Instream Flow Regime Criteria on a Watershed Scale

FRESNO RIVER

March 2020

Version 2, updated June 2020

Watershed Criteria Report No. 2020-02

California Department of Fish and Wildlife

Instream Flow Program

California Department of Fish and Wildlife
Water Branch
Instream Flow Program
Watershed Criteria Report No. 2020-02
Version 2

Prepared by:

Sean Windell[a], Instream Flow Program Senior Environmental Scientist

Amber Villalobos[b], Instream Flow Program Senior Environmental Scientist

California Department of Fish and Wildlife, West Sacramento, California

Suggested citation:

CDFW (2020). Instream flow regime criteria on watershed scale: Fresno River, Version 2. California Department of Fish and Wildlife, Instream Flow Program (CDFW), West Sacramento, CA. Watershed Criteria Report No. 2020-02.

[a] Project Lead; [b] Quality Assurance Officer

Table of Contents

INTRODUCTION 5

FRESNO RIVER WATERSHED 6

Flow Variation 9

Natural Flows 10

Functional Flows 17

Ecosystem Baseflows 21

Steelhead Habitat Optimum Flows 28

By Monthly Duration 28

By Drainage Area 29

REFERENCES 32

APPENDIX A 33

ADDENDUM 34

FIGURES

Figure 1. Map of the Department's Regions 6

Figure 2. Fresno River watershed map 7

Figure 3. Watershed Criteria Analysis Key 8

Figure 4. Variation in the Fresno River hydrograph 9

Figure 5. Timing and magnitude of lower Fresno River Functional Flows 17

Figure 6. Timing and magnitude of upper Fresno River Functional Flows 19

Figure 7. Ecosystem Baseflows 21

Figure 8. Salmonid Optimum Flows 28

TABLES

Table 1. Natural Flows 10

Table 2. Lower Fresno River Functional Flow metric median values 18

Table 3. Upper Fresno River Functional Flow metric median values 20

Table 4. Ecosystem Baseflows 22

Table 5. Salmonid Optimum Flows downstream of Hidden Dam 29

Table 6. Salmonid Optimum Flows upstream of Hidden Dam 30

Introduction

This *Instream Flow Regime Criteria on a Watershed Scale* report (Watershed Criteria Report) provides instream flow regime criteria for the Fresno River watershed. Its intended audience includes agencies, water managers, non-governmental organizations, and the public.

The Fresno River was identified in a petition for statutory adjudication of water rights submitted to the State Water Resources Control Board (SWRCB) in October of 2018. In September 2019, the SWRCB postponed making a decision on granting or denying the petition for eight months to allow water users to negotiate an independent agreement. The California Department of Fish and Wildlife (Department) is participating along with water right holders in the negotiation and adjudication processes, representing public trust resource-related needs within the Fresno watershed. This Watershed Criteria Report is intended to provide watershed-scale information to inform public trust resource needs throughout the negotiation and adjudication processes.

This Watershed Criteria Report presents stream assessments for 55 reaches. An overview of the analyses used to create instream flow regime criteria contained in this document, as well as examples of potential criteria applications, is found in the Department's *Overview of Analysis for Instream Flow Regime Criteria on a Watershed Scale* (Overview) document (CDFW 2020a). Reviewing and understanding the information contained in the Overview document is essential to understanding flow regime criteria contained in this report. Complete background files for this report are maintained in the Department's Headquarters office. This document and the Overview may be found on the Department's Instream Flow Program webpage (CDFW 2020b). The Sensitive Period Indicator and Salmonid Passage Flow analyses were not included in this study.

The Department provides this document as a tool for consideration in water management planning. It presents an analytical approach that can be implemented, if appropriate, under the specific circumstances of a watershed, stream, or informational need. This report and the Overview, in and of themselves, should not be considered to provide binding guidelines, establish legal compliance, or ensure project success.

Fresno River Watershed

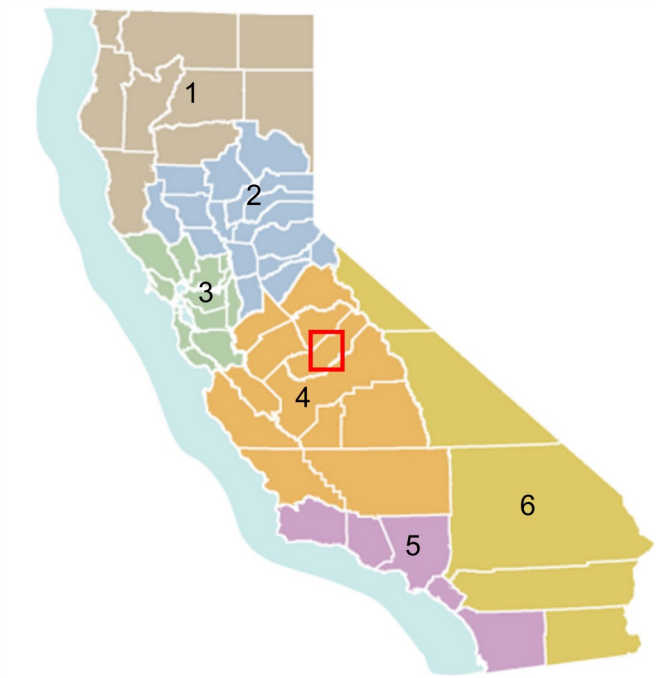


Figure 1. Map of the Department's Regions.

- Located in the Department's Region 4
- Spans Madera County
- Tributary to the San Joaquin River
- 593 square mile (mi^2) drainage area
- Supports rainbow trout, hardhead, and threespine stickleback

In this map (Figure 2), the dark red slash is Hidden Dam and the orange shapes are United States Geological Survey (USGS) gages. As a variation to other Watershed Criteria Reports, there was no GIS layer for steelhead range for the Fresno River and therefore reaches were selected through discussions with regional staff. Criteria were developed for each numbered reach. The common identifiers (COMIDs) that correspond to the numbered reaches are listed in Appendix A.

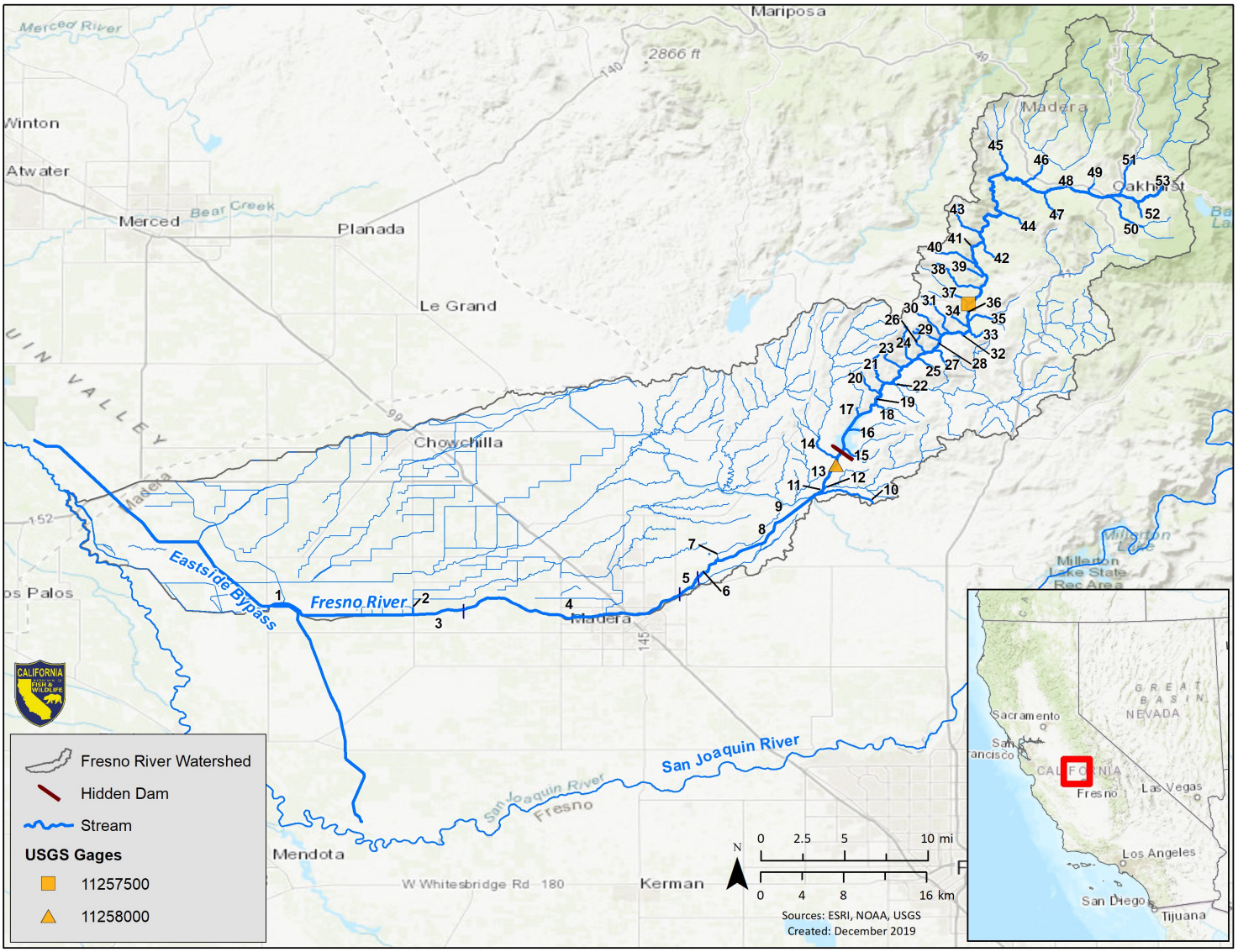


Figure 2. Fresno River watershed map.

1) Fresno 1
2) Tributary 1
3) Fresno 2
4) Fresno 3
5) Fresno 4
6) Fresno 5
7) Tributary 2
8) Fresno 6
9) Fresno 7
10) Tributary 3
11) Fresno 8
12) Tributary 4
13) Fresno 9
14) Willow Creek
15) Tributary 5
16) Tributary 6
17) Tributary 7
18) Mud Spring Creek
19) Fresno 10
20) Tributary 8
21) Tributary 9
22) Coarse Gold Creek
23) Tributary 10
24) Tributary 11
25) Tributary 12
26) Tributary 13
27) Tributary 14
28) Fresno 11
29) Tributary 15
30) Tributary 16
31) Tributary 17
32) Tributary 18
33) Tributary 19
34) Tributary 20
35) Tributary 21
36) Fresno 12
37) Spangle Gold Creek
38) Tributary 22
39) Tributary 23
40) Tributary 24
41) Fresno 13
42) Tributary 25
43) Tributary 26
44) Tributary 27
45) Crooks Creek
46) Miami Creek
47) Tributary 28
48) Fresno 14
49) Tributary 29
50) China Creek
51) Tributary 30
52) Tributary 31
53) Fresno 15

The summaries in Figure 3 provide an overview of analyses presented in this Watershed Criteria Report. For more details on each analysis see the Overview, which can be found on the Department's Instream Flow Program webpage (CDFW 2020b).

Flow Variation

Annual and interannual variation in flows is critical to long-term ecological functioning. These data provide an example of natural variation in the selected watershed.

Natural Flows

Natural Flows presents estimated natural streamflow data by water month type for each reach. These data form the input for the analyses.

Functional Flows

Functional Flows perform key ecological and geomorphic functions. This section presents information on the timing, magnitude, and duration of key Functional Flows within the annual hydrologic cycle.

Ecosystem Baseflows

Ecosystem Baseflows are monthly baseflows that preserve a healthy stream ecosystem. These are calculated as a percentage of monthly and annual Natural Flows and vary throughout the year.

Salmonid Habitat Optimum Flows

Salmonid Habitat Optimum Flows provide optimal access to preferred salmonid habitat. This section presents the optimal discharge for select salmonid life stages for each stream reach.

Figure 3. Watershed Criteria Analysis Key.

Flow Variation

Flows in the Fresno River watershed are variable throughout the year and from year to year. The hydrograph, in Figure 4, depicts the variation in mean daily flow at the USGS gage 11257500 upstream of Hidden Dam in extreme and median conditions (the driest, median, and wettest year) between 1912 and 1990 (USGS 2020). Median monthly flow for a moderate water month type (WMT) is also included. This gage was selected since it is the least-impaired gage and is free of dam and reservoir operations.

Precipitation variability in the Fresno River watershed is anticipated to increase and lead to more extreme fluctuations from drought to flooding as climate change impacts intensify (Westerling 2018). These shifts, combined with ongoing surface water and groundwater extractions, may result in higher stress to ecosystems and reduced water availability. Understanding natural variability and projected future changes to flow patterns can help water users and managers create a flow regime and plan for changes in water availability.

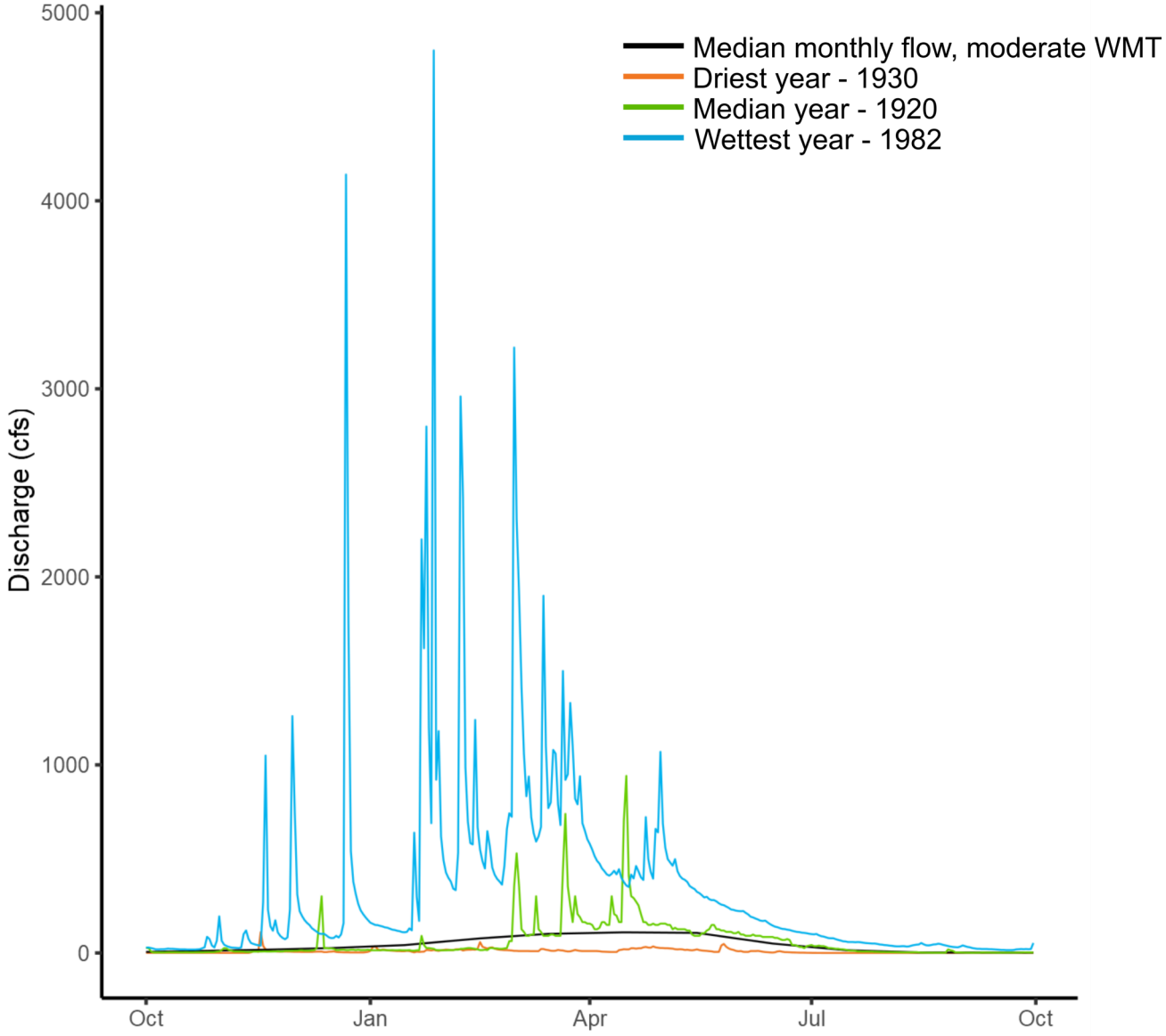


Figure 4. Variation in the Fresno River hydrograph (1912–1990).

Natural Flows

Natural Flows are the streamflows (in cfs) that would be expected with no human influence (data from Zimmerman et al. 2020). Table 1 presents median monthly Natural Flows by month for wet, moderate, and dry water month types for each Fresno River tributary and mainstem reach analyzed in this report. It also presents the drainage area in square miles (mi^2). The numbers next to each stream name correspond to the numbers found on the Fresno River watershed map (Figure 2).

Table 1. Natural Flows.

1) Fresno 1 593.4 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	166	274	389	320	181	104	32	7	6	11	27	76
	Moderate	42	92	105	80	73	23	7	1	2	3	11	26
	Dry	25	43	44	35	39	12	3	1	1	2	7	17

2) Tributary 1 0.2 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	9	17	26	19	9	4	2	3	5	1	1	8
	Moderate	6	7	7	8	3	2	1	2	4	1	1	6
	Dry	5	6	5	5	2	2	1	2	4	1	1	5

3) Fresno 2 581.1 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	201	308	429	366	182	111	36	10	6	10	26	80
	Moderate	46	96	118	105	97	34	8	1	1	3	14	27
	Dry	26	41	50	38	53	14	3	1	1	2	7	14

4) Fresno 3 577.8 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	204	309	439	368	182	111	36	10	6	10	29	80
	Moderate	47	97	123	106	97	34	8	1	1	3	13	26
	Dry	23	42	50	39	54	14	3	1	1	2	7	13

5) Fresno 4 293.4 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	222	322	442	362	178	112	39	10	7	10	23	82
	Moderate	54	109	130	108	101	47	9	1	1	3	12	28
	Dry	26	43	52	40	55	20	3	<1	<1	2	7	13

6) Fresno 5 291.4 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flow (cfs)	Wet	222	324	445	366	178	111	39	10	7	10	23	82
	Moderate	54	108	130	108	100	47	9	1	1	3	12	28
	Dry	26	43	52	40	55	20	3	<1	<1	2	7	13

7) Tributary 2 2.4 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	1	2	3	3	1	<1	<1	<1	1	<1	<1	1
	Moderate	1	1	1	1	<1	<1	<1	<1	1	<1	<1	1
	Dry	1	1	1	1	<1	<1	<1	<1	1	<1	<1	1

8) Fresno 6 286.4 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	236	327	461	367	183	109	45	10	6	10	22	84
	Moderate	57	110	124	109	102	49	10	1	1	3	12	28
	Dry	26	42	49	44	56	19	3	<1	<1	2	7	13

9) Fresno 7 285.7 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	235	328	458	367	183	109	46	10	6	10	22	83
	Moderate	57	110	126	110	101	49	10	1	1	3	12	28
	Dry	26	43	49	44	56	19	3	<1	<1	2	7	13

10) Tributary 3 1.1 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

11) Fresno 8 282.5 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	234	329	458	365	182	109	46	10	6	10	22	84
	Moderate	57	111	123	111	103	49	10	1	1	4	13	27
	Dry	26	43	50	47	56	19	3	<1	<1	2	8	14

12) Tributary 4 11.2 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	2	3	6	4	2	1	<1	<1	<1	<1	<1	1
	Moderate	1	1	1	1	1	<1	<1	<1	<1	<1	<1	1
	Dry	1	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1

13) Fresno 9 270.7 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	247	354	446	367	199	115	53	11	6	10	22	81
	Moderate	57	111	123	116	108	59	14	1	1	4	13	28
	Dry	26	45	54	53	62	24	5	<1	<1	2	8	15

14) Willow Creek 32.4 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	3	6	12	8	4	3	<1	<1	1	1	<1	2
	Moderate	2	2	2	2	1	1	<1	<1	1	<1	<1	1
	Dry	1	1	1	1	1	1	<1	<1	1	<1	<1	1

15) Tributary 5 3.4 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	<1	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

16) Tributary 6 1.3 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

17) Tributary 7 2.1 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	<1	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

18) Mud Spring Creek 1.8 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	<1	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

19) Fresno 10 224.4 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	263	340	445	351	182	85	37	10	6	9	25	103
	Moderate	74	121	145	110	89	39	12	1	2	4	12	30
	Dry	29	47	54	50	50	16	4	<1	<1	1	6	16

20) Tributary 8 0.8 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

21) Tributary 9 1.5 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	<1	<1	1	1	<1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

22) Coarse Gold Creek 67.7 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	34	64	73	66	27	14	3	1	1	1	2	13
	Moderate	8	18	20	15	10	5	1	<1	<1	<1	2	3
	Dry	3	6	7	6	5	2	<1	<1	<1	<1	1	2

23) Tributary 10 0.7 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

24) Tributary 11 1.9 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	1	1	1	1	1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

25) Tributary 12 0.6 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

26) Tributary 13 0.8 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	<1	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

27) Tributary 14 0.6 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

28) Fresno 11 146.2 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	126	205	241	244	165	111	46	19	7	13	27	54
	Moderate	44	76	103	116	109	47	14	3	1	6	17	26
	Dry	27	40	61	66	64	21	5	1	1	4	12	14

29) Tributary 15 0.6 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

30) Tributary 16 1.8 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	1	1	2	1	<1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

31) Tributary 17 2.1 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	1	1	2	1	1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

32) Tributary 18 0.6 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

33) Tributary 19 0.8 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	<1	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

34) Tributary 20 0.3 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

35) Tributary 21 3 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	1	2	3	2	1	1	<1	<1	<1	<1	<1	1
	Moderate	<1	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

36) Fresno 12 134.7 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	130	197	229	240	161	112	47	19	8	12	26	50
	Moderate	42	77	102	110	107	50	15	3	2	6	16	26
	Dry	23	39	60	68	65	22	6	1	1	4	12	13

37) Spangle Gold Creek 3.6 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	1	2	3	2	1	1	<1	<1	<1	<1	<1	<1
	Moderate	<1	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

38) Tributary 22 1.8 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	1	1	2	1	1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

39) Tributary 23 0.8 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	<1	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

40) Tributary 24 2.2 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	1	2	2	2	1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

41) Fresno 13 118.7 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	134	184	231	210	161	102	44	20	8	11	23	50
	Moderate	41	75	99	92	91	44	15	4	2	6	14	26
	Dry	22	36	55	56	53	19	6	1	1	3	11	12

42) Tributary 25 4 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	4	5	6	5	2	1	<1	<1	<1	<1	<1	1
	Moderate	1	2	2	1	1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1

43) Tributary 26 2.5 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	2	2	3	2	1	<1	<1	<1	<1	<1	<1	1
	Moderate	<1	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

44) Tributary 27 2.3 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	3	3	4	3	1	<1	<1	<1	<1	<1	<1	1
	Moderate	<1	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

45) Crooks Creek 7.8 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	10	12	15	12	5	2	1	<1	<1	<1	1	4
	Moderate	2	4	5	4	2	1	<1	<1	<1	<1	<1	1
	Dry	1	1	2	1	1	<1	<1	<1	<1	<1	<1	1

46) Miami Creek 31.3 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	33	45	60	55	34	22	10	4	1	3	5	13
	Moderate	9	19	26	22	16	8	3	1	<1	1	4	6
	Dry	5	8	13	12	7	2	1	<1	<1	1	3	3

47) Tributary 28 0.9 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	1	1	1	1	1	<1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

48) Fresno 14 58.4 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	80	100	136	146	111	73	26	14	5	8	12	29
	Moderate	23	47	60	53	54	25	11	6	1	4	8	14
	Dry	12	22	33	26	25	9	4	3	<1	2	5	8

49) Tributary 29 1.1 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	1	1	2	2	1	1	<1	<1	<1	<1	<1	<1
	Moderate	<1	<1	1	1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

50) China Creek 9.4 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	9	13	15	13	8	5	2	1	<1	<1	1	3
	Moderate	3	5	6	6	4	1	<1	<1	<1	<1	1	2
	Dry	2	2	3	3	1	<1	<1	<1	<1	<1	1	1

51) Tributary 30 34 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	57	68	93	125	146	115	24	13	8	7	11	21
	Moderate	17	33	44	71	59	31	9	6	4	4	7	10
	Dry	8	16	29	45	27	10	4	3	2	2	4	5

52) Tributary 31 1 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	2	2	3	2	1	<1	<1	<1	<1	<1	<1	1
	Moderate	<1	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

53) Fresno 15 2.6 mi^2

	Month Type	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Natural Flows (cfs)	Wet	2	4	4	3	2	1	<1	<1	<1	<1	<1	1
	Moderate	1	1	2	2	1	<1	<1	<1	<1	<1	<1	<1
	Dry	<1	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1

Functional Flows

This section presents examples illustrating Functional Flow components in the Fresno River watershed (data from Lane et al. 2020). Functional Flow timing throughout the watershed is likely consistent, but magnitudes differ (Rodríguez-Iturbe and Valdés 1979).

In Figures 5 and 6, the darkest colored boxes indicate the start timing and magnitude in 50% of years (25th–75th percentile values) for each Functional Flow component. The medium colored boxes represent start timing and magnitude in 80% of years (10th–90th percentile). The light blue and light yellow boxes link wet season start and dry season start to the next functional flow "season". The arrow indicates the spring recession rate. Tables 2 and 3 presents median start timing and magnitude along with additional metrics for each component (with 10th–90th percentile values in parentheses).

The metric values that define each Functional Flow component in Figure 5 and Table 2 are based on the water years 1942–1971 at the USGS gage on the lower Fresno River.

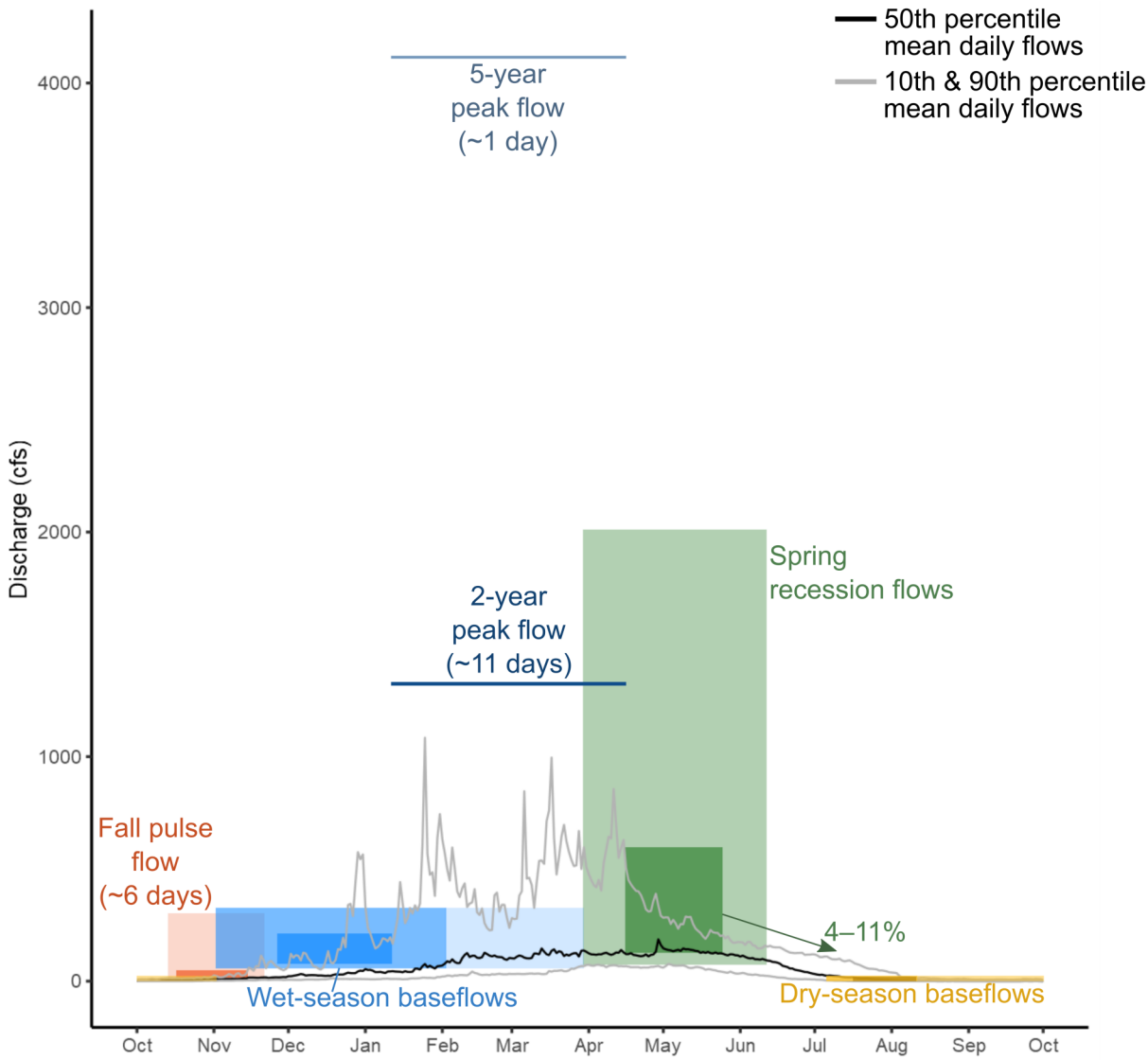


Figure 5. Timing and magnitude of the lower Fresno River Functional Flows.

Table 2. Lower Fresno River Functional Flow metric median values (10th-90th percentile in parentheses).

Metric	Start Timing	Duration (total days per year, when present)	Magnitude (cfs)	Frequency (events per year, when present)	Rate of Change (percent per day)
Fall pulse flow	Nov 2 (Oct 13–Nov 21)	6 (3–9)	29 (13–300)	-	-
Wet-season baseflows	Dec 18 (Nov 2–Feb 2)	-	109 (61–326)	-	-
2-year peak flow	-	5 (1–12)	1320	2 (1–5)	-
5-year peak flow	-	1 (1–3)	4110	1 (1–2)	-
Spring recession flows	May 15 (Mar 29–Jun 11)	76 (48–114)	184 (75–2009)	-	7 (4-11)
Dry-season baseflows	Jul 27 (Jul 5–Aug 11)	147 (94–210)	5 (0–11)	-	-

The metric values that define each Functional Flow component in Figure 6 and Table 3 are based on water years 1917–1971 at the USGS gage 11257500 on the upper Fresno River.

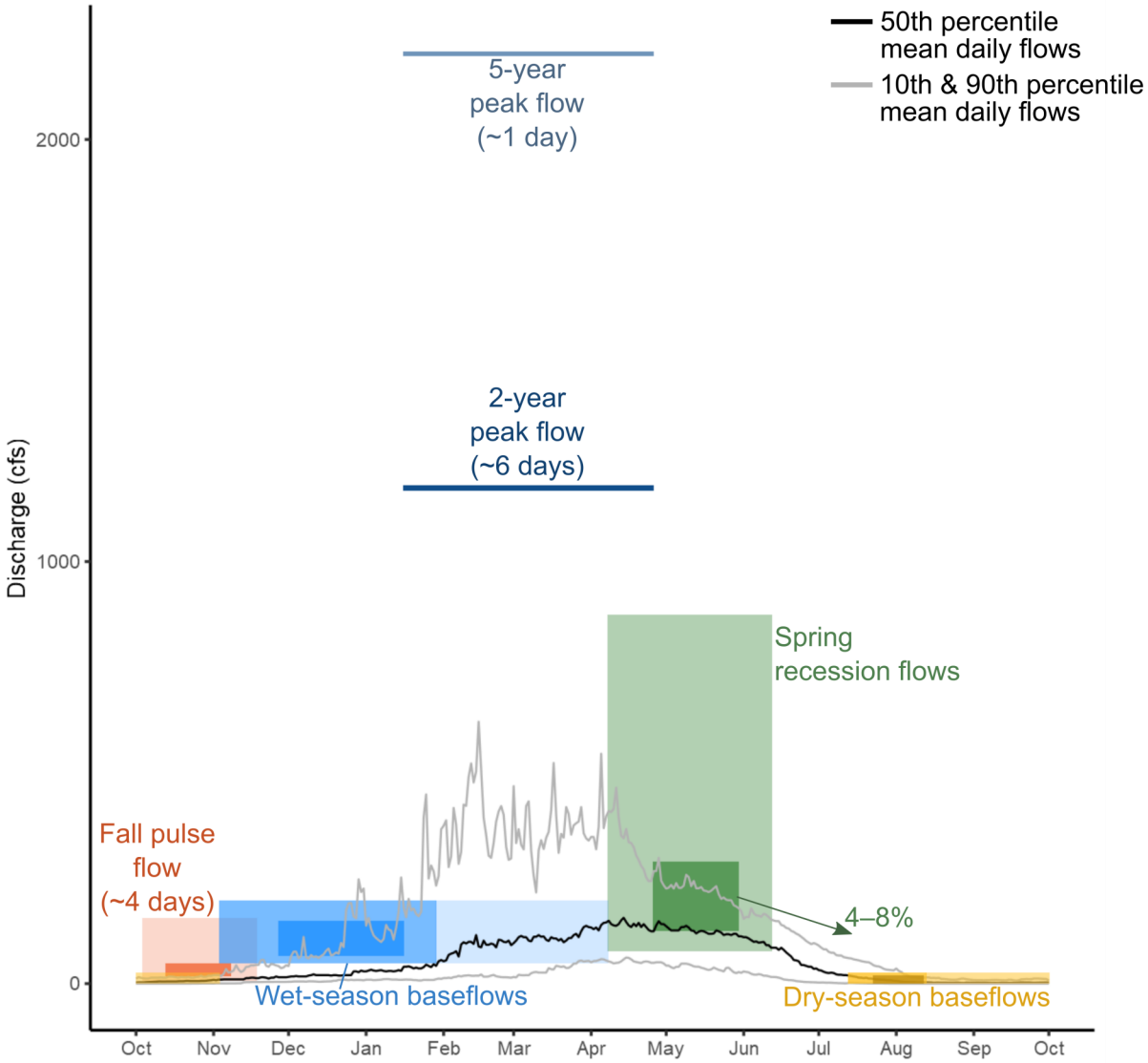


Figure 6. Timing and magnitude of upper Fresno River Functional Flows.

Table 3. Upper Fresno River Functional Flow metric median values (10th-90th percentile in parentheses).

Metric	Start Timing	Duration (total days per year, when present)	Magnitude (cfs)	Frequency (events per year, when present)	Rate of Change (percent per day)
Fall pulse flow	Oct 25 (Oct 3–Nov 18)	4 (2–7)	31 (8–154)	-	-
Wet-season baseflows	Dec 26 (Nov 3–Jan 29)	-	101 (49–196)	-	-
2-year peak flow	-	3 (1–6)	1170	2 (1–3)	-
5-year peak flow	-	1 (1–5)	2198	1 (1–3)	-
Spring recession flows	May 13 (Apr 7–Jun 12)	82 (50–115)	178 (78–872)	-	6 (4–11)
Dry-season baseflows	Aug 1 (Jul 12–Aug 13)	151 (90–183)	6 (0.2–12)	-	-

Ecosystem Baseflows

In wet water month types, median monthly discharge (MMD), derived using Natural Flows (data from Zimmerman et al. 2020), meets or exceeds Ecosystem Baseflows (Tessmann 1980) December through September for all reaches.

In moderate month types, MMD typically meets or exceeds Ecosystem Baseflows March through May (Figure 7). This pattern is similar for most sub-watersheds in the Fresno River watershed.

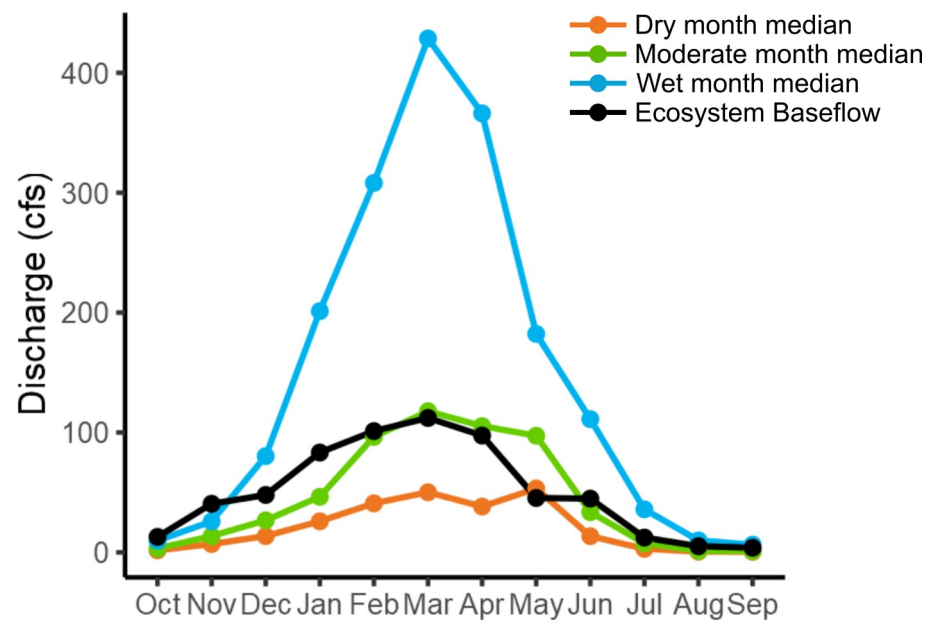


Figure 7. Ecosystem Baseflows (Fresno River 2).

Ecosystem Baseflows

Ecosystem Baseflows and drainage area are provided in Table 4 for each Fresno River tributary and mainstem reach analyzed in this report. There is one Ecosystem Baseflow value per month, which applies across all years. The numbers next to each stream name correspond to the numbers found on the Fresno River watershed map (Figure 2).

Table 4. Ecosystem Baseflows.

1) Fresno 1 593.4 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	99	99	110	85	44	44	11	5	5	13	43	47

2) Tributary 1 0.2 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	9	11	9	6	4	3	2	3	4	1	4	4

3) Fresno 2 581.1 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	83	101	112	97	45	45	12	5	4	13	41	48

4) Fresno 3 577.8 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	83	104	115	98	45	45	12	5	4	13	40	49

5) Fresno 4 293.4 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	85	109	126	100	48	48	16	5	3	12	40	52

6) Fresno 5 291.4 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	85	109	126	100	48	48	16	5	3	12	40	52

7) Tributary 2 2.4 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	1	2	1	1	1	<1	<1	<1	1	<1	1	1

8) Fresno 6 286.4 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	85	107	122	100	47	47	17	5	3	11	38	52

9) Fresno 7 285.7 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	86	107	122	100	47	47	17	5	3	11	38	51

10) Tributary 3 1.1 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

11) Fresno 8 282.5 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	86	107	121	99	47	47	17	5	3	12	37	51

12) Tributary 4 11.2 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	1	2	2	1	1	1	<1	<1	<1	<1	1	1

13) Fresno 9 270.7 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	85	107	119	100	49	47	20	5	3	12	37	50

14) Willow Creek 32.4 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	3	4	3	2	1	1	<1	<1	1	<1	1	1

15) Tributary 5 3.4 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

16) Tributary 6 1.3 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

17) Tributary 7 2.1 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

18) Mud Spring Creek 1.8 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

19) Fresno 10 224.4 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	104	121	134	96	51	50	13	5	3	12	47	59

20) Tributary 8 0.8 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

21) Tributary 9 1.5 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

22) Course Gold Creek 67.7 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	18	23	21	16	8	7	2	<1	1	1	7	9

23) Tributary 10 0.7 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

24) Tributary 11 1.9 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

25) Tributary 12 0.6 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

26) Tributary 13 0.8 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

27) Tributary 14 0.6 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

28) Fresno 11 146.2 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	47	69	74	72	50	33	22	12	5	10	29	33

29) Tributary 15 0.6 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

30) Tributary 16 1.8 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

31) Tributary 17 2.1 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

32) Tributary 18 0.6 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

33) Tributary 19 0.8 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

34) Tributary 20 0.3 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

35) Tributary 21 3 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	1	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1

36) Fresno 12 134.7 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	47	68	70	70	48	32	22	10	4	9	28	32

37) Spangle Gold Creek 3.6 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	1	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1

38) Tributary 22 1.8 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

39) Tributary 23 0.8 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

40) Tributary 24 2.2 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	1	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1

41) Fresno 13 118.7 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	48	67	66	63	41	31	23	12	6	9	28	31

42) Tributary 25 4 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	2	2	2	1	1	<1	<1	<1	<1	<1	1	1

43) Tributary 26 2.5 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	1	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1

44) Tributary 27 2.3 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	1	1	1	1	<1	<1	<1	<1	<1	<1	<1	1

45) Crooks Creek 7.8 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	4	5	5	3	2	1	<1	<1	<1	<1	1	2

46) Miami Creek 31.3 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	12	17	17	15	10	8	5	3	1	2	7	8

47) Tributary 28 0.9 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

48) Fresno 14 58.4 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	27	36	41	34	25	18	15	8	5	6	18	18

49) Tributary 29 1.1 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1

50) China Creek 9.4 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	4	5	5	4	2	2	1	<1	<1	1	2	2

51) Tributary 30 34 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	18	23	29	35	34	21	15	7	7	6	14	16

52) Tributary 31 1 mi^2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1

53) Fresno 15 2.6 mi^2

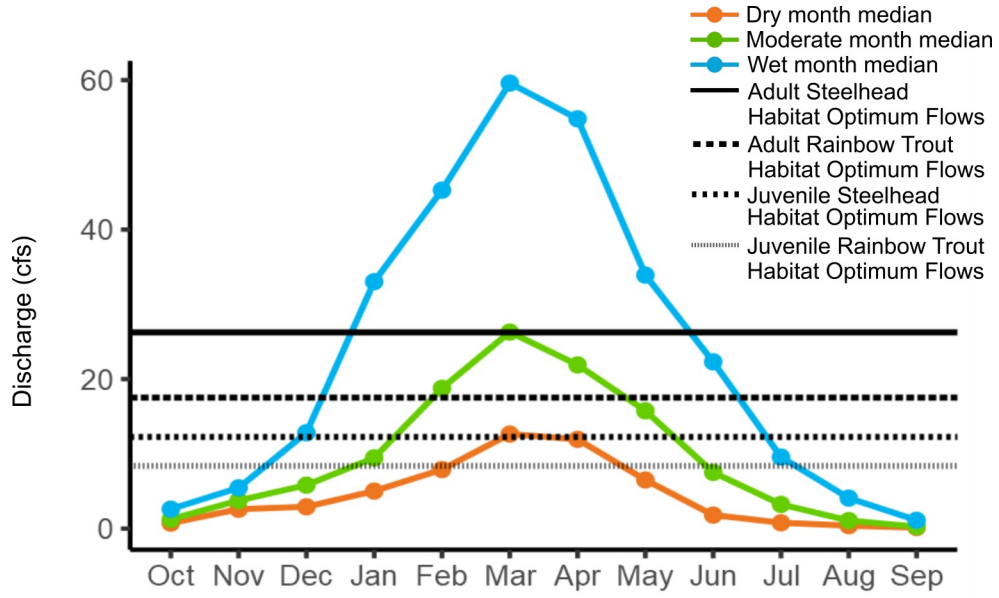
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ecosystem Baseflows (cfs)	1	1	1	1	1	1	<1	<1	<1	<1	<1	1

Salmonid Habitat Optimum Flows
By Monthly Duration

Figure 8 displays flows that maximize usable habitat for juvenile and adult steelhead and rainbow trout (Hatfield and Bruce 2000) along with median monthly Natural Flows (data from Zimmerman et al. 2020). The information is sorted by drainage area for the tributaries and mainstem. In drainages with altered flow, the period of flow below the juvenile steelhead Habitat Optimum Flows (Optimum Flows) may have a longer or shorter duration than shown here.

Tributary Streams: 0.2–68 mi^2

Natural Flows in most tributary streams are typically above the Optimum Flow for **2-5 months** of the year for moderate water month types for juvenile and adult rainbow trout and juvenile steelhead.



Fresno River: 2.6–623 mi^2

Natural Flows for the Fresno River are typically above the Optimum Flow for **2-6 months** of the year for moderate water month types for juvenile and adult rainbow trout and juvenile and adult steelhead.

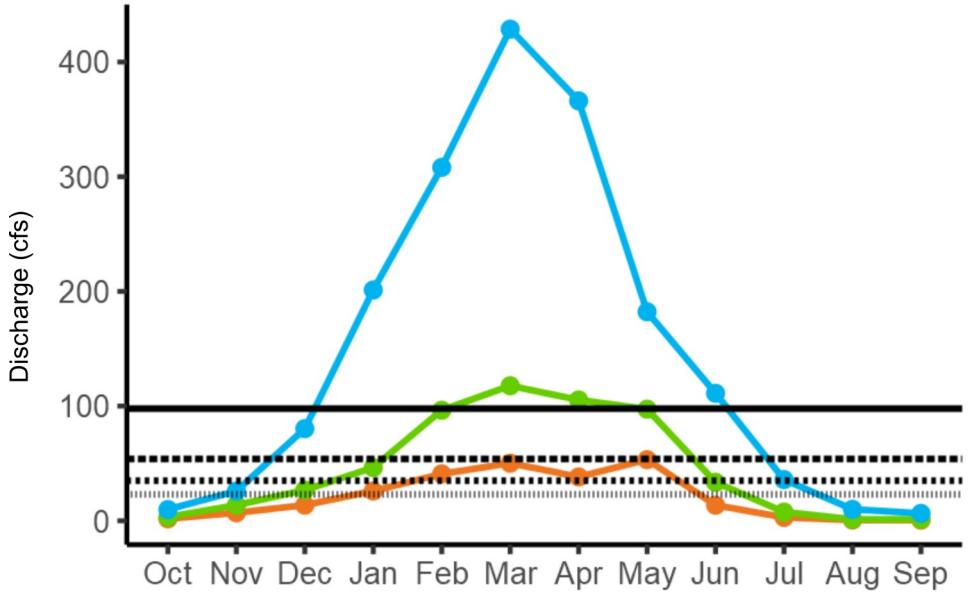


Figure 8. Salmonid Optimum Flows (for juvenile and adult steelhead and rainbow trout).

Salmonid Habitat Optimum Flows
By Drainage Area

Tables 5 and 6 present Optimum Flows for tributary streams and reaches on the Fresno River, grouped by location downstream or upstream of Hidden Dam.
Optimum Flows for steelhead and rainbow trout below Hidden Dam are displayed in Table 5.
Optimum Flows for steelhead and rainbow trout above Hidden Dam are displayed in Table 6.
The numbers next to each stream name correspond to the numbers found on the Fresno River watershed map (Figure 2).

Table 5. Salmonid Optimum Flows downstream of Hidden Dam (for juvenile and adult steelhead and rainbow trout).

Tributary Streams

Stream	Area (mi^2)	Juvenile Steelhead Optimum Flows (cfs)	Juvenile Rainbow Trout Optimum Flows (cfs)	Adult Steelhead Optimum Flows (cfs)	Adult Rainbow Trout Optimum Flows (cfs)
2) Trib 1	0.2	9	6	17	12
10) Trib 3	1.1	1	<1	1	1
7) Trib 2	2.4	3	2	4	3
12) Trib 4	11.2	3	2	4	4
14) Willow Creek	32.4	4	3	8	6

Fresno River

Stream	Area (mi^2)	Juvenile Steelhead Optimum Flows (cfs)	Juvenile Rainbow Trout Optimum Flows (cfs)	Adult Steelhead Optimum Flows (cfs)	Adult Rainbow Trout Optimum Flows (cfs)
13) Fresno 9	270.7	36	24	102	56
11) Fresno 8	282.5	36	24	101	56
9) Fresno 7	285.7	36	24	102	56
8) Fresno 6	286.4	36	24	102	56
6) Fresno 5	291.4	36	24	102	56
5) Fresno 4	293.4	36	24	102	56
4) Fresno 3	577.8	35	23	99	54
3) Fresno 2	581.1	34	23	98	54
1) Fresno 1	593.4	34	23	96	53

Table 6. Salmonid Optimum Flows upstream of Hidden Dam (for juvenile and adult steelhead and rainbow trout).

Tributary Streams

Stream	Area (mi^2)	Juvenile Steelhead Optimum Flows (cfs)	Juvenile Rainbow Trout Optimum Flows (cfs)	Adult Steelhead Optimum Flows (cfs)	Adult Rainbow Trout Optimum Flows (cfs)
34) Tributary 20	0.3	<1	<1	<1	<1
25) Tributary 12	0.6	1	<1	1	1
27) Tributary 14	0.6	1	<1	1	1
29) Tributary 15	0.6	1	<1	1	1
32) Tributary 18	0.6	1	<1	1	1
23) Tributary 10	0.7	1	<1	1	1
20) Tributary 8	0.8	1	<1	1	1
26) Tributary 13	0.8	1	1	1	1
33) Tributary 19	0.8	1	1	1	1
39) Tributary 23	0.8	1	1	1	1
47) Tributary 28	0.9	1	1	1	1
52) Tributary 31	1	2	1	2	2
49) Tributary 29	1.1	1	1	2	2
16) Tributary 6	1.3	1	1	1	1
21) Tributary 9	1.5	1	1	1	1
18) Mud Spring Creek	1.8	1	1	1	1
30) Tributary 16	1.8	1	1	2	2
38) Tributary 22	1.8	1	1	2	2
24) Tributary 11	1.9	1	1	2	2
17) Tributary 7	2.1	1	1	1	1
31) Tributary 17	2.1	1	1	2	2
40) Tributary 24	2.2	2	1	2	2
44) Tributary 27	2.3	2	2	3	3
43) Tributary 26	2.5	2	1	3	3
35) Tributary 21	3	2	1	3	2
15) Tributary 5	3.4	1	1	2	2
37) Spangle Gold Creek	3.6	2	1	3	3
42) Tributary 25	4	3	2	5	4
45) Crooks Creek	7.8	5	4	9	7
50) China Creek	9.4	6	4	10	8
46) Miami Creek	31.3	12	8	26	18
51) Tributary 30	34	19	13	46	29
22) Coarse Gold Creek	67.7	13	9	28	19

Fresno River

Stream	Area (mi^2)	Juvenile Steelhead Optimum Flows (cfs)	Juvenile Rainbow Trout Optimum Flows (cfs)	Adult Steelhead Optimum Flows (cfs)	Adult Rainbow Trout Optimum Flows (cfs)
53) Fresno 15	2.6	3	2	4	3
48) Fresno 14	58.4	21	14	50	31
41) Fresno 13	118.7	28	19	74	43
36) Fresno 12	134.7	29	20	77	44
28) Fresno 11	146.2	29	20	78	45
19) Fresno 10	224.4	38	25	107	59

REFERENCES

CDFW (2020a). Overview of analysis for instream flow regime criteria on a watershed scale. California Department of Fish and Wildlife, Instream Flow Program (CDFW), West Sacramento, CA.

CDFW (2020b). Instream Flow Program homepage. California Department of Fish and Wildlife, Instream Flow Program (CDFW), West Sacramento, CA. Available: https://www.wildlife.ca.gov/Conservation/Watersheds/Instream-Flow. Accessed: February 3, 2020.

Hatfield, T. and J. Bruce (2000). Predicting salmonid habitat-flow relationships for streams from western North America. North American Journal of Fisheries Management **20**: 1005-1015.

Lane, B., N. Patterson, L. Qiu, S. Sandoval, S. Yarnell, R. Lusardi, J. Zimmerman, E. Stein, L. Brown, T. Grantham and J. Howard (2020). Functional Flows Calculator v2.02. University of California, Davis, Davis, CA. Available: https://eflows.ucdavis.edu Accessed: March 4, 2020.

Rodríguez-Iturbe, I. and J. B. Valdés (1979). The geomorphic structure of hydrologic response. Water Resources Research 15(6): 1409-1420.

Tessmann, S. A. (1980). Environmental assessment, technical appendix E in environmental use sector reconnaissance elements of the western Dakotas region of South Dakota study. South Dakota State University, Water Resources Research Institute, Brookings, SD.

USEPA and USGS (2012). National Hydrography Dataset Plus (NHDPlus) medium resolution version 2.10. U.S. Environmental Protection Agency (USEPA) and the U.S. Geological Survey (USGS).

USGS (2020). National Water Information System data available on the World Wide Web (USGS Water Data for the Nation). Available: https://waterdata.usgs.gov/nwis. Accessed: January 23, 2020.

Westerling, L., J. Medellin-Azuara and J. Viers (2018). Preview San Joaquin Valley region report. California's Fourth Climate Assessment. SUM-CCCA4-2019-003.

Zimmerman, J. K. H., D. M. Carlisle, J. T. May, K. R. Klausmeyer, T. E. Grantham, L. R. Brown and J. K. Howard (2020). California Unimpaired Flows Database v2.0. The Nature Conservancy, San Francisco, CA. Available: https://rivers.codefornature.org. Accessed: February 28, 2020.

Mailing address:
California Department of Fish and Wildlife, P.O. Box 944209, Sacramento CA 94244-2090

All photos in this document were taken by Department Staff. Cover photos are Fresno River (Fresno River watershed, Madera County).

Appendix A
Reach Delineation

Table A-1 presents each reach analyzed in this report with the associated NHDPlus COMIDs. The stream reaches were delineated using NHDPlus Version 2 medium resolution mapping (USEPA and USGS 2012). The COMIDs were used to identify and download Natural Flow estimates for each selected reach.

Table A-1. Reach delineation.

Stream	COMID
1) Fresno 1	19797465
2) Tributary 1	19778971
3) Fresno 2	19784489
4) Fresno 3	19778977
5) Fresno 4	19778859
6) Fresno 5	19772797
7) Tributary 2	948040111
8) Fresno 6	19778077
9) Fresno 7	24721995
10) Tributary 3	17100663
11) Fresno 8	17100657
12) Tributary 4	17100633
13) Fresno 9	17100623
14) Willow Creek	17100575
15) Tributary 5	17101081
16) Tributary 6	17101073
17) Tributary 7	17101069
18) Mud Spring Creek	17100951
19) Fresno 10	17101085
20) Tributary 8	17100457
21) Tributary 9	17100395
22) Coarse Gold Creek	17100407
23) Tributary 10	17100351
24) Tributary 11	17100315
25) Tributary 12	17100355
26) Tributary 13	17100273
27) Tributary 14	17100353

Stream	COMID
28) Fresno 11	17100265
29) Tributary 15	17100255
30) Tributary 16	17100217
31) Tributary 17	17100199
32) Tributary 18	17100223
33) Tributary 19	17100241
34) Tributary 20	17100167
35) Tributary 21	17100135
36) Fresno 12	17100137
37) Spangle Gold Creek	17100117
38) Tributary 22	17100103
39) Tributary 23	17100077
40) Tributary 24	17100059
41) Fresno 13	17100057
42) Tributary 25	17100921
43) Tributary 26	17100005
44) Tributary 27	17099977
45) Crooks Creek	17099845
46) Miami Creek	17099879
47) Tributary 28	17099953
48) Fresno 14	17099911
49) Tributary 29	17099909
50) China Creek	17099991
51) Tributary 30	17099917
52) Tributary 31	17099967
53) Fresno 15	17099931

Addendum
06-02-2020

Instream Flow Regime Criteria on a Watershed Scale: Fresno River (Version 2, filename FresnoWCR_v2_06022020.pdf) was updated to meet the requirements of Web Content Accessibility Guidelines (WCAG). This document now complies with WCAG requirements for making web content more accessible to people with disabilities, per state and federal law at time of report issuance, and replaces the original document.

The following updates have also been made within the document:

- Page 7: The following sentence was added: “The common identifiers (COMIDs) that correspond to the numbered reaches are listed in Appendix A.”
- Page 17: Changed data access year for Lane et al. from 2019 to 2020.
- Page 30 and 31, Table 6: A duplicate reach position number was removed and replaced with the correct sequence of position numbers for the Tributary Streams and Fresno River table.
- Page 32: The following reference was added: “USEPA and USGS (2012). National Hydrography Dataset Plus (NHDPlus) medium resolution version 2.10. U.S. Environmental Protection (USEPA) and the U.S. Geological Survey (USGS).”
- Page 33: Appendix A was added, showing each reach analyzed in this report with the associated NHDPlus COMIDs.