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State of California – Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
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GAVIN NEWSOM, *Governor*
CHARLTON H. BONHAM, *Director*

February 26, 2021

Subject: CDFW Draft Instream Flow Recommendations – Lower Ventura River and Coyote Creek, Ventura County

Dear Stakeholders:

The Ventura River watershed is a priority stream under the 2016 California Water Action Plan (CWAP) and supports critical habitat for federally endangered Southern California steelhead (*Oncorhynchus mykiss*; SC steelhead). The CWAP calls for actions to protect and restore important ecosystems, support flow enhancement activities, and develop flow criteria in priority streams. Consistent with the CWAP, the California Department of Fish and Wildlife (CDFW) is providing draft flow recommendations in its attached report *DRAFT Instream Flow Regime Recommendations for the Lower Ventura River, Ventura County* (CDFW 2021) for two sections of the Watershed: (1) the lower Ventura River (from Shell Road to upstream of the confluence with San Antonio Creek); and (2) Coyote Creek below Casitas Dam.

CDFW's draft recommendations are based on the CDFW report *Instream Flow Regime Criteria on a Watershed Scale: Ventura River* and incorporate hydrology data from United States Geological Survey gages and statewide hydrologic models as appropriate. The draft recommendations identify flows necessary to support spawning, rearing, migration, and habitat for adult and juvenile SC steelhead, as summarized here:

- The lower Ventura River draft monthly flow recommendations support SC steelhead passage and habitat during the spawning season from December to May and protect low-flow habitat from June to October. In addition, the draft recommendations include fall pulse flows in October through December and varying peak flows January through May.
- The Coyote Creek draft monthly flow recommendations are designed to preserve a healthy stream ecosystem. In addition, the draft recommendations include fall pulse flows in October through December and varying peak flows January through May.

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CDFW will be accepting public input on the attached draft flow recommendations for a 30-day period starting on February 26, 2021. Input should be sent to InstreamFlow@wildlife.ca.gov by March 29, 2021.

Sincerely,

DocuSigned by:
Ed Pert
A87CE992DB57479...

Ed Pert
Regional Manager
CDFW, South Coast Region

Attachment: *DRAFT Instream Flow Regime Recommendations for the Lower Ventura River, Ventura County* (CDFW 2021)

State of California
Natural Resources Agency
California Department of Fish and Wildlife

DRAFT INSTREAM FLOW REGIME RECOMMENDATIONS FOR THE LOWER VENTURA RIVER, VENTURA COUNTY

FEBRUARY 2021

DRAFT

Cover photo: Lower Ventura River Reach 2 at 34.4 cfs, 03/28/2017.

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ABBREVIATIONS AND ACRONYMS

cfs	cubic feet per second
CWAP	California Water Action Plan
Department	California Department of Fish and Wildlife
NMFS	National Marine Fisheries Service
SHOF	Steelhead Habitat Optimum Flow
USGS	United States Geological Survey

CONVERSIONS

1 cubic foot per second ≈ 2.83×10^{-2} cubic meters per second

1 square mile ≈ 2.59 square kilometers

1 mile ≈ 1.61 kilometers

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1.0 BACKGROUND

The California Department of Fish and Wildlife (Department) has an interest in assuring that stream flows are maintained at levels that are adequate for long-term protection, maintenance, and continued viability of stream-related fish and wildlife resources. The Department holds fish and wildlife resources in California in trust for the people of the State and has jurisdiction over the conservation, protection, and management of those resources (Fish and Game Code §711.7; Fish and Game Code §1802). As the Trustee Agency, the Department seeks to maintain native fish, wildlife, plant species, and natural communities for their intrinsic and ecological values and for their benefits to citizens in the State. This includes habitat protection and maintenance of habitat in sufficient amounts and quality to ensure the survival of all native species and natural communities.

Additionally, Action 4 of the California Water Action Plan (CWAP) calls for actions to protect and restore important ecosystems, support flow enhancement activities, and develop flow criteria in five priority streams that support critical habitat for threatened and endangered anadromous salmonids. The Ventura River was selected as one of these five priority streams because of its high resource biological value and potential for species recovery (CDFW 2017b). The recommendations presented in this document were produced in part to implement activities for the CWAP (CNRA et al. 2014).

Of the six Pacific salmonid species native to the west coast of North America, steelhead (*Oncorhynchus mykiss*) are the only species naturally reproducing within Southern California coastal watersheds (NMFS 2012). In 1997, the National Marine Fisheries Service (NMFS) listed the Southern California distinct population segment of steelhead as endangered under the federal Endangered Species Act (62 Federal Register 43937; NMFS 2012). NMFS determined that the Southern California steelhead distinct population segment is "ecologically discrete" from other Pacific coastal steelhead populations (NMFS 2012).The Department has identified the Ventura River watershed as a high-priority watershed providing important habitat necessary for maintaining the health of Southern California steelhead (Allen 2015).

Several factors limiting steelhead production and recovery have been identified in the Ventura River watershed. These factors include altered flow regimes due to dams, barriers, drought, and climate change; stream habitat that lacks sufficient spawning gravels and pool habitat; decreased riparian habitat due to urbanization; and poor water quality associated with increased water temperatures related to reduced canopy cover and water diversions (Moyle et al. 2008; Walter 2015). The loss of high quality freshwater habitat is one of the leading causes of salmonid decline in California (CDFG 2004). Currently, access to over half of the historically available spawning and rearing habitat in the Ventura River watershed is blocked by the Matilija Dam and Casitas Dam

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(Entrix 2003). Furthermore, land use change and water withdrawals below these dams have degraded the remaining spawning and rearing habitat (Entrix 2003).

Maintaining suitable instream flows that protect basic ecosystem functions can help maintain freshwater habitat for migration, spawning, incubation, and juvenile rearing of salmonids. In this document, the Department presents a flow recommendation that identifies the necessary flows to protect all steelhead life stages and the habitats that support them in the lower Ventura River. The recommendations were developed using field- and desktop-based study results and incorporate life stage periodicity needs of adult and juvenile steelhead. The draft flow recommendations integrate flow criteria developed through a recent Watershed Criteria Report *Instream flow regime criteria on a watershed scale: Ventura River, Ventura County* (CDFW 2020a). The recommendations were developed for the lower Ventura River from Shell Road to upstream of the confluence with San Antonio Creek, as well as for Coyote Creek below Casitas Dam.

The Department believes these recommendations to be comprehensive and substantially complete. These flow recommendations were developed for use in water management planning and decision-making processes. The Department may revise instream flow criteria and recommendations for the lower Ventura River based upon any new scientific information that may become available. The State Water Resources Control Board's (State Water Board) forthcoming groundwater-surface water model will quantify the relationship between surface and subsurface flow, providing an understanding of water supply, water demand, and instream flows in the watershed (Geosyntec Consultants and David B Stephens & Associates 2019). Integration of the Department's study results with the State Water Board's groundwater-surface water model will be an important step in implementation of these flows within the Ventura River watershed.

2.0 VENTURA RIVER WATERSHED

The Ventura River watershed covers 226 square miles and is the smallest of three major watersheds in Ventura County (Figure 1). The river is 16.2 miles long from the mouth of the Ventura River at the Pacific Ocean to the Matilija Creek confluence (LARWQCB 2016; Walter 2015). Groundwater basins in the Ventura River watershed are composed of alluvial aquifers underlying the surface channels and are highly interconnected with surface water. These basins are quickly recharged or depleted dependent on surface water flow conditions (LARWQCB 2016).

In this document, the lower Ventura River is defined as the section of river that extends from the mouth of the Ventura River upstream to the confluence with San Antonio Creek. The lower Ventura River provides important habitat for fish and wildlife, including rearing and spawning habitat for anadromous steelhead (Allen 2015). Coyote Creek, a

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tributary to the Ventura River, historically also provided important steelhead spawning habitat, but currently has limited accessible habitat due to the construction of Lake Casitas (Titus et al. 2010).

For this study, the lower Ventura River study area was divided into three reaches, consistent with the Watershed Criteria Report (Reach 2, Reach 3, and Reach 4; Figure 2). These reaches were limited to public lands (e.g., state and public parks), and private property where access permission was granted. The three reaches are defined as follows:

- Reach 2 begins near Shell Road and continues to Weldon Canyon,
- Reach 3 begins at Weldon Canyon and extends upstream to just below the levee pool downstream of the confluence with San Antonio Creek,
- Reach 4 is the most upstream reach and is located between the levee pool and the San Antonio Creek confluence. Reach 4 is important as a transition area into the intermittent reach and San Antonio Creek.

Reach 3 and Reach 4 are generally within the live reach (Walter 2015). Survey sites were selected in each of the reaches that were representative of conditions within that reach.

Currently, there are five major urban water suppliers in the Ventura River watershed which provide water for roughly 42,000 connections; the City of Ventura supplies the majority with approximately 32,000 service connections (Walter 2015). These major suppliers use a combination of surface water withdrawals and groundwater withdrawals to meet the demand (Walter 2015). In addition, the watershed has 11 mutual water companies, which also withdraw groundwater to meet their demands. Lastly, domestic diversions in the watershed include an estimated 442 private wells and 21 surface water withdrawals (Walter 2015).

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Figure 1. Ventura River watershed map. Note: intermittent and perennial streams shown here were classified by USGS (USEPA and USGS 2012). Additional USGS gages not used in this report are not shown.

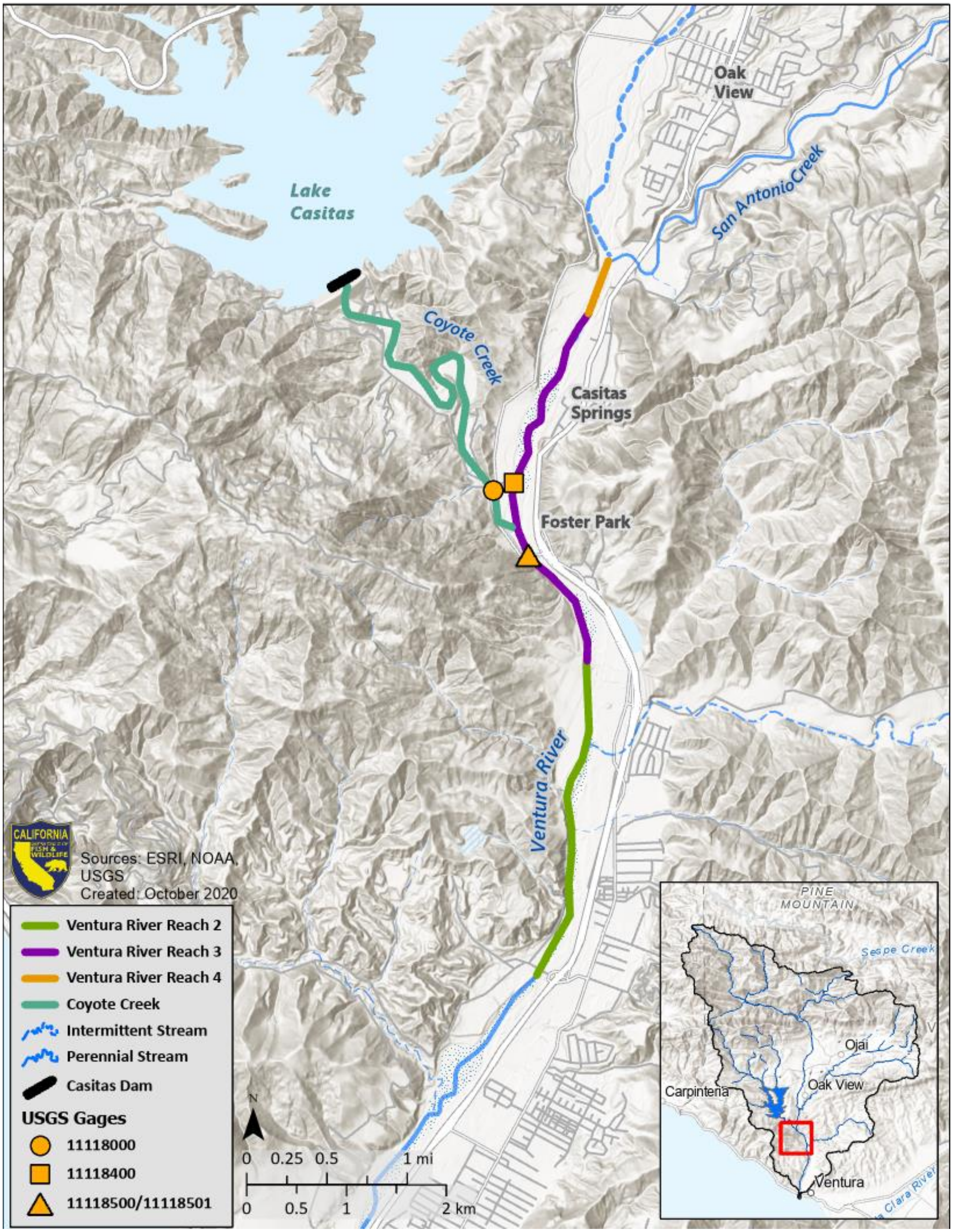

Figure 2. Map of lower Ventura River and Coyote Creek below Lake Casitas. Lower Ventura River reaches (CDFW 2020a) are indicated. Note: intermittent and perennial streams shown here were classified by USGS (USEPA and USGS 2012).

2.1 Ventura River Watershed Steelhead

Southern California steelhead are generally distributed in coastal streams from the Santa Maria River to the U.S.–Mexico border. Of the 46 watersheds historically supporting Southern California steelhead populations, over half have been extirpated. The four largest watersheds (including the Ventura River) have experienced declines in run sizes of 90% or more (Moyle et al. 2008). In 1996 the Department released the *Steelhead Restoration and Management Plan for California* (CDFG 1996), which reported that the Ventura River at one time likely supported one of the largest runs of steelhead on the South Coast (runs of 4,000–5,000 fish). In the 1940's, prolonged drought and the construction of Matilija Dam devastated the population. By 1976 the adult steelhead run size was estimated to be approximately 100 adults (Titus et al. 2010).

Southern California steelhead follow a similar life history to Northern California steelhead runs; however, they are ecologically and physiologically adapted to the seasonally warm and intermittent coastal streams of Southern California (Moyle et al. 2008; Titus et al. 2010). Additionally, Southern California steelhead rely on intermittent winter rainstorms to move through the lower watershed and seasonally open estuaries. This small window for passage results in a restricted spawning period (Moyle et al. 2008). Figure 3 shows the life stage periodicity for Southern California steelhead in the Ventura River watershed throughout the year.

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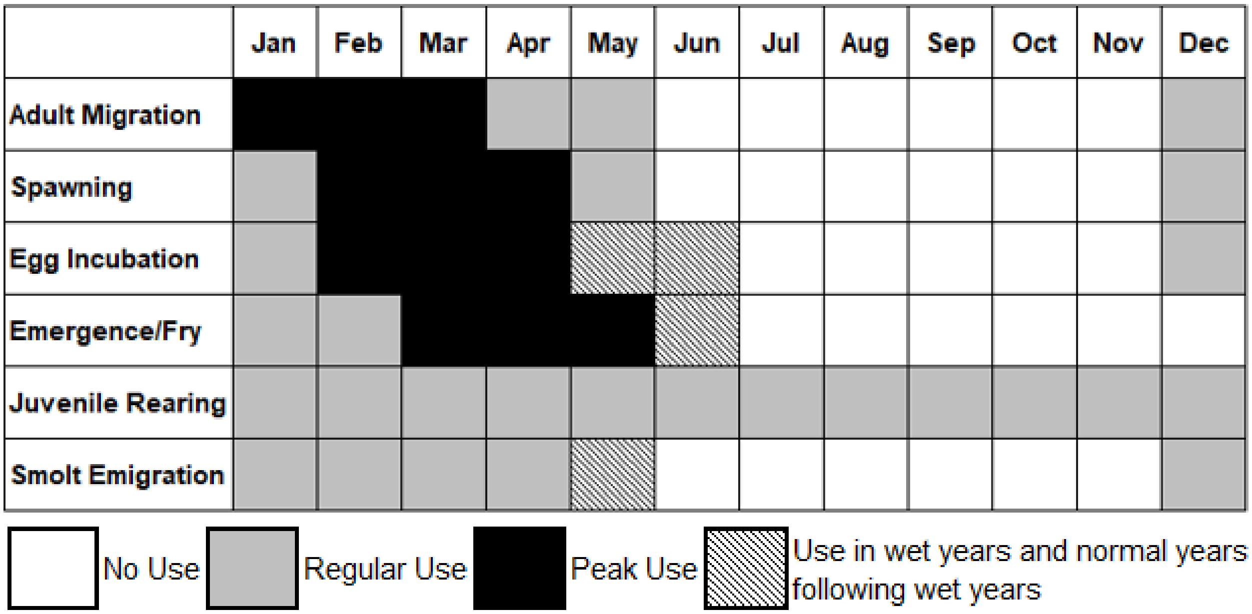

Figure 3. Life stage periodicity for Southern California steelhead in the Ventura River watershed.[a]

Although water quality and suitable habitat have been greatly reduced in the Ventura River watershed, adult, juvenile, and fry steelhead have all been detected in the upper portion of the live reach, suggesting that spawning substrate and rearing habitat still exist (Allen 2015; Capelli 1997; Entrix 2003). Also, juvenile steelhead have shown similar growth rates to those observed in other populations, indicating sufficient food production for juvenile rearing in the live reach of the Ventura River (Entrix 2003; Moore 1980).

Coyote Creek and its tributary Santa Ana Creek provided important steelhead habitat until the construction of Casitas Dam and Lake Casitas captured upstream flows and blocked fish passage beyond the first 3 miles of the creek, greatly reducing available steelhead spawning habitat within the watershed (Titus et al. 2010). The limited flows and degraded habitat in the lower portion of Coyote Creek are not currently sufficient to support steelhead populations (Grantham and Moyle 2014).

2.2 Hydrology

Like many coastal watersheds in California, the Ventura River is characterized by a Mediterranean climate. The Ventura River watershed follows a pattern of wet and cooler winters (November–March) and warmer dry summers (April–October). Discharge is

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[a] Larson, M. CDFW South Coast Region Fisheries Supervisor, personal communication August 14, 2018.

characterized by low summer flows and "flashy" short duration, high intensity peak storm events in the winter (Keller and Capelli 1992). In addition to the highly variable rainfall, the steepness of the landscape (~600 feet per mile elevation gain), creates an orographic effect that causes rapid flashy storm events (Walter 2015).

2.2.1 Lower Ventura River

From the estuary to Foster Park, the Ventura River receives flow inputs from Coyote Creek, Cañada Larga, various small springs, and treated effluent from the Ojai Valley Sanitary District treatment facility (Walter 2015). However, surface flow inputs from Coyote Creek have been minimal since the construction of the Casitas Dam in 1959. The significant input of treated effluent has resulted in increased flow in the Ventura River downstream of the treatment facility (Entrix and Woodward Clyde Consultants 1997; Entrix 2003).

Between Foster Park and the San Antonio Creek confluence, the lower Ventura River receives flow inputs from in-river groundwater springs near Casitas Springs and San Antonio Creek. Between 1906 and 1908, a subsurface diversion dam was constructed across most of the Ventura River channel near Foster Park at the Coyote Creek confluence. The purpose of the dam was to increase the amount of surfaced groundwater available for diversion (NMFS 2007; Walter 2015). This dam can result in increased surface flow from the San Antonio Creek confluence downstream through Casitas Springs to Foster Park, depending on rainfall patterns and groundwater conditions (Entrix 2003; Walter 2015).

Substantial flow contributions from surfaced groundwater and San Antonio Creek result in perennial flow in what is known as the "live reach" (Walter 2015). The live reach begins directly downstream of Foster Park and extends upstream to the confluence with San Antonio Creek (Walter 2015; Figure 2). However, during drought years, the section of the live reach between Foster Park and the levee pool near Casitas Springs can have little to no flow[b]. Above the live reach, surface flow is intermittent up to the Robles Diversion Dam (Entrix and Woodward Clyde Consultants 1997). The area where flow transitions from perennial to intermittent can vary annually depending on rainfall (Walter 2015).

[b] California Department of Fish and Wildlife Region 5, office files. Ventura River steelhead spawner surveys, drought data from December through July, 2015–2020.

The lower Ventura River contains three USGS gages with long-term hydrologic records (greater than 20 years of continuous data) that can be used to evaluate the existing hydrology (see Figure 2). The three gages are defined as follows:

- USGS gage 11118500 (Ventura R Nr Ventura CA) is located at the Casitas Vista Road bridge at Foster Park and represents current flows in the lower Ventura River. This gage has a period of record beginning in water year 1930 and extending through the present.
- USGS gage 11118400 (Ventura R Div Nr Ventura CA) represents the surface water diversion for municipal water supply to the City of Ventura. This gage has a period of record beginning in water year 1970 and ending in 2008.
- USGS gage 11118501 (Ventura R Nr Ventura + Div) combines the discharge of USGS 11118500 and USGS 11118400[c]. This gage, referred to here as the least-impaired gage, has a period of record between water years 1965 to 2007. The gage was established to compute the total runoff from the watershed by including the surface water diverted directly above gage 11118500 (as measured by gage 11118400)[d]. While we have determined this gage to be the least-impaired, flow results from this gage are still impacted by water users and artificial structures. Mean daily data for this gage are presented below to describe conditions in the lower Ventura River over the period of record (Figure 4).

[c] For the water years 1965 through 1969, the city gage 671 was used to represent city surface flow diversions prior to the installation of USGS gage 11118400.
[d] O'Neil, C. USGS, California Water Science Center, Hydrologic Technician, personal communication February 13, 2019.

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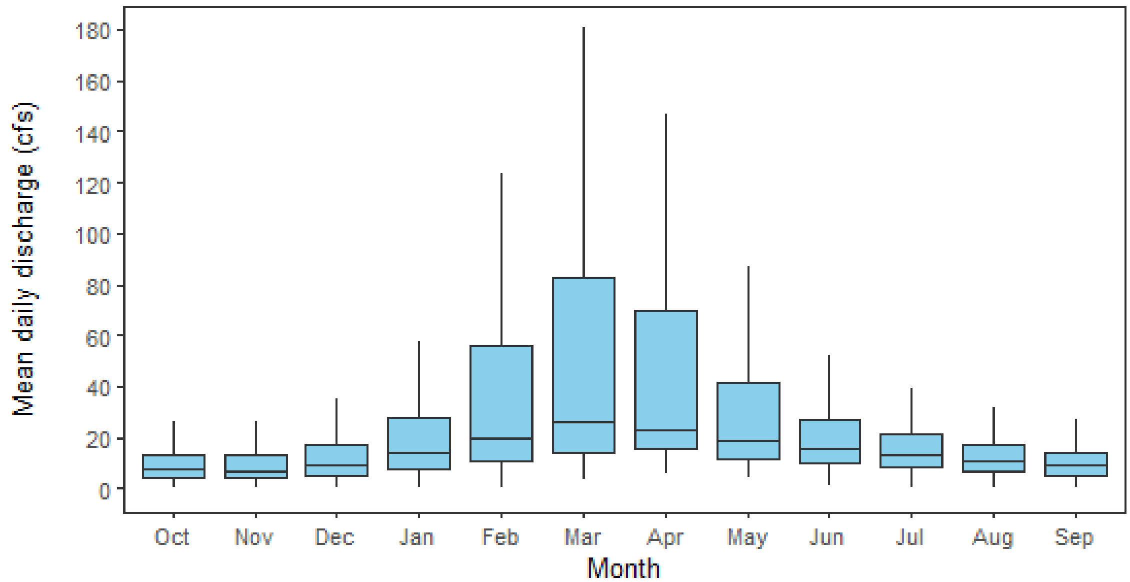

Figure 4. Boxplot of mean daily discharge by month in the lower Ventura River using USGS gage 11118501 for the water years 1965–2007. Colored bars represent 25th–75th percentile values, whiskers are 1.5× the interquartile range, and horizontal lines are median values. Outliers are not shown.

2.2.2 Coyote Creek

The headwaters of Coyote Creek are located upstream of Lake Casitas. The lake receives inflow from both Upper Coyote Creek and Santa Ana Creek. The Coyote Creek watershed was permanently modified by the construction of the Casitas Dam, which began in 1956. The dam was completed in 1959, forming Lake Casitas. Coyote Creek joins the Ventura River at the southern end of Foster Park (Figure 2). The section of Coyote Creek below Lake Casitas is not currently gaged; however, USGS gage 11118000 near the confluence with the Ventura River was active from water year 1928 to 1982 and allows for a comparison of conditions pre- and post-dam construction. The gage shows high seasonal and interannual flow variability in pre-dam years. Since the construction of the dam, flow has declined, such that the creek is typically dry after late spring (Grantham and Moyle 2014; Figure 5; NMFS 2007). The pre-dam period is represented by water years 1928–1955 and is relatively unimpaired, while water years 1970–1982 represent post-dam conditions (data were missing in 1933 and between 1959–1969).

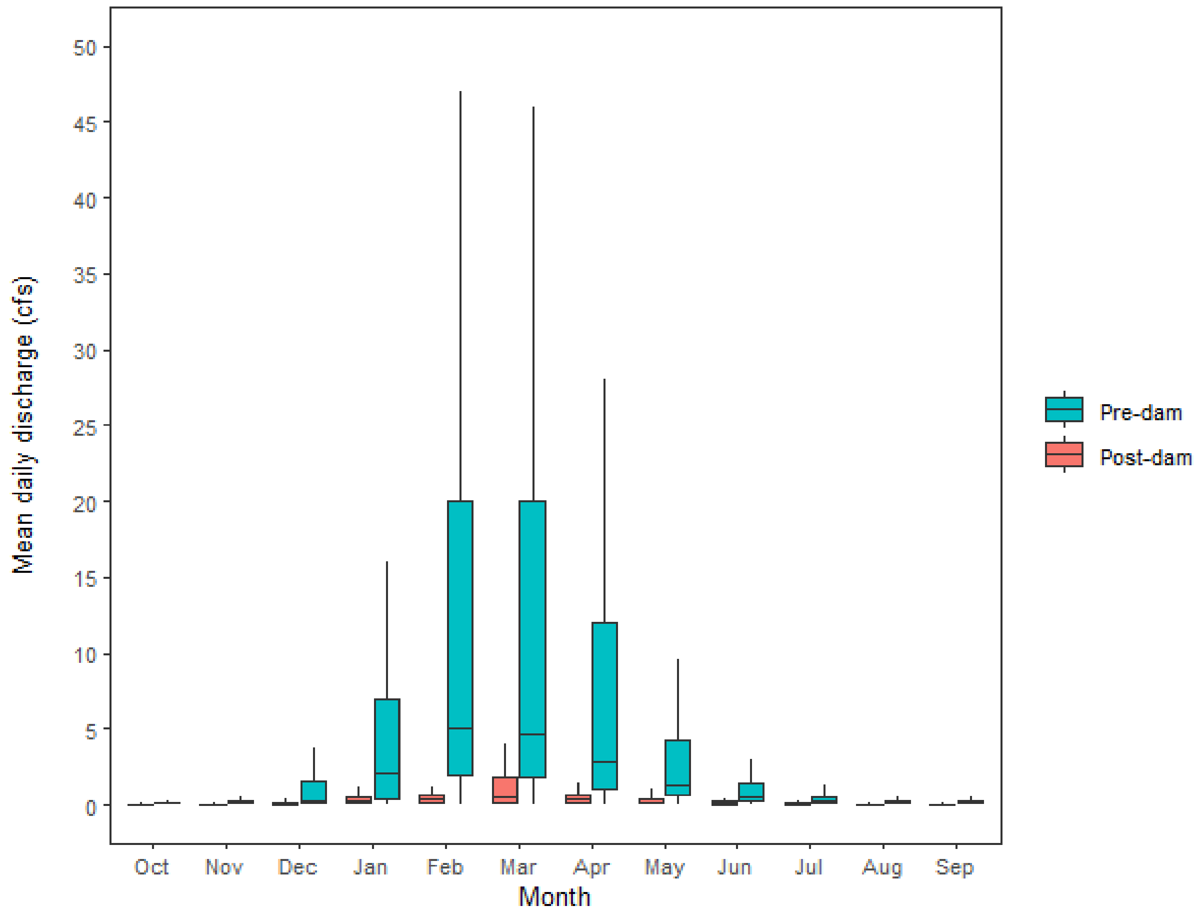

Figure 5. Boxplot of mean daily discharge by month in Coyote Creek using gage 11118000. Colored bars represent 25th–75th percentile values, whiskers are 1.5× the interquartile range, and horizontal lines are median values. Outliers are not shown.

3.0 DATA SOURCES

The section below describes the data sources that were used to determine the values included in the flow recommendations. Several of these datasets were published in the Ventura River Watershed Criteria Report and are replicated in the sections below (CDFW 2020a). Additionally, the sections below include supplemental results that were calculated using gage data and were not published in the Ventura River Watershed Criteria Report.

Functional flow metrics calculated using gage data were assessed to determine the appropriateness of these flows seasonally given historical records. Also, existing flow studies and recommendations generated by outside agencies were considered while creating the recommended flow criteria.

3.1 Sensitive Period Indicators

The Sensitive Period Indicator flow was used to identify the sensitive low-flow period. When streamflow drops below the Sensitive Period Indicator, fish and benthic macroinvertebrates may be particularly sensitive to additional water reductions and other stressors (e.g., poor water quality; Annear et al. 2004; CDFW 2017a; CDFW 2020b). The Sensitive Period Indicator was identified using the Department's *Standard operating procedure for the Wetted Perimeter Method* (CDFW 2020d).

To implement the Wetted Perimeter Method, channel cross sections were surveyed at select riffle crests with an accompanying discharge measurement, and then the wetted perimeter length was modeled at a range of discharges. The Sensitive Period Indicator flow must produce a wetted perimeter that covers at least 50% of the bankfull channel perimeter in streams up to 50 feet wide and 60–70% in wider streams (CDFW 2020d). When these criteria are not met, the stream ecosystem is likely to be in a sensitive period (CDFW 2017a).

There is one Sensitive Period Indicator flow value for each reach, which applies across all months and years. Results presented here are the mean of results for all sites within a reach (Table 1). The cross-section transect profiles and wetted perimeter vs. discharge curves used in the analysis for each site are located in Appendix B of the Ventura River Watershed Criteria Report (CDFW 2020a). Field data were not collected in Coyote Creek; therefore, Sensitive Period Indicator Flows are not available for Coyote Creek.

Table 1. Lower Ventura River watershed Sensitive Period Indicator Flows.

Reach	Sensitive Period Indicator Flow (cfs)
Ventura Reach 2	16
Ventura Reach 3	14
Ventura Reach 4	15

3.2 Steelhead Passage Flows

Field data were collected to assess minimum steelhead Passage Flows using the Department's *Standard Operating Procedure for the Habitat Retention Method in California* (CDFW 2018b). This method seeks to identify flows required to permit steelhead passage across the shallowest part of a channel, the hydraulic control. To perform this method, channel cross sections were surveyed at the hydraulic control points of riffles with an accompanying discharge measurement (CDFW 2020c). To determine minimum Passage Flows, depth, velocity, and wetted perimeter were modeled at a variety of discharges. Minimum Passage Flows for adult steelhead must

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produce a mean depth of 0.7 feet at the hydraulic control, while also meeting additional criteria for percent wetted perimeter or velocity to preserve connectivity between mesohabitat units (CDFW 2020b). The 0.7 ft minimum passage depth criterion is based on the water depth needed for an adult steelhead to adequately navigate over a riffle crest with sufficient clearance to minimize abrasion and contact with the streambed (R2 Resource Consultants Inc and Stetson Engineers Inc 2008).

Steelhead Passage Flows provide connectivity between mesohabitat units for steelhead. Results presented here are the mean of results for all sites within a reach (Table 2). The results of this method are published in the Ventura River Watershed Criteria Report (CDFW 2020a). Field data were not collected in Coyote Creek; therefore, steelhead Passage Flows are not available for Coyote Creek.

Table 2. Lower Ventura River watershed steelhead Passage Flows.

Reach	Steelhead Passage Flow (cfs)
Ventura Reach 2	40
Ventura Reach 3	33
Ventura Reach 4	44

3.3 Ecosystem Baseflows

Ecosystem Baseflows estimate monthly instream flows needed to preserve a healthy stream ecosystem (Tessmann 1980). However, flows greater than the Ecosystem Baseflows may be beneficial to specific species and/or the ecosystem. Ecosystem Baseflows by month are calculated using Tessmann's adaptation of the Tennant method (Tennant 1976; Tessmann 1980).

During drier months, when mean monthly discharge (MMD) is less than 40% of mean annual discharge (MAD), the MMD is the selected flow for that month. In wetter months, when 40% of the MMD is greater than 40% of the MAD, 40% of the MMD is the selected flow for that month (CDFW 2020a; CDFW 2020b).

Ecosystem Baseflows are provided in Table 3 for the lower Ventura River and Coyote Creek. The Ecosystem Baseflows for the lower Ventura River are applied across all reaches and were determined using the least-impaired USGS gage 11118501 during the water years 1965–2007. The analysis for Coyote Creek used discharge data from USGS gage 11118000 from water years 1928 to 1955 (data were missing in 1933) to represent the natural flows in the creek prior to the construction of Casitas Dam. There is one Ecosystem Baseflow value per month, which applies across all years. The analysis using long-term gage data for the lower Ventura River was published in the

Ventura River Watershed Criteria Report, Appendix A (CDFW 2020a). Ecosystem baseflow results using gaged data for Coyote Creek were calculated for this report.

Table 3. Ecosystem baseflows (in cfs) for the lower Ventura River and Coyote Creek based on data from USGS gage 11118501 from water year 1965–2007 and USGS gage 11118000 from water years 1928–1955 (missing data in 1933), respectively.

Reach	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lower Ventura River	74	131	93	38	33	26	17	12	11	10	20	33
Coyote Creek	11	18	18	5	4	1	1	0.4	0.3	0.4	1	5

3.4 Steelhead Habitat Optimum Flows

The steelhead Habitat Optimum Flows (SHOF) analysis estimates the optimal discharge for juvenile and adult steelhead, which is intended to maximize the amount of usable habitat. Habitat Optimum Flows for steelhead were determined using the equations developed by Hatfield and Bruce and are presented in Table 4 (CDFW 2020b; Hatfield and Bruce 2000). The equations were developed using a synthesis of existing PHABSIM[e] studies conducted across the western United States.

The SHOFs for the lower Ventura River apply across all reaches and were calculated using data from the least-impaired USGS gage 11118501 based on the water years 1965–2007. The SHOFs for Coyote Creek were determined using data from USGS gage 11118000 during the water years 1928–1955 (data were missing in 1933) to reflect pre-dam conditions. The lower Ventura River adult SHOF and both Coyote Creek SHOFs are only presented in this document. The lower Ventura River juvenile SHOF was published in the Ventura River Watershed Criteria Report (CDFW 2020a; Appendix A). The juvenile and adult SHOFs were calculated using the following equations:

$$\ln(\text{optimal discharge for juvenile steelhead}) = -8.482 + 0.593 \times \ln(MAD) + 2.555 + \ln(\text{latitude})$$

$$\ln(\text{optimal discharge for adult steelhead}) = 1.105 + 0.737 \times \ln(MAD)$$

[e] The Physical Habitat Simulation system (PHABSIM) is a one-dimensional hydraulic modeling program.

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Table 4. Steelhead Habitat Optimum Flows for the lower Ventura River and Coyote Creek. Results are based on data from USGS gage 11118501 from water year 1965–2007 and USGS gage 11118000 from water years 1928–1955 (missing data in 1933), respectively.

Reach	Juvenile SHOF (cfs)	Adult SHOF (cfs)
Lower Ventura River	24	80
Coyote Creek	8	20

3.5 Functional Flows

The California Environmental Flows Framework lists five functional flows for the State of California that represent distinct aspects of the natural flow regime and support geomorphic or biogeochemical functions (CEFF TWG 2019; Yarnell et al. 2015). Natural flow patterns vary across both space and time, creating the interannual flow variability to which native species are adapted. Important components of the annual hydrograph include fall pulse flows, peak magnitude flows, wet-season baseflows, spring recession flows, and dry-season baseflows (CEFF TWG 2019). These five flows are key components of a flow regime that sustains ecological function over time and are defined as follows (CDFW 2018a; Yarnell et al. 2015; Yarnell et al. 2020):

- The fall pulse flow is the first major storm event after the dry season and represents the transition between the dry and wet seasons. These flows move nutrients downstream and provide cues that aquatic species use to time behaviors such as migration and spawning.
- Peak magnitude flows are large-scale disturbances responsible for significant sediment transport and the maintenance and restructuring of river channels and floodplain landforms. These peak flows maintain habitat diversity over the long term.
- Wet-season baseflows are defined by a prolonged period of elevated baseflow. These higher flows support movement and provide habitat for species that over-winter in streams.
- Spring recession flows represent the transition between high and low flows. These gradually receding flows redistribute sediment mobilized by the higher flows earlier in the year and cue reproduction and migration of native species.
- Dry-season baseflows may be stressful and represent sensitive periods for native species (Yarnell et al. 2015).

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). To estimate these functional flow metrics under natural conditions, gaged flow data for the available gages that most closely represent unimpaired

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conditions for the reaches of interest (11118501 from 1965-2007 and 11118000 from 1928-1955) were input into the Functional Flows Calculator (Lane et al. 2020). The metric values presented in Table 5 are based on water years 1965–2007 at the USGS gage 11118501 on the lower Ventura River. Functional flow metrics for Coyote Creek are presented in Table 6 using gaged data from water years 1928–1955 (missing data from water year 1933) at the USGS gage 11118000 on Coyote Creek. Start timing is presented for wet years only, because start timing was extremely variable in moderate and dry years and in some cases the distinction between wet and dry season was not clear. For the purpose of this analysis, wet years were defined as the wettest 33% of years, based on mean annual discharge (CDFW 2013).

Functional flow metrics for the lower Ventura River were published in the Ventura River Watershed Criteria Report (CDFW 2020a). The functional flow metric values have been updated slightly in this report based on recent calculator updates. In addition, fall pulse flow metrics have been included. Coyote Creek functional flow criteria were not presented in the Ventura River Watershed Criteria Report.

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Table 5. Lower Ventura River functional flow metric median values based on data from USGS gage 11118501 during water years 1965–2007. Values represent median predictions across all years (or, when specified, within each water year type), with 10th–90th percentile ranges in parentheses (Lane et al. 2020).

Functional Flow Metric	Functional Flow Result
Fall pulse flow start timing (in wet years)	Nov 18 (Oct 23–Dec 5)
Fall pulse flow duration (days)	3 (1–4)
Fall pulse flow magnitude (cfs)	54 (9–302)
Wet-season baseflow start timing (in wet years)	Jan 13 (Dec 24–Feb 2)
Wet-season baseflow duration (days/year when present)	103 (47–170)
Wet-season median baseflow magnitude (cfs)	23 (9–529)
2-year peak flow duration (days/year when present)	3 (1–20)
2-year peak flow magnitude (cfs)	1,230
2-year peak flow frequency (events/year when present)	2 (1–5)
5-year peak flow duration (days/year when present)	2 (1–3)
5-year peak flow magnitude (cfs)	7,860
5-year peak flow frequency (events/year when present)	2 (1–2)
10-year peak flow duration (days/year when present)	1 (1–3)
10-year peak flow magnitude (cfs)	16,320
10-year peak flow frequency (events/year when present)	1 (1–2)
Spring recession flow start timing (in wet years)	Mar 27 (Feb 28–May 10)
Spring recession flow duration (days)	79 (23–153)
Spring recession flow magnitude (cfs)	36 (13–2,840)
Spring recession flow rate of change (%)	6 (3–11)
Dry-season baseflow start timing (in wet years)	Jun 1 (Mar 31–Jul 8)
Dry-season baseflow duration (days)	166 (92–267)
Dry-season median baseflow magnitude (cfs)	8 (2–21)

Table 6. Coyote Creek functional flow metric median values based on data from USGS gage 11118000 during water years 1928–1955 (missing data in 1933). Values represent median predictions across all years (or, when specified, within each water year type), with 10th–90th percentile ranges in parentheses (Lane et al. 2020).

Functional Flow Metric	Functional Flow Result
Fall pulse flow start timing (in wet years)	Nov 10 (Oct 17–Dec 10)
Fall pulse flow duration (days)	6 (3–10)
Fall pulse flow magnitude (cfs)	10 (2–120)
Wet-season baseflow start timing (in wet years)	Jan 2 (Dec 12–Jan 28)
Wet-season baseflow duration (days/year when present)	77 (31–122)
Wet-season median baseflow magnitude (cfs)	5 (1–65)
2-year peak flow duration (days/year when present)	4 (1–7)
2-year peak flow magnitude (cfs)	350
2-year peak flow frequency (events/year when present)	3 (1–4)
5-year peak flow duration (days/year when present)	1 (1–2)
5-year peak flow magnitude (cfs)	1,714
5-year peak flow frequency (events/year when present)	1 (1–2)
10-year peak flow duration (days/year when present)	1 (1–2)
10-year peak flow magnitude (cfs)	2,480
10-year peak flow frequency (events/year when present)	1 (1–2)
Spring recession flow start timing (in wet years)	Mar 19 (Mar 2–Apr 7)
Spring recession flow duration (days)	51 (30–120)
Spring recession flow magnitude (cfs)	176 (11–901)
Spring recession flow rate of change (%)	8 (6–16)
Dry-season baseflow start timing (in wet years)	Apr 23 (Apr 1–May 28)
Dry-season baseflow duration (days)	227 (164–273)
Dry-season median baseflow magnitude (cfs)	0.2 (0.1–1)

3.6 Existing Studies

The NMFS (2007) draft biological opinion addresses the effects of proposed actions at the Foster Park Well Facility on Southern California steelhead and critical habitat (NMFS 2007). The draft biological opinion suggests altering the Foster Park well field operations to maintain a flow that would minimize further degradation to the habitat and to steelhead populations. A minimum maintenance flow of 11–12 cfs was recommended at the Foster Park gage (USGS 11118500) to allow for improved growth and survival of juvenile steelhead (NMFS 2007).

The NMFS (2003) biological opinion outlines flow requirements for the Robles Diversion Dam, which impounds water from the Ventura River into Lake Casitas. The Robles Diversion Dam was constructed in 1958 and acted as a complete barrier to upstream migration until 2004 when a fish passage facility was constructed (Allen 2015). The Robles Diversion Dam has a required minimum bypass flow of 50 cfs when flows are available within the fish passage augmentation season (January 1–June 30) and a minimum bypass flow of 20 cfs outside this season (NMFS 2003). The Robles Diversion facility has the ability to divert up to 500 cfs (Leydecker and Grabowsky 2006). The Casitas Municipal Water District has been assessing upstream fish migration impediments up to the Robles Fish Facility as part of its fisheries monitoring and evaluation studies (CMWD 2018).

Additionally, the Department is producing technical reports that define flow criteria for the intermittent reach of the Ventura River and San Antonio Creek (CDFW 2017b; Cowan et al. 2021; Maher et al. 2021).

4.0 FLOW RECOMMENDATIONS

The following recommendations were designed to maintain streamflows at a level that will protect the Southern California steelhead population and the lower Ventura River ecosystem. To meet this objective, the datasets presented above were combined to produce a monthly flow schedule that supports steelhead habitat and passage while also protecting dry season low flows. A spawning and rearing season were determined using the steelhead life stage periodicity table (Figure 3). The spawning season spans from December–May. The rearing season is year-round but is applied from June–November outside the spawning season. Flow results were selected that would be protective of the appropriate steelhead or habitat needs during the corresponding spawning and rearing season. Flows recommended for adult spawning and migration are protective of resident and juvenile *O. mykiss* as well.

The Department understands these flows to be protective of steelhead and the habitat that supports them and recommends applying them across all water year types. In some cases, the recommended flows may not be available due to precipitation

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variability. When flows naturally fall below the flow recommendations for the lower Ventura River reaches 2,3, and 4, full natural flows should be maintained. Also, flows higher than the recommended criteria may be beneficial to the ecosystem and to steelhead.

Functional flow metrics presented in Section 3.5 were used to verify that flow recommendations matched the timing, magnitude, and duration for the wet and dry season baseflows. The timing and duration of the wet and dry season functional flow periods roughly match the timing of the steelhead spawning and rearing seasons used for flow criteria development. Accordingly, the wet and dry season baseflow magnitudes were compared with the spawning and rearing season flow criteria respectively, while the November criteria were compared with the fall pulse flow. This comparison was performed to verify that the recommended flows are reasonable given flow availability.

In addition, fall pulse flows should be allowed to pass through the system unaltered when naturally present (see Section 3.5). Fall pulse flows are produced by the first storm event of the season. These flows help to clean spawning gravels and provide important migration cues (Yarnell et al. 2015; Yarnell et al. 2020). Peak flows of varying magnitudes (e.g., two-, five-, and ten-year recurrence interval floods, defined as 50%, 20% and 10% exceedance peak flow events) should also be allowed to pass through the system. Peak flows scour and reshape the channel, redistributing sediment and maintaining habitat over time.

The Department may choose to incorporate additional flow data upon the release of the State Water Board’s groundwater-surface water interaction model describing unimpaired flow (Geosyntec Consultants and David B Stephens & Associates 2019). This model is currently under development.

4.1 Lower Ventura River Reach Recommendations

4.1.1 Lower Ventura River Reach 2

Lower Ventura River reach 2 begins just below Shell Road and continues upstream to Weldon Canyon. The criteria are presented in Table 7 using the following data sources:

- The adult steelhead Passage Flow was used for the spawning season of December–May
- The Sensitive Period Indicator was used for the low flow months of June–October
- The juvenile steelhead Habitat Optimum Flow was used for the transition month of November
- Fall pulse flows should flow unaltered with a natural recession when present during the months of October–December

- Peak flows of varying magnitudes and lengths based on the functional flows values should be protected January–May

4.1.2 Lower Ventura River Reach 3

Lower Ventura River reach 3 is located within the live reach and begins at Weldon Canyon to just below the levee pool. The criteria are presented in Table 7 using the following data sources:

- The adult steelhead Passage Flow was used for the spawning season of December–May
- The Sensitive Period Indicator was used for the low flow months of June–October
- The juvenile steelhead Habitat Optimum Flow was used for the transition month of November
- Fall pulse flows should flow unaltered with a natural recession in years when present during the months of October–December
- Peak flows of varying magnitudes and lengths based on the functional flows values should be protected January–May

4.1.3 Lower Ventura River Reach 4

Lower Ventura River reach 4 is also located within the live reach and begins at the levee pool and continues upstream to the San Antonio Creek confluence. The criteria are presented in Table 7 using the following data sources:

- The adult steelhead Habitat Optimum Flow was used for the spawning season of December–May
- The Sensitive Period Indicator was used for the low flow months of June–October
- The juvenile steelhead Habitat Optimum Flow was used for the transition month of November
- Fall pulse flows should flow unaltered with a natural recession in years when present during the months of October–December
- Peak flows of varying magnitudes and lengths based on the functional flows values should be protected January–May

The adult steelhead Habitat Optimum Flow was selected for the spawning season because this reach is a transition area into the intermittent reach and the important spawning grounds in San Antonio Creek (Allen 2009). The perennial flow and deep, abundant pools in this reach allow crucial resting spots for migrating adult steelhead (Entrix and Woodward Clyde Consultants 1997). Additionally, past studies have shown this reach to have the highest abundance of adult steelhead present out of the mainstem lower Ventura River reaches (Allen 2015).

4.1.4 Lower Ventura River Flow Recommendations Table

Table 7 below contains criteria for each reach in the lower Ventura River. The footnotes below the table describe the data sources supporting each of the flow criteria. When flows naturally fall below the flow recommendations, full natural flows should be maintained.

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Table 7. Lower Ventura River reaches 2, 3, and 4 flow recommendations.

Month(s)	Season	Ventura Reach 2 (cfs)	Ventura Reach 3 (cfs)	Ventura Reach 4 (cfs)	Additional Pulse Flows
January-May	Spawning/ adult migration	40[a]	33[a]	80[b]	Peak flow[c]
June-September	Rearing	16[d]	14[d]	15[d]	--
October	Rearing	16[d]	14[d]	15[d]	Fall pulse flow[e]
November	Rearing	24[f]	24[f]	24[f]	Fall pulse flow[e]
December	Spawning/ adult migration	40[a]	33[a]	80[b]	Fall pulse flow[e]

Table 7 notes:

a Adult steelhead Passage Flow for Reach 2 and Reach 3 (Table 2); results fall within the 10th–90th percentile range for wet-season baseflow functional flow (9–529 cfs; Table 5).

b Adult steelhead Habitat Optimum Flow (Table 4); result falls within the 10th–90th percentile range for wet-season baseflow functional flow (9–529 cfs; Table 5).

c Peak flows of varying magnitudes and lengths should be protected, consistent with the values in Table 5.

d Sensitive Period Indicator flow for Reach 2, Reach 3, and Reach 4 (Table 1); results fall within the 10th-90th percentile range for dry-season baseflow functional flow (2–21 cfs; Table 5).

e Fall pulse flows should flow unaltered with a natural recession in years when present (Table 5).

f Juvenile steelhead Habitat Optimum Flow (Table 4); result falls within the 10th–90th percentile range for fall pulse flow functional flow (9–302 cfs; Table 5).

4.2 Coyote Creek Recommendations

Flow recommendations are presented in Table 8 for the section of Coyote Creek from Casitas Dam to the confluence with the Ventura River. The footnotes below the table describe the data sources supporting each of the flow criteria. These flow criteria are presented by month and were developed using the results of the Ecosystem Baseflows

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analysis to protect basic ecosystem functions. Ecosystem Baseflow results that were less than 1 cfs were rounded to 1 cfs for these criteria. These flows should be met each month to maintain a healthy stream ecosystem but are not specific to steelhead flow needs. When reservoir inflows naturally fall below the flow recommendations, releases should be equal to inflows to the reservoir. Peak and pulse flows should be released from the reservoir in the months indicated in Table 8 as storm events occur.

Table 8. Coyote Creek flow recommendations.

Month(s)	Coyote Creek (cfs)	Additional Pulse Flows
January	11[aa]	Peak flow[bb]
February	18[aa]	Peak flow[bb]
March	18[aa]	Peak flow[bb]
April	5[aa]	Peak flow[bb]
May	4[aa]	Peak flow[bb]
June–September	1[cc]	--
October	1[cc]	Fall pulse flow[dd]
November	1[cc]	Fall pulse flow[dd]
December	5[aa]	Fall pulse flow[dd]

Table 8 notes:

aa Ecosystem Baseflows (Table 3); result is within the 10th–90th percentile range for wet-season baseflow functional flow (1–65 cfs; Table 6).

bb Peak flows of varying magnitudes and lengths should be protected, consistent with the values in Table 6.

cc Ecosystem Baseflows (Table 3); result is within the 10th–90th percentile range for dry-season baseflow functional flow (0.1–1 cfs; Table 6).

dd Fall pulse flows should flow unaltered with a natural recession in years when present (Table 6).

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5.0 CLIMATE CHANGE

The Department is committed to minimizing to the greatest extent practical the effects of climate change on the State's natural resources. Changes in temperature and precipitation could result in alteration to existing freshwater systems and an overall reduced availability of water for fish and wildlife species. Precipitation variability in the Ventura River watershed is anticipated to increase and lead to more extreme fluctuations from drought to flooding as climate change impacts intensify (Langridge 2018). These shifts, combined with ongoing surface water and groundwater extractions, may result in higher stress to ecosystems. In addition, these changes may impact groundwater recharge and over drafting as well as impacting hydropower and hatchery project operations, fish populations' passage issues, and water diversion projects. Given the uncertainty associated with climate change impacts, the Department reserves the right to modify the instream flow regime recommendations for the lower Ventura River as the science and understanding of climate change evolves.

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