Aquatic Groundwater Dependent Ecosystem Assessment

Upper Ventura River Groundwater Basin

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1 Introduction

This technical appendix to the Upper Ventura River Groundwater Agency (UVRGA) Groundwater Sustainability Plan (GSP) summarizes the process for identifying, characterizing, and assessing potential impacts to aquatic groundwater dependent ecosystems (GDEs) in the Upper Ventura River Groundwater Basin (UVRGB). This appendix builds upon the riparian GDE assessment (Rincon 2021) and assesses the important aquatic habitat and fish passage areas reliant on interconnected surface water within the basin. The riparian GDE assessment provided an analysis of GDEs comprised of riparian vegetation communities, while this appendix focuses on aquatic GDEs comprised of instream habitat. This appendix identifies and characterizes aquatic GDEs within the UVRGB and assesses how groundwater management may affect (e.g., impact) aquatic GDEs in the UVRGB. Additionally, this appendix identifies data gaps that would require additional study in order to establish or refine sustainable management criteria (SMC) and provides recommendations to fill data gaps and monitor changing conditions related to aquatic GDEs.

> **Groundwater Dependent Ecosystems:** *"ecological communities of species that depend on groundwater emerging from aquifers or on groundwater occurring near the ground surface"* – SGMA, 23 CCR § 351(m)

The Sustainable Groundwater Management Act (SGMA) requires groundwater sustainability agencies (GSAs) to consider GDEs and other beneficial uses of groundwater when developing their GSPs. Aquatic GDEs within the UVRGB are instream portions of the Ventura River with interconnected surface water that provide important habitat for aquatic species. Therefore, this assessment focuses on the *Depletion of Interconnected Surface Waters* SGMA sustainability indicator, whereas the riparian GDE assessment addressed the *Chronic Lowering of Groundwater Levels* and *Groundwater Storage* SGMA sustainability indicators.

The following outline provides a description of each of the sections found in this appendix:

- **Section 1. Introduction:** Provides a brief introduction to aquatic GDEs and an overview of this technical document.
- **Section 2. Aquatic GDE Identification:** Considers the potential aquatic GDEs that occur within the UVRGB and describes the process of identifying actual aquatic GDEs.
- **Section 3. Aquatic GDE Characterization:** Provides an overview of the ecological condition of the UVRGB and a detailed summary of the ecological condition of each aquatic GDE within the UVRGB, including: beneficial uses, federally designated critical habitat, special-status species, and overall ecological value.
- **Section 4. Aquatic GDE Impact Analysis:** Provides an analysis of potential impacts to aquatic GDEs related to depletion of interconnected surface water and presents initial considerations for developing SMC.

Note that GSP development is an iterative process, and preliminary considerations of SMC for aquatic GDEs are subject to change based on stakeholder input, monitoring data, and forthcoming studies.

2 Aquatic GDE Identification

This section summarizes the evaluation of potential aquatic GDEs and the identification of actual aquatic GDEs that occur within the UVRGB.

Note that a range of factors within the watershed can influence aquatic GDEs and the habitat they provide for aquatic species.[1] These can include natural climatic factors, anthropogenic factors, and hydrogeologic factors. Table 1 provides a summary of factors that influence aquatic GDEs within the UVRGB, which were considered during the process of aquatic GDE identification.

Table 1 Factors that Influence Aquatic GDEs within the UVRGB

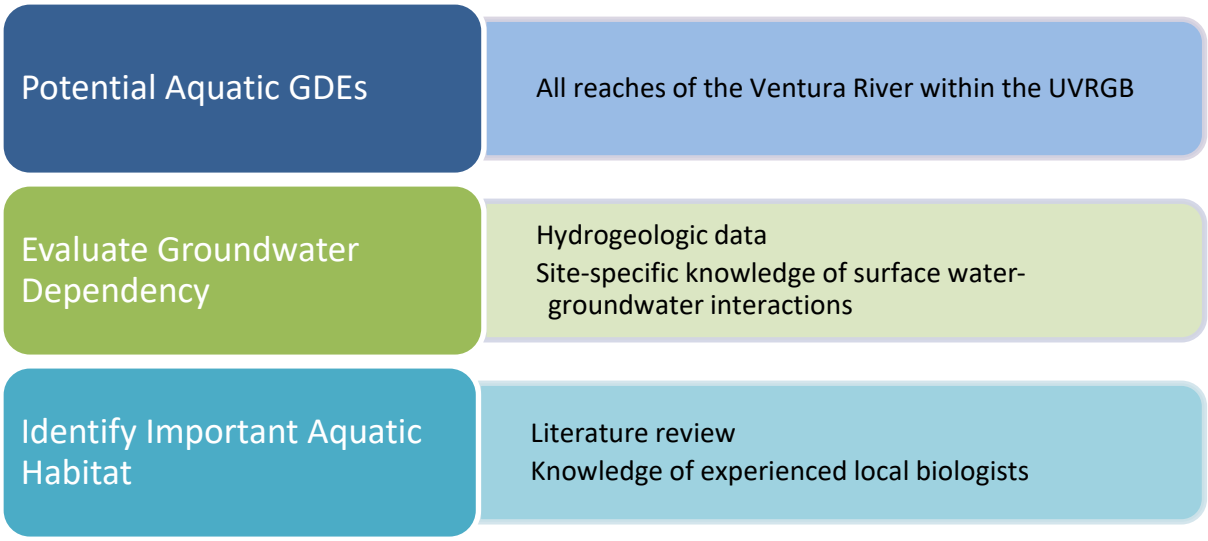
Natural Climatic Factors	Anthropogenic Factors	Hydrogeologic Factors
Storm pulses	Groundwater Pumping	Losing/Gaining Reaches
Drought	Surface Water Diversions	Depth to Groundwater

2.1 Aquatic GDE Identification Process

As mentioned in the riparian GDE assessment, the Natural Communities Commonly Associated with Groundwater (NCCAG) dataset (DWR 2021) was used to establish potential riparian GDEs within the UVRGB, which were then screened to determine actual riparian GDEs present within the basin (Rincon 2021). To determine aquatic GDEs that exist within the basin, a slightly different approach was necessary. For this analysis, all reaches of the Ventura River within the UVRGB were initially considered as potential aquatic GDEs. Local hydrogeologic data and site-specific knowledge were then used to analyze groundwater-surface water interactions within each reach of the river that falls within the UVRGB. Actual aquatic GDEs were then identified based on a review of published literature on important aquatic habitat and fish passage areas within the UVRGB (e.g., CDFW 2017, ENTRIX 1999), as well as the professional judgment of local biologists with extensive experience working in the Ventura River Watershed. Figure 1 provides an overview of the process used for identifying aquatic GDEs within the UVRGB.

[1] For this report, aquatic species are defined as those that require aquatic habitat for all or a portion of their life cycle.

Figure 1 Aquatic GDE Identification Process



2.1.1 Potential Aquatic GDEs and Groundwater Dependency

As defined by SGMA, interconnected surface water is surface water that is hydraulically connected at any point by a continuous saturated zone to the underlying aquifer and the overlying surface water is not completely depleted. Generally speaking, interconnected surface waters can interact with groundwater in two main ways: surface water can "gain" or "lose," meaning that surface waters can receive water from groundwater or outflow water to groundwater.

The UVRGA GSP characterizes the Ventura River as an interconnected surface water system, with varying levels of groundwater-surface water connection. As this dynamic system, all instream portions of the Ventura River that occur within the UVRGB were initially considered as potential aquatic GDEs. Groundwater dependency was evaluated using hydrogeologic data and site-specific knowledge of groundwater-surface water interactions (Figure 2). While groundwater dependency was evaluated during the process of aquatic GDE identification, some instream areas where groundwater is generally thought to be disconnected from surface water (i.e., the Robles area, just west of Meiners Oaks) were still considered as potential aquatic GDEs. Due to the complexity of interconnected surface water interactions within the basin, it is possible that groundwater pumping could indirectly impact important instream habitats without direct groundwater connectivity, and therefore, not all of the identified aquatic GDEs occur in reaches with known interconnected surface water (B. Bondy, personal communication, 2021).

Chapter 3.2.6 of the Draft UVRGA GSP provides additional information on the interconnected surface water system within the UVRGB.

Figure 2 Potential Aquatic GDEs and Interconnected Surface Water Systems within the UVRGB (Adapted from GSP Figure 3.2-10)

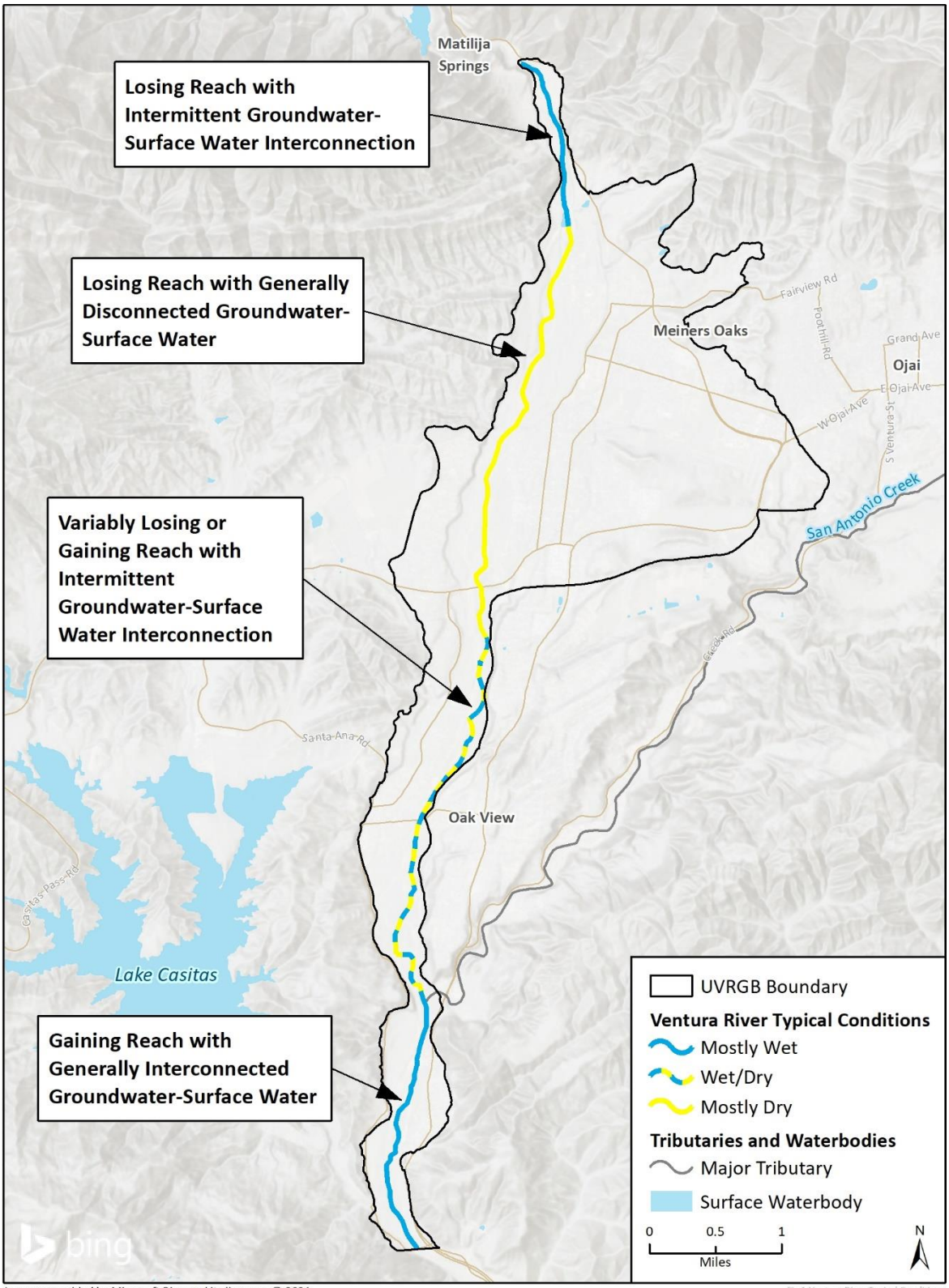


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Fig 1 Ventura River Typical Conditions

2.1.2 Identifying Important Aquatic Habitat

Once the hydrogeology of the basin was taken into account, areas of important aquatic habitat within the basin were identified. Previous studies within the UVRGB were reviewed (e.g., Normandeau 2015, CDFW 2017, ENTRIX 1999, Hopkins 2012) to determine which areas within the basin provide important habitat and/or passage for aquatic species. Important aquatic habitat includes areas utilized by fish and other aquatic species for upstream or downstream migration, refuge, spawning or breeding, rearing, and/or dispersal. While aquatic GDEs provide important habitat and/or passage for a large number of aquatic species, many of the criteria for determining aquatic GDEs within the UVRGB were based on the habitat requirements of federally endangered southern California Distinct Population Segment (DPS) steelhead (*Oncorhynchus mykiss irideus*). Defining aquatic GDEs based on the presence of habitat elements necessary for steelhead populations follows TNC guidance (Rhode et al., 2018), and encompasses habitat requirements for other special status aquatic species within the basin, including the federally threatened California red-legged frog (*Rana draytonii*).

Potentially important aquatic habitats identified within the UVRGB in the literature review were then further analyzed by Rincon Senior Fisheries Biologist Steve Howard, who has over twenty years of experience working within the Ventura River.

2.2 Aquatic GDEs within the UVRGB: Critical Riffles and Habitat Areas

Based on the literature review and analysis described above, two types of aquatic GDES were identified within the UVRGB: *Critical Riffles* and *Habitat Areas.*

A critical riffle for a river system is an area that can limit passage for migration of steelhead and can create bottlenecks for fish as they move upstream during low flow conditions. Riffles are reaches of swift, turbulent water with gravel, cobble, boulder, or bedrock substrates. Cobbles and boulders often emerge within riffles during low flow periods (Normandeau 2015). Depletion of interconnected surface water within critical riffles has the potential to preclude or delay upstream migration and can potentially cause fish stranding or mortality.

For the purposes of this assessment, a habitat area provides steelhead and other aquatic species with refuge, rearing, and spawning or breeding habitat required for survival and/or reproduction. These areas are generally comprised of several physical elements such as glides, runs, and pools, providing adequate connection and structure for various lifecycle activities.

Five aquatic GDEs were identified within the UVRGB: the *South Robles Critical Riffle*, the *South Santa Ana Critical Riffle*, the *North Robles Habitat Area*, the *Confluence Habitat Area*, and the *Foster Park Habitat Area* (Figure 3). Each of these aquatic GDEs and their importance for aquatic species within the UVRGB are described in Section 3.

Figure 3 Aquatic GDEs within the UVRGB

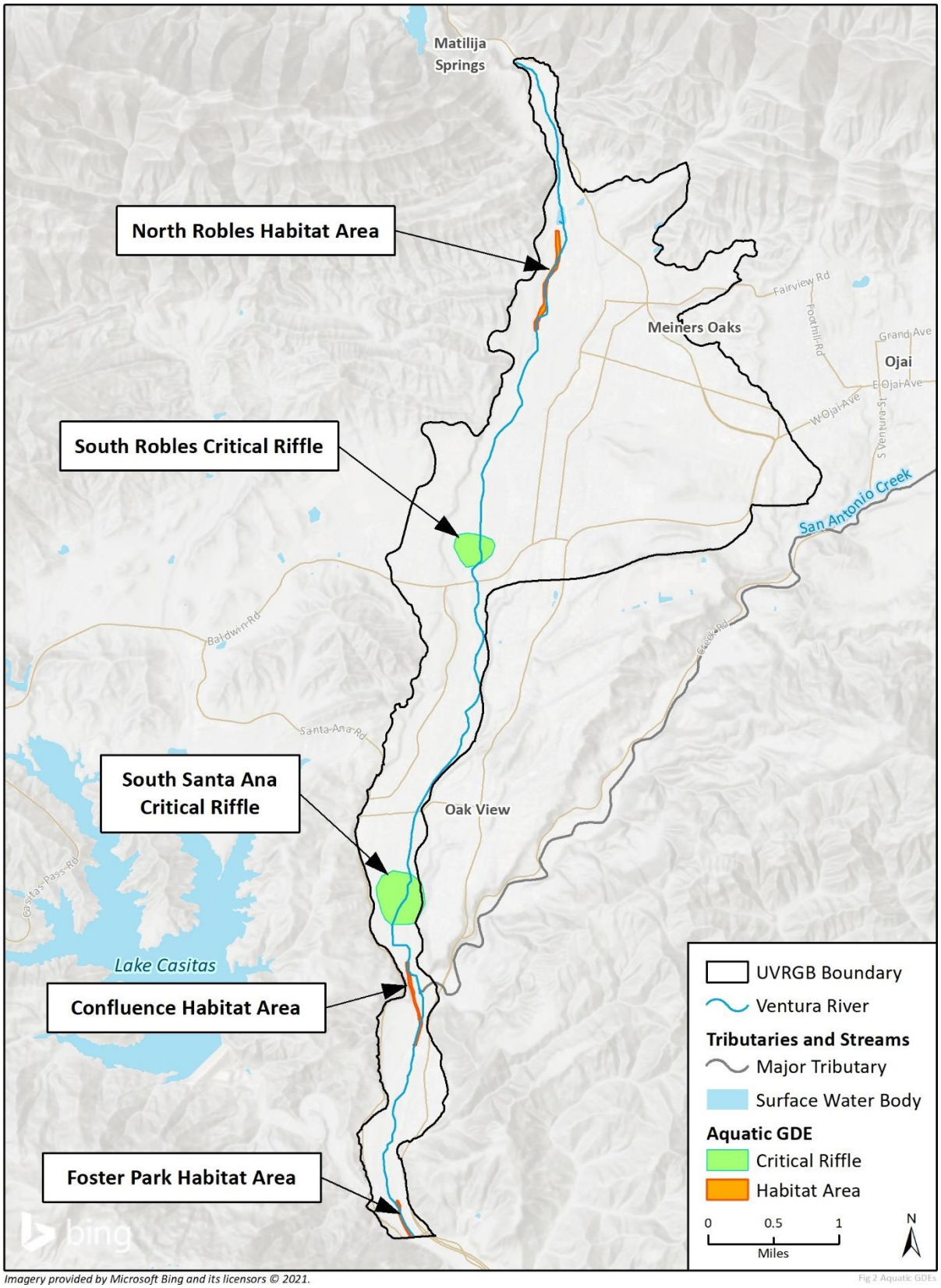

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Fig 2 Aquatic GDEs

3 Aquatic GDE Characterization

This section describes the ecological condition of aquatic habitat within the Ventura River that occurs in the UVRGB. This overview presents surface water beneficial uses related to GDEs, federally designated critical habitat, and special status aquatic species (including fish, amphibians, and reptiles) that are known to occur within the basin. Each aquatic GDE identified within the UVRGB is characterized individually with a description of special status aquatic species known or with potential to occur within each GDE, critical habitat that occurs within each GDE, and a description of important habitat elements for steelhead and other aquatic species that exist within each GDE.

3.1 UVRGB Ecological Condition Overview

Surface Water Beneficial Uses Related to GDEs

The Water Quality Control Plan (Basin Plan) for the Los Angeles Region (LARWQCB 2014) identifies the surface waters in the UVRGB as having a variety of beneficial uses pertaining to fish, wildlife, and GDEs. These beneficial uses apply to inland surface waters within the UVRGB that may be fed by groundwater and vary between aquatic features. Beneficial uses related to GDEs identified within the UVRGB include:

- Warm freshwater habitat (WARM)
- Cold freshwater habitat (COLD)
- Wildlife habitat (WILD)
- Support of habitat for rare, threatened or endangered species (RARE)
- Migration of aquatic organisms (MIGR)
- Spawning, reproduction, and/or early development habitat (SPWN)
- Wetland habitat (WET)

Critical Habitat

Rincon queried the U.S. Fish and Wildlife Service (USFWS) Critical Habitat Portal (USFWS 2021a) and the NOAA Critical Habitat maps (NOAA 2021) for information on federally designated critical habitat within the UVRGB. The UVRGB includes designated critical habitat for two federally listed aquatic species: southern California DPS steelhead (*Oncorhynchus mykiss irideus* pop. 10) and California red-legged frog (*Rana draytonii*) (NOAA 2005, USFWS 2010). A map of federally designated critical habitat for aquatic species within the UVRGB and surrounding area is presented as Figure 4.

Critical habitat for southern California DPS steelhead occurs within designated estuaries and streams with connectivity to the ocean up to impassible barriers in rivers and streams from the Santa Maria River (in southern San Luis Obispo County) south to San Mateo Creek (at the border of Orange and San Diego Counties). Within the UVRGB, critical habitat for steelhead exists within the entire stream channel of the Ventura River up to the ordinary high-water mark (OHWM) upstream to impassable barriers.

A large expanse of critical habitat for the California red-legged frog exists northwest of the UVRGB and overlaps with the northernmost portion of the basin. Critical habitat for the species also exists within San Antonio Creek to the east and overlaps with the UVRGB at the confluence of San Antonio Creek and the Ventura River (Figure 4).

Figure 4 Federally Designated Critical Habitat for Aquatic Species within the UVRGB and Region

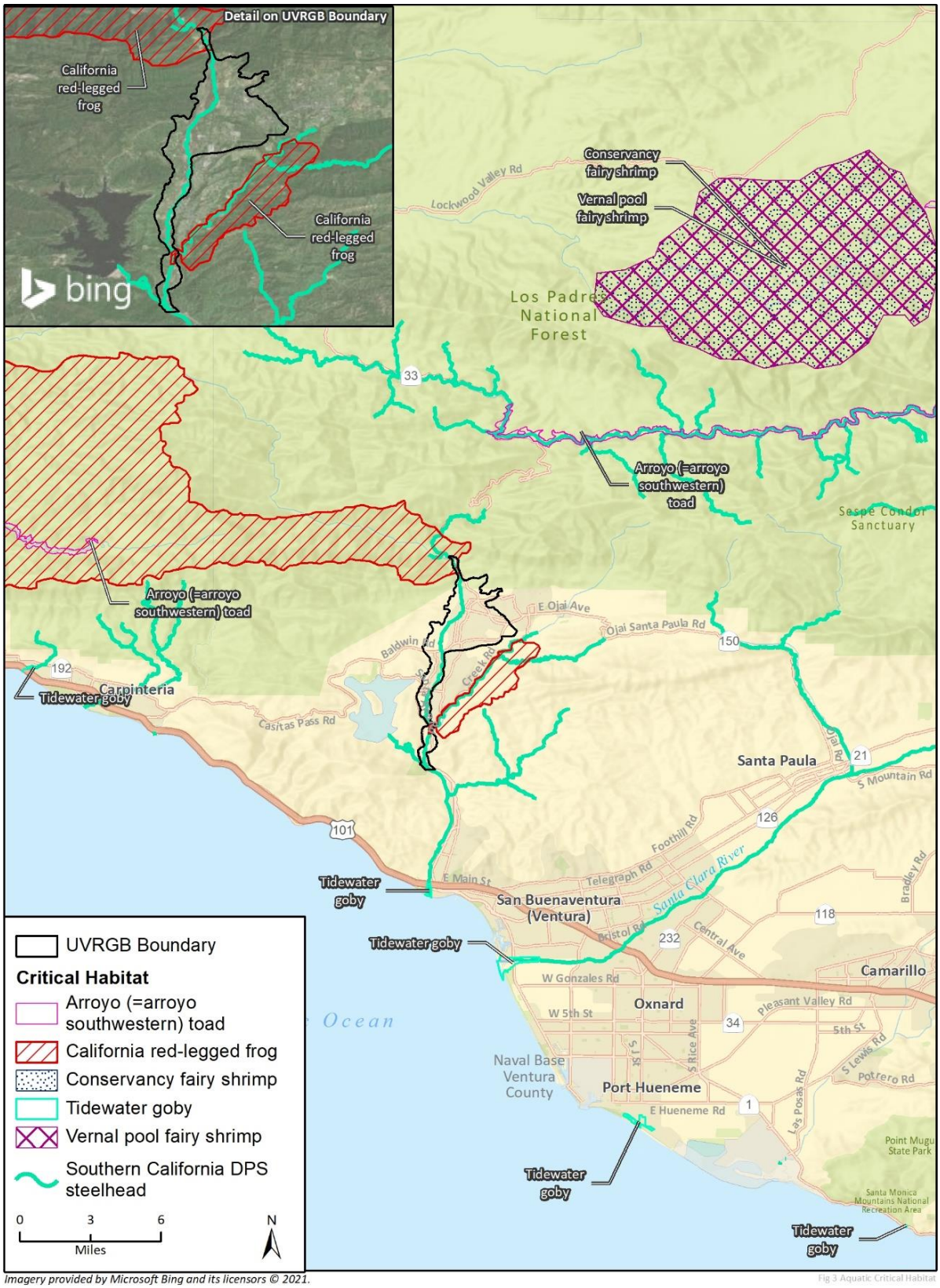

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Fig 3 Aquatic Critical Habitat

Special Status Aquatic Species

No special status aquatic plant species are known to occur within the UVRGB. For a summary of the evaluation of special status plant species with potential to occur in the UVRGB, please see Appendix B of the riparian GDE assessment (Rincon 2021).

Six special status fish and wildlife species that rely on aquatic habitat occur within the UVRGB. Table 2 provides a list of these species, as well as their regulatory status, habitat requirements, and documented occurrences within the basin. For a summary of the evaluation of special status fish and wildlife species with potential to occur in the UVRGB, please see Appendix B of the riparian GDE assessment.

3.2 Critical Riffles

Riffles are aquatic habitats in streams and rivers with shallow depth relative to other habitats (pools and runs) and swiftly flowing turbulent water. Riffles and specifically the crest of riffle habitats are considered to be the shallowest areas in a stream or river system that migrating fish, including steelhead, would migrate over to reach spawning grounds. This makes riffles a potential limiting habitat feature that could preclude upstream migration at certain flows as they recede following storm pulses. Riffles that are identified as critical riffles can be particularly shallow and sensitive to changes in stream flow. Critical riffles are often wide and can be braided or present as a split channel within the river channel, as seen in the Ventura River. As the shallowest and most susceptible part of the aquatic ecosystem, potential effects at critical riffles can be viewed as the most limiting characteristic to fish passage. As such, the presence or absence of effects at these locations would be indicative of potential fish passage effects elsewhere.

Two critical riffles within the Ventura River that could potentially limit upstream passage for adult steelhead during certain flow conditions, were identified as aquatic GDEs within the UVRGB. These two locations have been identified and evaluated for fish passage during studies conducted by environmental consultants, CDFW, and other investigators (e.g., Normandeau 2015, TRPA 2007-2010, CDFW 2017). Detailed descriptions and photographs of each critical riffle are provided below.

3.2.1 South Robles Critical Riffle

The South Robles Critical Riffle occurs within the South Robles hydrogeologic area near the center of the UVRGB (Figure 3). This area consists of a braided channel that goes dry during summer months and drought periods (Figure 5, Photograph 1). A study conducted by ENTRIX, Inc. in 1999 identified this area as a critical riffle and a potential natural passage barrier within the Ventura River at certain flow magnitudes (ENTRIX 1999). This study informed the flow release schedules from the upstream Robles Diversion to provide adequate passage conditions over this critical riffle.

3.2.2 South Santa Ana Critical Riffle

The South Santa Ana Critical Riffle occurs within the Santa Ana South hydrogeologic area in the southern portion of the UVRGB (Figure 3). This area exists in a shallow portion of the Ventura River that can go dry during summer months and drought periods (Figure 5, Photograph 2). This riffle could potentially limit upstream passage for adult steelhead during low flow conditions and was identified as a potential critical riffle by CDFW (CDFW 2017). The results of a fish passage study conducted by CDFW at this location are forthcoming.

Table 2 Special Status Aquatic Species within the UVRGB

Scientific Name Common Name	Status Fed/State ESA CDFW	Habitat Requirements and Documented Occurrences within the UVRGB
Actinemys pallida (Emys marmorata) Southwestern pond turtle	None/None SSC	Occurs in ponds, lakes, rivers, streams, creeks, marshes, and irrigation ditches with basking sites. Feeds on aquatic plants, invertebrates, worms, frog and salamander eggs and larvae, crayfish, and occasionally frogs and fish. Relies on surface water that may be supported by groundwater (Rhode et al. 2019). There are three occurrences of the species documented within the UVRGB from 2016. These occurrences were documented along the Ventura River near Casitas Springs and in the northwestern portion of the basin just southeast of the Matilija Dam (CDFW 2021a).
Entosphenus tridentatus Pacific lamprey	None/None SSC	Occurs in freshwater systems. Requires adequate flows for migration, suitable gravel substrate for spawning, and adequate cover for pre-spawning holding. Juveniles (ammocoetes) spend an extended period of time (4-10 years) burrowed in sediments, filter feeding on organic material and require suitable cover, flow, foraging conditions, and cool temperatures. Juvenile migrant (macropthalmia) outmigration to the ocean requires water conditions suitable for migration (i.e., velocity, depth, temperature, and dissolved oxygen levels within the surface water). Pacific lamprey ammocoetes were observed in the lower Ventura River in 2005 (Howard and Swift 2009). Migration (both upstream and downstream) could occur in all surface water reaches of the UVRGB.
Gila orcuttii Arroyo chub[1]	None/None SSC (Non-native to Ventura River)	Native to streams from Malibu Creek to San Luis Rey River basin. Introduced into streams in Santa Clara, Ventura, Santa Ynez, Mojave & San Diego river basins. Inhabits slow water stream sections with mud or sand bottoms. Feeds heavily on aquatic vegetation and associated invertebrates. Known to be common and widely distributed in some of the streams in which it was introduced, including the Ventura River (CDFW 2015). While this fish is a CDFW SSC, the Ventura River is not considered part of its native range.
Oncorhynchus mykiss irideus Southern California DPS steelhead	FE/None	Occurs in freshwater systems and requires adequate water conditions suitable for migration (i.e., natural flow magnitudes and duration, adequate dissolved oxygen levels, and water temperature suitable for passage and survival) and suitable substrate (i.e., clean gravels and cool, oxygenated water) for spawning. Juvenile *O. mykiss* require suitable cover, flow, foraging conditions, and cool temperatures for rearing. Juvenile (smolt) emigration (i.e., outmigration to the ocean) requires suitable flow and water quality conditions for migration. The Ventura River basin historically supported an abundant steelhead population (Moore 1980). Habitat within the basin has declined due to the construction of multiple dams, but the species is still known to occur within the Ventura River, and multiple life stages of the species were observed throughout the basin during surveys conducted from 2006-2012 (Allen et al. 2015). The current status of *O. mykiss* in the Ventura River watershed is unknown due to the effects on the watershed from the Thomas Fire in 2017-2018. Recent surveys have not successfully detected this species in the Ventura River.

Scientific Name Common Name	Status Fed/State ESA CDFW	Habitat Requirements and Documented Occurrences within the UVRGB
Rana draytonii California red-legged frog	FT/None SSC	Occurs in lowlands and foothills in or near permanent sources of deep water with dense, shrubby or emergent riparian vegetation. Requires 11-20 weeks of permanent water for larval development. Must have access to estivation habitat. There are 35 occurrences of the species documented in the CNDDB within the UVRGB. Two occurrences of the species are documented in the CNDDB within the UVRGB, one in 2016 and one in 2017 (CDFW 2021a). These occurrences were documented along San Antonio Creek from its confluences with the Ventura River to 0.6 miles upstream, and within the Ventura River north of Highway 33 at Casitas Vista Road. Juvenile California red-legged frogs were also relocated approximately 0.50 mile downstream of Foster Park in 2017 (Rincon 2020).
Thamnophis hammondii Two-striped gartersnake	None/None SSC	Highly aquatic snake species found in or near permanent fresh water, often along streams with rocky beds and riparian vegetation. Prey includes fish, fish eggs, tadpoles, newt larvae, small frogs and toads, leeches, and earthworms. There are three occurrences of the species documented within the UVRGB. These occurrences were documented in 2013, 2016 and 2018 along the Ventura River in the vicinity of Casitas Springs (CDFW 2021a).

[1] Note that arroyo chub are a CDFW SSC that is present within the UVRGB, but the fish species is not considered native to the Ventura River. Therefore, arroyo chub will not be directly discussed in the context of important aquatic species within aquatic GDEs within the UVRGB. However, habitat areas considered in the document as aquatic GDEs do include suitable habitat for arroyo chub, thus this species will be indirectly covered in this assessment.

Fed= Federal	ESA= Endangered Species Act	CDFW=California Department of Fish and Wildlife
FT = Federally Threatened	FE = Federally Endangered	SSC= CDFW Species of Special Concern

Figure 5 Photographs of Critical Riffles within the UVRGB

Photograph 1. South Robles Critical Riffle (facing north)

Photograph 2. South Santa Ana Critical Riffle (facing north)

Photographs by S. Howard, April 19, 2021

3.3 Habitat Areas

Three important habitat areas with high ecological value were identified as aquatic GDES within the UVRGB. These areas consist of aquatic habitats that provide refuge, rearing, migration, and breeding or spawning habitat for fish, amphibian, and reptile species. Detailed descriptions and photographs of each important habitat area are provided below.

3.3.1 North Robles Habitat Area

The North Robles Habitat Area is a dynamic area that includes surface flows from upstream areas that eventually go subsurface as flow enters the wide floodplain in the Ojai Valley Land Conservancy Ventura River Preserve. Steelhead have been documented migrating through this area, although rearing conditions in this reach can be unfavorable due to the high densities of non-native aquatic species (i.e., bullfrogs, bass and other sunfish) and the tendency for the area to go dry for several months each year. A few deep pools are located within the area that can provide important rearing habitats for special status aquatic species. However, these pools are known to naturally deplete in most dry seasons. Figure 6 presents photographs taken via aerial drone of the northern and southern portions of this area.

Due to the reasons stated above, conditions are currently poor for the survival of special status species rearing in the area, however, suitable habitat can exist and could provide the following:

- Spawning and rearing habitat for steelhead
- Breeding, rearing, and dispersal/migratory habitat for California red-legged frog (CRLF)
- Foraging and dispersal habitat for two striped gartersnake
- Feeding, nesting, and basking habitat for southwestern pond turtle
- Pacific lamprey spawning corridor

3.3.2 Confluence Habitat Area

The Confluence Habitat Area of the Ventura River and San Antonio Creek occurs in the southern portion of the UVRGB. This instream area is characterized by cool upwelling groundwater and inflow from San Antonio Creek, which is an important spawning tributary for southern California DPS steelhead (Normandeau 2015). The Confluence Area also includes federally designated critical habitat for steelhead and California red-legged frog (Figure 4).

San Antonio Creek provides important spawning and rearing habitat for steelhead (Payne 2009, Normandeau 2011) and fish must pass through the confluence area to reach this tributary of the Ventura River. One notable pool within the confluence area contains water even during periods of drought when many other portions of the river go dry[2] (CDFW 2017). Figure 7 presents photographs taken via aerial drone of the northern and southern portions of this area.

This area provides suitable habitat for special status aquatic species including:

- Spawning and rearing habitat for steelhead
- Breeding, rearing, and dispersal/migratory habitat for CRLF
- Foraging and dispersal habitat for two striped gartersnake

[2] Figure 3.1-8 of the Draft UVRGA GSP provides a map of wet and dry portions of the Ventura River within the UVRGB during drought conditions.

- Feeding, nesting, and basking habitat for southwestern pond turtle
- Pacific lamprey spawning corridor and potentially ~~spawning and~~ rearing

3.3.3 Foster Park Habitat Area

The Foster Park Habitat Area of the Ventura River occurs in the southernmost portion of the UVRGB. The Ventura River at Foster Park is considered perennial but certain reaches of this area apparently went dry at some point over an unknown duration during the current drought (M. Garcia, personal communication, 2019). Figure 8 presents photographs taken via aerial drone of the northern and southern portions of this area.

This area has been studied by various investigators over the years including consultants, federal and state resource agencies, and local water agencies and municipal government agencies. One notable study was conducted by Hopkins Groundwater Consultants, Inc. (Hopkins) and Padre Associates Inc. (Padre) in 2012 (Hopkins 2013). The focus of this study was to understand the groundwater conditions and how pumping might impact steelhead habitat in the Foster Park area. The results of this study informed the development of low flow pumping thresholds at the City's Foster Park wells. Section 4.2.3 provides a description of this study.

This area provides suitable habitat for special status aquatic species including:

- Spawning and rearing habitat for steelhead
- Breeding, rearing, and dispersal/migratory habitat for CRLF
- Foraging and dispersal habitat for two striped gartersnake
- Feeding, nesting, and basking habitat for southwestern pond turtle
- Pacific lamprey spawning corridor and potentially ~~spawning and~~ rearing

Specifically, the Foster Park Habitat Area provides important pool and other rearing habitat features for juvenile and adult steelhead, Pacific lamprey ammocoetes, CRLF, two striped garter snake, and southwestern pond turtle during the dry period of the year (June and October), when reaches of the river upstream and potentially downstream of Foster Park typically run dry.

Figure 6 North Robles Habitat Area Photographs

Photograph 1. Northern portion of North Robles Habitat Area (facing south)

Photograph 2. Southern portion of North Robles Habitat Area (facing south)

Photographs by S. Howard, April 19, 2021

Figure 7 Confluence Habitat Area Photographs

Photograph 1. Northern portion of Confluence Habitat Area (facing north)

Photograph 2. Southern portion of Confluence Habitat Area (facing north)

Photographs by S. Howard, April 19, 2021

Figure 8 Foster Park Habitat Area Photographs

Photograph 1. Northern portion of Foster Park Habitat Area (facing north)

Photograph 2. Southern portion of Foster Park Habitat Area (facing north)

Photographs by S. Howard, January 22, 2020 and April 19, 2021

4 Aquatic GDE Impact Analysis

Depletion of Interconnected Surface Water is understood to be the most applicable SGMA sustainability indicator for assessing potential effects to aquatic GDEs in the UVRGB. Following TNC guidance (Rohde et al. 2018), UVRGA provided modeled streamflow with and without pumping for each aquatic GDE to determine potential interconnected surface water depletion in each of these areas. The UVRGA GSP numerical model was used to simulate streamflow under pumping and non-pumping conditions for a baseline 50-year future period, using historical hydrologic data from 1970-2019. These flows were compared at each aquatic GDE for example water years during wet, median, and dry conditions to assess interconnected surface water depletion. Chapter 3.3 of the UVRGA GSP provides additional information related to the numerical model.

This section presents the simulated hydrographs and an analysis of potential impacts to each aquatic GDE area (Critical Riffles and Habitat Areas).

4.1 Critical Riffles

The two critical riffles identified in the Ventura River occur where groundwater-surface water interconnection is intermittent or generally disconnected. Further, it is understood that steelhead migration through these passage-limiting areas generally occurs during and following peak flows caused by storm events and fish migration typically does not occur during low-flow conditions.

4.1.1 South Robles and South Santa Ana Critical Riffles

Figure 9 and Figure 10 present the simulated streamflow with and without pumping at the South Robles and South Santa Ana Critical Riffles for the wet, median, and dry example water years. As illustrated in these hydrographs, streamflow depletion (the difference between pumping and no pumping) is nearly indistinguishable and the blue lines and red lines are close together. Considering that fish pass these critical riffles during storm pulses and when flows recede following storm pulses, it appears from the modeling results that there is likely minimal or no effect on interconnected surface water in these aquatic GDEs.

4.2 Habitat Areas

The Habitat Area aquatic GDEs generally feature a complex of runs, glides, and pools that provide important habitat for refuge, rearing, migration, and breeding or spawning for fish, amphibian, and reptile species. As streamflow decreases in these areas, potential impacts to aquatic species may include stressors such as stranding and pool isolation, and if depletion reduces instream habitat enough, potentially mortality.

4.2.1 North Robles Habitat Area

Figure 11 presents the simulated streamflow with and without pumping at the North Robles Habitat Area. As illustrated in these hydrographs, streamflow depletion is nearly indistinguishable during each example water year (blue lines and red lines remain close together). The dry example year chart shows visible difference between streamflow with and without pumping, although the difference is approximately 0.2 cubic feet per second (cfs). While the simulated streamflow with

pumping shows this slight depletion, it is important that this is observed during periods of natural streamflow recession. As streamflow without pumping is naturally depleting ~~for~~ during periods of these simulated example years~~.~~, it appears that there is minimal or potentially no effect on interconnected surface water in these aquatic GDEs.

The Robles Diversion Facility lies just north of the North Robles Habitat Area and diverts surface water from the Ventura River to Lake Casitas. The Biological Opinion (BO) from the National Marine Fisheries Service (NMFS 2007) for the Robles Diversion Fish Passage Facility project (NMFS 2003) requires that fish augmentation flows be maintained at or above 50 cfs during the first ten days following each migratory storm event (i.e., storms generating 150 cfs or greater, as measured at the Robles Diversion). The BO also requires that downstream flows of at least 30 cfs be maintained at the diversion facility between January 1 and June 30, as long as incoming flows at the diversion are greater than 30 cfs. Based on the models comparing streamflow with and without pumping, pumping is not significantly depleting instream flows in the North Robles Habitat Area during or following storm events. As presented in Table 3.2-01 of the GSP, the median streamflow depletion in this area for the historical simulation period (2005-2019) is 0.4 cfs or less during the migration season when flows are elevated during and following storm pulses. Fish passage flows at the Robles Diversion will continue to be maintained by Casitas Municipal Water District, as required by the BO.

4.2.2 Confluence Habitat Area

Figure 12 presents the simulated streamflow with and without pumping at the Confluence Habitat Area. As illustrated in these hydrographs, depletions of up to 4 cfs occur during the dry period of both the example wet and dry years. Note that the water year preceding the example median year appears to have been a dry year, and streamflow between October through February was at or near 0 cfs. It also appears that pumping could be accelerating the onset of dry conditions during dry years.

Based on these results, effects from pumping are potentially significant during dry periods. However, limited information related to the conditions of these aquatic GDEs during periods with depleted surface water is available. Aquatic species that live in intermittent or ephemeral environments have adapted to these conditions to survive. Aquatic species could disperse to perennial portions of this habitat area as flows recede or potentially become stranded in isolated habitat areas or killed from exposure as conditions deteriorate. The actual effects at the Confluence Habitat Area ~~-~~related to natural depletion without pumping ~~is~~ are currently not known. ~~As such, the~~This lack of knowledge of the specific effects of pumping to this area is a data gap, and it is unknown what type of impact (significant or not), if any, is occurring.

4.2.3 Foster Park Habitat Area

Figure 13 presents the simulated streamflow with and without pumping at the Foster Park Habitat Area. As illustrated in these hydrographs, depletions of up to approximately 8 cfs can occur during the dry period of both the example wet and median years (natural streamflow without pumping ranging from approximately 12 to 28 cfs), and up to 7 cfs during the example dry year (natural streamflow without pumping ranging from approximately 10 to 20 cfs). Based on these results and the information discussed below, it appears pumping can cause significant effects to aquatic GDEs during dry periods. However, the City of Ventura (City) has developed pumping thresholds based on studies described below to potentially avoid significant impacts to aquatic GDEs at Foster Park.

City of Ventura Flow Study

Certain operational protocols referred to as the "Foster Park Flow Protocols" are proposed by the City in the Proposed Stipulated Physical Solution and Judgment, dated September 15, 2020 (Proposed Physical Solution). The Foster Park Flow Protocols are intended to address juvenile steelhead rearing in the Foster Park Habitat Area (one of three high priority areas identified in the Proposed Physical Solution). The Foster Park Flow Protocols are based on field studies conducted in 2012 in the Foster Park and Casitas Springs reach of the Ventura River (Hopkins 2013).

Padre conducted a Rainbow Trout Habitat Suitability Indices (HSI) study in the Foster Park area, while a simultaneous surface flow data collection effort was completed by Hopkins (Hopkins 2013). Prior to this study, Hopkins completed an evaluation of interconnected surface water that demonstrated a close relationship between pumping and surface water depletion (Hopkins 2012). According to the Padre study, the HSI scores for all or the majority of the Rainbow Trout HSI variables declined as flows receded. However, the HSI score associated with average thalweg depth started to decline at around 4 cfs and then dropped precipitously at approximately 2 cfs (measured at the Casitas Vista Road bridge) (Figure 14). It appears that this was the only variable that had a sharp decline and provided a clear delineation for quantifiable surface flow thresholds.

The results of this study were apparently relied upon to develop a minimum pumping threshold at the City's Foster Park wells. The Foster Park Flow Protocols include the reduction of City pumping when river flow is below 4 cfs and the cessation of City pumping when the river flow is below 3 cfs.

California Department of Fish and Wildlife Draft Instream Flow Recommendations

The California Department of Fish and Wildlife (CDFW) released draft instream flow regime recommendations for the lower Ventura River in February 2021 (CDFW 2021a). The recommendations apply to reaches of the Ventura River up to the confluence with San Antonio Creek, and include the Foster Park Habitat Area. The minimum flow recommendation for the reach of the Ventura River that includes Foster Park is 14 cfs defined as a "sensitive period indicator flow."

The "sensitive period indicator flow" represents the flow in which "fish and benthic macroinvertebrates may be particularly sensitive to additional water reductions and other stressors." The key consideration from this description when evaluating potential significant and unreasonable effects in the context of SGMA is the word "may." As such, sensitive period indicator flows of less than 14 cfs do not necessarily mean that effects will occur, let alone be significant and unreasonable effects.

Additionally, it's important to understand that this uncertainty of potential effects is representative of uncertainties in the sensitive period indicator flow analysis method. The methodology used to determine sensitive indicator flows was the "wetted perimeter method", which only considers wetted perimeter as a proxy for habitat suitability. This may be an unreliable indicator because there is some subjectivity involved in picking an instream flow criterion from the resulting flow-wetted perimeter curve. Further, there is greater uncertainty in quantifying the biological significance of what the percent of bankfull wetted perimeter criterion means.

Overall, the wetted perimeter method includes uncertainties that can provide unreliable results and does not necessarily indicate the onset of significant and unreasonable effects as required under SGMA.

National Marine Fisheries Service Biological Opinion (City of Ventura)

The National Marine Fisheries Service (NMFS) provided the City of Ventura a Draft Biological Opinion (BO) for Foster Park in 2007, which recommends a minimum maintenance flow of 11-12 cfs at the Foster Park gage (USGS 1118500) to allow for natural rates of growth and high rates of survival of juvenile steelhead. This minimum maintenance flow was based on a study completed in the summer-fall baseflow periods of 1976, 1977, and 1978 (Moore 1980) and was established as a flow recommendation to maintain beneficial conditions for natural rates of growth and survival of steelhead (NMFS 2007). Set to the context of SGMA, this minimum maintenance flow defines flows for beneficial conditions to steelhead rainbow trout and does not establish a minimum threshold below which significant and unreasonable effects would occur. While the study does show that diminishing flow is a factor influencing growth and survival, the study does not identify a threshold below which significant and unreasonable effects may occur. This means that the Draft BO flow~~s~~ criteria or requirements are too high to use as a basis for a minimum threshold for significant and unreasonable effects from groundwater pumping.

In addition, the Moore 1980 study period included two consecutive drought years (1976 and 1977) where flows ranged on the low end between 2 and 4 cfs in 1977. This is referenced on page 12 of the Draft BO with the following statement: *"Summertime survival of wild steelhead is substantially lower (19%) during drought conditions when flows are between 2 to 4 cfs (Moore 1980)."* This statement indicates flow conditions that can have an effect on survival and is more consistent with the minimum threshold for significant and unreasonable effects. These flows are also in line with the Padre (2013) flow study.

Consideration of CDFW Draft Instream Flow Recommendations and NMFS Draft BO

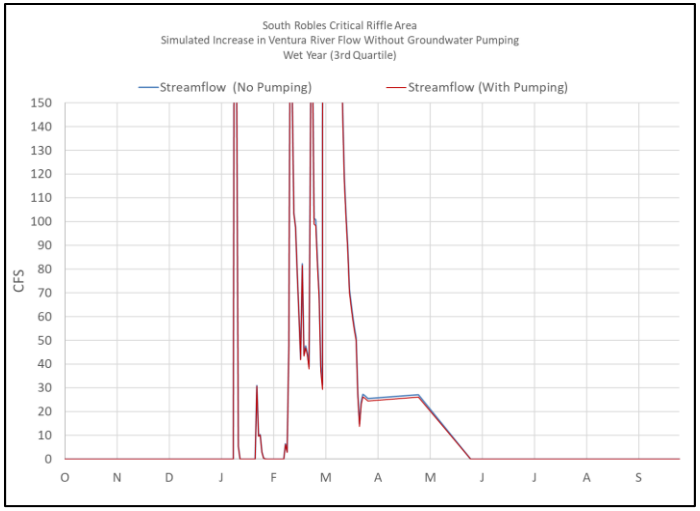
The CDFW instream flow recommendations (CDFW 2021a) and the NMFS Draft BO (NMFS 2007) provide surface flow recommendations and requirements, respectively, to maintain beneficial habitat conditions for steelhead within portions of the Ventura River, at all times. While these flows may provide beneficial conditions for steelhead, they do not represent the minimum threshold below which significant and unreasonable impacts to steelhead would occur due to the depletion of ISW, as required by SGMA.

The UVRGA agrees that surface water flows are important for maintaining the health and survival of aquatic species and their habitats, including steelhead. However, SGMA does not require UVRGA to maintain beneficial surface water conditions for riverine species, but rather to manage significant and unreasonable effects to surface flows related to groundwater pumping.

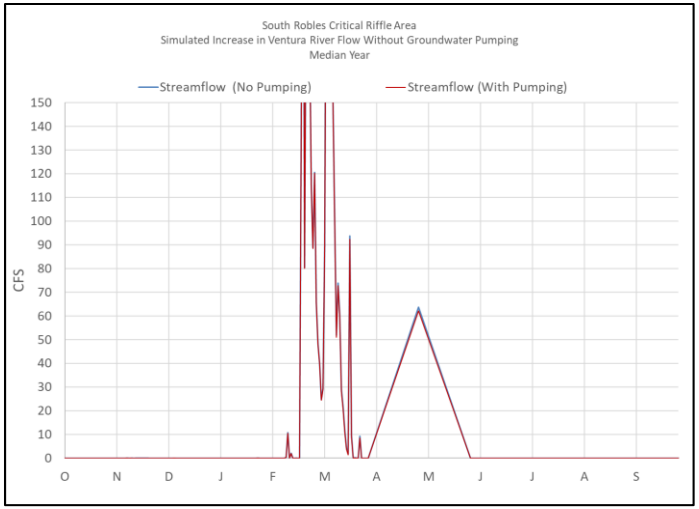
The UVRGA has taken the CDFW and NMFS recommendations into account but believes that the flow study conducted by Padre (2013) on behalf of the City of Ventura currently provides the most relevant data for developing minimum thresholds for significant and unreasonable effects due to depletion of interconnected surface flows in the Foster Park Habitat Area from groundwater pumping, as required by SGMA. However, future data collection and review of final instream flow policies can inform minimum thresholds to avoid significant and unreasonable effects.

Figure 9 Simulated Streamflow at South Robles Crticial Riffle

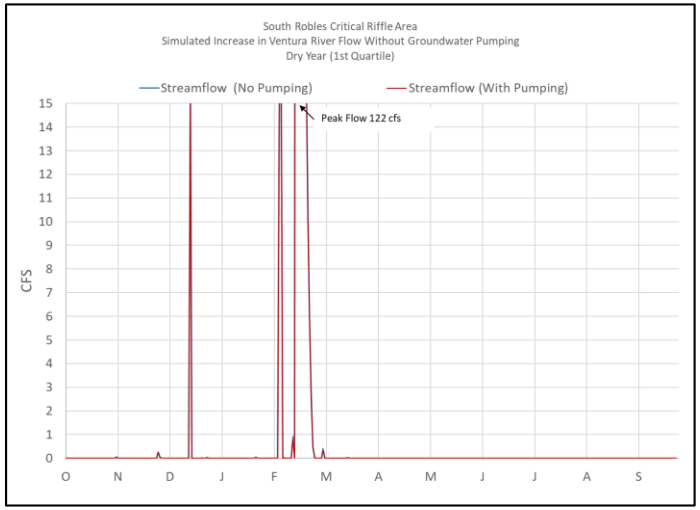
Wet Example Year



Median Example Year



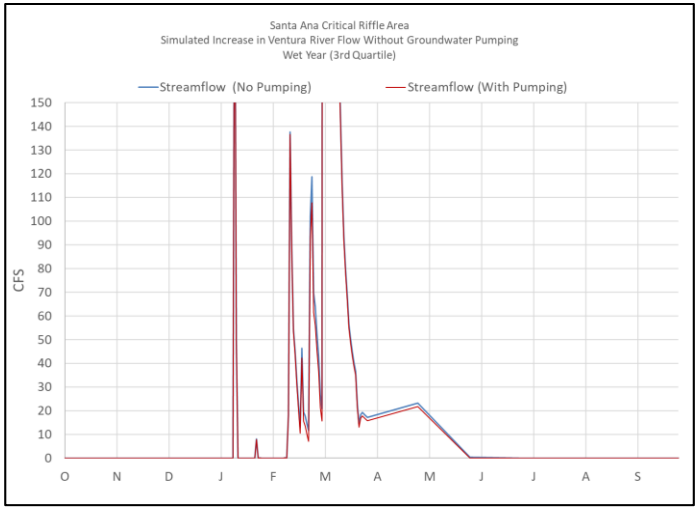
Dry Example Year



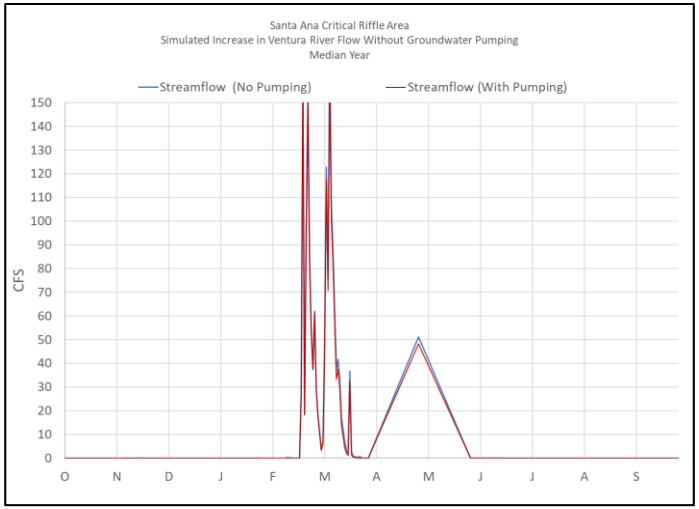
Note: Model presents data on a daily basis for November through March, and monthly for April through October

Figure 10 Simulated Streamflow at South Santa Ana Critical Riffle

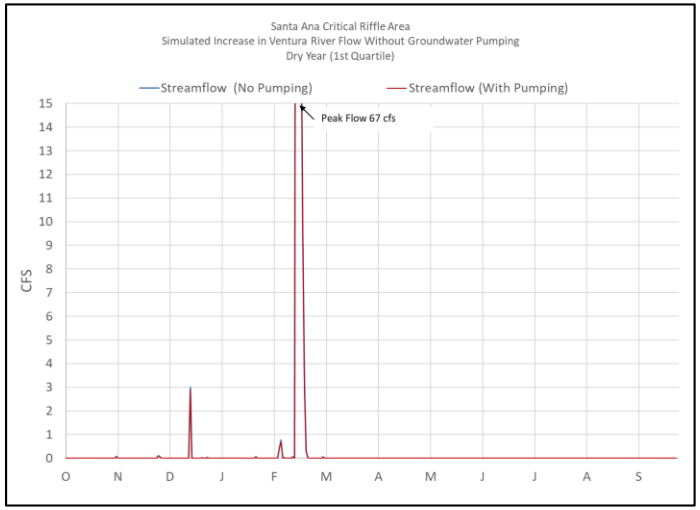
Wet Example Year



Median Example Year



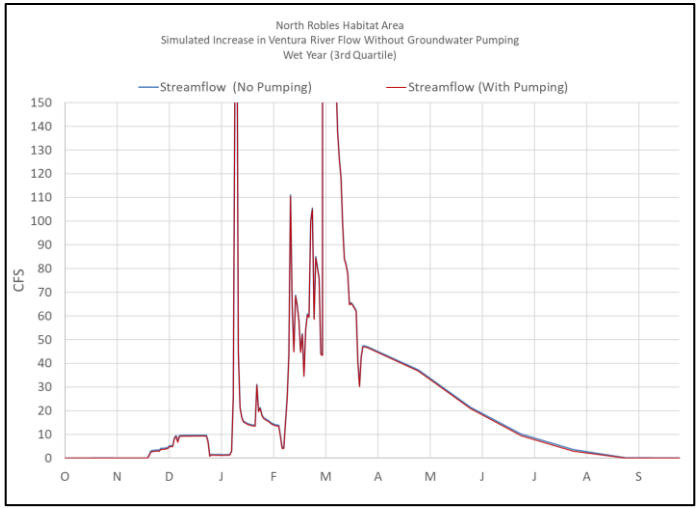
Dry Example Year



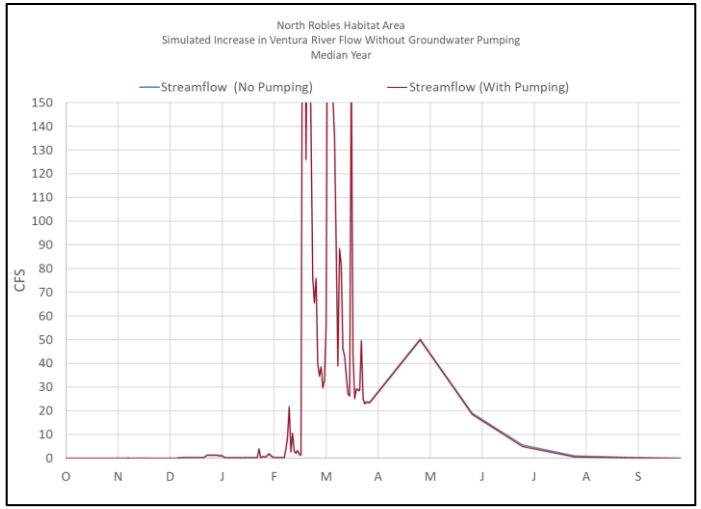
Note: Model presents data on a daily basis for November through March, and monthly for April through October

Figure 11 Simulated Streamflow at North Robles Habitat Area

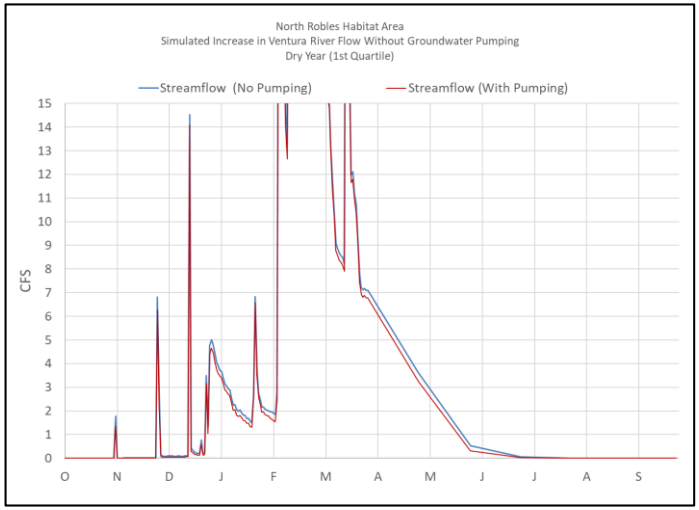
Wet Example Year



Median Example Year



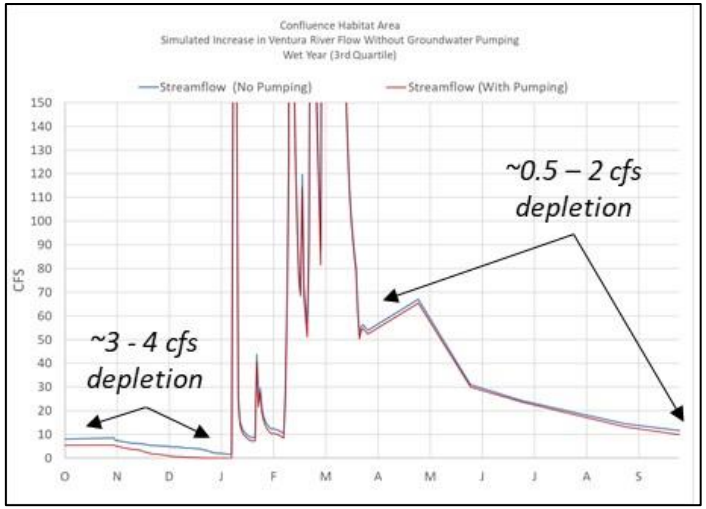
Dry Example Year



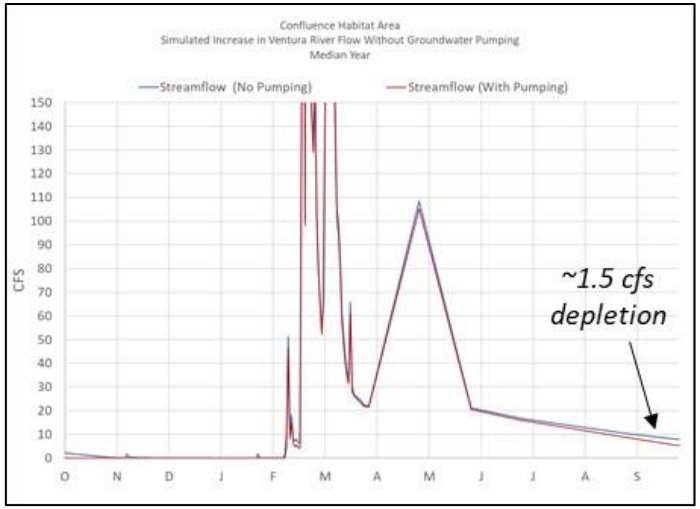
Note: Model presents data on a daily basis for November through March, and monthly for April through October

Figure 12 Simulated Streamflow at Confluence Habitat Area

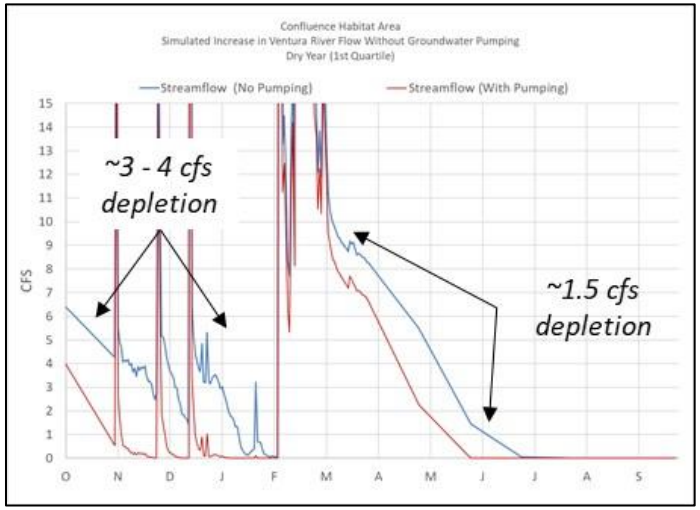
Wet Example Year



Median Example Year



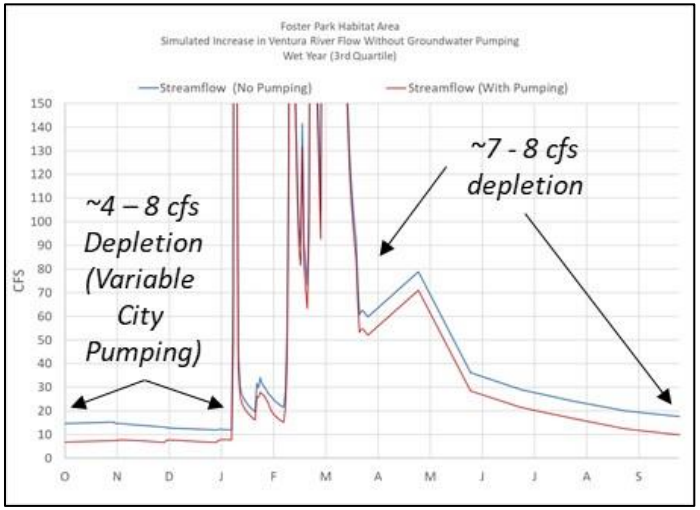
Dry Example Year



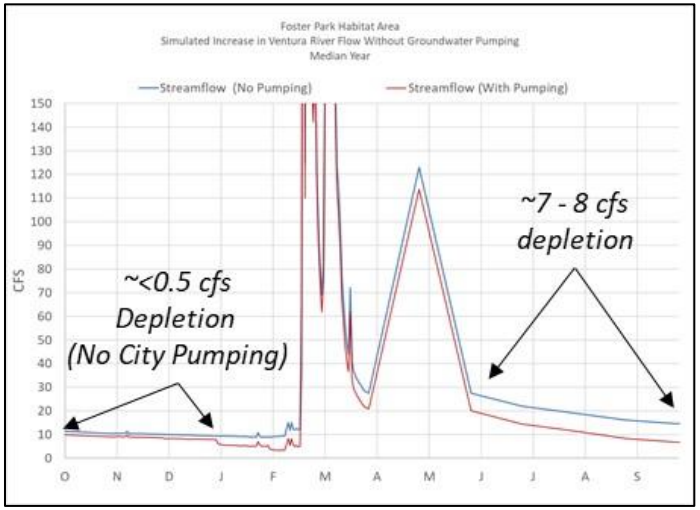
Note: Model presents data on a daily basis for November through March, and monthly for April through October

Figure 13 Simulated Streamflow at Foster Park Habitat Area

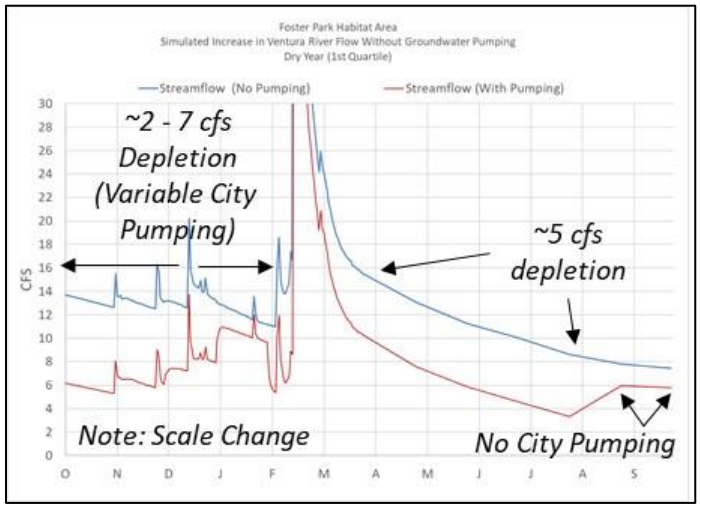
Wet Example Year



Median Example Year



Dry Example Year



Note: Model presents data on a daily basis for November through March, and monthly for April through October

Figure 14 Adult Steelhead Thalweg Depth HSI Scores Related to Flow

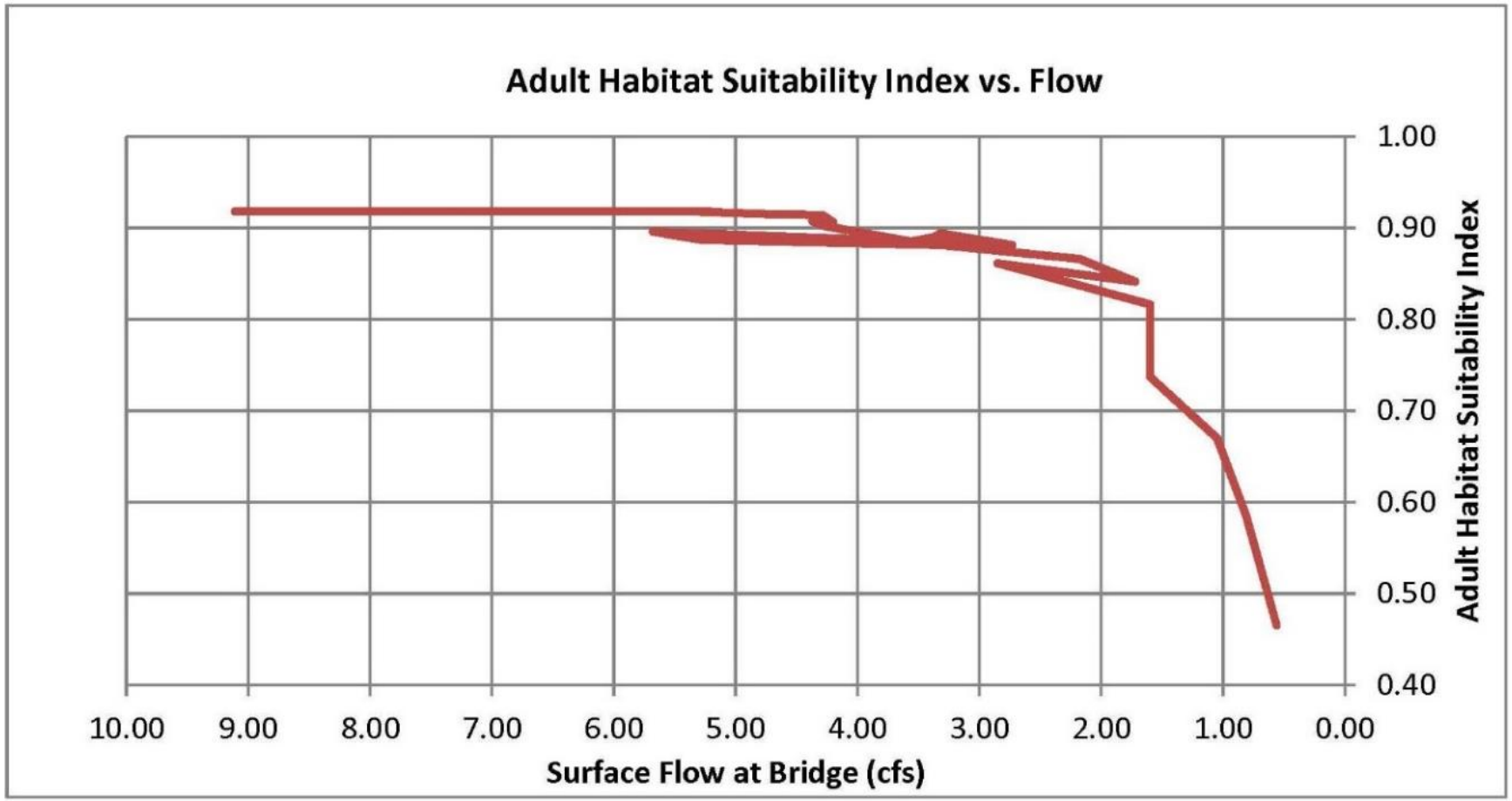


Figure taken from Hopkins 2013

4.3 Monitoring and Management Considerations

No monitoring is recommended at either of the critical riffle aquatic GDEs or the Robles Habitat Area, as impacts from pumping in these areas were determined to be minimal or non-existent.

For the Confluence Habitat Area, future monitoring is recommended to address data gaps that exist in order to determine if significant effects are occurring to the aquatic GDE. It is recommended that a formal monitoring plan be developed to understand what effects are occurring, and whether aquatic habitats are being depleted earlier in the year or for prolonged periods due to pumping. Potential elements of the monitoring could include physical monitoring and mapping during dry conditions, which could provide valuable information on the timing, frequency and duration of surface water loss from pumping and the potential impacts this could have on sensitive aquatic species. Aerial imagery could also be a valuable and cost-saving component of a monitoring plan.

For the Foster Park Habitat Area, while the City's low-flow thresholds are based on only one HSI score evaluated in the Padre study (average thalweg depth), we understand this currently provides the best available information to establish minimum thresholds for the depletion of interconnected surface water sustainability criteria. As such, these low-flow thresholds may be suitable for providing the basis for minimum thresholds in the UVRGA GSP. However, future data collection conducted by the City, UVRGA, local stakeholders, and resource agencies can inform potential adjustment of the minimum thresholds for the depletion of interconnected surface waters from groundwater pumping at Foster Park. UVRGA may conduct monitoring ~~if needed~~ in this area and include monitoring results, or results of other monitoring efforts, into 5-year GSP revisions.

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