Metadata: Discrete flow, water temperature, chlorophyll and inundation, Sacramento-San Joaquin Delta, CA, 1999-2019

Version: 1.1

Dataset Title

Discrete water temperature, flow, solar radiation, chlorophyll-a and inundation, Sacramento-San Joaquin Delta, CA, 1999-2019

Abstract

The objective of our study is to better understand the factors affecting chlorophyll-a production within a floodplain and its transport downstream to determine how lateral connectivity influences longitudinal connectivity. The Yolo Bypass is a floodplain of the Sacramento River that inundates during periods of high outflow via overtopping weirs. Water traveling through the Yolo Bypass flows parallel to the Sacramento River and re-connects to the mainstem at the southern extent of the floodplain. Several monitoring programs in the Sacramento San-Joaquin Delta and Yolo Bypass collect discrete and continuous water quality data, including chlorophyll measurements. For this study, we synthesized available flow, solar radiation (modeled), water temperature, chlorophyll and inundation data between March 1999 to December 2019 to investigate the effects of environmental variables and inundation on chlorophyll-a production in the floodplain, the mainstem, and downstream of the floodplain/mainstem.

Investigators

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License

Keywords

chlorophyll a, primary productivity, connectivity, floodplain, river, Sacramento-San Joaquin Delta

Funding of this work:

This project was supported by an agreement with the Delta Science Program, Delta Stewardship Council (DSC contract 19167). Funding was provided by the Delta Science Program and activities were supported by the National Center for Ecological Analysis and Synthesis (NCEAS) Learning Hub. The contents may not necessarily reflect the official views or policies of the State of California.

Delta Science Program, Department of Water Resources, California Department of Fish and Wildlife, United States Geological Survey, Bureau of Reclamation, US Fish and Wildlife Service and UC Davis contributed (via staff time) to this collaborative synthesis project, supported by the Delta Science Program in collaboration with the NCEAS Learning Hub.

Timeframe

- Begin date: 3/9/1999
- End date: 12/27/2019
- Data collection ongoing or completed: completed

Geographic location

- Verbal description: Sacramento-San Joaquin Delta, including mainstem Sacramento River, Yolo Bypass, and downstream reaches
- North bounding coordinate (decimal degree): -121.353
- South bounding coordinate (decimal degree): -122.002
- East bounding coordinate (decimal degree): 38.08453
- West bounding coordinate (decimal degree): 38.77435

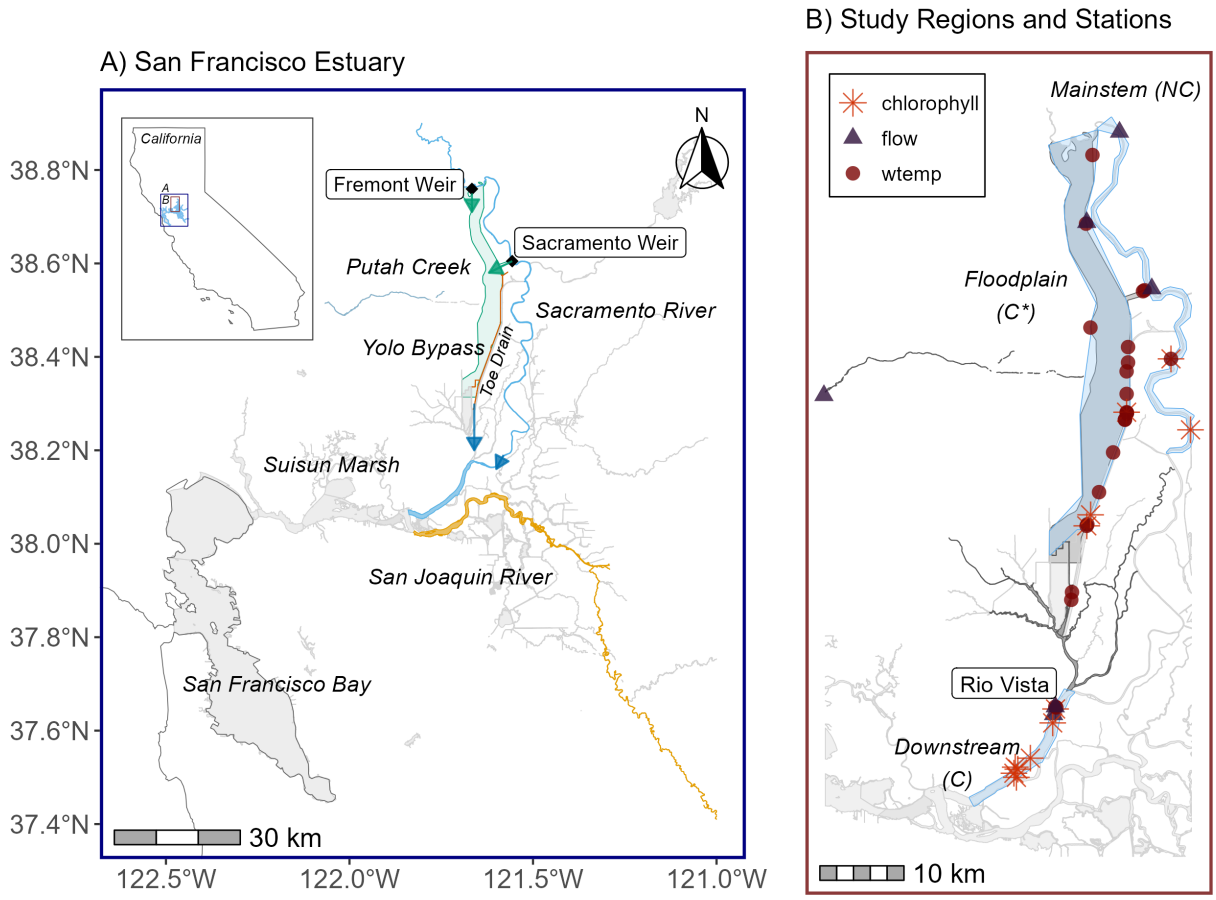

Figure 1. Map of A) San Francisco Estuary, B) Regions and Stations used in study. A) Green arrows denote lateral connectivity between the mainstem and floodplain. Blue arrows denote longitudinal connectivity to downstream region. B) NC = not connected, C* = conditionally connected (during inundation), C = connected.

Methods

We integrated data collected from various agencies to examine the relationship between chlorophyll and water temperature, solar radiation, flow, and inundation. Please see original data sources for metadata and associated code. Data were downloaded and integrated using R Version 4.3.0.

- We downloaded parameters of interest (flow, inundation, solar radiation, water temperature) from original data sources (Table 1).
  - Flow
    - We obtained USGS daily mean flow data using the "readNWISdv" function from the *dataRetrieval* package (DeCicco et al. 2022).
    - We obtained dayflow data using the "calc_inundation" function from the *inundation* package (Clark & Goertler 2022; Goertler 2022).

    - Inundation
        - We obtained inundation data using the "calc_inundation" function from the *inundation* package (Clark & Goertler 2022).
    - Solar radiation
        - We obtained solar radiation data using the "download_daymet" function from the *daymetr* package (Hufkens et al. 2018).
    - Water temperature
        - We obtained water temperature data from Goertler & Pien (2022).
- We further processed data and created a full dataset for covariates.
    - We used the "rollapply" function from the *zoo* package (Zeileis & Grothendiek 2005) to calculate weekly mean water temperature and solar radiation.
    - Missing data
        - We filled missing flow data at Sacramento River at Rio Vista using linear regression with an upstream station (USGS-11447905, Sacramento River below Georgiana Slough; $R^2 = 0.938$). For any remaining missing data, values were imputed with the *imputeTS* R package (Moritz and Bartz-Beielstein 2017).
        - Missing solar radiation data were filled with the "fill" function from the *tidyr* package when data were missing (Wickham & Girlich 2023).
    - We assigned each data point to the designated region (Figure 1B).
- We downloaded chlorophyll a data from original data sources (Table 1), and assigned each station to the designated region. When there was more than one chlorophyll value for a given station on a given date (8 instances), we used the mean of the values.
- We joined covariates to the chlorophyll-a data, thus removing dates when chlorophyll-a data were not available.
- We filtered the dataset to March 1999 to December 2019 to cover the period of data availability.
- We filtered the dataset to period of potential inundation (December 5 to May 2) based on historical dates of inundation.
- Processing code are available at: https://github.com/Delta-Stewardship-Council/swg-21-connectivity/tree/main/data_publication/R

Table 1. Summary of Data Sources and Metrics in Integrated Dataset.

Data type	Metric	Dataset	Description of dataset	Reference
Chlorophyll-a	Chlorophyll-a (µg/L)	Yolo Bypass Fish Monitoring Program	Discrete chlorophyll data	Adams and Pien 2023

Chlorophyll-a	Chlorophyll-a (µg/L)	Discrete Water Quality Integrated Dataset	Discrete chlorophyll from 16 monitoring programs	Bashevkin et al. 2023
Flow	Daily mean flow (cfs)	USGS flow data	Continuous discharge (parameter 00060) from USGS 11445500 (Sacramento River at Verona)	USGS 2023
Flow	Daily mean flow (cfs)	USGS flow data	Continuous tidally filtered discharge (parameter 72137) from USGS 11455420 (Sacramento River at Rio Vista)	USGS 2023
Flow	Daily mean QYOLO (cfs)	Dayflow	Modeled Yolo Bypass flow	CDWR 2022
Solar radiation	Mean weekly solar radiation	Daymet	Simulated daily solar radiation	Hufkens et al. 2018
Water temperature	Mean weekly water temperature	Yolo Bypass water temperature dataset	Continuous and discrete water temperature from the Yolo Bypass, Rio Vista and Sacramento River at Sherwood Harbor	Goertler & Pien 2022
Inundation	Inundation duration factor (no inundation, short inundation <21 days, long inundation >= 21 days)	Yolo Bypass Inundation	Inundation metrics based on stage height at Fremont Weir and modeled flow data	Clark & Goertler 2022

Methods References

Adams, J. and C. Pien. 2023. Interagency Ecological Program: Discrete water quality and phytoplankton data from the Sacramento River floodplain and Yolo Bypass tidal slough, collected by the Yolo Bypass Fish Monitoring Program, 1998 - 2022 ver 1. Environmental Data Initiative. https://doi.org/10.6073/pasta/5791d7eaca09fb9471c5589c66f86863.

Bashevkin, S.M., D. Bosworth, S.E. Perry, E.B. Stumpner, and R. Hartman. 2023. Six decades (1959-2022) of water quality in the upper San Francisco Estuary: an integrated database of 16 discrete monitoring surveys in the Sacramento San Joaquin Delta, Suisun Bay, Suisun Marsh, and San Francisco Bay ver 7. Environmental Data Initiative. https://doi.org/10.6073/pasta/8dbd29c8c22f3295bbc5d3819fb51d00.

California Department of Water Resources (CDWR). 2023. Dayflow data available on the World Wide Web, accessed in 2023. https://data.cnra.ca.gov/dataset/dayflow.

Clark J, Goertler P (2022). _inundation: Calculate Delta Inundation Metrics_. R package version 0.1.0. https://zenodo.org/records/6450272

De Cicco, L.A., Hirsch, R.M., Lorenz, D., Watkins, W.D., Johnson, M., 2022, dataRetrieval: R packages for discovering and retrieving water data available from Federal hydrologic web services, v.2.7.12, doi:10.5066/P9X4L3GE

Goertler, P. 2022. Modeled daily Yolo Bypass inundation ver 1. Environmental Data Initiative. https://doi.org/10.6073/pasta/d57a74bcff69ed673bfac1de994dd9d2.

Goertler, P. and C. Pien. 2022. Daily water temperature (C) in the Yolo Bypass and Sacramento River, 1998-2019 ver 2. Environmental Data Initiative. https://doi.org/10.6073/pasta/5d84e5b8ea74dd0854d4aba1e4a6122d.

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Moritz S, Bartz-Beielstein T (2017). “imputeTS: Time Series Missing Value Imputation in R.” _The R Journal_,9(1), 207-218. doi:10.32614/RJ-2017-009 <https://doi.org/10.32614/RJ-2017-009>.

U.S. Geological Survey (USGS). 2023, National Water Information System data available on the World Wide Web (Water Data for the Nation), accessed in 2023. http://waterdata.usgs.gov/nwis/.

Wickham H, Vaughan D, Girlich M (2023). _tidyr: Tidy Messy Data_. R package version 1.3.0, <https://CRAN.R-project.org/package=tidyr>.

Data Table

Table name: Chlorophyll and Covariate Data

Table description: Chlorophyll, Solar Radiation, Water Temperature, Flow and Inundation Data, 1999-2019

Column name	Description	Unit or code explanation or date format	Missing value code
date	Date	M/D/Y	
doy1998	Count of days since January 1, 1998	nominalDay	
dowy	Day of water year	nominalDay	
month	Month	dimensionless	
water_year	Water year	nominalYear	
inundation	Inundated or not inundated	0 = no inundation; 1 = inundation	
inund_days	Number of days inundated during the current inundation event	nominalDay	
inund_factor	Categorical classification of number of days inundated	None = no inundation; Short = less than or equal to 21 days of inundation; Long = greater than 21 days inundation	
region	Region	Upstream = mainstem, yolo = floodplain, downstream = downstream	
Q_sday	Mean daily flow	cubicFeetPerSecond	
log_qsdy	Log of mean daily flow	cubicFeetPerSecond	
WTmwk	Mean weekly water temperature	celsius	
sradmwk	Mean weekly solar radiation	wattPerMeterSquared	
chlorophyll	Chlorophyll-a concentration	microgramsPerLiter	
log_chla	Log of chlorophyll-a concentration	microgramsPerLiter	
station	Station code or number		

Table name: Stations
Table description: Station Locations, Descriptions, Frequency of Sampling

Column name	Description	Unit or code explanation or date format	Missing value code
latitude	Latitude	decimalDegree	
longitude	Longitude	decimalDegree	
station	Station code or number		
region	Region name		
data_type	Metric		
station_name	Station name		
agency_program	Agency and/or Program name		
sampling_frequency	Sampling frequency		

Data provenance

Dataset title	Dataset DOI or URL	Creator (name & email)	Contact (name & email)
Six decades (1959-2022) of water quality in the upper San Francisco Estuary: an integrated database of 16 discrete monitoring surveys in the Sacramento San Joaquin Delta, Suisun Bay, Suisun Marsh, and San Francisco Bay	https://doi.org/10.6073/pasta/8dbd29c8c22f3295bbc5d3819fb51d00	Sam Bashevkin (Sam.Bashevkin@waterboards.ca.gov)	Sam Bashevkin (Sam.Bashevkin@waterboards.ca.gov)
Interagency Ecological Program: Discrete water quality and phytoplankton data from the Sacramento River floodplain and Yolo Bypass tidal slough, collected by the Yolo Bypass Fish Monitoring Program, 1998 - 2022	https://doi.org/10.6073/pasta/5791d7eaca09fb9471c5589c66f86863	Jesse Adams (Jesse.Adams@water.ca.gov)	Jesse Adams (Jesse.Adams@water.ca.gov)
USGS Flow Data	https://waterservices.usgs.gov/	Elizabeth Stumpner (Elizabeth.Stumpner@water.ca.gov), Cathy Ruhl	Elizabeth Stumpner (Elizabeth.Stumpner@water.ca.gov), Cathy

Dataset title	Dataset DOI or URL	Creator (name & email)	Contact (name & email)
		(cruhl@usgs.gov)	Ruhl (cruhl@usgs.gov)
Dayflow	https://data.cnra.ca.gov/dataset/dayflow	Robin Cheng (robin.cheng@water.ca.gov)	Robin Cheng (robin.cheng@water.ca.gov)
Daily water temperature (C) in the Yolo Bypass and Sacramento River, 1998-2019	https://doi.org/10.6073/pasta/5d84e5b8ea74dd0854d4aba1e4a6122d	Pascale Goertler (Pascale.Goertler@water.ca.gov)	Pascale Goertler (Pascale.Goertler@water.ca.gov)

Versioning History

Version number	Date created	Description of changes	Justification for change	Version editor(s)	Contact info
v1.0	12/4/2023	Initial document	Initial document	Catarina Pien	cpien@usbr.gov
v1.1	12/12/2023	Edited methods references to be citation instead of table; Added an ORCID	More traditional way to cite resources	Catarina Pien	cpien@usbr.gov

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