

WATER SUPPLY AND DEMAND MODELING IN THE BUTTE CREEK WATERSHED

INFORMATIONAL FACT SHEET

The State Water Board is developing tools to better understand water supply and demand in select watersheds across California. The project involves three pilot watersheds, including the Butte Creek watershed, with plans to expand the modeling effort to include additional watersheds of interest.

Background

The State Water Board is responsible for allocating surface water through California's water rights priority system. Watershed-specific supply information from year to year is generally lacking, making water management planning difficult, especially in times of water shortage. Recent droughts (2013-2016, 2021-2023) highlighted the need for specialized data and tools to assess water availability and demand and evaluate how limited water resources are allocated.

In 2021, in response to the drought emergency in Sonoma and Mendocino Counties, the State Water Board developed tools and information to better understand water supply and demand in the Russian River watershed. Staff developed a water supply model and evaluated water diversion data to estimate watershed demand. Staff also used a tool to allocate water to right holders based on the modeled available surface water supply, water demand data and water right priorities. The supply and demand data, when integrated into the water allocation tool, was a key component in the State Water Board's implementation of drought emergency actions in the watershed.

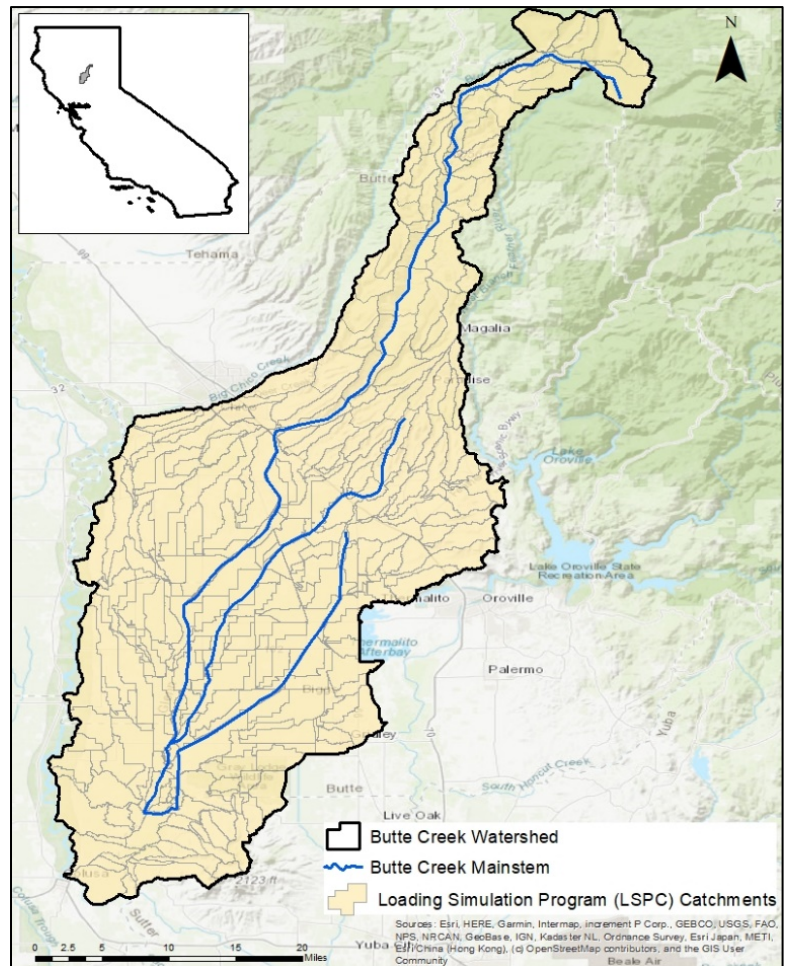


Figure 1. The Butte Creek Watershed Subbasins and Flowlines

The State Water Board established the Supply and Demand Assessment Unit in 2022 to develop supply models and demand assessments for new watersheds using an approach similar to the one



used for the Russian River during the most recent drought. This effort will enable the board to prepare for future dry conditions in other watersheds and provide data to help local water managers better understand supply constraints, develop local responses and plan for droughts. The work could also inform future curtailments, if needed.

Water Supply and Demand Modeling

Evaluating water supply and demand in a watershed enables improved comparison of the available water in the system and the demands associated with different water uses. State Water Board staff are working with Paradigm Environmental, Inc. to develop water supply (hydrologic) models that assess surface water availability in select watersheds where low flows and drought conditions may threaten water supplies, impair critical habitat, and create uncertainty for water users. Water supply modeling tasks are underway in Butte Creek (tributary to the Sacramento River), the Napa and Navarro Rivers, and six additional watersheds. These watersheds were selected because: 1) water demand is highly dependent on surface water and any future curtailment in the watersheds by the State Water Board can benefit from such a modeling framework; and 2) they contain areas of salmonoid habitat and important fisheries. These watersheds provide a range of watershed characteristics and conditions that will likely be encountered in future work and establish outreach and engagement protocols.

Modeling watershed-specific scenarios can improve understanding of water availability based on available surface water, water demands, and water right priority. All data and tools developed under this effort will be open source and available to the public so local water managers and other interested parties can assess surface water availability conditions and evaluate potential management options.

Butte Creek Watershed

Watershed Background

The Butte Creek watershed is located mostly within Butte County and has a drainage area of 820 square miles. One of the major tributaries of the Sacramento River, Butte Creek begins almost 50 miles north of Chico at around 7,000 feet of elevation in the forested Butte Meadows/Jonesville Basin region. It continues to flow southeast through the Sacramento Valley into a primarily agricultural region. At multiple locations in the upper section of the watershed, flows are diverted for hydroelectric power generation, and the lower section of the watershed is primarily used for irrigation and flood mitigation. The watershed has retained its rural nature with less than 6% of land cover being developed area and 52% of land cover being cultivated crops. Butte Creek has a distinct wet and dry season with a mean annual precipitation ranging between 20 inches in the valley and 50 inches in the higher elevations.

The Butte Creek watershed provides critical habitat for the state's largest naturally spawning population of Central Valley spring-run Chinook salmon and supports a population of Central Valley



steelhead. Both species have experienced significant declines over recent decades and are listed as threatened under the federal Endangered Species Act. Key factors impacting these populations include habitat degradation and loss due to impaired streamflow conditions, elevated water temperatures, and sedimentation from surface erosion related to roads, logging, and other land-use activities. Additionally, the watershed supports other native fish species, including Pacific lamprey and Sacramento pikeminnow.

Model and Data Specifications

The model uses a large library of publicly available data from state and federal agencies, including the following types:

- Meteorological: Historical weather data such as precipitation (rainfall and snow water equivalent), evapotranspiration (the amount of water evaporated or used by plants), air temperature, vapor pressure, and wind speed allow for modeling conditions that affect water supply.
- Hydrological: Current and historical data on the river's streamflow rate and the watershed's snowpack are used for calibration and validation of the model.
- Water use and diversion: Data showing how much water has been taken out of the river in the past serves as a proxy for watershed demand and how it affects streamflow.
- Geospatial: Data that describe where the boundaries and channels of the watershed are, as well as its physical properties, such as soil type, land cover type, and topography. These datasets are important for understanding characteristics that influence how water moves through and is absorbed by the landscape.

All datasets used in the model are subject to extensive quality control and quality assurance procedures that ensure their accuracy. This is particularly important when it comes to incorporating required water use and diversion data that is self-reported by water right holders. The cleaned data is then used to run the water supply model to simulate hydrological processes in the watershed at the scale of small tributaries (small catchments), allowing for water management decisions to be made at a very fine geographic scale.

The Loading Simulation Program in the programming language C++ (LSPC) is the water supply (hydrologic) model that was selected for this watershed. LSPC has been used extensively in California to model and manage the state's unique watersheds. Calibration of the LSPC model of Butte Creek involved analyzing critical hydrology parameters. For example, snow processes play an important role in the Butte Creek watershed as precipitation falls in the form of snow at higher altitudes during certain times of the water year. For this reason, a combination of grid cells and NHDPlus High Resolution (HR) catchments are used for the Butte Creek model segmentation. The grid represents LSPC catchments for upstream areas of the watershed where snow processes dominate and the NHDPlus HR catchment boundaries are used for downstream areas of the watershed where heavy agricultural operations exist. The calibrated model is then validated using observed streamflow that was not incorporated in the calibration phase. Data produced by the LSPC model will be used as an input for the Drought Water Rights Allocation Tool (DWRAT, or Allocation



Tool) to allocate water within each catchment based on available surface water, water demands, and water right priorities. Further details on the model are available in the [Butte Creek Watershed Model Work Plan](#), submitted by Paradigm.

Additional Resources

More information is available on the Supply and Demand Assessment [Butte Creek webpage](#). To sign up to receive email updates, please visit bit.ly/swb-subscribe and select the Water Rights' "Watershed Supply & Demand Allocations" email subscription list.

For additional questions, please contact State Water Board project staff at: DWR-SDA@waterboards.ca.gov.