Daily D-1641 Regulations in CalLite

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04/04/2022
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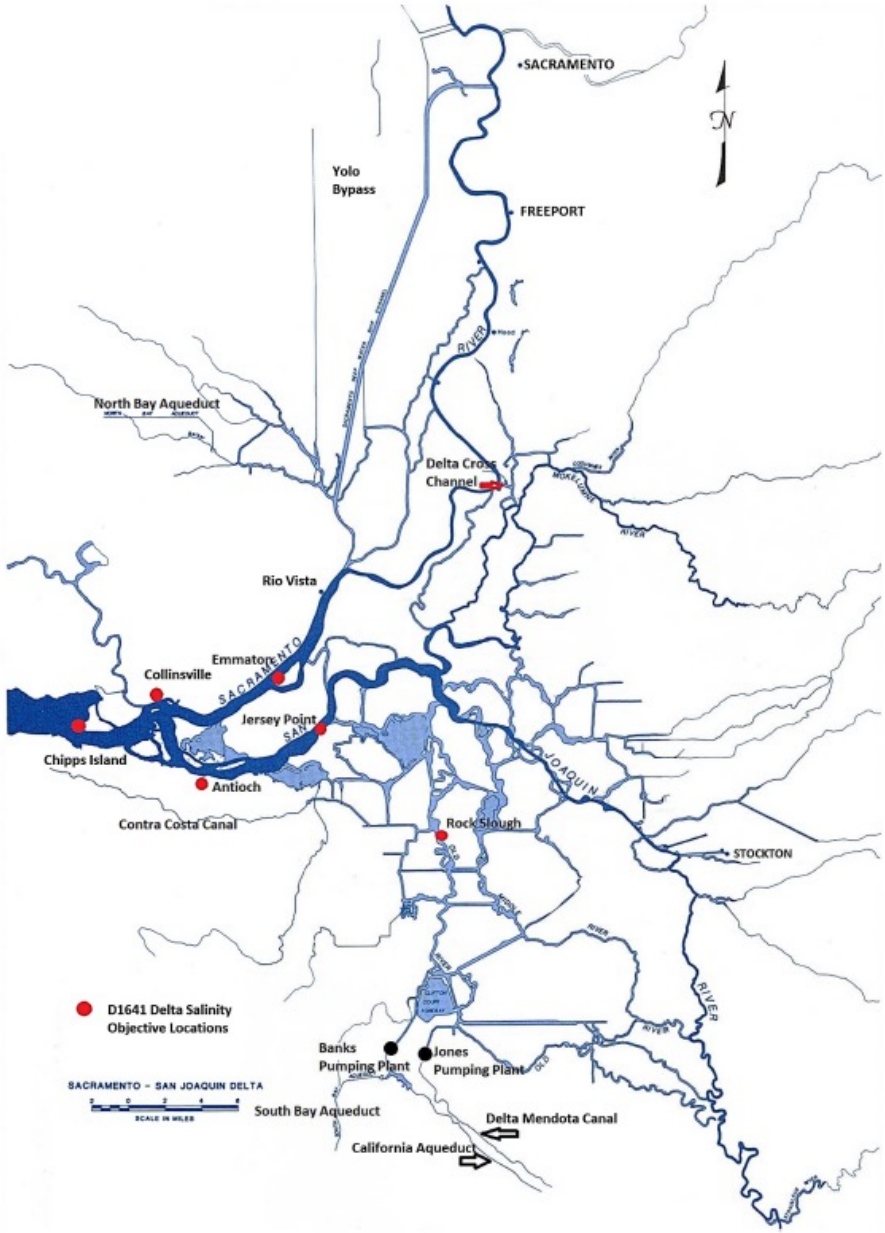

Jayasundara, N. C., Seneviratne, S. A. , Reyes, E. , and Chung, F. I. 2020. “Artificial neural network for Sacramento–San Joaquin Delta flow– salinity relationship for CalSim 3.0.” J. Water Resour. Plann. Manage. 146 (4): 04020015. https://doi.org/10.1061/(ASCE)WR.1943-5452 .0001192

Outline

Overall research objective

Implement daily timestep mode in the CalLite: Central Valley Water Management Screening model

Daily timestep relevance

Images from https://pixel-ca-dwr.photoshelter.com/galleries

Examples of other river/reservoir system models with daily timestep capability

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nental Systems

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RiverWare

RiverWare is a river syst
operational decision ma
evaluation, system optir
administration and long
applications is made po
ranging from one hour t

Physical Processes

Simulation and Rul

Optimization

Texas A&M AgriLife Research | Extension

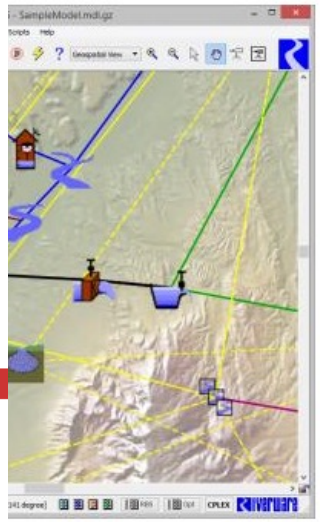
TEXAS A&M UNIVERSITY

Texas Water Resources Institute TR-430
August 2012

Water Rights Analysis Package (WRAP) Daily Modeling System

Ralph A. Wurbs and Richard J. Hoffpauir
Texas A&M University

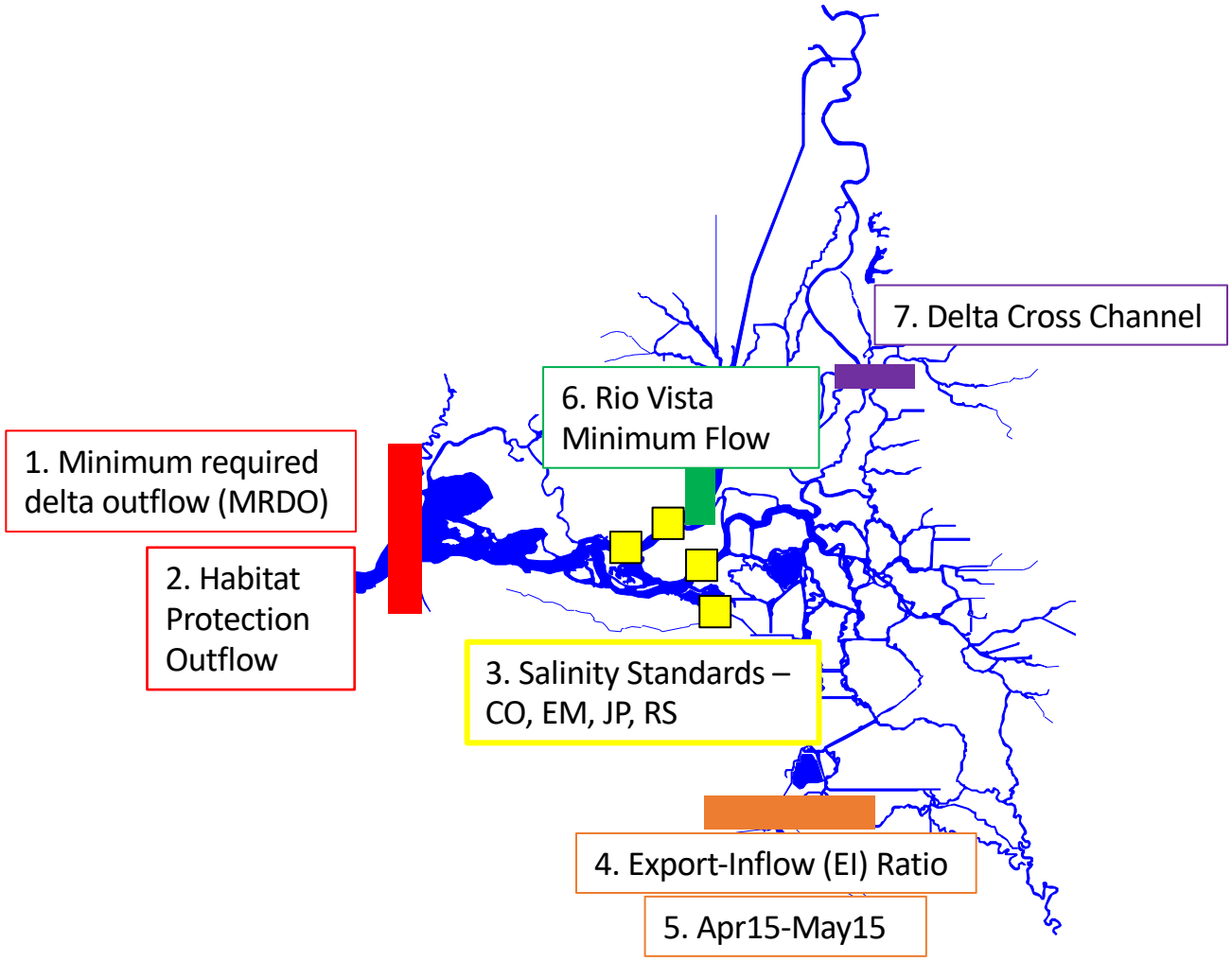
Texas Water Resources Institute
make every drop count



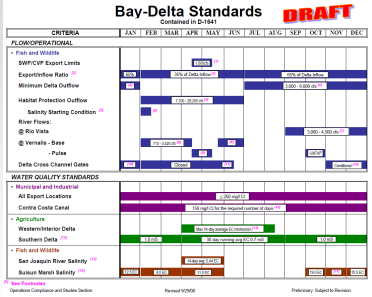
Model setup: CalSim II base is DCR 2017

Category	Description
Period 	Water year 1997 (October 1996 to September 1997)
Spatial scope 	North of Delta, Delta
Sacramento River inflow and Delta outflow 	Driven by D-1641 requirements
South of Delta operations 	Driven by historical timeseries
San Joaquin River inflow to Delta 	Driven by historical timeseries
Channel routing 	To be implemented

State Water Resources Control Board D-1641 Standards in CalLite



Hoang, R. 2016. "D1641 & Biological Opinion ." CA DWR, Sacramento, CA.



Step 1: Review each regulation

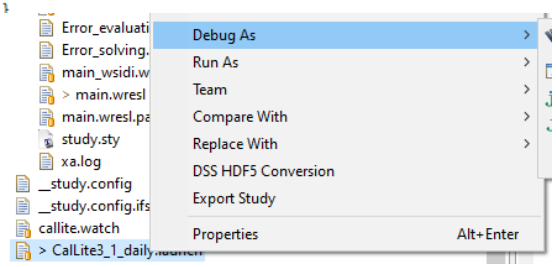
[1] Maximum 3-day running average of combined export rate (cfs)

Year Type	All
Apr15 - May15*	The greater of 1,500 or 100% of 3-day avg. Vernalis flow

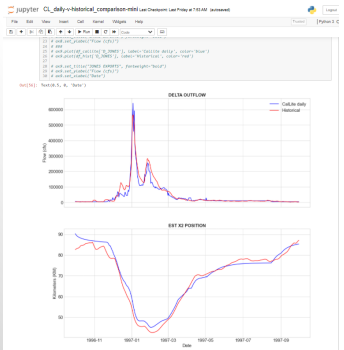
Step 2: Note any language that mentions daily or rolling averages

```
goal compare_sjrflow {!PulseExpCtrl < max(1500.0, AD_SJR_Pulse)}
    lhs PulseExpCtrl
        case VAMPexpCtrlON {
            condition    VAMP_DLTSW == 1 .and. (month == Apr .and. day >= 15) .or. (month == MAY .and. day <= 15)
            rhs          max(1500.0, C_SJRVer_3dayavg) ! Using DAYFLOW SJR Vernalis data, NSO 01/20/2022
            lhs<rhs      penalty 0 }
        case otherwise {
            condition     always
            rhs           99999.
            lhs<rhs       penalty 0 }
}
```

Step 3: Update code and/or lookup tables



Step 4: Run and debug model

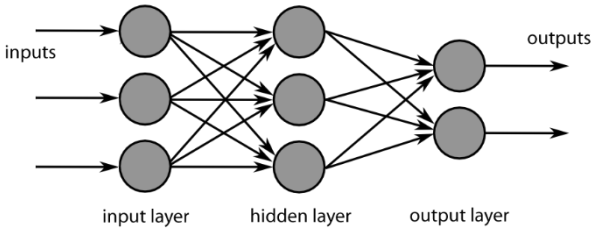


Step 5: Review results and repeat steps 3-5 as needed

The G-model and Jassby Equations were ANN alternatives.

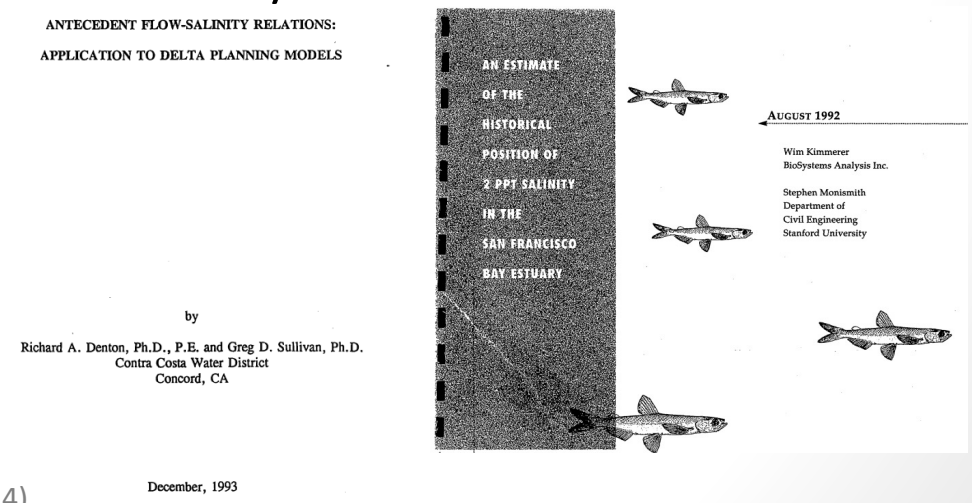
CalLite monthly

Artificial Neural Network (ANN)



CalLite Daily

- Salinity - G-model
  - Empirical
  - Steady vs unsteady state versions
- X2 position – Jassby equation
  - Autoregressive lag equation
  - Used by DWR DAYFLOW


ANTECEDENT FLOW-SALINITY RELATIONS:

APPLICATION TO DELTA PLANNING MODELS

by

Richard A. Denton, Ph.D., P.E. and Greg D. Sullivan, Ph.D.
Contra Costa Water District
Concord, CA

December, 1993

AN ESTIMATE OF THE HISTORICAL POSITION OF 2 PPT SALINITY IN THE SAN FRANCISCO BAY ESTUARY

AUGUST 1992

Wim Kimmerer
BioSystems Analysis Inc.

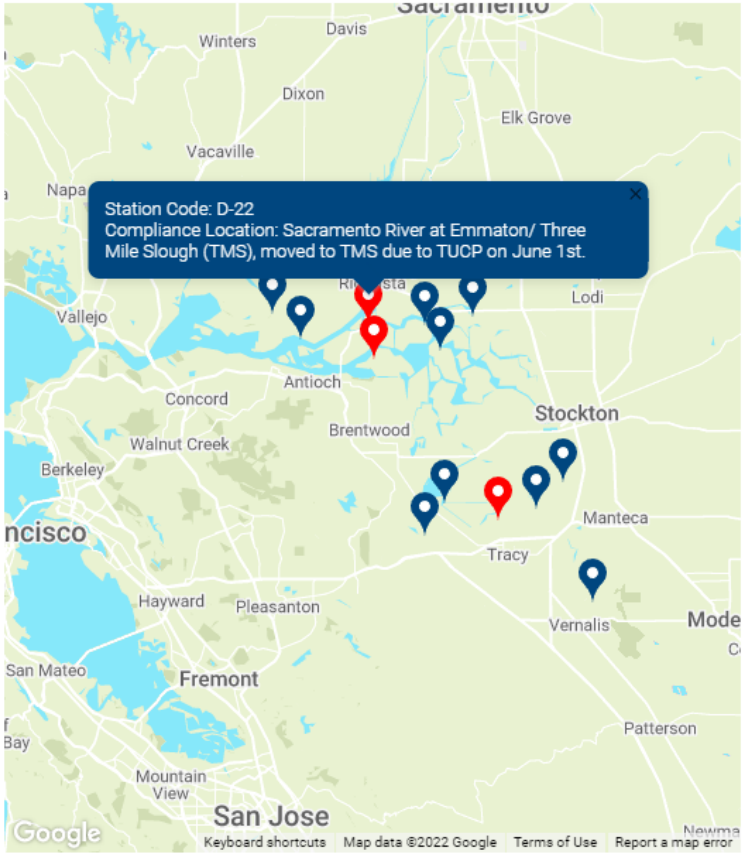
Stephen Monismith
Department of
Civil Engineering
Stanford University

"K-M equation" is a misnomer according to Reed et al. (2014)

Reed, D. et al. 2014. Panel Summary Report on the State Water Resources Control Board's Workshop on Delta outflows and Related Stressors, on the Internet at: https://cawaterlibrary.net/wp-content/uploads/2017/05/delta_outflows_summary_report.pdf

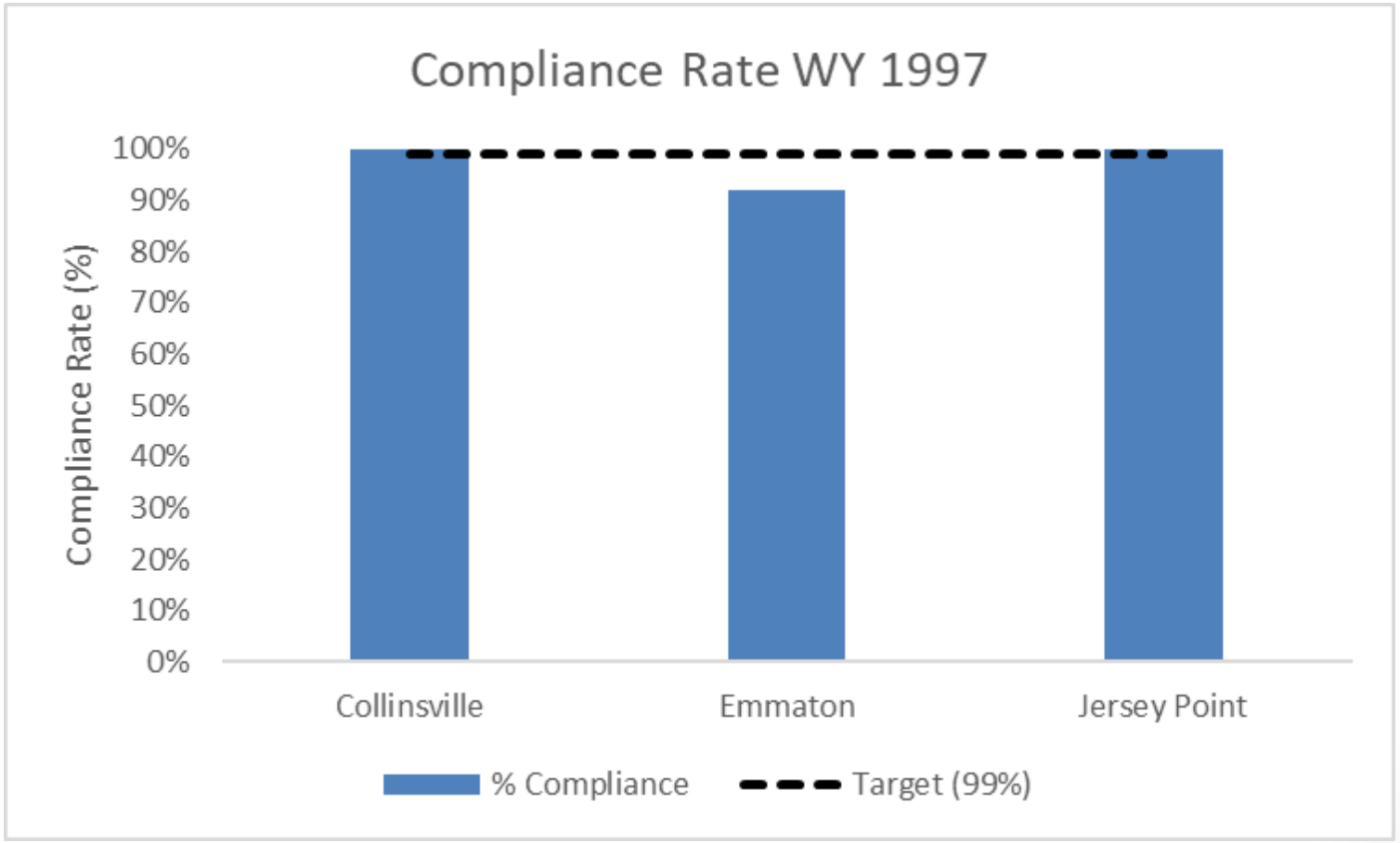
How is salinity standard compliance tracked in real life?

Annual Emmaton compliance from 2016 to 2021



https://viewperformance.deltacouncil.ca.gov/pm/salinity

Emmaton is under compliance using the steady state G-model equation.



Rock Slough is meeting specified days below 150 mg/L.

State of California - Department of Water Resources - Division of Operations & Maintenance - Operations Control Office

Delta Water Quality Conditions

for the Sacramento - San Joaquin Delta and Suisun Marsh

Thursday, March 31, 2022

Flow/Operational	Standard	Current Status
% of inflow diverted	35 %	35 % 14 Day Average
NDOI, monthly average *	>=7,100 cfs	9,557 cfs
Vernalis Base Flow, monthly average *	>=710 cfs	950 cfs
Vernalis Base Flow, 7 Day average*	>=568 cfs	853 cfs
Habitat Protection, X2/Flow	31 days at Collinsville	30 days
	14 days at Chipps Island	14 days

Water Quality	Standard	Current Status
Days @ CCWD PP#1 w/ chlorides <= 150 mg/l	155 days	90 days
Export Areas for SWP, CVP, CCWD, et al	<= 250 mg/l Cl	43 mg/l

Actual Daily Delta Water Quality Controls

Simulated G-model Rock Slough Water Quality Compliance WY 1997

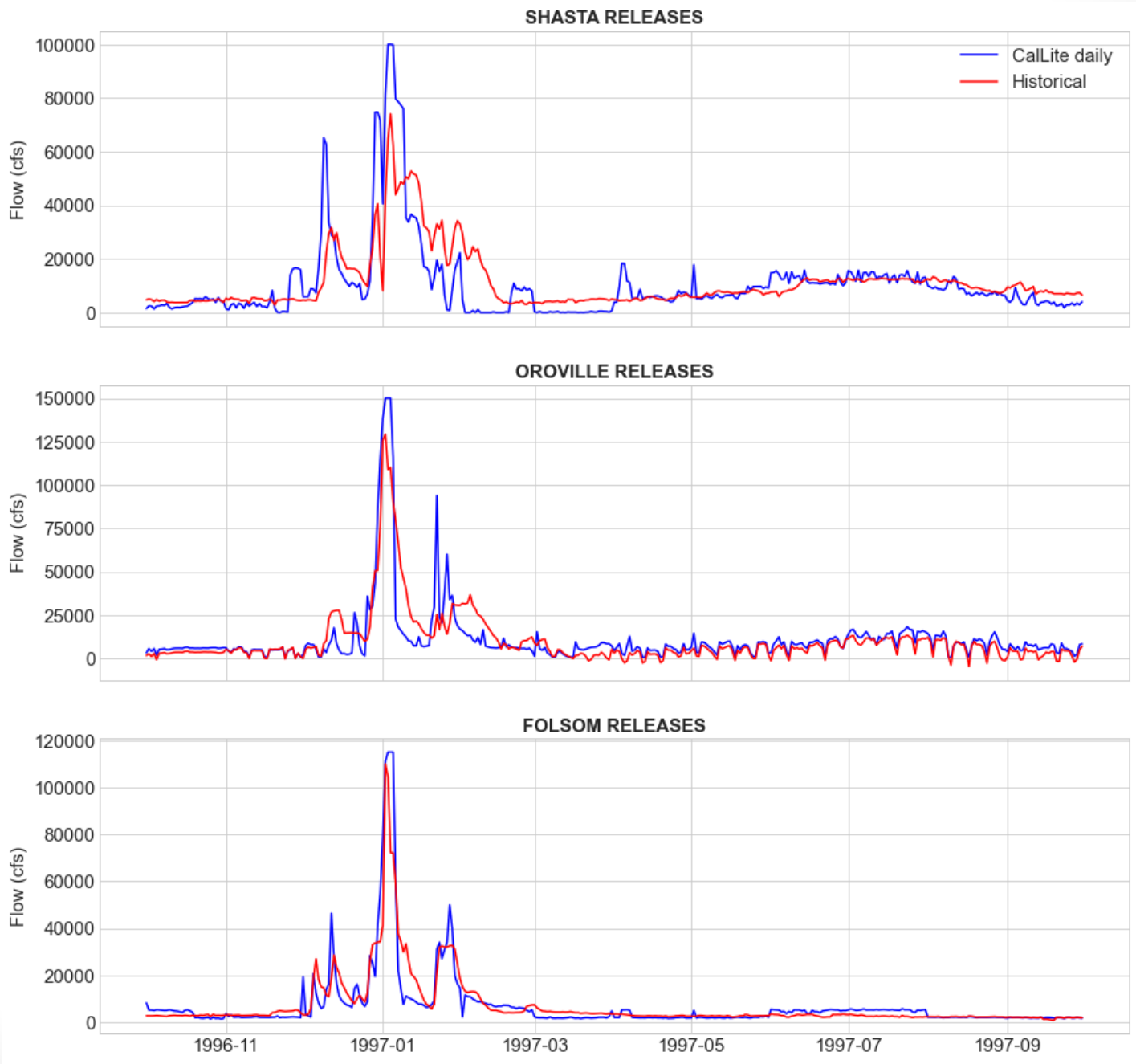
Station	Standard (days)	Days @ CCWD PP#1 w/ chlorides <= 150 mg/l
Rock Slough	240	243

https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/State-Water-Project/Operations-And-Maintenance/Files/Operations-Control-Office/Delta-Status-And-Operations/Delta-Water-Quality-Daily-Summary.pdf

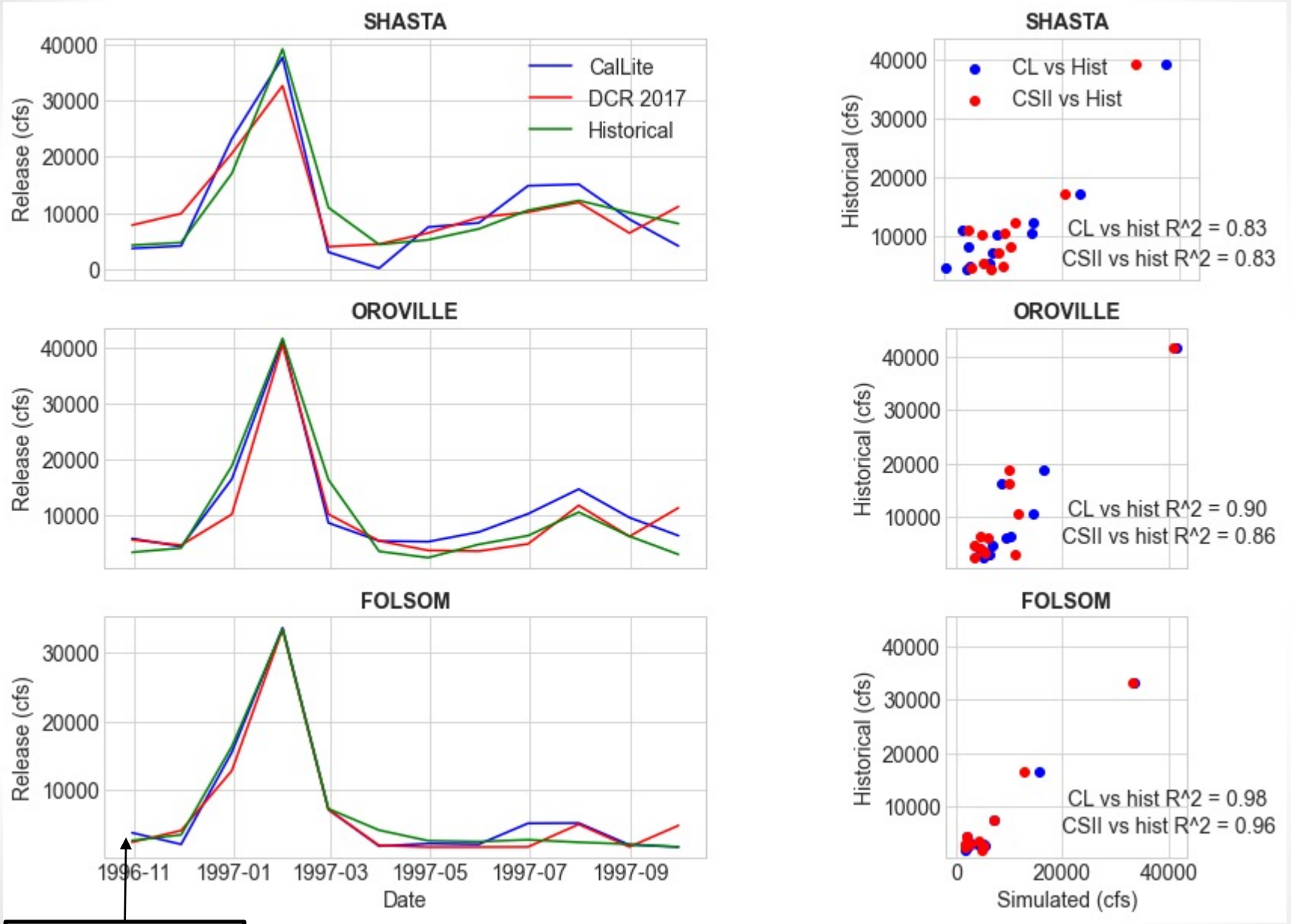
Results – Two perspectives

- **Daily** simulated vs historical
- **Monthly** simulated vs historical
  - Daily CalLite aggregated to monthly
  - DCR 2017 CalSim II

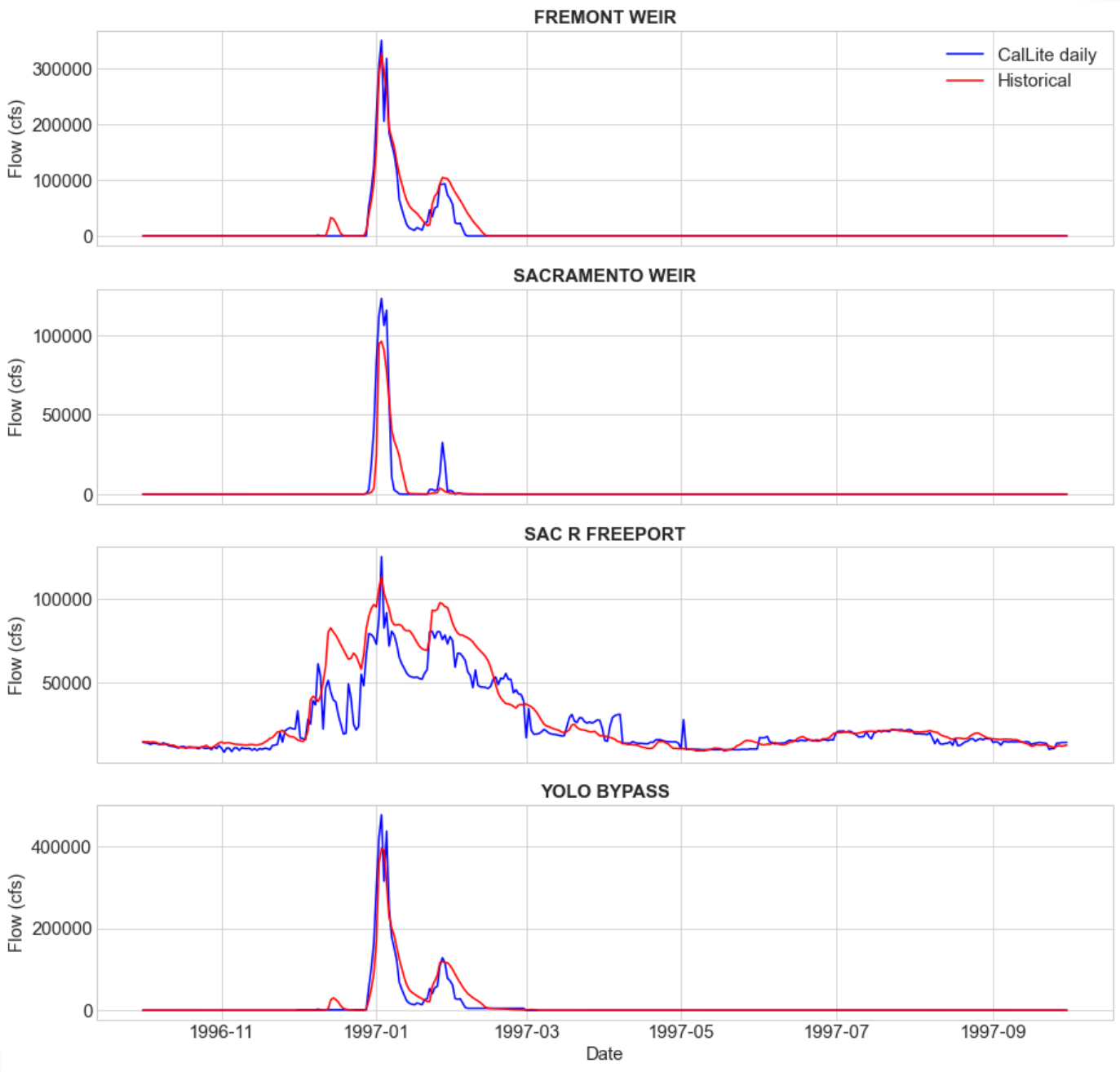
Daily Results – Reservoir releases



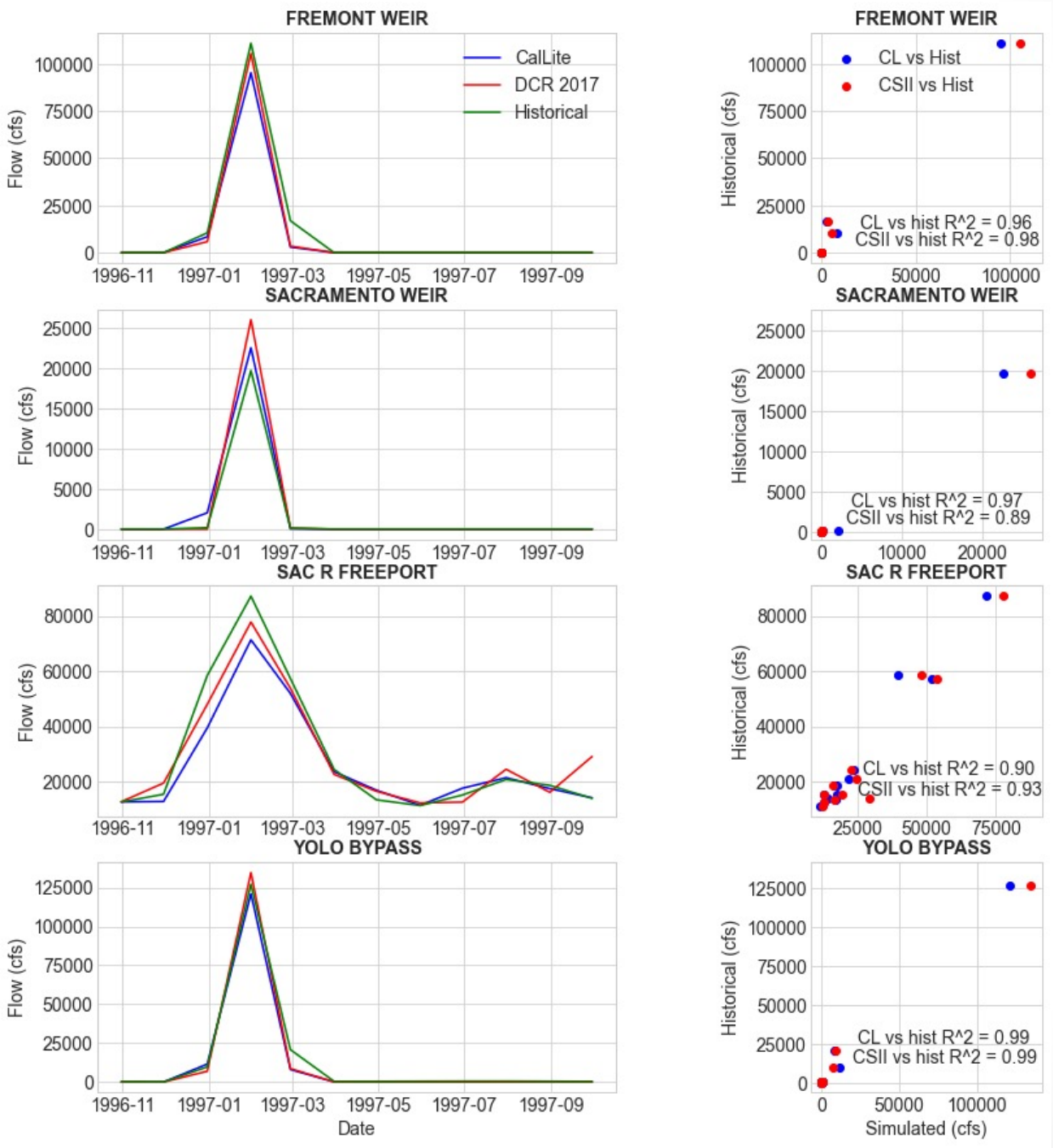
Monthly Results – Reservoir releases



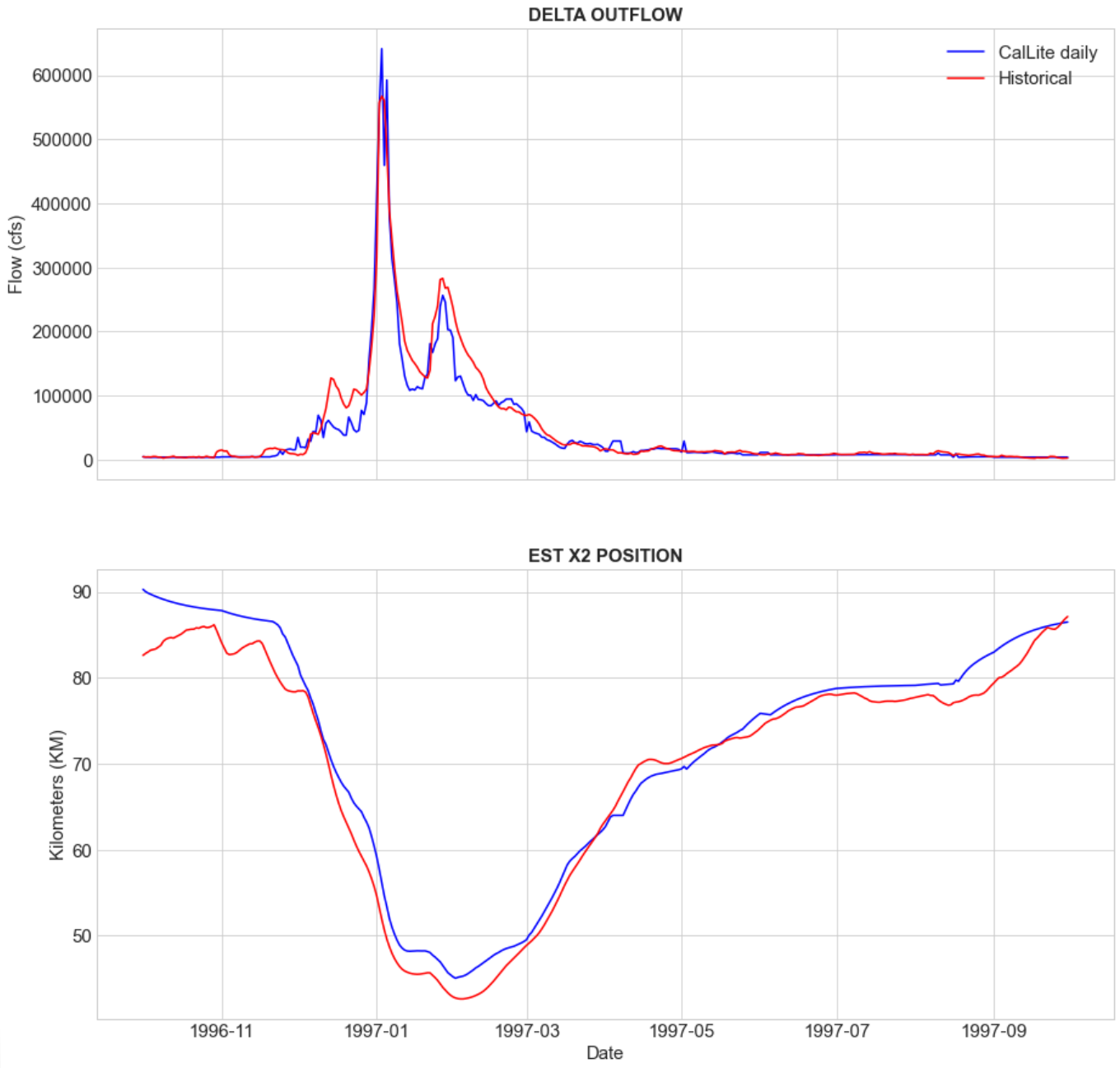
Daily Results – NOD flows



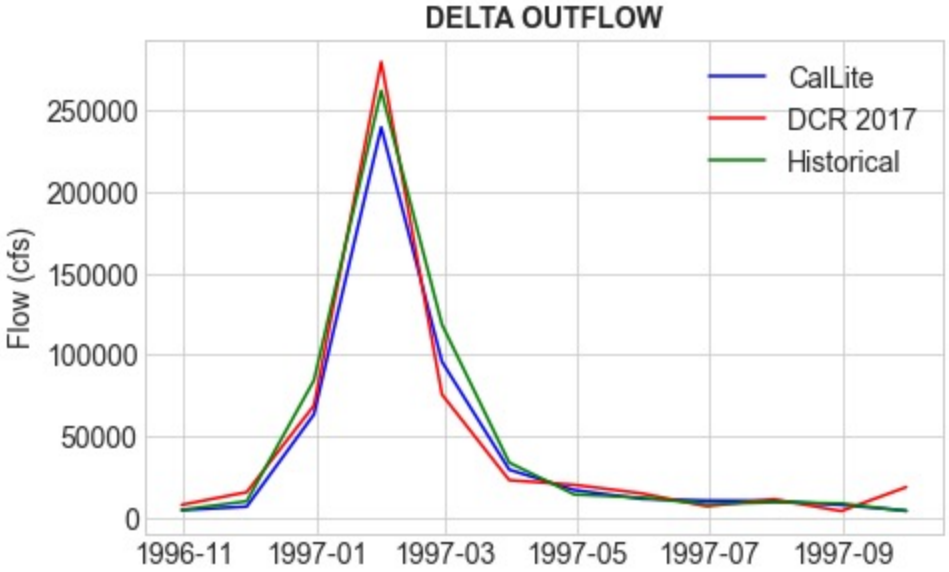
Monthly Results – NOD flows

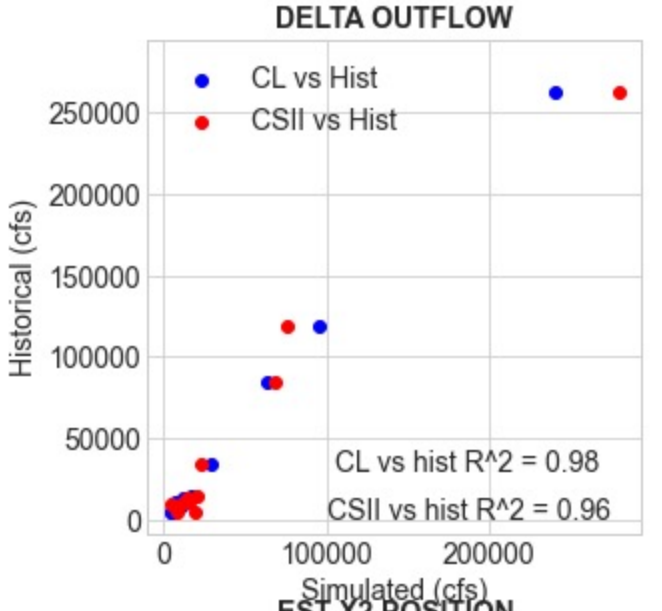


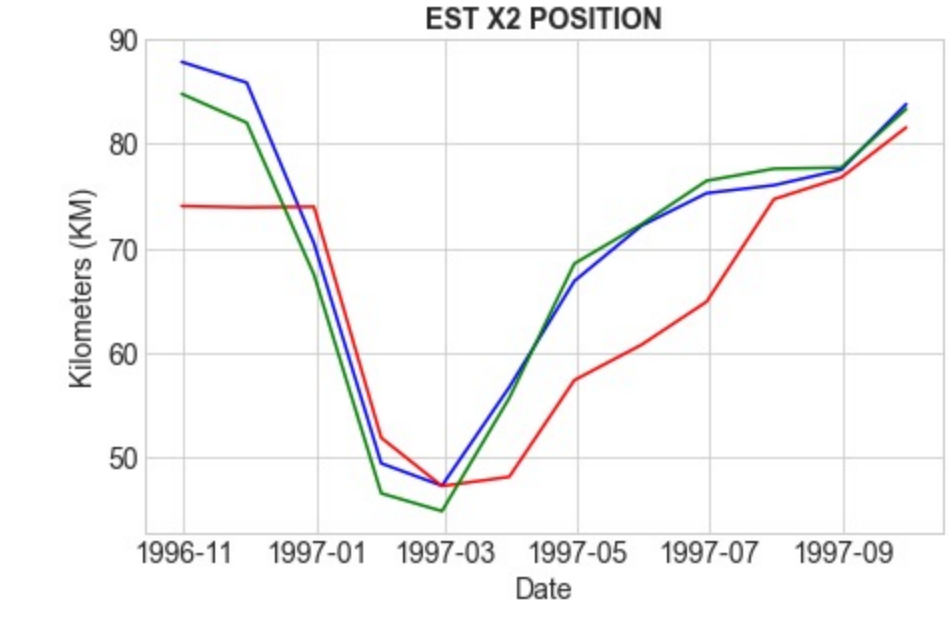
Daily Results – Delta

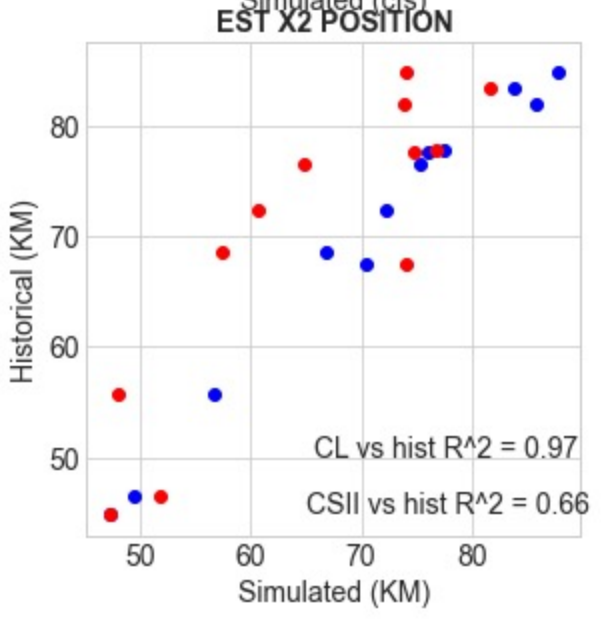


Monthly Results – Delta









Areas of Improvement

Model representation improvement list

- Reservoir operations
  - CVP NOD reservoir balancing equations
  - USACE flood control rule curves
  - Storage-elevation-discharge curves
  - New Bullards Bar dynamic simulation
- Fremont Weir and Sacramento Weir logic
- Delta and South of Delta
  - Update and review ‘08-09 BO RPAs
  - Exports and San Luis dynamic simulation

Summary

- Daily timestep makes it easier to represent D-1641 regulations
- G-model steady-state and Jassby equation used to simulate Delta salinity, outflow, and X2
- North of Delta reservoir operations code and inputs have much room for improvement
- Monthly historical comparison shows that CalLite daily is generally performing similarly or “better” than the CSII model counterpart

What's next?

- Linear hydrologic routing
  - **Muskingum parameters**: HEC-FCLP from Dustin Jones MS thesis, USACE Comp Study
  - **Lag and K parameters**: California-Nevada River Forecast Center (Pete Fickenscher), DWR Estimated Travel Times 2016
- Multi-timestep optimization (MTO)
  - Prevents model from excess reservoir releases to reduce travel time (Ilich 2008)

Ilich, N. (2008). "Shortcomings of linear programming in optimizing river basin allocation." *Water Resour. Res.*, 44, W02426, 10.1029/2007WR006192

This aerial view looks west toward the Sacramento Weir with all 48 gates open during the massive flood that hit Northern California in 1997. https://pixel-ca-dwr.photoshelter.com/

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THANK YOU!