Developing Ecological Flow Criteria in a Highly Altered Region: Application of CEFF in South Orange County

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CEFF Workshop hosted by Cal-SFS

2022 CABW/Cal-SFS Meeting

Need for CEFF Case Studies

- Demonstrate application of CEFF
- Refine process through real world experience
- Create “templates” for broader application
- Build constituency through participation

Case Studies Implementing CEFF

- South OC Flow Ecology Study
- LA River Environmental Flows Study
- Cosumnes River
- Little Shasta River
- South Fork Eel River
- Others

Supplemental Bioassessment Studies: linking functional flow alteration to biological stream condition indices statewide (Peek et al., 2022) and in southern California (Irving et al., 2022)

CEFF Application Highlights

- Highly modified watershed where establishing reference-based flows may be challenging
- Flow modifications are from diffuse non-point sources
- Groundwater may be a significant contributor to summer baseflows

Study Objectives

- Provide demonstration of CEFF in a highly altered system
- Develop ecological flow criteria that consider channel enlargement and are supportive of key ecological management objectives
- Provide example of how changes to channel form can help achieve ecological flow criteria

Ecological Management Objectives

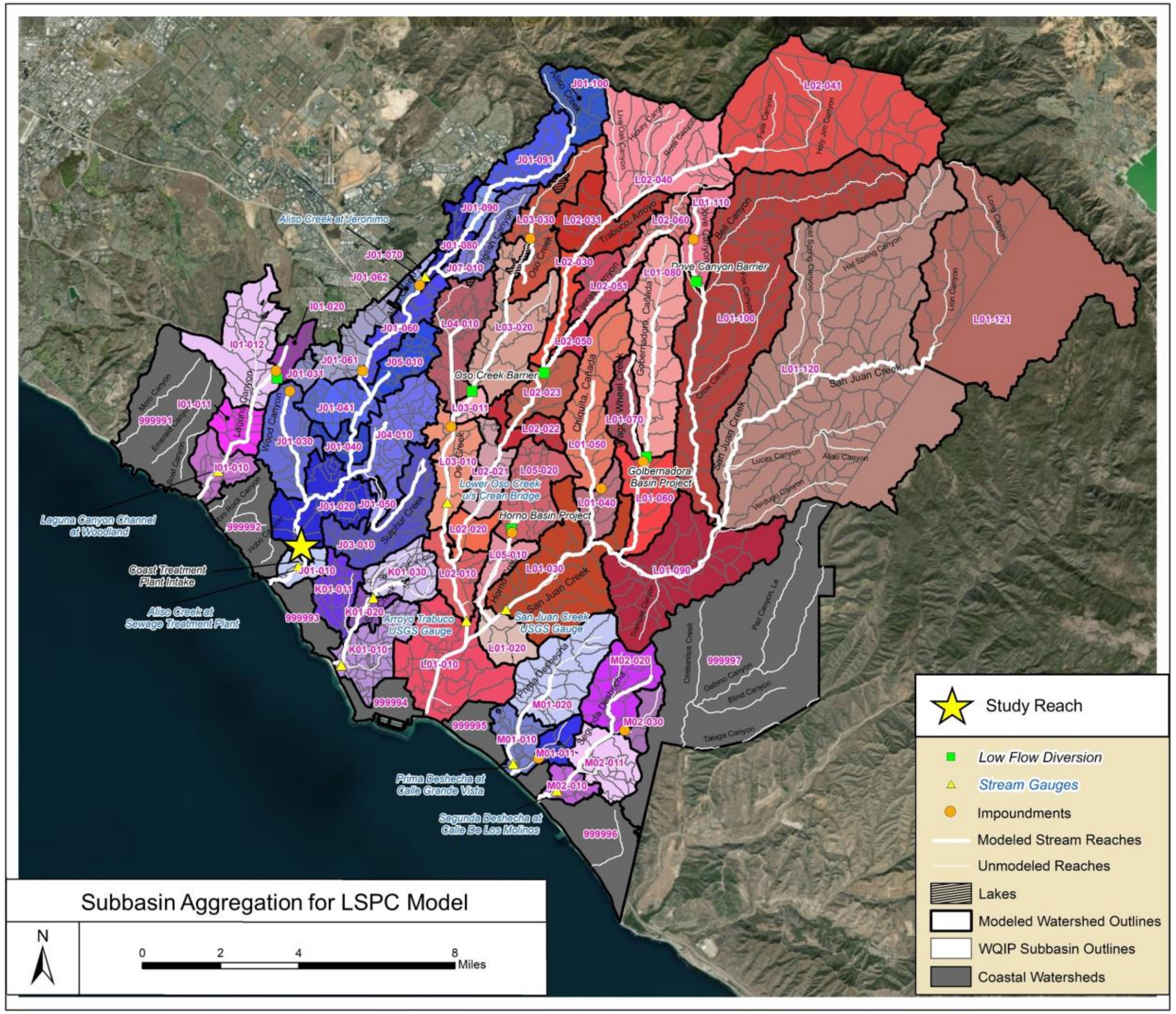
- Improve stream flow conditions to benefit overall stream ecosystem health
- Reduce unnatural flows that favor invasive species
- Provide habitat to support federally endangered least Bell's vireo
- Restore habitat for native fish populations

Study Area

South Orange County, CA
Watershed Management Area

- Focus: Aliso Creek Watershed

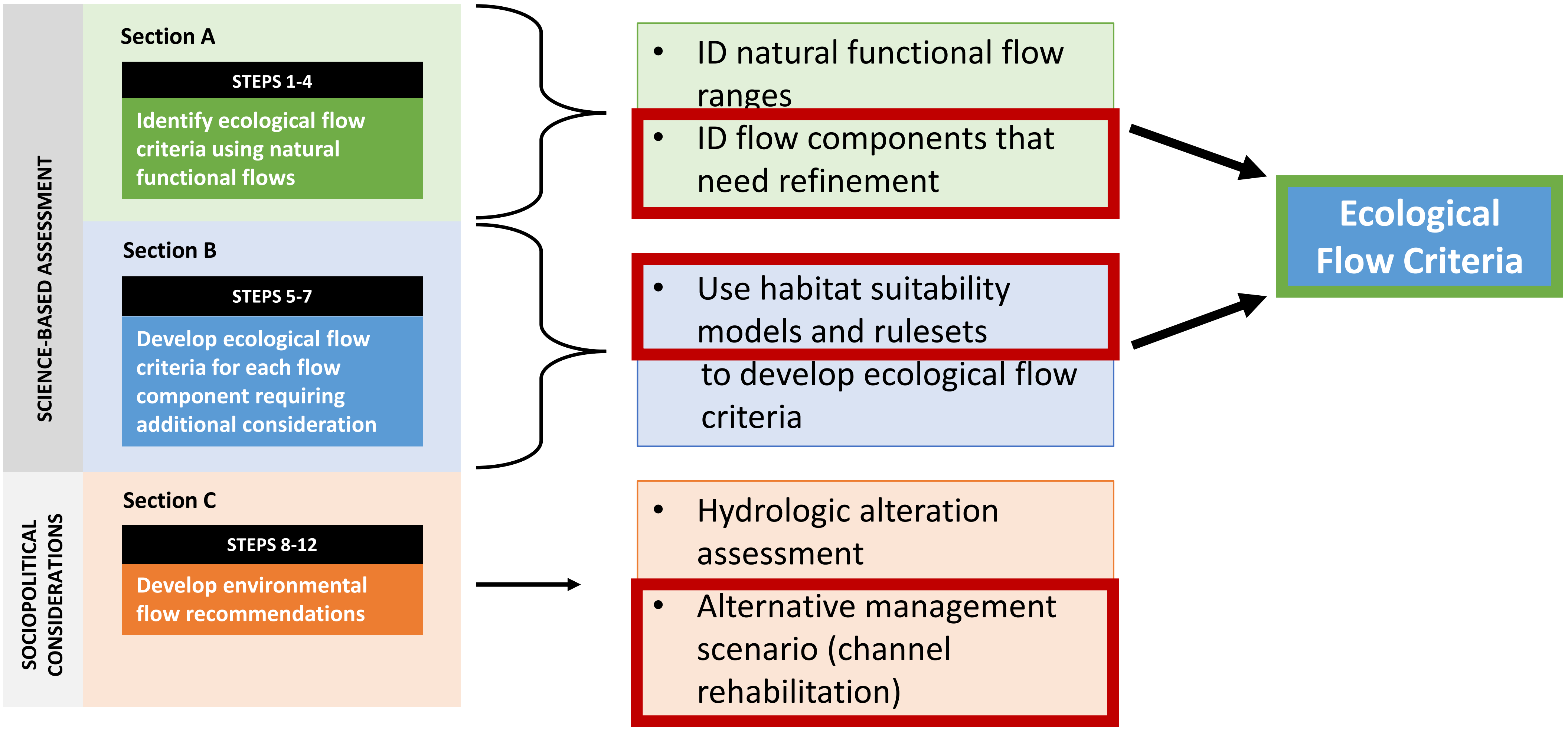
Altered hydrology and channel erosion identified as the highest priority water quality conditions[1]



[1]*South OC Watershed Management Area Water Quality Improvement Plan, 2018*

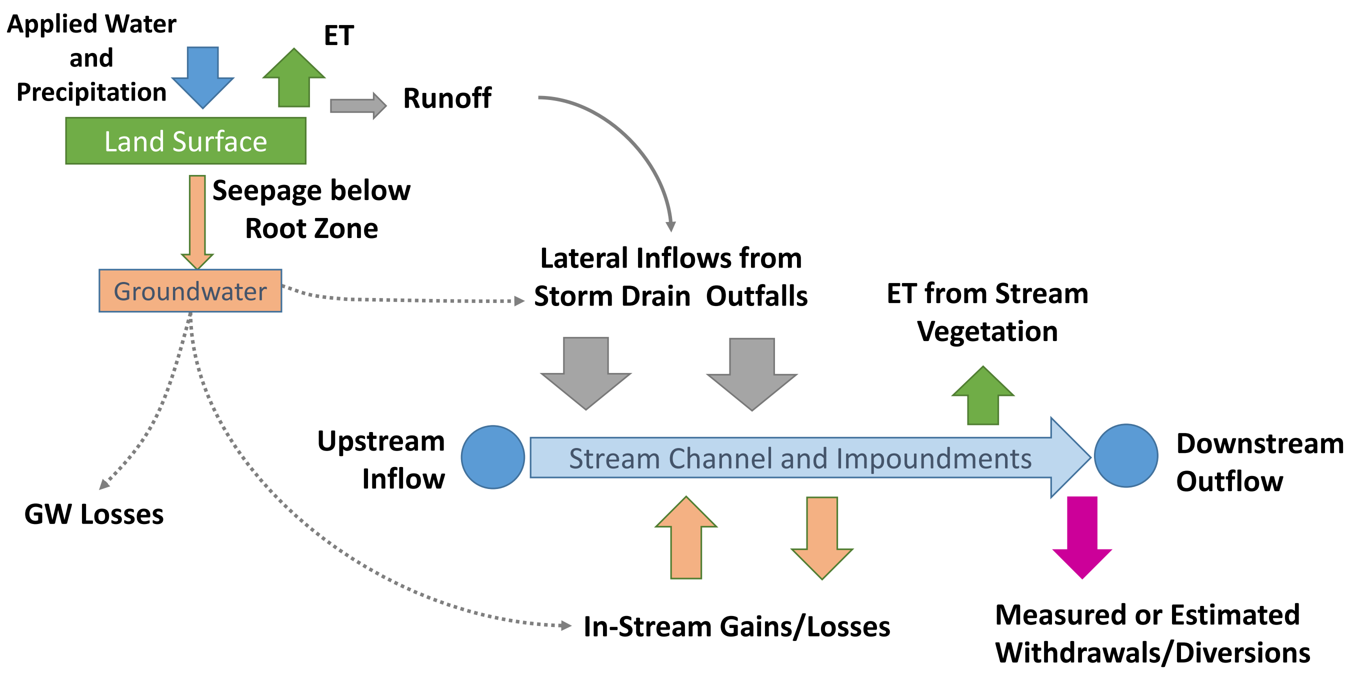
Today's focus

CEFF Application Overview



Hydrologic Modeling

- Utilized isotope analysis to quantify groundwater contribution to summer baseflows (Lai, 2020)
- Developed watershed model that accounts for groundwater inputs



Used Loading Simulation Program in C++

Current condition

- Current land use and flow management measures
- Recent climate: 1990-2019; Recent irrigation patterns: 2010-2019
- Calibrated to streamflow gages, outfall monitoring, and water isotope data

Reference condition

- Remove urban land, irrigated agriculture, diversions, and impoundments
- Same time period

Future scenarios

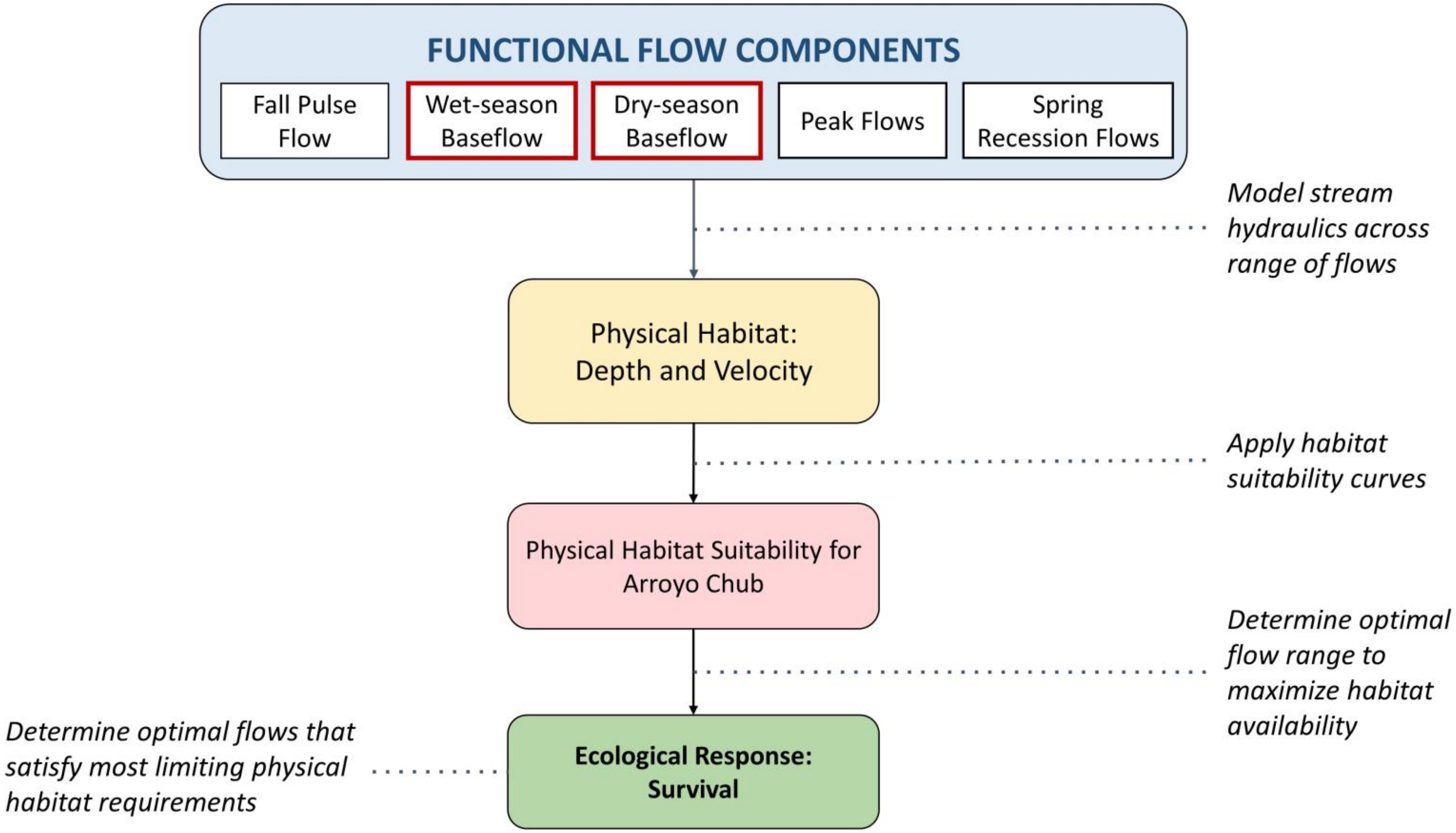
- Climate change at mid-century
- Increased water conservation progress

Non-Flow Limiting Factors

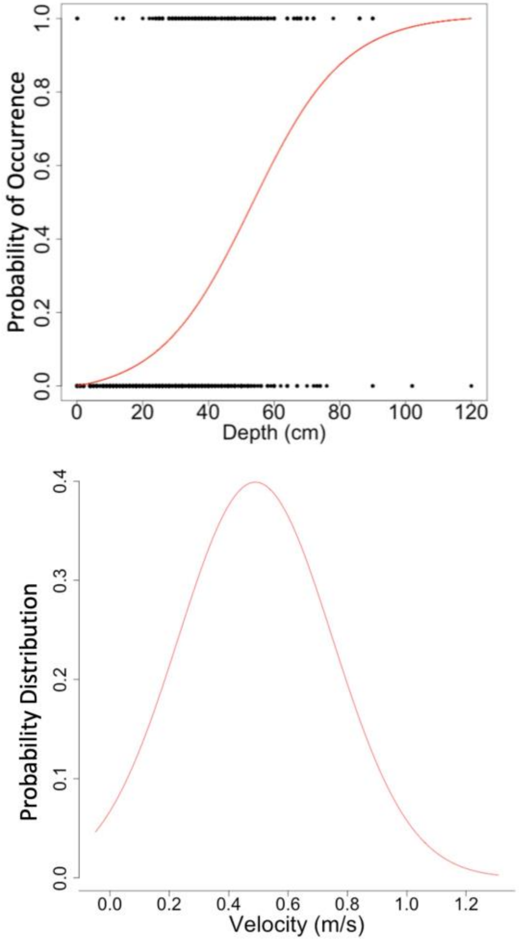
Functional Flow Component	**Potential Limiting Factor**	**Affected Ecosystem Function(s)**
Fall pulse flow	None identified	None
Peak flows	None identified	None
Wet-season baseflow	**Altered channel morphology**	Potential limited habitat availability to support migration, spawning, and residency of aquatic organisms; Potential limited access to shallow groundwater (riparian)
Spring flow recession	**Altered channel morphology**	Potential limited floodplain inundation and hydrologic conditions for riparian species recruitment and seed dispersal
Dry-season baseflow	**Altered channel morphology**	Potential limited habitat availability (i.e., depth) for native aquatic species; Potential limited riparian soil moisture

Section B: Arroyo Chub

Conceptual Model



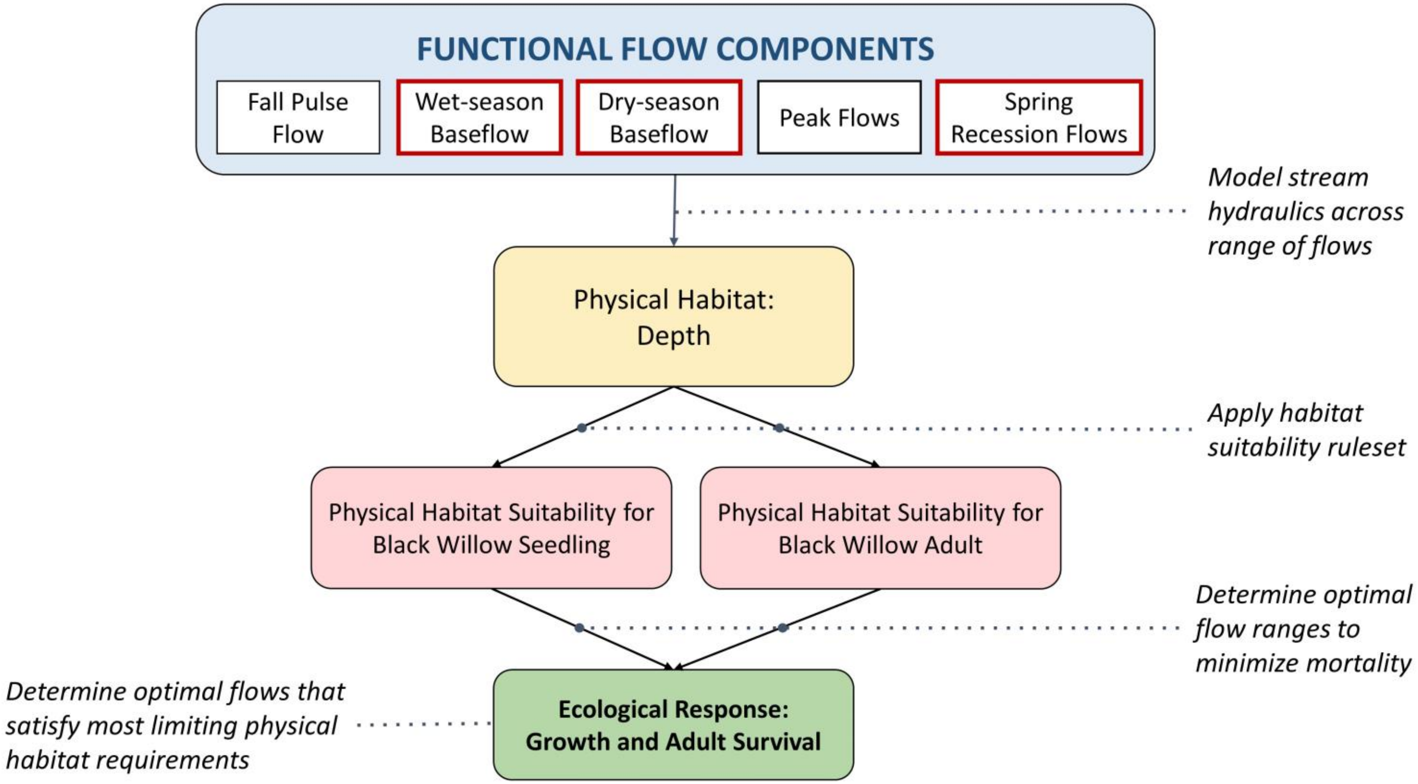
Suitability Curves



Data from Wulff et al. 2017

Section B: Willow

Conceptual Model



Suitability Ruleset

Life Stage	Functional Flow Metric	Lower Limit	Upper limit
Adult	Wet-Season Baseflow Magnitude	Discharge necessary to maintain at least 3 cm depth of flow in the river, under the assumption that roots can reach water table	Maximum flow that would not inundate the overbank area to limit oversaturated soils in the overbanks
	Dry-Season Baseflow Magnitude		
Adult & Seedling	Spring Recession Start Magnitude	Discharge necessary to inundate 10 cm depth in the overbank areas for seed dispersal and to provide soil moisture in the overbanks prior to the start of the dry-season	No upper limit, used the reference 90th percentile if > lower limit (only refined the lower limit to ensure overbank inundation at the start of spring recession)

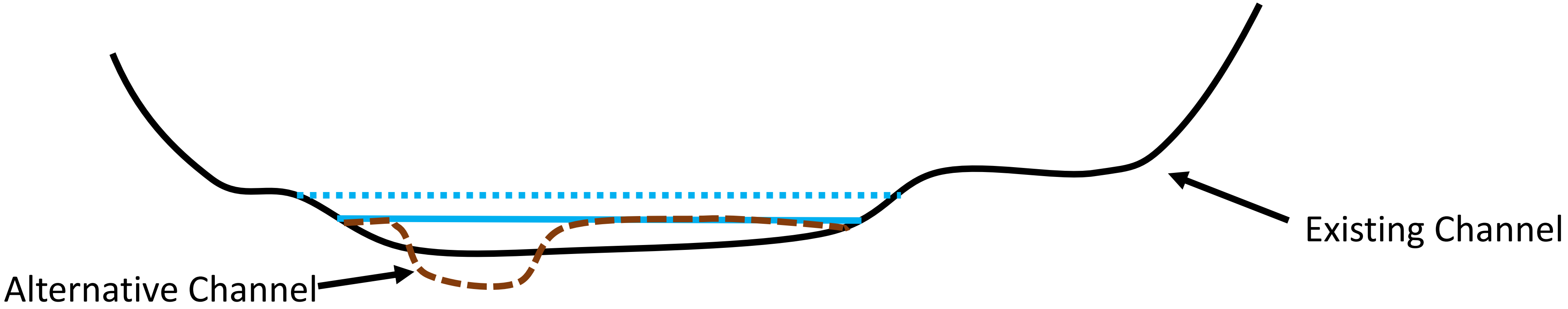
Ecological Flow Criteria

Flow Component	Flow Metric	Natural Range of Flow Metrics median (10th - 90th)	Ecological Flow Criteria: Black Willow	Ecological Flow Criteria: Arroyo Chub
Fall pulse flow	Fall pulse magnitude	2.4 (1.7 - 5) cfs	Same as natural range	Same as natural range
	Fall pulse timing	Nov 29 (Oct 24 - Dec 3)	Same as natural range	Same as natural range
	Fall pulse duration	11 (3 - 16) days	Same as natural range	Same as natural range
Wet-season baseflow	Wet-season baseflow magnitude	3 (2 – 5) cfs	**0.1 – 12 cfs**	> 120 cfs[a]
	Wet-season timing	Dec 15 (Oct 10 – Jan 25)	Same as natural range	Same as natural range
	Wet-season duration	67 (30 - 133) days	Same as natural range	Same as natural range
Peak flows	2-year peak flow magnitude	31 cfs	Same as natural range	Same as natural range
	2-year peak flow duration	4 (1 – 25) days	Same as natural range	Same as natural range
	2-year peak flow frequency	2 (1 – 8)	Same as natural range	Same as natural range
	5-year peak flow magnitude	423 cfs	Same as natural range	Same as natural range
	5-year peak flow duration	3 (1 - 6) days	Same as natural range	Same as natural range
	5-year peak flow frequency	3 (1 - 4) event(s)	Same as natural range	Same as natural range
Spring recession flows	Spring recession start magnitude	15 (3 - 528) cfs	**33** - 528 cfs	Same as natural range
	Spring timing	Mar 3 (Feb 22 - Mar 18)	Same as natural range	Same as natural range
	Spring duration	109 (76 - 125) days	Same as natural range	Same as natural range
	Spring rate of change	1.4 (0.9 – 1.9) % decline per day	Same as natural range	Same as natural range
Dry-season baseflow	Dry-season baseflow magnitude	2 (0.5 – 4) cfs	**0.1 – 12 cfs**	> 120 cfs[a]
	Dry-season timing	June 20 (May 9 - Jul 10)	Same as natural range	Same as natural range
	Dry-season duration	198 (116 - 220) days	Same as natural range	Same as natural range

[a] High baseflow criteria due to enlarged channel morphology. Channel modifications needed for suitable baseflow depths

Can we get more out of the water we have?

- Existing channel too wide to provide suitable depths for arroyo chub



Can changes to the channel morphology be made to provide more suitable habitat conditions?

- ➢Example design with narrower channel and inset floodplain

Lessons Learned

- CEFF provides flexible guidance
  - Multiple approaches can be implemented in Section B
- In highly altered systems:
  - Consideration of mediating factors (i.e., channel alteration) is important
  - Non-flow management actions may be necessary to achieve ecological flow criteria
- CEFF can be used to prioritize areas and inform channel restoration designs

https://www.frontiersin.org/articles/10.3389/fenvs.2022.787631/full

ORIGINAL RESEARCH article

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Developing Ecological Flow Needs in a Highly Altered Region: Application of California Environmental Flows Framework in Southern California, USA

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Questions?

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Photo: South OC Wastewater Authority