



TECHNICAL MEMORANDUM

DATE: January 7, 2026

TO: Christina Buck, Butte County Water and Resource Conservation

FROM: Lisa Porta, P.E. (with review from Charles Brush, Hydrolytics, LLC)
Modeling support provided by Woodard & Curran

PROJECT: Butte County Inter-Basin Coordination and Model Updates

SUBJECT: Inter-basin Flow Evaluation with Regional Model

INTRODUCTION AND BACKGROUND

Butte County is leading an Inter-Basin Coordination (IBC) Analysis and Modeling project on behalf of the Vina and Wyandotte Creek Subbasin Groundwater Sustainability Agencies (GSAs), both of whom received sustainable groundwater management grant program funds for this project in 2023 from the California Department of Water Resources (DWR). The work includes a joint analysis of Groundwater Sustainability Plans (GSPs) in the region and focuses on a technical analysis and summarizes foundational information for outreach materials to communicate with the public and stakeholders to support coordination among Northern Sacramento Valley (NSV) GSAs. It also includes a review of modeling results to assess inter-basin flows and stream-aquifer flows at subbasin boundaries.

Groundwater modeling coordination goals include developing a shared understanding of conditions occurring at each subbasin boundary, such as stream-aquifer interactions and cross-boundary flows (volume and direction).

This evaluation project supports these goals by providing the data and tools needed to make informed modeling decisions and allows GSAs to coordinate on these topics as they begin work on their Periodic Evaluations for submission by January 2027.

Key tasks and goals for this work include the following:

- Evaluate and compare modeling tools identified in GSPs.
- Review modeling results at subbasin boundaries.
- Estimate groundwater flow and stream-aquifer interactions at subbasin boundaries.

This technical memorandum was developed to provide boundary flows between the three Butte County subbasins with their neighboring subbasins using the newly released C2VSimFG V1.5 by DWR.

PURPOSE AND NEED

In the North Sacramento Valley, inter-basin coordination occurs at different levels between technical teams, GSA staff and managers, and to a lesser extent, at the policy level between GSA boards.

Inter-basin Coordination During GSP Development

During GSP development, initial inter-basin coordination was driven by the technical information needs outlined in Article 8 of GSP Regulations for Inter-basin Agreements, in particular the following items that require modeling approaches:

- *An estimate of groundwater flow across basin boundaries, including consistent and coordinated data, methods and assumptions*
- *An estimate of stream-aquifer interactions at boundaries*

Inter-basin coordination efforts are focused on establishing a foundation and guidelines for sustained inter-basin coordination through GSP implementation, as described in the *Northern Sacramento Valley Inter-basin Coordination Report*¹ (*Inter-basin Coordination Report*).

The information sharing is the first pillar established in the *Inter-basin Coordination Report* (Figure 1). A key challenge identified during GSP development and early inter-basin coordination efforts was the subbasins' differing groundwater flow models and the challenges of estimating and comparing flows at subbasin boundaries.

¹ <https://www.buttecounty.net/DocumentCenter/View/5476/Northern-Sacramento-Valley-Inter-Basin-Coordination-Report---Final-PDF>

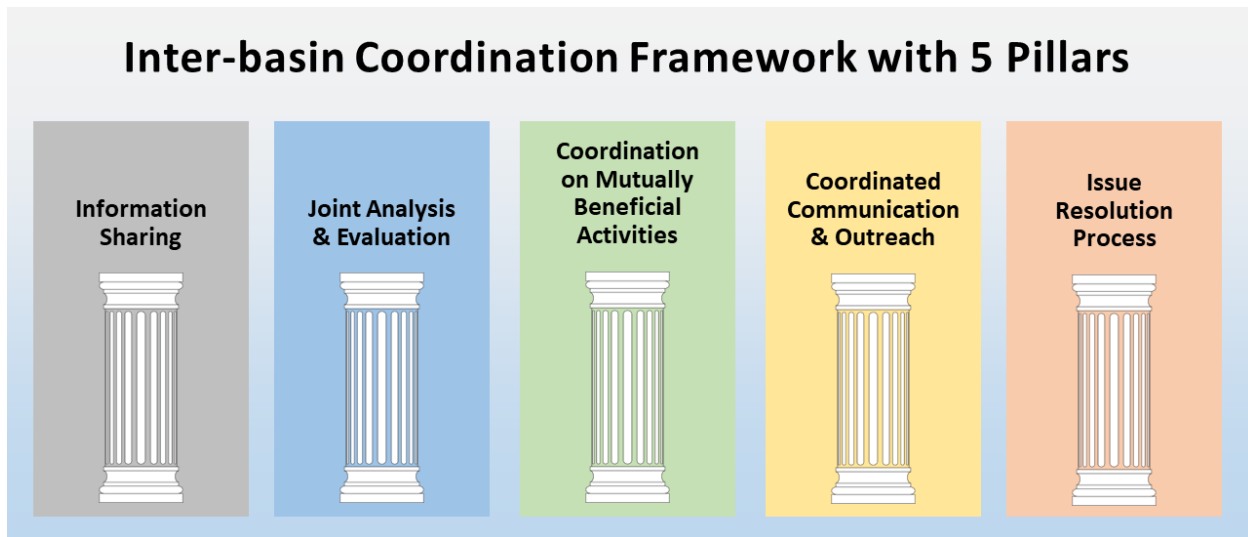


Figure 1. Five Pillars of Activities for Inter-basin Coordination in the Northern Sacramento Valley

Since groundwater in the Sacramento Valley flows across subbasin boundaries, successful SGMA implementation and reaching groundwater sustainability in the Butte County subbasins also depends on the neighboring subbasins to coordinate.

Initial Understanding of Regional Modeling Approaches

Phase 1 of the inter-basin coordination efforts during GSP development (2020-2022) included an evaluation on the 2022 GSP models. Six different groundwater flow models used across the Northern Sacramento Valley Subbasins were identified (Figure 2). Commonalities and differences exist among these models, as summarized below:

- All models use the same numerical code: DWR's Integrated Groundwater Flow Model (IWFM); however, various versions of the code are being used (DWR updates model codes and applications regularly, but not on a consistent basis).
- Overlapping boundaries between models exist.
- Different modeling timeframes are used for historical periods.
- Overall similar approaches are used for projected timeframes with climate change data.
- Different types of inputs are sometimes used, particularly for land use and crop coefficients.
- Different approaches are used to estimate projected future land use.
- Different approaches are used for GSP implementation and model updates; for example, some subbasins update their models annually to coincide with annual reports, while others use different methods for annual report pumping and change in storage estimates.

Application of different groundwater models created the following challenges in modeling coordination:

- Differences in model characteristics made it difficult to consistently compare inter-basin flows.
- Key subbasin boundaries align with the Sacramento River (and also a model boundary).
- Differing vertical extents along subbasin boundaries complicate comparison of boundary flow estimates.

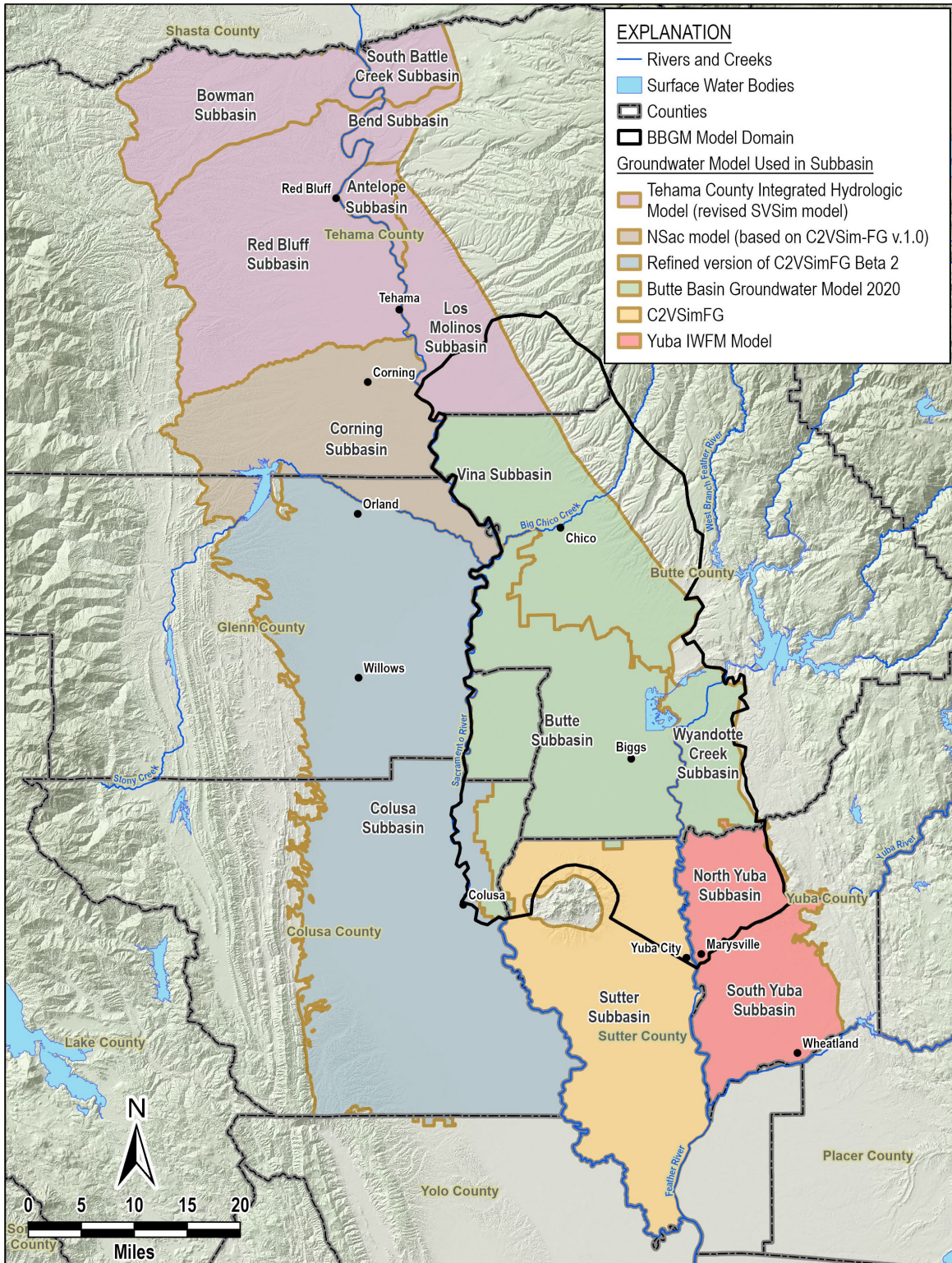


Figure 2. Groundwater Models Used in the Northern Sacramento Valley Subbasins During GSP Development

Modeling Efforts During GSP Implementation

Subbasin modeling efforts are anticipated for technical support to complete the Periodic Evaluations (PE) due in January 2027, such as:

- Updating current and projected water budgets
- Simulating projects and management actions to assess long-term sustainability
- Evaluating depletions of interconnected surface water

All these items would benefit from continued regional collaboration in line with other ongoing technical inter-basin coordination and joint analysis efforts.

Different regional models will be used moving forward, with ongoing plans for model updates summarized in Table 1.

Table 1. NSV Planned Model Updates

Subbasin(s)	Anticipated Model for 2027 PE	Planned Model Updates
Vina, Butte, and Wyandotte Creek	Butte Basin Groundwater Model - 2025 v1.3 (BBGM 2025)	Revised boundary conditions Updated IWFM version Timeframe extension to 2024
North and South Yuba	Yuba Groundwater Model (YGM)	Model updated annually, using latest IWFM codes Well maintained and calibrated
Tehama County Subbasins	Tehama County Subbasins: Tehama IHM (based on revised SVSim) Corning Subbasin: NSac Model (based on revised C2VSimFG v1.0)	For both models: Improve texture model with borehole geophysical data and AEM data; update ET values and crop coefficients within expanded model domains; improve streamflow calibration
Sutter	C2VSimFG v1.1	Planned updates to C2VSimFG v1.1 to reflect new IWFM codes and more recent conditions
Colusa	C2VSimFG v1.5	No extensive local refinements planned

INTER-BASIN MODELING COORDINATION AND FLOW EVALUATION APPROACH

GSAs understand that technical tools to support scientific understanding of inter-basin flows between neighboring subbasins will be crucial to advance toward sustainable groundwater management on a regional level.

Comparing various models with different boundaries across subbasins is a large effort, necessitating advanced technical understanding of each model and tools to extract model outputs to compare between models.

Similar to GSP development efforts, the various Subbasins and their GSAs are on different timeframes and have different budget and capacity available to undertake major model updates and simulation efforts for the Periodic Evaluation. Therefore, for this evaluation of inter-basin flows the latest DWR C2VSimFG v1.5 model (released June 2025) was used to better understand regional hydrogeology and the need to coordinate on flows across subbasins. C2VSimFG covers the entire Central Valley aquifer (Figure 3). The purple circle on Figure 3 shows the approximate location of the BBGM model domain.

The brief update documentation (DWR, 2025) accompanying this model release includes the following information:

- Historical simulation period covers WY 1974-2021
- Developed with the Integrated Water Flow Model version IWFM-2024.2.1594 (released October 28, 2024)
- Incorporates local data from many submitted GSPs provided by GSAs, including Butte County
- Updates include:
 - New land use, evapotranspiration, precipitation, and urban water use
 - Updated Sacramento-San Joaquin Delta representation
 - Updated small watersheds
- Some manual calibration focused on land use and root zone properties at subregion scale

The following sections provide results for inter-basin flows and stream-aquifer interaction at boundary streams for the IBC Subbasins.



Figure 3. C2VimFG 1.5 Model Extent (source: DWR, 2025)

INTER-BASIN FLOW EVALUATION WITH REGIONAL MODEL RESULTS

To better interpret the results in the following pages, it is useful to identify the climatic condition of each water year. For reference, Figure 4 shows the water year type for each year within the C2VSim FG 1.5 model simulation period (WY 1974-2021).

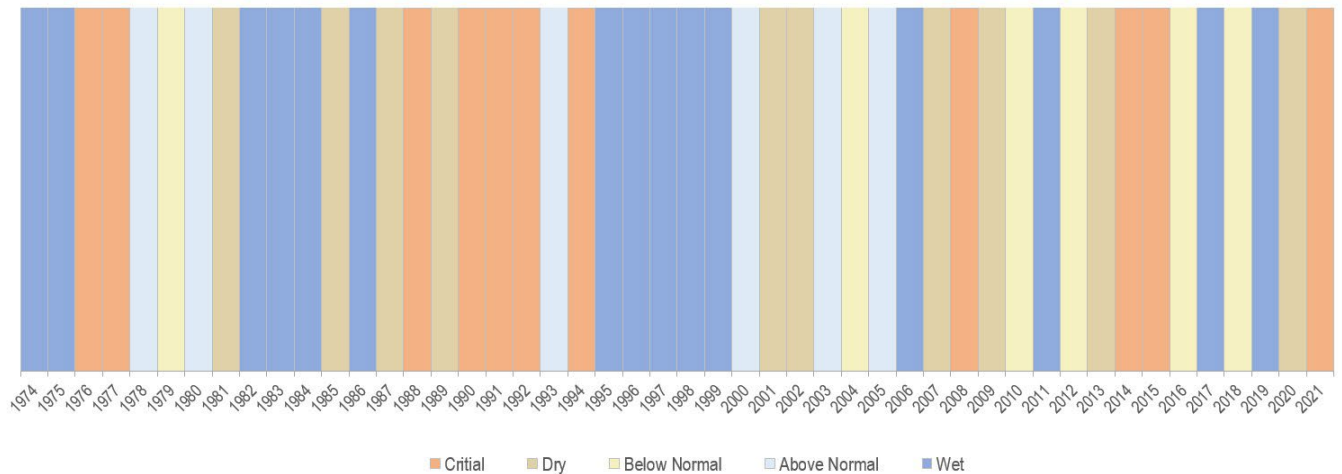


Figure 4. Water Year Type for Model Simulation Period

The evaluation of major groundwater budget components includes:

- Inter-basin flow representing subsurface groundwater flow from adjacent zones (groundwater subbasins) within model (as illustrated on Figure 5)
- Stream-aquifer interaction flow representing flow between the shallow groundwater and the streams simulated in the model. Figure 6 shows the major rivers that constitute subbasin boundaries.

Results presented below are shown for each Butte County Subbasin as annual totals and annual averages. Full Subbasin water budgets are provided in Attachment 1.

In general, inter-basin groundwater flows are steady from year to year, but may be affected during drought years when pumping increases across the region due to cutbacks to surface water supplies and reduced precipitation.

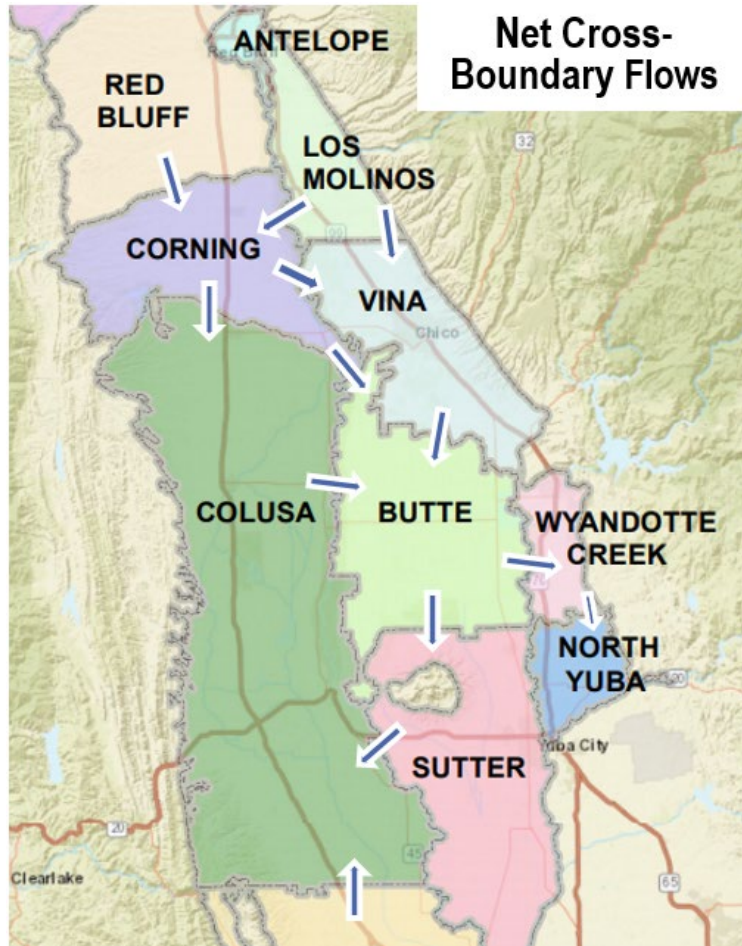


Figure 5. Northern Sacramento Valley Subbasin Net Boundary Flows

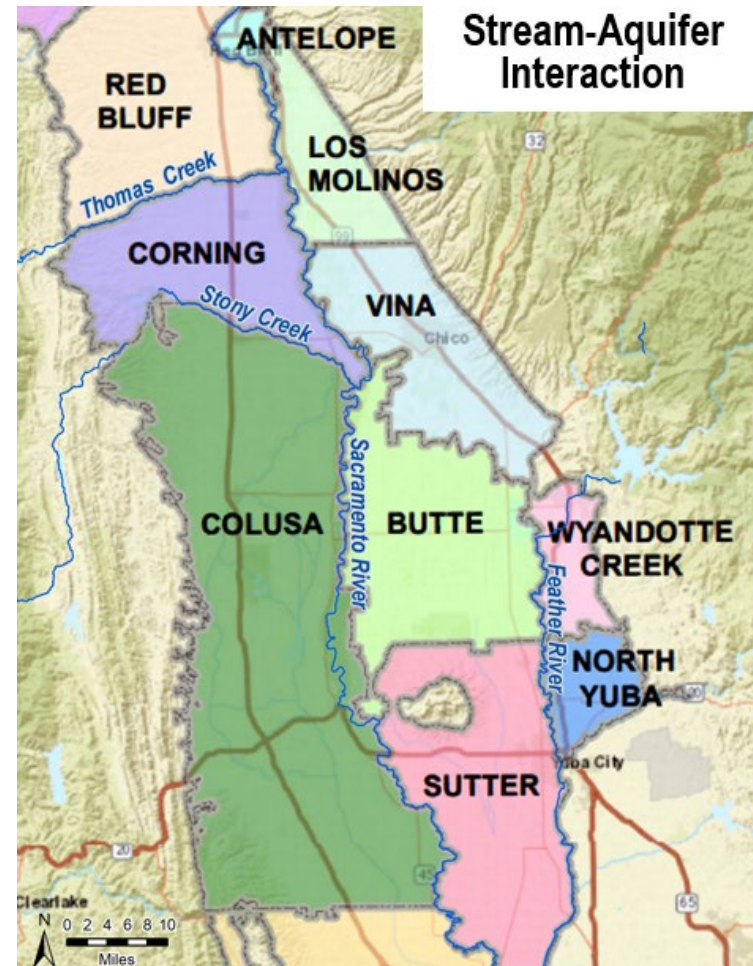


Figure 6. Rivers Constituting Boundaries in the Northern Sacramento Valley Subbasins

Vina Subbasin

Inter-basin flows for the Vina Subbasin from the C2VSimFG v1.5 model are shown on Figure 7 and Figure 8, and summarized in Table 2. Figure 7 provides a timeseries of simulated net inter-basin flows from the perspective of the Vina Subbasin for the entire model timeframe from 1974 to 2021. The Net Vina Flow component indicates that in the past 15 years, the Vina Subbasin mostly gains subsurface flows from its neighboring subbasins. Figure 8 depicts the information in a geographical representation of the net direction of flow from Vina Subbasin to and from neighboring Subbasins, including net average flows for two timeframes.

Observations include:

- Gaining subsurface groundwater flow from the Los Molinos and Corning subbasins
- Losing subsurface groundwater flow to the Butte Subbasin
- Long-term (WY 1974-2021) net subsurface groundwater flow gain to the Vina Subbasin averages 7 thousand acre-fee per year (TAF/year or TAFY)
- Recent 15-year (WY 2007-2021) net subsurface groundwater flow gain to the Vina Subbasin averages 19 TAFY

Table 2. Vina Subbasin Net Boundary Flows with Neighboring Subbasins

Model	Subbasin	Long-term Inter-basin Flow Average WY 1974-2021 (AFY)	15-Year Inter-basin Flow Average, WY 2007-2021 (AFY)
C2VSimFG v1.5	Corning	8,400	11,700
C2VSimFG v1.5	Los Molinos	24,500	27,400
C2VSimFG v1.5	Wyandotte Creek	-900	-800
C2VSimFG v1.5	Butte	-24,700	-19,300

AFY = acre-feet per year

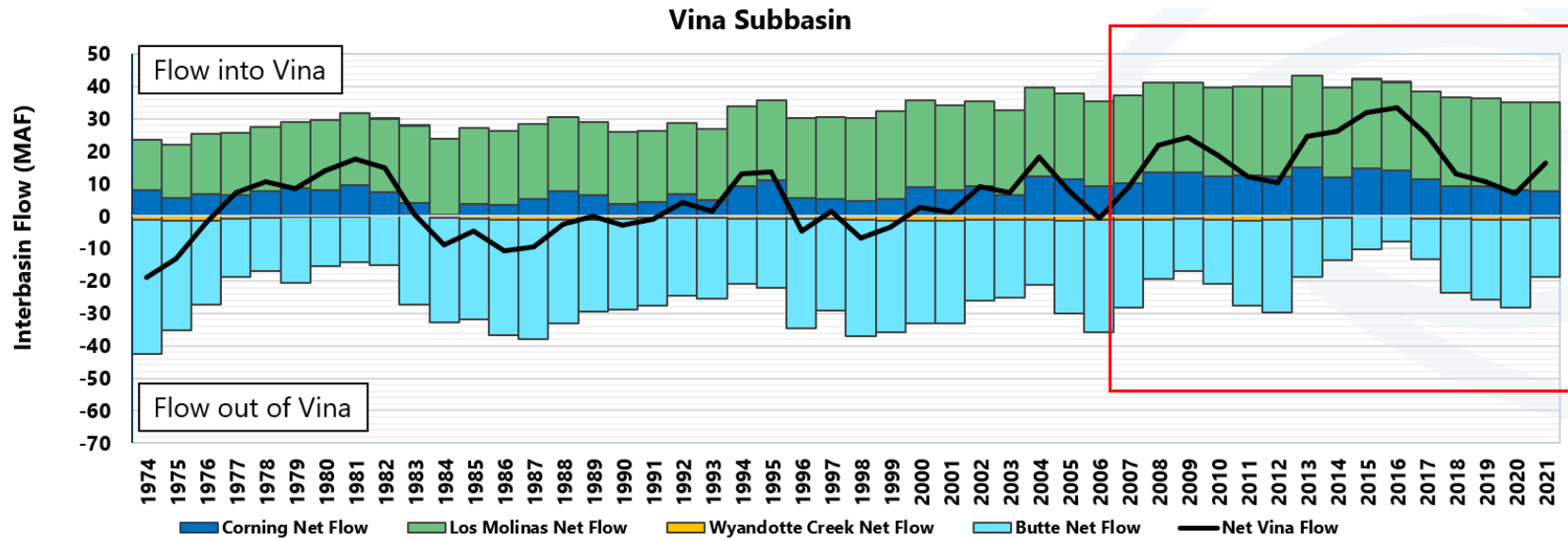
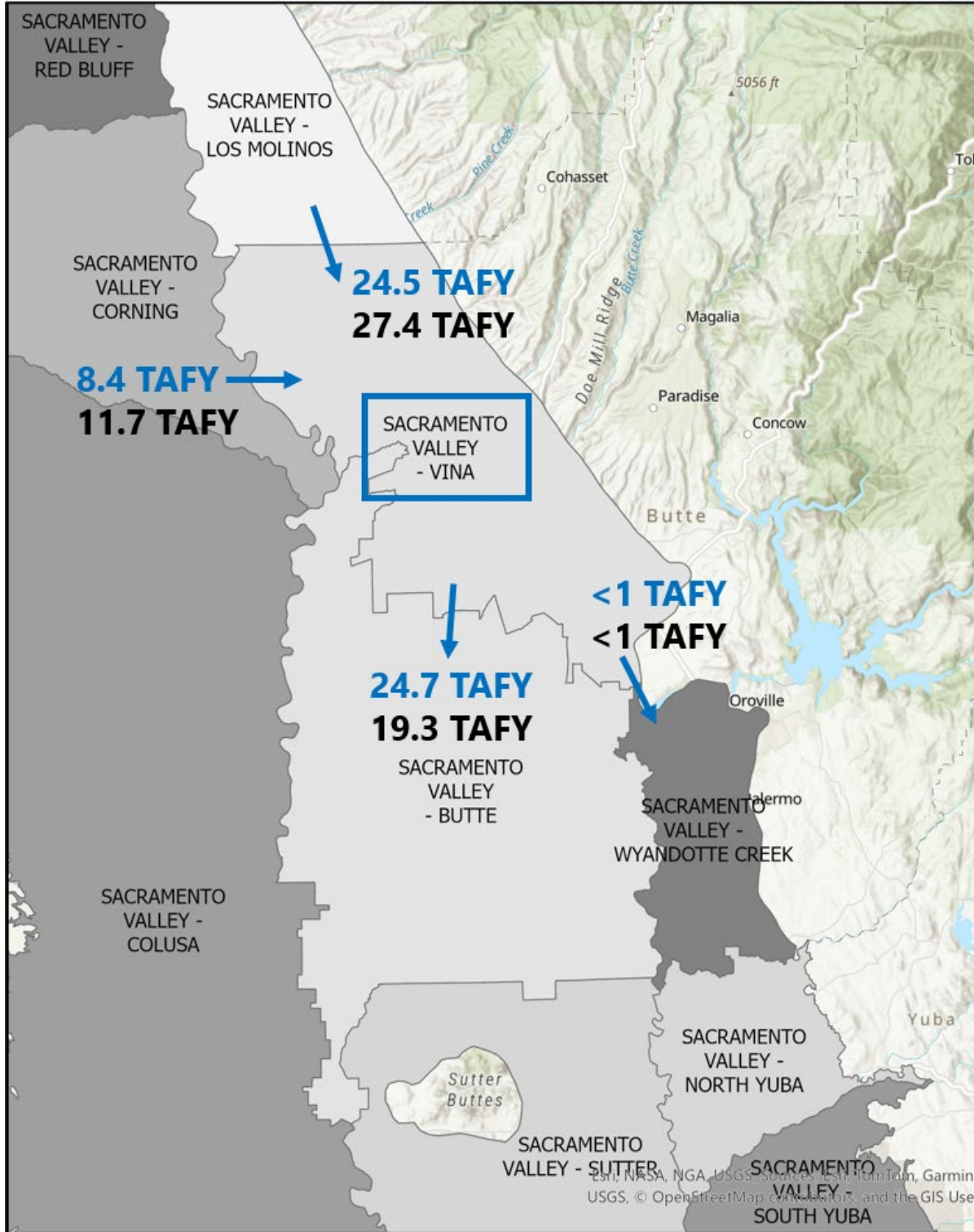


Figure 7. C2VSimFG 1.5 Inter-basin Flows for the Vina Subbasin



Note: WY 1974-2021 net subsurface groundwater flow averages are shown in **blue** and WY 2007-2021 net subsurface groundwater flow averages are shown in **black**

Figure 8. Vina Subbasin Long-Term Net Inter-basin Flow Averages (TAFY)

Butte Subbasin

Inter-basin flows for the Butte Subbasin from the C2VSimFG v1.5 model are shown on Figure 9 and Figure 10, and summarized in Table 3. Figure 9 provides a timeseries of simulated net inter-basin flows from the perspective of the Butte Subbasin for the entire model timeframe from 1974 to 2021. The Net Butte Flow component indicates that in the past 15 years, the Butte Subbasin always loses subsurface flows to its neighboring subbasins. Figure 10 depicts the information in a geographical representation of the net direction of flow from Butte Subbasin to and from neighboring Subbasins, including net average flows for two timeframes.

Observations include:

- Gaining subsurface groundwater flow from the Vina and Corning subbasins
- Losing subsurface groundwater flow to the Colusa, Sutter and Wyandotte Creek subbasins
- Long-term (WY 1974-2021) net subsurface groundwater flow loss to the Butte Subbasin averages 21 TAFY
- Recent 15-year (WY 2007-2021) net subsurface groundwater flow loss to the Butte Subbasin averages 24 TAFY

Table 3. Butte Subbasin Boundary Flows

Model	Basin	Long-term Inter-basin Flow Average WY 1974-2021 (AFY)	15-Year Inter-basin Flow Average WY 2007-2021 (AFY)
C2VSimFG v1.5	Corning	2,100	2,500
C2VSimFG v1.5	Colusa	-29,100	-29,000
C2VSimFG v1.5	Vina	24,700	19,300
C2VSimFG v1.5	Sutter	-12,300	-11,700
C2VSimFG v1.5	Wyandotte Creek	-5,900	-4,800

AFY = acre-feet per year

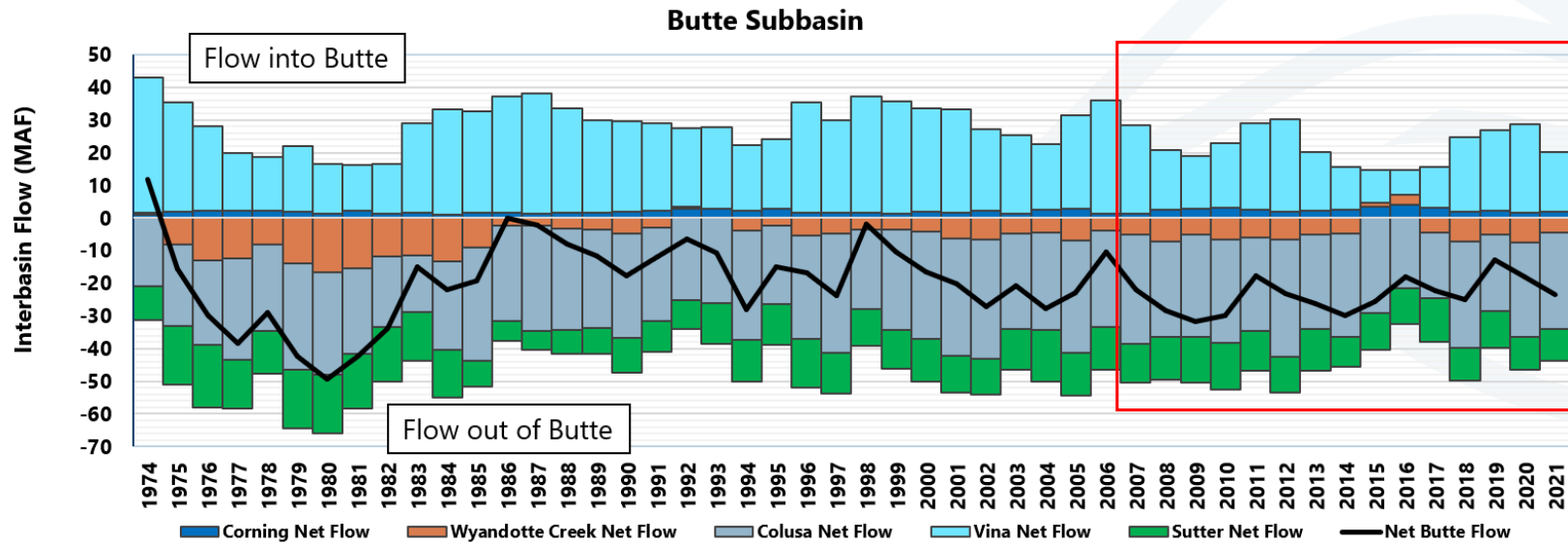
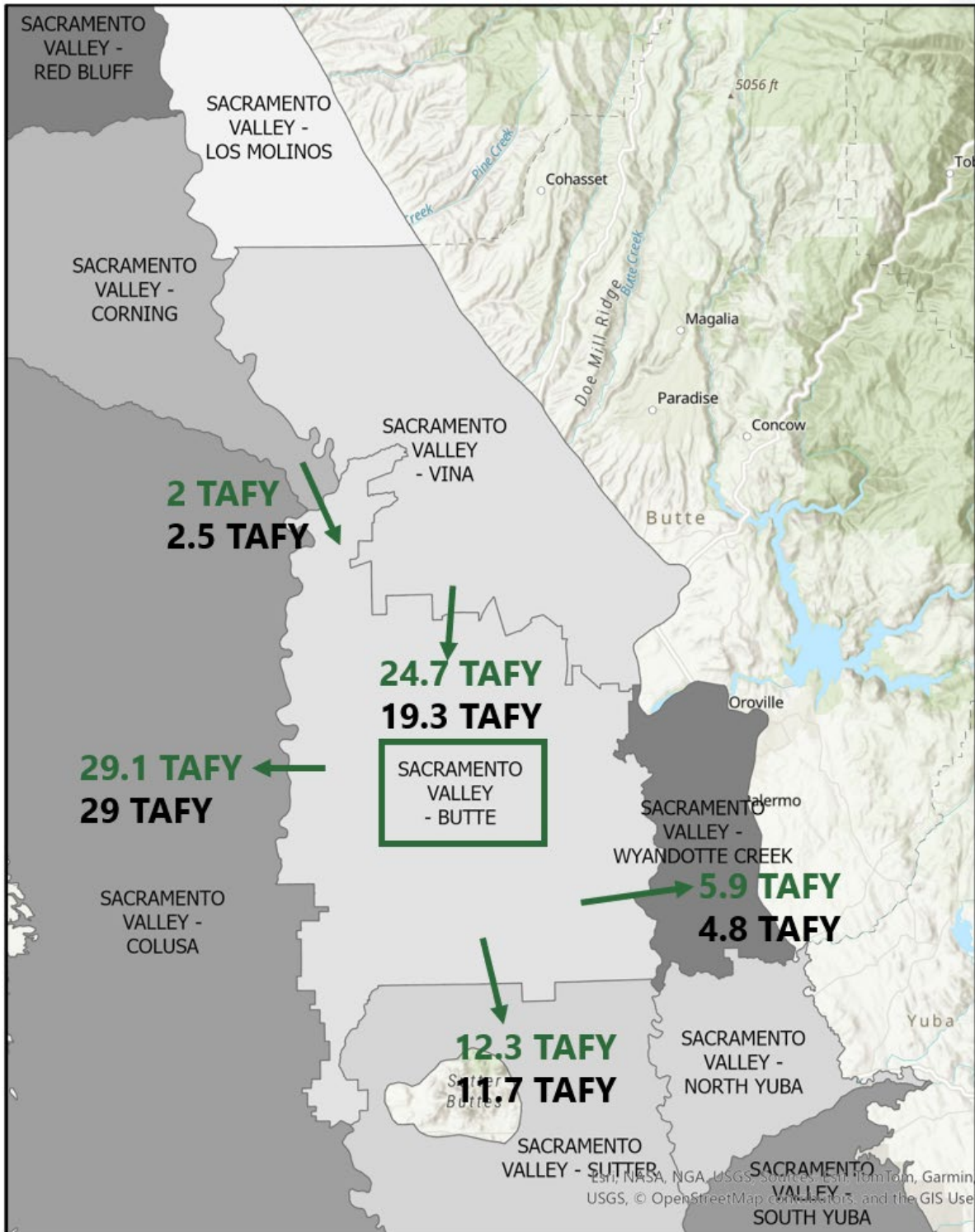


Figure 9. C2VSimFG 1.5 Inter-basin Flows for the Butte Subbasin



Note: WY 1974-2021 net subsurface groundwater flow averages are shown in **green** and WY 2007-2021 net subsurface groundwater flow averages are shown in **black**.

Figure 10. Butte Subbasin Long-Term Inter-basin Flow Averages (TAFY)

Wyandotte Creek Subbasin

Inter-basin flows for the Wyandotte Creek Subbasin from the C2VSimFG v1.5 model are shown on Figure 11 and Figure 12, and summarized in Table 4. Figure 11 provides a timeseries of simulated net inter-basin flows from the perspective of the Wyandotte Creek Subbasin for the entire model timeframe from 1974 to 2021. The Net Wyandotte Creek Flow component indicates that in the past 15 years, the Wyandotte Creek Subbasin mostly gains subsurface flows from its neighboring subbasins, except in drought years, such as in 2015 and 2016. These water years were classified as critical and dry, respectively (Figure 4). Figure 12 depicts the information in a geographical representation of the net direction of flow from Wyandotte Creek Subbasin to and from neighboring Subbasins, including net average flows for two timeframes.

Observations include:

- Gaining subsurface groundwater flow from the Vina, Butte, and North Yuba subbasins
- Losing subsurface groundwater flow to the Sutter Subbasin
- Long-term (WY 1974-2021) net subsurface groundwater flow gain to the Wyandotte Subbasin averages 9 TAFY
- Recent 15-year (WY 2007-2021) net subsurface groundwater flow gain to the Wyandotte Subbasin averages 6.5 TAFY
- During the 2015-2016 drought, surface water shortages corresponding to increased groundwater demand in Butte Subbasin caused a reversal in subsurface groundwater flows

Table 4. Wyandotte Creek Subbasin Boundary Flows

Model	Basin	Long-term Inter-basin Flow Average WY 1974-2021 (AFY)	15-Year Inter-basin Flow Average WY 2007-2021 (AFY)
C2VSimFG v1.5	Vina	900	800
C2VSimFG v1.5	North Yuba	2,600	1,600
C2VSimFG v1.5	Sutter	-700	-700
C2VSimFG v1.5	Butte	5,900	4,800

AFY = acre-feet per year

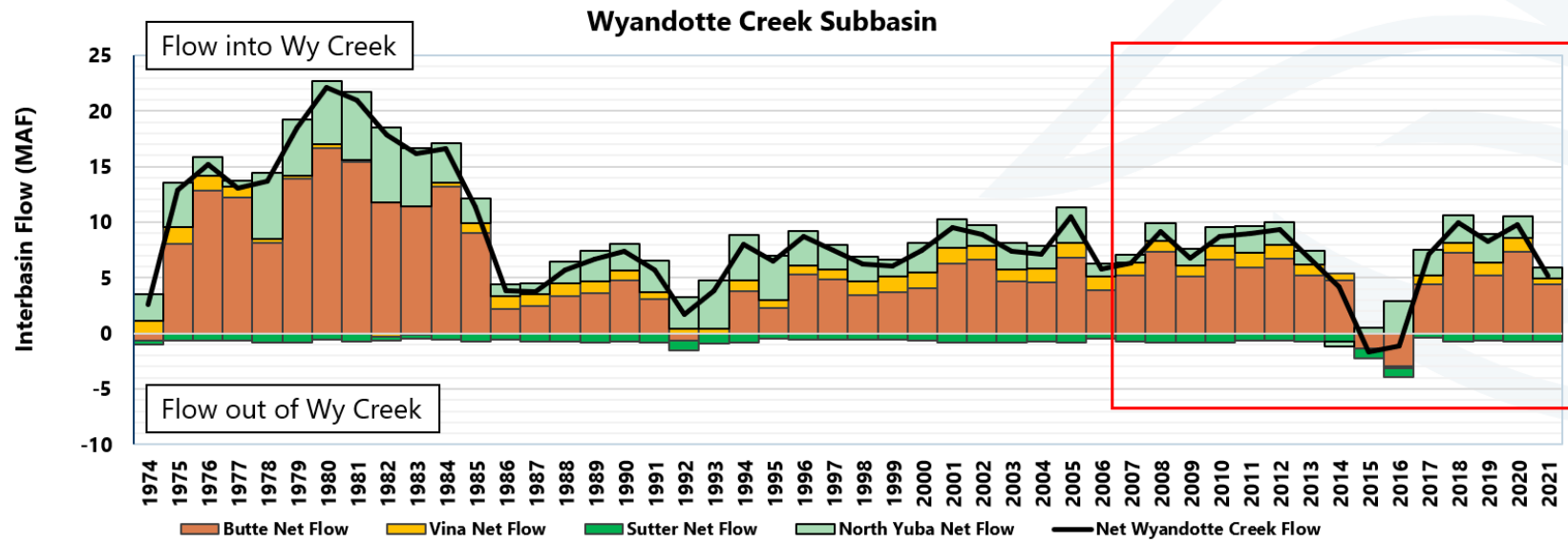
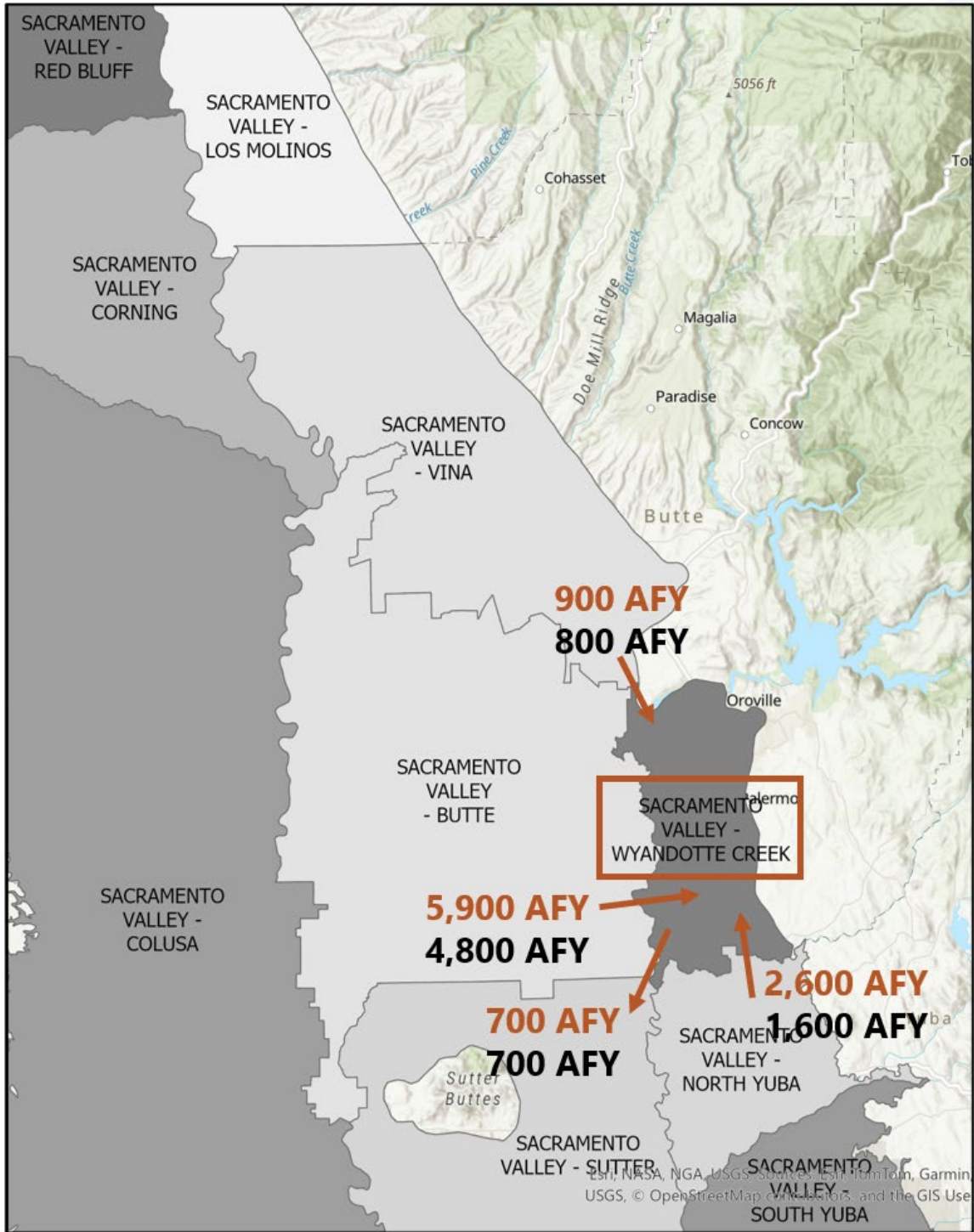


Figure 11. C2VSimFG 1.5 Inter-basin Flows for the Wyandotte Creek Subbasin



Note: WY 1974-2021 net subsurface groundwater flow averages are shown in **orange** and WY 2007-2021 net subsurface groundwater flow averages are shown in **black**.

Figure 12. Wyandotte Creek Subbasin Long-Term Inter-basin Flow Averages (AFY)

STREAM-AQUIFER INTERACTIONS RESULTS

For this evaluation, stream nodes for selected groundwater basin boundaries were identified and categorized for each major stream system, as shown below.

Sacramento River Corridor is broken up into 4 segments at subbasin boundaries (Figure 13):

- **Reach A:** Border of Vina-Corning
- **Reach B:** Border of Butte-Corning
- **Reach C:** Border of Butte-Colusa
- **Reach D:** Within Colusa Subbasin

Feather River Corridor is broken up into 3 segments at subbasin boundaries (Figure 14):

- **Reach FR1:** Within Wyandotte Creek Subbasin
- **Reach FR2:** Border of Wyandotte Creek-Butte
- **Reach FR3:** Border of North Yuba-Sutter

Total stream-aquifer interaction and stream inflows are computed on an annual basis and also presented as net annual average gain/loss for entire simulation period (WY 1974-2021) and for the recent 15-year period from WY 2007-2021.

In general, most stream reaches in both the Sacramento River and Feather River Corridors are gaining from groundwater every year.

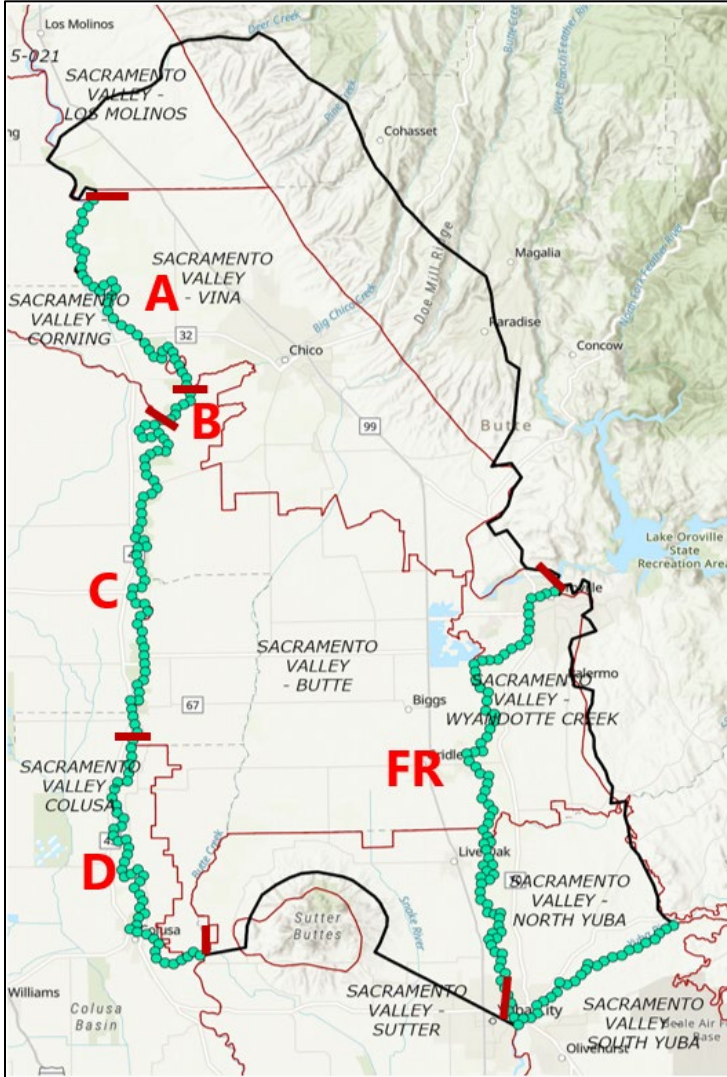


Figure 13. Sacramento River Stream Reaches

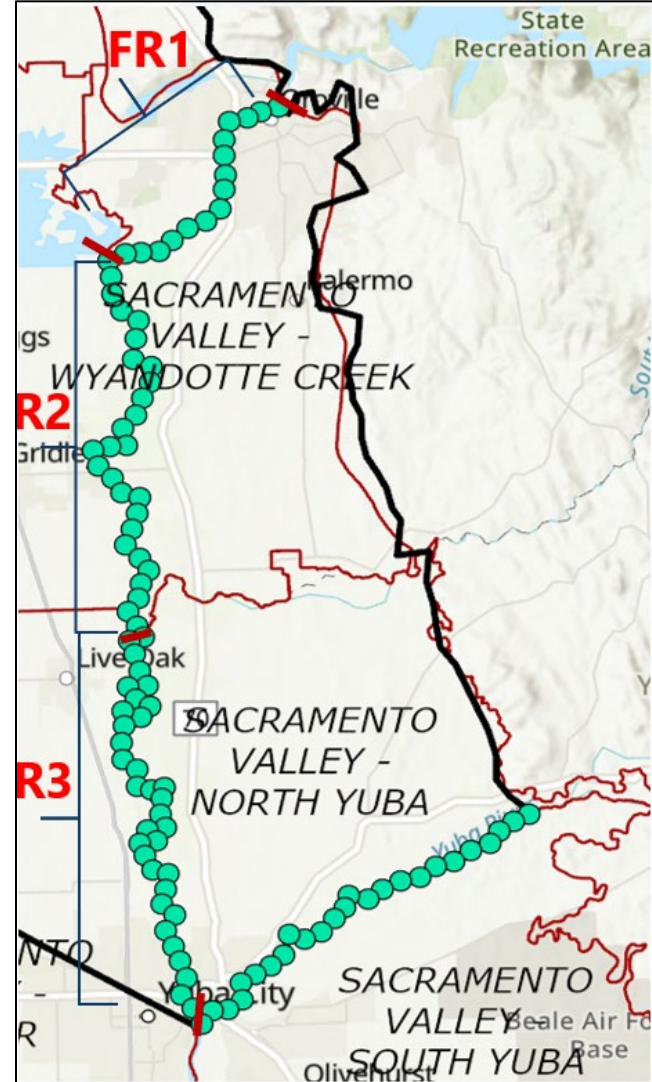


Figure 14. Feather River Stream Reaches

Sacramento River Corridor

Reach A – Border between Vina and Corning Subbasins

Aquifer-stream interaction flows for Reach A are shown on Figure 15 and summarized in Table 5.

Observations include:

- Always a gaining reach prior to WY 2021
- Low groundwater inflow in drought years, becoming a slightly losing reach in WY 2021
- Some declines in groundwater inflow since WY 2013
- Groundwater inflows are generally not a significant component of river flow (less than 1% of total river inflow to the reach)

Reach B - Border Between Butte and Corning Subbasins

Aquifer-stream interaction flows for Reach A are shown on Figure 16 and summarized in Table 6.

Observations include:

- Always a slightly losing reach
- A very short reach with no noticeable trend

Reach C - Border Between Butte and Colusa Subbasins

Aquifer-stream interaction flows for Reach C are shown on Figure 17 and summarized in Table 7.

Observations include:

- Always a gaining reach
- Some declines in groundwater inflow since WY 2013 with noticeable drops in drought years
- Groundwater inflows are generally not a significant component of river flow (less than 1% of total river inflow to the reach).

Reach D – Within Colusa Subbasin

Aquifer-stream interaction flows for Reach D are shown on Figure 18 and summarized in Table 8.

Observations include:

- Always a gaining reach
- Some declines in groundwater inflow since WY 2013

- Groundwater inflows are generally not a significant component of river flow (less than 1% of total river inflow to the reach).

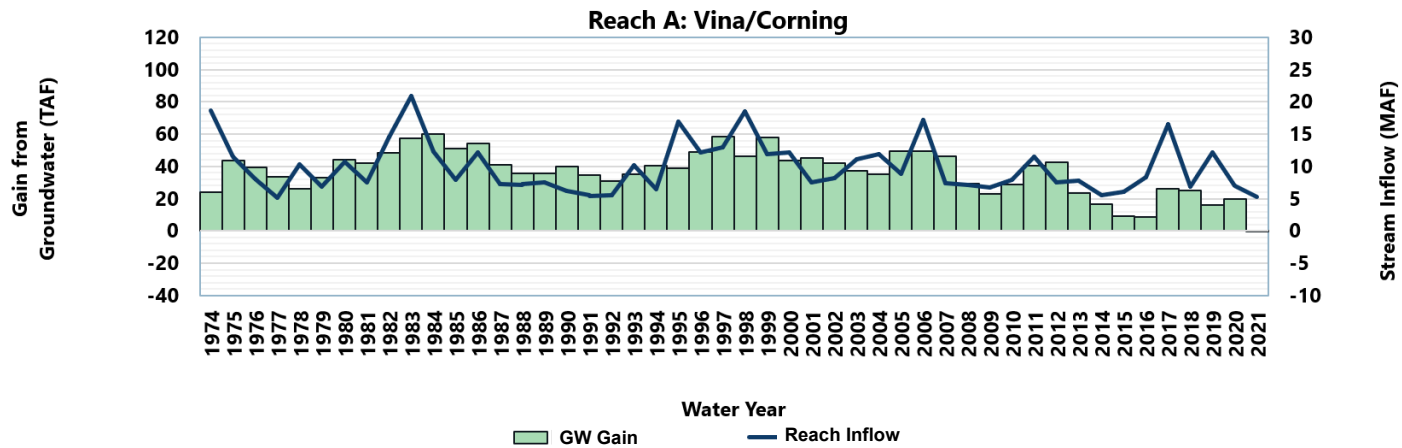


Figure 15. C2VSimFG 1.5 Stream-Groundwater Flows for Reach A

Table 5. Average Stream-Groundwater Flows for Reach A

Model	Average Streambed Conductivity	Number of Nodes	Long-term Average Stream Inflow (AFY) WY 1974-2021	15-Year Average Stream Inflow (AFY) WY 2007-2021	Long-term Average Net Gain/Loss (AFY) WY 1974-2021	15-Year Average Net Gain/Loss (AFY) WY 2007-2021
C2VSimFG v1.5	3.53 feet/day	40	9,909,900	8,265,800	36,700	23,700

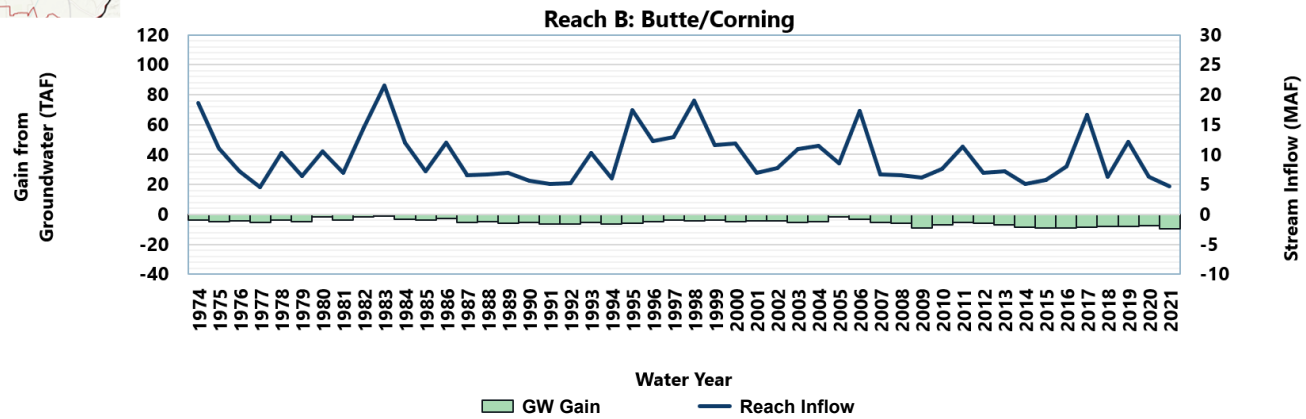


Figure 16. C2VSimFG 1.5 Stream-Groundwater Flows for Reach B

Table 6. Average Stream-Groundwater Flows for Reach B

Model	Average Streambed Conductivity	Number of Nodes	Long-term Average Stream Inflow (AFY) WY 1974-2021	15-Year Average Stream Inflow (AFY) WY 2007-2021	Long-term Average Net Gain/Loss (AFY) WY 1974-2021	15-Year Average Net Gain/Loss (AFY) WY 2007-2021
C2VSimFG v1.5	2.89 feet/day	7	9,598,000	7,821,700	-5,300	-7,600

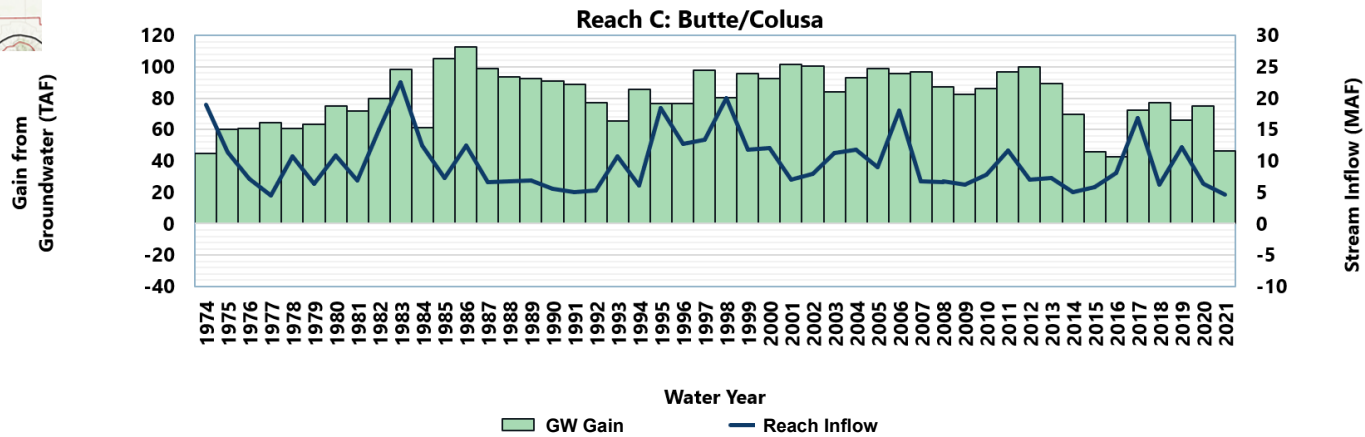


Figure 17. C2VSimFG 1.5 Stream-Groundwater Flows for Reach C

Table 7. Average Stream-Groundwater Flows for Reach C

Model	Average Streambed Conductivity	Number of Nodes	Long-term Average Stream Inflow (AFY) WY 1974-2021	15-Year Average Stream Inflow (AFY) WY 2007-2021	Long-term Average Net Gain/Loss (AFY) WY 1974-2021	15-Year Average Net Gain/Loss (AFY) WY 2007-2021
C2VSimFG v1.5	2.12 feet/day	55	9,823,500	7,903,300	80,800	75,500

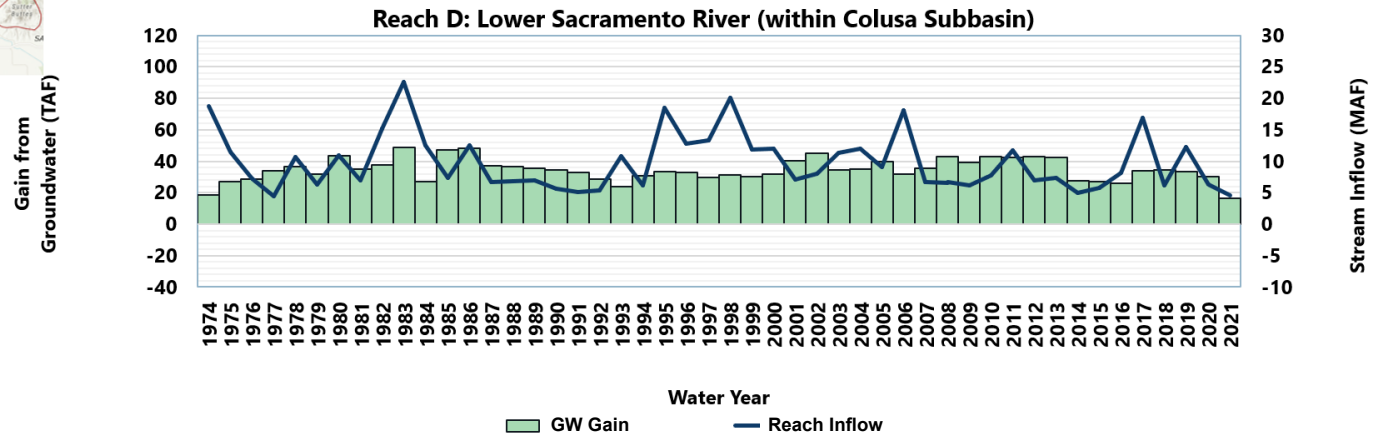


Figure 18. C2VSimFG 1.5 Stream-Groundwater Flows for Reach D

Table 8. Average Stream-Groundwater Flows for Reach D

Model	Average Streambed Conductivity	Number of Nodes	Long-term Average Stream Inflow (AFY) WY 1974-2021	15-Year Average Stream Inflow (AFY) WY 2007-2021	Long-term Average Net Gain/Loss (AFY) WY 1974-2021	15-Year Average Net Gain/Loss (AFY) WY 2007-2021
C2VSimFG v1.5	1.42 feet/day	46	9,850,900	7,896,200	34,500	34,500

Feather River Corridor

Reach FR1 – Within Wyandotte Creek Subbasin

Aquifer-stream interaction flows for Reach FR1 are shown on Figure 19 and summarized in Table 9.

Observations include:

- Since the early 1980s, a slightly gaining or slightly losing reach
- Groundwater inflows or outflows are not a significant component of river flow (less than 1% of total river inflow to the reach).

Reach FR2 – Border between Wyandotte Creek and Butte Subbasins

Aquifer-stream interaction flows for Reach FR2 are shown on Figure 20 and summarized in Table 10.

Observations include:

- Always a gaining reach
- Reduced groundwater inflows in drought years
- Groundwater inflows or outflows are not a significant component of river flow (less than 1% of total river inflow to the reach).

Reach FR3 – Border between North Yuba and Sutter Subbasins

Aquifer-stream interaction flows for Reach FR3 are shown on Figure 21 and summarized in Table 11.

Observations include:

- Always a gaining reach
- Reduced groundwater inflow in drought years
- Groundwater inflows or outflows are not a significant component of river flow (less than 1% of total river inflow to the reach).

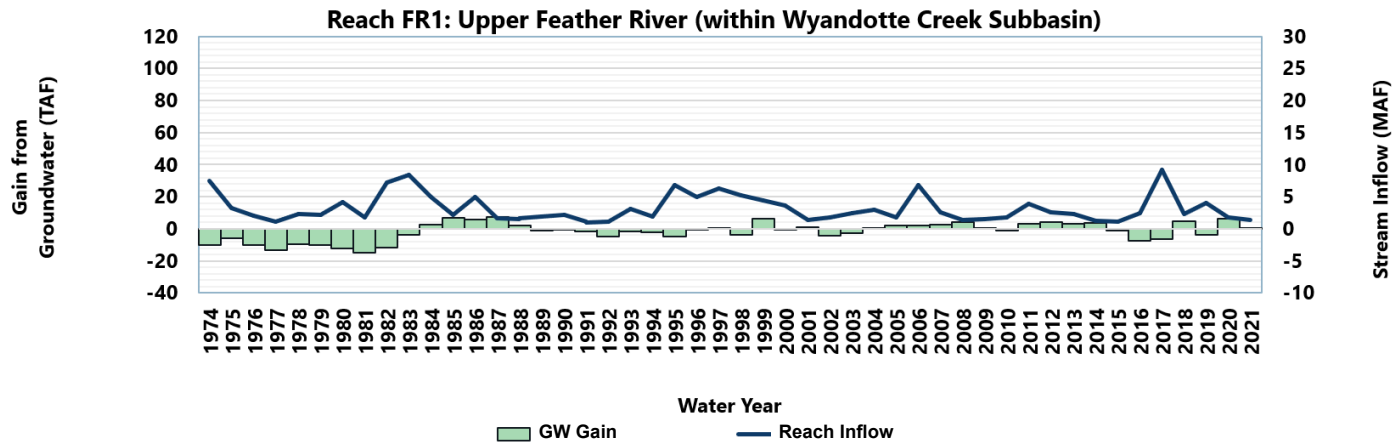


Figure 19. C2VSimFG 1.5 Stream-Groundwater Flows for Reach FR1

Table 9. Average Stream-Groundwater Flows for Reach FR1

Model	Average Streambed Conductivity	Number of Nodes	Long-term Average Stream Inflow (AFY) WY 1974-2021	15-Year Average Stream Inflow (AFY) WY 2007-2021	Long-term Average Net Gain/Loss (AFY) WY 1974-2021	15-Year Average Net Gain/Loss (AFY) WY 2007-2021
C2VSimFG v1.5	2.34 feet/day	15	3,225,000	2,634,400	-1,600	900

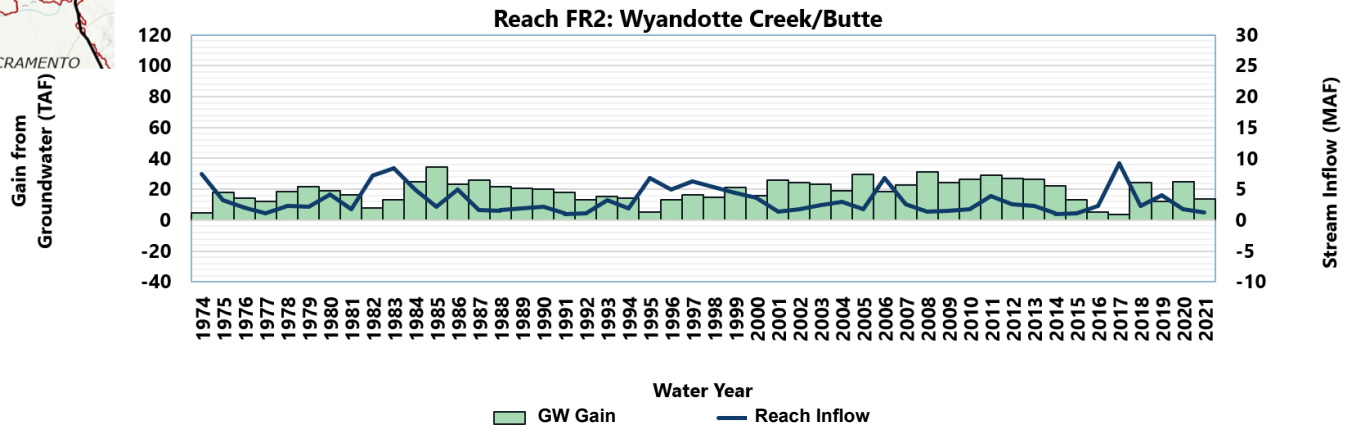


Figure 20. C2VSimFG 1.5 Stream-Groundwater Flows for Reach FR2

Table 10. Average Stream-Groundwater Flows for Reach FR2

Model	Average Streambed Conductivity	Number of Nodes	Long-term Average Stream Inflow (AFY) WY 1974-2021	15-Year Average Stream Inflow (AFY) WY 2007-2021	Long-term Average Net Gain/Loss (AFY) WY 1974-2021	15-Year Average Net Gain/Loss (AFY) WY 2007-2021
C2VSimFG v1.5	1.911 feet/day	28	3,224,900	2,631,500	19,000	20,500

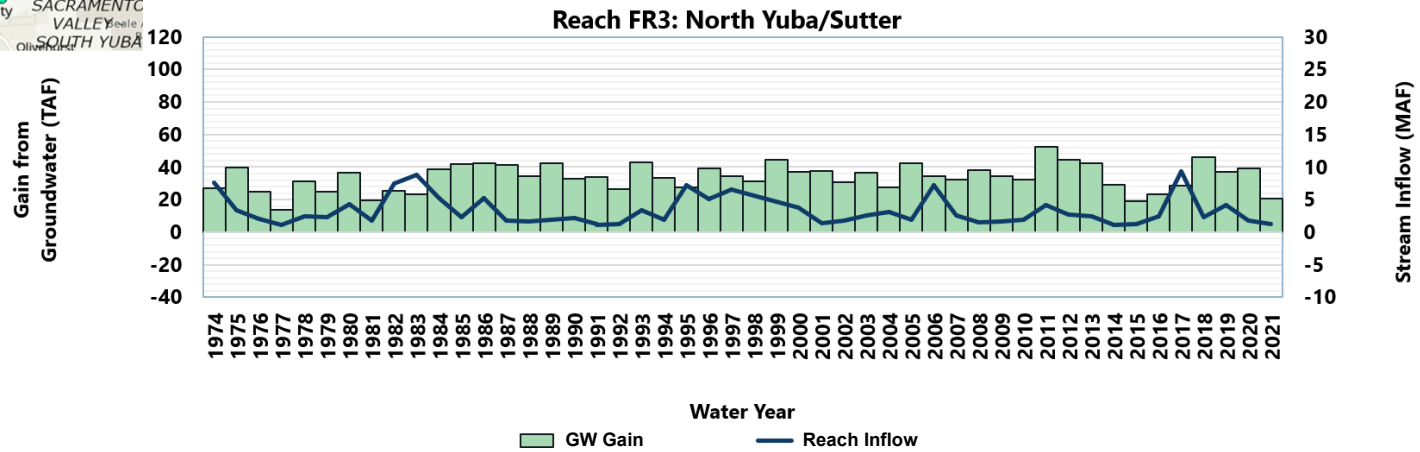


Figure 21. C2VSimFG 1.5 Stream-Groundwater Flows for Reach FR3

Table 11. Average Stream-Groundwater Flows for Reach FR3

Model	Average Streambed Conductivity	Number of Nodes	Long-term Average Stream Inflow (AFY) WY 1974-2021	15-Year Average Stream Inflow (AFY) WY 2007-2021	Long-term Average Net Gain/Loss (AFY) WY 1974-2021	15-Year Average Net Gain/Loss (AFY) WY 2007-2021
C2VSimFG v1.5	1.79 feet/day	36	3,343,900	2,702,500	33,700	34,600

OBSERVATIONS AND C2VSIMFG V1.5 LIMITATIONS

The review of C2VSimFG v1.5 outputs for Northern Sacramento Valley Subbasins provided a useful initial overview of regional flows between subbasins and stream-aquifer interaction flows for rivers that constitute a boundary between neighboring subbasins. This information can be used for initial summaries in Periodic Evaluations and can be compared to revised local models; however, it should be reviewed with care and knowledge of model limitations as described below.

C2VSimFG v1.5 has not gone through a full and robust recalibration since new data were added. Specifically, in the Northern Sacramento Valley, it appears some of the key factors such as pumping and stream diversions show differences compared to other locally derived estimates. Figure 22 shows pumping and surface water deliveries estimated by C2VSimFG v1.5 compared to what was provided in the GSPs and Annual Reports, for the Northern Sacramento Valley IBC Subbasins, for WY 2021.

For most Subbasins, C2VSim underestimates the pumping compared to GSP values, except for the Sutter and North Yuba Subbasins. C2VSim generally excludes direct estimates of domestic pumping—as it is such a small volume compared to the agricultural pumping—and would probably not make a very big difference in the total subbasin water budget. Local estimates in the GSP are much more granular with pumping categories split up to include additional pumping that may not be in C2VSim, such as industrial pumping estimates as well as domestic pumping. Surface water deliveries tend to be higher in C2VSim results compared to local estimates, but that could also be due to various assumptions related to delivery losses in the model. Higher surface water deliveries may also be an important contributor to the lower groundwater estimates (since groundwater pumping is largely estimated to meet the difference between estimated total irrigation demand and available surface water supply).

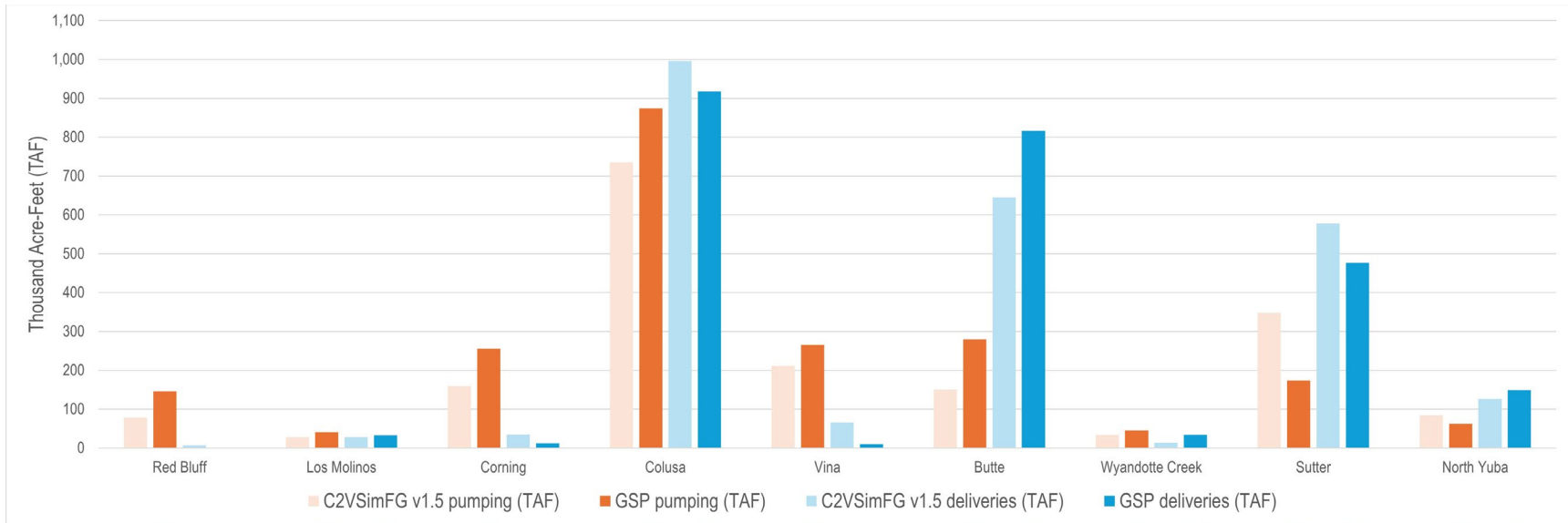


Figure 22. Comparison Between GSP Data and C2VimFG v1.5 Results for WY 2021 in Northern Sacramento Valley Subbasins (source: DWR, 2025)

Also, some subbasins did not provide locally refined data to DWR (Red Bluff, Corning, Colusa Subbasins; see Figure 1 in Attachment 2). Butte County provided updated data by sharing BBGM files for the three Subbasins, but still significant differences remain. Further review of model input data and assumptions, as well as model outputs is warranted during the next phase of model improvements and calibration.

In addition, as shown in Figure 3, several streams are not represented within the C2VSim simulation domain, including Little Dry Creek and Dry Creek in the Butte Subbasin. As expected for a large-scale regional model, the number of simulated streams is limited, which should be considered when evaluating its suitability for interconnected surface water analyses in the Sacramento Valley.

Groundwater budgets provided in Attachment 1 show the following questionable outputs:

- Water budgets before the 1980s show very different trends than more recent years starting in the 1990s. This can be attributable to the fact that less water level data existed and there is increased confidence in model inputs in more recent decades, such as better land use and cropping representation.
- Pumping volumes in the first 2 decades of the model run seem to be much higher than expected for the Wyandotte Creek Subbasin.
- Cumulative change in storage shows a steep upward trend for Corning Subbasin from 1990 to 2006; while it shows the opposite trend (steep decline from 1974 to 1992) for the Red Bluff Subbasin

Some of these observations may be artifacts of model computational issues, and would need to be further reviewed during model re-calibration.

- Groundwater elevation hydrographs comparing simulated values from C2VSimFG v1.5 to observed measurements shows areas that are not representing observed groundwater elevations well. Figures in Attachment 2 for 4 model subregions show that:
- Subregion 2: Model tends to overestimate groundwater elevation by 10 to 40 feet; however, in more recent years, some areas, show much better groundwater level matching with observed values, especially in the western part of the subregion.
- Subregion 3: Simulated groundwater elevations are often seen to be above the ground surface elevation, but to a lesser degree than the previous version of the model (v1.01); generally v1.5 is much improved from v1.01 in this subregion with observed groundwater elevations being better matched by the model.

- Subregion 4: Simulated groundwater elevations in this subregion match the observed values fairly well in most wells, with large improvements seen compared to v1.01.
- Subregion 5: This subregion has also seen improvements since v1.01, with simulated groundwater elevations in layer 1 no longer shown above the groundwater surface elevation. V1.5 simulated groundwater elevations match observed values fairly well, with some areas showing underestimated (lower) elevations than observed, especially in more recent years, when more data are available.

Other general limitations of using large regional modeling tools include:

- Limitations of available monitoring data and well construction information to compare to the simulated data within the appropriate model layers
- Larger subregional water budgets used for calibration versus more locally refined water level calibration efforts

Therefore, while the model remains a valuable regional tool, additional Sacramento Valley subbasin-specific refinements are needed to better support local groundwater management efforts.

DWR plans to make further updates to the structural geology and the hydrogeologic conceptual model, which will necessitate a full model recalibration. DWR intends to release a version 2 of the model in late 2026 or after, which would be a fully recalibrated version.

RECOMMENDATIONS FOR MODELING COORDINATION ACTIVITIES TO SUPPORT INTER-BASIN COORDINATION

To support this effort, modeling approaches and use of various tools were discussed between technical teams to gain a better understanding of Sacramento Valley wide modeling efforts as well as how a partnership with DWR could strengthen local modeling efforts for sustainability analysis. Some initial key considerations were developed for future modeling efforts.

Recent Informal Model Collaboration Efforts

During joint GSP evaluation work, modeling teams shared information on modeling efforts that occurred during GSP implementation. The outcomes of these discussions are briefly described below.

- DWR Communications:
 - Butte County staff and consultant team met with DWR Sustainable Groundwater Management Office (SGMO) staff, received an update on their schedule for C2VSimFG revisions and publication, and discussed general state/regional/local roles and coordination on model updates and approach moving forward.
 - Butte County Board of Supervisors sent a letter to DWR urging continued support to GSAs for modeling efforts as they transition to GSP implementation.
- Regional Communication with GSA technical consultant teams:
 - Butte County staff organized a roundtable discussion with representatives from Northern Sacramento Valley modeling technical teams in January 2025 to review modeling approaches for each subbasin, the status of model updates, and to discuss potential future regional collaboration and interaction with DWR.
 - The teams recognized the need to continue sharing information on modeling approaches, even if it might be difficult to be fully coordinated for this first Periodic Evaluation development.
 - Initial efforts have begun on a work plan to address regional aspects of Interconnected Surface Water issues and develop appropriate data, tools and approaches for robust evaluations in the Sacramento Valley.

Long-Term Regional Modeling Coordination Approaches

From initial discussions held with DWR and with the GSA technical consultant teams, key considerations include the following:

- **Challenge:** Different modeling versions and overlapping boundaries call for regional coordination and collaboration with DWR and among neighboring North Sacramento Valley GSAs.
- **Goal:** Continue to support regional/subbasin conversations by providing data and tools with regard to modeling and monitoring to reduce costs to GSAs and to support informed decision making.
- **Considerations:** Modeling versus data collection – consider appropriate use and funding to advance sustainable groundwater management.

Recommendations

It is beneficial for GSAs to work with DWR to incorporate their information to reflect local understanding into regional tools. Local data can inform better regional modeling for water

management and planning. In turn, regional models provide GSAs with a consistent starting point for evaluating boundary conditions, inter-basin flows, scenario comparisons, and assumptions that can inform the development and updating of local models.

Potential next steps include:

- Coordinate regional model revisions with GSA/Subbasin model revisions by developing a framework approach that sequences updates to align with GSA regulatory compliance deadlines.
- Further define the need for specific DWR assistance on model updates and data.
- Develop potential approaches to using both a locally refined model and regional model for comparison of inter-basin flows and water budget calculations.

REFERENCES

California Department of Water Resources (DWR). 2025. California Central Valley Groundwater-Surface Water Simulation Model – Fine Grid version 1.5. Sacramento, CA:

California Department of Water Resources. Available at:

<https://data.ca.gov/dataset/california-central-valley-groundwater-surface-water-simulation-model-fine-grid-c2vsimfg>

Consensus Building Institute. 2021. Northern Sacramento Valley Inter-basin Coordination Report. Available at:

<https://www.buttecounty.net/DocumentCenter/View/5476/Northern-Sacramento-Valley-Inter-Basin-Coordination-Report---Final-PDF>

Attachment 1

North Sacramento River and Feather River Corridor Groundwater Budgets

NORTH SACRAMENTO RIVER AND FEATHER RIVER CORRIDOR GROUNDWATER BUDGETS

This Attachment provides the full water budgets for each subbasin within the inter-basin coordination footprint, as computed from the DWR C2VSimFG v1.5 model.

Figure 1 shows the North Sacramento River Corridor and Feather River Corridor Subbasins within the Northern Sacramento Valley, for reference.

The water budget graphs show the major groundwater inflow components (inflow from small watersheds, canal and reservoir recharge, deep percolation) and groundwater outflow components (root water uptake, groundwater pumping). Other components are shown as a net value, and depending on the aquifer conditions, they may either contribute to the groundwater inflows or outflows (interaction with streams, net flow from subbasins).

The subsidence component indicates the one-time volume of water released to an aquifer as a result of land subsidence. A positive subsidence value indicates that the land compressed slightly and released groundwater into the aquifer system and a negative value indicates that the land decompressed and groundwater flowed back into interbed thickness.

The boundary conditions component represents the groundwater budget inflow as a result of Constrained General Head Boundary Conditions, used to represent a few select reservoirs in the Central Valley. Thermalito Afterbay is simulated using this approach, so boundary conditions flows appears in the Wyandotte Creek and Butte Subbasins' water budgets.

Change in storage is computed as the total inflows minus the total outflows, which means it can be either a positive or a negative value. In order to balance the water budget, when the inflows are less than the outflows, the change in storage is a negative value, but is shown on the graphs as a component of the inflows, as it is closing the water budget gap. Similarly, when outflows are less than inflows, the change in storage is positive, but shown as a component of the outflows to close the water budget gap. Cumulative change in storage is then computed as the accumulated change in storage year after year, considering the correct sign of the annual change in storage value.

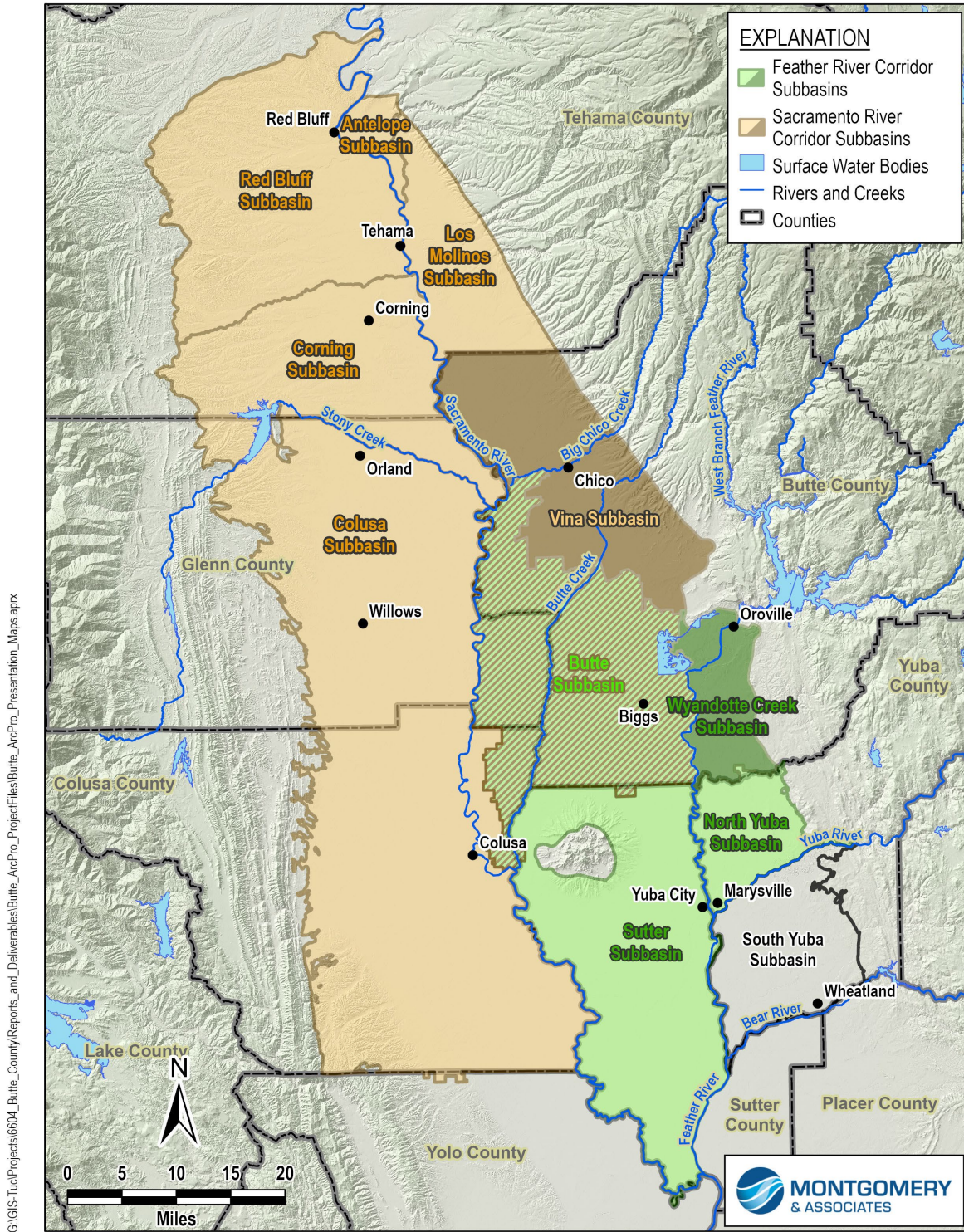
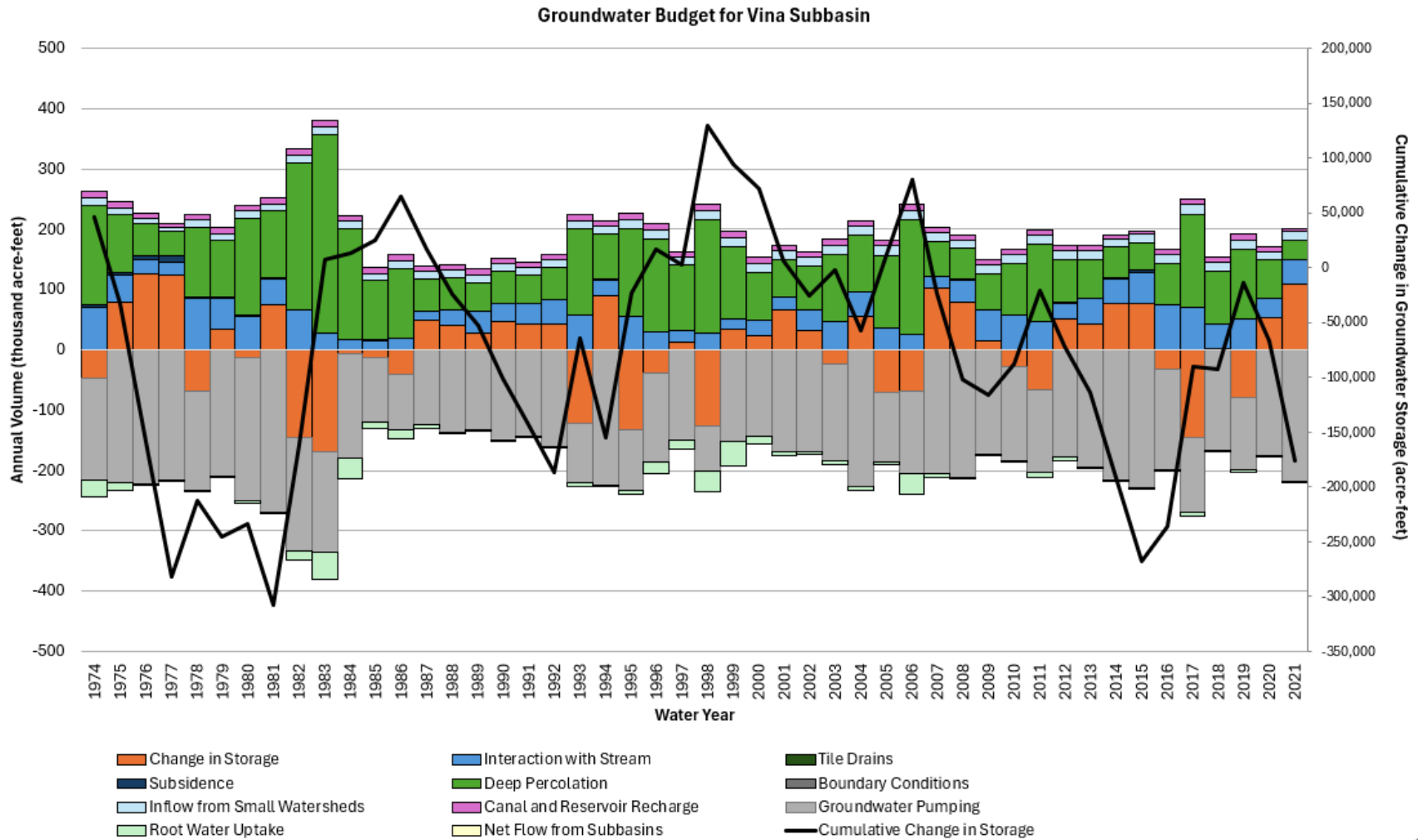


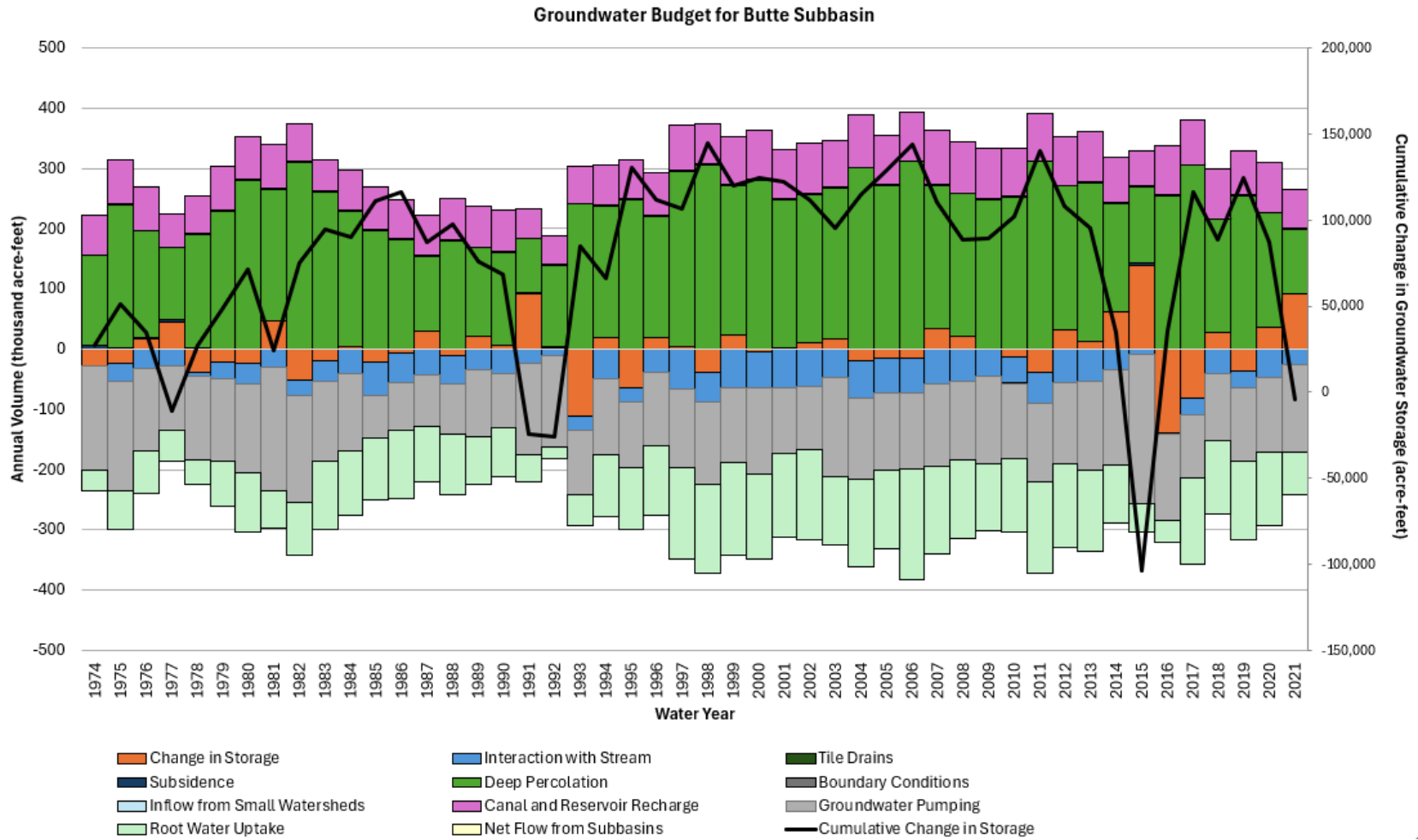
Figure 1. Sacramento and Feather River Corridor Subbasins

North Sacramento River Corridor Water Budgets

Vina Subbasin

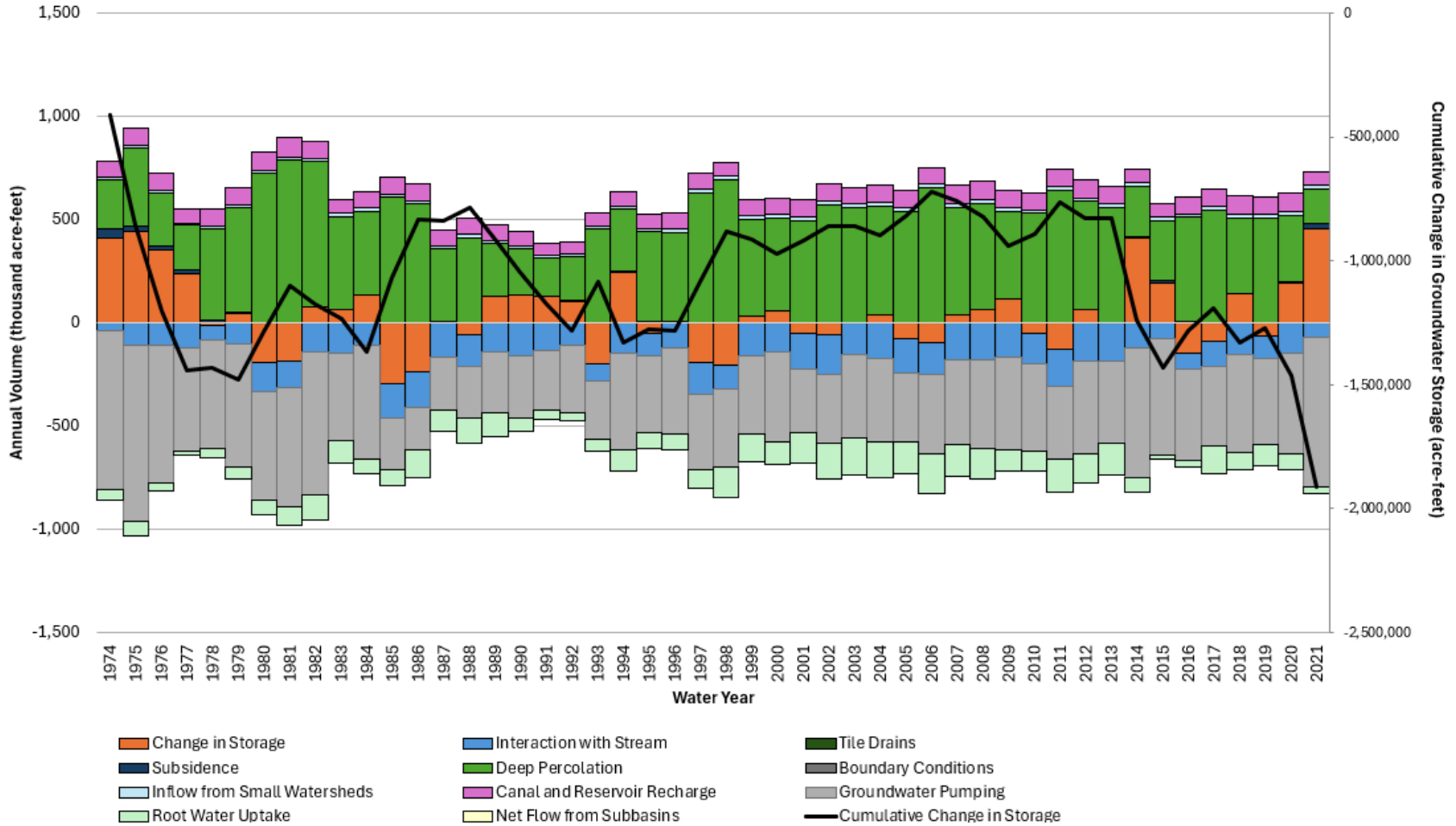


Butte Subbasin

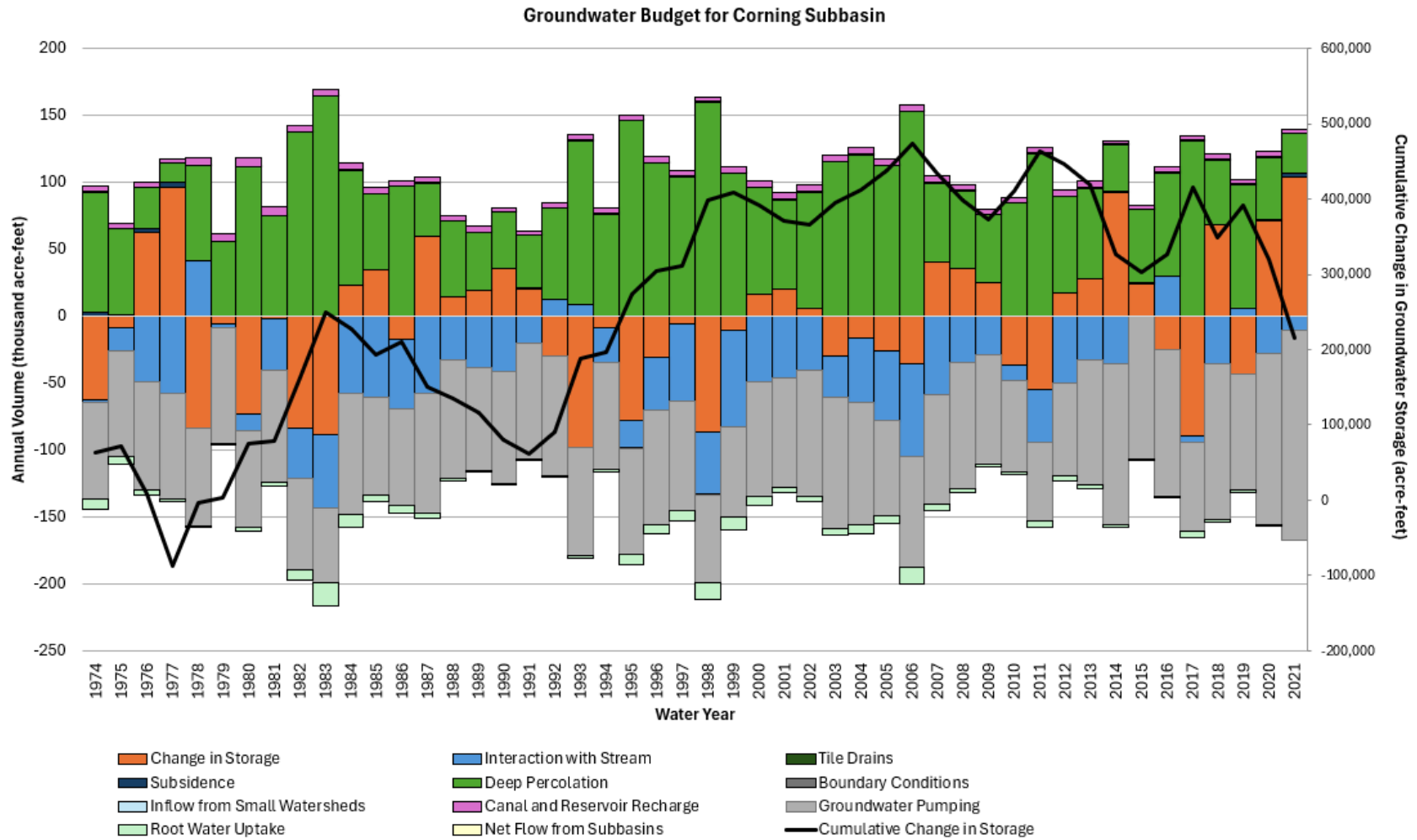


Colusa Subbasin

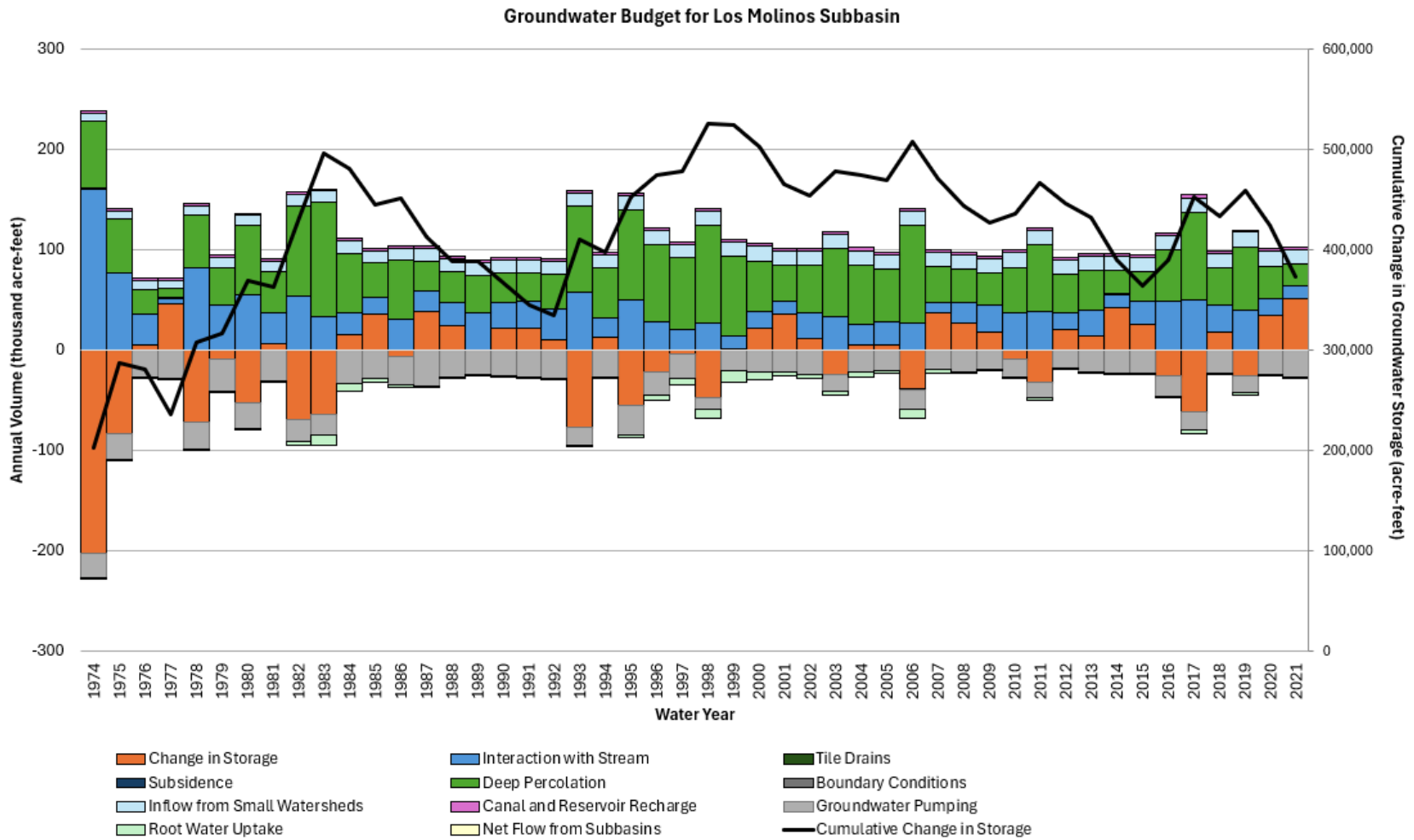
Groundwater Budget for Colusa Subbasin



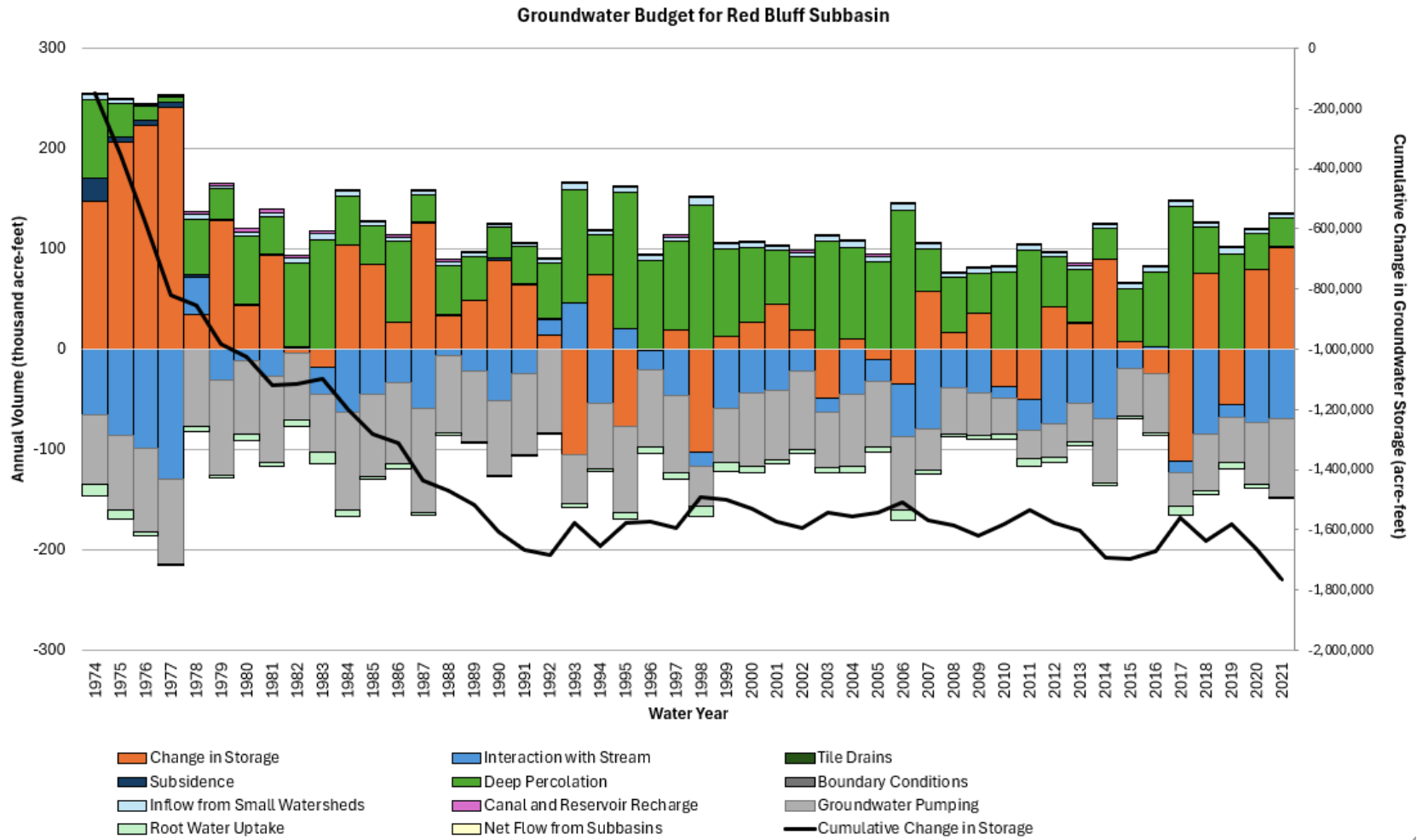
Corning Subbasin



Los Molinos Subbasin

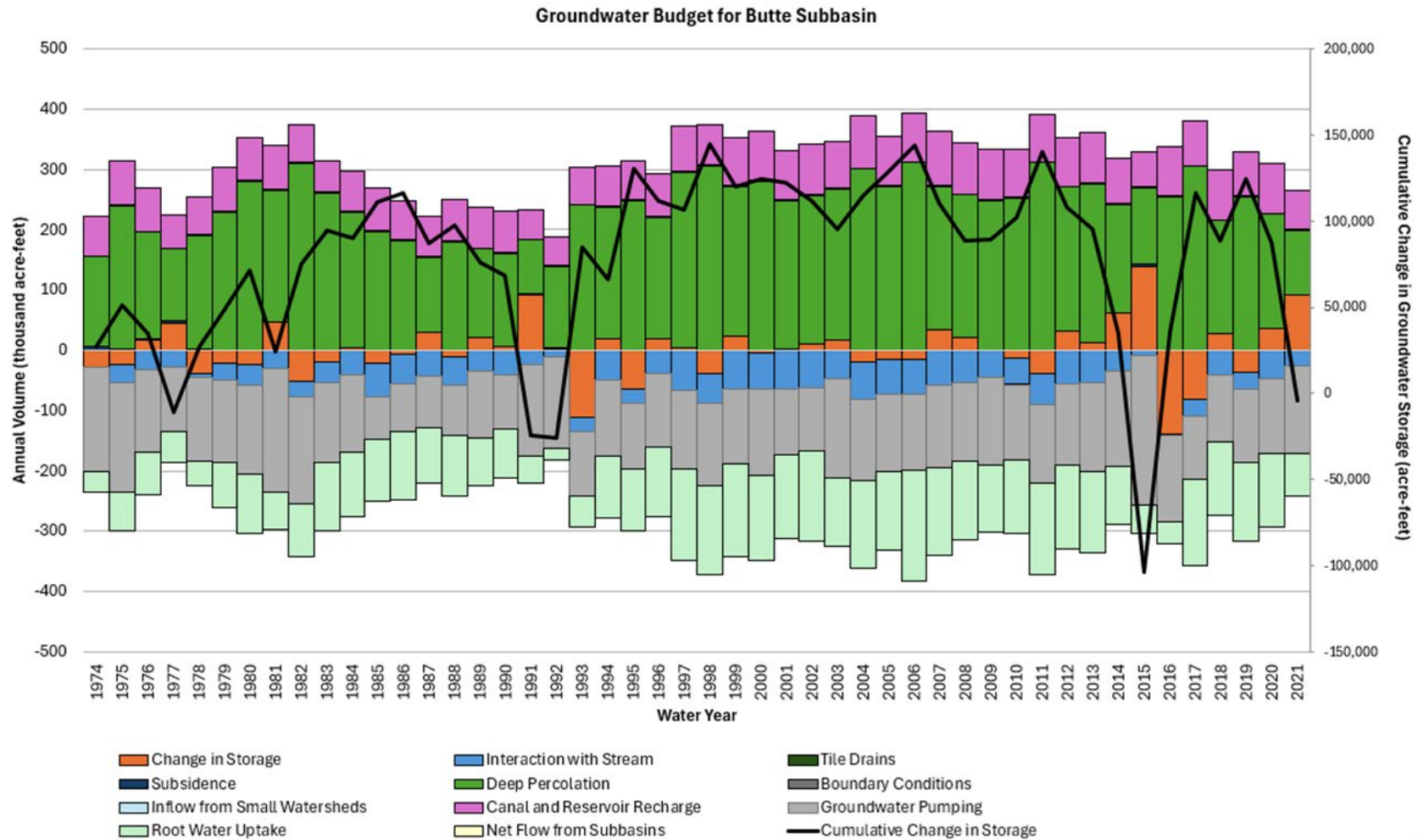


Red Bluff Subbasin

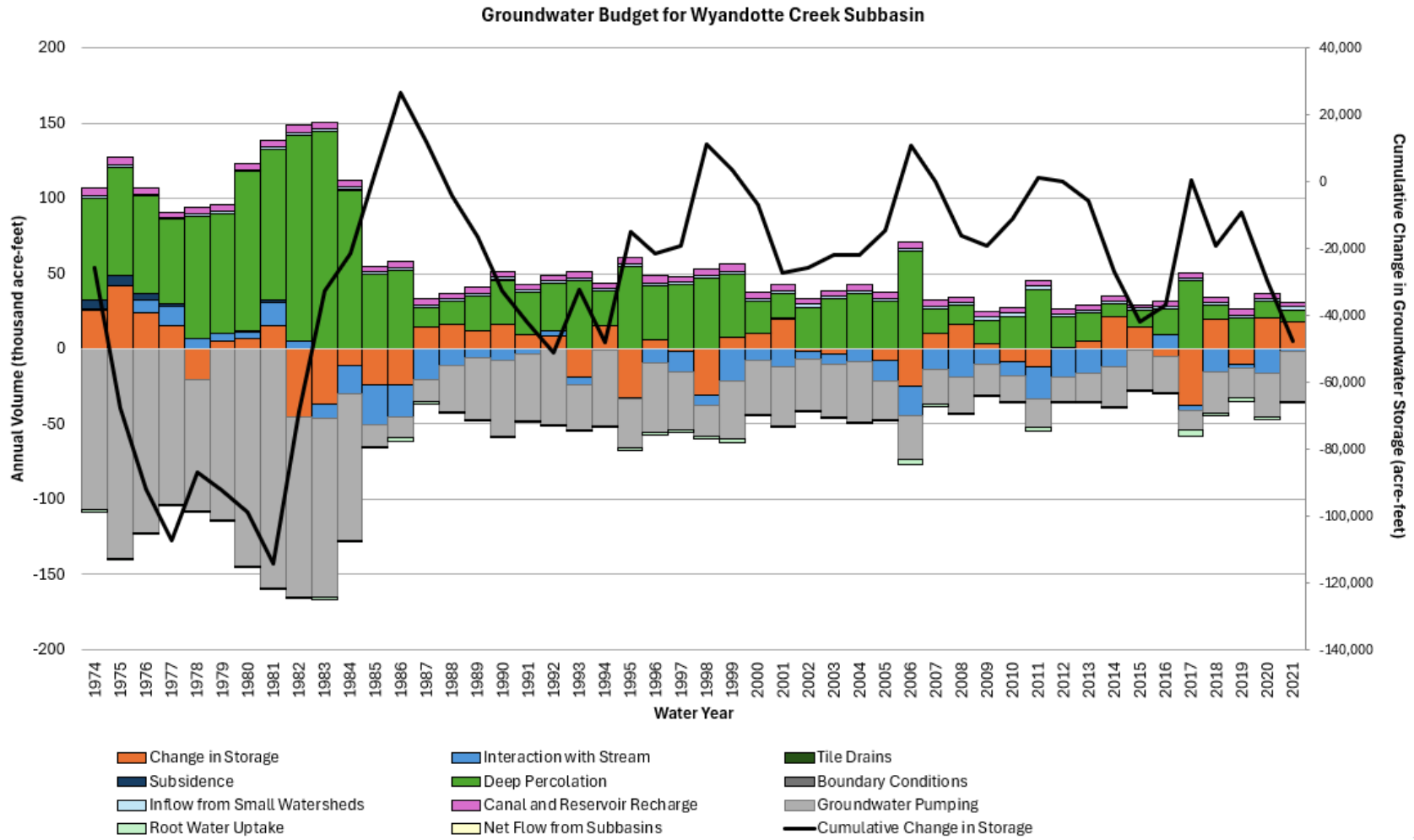


Feather River Corridor Water Budgets

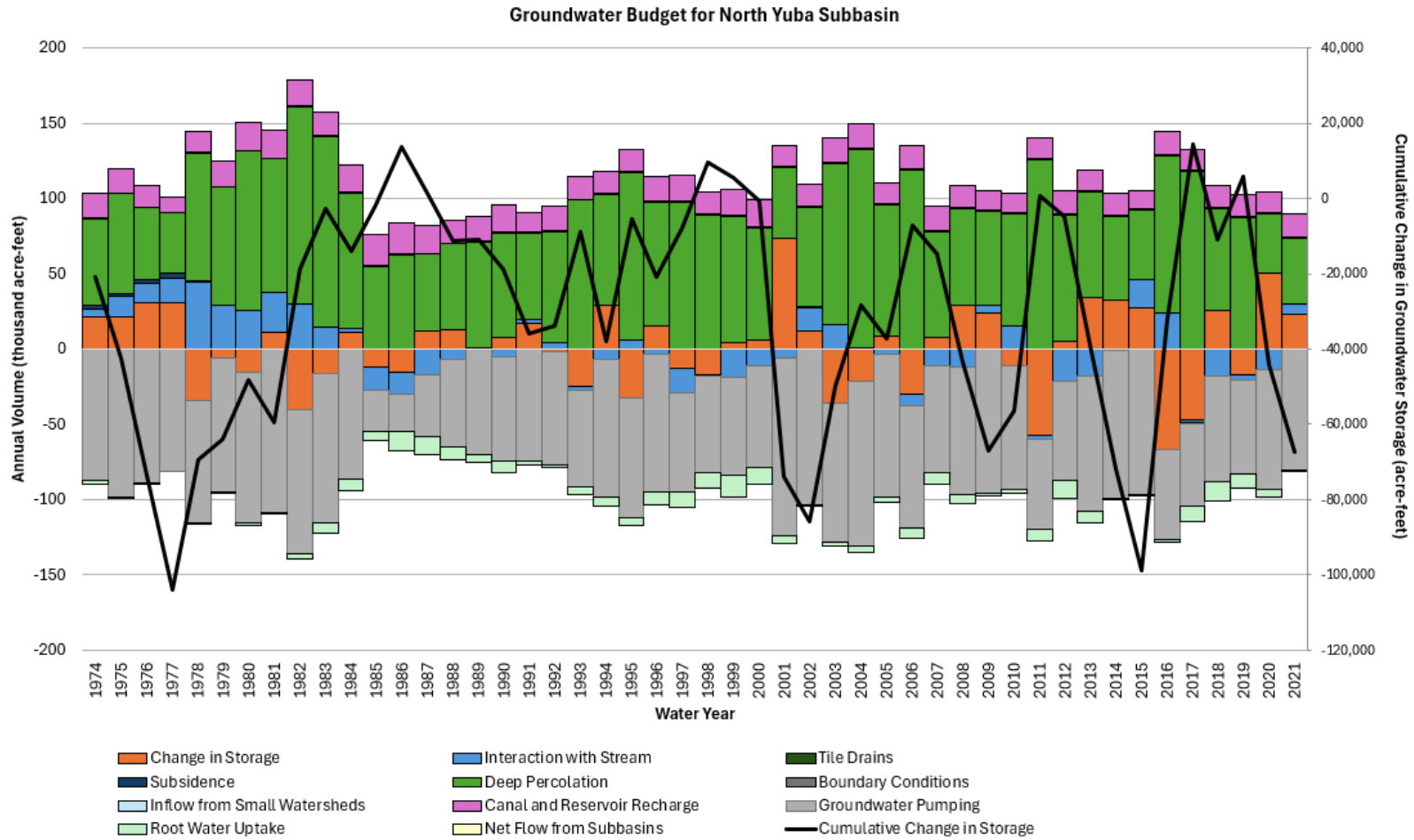
Butte Subbasin



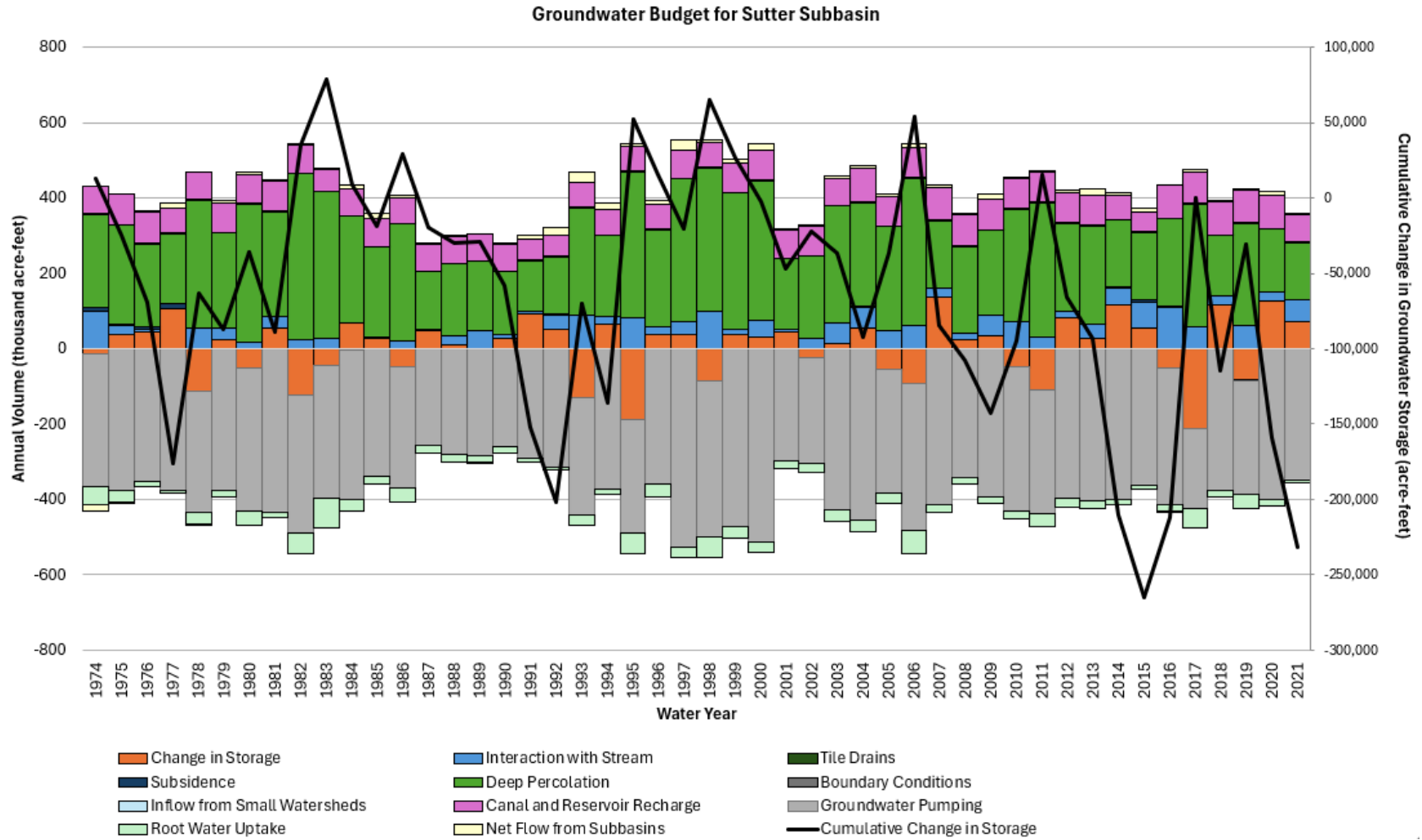
Wyandotte Creek Subbasin



North Yuba Subbasin



Sutter Subbasin



Attachment 2

Groundwater Elevation Comparison at C2VSimFG Groundwater Nodes Grouped by Subregion in the Northern Sacramento Valley

GROUNDWATER ELEVATION COMPARISON AT C2VSIMFG GROUNDWATER NODES GROUPED BY SUBREGION IN THE NORTHERN SACRAMENTO VALLEY

This Attachment provides select groundwater elevation hydrographs showing observed measurements and simulated values from C2VSimFG v1.5 at nodes for Subregions within the Northern Sacramento Valley inter-basin coordination footprint (Subregions 2, 3, 4, and 5). Representative hydrographs were selected from Appendix H of the C2VSimFG v.1.5 Report (DWR, 2025)¹. The appendix contains comparison plots for the model groundwater nodes in each subregion, comparing simulated groundwater elevations to nearby well measurements. C2VSimFG Subregions are shown in Figure 1.

¹ <https://data.ca.gov/dataset/california-central-valley-groundwater-surface-water-simulation-model-fine-grid-c2vsimfg>

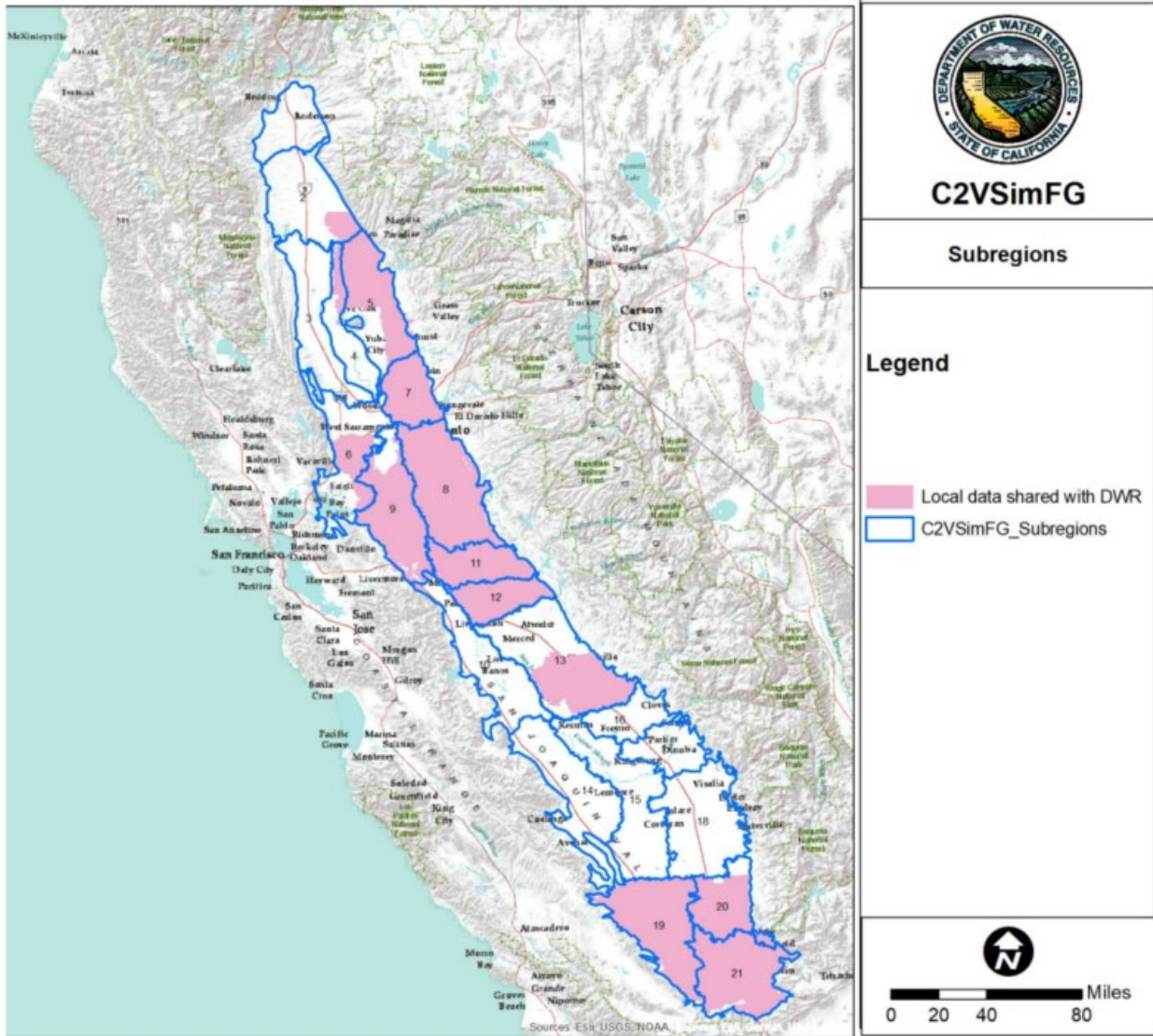
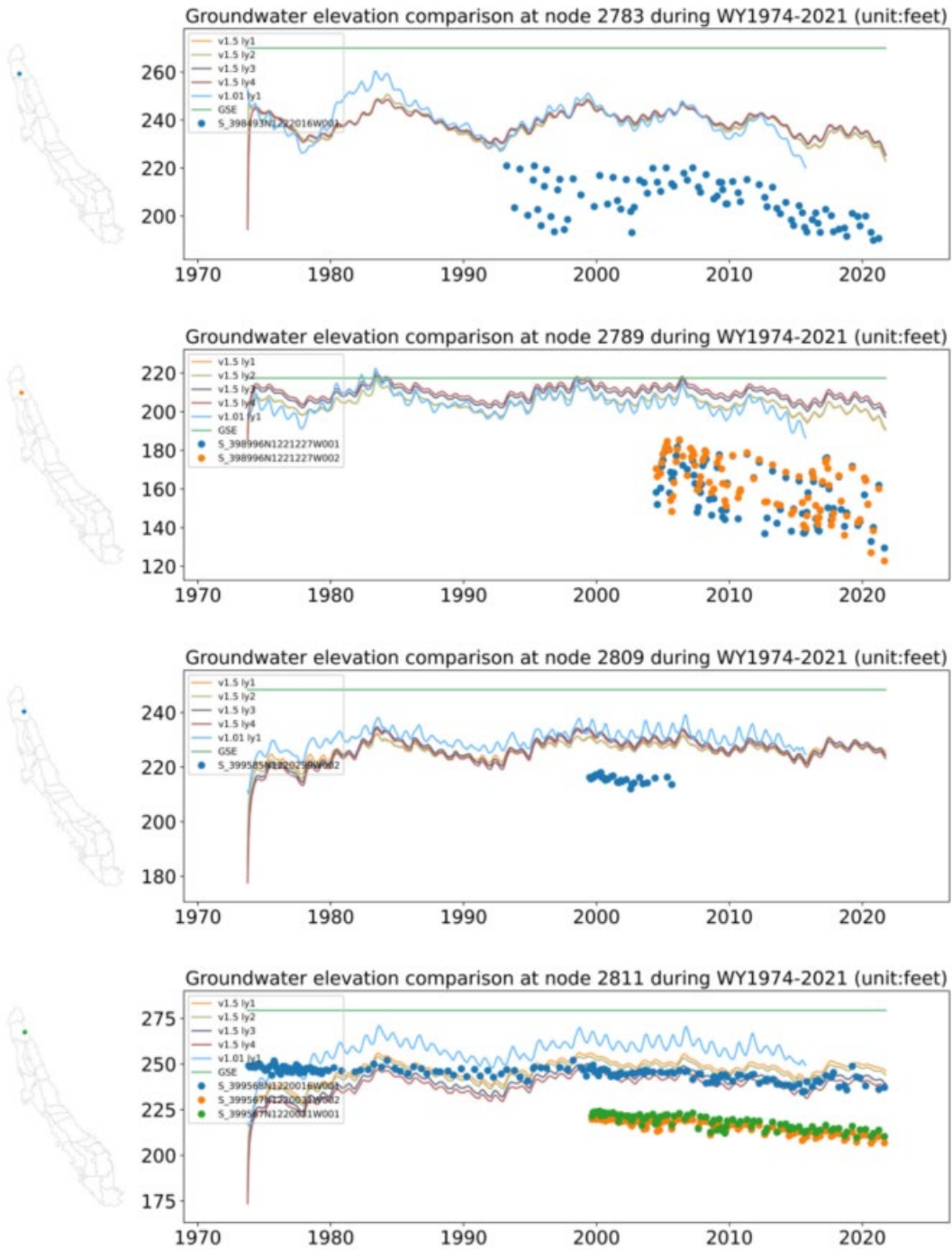
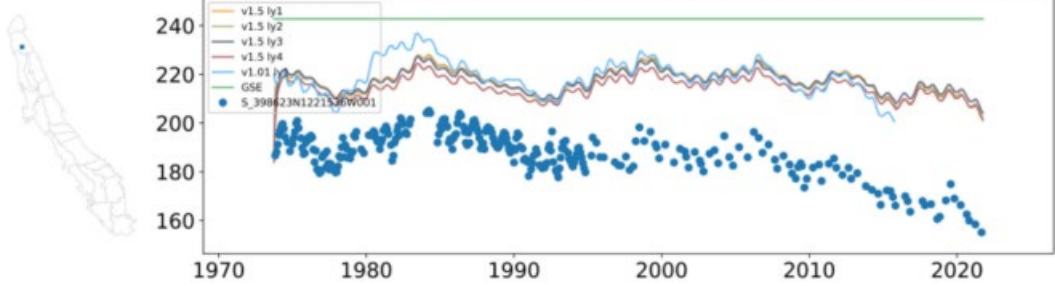


Figure 1. C2VimFG 1.5 Subregions (source: DWR, 2025)

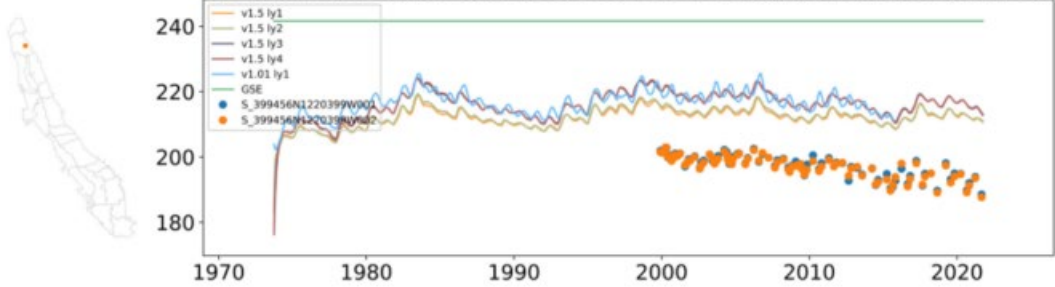
Subregion 2



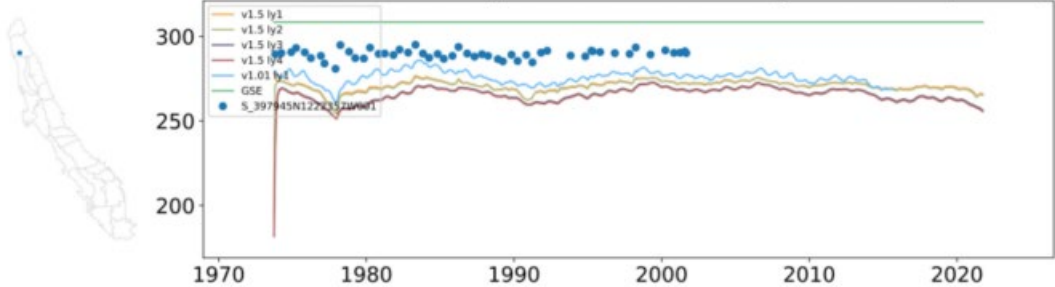
Groundwater elevation comparison at node 2858 during WY1974-2021 (unit:feet)



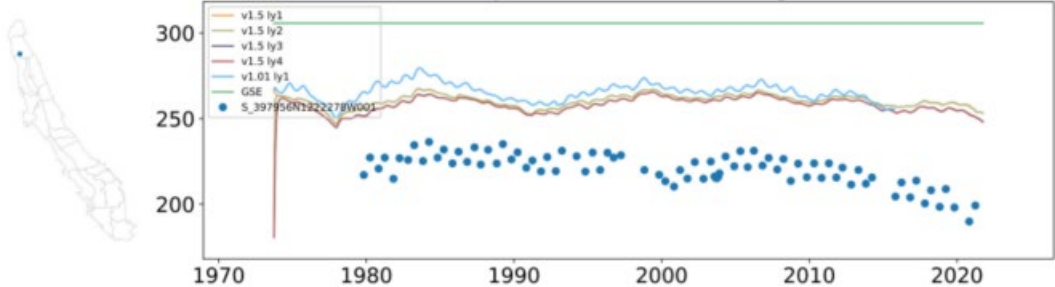
Groundwater elevation comparison at node 2879 during WY1974-2021 (unit:feet)

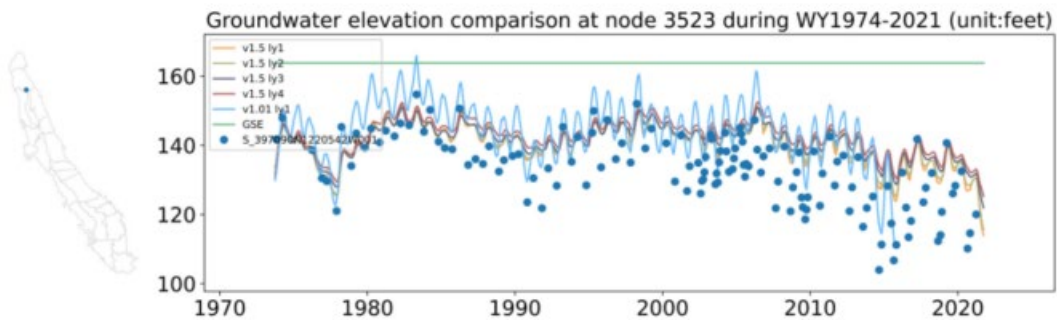
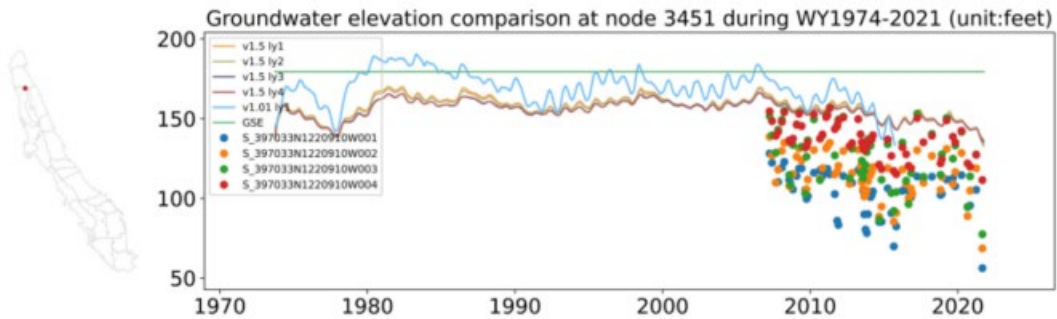
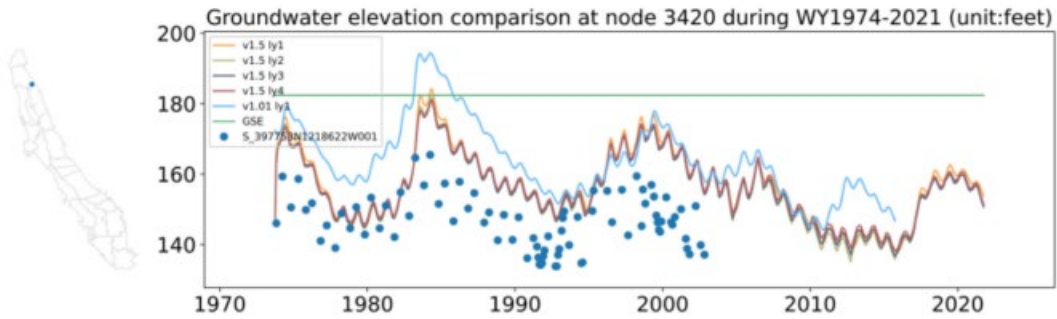
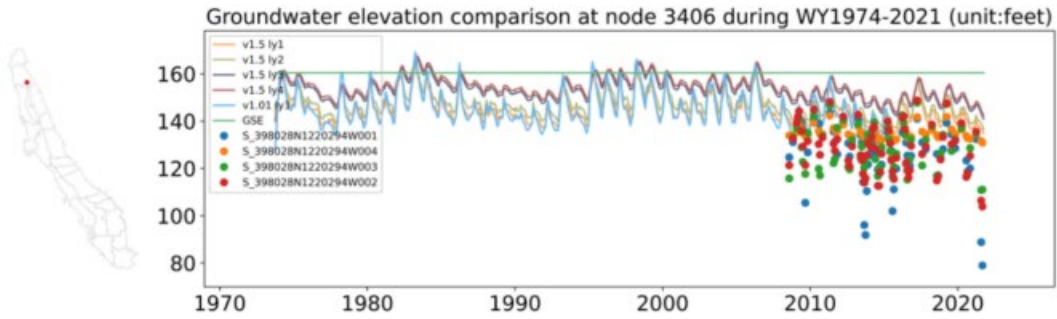


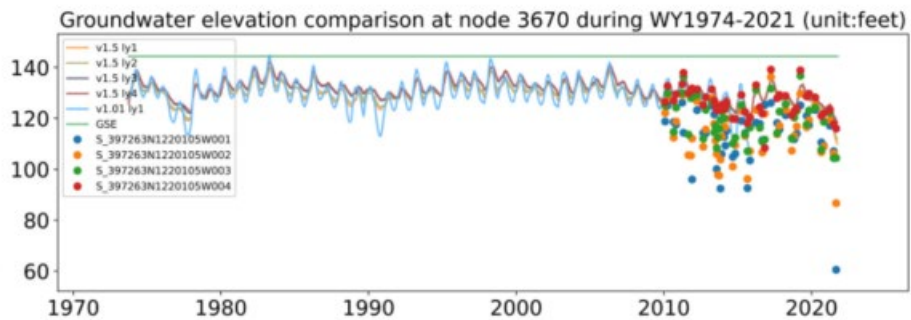
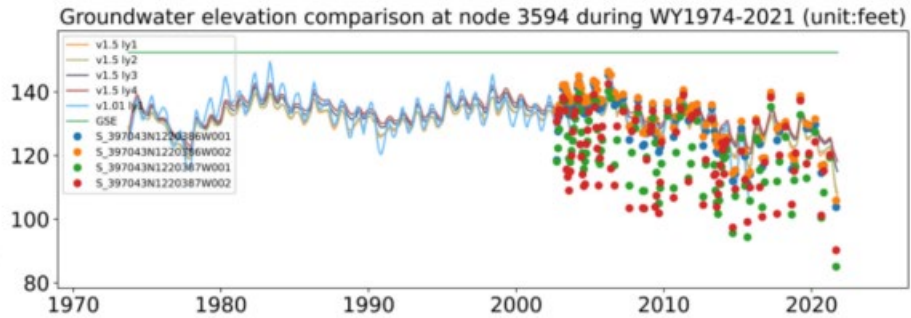
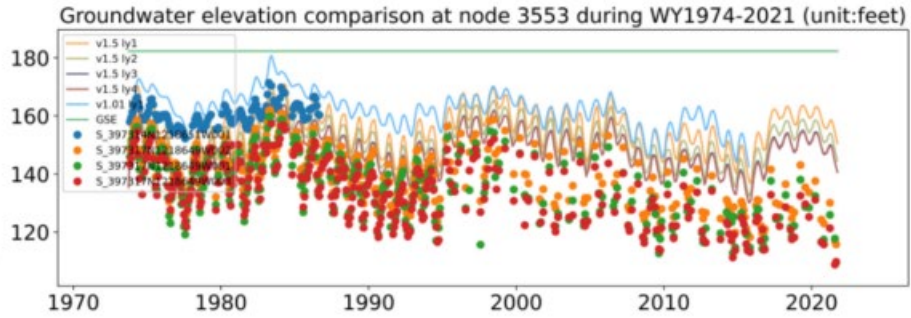
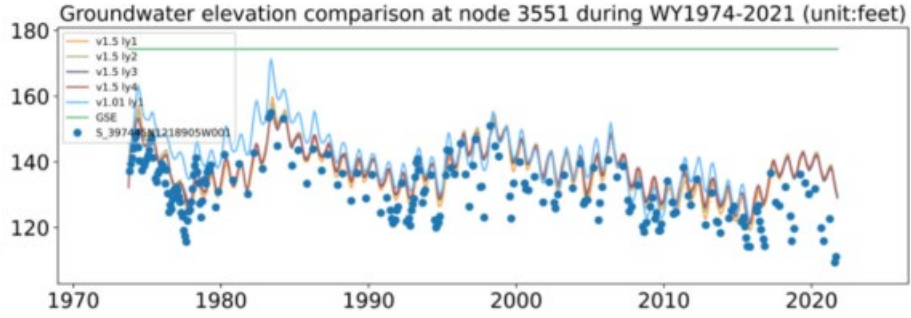
Groundwater elevation comparison at node 2919 during WY1974-2021 (unit:feet)

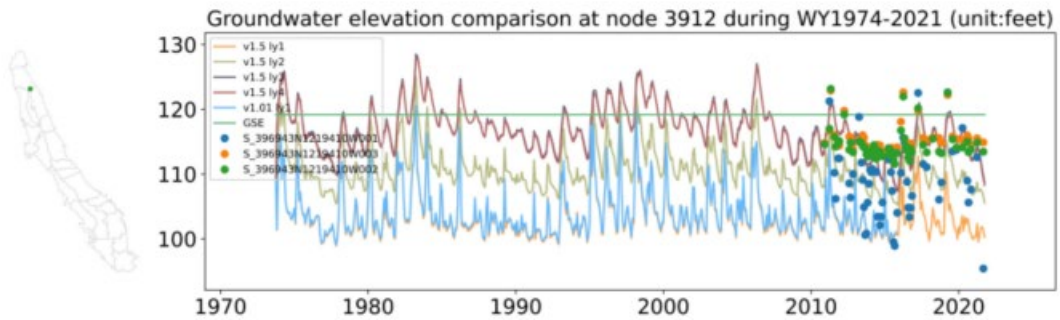
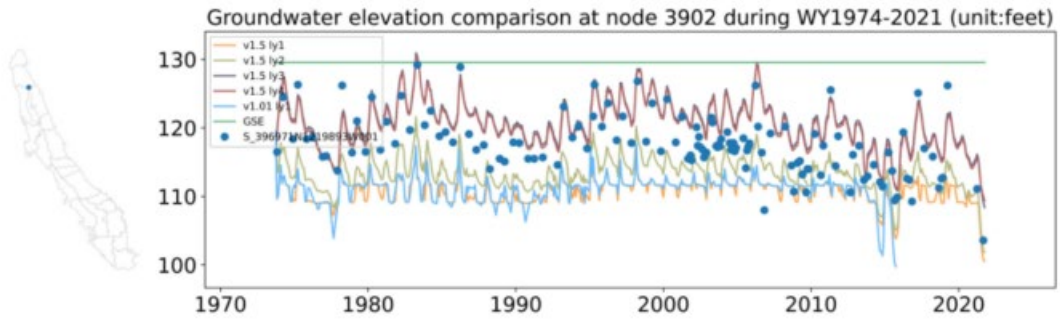
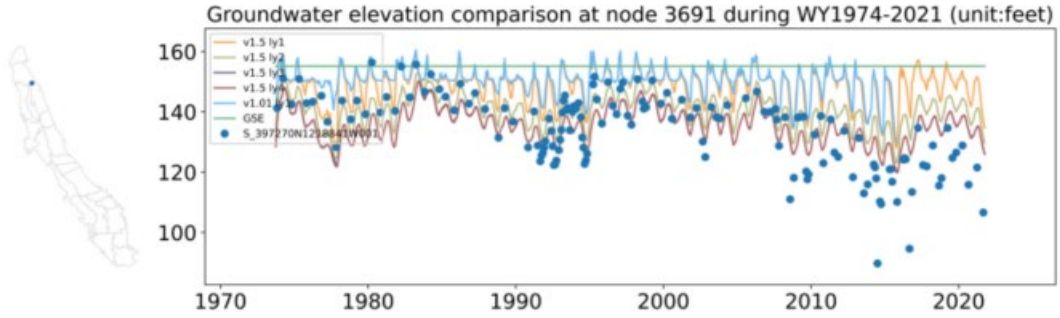


Groundwater elevation comparison at node 2920 during WY1974-2021 (unit:feet)

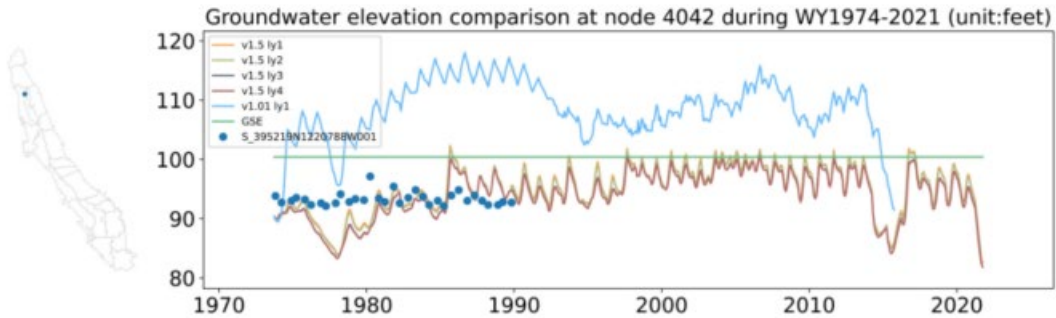
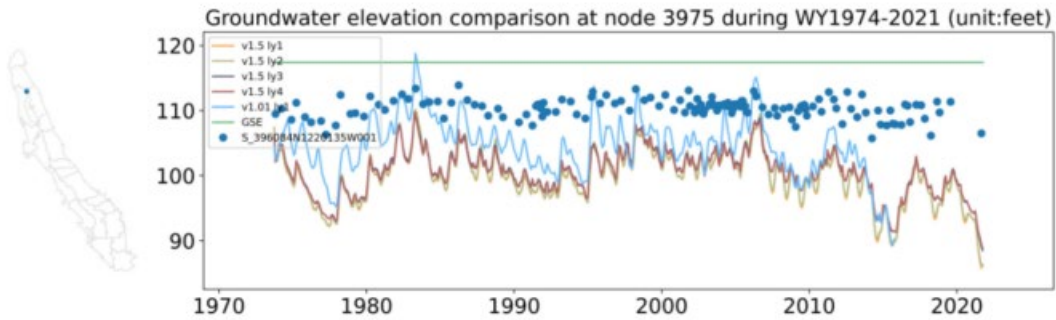
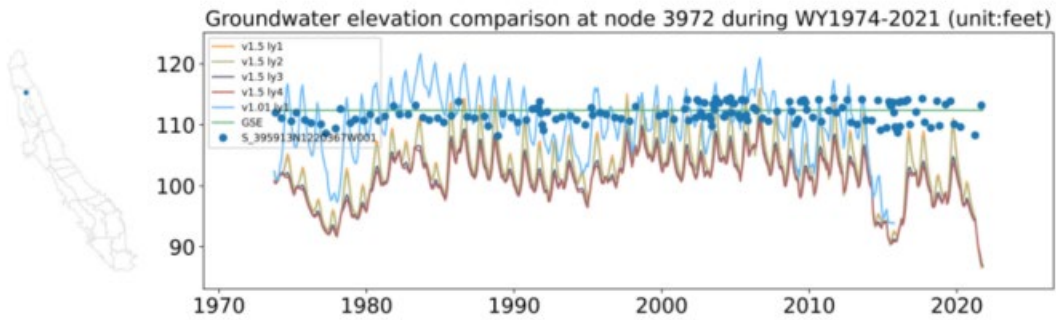
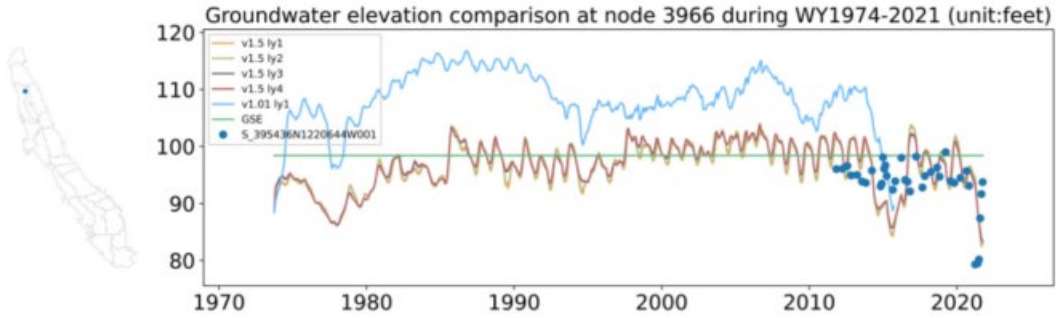


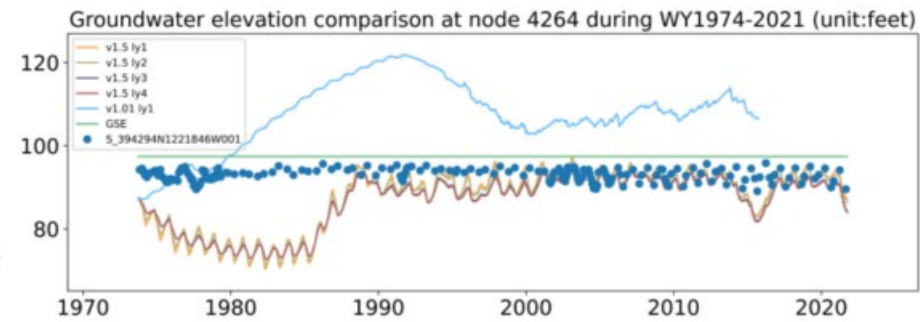
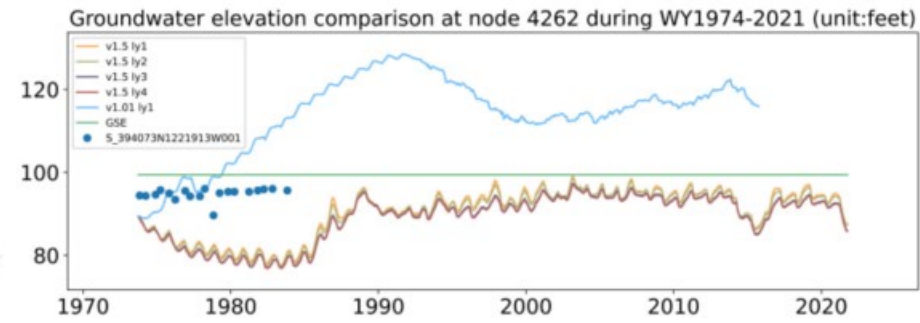
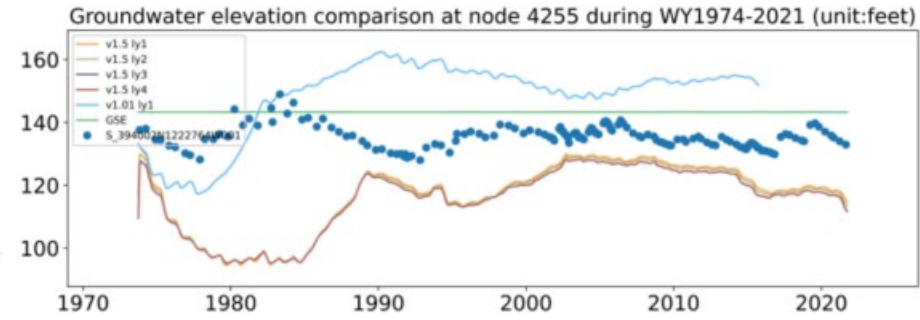
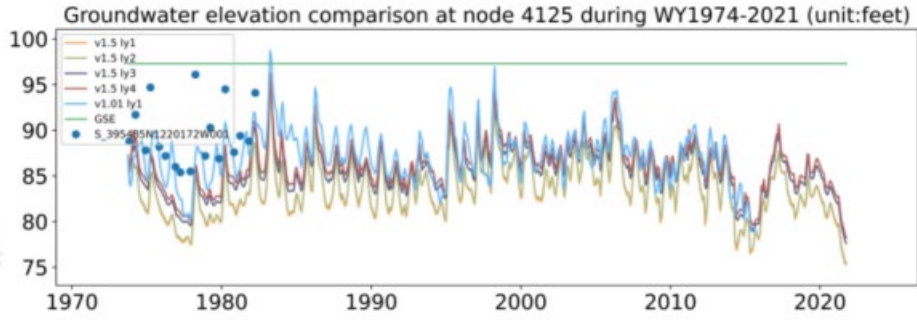


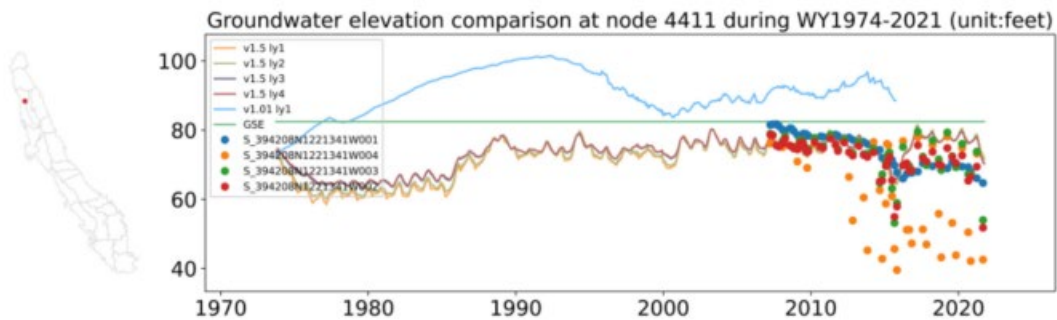
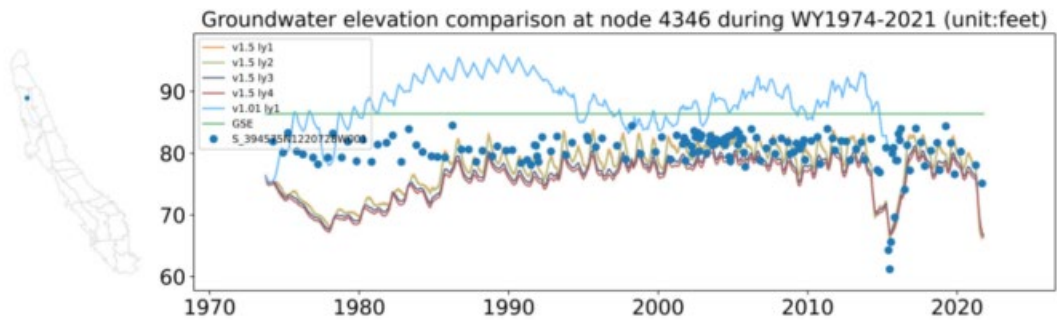
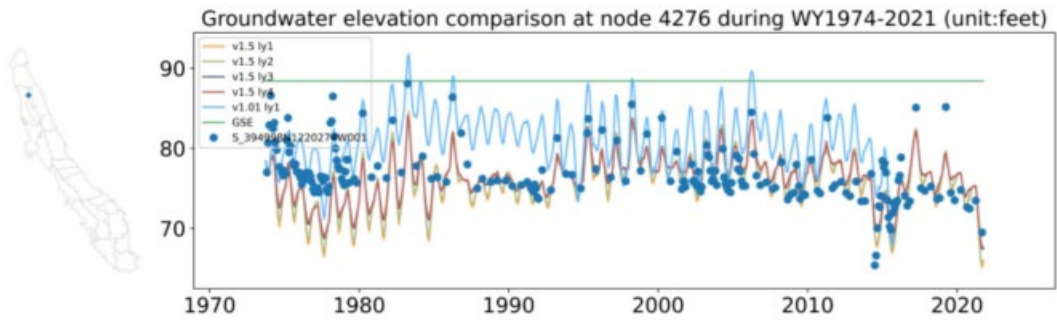
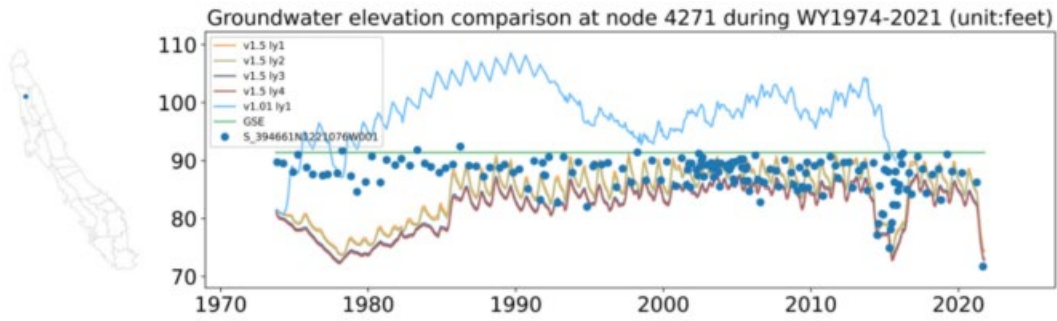


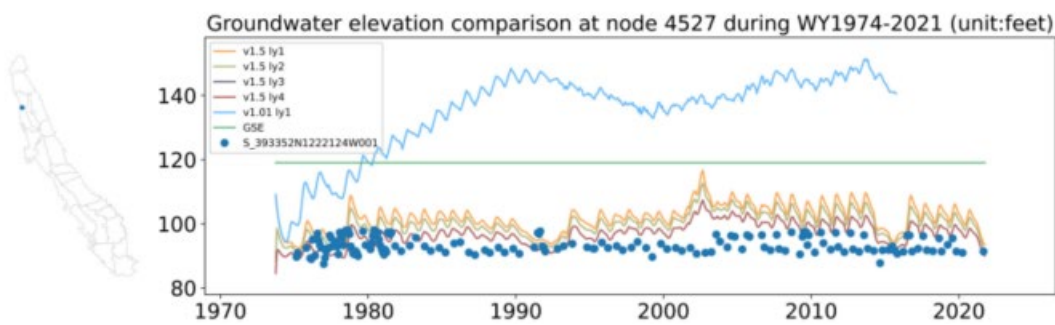
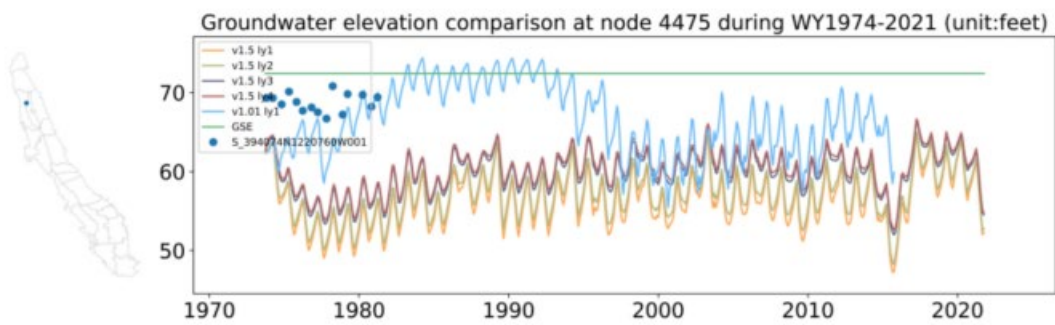
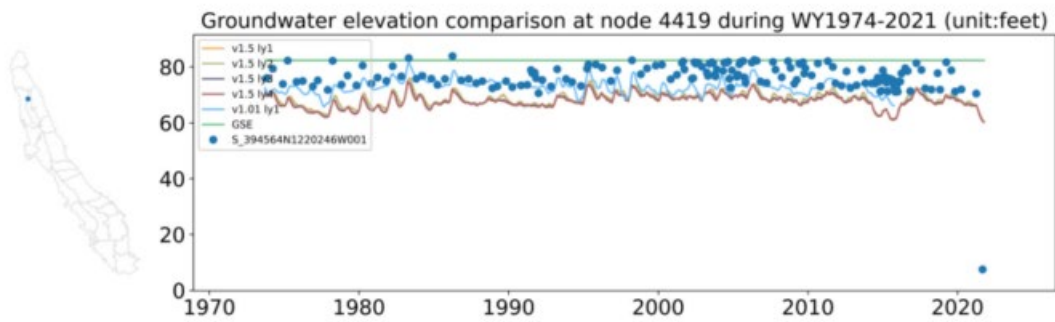
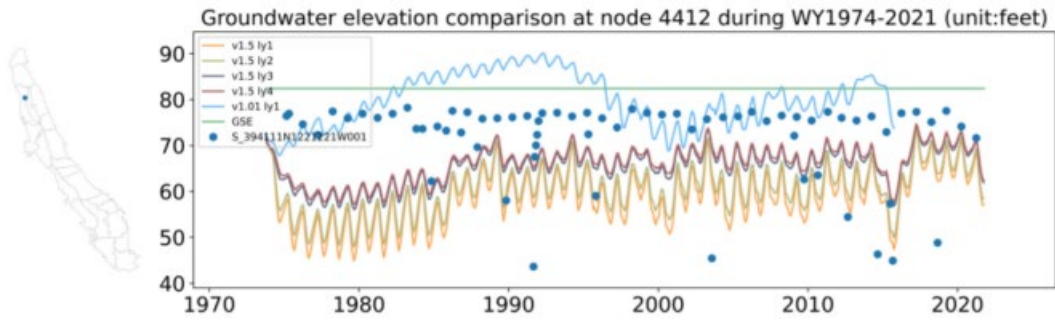


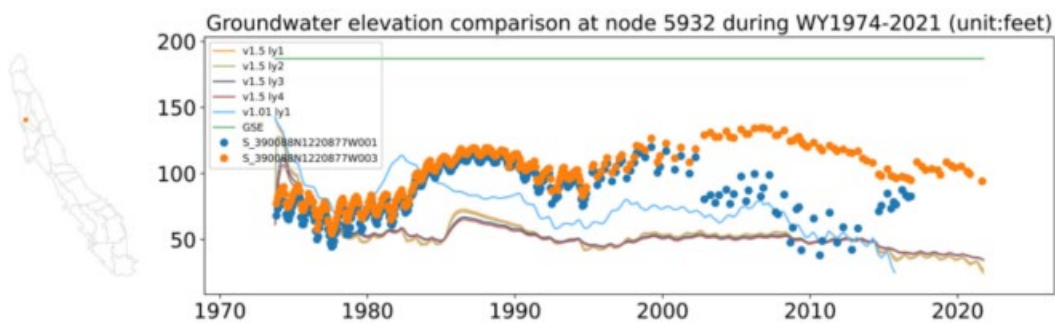
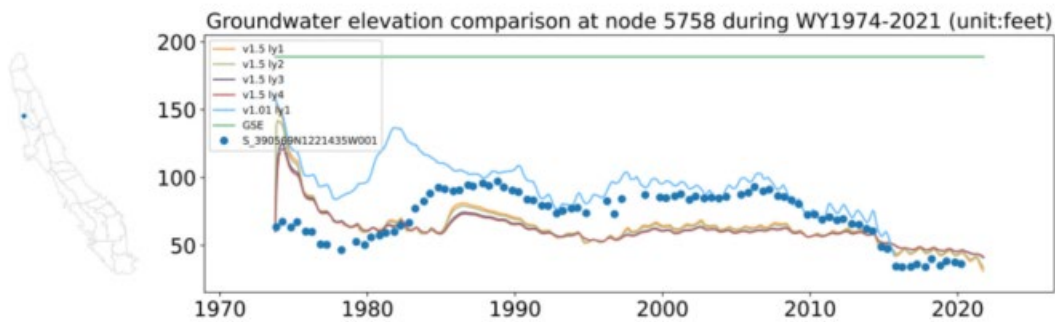
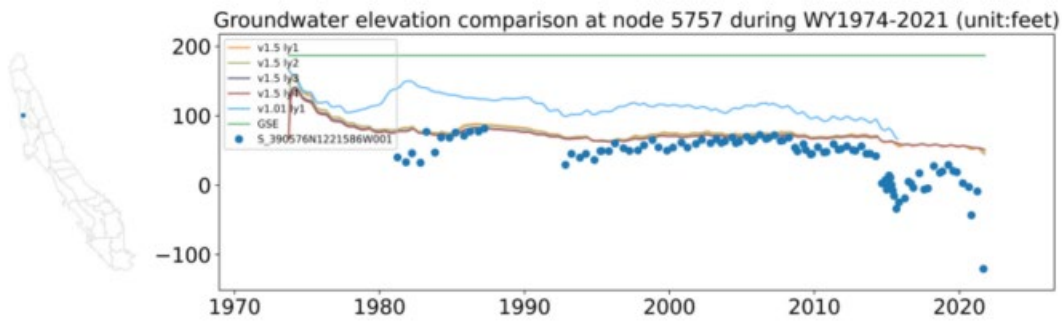
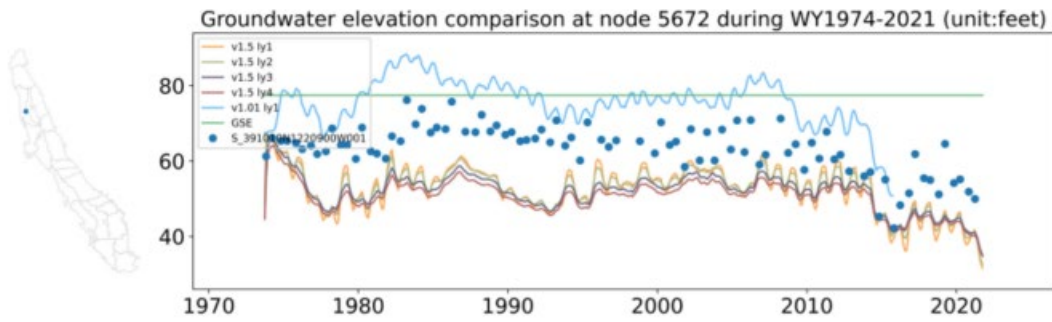
Subregion 3



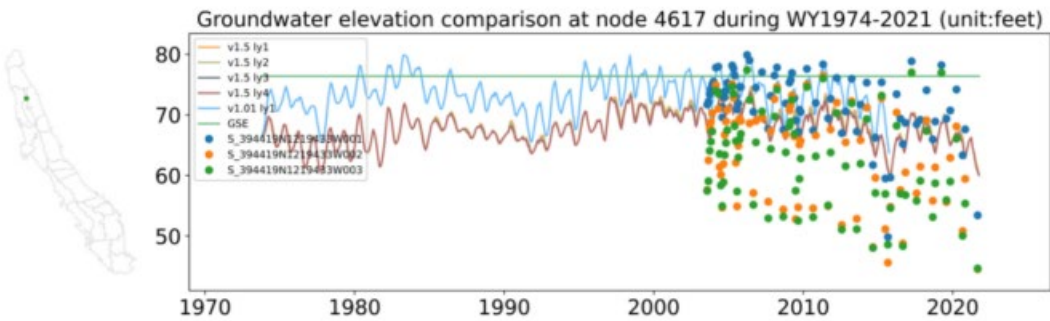
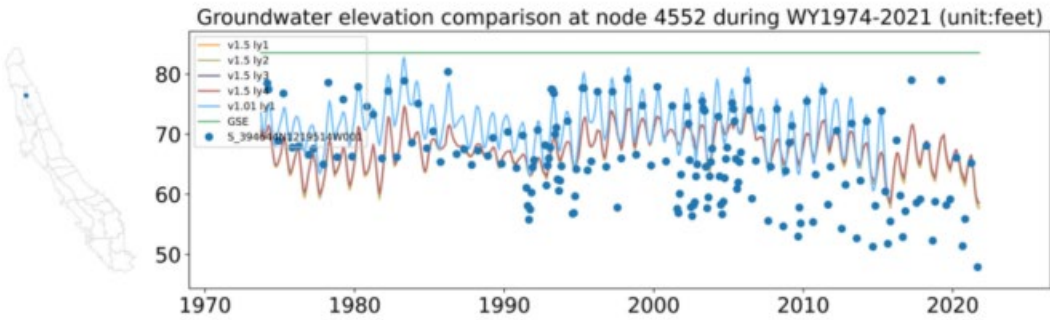
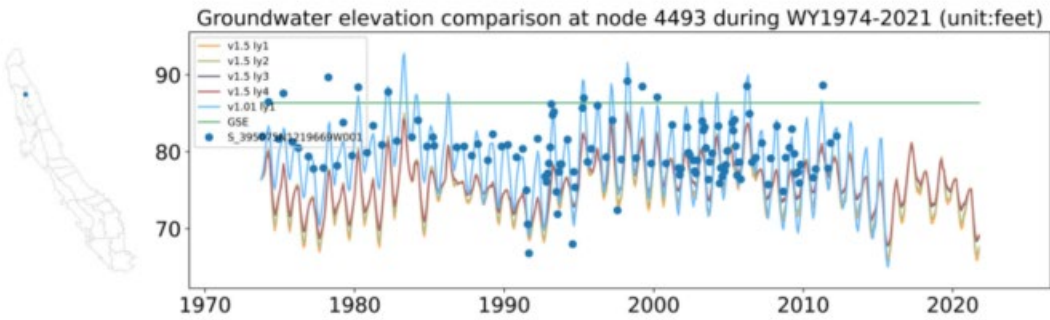
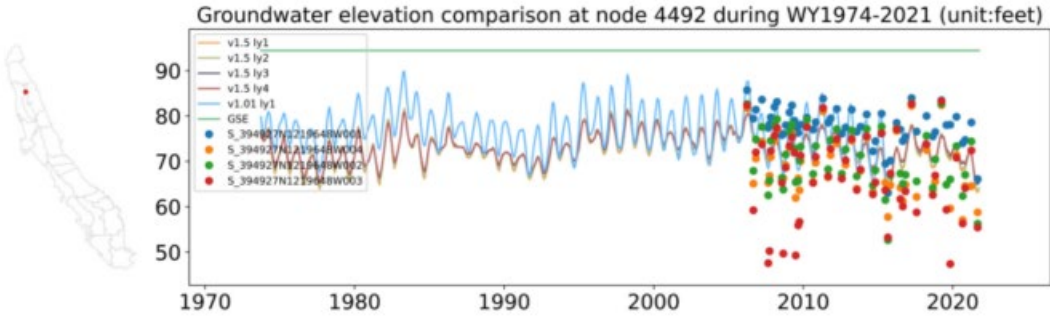


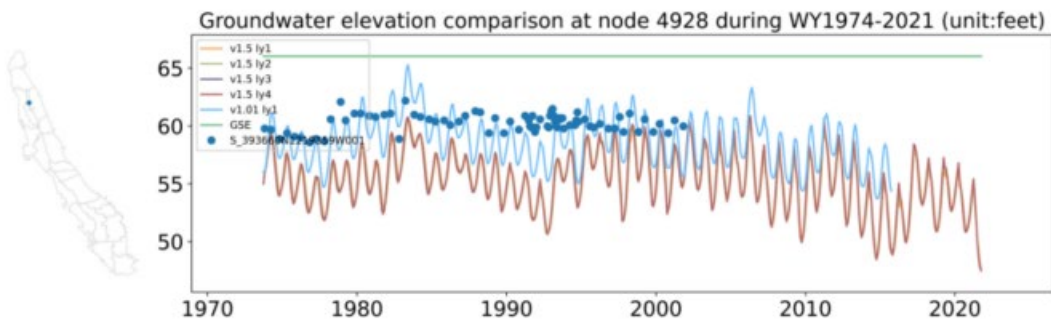
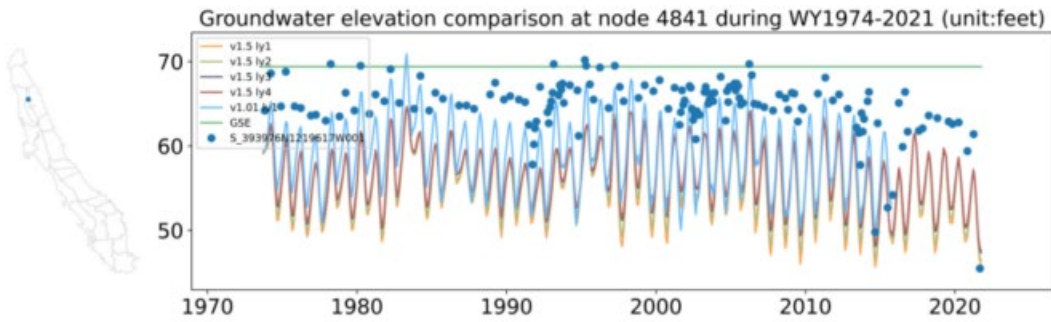
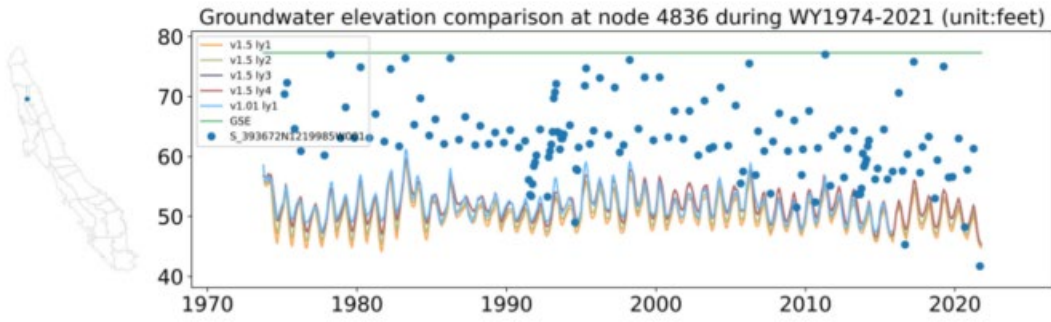
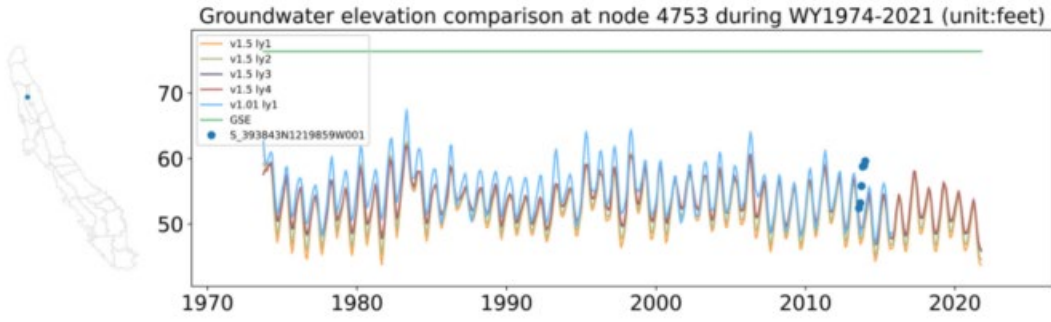


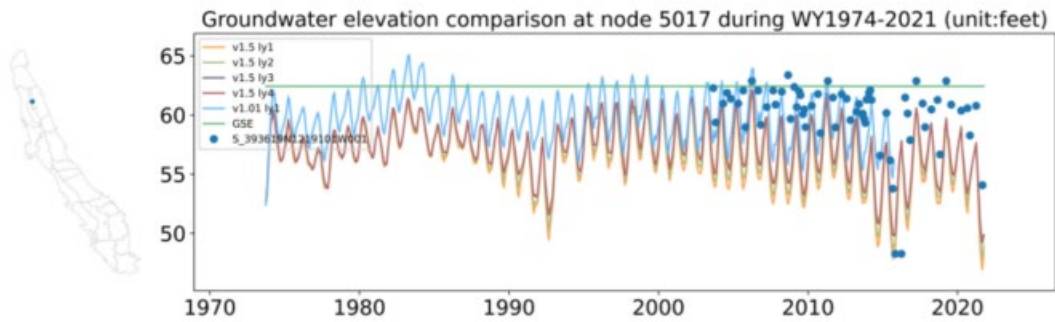
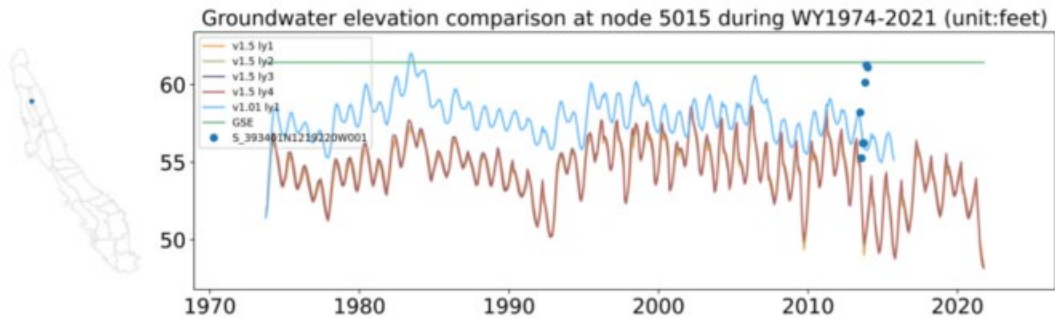
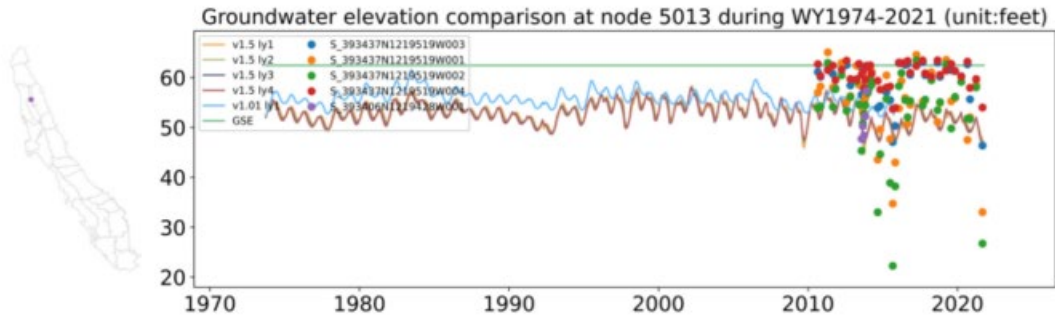
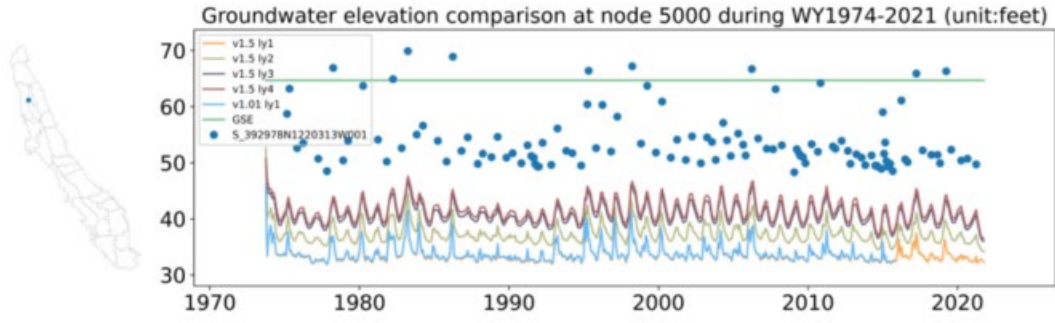


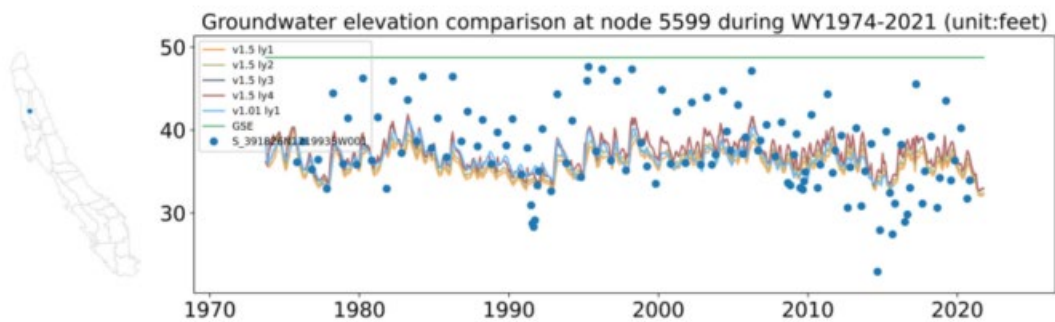
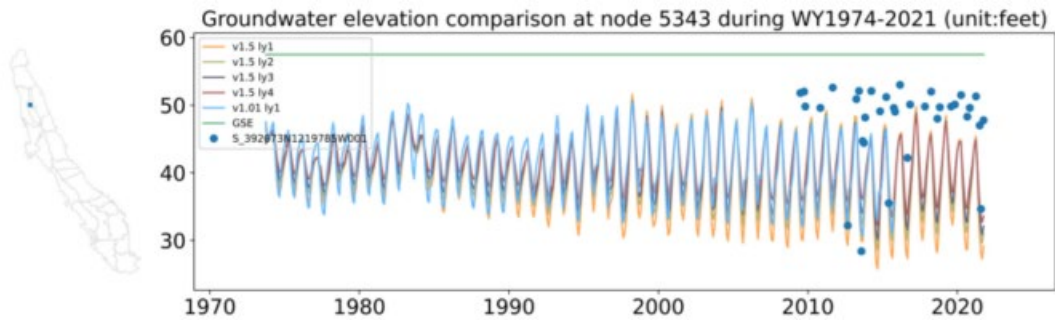
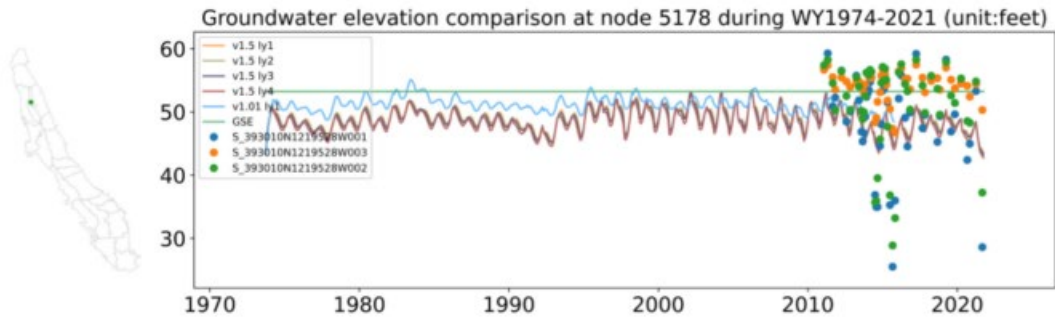
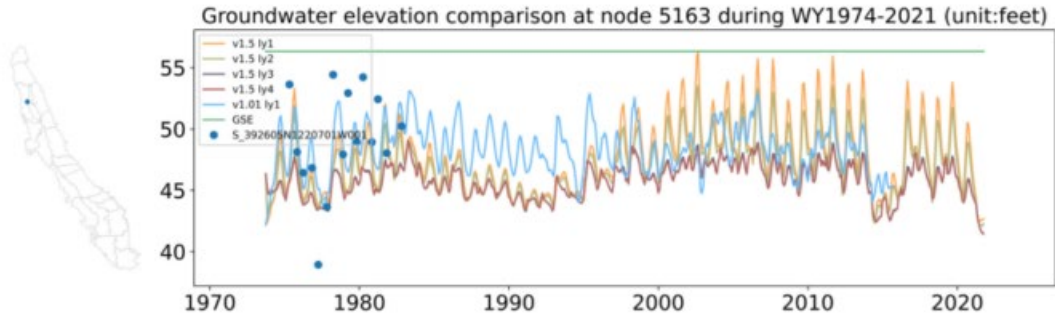


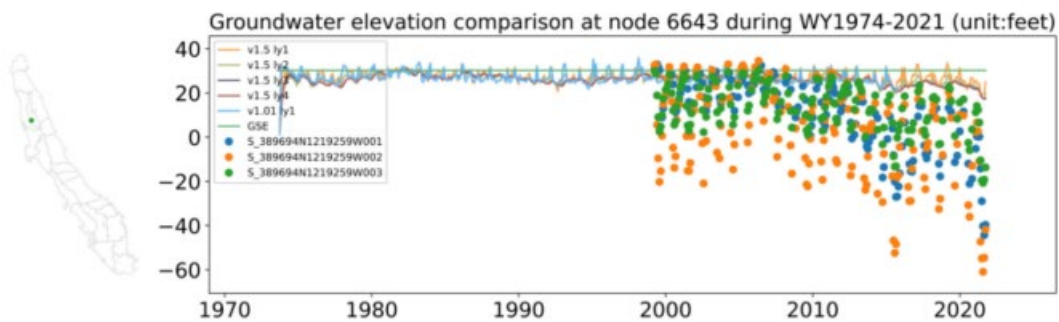
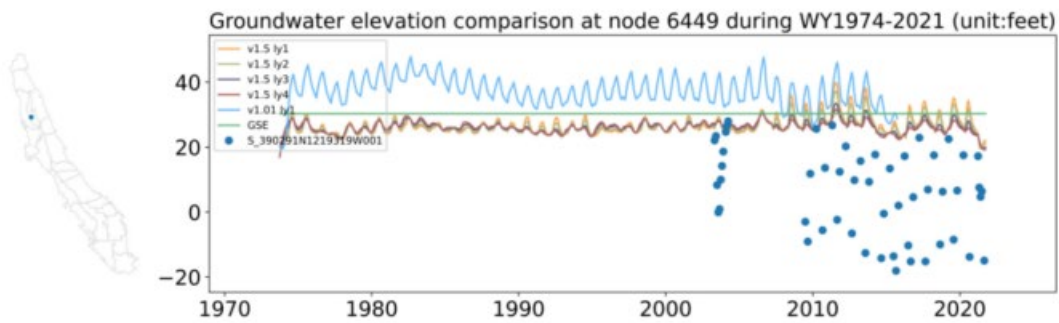
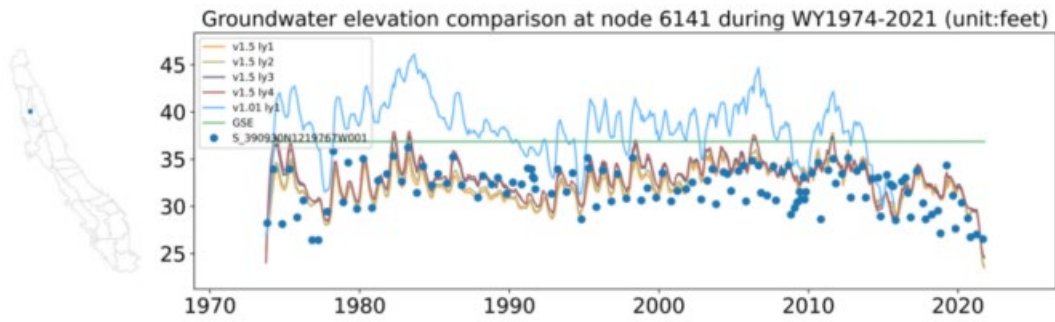
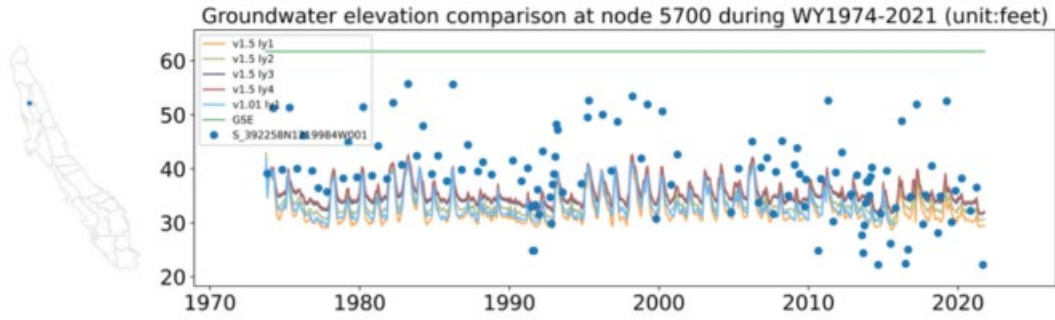
Subregion 4

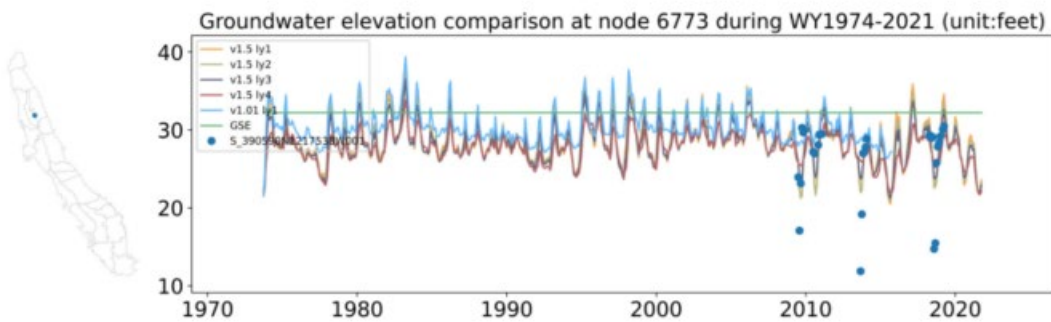
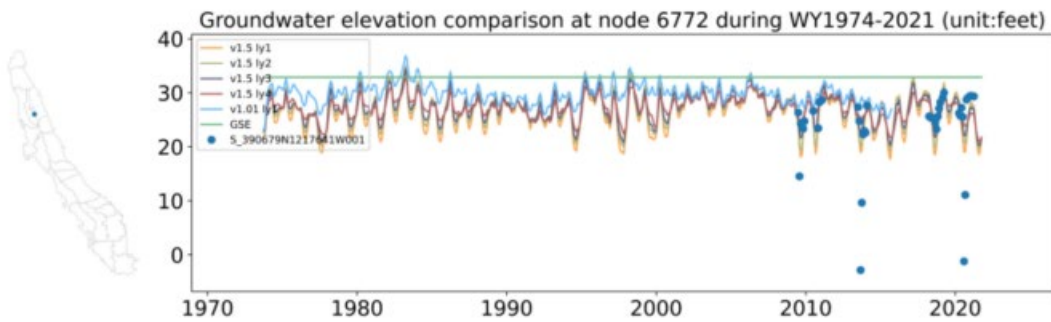
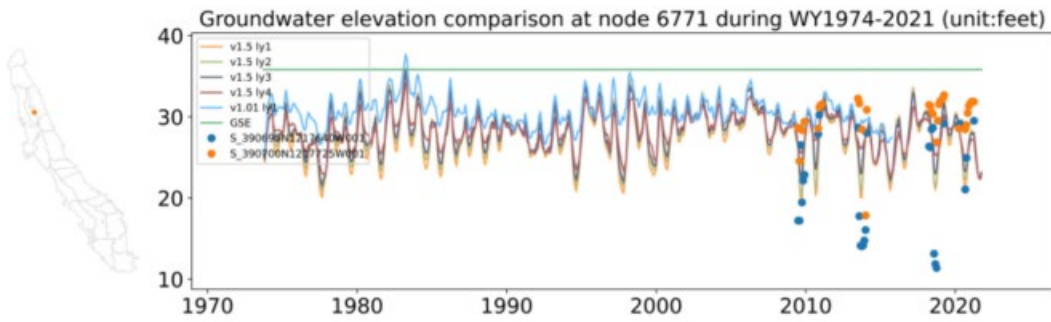
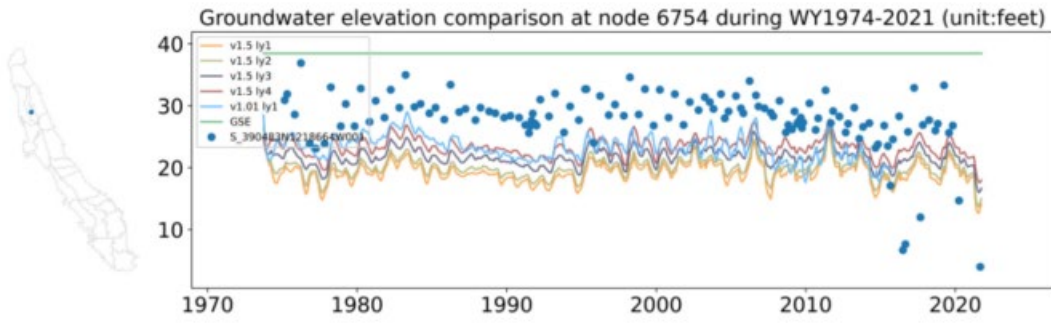


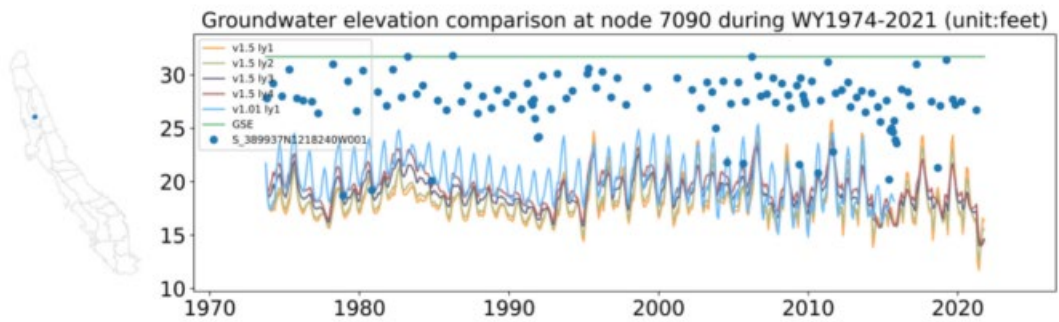
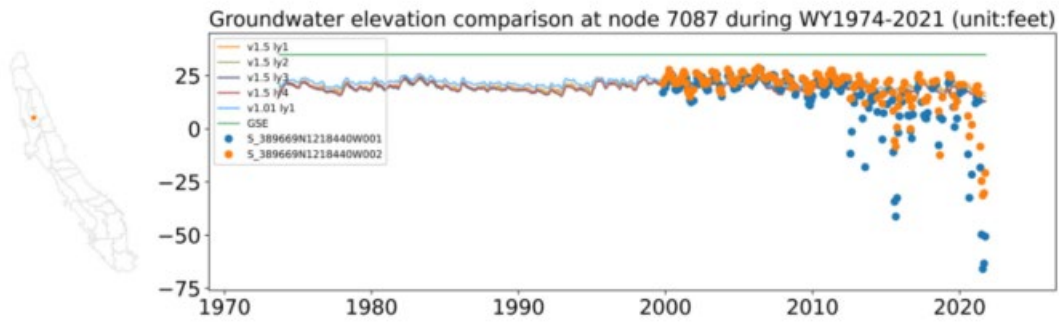
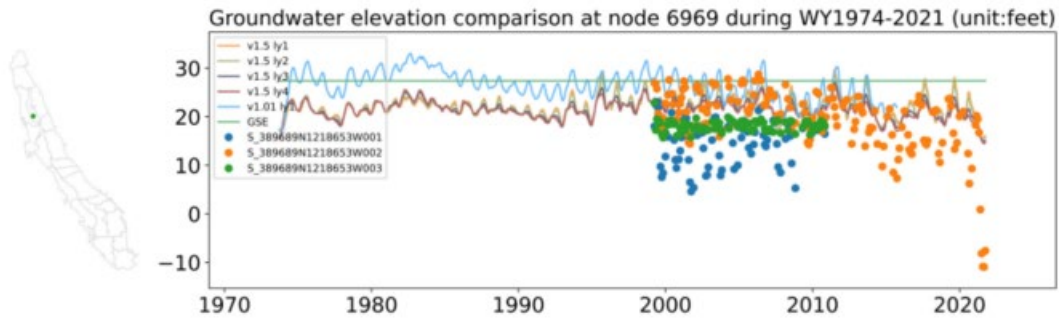
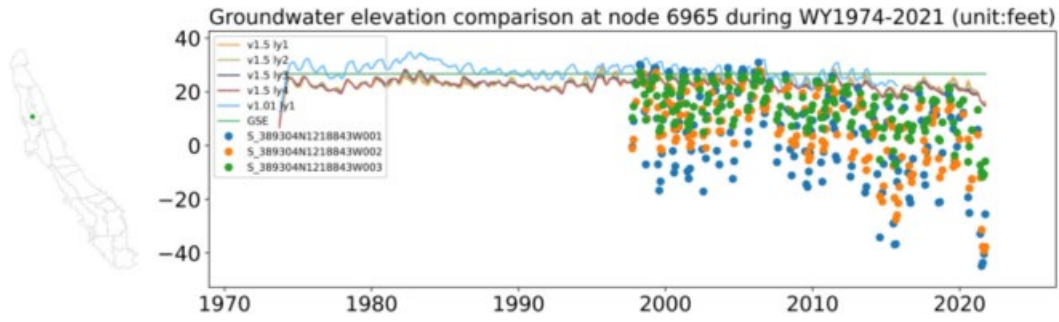


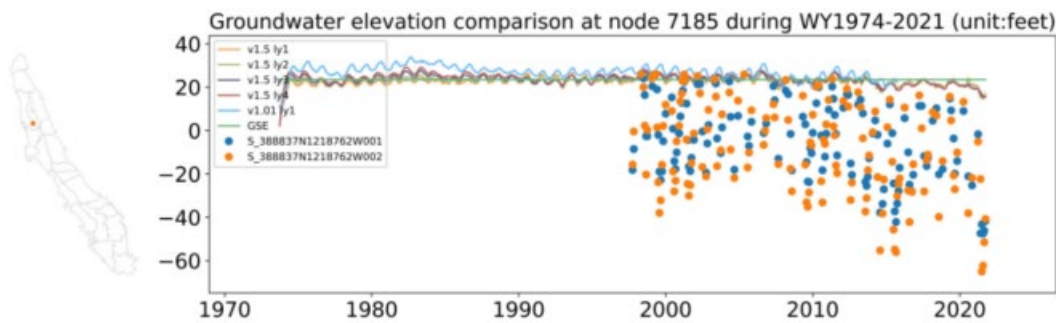
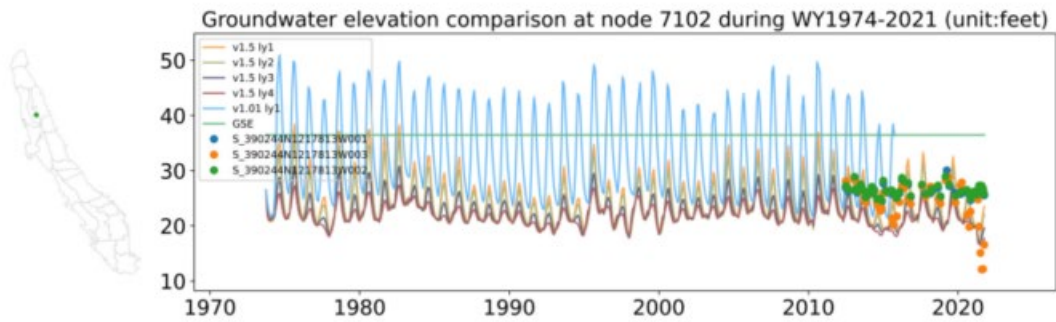
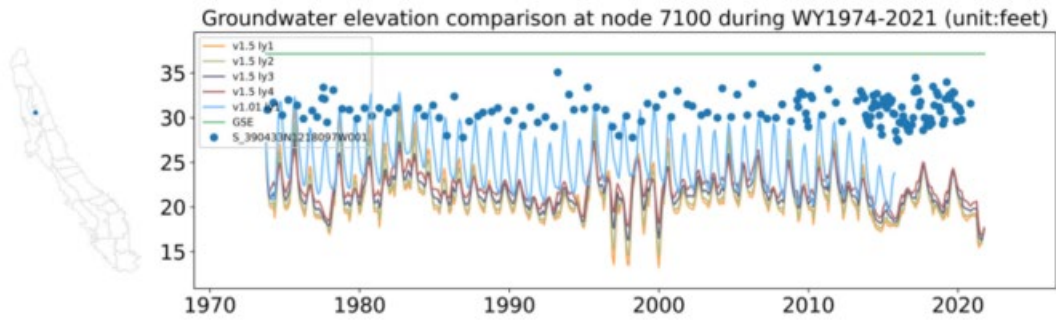
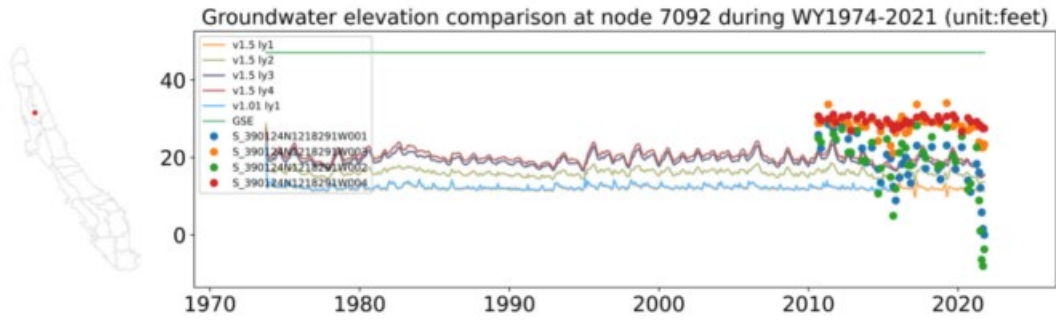




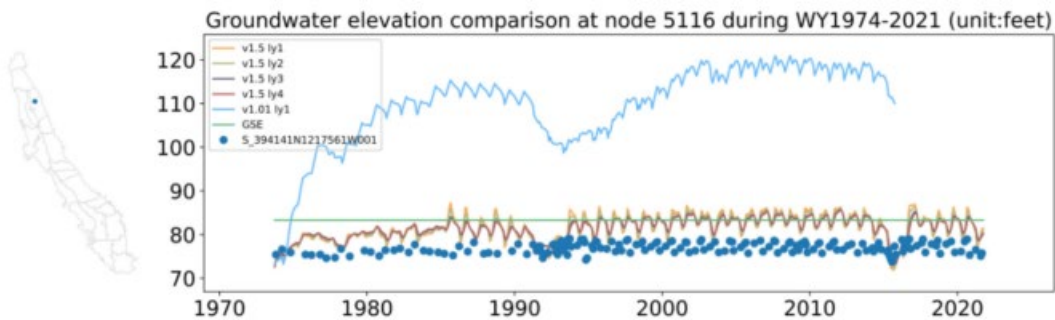
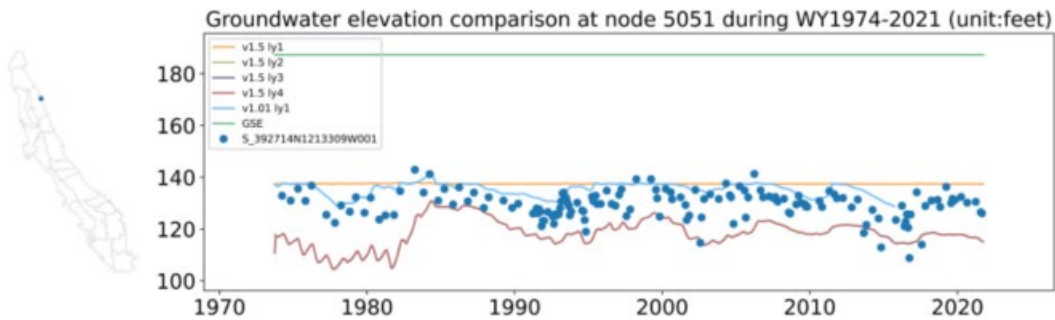
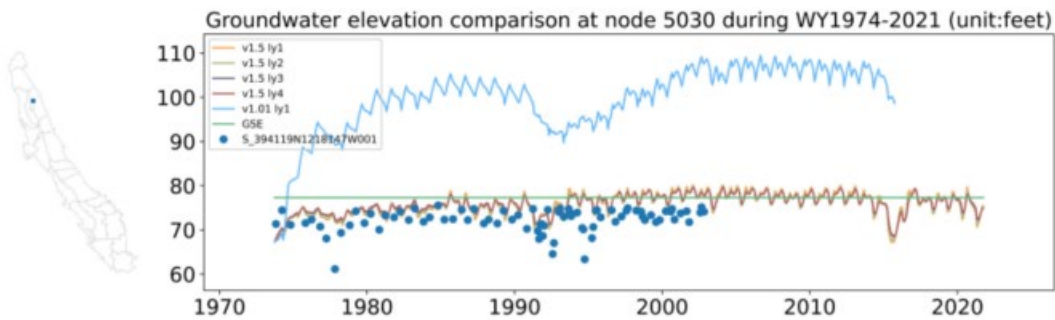
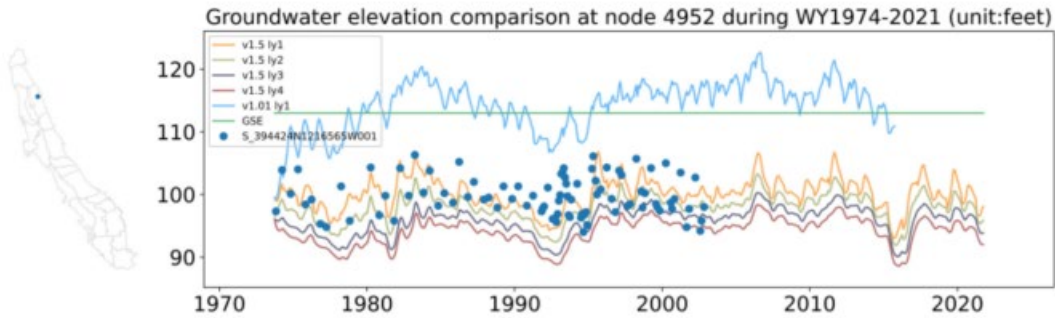




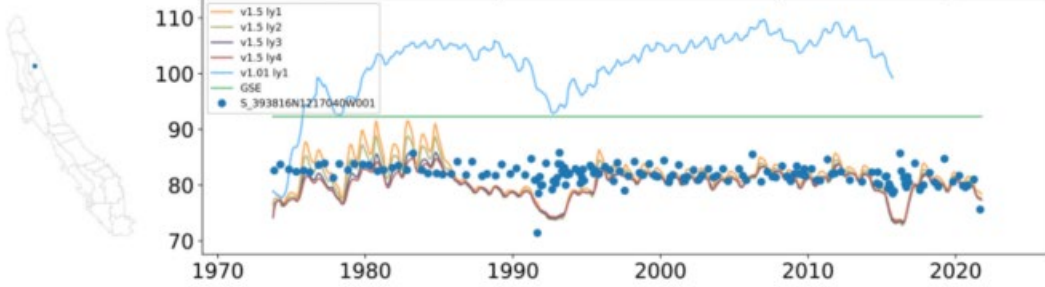




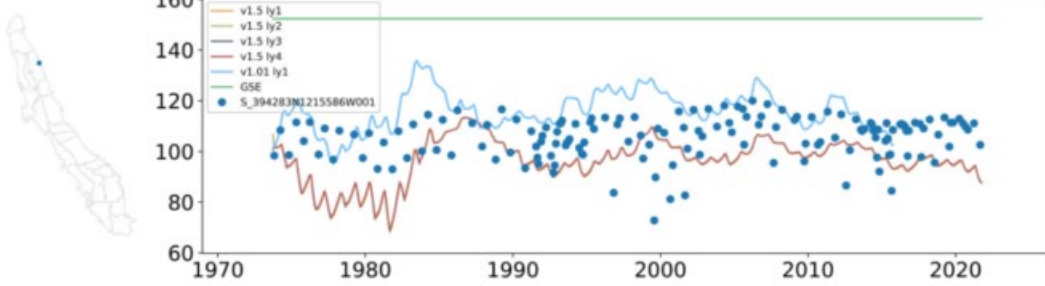
Subregion 5



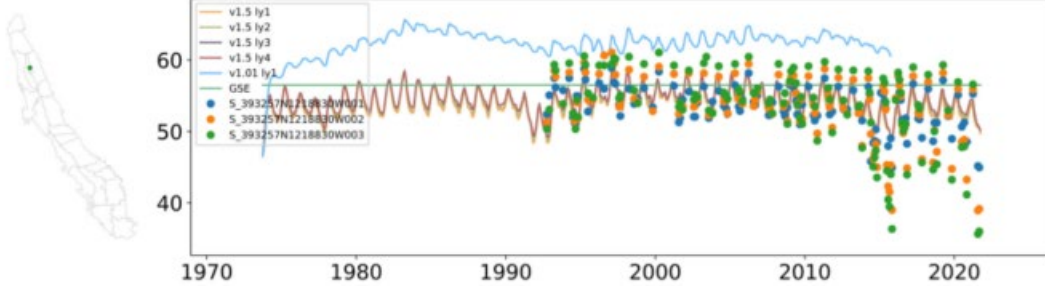
Groundwater elevation comparison at node 5204 during WY1974-2021 (unit:feet)



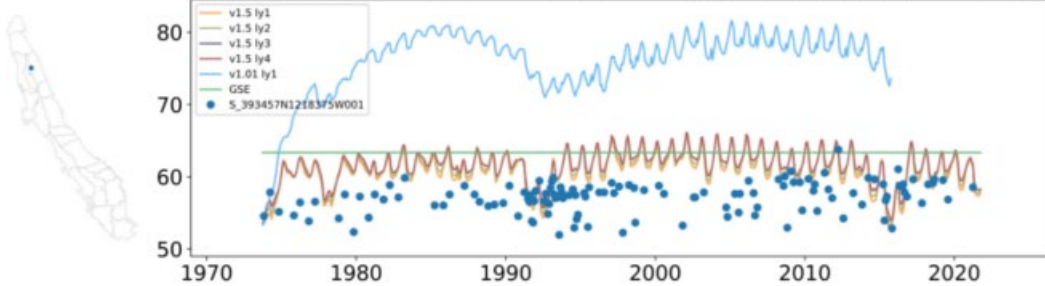
Groundwater elevation comparison at node 5217 during WY1974-2021 (unit:feet)



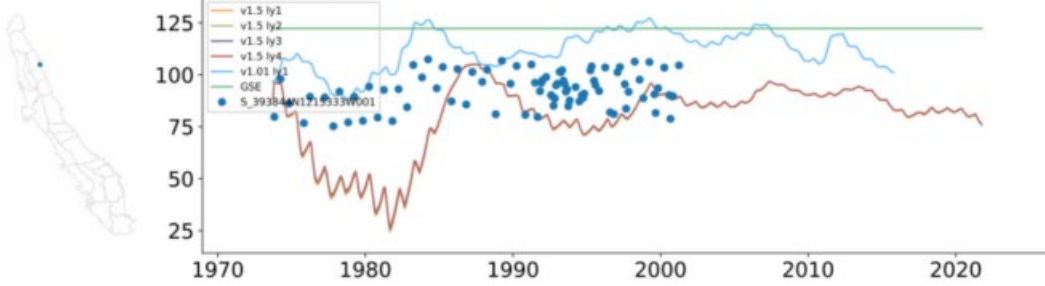
Groundwater elevation comparison at node 5271 during WY1974-2021 (unit:feet)



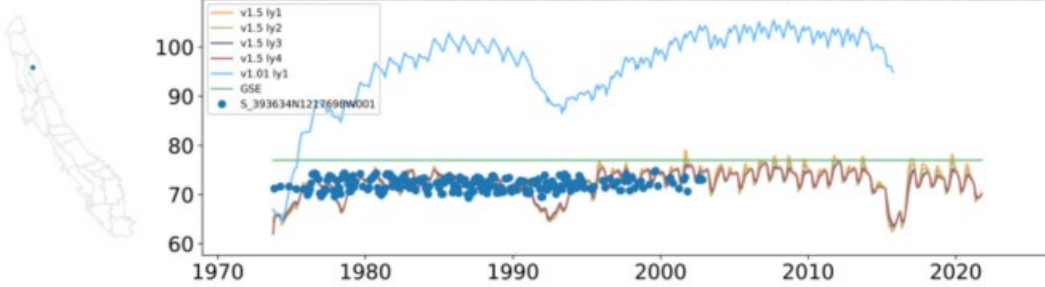
Groundwater elevation comparison at node 5275 during WY1974-2021 (unit:feet)



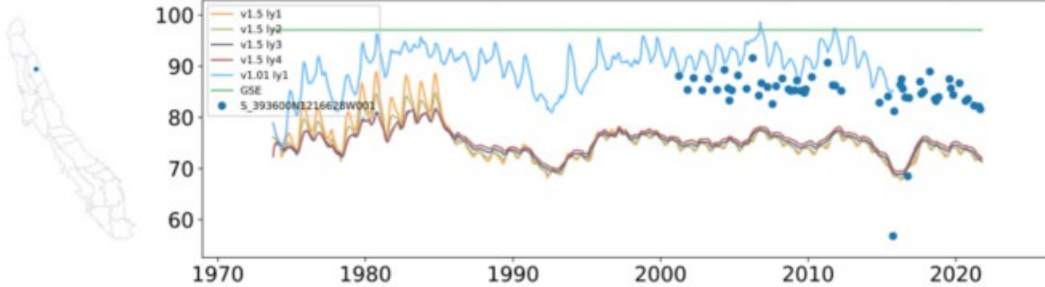
Groundwater elevation comparison at node 5300 during WY1974-2021 (unit:feet)



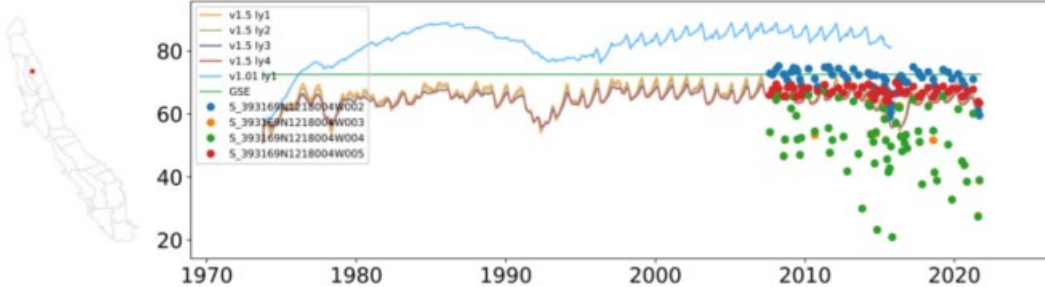
Groundwater elevation comparison at node 5364 during WY1974-2021 (unit:feet)



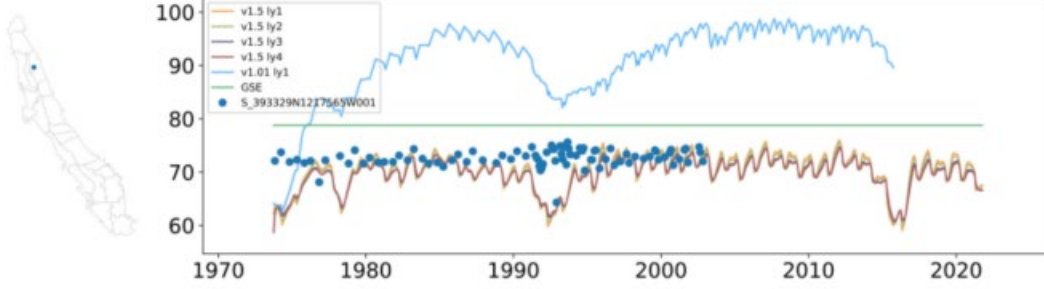
Groundwater elevation comparison at node 5370 during WY1974-2021 (unit:feet)



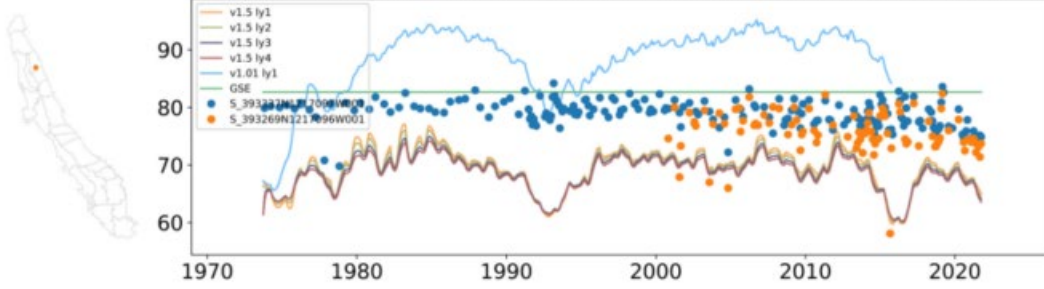
Groundwater elevation comparison at node 5445 during WY1974-2021 (unit:feet)



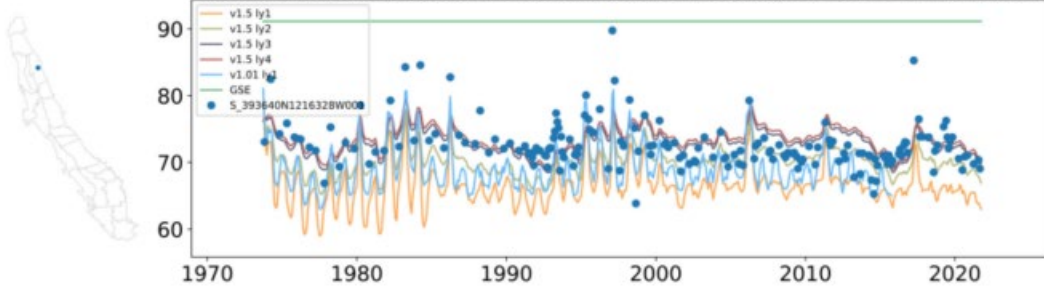
Groundwater elevation comparison at node 5447 during WY1974-2021 (unit:feet)



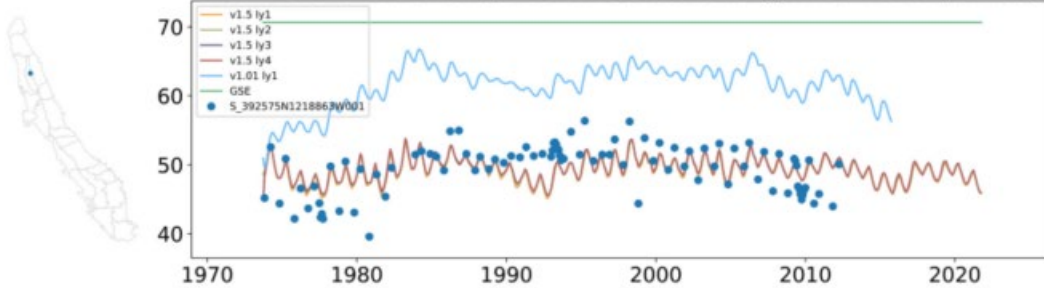
Groundwater elevation comparison at node 5450 during WY1974-2021 (unit:feet)



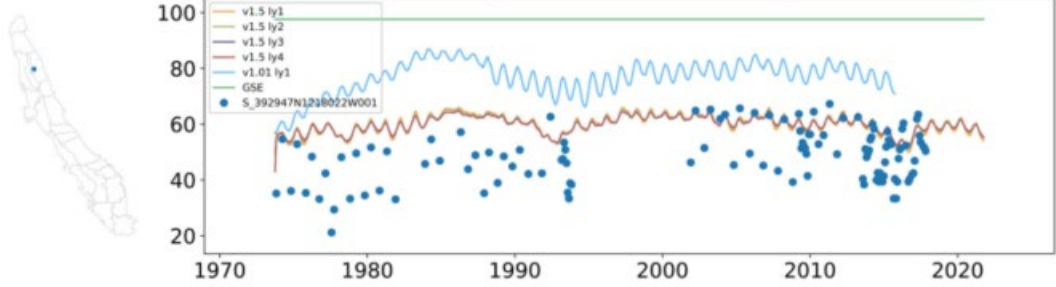
Groundwater elevation comparison at node 5462 during WY1974-2021 (unit:feet)



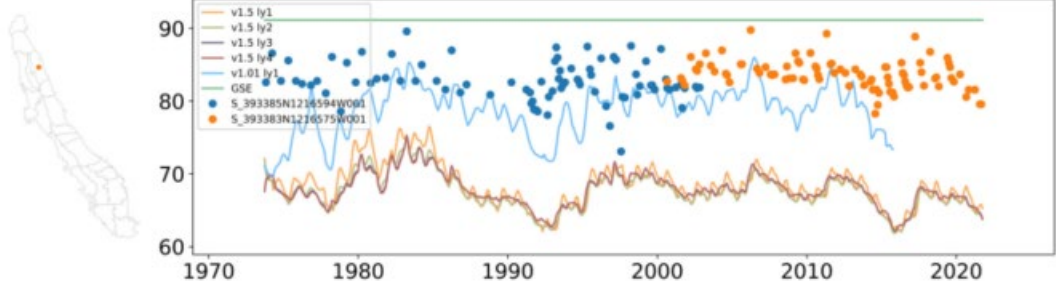
Groundwater elevation comparison at node 5529 during WY1974-2021 (unit:feet)



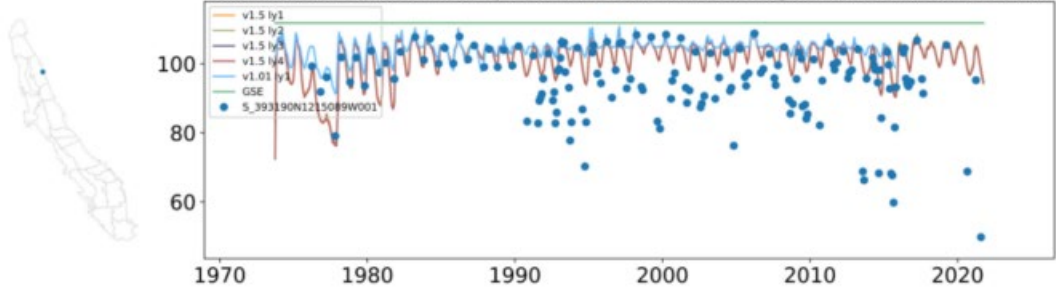
Groundwater elevation comparison at node 5534 during WY1974-2021 (unit:feet)



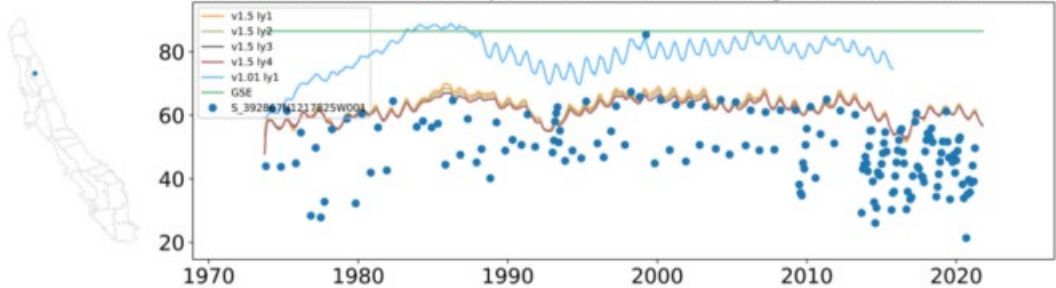
Groundwater elevation comparison at node 5546 during WY1974-2021 (unit:feet)

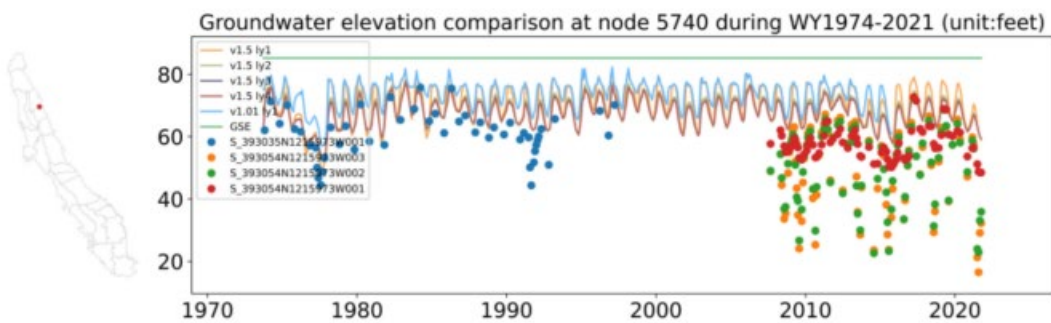
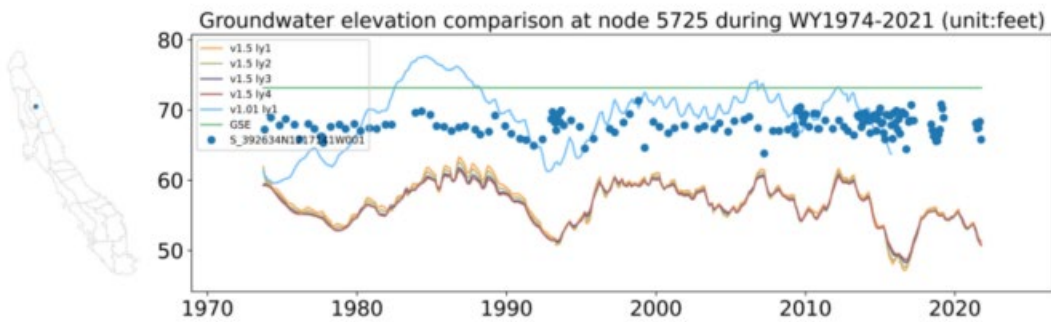
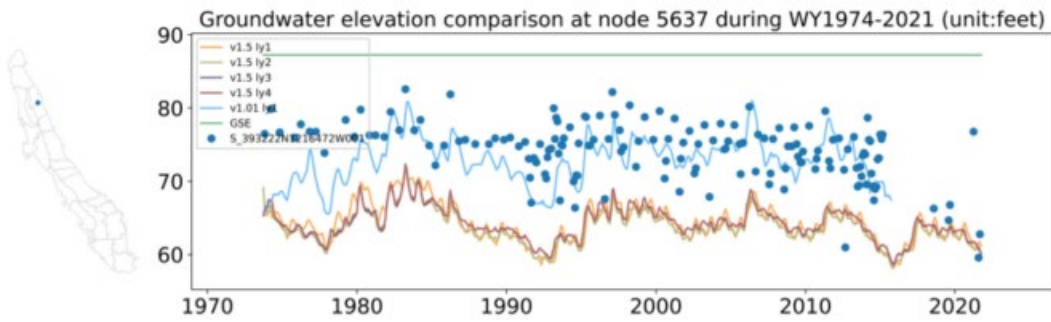
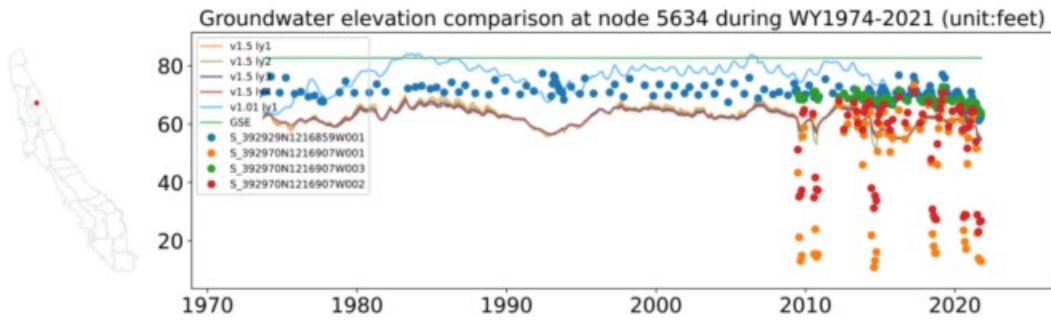


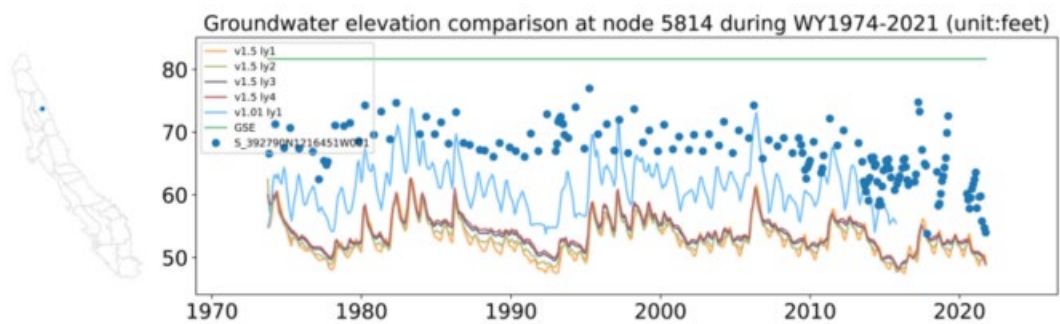
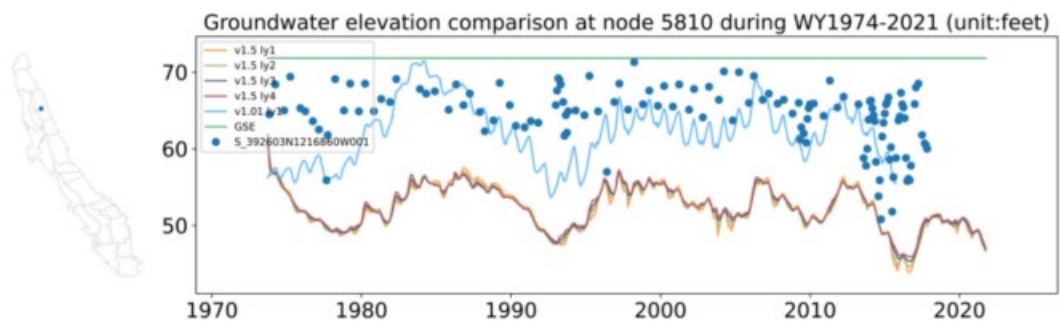
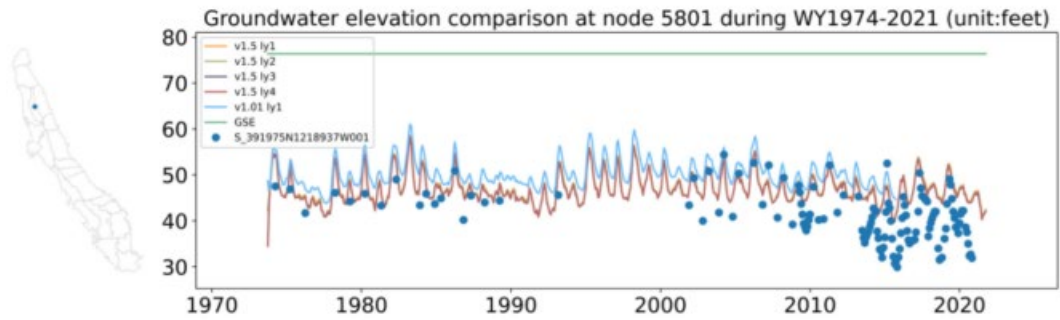
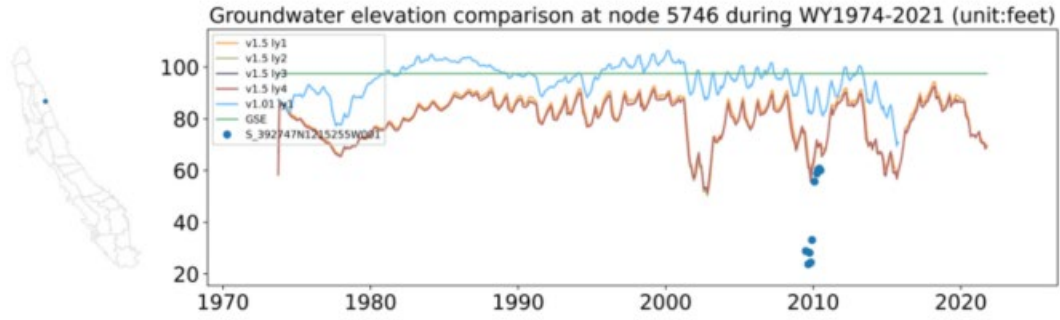
Groundwater elevation comparison at node 5564 during WY1974-2021 (unit:feet)



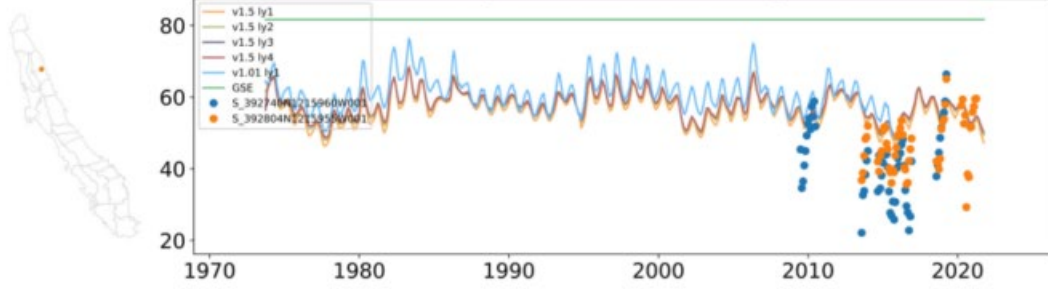
Groundwater elevation comparison at node 5626 during WY1974-2021 (unit:feet)



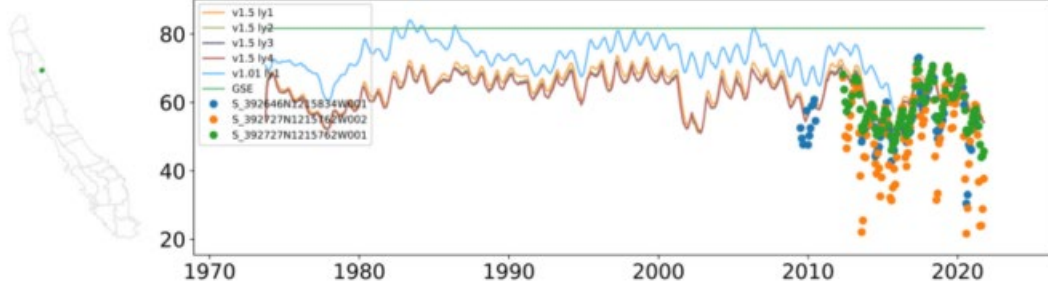




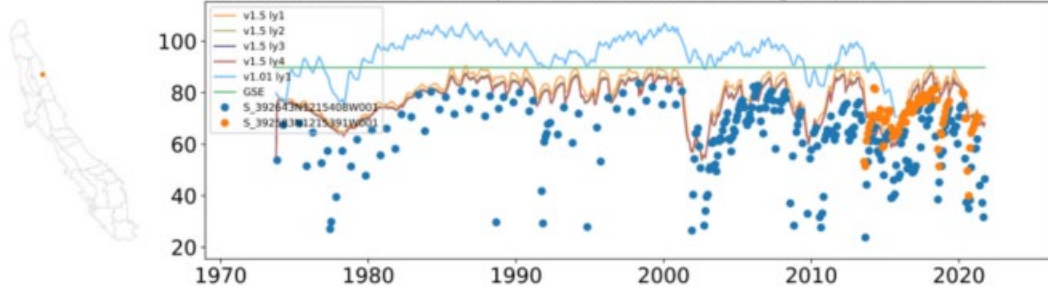
Groundwater elevation comparison at node 5825 during WY1974-2021 (unit:feet)



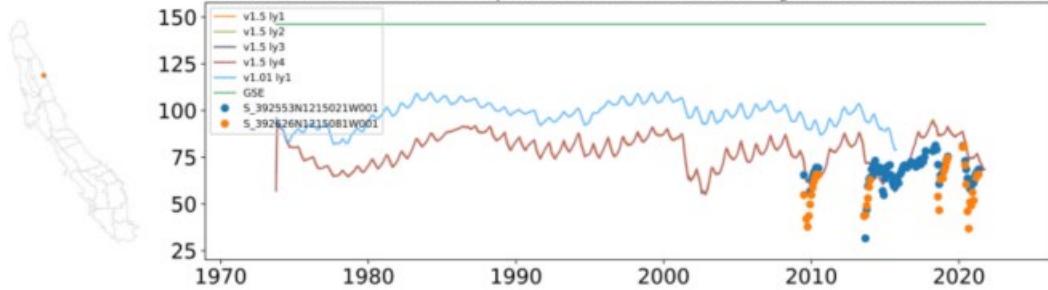
Groundwater elevation comparison at node 5826 during WY1974-2021 (unit:feet)



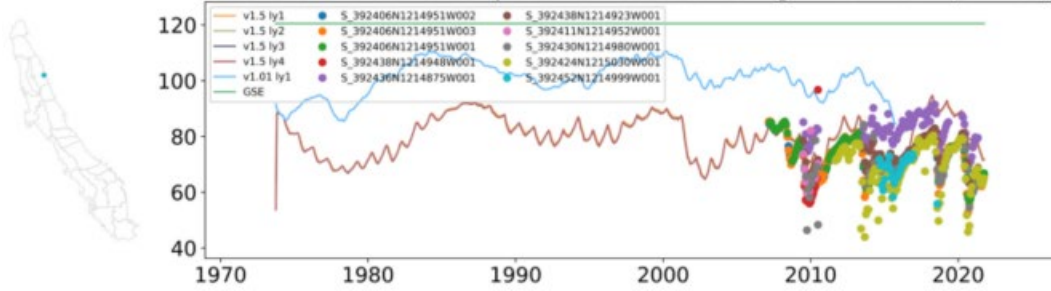
Groundwater elevation comparison at node 5829 during WY1974-2021 (unit:feet)



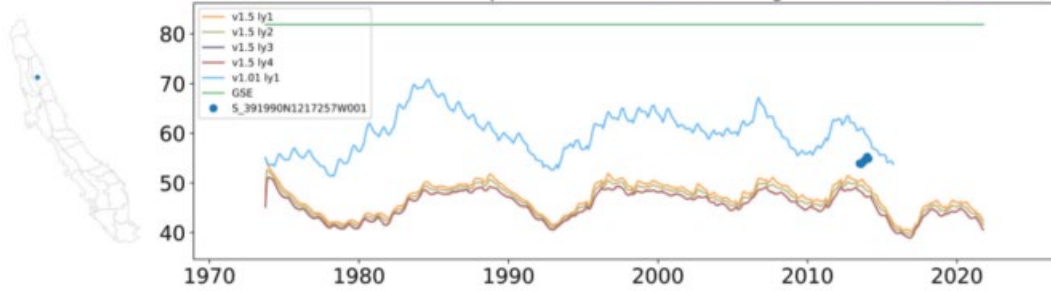
Groundwater elevation comparison at node 5831 during WY1974-2021 (unit:feet)



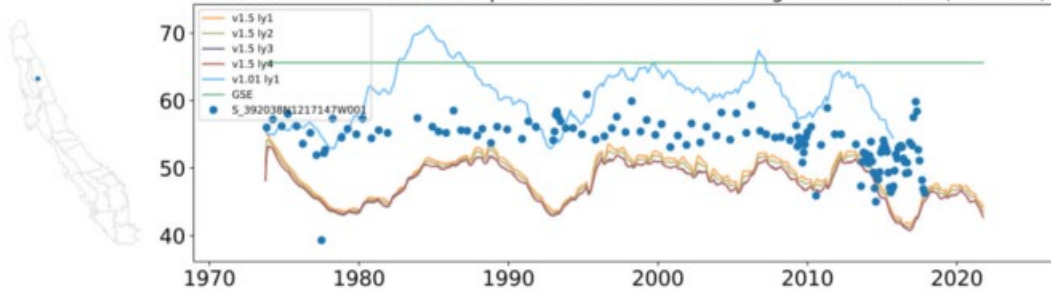
Groundwater elevation comparison at node 5832 during WY1974-2021 (unit:feet)



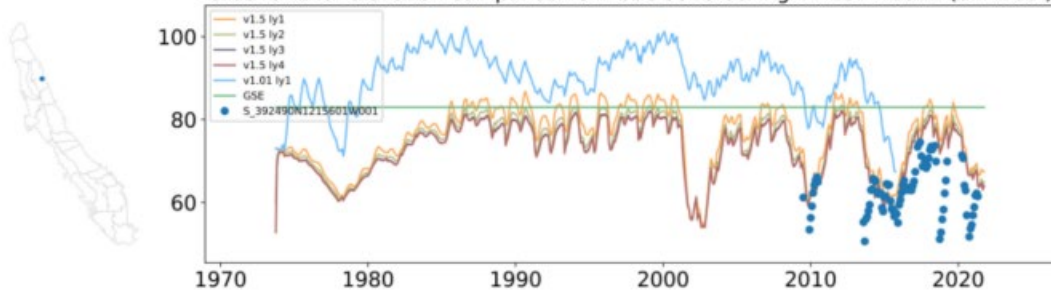
Groundwater elevation comparison at node 5889 during WY1974-2021 (unit:feet)

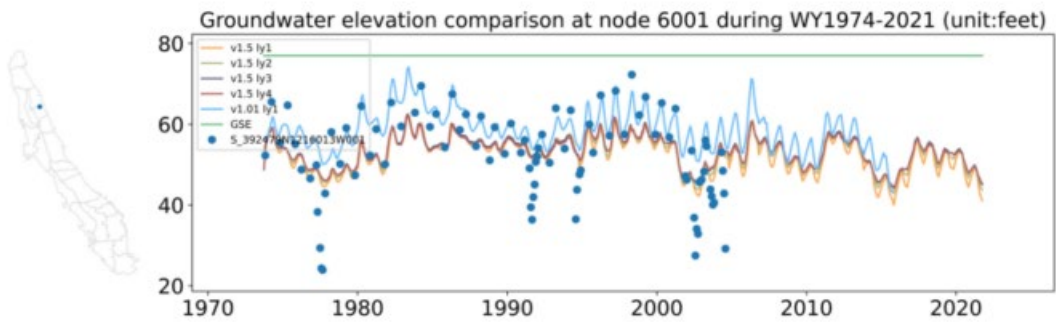
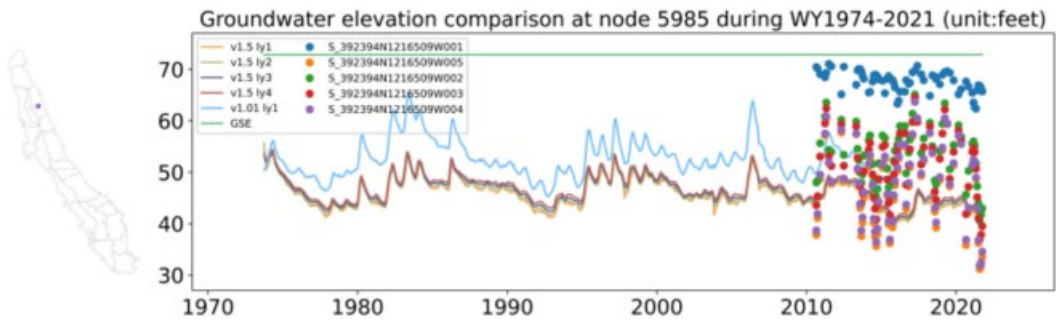
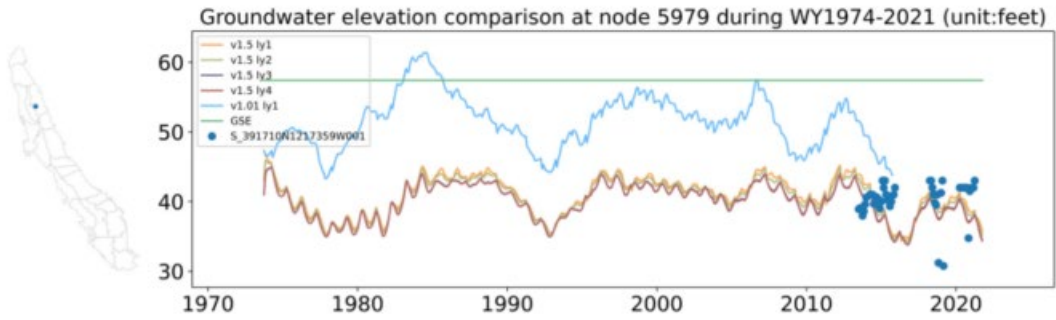
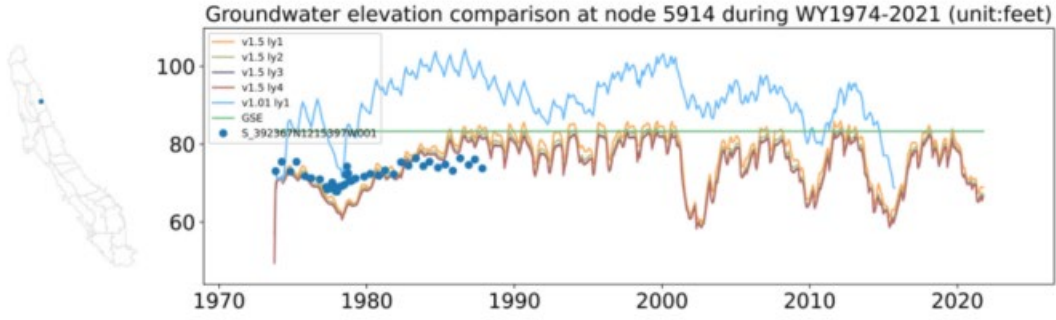


Groundwater elevation comparison at node 5890 during WY1974-2021 (unit:feet)

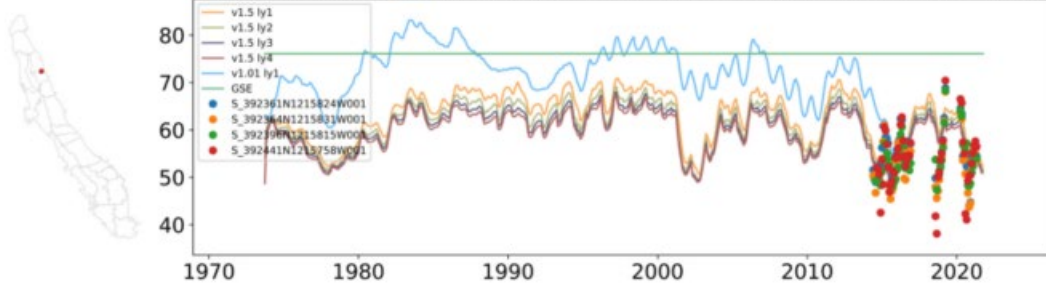


Groundwater elevation comparison at node 5913 during WY1974-2021 (unit:feet)

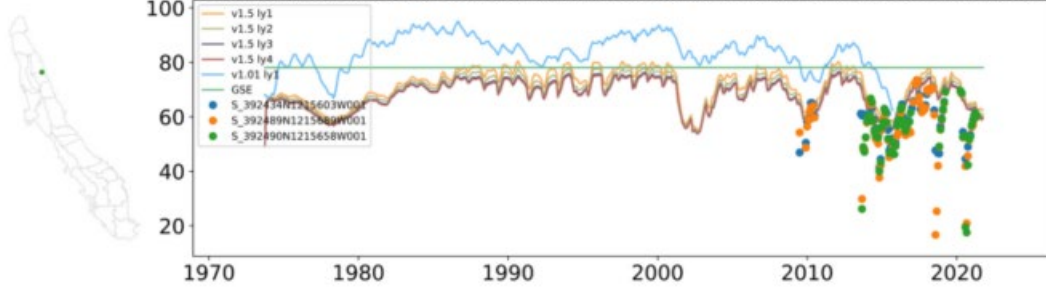




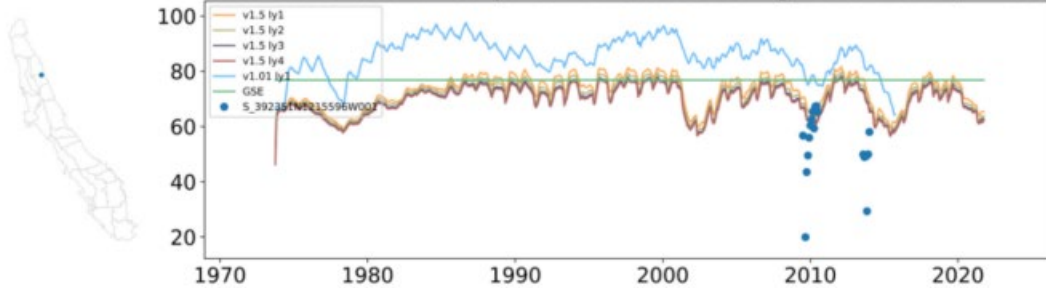
Groundwater elevation comparison at node 6002 during WY1974-2021 (unit:feet)



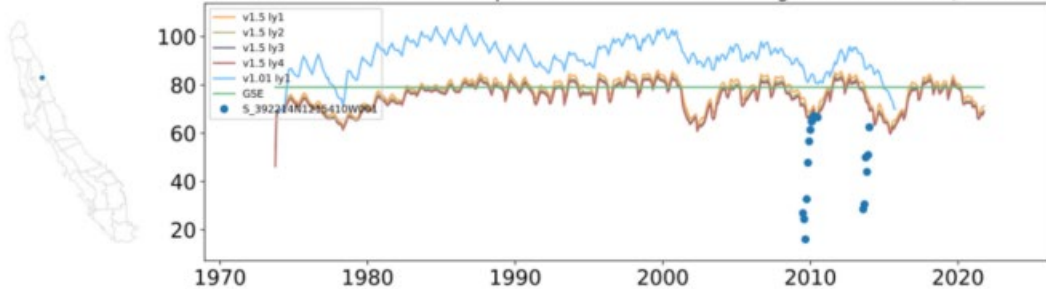
Groundwater elevation comparison at node 6003 during WY1974-2021 (unit:feet)

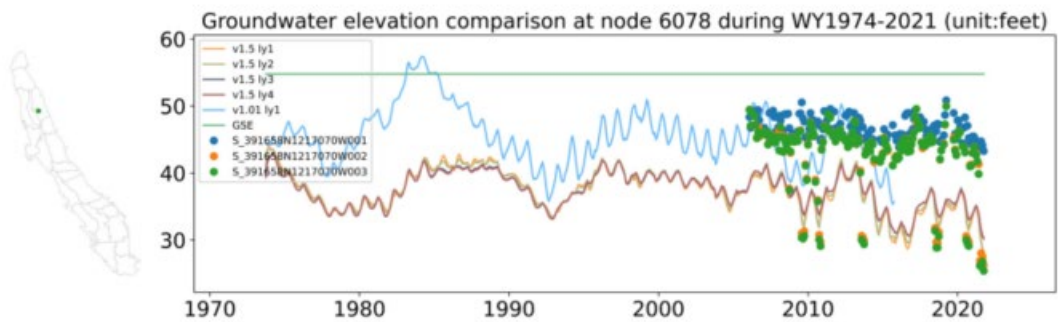
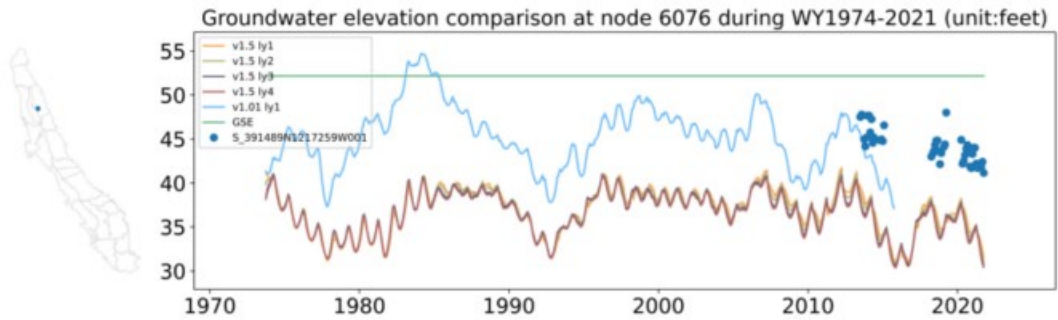
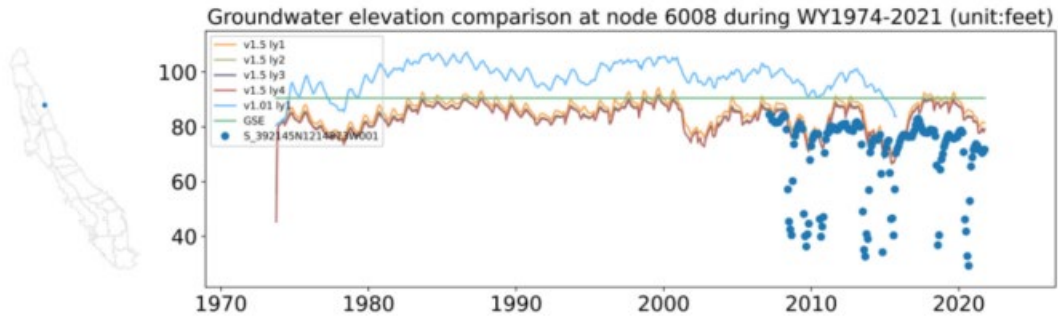
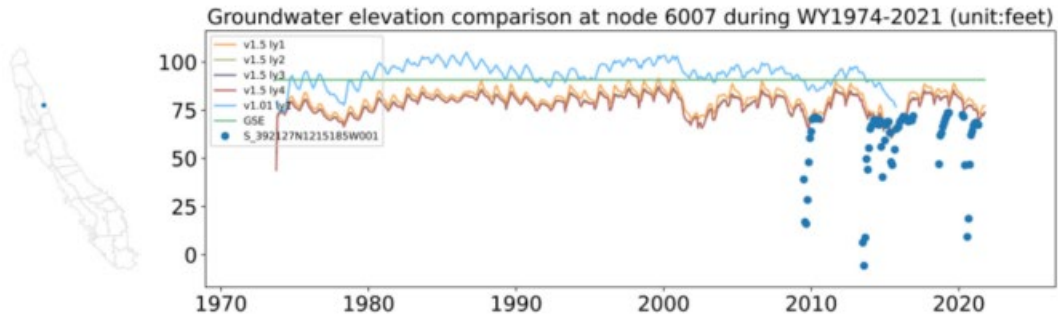


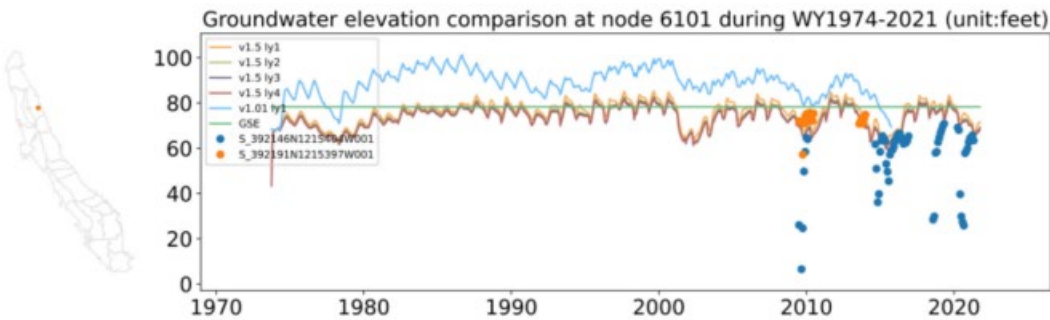
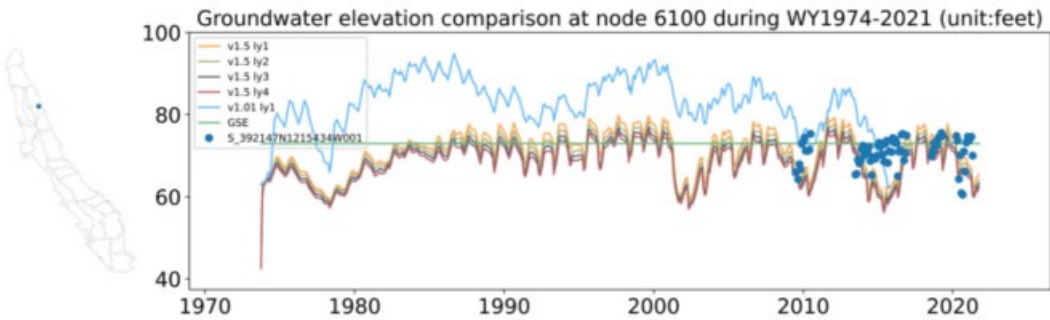
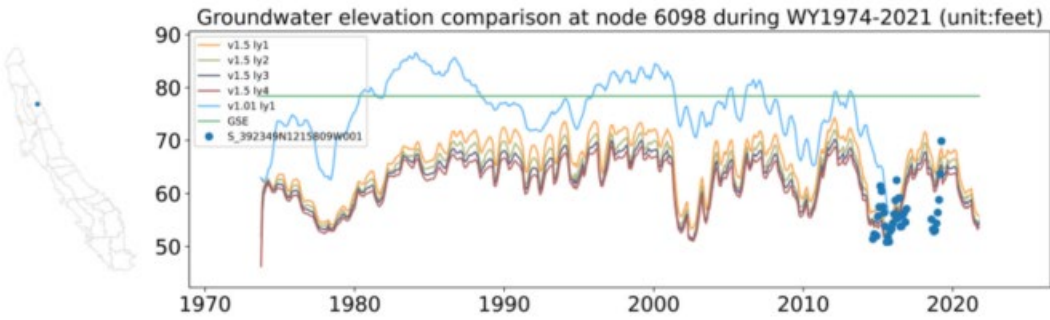
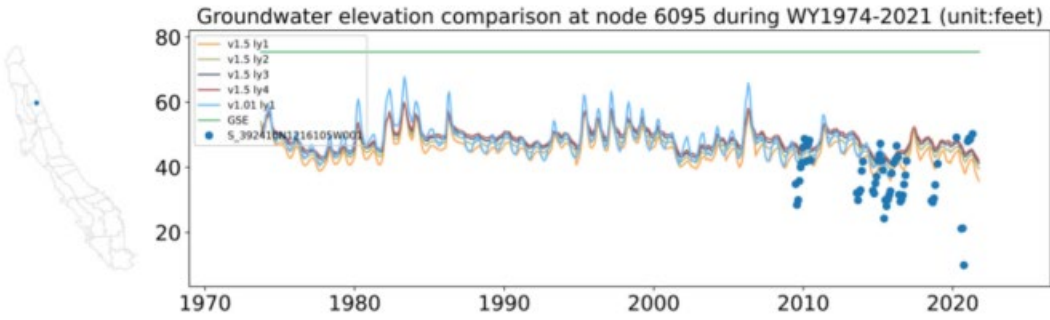
Groundwater elevation comparison at node 6004 during WY1974-2021 (unit:feet)

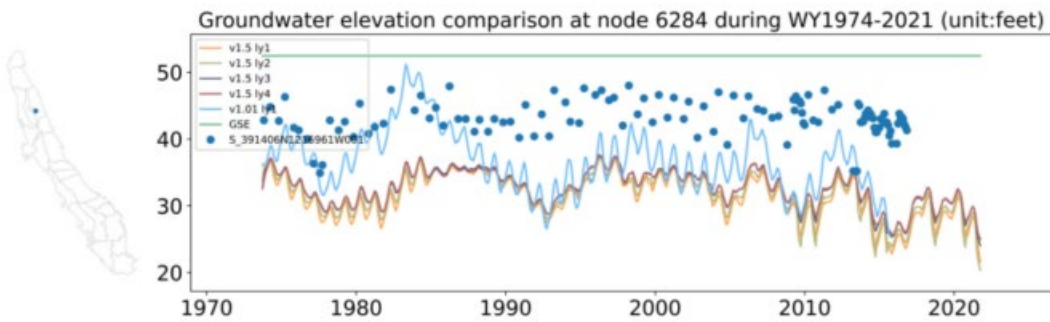
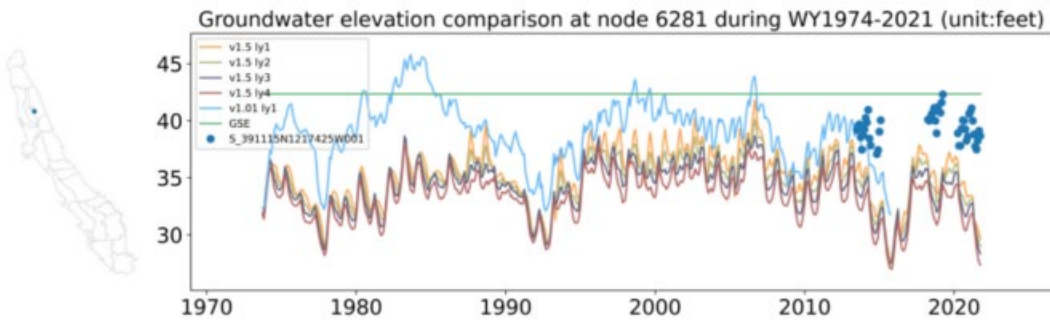
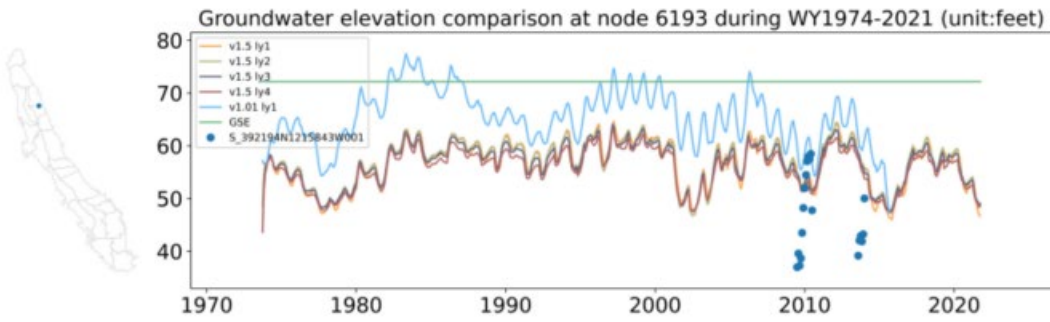
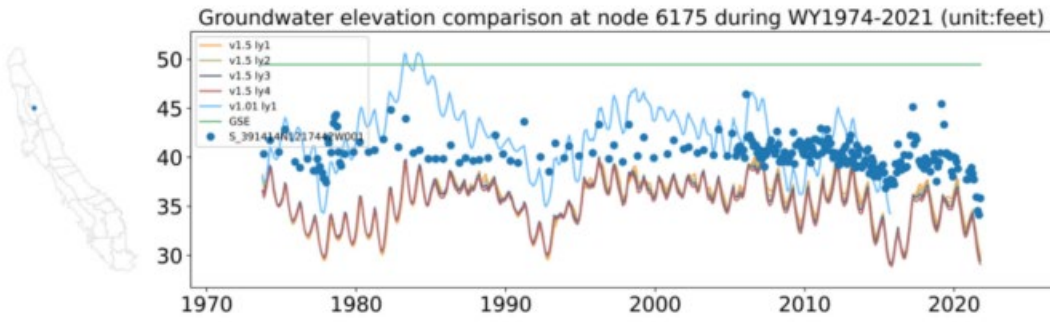


Groundwater elevation comparison at node 6005 during WY1974-2021 (unit:feet)

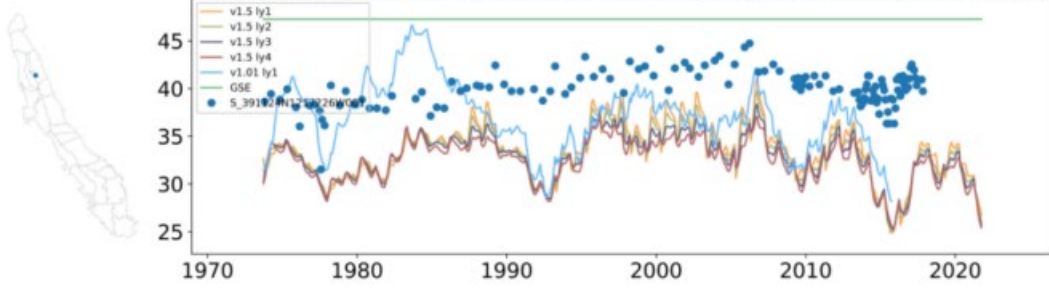




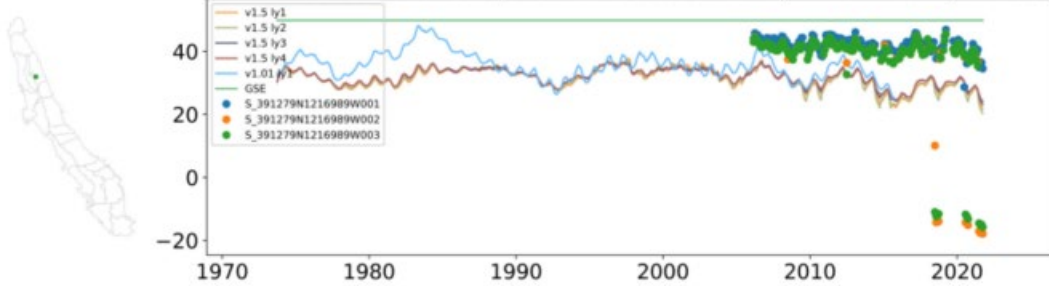




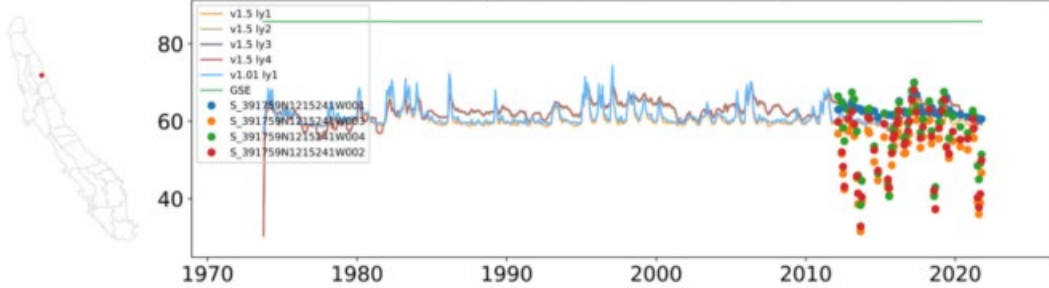
Groundwater elevation comparison at node 6382 during WY1974-2021 (unit:feet)



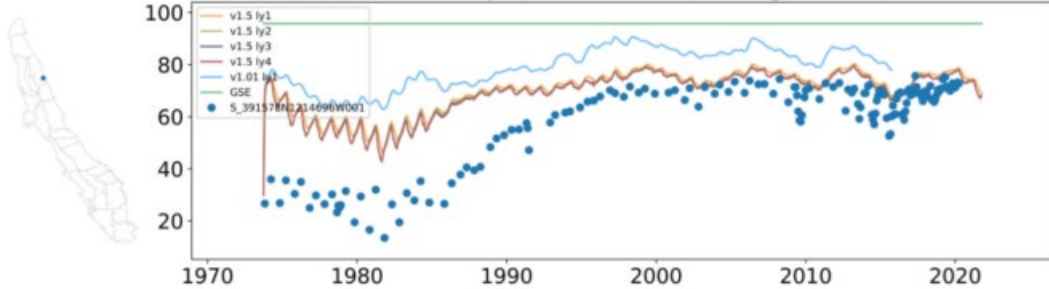
Groundwater elevation comparison at node 6383 during WY1974-2021 (unit:feet)



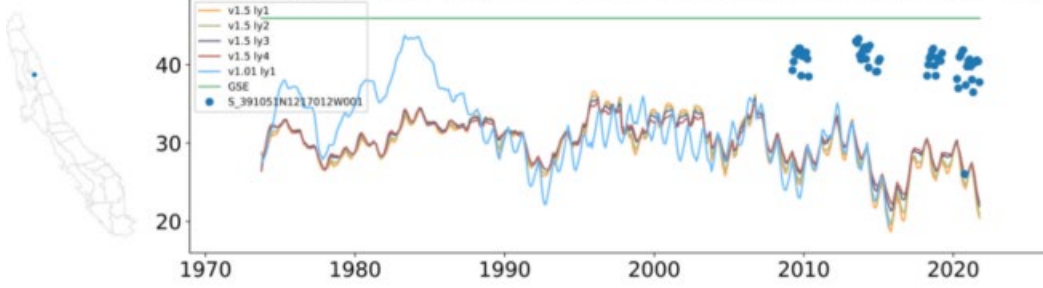
Groundwater elevation comparison at node 6402 during WY1974-2021 (unit:feet)



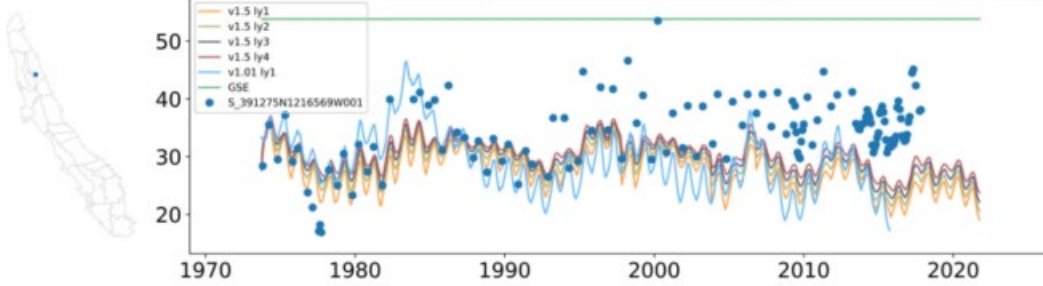
Groundwater elevation comparison at node 6409 during WY1974-2021 (unit:feet)



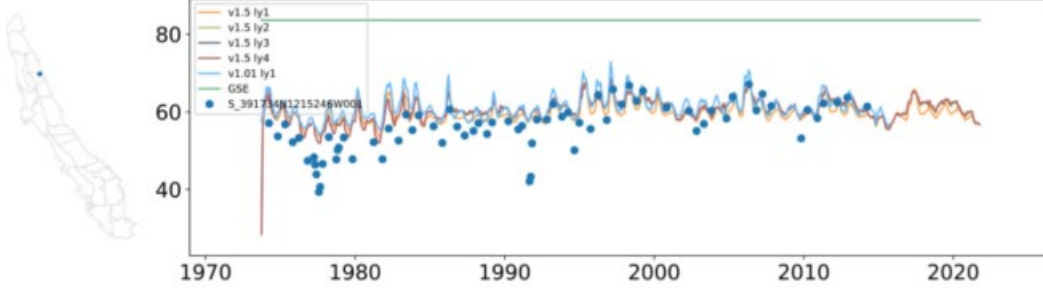
Groundwater elevation comparison at node 6482 during WY1974-2021 (unit:feet)



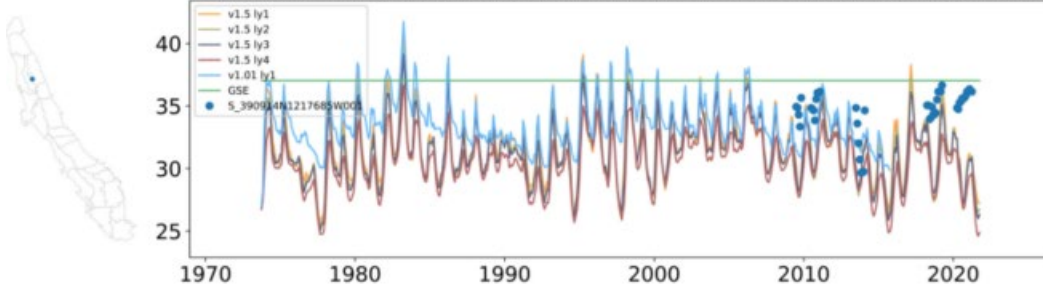
Groundwater elevation comparison at node 6485 during WY1974-2021 (unit:feet)



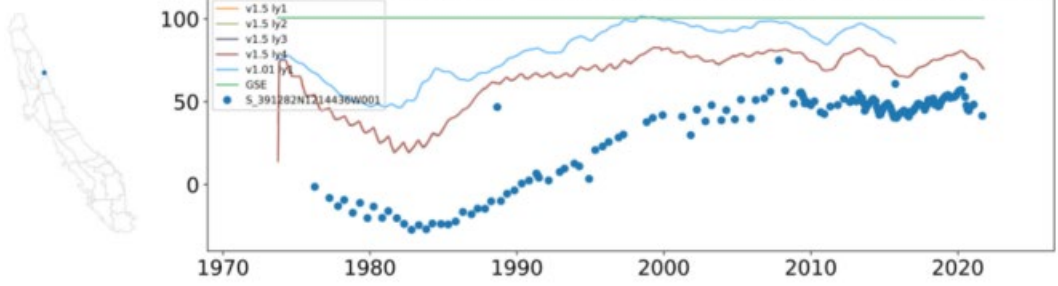
Groundwater elevation comparison at node 6507 during WY1974-2021 (unit:feet)



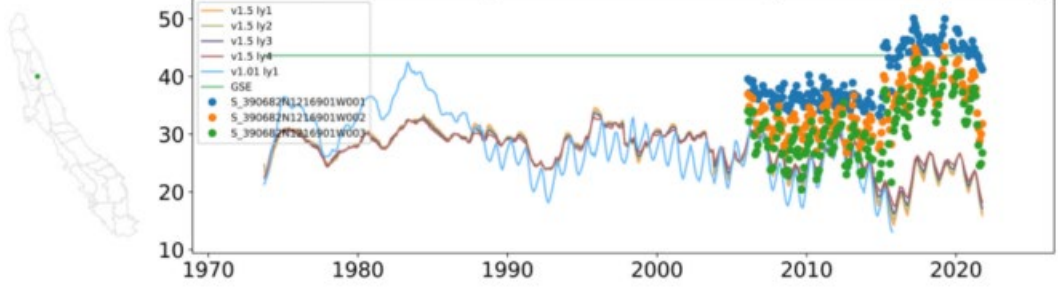
Groundwater elevation comparison at node 6574 during WY1974-2021 (unit:feet)



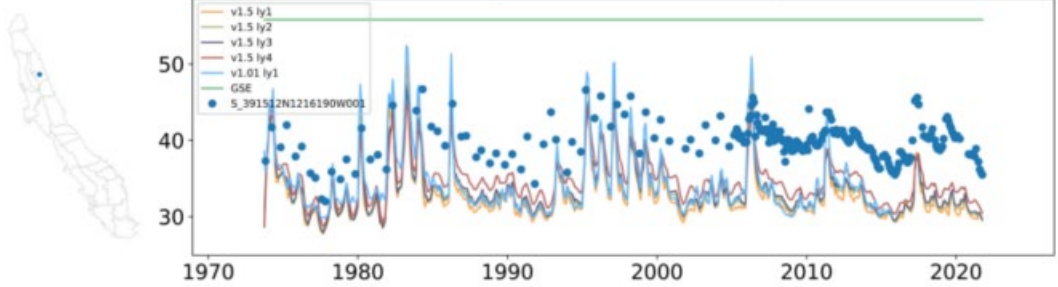
Groundwater elevation comparison at node 6614 during WY1974-2021 (unit:feet)



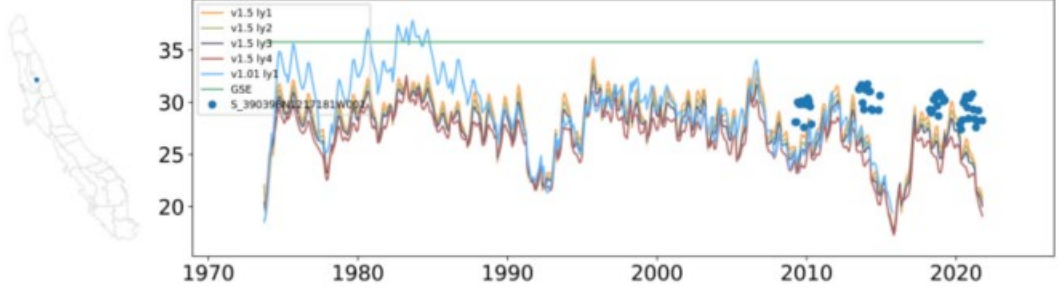
Groundwater elevation comparison at node 6677 during WY1974-2021 (unit:feet)



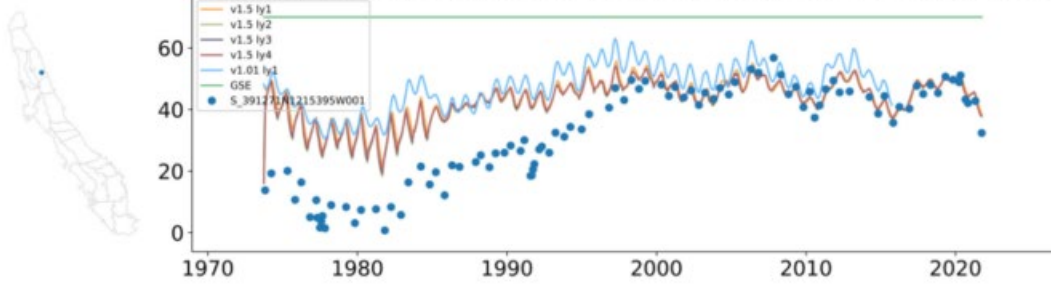
Groundwater elevation comparison at node 6688 during WY1974-2021 (unit:feet)



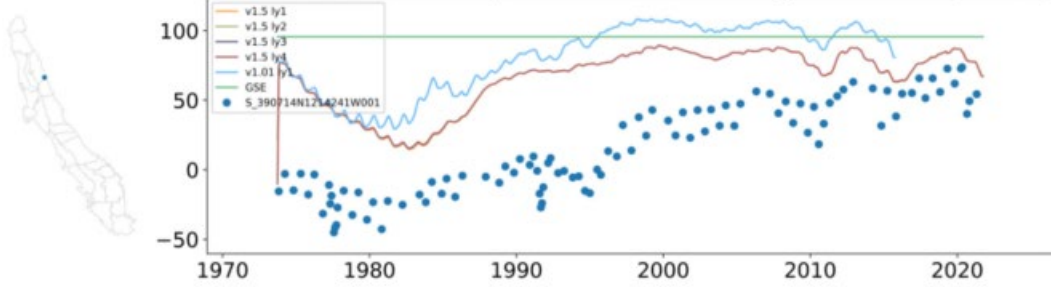
Groundwater elevation comparison at node 6779 during WY1974-2021 (unit:feet)



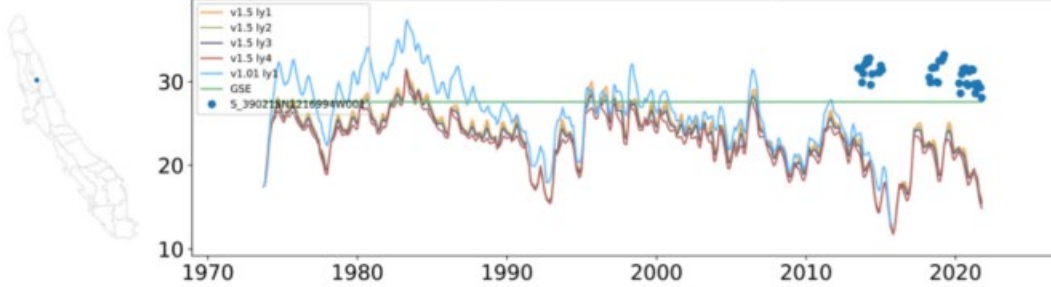
Groundwater elevation comparison at node 6805 during WY1974-2021 (unit:feet)



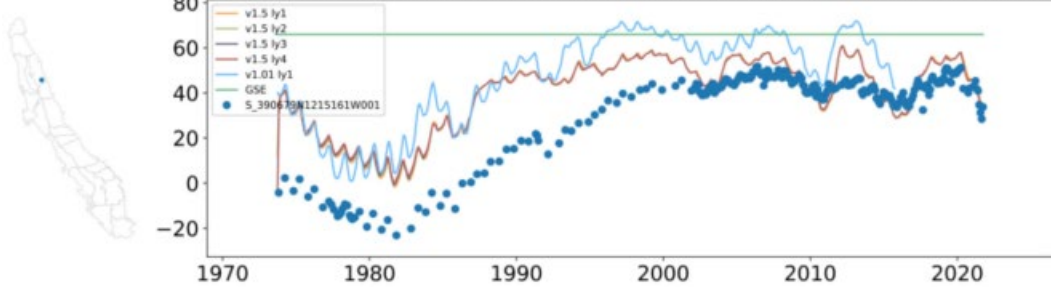
Groundwater elevation comparison at node 6922 during WY1974-2021 (unit:feet)

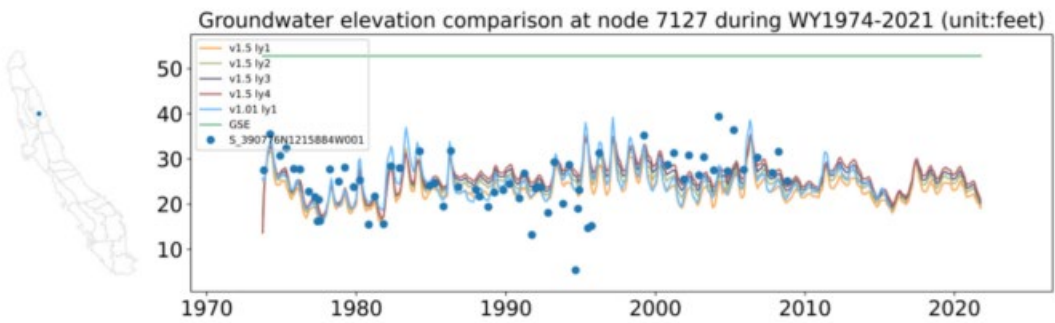
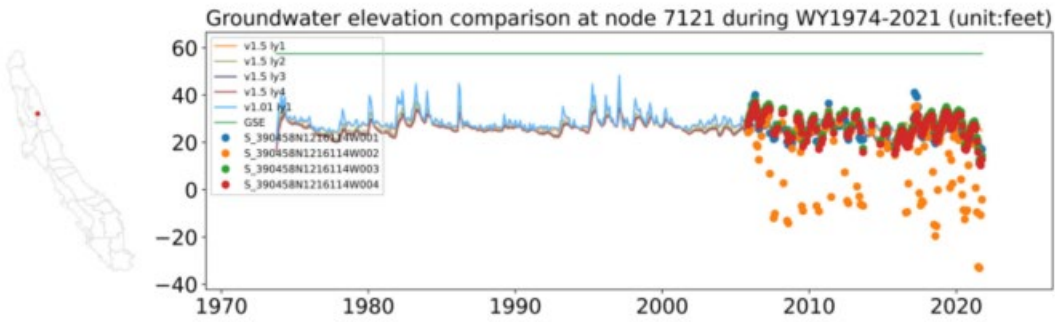
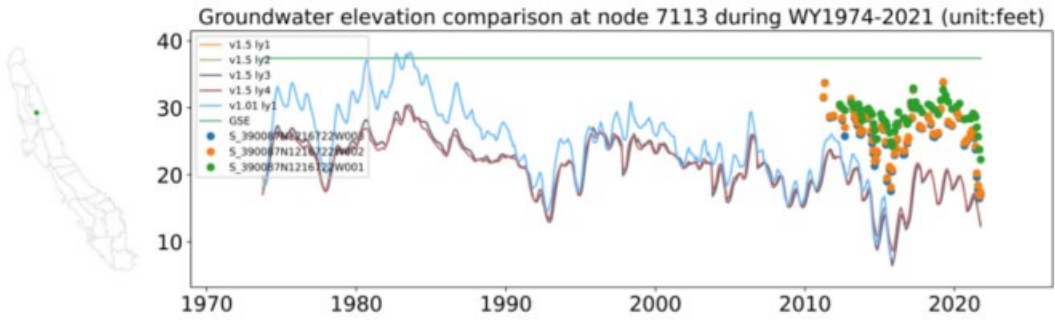
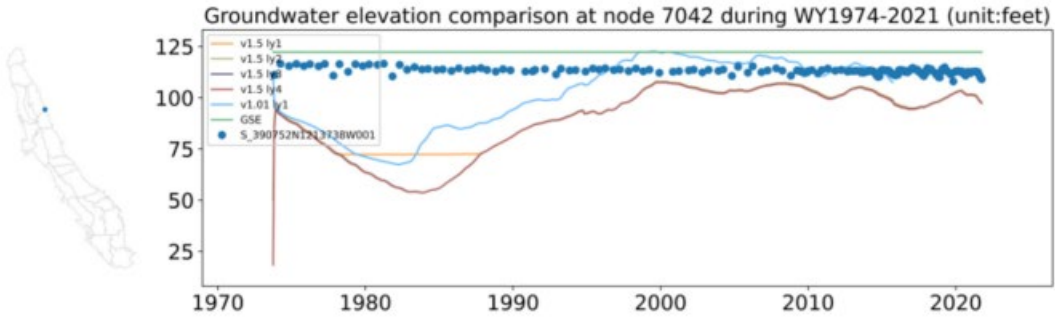


Groundwater elevation comparison at node 7000 during WY1974-2021 (unit:feet)

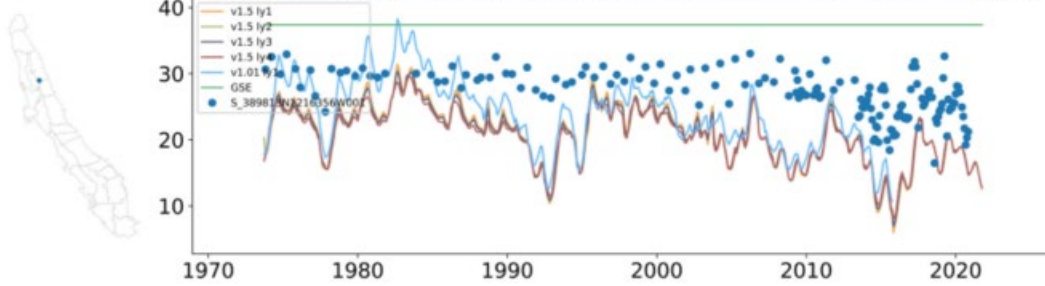


Groundwater elevation comparison at node 7031 during WY1974-2021 (unit:feet)

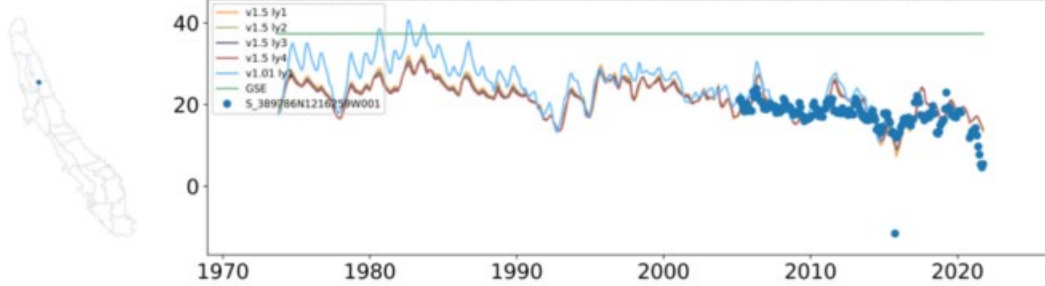




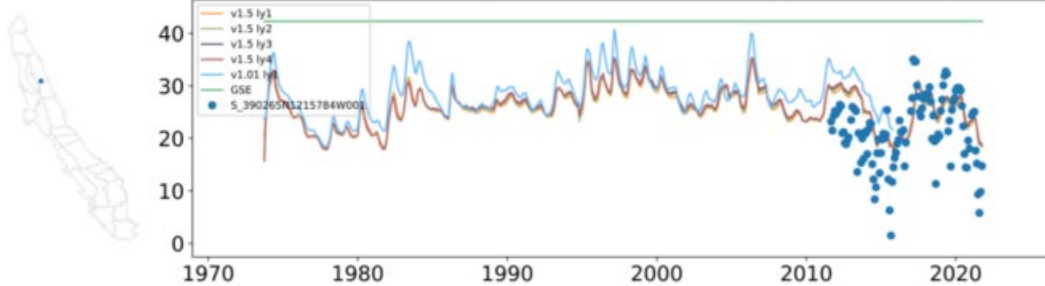
Groundwater elevation comparison at node 7341 during WY1974-2021 (unit:feet)



Groundwater elevation comparison at node 7342 during WY1974-2021 (unit:feet)



Groundwater elevation comparison at node 7471 during WY1974-2021 (unit:feet)



Groundwater elevation comparison at node 7472 during WY1974-2021 (unit:feet)

