California Environmental Flows Framework

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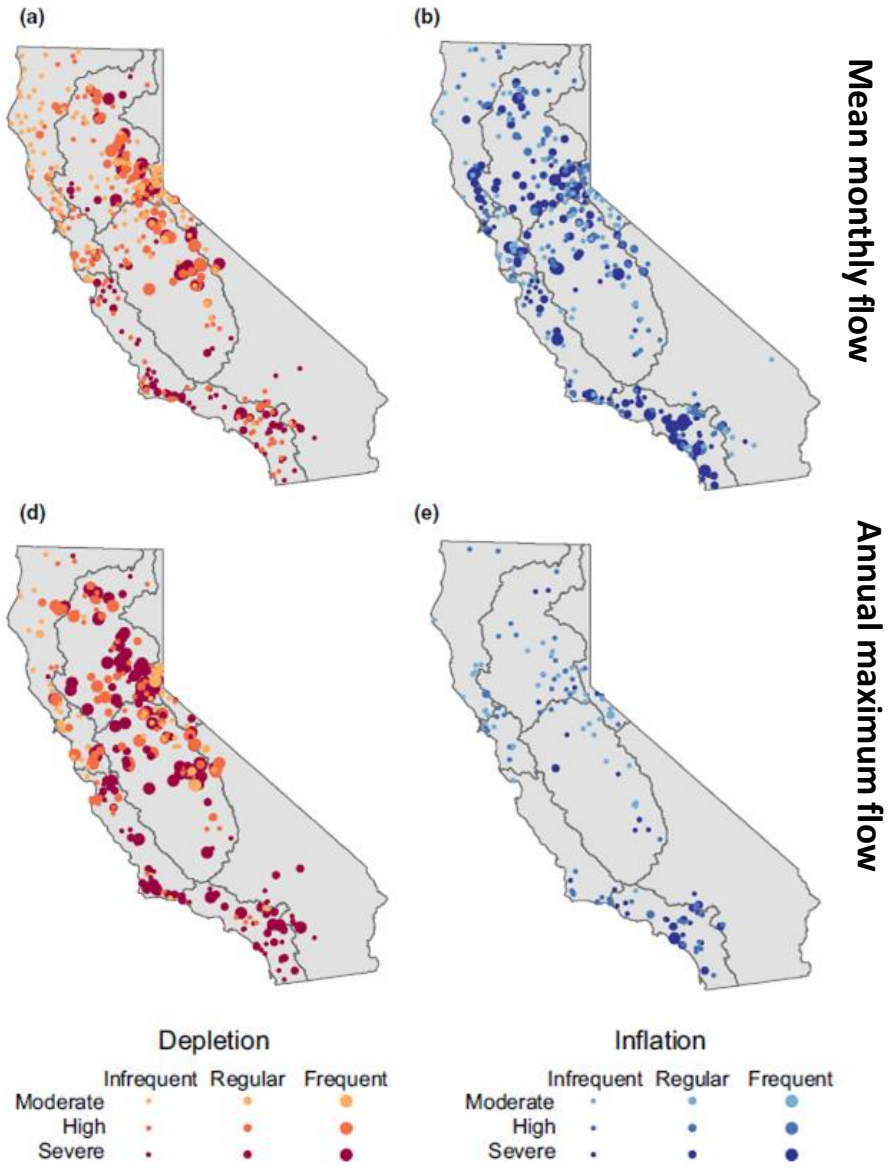
Statewide Hydrologic Impairment



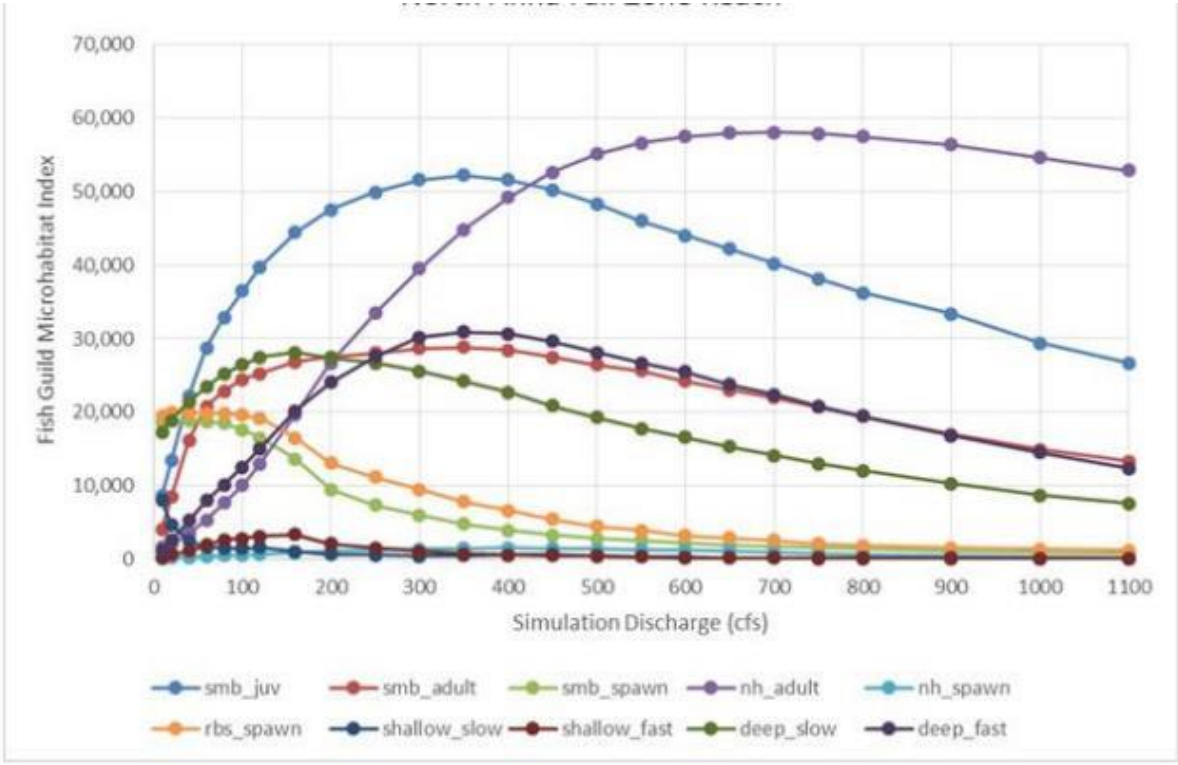
95% of gauged locations have at least some altered flows; 11% have pervasive alteration

- What is the biological effect of these impairments?
- What elements of the flow regime are most important to manage?
- How much water needs to stay in river to adequately protect ecosystems?

Zimmerman et al. 2018 *Freshwater Biology*

How do we answer those questions?

- Develop quantitative flow-ecology and flow-habitat relationships
- But flow-ecology relationships have limitations, including that they are:
  - only described for a limited set of flow metrics
  - averaged over the flow record
  - static, not time variable
  - often single species focused
  - not process-based
  - don't help assess tradeoffs with other water uses
  - do not comprehensively capture the ecological functionality of natural or prescribed flow regimes



California Environmental Flows Framework

Prepared by:

California Environmental Flow Working Group, a committee of the California Water Quality Monitoring Council

Funded by:

State Water Resources Control Board, Division of Water Rights

November XX 2020

CEFF TECHNICAL TEAM

- Alyssa Obester – CA Department of Fish and Wildlife
- Amber Villalobos - CA Department of Fish and Wildlife
- Belize Lane – Utah State University
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- Daniel Schultz – State Water Resources Control Board
- Eric Stein – Southern CA Coastal Water Research Project
- Jeanette Howard – The Nature Conservancy
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- Sam Sandoval-Solis – University of California, Davis
- Samuel Cole – State Water Resources Control Board
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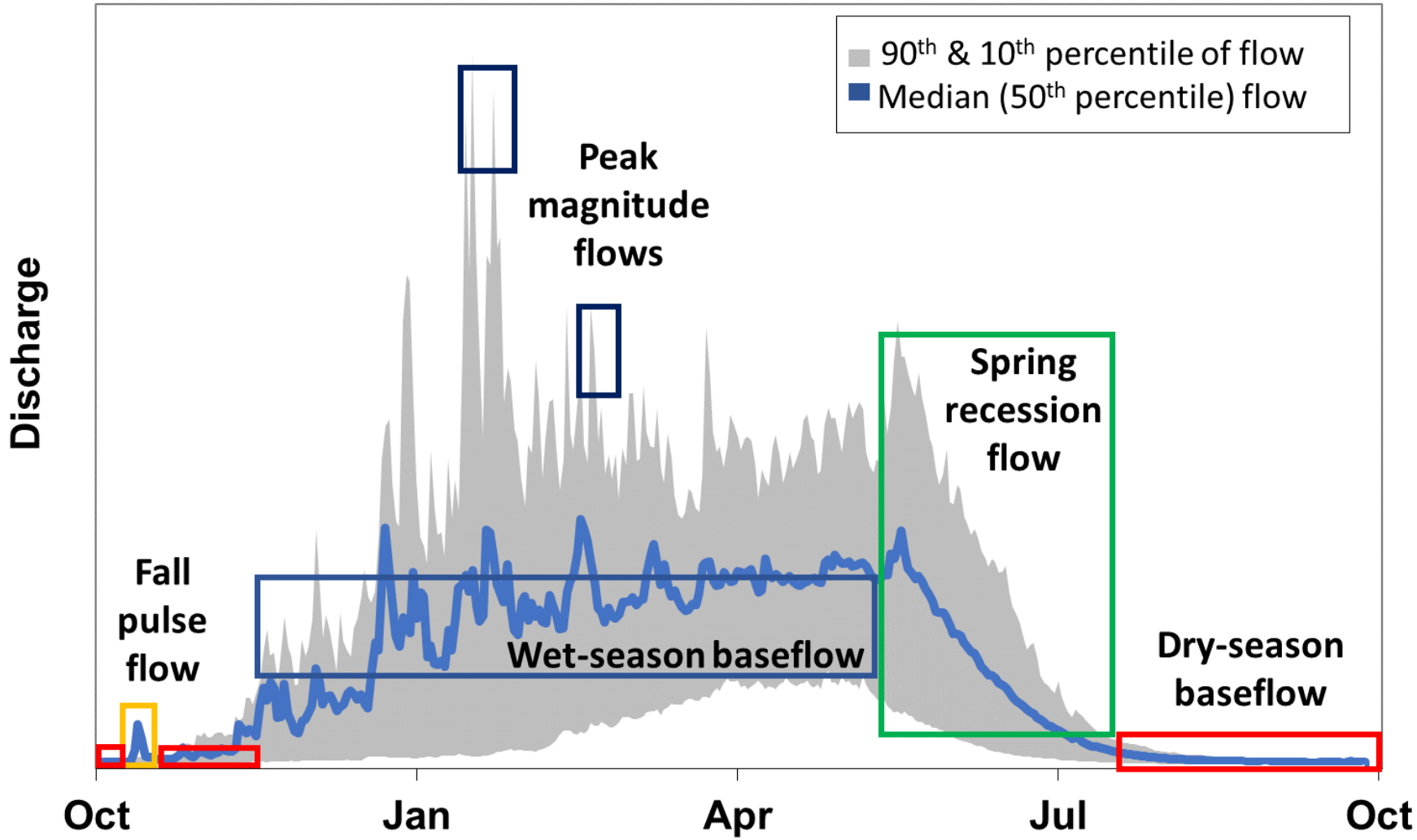
Functional Flows in California



Yarnell et al. 2020 *RRA*

Natural flows database

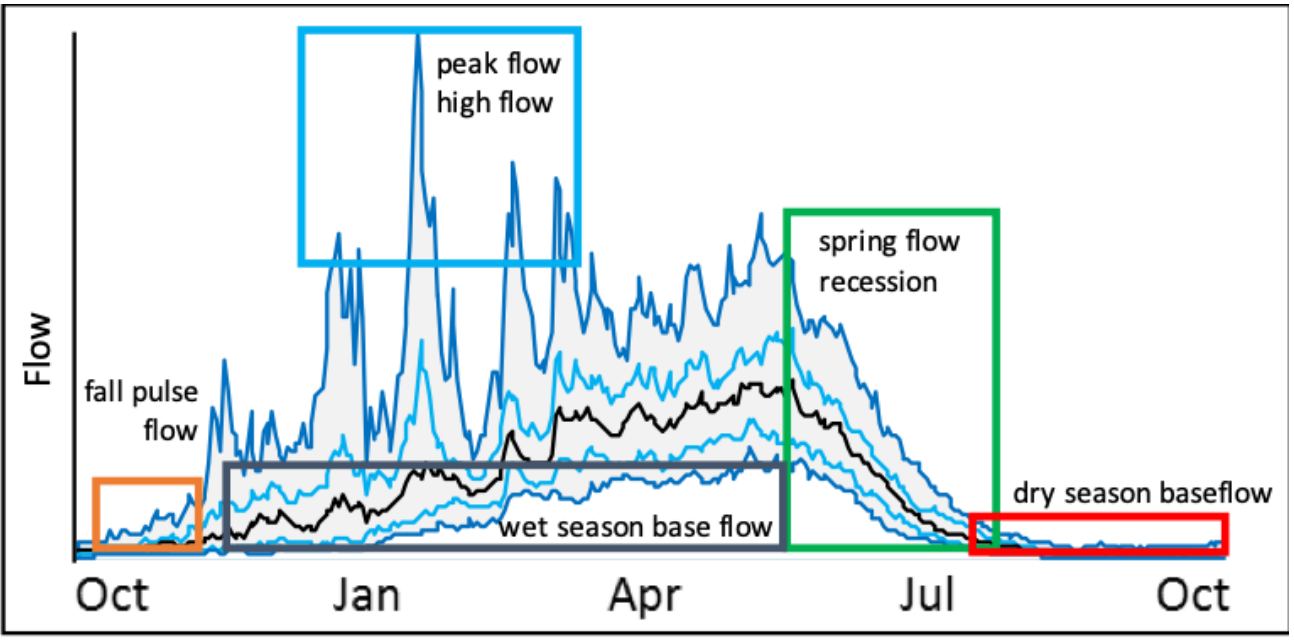
- Partnership between USGS, TNC and UC Berkeley
- Machine learning approach to predict natural monthly flows for every stream reach in CA
- Model was trained with flow data from 250 reference gages in CA, as well as precipitation, air temp, and many physical habitat variables; extensively validated
- Outputs: mean, max, min monthly unimpaired flow estimates, 1950-2015

Zimmerman et al. 2018 *Freshwater Biology*

Functional flow metrics

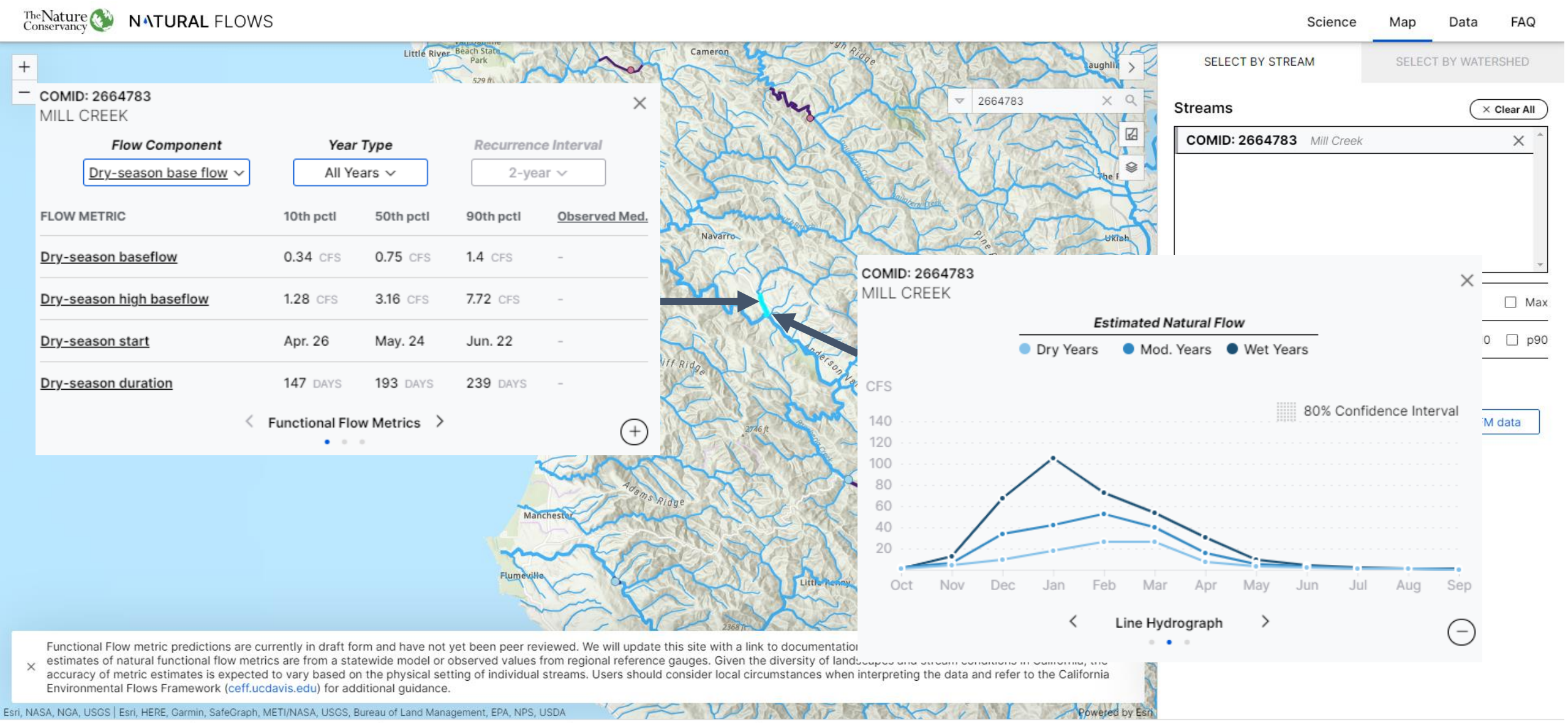
- Developed by the CEFF partnership
- Uses similar machine learning approach to predict FFMs for every stream reach in CA
- Outputs: predictions of functional flow metrics for each stream segment; provided as a range (p10, p90, p50) to reflect model uncertainty and interannual variation
- Also, reported in bins: wet, moderate and dry years

Functional flow metrics



Flow Component	Flow Characteristic
Fall pulse flow	Magnitude (cfs)
	Timing (date)
	Duration (days)
Wet-season base flow	Magnitude (cfs)
	Timing (date)
	Duration (days)
Wet-season peak flow	Magnitude (cfs)
	Duration (days)
	Frequency
Spring recession flow	Magnitude (cfs)
	Timing (date)
	Duration (days)
	Rate of change (%)
Dry-season base flow	Magnitude (cfs)
	Timing (date)
	Duration (days)

Natural Flows Web Tool: rivers.codefornature.org



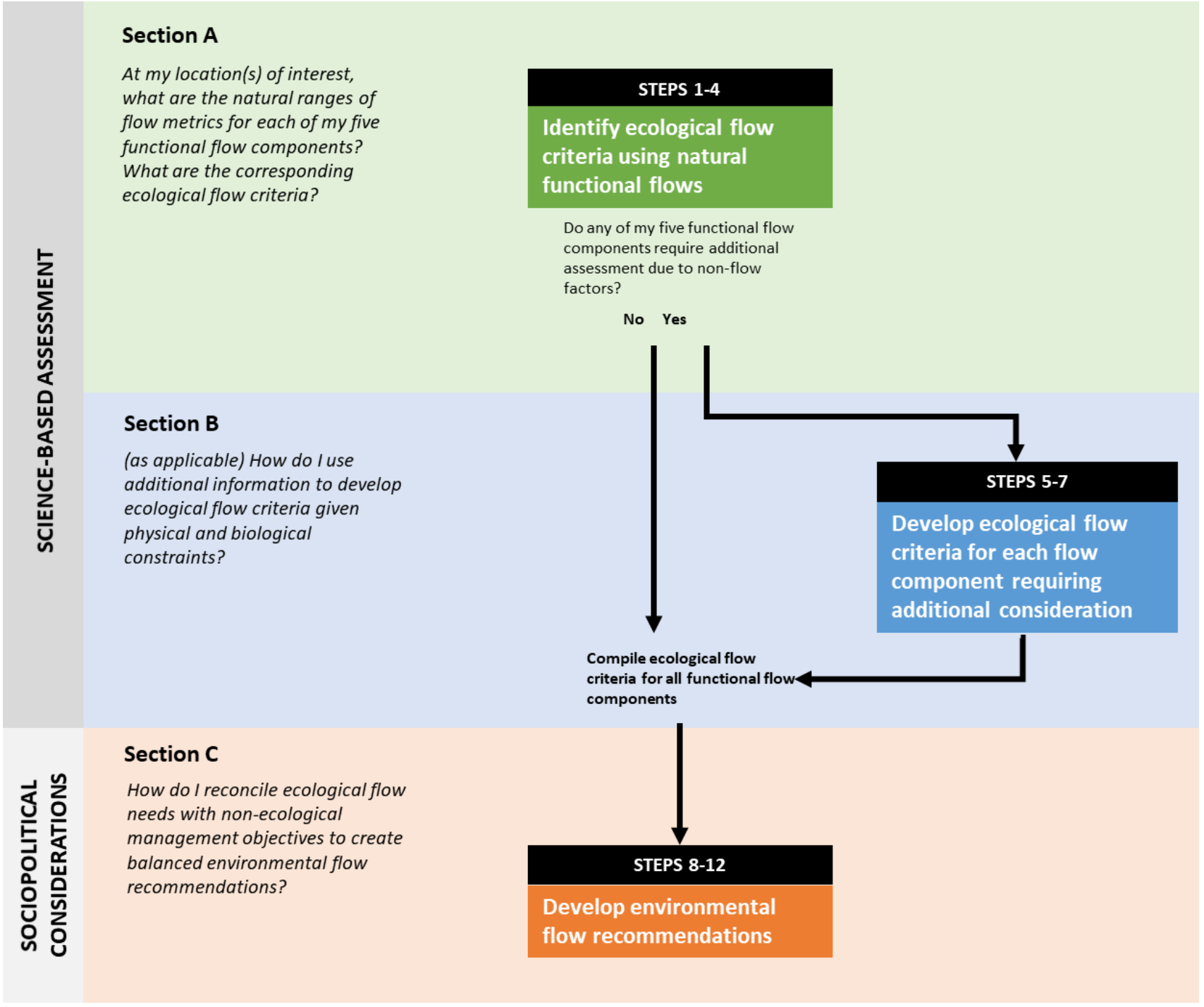
*Functional flows alone do not provide ecosystem function (water quality and physical habitat)

CEFF Definitions

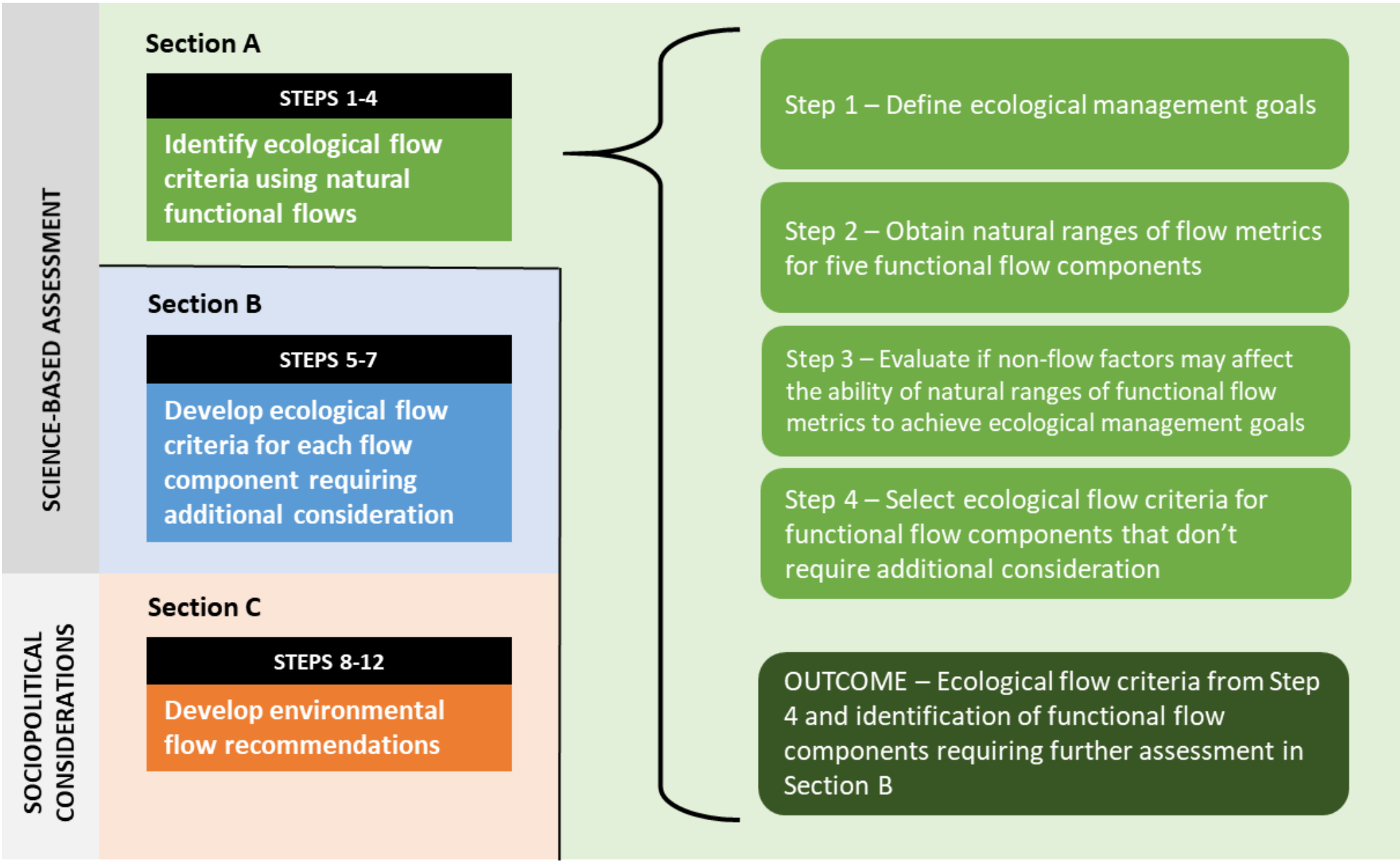
Ecological flow criteria: metrics that describe the range of flows that must be maintained within a stream and its margins to support the natural functions of healthy ecosystems

Environmental flow criteria: metrics that consider human uses and other management objectives along with ecological flow criteria

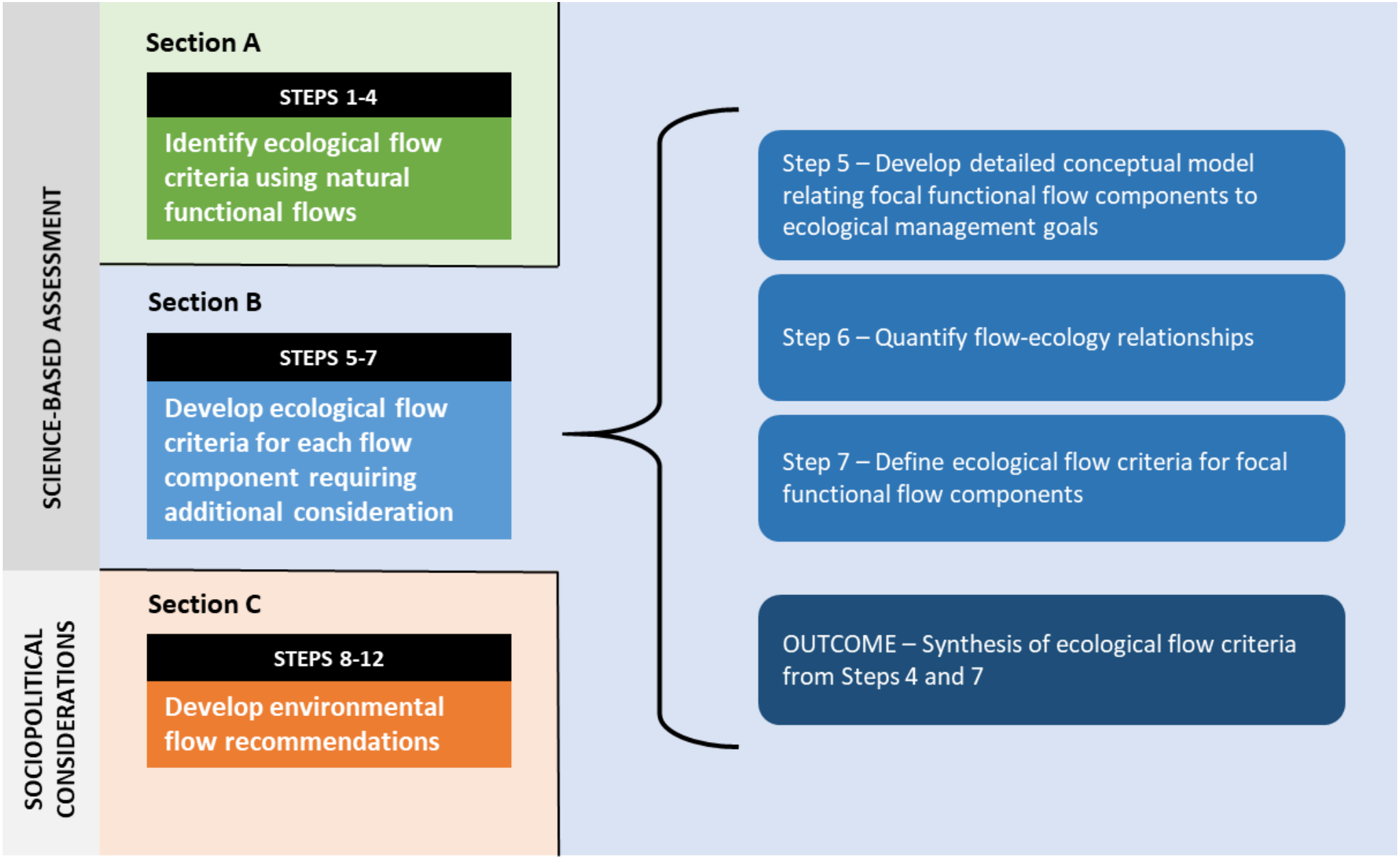
CEFF Steps Overview (Nov 2020)



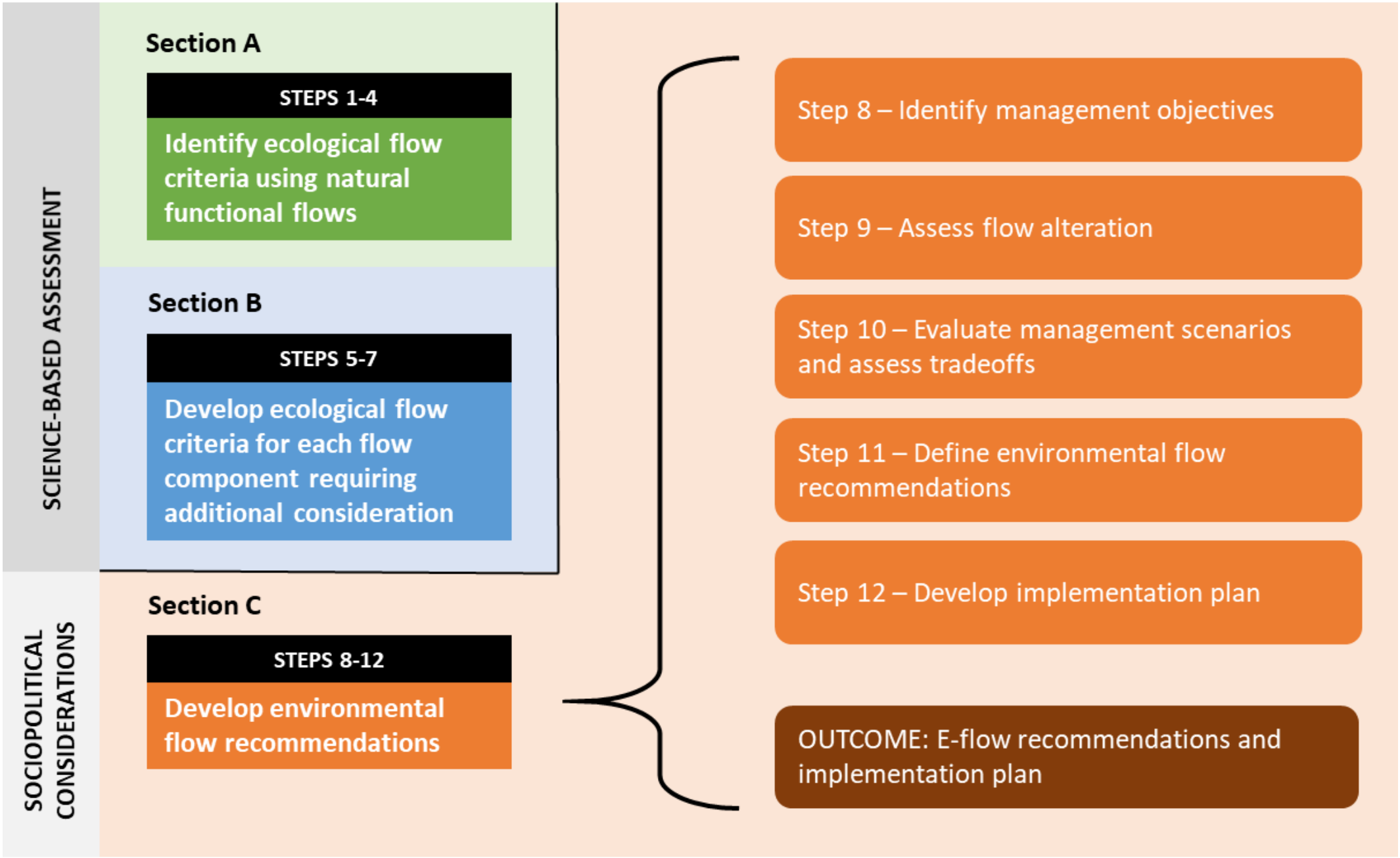
CEFF Section A



CEFF Section B



CEFF Section C



Outcomes of CEFF

- Ecological flow criteria for areas of interest
- Environmental flow recommendations (via stakeholder process)
- Recommended mitigation measures (via stakeholder process)
- Implementation, monitoring and adaptive management plan
- Online tools:
  - natural flows database/web tool (rivers.codefornature.org)
  - information repository (ceff.ucdavis.edu)

Flow Component	Flow Metric	Predicted Range at Lower Mill-Na02 and Na13 (COMID 2664783); median (10th - 90th percentile)	Predicted Range at Mid Mill - Na12 (COMID 2664737); median (10th - 90th percentile)	Predicted Range at Upper Mill - Na11 (COMID 2664723); median (10th - 90th percentile)	Predicted Range at Little Mill (COMID 2664675); median (10th - 90th percentile)	Predicted Range at Meyer Gulch (COMID 2664715); median (10th - 90th percentile)
Fall pulse flow	Fall pulse magnitude	5.44 (1.78-33) cfs	4.59 (1.69-18.2) cfs	2.87 (1.08-10.5) cfs	0.77 (0.26-3.08) cfs	0.72 (0.21-5.19) cfs
	Fall pulse timing	Oct. 27 (Oct. 9-Nov. 14)	Oct. 27 (Oct. 9-Nov. 14)	Oct. 27 (Oct. 9-Nov. 13)	Oct. 29 (Oct. 8-Nov. 19)	Oct. 29 (Oct. 8-Nov. 20)
	Fall pulse duration	3 (2-6.5) days	3 (2-6.5) days	3 (2-6.5) days	No data	No data
Wet season baseflow	Wet season baseflow (median magnitude)	16.9 (8.38-34) cfs	15.4 (7.88-30.8) cfs	10.8 (5.3-19.2) cfs	2.11 (1.06-3.79) cfs	1.78 (0.86-3.47) cfs
	Wet season start date	Dec. 3 (Nov. 20-Dec. 22)	Dec. 3 (Nov. 19-Dec. 21)	Dec. 2 (Nov. 21-Dec. 18)	Dec. 5 (Nov. 15-Dec. 30)	Dec. 5 (Nov. 13-Dec. 31)
	Wet season duration	117 (74-155) days	116 (75-154) days	117 (78-152) days	113 (69-159) days	111 (67-159) days
Peak flows	5-year flood magnitude	893 (488-1300) cfs	818 (447-1340) cfs	482 (263-984) cfs	104 (56-171) cfs	91 (45-149) cfs
	5-year flood duration	2.5 (1-6) days	2.5 (1-6) days	2.5 (1-6) days	No data	No data
	5-year flood frequency (number of 5-year floods/year)	1 (1-3) occurrences	1 (1-3) occurrences	1 (1-3) occurrences	No data	No data
Spring recession flows	Spring recession magnitude	88 (22-276) cfs	78.9 (20.5-239) cfs	47.5 (13.2-132) cfs	10.7 (2.99-41.1) cfs	9.75 (2.55-39.5) cfs
	Spring recession timing	Apr. 2 (Mar. 12-Apr. 28)	Apr. 2 (Mar. 13-Apr. 27)	Apr. 4 (Mar. 15-Apr.26)	Apr. 2 (Mar.8-May 1)	Mar. 31 (Mar. 8-May 1)
	Spring recession duration	40 (25-77) days	40 (25-76) days	39 (26-74) days	42 (24-102) days	43 (24-105) days
	Spring recession rate of change	6 (3-10) %	6 (3-10) %	6 (3-10) %	No data	No data
Dry season baseflow	Dry season (median) baseflow	0.75 (0.34-1.4) cfs	0.71 (0.32-1.33) cfs	0.43 (0.2-0.92) cfs	0.11 (0.05-0.26) cfs	0.09 (0.03-0.23) cfs
	Dry season start date	May 24 (Apr. 26-Jun. 22)	May 24 (Apr. 28-Jun. 22)	May 24 (May 3-Jun. 20)	May 28 (Apr. 25-Jul. 5)	May 26 (Apr. 23-Jul. 6)
	Dry season duration	193 (147-239) days	192 (148-235) days	192 (149-234) days	190 (133-241) days	190 (135-242) days

Flow Component	Flow Metric	Predicted Range at Lower Mill - Na02 and Na13 (COMID 2664783); median (10th - 90th percentile)	Predicted Range at Mid Mill - Na12 (COMID 2664737); median (10th - 90th percentile)	Predicted Range at Upper Mill - Na11 (COMID 2664723); median (10th - 90th percentile)	Predicted Range at Little Mill (COMID 2664675); median (10th - 90th percentile)	Predicted Range at Meyer Gulch (COMID 2664715); median (10th - 90th percentile)
Fall pulse flow	Fall pulse magnitude	likely unaltered	likely unaltered	likely unaltered	likely unaltered	likely unaltered
	Fall pulse timing	likely unaltered	likely unaltered	likely unaltered	likely unaltered	likely unaltered
	Fall pulse duration	likely unaltered	likely unaltered	likely unaltered	No data	No data
Wet season baseflow	Wet season baseflow (median magnitude)	unclear if altered*	unclear if altered*	likely altered (low)*	unclear if altered*	likely unaltered*
	Wet season start date	unclear if altered	likely unaltered	unsure if altered	likely unaltered	likely unaltered
	Wet season duration	likely unaltered	likely unaltered	likely unaltered	likely unaltered	likely unaltered
Peak flows	5-year flood magnitude	likely altered (low)*	likely altered (low)*	likely altered (low)*	likely altered (low)*	likely altered (low)*
	5-year flood duration	likely unaltered	likely unaltered	likely unaltered	No data	No data
	5-year flood frequency (number of 5-year floods/year)	likely unaltered	likely unaltered	likely unaltered	No data	No data
Spring recession flows	Spring recession magnitude	likely unaltered	likely unaltered	likely unaltered	likely unaltered	likely unaltered
	Spring recession timing	unclear if altered	unclear if altered	unclear if altered	likely altered (early)	likely altered (early)
	Spring recession duration	likely unaltered	likely unaltered	likely unaltered	unclear if altered	likely unaltered
	Spring recession rate of change	likely unaltered	likely unaltered	likely unaltered	No data	No data
Dry season baseflow	Dry season (median) baseflow	likely altered (low)	likely altered (low)	likely unaltered	likely altered (low)	likely altered (low)
	Dry season start date	likely unaltered	likely unaltered	unclear if altered	likely unaltered	likely unaltered
	Dry season duration	likely unaltered	likely unaltered	likely unaltered	likely unaltered	likely unaltered

	July mean monthly flow observed (cfs)	Natural Flows Database mean monthly				August mean monthly flow observed (cfs)	Natural Flows Database mean monthly			
		10th percentile	Dry years	Mod. Years	Wet years		10th percentile	Dry years	Mod. Years	Wet years
Little Mill	no data	0.03	0.14	0.18	0.24	no data	0.00	0.05	0.09	0.15
Meyer Gulch	no data	0.01	0.1	0.13	0.2	no data	0.00	0.00	0.04	0.09
Upper Mill (Na13)	0.29	0.31	0.59	0.77	1.12	0.16	0.13	0.42	0.51	0.67
Middle Mill (Na12)	0.31	0.48	0.92	1.28	1.71	0.12	0.20	0.59	0.74	0.92
Lower Mill (Na02 & Na13)	0.29	0.52	1	1.39	1.86	0.10	0.23	0.65	0.81	1.02

	Sept. mean monthly flow observed (cfs)	Natural Flows Database mean monthly				October mean monthly flow observed (cfs)	Natural Flows Database mean monthly			
		10th percentile	Dry years	Mod. Years	Wet years		10th percentile	Dry years	Mod. Years	Wet years
Little Mill	no data	0.00	0.01	0.00	0.03	no data	0.03	0.13	0.18	0.2
Meyer Gulch	no data	0.00	0.00	0.00	0.00	no data	0.02	0.11	0.15	0.17
Upper Mill (Na13)	0.09	0.03	0.24	0.26	0.35	0.23	0.31	0.60	0.88	1.13
Middle Mill (Na12)	0.09	0.06	0.33	0.38	0.51	0.25	0.49	1.01	1.94	1.30
Lower Mill (Na02 & Na13)	0.06	0.07	0.36	0.41	0.55	0.24	0.52	1.12	2.07	1.41

Next Steps

CEFF is a “living document”

- Reviewed by the WQMC eflows workgroup
- Revised technical report should be available soon
- FAQs available: https://ceff.ucdavis.edu/fact-sheets-and-faqs

Multiple case studies under development

- North Coast – water diversions
- Eel River – dam relicensing and reoperation
- Southern California – flow requirements for water quality

Workplan to guide and prioritize new efforts

- Improvements in technical tools
- Track and document case studies
- Mechanisms for ongoing data and information sharing