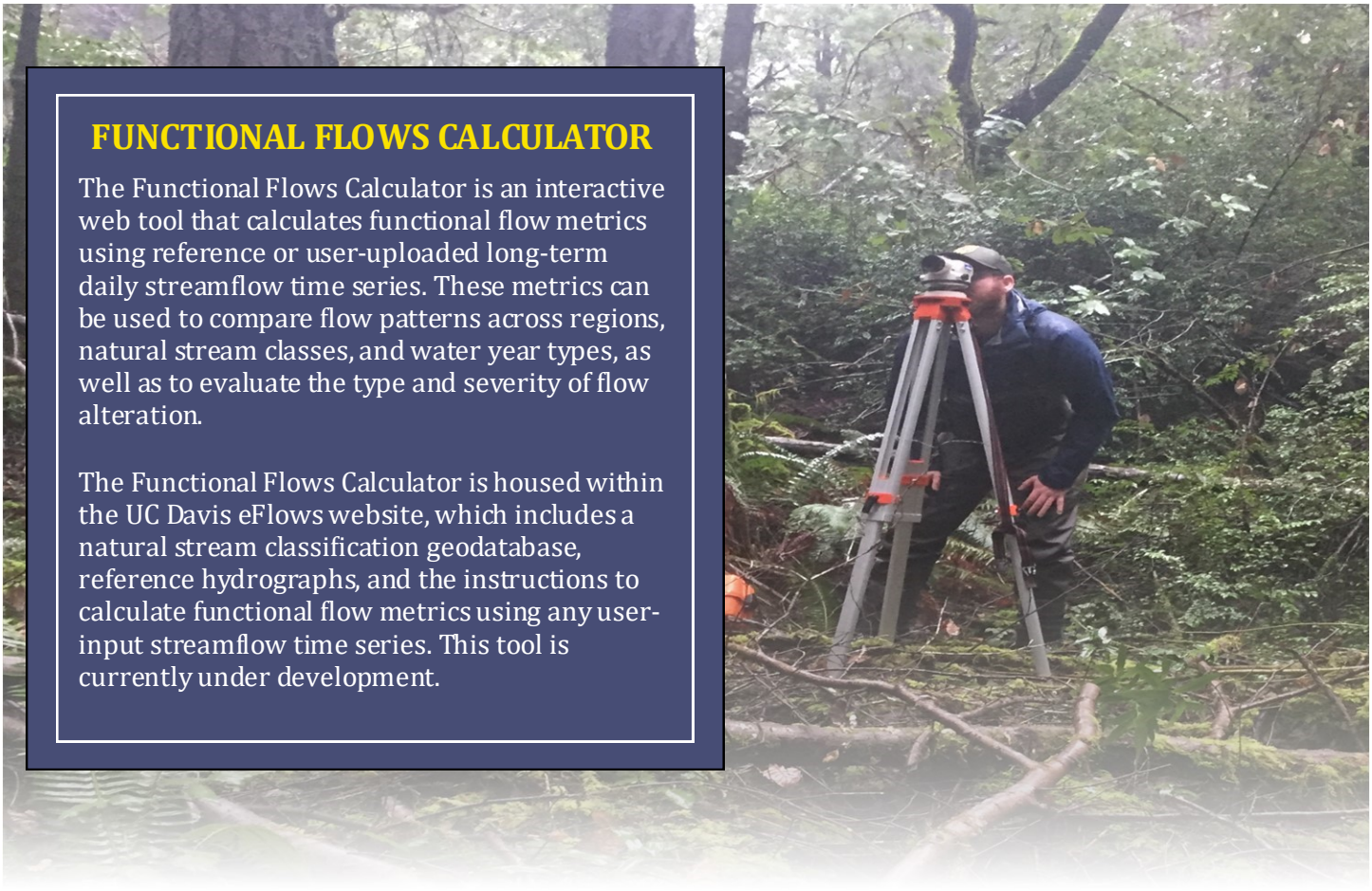
FUNCTIONAL FLOW COMPONENTS

(Yarnell et al. 2015; Yarnell et al. 2020): Elements of the natural flow regime hypothesized to support important ecosystem processes and functions. Five functional flow components have been identified for California: fall pulse flows; wet-season baseflows; wet-season peak flows; spring recession flows; and dry-season baseflows. Each functional flow component can be quantified using flow metrics that measure ecologically-relevant flow characteristics (i.e., magnitude, frequency, duration, timing, rate of change). Functional flow metrics under reference conditions have been estimated for every reach in the state using models trained on the set of reference gages and are available on the California Natural Flows Database website.



Functional Flow Components

Flow Characteristics	Fall Pulse	Wet Baseflow	Peak Flow	Spring Recession	Dry Baseflow
Magnitude	X	X	X	X	X
Timing	X	X	X	X	X
Duration		X	X	X	X
Frequency			X		
Rate of Change				X	X



FUNCTIONAL FLOWS CALCULATOR

The Functional Flows Calculator is an interactive web tool that calculates functional flow metrics using reference or user-uploaded long-term daily streamflow time series. These metrics can be used to compare flow patterns across regions, natural stream classes, and water year types, as well as to evaluate the type and severity of flow alteration.

The Functional Flows Calculator is housed within the UC Davis eFlows website, which includes a natural stream classification geodatabase, reference hydrographs, and the instructions to calculate functional flow metrics using any user-input streamflow time series. This tool is currently under development.

The Framework in Action

Additional information on developing ecological flow criteria using CEFF will be available soon as part of the CEFF Guidance Document. Staff at the California Department of Fish and Wildlife and other State agencies may have use for flow criteria developed using CEFF for tasks including:

- Permitting
- Water rights
- Bypass flows
- Water availability
- Surface water/groundwater interconnectivity
- Grant projects
- Stream condition assessments
- Restoration

Department staff representing a variety of public trust interests (i.e., water, groundwater, fisheries, cannabis regulation) are participating in the development and implementation of CEFF via the eFlows TWG. The primary partners developing CEFF in collaboration with the eFlows TWG are:

Berkeley UNIVERSITY OF CALIFORNIA

University of California Agriculture and Natural Resources

The Nature Conservancy

UC DAVIS UNIVERSITY OF CALIFORNIA

USGS science for a changing world

California Water Boards

California Department of Fish & Wildlife

Utah State University

SCCWRP Established 1969

California Water Quality Monitoring Council

The Framework Report Card

CEFF meets several important California Department of Fish and Wildlife instream flow objectives.

Instream Flow Objectives	Met?
Forms a partnership under the California Water Quality Monitoring Council	✓
Provides ecological flow criteria	✓
Is supported by published literature and defensible	✓
Takes a rapid assessment approach based on reference hydrologic data	✓
Incorporates water availability (i.e., dry, moderate, wet seasons)	✓
Applies statewide	✓

How Can I Learn More?

For more information, please visit:

https://ceff.ucdavis.edu:
Framework overview

https://eflows.ucdavis.edu:
Functional flows calculator; statewide hydrological, geomorphic, and ecological conditions

https://rivers.codefornature.org:
Estimates of monthly natural flows and predicted functional flow metrics

You may also contact Brionna Drescher, California Department of Fish and Wildlife Statewide Instream Flow Coordinator: brionna.drescher@wildlife.ca.gov.

STATEWIDE WATER PLANNING PROGRAM
CALIFORNIA DEPARTMENT OF FISH & WILDLIFE
Water Rights
Instream Flow
Groundwater

Literature Cited

Annear, T., I. Chisholm, H. Beecher, A. Locke, and 12 other coauthors. 2004. Instream Flows for Riverine Resource Stewardship, Revised Edition. Instream Flow Council, Cheyenne, Wyoming.

California Environmental Flows Framework Technical Team. 2020. The California Environmental Flows Framework website. http://ceff.ucdavis.edu.

Lane, B. A., S. Sandoval-Solis, E. D. Stein, S. M. Yarnell, G.B. Pasternack, and H. E. Dahlke. 2018. Beyond metrics? The role of hydrologic baseline archetypes in environmental water management. Environmental Management. DOI: 10.1007/s00267-018-1077-7.

Yarnell, S. M., G. E. Petts, J. C. Schmidt, A. A. Whipple, E. E. Beller, C. N. Dahm, P. Goodwin, and J. H. Viers. 2015. Functional Flows in Modified Riverscapes: Hydrographs, Habitats and Opportunities. BioScience 65:963-972.

Yarnell, S. M., E. D. Stein, J. A. Webb, T. Grantham, R. A. Lusardi, J. Zimmerman, R. A. Peek, B. A. Lane, J. Howard and S. Sandoval-Solis. 2020. A functional flows approach to selecting ecologically relevant flow metrics for environmental flow applications. River Research and Applications 36(2): 318-324.