# Estimating Streamflow in Antelope Creek

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USGS
February 15, 2024

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# Goal of this talk

Discuss Antelope Creek

Show existing measurement data and gaps

Describe methods for estimating historic streamflow during periods without measurements & **get feedback**

# Antelope Creek in the Big Lost River Valley

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# Location

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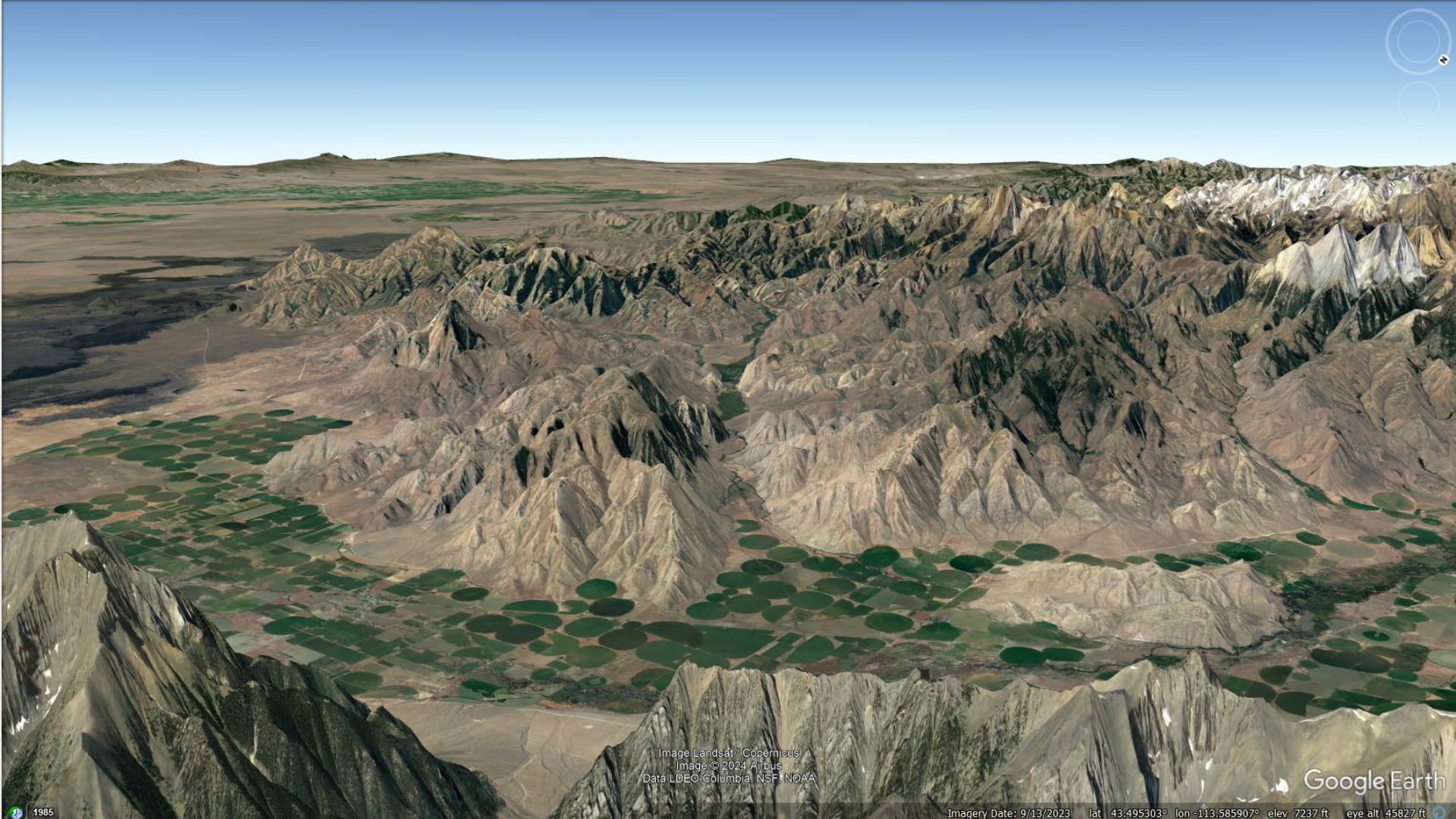
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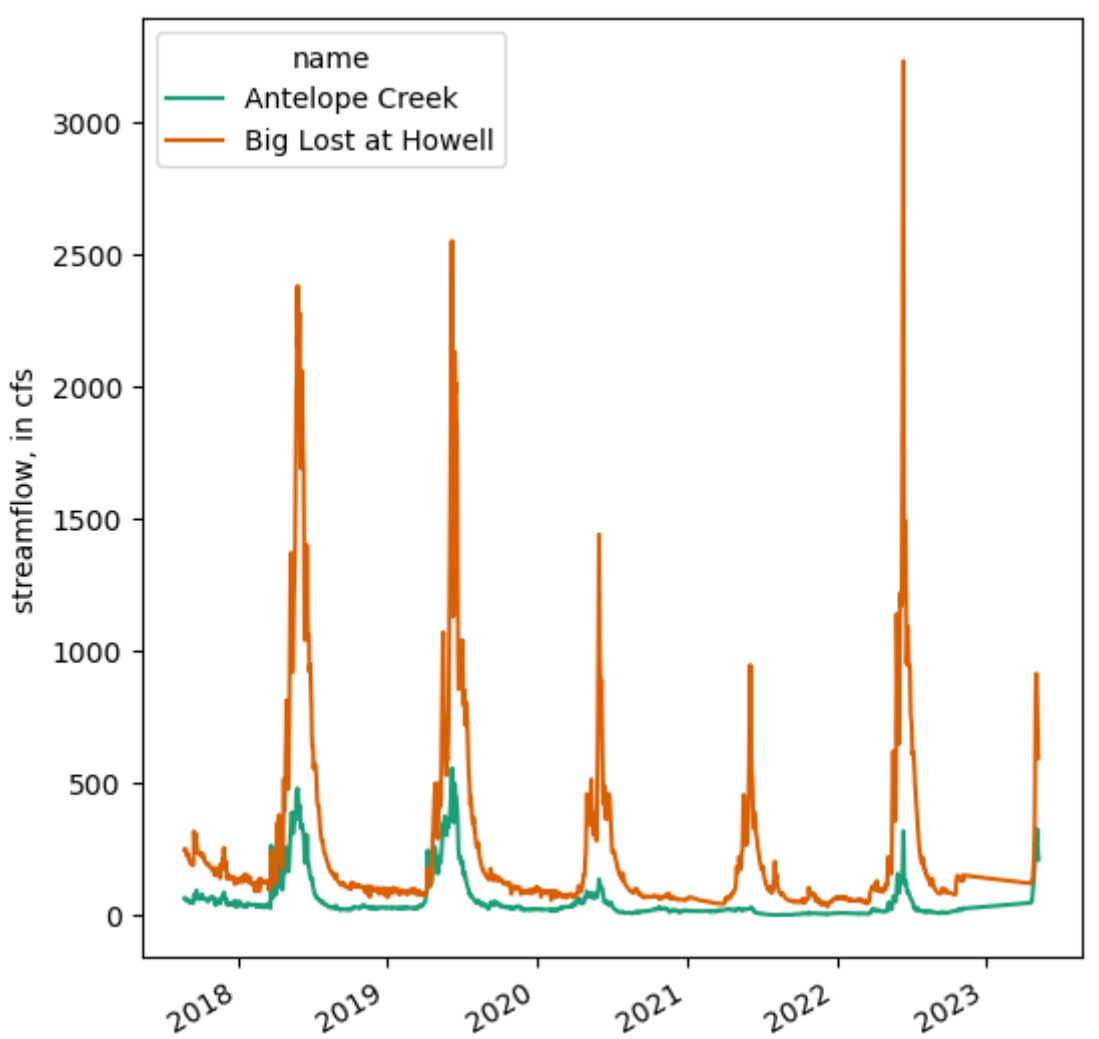
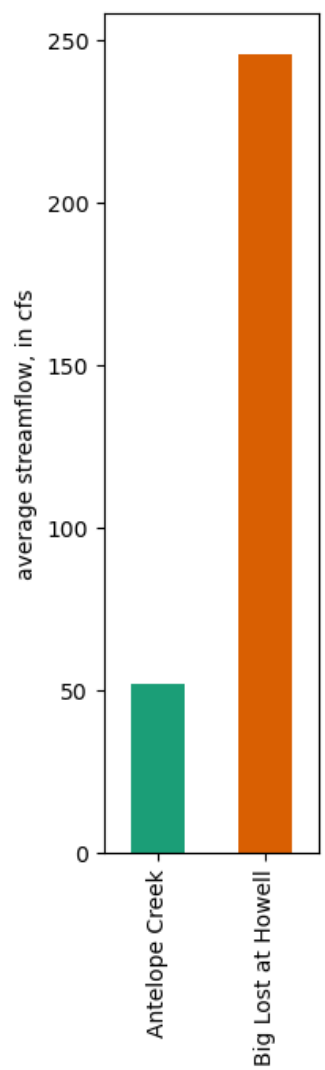
# Annual Streamflow

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# Annual Streamflow

Clark (2021)

| Year | Antelope Creek (13131000)[1] |
|---|---|
| 2000 | 25,229 |
| 2001 | 18,560 |
| 2002 | 21,579 |
| 2003 | 32,372 |
| 2004 | 27,083 |
| 2005 | 52,823 |
| 2006 | 51,239 |
| 2007 | 20,419 |
| 2008 | 22,311 |
| 2009 | 47,129 |
| 2010 | 47,041 |
| 2011 | 40,377 |
| 2012 | 47,132 |
| 2013 | 14,872 |
| 2014 | 26,103 |
| 2015 | 25,736 |
| 2016 | 48,370 |
| 2017 | 94,831 |
| 2018 | 65,860 |
| 2019 | 70,413 |
| Mean | 39,974 |

Table 9.4. Estimated seepage, Leslie (Idaho Power streamgage 13136500) to Arco (USGS streamgage 13132500), in the Big Lost River below Mackay Dam, 2000–19.

Table 4. Estimated annual groundwater budgets for the Big Lost River Basin, south-central Idaho, for average conditions during 2000–19, 2014 (dry), and 2017 (wet).

[All values in acre feet per year (acre-ft/yr) are rounded up or down to the nearest 100]

| Budget component | Entire basin | | | Above Mackay Dam | | | Below Mackay Dam | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2000–19 | 2014 | 2017 | 2000–19 | 2014 | 2017 | 2000–19 | 2014 | 2017 |
| Tributary canyon underflow | 88,700 | 87,900 | 124,200 | 50,900 | 49,800 | 72,100 | 37,800 | 38,100 | 52,100 |
| Areal recharge | 99,700 | 116,200 | 146,800 | 36,800 | 44,200 | 62,500 | 62,900 | 72,000 | 84,300 |
| Applied irrigation recharge | 46,900 | 15,800 | 71,700 | 16,600 | 5,300 | 20,700 | 30,300 | 10,500 | 51,000 |
| Canal seepage | 55,300 | 43,000 | 70,800 | 19,000 | 18,600 | 23,000 | 36,300 | 24,400 | 47,800 |
| Managed recharge (winter) | 1,900 | 0 | 6,100 | 100 | 0 | 400 | 1,800 | 0 | 5,700 |
| Septic system effluent | 200 | 100 | 300 | 0 | 0 | 0 | 200 | 100 | 300 |
| Losing river reaches | 144,800 | 109,600 | 339,900 | 6,600 | 0 | 70,500 | 138,200 | 109,600 | 269,400 |
| Mackay Reservoir seepage | 1,600 | 1,300 | 2,300 | 1,600 | 1,300 | 2,300 | 0 | 0 | 0 |
| Groundwater inflow (above dam residual) | 0 | 0 | 0 | 0 | 0 | 0 | 100,400 | 96,700 | 248,300 |
| Groundwater pumpage to canals | 8,300 | 22,400 | 2,900 | 0 | 0 | 0 | 8,300 | 22,400 | 2,900 |
| Irrigation pumpage | 76,000 | 112,700 | 49,000 | 4,200 | 4,700 | 3,100 | 71,800 | 108,000 | 45,900 |
| Domestic supply pumpage | 500 | 400 | 800 | 100 | 100 | 100 | 400 | 300 | 700 |
| Municipal supply pumpage | 600 | 300 | 700 | 0 | 0 | 0 | 600 | 300 | 700 |
| Gaining river reaches | 26,900 | 17,700 | 0 | 26,900 | 17,700 | 0 | 0 | 0 | 0 |
| **Total inflow (recharge)** | 439,100 | 373,900 | 762,100 | 131,600 | 119,200 | 251,500 | 407,900 | 351,400 | 758,900 |
| **Total outflow (discharge)** | 112,300 | 153,500 | 53,400 | 31,200 | 22,500 | 3,200 | 81,100 | 131,000 | 50,200 |
| **Difference (residual)** | 326,800 | 220,400 | 708,700 | 100,400 | 96,700 | 248,300 | 326,800 | 220,400 | 708,700 |

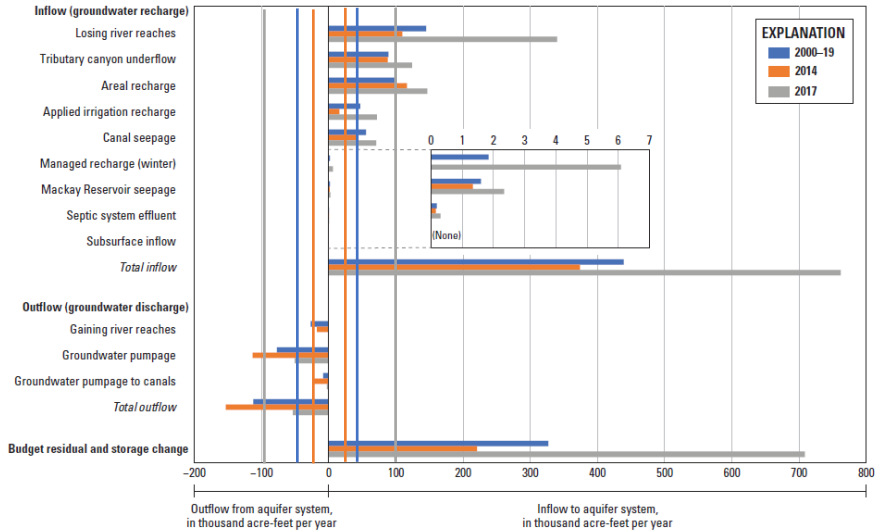


**Figure 5.** Average groundwater-budget components, as calculated in this report, for the Big Lost River Basin, south-central Idaho, 2000–19, 2014, and 2017. See table 4 for data.

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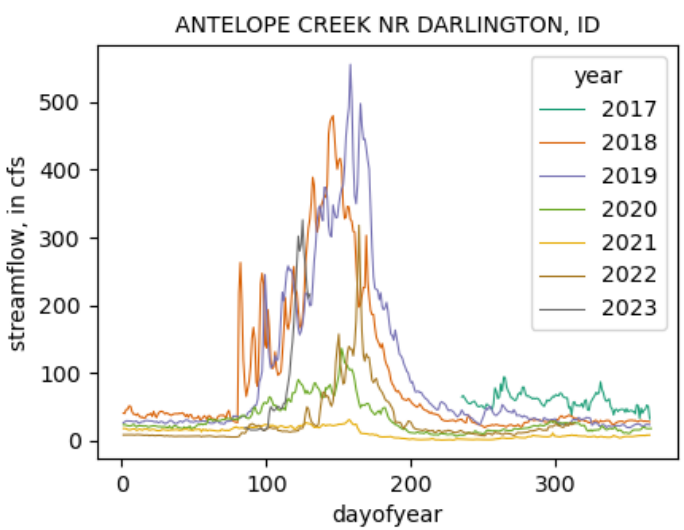
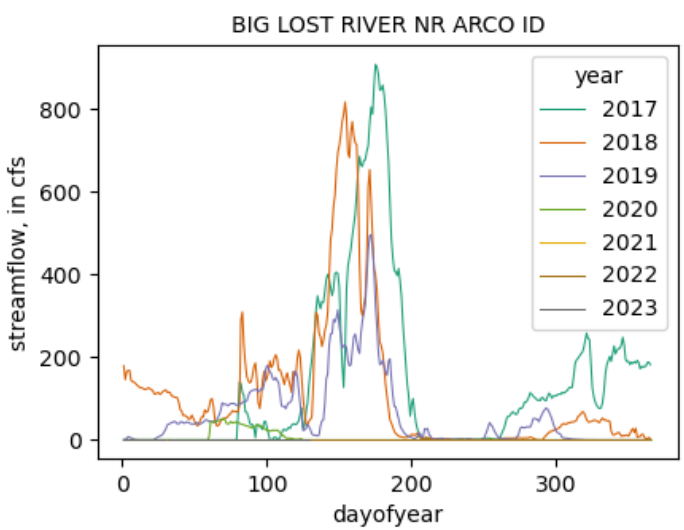
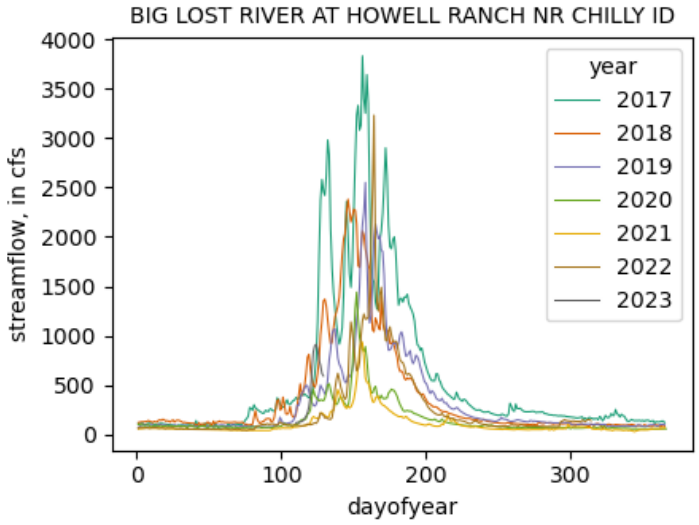
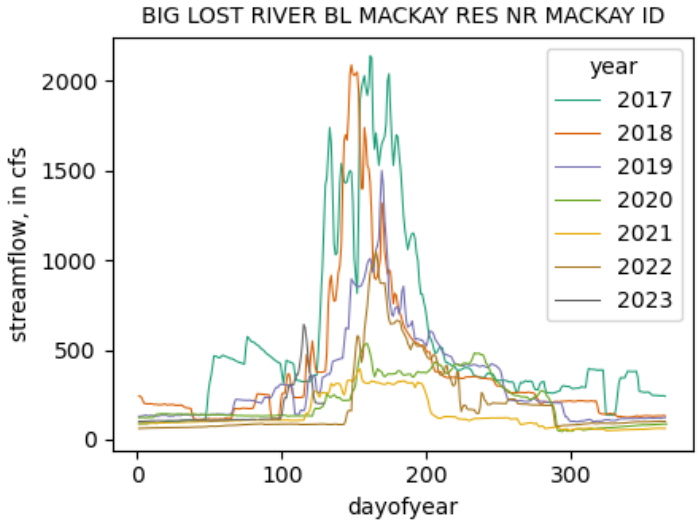
# Seasonal Streamflow

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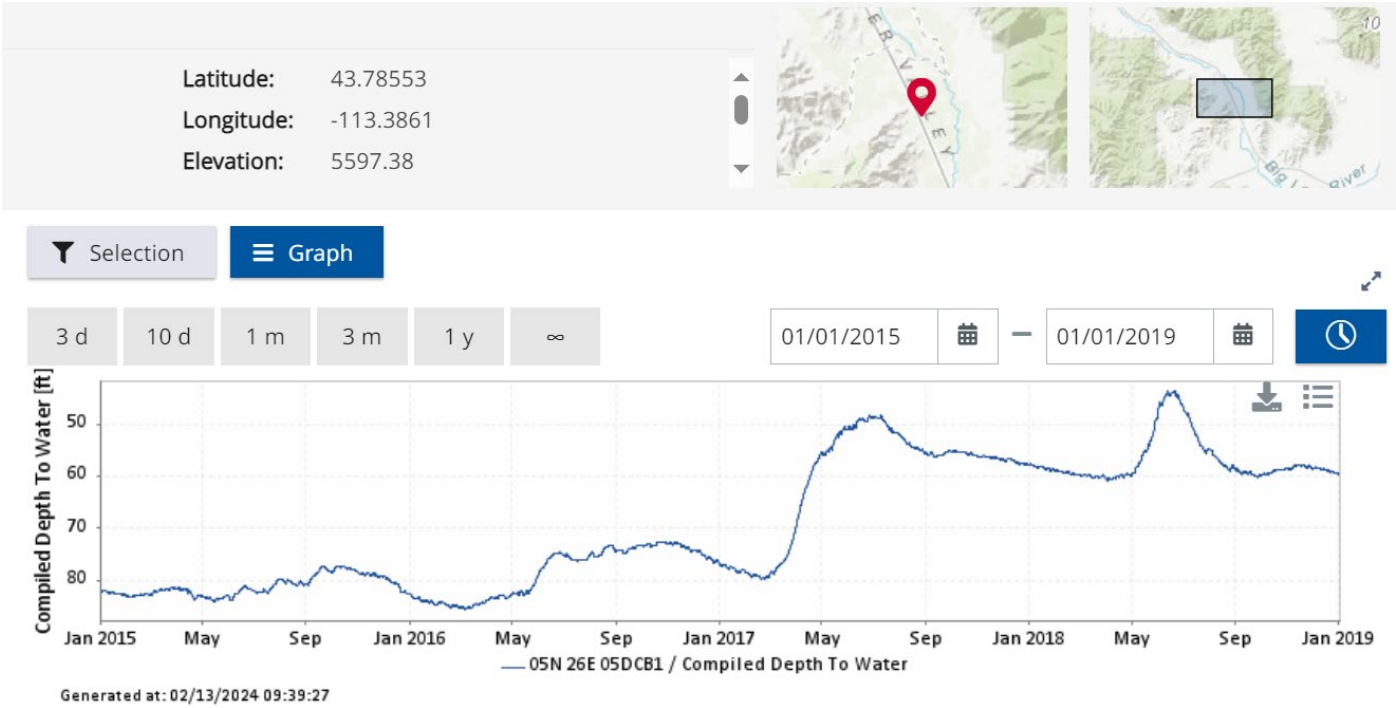


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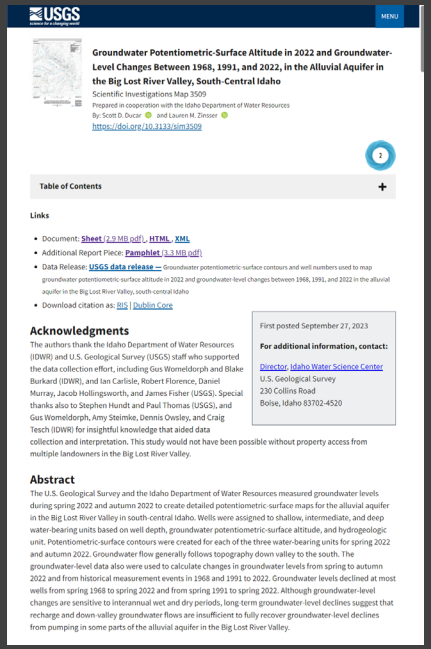
# Nearby water table



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MENU

**Groundwater Potentiometric-Surface Altitude in 2022 and Groundwater-Level Changes Between 1968, 1991, and 2022, in the Alluvial Aquifer in the Big Lost River Valley, South-Central Idaho**

Scientific Investigations Map 3509

Prepared in cooperation with the Idaho Department of Water Resources

By: Scott D. Ducar and Lauren M. Zinsser

https://doi.org/10.3133/sim3509

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Links

- Document: **Sheet** (2.9 MB pdf), **HTML**, **XML**
- Additional Report Piece: **Pamphlet** (3.3 MB pdf)
- Data Release: **USGS data release —** Groundwater potentiometric-surface contours and well numbers used to map groundwater potentiometric-surface altitude in 2022 and groundwater-level changes between 1968, 1991, and 2022 in the alluvial aquifer in the Big Lost River Valley, south-central Idaho
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**For additional information, contact:**

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## Acknowledgments

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## Abstract

The U.S. Geological Survey and the Idaho Department of Water Resources measured groundwater levels during spring 2022 and autumn 2022 to create detailed potentiometric-surface maps for the alluvial aquifer in the Big Lost River Valley in south-central Idaho. Wells were assigned to shallow, intermediate, and deep water-bearing units based on well depth, groundwater potentiometric-surface altitude, and hydrogeologic unit. Potentiometric-surface contours were created for each of the three water-bearing units for spring 2022 and autumn 2022. Groundwater flow generally follows topography down valley to the south. The groundwater-level data also were used to calculate changes in groundwater levels from spring to autumn 2022 and from historical measurement events in 1968 and 1991 to 2022. Groundwater levels declined at most wells from spring 1968 to spring 2022 and from spring 1991 to spring 2022. Although groundwater-level changes are sensitive to interannual wet and dry periods, long-term groundwater-level declines suggest that recharge and down-valley groundwater flows are insufficient to fully recover groundwater-level declines from pumping in some parts of the alluvial aquifer in the Big Lost River Valley.


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# Nearby water table

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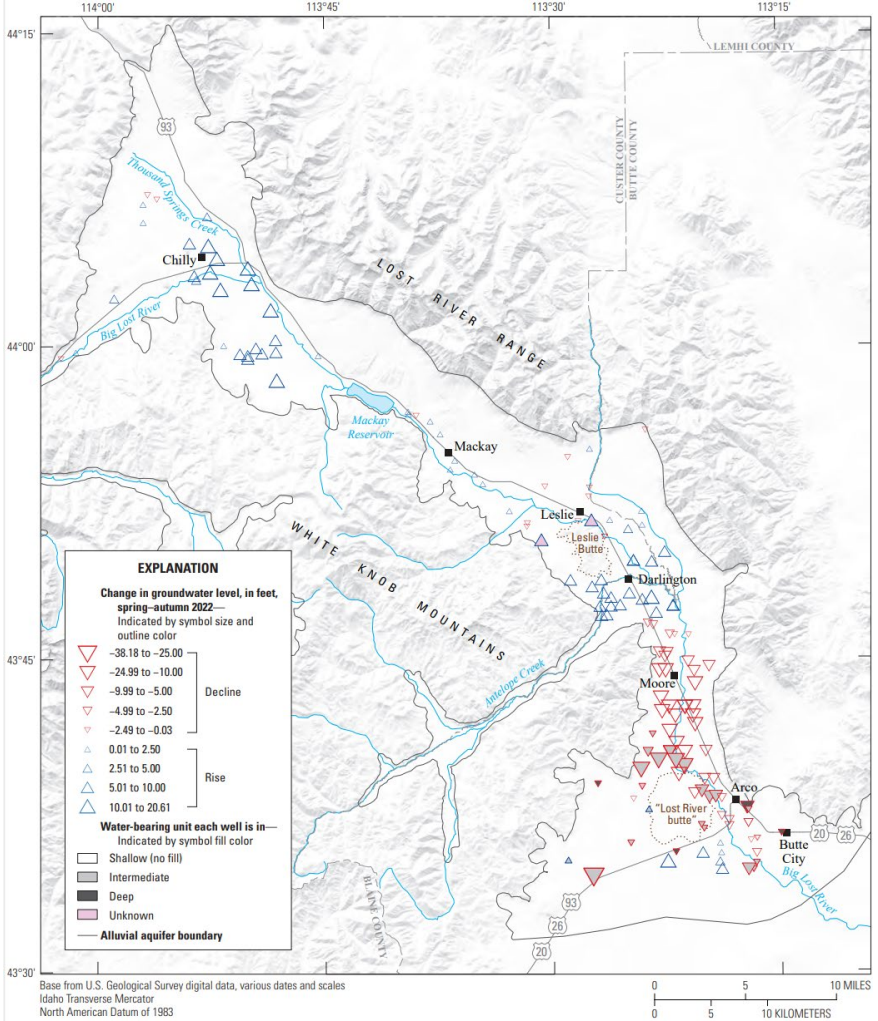
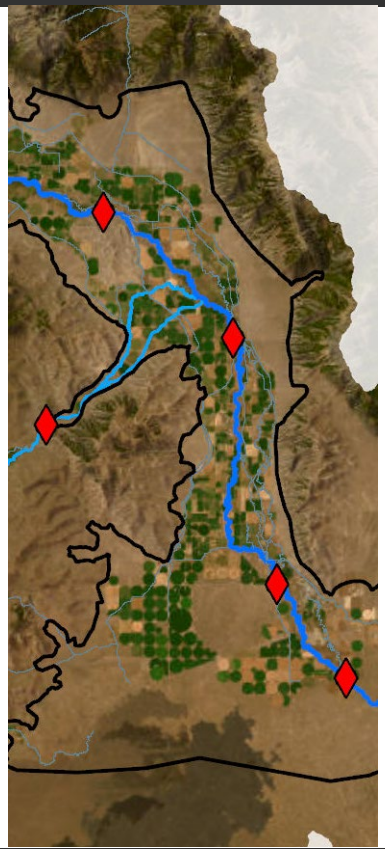



**Figure 1.** Change in groundwater level from spring 2022 to autumn 2022 in the Big Lost River Valley, south-central Idaho (Ducar and Zinsser, 2023; Idaho Department of Water Resources, 2023; U.S. Geological Survey, 2023).

# Antelope Creek in the model

# Modelled states and fluxes impacted by Antelope Creek

Irrigation: pumping & incidental recharge

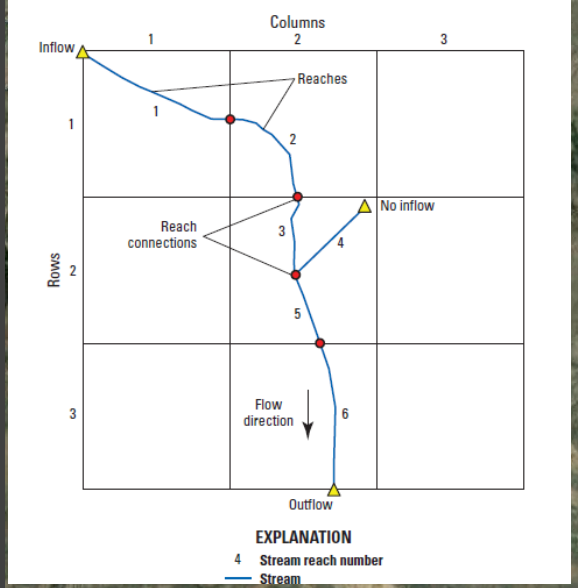


Streamflow

Groundwater levels

Stream seepage

# Streamflow - SFR







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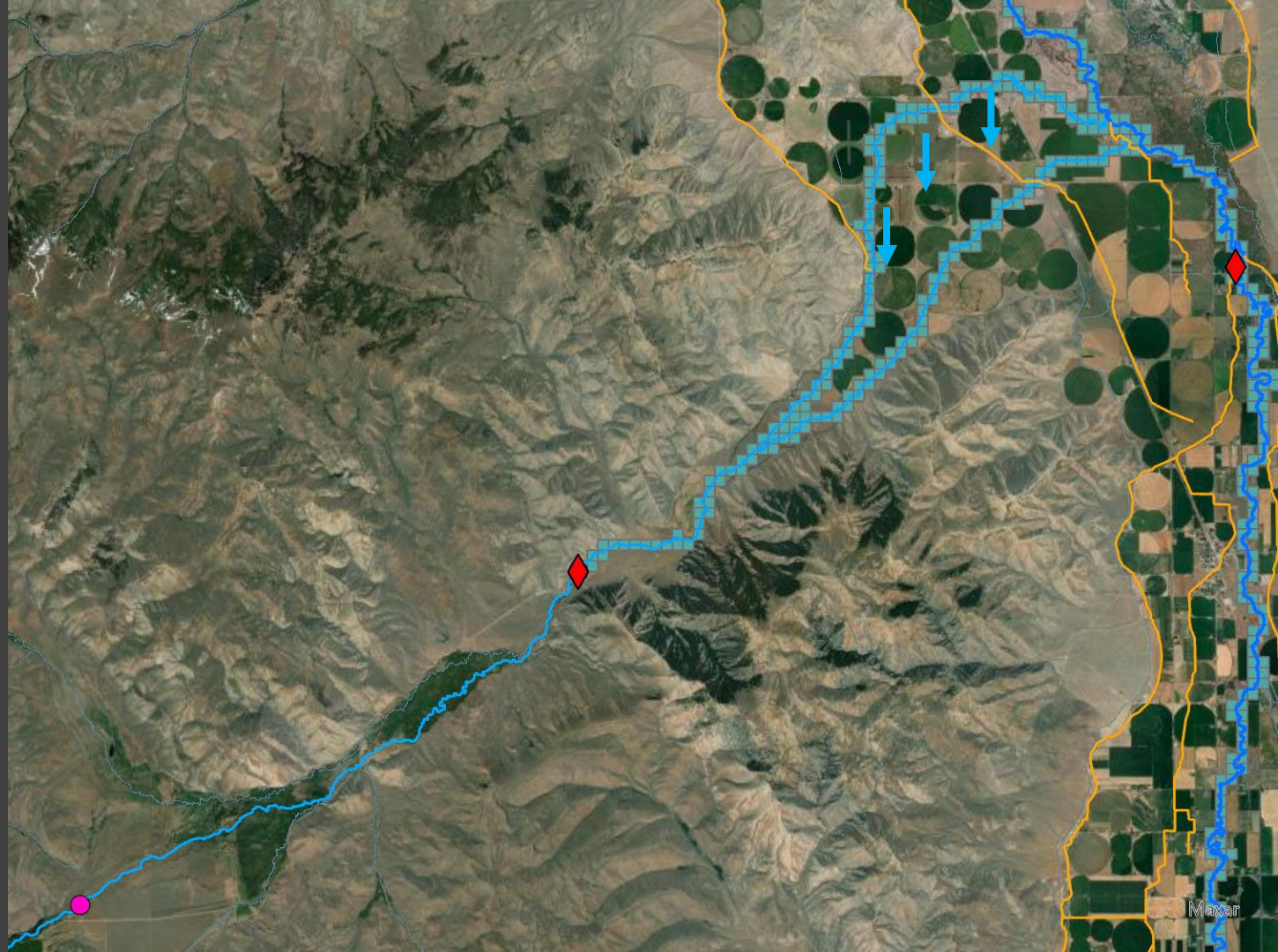
# Seepage / recharge

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# Irrigation Calculations


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# Irrigation Calculations


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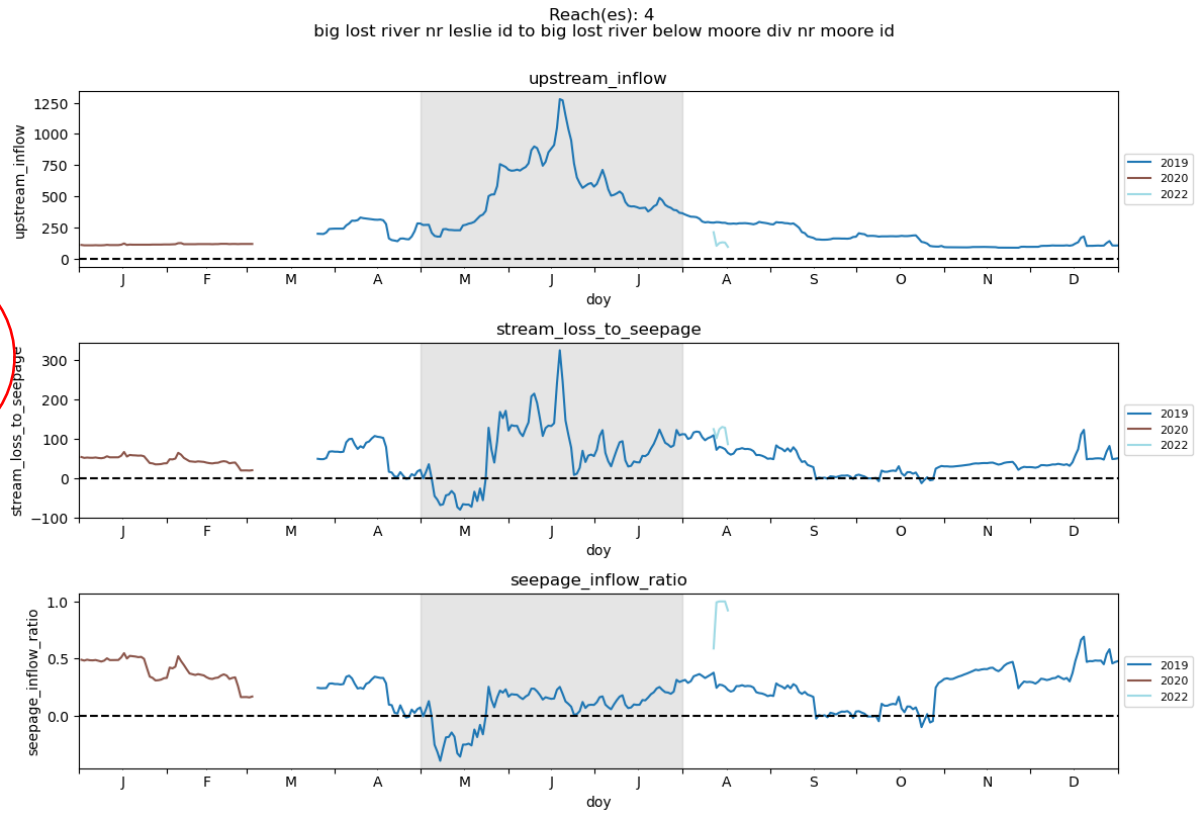
# Seepage Calculations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# Datasets for Antelope Creek

# Stream gages


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# Irrigation Data


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# Associated Data

- Watershed area
- Precipitation
- Evapotranspiration
- Temperature
- Altitude
- Slope
- Land cover
- Soil
- Surficial geology
- …

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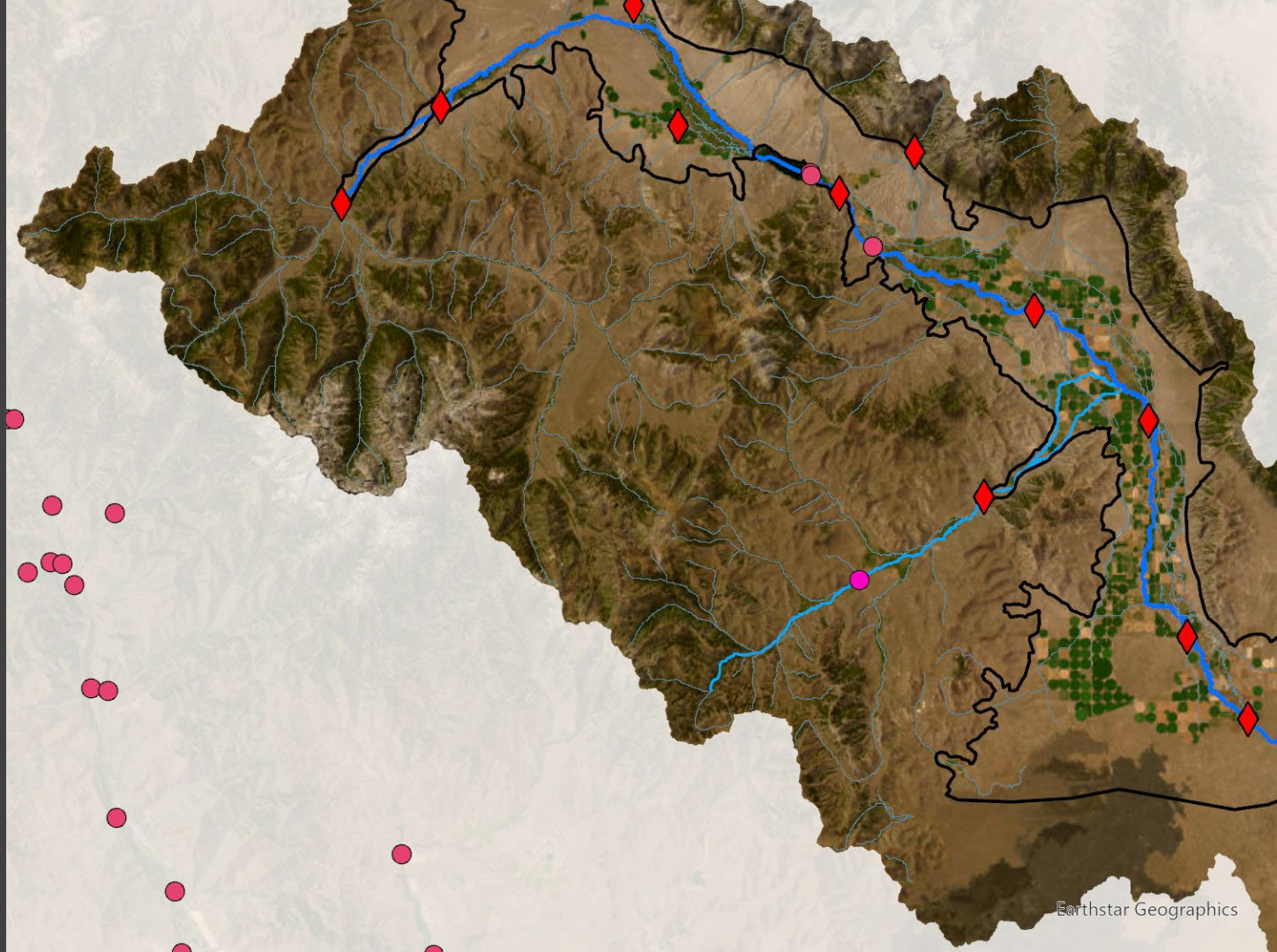
# Other gages

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# Estimation Methods

# Possible Estimation Methods

What data should I use to model the streamflow?

**Antelope gage data only**

**Meteorological & watershed data**

**Index gage**

**Combination**

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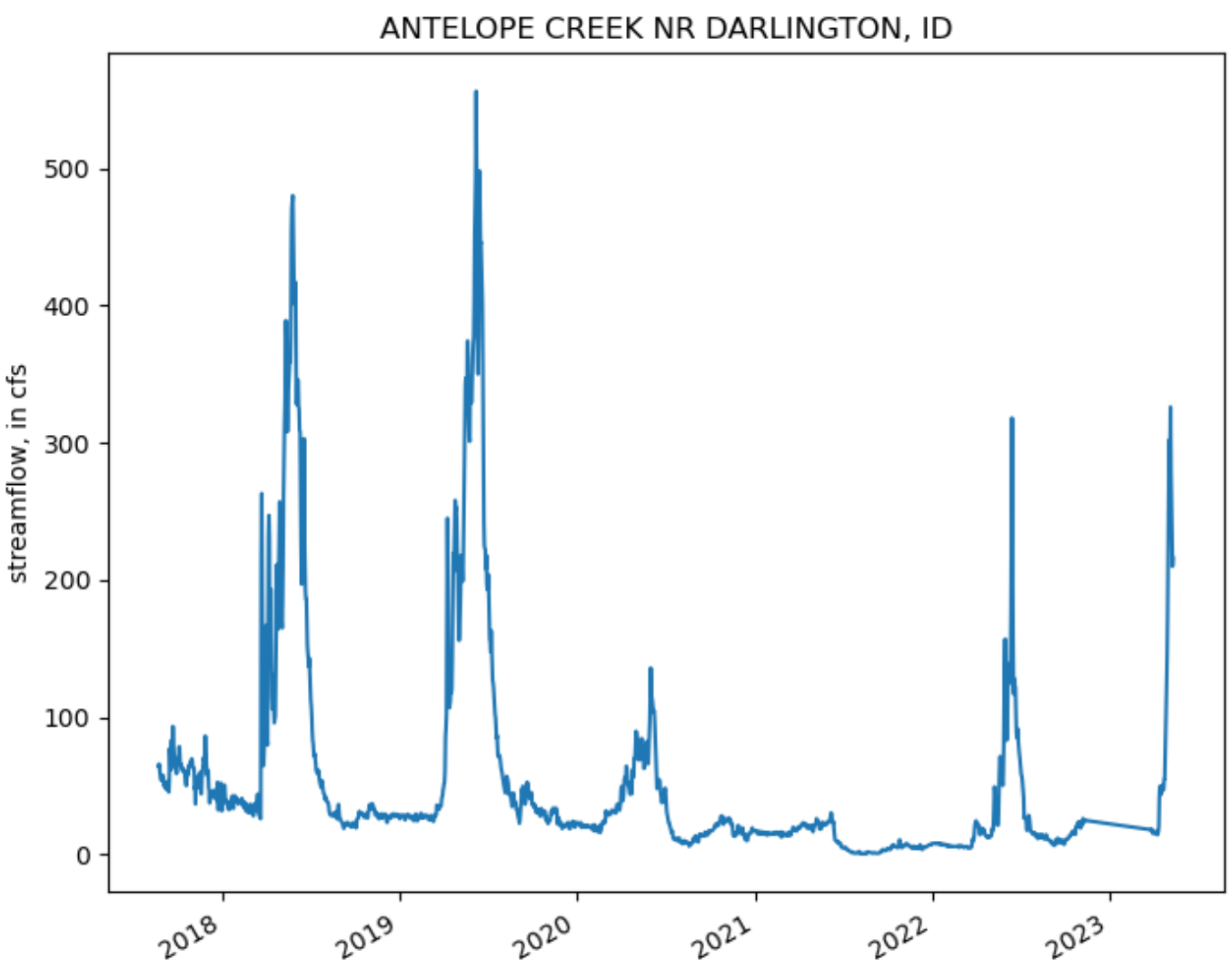
# Antelope gage only

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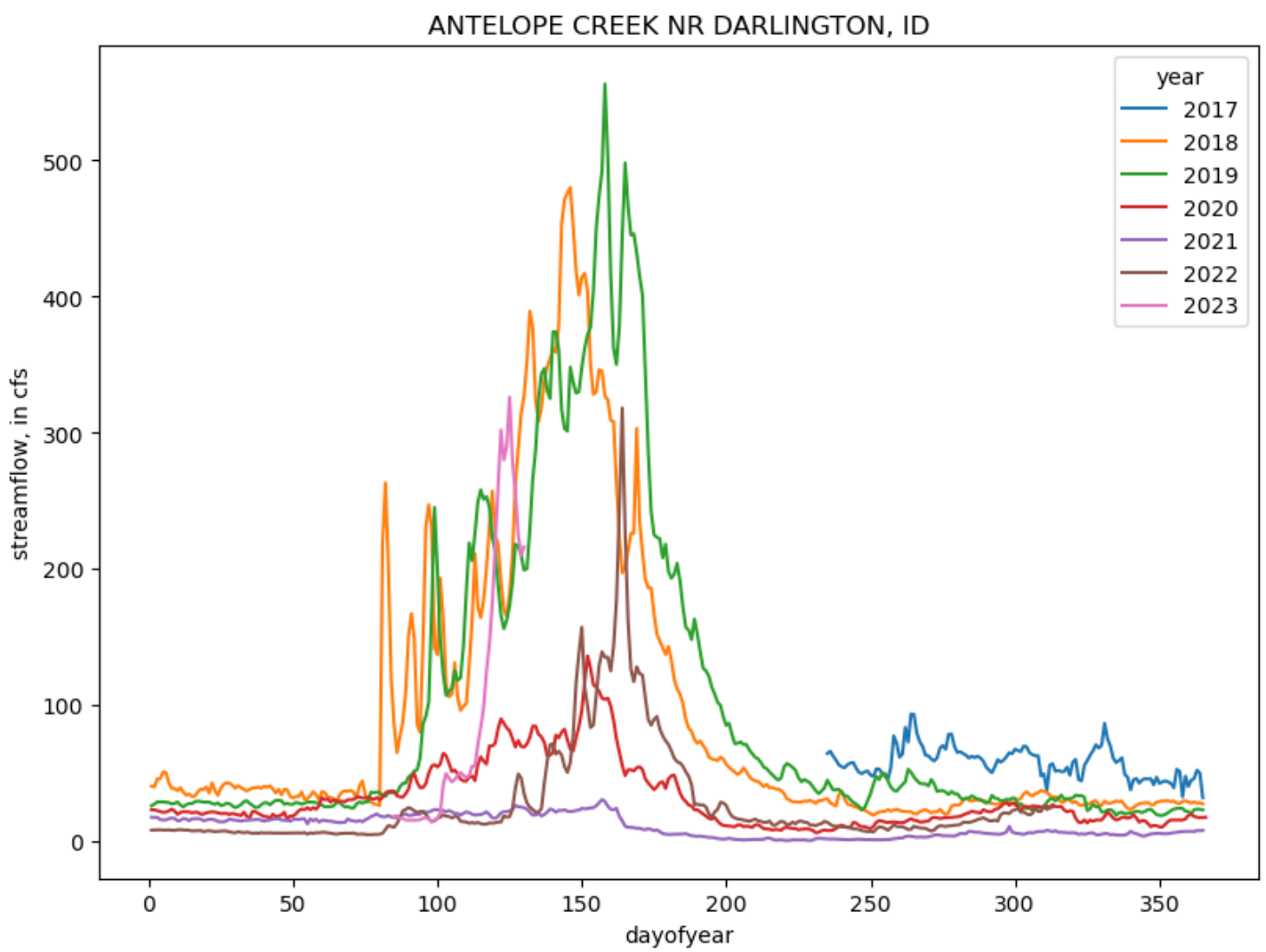


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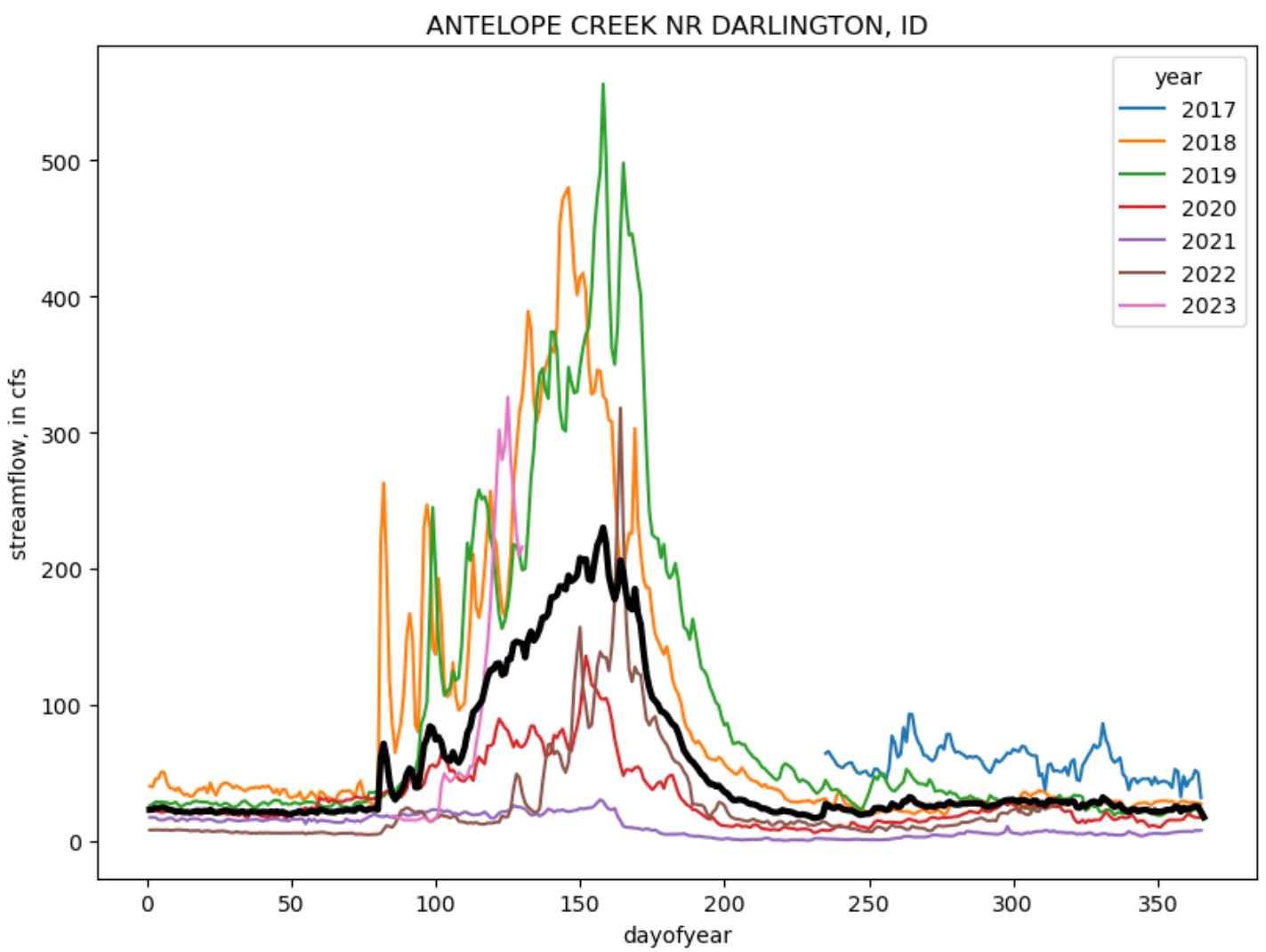


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# Met & other data

Clark combined:
- Stream stats
- PRISM precipitation



The Moore streamgage location (IDWR site 13132100 and USGS streamgage 13132100) ultimately was not selected for river-seepage analysis because of insufficient available data during the study period. Substantial flow was diverted from the Big Lost River to the Moore Canal (IDWR site 13132050) and East Side Ditch (IDWR site 13132060) above the Moore streamgage location. The Moore Canal and East Side Ditch measured diversions and estimated streamflow at the Moore streamgage (IDWR site 13132100)[2] were reported in the IDWR Water District surface-water diversion database (IDWR, 2020d) and in the IDWR water rights accounting database (IDWR, 2020e) in diversion units of cubic feet per day instead of in flow units of cubic feet per second. Flow rates at the Moore streamgage (USGS streamgage 13132100) installed by the USGS in 2019 (U.S. Geological Survey, 2020) were reported in cubic feet per second, resulting in different estimated mean flows for 2019 when compared to the total annual flow in the diversion database[3]. The mean streamflow for the period from March 25, 2019, to December 31, 2019, reported by the USGS at the Moore streamgage, was 135.6 cubic feet per second ($ft^3/s$; 98,200 acre feet per year [acre-ft/yr]). This flow was substantially greater than reported in IDWR records during prior years at IDWR site 13132100. Before streamgage instrumentation in 2019, data reported for the Moore location typically reflected the irrigation season but not other times when flow might occur. Records indicate that values were either measured, estimated, or interpolated. Estimates of Big Lost River flows at Moore were not reported for 2006, 2007, 2011, and 2015. Some flow likely occurred during wet years such as 2006 and 2011 or outside the irrigation season. Measured flow at the downstream USGS Arco streamgage (13132500) in wet years suggests that unmeasured flow likely occurred at Moore during wet years and non-irrigation periods.

## Unmeasured Tributary Streamflow Assumptions

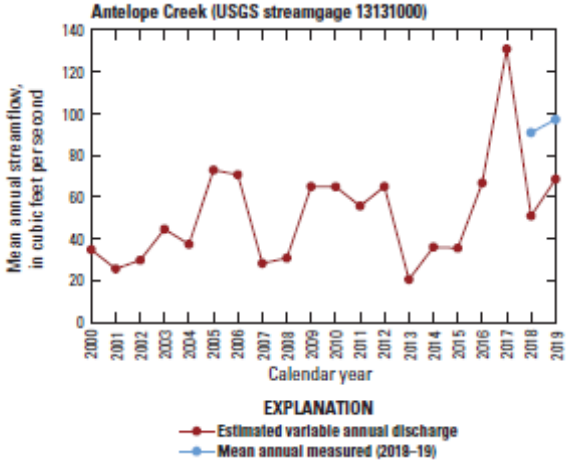
Flows historically were monitored by the USGS on Antelope Creek at two streamgage locations: 13130900 above Cherry and Dry Fork Creeks from 1966 to 1974, and 13131000 below the confluence of Waddoups Canyon at the current streamgage site, intermittently from 1913 to 1922 and again from 2017 to present. Alder Creek was monitored at USGS streamgage 13129800 from 1966 to 1968, and USGS streamgage 13130000 was active from 1920 to 1922 and again from 2018 to present. Warm Springs Creek was monitored at USGS streamgage 13124500 from 1919 to 1959 and at the current USGS streamgage 13124265 from 2019 to the present. The west channel of Warm Springs Creek was monitored at USGS streamgage 13125000 from 1919 to 1959. Pass Creek was monitored at USGS streamgage 13131500 intermittently from 1920 to 1922 and again from 2002 to present. Streamgage datasets may be accessed from the USGS (U.S. Geological Survey, 2020). Crosthwaite and others (1970a) summarized miscellaneous streamflow measurements (1966–68) at several gaged and ungaged stream locations. Although historical conditions may not reflect the 2000–19 study period, available datasets were reviewed to provide a general indication of the timing and magnitude of potential flows.

StreamStats (U.S. Geological Survey, 2016) flagged some results returned during tributary basin delineation as having one or more parameters outside the range of the basin characteristics for the sites used to develop the supporting regression equations, causing the results to be extrapolated. Hortness and Berenbrock (2001) prepared regression equations for the Big Lost Basin as part of an evaluation of ungaged tributary basins using three streamgages (North Fork of the Big Lost River at Wild Horse, Big Lost River at Howell Ranch, and Lower Cedar Creek), with a reported median (Q50) standard error range of –55 to +120 percent. Therefore, estimates of unmeasured streamflow within the Big Lost River Basin may include appreciable errors related to the regression equations.

Total annual precipitation derived from Parameter-elevation Regressions on Independent Slopes Model (PRISM; PRISM Climate Group, 2020) was compiled for the same tributary drainage areas, and the deviation from the average precipitation from 2000 to 2019 was used to estimate annual streamflow by adjusting accordingly the predicted StreamStats (U.S. Geological Survey, 2016) median streamflow. Use of the mean annual streamflow estimate typically either overestimated or underestimated streamflow compared to measured streamflow. However, few years were available to evaluate trends. Therefore, a flow-duration statistic (20-percent flow exceedance [Q20], Q50, or 80-percent flow exceedance [Q80]) was assigned to a given year based on the relative wet-, average-, or dry-year conditions, respectively. Years 2000–02, 2004, 2007–08, and 2013–15 overall were dry (assigned the Q80 statistic), 2017 was assigned as the Q20 statistic, and the remainder of the years were assigned the Q50 statistic. Comparison of estimated to measured streamflow and the mean annual flow duration curves over the respective available period of record for the North Fork at Wild Horse and Howell Ranch USGS streamgages (U.S. Geological Survey, 2020) was used to guide assignment of annual flow-duration statistics. This assignment was somewhat subjective and likely did not reflect actual, unmeasured flows. However, the estimated tributary streamflow was well correlated ($R^2$ of about 0.74–0.87)

[2]A measuring device was installed by IDWR at IDWR site 13132100 in 2016 but was removed in 2017 because of flooding concerns (D. Hoekema, IDWR, written commun., 2021).

[3]Measured and estimated diversions and streamflow were converted to acre feet per year for the water budget. Daily diversions were summed over the calendar year and converted from units of cubic feet per second per day to acre-feet per foot per year as 1 acre foot year = (cubic feet per second per day×60×60×24)/43,560. Mean annual stream streamflow is converted from units of cubic feet per second to acre-feet year as 1 acre-foot per year = (cubic feet per second x 60×60×24×365)/43,560.

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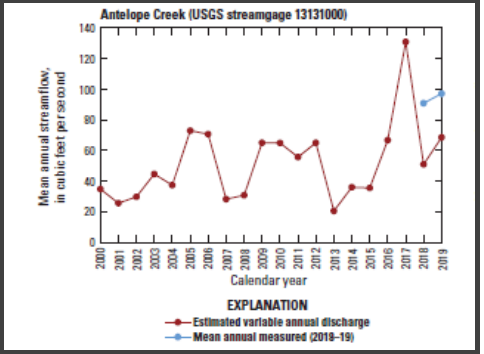
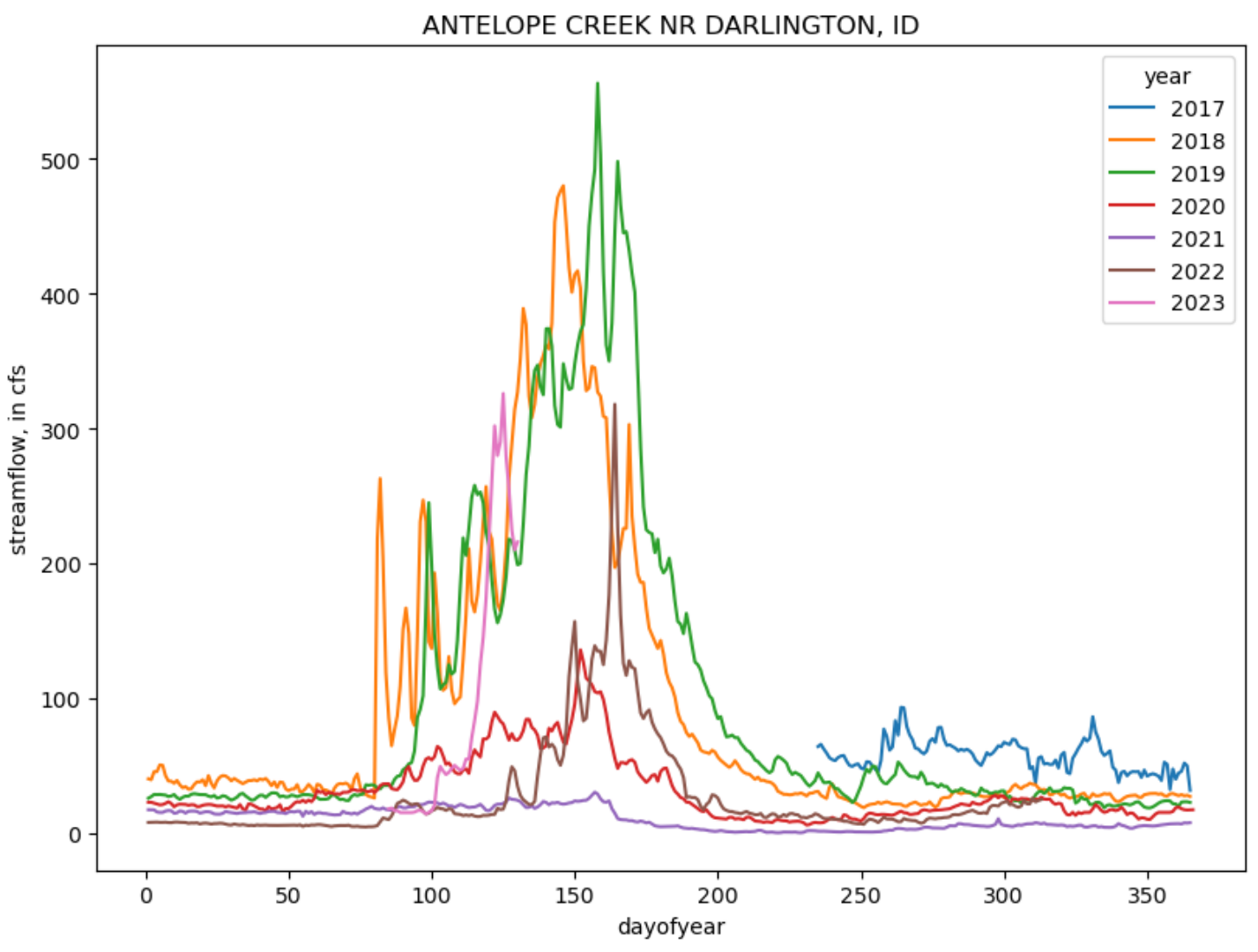
# Met & other data

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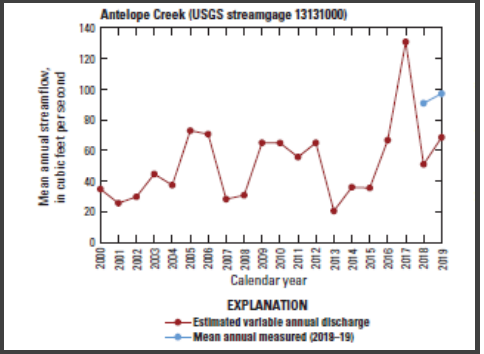


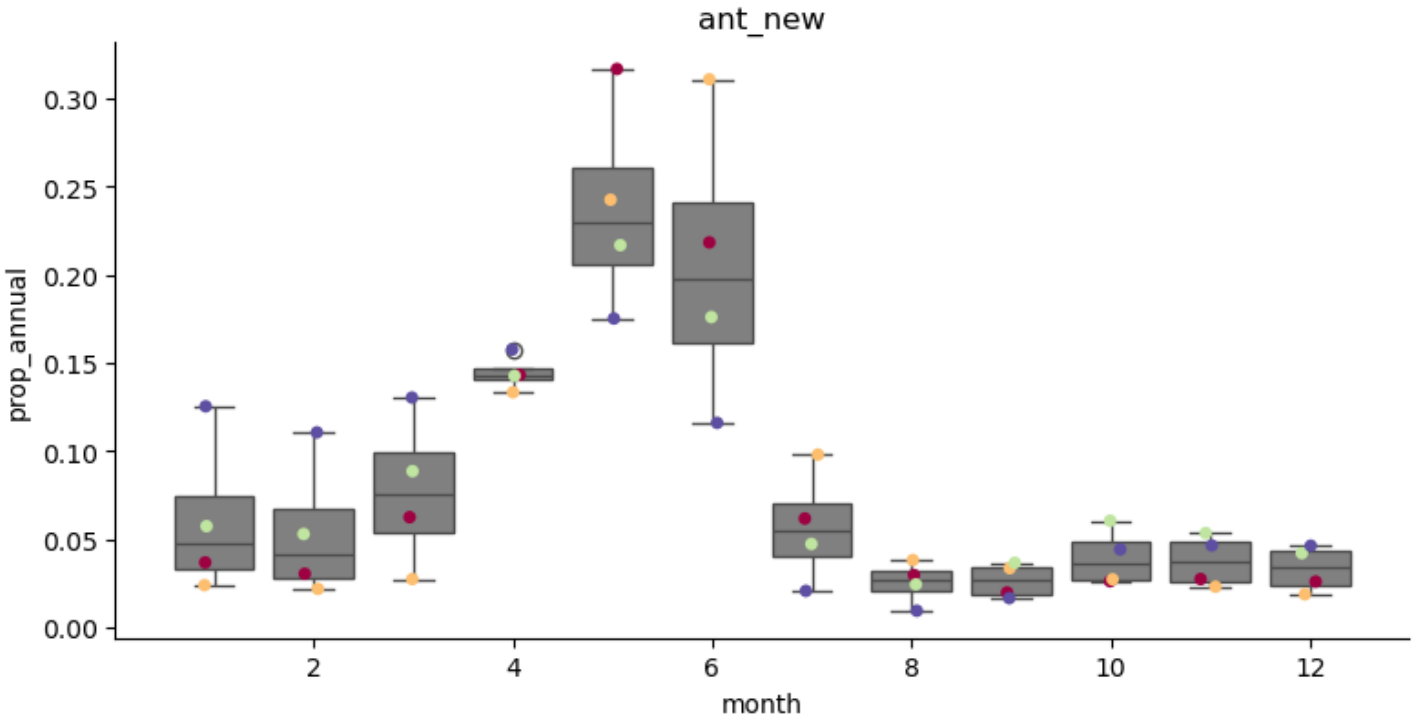


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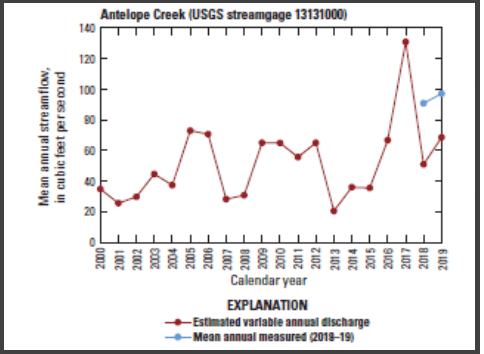


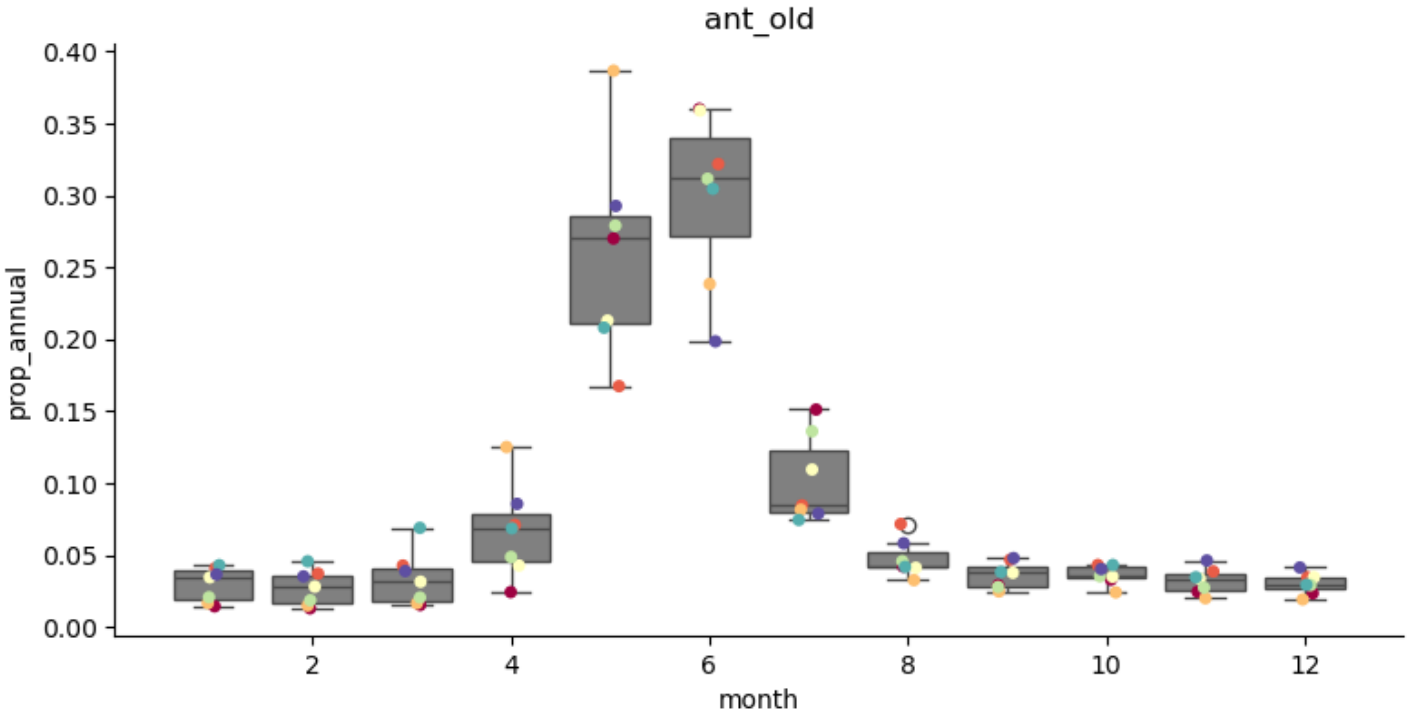


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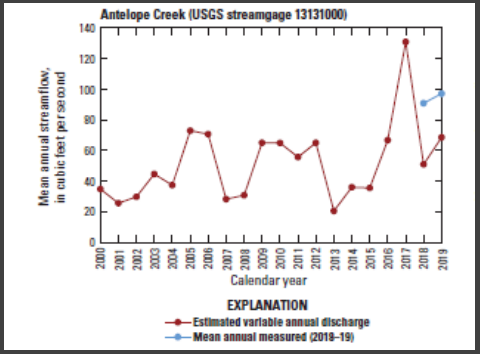
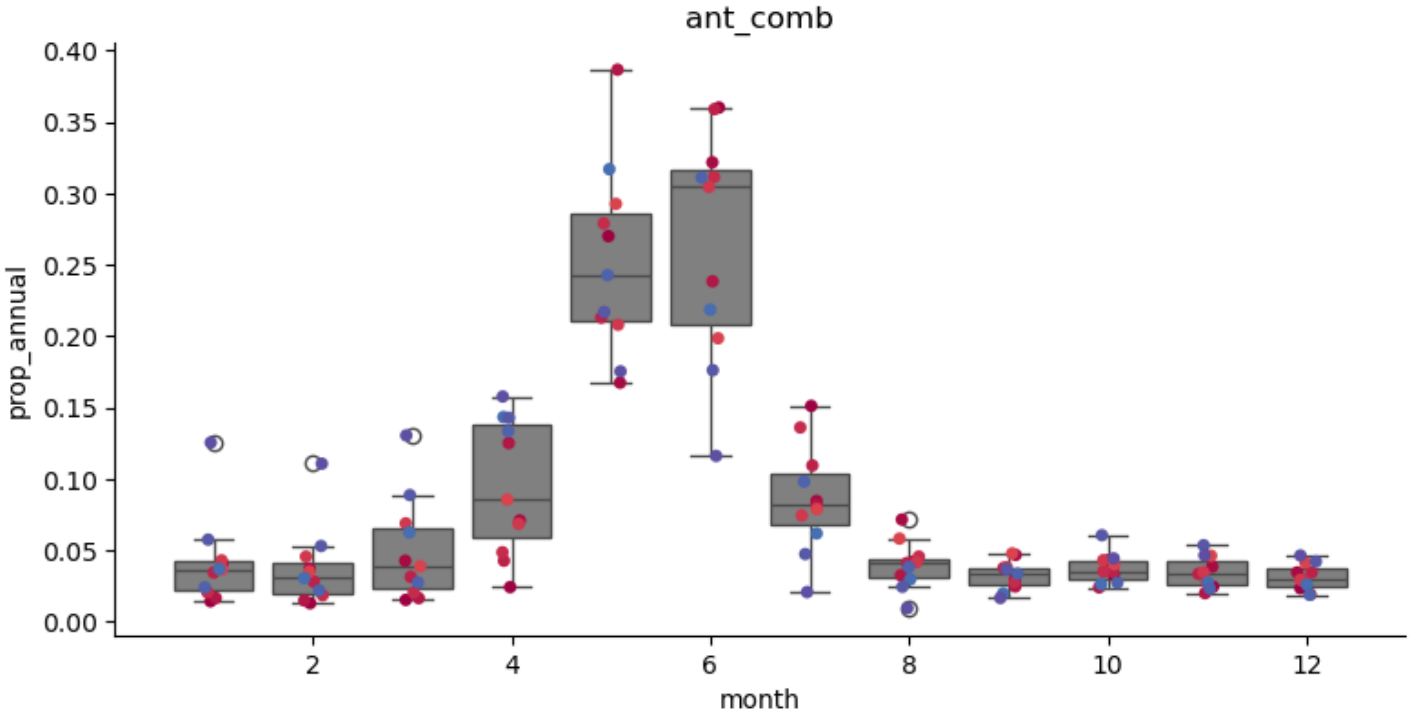
# Met & other data

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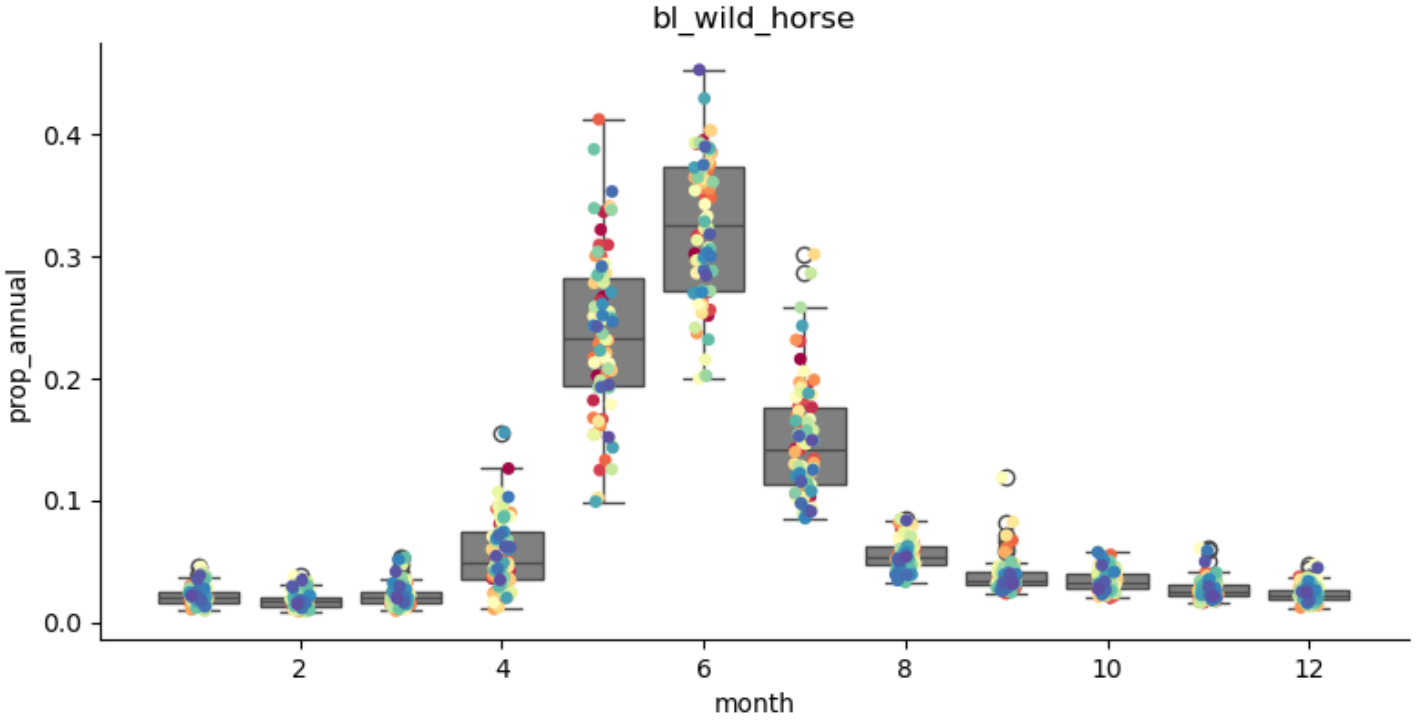


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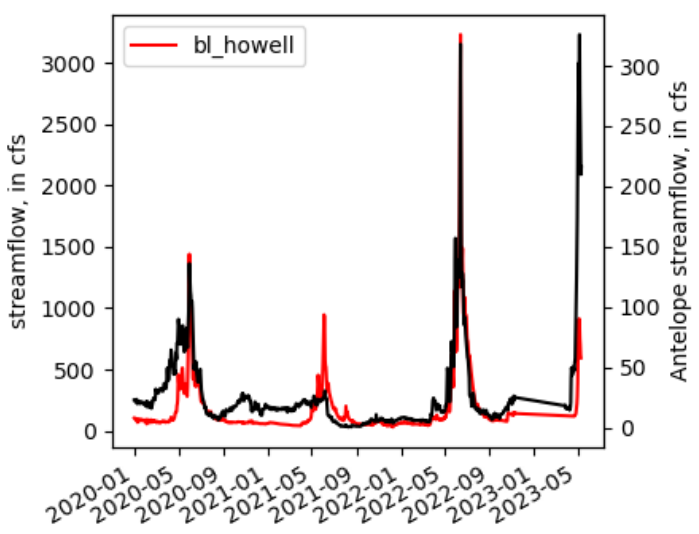


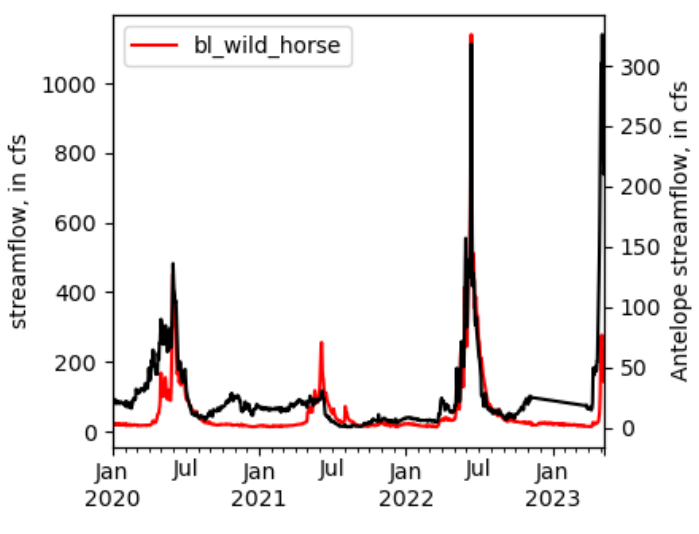


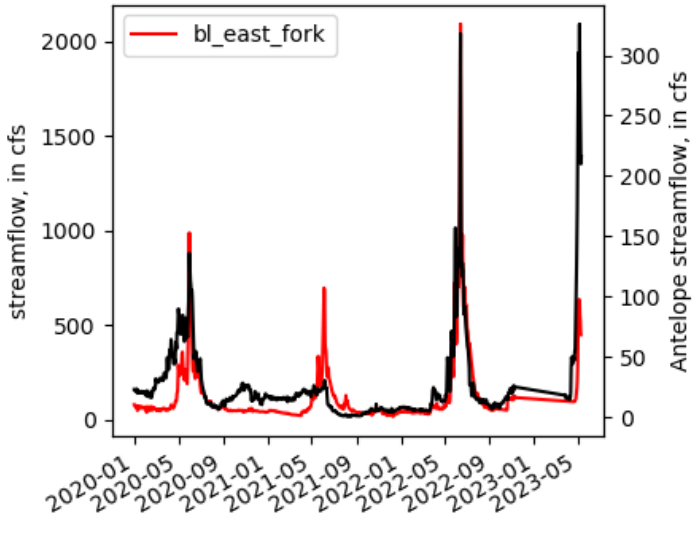


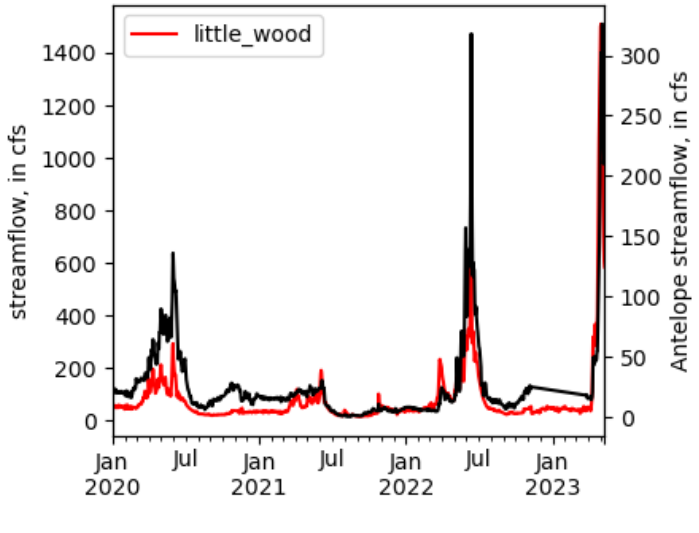


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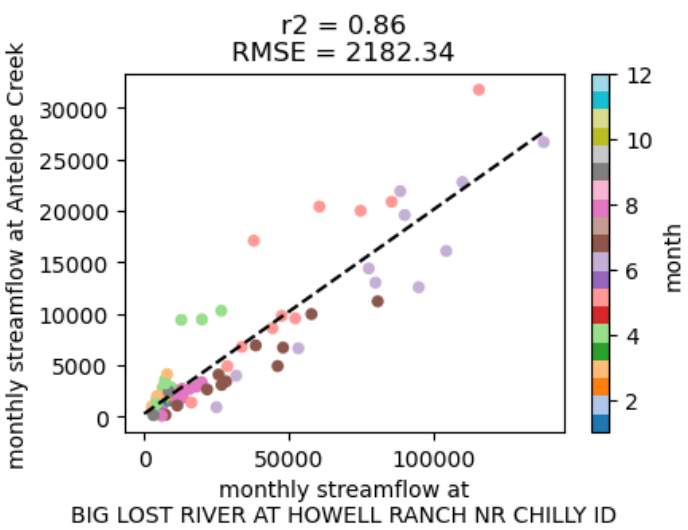


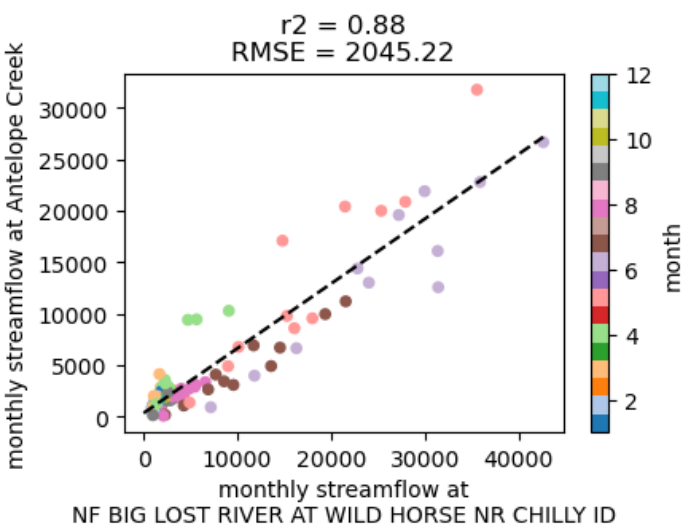


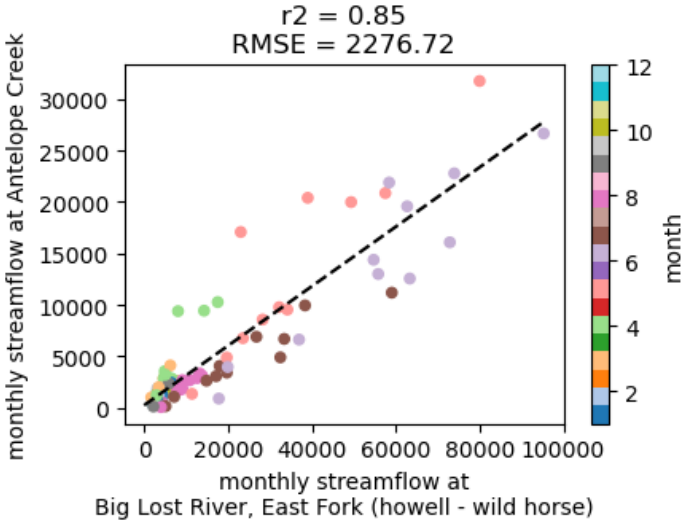


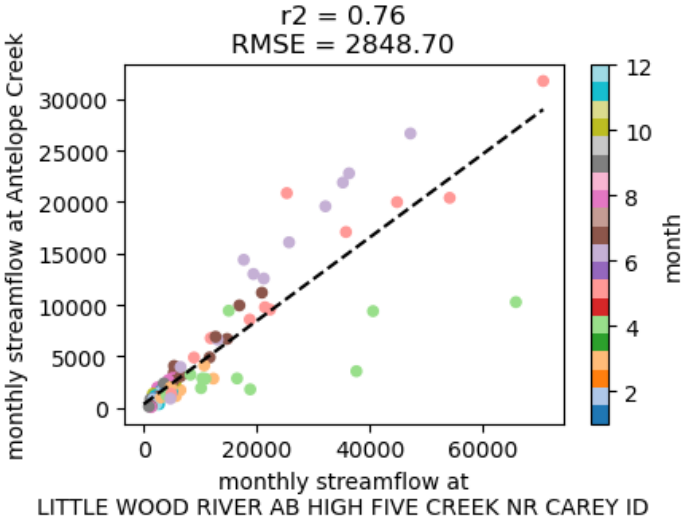


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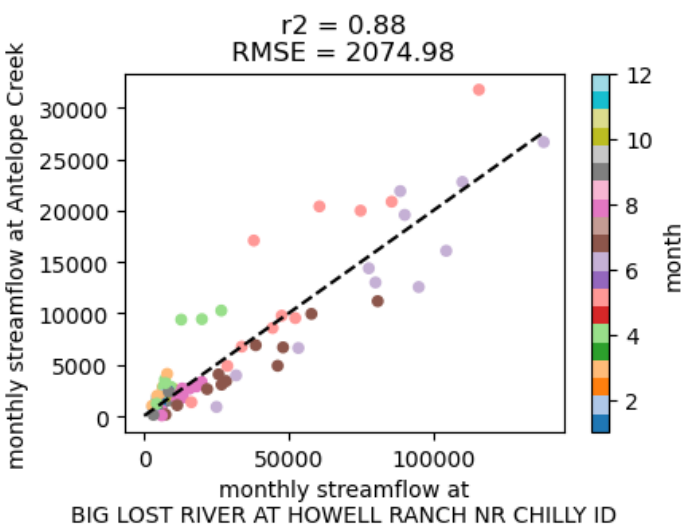


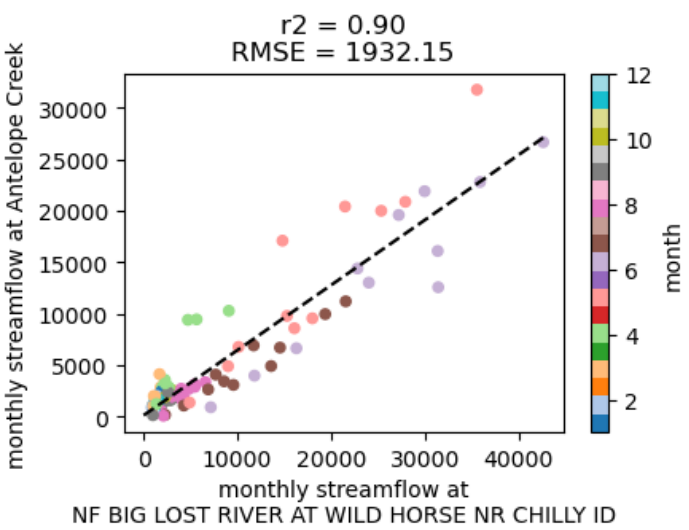


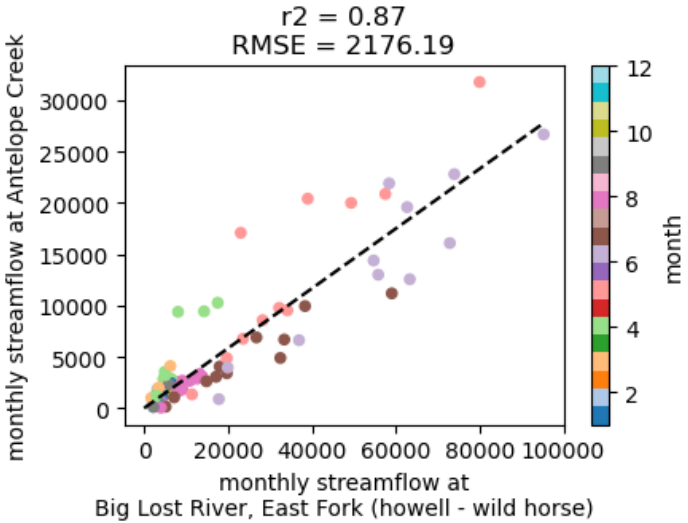


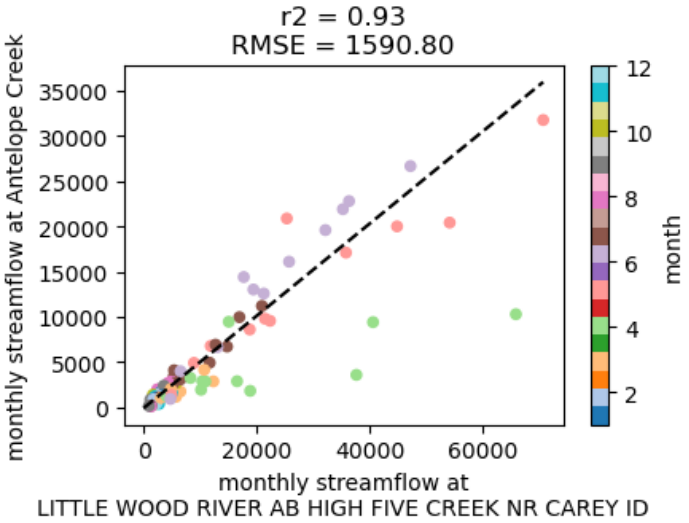


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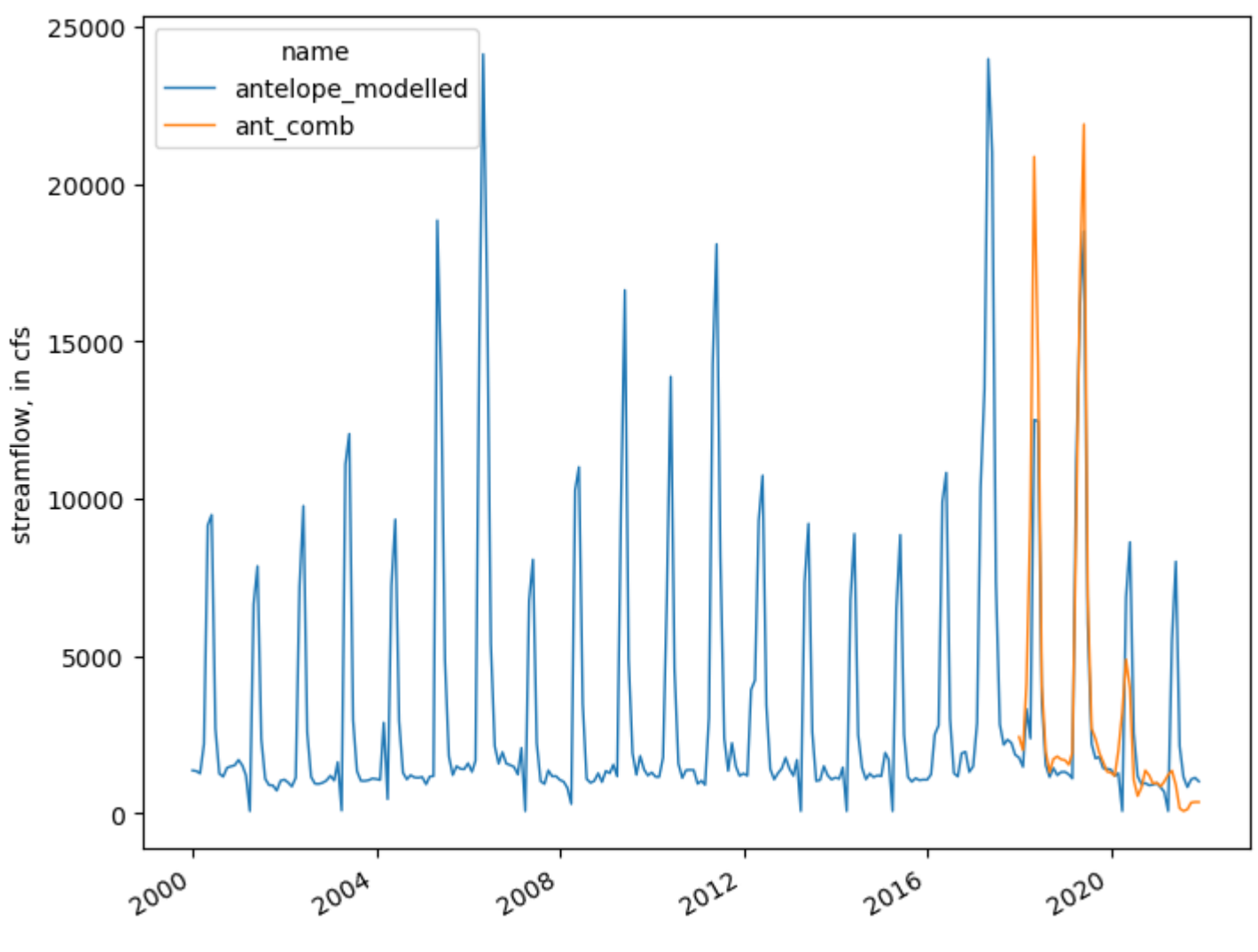


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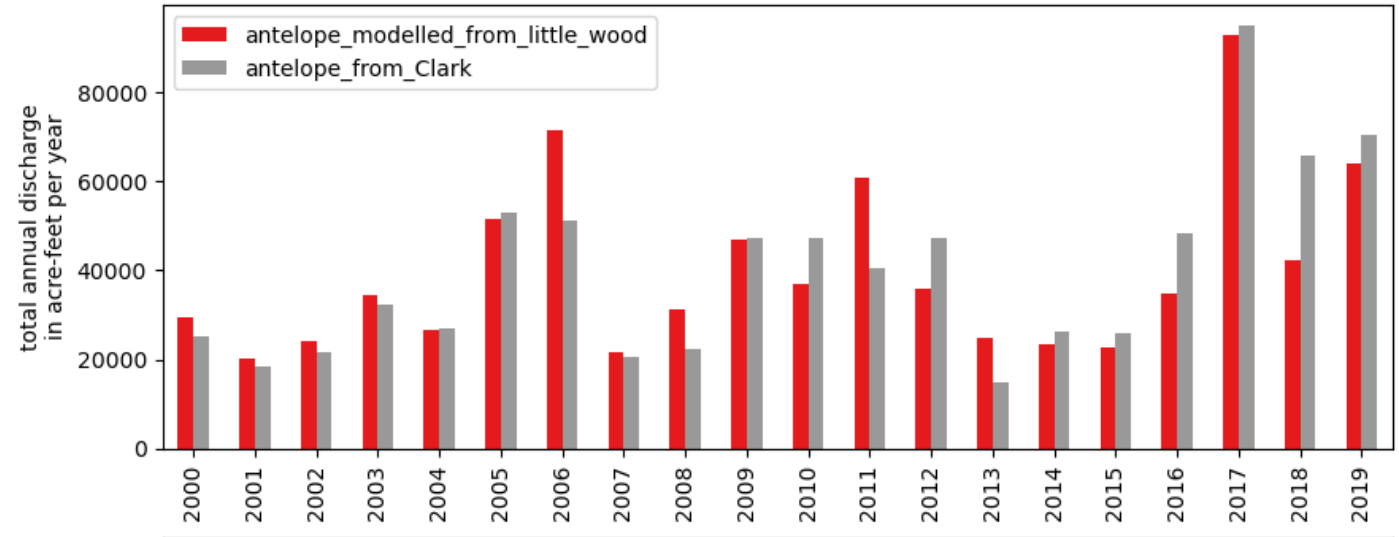
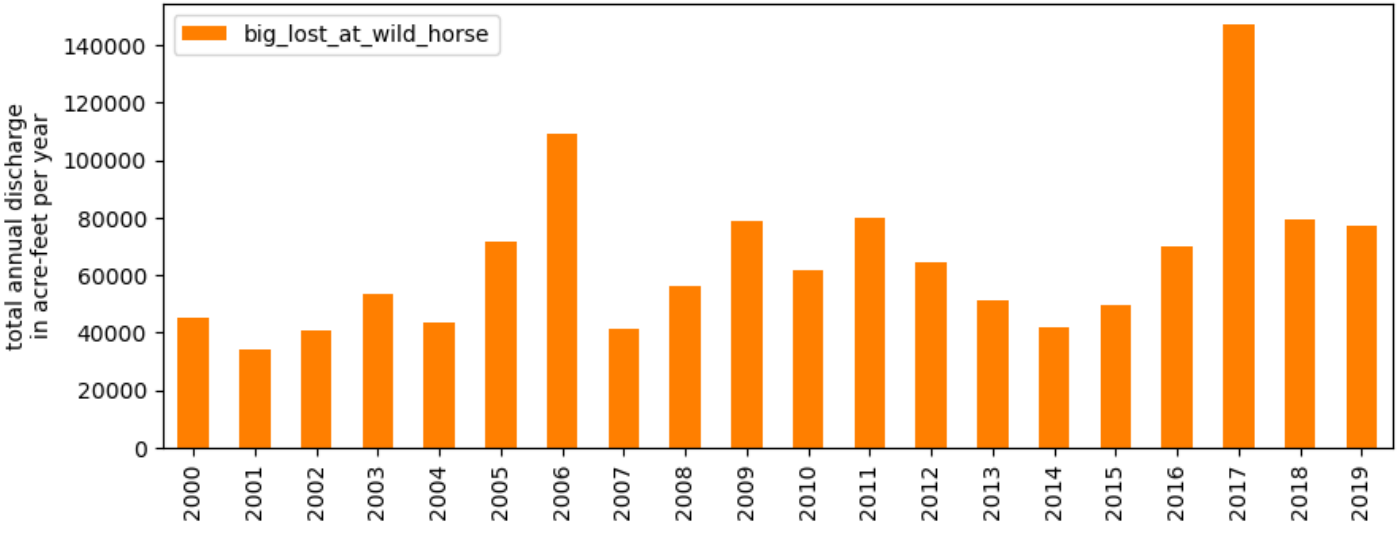
# Index gage or combination?

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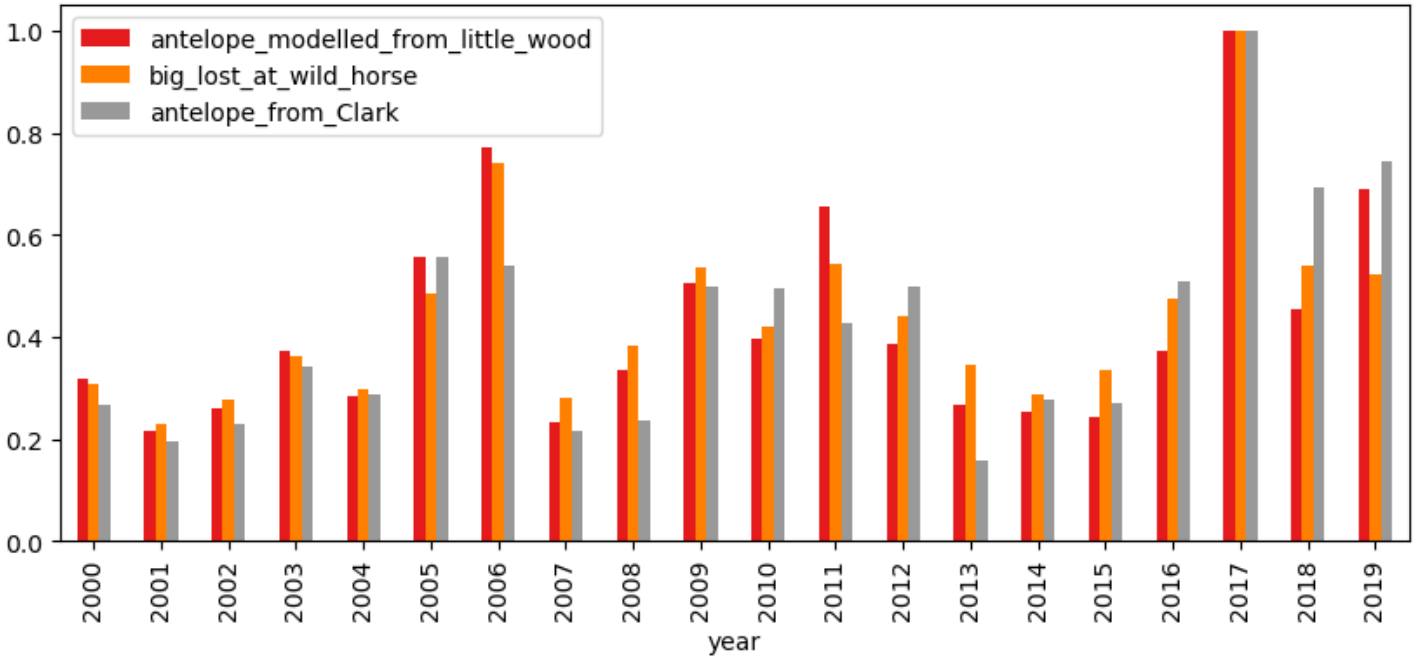


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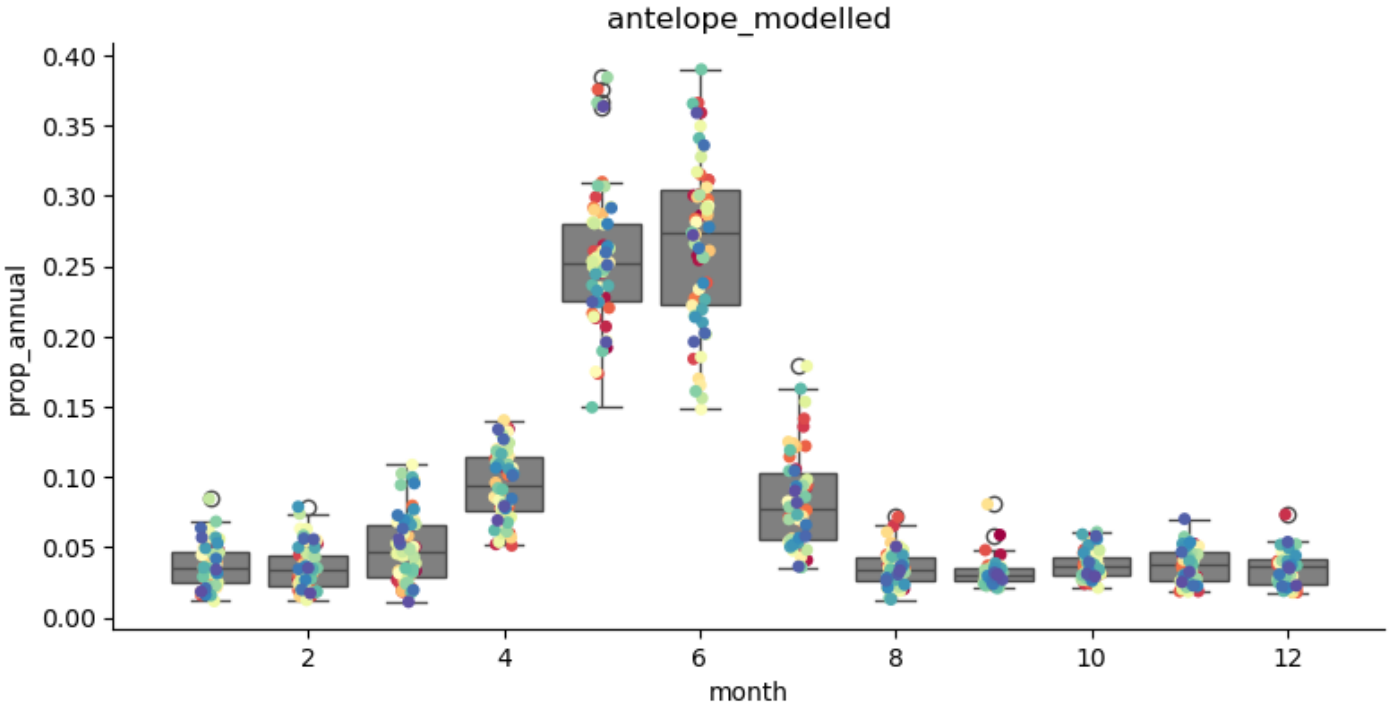
# Combination

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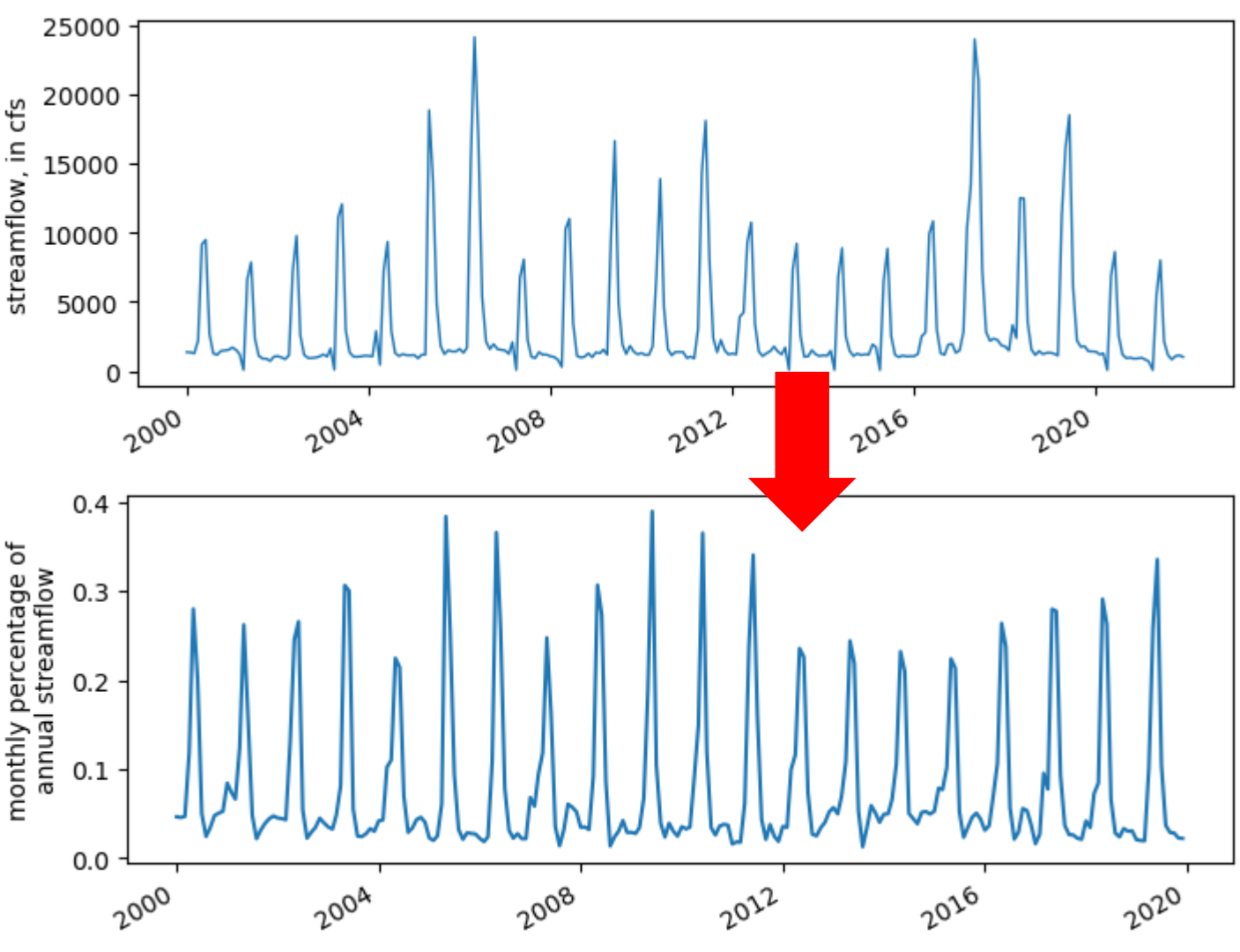


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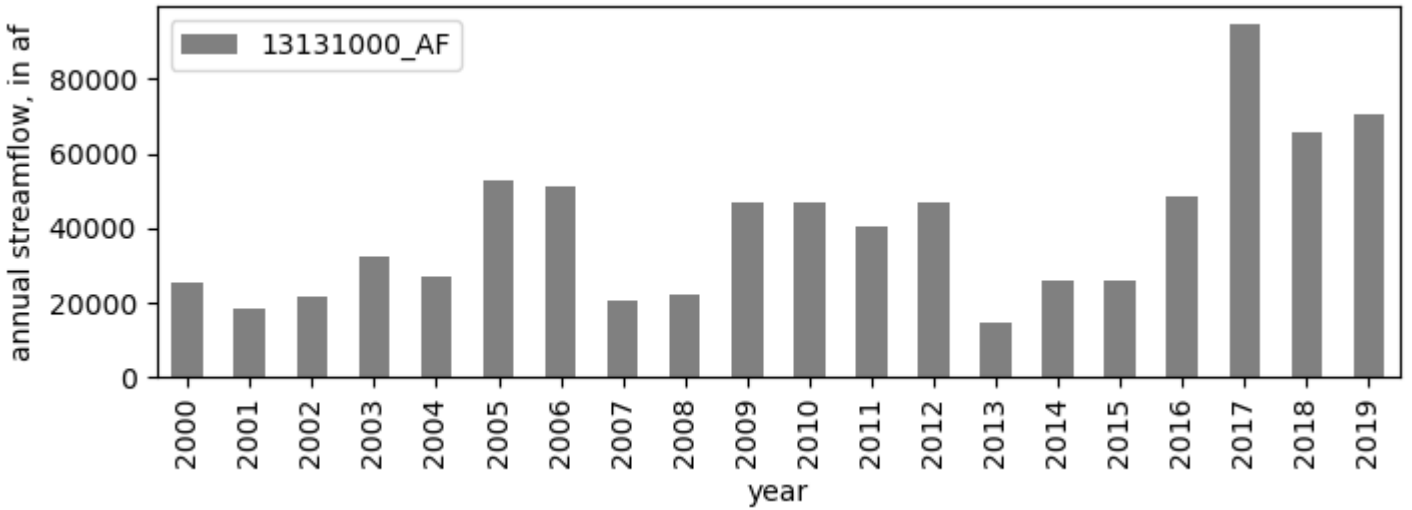
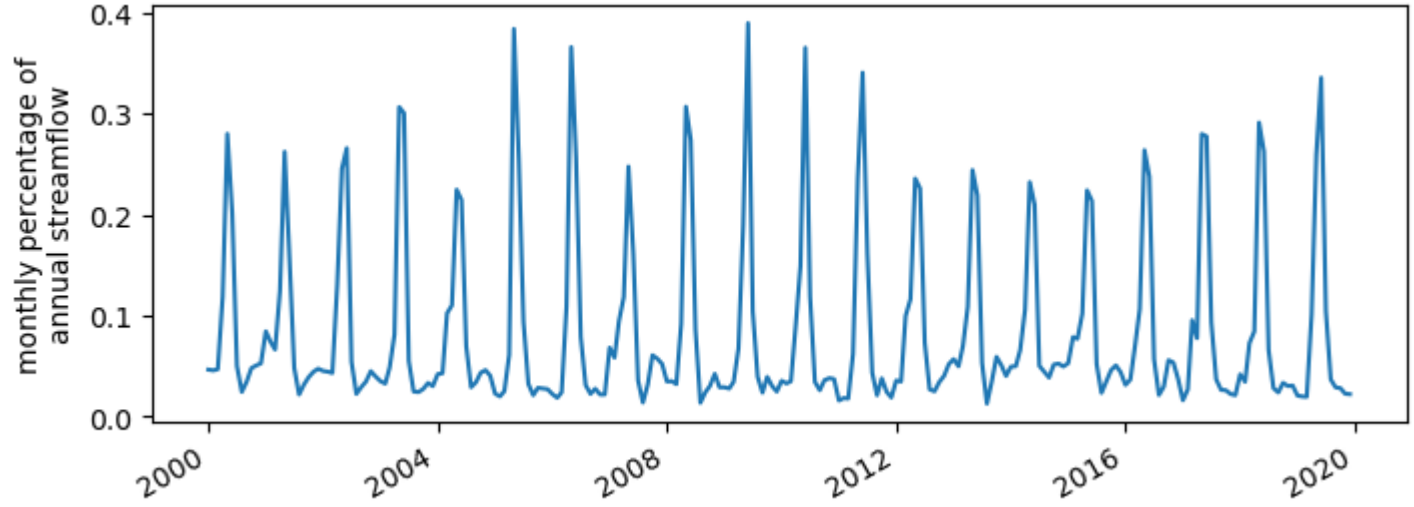
# Combination

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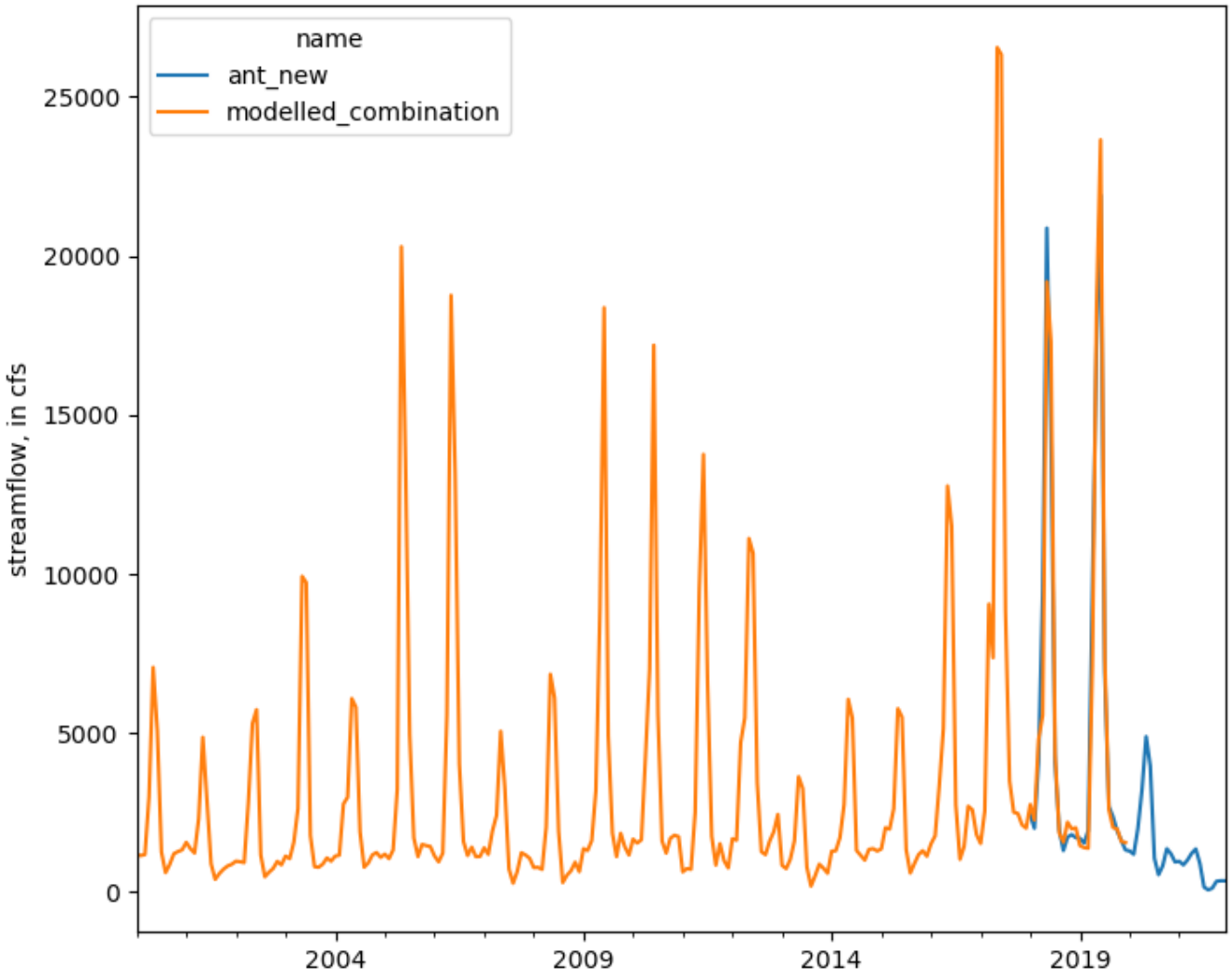
# Combination

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# Thanks!

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