EPA Ground Water Issue

Standard methods for the examination of water and wastewater.

Use of Passive Diffusion Samplers for Monitoring Volatile Organic Compounds in Groundwater

National Field Manual for the Collection of Water Quality Data. U.S. Geological Survey Techniques of Water-Resources Investigations, Book 9

General Information and Guidelines: U.S. Geological Survey Techniques of Water-Resources Investigations

APPENDIX 3-C. Scott Valley Dry Well Risk Analysis

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10/10/2021

Contents

Introduction

This analysis seeks to determine the number of wells that may be dewatered due to declining groundwater levels. In the Scott Valley, groundwater elevations are highly seasonal, so the highest risk of dewatering occurs in the late summer and early fall.

A thorough assessment would involve a comparison of historic and current water levels against well construction details across all or a representative subset of wells in Scott Valley. However, two key data limitations inhibit a comparison of well construction details with water levels where they have been measured in wells:

- Well depth and perforated intervals, on one hand, and water level observations on the other have been collected by multiple organizations/agencies. They are listed here along with their abbreviations used in Table 1.
  - California Department of Water Resources (DWR)
  - UC Davis researchers, in a 2013 review of Well Completion Reports (UCD Review 2013)
  - Quartz Valley Indian Reservation (QVIR)
  - Transducer data collected by Larry Walker and Associates for the County of Siskiyou, referred to collectively as the Groundwater Observatory (LWA GWO)
- For most wells associated with water level measurements, no well construction information is readily available, making a direct comparison of water levels and well depth or perforated interval impossible without significant further reconnaisance.
  - In some cases, well construction details may be available for some wells with observations, but matching them is currently not possible because different organizations/agencies refer to wells with different identifiers.

Consequently, rather than comparing groundwater elevations with screened intervals, this analysis focuses on interpolated groundwater elevation data to assess the aggregated risk of wells not being able to pump water due to low water levels ("well outages"). The risk analysis necessarily utilizes basic information that is readily available and is therefore limited in its specificity. Future analysis may provide a more refined risk assessment.

Methods

Information available for conducting this well outage risk analysis is shown below in Table 1. All wells are associated with location (latitude and longitude). Well locations are accurate to the section level (1 square mile). Well completion reports (e.g., https://water.ca.gov/Programs/Groundwater-Management/Wells/Well-Completion-Reports) may have more detailed information, but these are generally not digitized and field-validated for their exact location and elevation datum.

Estimating the elevation datum for each well is based on the USGS reported elevation at the location of the well reported by the respective program agency (mostly DWR). The accuracy of the elevation is estimated to be within 3% of one-half mile, i.e., 80 feet, where 3% represents a general maximum landscape slope within the Scott Valley groundwater basin and one-half mile represents the maximum distance of the actual well location from the reported well location. Clearly, for comparison of water levels with well depth, an inaccuracy of potentially several tens of feet in the well location elevation is highly problematic.

Hence, a first step in this analysis was to identify wells where observed water levels could be directly compared against screened intervals, or, failing that, against the total depth of the well within which the measurement was taken. Wells located in the UC Davis 2013 Well Review, during development of the Scott Valley Integrated Hydrologic Model, were associated only with a well completion report. DWR's CASGEM program collected observations and some well construction information for a limited number of wells. The Quartz Valley Indian Reservation's private monitoring program has collected observations in domestic wells, but well construction information for these wells was not available. Similarly, well depth is available for only 6 wells participating in the LWA GWO transducer program (i.e. continuous water elevation monitoring).

A direct comparison of water levels to screened interval or well depth is not currently possible for the overwhelming majority of Scott Valley wells. A future matching effort would help connect some of the UCD Review wells (from Well Completion Reports) with anonymized well identifiers used for recent water level observations, for an aggregated analysis of well outage risk within the network of wells with known water levels.

Instead, the analysis focuses a) on overall well depth distribution in Scott Valley and b) a preliminary, highly approximative estimate of the depth of the bottom of a well below the water table ("wet water column depth of wells") that is used to determine the cumulative distribution of well depth, especially at depths that are approximately equal to the water level.

Table 1: Available information for Scott Valley wells, collected by 4 different monitoring programs/agencies.

Depth, Obs., Perf. Available?	Well Info Source	No. of Wells
None (location only)	LWA GWO	7
None (location only)	QVIR	3
Total Depth Only	LWA GWO	3
Total Depth Only	UCD Review 2013	136
Observations Only	DWR	5
Observations Only	LWA GWO	1
Observations Only	QVIR	16
Observations Only	UCD Review 2013	50
Perforation Only	–	0
Observations and Depth	DWR	6
Observations and Depth	LWA GWO	6
Perforation and Observations	DWR	1
Perforations and Depth	UCD Review 2013	61
Depth, Obs. and Perf.	–	0

The second step in the risk analysis, after considering well depth distribution, is a comparison of an interpolated water level, obtained by mapping measured water levels in Scott Valley, against the estimated elevation of the bottom of each well for which depth information is available, at the reported location. The difference between these two values is herein referred to as the "wet water column depth", or:

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[interpolated groundwater surface] - [estimated elevation of bottom of
well] = [wet water column depth]
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Three water level maps were constructed from water levels measured in the fall of 2014 (dry year), in the fall of 2015 (dry year), and in the fall of 2017 (wet year). Most wells in Scott Valley reached their lowest recorded water levels in the fall of 2014 or in the fall of 2015, but recovered by the fall of 2017. Water level maps were constructed using spline interpolation on water level measurements in over thirty wells. The water level maps were used to digitally determine the interpolated water level elevation at the reported location of each well considered.

The risk of residential wells is obviously more of a threat to human health and safety than other well types. However, because the number of residential wells within the existing database represents only a small subset of the residential wells located through out Scott Valley, threats to residential wells specifically have not been evaluated here. The uses of wells in this dataset, broken out by data source, is listed in Table 2.

Table 2: Available well use information for Scott Valley wells, collected by 4 different monitoring programs/agencies.

Well Use	Well Info Source	No. of Wells
Irrigation	DWR	1
Other	DWR	1
Residential	DWR	7
Unknown	DWR	3
Irrigation	LWA GWO	3
Observation	LWA GWO	3
Residential	LWA GWO	5
Residential	QVIR	19
Irrigation	UCD Review 2013	197

Results and Discussion

The distribution of available data on well depth and perforation intervals is shown in Figure 1. Well depth reported for irrigation wells in Scott Valley range from as little as 10 feet to as deep as 400 feet. One quarter of wells is less than 70 feet deep, one quarter of wells is more than 150 feet deep, and the average well depth is about 100 feet (all depths are below ground surface, bgs). Most irrigation wells appear to be screened from about 30 feet depth to the bottom of the well. Few irrigation wells (based on the limited number of wells for which screen information is available), have their top of screen deeper than 50 feet.

The cumulative distribution (CD) of well depth and the cumulative distribution of depth to groundwater (measurements collected 2010-2021) are compared in Figure 2. We note that the two curves represent two separate groups of wells: The dots on the blue curve do not represent the water level depth corresponding to the well depth (black dot) at the same x-axis position (directly below the blue dot). The water level depth data represent actually measured water levels from the last ten years, across the available datasets. Most wells in Scott Valley have a relatively shallow depth to groundwater: Two-thirds of measurement data show depth to the water table of less than 30 feet below ground surface. There are few wells with relatively deep water levels: About 5% of measurements indicate water level depths exceeding 75 feet. This finding corresponds to the distribution of water level depths in the representative monitoring network for groundwater levels (Chapter 3 in the Scott Valley Grounwater Sustainability Plan). Overall well depth exceeds depth to water table by more than 70 feet. However, some deep wells may have very shallow water table and some shallow wells may have intermediate depth to water table with relatively shallow water column.

The interpolated, contoured groundwater elevation in September of 2015 is shown in Figure 3, together with the location of the wells with water level measurements that are used for the water level interpolation. Estimates of water levels are most accurate near the locations of the measured wells. Estimates deteriorate in accuracy with larger distance from a measured well (also see Chapter 2 in the Scott Valley Groundwater Sustainability Plan).

The estimated wet water column depth is shown in the following map. If the interpolated elevation of the water table was above the bottom of the well, the wet water column depth is positive (color-coded blue in Figure 4 and Figure 5). If the interpolated water level elevation was below the bottom the well, the difference is shown as a negative number, and these wells are color coded orange or red in Figure 4 and Figure 5. About 10% of wells have an estimated wet water column depths that is negative. About 20% of wells are estimated to have non-negative wet water column depths that is relatively shallow - less than 50 feet. Over two-thirds of wells are estimated to have a wet water column depth of more than 50 feet, consistent with the illustrated difference between the water table depth CD and the well depth CD in Figure 2. The wells most vulnerable to well outage are those with the least (or negative) wet water column depth.

A negative wet water column depth may be the result of a real event, e.g., the well is old and has been dry for some time. A negative wet water column depth may also be the result of estimation errors:

1) the interpolated water level elevation used to estimate wet water column depth can be associated with significant error, from few feet to few tens of feet, due to limitations of the interpolation algorithm
2) the elevation at the reported well location is significantly different from the land elevation at the actual well location (up to 80 feet, see above), or
3) well depth is inaccurately reported.

The absolute value of the wet water column depth is therefore thought to be of poor accuracy. However, their cumulative distribution is indicative of the relative distribution of wet water column depths. The cumulative distribution of the wet water column depth is shown in Figure 6 for all three times for which the esimate was computed. A zoomed-in version of this Figure, focused on wet water column depths from 0 feet to 200 feet is shown in Figure 7. Fall water wet water column depths are shown for dry years 2014 and 2015 as well as the fall of 2017, following a wet winter, for comparison purposes. The cumulative distribution of wet water column depth indicates that fall 2015 water level conditions resulted in the shallow-most conditions across nearly all wells in the Scott Valley (in other words, the green curve is above - shallower than - the blue and yellow curve). As expected, wet water column depth is largest (in the figure: lowest) in 2017, a wet year. The difference between years is least where (estimated) wet water column depth is either very shallow or even negative and also where it is over 100 feet. In the intermediate range, from 30 feet to 120 feet wet water column depth, the difference between fall of 2015 and fall of 2017 is about 10 feet (about 50% of wells).

The absolute value of the wet water column depth is, as indicated, highly uncertain. However, the slope of the cumulative distribution shown is relatively uniform at either end of the distribution and is therefore much less sensitive to the above listed uncertainties. Figure 6 indicates that the slope of the CD is approximately 0.1 (in x-axis direction) per 50 feet (in y-axis direction), for the range of wet water column depths of -30 feet to 30 feet. This slope is equal to 0.02 per 10 feet or 0.01 per 5 feet. Hence, this slope is representative for the approximately one-fifth of Scott Valley wells that have the least estimated wet water column depth and would be most susceptible to well outages. Given the range over which the slope applies, the slope value is much less sensitive to the specific estimated wet water column depth at a well, but rather applies to all shallow (or negative) values. If we further assume that the minimum wet water column depth needed is similar for most domestic wells, then the slope can be interpreted as the risk for well outage with additional water level decline below the historically low values of 2014 and 2015: The slope of 0.01 per 5 feet indicates that 1% of Scott Valley wells are likely to experience well outage for every 5 feet of water level decline below water levels of 2014 and 2015.

Importantly, this approach to estimating well outage risk does not require knowledge of specific well information about pumping bowl elevation relative to the screen location, or about a minimum wet water level depth needed to pump properly. It only assumes that the historically low water level depths of 2014 and 2015 brought some wells close to well outage (or did cause unreported outage) and, hence, the selected slope is representative of the 20% wells at most risk to well outage.

This allows for an estimate of the undesirable result that would occur if water levels declined to the minimum threshold. The depth to water level at the minimum threshold is defined as 110% of the deepest depth to water level observed. In most areas of the groundwater basin, the deepest depth to the water level observed over time is less than 30 feet (see above), hence the minimum threshold in most areas would allow at most 3 feet of additional lowering of water levels. Only one well in the Representative Monitoring Network has a water level depth of 100 feet, and would be allowed an additional 10 feet of water level lowering. Given that a 5 foot decline puts about 1% of Scott Valley wells at risk of well outage, the selection of the minimum threshold does not pose a significant risk of widespread well outage: about 10 wells out of approximately 1,000 domestic wells would be at risk of well outage if water levels lowered to the minimum threshold everywhere in Scott Valley.

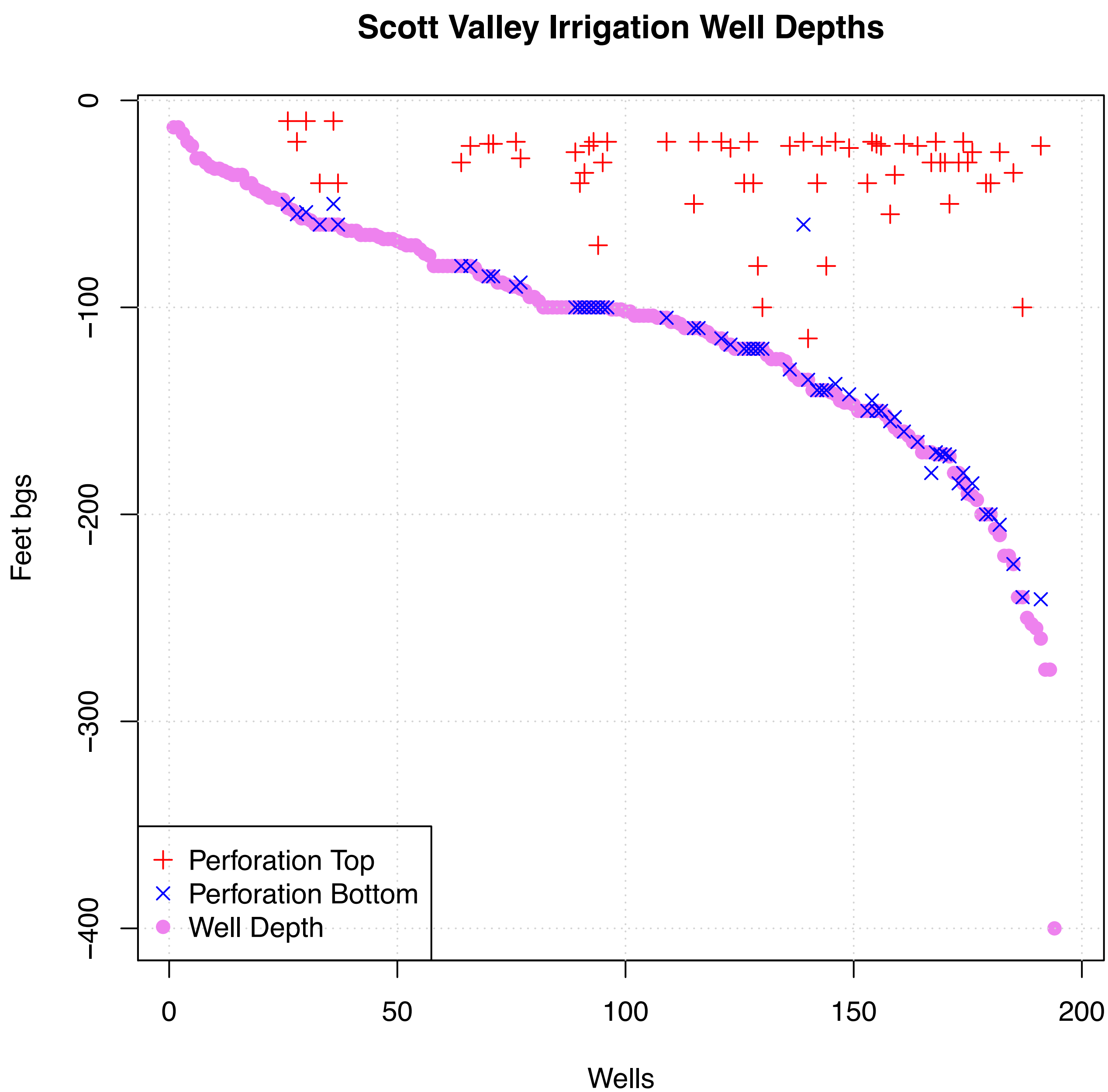

Figure 1: Distribution of well depths and associated screened intervals available for Scott Valley wells.

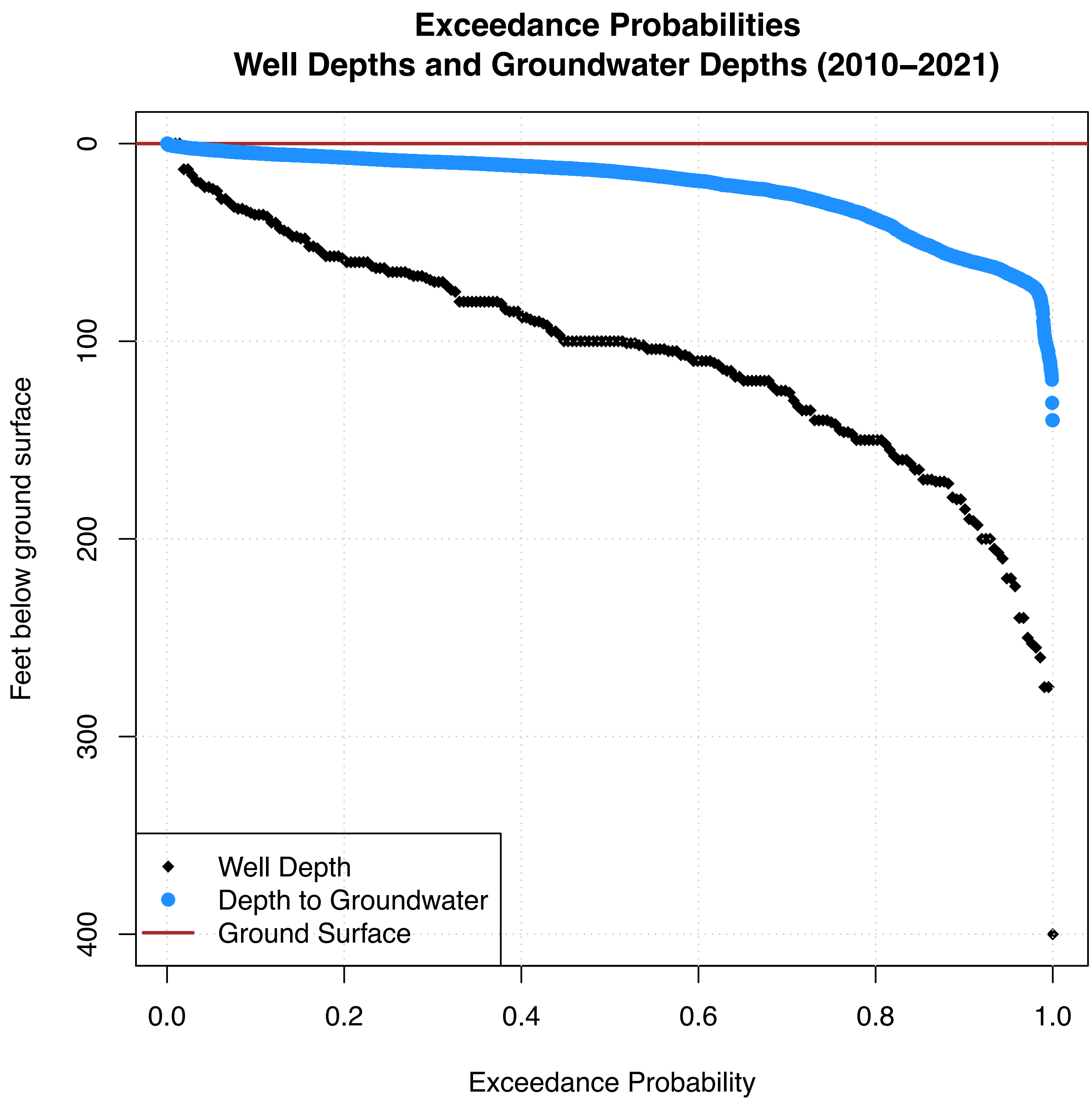

Figure 2: Distribution of all well depths and, separately, distribution of the last 10 years of water level data available for Scott Valley wells.

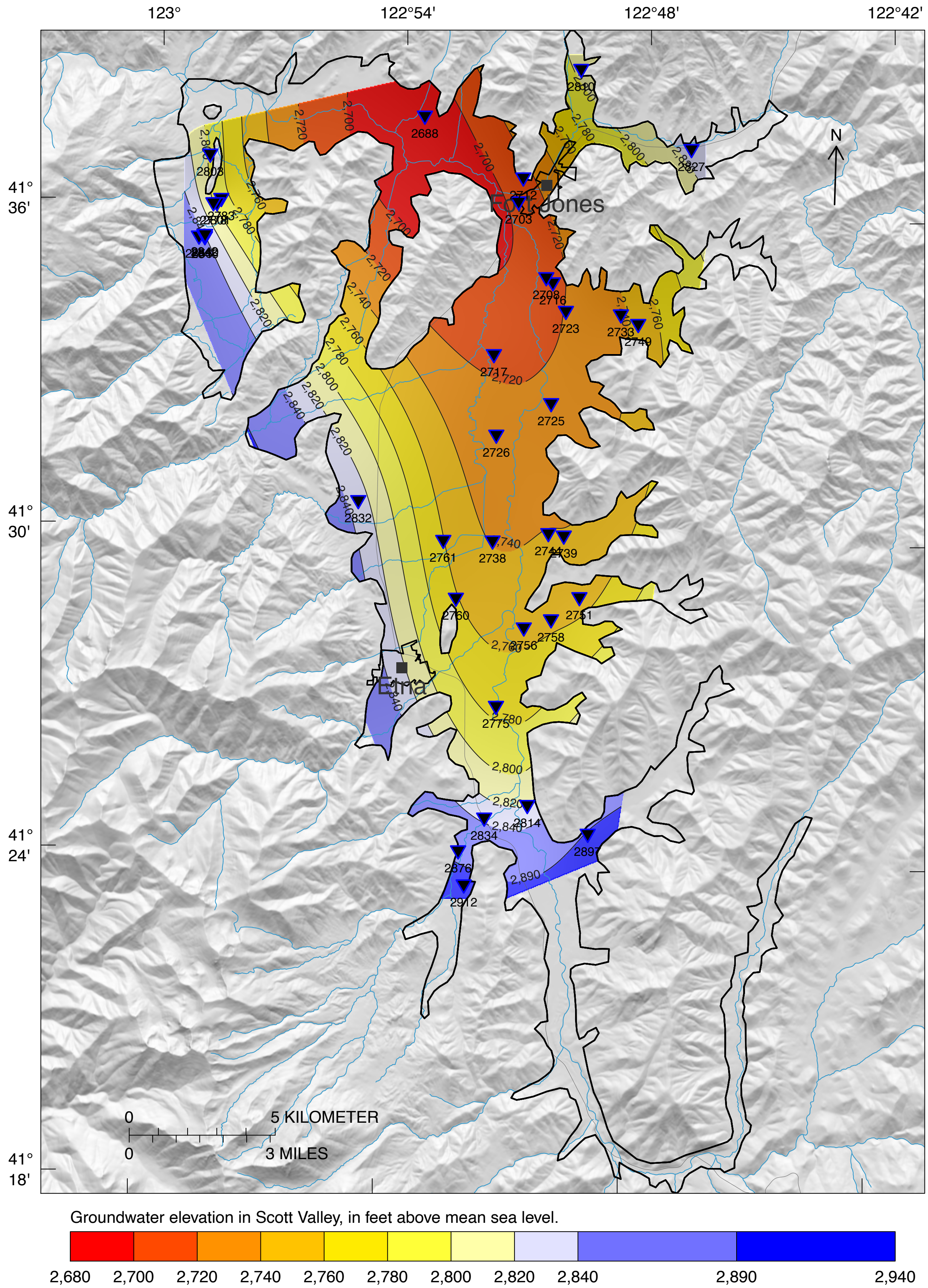

Figure 3: Interpolated (splined) Scott Valley groundwater table elevation, September 2015. Blue triangles indicate points of measurement.

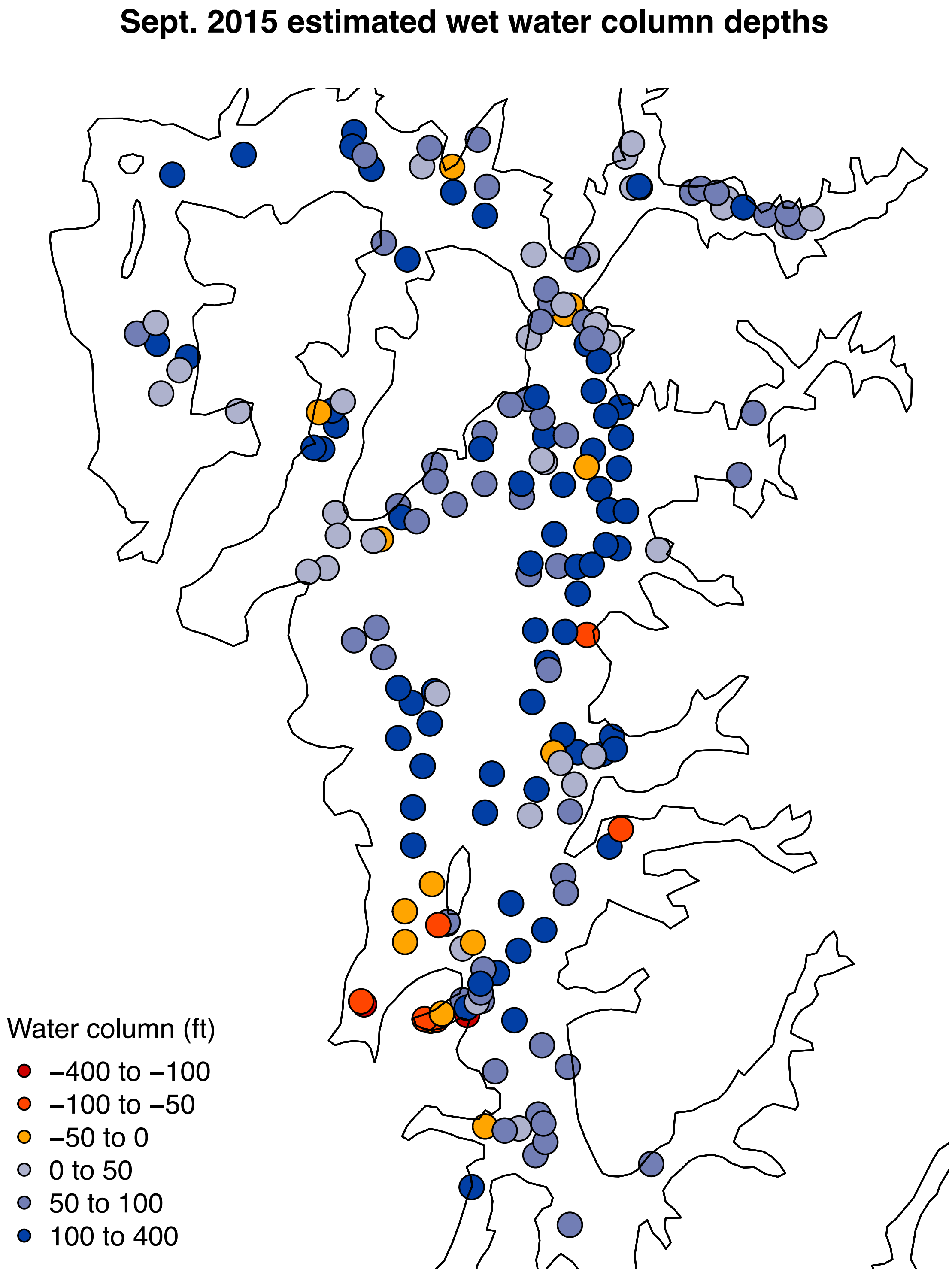

Figure 4: Wet water column depths based on interpolated, contoured groundwater level elevations, September 2015. Negative values indicate that the interpolated groundwater level is below the estimated depth of the well (see Discussion for further information).

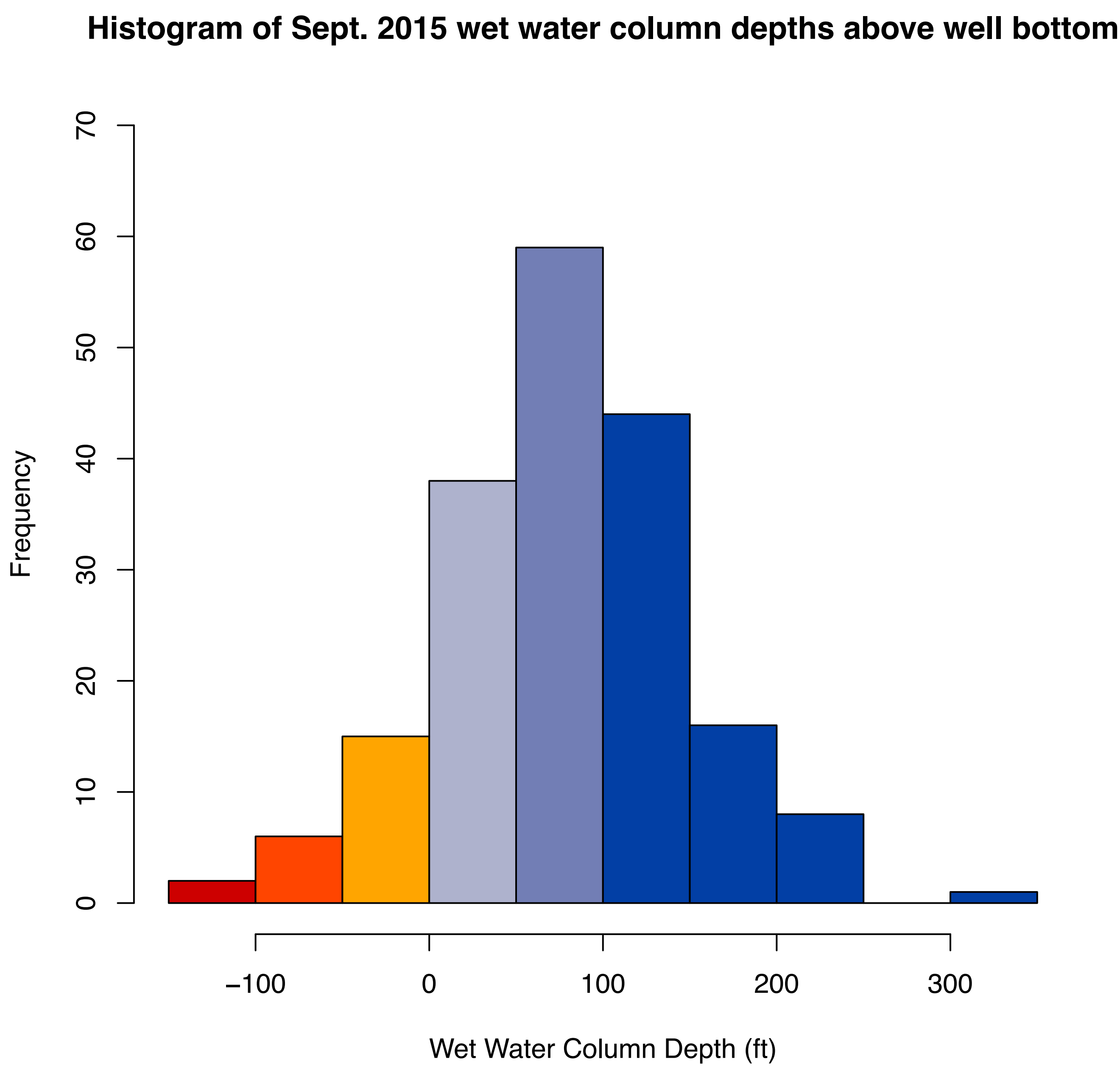

Figure 5: Histogram of wet water column depths based on interpolated, contoured groundwater level elevations, September 2015.

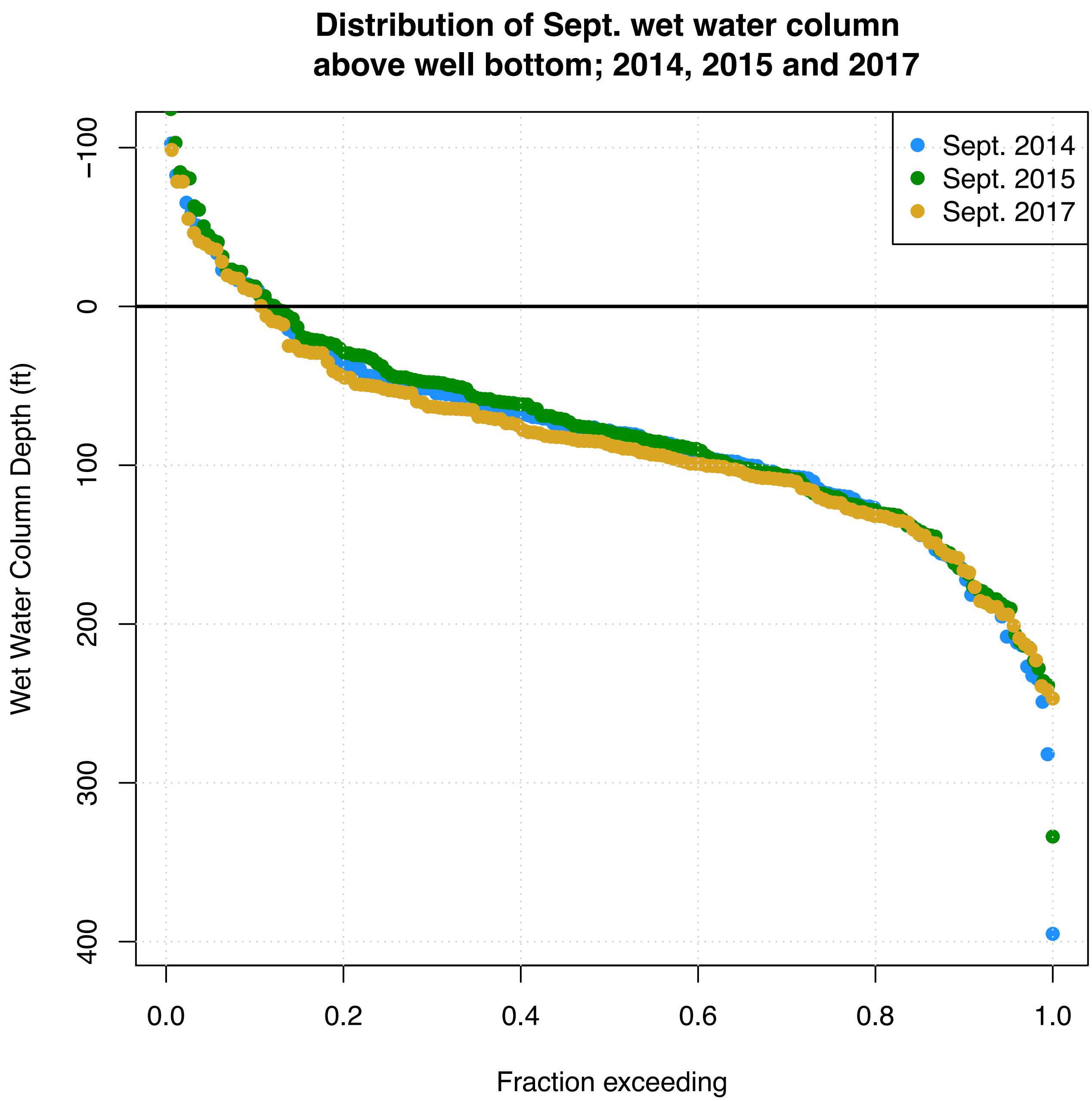

Figure 6: Cumulative distribution function of wet water column depths based on interpolated, contoured groundwater level elevations, Septembers of 2014, 2015 and 2017.

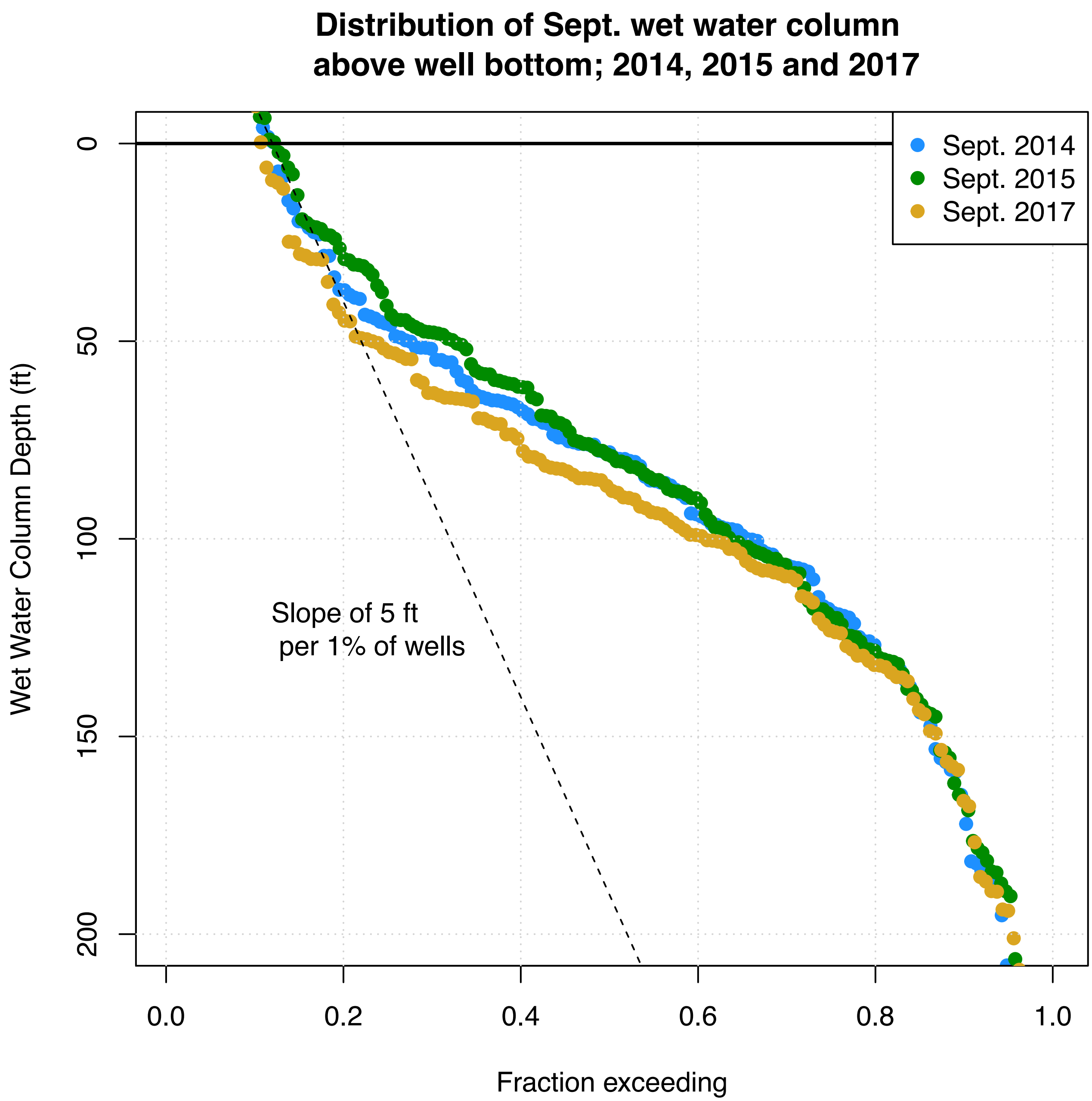

Figure 7: Cumulative distribution function of wet water column depths based on interpolated, contoured groundwater level elevations, Septembers of 2014, 2015 and 2017, here showing only the portion of the cumulative distribution function for depths 0 feet to 200 feet.

Conclusion

We identified three key findings with respect to well outages:

Majority of wells unlikely to be affected by dewatering. Most wells in Scott Valley have well depths of 50 feet or more below the interpolated groundwater elevations depths of 2014 and 2015 (at least 65%).

Uncertainty affects analysis quality. The analysis is relatively uncertain due to the lack of wells with both water level measurements and known well construction. The analysis needed to rely on interpolated water level data, which may be several feet or even tens of feet incorrect in some areas. This may be the case especially regarding the ~13% of wells which bottom out above the interpolated water level depth and wells with very shallow (< 30 feet) wet water column depth (Figure 7) in 2014, 2015 (two dry years) and 2017 (a wet year).

Negative and exceedingly shallow positive wet water column depths are the result of any of the following:

1) the well goes dry in the fall, regardless of water year type, or, if it does not,
2) the water level interpolation is erroneous, or
3) the well is located at a lower elevation than estimated for the reported location, or
4) well depth is inaccurately reported.

We relied instead on the slope of the cumulative distribution of estimated wet water column depth, which is a more stable indicator of how many additional wells fall dry per 5 foot decline in water levels below historically low water levels of 2014 and 2015. We find that:

The number of wells affected by groundwater elevations at the Minimum Threshold is probably very small. The minimum threshold is 10% lower than the minimum measured depth to the water table (see Chapter 3). In most Scott Valley areas, where water depth of groundwater is less than 30 feet, water levels at the minimum threshold would be less than 3 feet lower than in 2014. A very small number of wells would be affected by that, as shown in Figures 5 and 6. Considering Table 5 of Chapter 3 (page 35), the minimum threshold is at most 10 ft below the historically deepest measured water level. This much lowering to the MT would occur only in wells that already have a depth to water of 100 feet. For most wells, the MT is less than five feet below historically low levels. Based on slope of the CD of the wet water column depth, a five foot lowering of the water level would affect approximately 1% of domestic wells (about 10) and 1% of agricultural wells (about 2).

Appendix 3-D Water Quality Assessment

Regulatory Background

Federal and State Regulations

The overarching federal law concerning groundwater quality is the Clean Water Act, passed in 1972, and applicable to surface waters and wetlands. In contrast, the federal Safe Drinking Water Act (SDWA) applies to both surface and groundwater, providing protection to drinking water supplies. Under the SDWA, federal standards were established through the United States Environmental Protection Agency (USEPA), in the form of maximum concentration levels (MCLs). Secondary maximum contaminant levels (SMCLs) have also been established at the federal level; these address esthetics of drinking water sources and are not enforceable. The state of California has its own Safe Drinking Water Act that includes MCLs and SMCLs which are, for select constituents, stricter than those set at the federal level. The California MCLs and SMCLs are codified in Title 22 of the California Code of Regulations (CCR). The standards established under the federal and state Safe Drinking Water Acts are enforced through the State Water Resource Control Board's (SWRCB's) Division of Drinking Water (DDW).

The California Porter-Cologne Water Quality Act, contained in California Water Code Division 7, applies to groundwater and surface waters, designating responsibility for water quality and safe drinking water to the SWRCB and the nine Regional Water Quality Control Boards (RWQCB) in California. The Act requires RWQCBs to develop water quality control plans for the region with defined water quality objectives. These water quality objectives, defined for specific hydrologic regions, protect the quality of surface waters, groundwaters, and associated beneficial uses. The water quality control plan must be approved by both the SWRCB and the USEPA. The Scott Valley Basin is in the North Coast Region and is regulated under the North Coast Regional Water Quality Control Board (Regional Water Board), with water quality objectives detailed in the Water Quality Control Plan for the North Coast Region (Basin Plan)[1] .

The SWRCB's Policy for Water Quality Control For Recycled Water (Recycled Water Policy)[2] , most recently amended in 2018, includes additional requirements to address salt and nutrients. Under this policy, Regional Water Boards are required to assess basins or subbasins within the region where water quality is threatened by salt and nutrients, and where management is required. In basins or subbasins where salt and nutrients are identified as a threat, a salt and nutrient management plan (SNMP) or equivalent management plan is required; this plan can address other constituents in addition to salt and nutrients.

Water Quality Control Plan for the North Coast Region

The Water Quality Control Plan for the North Coast Region (Basin Plan) is a regulatory tool used by the North Coast Regional Water Quality Control Board (Regional Water Board) to protect water quality within the North Coast Region. The Basin Plan is adopted by the NCRWQCB and approved by the State Water Resources Control Board; the water quality standards are approved by the United States Environmental Protection Agency (USEPA). Within the Basin Plan, beneficial uses of water, water quality objectives, including an antidegradation policy and plans for implementing protections are included. Table 2-1 of the Basin Plan designates all groundwaters with the beneficial uses of: Municipal and Domestic Supply (MUN), Agricultural Supply (AGR), Industrial Service Supply (IND), and Native American Culture (CUL) with potential beneficial of Industrial Process Supply (PRO) and Aquaculture (AQUA) (California North Coast Regional Water Quality Control Board 2018). For chemical constituents

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[1] North Coast Regional Water Quality Control Board. 2018. "Water Quality Control Plan for the North Coast Region". Available: https://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/}

[2] SWRCB Resolution No. 2018-0057 and "Amendment to the Policy for Water Quality Control For Recycled Water". Available:
https://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2018/121118_7_final_amendment_oal.pdf

in waters with MUN beneficial uses, the Basin Plan specifies that no waters are to exceed the maximum contaminant levels (MCL) in Title 22 of the California Code of Regulations (CCR). The Basin Plan also includes numeric water quality constituents, specifically for groundwaters in the Scott Valley hydrologic area. A complete list of constituents, comparison concentrations and sources are listed in Table 2.

Table 2: Comparison concentrations and data sources for constituents used in the water quality assessment

Full Name	MCL	Units	Source
2,4-Dichlorophenoxyacetic acid (2,4 D)	70	ug/L	Title 22 - Table 64444-A
Acetone	6300	ug/L	RfD
Silver	100	ug/L	Title 22 - Table 64449-A
Aluminum	200	ug/L	Title 22 - Table 64449-A
Alachlor	2	ug/L	Title 22 - Table 64444-A
Aldicarb	7	ug/L	HBSL
Aldicarb Sulfone	7	ug/L	HBSL
Aldicarb sulfoxide	7	ug/L	HBSL
Gross Alpha radioactivity	15	pCi/L	Title 22 - Table 64442
Arsenic	10	ug/L	Title 22 - Table 64431-A
Asbestos	7	MFL	Title 22 - Table 64431-A
Atrazine	1	ug/L	Title 22 - Table 64444-A
Azinphos Ethyl	10	ug/L	HBSL
Guthion (Azinphos Methyl)	10	ug/L	HBSL
Boron	0.1 (50% and 90% UL),	mg/L	Basin Plan - Table 3-1
Barium	1	mg/L	Title 22 - Table 64431-A
Bromodichloromethane (THM)	80	ug/L	MCL
Beryllium	4	ug/L	Title 22 - Table 64431-A
Bensulfuron Methyl	1000	ug/L	HBSL
Gross beta	50	pCi/L	MCL-US
Alpha-Benzene Hexachloride (Alpha-BHC)	0.15	ug/L	CA-Prop65
Beta-Benzene Hexachloride (Beta-BHC)	0.25	ug/L	CA-Prop65
Lindane (Gamma-BHC)	0.2	ug/L	Title 22 - Table 64444-A
Di(2-ethylhexyl)phthalate (DEHP)	4	ug/L	Title 22 - Table 64444-A
Methyl Bromide (Bromomethane)	10	ug/L	US-HAL
Bromate	10	ug/L	MCL-US
Bromacil	70	ug/L	US-HAL
n-Butylbenzene	260	ug/L	NL
sec-Butylbenzene	260	ug/L	NL
tert-Butylbenzene	260	ug/L	NL
Bentazon	18	ug/L	Title 22 - Table 64444-A
Benzene	1	ug/L	Title 22 - Table 64444-A
Benzo(a)pyrene	0.2	ug/L	Title 22 - Table 64444-A
Toluene	150	ug/L	Title 22 - Table 64444-A
Cadmium	5	ug/L	Title 22 - Table 64431-A
Carbon Disulfide	160	ug/L	HBSL
Chlorate	800	ug/L	NAS-HAL
Chlordane	0.1	ug/L	Title 22 - Table 64444-A
Chlorite	1	mg/L	MCL-US
Chloride	500	mg/L	Title 22 - Table 64449-B

Full Name	MCL	Units	Source
Chlorobenzene	70	ug/L	Title 22 - Table 64444-A
2 Chlorotoluene	140	ug/L	US-HAL
4 Chlorotoluene	140	ug/L	HBSL
Chloropicrin	12	ug/L	NAS-HAL
Cyanide (CN)	150	ug/L	Title 22 - Table 64431-A
Total Coliform Bacteria	0.99	Count	MCL
Chromium	50	ug/L	Title 22 - Table 64431-A
Chromium, Hexavalent (Cr6)	20	ug/L	HBSL
Carbofuran	18	ug/L	Title 22 - Table 64444-A
Carbon Tetrachloride	0.5	ug/L	Title 22 - Table 64444-A
Copper	1	mg/L	Title 22 - Table 64449-A
Cyanazine	0.3	ug/L	HBSL
Cypermethrin	40	ug/L	HBSL
Dacthal	70	ug/L	HBSL
Dalapon	200	ug/L	Title 22 - Table 64444-A
Dibromochloromethane (THM)	80	ug/L	MCL
1,2-Dibromo-3-chloropropane (DBCP)	0.2	ug/L	Title 22 - Table 64444-A
1,1-Dichloroethane (1,1 DCA)	5	ug/L	Title 22 - Table 64444-A
1,2 Dichloroethane (1,2 DCA)	0.5	ug/L	Title 22 - Table 64444-A
1,2 Dichlorobenzene (1,2-DCB)	600	ug/L	Title 22 - Table 64444-A
1,3-Dichlorobenzene	600	ug/L	US-HAL
1,4-Dichlorobenzene (p-DCB)	5	ug/L	Title 22 - Table 64444-A
1,1 Dichloroethylene (1,1 DCE)	6	ug/L	Title 22 - Table 64444-A
cis-1,2 Dichloroethylene	6	ug/L	Title 22 - Table 64444-A
trans-1,2, Dichloroethylene	10	ug/L	Title 22 - Table 64444-A
Dichloromethane (Methylene Chloride)	5	ug/L	Title 22 - Table 64444-A
1,3 Dichloropropene	0.5	ug/L	Title 22 - Table 64444-A
1,2 Dichloropropane (1,2 DCP)	5	ug/L	Title 22 - Table 64444-A
Dichlorprop	300	ug/L	HBSL
4,4’-DDD	0.1	ug/L	CA-CPF
4,4’-DDE	0.1	ug/L	CA-CPF
4,4’-DDT	0.1	ug/L	CA-CPF
Deethylatrazine	50	ug/L	CA-Prop65
Diazinon	1.2	ug/L	HBSL
Dicamba	210	ug/L	RfD
Dichlorvos (DDVP)	0.4	ug/L	HBSL
Dieldrin	0.002	ug/L	HBSL
Diesel	100	ug/L	US-HAL
Dimethoate	2	ug/L	HBSL
Dinoseb	7	ug/L	Title 22 - Table 64444-A
1,4-Dioxane	1	ug/L	HBSL
Diquat	20	ug/L	Title 22 - Table 64444-A
Diuron	2	ug/L	HBSL

Continued on next page

Full Name	MCL	Units	Source
Di(2-ethylhexyl)adipate	0.4	mg/L	Title 22 - Table 64444-A
Ethylbenzene	300	ug/L	Title 22 - Table 64444-A
1,2 Dibromoethane (EDB)	0.05	ug/L	Title 22 - Table 64444-A
Endosulfan I	42	ug/L	RfD
Endosulfan II	42	ug/L	RfD
Endosulfan Sulfate	42	ug/L	RfD
Endothall	100	ug/L	Title 22 - Table 64444-A
Endrin	2	ug/L	Title 22 - Table 64444-A
EPTC	200	ug/L	HBSL
Ethylene glycol	14	mg/L	US-HAL
Fluoride	2	mg/L	Title 22 - Table 64431-A
Trichlorofluoromethane (Freon 11)	150	ug/L	Title 22 - Table 64444-A
1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	1.2	mg/L	Title 22 - Table 64444-A
Dichlorodifluoromethane	1	mg/L	HBSL
Fecal Coliform (bacteria)	0.99	Count	MCL
Iron	300	ug/L	Title 22 - Table 64449-A
Fenamiphos	0.7	ug/L	HBSL
Foaming Agents (MBAS)	0.5	mg/L	Title 22 - Table 64449-A
Fonofos	10	ug/L	HBSL
Formaldehyde	100	ug/L	US-HAL
Gasoline	5	ug/L	US-HAL
Glyphosate (Round-up)	700	ug/L	MCL-US
Tritium	20000	pCi/L	Title 22 - Table 64443
Hexachlorobutadiene	0.9	ug/L	HBSL
Hexachlorocyclopentadiene	50	ug/L	Title 22 - Table 64444-A
Hexachlorobenzene (HCB)	1	ug/L	MCL-US
Heptachlor	0.01	ug/L	Title 22 - Table 64444-A
Heptachlor Epoxide	0.01	ug/L	Title 22 - Table 64444-A
Hexazinone	400	ug/L	HBSL
Mercury	2	ug/L	Title 22 - Table 64431-A
Octogen (HMX)	0.35	mg/L	US-HAL
Iodide	1190	ug/L	NAS-HAL
Isopropylbenzene (Cumene)	770	ug/L	HBSL
Iprodione	0.8	ug/L	HBSL
Kerosene	100	ug/L	US-HAL
Linuron	5	ug/L	HBSL
Malathion	500	ug/L	HBSL
Metalaxyl	500	ug/L	HBSL
Methomyl	200	ug/L	HBSL
Metolachlor	700	ug/L	HBSL
Metribuzin	90	ug/L	HBSL
Methyl Isobutyl Ketone (MIBK)	120	ug/L	NL

Continued on next page

Full Name	MCL	Units	Source
Manganese	50	ug/L	Title 22 - Table 64449-A
Molybdenum	40	ug/L	US-HAL
Molinate	20	ug/L	Title 22 - Table 64444-A
MTBE (Methyl-tert-butyl ether)	5	ug/L	Title 22 - Table 64449-A
Methoxychlor	30	ug/L	Title 22 - Table 64444-A
Sodium	50	mg/L	AL
Naled	10	ug/L	HBSL
Naphthalene	17	ug/L	HBSL
Napropamide	800	ug/L	HBSL
Ammonia	30	mg/L	US-HAL
Nickel	100	ug/L	Title 22 - Table 64431-A
N-Nitrosodiethylamine (NDEA)	0.01	ug/L	CA-CPF
N-Nitrosodimethylamine (NDMA)	0.01	ug/L	CA-CPF
N-Nitrosodi-N-Propylamine (NDPA)	0.01	ug/L	CA-CPF
Nitrite as N	1	mg/L	Title 22 - Table 64431-A
Nitrate as N	10	mg/L	Title 22 - Table 64431-A
Nitrate+Nitrite	10	mg/L	Title 22 - Table 64431-A
Norflurazon	10	ug/L	HBSL
Oxamyl	50	ug/L	Title 22 - Table 64444-A
Oxyfluorfen	20	ug/L	HBSL
Parathion	0.02	ug/L	HBSL
Lead	15	ug/L	AL
n-Propylbenzene (Isocumene)	260	ug/L	NL
1,1,2,2 Tetrachloroethane (PCA)	1	ug/L	Title 22 - Table 64444-A
Perchlorate	6	ug/L	Title 22 - Table 64431-A
Polychlorinated Biphenyls (PCBs)	0.5	ug/L	MCL-US
Tetrachloroethene (PCE)	5	ug/L	Title 22 - Table 64444-A
PCNB	21	ug/L	RfD
Pentachlorophenol (PCP)	1	ug/L	MCL-US
Permethrin	4	ug/L	HBSL
Perfluorooctanoic acid	5.1	ng/L	US-HAL
Perfluorooctanoic sulfonate	6.5	ng/L	NL
pH	7.0-8.0	-log[H+]	Basin Plan - Table 3-1
Phorate	4	ug/L	HBSL
Picloram	0.5	mg/L	Title 22 - Table 64444-A
Prometon	400	ug/L	HBSL
Prometryn	300	ug/L	HBSL
Propachlor (2-Chloro-N-isopropylacetanilide)	90	ug/L	HBSL
Propanil	6	ug/L	HBSL
Propargite	1	ug/L	HBSL
Radium 226	5	pCi/L	Title 22 - Table 64442
Radium 228	5	pCi/L	Title 22 - Table 64442

Continued on next page

Full Name	MCL	Units	Source
RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine)	0.3	mg/L	US-HAL
Radon 222	4000	pCi/L	MCL-US
Antimony	6	ug/L	Title 22 - Table 64431-A
Specific Conductivity	250 (50% UL), 500 (90% UL)	micromhos	Basin Plan - Table 3-1
Selenium	50	ug/L	Title 22 - Table 64431-A
Carbaryl (1-naphthyl methylcarbamate)	40	ug/L	HBSL
2,4,5-TP (Silvex)	50	ug/L	Title 22 - Table 64444-A
Simazine	4	ug/L	Title 22 - Table 64444-A
Sulfate	500	mg/L	Title 22 - Table 64449-B
Strontium	4000	ug/L	US-HAL
Strontium 90	8	pCi/L	Title 22 - Table 64443
Styrene	100	ug/L	Title 22 - Table 64444-A
tert-Butyl alcohol (TBA)	12	ug/L	NL
Bromoform (THM)	80	ug/L	MCL
1,1,1-Trichloroethane	200	ug/L	Title 22 - Table 64444-A
1,1,2-Trichloroethane	5	ug/L	Title 22 - Table 64444-A
1,2,4- Trichlorobenzene (1,2,4 TCB)	5	ug/L	Title 22 - Table 64444-A
2,3,7,8-TCDD	0.00003	ug/L	MCL-US
Trichloroethene (TCE)	5	ug/L	Title 22 - Table 64444-A
Chloroform (THM)	80	ug/L	MCL
1,2,3-Trichloropropane (1,2,3 TCP)	0.005	ug/L	Title 22 - Table 64444-A
Total Dissolved Solids	1000	mg/L	Title 22 - Table 64449-B
tebuthiuron	1000	ug/L	HBSL
Thiabendazole	231	ug/L	HHBP
Thiobencarb	1	ug/L	Title 22 - Table 64449-A
Total Trihalomethanes	80	ug/L	MCL-US
Thallium	2	ug/L	Title 22 - Table 64431-A
1,2,4-Trimethylbenzene	330	ug/L	NL
1,3,5-Trimethylbenzene	330	ug/L	NL
2,4,6-Trinitrotoluene (TNT)	1	ug/L	US-HAL
Toxaphene	3	ug/L	Title 22 - Table 64444-A
Trichlopyr	400	ug/L	HBSL
Trifluralin	20	ug/L	HBSL
Uranium	20	pCi/L	Title 22 - Table 64442
Vanadium	50	ug/L	RfD
Vinyl Chloride	0.5	ug/L	Title 22 - Table 64444-A
Warfarin	2	ug/L	HBSL
Xylenes (total)	1750	ug/L	Title 22 - Table 64444-A
Xylene, Isomers m & p	1750	ug/L	Title 22 - Table 64444-A
Zinc	5	mg/L	Title 22 - Table 64449-A

Water Quality Assessment

Data Sources

Water quality data was obtained from several databases and supplemented with data provided by local organizations and community members. The majority of the water quality data used in the assessment was sourced from the SWRCB's Groundwater Ambient Monitoring and Assessment Program (GAMA), a database containing datasets from agencies including the Department of Pesticide Regulation (DPR), Department of Water Resources (DWR), the State Water Board, Lawrence Livermore National Laboratory (LLNL) and the United States Geological Survey (USGS).

The datasets in GAMA with information in Scott Valley Groundwater Basin are:

- **The Public Water System Wells** dataset includes wells regulated by the State Water Board's Division of Drinking Water (DDW). This dataset includes information for active and inactive drinking water sources with 15 or more connections or more than 25 people per day.
- **National Water Information System (NWIS)**, a dataset provided by USGS with samples from water supply wells and reported quarterly to the State Water Board's data management system, GeoTracker.
- **Monitoring wells** regulated by the State Water Board includes wells under different regulatory programs, with data available for download through GeoTracker. There are monitoring wells in Scott Valley Basin for the following programs:
- Leaking Underground Storage Tank (LUST) Cleanup sites
- Department of Toxic Substances Control (DTSC) Cleanup Sites
- **DWR's Water Data Library**, a dataset including groundwater quality and depth data with samples from multiple well types including irrigation, stock, domestic and public supply.

In addition, information was obtained from USEPA Storage and Retrieval Data Warehouse (STORET), accessed through the National Water Quality Monitoring Council's (NWQMC) Water Quality Portal.

Selection of Numeric Thresholds

Numeric thresholds are used with well data to evaluate groundwater quality. These numeric standards are selected to satisfy all relevant groundwater quality standards and objectives; the general selection approach used is consistent with recommendations by the State Water Board for determination of assessment thresholds for groundwater [Reference]. More than one water quality objective or standard may apply to a constituent and a prioritization process is used to select the numeric threshold value. Where available, the strictest value, of the federal and state regulated water quality standards, and water quality objectives specified in the Basin Plan, is used.

The following sources were used in establishing the numeric thresholds:

i) Basin Plan numeric water quality objectives

Specific groundwater quality objectives are defined in the Basin Plan for specific conductance, nitrate and benzene. These limits are listed in Table 1 below.

ii) State and Federal Maximum Contaminant Levels (MCLs)

MCL-CA: State of California MCLs

MCL-US: Federal MCLs

Per the Basin Plan, groundwaters in the Scott Valley hydrologic area have a designated beneficial use as domestic or municipal water supply (MUN) beneficial use and must not exceed the maximum contaminant levels (MCLs) and secondary maximum contaminant levels (SMCLs) defined in Title 22 of the California Code of Regulations (CCR). The strictest value of the state and federal MCLs and SMCLs is used.

Table 1: Constituents of interest and associated regulatory thresholds for Scott River Valley Groundwater Basin

Constituent	Regulatory Source	Value
Benzene (ug/L)	Title 22	1 ug/L
Nitrate as Nitrogen (mg/L)	Title 22	10 mg/L
Specific Conductivity (mmhos)	Title 22	900 mmhos
Specific Conductivity (mmhos)	Basin Plan 90% Upper Limit	500 mmhos
Specific Conductivity (mmhos)	Basin Plan 50% Upper Limit	250 mmhos

Calculations

Specific water quality objectives for the Scott Valley hydrologic area groundwaters, as defined in the Basin Plan have specific limits and calculation requirements associated with specific conductance, hardness and boron. Per the Basin Plan, the 50% upper limit and 90% upper limit are defined as follows:

- 50% upper limits represent "the 50 percentile values of the monthly means for a calendar year. 50% or more of the monthly means must be less than or equal to an upper limit and greater"
- 90% upper limits represent "the 90 percentile values for a calendar year. 90% or more of the values must be equal to an upper limit and greater than or equal to a lower limit".

Measurements of specific conductance and boron were organized to enable comparison to the 50% and 90% limits through calculation of monthly means for comparison to the 50% upper limits and organization by calendar year for comparison to the 50% and 90% upper limits.

Filtering Process

To analyze groundwater quality, several filters were applied for relevance and quality. Though groundwater quality data for the Basin is available from 1952, data was limited to only include information collected in the past 30 years. Restricting the timespan from which data was collected increases confidence in data collection methods and quality of the data and focuses on information that is reflective of current groundwater quality conditions.

Groundwater quality was analyzed through comparison, for each constituent, of well data to the corresponding comparison concentration. Maps were generated for each constituent showing well locations and number of samples and categorizing and displaying data into the following groups:

a) Not detected
b) Detected but below half of the comparison concentration
c) Detected and above half of the comparison concentration
d) Above the comparison concentration

Two iterations of of map generation was conducted with the following scenarios:

1. Data is limited to those collected in the past 30 years only (1990-2020)
2. Data is limited to wells that have more than one data point in the past 30 years (1990-2020)

For the second scenario, where data is limited to wells that have more than one data point in the past 30 years, timeseries are generated for each constituent and well to identify changes over time in groundwater quality at a location.

The following sections contain the maps produced from these analyses.

Results

Constituents of Concern (COCs)

Constituents of Concern (COCs) were identified based on visual identification of potential groundwater quality issues using the maps generated in this assessment, identification of common constituents of concern and through discussion with stakeholders. Resulting from this analysis and discussion with stakeholders, the full list of constituents of concern (COCs) were:

1. Nitrate as N
2. Specific Conductivity
3. Benzene

A series of maps for each COC, with water quality data from the past 30 years (1990-2020), show the location of tested wells and whether the maximum concentration ever recorded in that well has violated the MCL. In SCott River Valley, the water quality source database categorized some wells as either municipal or monitoring. Municipal wells are a public supply well related to a city or town. Monitoring wells are used for monitoring groundwater, such as for site cleanup programs or irrigated lands regulatory program.

The maps and associated timeseries for nitrate data in the Basin over the past 30 years are shown below.

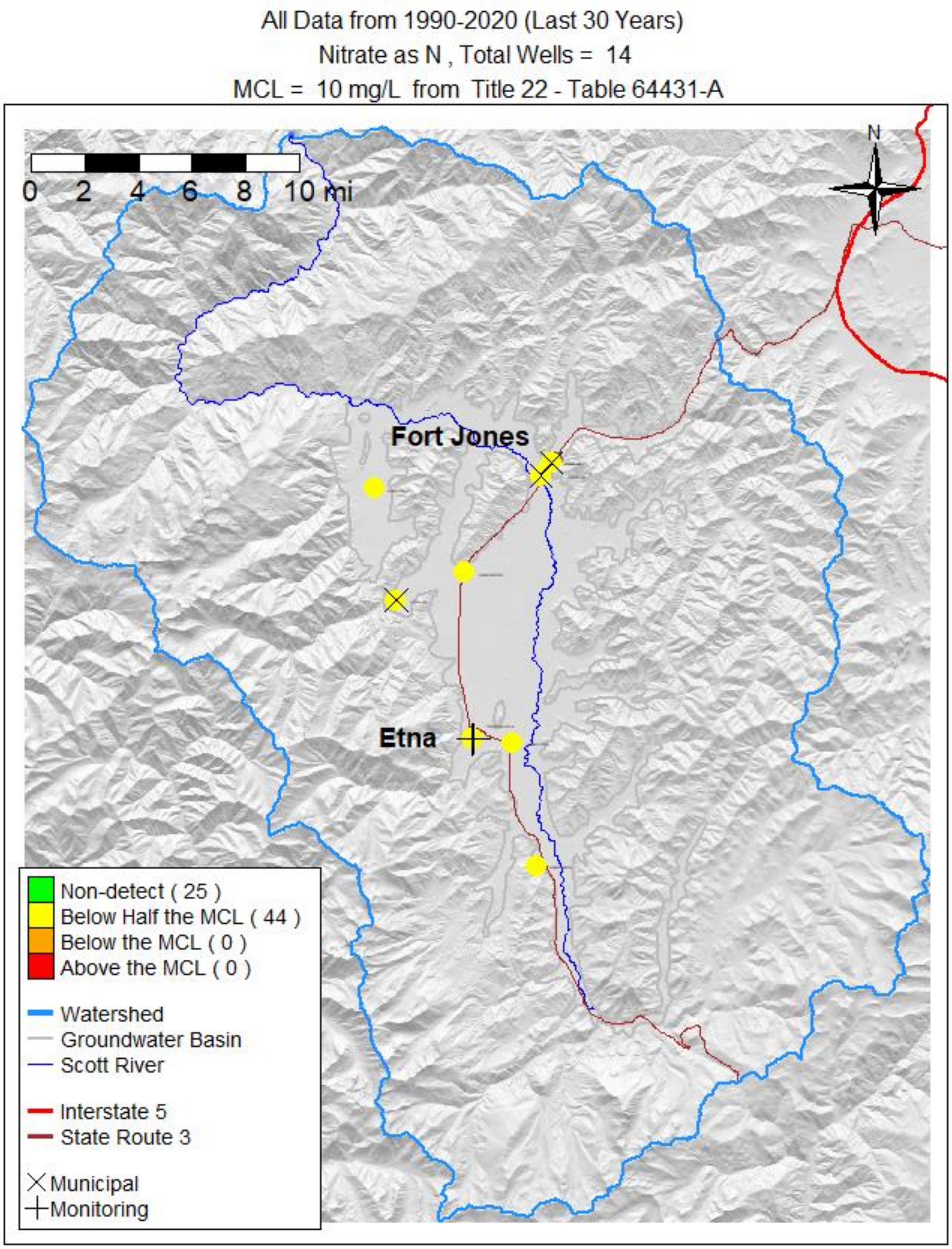

Figure 1: Well locations and detection magnitudes of nitrate data collected over the past 30 years in the Scott River Valley Groundwater Basin.

Wells with two or more monitoring events, from 1990-2020 (Last 30 Years)
Nitrate as N , Total Wells = 9
MCL = 10 mg/L from Title 22 - Table 64431-A

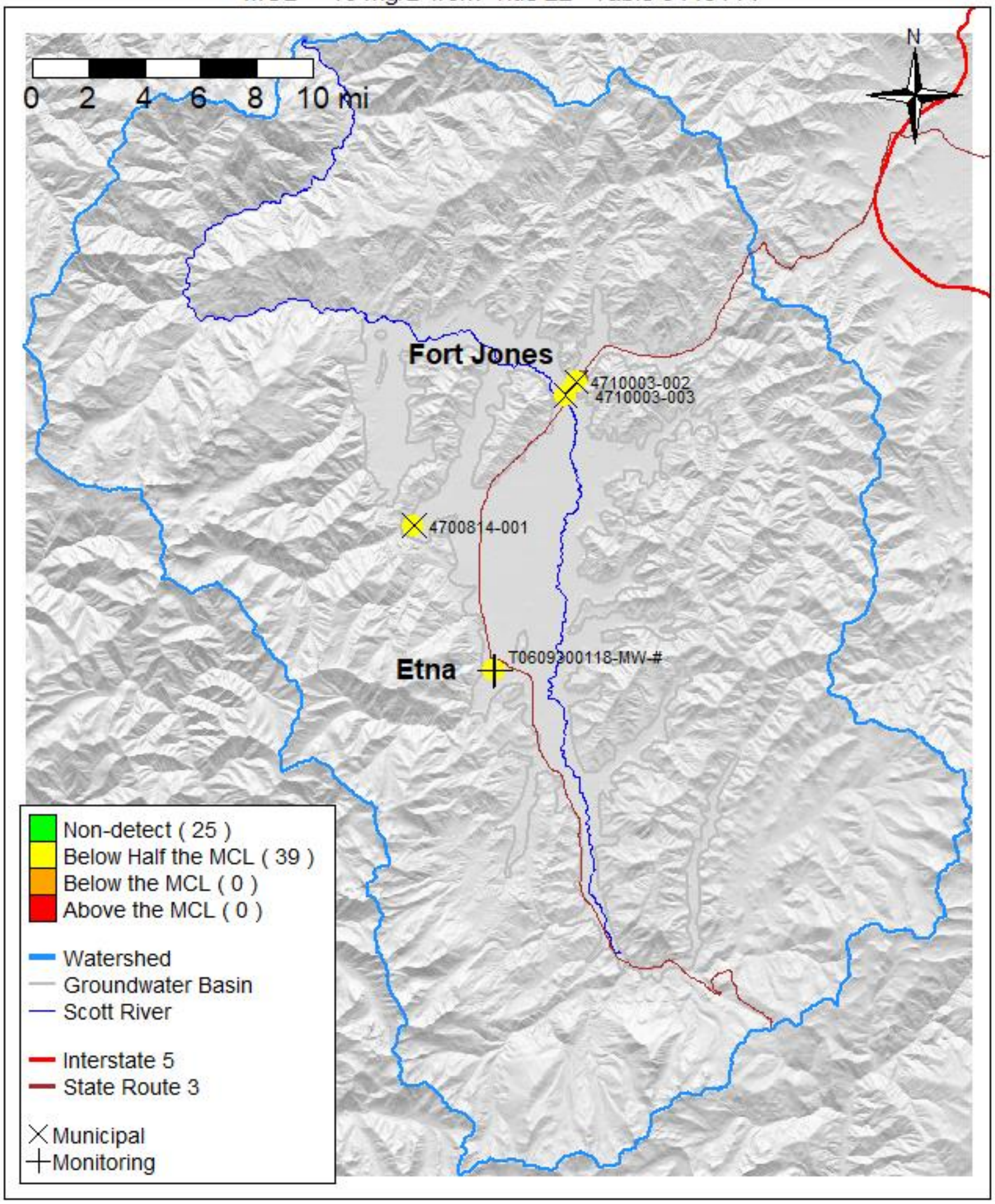

Figure 2: Well locations and detection magnitudes of nitrate data collected over the past 30 years in the Scott River Valley Groundwater Basin from wells with two or more monitoring events.

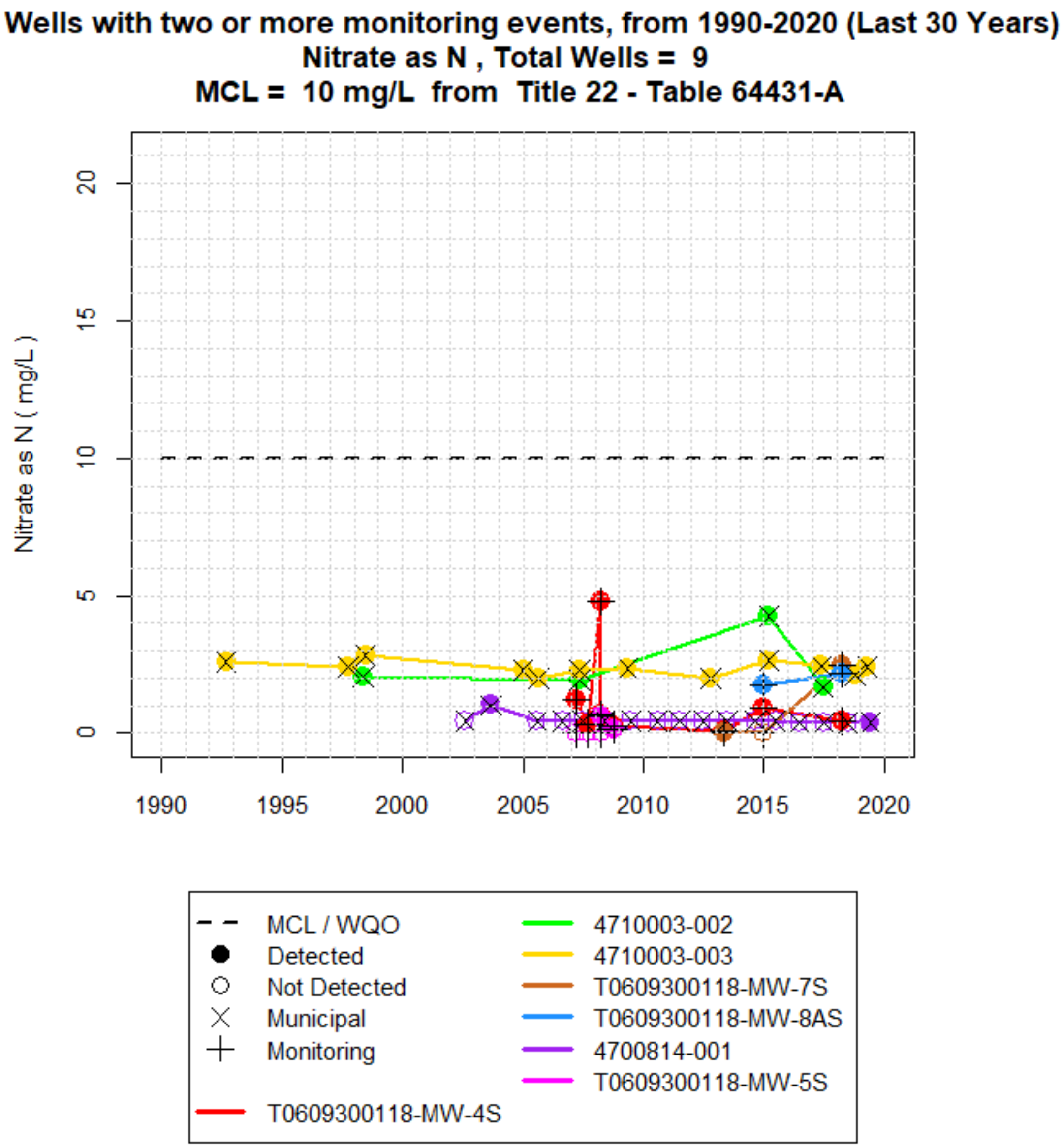

Figure 3: Timeseries plots of nitrate data collected over the past 30 years in the Scott River Valley Groundwater Basin from wells with two or more monitoring events

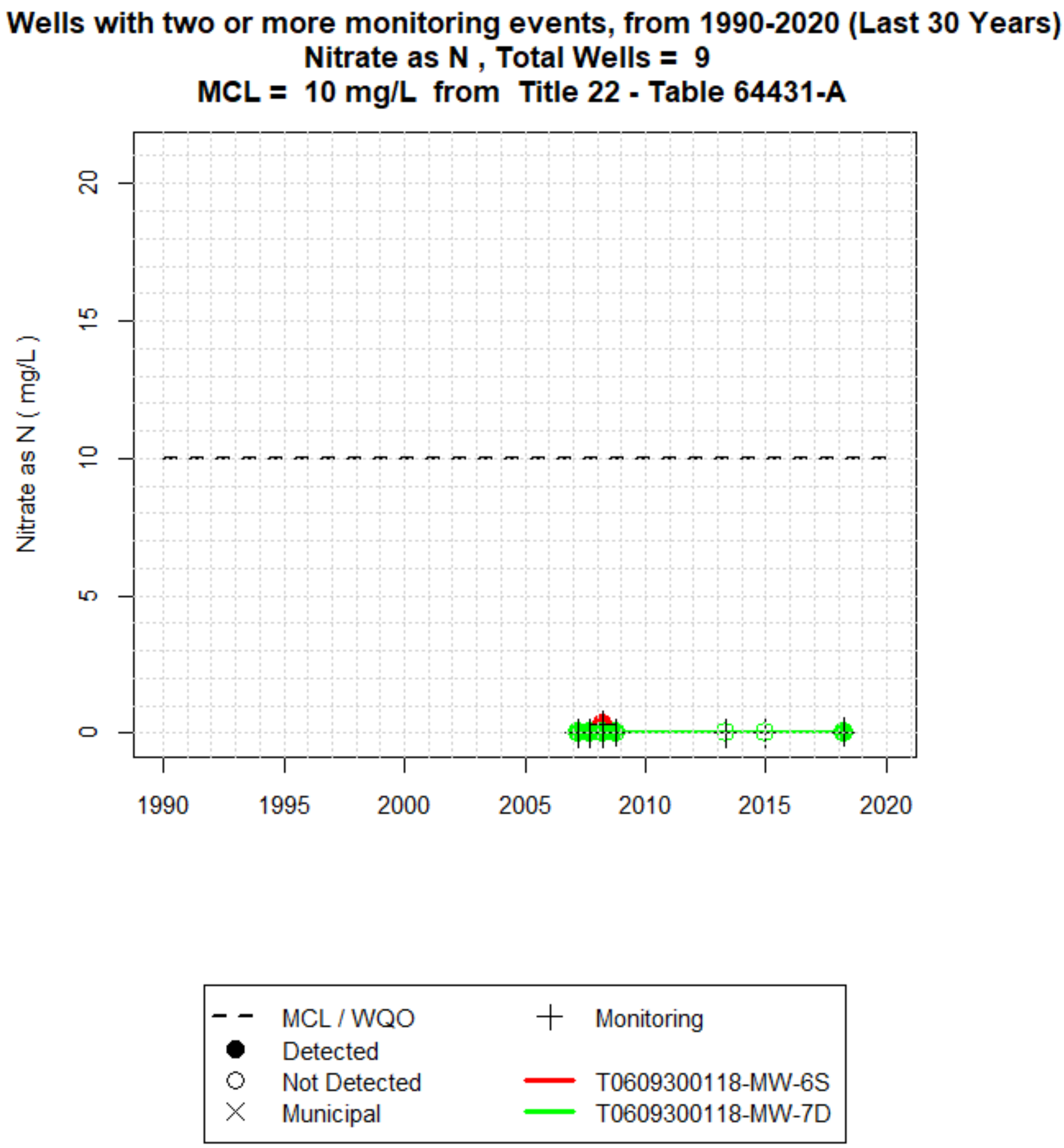

Figure 4: Timeseries plots of nitrate data collected over the past 30 years in the Scott River Valley Groundwater Basin from wells with two or more monitoring events

The maps and associated timeseries for specific conductivity data in the basin are shown below.

specific conductivity data are shown in Figure .

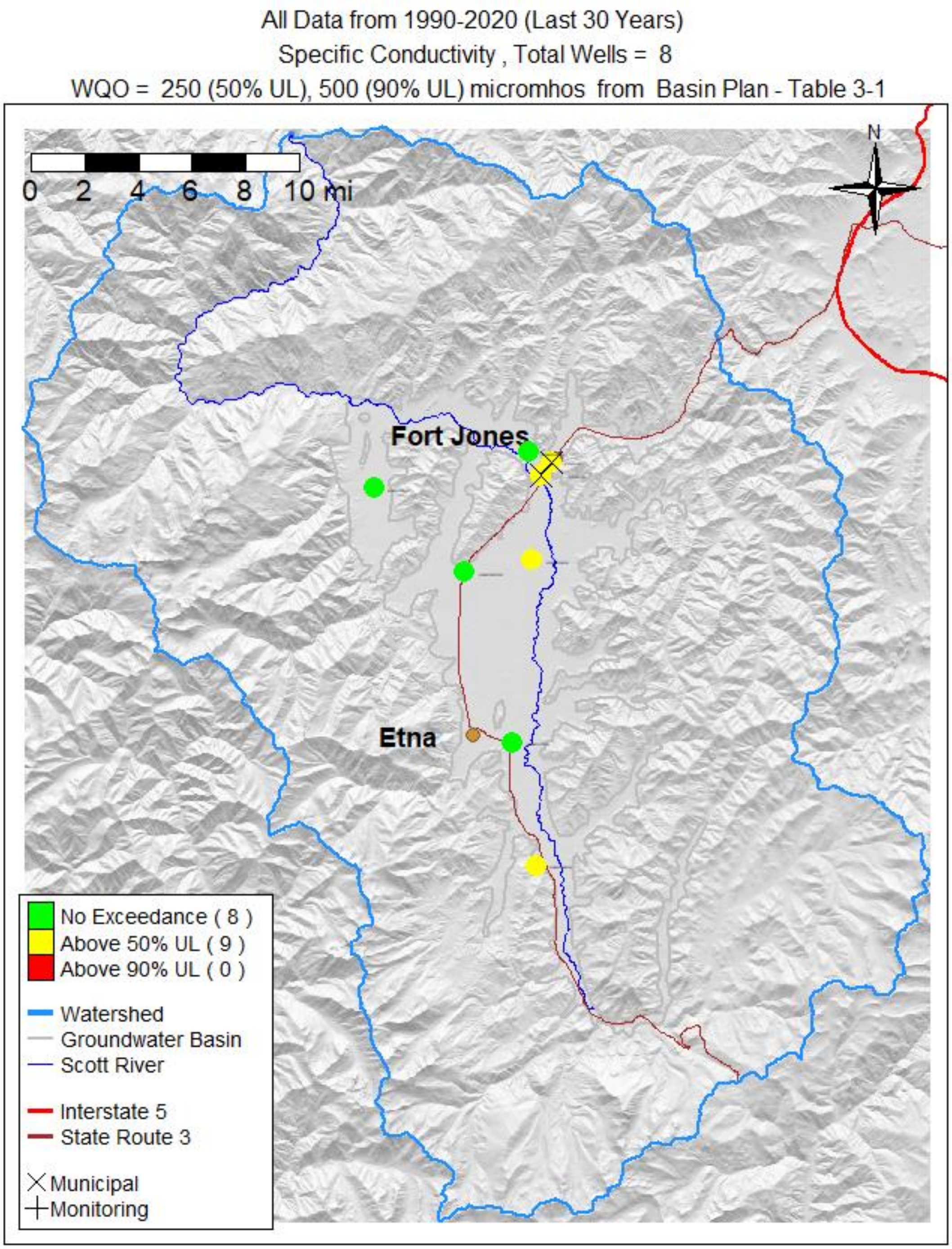

Figure 5: Well locations and detection magnitudes of specific conductivity data collected over the past 30 years in Scott River Valley Groundwater Basin.

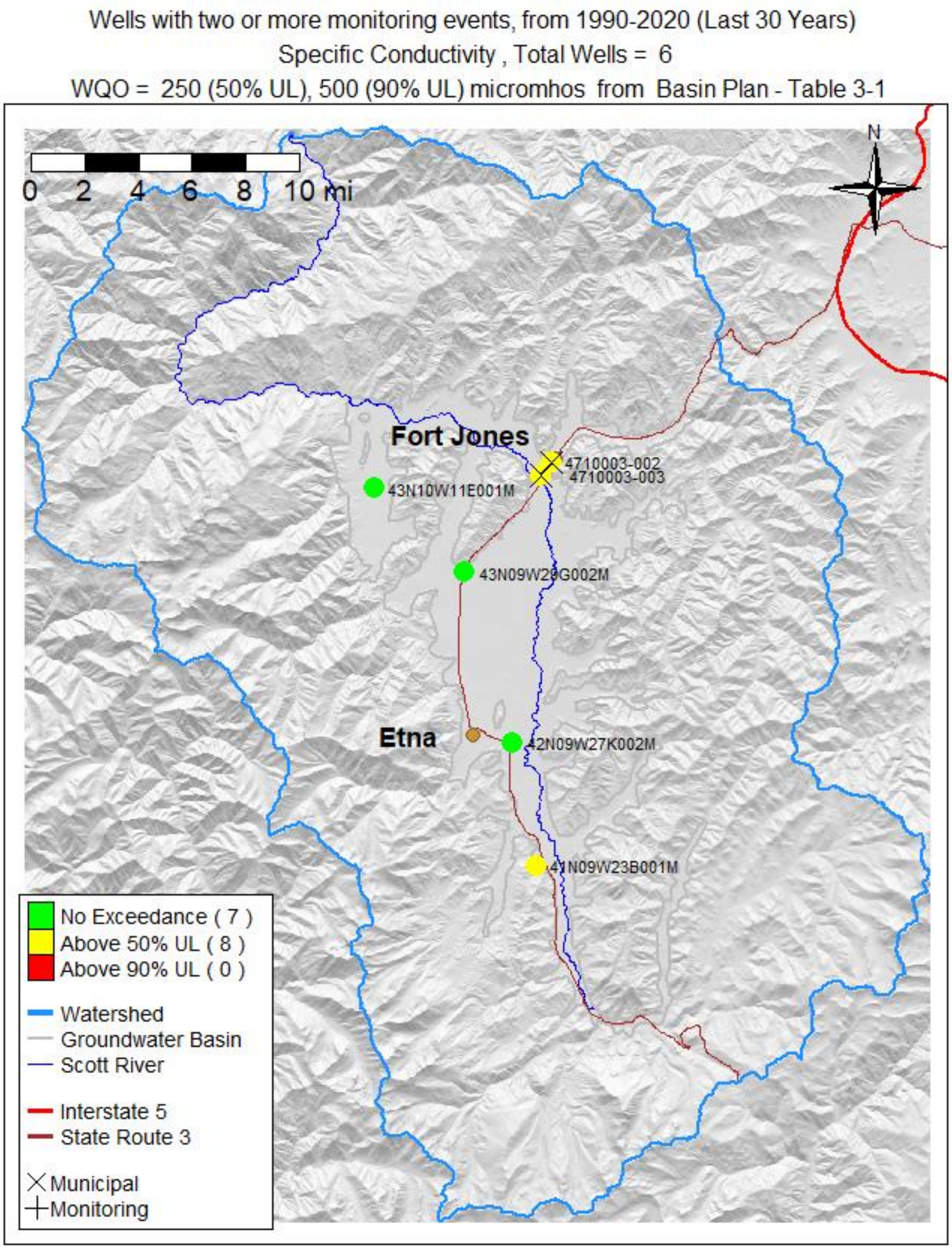

Figure 6: Well locations and detection magnitudes of specific conductivity data collected over the past 30 years in Scott River Valley Groundwater Basin from wells with two or more monitoring events.

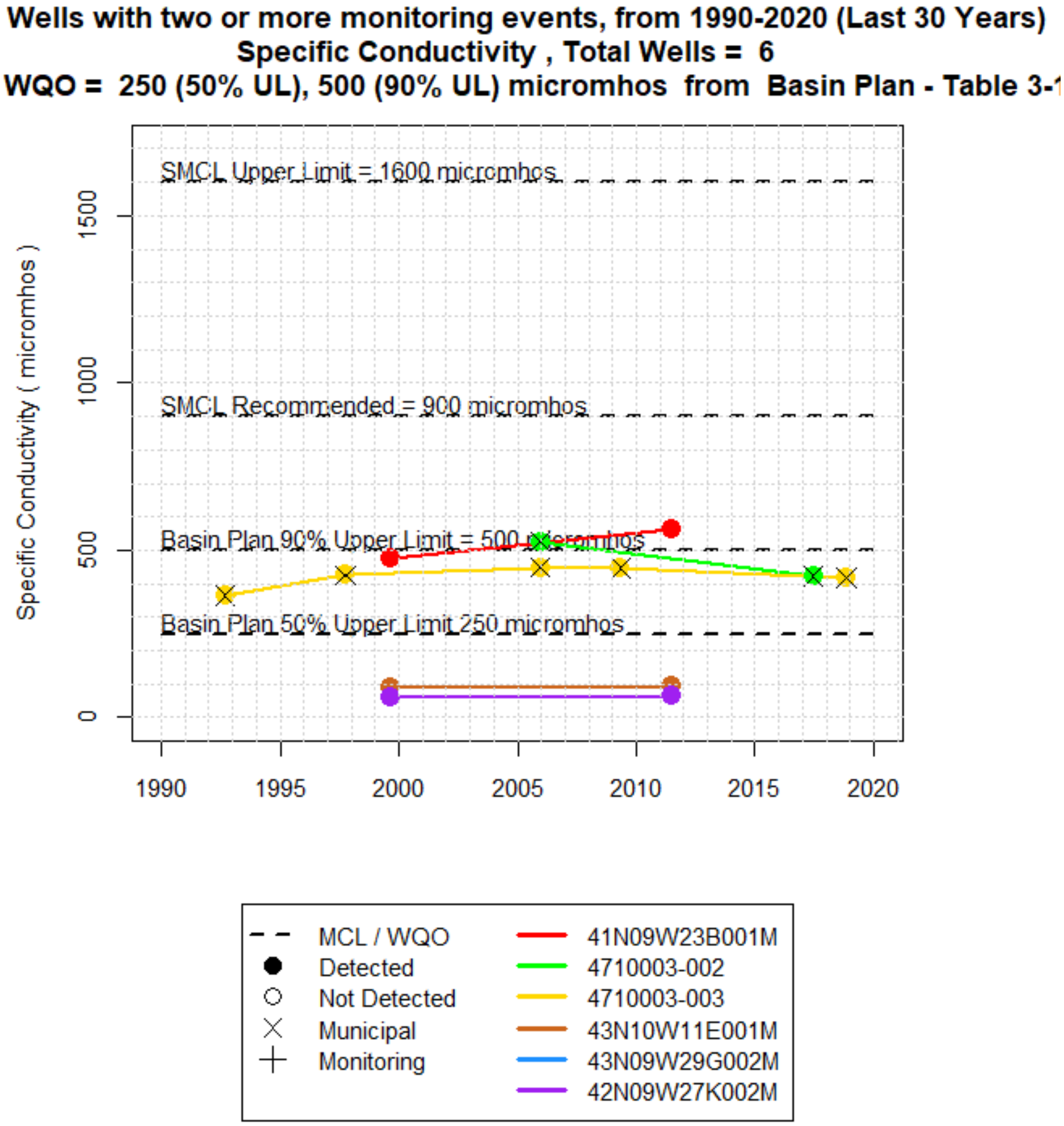

Figure 7: Timeseries plot of specific conductivity data collected over the past 30 years in Scott River Valley Groundwater Basin from wells with two or more monitoring events.

The maps and associated timeseries for benzene data in the Basin are shown below.

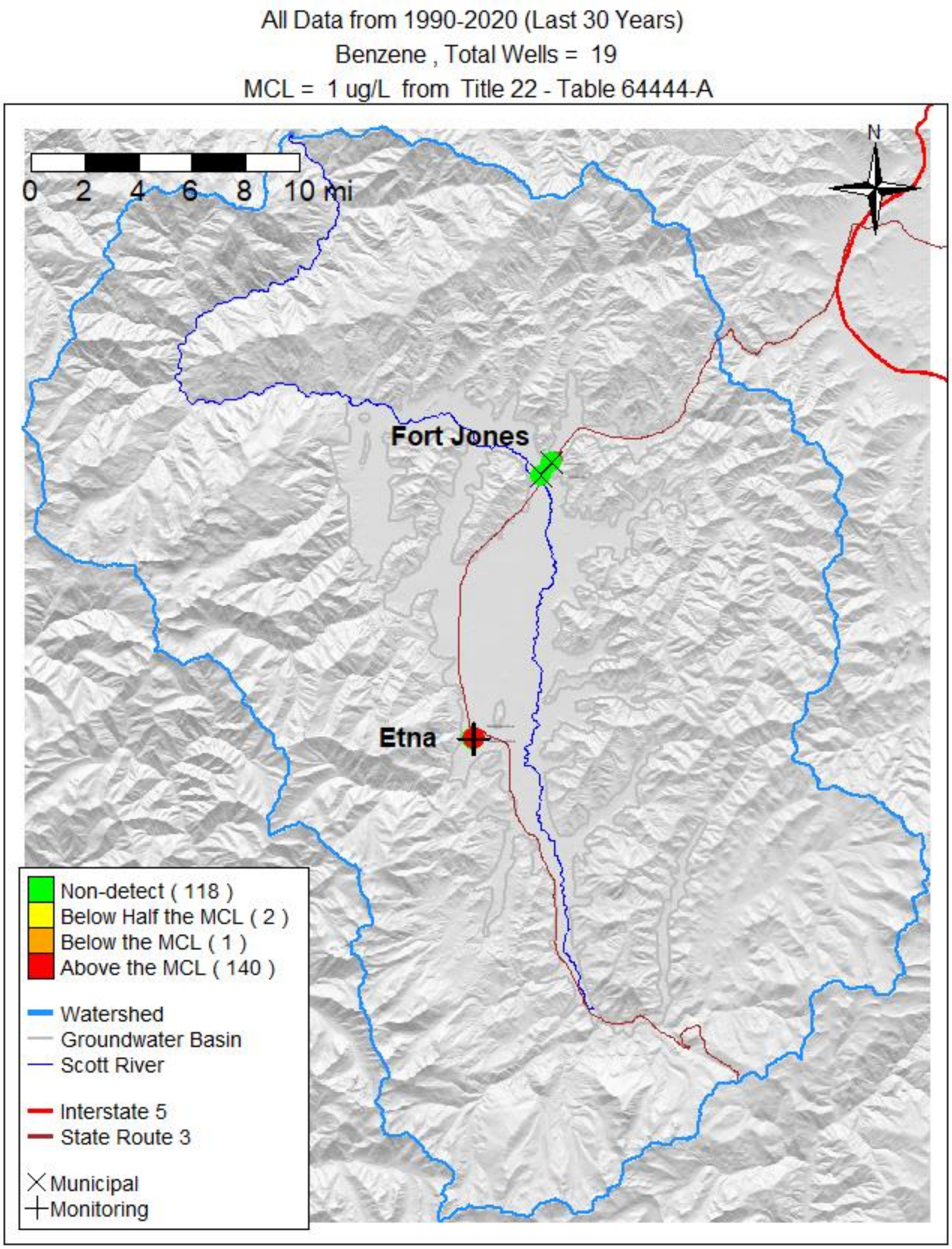

Figure 8: Well locations and detection magnitudes of benzene data collected over the past 30 years in the Scott River Valley Groundwater Basin.

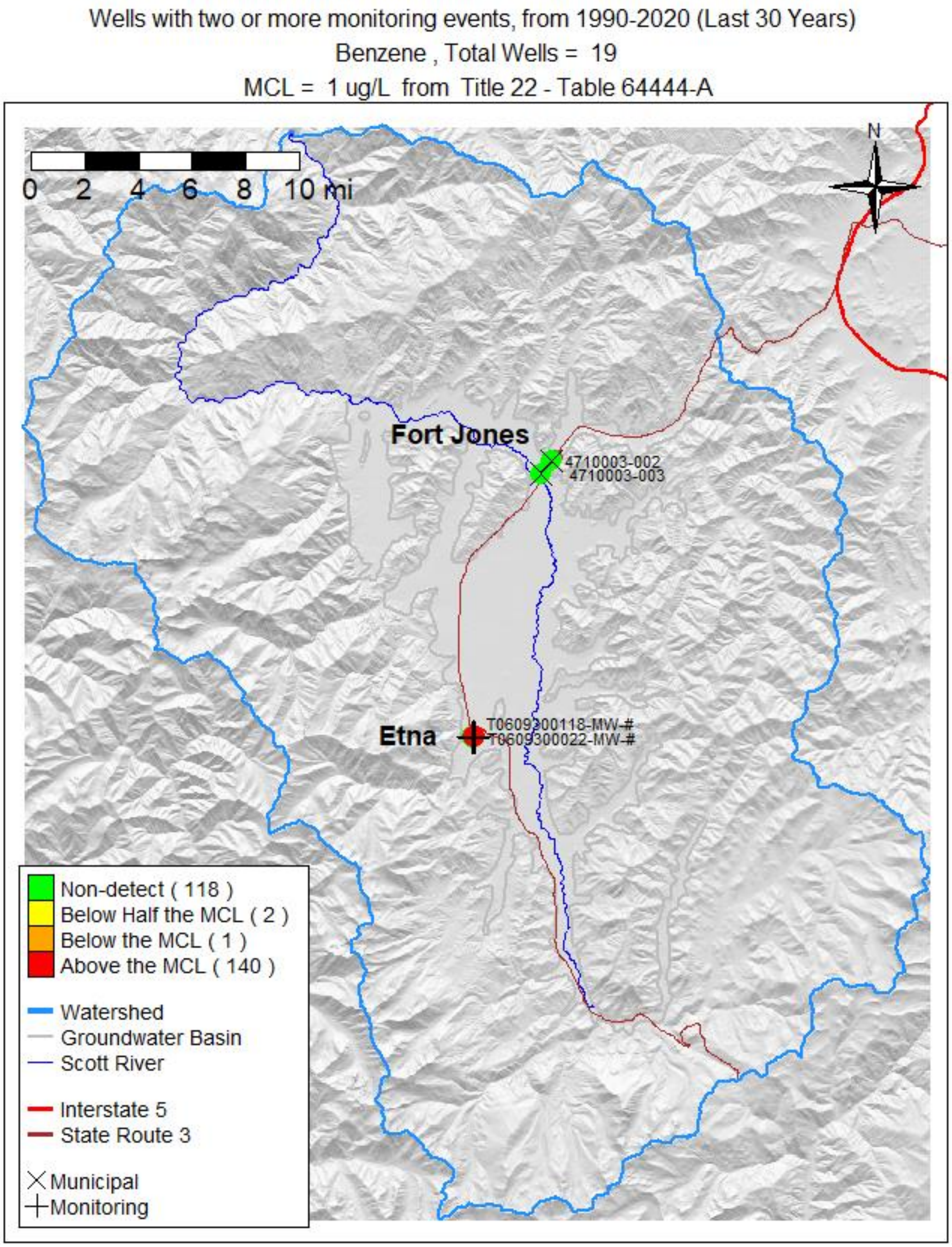

Figure 9: Well locations and detection magnitudes of benzene data collected over the past 30 years in the Scott River Valley Groundwater Basin for wells with two or more monitoring events.

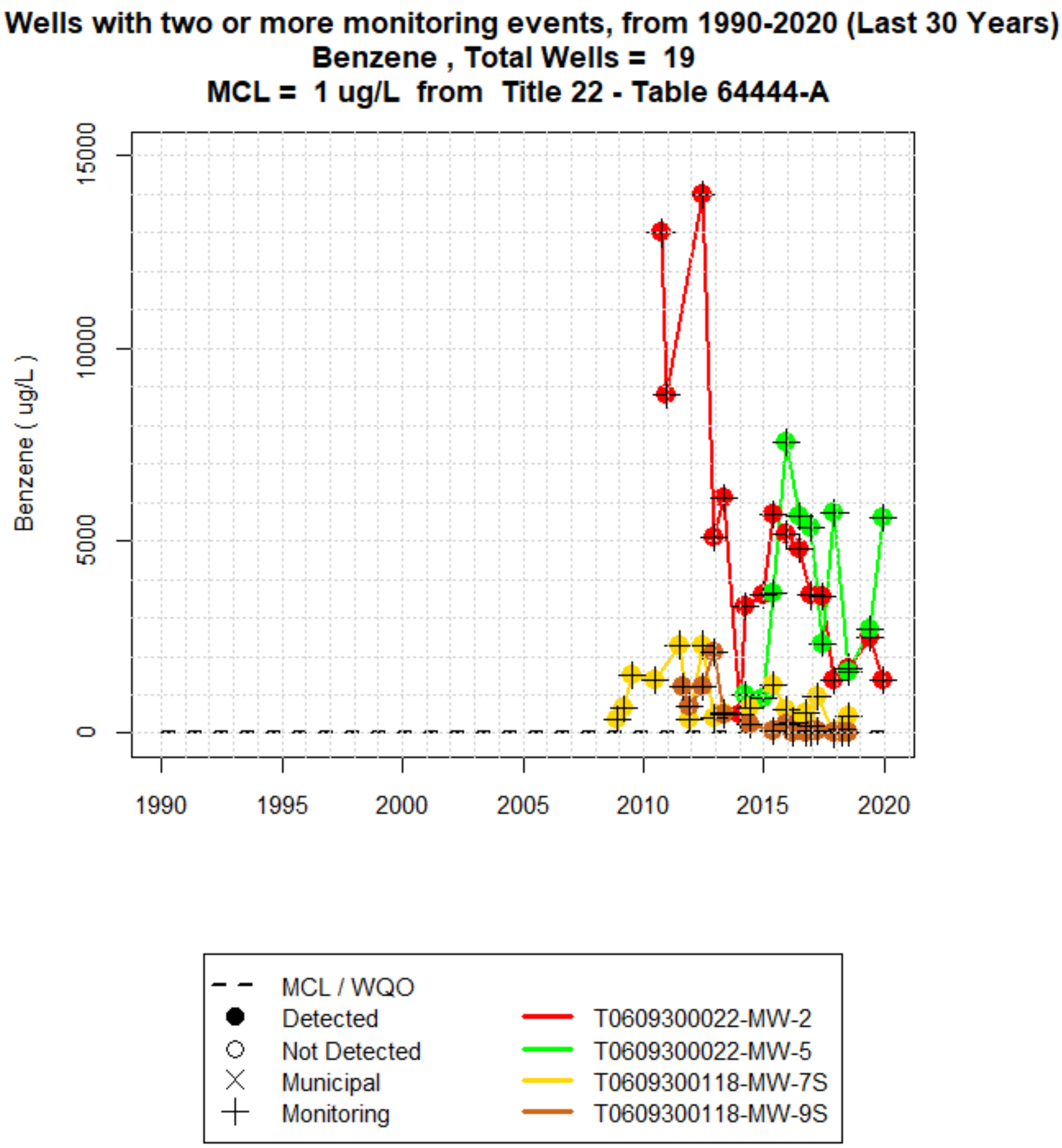

Figure 10: Timeseries plot of benzene data collected over the past 30 years in the Scott River Valley Groundwater Basin from wells with two or more monitoring events.

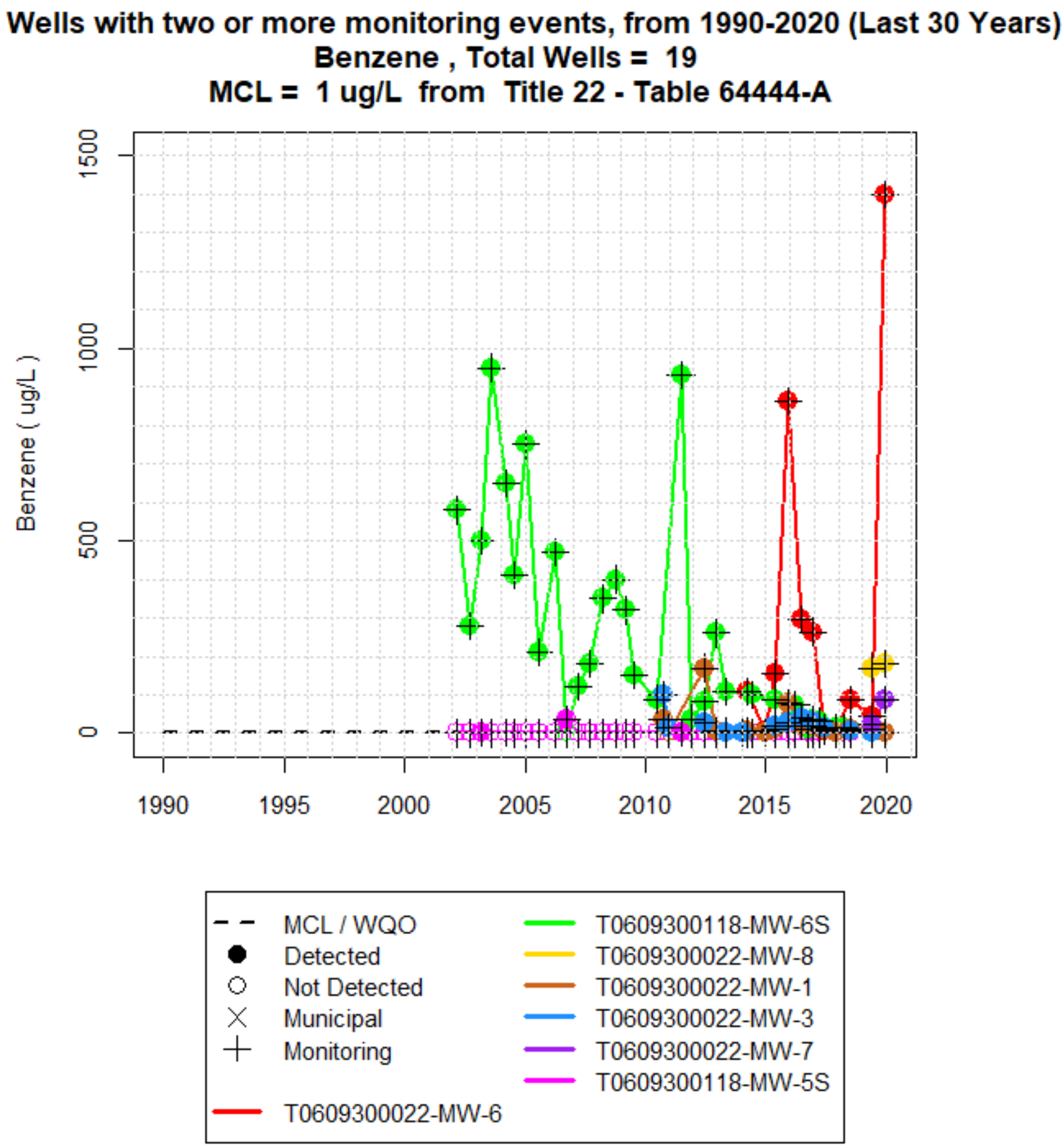

Figure 11: Timeseries plot of benzene data collected over the past 30 years in the Scott River Valley Groundwater Basin from wells with two or more monitoring events.

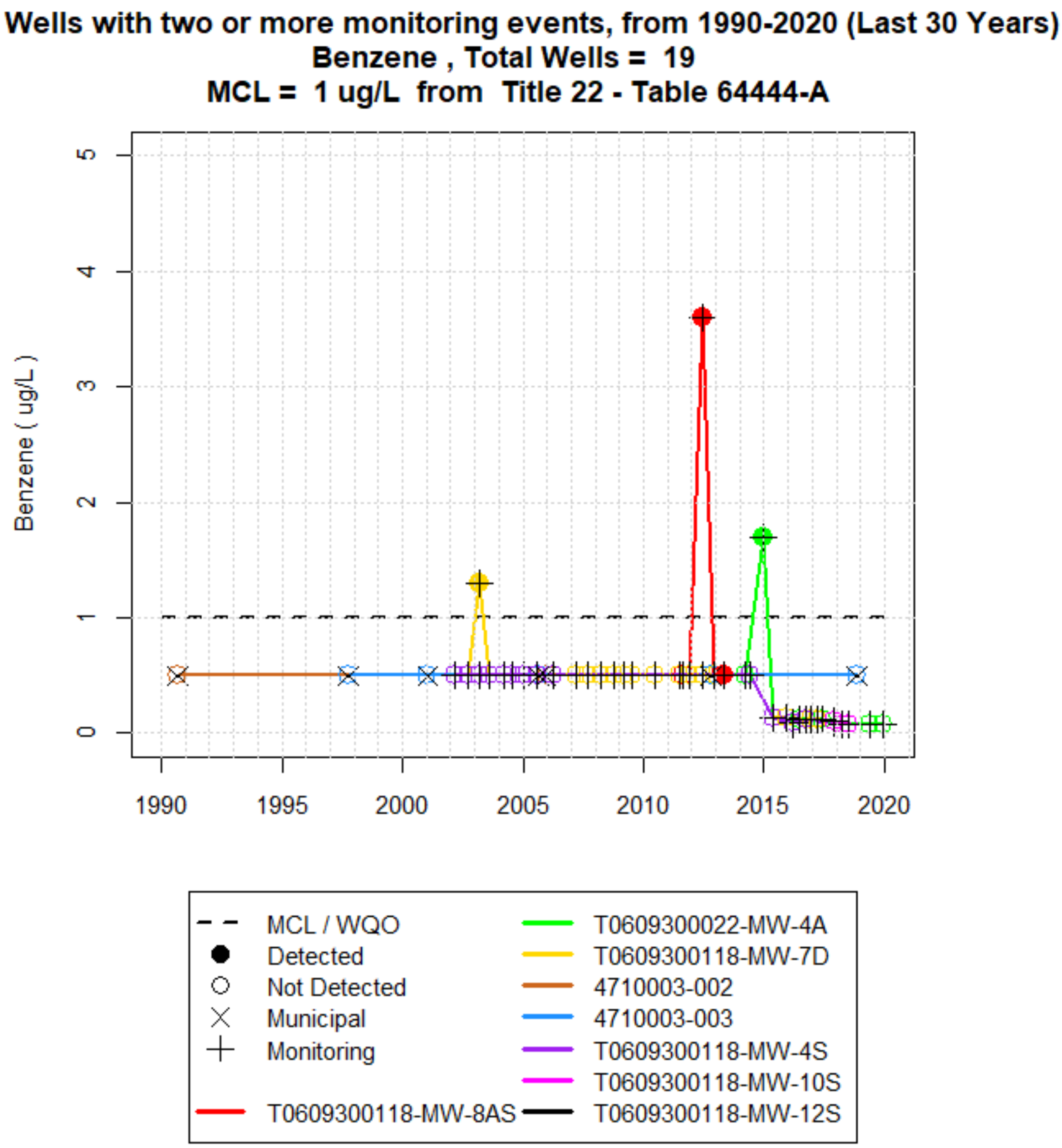

Figure 12: Timeseries plot of benzene data collected over the past 30 years in the Scott River Valley Groundwater Basin from wells with two or more monitoring events.

Appendix 4-A Scott Valley Management Scenario Results

Scott Valley Management Scenario Results

Claire Kouba

3/3/2021

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Scott Valley Management Scenario Results

Summary Table

Scenario Type	Scenario ID	Scenario Depletion Reversal, Sep-Nov '91-'18 (TAF)	Relative Depletion Reversal, Sep-Nov '91-'18
Enhanced Recharge	MAR (Managed Aquifer Recharge) in Jan-Mar	13	10%
	ILR (In-Lieu Recharge) in the early growing season	12	9%
	MAR + ILR	25	19%
	Expanded MAR + ILR *(assumed max infiltration rate of 0.019 m/d)*	60	44%
Diversion Limits	All surface water diversions limited at low FJ flows	51	38%
	MAR + ILR, with all surface water diversions limited at low FJ flows	77	57%
Crop change	80% Irrigation demand	82	61%
	90% Irrigation demand	40	29%
Irrigation Efficiency	Improve irrigation efficiency by 0.1	5.8	4%
	Improve irrigation efficiency by 0.2	16	12%
	Reduce irrigation efficiency by 0.1	-3.2	-2%
Irrigation schedule change	Alfalfa irrigation schedule - July 10 end date	117	86%
	Alfalfa irrigation schedule - Aug 01 end date	82	60%
	Aug 01 end date, *dry years only ('91, '92, '94, '01, '09, '13, '14, '18)*	19	14%
	Alfalfa irrigation schedule - Aug 15 end date	45	33%
	Aug 15 end date, *dry years only ('91, '92, '94, '01, '09, '13, '14, '18)*	9	7%
Attribution - adjudicated area impacts	Natural Vegetation Outside Adjudicated area (NVOA)	171	126%
	Natural Vegetation, on Groundwater- or Mixed-source fields, Outside Adjudicated area (NV-GWM-OA)	**136**	100%
	Natural Vegetation Inside Adjudicated area (NVIA)	126	93%
	Natural Vegetation, on Groundwater- or Mixed-source fields, Inside Adjudicated area (NV-GWM-IA)	116	85%
	Natural Vegetation (NV)	287	212%
	Natural Vegetation on all Groundwater- or Mixed-source fields (NV-GWM)	233	171%
Reservoir	9 TAF Reservoir, 30 cfs release, Shackleford	46	34%
	9 TAF Reservoir, 30 cfs release, Etna	65	48%
	9 TAF Reservoir, 30 cfs release, French	78	58%
	9 TAF Reservoir, 30 cfs release, S. Fork	35	26%
100% reliable reservoir	29 TAF Reservoir, 100% reliability 30 cfs release	72	53%
	134 TAF Reservoir, 100% reliability 60 cfs release	250	184%

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Summary of scenarios

- Supply-side scenarios
  - Enhanced Recharge
  - Reservoirs
- Demand-side scenarios
  - Crop change
  - Irrigation efficiency
  - Irrigation schedule change
  - Diversion limits (or surface water leases)

- Attribution
  - Impact of pumping inside and outside adjudicated zone
- Range of depletion reversal: 4% - 86%
  - Excluding the Attribution scenarios (85% - 212% reversal) and the 100% reliable 60 cfs release scenario (184% reversal)

Explanatory Material

The following information is intended to help a reader understand the scenario results plots and interpret them in the context of setting the surface water SMC for the Scott Valley Groundwater Sustainability Plan.

Acronyms:

UR – Undesirable Result

- Informed by Sustainability Goal, but must be tied to metric(s)

MT – Minimum (or Maximum) Threshold.

- The MT is the boundary beyond which a UR occurs.
- *Note*: MT and UR definitions are **linked.**

MO – Measurable Objective

- Ideal operating range

SMC – Sustainable Management Criteria (includes URs, MO and MTs)

PMAs – Projects and Management Actions

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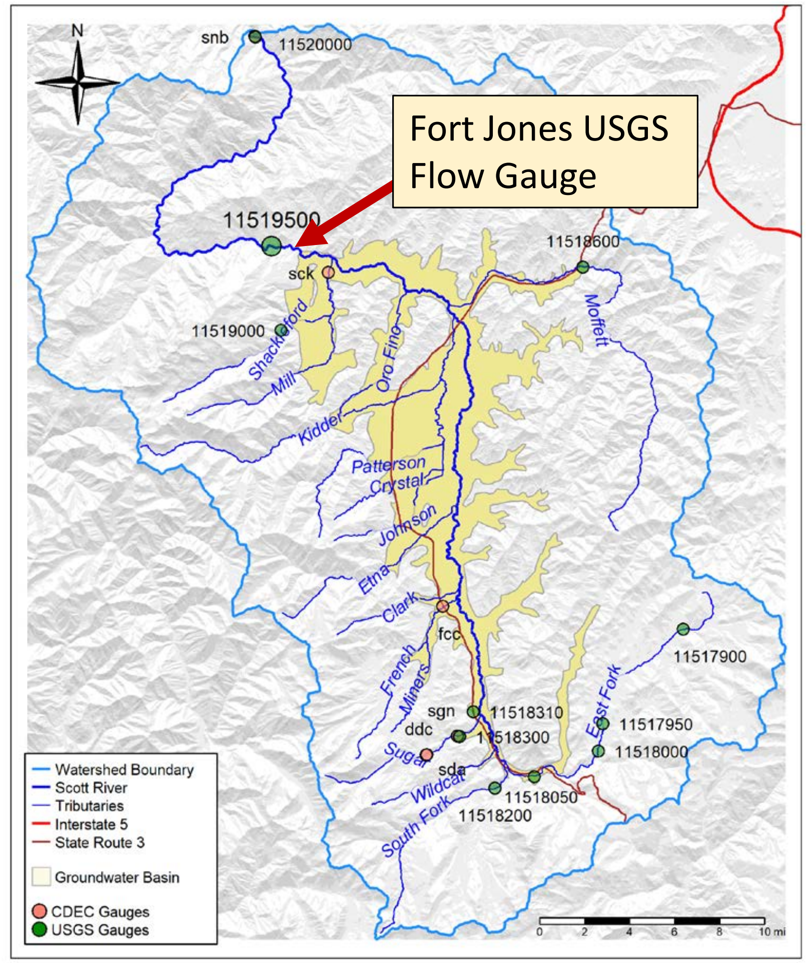
Quantifying the SMC

Streamflow Depletion is quantified as:

- the **difference in flow** at the Fort Jones Gauge…
- over the model period of 1991-2018…
- between the simulated Basecase (actual historical/current) conditions and a simulated management scenario.



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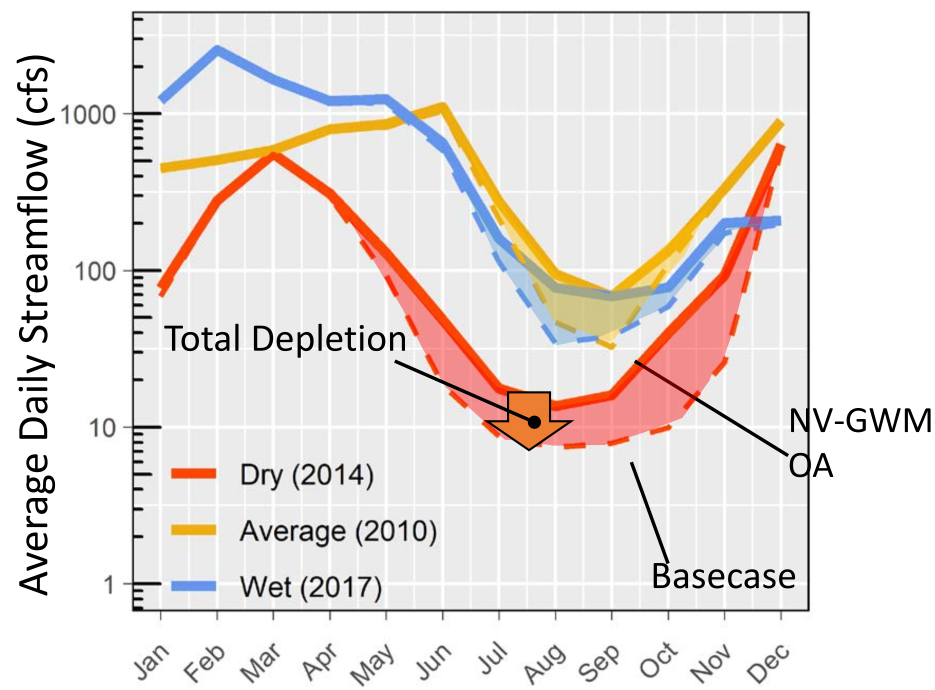
Quantifying the SMC

Total Streamflow Depletion* is quantified as:

- the **difference in flow** at the Fort Jones Gauge…
- over the model period of 1991-2018…
- between the simulated Basecase (actual historical/current) conditions and the simulated No Pumping** Reference case.

*Note: Areas not proportional due to log-y axis



* Due to pumping in SGMA wells

** Also referred to as "Natural Vegetation on GW and Mixed-source fields Outside the Adjudicated Zone", or NV-GWM-OA

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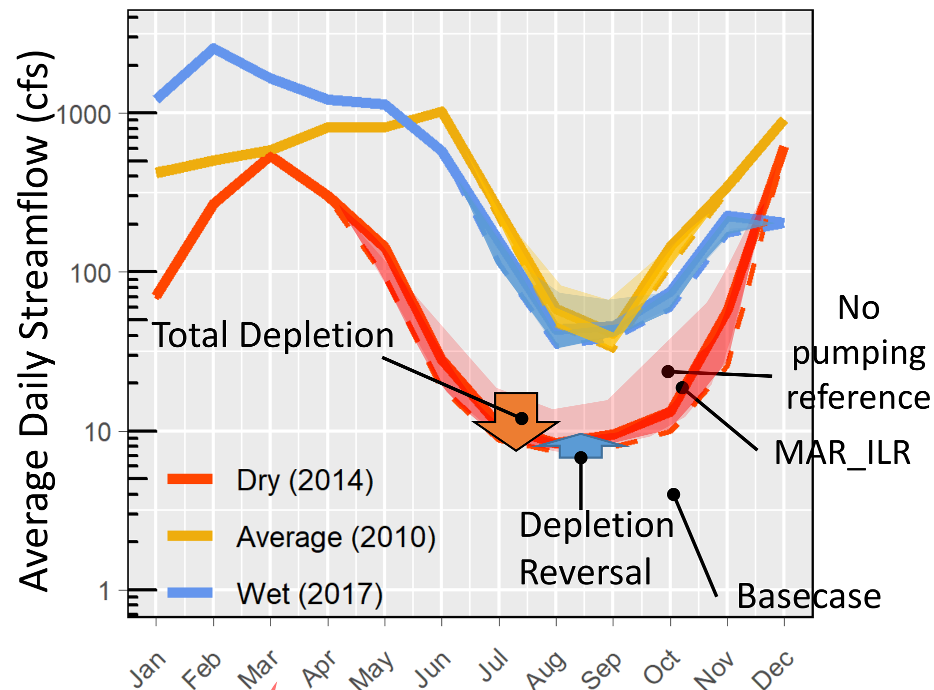
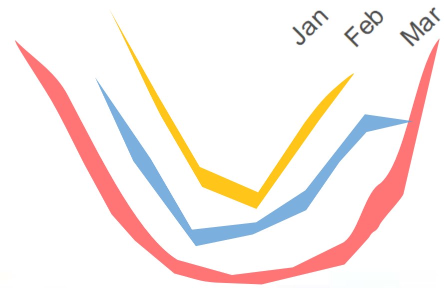
Quantifying the SMC

Depletion Reversal is quantified for **each** scenario as the difference between the Basecase (simulated historical & current) conditions and the relevant scenario (for example, MAR+ILR).

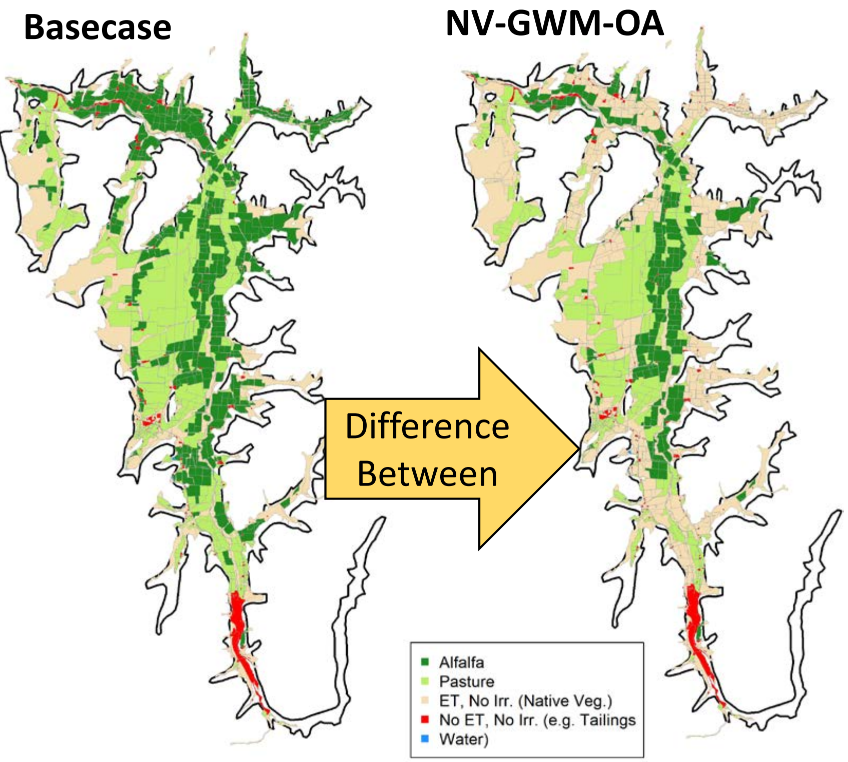
*Note: Areas not proportional due to log-y axis

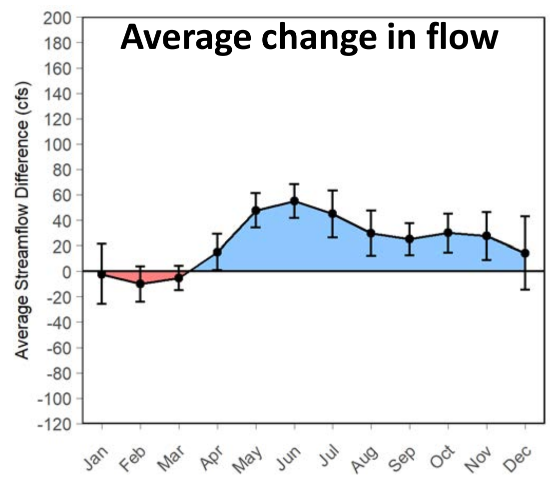


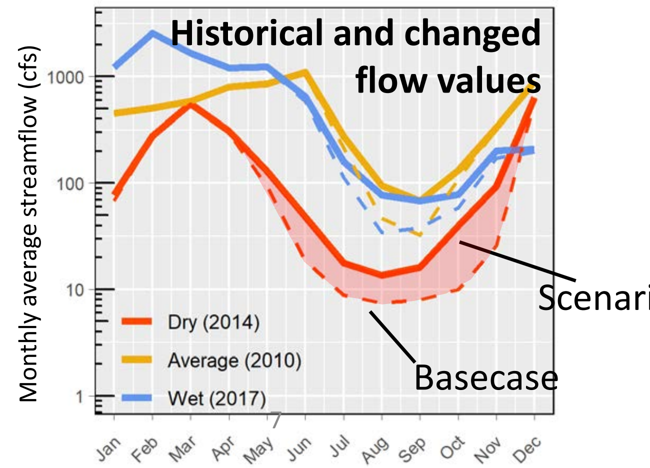


Note: Total Depletion, Depletion Reversal, and the remaining Depletion (i.e., the difference between Total Depletion and Depletion Reversal) can be computed for each day or each month of the simulation period. Averages for specific periods can also be computed.

Total Depletion: no-pumping reference case maps







Basecase Landuse

Native Vegetation on *GW and Mixed Water Source Fields* Outside Adjudication

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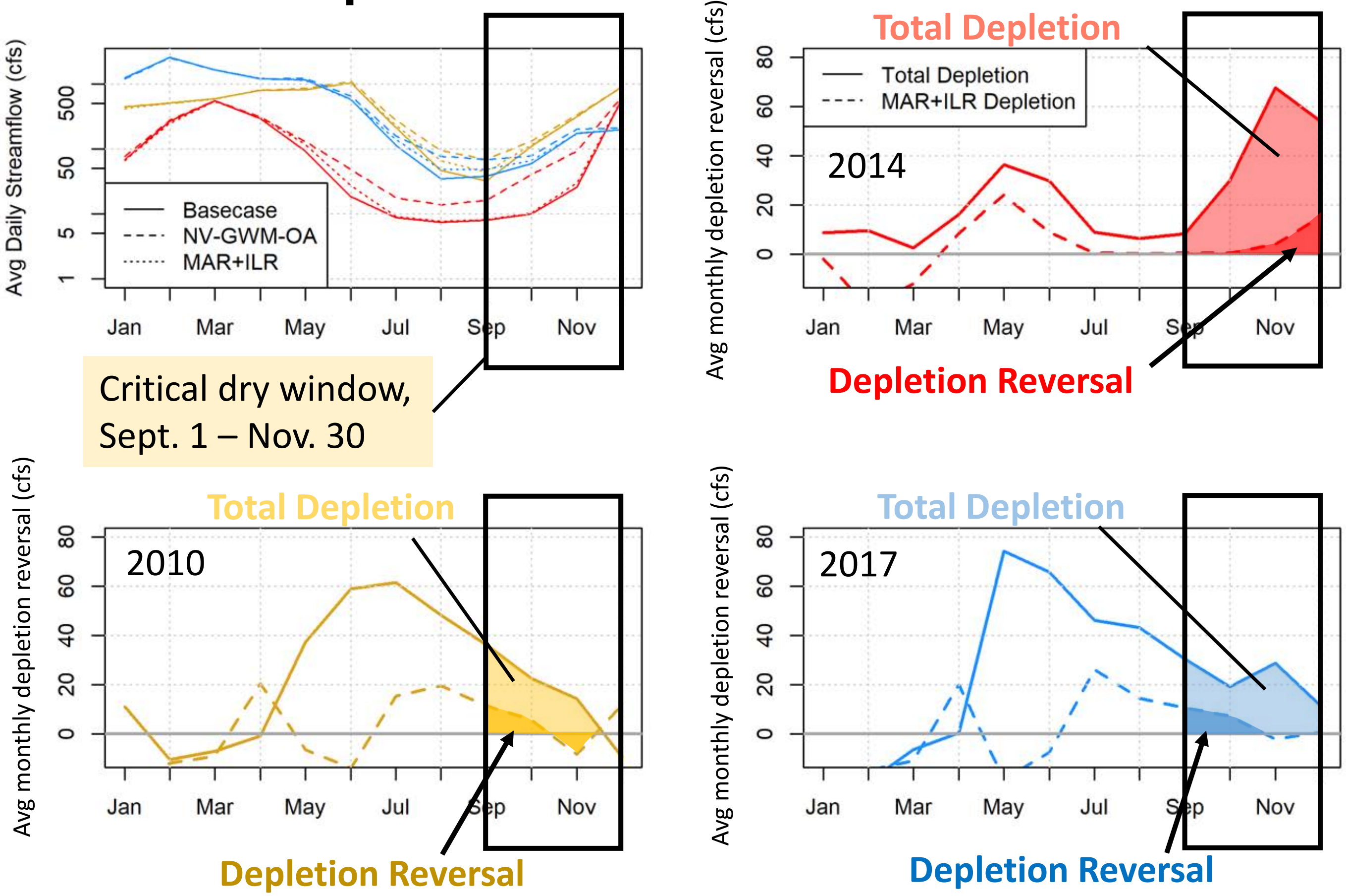
Quantifying Relative Depletion Reversal, Sept-Nov critical period



To calculate relative depletion reversal, sum the darker areas in the Sept-Nov window for each year and divide by the sum of the lighter areas in the Sept-Nov window.

Relative Depletion Reversal for MAR+ILR:

19%

of Total Depletion, Sept.-Nov. for 1991-2018.

Setting the SMC – Minimum Threshold (MT)

- The MT selected will define the "significant and unreasonable" undesirable result.
- The MT will be set as the amount of stream depletion reversal achieved by the minimum required PMA.
- The PMA(s) selected to define the MT should be realistic, feasible, and fair.

How to read and interpret graphs of scenario results

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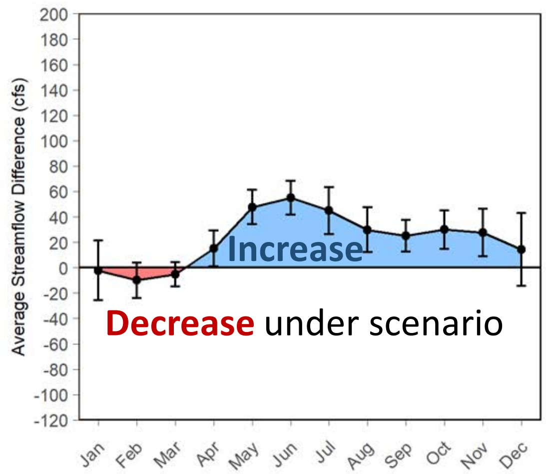
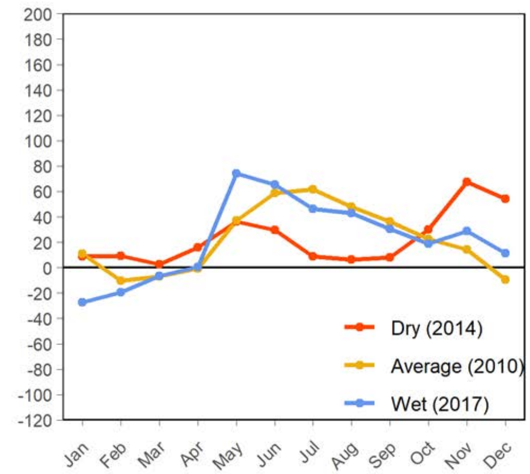
Flow Change Results

All flows and flow changes plotted are for the Fort Jones Gauge location

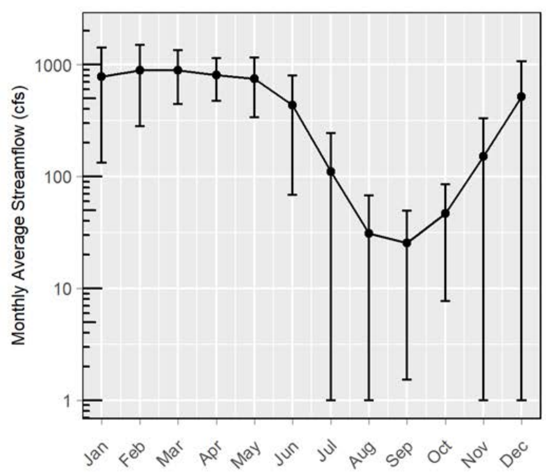
Change in flow, scenario minus basecase - 28 years, averaged monthly

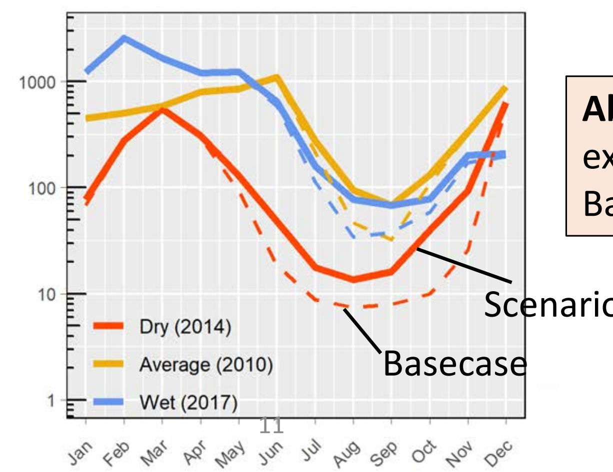




Change in flow, scenario minus basecase – 3 example years

Absolute flow value (simulated historical basecase) – 28 years, averaged monthly





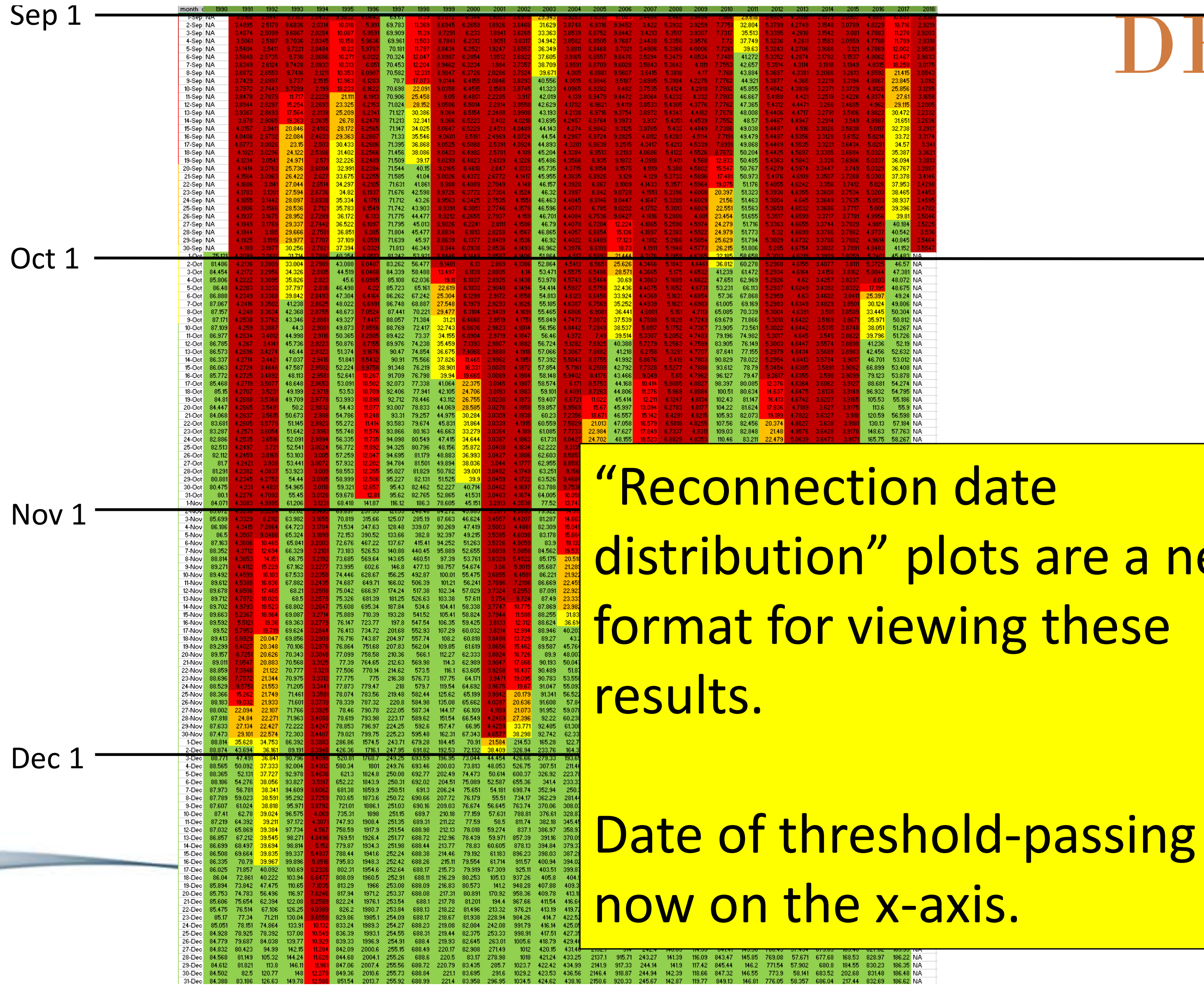
Absolute flow value – 3 example years, Basecase and Scenario

Threshold-passing or “reconnection” date distribution graphs

Basecase

(Simulated historical period)

DRAFT



Below 10 cfs
10-20 cfs
20-30 cfs
30-40 cfs
Above 40 cfs

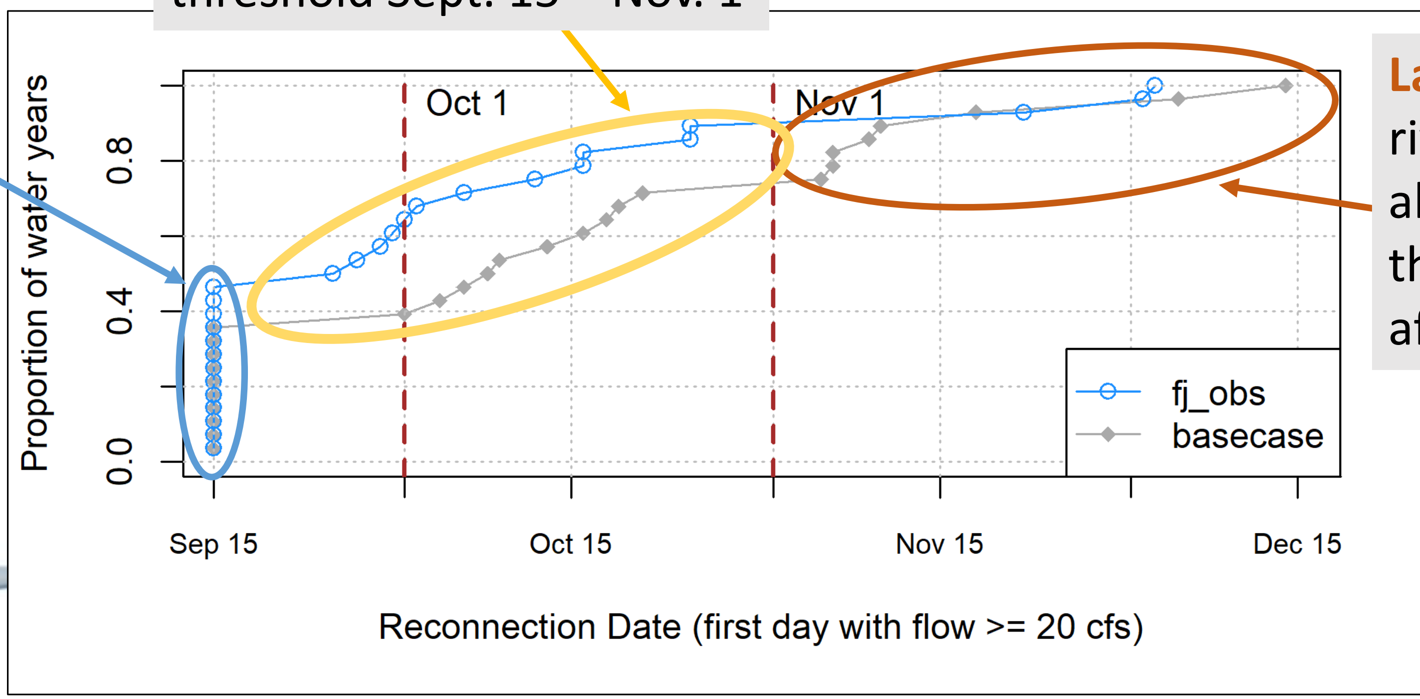
"Reconnection date distribution" plots are a new format for viewing these results.

Date of threshold-passing is now on the x-axis.

Threshold-passing or "reconnection" date distribution graphs

Intermediate years – river flow rose above the threshold Sept. 15 – Nov. 1

Early years – river passed this threshold on or before Sept. 15, or never fell below it



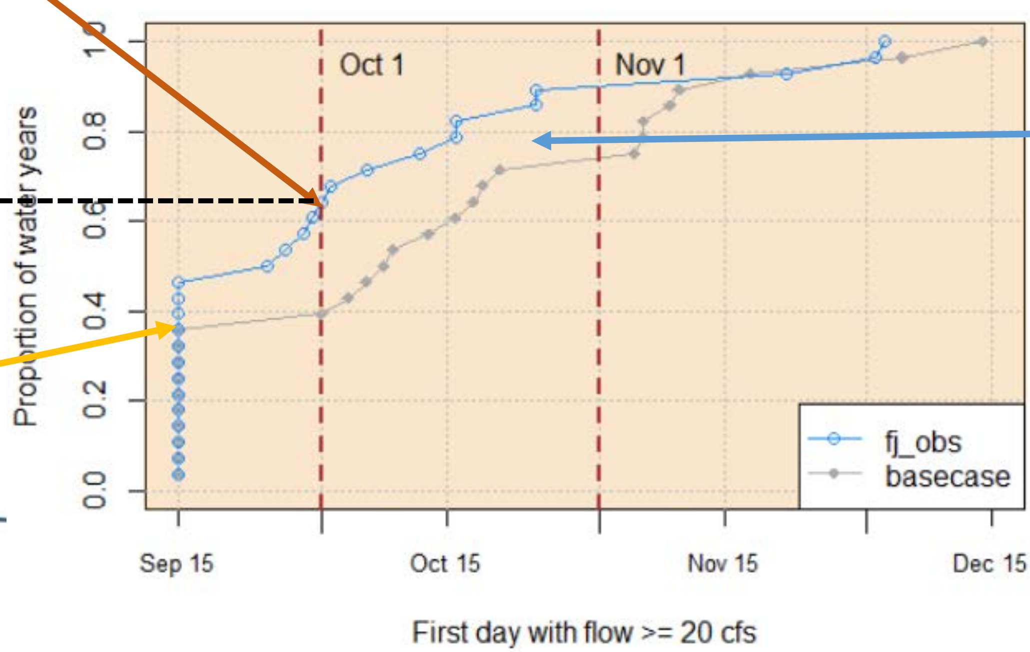
Late years – river flow rose above the threshold after Nov 1

DRAFT

Threshold-passing or "reconnection" date distribution graphs

How to read this graph: From 1991-2018, the FJ gauge measured flow >20 cfs **on or before Oct. 1** in ~**63%** of years.

Y-intercept of ~0.63, or ~63%

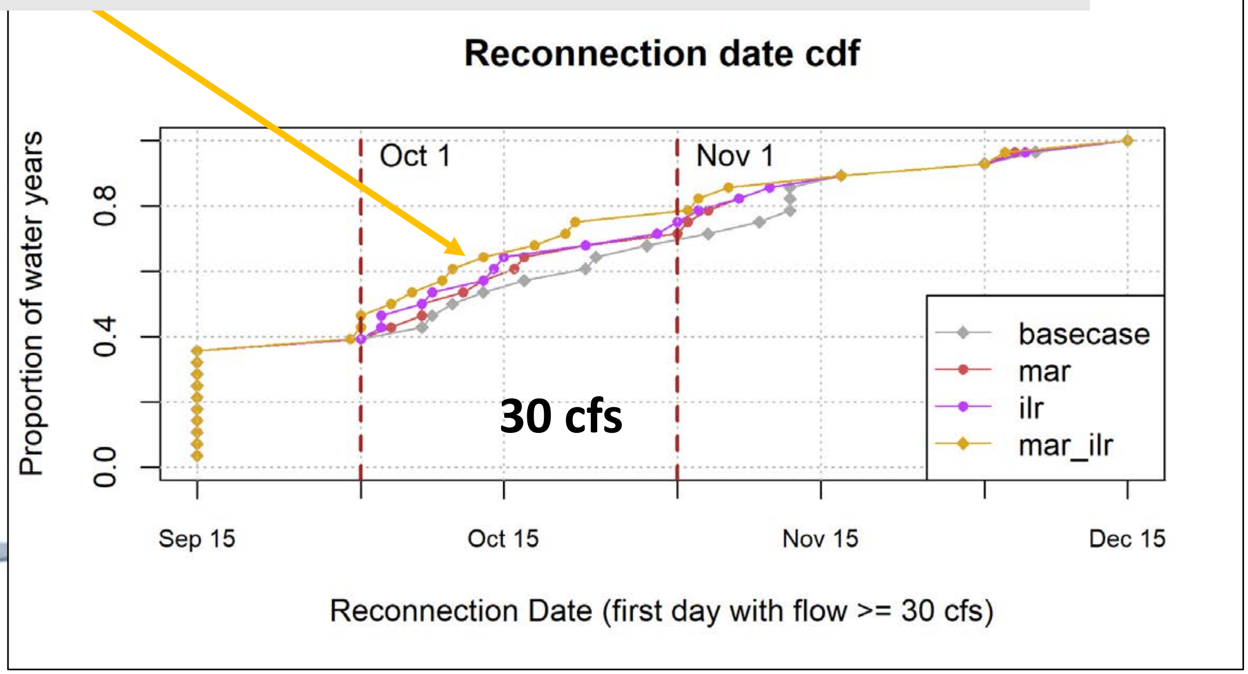


Notes on model performance: The basecase simulates 10 years with flow >20 cfs before Sept 15, or not dropping below 20 cfs at all **(early years)**; in the observed record it's 13 years.

Notes on model performance: The discrepancies between the observed and simulated basecase distributions are another reason to think of scenario results as "relative change" rather than a prediction of future conditions.

Threshold-passing or “reconnection” date distribution graphs

MAR+ILR: Generates a gain of ~7 days in higher-flow dais intermediate and some late years

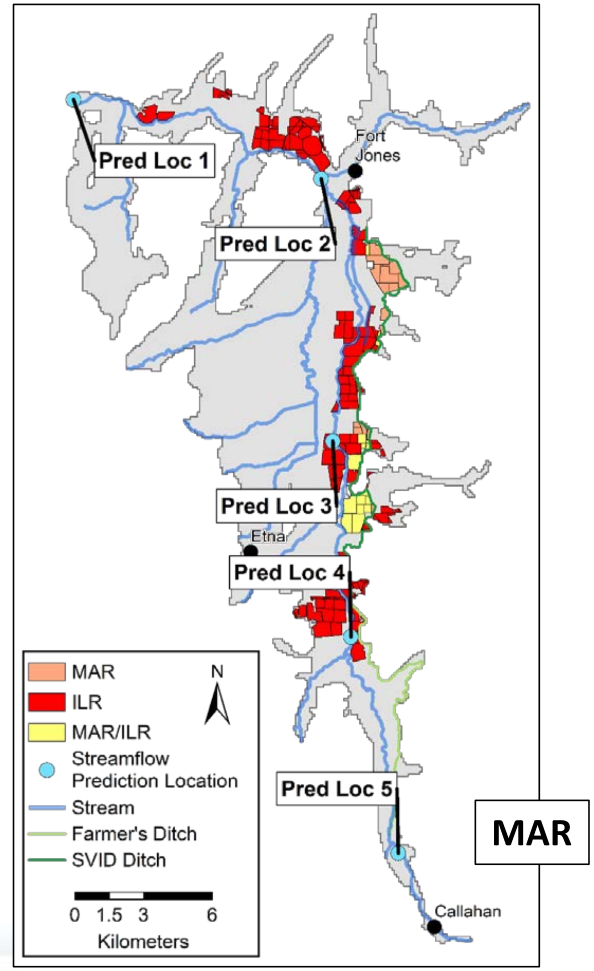


DRAFT

Scenario descriptions and visual references

MAR (Managed Aquifer Recharge)

- 1,390 acres
- Surface water applied to orange and yellow fields, Jan-Mar.
- Water delivered through SVID Ditch



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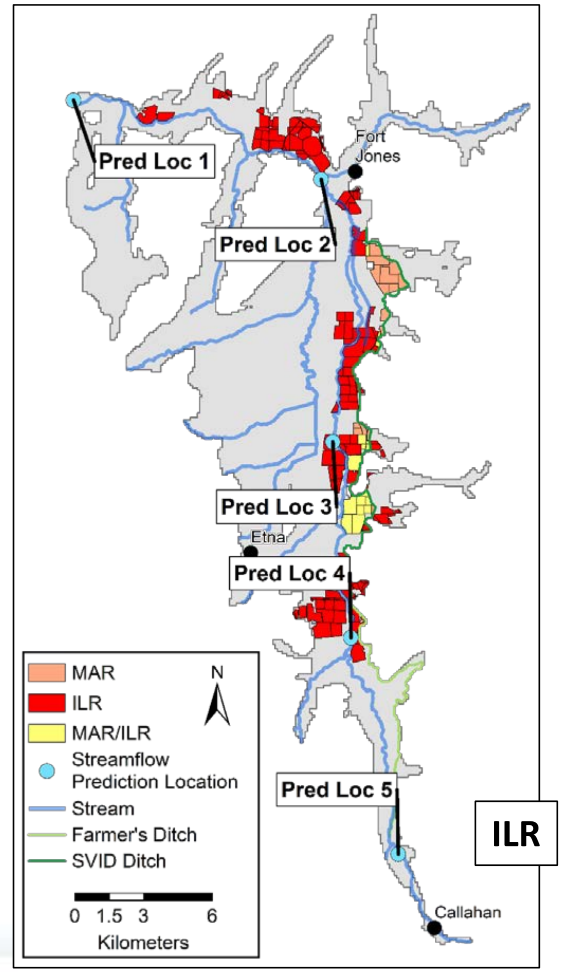
ILR (In-Lieu Recharge)

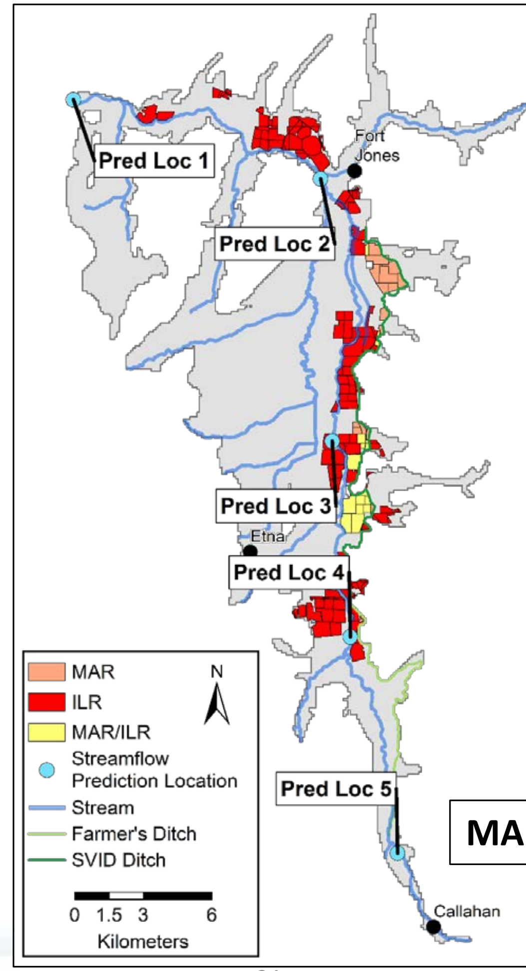
- 5,490 acres
- Operator applies surface water to yellow and red fields instead of pumping groundwater in the early growing season, as long as surface water is available.
- Water delivered through SVID Ditch



DRAFT

MAR+ILR

- 6,250 combined acres
- Both MAR (January-March) and ILR (early growing season) practices used.

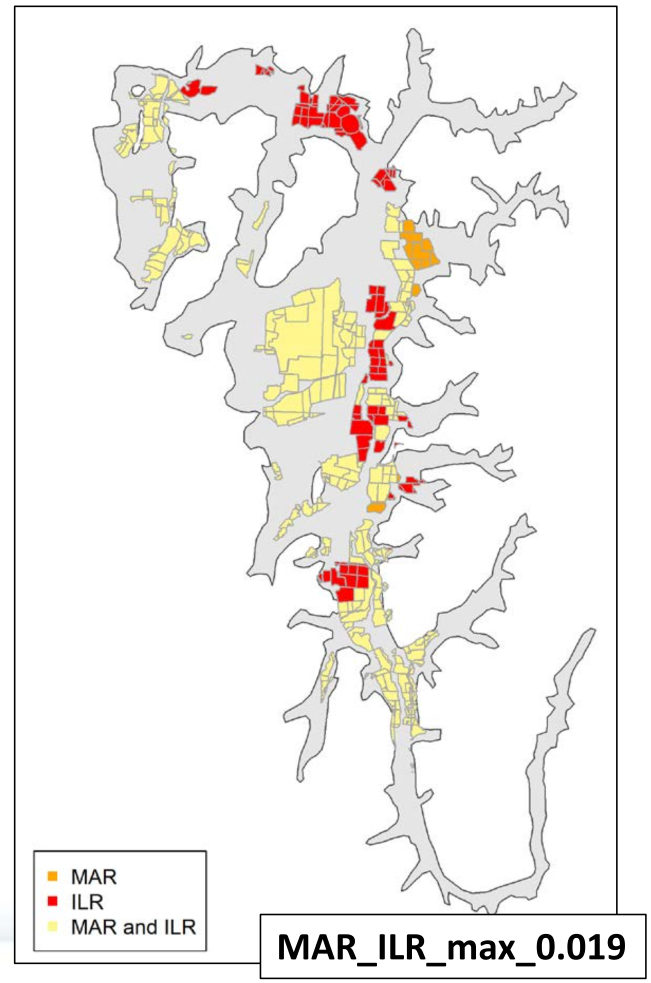


MAR_ILR

DRAFT

MAR+ILR expanded, 0.019 m/day, diversion limits on MAR

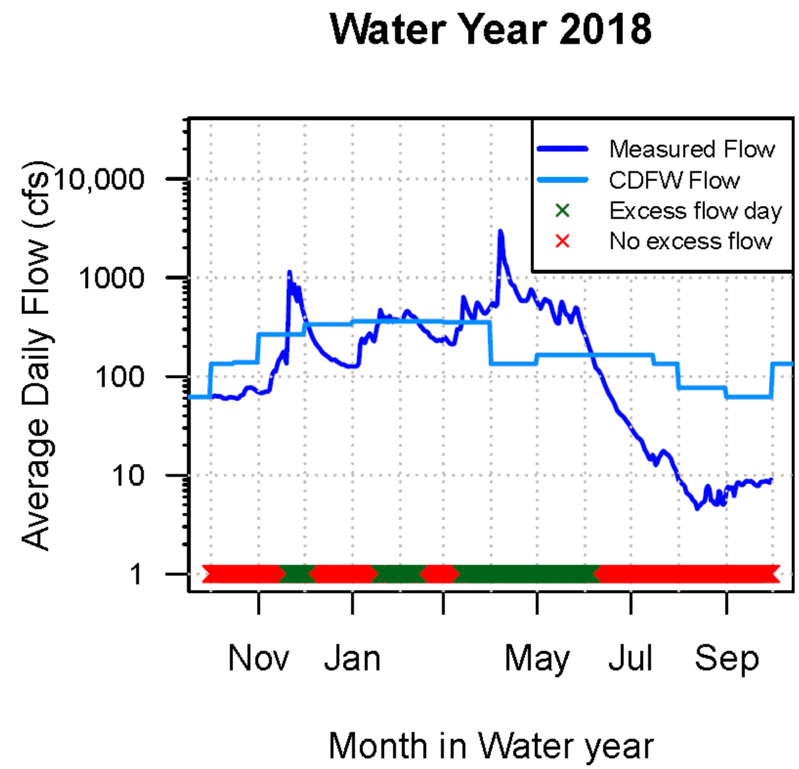
- 16,450 combined acres
- In this expanded scenario, MAR and ILR irrigation practices were assumed to be practicable on all fields with a surface water irrigation source.
  - MAR surface water diversions limited on days with FJ flow near or below the CDFW recommended instream flows.
  - Current known range of infiltration capacities is 0.003-0.035 m/day. In fields with unknown infiltration capacities, 0.019 m/day infiltration rate is assumed.



DRAFT

Restrictions on tributary flow diversions at low FJ flows

- Simulates the effect of limitations on surface water diversions in two scenarios:
  - the historical basecase
  - the MAR + ILR scenario.
    - "Available" water is defined as the proportion of total flow at the FJ gauge in excess of CDFW 2017 recommended instream flow values.
    - The "available" percentage is applied to the flow in each tributary and used to limit surface flow diversions.
- Surface water rights are not accounted for in this scenario. It is included in this appendix to explore the outcome of management actions such as surface water leases.

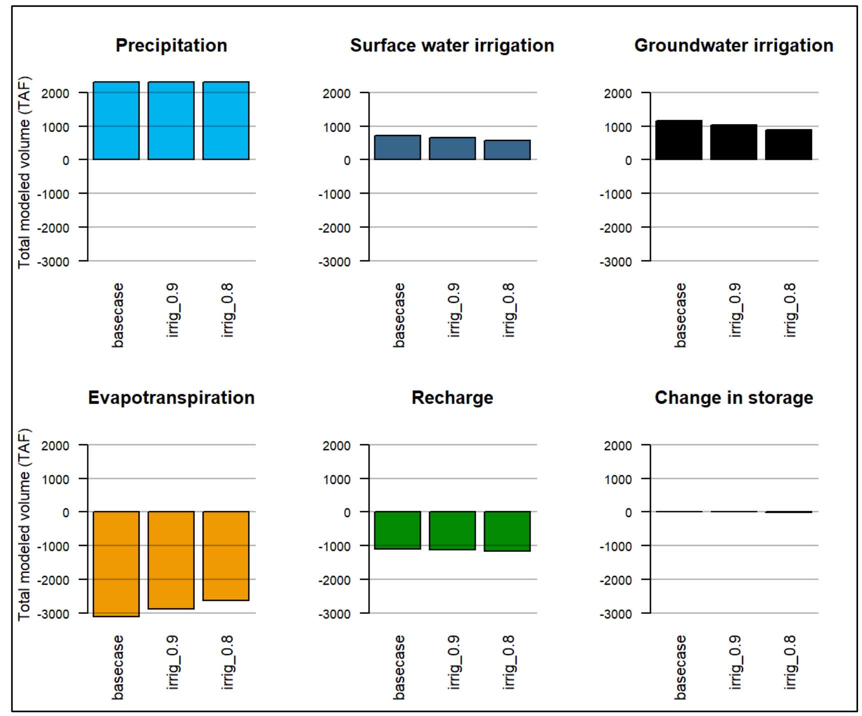


flow_lims
mar_ilr_flowlims

Irrigation demand change

- Two scenarios in which an unspecified crop change results in:
  - 90%
  - 80%

of the historical crop ET from all crops, which drives irrigation demand (a 10% or 20% reduction in ET on irrigated fields).



irrig_0.8
irrig_0.9

Irrigation efficiency scenarios

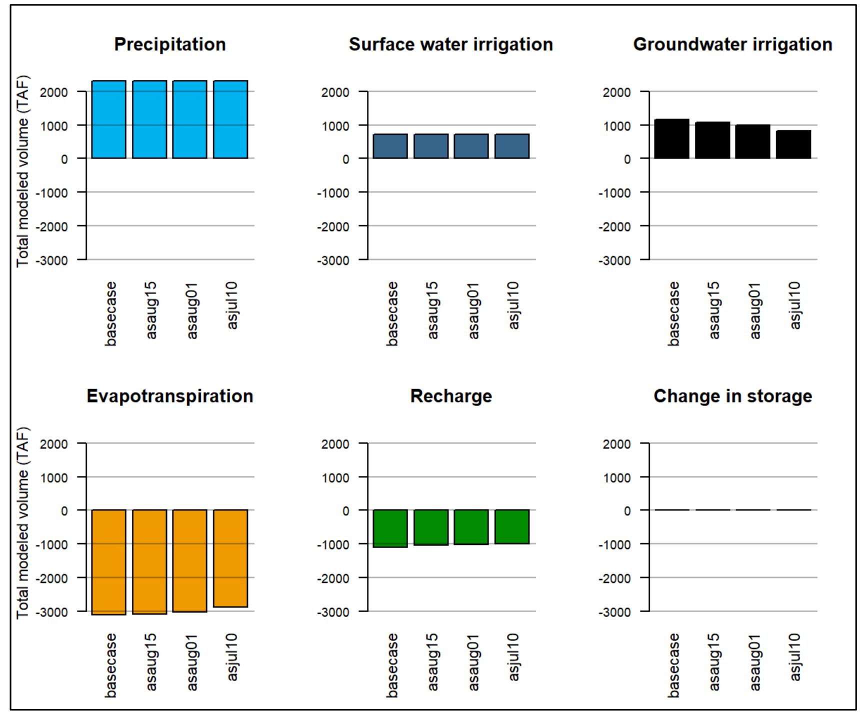
- Three scenarios:
  - Improve by 10%
  - Improve by 20%
  - Reduced (worsen) by 10%
- These scenarios assume an unspecified change in irrigation equipment that results in either an increase or decrease in irrigation efficiency on all irrigated fields.

irr_eff_improve_0.1
irr_eff_improve_0.2
irr_eff_worse_0.1

DRAFT

Alfalfa irrigation schedule change

- Three scenarios, in which irrigation on all alfalfa fields ceases, in all water years, on:
  - July 10
  - August 1
  - August 15
- Would presumably involve an incentive or compensation program (a back-of-the-envelope estimate of the value of the 3rd cutting of alfalfa is approximately $7.5 million).



alf_irr_stop_jul10
alf_irr_stop_aug01
alf_irr_stop_aug15

DRAFT

Alfalfa irrigation schedule change, dry years only

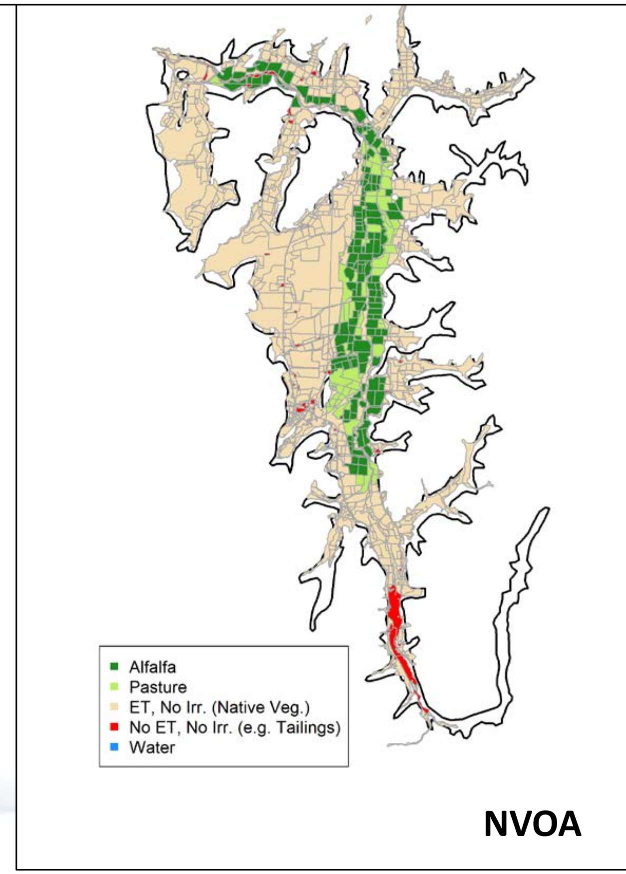
- Two scenarios, in which irrigation on all alfalfa fields ceases, in dry water years only, on:
  - August 1
  - August 15
  - Dry water years in this simulation: ’91, ’92, ’94, ’01, ’09, ’13, ’14, ’18.
- Would presumably involve an incentive or compensation program (a back-of-the-envelope estimate of the value of the 3rd cutting of alfalfa is approximately $7.5 million).

alf_irr_stop_aug01_dry_yrs_only
alf_irr_stop_aug15_dry_yrs_only

Turn off *all irrigation* outside adjudicated area

- 23,070 acres of cultivated crops converted to native vegetation.

Native Vegetation on All Fields Outside Adjudication



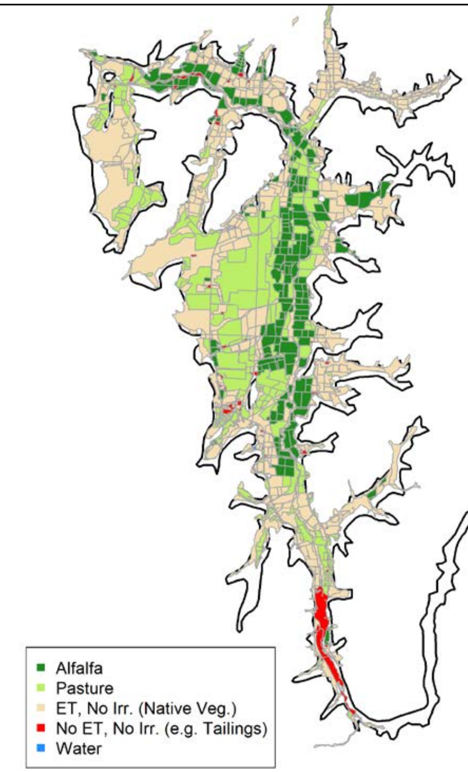
DRAFT

Used as no-pumping reference case in SMC definition

Turn off *pumping* outside adjudicated area

- 11,630 acres of cultivated crops converted to native vegetation.

Native Vegetation on *GW and Mixed Water Source Fields* Outside Adjudication



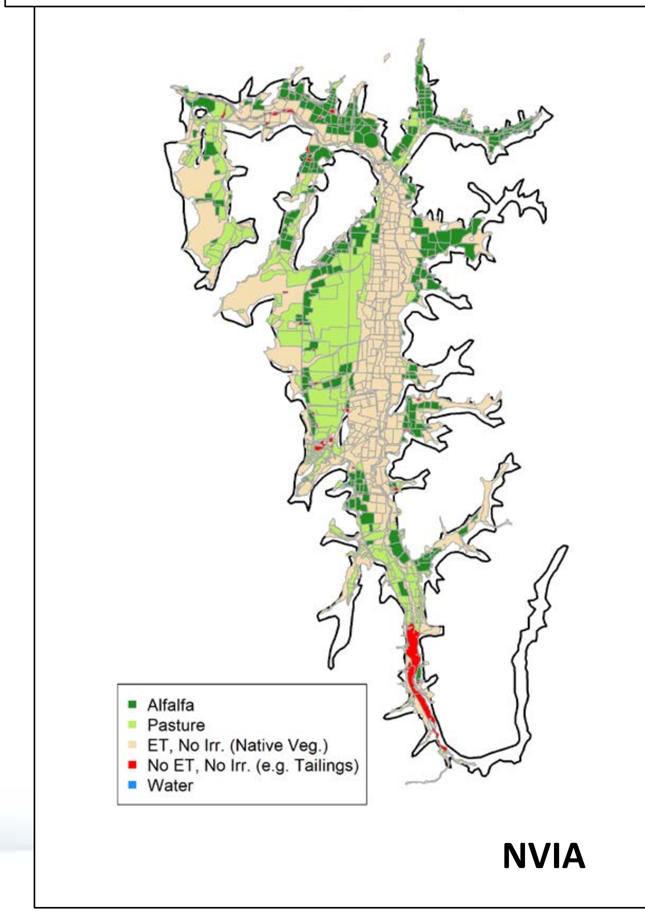
NV-GWM-OA

DRAFT

Turn off *all irrigation* **inside** adjudicated area

- 10,980 acres of cultivated crops converted to native vegetation.

Native Vegetation Inside Adjudication

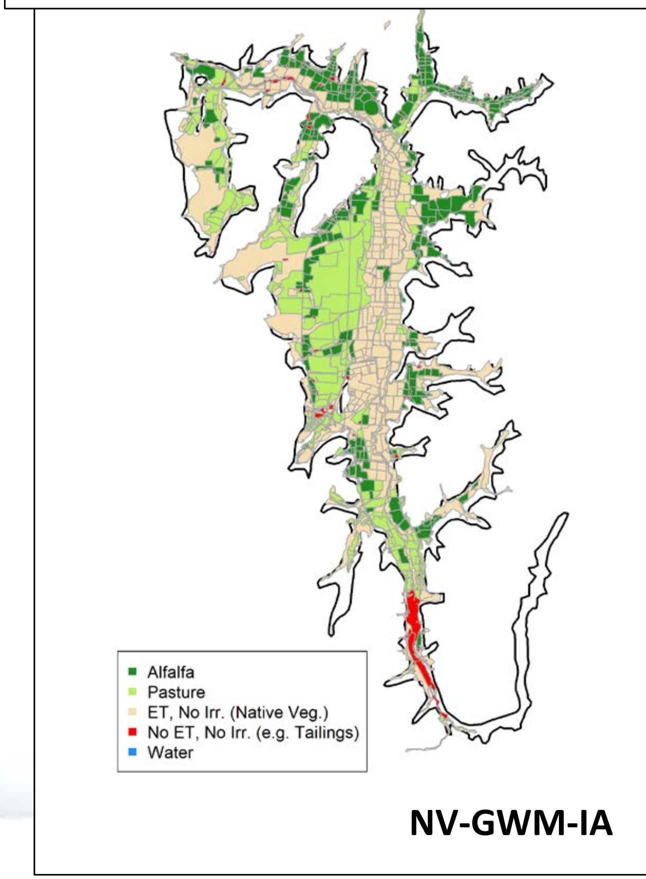


DRAFT

Turn off *pumping* **inside** adjudicated area

- 9,900 acres of cultivated crops converted to native vegetation.

Native Vegetation on *GW and Mixed Water Source Fields* Inside Adjudication

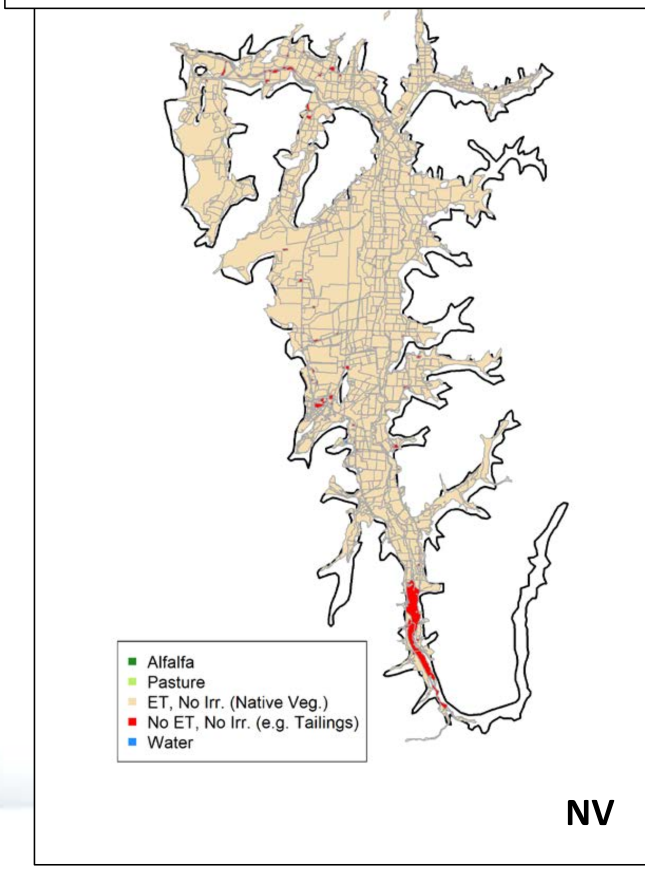


DRAFT

Turn off *all irrigation* in Scott Valley

- 34,040 acres of cultivated crops converted to native vegetation.

Native Vegetation on all non-urban fields/parcels

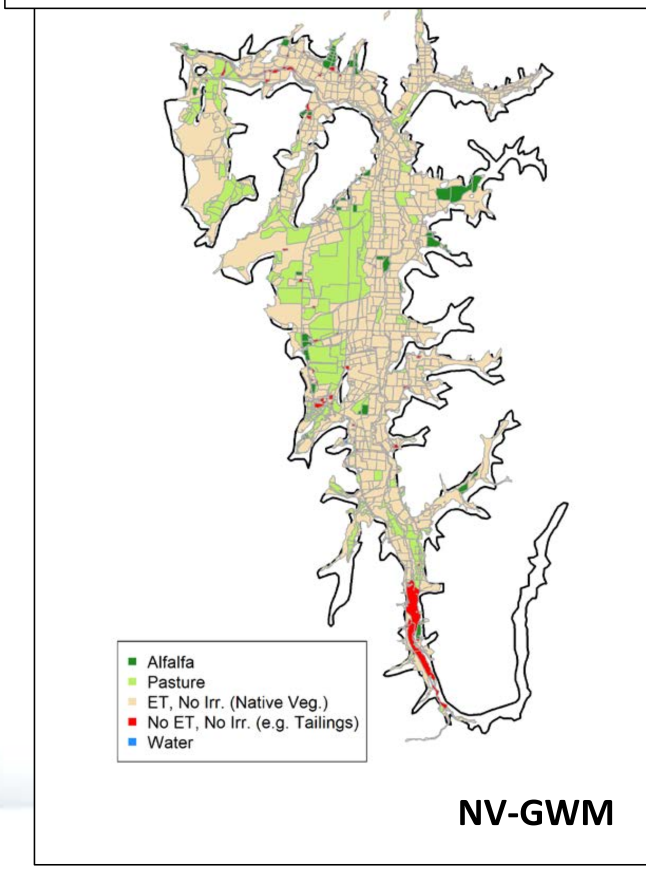


DRAFT

Turn off *all pumping* in Scott Valley

- 21,530 acres of cultivated crops converted to native vegetation.

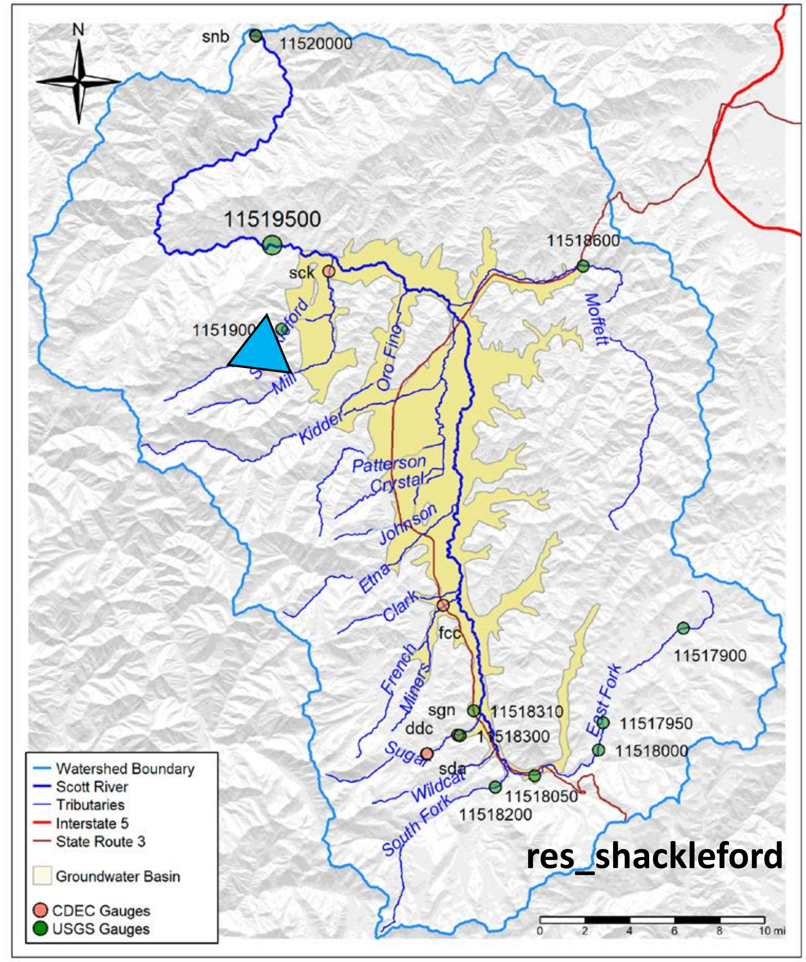
Native Vegetation on all *GW and Mixed Water Source Fields*



DRAFT

Reservoir, 30 cfs dry season release, Shackleford

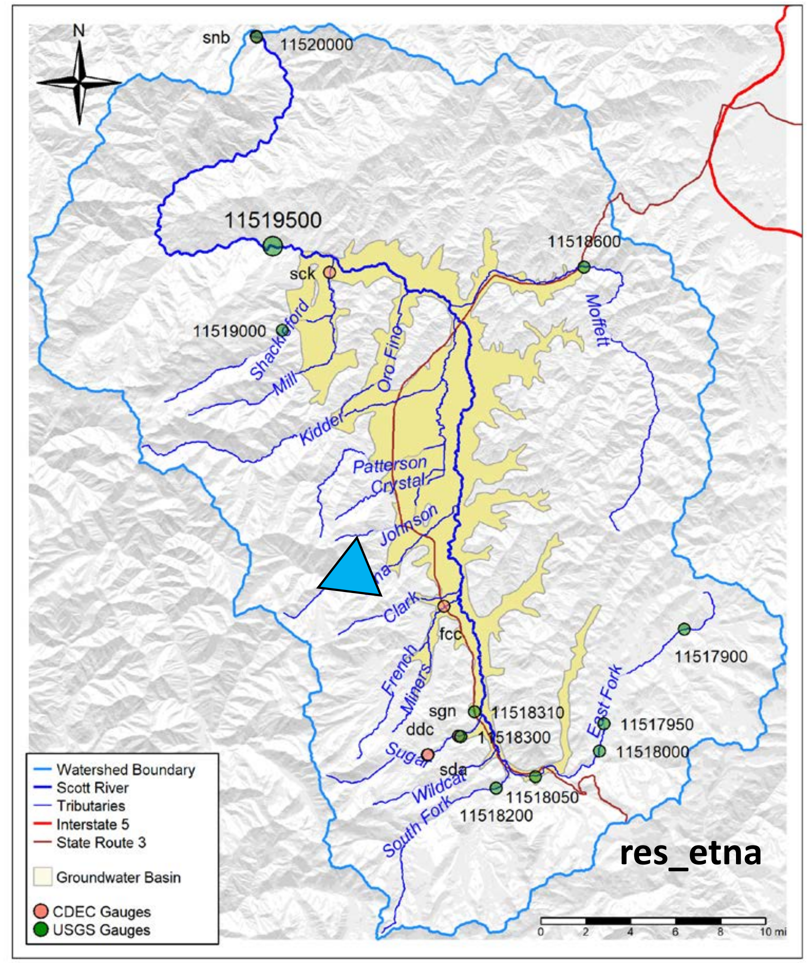
- Alters the flow of Shackleford creek to simulate a 9 TAF reservoir storing and releasing flow.
- Holds all water except 30 cfs back in the wet season (Dec. 1-Mar. 31), until the reservoir is full.
- Allows water to pass through during the growing season (Apr. 1-June 31), but retains water in storage.
- Releases 30 cfs in the dry season (July 1-Nov. 30), unless the reservoir runs dry.



DRAFT

Reservoir, 30 cfs dry season release, Etna Creek

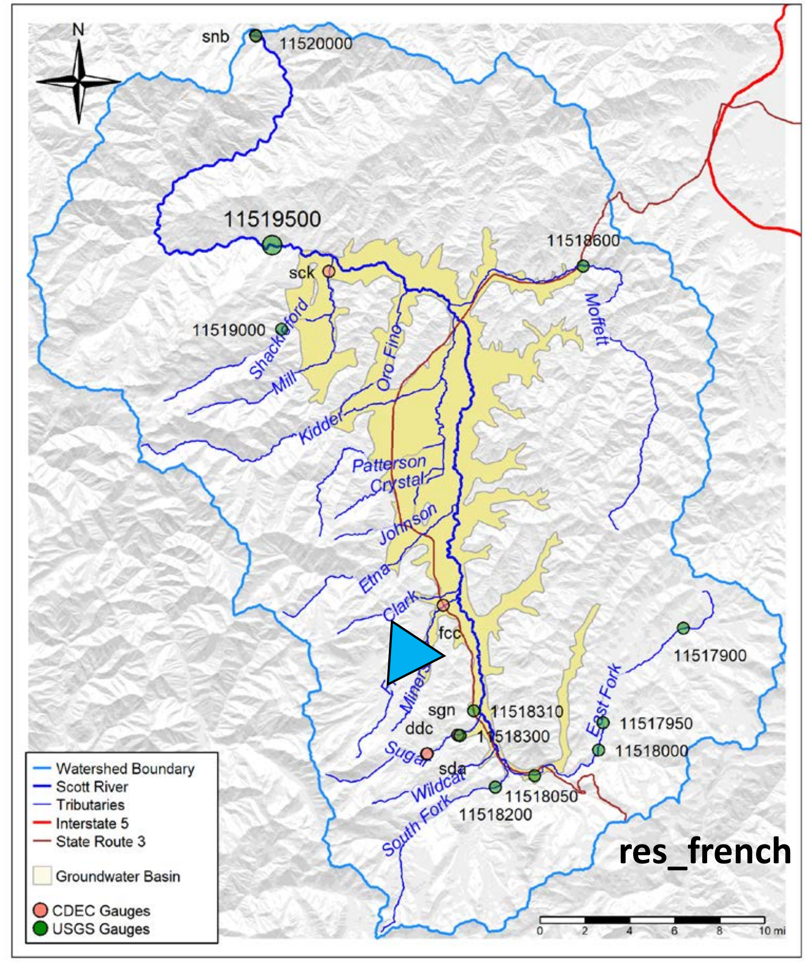
- Alters the flow of Etna creek to simulate a 9 TAF reservoir storing and releasing flow.
- Holds all water except 30 cfs back in the wet season (Dec. 1-Mar. 31), until the reservoir is full.
- Allows water to pass through during the growing season (Apr. 1-June 31), but retains water in storage.
- Releases 30 cfs in the dry season (July 1-Nov. 30), unless the reservoir runs dry.



DRAFT

Reservoir, 30 cfs dry season release, French Creek

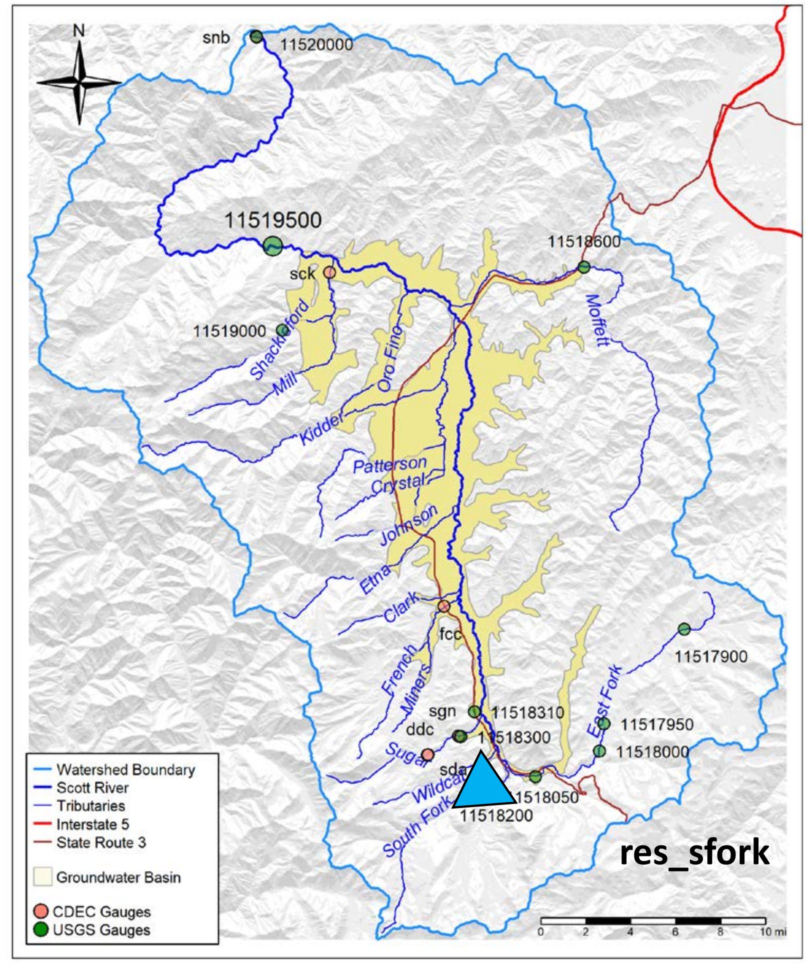
- Alters the flow of French creek to simulate a 9 TAF reservoir storing and releasing flow.
- Holds all water except 30 cfs back in the wet season (Dec. 1-Mar. 31), until the reservoir is full.
- Allows water to pass through during the growing season (Apr. 1-June 31), but retains water in storage.
- Releases 30 cfs in the dry season (July 1-Nov. 30), unless the reservoir runs dry.



DRAFT

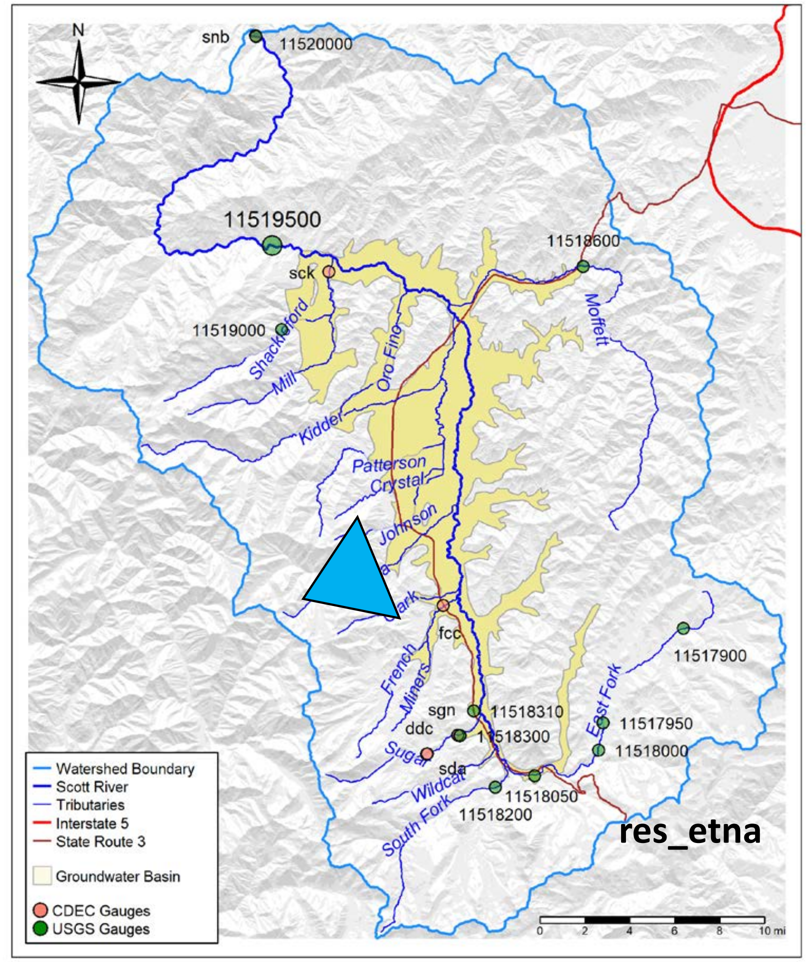
Reservoir, 30 cfs dry season release, South Fork

- Alters the flow of South Fork to simulate a 9 TAF reservoir storing and releasing flow.
- Holds all water except 30 cfs back in the wet season (Dec. 1-Mar. 31), until the reservoir is full.
- Allows water to pass through during the growing season (Apr. 1-June 31), but retains water in storage.
- Releases 30 cfs in the dry season (July 1-Nov. 30), unless the reservoir runs dry.



Multiple reservoirs providing 100% reliable 30 cfs dry season release at Etna Creek and Scott River

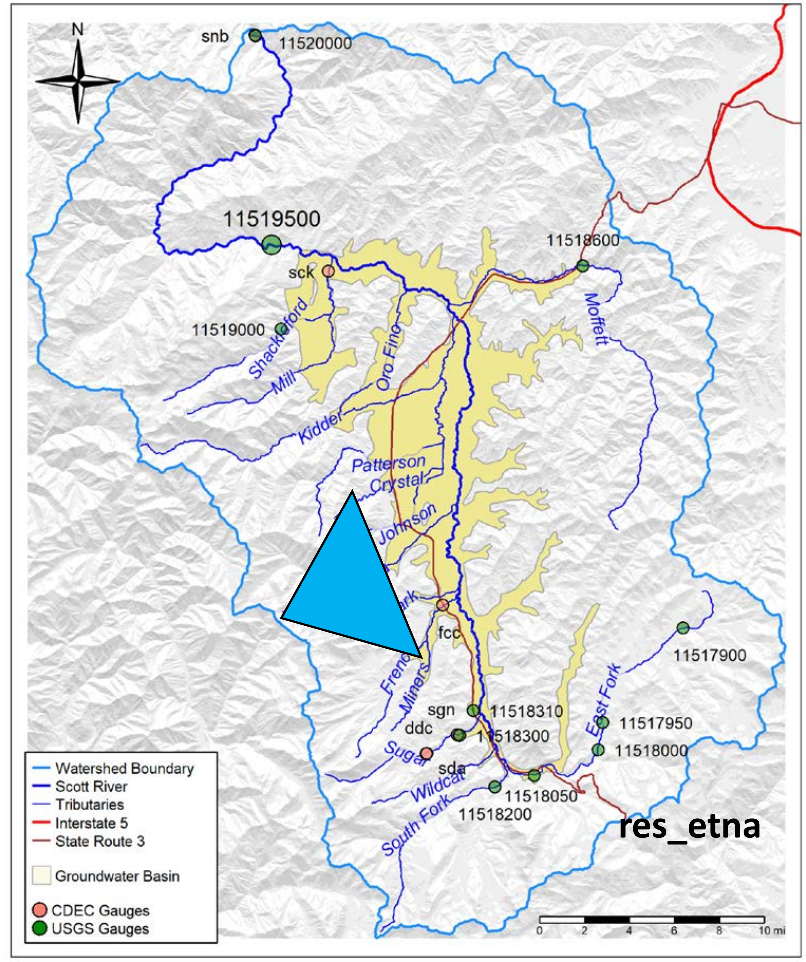
- Multiple reservoirs represented by one 29 TAF reservoir located on Etna Creek. Alters the flow of Etna creek to simulate storing and releasing flow.
- Holds all water except 30 cfs back in the wet season (Dec. 1-Mar. 31), until the reservoir is full.
- Allows water to pass through during the growing season (Apr. 1-June 31), but retains water in storage.
- Releases 30 cfs in every dry season (July 1-Nov. 30). This reservoir does not run dry during the 1991-2018 period.



Multiple reservoirs providing 100% reliable 60 cfs dry season release at Etna Creek and Scott River

DRAFT

- Multiple reservoirs represented by one 134 TAF reservoir located on Etna Creek. Alters the flow of Etna creek to simulate a storing and releasing flow.
- Holds all water except 30 cfs back in the wet season (Dec. 1-Mar. 31), until the reservoir is full.
- Allows water to pass through during the growing season (Apr. 1-June 31), but retains water in storage.
- Releases 60 cfs in every dry season (July 1-Nov. 30). This reservoir does not run dry during the 1991-2018 period.



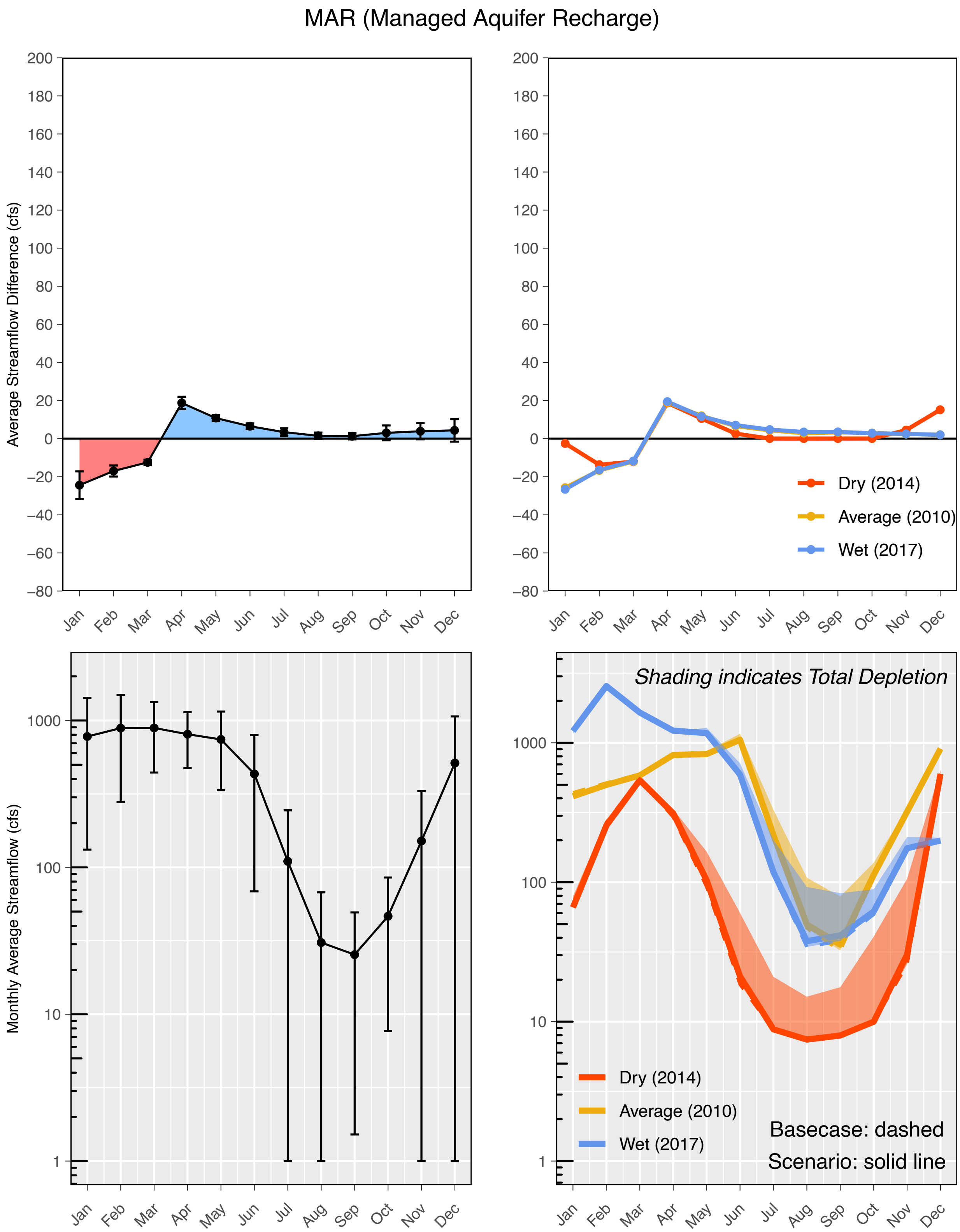
Flow change results (Fort Jones Gauge)

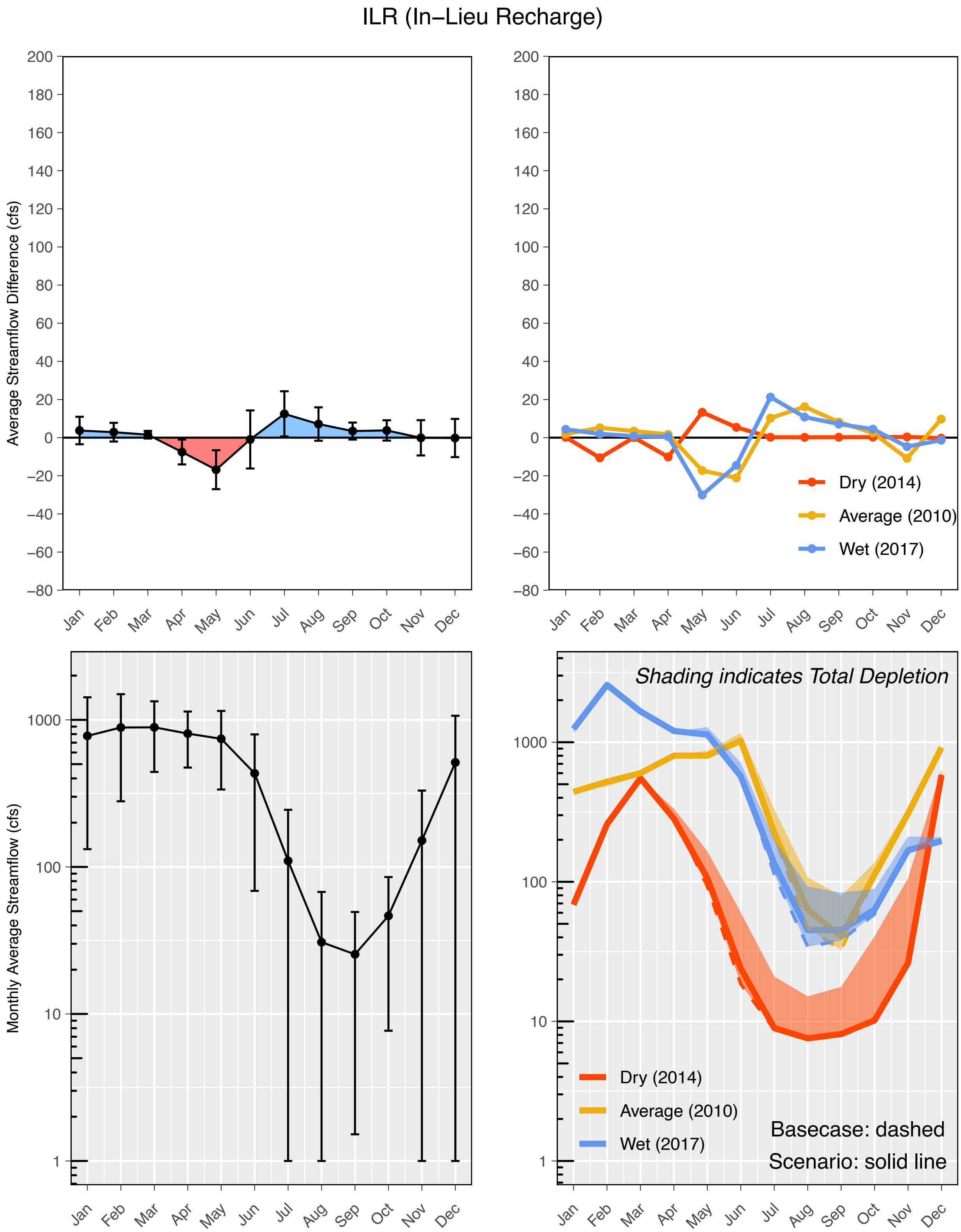
Changes in the simulated flow at the Fort Jones USGS flow gauge (number 11519500) are an indicator of the effect of a project or management action (PMA) on the Scott River stream system. Interpretation details are below; see explanatory plots at the beginning of this appendix for more information.

- Upper left plot: Black dots show the average change in flow (scenario minus basecase) in each month (e.g., all Januaries averaged over the 28-year model period). Whiskers indicate the standard deviation of flow values for each month. Blue areas show that on average, the scenario flow in those months is higher than the historical basecase, indicating that the project or management action would have increased flow in that month. Red areas indicate months with lower flow under the specified scenario.
- Upper right plot: Red, yellow and blue dots and lines indicate the monthly average change in flow in three example water years: 2014 (Dry), 2010 (Average), and 2017 (Wet). Some dots may be missing for some months - this indicates they are beyond the bounds of the figure axes. These example years are included to show deviations from average system behavior due to water year type and year-to-year variability.
- Lower left plot: Black dots show the monthly streamflow (averaged over the 28 year model period) in the historical basecase simulation. Whiskers show the standard deviation of those monthly flows. This is included for reference and is the same on every page of this appendix.
- Lower right plot: Dashed lines indicate the monthly hydrograph in the basecase (in dotted lines) and in the specified scenario (in solid lines) for the three example water years specified above. Shading has been added to each plot to indicate "Total Depletion" used to define the SMC.

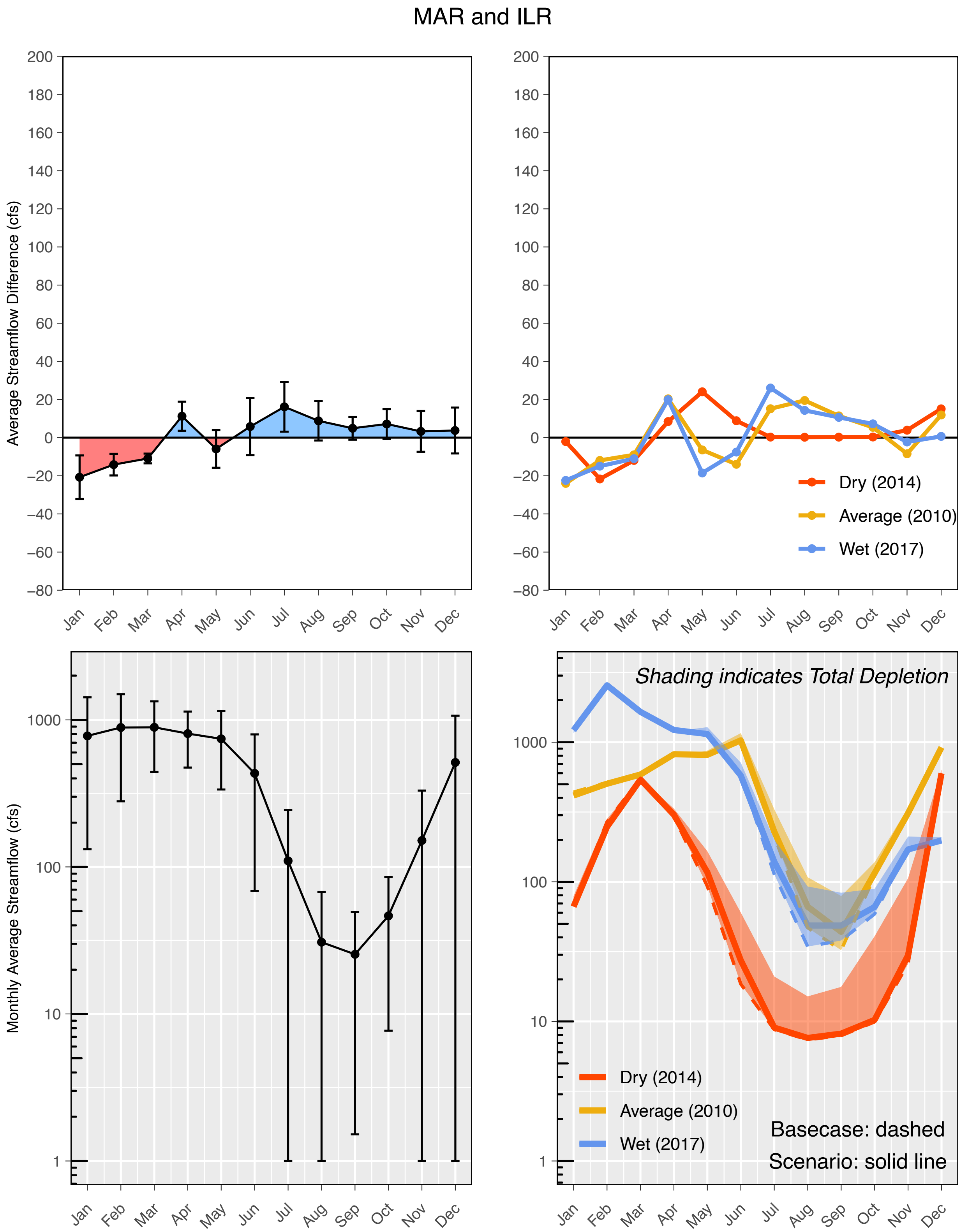
Total Depletion is defined as the difference in simulated Fort Jones flow between the basecase and the No-Pumping Reference Case, in which pumping is turned off outside the adjudicated zone and a reversion to natural vegetation is assumed on all fields serviced by groundwater or mixed groundwater-surface water sources. The No-Pumping Reference Case has also been referred to with these names: "No Pumping Outside Adjudicated Zone" or "Natural Vegetation, Groundwater and Mixed-source fields, Outside Adjudicated Zone [NV-GWM-OA]".

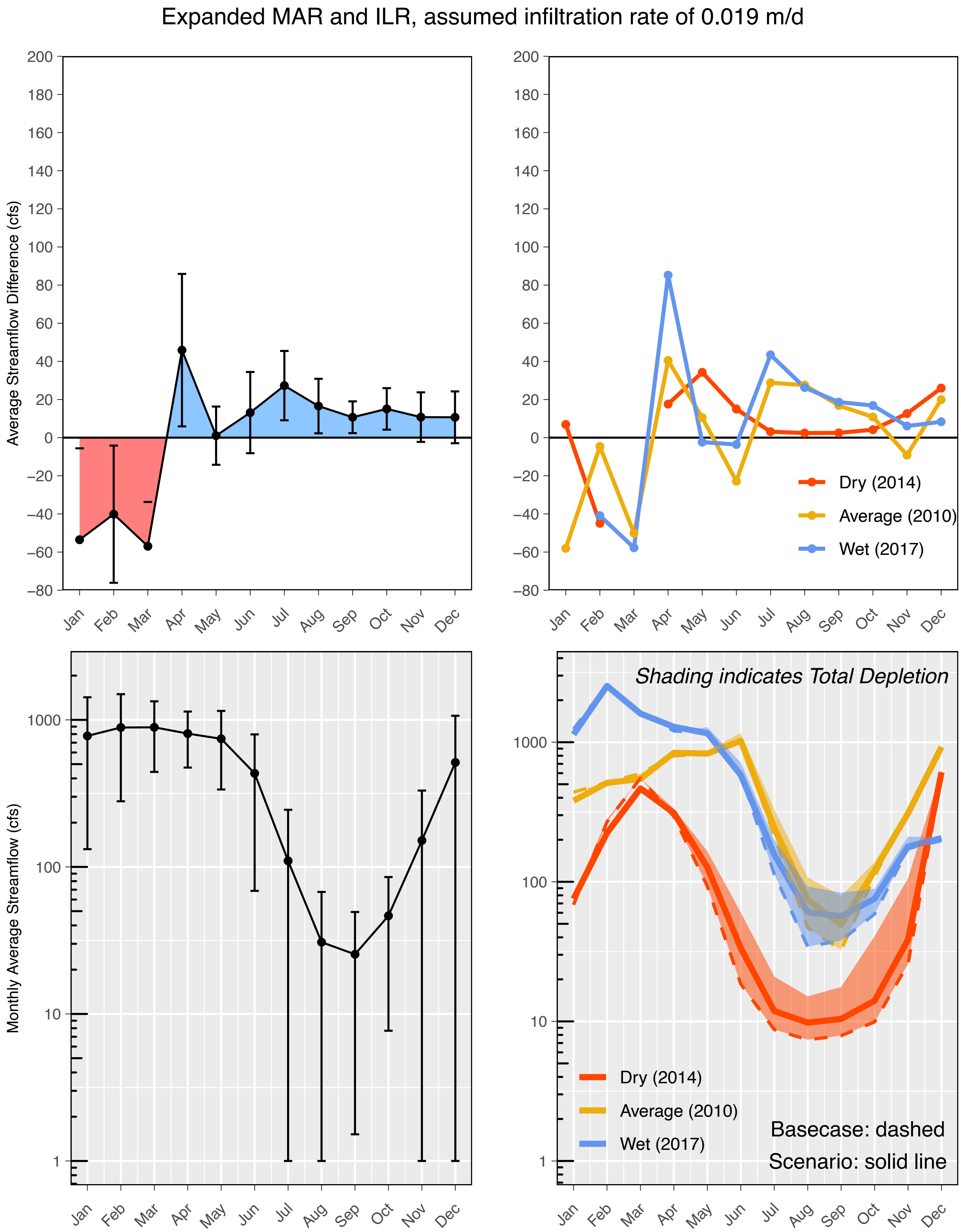
In all graphs, the Total Depletion is indicated by the shaded area. The top of the shaded area is the unmarked hydrograph for the No-Pumping Reference case. The bottom of the shaded area, marked by the dashed line, is the hydrograph of the Basecase. Hydrographs for the scenarios are shown with solid lines. The relative position of the solid line within the shaded area shows how much a PMA can increase streamflow (reverse stream depletion) relative to the Basecase (dashed line) and relative to the Total Depletion (shaded area).

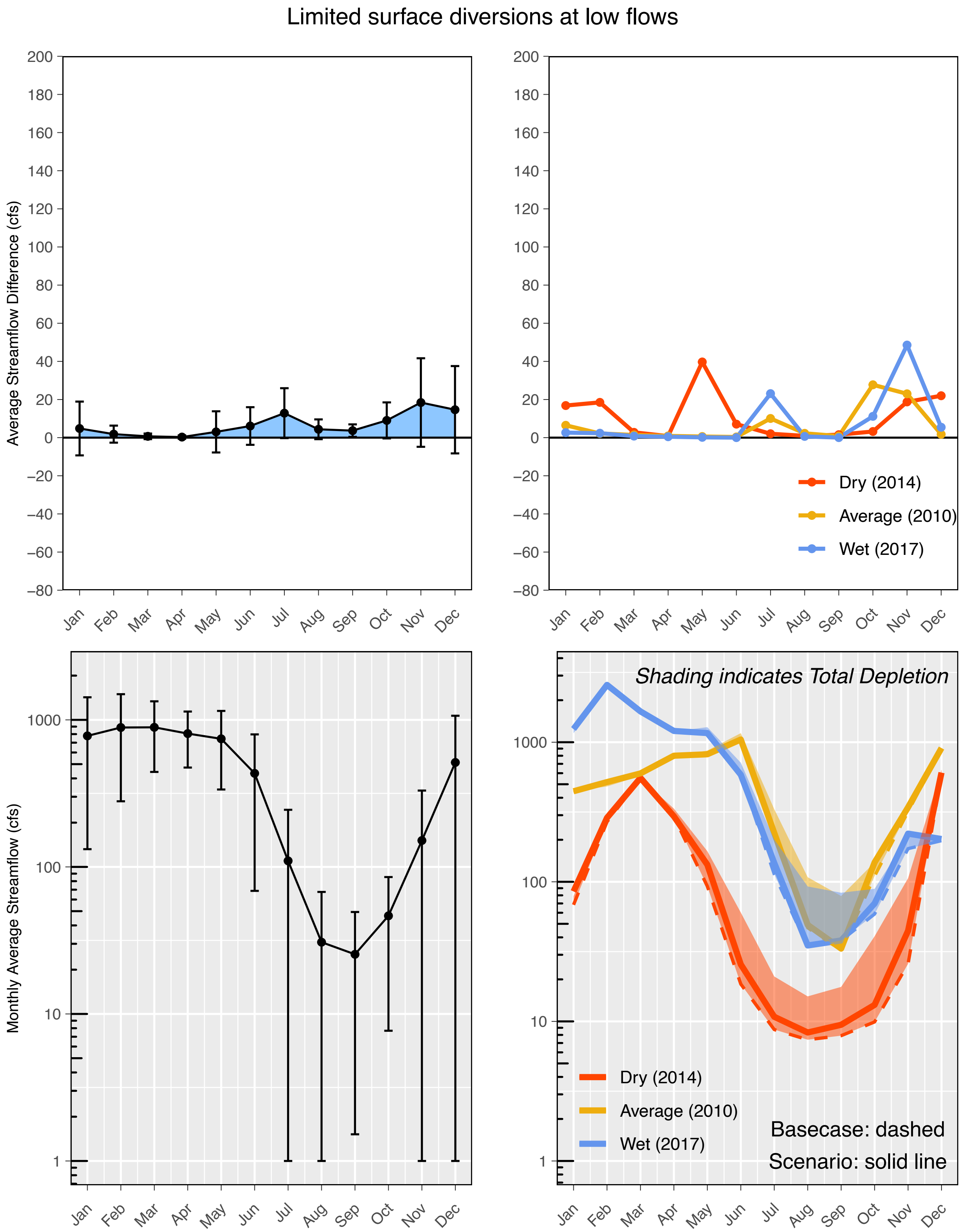

MAR (Managed Aquifer Recharge)
Average Streamflow Difference (cfs)
200
180
160
140
120
100
80
60
40
20
0
−20
−40
−60
−80
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Dry (2014)
Average (2010)
Wet (2017)
Monthly Average Streamflow (cfs)
1000
100
10
1
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line

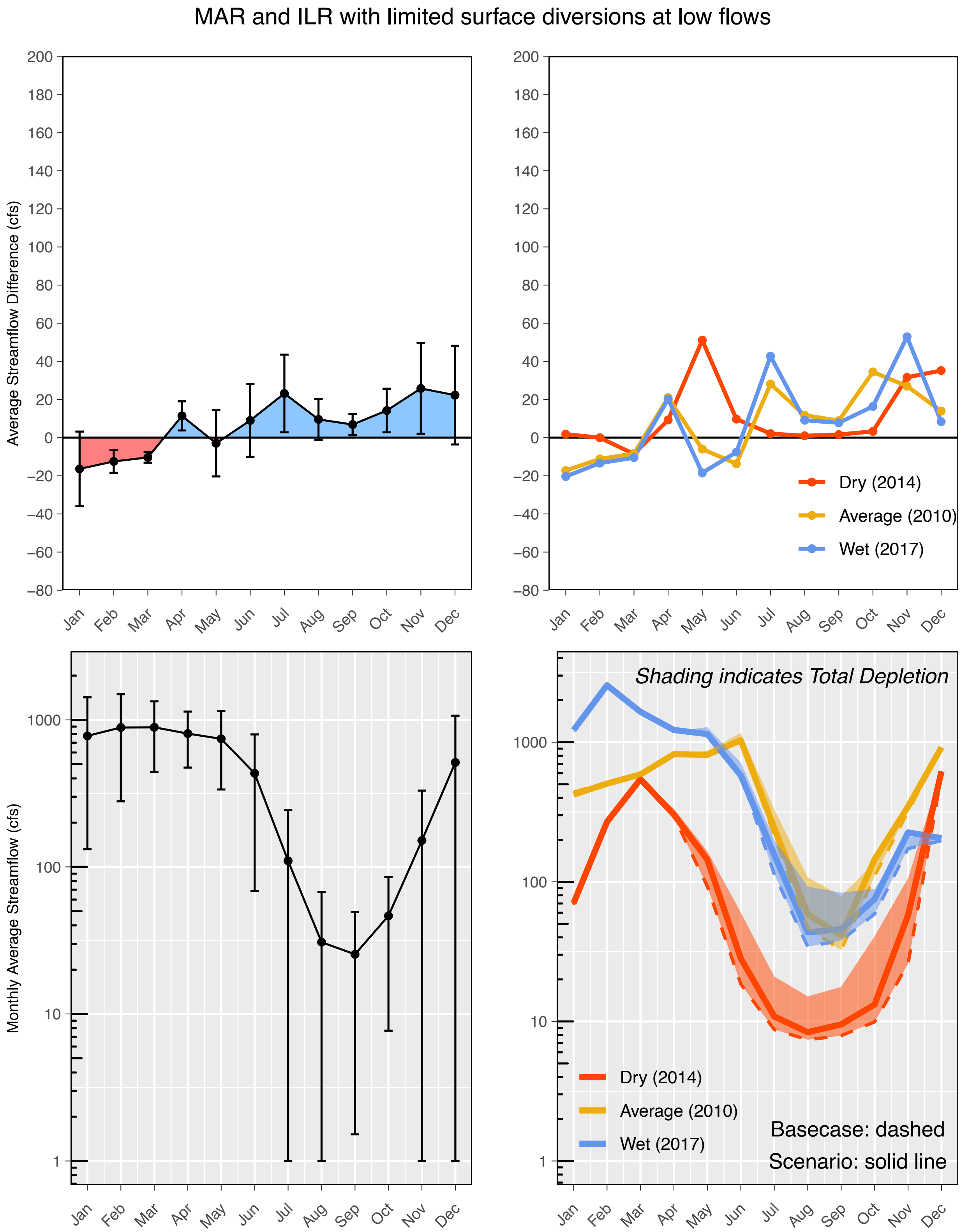


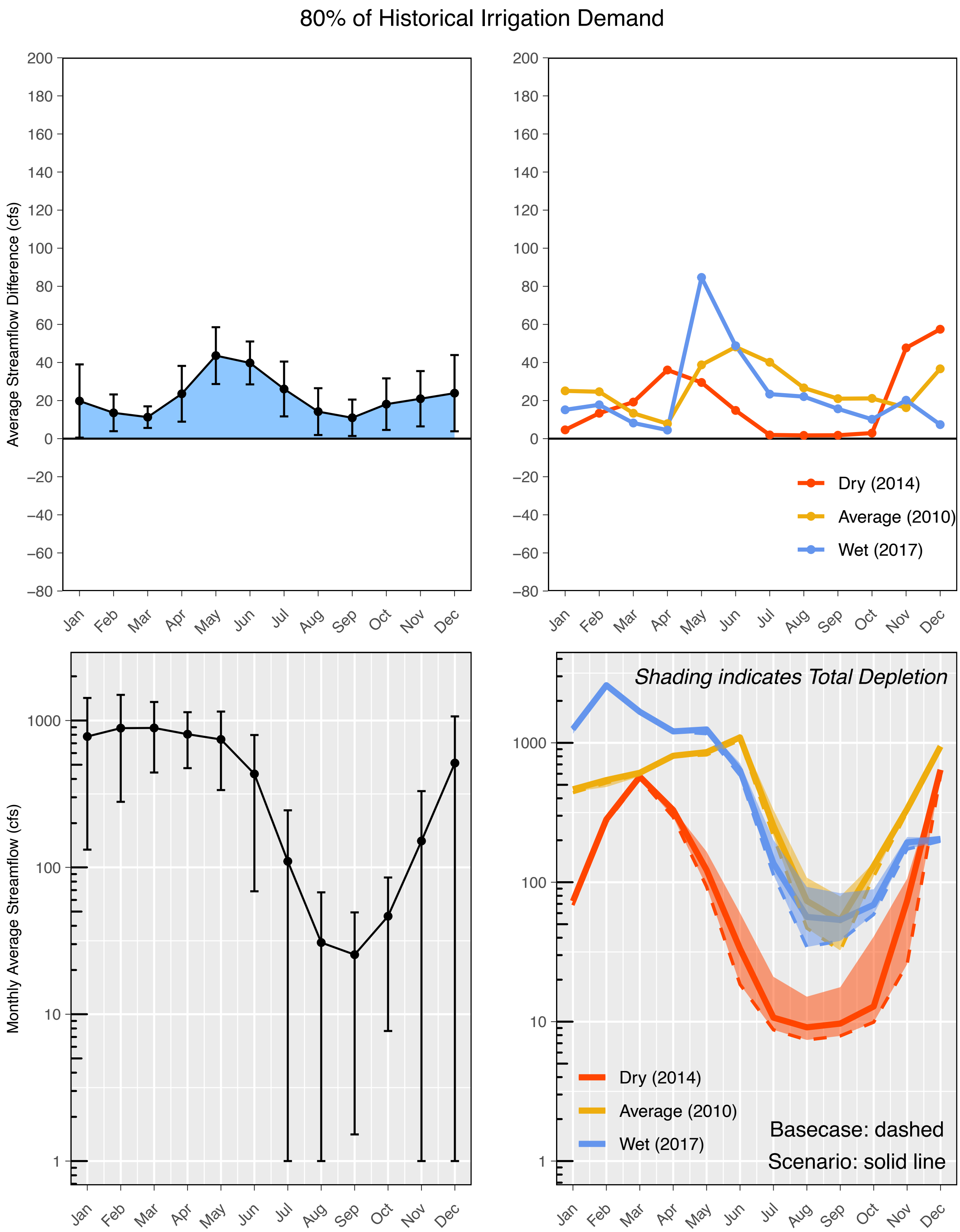
ILR (In−Lieu Recharge)
Average Streamflow Difference (cfs)
200
180
160
140
120
100
80
60
40
20
0
−20
−40
−60
−80
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Dry (2014)
Average (2010)
Wet (2017)
Monthly Average Streamflow (cfs)
1000
100
10
1
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line

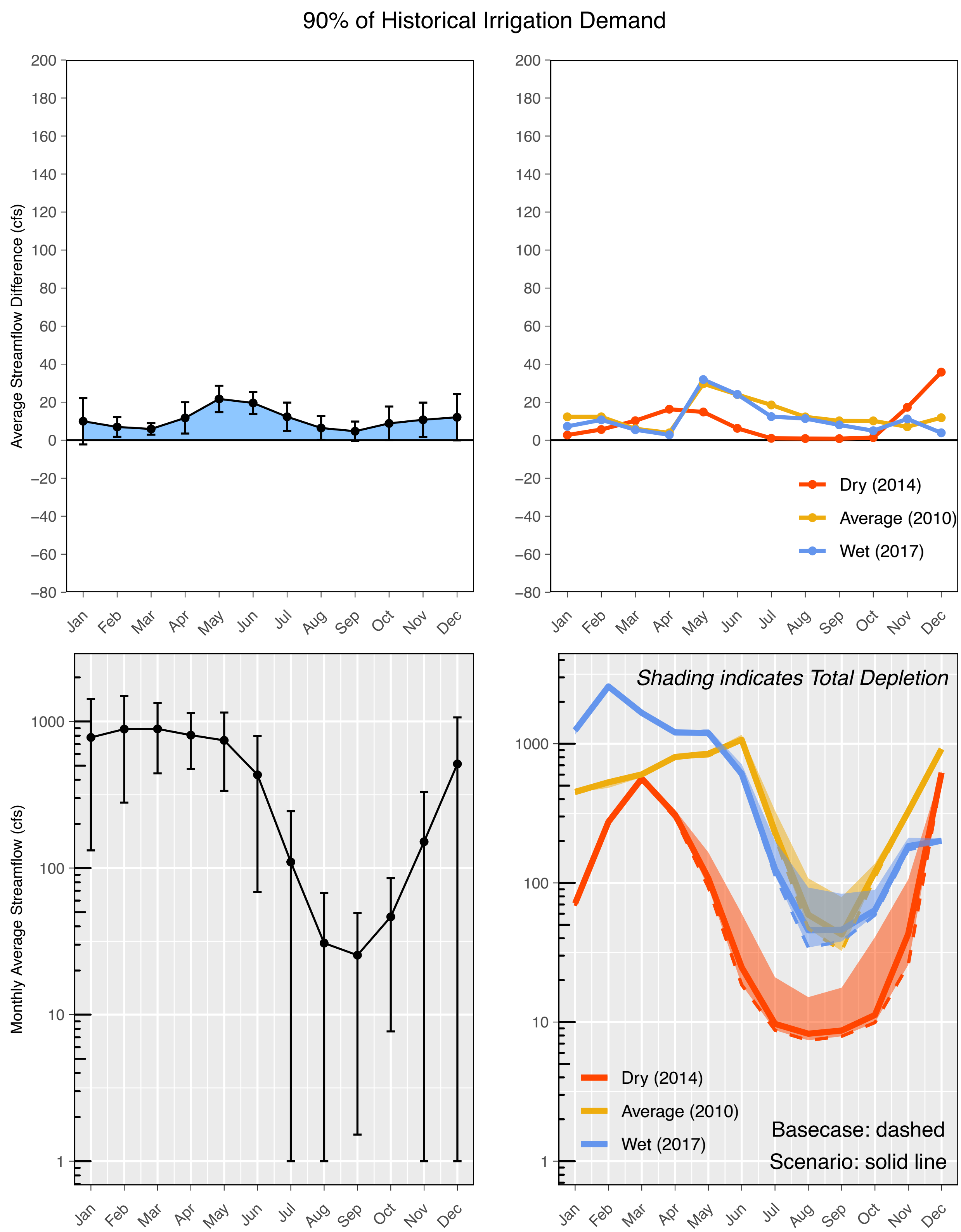

MAR and ILR
Average Streamflow Difference (cfs)
200
180
160
140
120
100
80
60
40
20
0
−20
−40
−60
−80
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Dry (2014)
Average (2010)
Wet (2017)
Monthly Average Streamflow (cfs)
1000
100
10
1
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line


Expanded MAR and ILR, assumed infiltration rate of 0.019 m/d
Average Streamflow Difference (cfs)
Dry (2014)
Average (2010)
Wet (2017)
Monthly Average Streamflow (cfs)
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

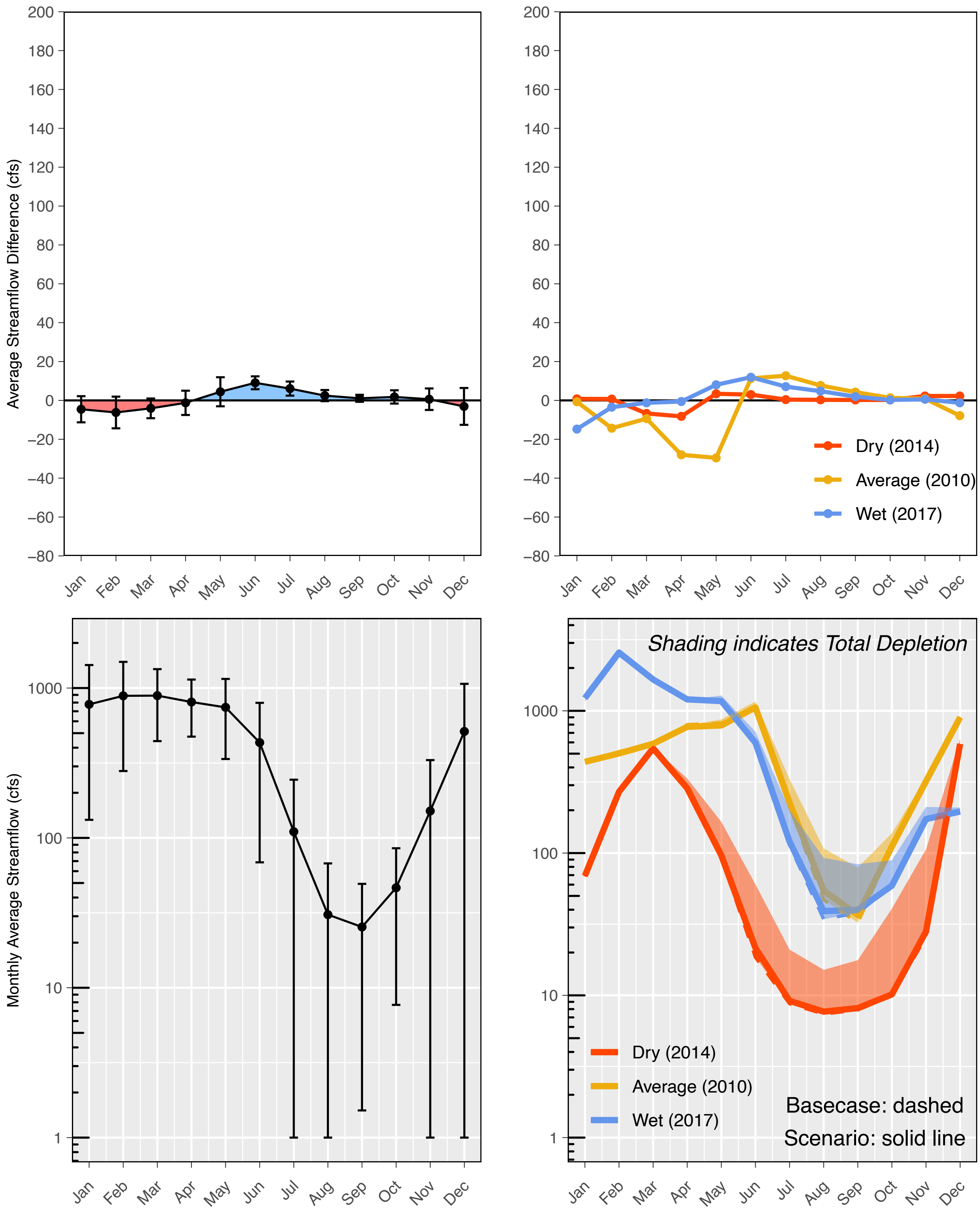

Limited surface diversions at low flows
Average Streamflow Difference (cfs)
Monthly Average Streamflow (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Dry (2014)
Average (2010)
Wet (2017)
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line


MAR and ILR with limited surface diversions at low flows
Average Streamflow Difference (cfs)
Monthly Average Streamflow (cfs)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Dry (2014)
Average (2010)
Wet (2017)
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line

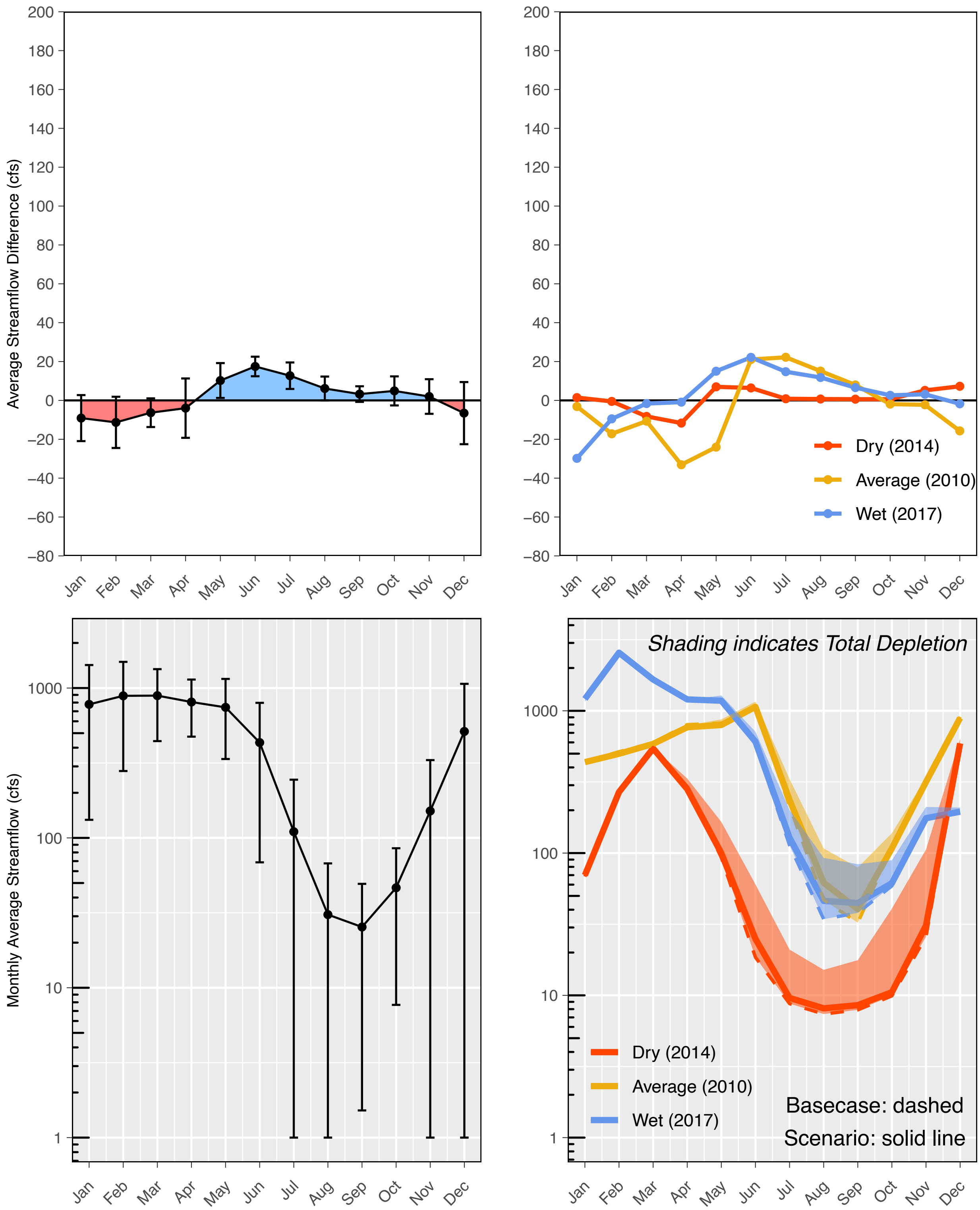

80% of Historical Irrigation Demand
Average Streamflow Difference (cfs)
Monthly Average Streamflow (cfs)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Dry (2014)
Average (2010)
Wet (2017)
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line

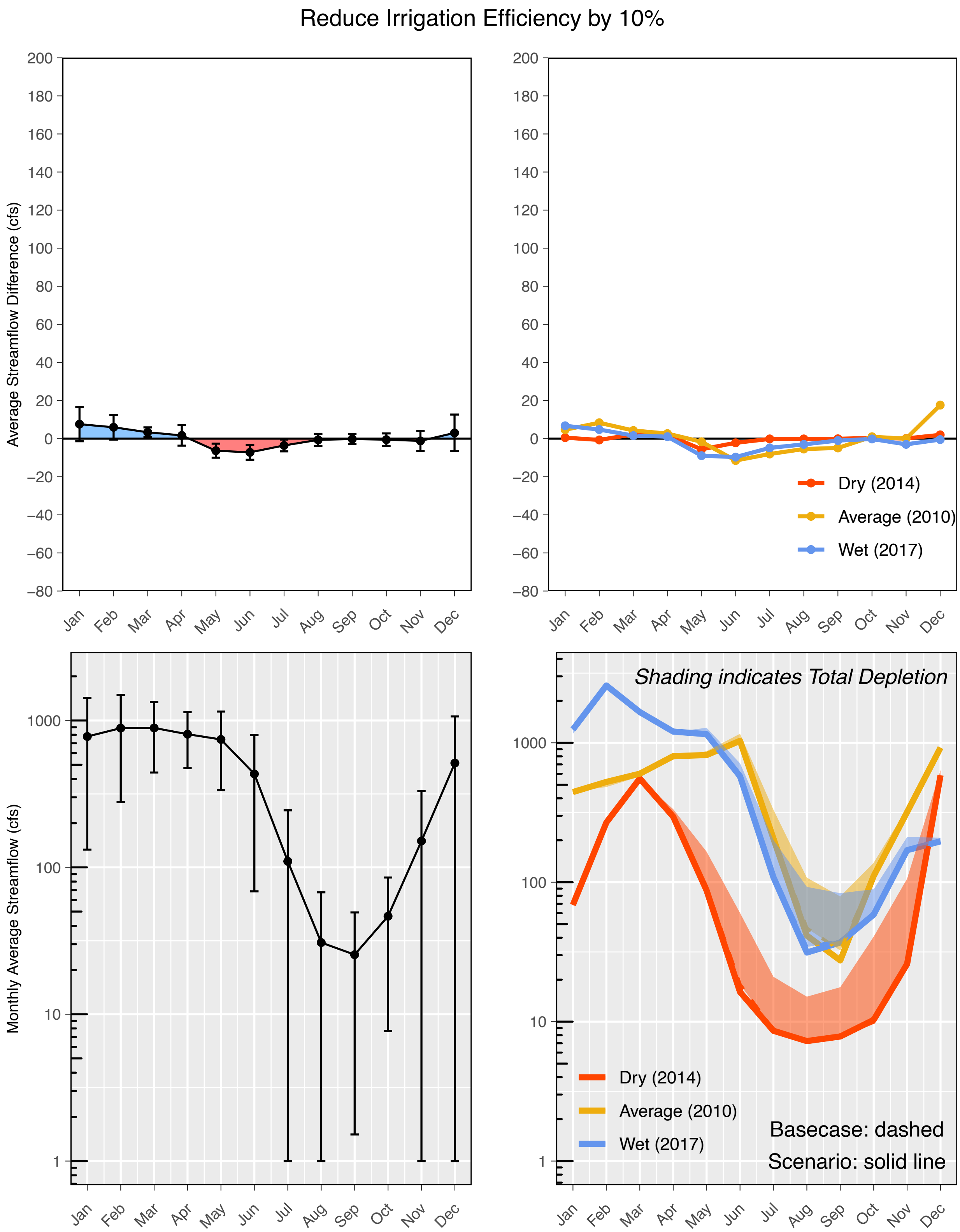

90% of Historical Irrigation Demand
Average Streamflow Difference (cfs)
Dry (2014)
Average (2010)
Wet (2017)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Monthly Average Streamflow (cfs)
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line

Improve Irrigation Efficiency by 10%

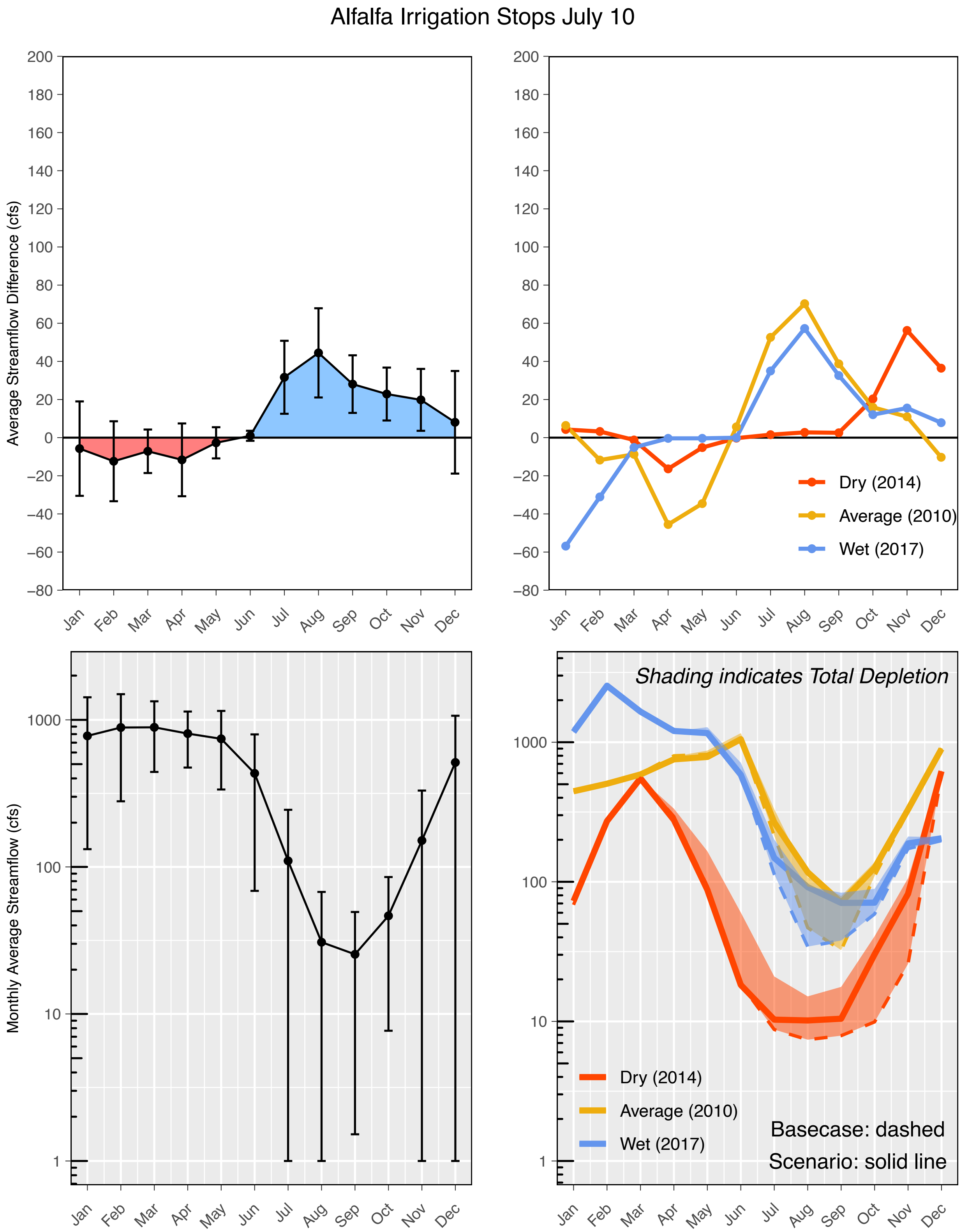


Improve Irrigation Efficiency by 20%

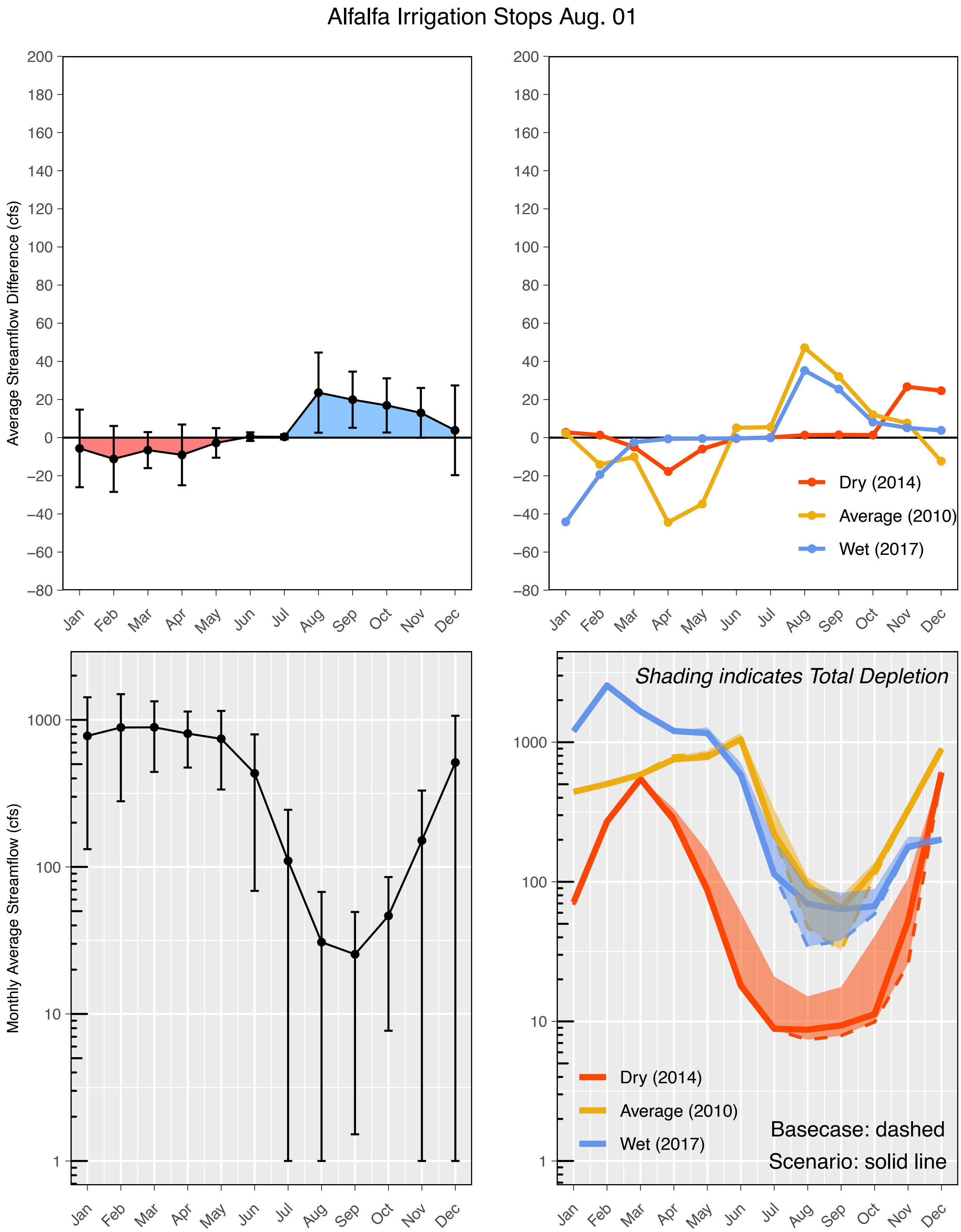


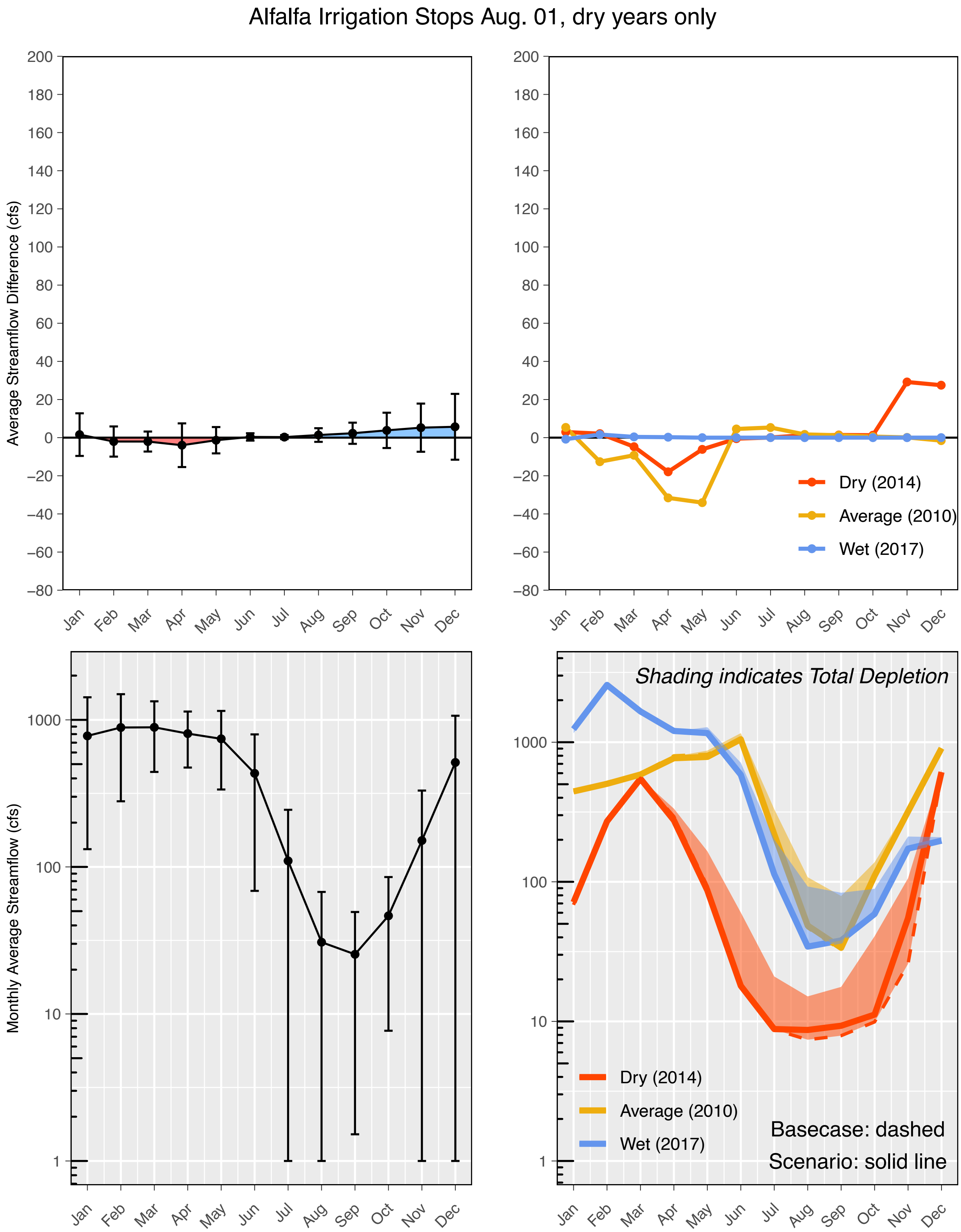


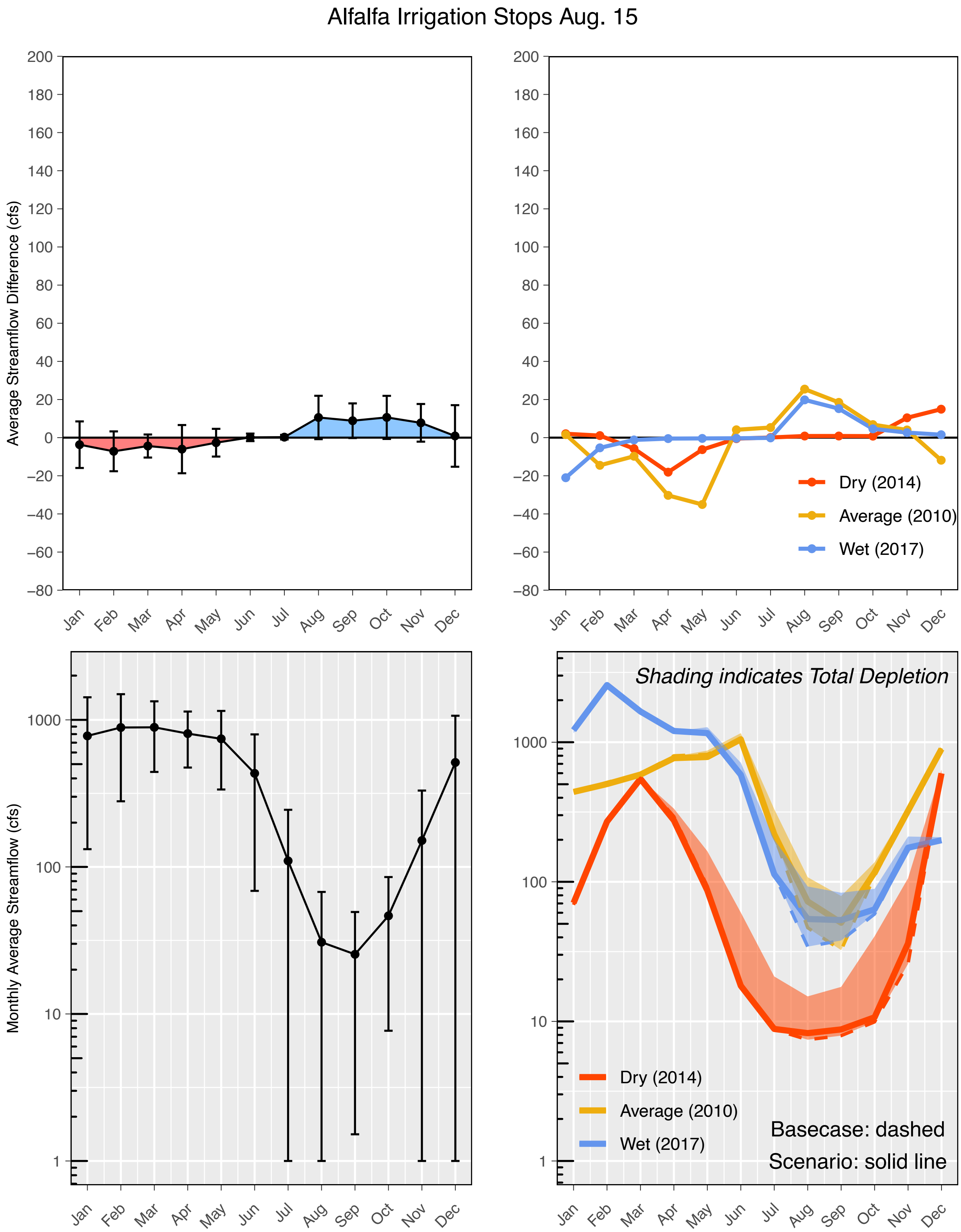
Reduce Irrigation Efficiency by 10%
Average Streamflow Difference (cfs)
Monthly Average Streamflow (cfs)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Dry (2014)
Average (2010)
Wet (2017)
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line

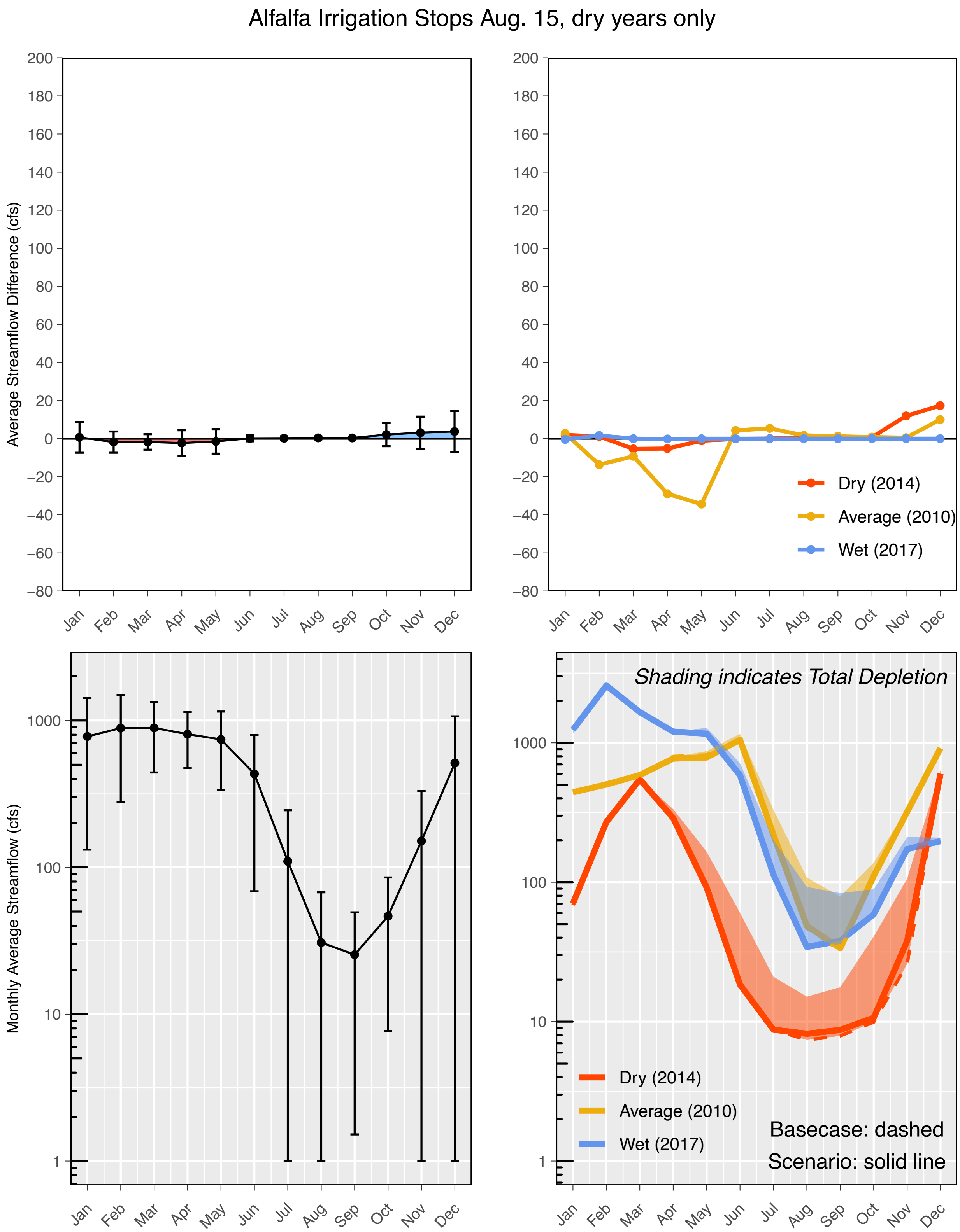


Alfalfa Irrigation Stops July 10
Average Streamflow Difference (cfs)
Dry (2014)
Average (2010)
Wet (2017)
Monthly Average Streamflow (cfs)
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

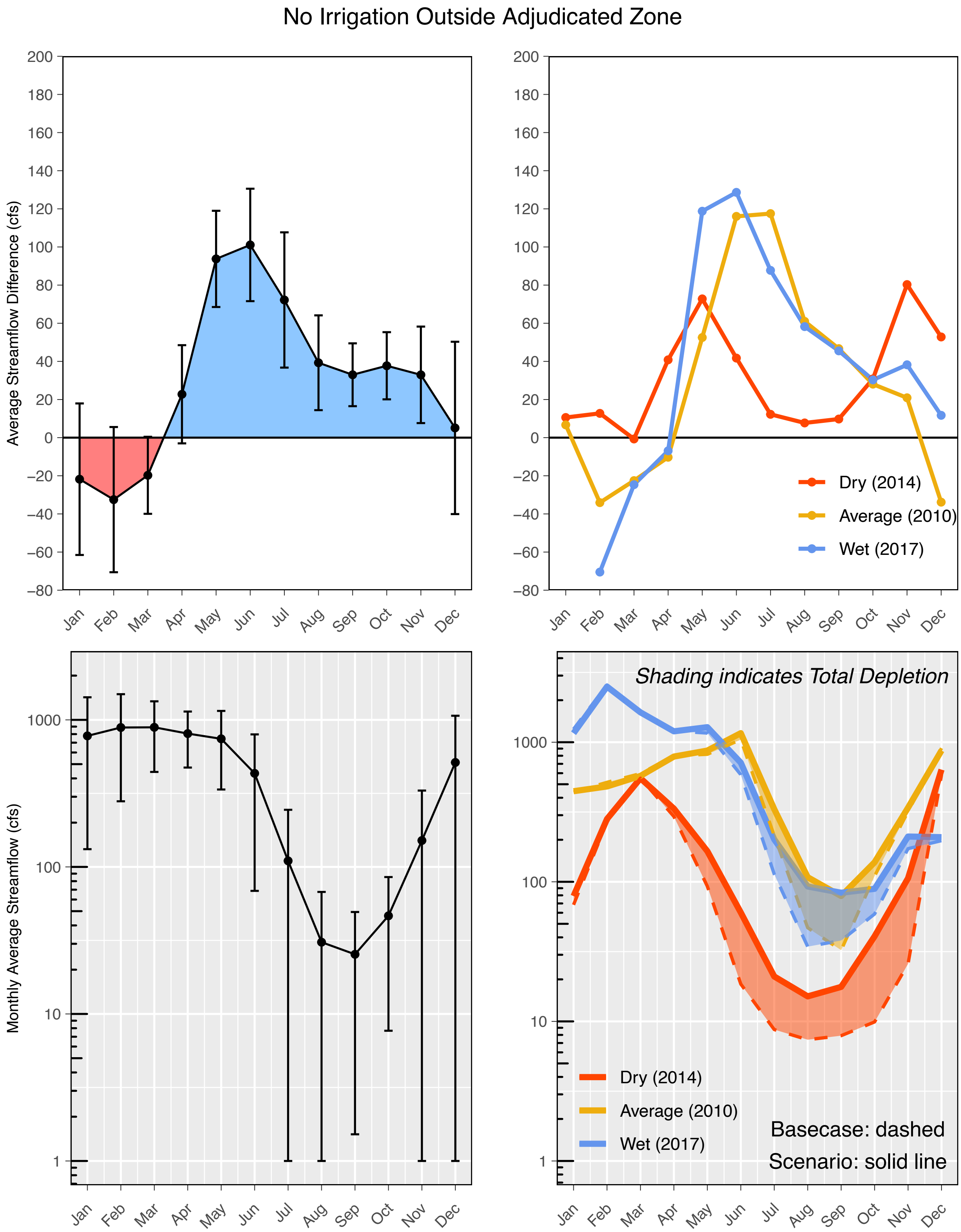

Alfalfa Irrigation Stops Aug. 01
Average Streamflow Difference (cfs)
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Dry (2014)
Average (2010)
Wet (2017)
Monthly Average Streamflow (cfs)
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line

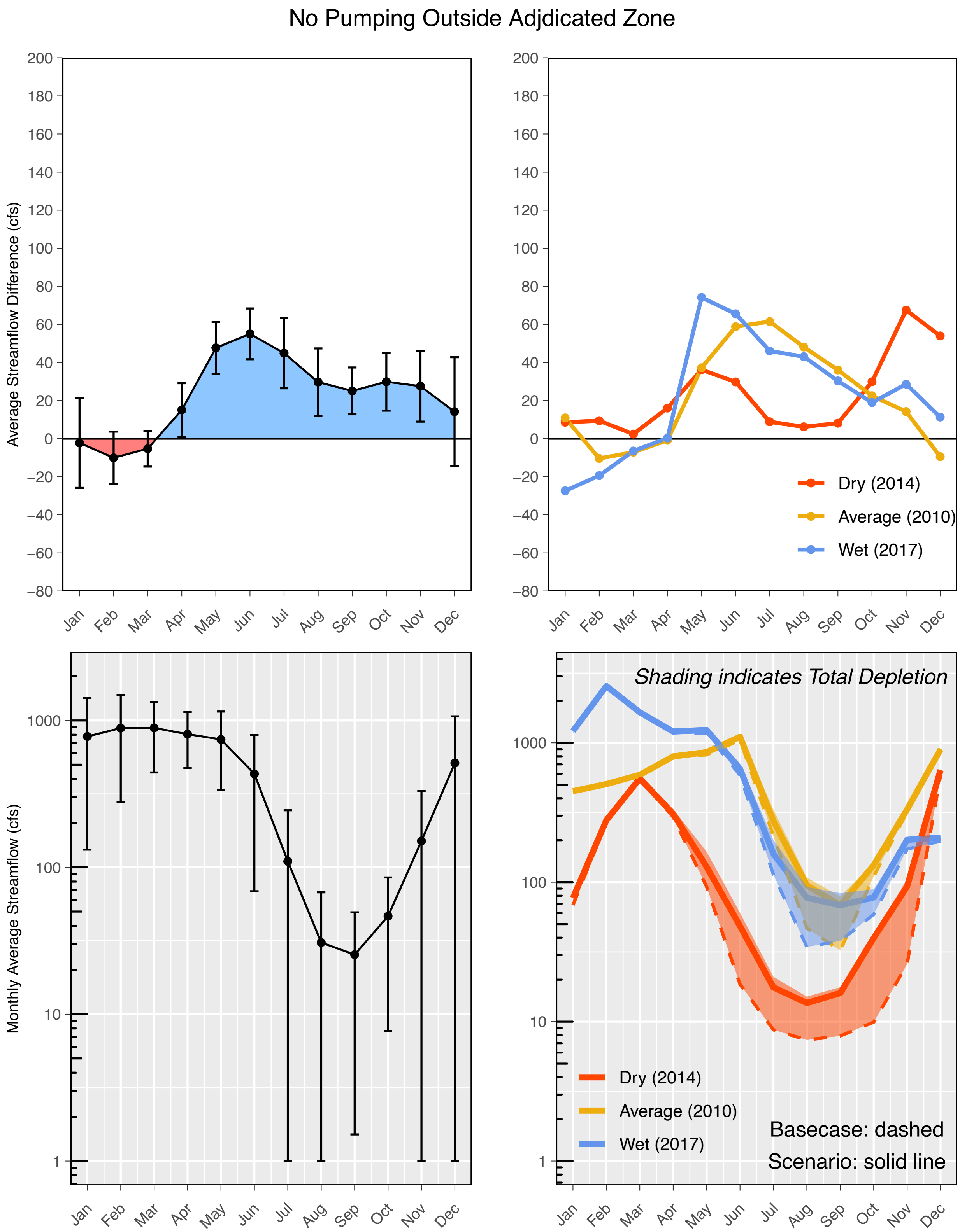

Alfalfa Irrigation Stops Aug. 01, dry years only
Average Streamflow Difference (cfs)
Monthly Average Streamflow (cfs)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Dry (2014)
Average (2010)
Wet (2017)
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line

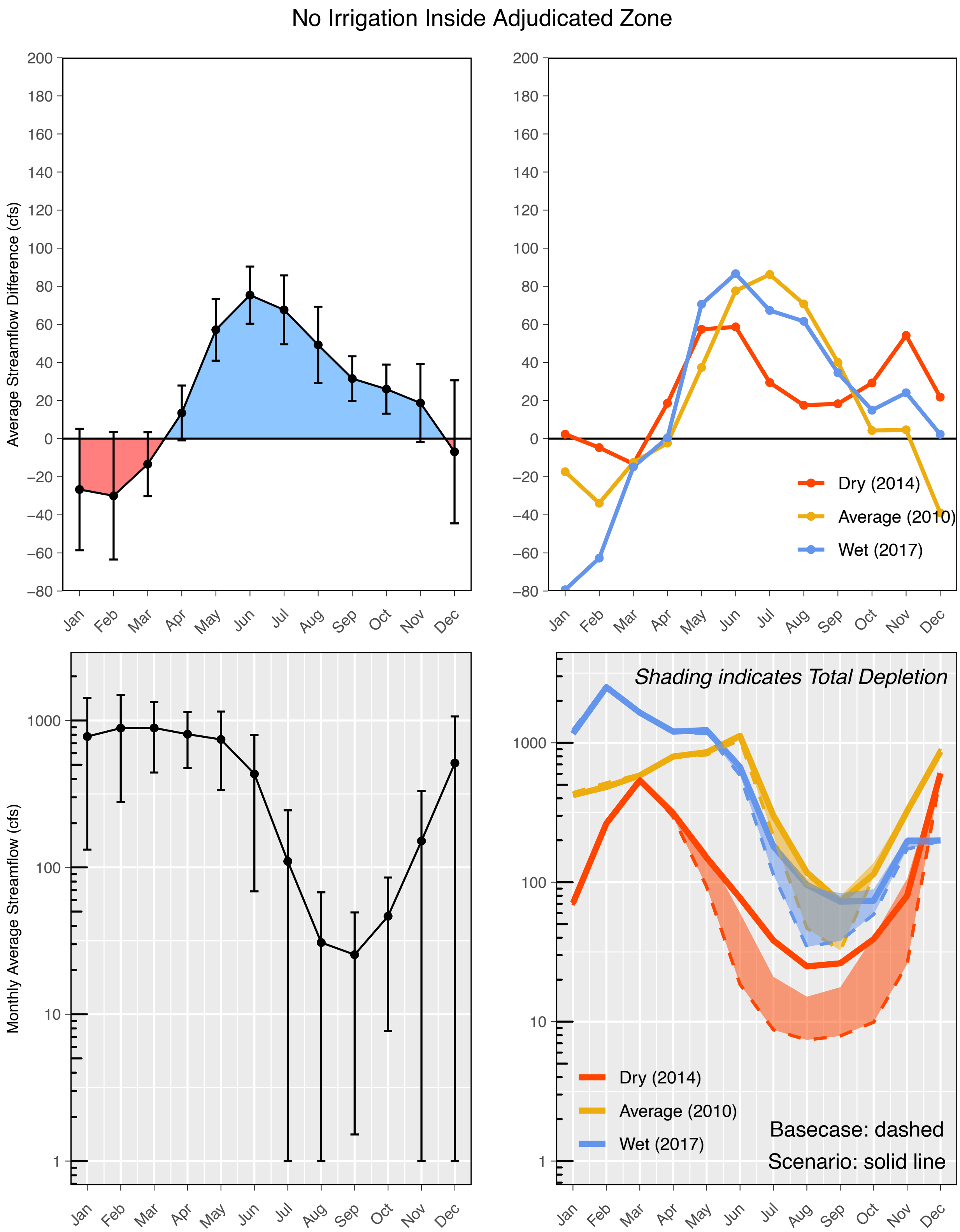

Alfalfa Irrigation Stops Aug. 15
Average Streamflow Difference (cfs)
Dry (2014)
Average (2010)
Wet (2017)
Monthly Average Streamflow (cfs)
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



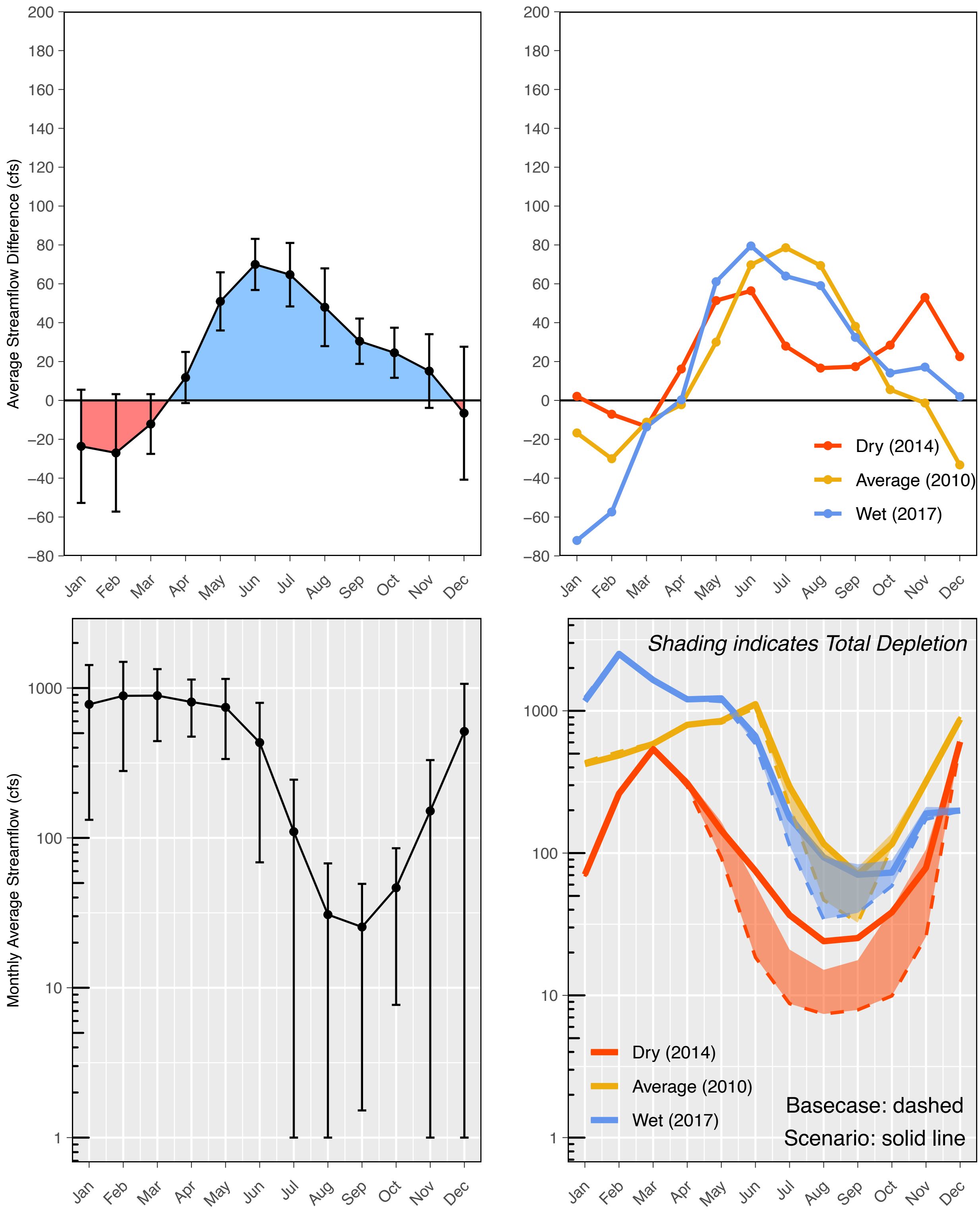
Alfalfa Irrigation Stops Aug. 15, dry years only
Average Streamflow Difference (cfs)
Monthly Average Streamflow (cfs)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Dry (2014)
Average (2010)
Wet (2017)
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line


No Irrigation Outside Adjudicated Zone
Average Streamflow Difference (cfs)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Dry (2014)
Average (2010)
Wet (2017)
Monthly Average Streamflow (cfs)
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line

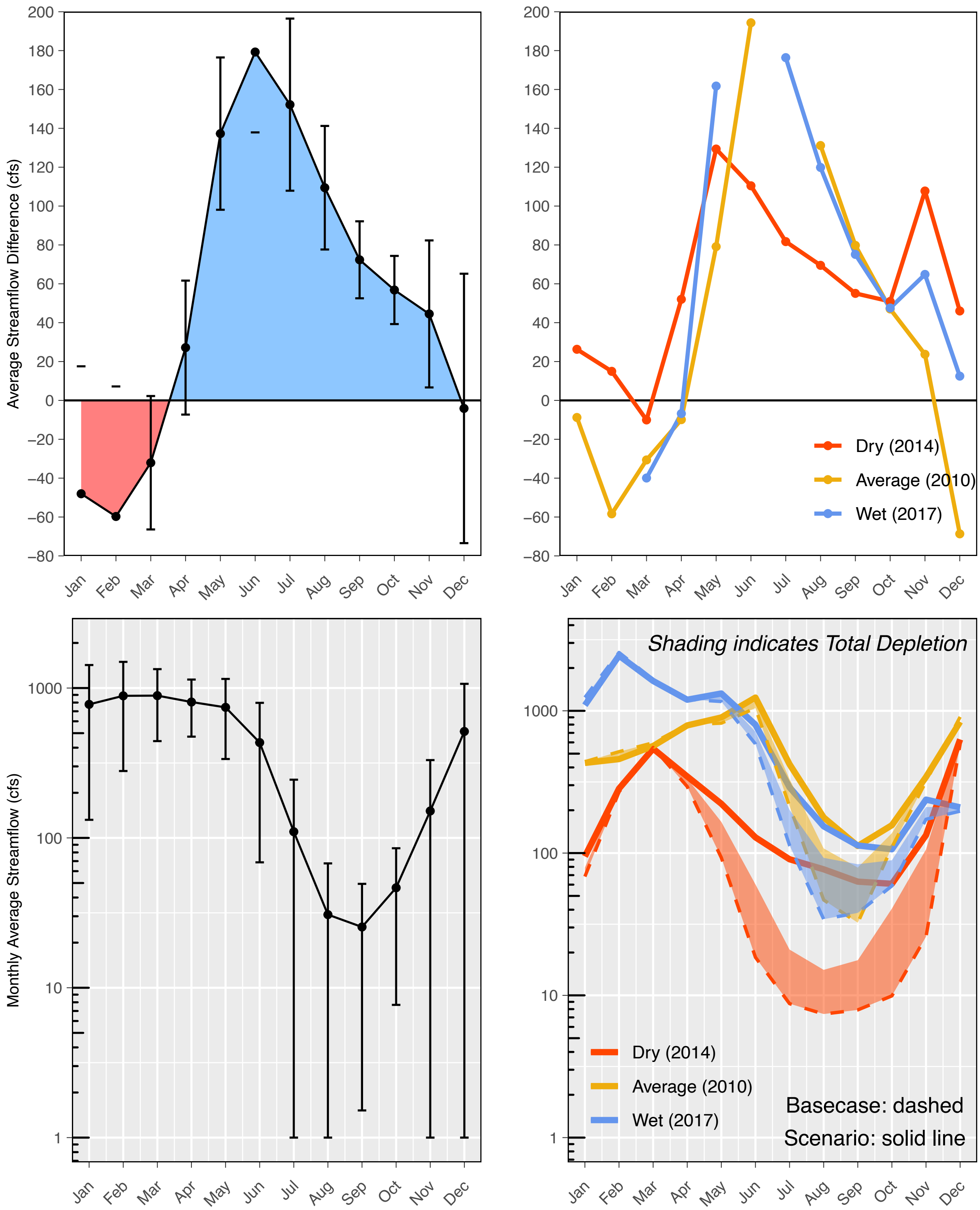

No Pumping Outside Adjdicated Zone
Average Streamflow Difference (cfs)
200
180
160
140
120
100
80
60
40
20
0
−20
−40
−60
−80
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Dry (2014)
Average (2010)
Wet (2017)
Monthly Average Streamflow (cfs)
1000
100
10
1
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line


No Irrigation Inside Adjudicated Zone
Average Streamflow Difference (cfs)
Dry (2014)
Average (2010)
Wet (2017)
Monthly Average Streamflow (cfs)
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

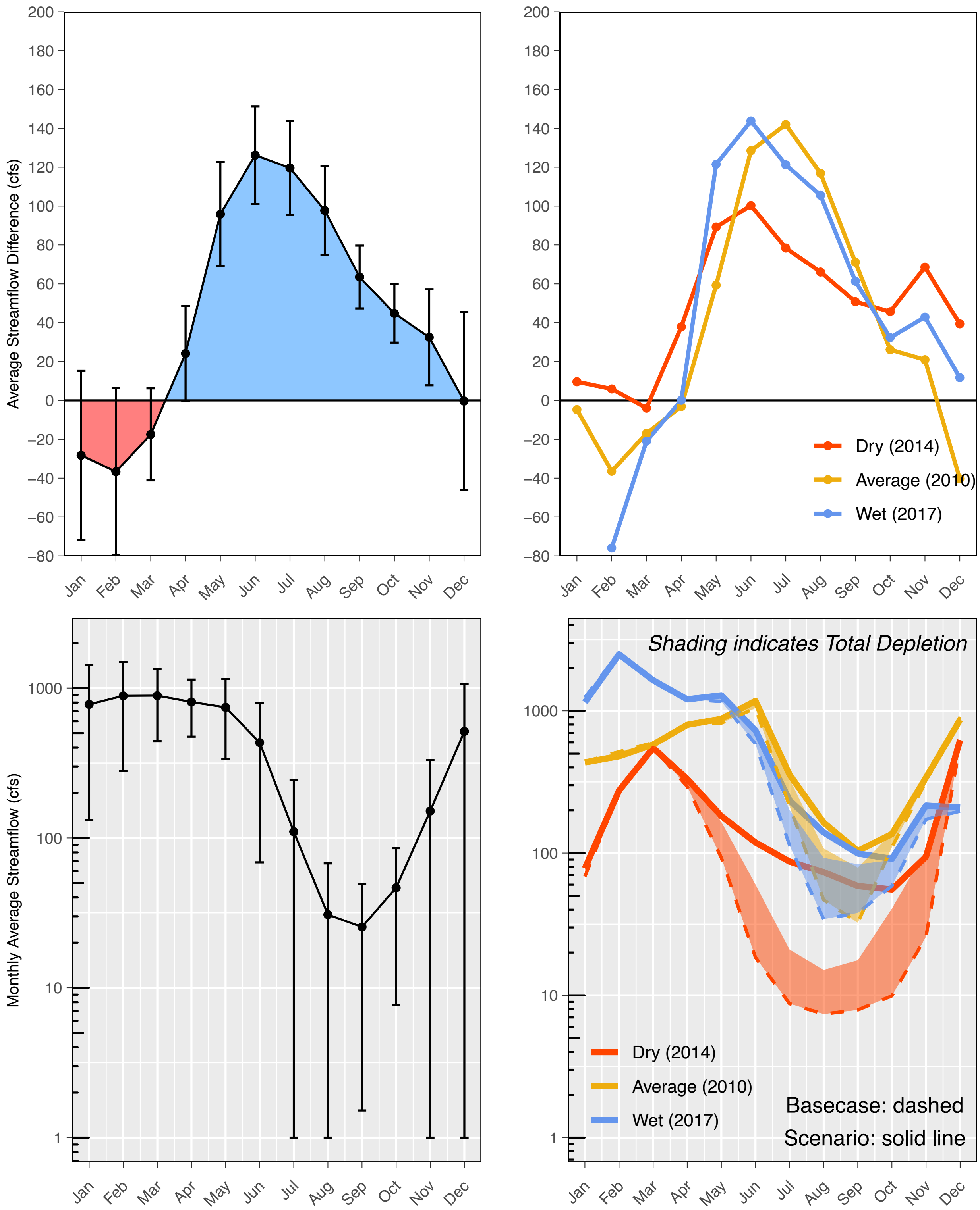
No Pumping Inside Adjdicated Zone

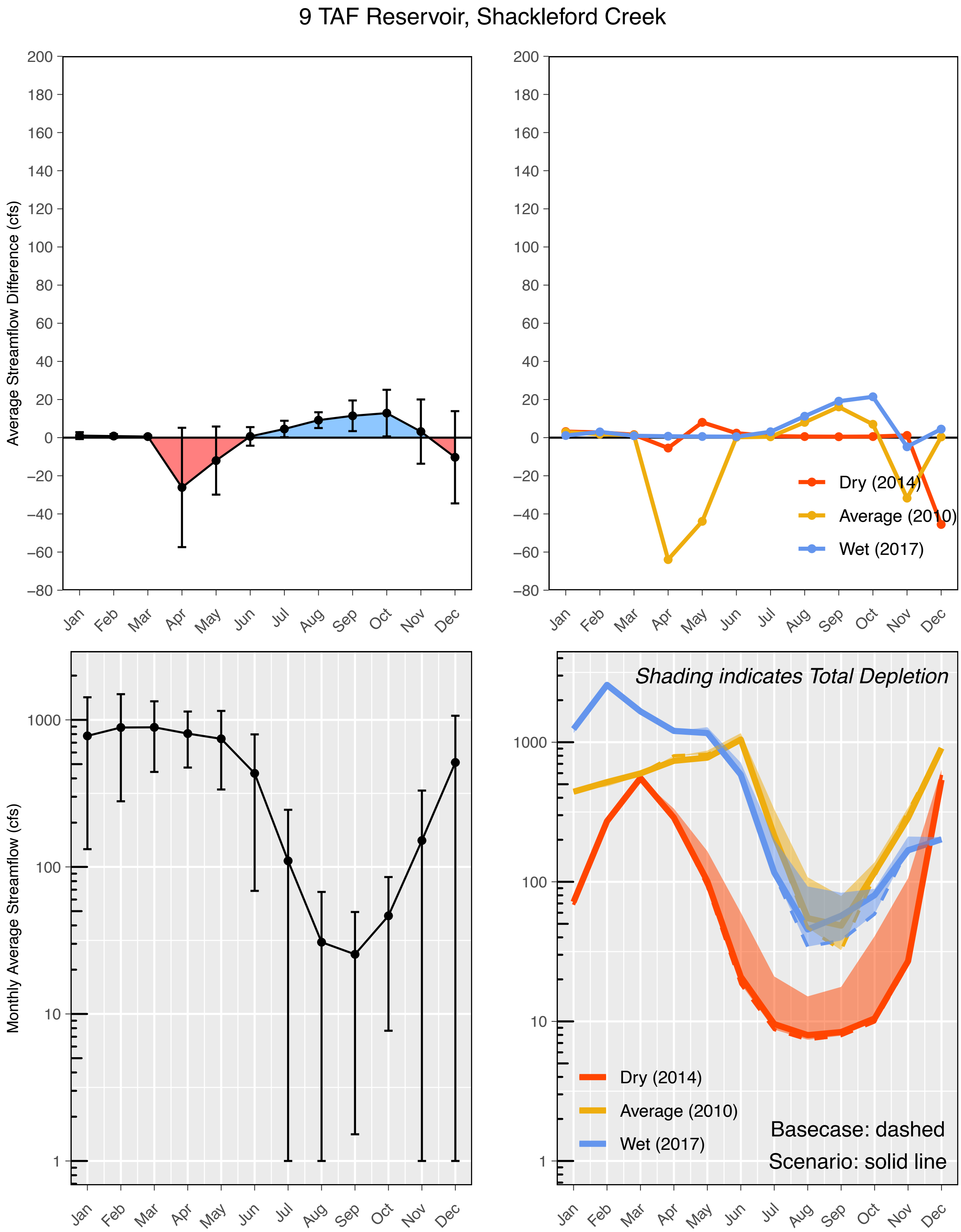


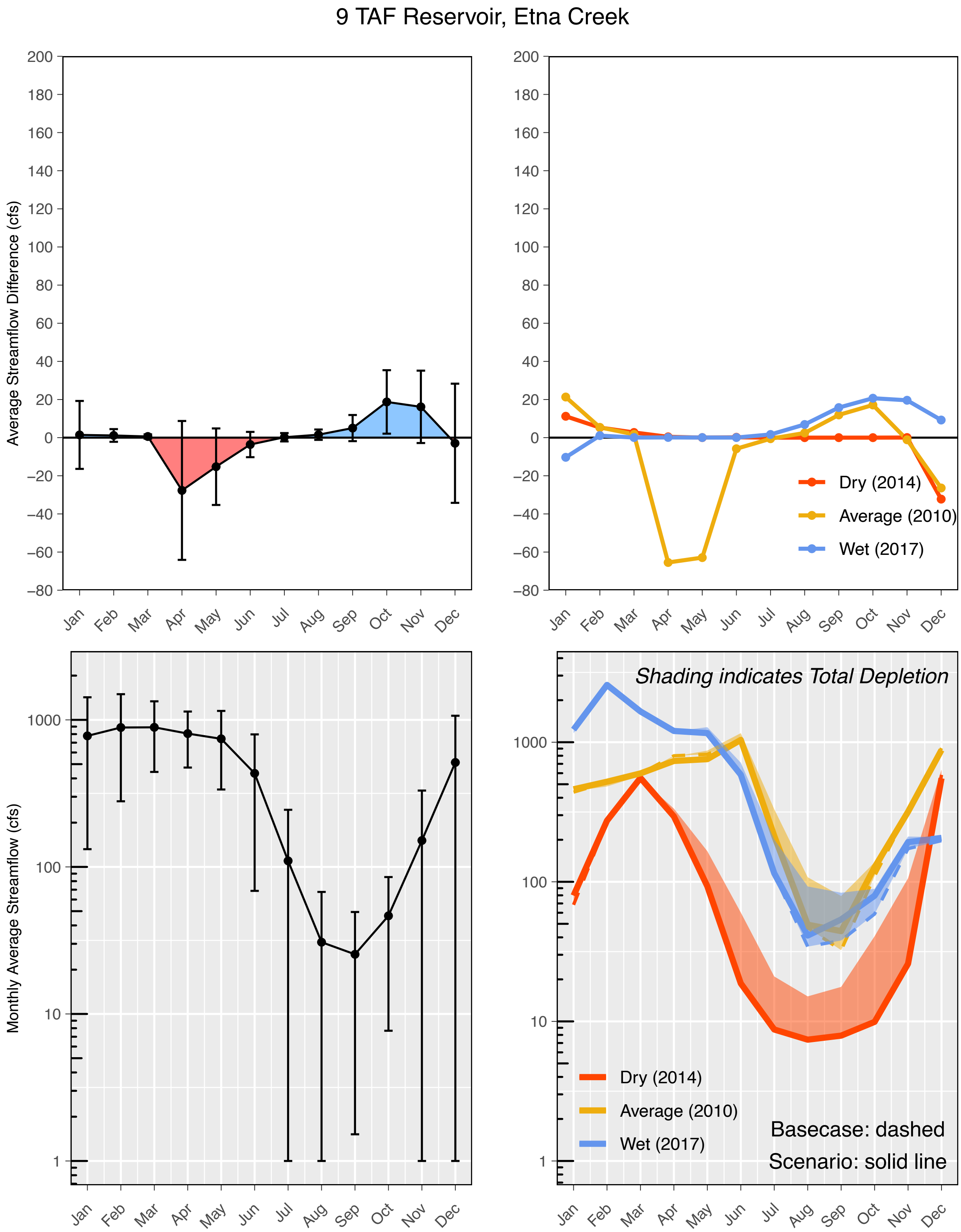
No Irrigation, Both Zones



No Pumping, Both Zones

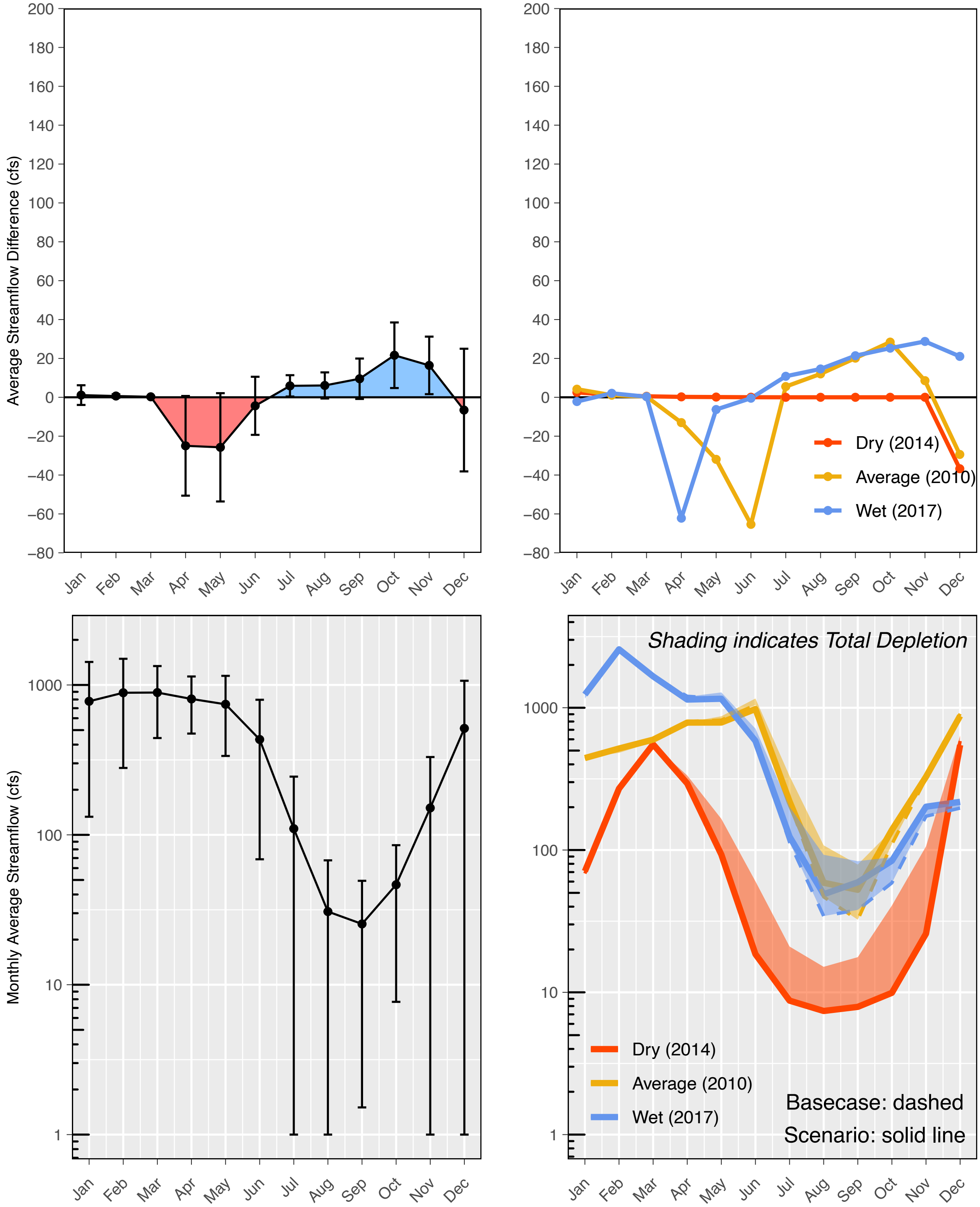


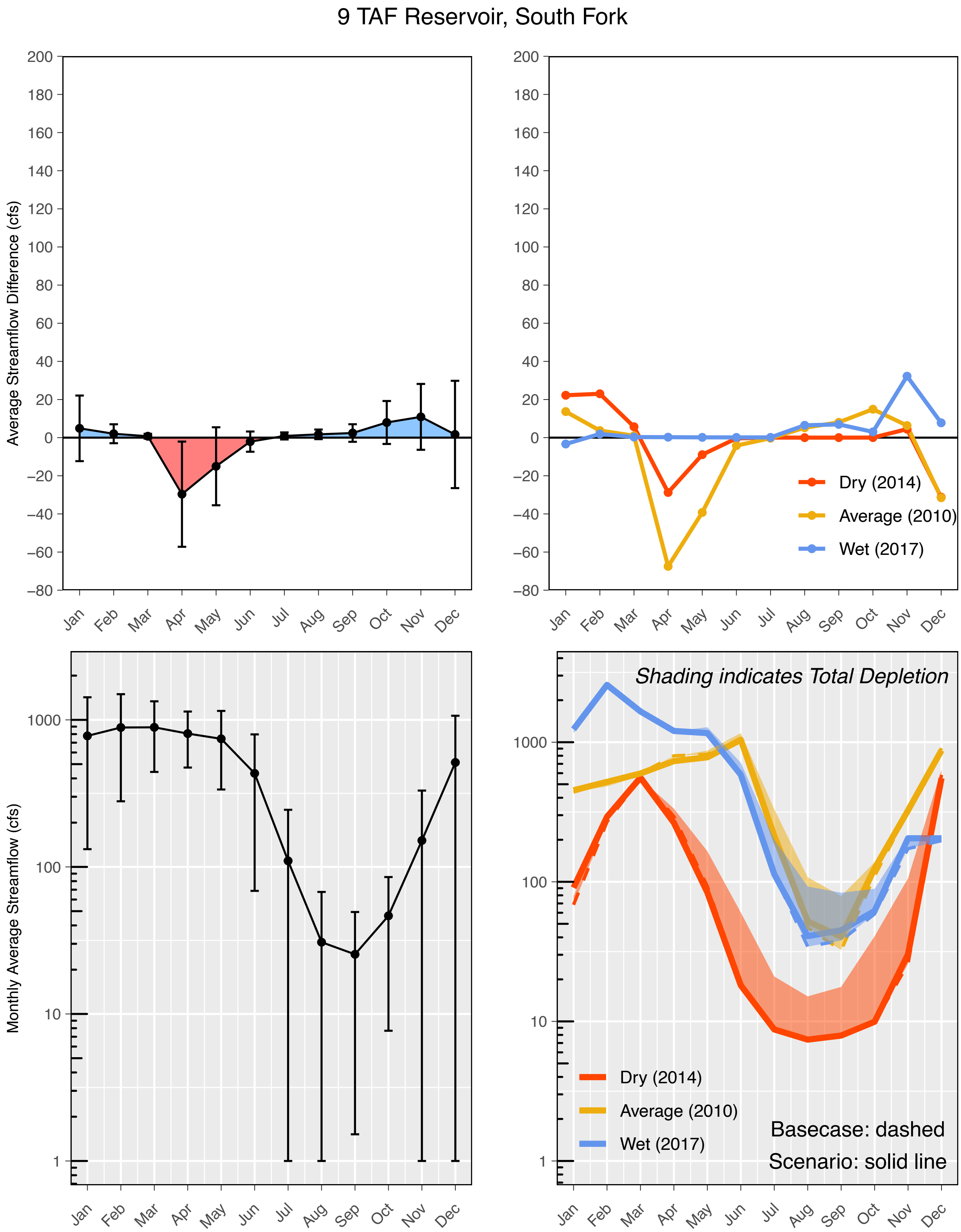

9 TAF Reservoir, Shackleford Creek
Average Streamflow Difference (cfs)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Dry (2014)
Average (2010)
Wet (2017)
Monthly Average Streamflow (cfs)
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line

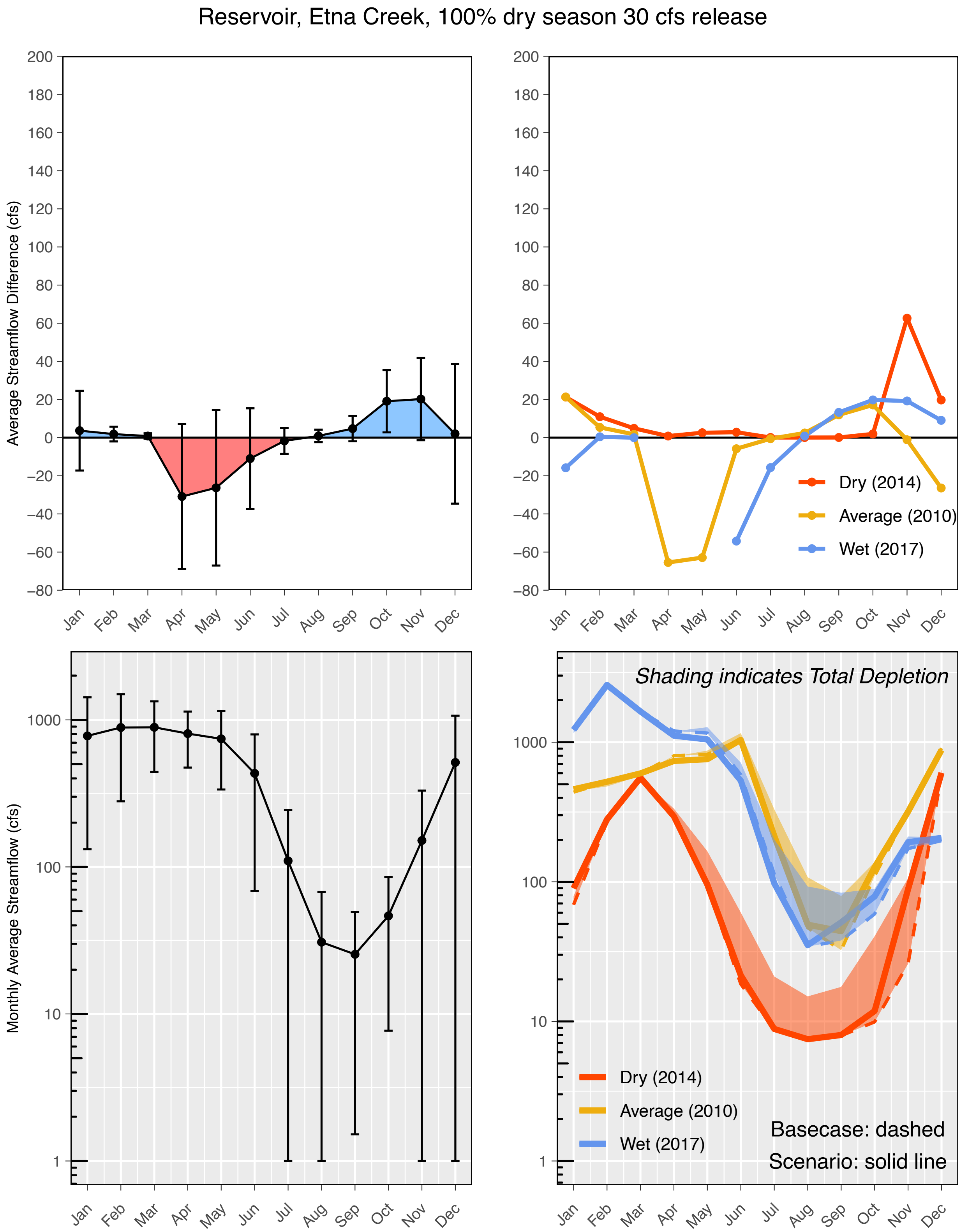


9 TAF Reservoir, Etna Creek
Average Streamflow Difference (cfs)
Monthly Average Streamflow (cfs)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Dry (2014)
Average (2010)
Wet (2017)
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line

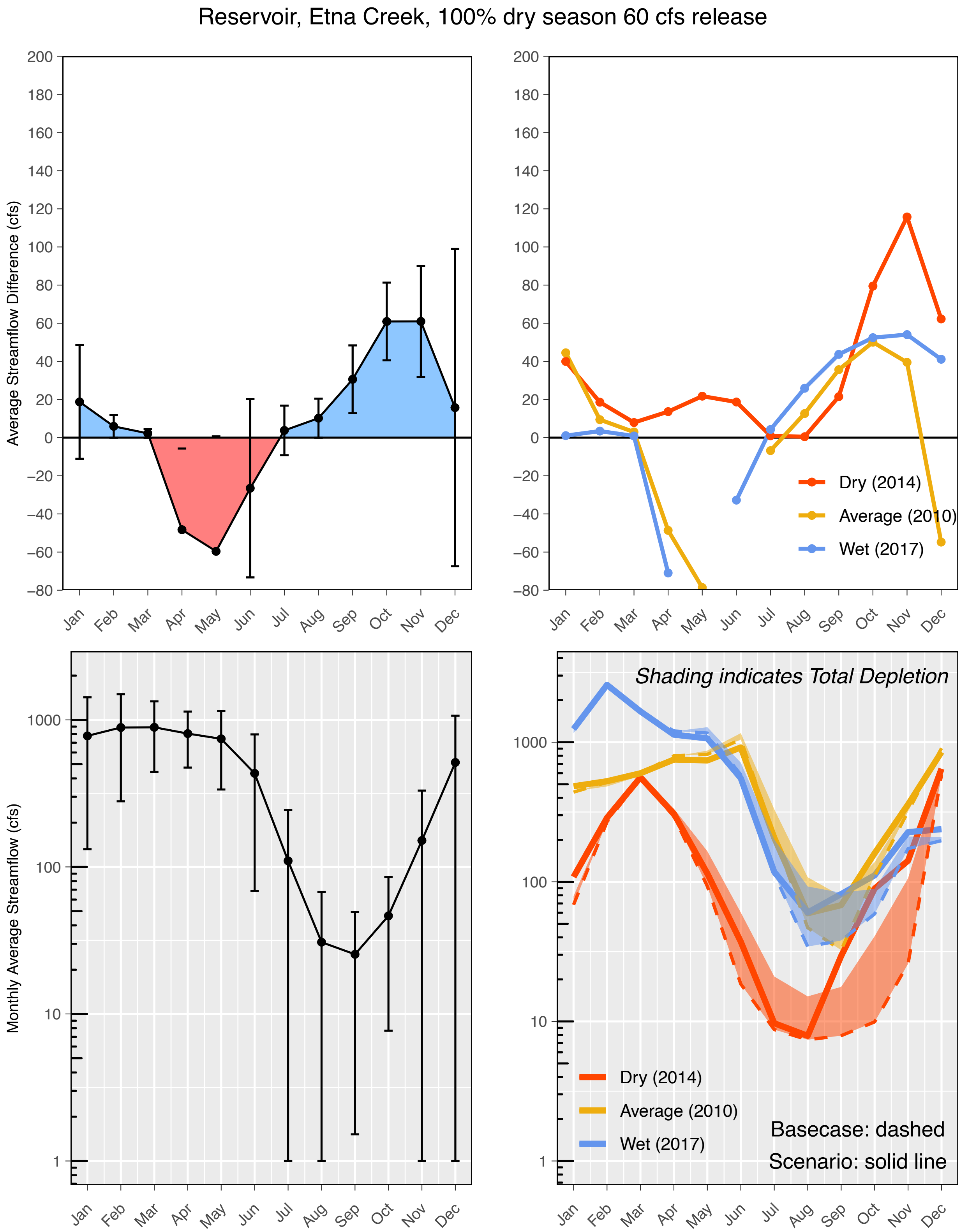
9 TAF Reservoir, French Creek




9 TAF Reservoir, South Fork
Average Streamflow Difference (cfs)
Dry (2014)
Average (2010)
Wet (2017)
Monthly Average Streamflow (cfs)
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec



Reservoir, Etna Creek, 100% dry season 30 cfs release
Average Streamflow Difference (cfs)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Dry (2014)
Average (2010)
Wet (2017)
Monthly Average Streamflow (cfs)
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line



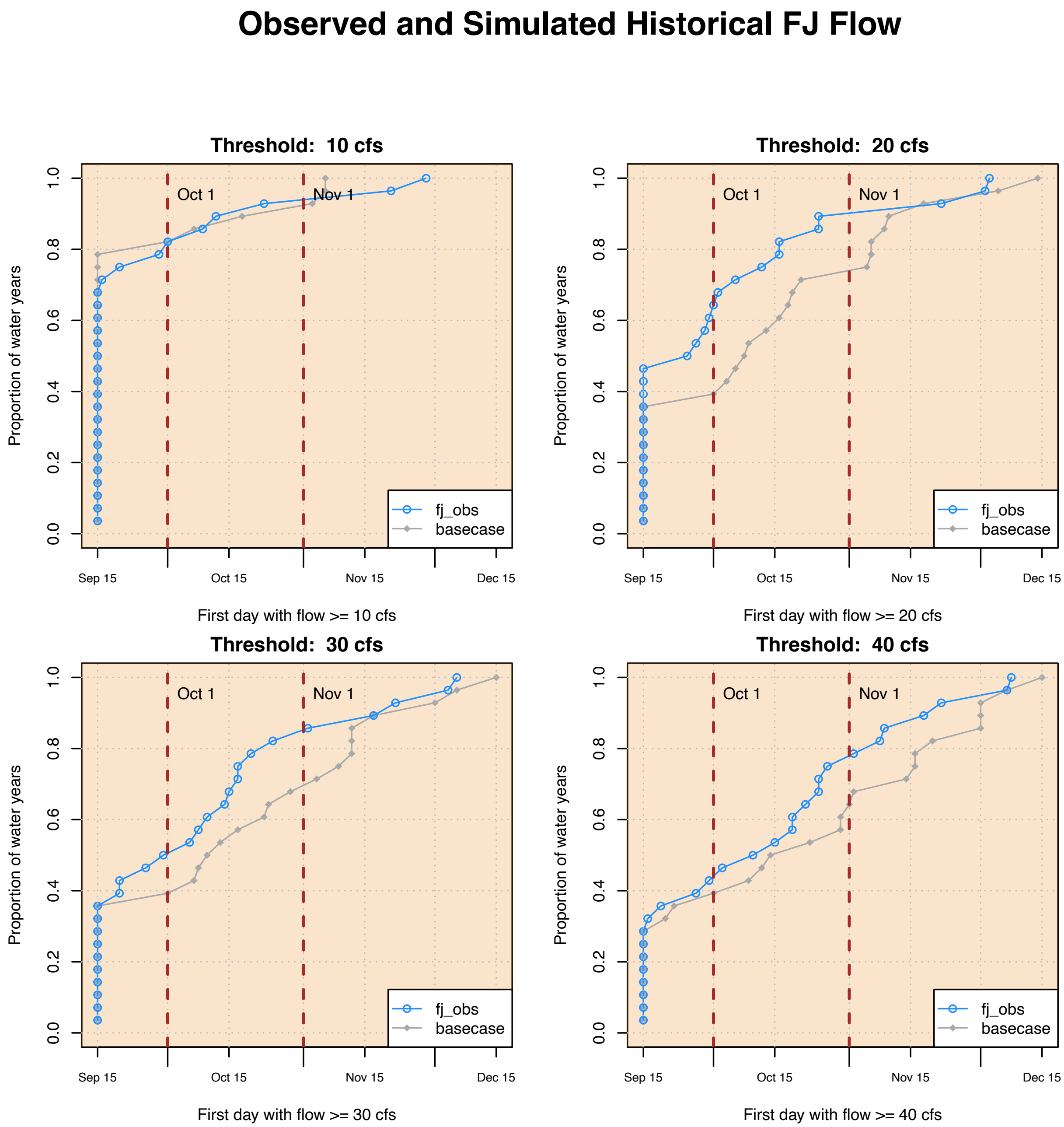
Reservoir, Etna Creek, 100% dry season 60 cfs release
Average Streamflow Difference (cfs)
Dry (2014)
Average (2010)
Wet (2017)
Monthly Average Streamflow (cfs)
Shading indicates Total Depletion
Basecase: dashed
Scenario: solid line
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

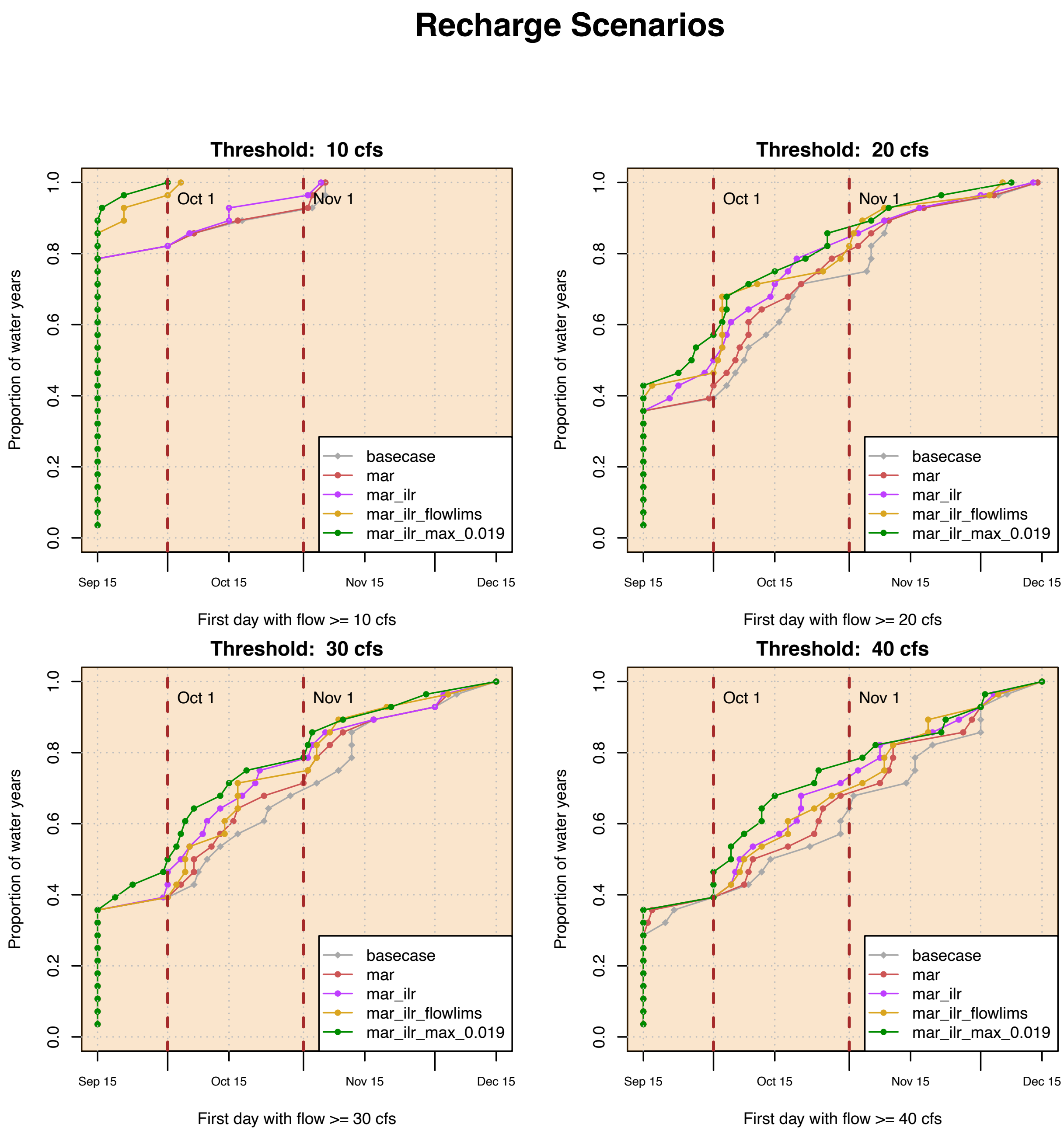
Rising flows in the fall (“reconnection” date distribution)

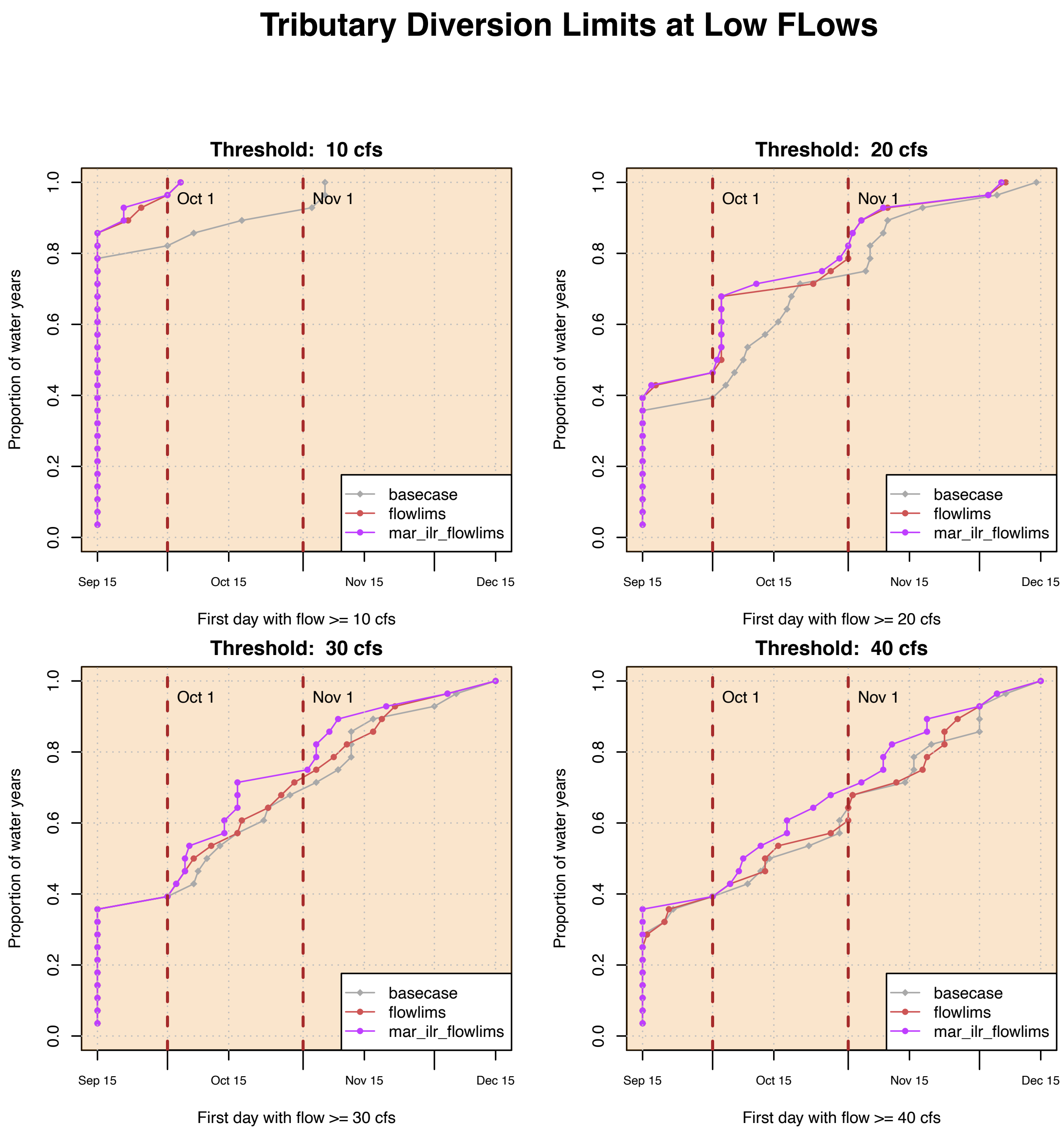
In the late summer and early fall, the Scott River can be dry, or running so low as to be impassable for spawning salmon. In these years, the “reconnection date” of the river is an important metric of ecosystem services: did the river become passable for salmon early enough in the spawning season?

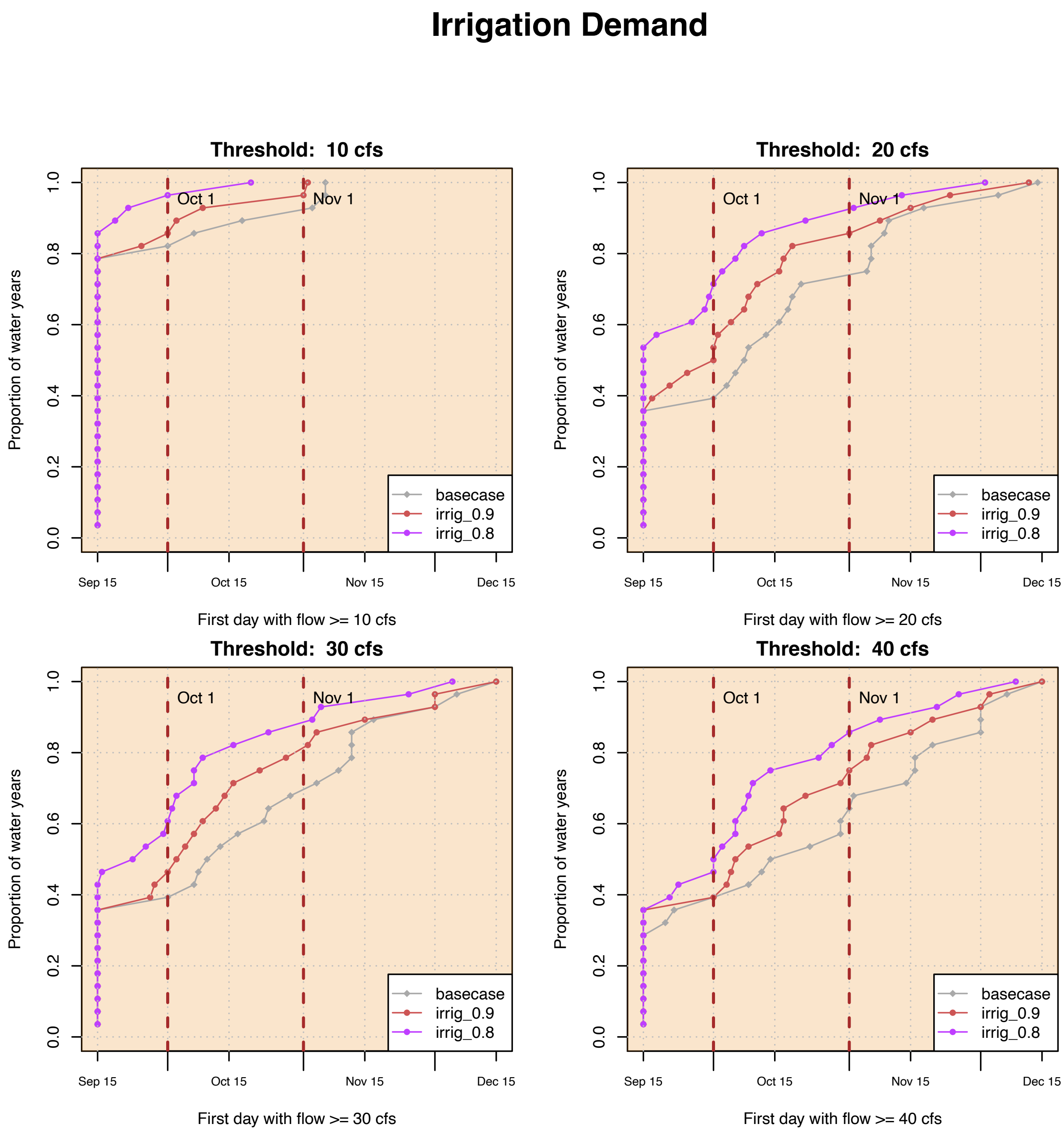
These results show the distribution of threshold-crossing dates of flow at the Fort Jones Gauge, or the first date in the fall season on which the flow exceeded a threshold. This threshold-crossing metric is assumed to be a proxy for reconnection dates. Multiple thresholds are depicted (10, 20, 30 and 40 cfs) to indicate uncertainty in the exact threshold of “reconnection” of different parts of the lower Scott River stream system.

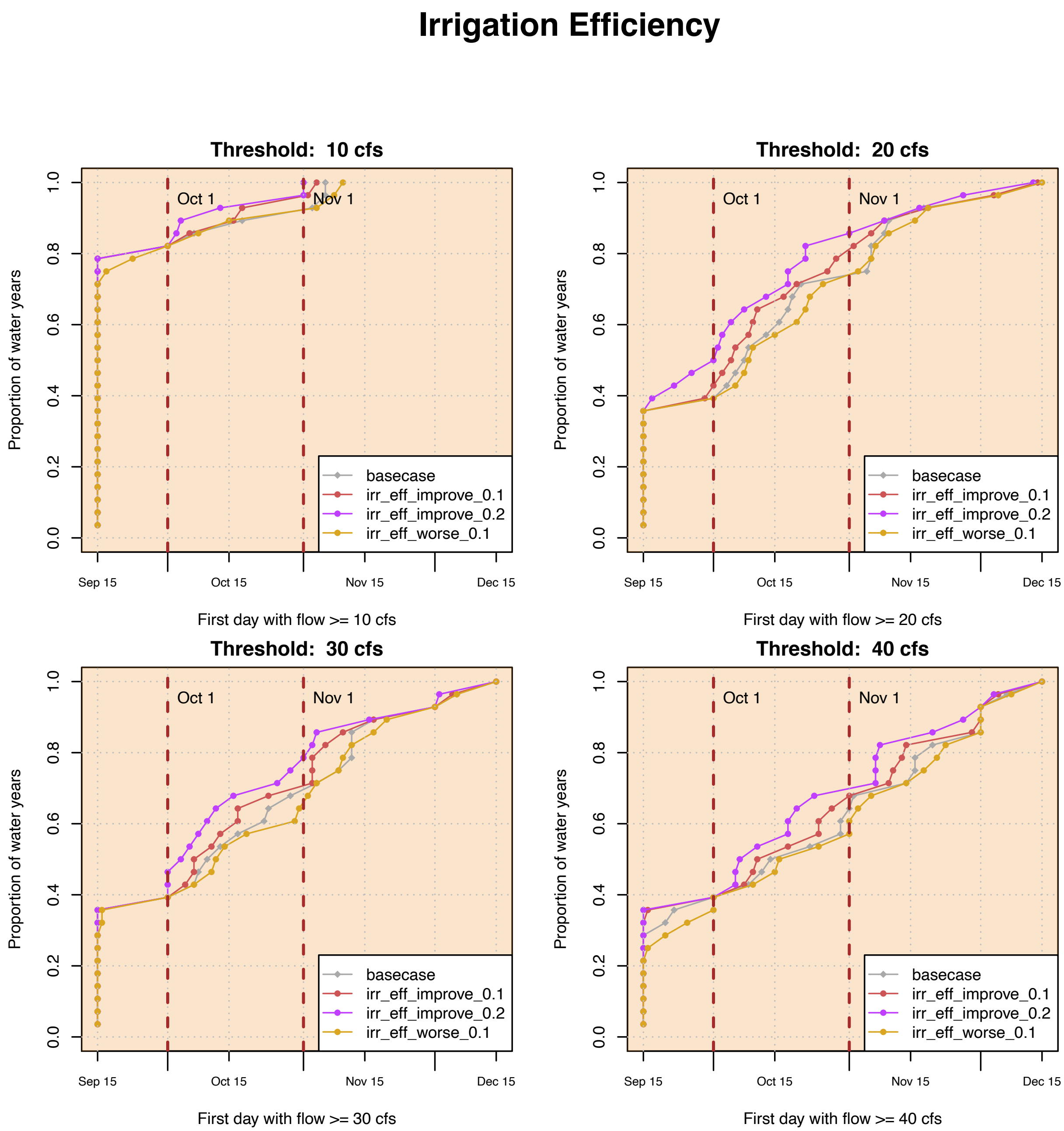
In general, scenarios in which more water years rise above the threshold earlier indicate more favorable hydrologic conditions (or, more dots on the left side of the plots is better). See explanatory graphs at the beginning of this appendix for more information.

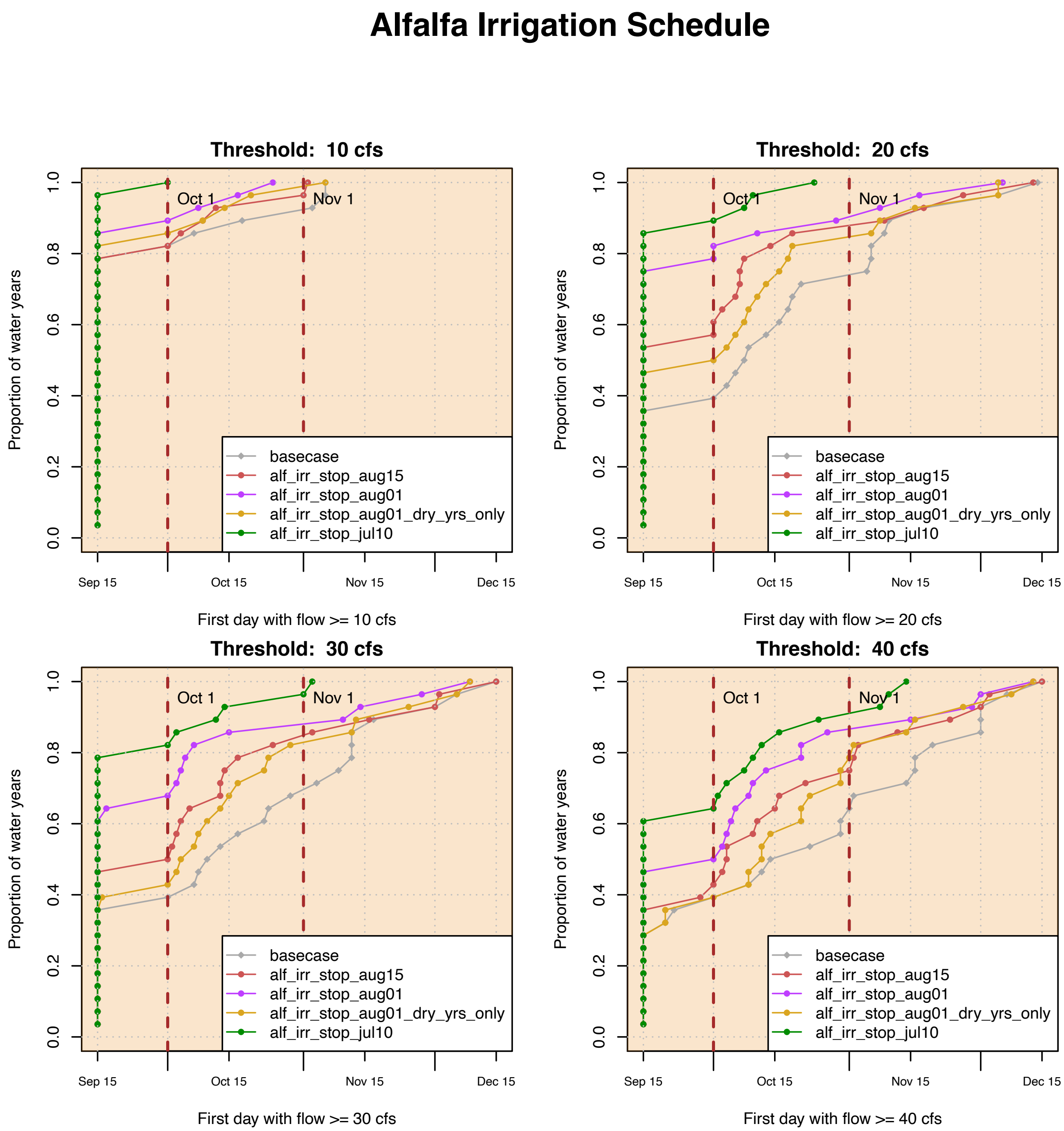

Observed and Simulated Historical FJ Flow
Threshold: 10 cfs
Threshold: 20 cfs
Threshold: 30 cfs
Threshold: 40 cfs
Proportion of water years
0.0
0.2
0.4
0.6
0.8
1.0
Oct 1
Nov 1
fj_obs
basecase
Sep 15
Oct 15
Nov 15
Dec 15
First day with flow >= 10 cfs
First day with flow >= 20 cfs
First day with flow >= 30 cfs
First day with flow >= 40 cfs

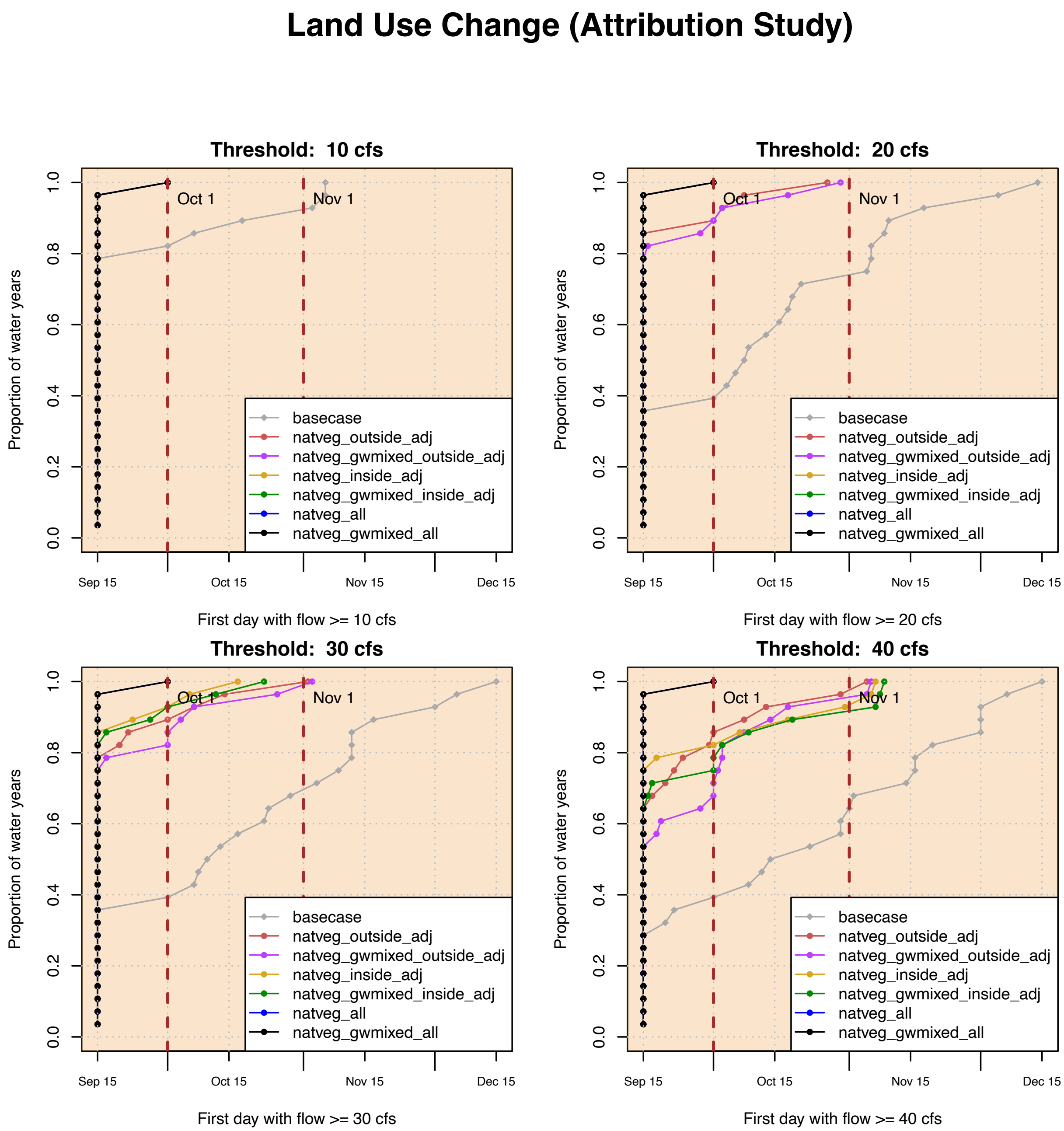

Recharge Scenarios
Threshold: 10 cfs
Threshold: 20 cfs
Threshold: 30 cfs
Threshold: 40 cfs
Oct 1
Nov 1
Proportion of water years
0.0
0.2
0.4
0.6
0.8
1.0
Sep 15
Oct 15
Nov 15
Dec 15
basecase
mar
mar_ilr
mar_ilr_flowlims
mar_ilr_max_0.019
First day with flow >= 10 cfs
First day with flow >= 20 cfs
First day with flow >= 30 cfs
First day with flow >= 40 cfs

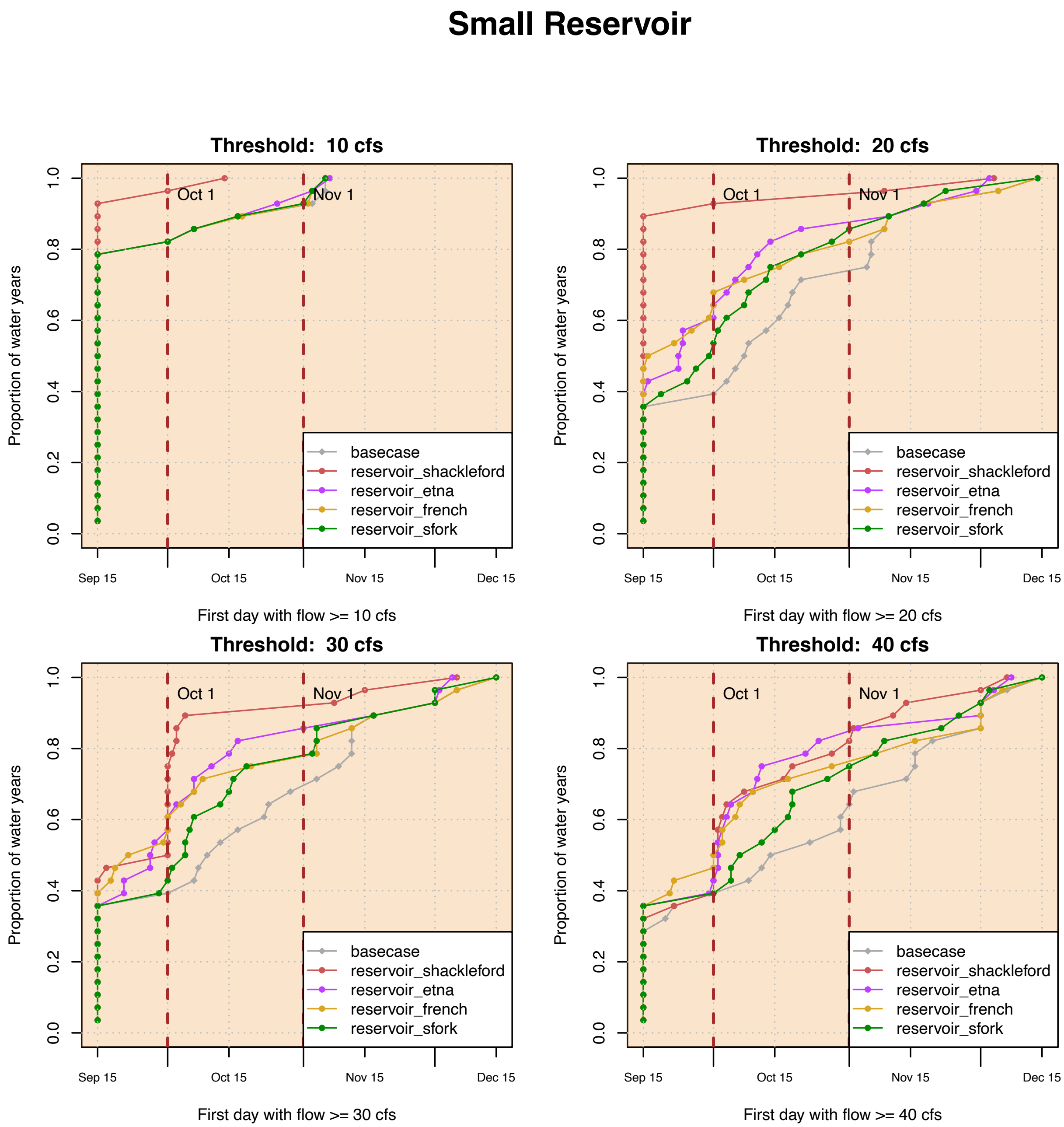

Tributary Diversion Limits at Low FLows
Threshold: 10 cfs
Threshold: 20 cfs
Threshold: 30 cfs
Threshold: 40 cfs
Proportion of water years
0.0
0.2
0.4
0.6
0.8
1.0
Oct 1
Nov 1
basecase
flowlims
mar_ilr_flowlims
Sep 15
Oct 15
Nov 15
Dec 15
First day with flow >= 10 cfs
First day with flow >= 20 cfs
First day with flow >= 30 cfs
First day with flow >= 40 cfs


Irrigation Demand
Threshold: 10 cfs
Threshold: 20 cfs
Threshold: 30 cfs
Threshold: 40 cfs
Proportion of water years
0.0
0.2
0.4
0.6
0.8
1.0
Oct 1
Nov 1
Sep 15
Oct 15
Nov 15
Dec 15
basecase
irrig_0.9
irrig_0.8
First day with flow >= 10 cfs
First day with flow >= 20 cfs
First day with flow >= 30 cfs
First day with flow >= 40 cfs

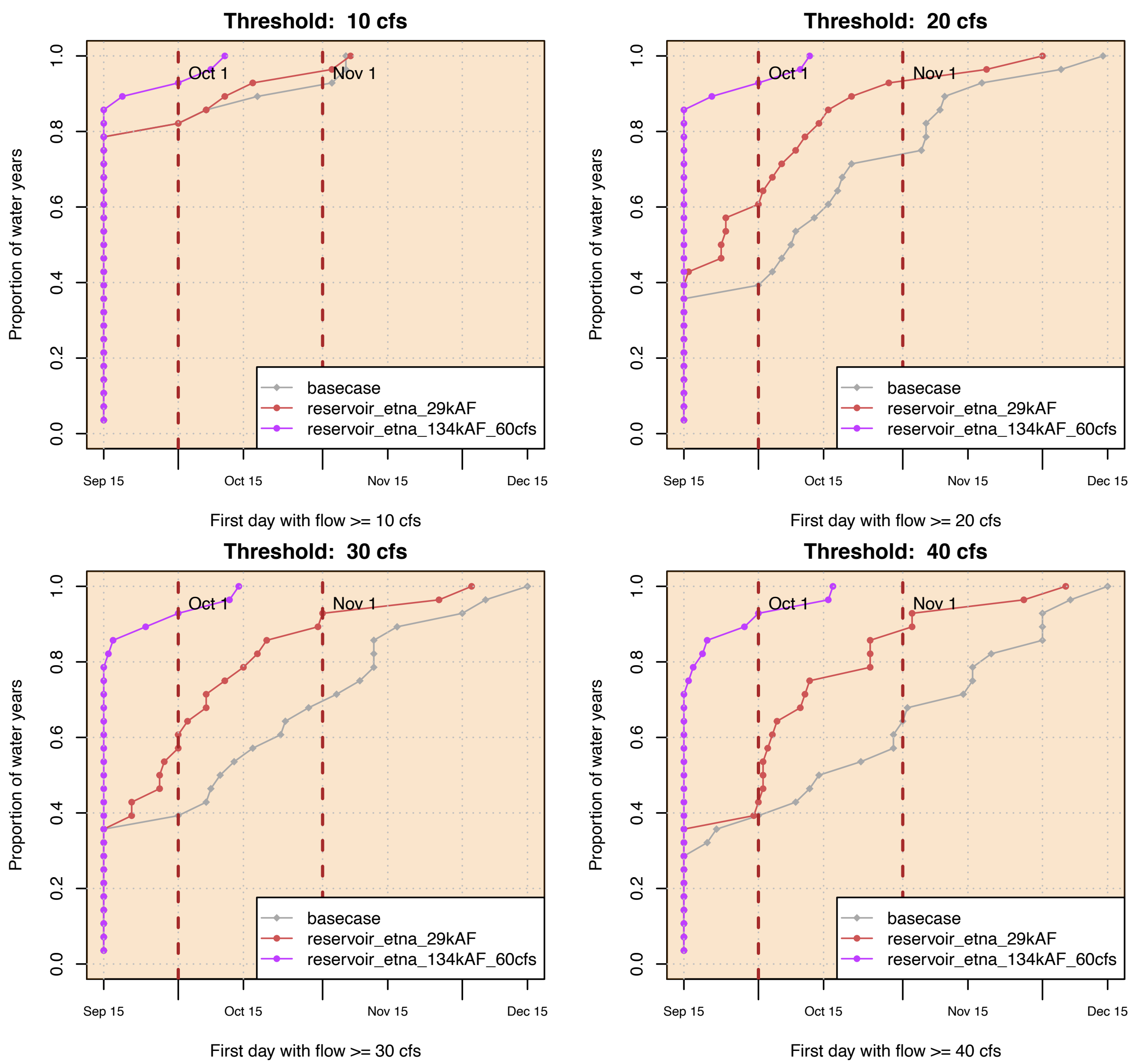

Irrigation Efficiency
Threshold: 10 cfs
Threshold: 20 cfs
Threshold: 30 cfs
Threshold: 40 cfs
Oct 1
Nov 1
Proportion of water years
0.0
0.2
0.4
0.6
0.8
1.0
Sep 15
Oct 15
Nov 15
Dec 15
basecase
irr_eff_improve_0.1
irr_eff_improve_0.2
irr_eff_worse_0.1
First day with flow >= 10 cfs
First day with flow >= 20 cfs
First day with flow >= 30 cfs
First day with flow >= 40 cfs


Alfalfa Irrigation Schedule
Threshold: 10 cfs
Threshold: 20 cfs
Threshold: 30 cfs
Threshold: 40 cfs
Oct 1
Nov 1
Proportion of water years
0.0
0.2
0.4
0.6
0.8
1.0
Sep 15
Oct 15
Nov 15
Dec 15
basecase
alf_irr_stop_aug15
alf_irr_stop_aug01
alf_irr_stop_aug01_dry_yrs_only
alf_irr_stop_jul10
First day with flow >= 10 cfs
First day with flow >= 20 cfs
First day with flow >= 30 cfs
First day with flow >= 40 cfs


Land Use Change (Attribution Study)
Threshold: 10 cfs
Threshold: 20 cfs
Threshold: 30 cfs
Threshold: 40 cfs
Proportion of water years
0.0
0.2
0.4
0.6
0.8
1.0
Oct 1
Nov 1
Sep 15
Oct 15
Nov 15
Dec 15
First day with flow >= 10 cfs
First day with flow >= 20 cfs
First day with flow >= 30 cfs
First day with flow >= 40 cfs
basecase
natveg_outside_adj
natveg_gwmixed_outside_adj
natveg_inside_adj
natveg_gwmixed_inside_adj
natveg_all
natveg_gwmixed_all


Small Reservoir
Threshold: 10 cfs
Threshold: 20 cfs
Threshold: 30 cfs
Threshold: 40 cfs
Oct 1
Nov 1
Proportion of water years
0.0
0.2
0.4
0.6
0.8
1.0
Sep 15
Oct 15
Nov 15
Dec 15
basecase
reservoir_shackleford
reservoir_etna
reservoir_french
reservoir_sfork
First day with flow >= 10 cfs
First day with flow >= 20 cfs
First day with flow >= 30 cfs
First day with flow >= 40 cfs

100% Reliable Reservoir (30 or 60 cfs release)



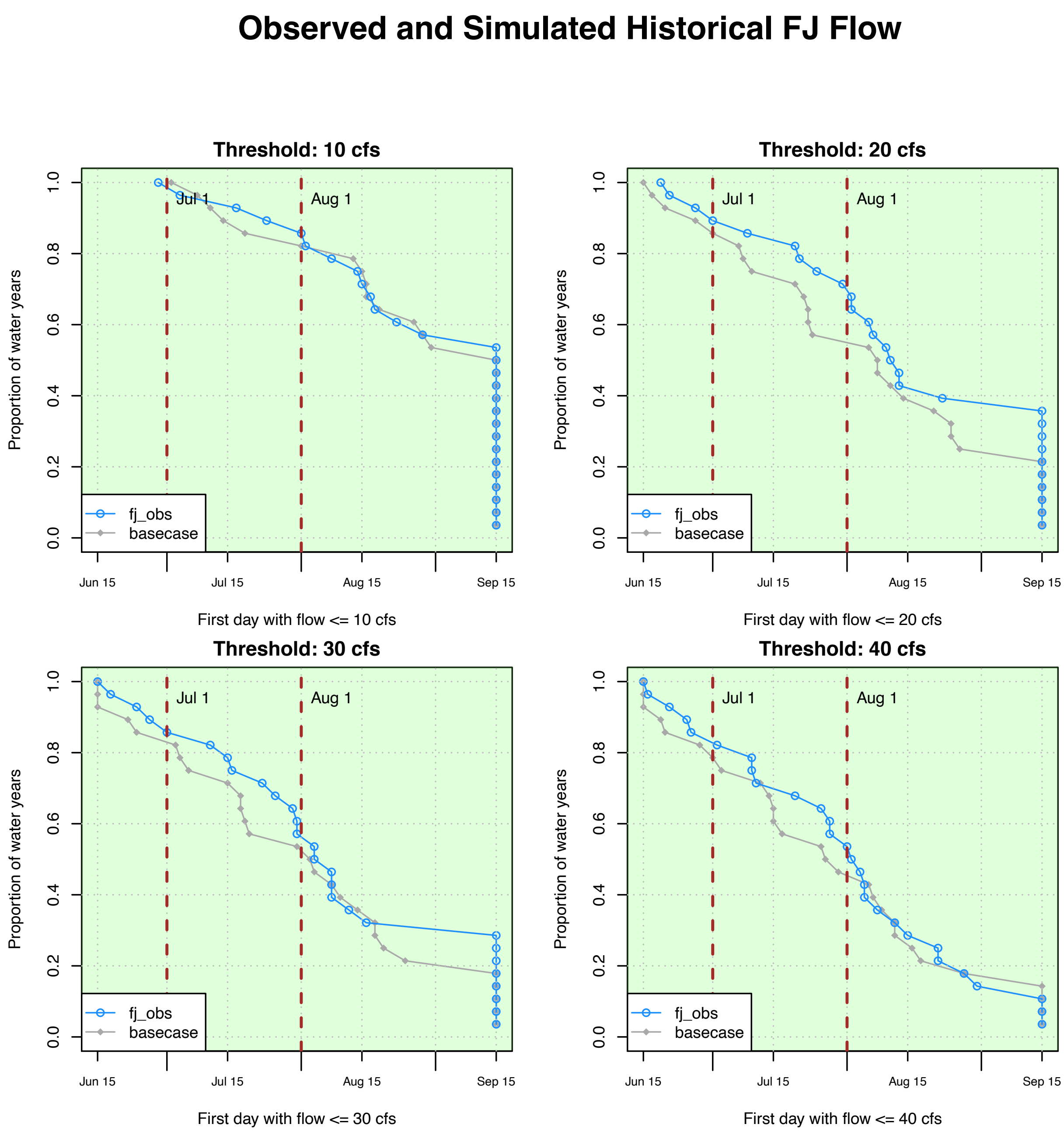
Declining flows in the summer ("disconnection" date distribution)

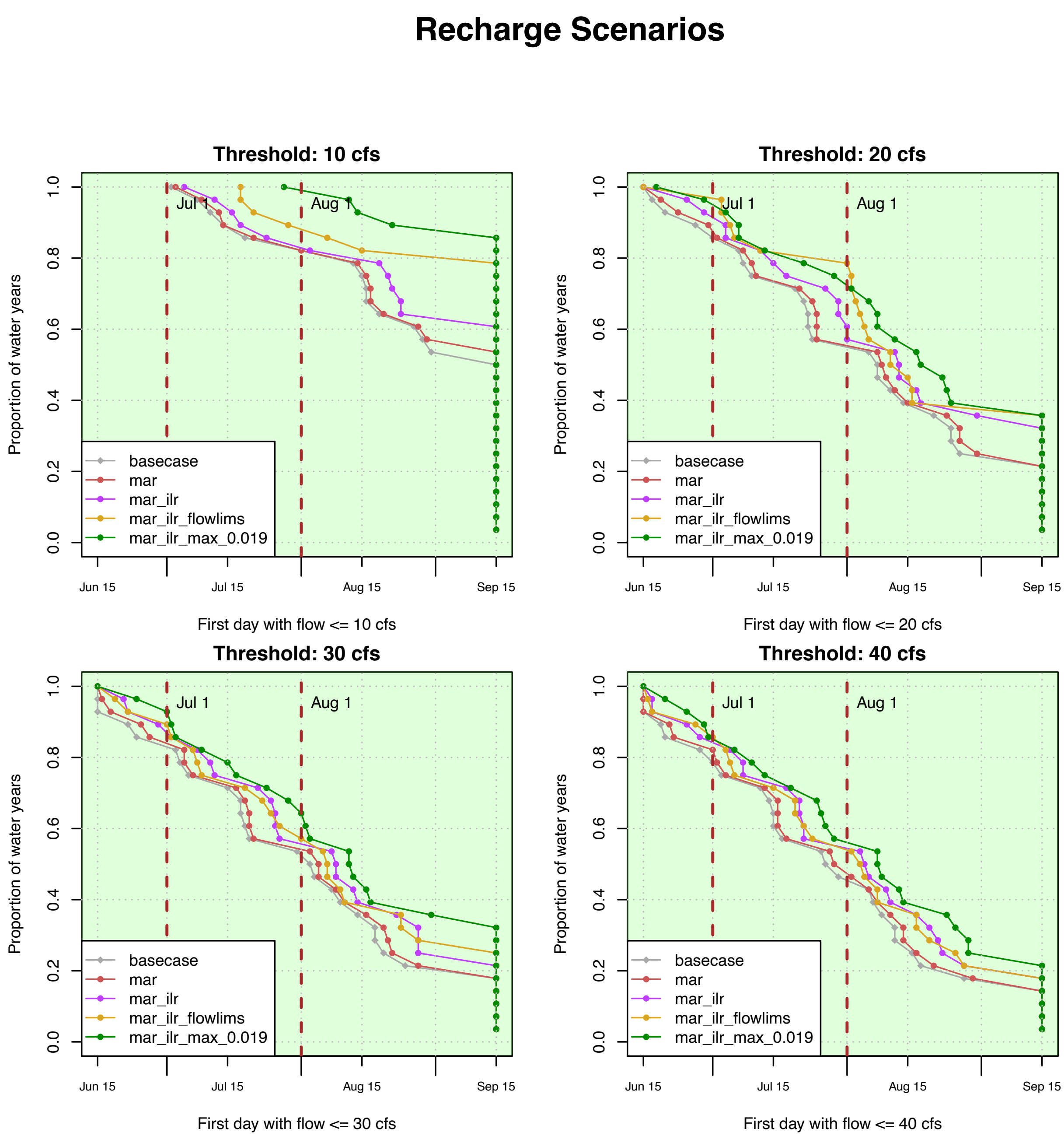
Over the course of the late spring and summer, the Scott River decreases gradually from snowmelt-influenced high flows to summer baseflow. Earlier decline in summer flows is believed to correspond to poorer habitat conditions for juvenile salmonids.

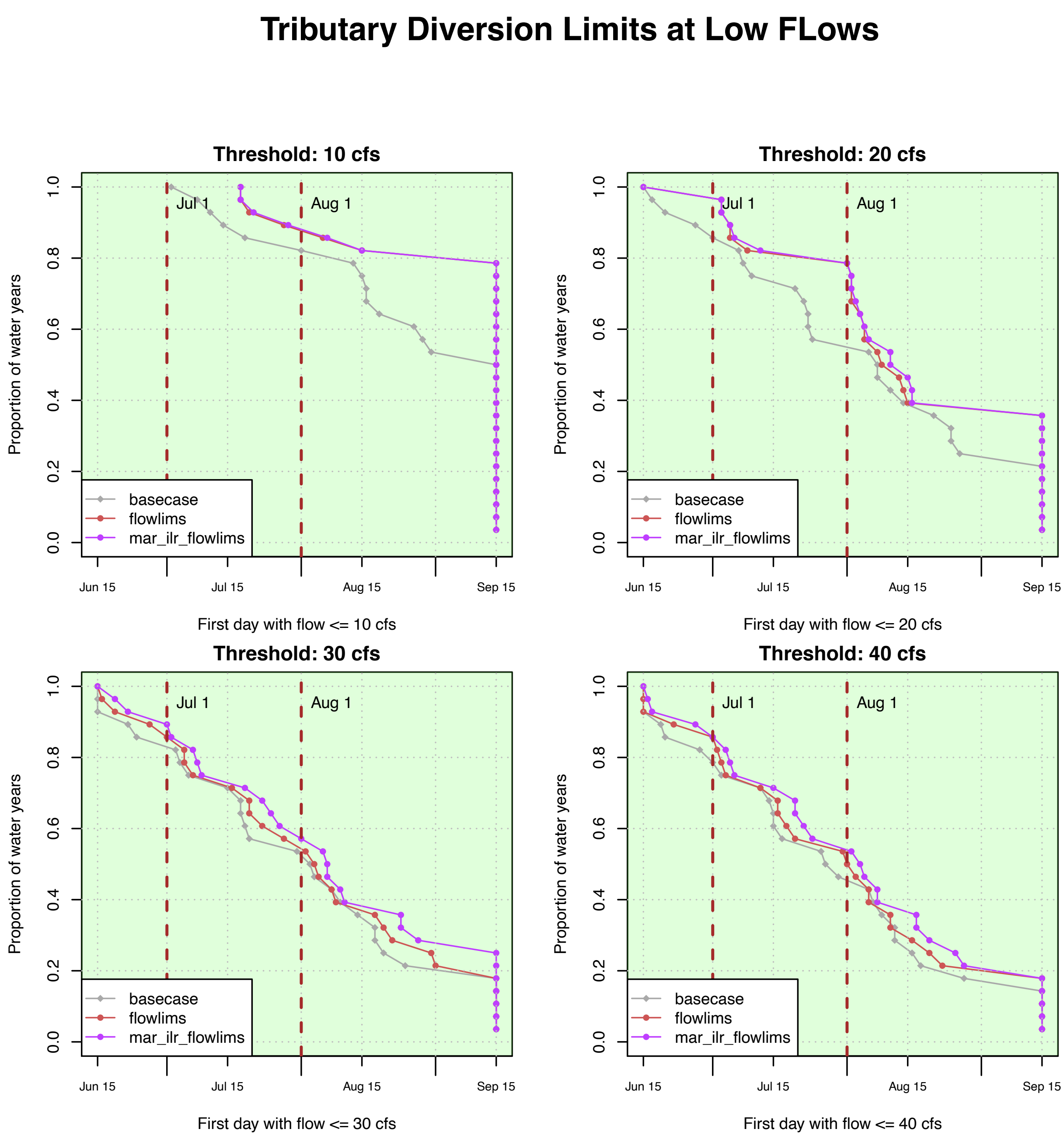
In particular, the "disconnection date" of the river is an important metric of ecosystem services: was the river flow high enough for long enough to allow juvenile salmonids to migrate out of the watershed towards the ocean?

These results show the distribution of threshold-crossing dates of flow at the Fort Jones Gauge, or the first date in the summer season on which the flow fell below a threshold. This threshold-crossing metric is assumed to be a proxy for disconnection dates. Multiple thresholds are depicted (10, 20, 30 and 40 cfs) to indicate uncertainty in the exact threshold of "disconnection" of different parts of the lower Scott River stream system.

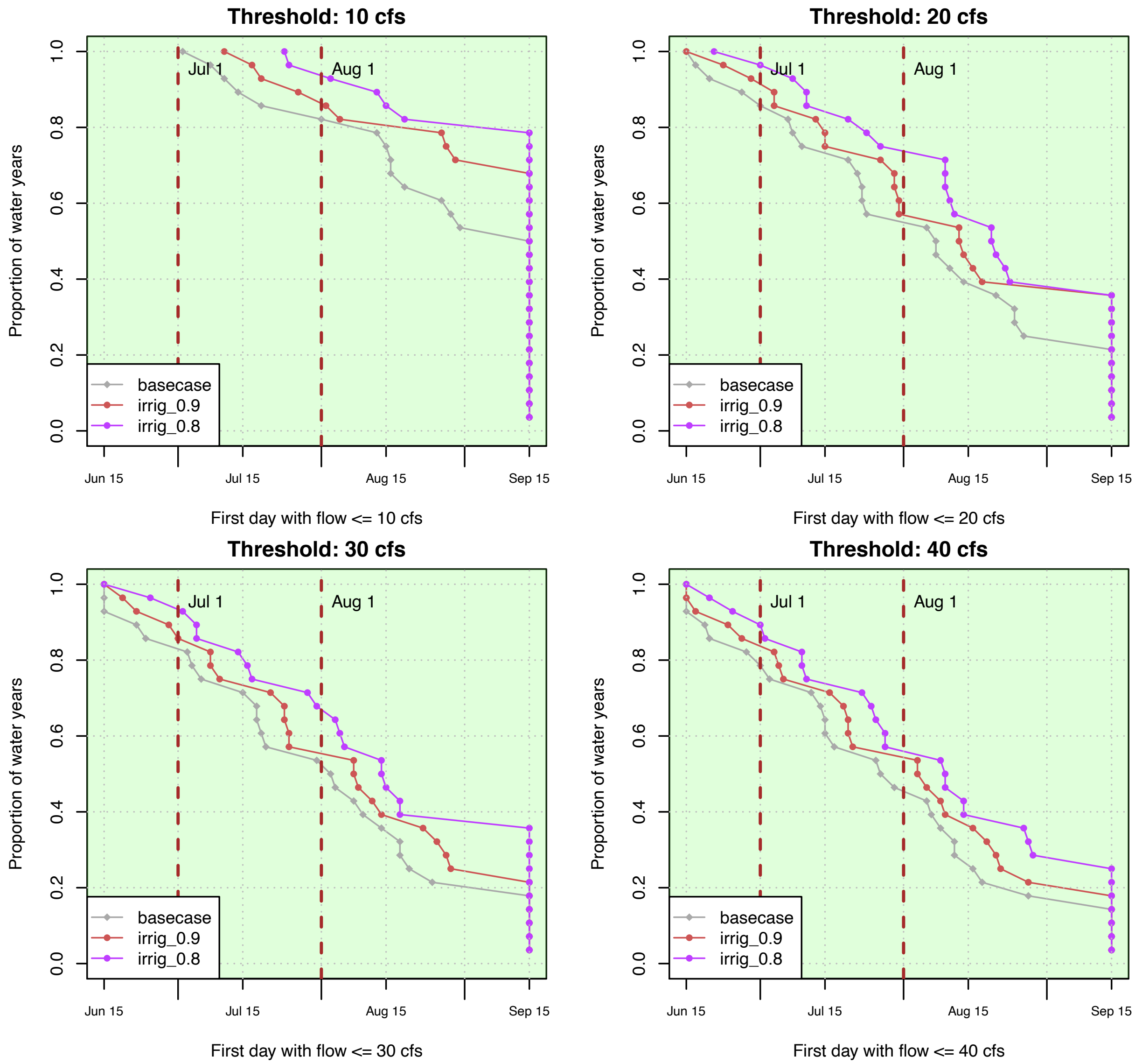
In general, scenarios in which more water years fall below the threshold later indicate more favorable hydrologic conditions (or, more dots on the right side of the plots is better). See explanatory graphs at the beginning of this appendix for more information.

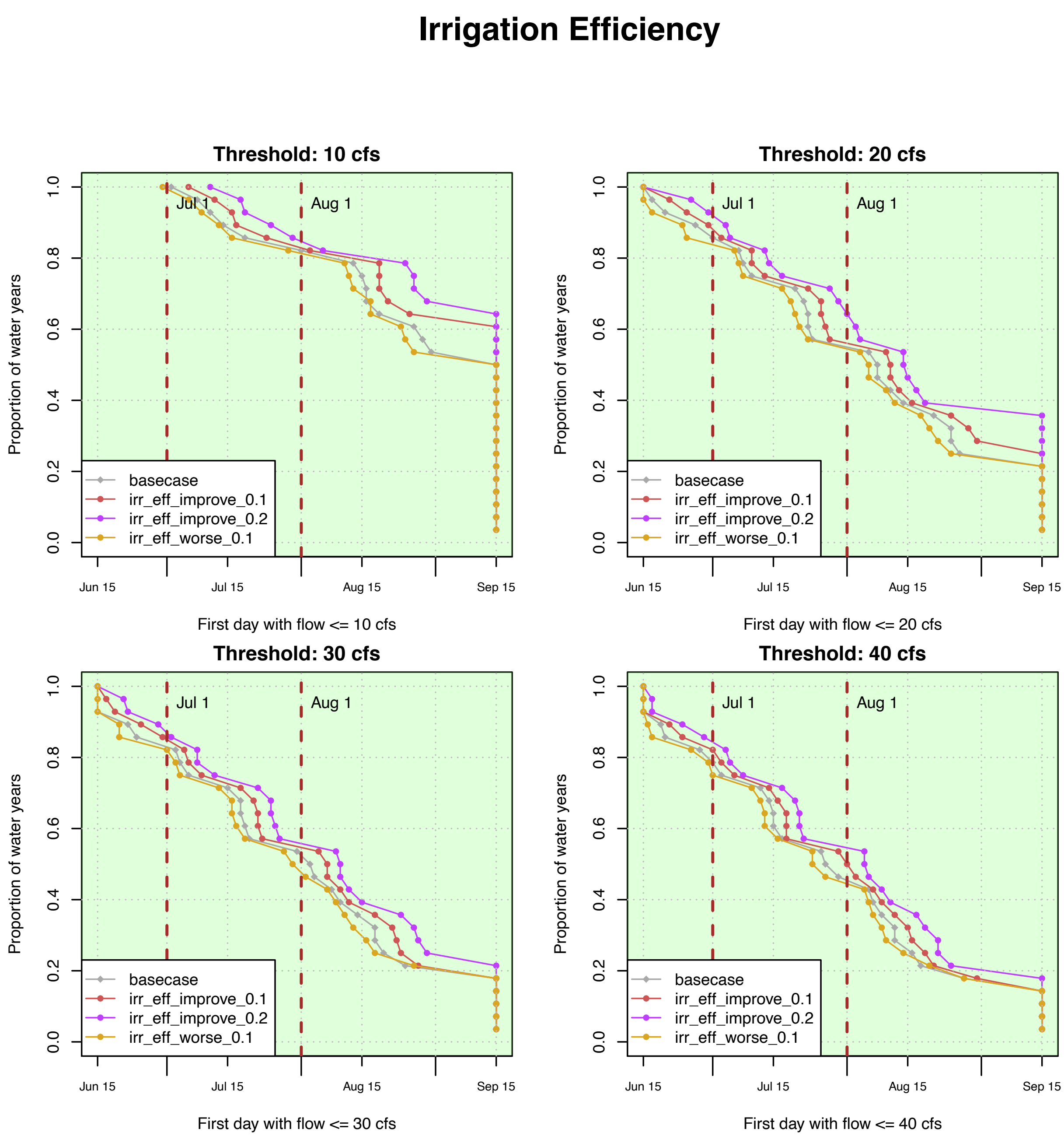

Observed and Simulated Historical FJ Flow
Threshold: 10 cfs
Threshold: 20 cfs
Threshold: 30 cfs
Threshold: 40 cfs
Proportion of water years
0.0
0.2
0.4
0.6
0.8
1.0
Jul 1
Aug 1
fj_obs
basecase
Jun 15
Jul 15
Aug 15
Sep 15
First day with flow <= 10 cfs
First day with flow <= 20 cfs
First day with flow <= 30 cfs
First day with flow <= 40 cfs

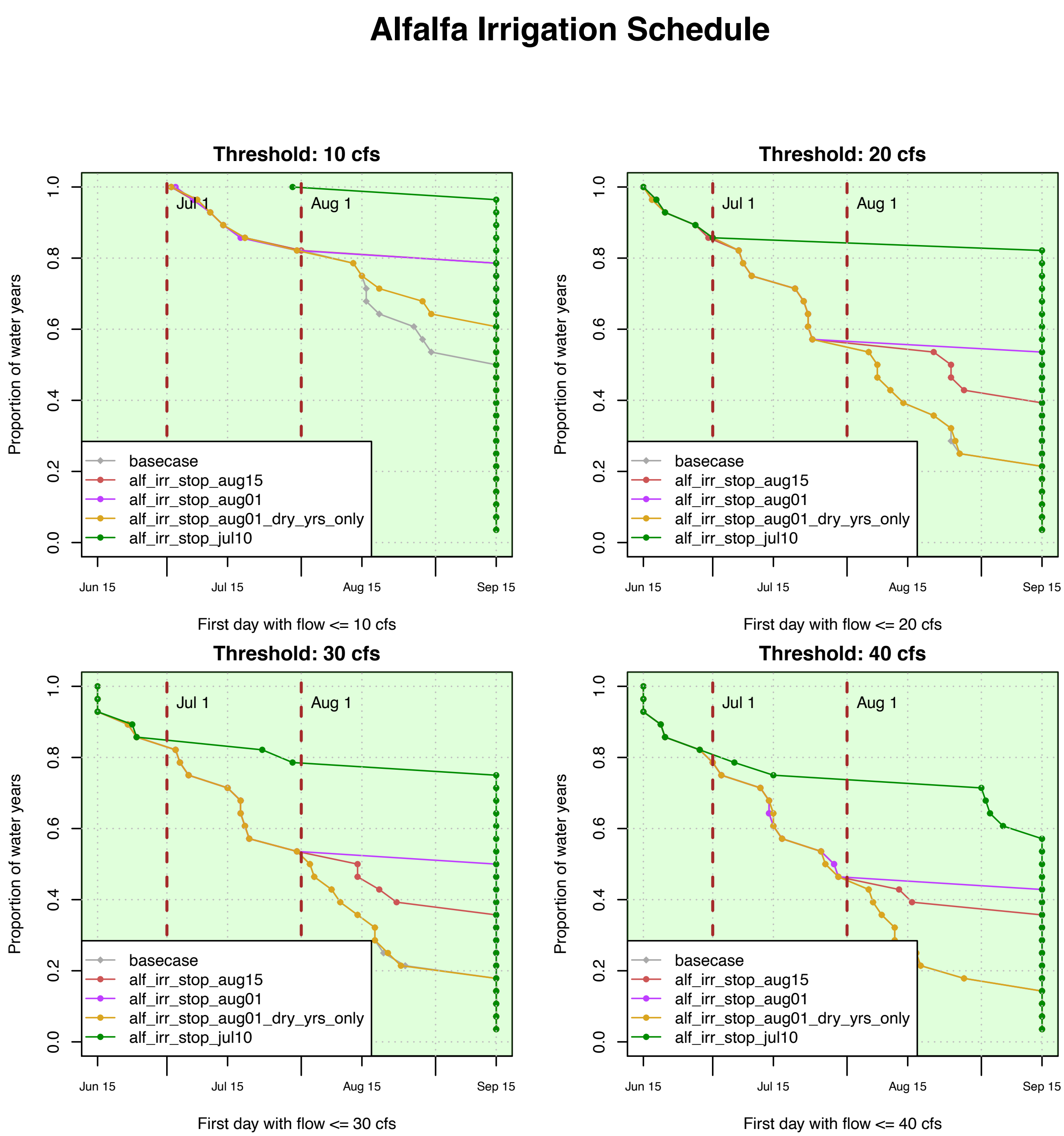

Recharge Scenarios
Threshold: 10 cfs
Threshold: 20 cfs
Threshold: 30 cfs
Threshold: 40 cfs
Proportion of water years
0.0
0.2
0.4
0.6
0.8
1.0
Jul 1
Aug 1
Jun 15
Jul 15
Aug 15
Sep 15
basecase
mar
mar_ilr
mar_ilr_flowlims
mar_ilr_max_0.019
First day with flow <= 10 cfs
First day with flow <= 20 cfs
First day with flow <= 30 cfs
First day with flow <= 40 cfs


Tributary Diversion Limits at Low FLows
Threshold: 10 cfs
Threshold: 20 cfs
Threshold: 30 cfs
Threshold: 40 cfs
Proportion of water years
0.0
0.2
0.4
0.6
0.8
1.0
Jul 1
Aug 1
basecase
flowlims
mar_ilr_flowlims
Jun 15
Jul 15
Aug 15
Sep 15
First day with flow <= 10 cfs
First day with flow <= 20 cfs
First day with flow <= 30 cfs
First day with flow <= 40 cfs

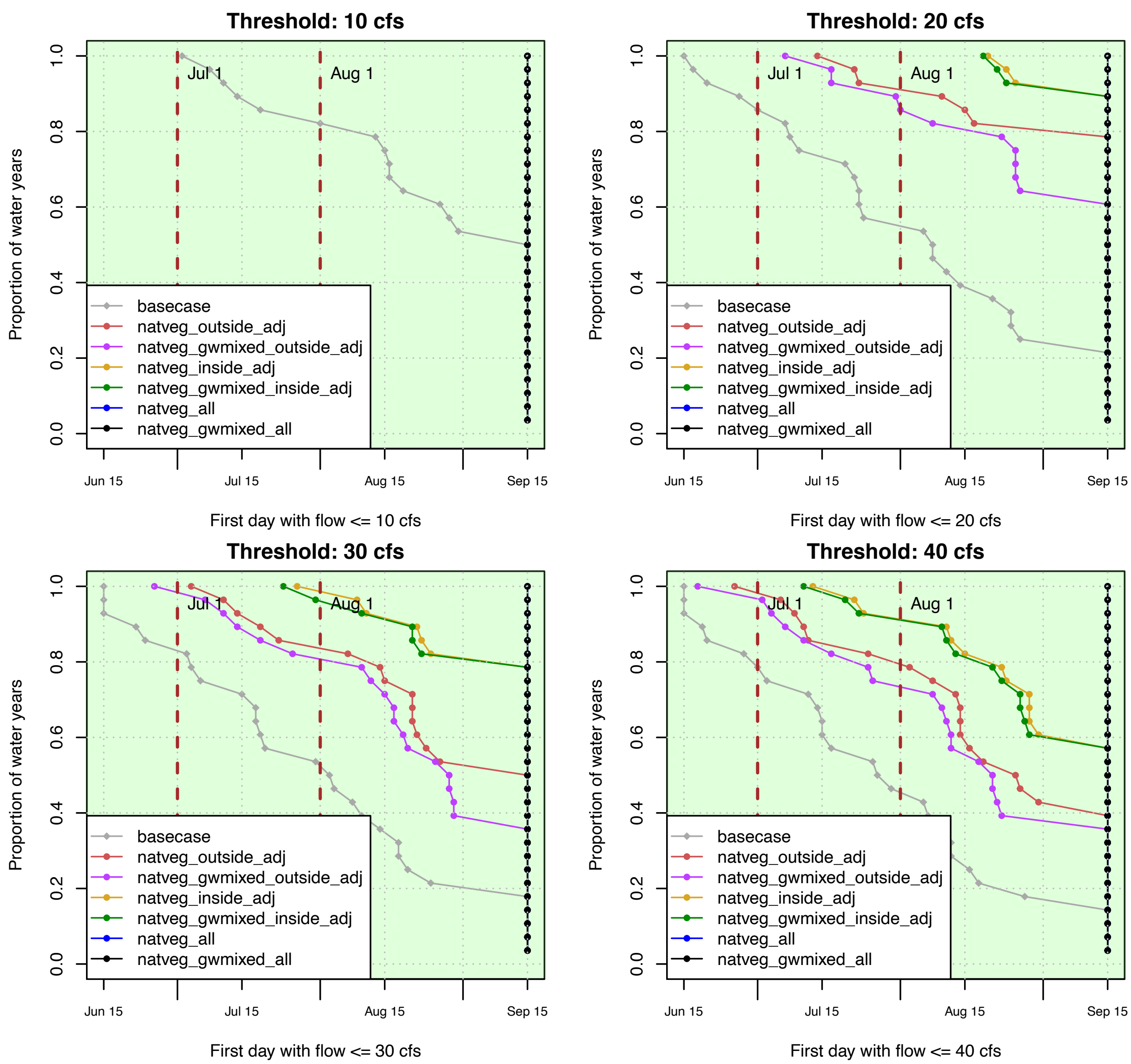
Irrigation Demand

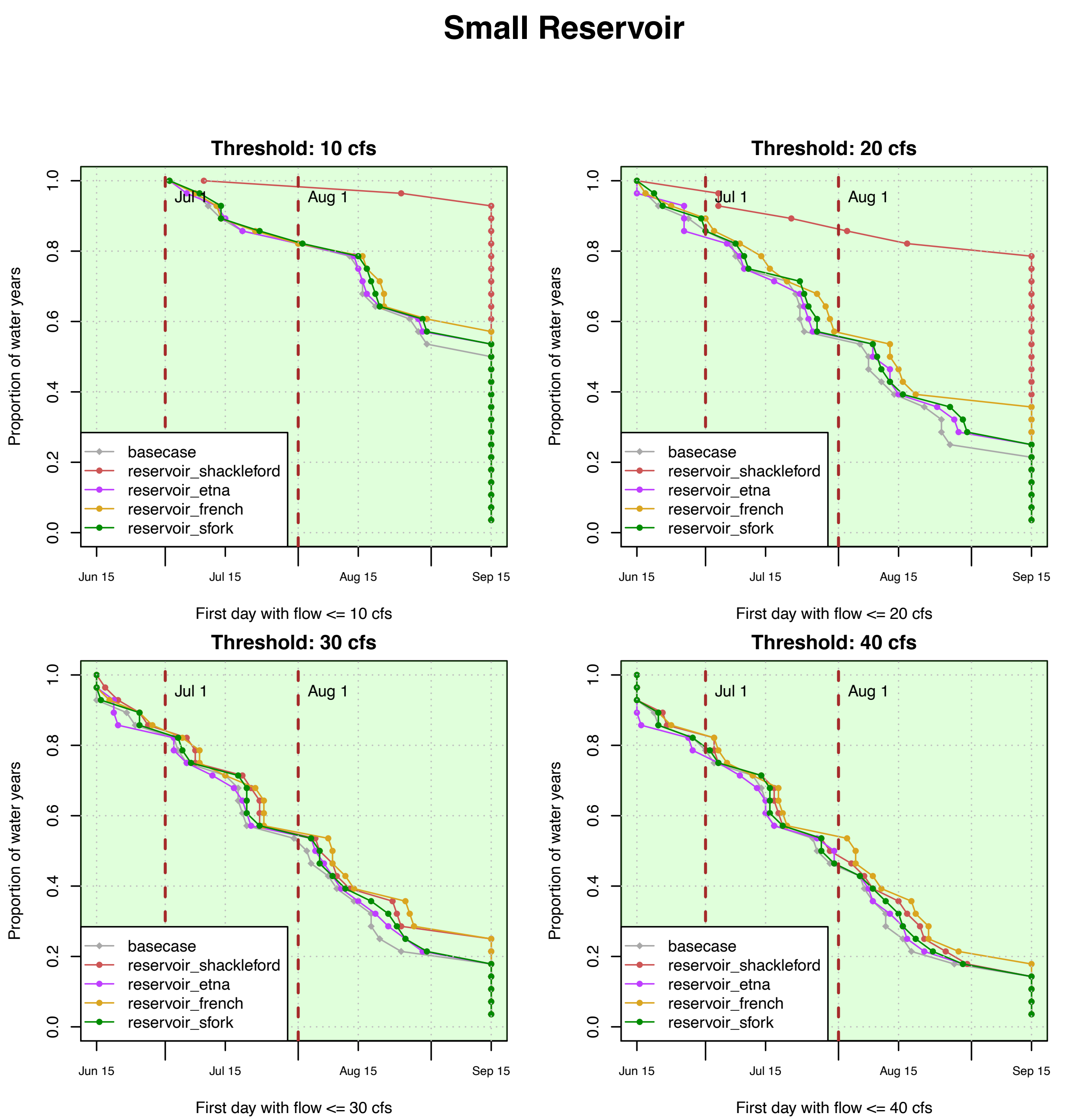


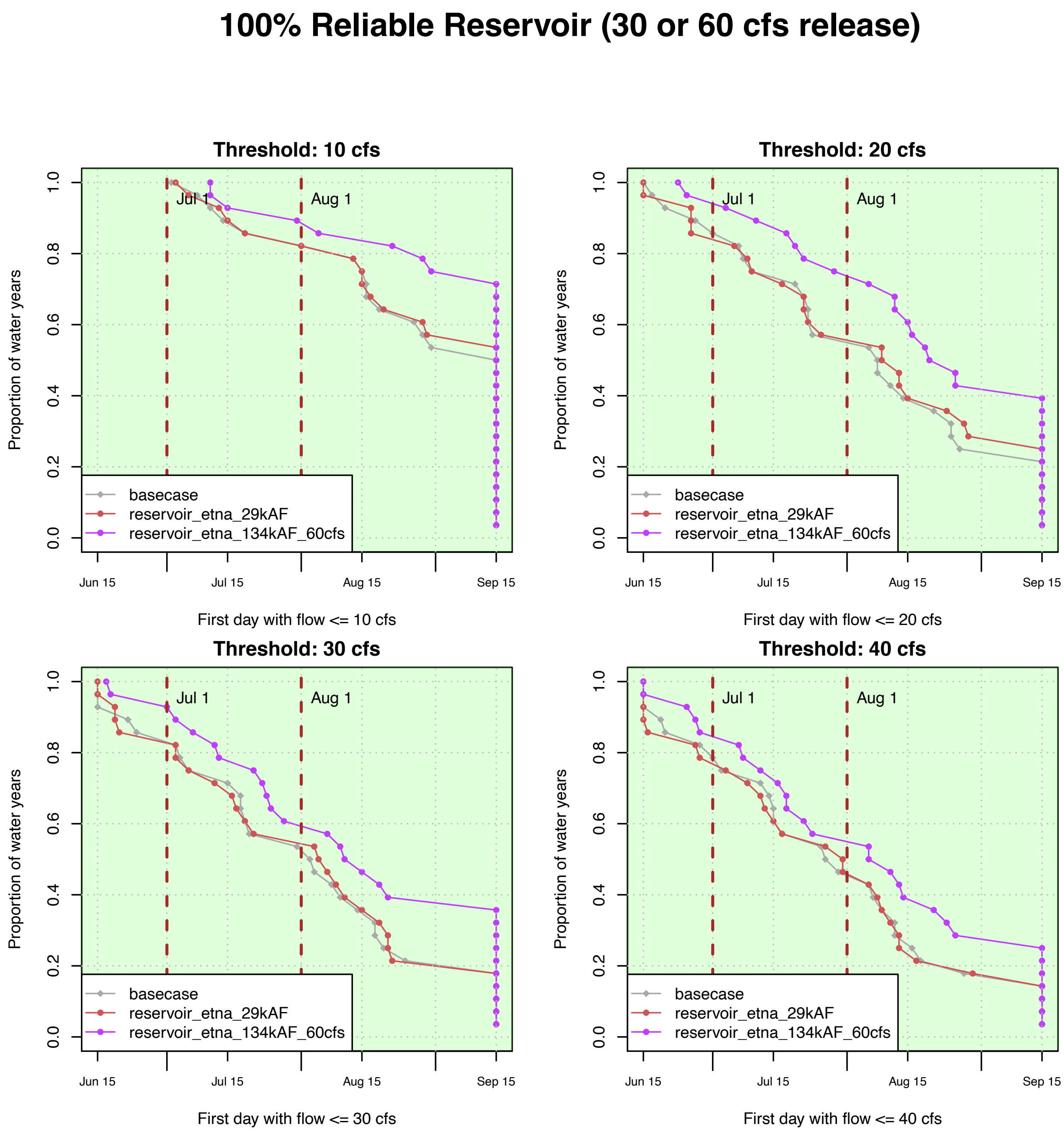

Irrigation Efficiency
Threshold: 10 cfs
Threshold: 20 cfs
Threshold: 30 cfs
Threshold: 40 cfs
Proportion of water years
Jul 1
Aug 1
Jun 15
Jul 15
Aug 15
Sep 15
basecase
irr_eff_improve_0.1
irr_eff_improve_0.2
irr_eff_worse_0.1
First day with flow <= 10 cfs
First day with flow <= 20 cfs
First day with flow <= 30 cfs
First day with flow <= 40 cfs


Alfalfa Irrigation Schedule
Threshold: 10 cfs
Threshold: 20 cfs
Threshold: 30 cfs
Threshold: 40 cfs
Jul 1
Aug 1
Proportion of water years
0.0
0.2
0.4
0.6
0.8
1.0
Jun 15
Jul 15
Aug 15
Sep 15
First day with flow <= 10 cfs
First day with flow <= 20 cfs
First day with flow <= 30 cfs
First day with flow <= 40 cfs
basecase
alf_irr_stop_aug15
alf_irr_stop_aug01
alf_irr_stop_aug01_dry_yrs_only
alf_irr_stop_jul10

Land Use Change (Attribution Study)




Small Reservoir
Threshold: 10 cfs
Threshold: 20 cfs
Threshold: 30 cfs
Threshold: 40 cfs
Proportion of water years
0.0
0.2
0.4
0.6
0.8
1.0
Jul 1
Aug 1
Jun 15
Jul 15
Aug 15
Sep 15
basecase
reservoir_shackleford
reservoir_etna
reservoir_french
reservoir_sfork
First day with flow <= 10 cfs
First day with flow <= 20 cfs
First day with flow <= 30 cfs
First day with flow <= 40 cfs

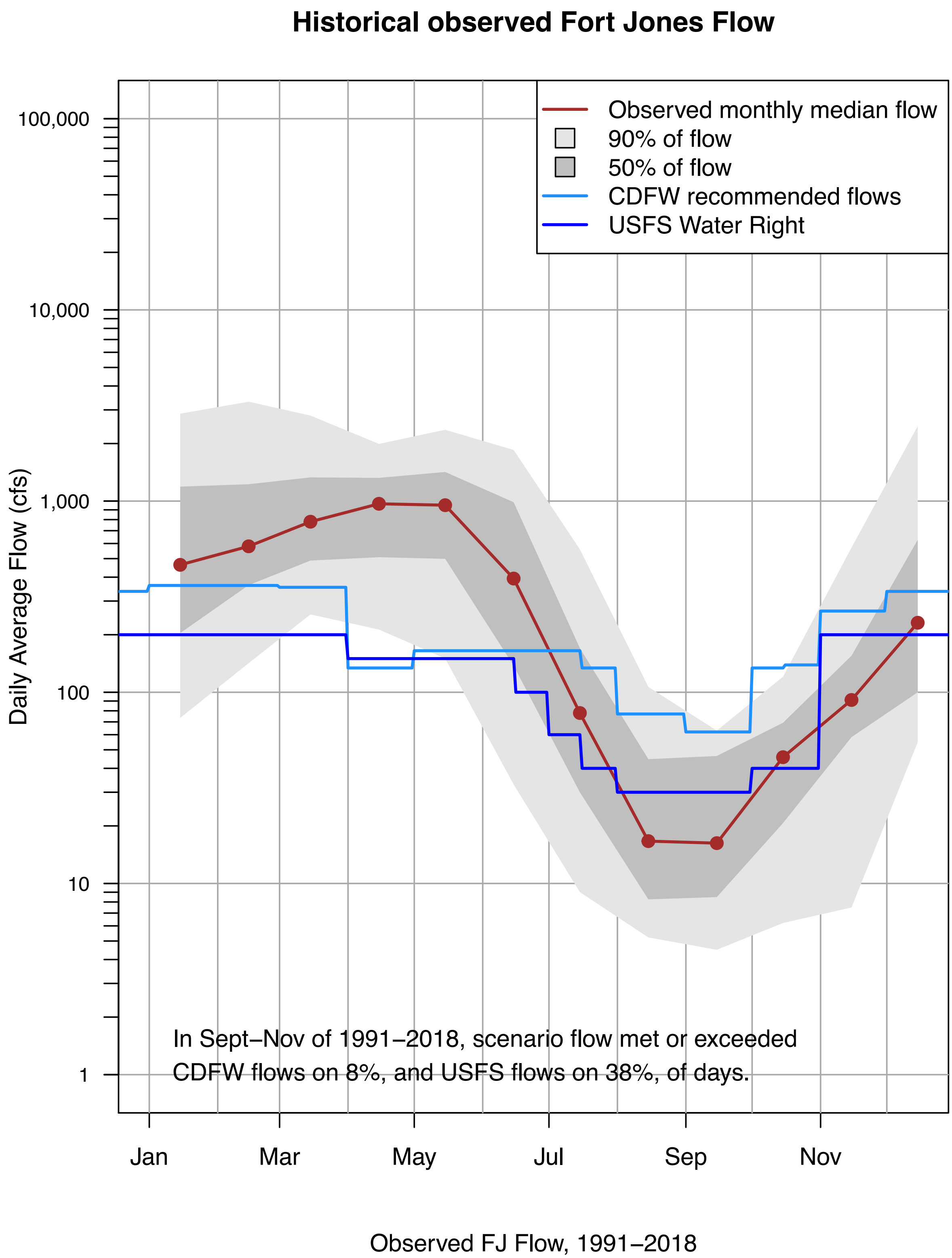

100% Reliable Reservoir (30 or 60 cfs release)
Threshold: 10 cfs
Threshold: 20 cfs
Threshold: 30 cfs
Threshold: 40 cfs
Proportion of water years
0.0
0.2
0.4
0.6
0.8
1.0
Jul 1
Aug 1
Jun 15
Jul 15
Aug 15
Sep 15
basecase
reservoir_etna_29kAF
reservoir_etna_134kAF_60cfs
First day with flow <= 10 cfs
First day with flow <= 20 cfs
First day with flow <= 30 cfs
First day with flow <= 40 cfs

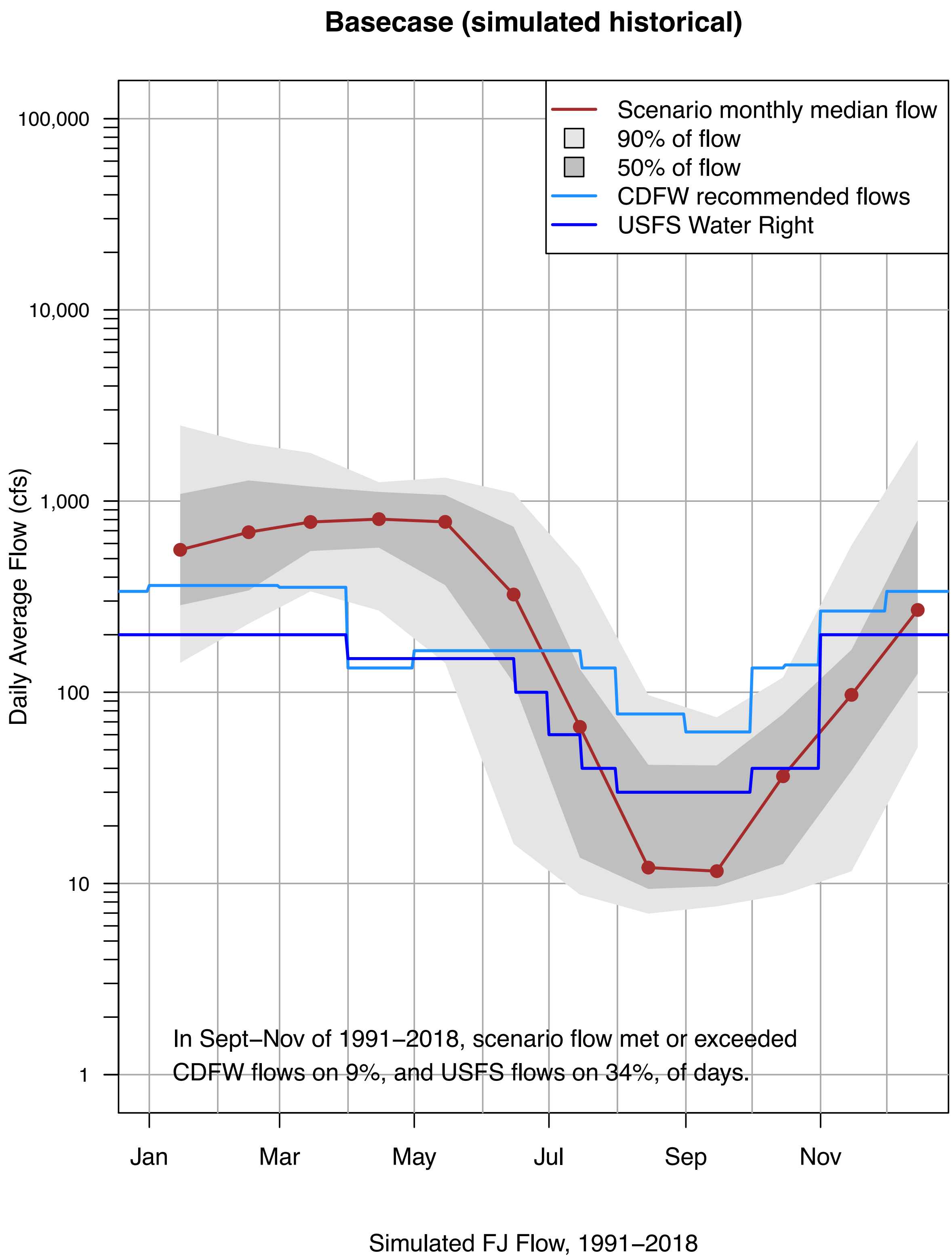
Percentile Flows and Flow Regime Comparison

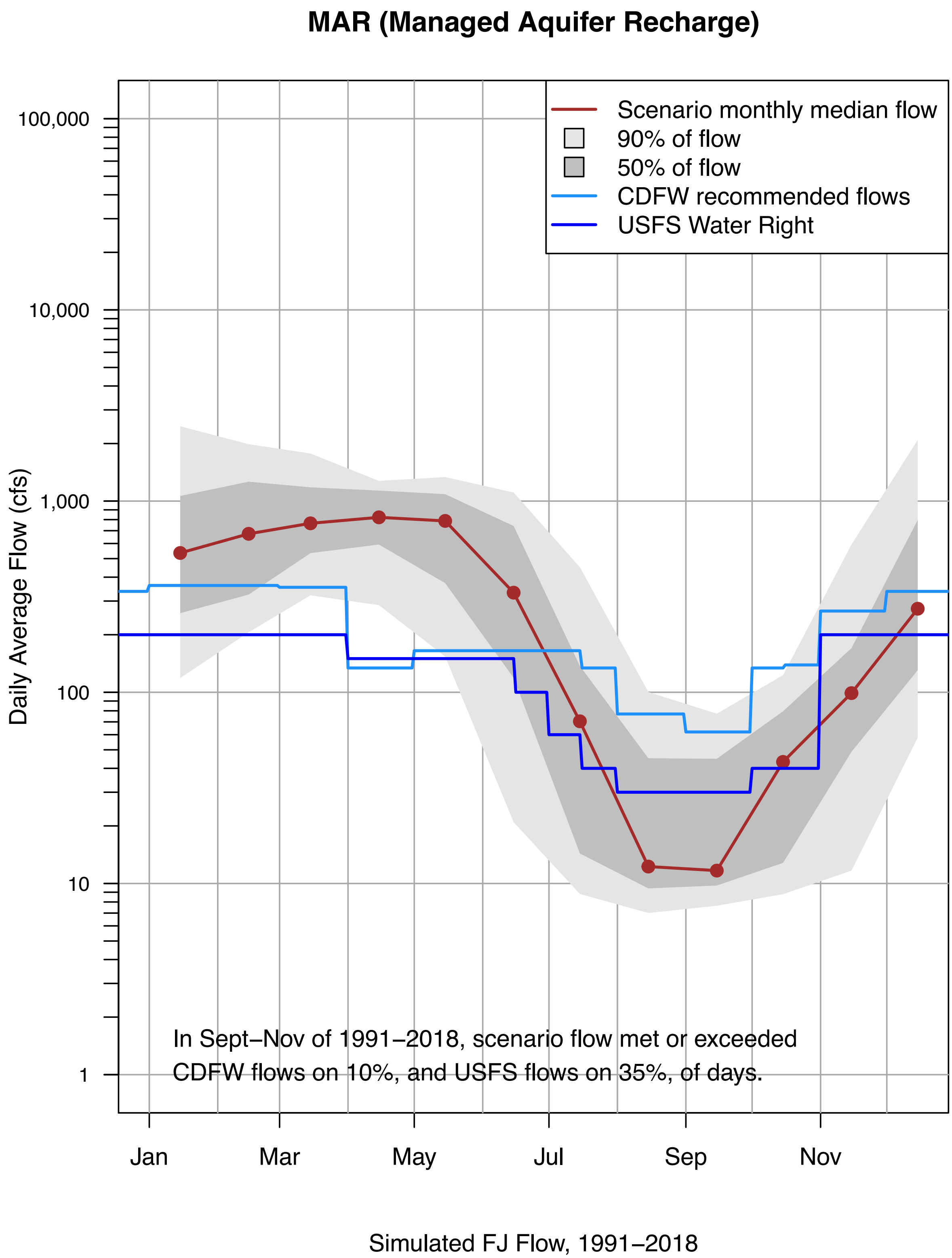
The goal of these plots is to 1) visualize the variability in Fort Jones flow in each model scenario, and 2) compare the flow to two proscribed flow regimes.

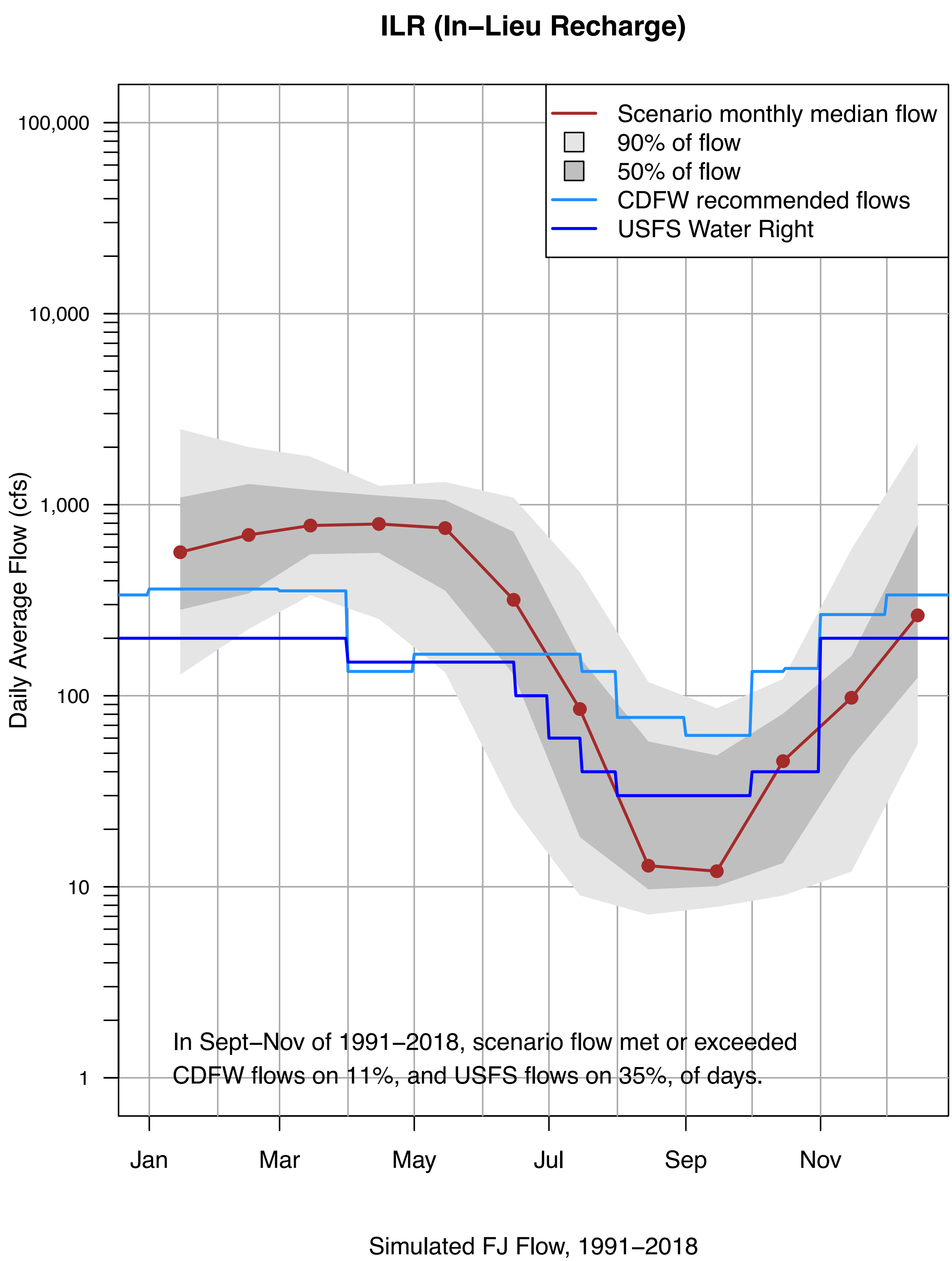
- Brown dots and line: The brown dots indicate the median flow recorded on all days falling in a given month in the 28-year model period (e.g., the median flow of all days of all the Januaries 1991-2018). That means that flow exceeds this brown line on approximately 50% of days in a given scenario.
- Gray shading: The dark gray shading captures the area from the 25th to the 75th percentiles of flow in a given month, and the light gray shading encompasses the 5th to the 95th percentiles. This means that that flow in a given scenario falls within the dark gray area on 50%, and within the light gray area on 90%, of days.
- Blue lines: The light blue line shows the flow regime published in the 2017 California Department of Fish and Wildlife (CDFW) report "Interim Instream Flow Criteria for the Protection of Fishery Resources in the Scott River Watershed, Siskiyou County". The dark blue line shows the flow regime for the United States Forest Service (USFS) water right as quantified in the Scott River Adjudication of 1980 (Decree No. 30662).

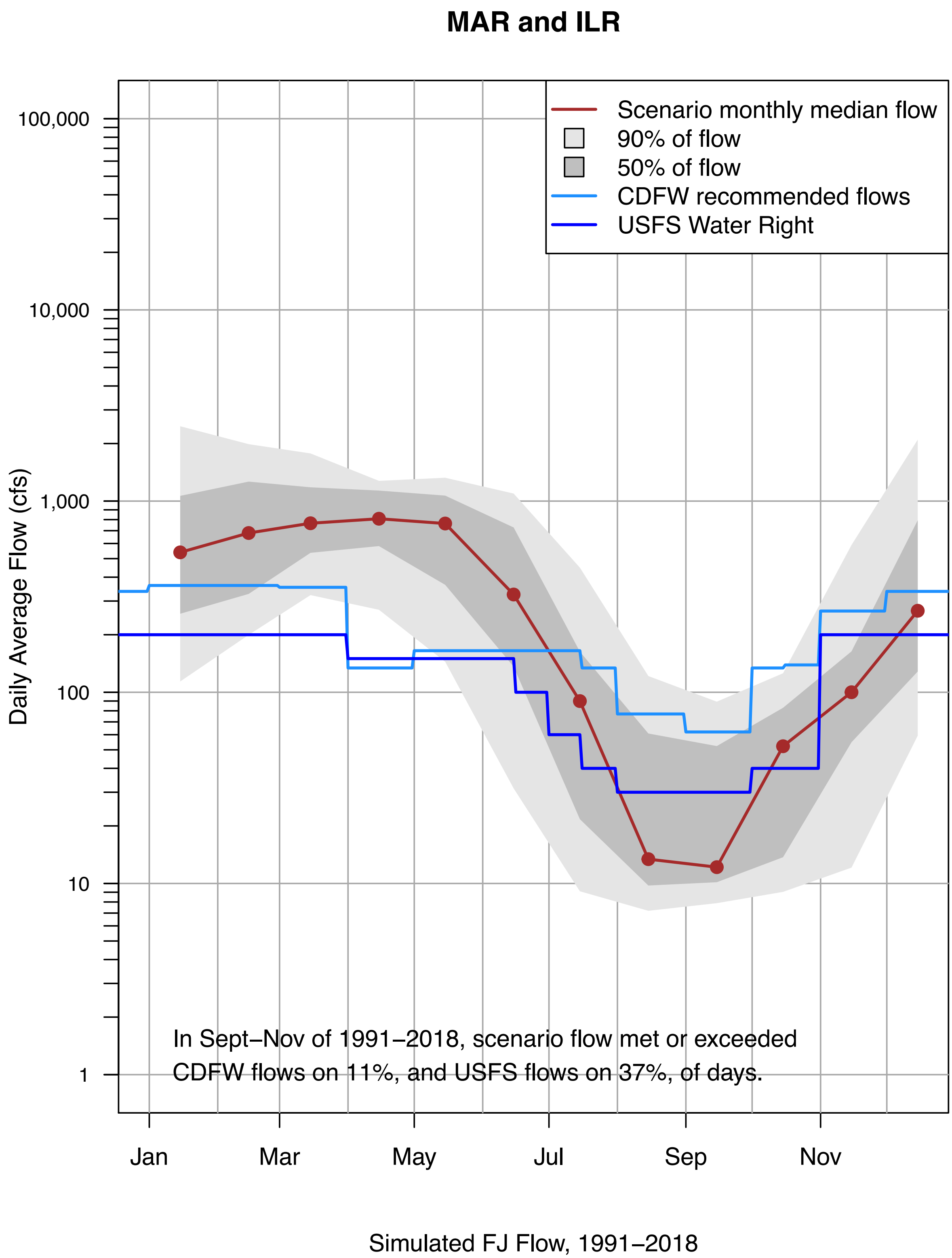
At the bottom of each plot, a note indicates the percentage of days in the critical low flow window (Sept. 1-Nov. 30, for all water years 1991-2018) on which each threshold was met.

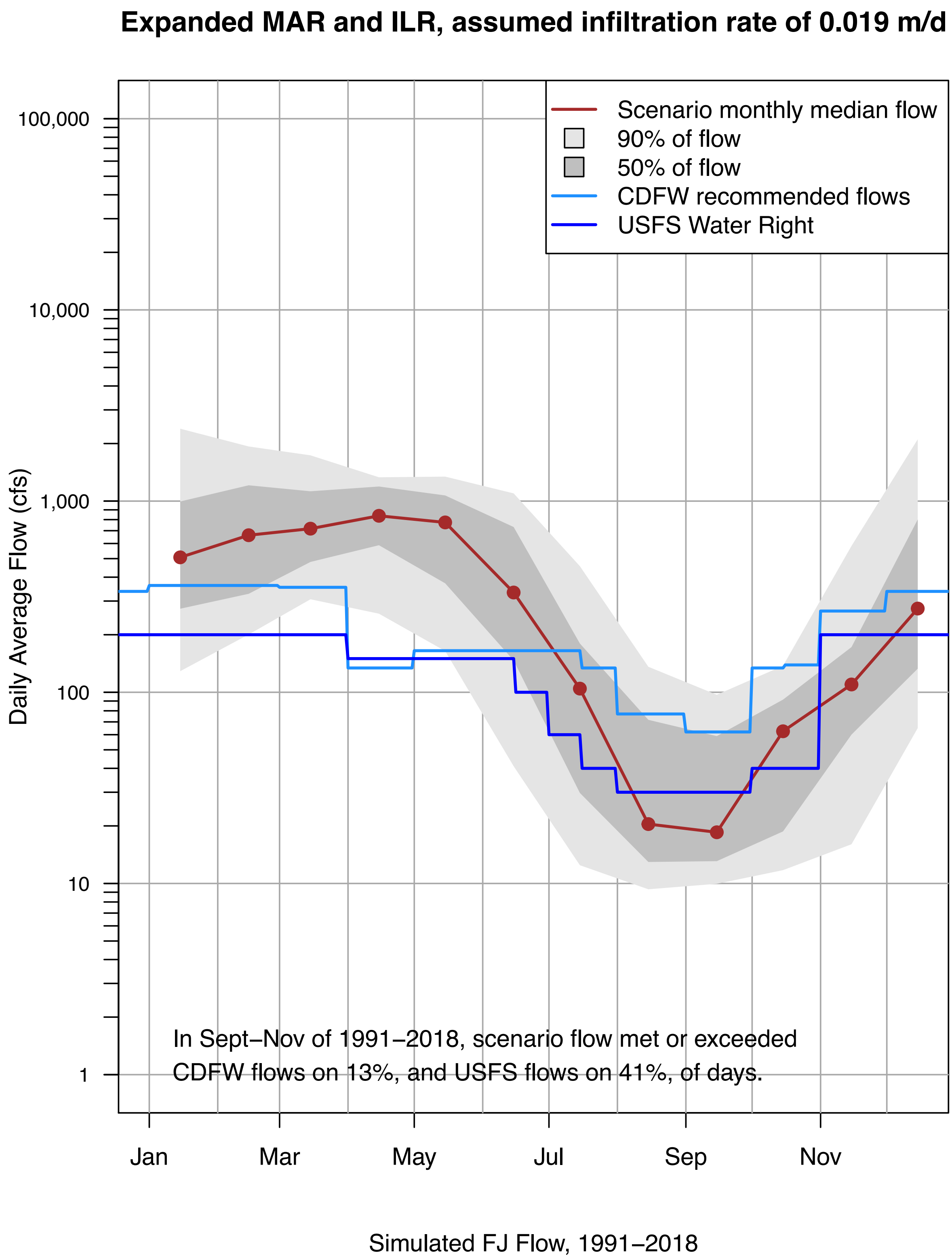

Historical observed Fort Jones Flow
Observed monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 8%, and USFS flows on 38%, of days.
Jan
Mar
May
Jul
Sep
Nov
Observed FJ Flow, 1991–2018

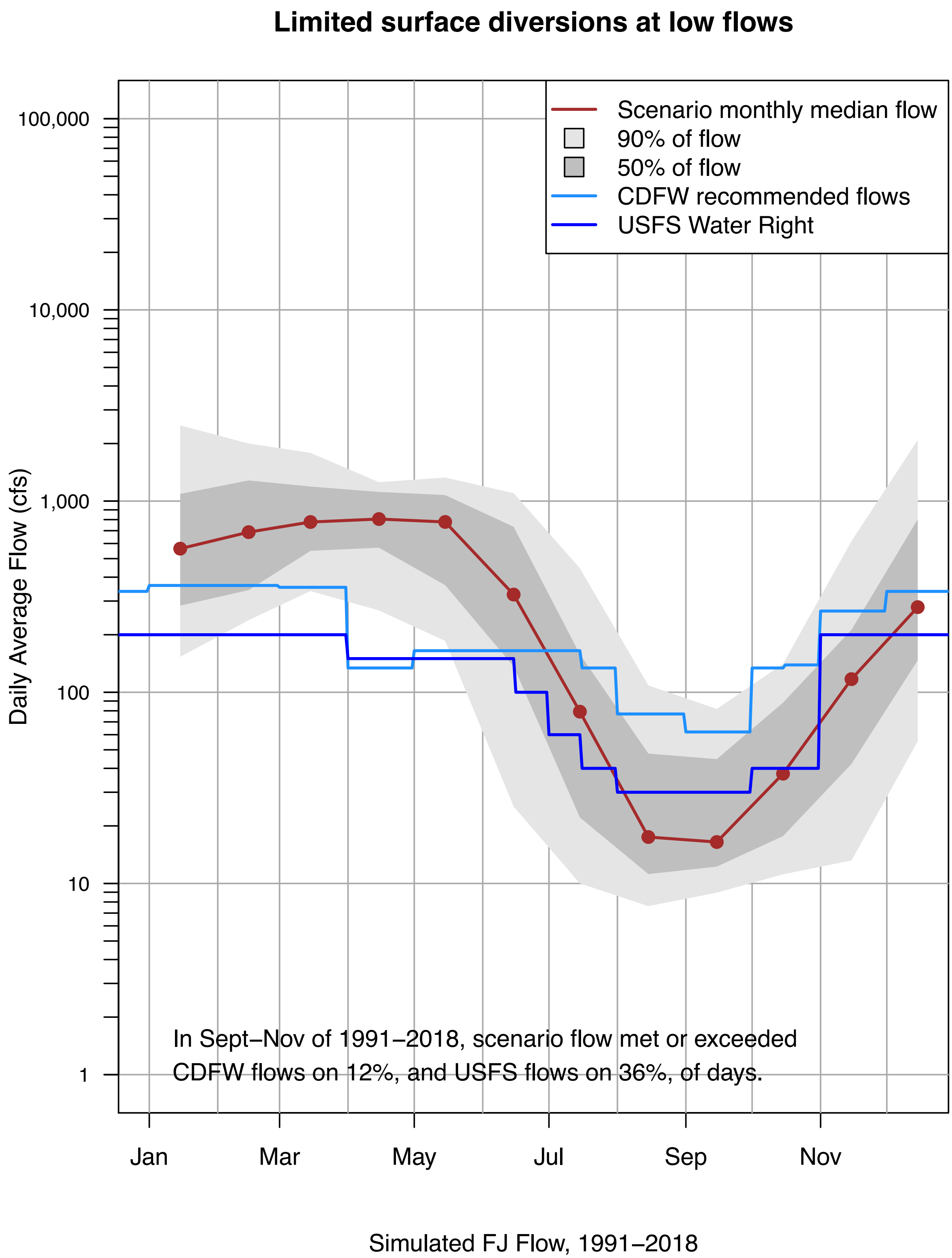

Basecase (simulated historical)
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
Jan
Mar
May
Jul
Sep
Nov
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 9%, and USFS flows on 34%, of days.
Simulated FJ Flow, 1991–2018

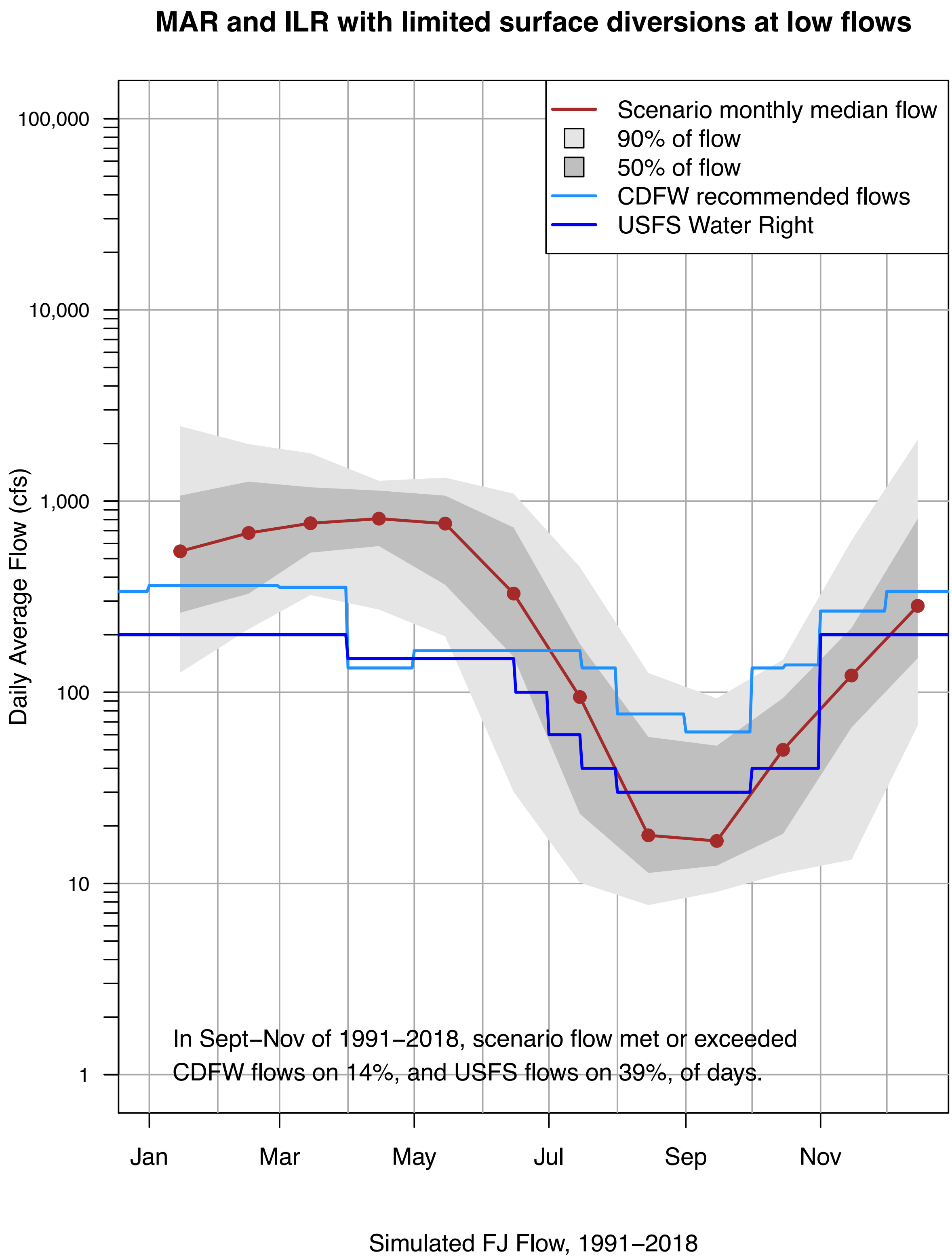

MAR (Managed Aquifer Recharge)
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 10%, and USFS flows on 35%, of days.
Jan
Mar
May
Jul
Sep
Nov
Simulated FJ Flow, 1991–2018

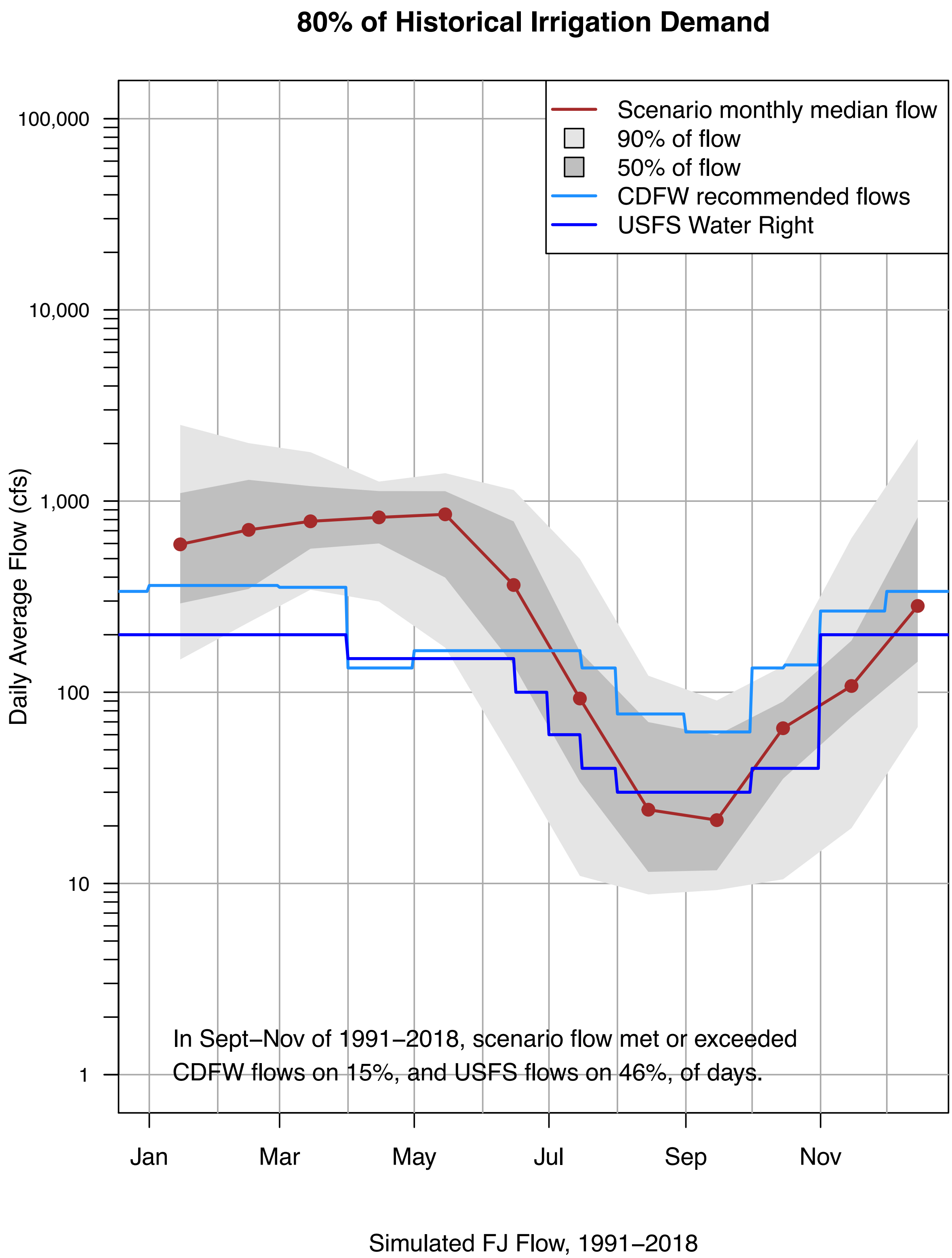

ILR (In–Lieu Recharge)
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
Jan
Mar
May
Jul
Sep
Nov
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 11%, and USFS flows on 35%, of days.
Simulated FJ Flow, 1991–2018

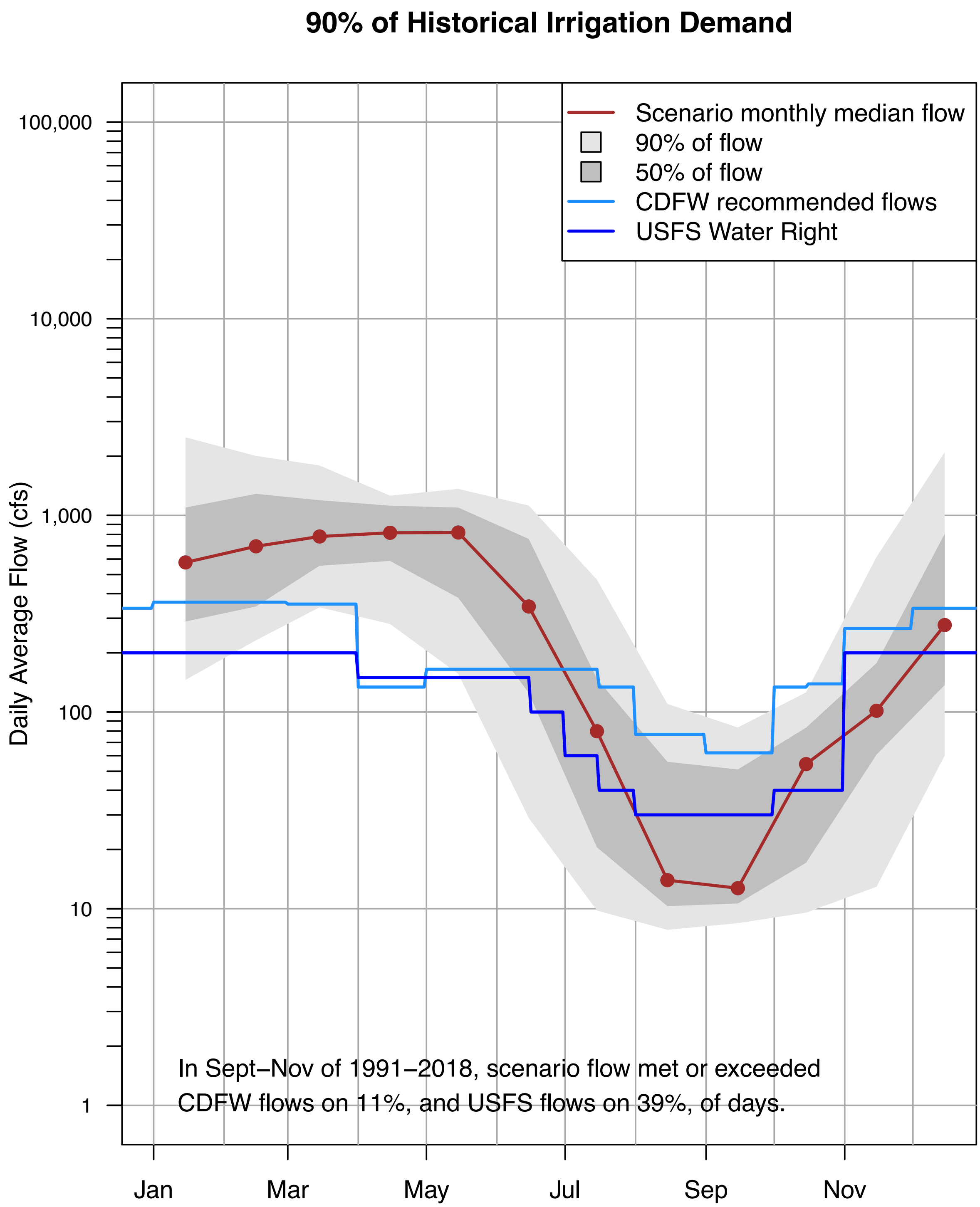

MAR and ILR
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
Jan
Mar
May
Jul
Sep
Nov
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 11%, and USFS flows on 37%, of days.
Simulated FJ Flow, 1991–2018


Expanded MAR and ILR, assumed infiltration rate of 0.019 m/d
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 13%, and USFS flows on 41%, of days.
Jan
Mar
May
Jul
Sep
Nov
Simulated FJ Flow, 1991–2018

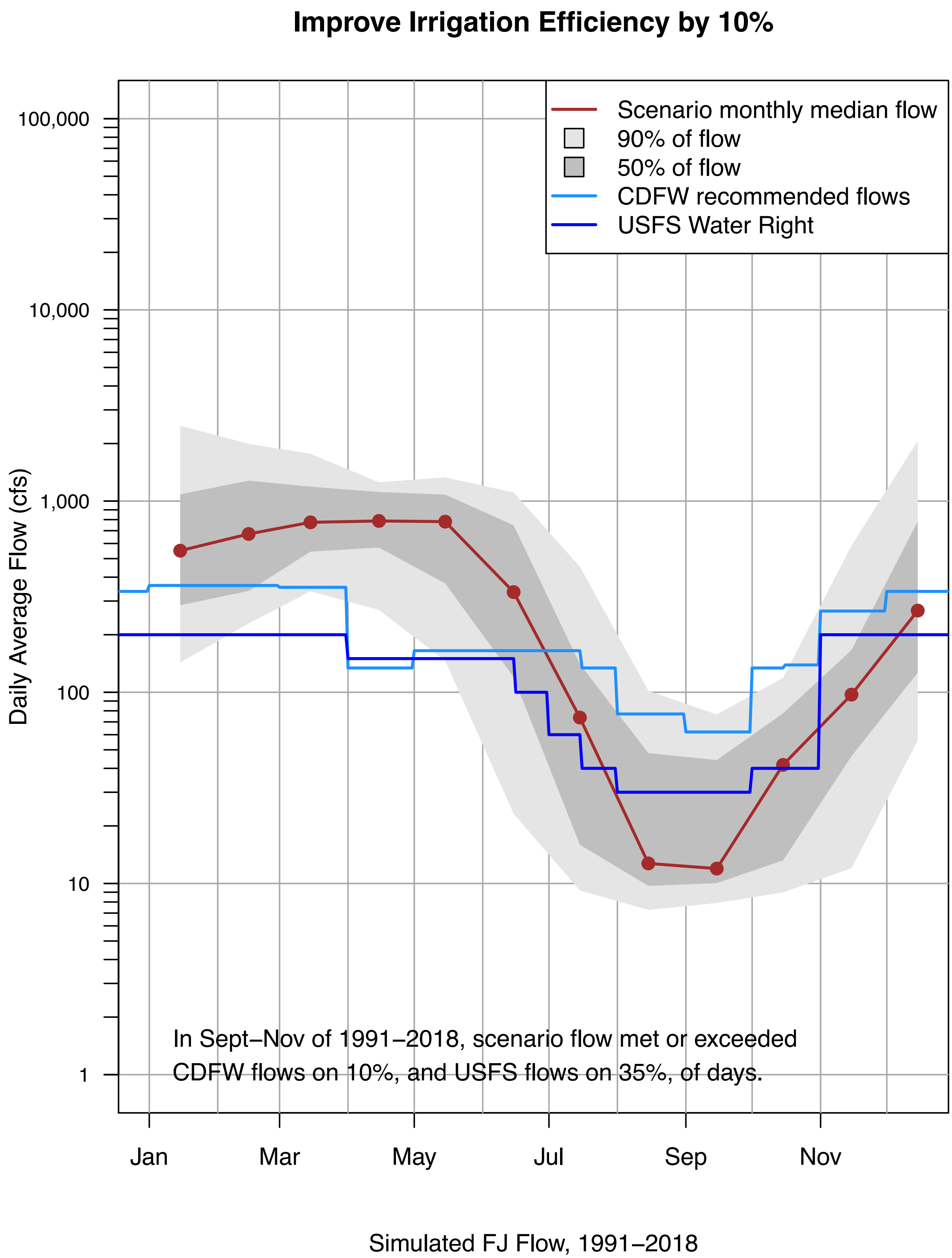

Limited surface diversions at low flows
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
Daily Average Flow (cfs)
100,000
10,000
1,000
100
10
1
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 12%, and USFS flows on 36%, of days.
Jan
Mar
May
Jul
Sep
Nov
Simulated FJ Flow, 1991–2018

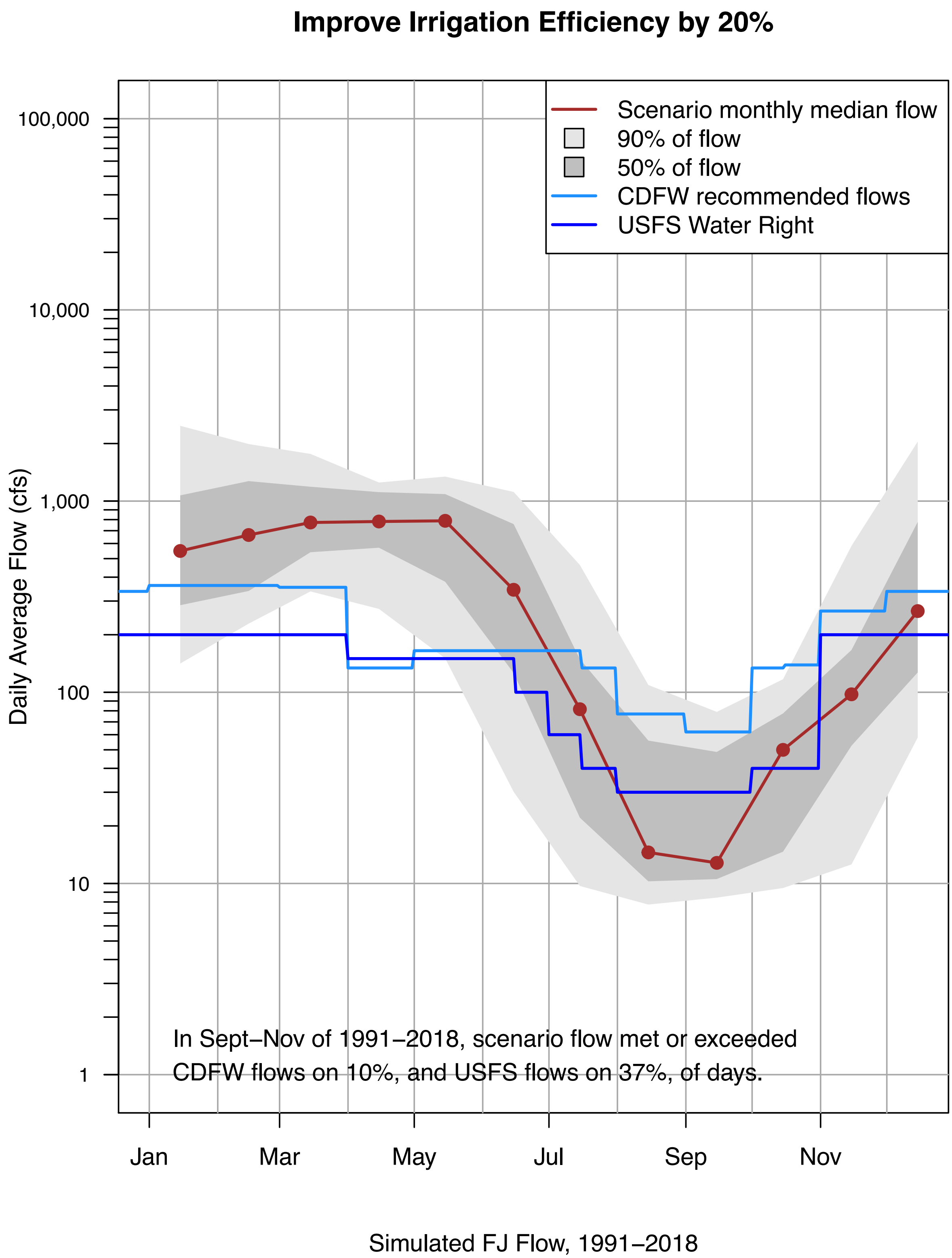

MAR and ILR with limited surface diversions at low flows
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
Daily Average Flow (cfs)
100,000
10,000
1,000
100
10
1
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 14%, and USFS flows on 39%, of days.
Jan
Mar
May
Jul
Sep
Nov
Simulated FJ Flow, 1991–2018

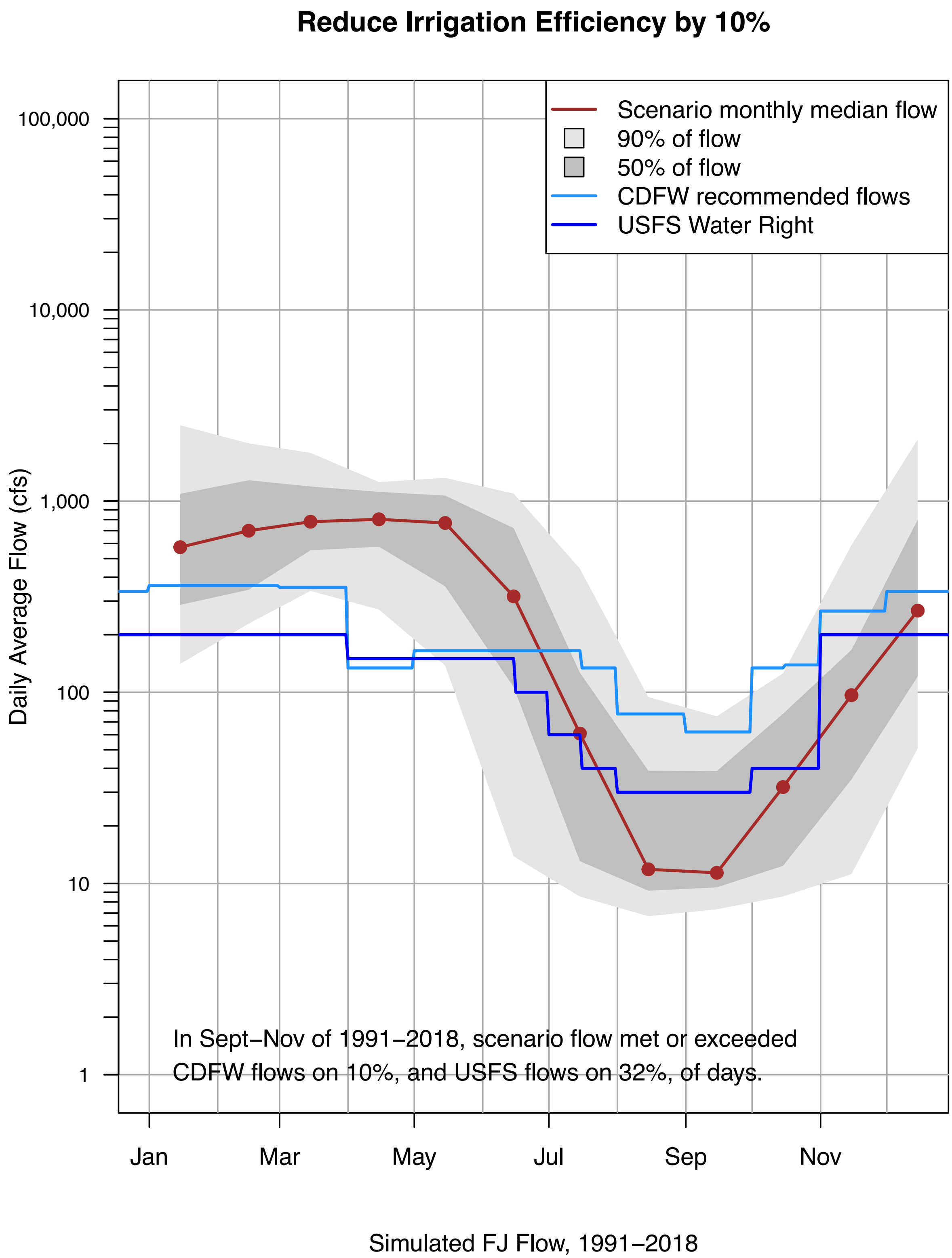

80% of Historical Irrigation Demand
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
Jan
Mar
May
Jul
Sep
Nov
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 15%, and USFS flows on 46%, of days.
Simulated FJ Flow, 1991–2018



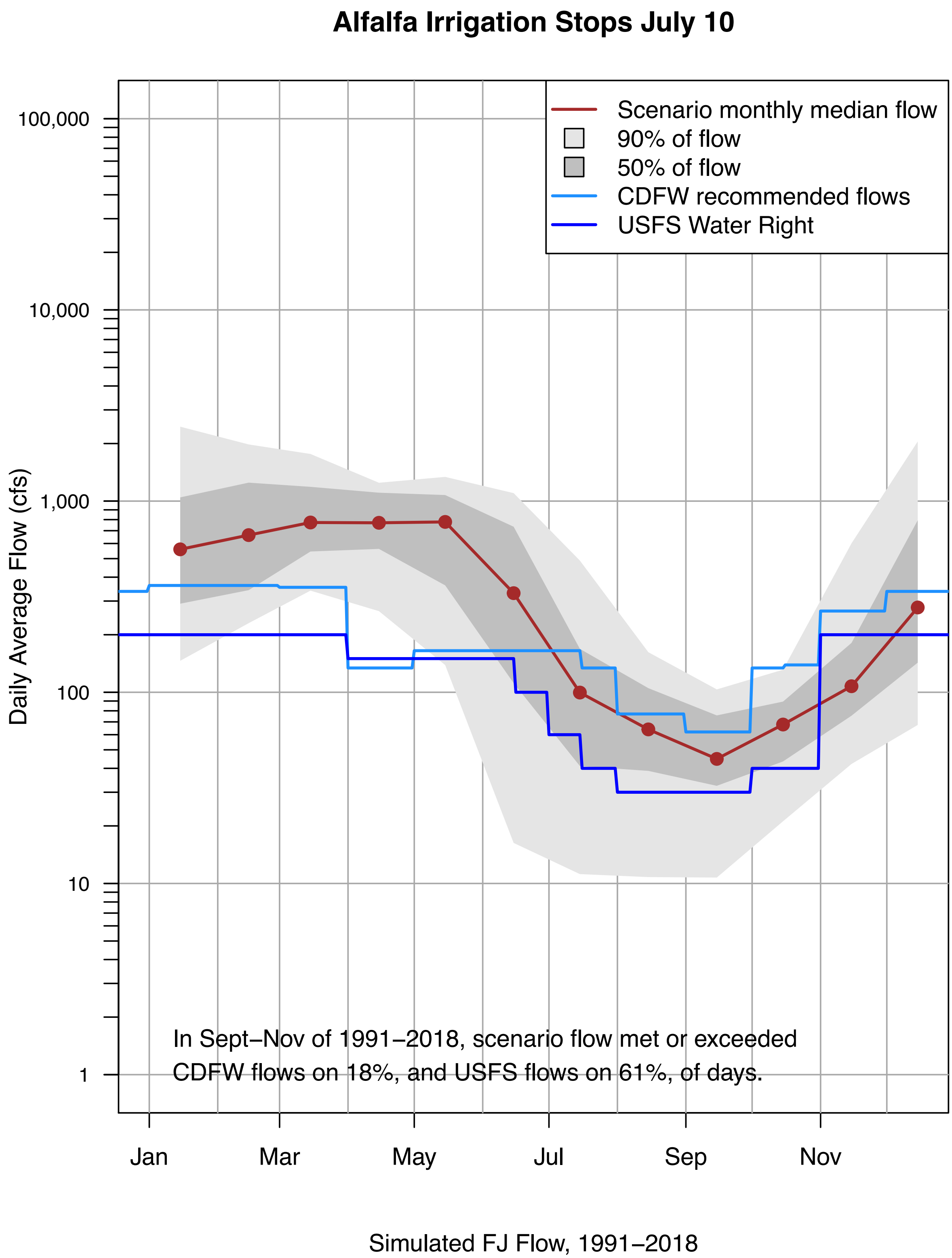
Simulated FJ Flow, 1991–2018

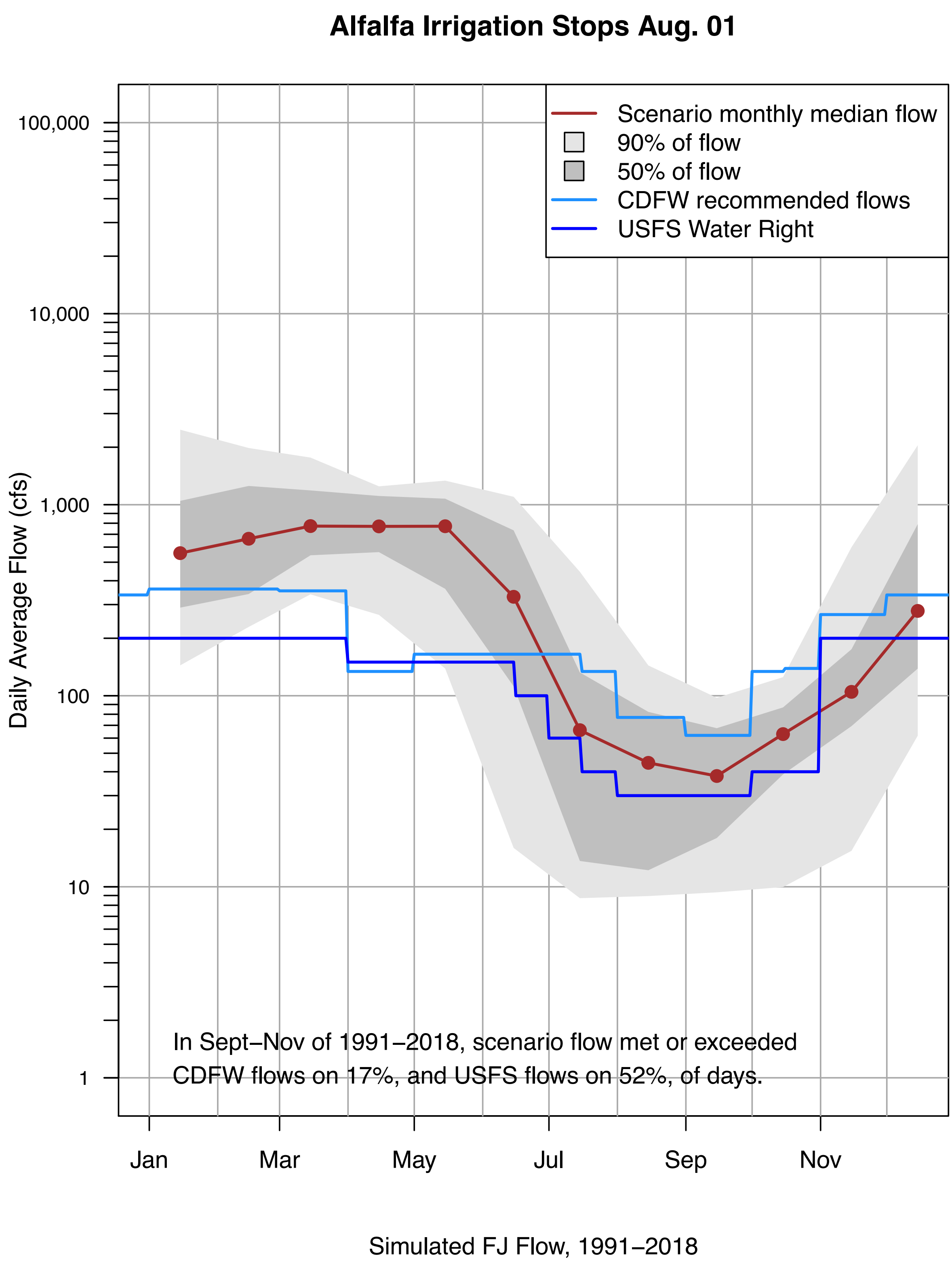

Improve Irrigation Efficiency by 10%
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 10%, and USFS flows on 35%, of days.
Jan
Mar
May
Jul
Sep
Nov
Simulated FJ Flow, 1991–2018

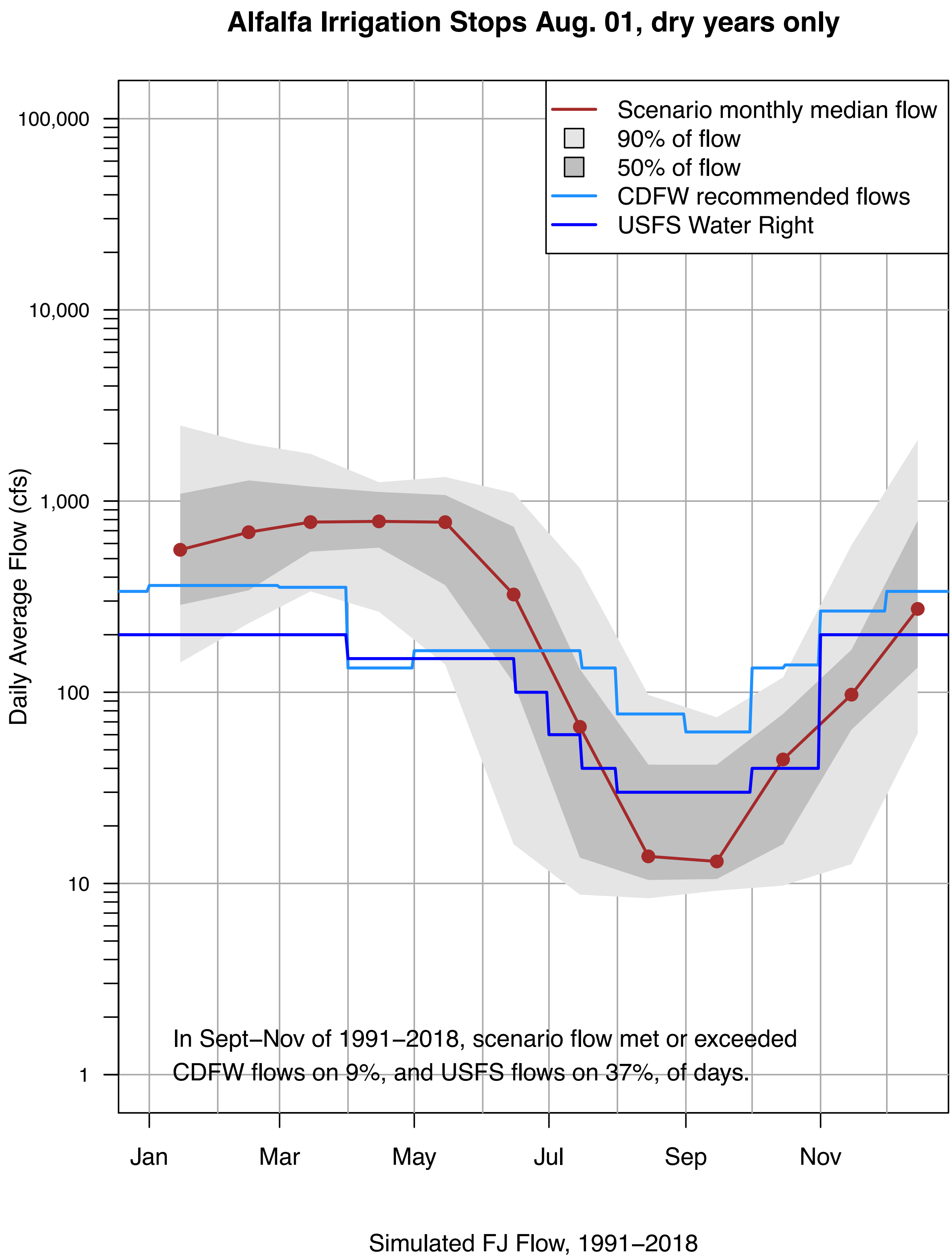

Improve Irrigation Efficiency by 20%
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 10%, and USFS flows on 37%, of days.
Jan
Mar
May
Jul
Sep
Nov
Simulated FJ Flow, 1991–2018

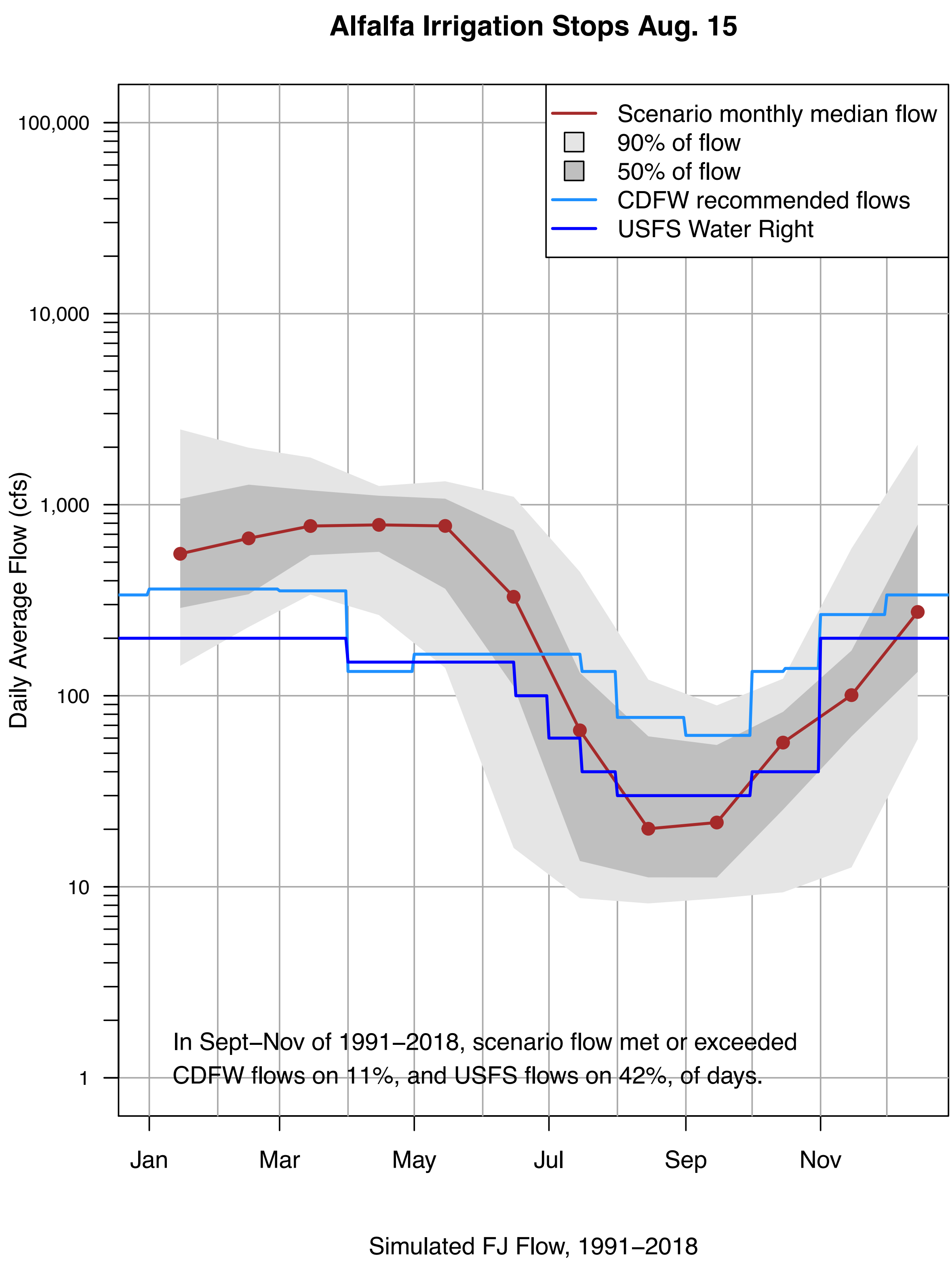


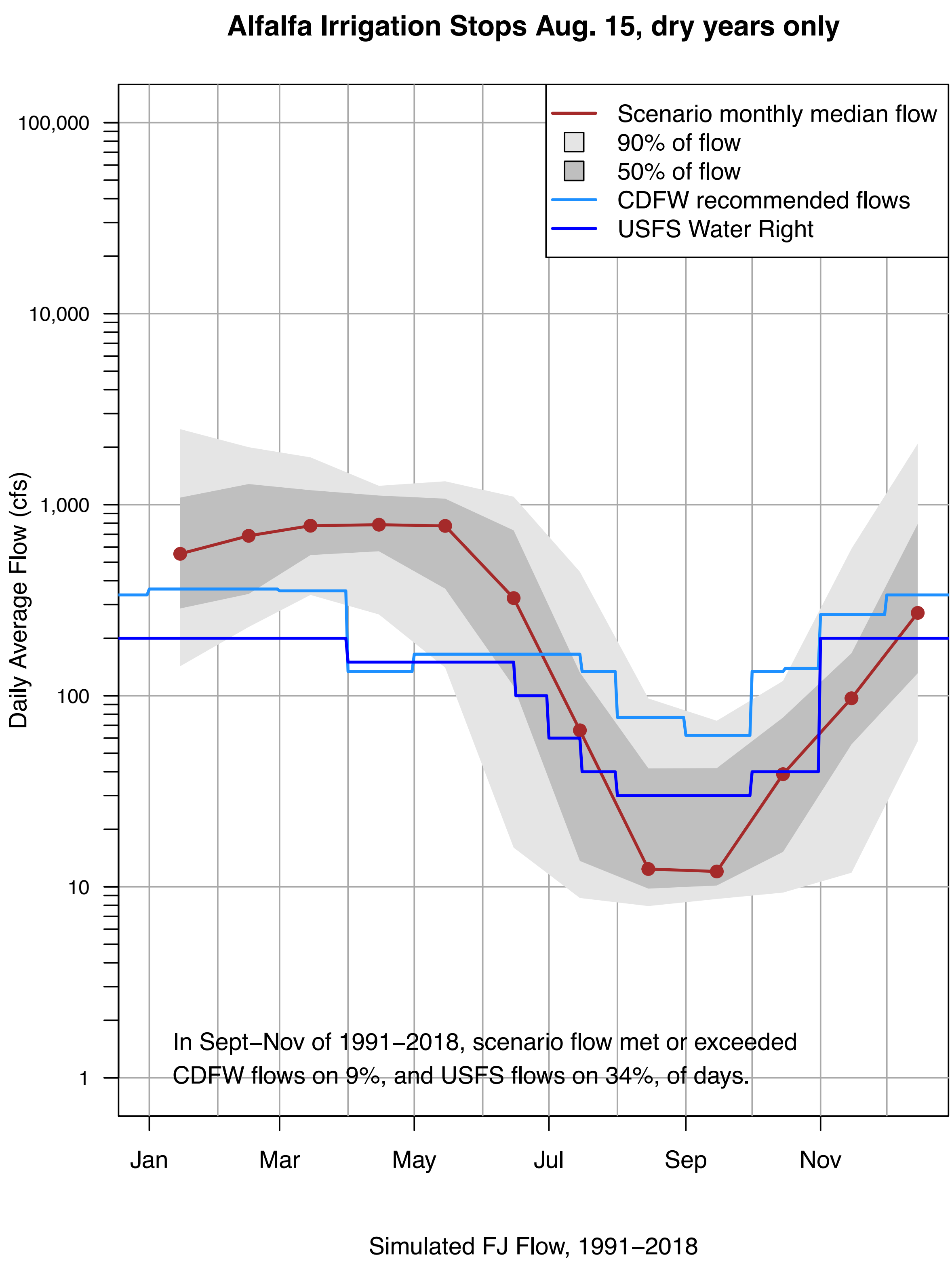
Reduce Irrigation Efficiency by 10%
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
Daily Average Flow (cfs)
100,000
10,000
1,000
100
10
1
Jan
Mar
May
Jul
Sep
Nov
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 10%, and USFS flows on 32%, of days.
Simulated FJ Flow, 1991–2018


Alfalfa Irrigation Stops July 10
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
Jan
Mar
May
Jul
Sep
Nov
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 18%, and USFS flows on 61%, of days.
Simulated FJ Flow, 1991–2018

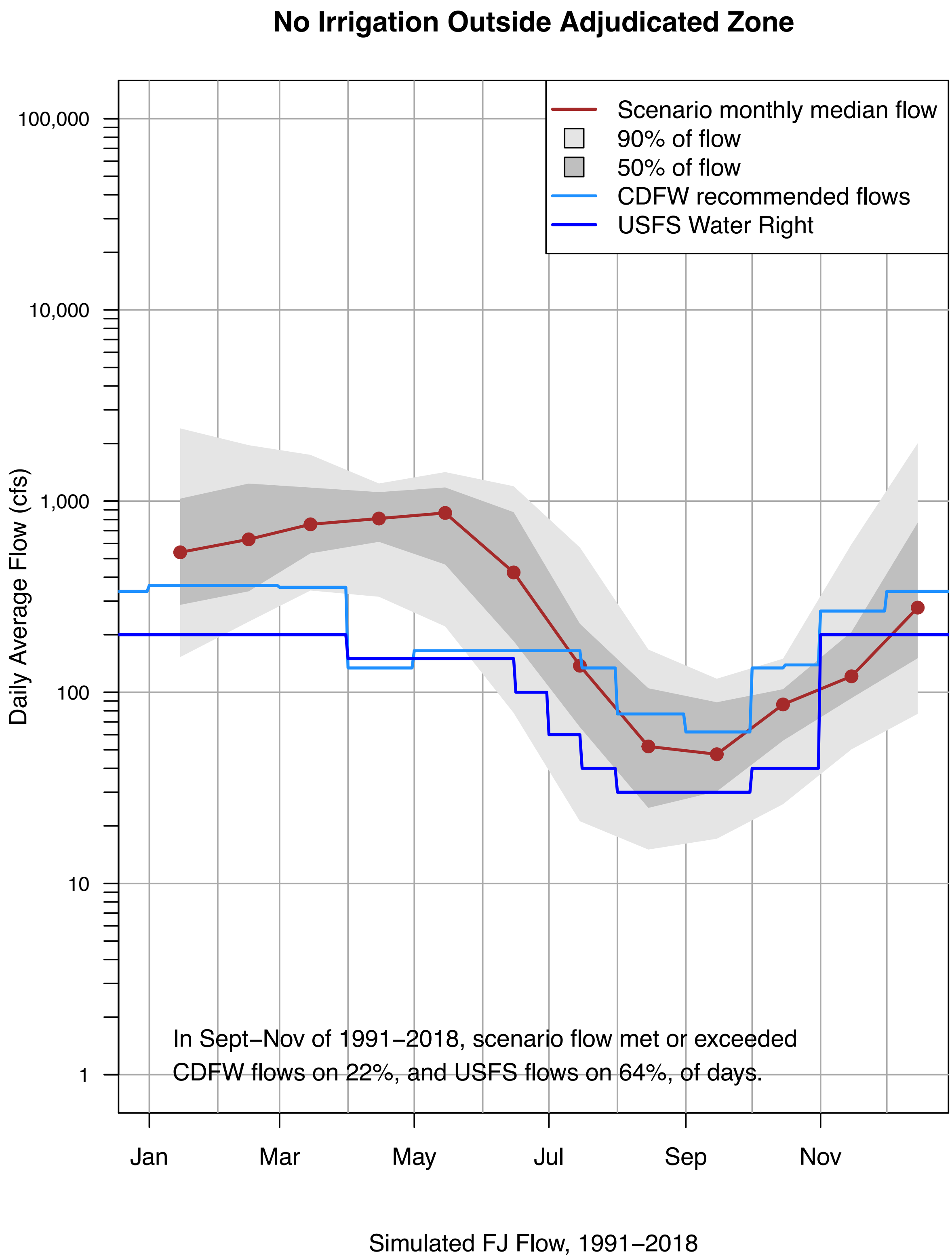

Alfalfa Irrigation Stops Aug. 01
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 17%, and USFS flows on 52%, of days.
Jan
Mar
May
Jul
Sep
Nov
Simulated FJ Flow, 1991–2018

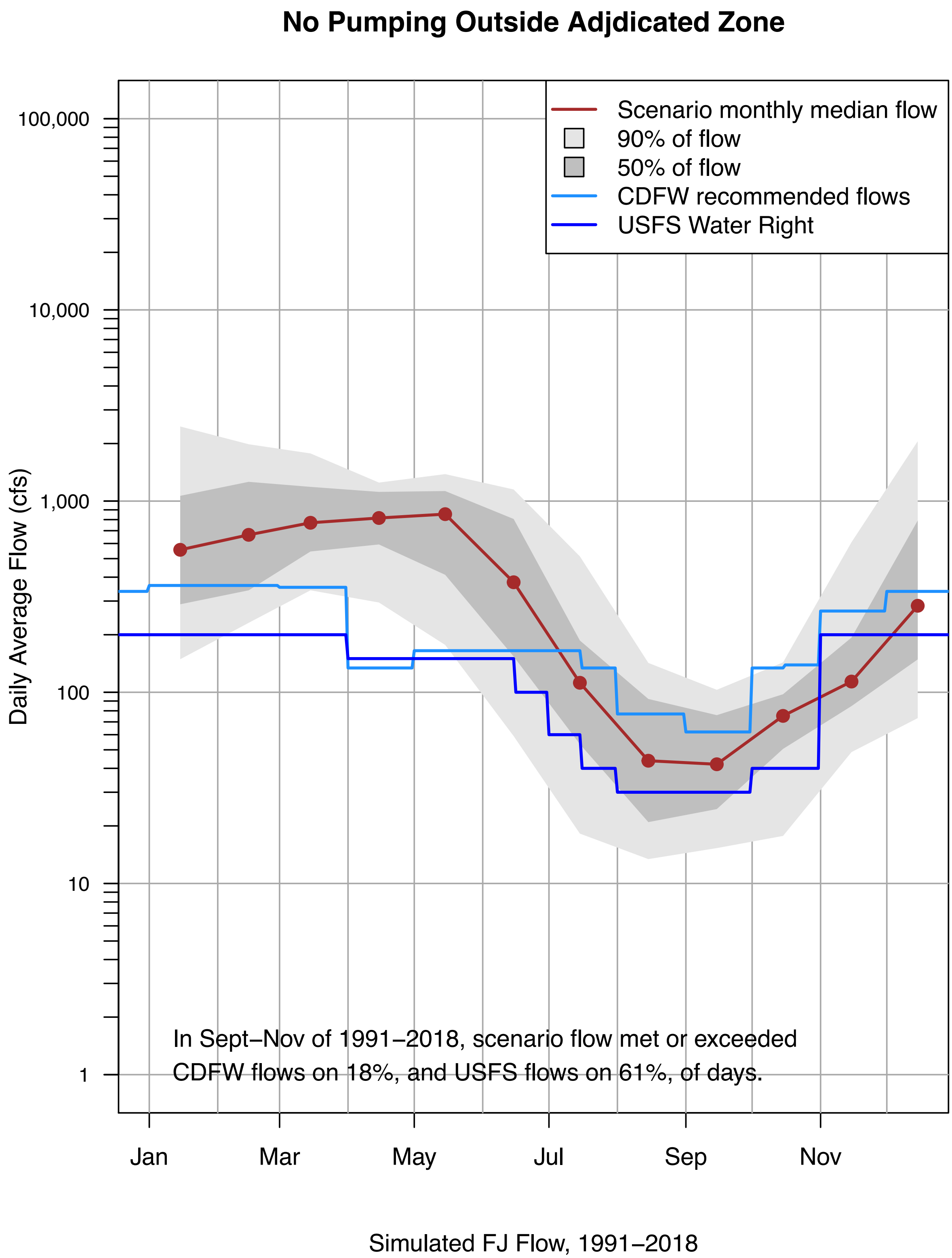

Alfalfa Irrigation Stops Aug. 01, dry years only
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
In Sept–Nov of 1991–2018, scenario flow met or exceeded CDFW flows on 9%, and USFS flows on 37%, of days.
Jan
Mar
May
Jul
Sep
Nov
Simulated FJ Flow, 1991–2018

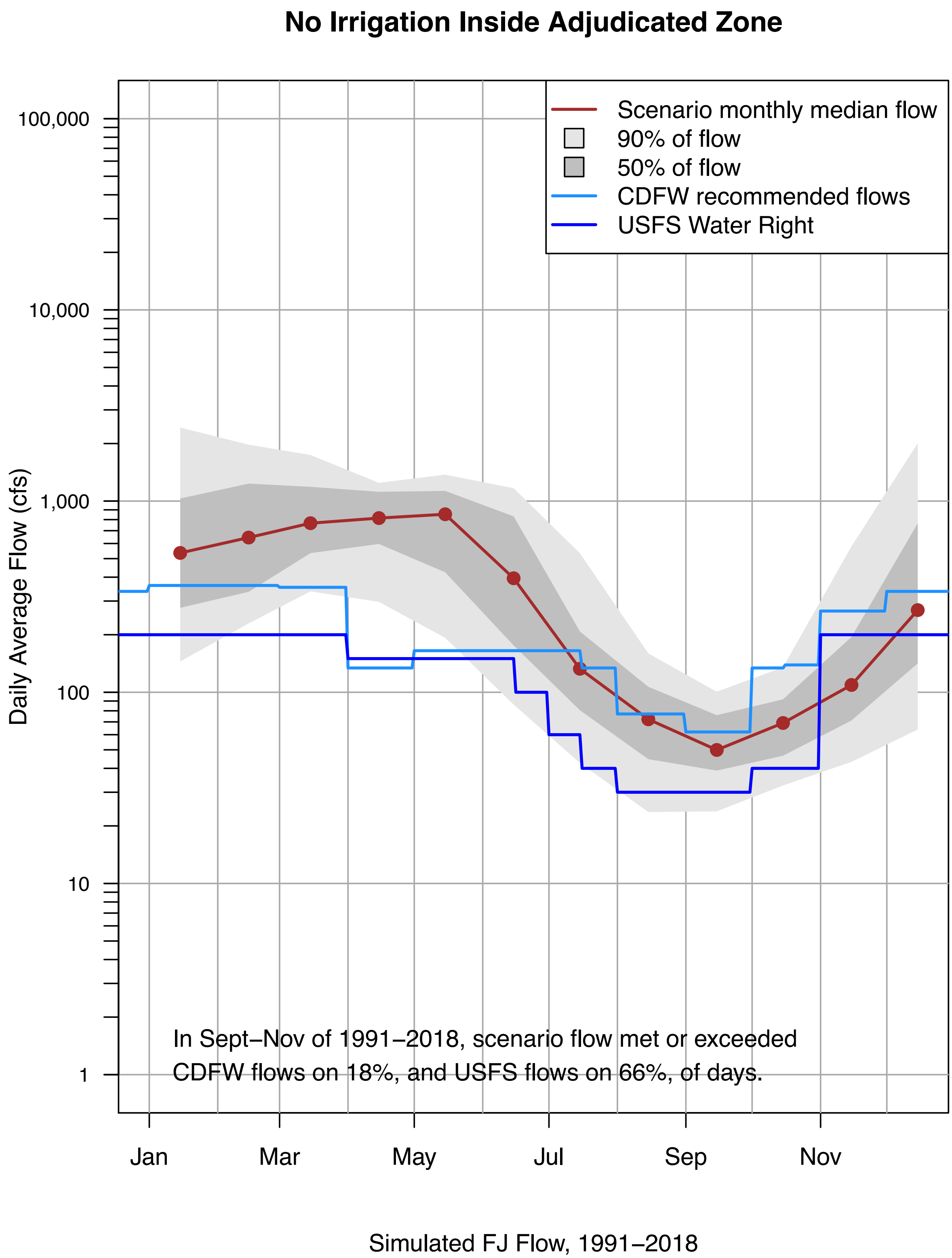

Alfalfa Irrigation Stops Aug. 15
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
Jan
Mar
May
Jul
Sep
Nov
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 11%, and USFS flows on 42%, of days.
Simulated FJ Flow, 1991–2018

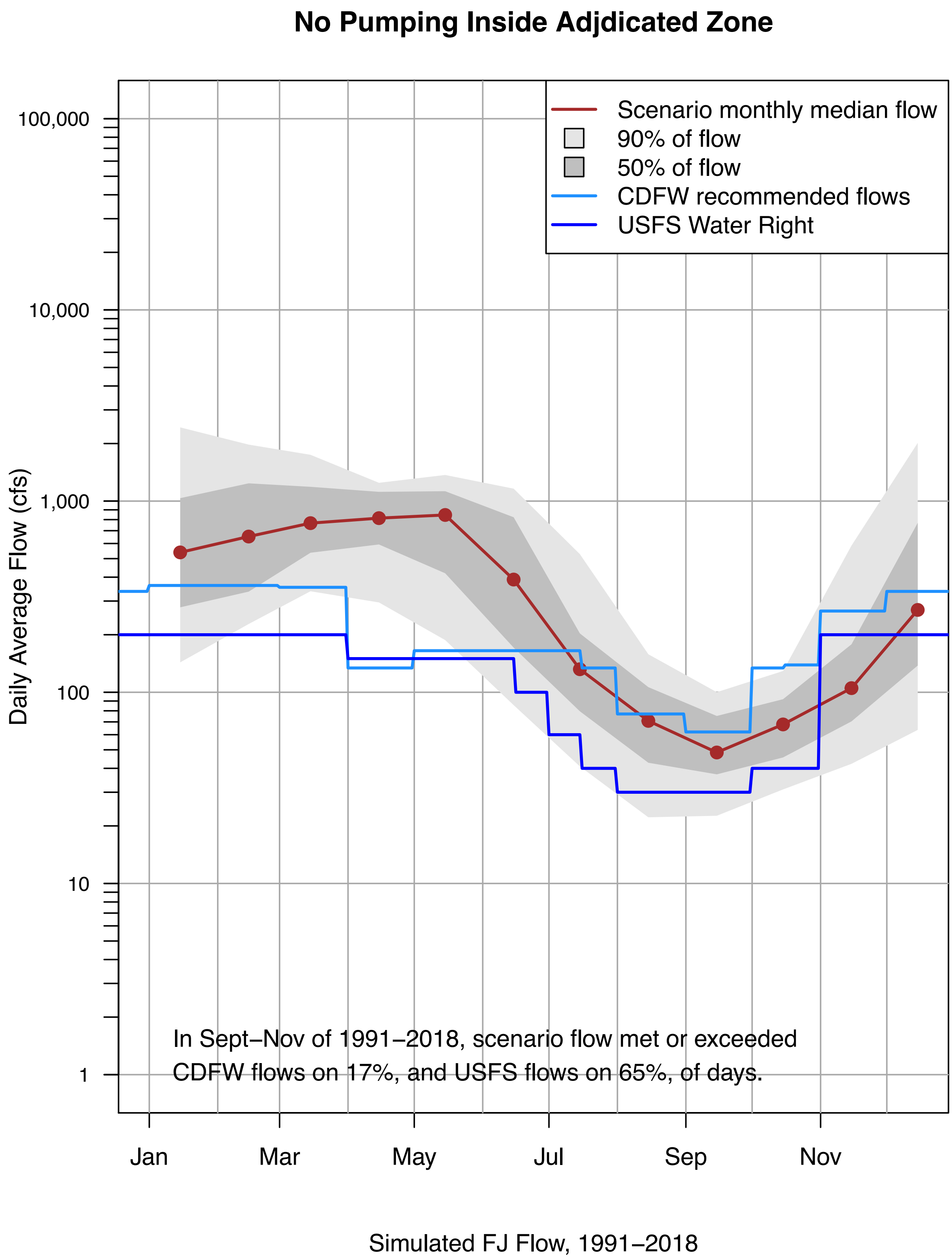


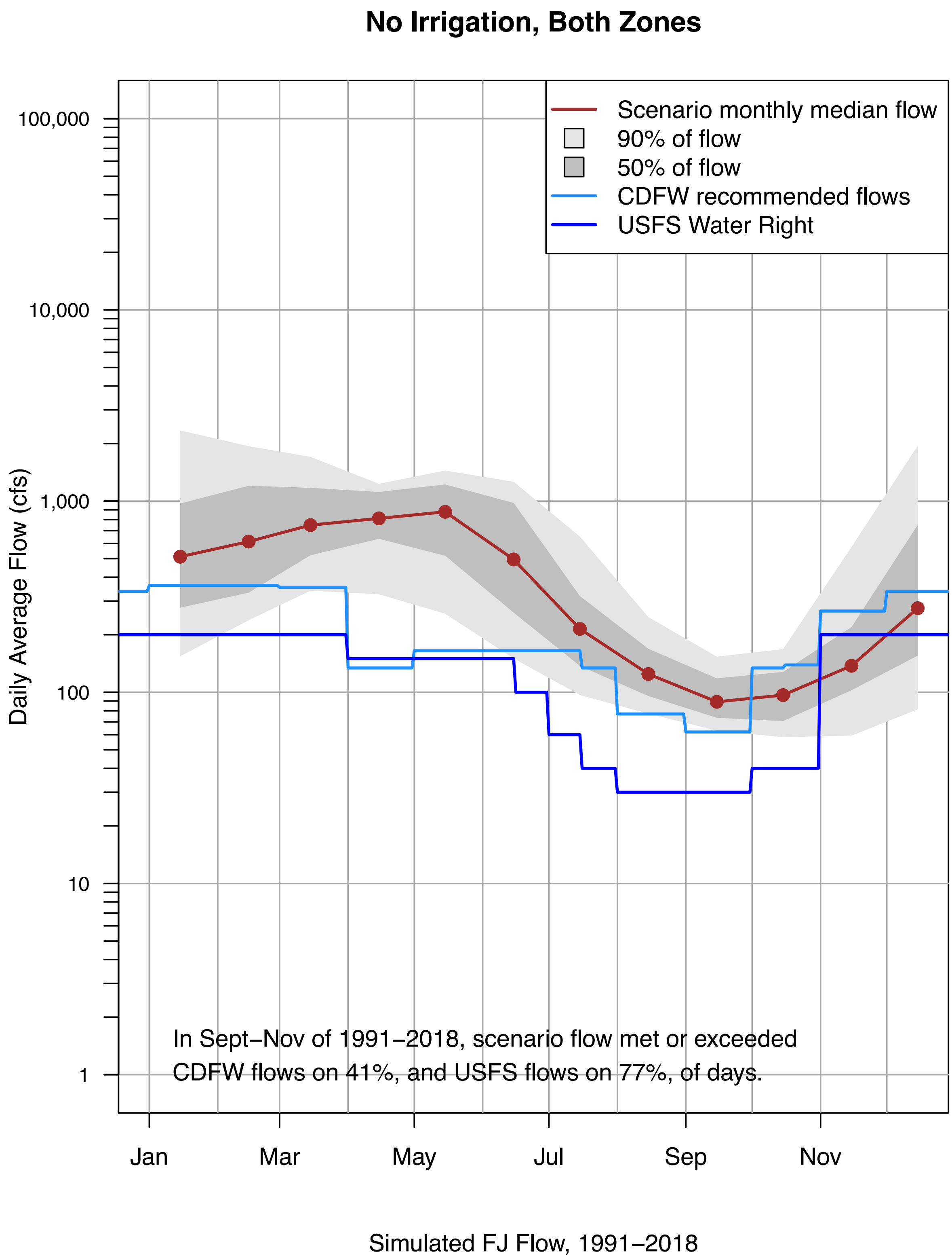
Alfalfa Irrigation Stops Aug. 15, dry years only
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 9%, and USFS flows on 34%, of days.
Jan
Mar
May
Jul
Sep
Nov
Simulated FJ Flow, 1991–2018

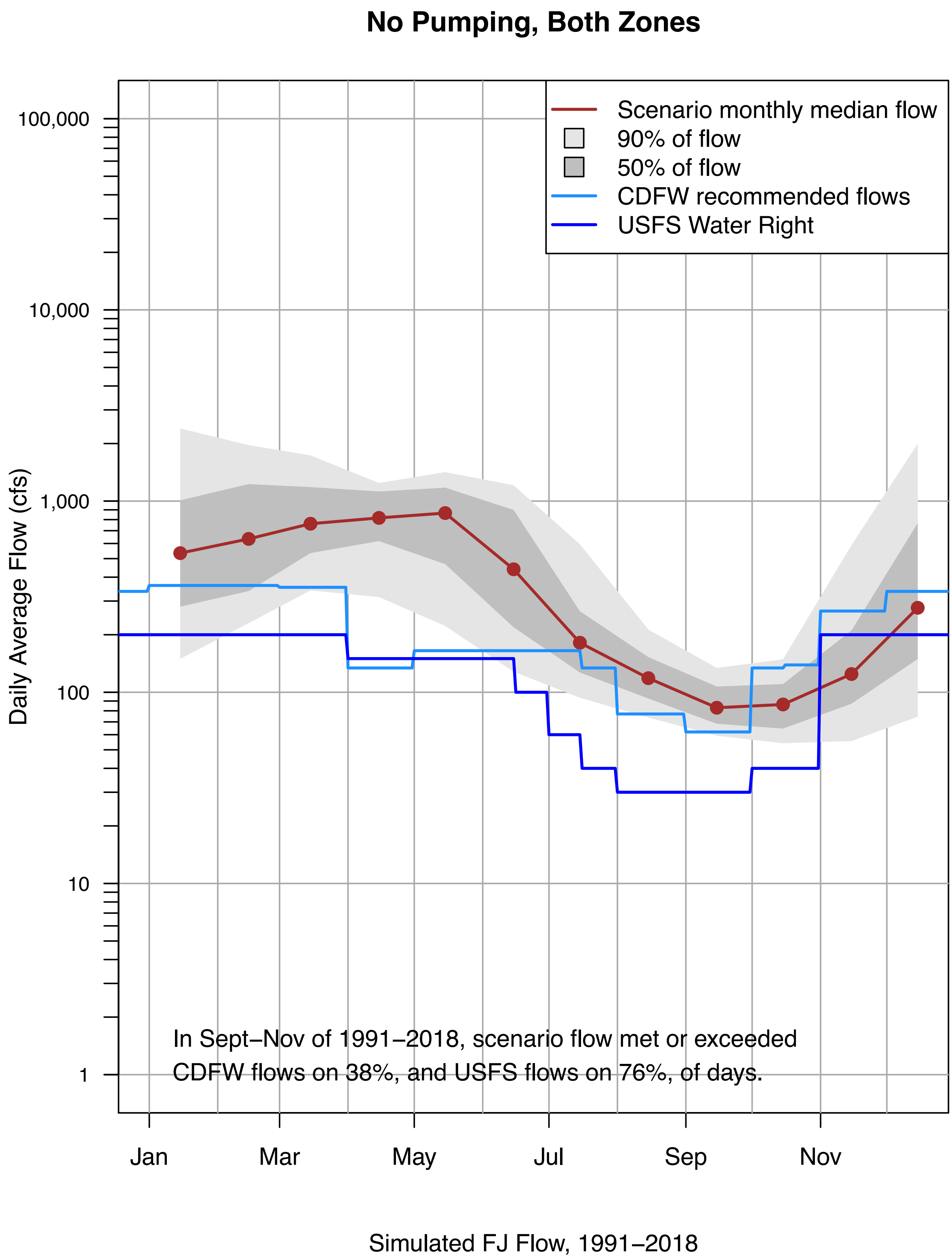

No Irrigation Outside Adjudicated Zone
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 22%, and USFS flows on 64%, of days.
Jan
Mar
May
Jul
Sep
Nov
Simulated FJ Flow, 1991–2018

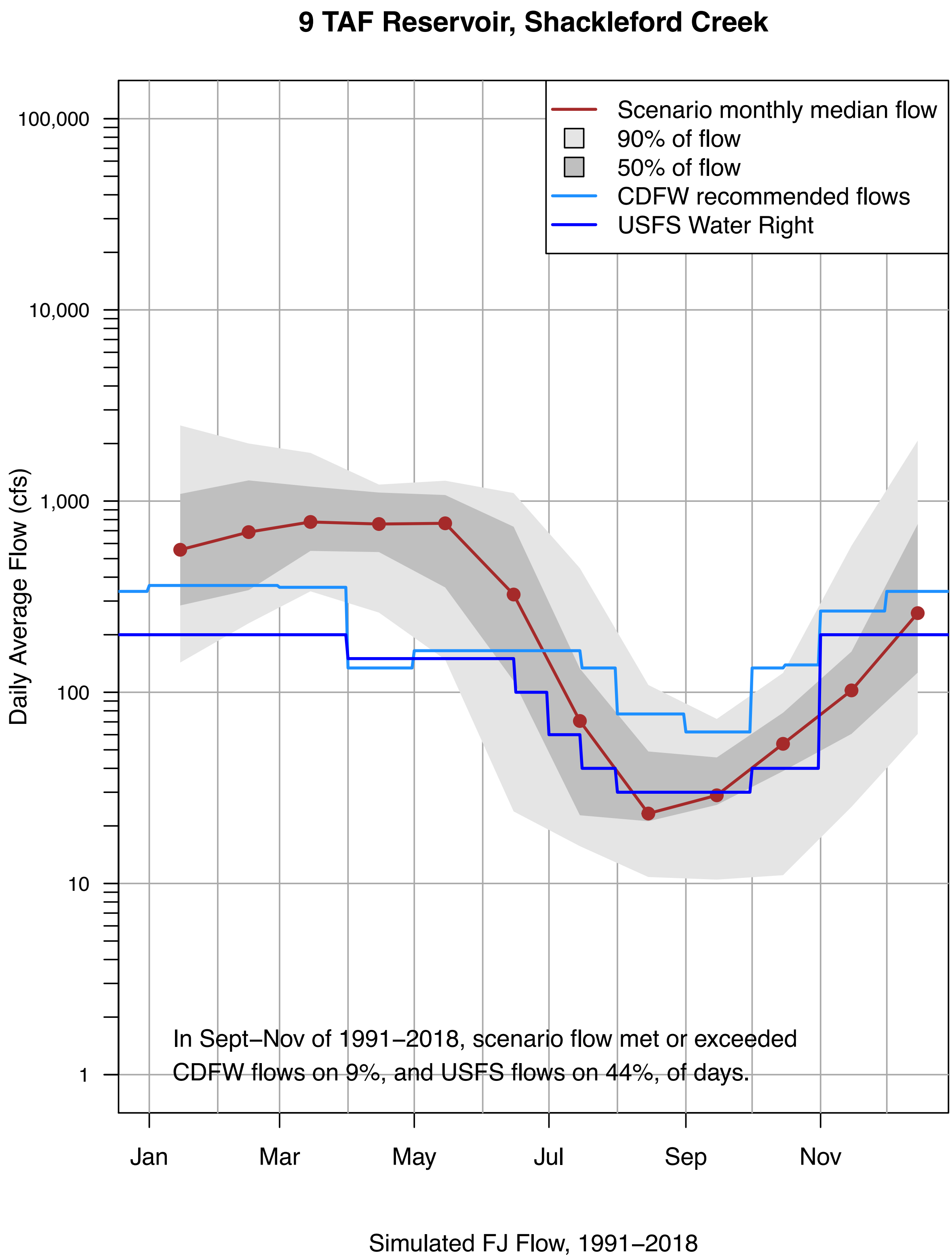

No Pumping Outside Adjdicated Zone
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
Daily Average Flow (cfs)
100,000
10,000
1,000
100
10
1
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 18%, and USFS flows on 61%, of days.
Jan
Mar
May
Jul
Sep
Nov
Simulated FJ Flow, 1991–2018

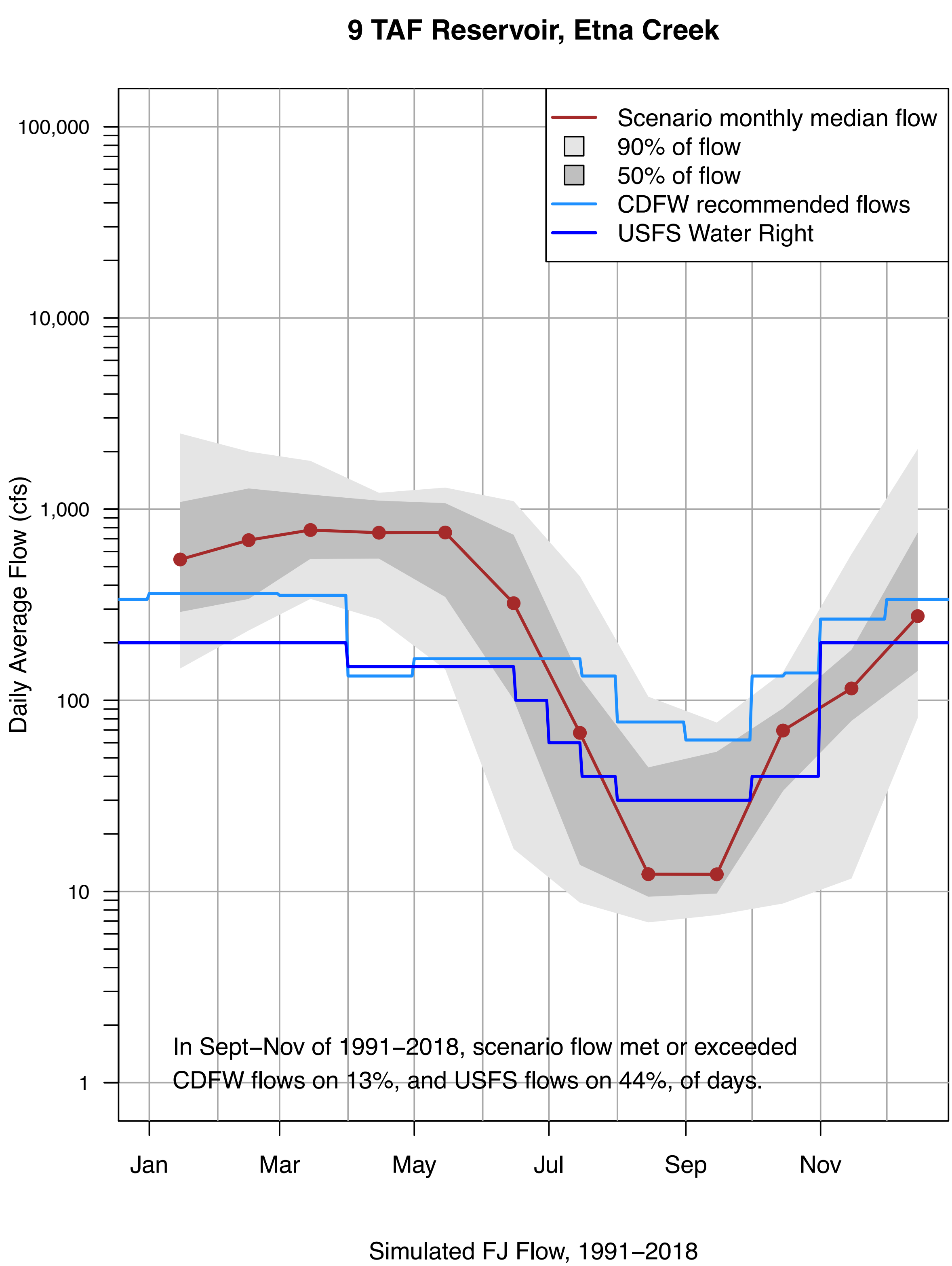

No Irrigation Inside Adjudicated Zone
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 18%, and USFS flows on 66%, of days.
Jan
Mar
May
Jul
Sep
Nov
Simulated FJ Flow, 1991–2018

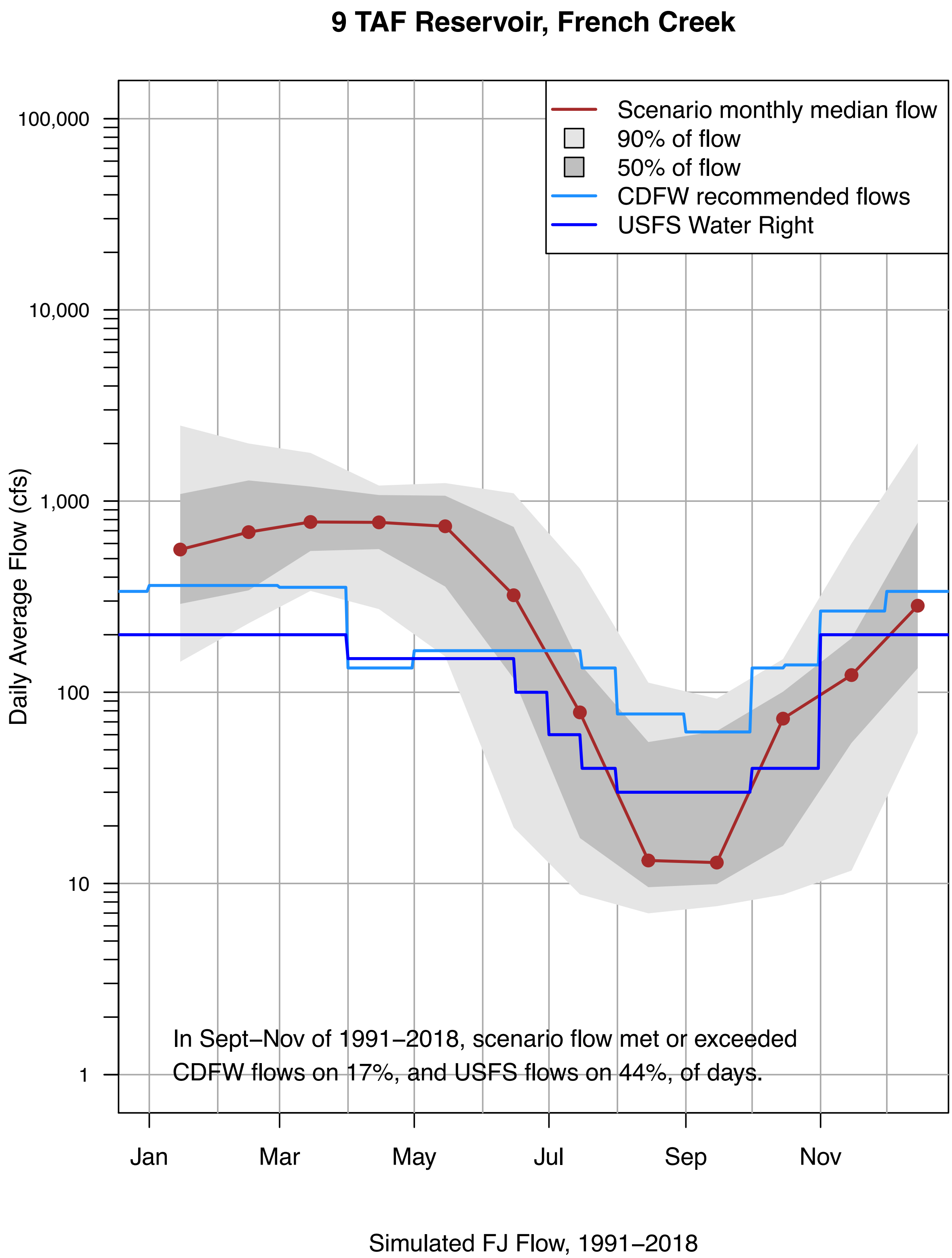

No Pumping Inside Adjdicated Zone
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
Daily Average Flow (cfs)
100,000
10,000
1,000
100
10
1
Jan
Mar
May
Jul
Sep
Nov
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 17%, and USFS flows on 65%, of days.
Simulated FJ Flow, 1991–2018

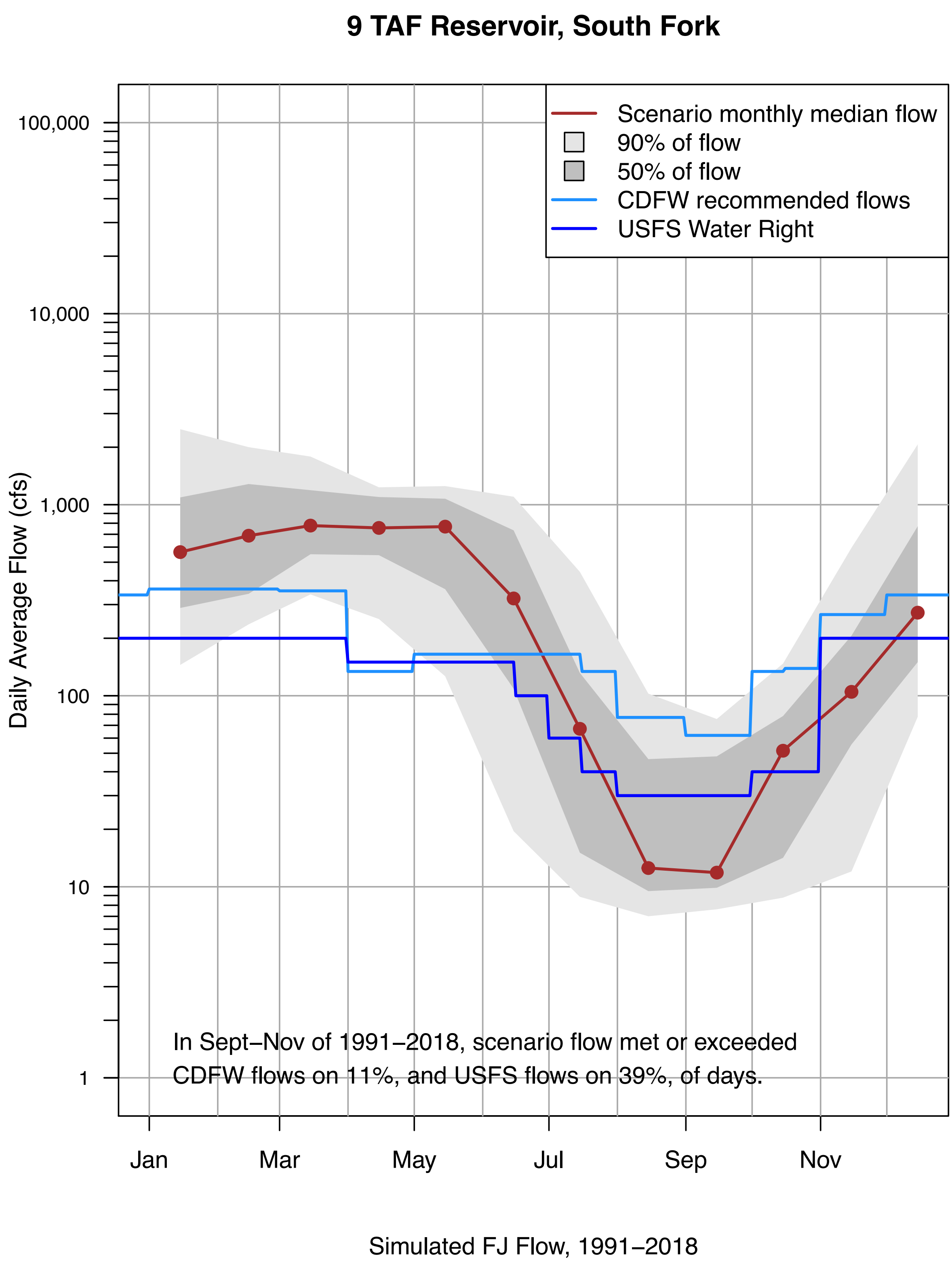

No Irrigation, Both Zones
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
Jan
Mar
May
Jul
Sep
Nov
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 41%, and USFS flows on 77%, of days.
Simulated FJ Flow, 1991–2018

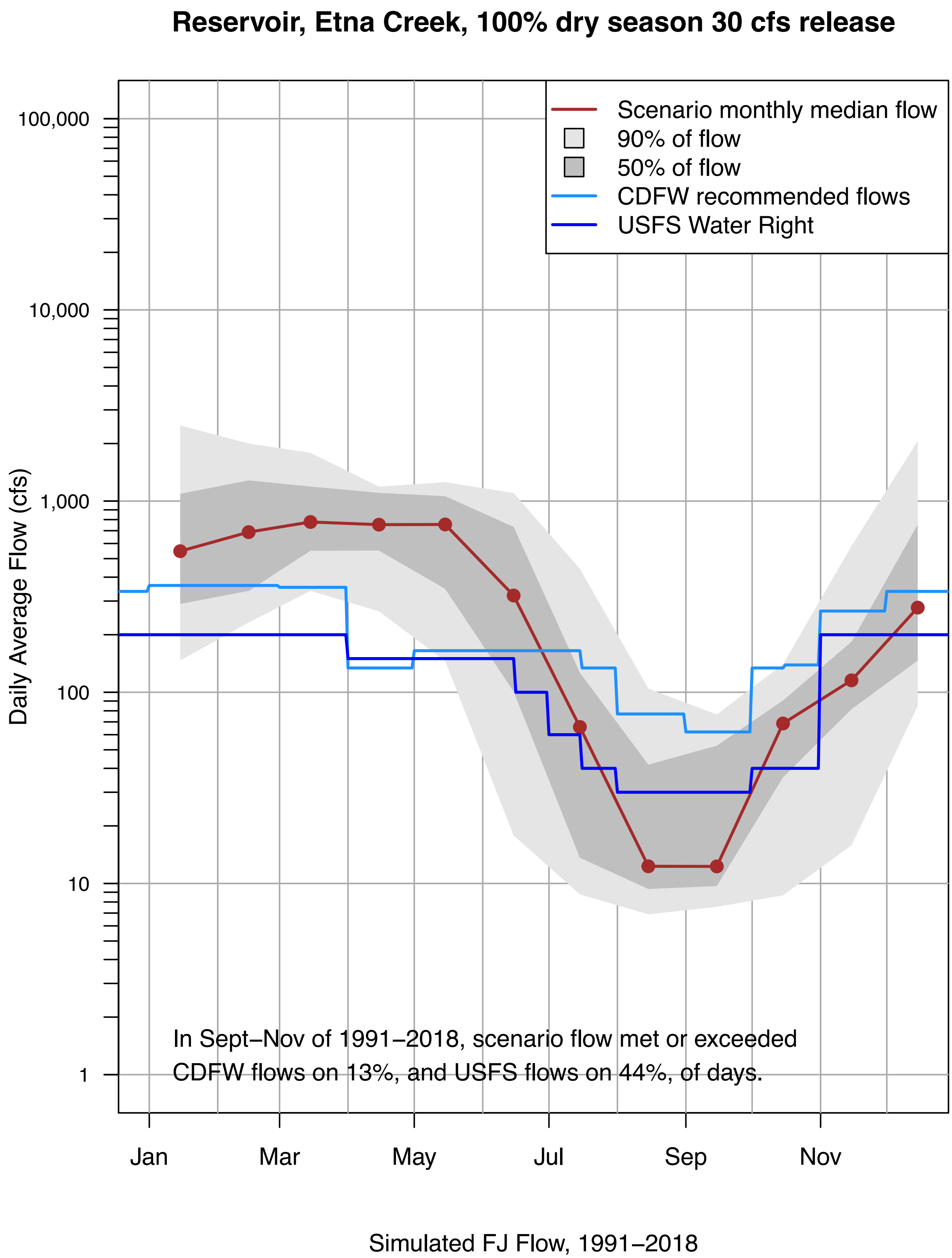

No Pumping, Both Zones
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 38%, and USFS flows on 76%, of days.
Jan
Mar
May
Jul
Sep
Nov
Simulated FJ Flow, 1991–2018

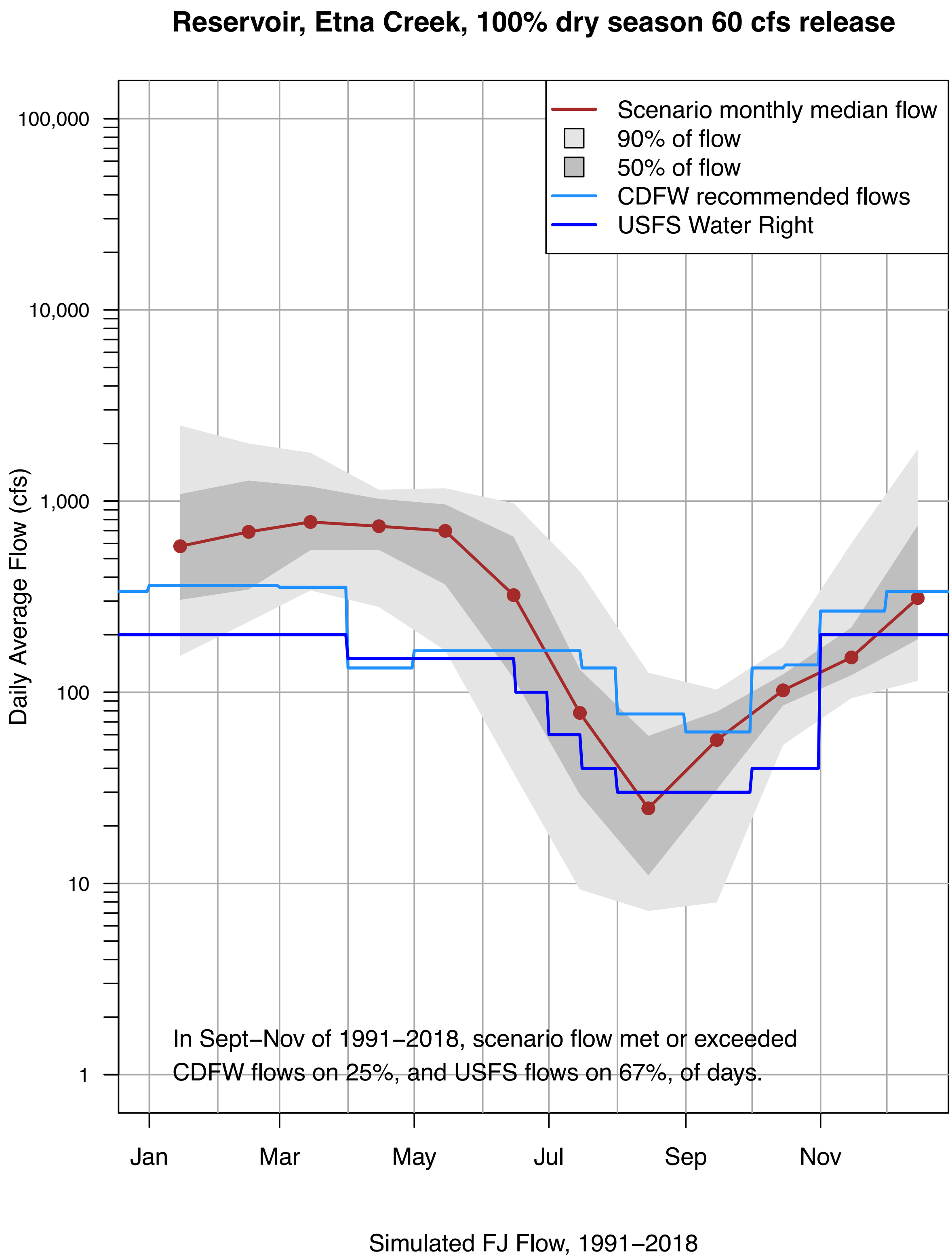

9 TAF Reservoir, Shackleford Creek
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
Daily Average Flow (cfs)
100,000
10,000
1,000
100
10
1
Jan
Mar
May
Jul
Sep
Nov
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 9%, and USFS flows on 44%, of days.
Simulated FJ Flow, 1991–2018


9 TAF Reservoir, Etna Creek
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
Jan
Mar
May
Jul
Sep
Nov
In Sept–Nov of 1991–2018, scenario flow met or exceeded CDFW flows on 13%, and USFS flows on 44%, of days.
Simulated FJ Flow, 1991–2018


9 TAF Reservoir, French Creek
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
Jan
Mar
May
Jul
Sep
Nov
In Sept–Nov of 1991–2018, scenario flow met or exceeded CDFW flows on 17%, and USFS flows on 44%, of days.
Simulated FJ Flow, 1991–2018


9 TAF Reservoir, South Fork
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
In Sept–Nov of 1991–2018, scenario flow met or exceeded CDFW flows on 11%, and USFS flows on 39%, of days.
Jan
Mar
May
Jul
Sep
Nov
Simulated FJ Flow, 1991–2018


Reservoir, Etna Creek, 100% dry season 30 cfs release
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
Jan
Mar
May
Jul
Sep
Nov
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 13%, and USFS flows on 44%, of days.
Simulated FJ Flow, 1991–2018


Reservoir, Etna Creek, 100% dry season 60 cfs release
Scenario monthly median flow
90% of flow
50% of flow
CDFW recommended flows
USFS Water Right
100,000
10,000
1,000
100
10
1
Daily Average Flow (cfs)
Jan
Mar
May
Jul
Sep
Nov
In Sept–Nov of 1991–2018, scenario flow met or exceeded
CDFW flows on 25%, and USFS flows on 67%, of days.
Simulated FJ Flow, 1991–2018

Appendix 4-B Draft Final Project Plan Scott Groundwater Recharge Project

US Fish and Wildlife Service
Coalition of the Willing Final Proposal
June 2020

Project Title: Coalition of the Willing Project: Groundwater Recharge Pilot Study to Determine Instream Benefits for the Scott River, Siskiyou County, California

Principal Investigator: Shasta-Scott Basin sub-group (County of Siskiyou, County of Modoc, Cal Trout, Karuk Tribe, Yurok Tribe, Quartz Valley Indian Reservation, Scott Valley Irrigation District)

Background: The Shasta-Scott Basins subgroup was tasked with developing a project that would garner broad support amongst the Coalition of the Willing and would serve to address critical questions and needs related to water quantity and quality within the sub-basin. The subgroup worked together and identified groundwater recharge as the best option for their initial work as the project is relatively simple to complete, has direct ties to the Sustainable Groundwater Management Act (SGMA), and has the possibility to address water quantity, and potentially quality, needs during critical fish migration times in the Scott Valley. It was also recognized that this pilot study could serve to build trust and relationships amongst the represented entities and agencies in the sub-group which is critical to the Coalitions goals.

Justification: There is a need to address water quantity and quality needs within the Scott River system, and the use of groundwater recharge may be one of the many actions that can assist in meeting these needs. Given that groundwater recharge is relatively easy to plan and implement, and that one year of a study has already been performed in the in the Scott Valley, the Shasta-Scott sub-group of the Coalition of the Willing has chosen this activity as their spearhead project. The pilot study will conclude with a report that outlines the actions and outcomes, which will serve to educate the Coalition, and the Groundwater Sustainability Plan being developed in the Scott Valley as part of the SGMA. This report will help guide future groundwater recharge efforts to ensure that such actions are done at the correct timing, in the correct amounts and at the correct locations.

Objectives: The Project aims to answer the following three questions:

1. Where and when does water that is recharged enter the Scott River?
2. How much water can we put back in the Scott River via groundwater recharge?
3. Are there specific water quality benefits to using groundwater derived inflow (e.g. temperature)?

It is also anticipated that the Project could help answer the other following questions, understating that more work/ considerations may be needed outside of this pilot study to fully answer them:

4. Where in the basin is water most beneficial for fish during different water year types?

5. Do we have a sufficient monitoring system in place to evaluate a recharge study? How will we monitor?

Procedures: This project will entail up to a five-year continuation of a groundwater recharge pilot study in the Scott River Basin to further inform the potential instream benefits of applying small portions of high winter Scott river flows on private farming land. Information to be gleaned will include the timing and location of applied water re-entering the Scott River, and the potential to address in-stream water quantity and quality needs during critical fish migration.

The groundwater recharge pilot study will provide needed information on the ability to augment groundwater conditions to enhance flow and improve water quality at critical habitat and during critical migration times on the mainstem Scott River. Utilizing the Scott Valley Irrigation District (SVID) canal system, up to 20 to 30 cfs would be diverted from the Scott River and applied to identified agricultural fields during the non-irrigation season (approximately Dec 1 – February 28th). The technical team, agencies and consultants will be tasked with assessing precipitation and river flows prior to December of each year to determine the timing and amount of diversions. It is anticipated that no more than 5% of river flows will be required on a yearly basis for the pilot study. State and federal agencies will be involved in this process regarding their responsibilities surrounding the Endangered Species Act and issuance of water rights in order to divert flows.

In 2011, the University of California, Davis (UC Davis) partnered with the local Scott Valley Groundwater Advisory Committee to identify best management practices and groundwater recharge scenarios for the Scott Valley watershed. Groundwater Recharge (Managed Aquifer Recharge) was developed as a potential scenario, and modelling results indicated that 42 cfs of water diverted and applied to 1,400 acres over a three-month period could provide a 7.5 cfs increase in mainstem flows during the summer/early fall months. In 2016, Scott Valley Irrigation District received a temporary water right and diverted approximately 680 acre-feet to be applied on farmland from February 4 – March 31 of that year. Results showed a significant holding capacity for groundwater recharge with no negative impacts to crop yield. Above average rainfall during the implementation period limited the amount of water that could be applied, and it was determined that 680 AF of water was too small to provide measurable benefits. However, this recharge effort was considered a successful implementation, and the participants felt it would enhance instream conditions within the basin if applied on a larger scale.

The effort outlined in this proposal would continue, over a three-year period, the research necessary to identify the overall benefit of groundwater recharge on the mainstem Scott River. The Shasta-Scott subbasin group is made up of representatives from the County of Siskiyou, County of Modoc, Scott Valley irrigators, Cal Trout, the Karuk Tribe, Yurok Tribe and the Quartz Valley Indian Reservation. The group, with the assistance of NFWF, who will be responsible for grant administration, will consult with Larry Walker Associates and UC Davis to perform the technical work under this project, including final project development, data collection, analysis and report writing. The subgroup will also work with the SVID to utilize their irrigation system to divert water and apply it on landowner property, and to obtain the necessary permits and water rights needed to perform the work. The Scott Valley Advisory Committee (advisory committee for SGMA and Groundwater Sustainability Plan development) will assist in obtaining landowner cooperation and support and to ensure that this work is done in conjunction with efforts as part of SGMA as it relates to groundwater recharge.

The sub-group, advisory committee and consultants will identify two properties at the outset of the project, where recharge will occur during the first year. Future planning efforts will include identifying the need for, and location of, additional properties where recharge will occur, and other opportunities to upscale this project. Data from recharge activities will be collected through the use of shallow piezometers and isotopes, which will be purchased with grant funding. Further detail will be provided as the consultants and technical team plan out the project on a month-to-month timeline.

The advisory committee, Siskiyou County and its consultants, have been performing needed and critical work as part of SGMA efforts and it will be important that the actions outlined under this pilot study build upon that work. The subgroup, through its technical team, is also coordinating with the California Department of Fish and Wildlife and the North coast Regional Water Quality Control Board; the agencies role will include advising the technical group of actions that need to be taken to meet agency regulations and requirements and to assist in obtaining required permits and water rights.

Siskiyou County, through its efforts related to the SGMA, has obtained a grant through Proposition 68 that would allow UC Davis staff to use isotopes during groundwater recharge activities. This will help answer critical questions as to the timing and location of applied water augmenting Scott River base flows. It is the group's goal to use all this information to determine the feasibility and applicability of taking these efforts from a pilot study to a full-scale project that provides in-stream benefits to the Scott River on a yearly, as needed or as available basis.

Deliverables will include a report outlining the work completed, the information obtained, lessons learned, and the opportunities/potential of taking efforts full scale.

Lastly, it should be considered a significant achievement that the members of this group were able to work together and overcome conflict and differences to develop this pre-proposal, which we hope can be used as a tool for addressing some of the in-stream needs for the Scott River. These members include Siskiyou County, Modoc County, the City of Yreka, Shasta and Scott irrigators, the Karuk Tribe and Cal Trout; with support from the Yurok Tribe and Quartz Valley Indian Reservation.

Schedule: Outreach, coordination, permitting, and final planning has started and will continue through the duration of the project**.** On-the-ground work will commence December 2020 and will conclude February 2025, with data analysis and report writing occurring through September 2025. The proposal will cover three years of the pilot study, if needed. It is anticipated that diversions from the Scott River and water application of landowner property will occur during the time periods of December through February, however, the technical team and consultants will be tasked with assessing precipitation and river flows prior to December of each year to determine the timing and amount of diversions.

Cooperators/Consultants: Aside from the Shasta-Scott sub-basin group members, cooperators will include the US Fish and Wildlife Service, California Department of Fish and Wildlife and the North coast Regional Water Quality Control Board. The group will utilize National Fish and Wildlife Foundation (NFWF) for grant administration purposes, and Larry Walker Associates subcontracting with UC Davis as the consultants to perform the majority of the technical work, including data collection, analysis and report writing. UC Davis has been intricately involved in Scott Valley groundwater related work for over 10 years, including the initial pilot study in 2016. Larry Walker Associates, subcontracting with UC Davis, is contracted with Siskiyou County to perform technical work related to the SGMA, including developing the Groundwater Sustainability Plan for the Scott Valley.

Responsibility: The Shasta Scott sub-group, and the subgroup's technical team will be responsible for developing and guiding this effort, and will coordinate with the Scott Valley Advisory Committee as it relates to the SGMA and actions related to groundwater recharge. The subgroup and the advisory committee will also work together to obtain landowner participation and support to perform the pilot study. The advisory committee well understands the landowner community and the needs of landowners in order to participate in this effort. The technical team in coordination with the Scott Valley Irrigation District will be responsible for obtaining needed permits and water rights to divert from the Scott River. UC Davis and Larry Walker Associates will perform the majority of work related to data collection, analysis and report writing. NFEF will be responsible for grant administration, in coordination with the subgroup.

Budget: The subgroup has budgeted for a total of $200,000 for the pilot study. We anticipate this funding will cover the work needed to obtain temporary water permits, CEQA compliance, outreach and coordination with stakeholders and local tribes, on-the ground activities, monitoring, grant administration and report writing. Other funding sources would include the Proposition 68 grant awarded to Siskiyou County, which would provide for using isotopes as part of the pilot study.

- Grant Administration - ***$3,500*** – Grant Administration will be performed by NFWF, who will coordinate as needed with the sub-group and consultants. NFWF will be responsible for providing annual reports to USFWS as required for mandatory reporting requirements.
- Infrastructure/Equipment - ***$90,000*** – This will include the purchase, instrumentation, and installation of shallow piezometers, estimated at $10,000 for each piezometer. If additional piezometers are needed this will be utilized from the budget for future planning and implementation. $30,000 is estimated for the use of isotopes and other

water quality equipment, specific water quality equipment will be further detailed as the project is fully developed. All of this equipment is necessary in meeting the objectives of this project by answering the following questions:

1. Where and when does water that is recharged enter the Scott River?
2. How much water can we put back in the Scott River via groundwater recharge?
3. Are there specific water quality benefits to using groundwater derived inflow (e.g. temperature)?

- Data Analysis/Report Writing - ***$30,000*** – This will include the work necessary to collect data, analyze it and synthesis it into a report for the sub-group. The contractor will coordinate with the sub-group and the Scott Valley Advisory Committee throughout this process to ensure transparency and include data and analysis that will be useful to the sub-group and the Scott Valley Advisory Committee in their efforts towards developing a Groundwater Sustainability Plan. The report will center around addressing the three questions as outlined above, and will address opportunities for future efforts and work needed.
- State Permitting - ***$16,000***:
    - $7,000 - State Water Resources Control Board Application for Temporary Permit filed pursuant to Water Code 1425 to Diver to Underground Storage During High Flow Events.
    - $5,000 – California Department of Fish and Wildlife Lake and Streambed Alteration Agreement
    - $4,000 – Work necessary to be performed by consultants, and the Scott Valley Irrigation District in obtaining permits and temporary water rights.
- Facilitation - ***$8,000*** – This includes funding to continue facilitation with Rich Wilson, as needed, throughout the life of this project.
- Future Planning and Implementation - ***$52,500*** - This includes funding to further develop and implement the project, including installing equipment (i.e. piezometers) at future locations where groundwater recharge will occur. It is anticipated that additional property will be secured in the future at strategic locations throughout the valley to broaden the study and collect more needed data. In addition, should additional infrastructure be needed to divert, or apply, water, funding will be covered under this category.

Appendix 5-A PMA Prioritization and Scoring System

Preliminary criteria, and an associated scoring system, were developed to assist in the evaluation and prioritization of the PMA options identified in Chapter 4. This prioritization system is intended to facilitate strategic implementation of PMAs based on factors including effectiveness, cost, and stakeholder support. The criteria and descriptions for each scoring category are shown in Table 1. A template, with the PMAs identified in Chapter 4 for near-term and for future implementation (Tiers II and III), is included as Table 2. Categories and scoring may be modified throughout GSP implementation to reflect the principal objectives for PMAs.

Table 1: PMA prioritization criteria and score descriptions.

		Score		
Category		**1**	**2**	**3**
Effectiveness	**Anticipated Benefit**	Some physical benefit anticipated	Medium level of benefit anticipated (relative to other PMAs identified).	High level of benefit anticipated (i.e., streamflow depletion reversal is expected to be significant).
	Frequency	One-time benefit expected	PMA expected to provide benefit on more than one occurrence.	Benefits expected to occur repeatedly.
	Duration	Only short-term benefits expected (1-2 years)	Benefits expected over 2-5 years.	Benefits expected to occur over the long term (>5 years)
Completeness		No planning or studies have been completed, required permitting and funding sources have not been identified.	Some planning or studies have been completed, required permitting and funding sources may be identified and/ or secured.	Plans or studies have been completed, permitting has been secured, project is funded.
Complexity		Requires little planning and design, labor or materials to implement	Requires some planning, design and/or some labor or materials to implement.	Requires significant planning, design and/or significant labor or material to implement
Cost		Low cost or funding has been secured.	Mid-range cost and/or potential funding sources identified.	High cost and / or funding sources have been identified.
Uncertainty		Unproven technology or mechanism, legal authority unclear or no legal authority, anticipated difficulty obtaining required permits for project implementation.	Proven technology may be unproven in Basin setting or conditions), and/ or modelled results show an expected benefit, legal authority exists, and permits are anticipated to be attainable.	Proven technology and/or modelled results show an expected benefit, clear legal authority and required permitting is attainable.
Acceptability		Low or no support from stakeholders.	Medium support or desirability from stakeholders.	Strong support from stakeholders.

Table 2: Scott River Valley GSP PMA prioritization table template

Scott River Valley GSP Proposed List of Projects and Management Actions																		
										Evaluation Criteria and Score								
			Relevant Sustainability Indicators Affected							**Effectiveness**								
Tier	**Project Name**	**Lead Agency**	**Groundwater Levels and Storage**	**Groundwater Quality**	**Land Subsidence**	**SW & GW Interconnection**	**Status**	**Timetable / Circumstances for Initiation**	**Physical Benefit (i.e., stream depletion reversal)**	**Anticipated Benefits**	**Frequency**	**Duration**	**Completeness**	**Complexity**	**Cost**	**Uncertainties**	**Acceptability/ Support**	**Total/ Ranking**
Tier II Projects (PMAs Planned for Near Term Implementation 2022-2027)																		
II	Avoiding Significant Increase of Total Net Groundwater Use from the Basin	GSA, County of Siskiyou, City of Etna, City of Fort Jones	•			•	Conceptual only	TBD										
II	Beaver Dam Analogues	Scott River Watershed Council					Planning phase	TBD										
II	Conservation Programs and Green	Scott River Watershed Council	•			•	Planning phase	TBD										

	Infrastructure in the Upper Watershed																	
II	Instream Habitat Improvement on the East Fork Scott River	Siskiyou Resource Conservation District					Planning Phase	TBD										
II	Scott River Basin Stream Flow Monitoring	Siskiyou Resource Conservation District				•	Plannning Phase	TBD										
II	Irrigation Efficiency Improvements	GSA, UCCE	•			•	Planning phase	TBD	up to 12% stream depletion reversal									
II	Managed Voluntary Land Repurposing	TBD	•			•	Planning phase	Anticipated 2022-2027										
II	MAR & ILR: NFWF Scott Recharge Project	Scott Valley Irrigation District	•			•	Active	Anticipated Completion by February 2023										
II	MAR & ILR	GSA, Siskiyou Resource Conservation District	•			•	Planning phase	TBD										
II	Stockwater diversion and delivery system improvements	GSA	•			•	Conceptual phase	TBD										
II	Upslope Water Yield Projects	SRWC	•			•	Planning Phase	TBD										
II	Well Inventory	GSA, TBD					Planning Phase	TBD										

Tier III Projects (PMAs with potential implementation in 2027-2042)																		
III	Alternative, lower ET Crops	TBD	•				Conceptual phase											
III	Floodplain Reconnection/ Expansion	TBD	•			•	Conceptual only	TBD										
III	High Mountain Lakes	TBD	•				Conceptual only	TBD										
III	Reservoirs	TBD	•				Conceptual only	TBD	34-184% stream depletion reversal									
III	Sediment Removal and River Restoration	TBD	•			•	Scoping phase	TBD										
III	Strategic Groundwater Pumping Restriction	GSA	•			•	Conceptual only	TBD	7-86% stream depletion reversal									
III	Watermaster Program	Scott Valley and Shasta Valley Watermast er District	•			•	Conceptual only	TBD										

Appendix 5-B Annual Reporting Template

This appendix presents an example template for annual reporting. Use of this appendix is intended as an example only and is not intended to be specific to the Basin. Modification will be required based on specifics outlined in the Basin's Groundwater Sustainability Plan.

SMC Tracker: A web dashboard to support GSP annual reporting with centralized monitoring, modeling, and data access

Contents

Introduction

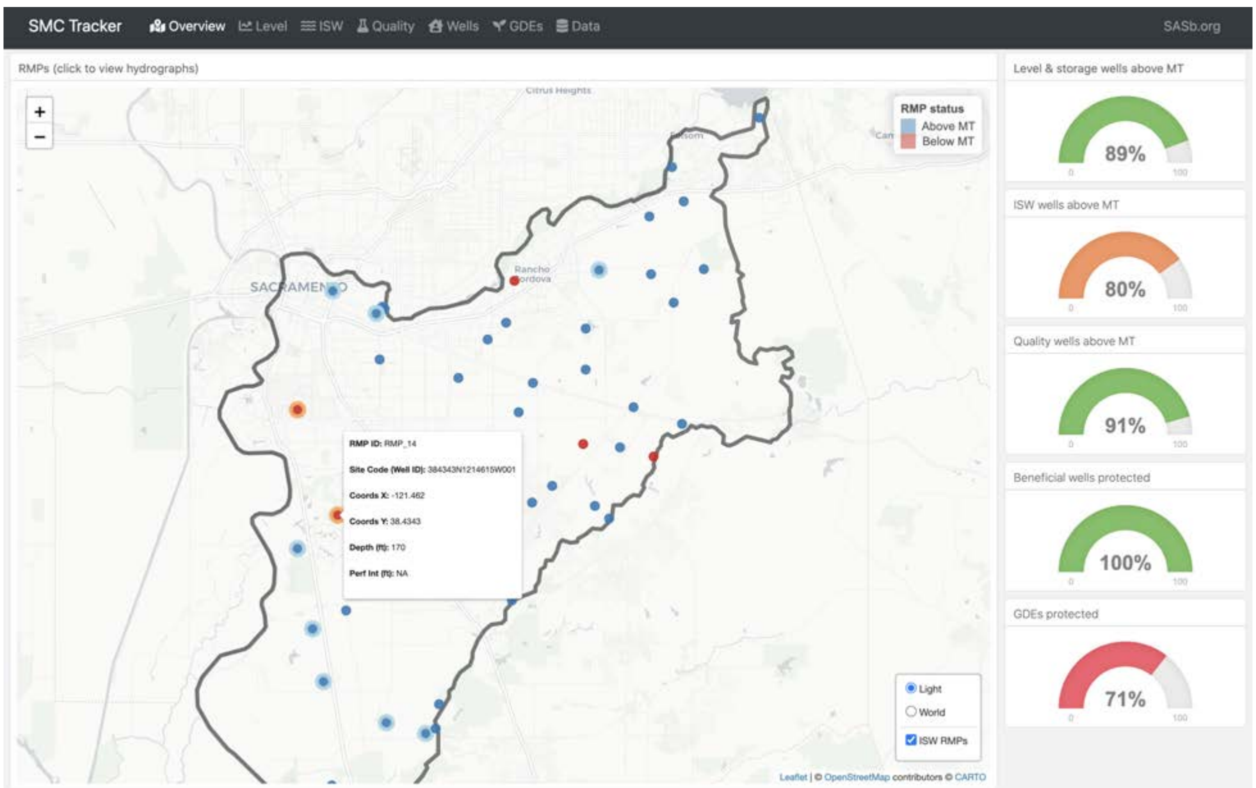
Annual reporting for SGMA requires monitoring at representative monitoring points (RMPs), analysis of potential impacts to beneficial users, evaluation of physical conditions in the basin to sustainable management criteria (SMC), and submission of data to the State. Data is collected different ways and at different sampling frequencies–often by multiple agencies and consulting firms–and the analysis, storage, reporting, and sharing of this information introduces friction into annual reporting, compliance assessment, and decision making. The need for streamlined annual reporting solutions is especially acute during severe drought where rapid access to information to guide critical decision making is paramount.

We propose a solution called **SMC Tracker**: a web-based data reporting and SMC tracking dashboard that integrates RMP monitoring data with assessments to beneficial users in automated interactive visualizations. This dashboard will summarize groundwater conditions in the basin, integrate data and models used in the annual report, and provide a central hub for tracking SMC in near-real time. Users will be able to visualize all RMPs at a glance, drill down into monitoring data collected at each RMP, and use summary panels to rapidly assess "basin vitals" that show if the basin has identified significant and unreasonable results for a given sustainability indicator and/or beneficial users of groundwater. And finally, users will be able to export data for analysis and in forms that directly comply with DWR submission criteria for a painless, drag-and-drop solution.

Overview page

The SMC Tracker main page provides an overview of basin sustainability at a glance. All RMPs for groundwater level and storage are shown. Users can:

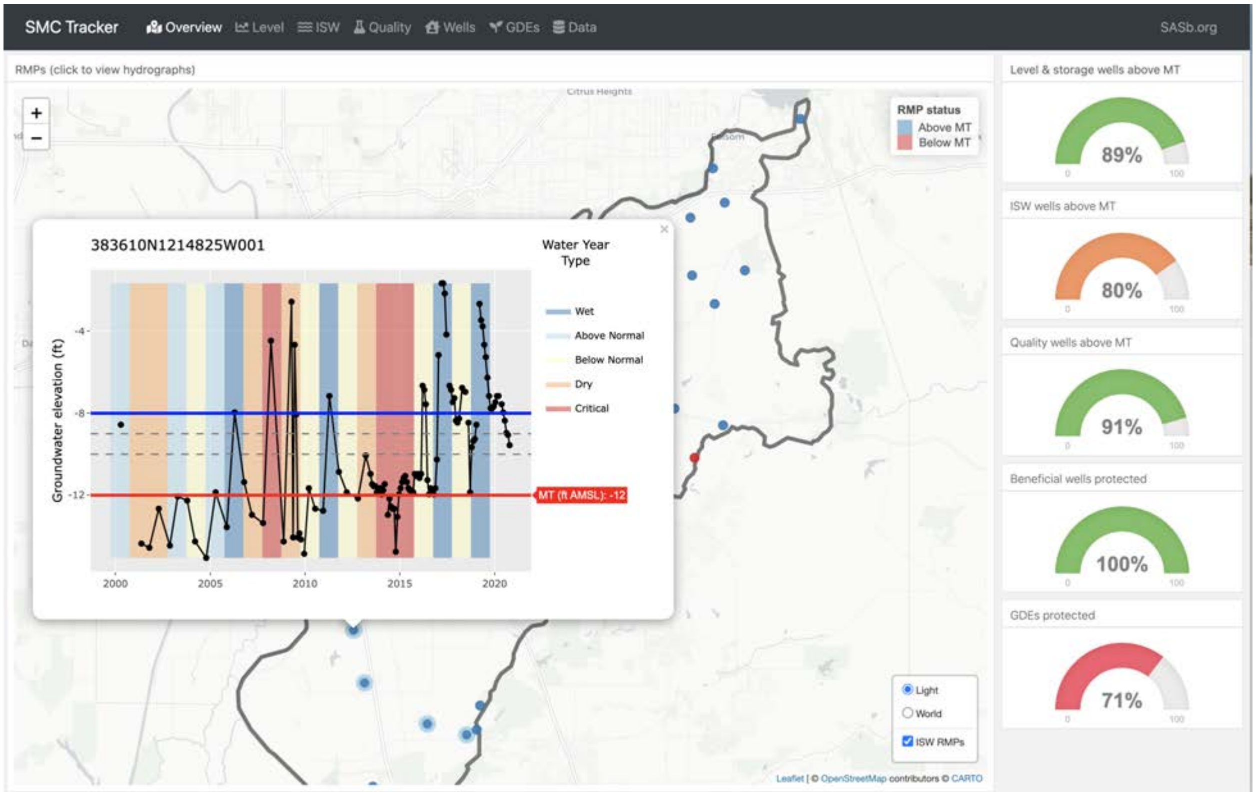
- hover over points to view site metadata
- use the legend to quickly identify RMPs that are above or below their MT
- use the legend to toggle between groundwater level, storage, and ISW monitoring points
- toggle basemaps to view satellite imagery
- click points to expand interactive timeseries plots that allow the user to zoom, pan, and export plots. Plots show:
  - water year type
  - historical data through the present day
  - SMC (minimum thresholds, measurable objectives, and interim milestones)



The lefthand sidebar shows "odometer" gauges which represent critical sustainability criteria, including:

- percentage of groundwater level and storage RMPs above the MT
- percentage of ISW RMPs above the MT
- percentage of water quality wells above the MT
- percentage of shallow wells protected at current groundwater levels
- percentage of GDEs protected

Colors of the gauges can be configured such that when the basin dips into “trigger” or “undesirable result” territory, the gauges show this.



Groundwater level page

The “Groundwater level” pageis one example of many other pages where users can drill down into aggreagted data for a particular sustainability indicator. Whereas in the “Overview” page, users interact with RMPs spatially and click on individual RMPs to view groundwater levels, on the “Groundwater level” page, all groundwater levels are shown in a single interactive visualization.

This page will be configured to automatically incorporate data as is it collected in a standard form by agencies and consultants. In the event that data is collected via telemetry, this page can be configured to auto-update at a regular time interval (e.g., daily) so that users can always view the most up-to-date data. Features include:

- a right hand legend that can be clicked to toggle individual points on and off or highlight one timeseries line
- interactive zoom and pan to inspect small details in the timeseries data
- two tabs that render the data in terms of water surface elevation (ft AMSL) and depth to groundwater (ft below land surface)
- groundwater level data on hover including the site ID, the date, and the groundwater level
- a button to export the current state of the plot to a .png file which can be included in a presentation or a report

Other pages

Just as the "Groundwater level" page allows the user to drill down into groundwater level data, users needs information on other Sustainability indicators that may include interconnected surface water (ISW), groundwater quality, land subsidence, and/or seawater intrusion. Moreover, key beneficial users may include shallow wells and GDEs, and the user may need information on impacts to these users suggested by the latest monitoring data and modeling. "Other" pages accomplish this, and are listed in the header from left to right. Here we include examples for ISW, groundwater quality, wells, and GDEs. Content on these pages will be developed to address basin-specific needs.

Data access

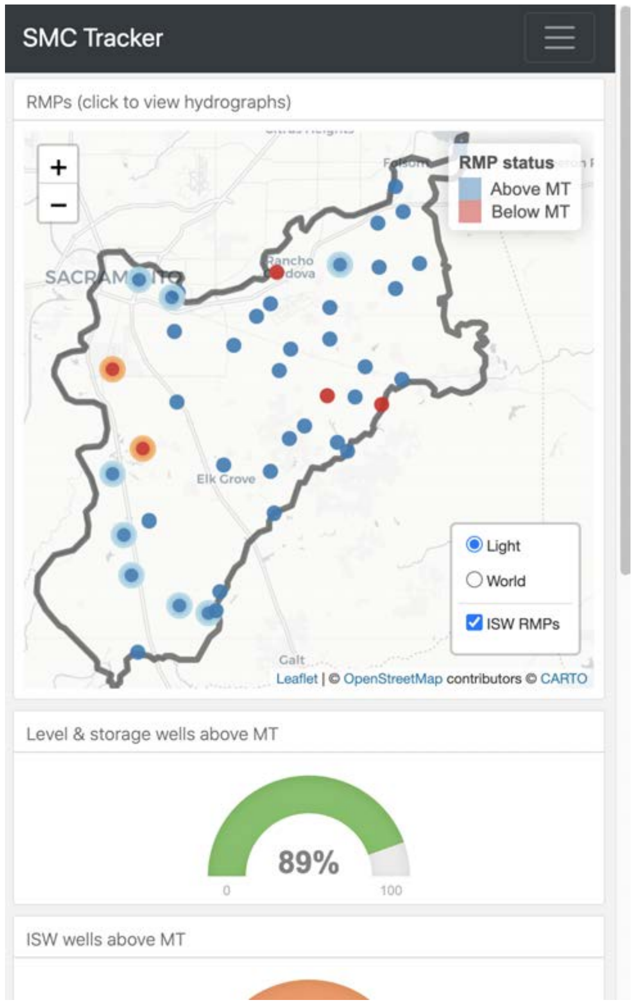
Agencies and consultants may require data from time to time, and as new data is made available, it must be centralized and distributed. SMC Tracker accomplishes this centralization and distribution on a "Data" page with links to the most up-to-date data. Also on this page are download links to data in DWR annual reporting templates for fast, painless, drag-and-drop solutions to annual reporting requirements.

Additional features

Dashboards are highly customizable and additional features may be added on an ad-hoc basis.

Mobile display

SMC Tracker is built with modern software optimized for mobile display. It looks great on smartphones and tablets.



Near-real time monitoring

Custom data extraction for any continuous monitoring sites can be integrated into SMC Tracker so that GSAs can track groundwater levels and other sustainability indicators in near-real-time (e.g., following a recharge project, or during a severe drought). Receiving automated information quickly and in a visual format can help focus priorities for working groups, and allow consultant teams access to standardized data as soon as it is available so data-driven management actions can be rapidly planned and executed.

Password protection and data privacy

Depending on GSA needs, dashboards can be made public or private. If dashboards are made private, they will sit behind password-protected walls for authorized users.

All data will be stored and protected on private servers configured by LWA.

Conclusion

Once developed, SMC defined in GSPs must be monitored for the identification of significant and unreasonable results. Monitoring at RMPs occurs throughout the year and is reported to DWR annually. Data collection, analysis, reporting, and sharing all present friction in the annual reporting and compliance process. These challenges are obviated by centralizing all monitoring data in one place to visualize near-real-time groundwater conditions in the basin and how they measure up to SMC. The SMC Tracker tool will aid agencies and consultants by providing access to monitoring data, SMC tables, and standardized excel data export sheets that can be dragged and dropped into DWR's online reporting system.

Appendix 5-C Financial Analysis for GSP Implementation

SISKIYOU COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT GROUNDWATER SUSTAINABILITY AGENCY

BUTTE VALLEY, SCOTT VALLEY, AND SHASTA VALLEY BASINS

FUNDING OPTIONS TECHNICAL MEMORANDUM

JULY 2021

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Robert Moser, Municipal/City
Lisa Faris, Big Springs Irrigation District
Justin Sandahl, Shasta River Water Users Association

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INTRODUCTION AND GOALS

The Siskiyou County Flood Control and Water Conservation District (District) was enacted in 1957 to provide for the control and conservation of flood and storm waters and the protection of watercourses, watersheds, public highways, life and property damage or destruction from such waters; to provide for the acquisition, retention, and reclaiming of drainage, storm, flood, and other waters; to save, conserve, and distribute such waters for beneficial use within the District boundaries, and to replenish and augment the supply of water in natural underground reservoirs. The boundaries of the District coincide with the County, and the Siskiyou County Board of Supervisors serve as the Board of Directors (Board) of the Flood and Water Conservation District; however, the District is a separate legal entity from the County, with independent rights and limited powers set forth in its originating act.

The Board passed a resolution on April 4th, 2017 to serve as the Groundwater Sustainability Agency (GSA or Agency) for the Butte Valley, Scott Valley, and Shasta Valley Basins (basins) as required by the Sustainable Groundwater Management (SGMA) Act of 2014.

In the Winter of 2018, the Agency engaged a consultant team led by Larry Walker Associates (LWA Team) to develop the Groundwater Sustainability Plan in compliance with the SGMA for the three basins.

A Groundwater Sustainability Plan (GSP) for each of the three basins includes goals and recommendations, as well as the associated costs required for its implementation. Accordingly, the purpose of this technical memorandum is to describe a path forward to fund the GSP's implementation. It should be noted that SGMA and its associated requirements and goals are quite new, and there is not a clear, well-tested path forward to fund GSP implementations. Rather, the funding efforts for GSP implementation in the three basins need to be carefully crafted for local conditions, preferences, and politics – as well as being flexible, creative, and reactive.

The GSA has been initially funded by existing general funds and grants. The general direction from the GSA Board of Directors in regard to funding the GSP implementation can be summarized as:

- GSA expenses should be well-controlled
- Funding strategy needs to be locally viable and right-sized
- Metering of wells is not desired

EXECUTIVE SUMMARY

Following is a brief summary of the findings and recommendations contained within this Technical Memo, including a summary of the GSP implementation costs, potential funding mechanisms, and recommendations for funding of the implementation.

REVENUE NEEDED FOR GROUNDWATER SUSTAINABILITY PLAN IMPLEMENTATION

The GSP makes numerous implementation recommendations, including annual operations and maintenance as well as capital projects. The associated costs for these tasks, including the low range and high range, are summarized in Tables 1, 2, and 3 below. The total estimated annual costs for all three basins combined ranges from $438,750 to $747,500.

TABLE 1 – SUMMARY OF TOTAL ESTIMATED ANNUAL COSTS FOR BUTTE VALLEY BASIN

Summary	Annual Budget	
	Low Range	**High Range**
Operations and Maintenance	$120,000	$210,000
Grant Writing	$15,000	$20,000
Capital Projects	TBD	TBD
Total	**$135,000**	**$230,000**

TABLE 2 – SUMMARY OF TOTAL ESTIMATED ANNUAL COSTS FOR SCOTT VALLEY BASIN

Summary	Annual Budget	
	Low Range	**High Range**
Operations and Maintenance	$120,000	$210,000
Grant Writing	$15,000	$20,000
Capital Projects	TBD	TBD
Total	**$135,000**	**$230,000**

TABLE 3 – SUMMARY OF TOTAL ESTIMATED ANNUAL COSTS FOR SHASTA VALLEY BASIN

Summary	Annual Budget	
	Low Range	**High Range**
Operations and Maintenance	$150,000	$262,500
Grant Writing	$18,750	$25,000
Capital Projects	TBD	TBD
Total	**$168,750**	**$287,500**

It is anticipated that capital projects will be primarily grant-funded. More detail is provided in Section II., below.

FUNDING APPROACHES AND OPTIONS FOR GSP IMPLEMENTATION

There are a variety of funding approaches, each with pros and cons, and most likely a portfolio of various approaches will prove optimal. The likely most optimal funding mechanisms are listed below:

Best Options

- Existing Revenue Sources
- Grants and Loans
- Regulatory Fees

If additional revenue is needed:

- Property Related Fees – non-Balloted (*allocated to well owners*)
- Special Taxes – Balloted (allocated to all property owners within the basins or County)

Less optimal

- Property Related Fees – Balloted
- Benefit Assessments

Each funding mechanism and approach has key attributes - each of which should be considered to select the optimal funding portfolio, including:

  - Flexibility of Methodology (per acre, per acre-feet pumped, per well, etc.)
  - Costs of Implementation
  - Revenue Potential
  - Political Viability / Community Acceptance
  - Legal Rigor
  - Administration

ALLOCATING IMPLEMENTATION COSTS TO WELL OWNERS VERSUS PROPERTY OWNERS

If funding beyond use of existing sources, grants and regulatory fees is needed, then one of the most important considerations for the GSP's is the allocation of the GSP implementation cost between the well owners and the larger group of all property owners within the three basins, or even County-wide. Conventional wisdom suggests that the costs of the implementation of groundwater mitigation policies should be directly borne by the immediate users of the groundwater – the well owners. However, there are clear benefits to all properties and residents within a well-managed groundwater basin that provides additional, lower cost water resources. It can be argued that a community-wide funding mechanism in which all properties and/or residents pay their fair share is a more optimal approach. Both types of approaches are discussed in Section II of this technical memo.

ROADMAP FORWARD AND RECOMMENDATIONS

A summary of this Technical Memo's major recommendations for implementation includes a step sequential roadmap as summarized below:

1. Conduct community outreach regarding the GSP and its implementation
2. Pursue use of existing revenue sources, grants, and regulatory fees to fund implementation

If additional revenue is needed:

3. Conduct a public opinion survey and focused community outreach
4. Implement a property related fee or special tax

The process of establishing long-term, sustainable, comprehensive funding for GSP implementation will likely take at least 18 months to complete. More detail is provided in Section III., below.

I. DETAILED REVENUE NEEDS

ANNUAL OPERATIONS AND MAINTENANCE COSTS

The GSP includes numerous recommendations for annual operations and maintenance in support of the long-term sustainability of the three basins. The costs of these recommendations have been developed and bracketed with a low range of $120,000 per year and a high range of $210,000 for Butte Valley and Scott Valley Basins, and a low range of $150,000 per year and a high range of $262,500 for Shasta Valley Basin. These figures are detailed in Tables 4, 5, and 6 below:

Table 4 – Detailed Summary of Estimated Maintenance and Operations Costs for Butte Valley Basin

Operations and Maintenance	Annual Budget	
	Low Range	High Range
General GSA Operations	$10,000	$25,000
Annual Reporting	$15,000	$25,000
Model Maintenance	$40,000	$80,000
Monitoring	$45,000	$60,000
Future Stakeholder Engagement	$10,000	$20,000
Mediation Fund	TBD	TBD
Total	**$120,000**	**$210,000**

Table 5 – Detailed Summary of Estimated Maintenance and Operations Costs for Scott Valley Basin

Operations and Maintenance	Annual Budget	
	Low Range	High Range
General GSA Operations	$10,000	$25,000
Annual Reporting	$15,000	$25,000
Model Maintenance	$40,000	$80,000
Monitoring	$45,000	$60,000
Future Stakeholder Engagement	$10,000	$20,000
Mediation Fund	TBD	TBD
Total	**$120,000**	**$210,000**

Table 6 – Detailed Summary of Estimated Maintenance and Operations Costs for Shasta Valley Basin

Operations and Maintenance

	Annual Budget	
	Low Range	**High Range**
General GSA Operations	$12,500	$31,250
Annual Reporting	$18,750	$31,250
Model Maintenance	$50,000	$100,000
Monitoring	$56,250	$75,000
Future Stakeholder Engagement	$12,500	$25,000
Mediation Fund	TBD	TBD
Total	**$150,000**	**$262,500**

Where:

General GSA Operations includes costs to operate the GSA including supporting and facilitating Board and committee meetings, disseminating information, satisfying existing grant administrative requirements, managing contracts for tasks listed below, maintaining the website, etc.

Annual Reporting: includes costs to draft and submit all required annual reports.

Model Maintenance: includes the annual installment costs to use the models every year to test scenarios of Projects and Management Actions and to recalibrate and update the model every 5 years.

Monitoring – Interconnected Surface Water: costs are different in Shasta and Scott Valley, and they do not apply to Butte Valley. In Shasta Valley, cost includes the periodic (likely semi-annual) inspection and maintenance at 3 transects sites already fully installed and equipped - approximately 6 visits per year. For both Shasta and Scott, cost of monitoring of the wells located near the river and already equipped with continuous data is already included in the Water Level Monitoring. Further data collections for SW/GW in both Shasta and Scott will be coordinated with other partners and included in the GSP as management action.

Monitoring - Water Level: includes the periodic (likely semi-annual) inspection of water level monitoring equipment at CASGEM and DWR well sites and 10-15 additional well sites with continuous monitoring – approximately 6 visits per year and, as needed, hardware replacement.

Monitoring - Water Quality: includes the periodic sampling of water quality – approximately 10-15 samples per year.

Mediation Fund: is a placeholder for funds in support of mediation. For example, a grant program could be established for local well-owners to access capital to address compliance issues.

Future Stakeholder Engagement: Costs for future stakeholder engagement have not been included in these budgets but may be incurred.

ANNUAL CAPITAL COSTS

The GSPs include numerous recommendations for capital improvements in support of the long-term sustainability of the Basins. Most likely, these capital improvements will be implemented if and only if significant grant funding is available. However, there are often associated costs with grants including grants writing and grants administration.

The costs of these recommendations have been developed and bracketed with a low range of $10,000 per year and a high range of $40,000, and are detailed in Tables 7, 8, and 9 below:

TABLE 7 – DETAILED SUMMARY OF ESTIMATED MAINTENANCE AND OPERATIONS COSTS FOR BUTTE VALLEY BASIN

Capital Projects	Annual Budget	
	Low Range	High Range
Grant Writing	$15,000	$20,000
Annual Grant Administration	TBD	TBD
Capital Projects Costs	TBD	TBD
Total	**$15,000**	**$20,000**

TABLE 8 – DETAILED SUMMARY OF ESTIMATED MAINTENANCE AND OPERATIONS COSTS FOR SCOTT VALLEY BASIN

Capital Projects	Annual Budget	
	Low Range	High Range
Grant Writing	$15,000	$20,000
Annual Grant Administration	TBD	TBD
Capital Projects Costs	TBD	TBD
Total	**$15,000**	**$20,000**

TABLE 9 – DETAILED SUMMARY OF ESTIMATED MAINTENANCE AND OPERATIONS COSTS FOR SHASTA VALLEY BASIN

Capital Projects

	Annual Budget	
	Low Range	**High Range**
Grant Writing	$18,750	$25,000
Annual Grant Administration	TBD	TBD
Capital Projects Costs	TBD	TBD
Total	**$18,750**	**$25,000**

Where:

Grant Writing: includes periodic grant writing primarily for capital projects.

Annual Grant Administration: includes costs satisfying annual grant administrative requirements including reporting and budget management.

TOTAL ANNUAL IMPLEMENTATION COSTS

The total costs of these recommendations have been developed and bracketed with a low range of $90,000 per year and a high range of $182,500, and are detailed in Tables 10, 11, and 12 below:

TABLE 10 – SUMMARY OF TOTAL ESTIMATED COSTS FOR BUTTE VALLEY BASIN

Summary

	Annual Budget	
	Low Range	**High Range**
Operations and Maintenance	$120,000	$210,000
Grant Writing	$15,000	$20,000
Capital Projects	TBD	TBD
Total	**$135,000**	**$230,000**

TABLE 11 – SUMMARY OF TOTAL ESTIMATED COSTS FOR SCOTT VALLEY BASIN

Summary

	Annual Budget	
	Low Range	**High Range**
Operations and Maintenance	$120,000	$210,000
Grant Writing	$15,000	$20,000
Capital Projects	TBD	TBD
Total	**$135,000**	**$230,000**

TABLE 12 – SUMMARY OF TOTAL ESTIMATED COSTS FOR SHASTA VALLEY BASIN

Summary

	Annual Budget	
	Low Range	**High Range**
Operations and Maintenance	$150,000	$262,500
Grant Writing	$18,750	$25,000
Capital Projects	TBD	TBD
Total	**$168,750**	**$287,500**

Shasta Valley Basin costs: Total estimated costs for the Shasta Valley Basin are generally estimated to be 25% higher than for Butte Valley and Scott Valley.

II. EVALUATION OF POTENTIAL FUNDING MECHANISMS

INTRODUCTION TO AVAILABLE POTENTIAL FUNDING MECHANISMS OPTIONS IN CALIFORNIA

Existing California law provides a relatively finite number of mechanisms for local public agencies to reliably generate revenue to provide services. In many cases, a portfolio approach of several of these mechanisms will be optimal. Also, it is crucial to work closely with legal counsel on the implementation of all funding mechanisms to ensure legal compliance. This section provides a discussion of the mechanisms best suited to provide funding for groundwater management services recommended in the Agency GSP, including, but not limited to, the following:

Best Options

- Existing Revenue Sources
- Grants and Loans
- Regulatory Fees

If Additional Revenue is Needed

- Property Related Fees – non-Balloted (*allocated to well owners*)
- Special Taxes – Balloted (allocated to all property owners within the basin)

Less Optimal

- Property Related Fees – Balloted
- Benefit Assessments

Existing Revenue Sources and Grants Are Likely the Preferred Approach

Of course, it is recommended that the Agency rigorously explore all opportunities to fund the recommended groundwater management services through existing revenue sources and grants, eliminating the need for an additional allocation for well owners or all basin property owners. However, there are likely not sufficient available existing revenue sources to support GSP implementation, especially over the long term. See the discussion "Grants and Loans" below.

Regulatory Fee Should Be Imposed

Regulatory fees are an excellent source of reimbursement of actual costs for inspections, plan checks, etc., and should be imposed.

However, If Additional Revenue is Needed

If additional revenue is need beyond the amount that can be generated by existing revenue sources, there are two primary approaches:

Revenue Generated from	Optimal Revenue Mechanism
Well Owners	Property Related Fee (non-balloted)
All Property Owners	Special Tax (balloting is required)

<u>Additional Funding from Well Owners or Community Property Owners</u>

One unique challenge, and opportunity, associated with implementation of a funding mechanism for groundwater sustainability management is the decision regarding how costs will be allocated between well owners and the overall community of property owners. Generally speaking, the development of the Sustainable Groundwater Management Act was based upon the assumption that the allocation of costs would be primarily, perhaps exclusively, assigned to well owners, with some consideration of *de minimis* ground water users. However, there are clear benefits to all properties and residents within a basin, or even the entire county, with well managed groundwater resources. It can be argued that a community-wide funding mechanism in which all properties and/or residents pay their fair share is a more optimal approach.

Local political forces, often concentrated with well owners, may dictate a preference for allocating the GSP implementation costs more broadly to all property owners within the basins or county, but it should be noted that California law requires that special taxes, which would be the mechanism required for an allocation on all basins or county property owners, requires a balloting. Balloted revenue mechanisms are arguably more legally rigorous, and legal challenges to voter-approved fees have rarely been successful. However, the balloting requirement significantly limits the total revenue that may be generated, as it is limited by the political "willingness to pay" of the local voters or property owners. Ballotings are also expensive and politically risky. For that reason, non-balloted approaches are typically preferable, and do not have the same apparent political limitation on the amount of revenue that can be generated, but political realities and influences are still significant.

As the Agency determines its funding strategy, it should take an in-depth look at many attributes, including flexibility of methodology (per acres, per water quantity, per well, per parcel, etc.), costs of implementation, revenue generation potential, political viability, legal rigor, administrative burden, etc., as described below.

EXISTING REVENUE SOURCES

If the Agency can fund the groundwater management services with existing revenue sources, that is certainly optimal. However, even if this is possible in the short term, it is likely not possible very far into the future.

GRANTS AND LOANS

Grant funding is highly desirable, as it eliminates/lessens the need to generate revenue directly from well owners and/or the broader community of property owners. Grant funding is typically available for capital projects but can be available for other programmatic activities, including maintenance and operations. It is worth noting that grants often come with other funding requirements such as matching funds or requirements for post-project maintenance. For these reasons, an underlying revenue stream is very important to have access to leverage these opportunities.

California has a limited number of State grants and programs which provide funding opportunities for groundwater sustainability. The primary grants in support of SGMA are described below (*from https://water.ca.gov/Work-With-Us/Grants-And-Loans/Sustainable-Groundwater*):

"The SGMA Grant Program is funded by Proposition 68 and Proposition 1. To date, the California Department of Water resources (DWR) has awarded $139.5 million in three rounds of planning grants for development of Groundwater Sustainability Plans (GSPs) and related projects. All Proposition 1 funds have been awarded, with about $103 million now remaining to be awarded using Proposition 68 funds. Additional information can be found below.

PROPOSITION 1, CHAPTER 10: GROUNDWATER SUSTAINABILITY

On November 4, 2014, California voters approved Proposition 1, which authorized $100 million be made available for competitive grants for projects that develop and implement groundwater plans and projects in accordance with groundwater planning requirements established under Division 6, commencing with §10000, Water Code §79775. DWR completed two grant solicitations for planning grants.

PROPOSITION 68, CHAPTER 11.6: REGIONAL SUSTAINABILITY FOR DROUGHT AND GROUNDWATER, AND WATER RECYCLING

On June 5, 2018, California voters approved Proposition 68, which amended the Water Code to add, among other articles, §80146, authorizing the Legislature to appropriate funds for competitive grants for proposals that:

- Develop and implement groundwater plans and projects in accordance with groundwater planning requirements.
- Address drought and groundwater investments to achieve regional sustainability for investments in groundwater recharge with surface water, stormwater, recycled water, and other conjunctive use projects, and projects to prevent or cleanup contamination of groundwater that serves as a source of drinking water."

The Agency should plan to submit an application for the next round of Proposition 68 funding.

FUTURE STATE GRANT OPPORTUNITIES

Since all of Proposition 1 funding has been awarded and the remaining portion of Proposition 68 funding (just over $100 million) will be awarded over the next several years, there will likely be a shortfall of grant funding for GSP implementation in the near future. Unfortunately, there are not any large statewide bond measures (with grant opportunities) on the political horizon, but the Agency should continue to track such efforts. Also, future bond measures will likely emphasize funding for multi-benefit projects and programs that cross traditional organizational structures, and the Agency should also consider coordinating with other affected local agencies to put forth larger and potentially more competitive grant applications.

Proposition 68

The final Proposition 68 Implementation Proposal contains $103 million in available funding. DWR has released Round 1 draft funding recommendations, allocating $26 million to high priority basins.[1] Of the remaining $77 million, $15 million will be reserved for Underrepresented Communities, leaving $62 million available for general awards in Round 2 Implementation.[2]

Round 2 Grant Solicitation will open in spring of 2022, with final awards disbursed in fall of that year. Awards will be allocated to medium and high priority basins that have adopted a GSP that has been deemed complete by DWR. Grant amounts must be between $2 million and $5 million, with a 25% locally matched cost share requirement. A cost share waiver is available for eligible projects proportionate to the degree that they serve Underrepresented Communities. Any local cost share cannot have contributed to other grant awarded projects. Project expenses must be incurred after January 31, 2022, the due date for medium and high priority basin GSPs. The state encourages applicants to work with the stakeholders and other non-member agencies in their basin that have potential activities and tasks that are complimentary to the overall project. Eligible projects are defined by Proposition 68 Chapter 11.6 and include sustainability measures such as groundwater recharge and contamination prevention.

OTHER TYPES OF GRANTS

The Agency should work to identify applicable Federal grants, if any, and compete, in coordination with other affected local agencies for funding. Also, the Agency should consider working with local elected officials to pursue provisions that direct approved funds to be spent on specific projects, often called earmarks.

Grants from non-profits, foundations, high-net-worth individuals, and other stakeholders should be considered, especially with an emphasis on environmental sustainability.

REQUIRED DOCUMENTS FOR GRANTS

- Grant applications meeting specific requirements.

FLEXIBILITY OF METHODOLOGY

Use of grant funding is well-specific in the specific grant.

REVENUE GENERATION POTENTIAL

Amount of grant funding is well-specific in the specific grant.

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1 Proposition 68 SGM Grant Program's Implementation – Round 1 Draft Award List (ca.gov)

2 https://www.grants.ca.gov/grants/sustainable-groundwater-management-sgm-grant-programs-proposition-68-implementation-round-2/

ADVANTAGES

- Does not require cost to be allocated to local well owners or property owners.
- Revenue generation can be sufficient to offset significant costs of certain key activities.
- Legally rigorous as long as grants are expended on eligible activities.

CHALLENGES

- Provides funding for a limited time period only – difficult for long term planning solution.
- Awarded through a highly competitive process.
- Often requires matching local funds, tends to be focused on capital expenses, and are often narrowly focused in terms of scope and services.

REGULATORY FEES

Public agencies throughout California often reimburse themselves for the costs of site inspections, permits, plan checks, plan reviews, and associated administrative and enforcement activities using regulatory fees. These fees are often approved and published as part of a "Master Fee Schedule," and are often collected as part of review for approval process. This approach can assist in significantly reducing the GSA's financial burden.

Proposition 26, approved by California voters in 2010, tightened the definition of regulatory fees. It defined a special tax to be *"any levy, charge, or exaction of any kind imposed by a local government"* with certain exceptions. Pursuant to law, all special taxes must be approved by a two-thirds vote of the electorate.

Regulatory fees are thus defined through the cited exceptions. The pertinent exception is, "a charge imposed for the reasonable regulatory costs to a local government for issuing licenses and permits, performing investigations, inspections, and audits, enforcing agricultural marketing orders, and the administrative enforcement and adjudication thereof." The other pertinent exception is, "assessments and property-related fees imposed in accordance with the provisions of Article XIIID."

The Proposition goes on to state that, "the local government bears the burden of proving by a preponderance of the evidence that a levy, charge, or other exaction is not a tax, that the amount is no more than necessary to cover the reasonable costs of the governmental activity, and that the manner in which those costs are allocated to a payor bear a fair or reasonable relationship to the payor's burdens on, or benefits received from, the governmental activity."

Proposition 26 provides the primary guidance for the funding of the Agency's plan review and inspection fees as regulatory fees. Moreover, Section 10730 of the California Water Code, (which corresponds well with Proposition 26 guidance) stipulates that these fees can be used "to fund the costs of a groundwater sustainability program, including, but not limited to, preparation, adoption, and amendment of a groundwater sustainability plan, and investigations, inspections, compliance assistance, enforcement, and program administration, including a prudent reserve." Hence, it seems that the intent of this section is that the development of the plan can be financed through regulatory fees (and this has been widely agreed upon) as well as some, but not all, GSP implementation activities. In any case, Water Code Section 10730 includes several unique requirements that should be carefully followed when implementing regulatory fees for GSP implementation.

REGULATORY FEE IMPLEMENTATION PROCESS

Regulatory fees are relatively easy and straightforward to implement. Neither a public noticing nor a balloting is required. Typically, a public agency will engage a specialized consultant to conduct a Fee Study. This Study will present findings to meet the procedural requirements of Proposition 26, which require analysis and support that:

1. The levy, charge, or other exaction is not a tax; and
2. The amount is not more than necessary to cover the reasonable cost of the governmental activity; and
3. The way those costs are allocated to a payor bears a fair or reasonable relationship to the payor's burden on, or benefits received from, the governmental activity.

Additionally, case law has provided further clarification of these substantive requirements, that:

1. The costs need not be "finely calibrated to the precise benefit each individual fee payor might derive."
2. The payor's burden or benefit from the program is not measured on an individual basis. Rather, it is measured collectively, considering all fee payors.
3. That the amount collected is no more than is necessary to cover the reasonable costs of the program is satisfied by estimating the approximate cost of the activity and demonstrating that this cost is equal to or greater than the fee revenue to be received. Reasonable costs associated with the creation of the regulatory program may be recovered by the regulatory fee.

REQUIRED DOCUMENTS FOR REGULATORY FEES

- A Fee Study, reviewed by legal counsel and adopted by the governing authority.

FLEXIBILITY OF METHODOLOGY

Legal requirements and industry practice limit these fees to recovery of costs associated with eligible activities (e.g., inspections, permits, etc.) The Agency is advised to work closely with legal counsel and review Proposition 26 and Water Code Section 10730 requirements.

REVENUE GENERATION POTENTIAL

Full recovery of costs associated with eligible activities (e.g., inspections, permits, etc.)

ADVANTAGES

- Quick and inexpensive to implement. No noticing nor balloting is required.

- Revenue generation is sufficient to offset significant costs of certain key activities.
- Legally rigorous as long as fees are for eligible activities.
- Efficient administration.

CHALLENGES

- Very limited revenue generation potential
- Potential for "push back" from affected well owners against fees.
- Potential legal scrutiny if fee covers non-eligible activities.
- Do not typically apply to infrastructure operations and capital costs.

IF ADDITIONAL REVENUE IS NEEDED

To be clear, this technical memorandum is recommending that (if the costs of GSP implementation necessitate it) the Agency consider either a Non-balloted Property Related Fee on Well Owner parcels or a Special Tax on all property owners in the basin, but likely not both, unless the financial need is very significant.

PROPERTY-RELATED FEE – (NON- BALLOTED) ON WELL OWNERS

Property-related fees were first described in 1996's Proposition 218, (which is manifested as Section 6 of Article XIII D of the California Constitution) and are commonly used today to fund water, sewer, solid waste and even storm drainage. They are most commonly referred to as a "water charge or a "sewer charge," etc., but are technically a property-related fee.

Proposition 218 imposes certain procedural requirements for imposing or increasing property related fees. There are two distinct steps: 1.) a mailed noticing of all affected property owners (well owners in this case) and 2.) a mailed balloting on all affected property owners requiring a 50% approval for adoption.

A REALLY IMPORTANT EXEMPTION ELIMINATES THE BALLOTING REQUIREMENT

Proposition 218 goes on to exempt fees for water, sewer and refuse collection from the second step – the balloting. Hence, a property-related fee imposed on well owners' properties would be exempt from the balloting requirement. This is very significant because it reduces costs and political risk and lessens willingness-to-pay limitations.

California Water Code Provides Additional Clarity in 10730.2
California Water Code, Division 6., Part 2.74., Chapter 8. Financial Authority [10730 - 10731] provides considerable direction and authority to local governments tasked with groundwater sustainability regarding property-related fees.

In particular, Section 10730.2 (c) in the water code states:

"Fees imposed pursuant to this section shall be adopted in accordance with subdivisions (a) and (b) of Section 6 of Article XIII D of the California Constitution."

Section 6 of Article XIII of the California Constitution describes the specific requirements of the implementation of a property related fee, and most importantly, refers to subdivision (a) as the noticing requirement, (b) as the limitations on fees and services, and subdivision (c) as the balloting requirement. Hence, by omission of (c) in Section 10730.2, balloting is not required for property related fees for groundwater sustainability.

PROPERTY RELATED FEE IMPLEMENTATION PROCESS

As described above, only the first step of the two-step process applies to property related fees in this context. That step is the noticed public hearing. Once the Agency has determined the fees they wish to impose, they must mail a written notice to each affected property owner at least 45 days prior to the public hearing. During that time, and up until the conclusion of the hearing, any affected property owner may file a written protest opposing the proposed fees. If the owners of a majority of the affected parcels file a written protest, the agency cannot impose the fee (known as a “majority protest”). If a majority protest is not formed, the agency may impose the fees.

Also, Section 10730.2 of the California Water Code includes several unique requirements that should be carefully followed when implementing property related fees for GSP implementation.

REQUIRED DOCUMENTS FOR A PROPERTY RELATED FEE

- Mailed Notices of Rate Proposal/Opportunity to Protest/Public Hearing.
- Fee Report and Presentation for Public Hearing.
- Report to Governing Board (assumes < 50% protest).
- Ordinance or Resolution Adopting Fees (assumes >50% support).

FLEXIBILITY OF METHODOLOGY

Long standing use of property related fees for water charges support relatively flexible use of this approach to fund a wide range of GSP implementation activities.

Section 10730.2 of the California Water Code lists potential uses as:

(1) Administration, operation, and maintenance, including a prudent reserve.
(2) Acquisition of lands or other property, facilities, and services.
(3) Supply, production, treatment, or distribution of water.
(4) Other activities necessary or convenient to implement the plan.

This section also specifies that “fees imposed pursuant to this section may include fixed fees and fees charged on a volumetric basis, including, but not limited to, fees that increase based on the quantity of groundwater produced annually, the year in which the production of groundwater commenced from a groundwater extraction facility, and impacts to the basin.”

Other ideas to consider include:

- Parcel-based Administration Fee,
- Remediation Fee for over-pumping.

- Augmentation Fee on over users to pay to import water.

REVENUE GENERATION POTENTIAL

Two potential revenue methodologies are modelled below based upon the use of a property related fee. Tables 13, 14, and 15 model rates and revenue generated using a hypothetical "flat" annual rate for each type of well. Most notably, this approach relies on "estimated usage" based upon attributes such as land use, affected acreage, etc., and does not rely on use of metered extraction amount. (Number and types of wells is approximate):

TABLE 13 – MODEL OF ESTIMATED USAGE RATE AND REVENUE FOR PROPERTY RELATED FEE ON WELLS IN BUTTE VALLEY BASIN

Basin Wells

	Approx. Number	**Low Range**		**High Range**	
		Rate	**Revenue**	**Rate**	**Revenue**
Agricultural	34	$3,000.00	$102,000	$5,300.00	$180,200
Industrial	0	$3,000.00	$0	$5,300.00	$0
Municipal	7	$3,000.00	$21,000	$5,300.00	$37,100
Domestic	73	$125.00	$9,125	$150.00	$10,950
Other (Monitoring, injection, etc.)	24	$125.00	$3,000	$150.00	$3,600
Total	**138**		**$135,125**		**$231,850**
	Revenue Goals:		$135,000		$230,000

TABLE 14 –MODEL OF ESTIMATED USAGE RATE AND REVENUE FOR PROPERTY RELATED FEE ON WELLS IN SCOTT VALLEY BASIN

Basin Wells

	Approx. Number	**Low Range**		**High Range**	
		Rate	**Revenue**	**Rate**	**Revenue**
Agricultural	88	$1,100.00	$96,800	$2,000.00	$176,000
Industrial	0	$1,100.00	$0	$2,000.00	$0
Municipal	7	$1,100.00	$7,700	$2,000.00	$14,000
Domestic	336	$75.00	$25,200	$100.00	$33,600
Other (Monitoring, injection,etc.)	86	$75.00	$6,450	$100.00	$8,600
Total	**517**		**$136,150**		**$232,200**
	Revenue Goals:		$135,000		$230,000

TABLE 15 –MODEL OF ESTIMATED USAGE RATE AND REVENUE FOR PROPERTY RELATED FEE ON WELLS IN SHASTA VALLEY BASIN

Basin Wells

	Approx. Number	Low Range		High Range	
		Rate	**Revenue**	**Rate**	**Revenue**
Agricultural	139	$850.00	$118,150	$1,500.00	$208,500
Industrial	8	$850.00	$6,800	$1,500.00	$12,000
Municipal	10	$850.00	$8,500	$1,500.00	$15,000
Domestic	885	$30.00	$26,550	$50.00	$44,250
Other (Monitoring, injection, etc.)	206	$30.00	$6,180	$50.00	$10,300
Total	**1,248**		**$166,180**		**$290,050**
	Revenue Goals:		$168,750		$287,500

Also, a property related fee could be established based upon water drawn out of the basin (which would require of metered measuring of extraction amount), as modelled in Tables 16, 17 and 18, below:

TABLE 16 – MODEL OF METERED USAGE RATE AND REVENUE FOR PROPERTY RELATED FEE ON ACRE-FEET IN BUTTE VALLEY BASIN

Basin Wells

	Approx. Acre Feet	Low Range		High Range	
		Rate	**Revenue**	**Rate**	**Revenue**
All Wells	85,000	$1.60	$136,000	$2.75	$233,750
Total	**85,000**		**$136,000**		**$233,750**
	Revenue Goals:		$135,000		$230,000

TABLE 17 – MODEL OF METERED USAGE RATE AND REVENUE FOR PROPERTY RELATED FEE ON ACRE-FEET IN SCOTT VALLEY BASIN

Basin Wells

	Approx. Acre Feet	Low Range		High Range	
		Rate	Revenue	Rate	Revenue
All Wells	40,000	$3.25	$130,000	$5.75	$230,000
Total	**40,000**		**$130,000**		**$230,000**
	Revenue Goals:		$135,000		$230,000

TABLE 18 – MODEL OF METERED USAGE RATE AND REVENUE FOR PROPERTY RELATED FEE ON ACRE-FEET IN SHASTA VALLEY BASIN

Basin Wells

	Approx. Acre Feet	Low Range		High Range	
		Rate	Revenue	Rate	Revenue
All Wells	44,000	$3.75	$165,000	$6.50	$286,000
Total	**44,000**		**$165,000**		**$286,000**
	Revenue Goals:		$150,000		$262,500

It should be noted that while a "metered usage" rate fee will fluctuate each year with the amount of water drawn, and a fixed "estimated usage" rate fee would be relatively uniform each year. Costs are likely to be relatively uniform and do not fluctuate with amount of water drawn out of the basins.

ADVANTAGES

- Revenue generation is likely sufficient to fund all GSP implementation costs.
- Legally rigorous. Property related fees are the described in the Water Code for funding groundwater sustainability.
- Process is exempt from a balloting, and the likelihood of a 50% protest (out of +- 1,900) well owners is unprecedented.
- Cost of implementation is relatively low and includes a fee study, a mailing and additional outreach.
- Efficient administration.

CHALLENGES

- Politically challenging. Many well owners within the basins have made it clear that they prefer the costs be allocated to all properties within the basin and/or county and not just the well owners. Well owners exert significant political influence within the basins. Although a balloting is not required, well owners may be able to stop the process legislatively or possibly could attain a 50% protest, which would force a balloting.

- Unfamiliar Process. One potential criticism of the property-related fee is that property owners are generally unfamiliar with the process, and opponents can exploit this. However, with the recent dramatic increase in voting by mail in California, this is less of a major issue. Nonetheless, political opponents can exploit this unfamiliarity and focus the public's attention on the Proposition 218 process, and away from the proposed groundwater sustainability goals and messaging.

SPECIAL TAX ON ALL PROPERTY OWNERS IN THE BASINS OR COUNTY-WIDE

Special taxes are decided by registered voters and almost always require a two-thirds majority for approval. Traditionally, special taxes have been decided at polling places, or more recently by mail, corresponding with general and special elections. Special taxes are well known to Californians but are not as common as property related fees for funding of water-related services and infrastructure activities.

As a reminder, this technical memorandum is recommending that (only if the costs of GSP implementation requires it) the Agency consider either a Non-balloted Property Related Fee on Well Owner parcels or a Special Tax (described below) on all property owners in the basin, but likely not both, unless the financial need is very significant.

PARCEL BASED TAXES

Many special taxes are conducted on a parcel basis with a uniform "flat" rate across all parcels, or varied rates based upon property attributes such as use and/or size. Parcel taxes based upon the assessed value of a property are not allowed. Parcel based taxes (as opposed to sales taxes, etc.) are the most viable type of special tax for funding water-related activities. As such, most discussion of special taxes in this report will focus on parcel taxes.

LIMITATIONS OF TAXING AUTHORITY – FLOOD CONTROL DISTRICT VERSUS COUNTY

State law requires that only a local government agency, with specific taxing authority, may propose and potentially impose a tax on its underlying parcels. (SGMA does not grant GSAs with specific taxing authority.) The Flood Control District, Siskiyou County and the potentially affected incorporated cities of (Etan, Dorris, Fort Jones, Montague, Yreka and Weed within the basins as well as Dunsmuir, Mount Shasta and Tule Lake if the effort was county-wide) do have taxing authority. Neither the Flood Control District, nor Siskiyou County can tax within the incorporated cities without specific permission.

The Flood Control District is likely the optimal agency to propose the tax, either county-wide or in specific basin areas. The Siskiyou County Flood Control District has the authority, granted by its establishing Act, to establish zones within its boundaries for the purpose of levying taxes. For the GSA to levy a special tax in specific basin areas these areas would need to be established as the zones of benefit for the purposes of the GSA and the implementation of the GSP. The governing board (Siskiyou County Board of Supervisors) is granted the authority to levy taxes upon the taxable property in the benefitting zones to carry out the purposes of its establishing Act, and “to pay the costs and expenses of maintaining, operating, extending and repairing any work or improvement of such zones for the ensuing fiscal year” (Cal Uncod. Water Deer, Act 1240 § 33). The Act stipulates that the Board shall have the power to control and order the expenditures of all tax revenue, with a limitation $0.05 per one hundred dollars of the assessed valuation of property within each zone, and that all taxes levied shall be apportioned in accordance with the established zones.

Other requirements and limitations are included in the Siskiyou County Flood Control District Act that may additionally hamper the District’s ability to efficiently and effectively propose a well-designed tax. Modification of the Act, albeit requiring legislative State-level consideration and approval, should be considered.

COUNTY-WIDE VERSUS BASIN SPECIFIC SPECIAL TAX

Both a county-wide and basin area special tax should be considered. A county-wide tax would result in a lower and more voter-palatable proposed tax rate as the needed revenue would be spread over a large number of parcels. However, voters who do not reside within the basin areas may be significantly less likely to vote in favor of a prosed tax as they would be less likely to perceive a direct benefit. Also, special consideration would need to be made for the Tule Lake area which has a different GSA. See Table 26 for a county-wide model of the tax rates that would be need.

Because the tax rates are relatively low for all tax models (<<$15.00 per year) (Tables 23-26), the political advantage of a county-wide tax is muted.

SPECIAL TAX IMPLEMENTATION PROCESS

Public agencies typically work with special consultants familiar with the administrative and political aspects of proposing a special tax to a community. Special tax elections held at polling places are conducted on the statutorily designated dates (typically in November for the general election and either March or June for the primary).

If the Agency ultimately decides to pursue a special tax, it is highly recommended that a special all-mail election be considered. Special all-mail ballot elections are often less expensive and allow for more optimization of the election date, as well as having the advantage of presenting a single issue to the voters.

REQUIRED DOCUMENTS FOR A PARCEL BASED SPECIAL TAX

- Ordinance or Resolution stating: tax type, tax rates, collection method, election date and services provided
- Notice to the Registrar of Voters of measure submitted to voters
- Measure Text including:
    - Ballot question (75 words or less)
    - Full ballot text (300 words or less) including rate structure
    - Arguments in favor or against and independent analysis

- Tax Report

FLEXIBILITY OF METHODOLOGY

There is considerable flexibility in tax methodology. The Agency could propose a flat tax rate in which all parcels are charged the same or a "tiered approach" where, for example larger, and/or commercial parcels may be taxed more than vacant lots. If a tiered approach is considered, the Agency should consider using existing Community Facilities District ("CFD") law and practice which better defends the use of a tiered structure.

REVENUE GENERATION POTENTIAL

A detail breakdown of the parcel attributes including number of parcels, number of residential units (for multi-family parcels) and acres for agricultural parcels in the three basins is shown in Tables 19, 20, and 21 below:

TABLE 19 – PARCEL ATTRIBUTES WITHIN BUTTE VALLEY BASIN

	Parcels	Residential Units	Acres
Single Family	410	434	1,318
Multi: 2 - 4 units	68	136	117
Mobile Home	117	117	4,821
Commercial/Industrial	79	NA	114
Office	12	NA	6
Vacant	540	NA	2,198
Parking & Storage	11	0	16
Agricultural	442	NA	51,904
Timber & Pasture	119	NA	40,372
Not Assessable	55	NA	168
Totals	**1,853**	**687**	**101,035**

TABLE 20 – PARCEL ATTRIBUTES WITHIN SCOTT VALLEY BASIN

	Parcels	Residential Units	Acres
Single Family	1,375	1,401	10,684
Multi: 2 - 4 units	140	280	599
Mobile Home	191	191	3,926
Commercial/Industrial	150	NA	376
Office	16	NA	17
Vacant	659	NA	8,271
Institutional & Gov't	9	0	54
Multi: 5+ units	13	NA	80
Cemetaries	2	NA	34
Agricultural	972	NA	66,763
Timber & Pasture	77		13,981
Not Assessable	167		617
Totals	**3,527**	**1,872**	**90,803**

TABLE 21 – PARCEL ATTRIBUTES WITHIN SHASTA VALLEY BASIN

	Parcels	Residential Units	Acres
Single Family	4,671	4,868	19,828
Multi: 2 - 4 units	441	882	1,526
Condo	21	21	19
Mobile Home	465	465	8,921
Commercial/Industrial	384	NA	1,099
Office	89	NA	32
Vacant	5,303	0	27,291
Parking & Storage	11	NA	19
Multi: 5+ units	28	NA	10
Cemeteries	344	NA	2,405
Agricultural	1,238	NA	167,985
Timber & Pasture	136	NA	31,400
Unassessable	363	NA	1,822
Totals	**13,494**	**6,236**	**262,355**

Next, we have modelled hypothetical rates to generate the revenue goals in the three basins Tables 22, 23, and 24. Table 25 models Shasta Valley is the boundaries are enlarged to include all parcels with the Shasta Valley Watershed. Table 26 models a special tax for all of Siskiyou County (including the Tule Lake GSA area).

TABLE 22 – MODEL OF TAX RATE AND REVENUES FOR SPECIAL TAX IN BUTTE VALLEY BASIN

	Parcels	Residential Units	Acres	Low Range		High Range		Units
Single Family	410	434	1,318	$4.50	$1,953	$10.50	$4,557	*per residential unit*
Multi: 2 - 4 units	68	136	117	$4.50	$612	$10.50	$1,428	*per residential unit*
Mobile Home	117	117	4,821	$4.50	$527	$10.50	$1,229	*per residential unit*
Commercial/Industrial	79	NA	114	$4.50	$356	$10.50	$830	*per parcel*
Office	12	NA	6	$4.50	$54	$10.50	$126	*per parcel*
Vacant	540	NA	2,198	$4.50	$2,430	$10.50	$5,670	*per parcel*
Parking & Storage	11	0	16	$4.50	$0	$10.50	$116	*per parcel*
Agricultural	442	NA	51,904	$1.40	$72,666	$2.35	$121,975	*per acre*
Timber & Pasture	119	NA	40,372	$1.40	$56,521	$2.35	$94,875	*per acre*
Not Assessable	55	NA	168	$0.00	$0	$0.00	$0	*per parcel*
Totals	**1,853**	**687**	**101,035**		**$135,118**		**$230,805**	
				Revenue Goals:	**$135,000**		**$230,000**	

TABLE 23 – MODEL OF TAX RATE AND REVENUES FOR SPECIAL TAX IN SCOTT VALLEY BASIN

	Parcels	Residential Units	Acres	Low Range		High Range		Units
Single Family	1,375	1,401	10,684	$6.50	$9,107	$13.00	$18,213	*per residential unit*
Multi: 2 - 4 units	140	280	599	$6.50	$1,820	$13.00	$3,640	*per residential unit*
Mobile Home	191	191	3,926	$6.50	$1,242	$13.00	$2,483	*per residential unit*
Commercial/Industrial	150	NA	376	$6.50	$975	$13.00	$1,950	*per parcel*
Office	16	NA	17	$6.50	$104	$13.00	$208	*per parcel*
Vacant	659	NA	8,271	$6.50	$4,284	$13.00	$8,567	*per parcel*
Institutional & Gov't	9	0	54	$6.50	$0	$13.00	$117	*per parcel*
Multi: 5+ units	13	NA	80	$1.75	$140	$3.00	$240	*per acre*
Cemetaries	2	NA	34	$1.75	$59	$3.00	$101	*per acre*
Agricultural	972	NA	66,763	$1.75	$116,835	$3.00	$200,289	*per acre*
Timber & Pasture	77		13,981	$1.75	$24,466	$2.75	$38,447	*per acre*
Not Assessable	167		617	$0.00	$0	$0.00	$0	*per parcel*
Totals	**3,527**	**1,872**	**90,803**		**$134,565**		**$235,808**	
				Revenue Goals:	**$135,000**		**$230,000**	

TABLE 24 – MODEL OF TAX RATE AND REVENUES FOR SPECIAL TAX IN SHASTA VALLEY BASIN

	Parcels	Residential Units	Acres	Low Range		High Range		Units
Single Family	4,671	4,868	19,828	$3.00	$14,604	$7.00	$34,076	*per residential unit*
Multi: 2 - 4 units	441	882	1,526	$3.00	$2,646	$7.00	$6,174	*per residential unit*
Condo	21	21	19	$3.00	$63	$7.00	$147	*per residential unit*
Mobile Home	465	465	8,921	$3.00	$1,395	$7.00	$3,255	*per parcel*
Commercial/Industrial	384	NA	1,099	$3.00	$1,152	$7.00	$2,688	*per parcel*
Office	89	NA	32	$3.00	$267	$7.00	$623	*per parcel*
Vacant	5,303	0	27,291	$3.00	$0	$7.00	$37,121	*per parcel*
Parking & Storage	11	NA	19	$0.75	$14	$1.00	$19	*per acre*
Multi: 5+ units	28	NA	10	$0.75	$8	$1.00	$10	*per acre*
Cemeteries	344	NA	2,405	$0.75	$1,804	$1.00	$2,405	*per acre*
Agricultural	1,238	NA	167,985	$0.75	$125,989	$1.00	$167,985	*per acre*
Timber & Pasture	136	NA	31,400	$0.75	$23,550	$1.00	$31,400	*per acre*
Unassessable	363	NA	1,822	$0.00	$0	$0.00	$0	*per parcel*
Totals	**13,494**	**6,236**	**262,355**		**$171,491**		**$285,903**	
				Revenue Goals:	**$168,750**		**$287,500**	

Alternatively, a model of tax rate and revenues might be considered for the Shasta watershed as a whole, given the amount of interconnected surface water above the Basin. This model is shown in table 25 below:

TABLE 25 – MODEL OF TAX RATE AND REVENUES FOR SPECIAL TAX IN THE ENTIRE SHASTA VALLEY WATERSHED

	Parcels	Residential Units	Acres	Low Range		High Range		Units
Single Family	6,556	5,033	25,487	$2.50	$12,583	$4.50	$22,649	*per residential unit*
Multi: 2 - 4 units	552	882	552	$2.50	$2,205	$4.50	$3,969	*per residential unit*
Mobile Home	671	483	9,880	$2.50	$1,208	$4.50	$2,174	*per residential unit*
Commercial/Industrial	563	N/A	1,856	$2.50	$1,408	$4.50	$2,534	*per parcel*
Office	105	N/A	38	$2.50	$263	$4.50	$473	*per parcel*
Vacant	6,653	N/A	49,196	$2.50	$16,633	$4.50	$29,939	*per parcel*
Parking & Storage	11	N/A	19	$2.50	$28	$4.50	$50	*per parcel*
Agricultural	1,397	N/A	196,618	$0.50	$98,309	$0.85	$167,125	*per acre*
Timber & Pasture	266	N/A	76,341	$0.50	$38,170	$0.85	$64,890	*per acre*
Not Assessable	393	N/A	1,872	$0.00	$0	$0.00	$0	*per parcel*
Totals	**17,167**	**6,398**	**361,857**		**$170,804**		**$293,800**	
				Revenue Goals:	**$168,750**		**$287,500**	

Another consideration for a special tax is implementing a county-wide model. This would help to spread costs out among all landowners in the county, lessening the financial burden for well owners. This may be perceived as unfair to those who do not reside above the basins, but it can be asserted that the GSP implementation is beneficial to all county residents. A county-wide special tax is modelled below in Table 26:

TABLE 26 – MODEL OF TAX RATE AND REVENUES FOR SPECIAL TAX IN ENTIRE SISKIYOU COUNTY

	Parcels	Residential Units	Acres	Low Range		High Range		Units
Single Family	14,863	7,725	69,376	$2.75	$21,244	$5.25	$40,556	*per residential unit*
Multi: 2 - 4 units	2,185	1,323	5,993	$2.75	$3,638	$5.25	$6,946	*per residential unit*
Mobile Home	2,914	921	32,626	$2.75	$2,533	$5.25	$4,835	*per residential unit*
Commercial/Industrial	1,415	N/A	6,067	$2.75	$3,891	$5.25	$7,429	*per parcel*
Office	186	N/A	66	$2.75	$512	$5.25	$977	*per parcel*
Vacant	16,833	N/A	169,920	$2.75	$46,291	$5.25	$88,373	*per parcel*
Parking & Storage	46	N/A	135	$2.75	$127	$5.25	$242	*per parcel*
Agricultural	4,078	N/A	548,372	$0.30	$164,512	$0.50	$274,186	*per acre*
Timber & Pasture	2,078	N/A	660,295	$0.30	$198,088	$0.50	$330,147	*per acre*
Not Assessable	988	N/A	21,473	$0.00	$0	$0.00	$0	*per parcel*
Totals	**45,586**	**9,969**	**1,514,323**		**$440,835**		**$753,691**	
			Revenue Goals:		$438,750		$747,500	

ADVANTAGES

- Revenue generation is likely sufficient to fund all GSP implementation costs if voter approved.
- Legally rigorous. Special taxes, if approved by two-thirds of the registered voters within a community, are very reliable and very rarely legally challenged successfully. Special tax revenue has not been subject to state level "take-aways" like ERAF.
- Well known. Most property owners are aware and comfortable with (but not necessarily supportive of) the special taxes and the special tax process.
- Very low tax rates (<<$15.00) per year are often reasonably well-supported by voters
- Efficient administration

CHALLENGES

- Political support at required rate and revenue may be difficult. Generally speaking, the two-thirds majority threshold for approval is very politically challenging. Special taxes are subject to significant outside influence from media and opposition groups during voting and are more vulnerable to other measures and candidates that share the ballot. (However, a recent California Supreme Court decision called the “Upland Case” allows for voter initiatives to be approved with a more easily achievable 50% threshed. The Agency should evaluate the pros and cons of the effectiveness of an voter initiative.)

GENERAL OBLIGATION BONDS SUPPORTED BY A SPECIAL TAX

In California, special taxes can be linked directly to the sale of general obligation bonds to finance the construction of infrastructure. In 2004, the City of Los Angeles successfully passed "Measure O" which provided funding for a variety of capital improvements related to water quality. Arguably, voters are more likely to support general obligation bond special taxes than parcel-based taxes at equivalent rates.

However, since special taxes for general obligations bonds can only be used for the financing of capital improvements, this mechanism could only be used to fund the CIP portion of the needs – not the operating costs of the groundwater management infrastructure.

In other words, the passage of a G.O. Bond would not satisfy the Agency's overall groundwater management funding goals, because this source could not fund ongoing operations and maintenance. However, it is possible that community priorities and a revised funding strategy could dictate that pursuit of a G.O. bond measure is optimal to fund any significant groundwater management capital projects. Results of the public opinion survey should help guide this decision.

OTHER APPROACHES – LESS OPTIMAL

BALLOTED PROPERTY-RELATED FEE OR BENEFIT ASSESSMENTS ON ALL PROPERTY OWNERS IN THE BASIN

If the Agency decides to pursue a revenue mechanism applied to well owners, a non-balloted property related fee is optimal, and if the Agency decides to pursue a revenue mechanism applied to all property owners in the basin, a special tax is most likely the best choice. However, there are two other approaches described in Proposition 218 worthy of discussion, especially if voter support is marginal: 1.) a balloted property related fee or 2.) a benefit assessment. Both of these are more expensive to implement and administer and are considerably less legally rigorous (especially with no current precedent) than a special tax. Nonetheless, both require only a 50% approval for implementation. Further research and evaluation would need to be pursued.

OTHER CONSIDERATIONS

CONDUCT A SURVEY IF CONSIDERING A PROPERTY-RELATED FEE OR SPECIAL TAX

See a full discussion in the next section.

IMPLEMENT RIGOROUS COMMUNITY OUTREACH IF CONSIDERING A PROPERTY-RELATED FEE OR SPECIAL TAX

See a full discussion in the next section.

TIMING AND SCHEDULE

The selection of the balloting date is one of the most important factors affecting the success of any measure. Potential competition with other measures, income and property tax due dates, seasons, and holidays, etc. should all be evaluated when choosing a balloting date.

A COST ESCALATOR IS RECOMMENDED FOR BALLOTED MECHANISMS

Non-balloted funding mechanisms can be updated periodically using the noticed public hearing procedure described above. This is the typical method of keeping revenues aligned with costs through the years as in the case for retail water and sewer fees. Accordingly, the rates can be kept updated for inflationary forces and other cost increases on a five-year recurrence cycle.

However, for balloted mechanisms, any increase or change in rate structures requires a re-balloting unless the original balloting included a pre-determined formula for escalation – such as the Consumer Price Index (CPI). Infrastructure-intensive utilities are driven by many different forces than those that drive the CPI, including the need for capital investment programs, regulatory programs, and the economics of sustainability, conservation, and commodity constraints. Due, in part, to these other drivers, rates for utilities have not traditionally been tied to a straightforward CPI, but rather have been expressed as a specific rate amount for a given year based on actual projected costs. Nonetheless, costs do increase over time and a cost escalator is recommended to reimburse the Agency for this increase. The simplest to explain to property owners and to administer annually is a CPI, based upon a readily available index such as the U.S. Department of Labor, which would allow for annual rate increases without annual balloting. A CPI escalator is legally defensible with property related fees, regulatory fees, and special taxes.

However, a CPI approach may make it difficult to accommodate infrastructure-driven cost increases in coming years. An alternative approach would be to include a rate adjustment schedule that would include specific increases in future years that meet the UVBGAS's needs. (This approach, commonly used by water and sewer providers, often communicates to the property owner in table form with the proposed rate corresponding to each year for the next four or five years.)

At this point in the process, it is difficult to make a concise recommendation for the escalator mechanism. It would depend on the escalating costs and how they affect the proposed rates in the foreseeable future. It would also depend in part on the proposed rate structure itself, as some structures may be based on variables that intrinsically accommodate increasing groundwater management needs. Finally, it would depend on the political considerations that come with any ballot measure. Historically, the majority of survey data supports the fact that a CPI escalator introduces minimal decay in overall support.

A SUNSET PROVISION IS NOT RECOMMENDED, BUT SHOULD BE CONSIDERED

A "Sunset Provision" is a mechanism used to increase political support by setting an expiration date for a measure, and can be used with a property related fee, regulatory fee, or tax. Sunset provisions typically range from five years to as much as 20 years in some rare cases. However, the political advantage may be slight and does not outweigh the negative aspect of the increased costs and political risk of having to re-ballot at the termination of the sunset period.

One variation is the "sundown" clause. This is the name given to a tax or fee that would reduce after a specific date – leaving a portion of the tax or fee to continue indefinitely. This tactic is useful for programs that have a one-time capital need and then would reduce to fund only operations and maintenance beyond that. If the one-time capital need is debt financed, the "sundown" period would need to be at least as long as the debt repayment period.

A "DISCOUNT MECHANISM" SHOULD BE CONSIDERED, BUT MAY NOT BE COST-EFFECTIVE

Consistent with the efforts of obtaining higher quality groundwater, a discount or "rate reduction" program should be considered which rewards well owners implementing groundwater sustainability management measures on their properties with a lower fee, based on the reduced cost of providing groundwater service. Any such program would need to be coordinated with whatever rate structure the Agency decides on to ensure that it fits with the rationale and is compliant with Proposition 218.

The advantages of such a program include improved water quality, improved engagement by the community, as well as a rate more tailored to individual usage. Also, discount programs tend to be well received by the electorate, although most people do not participate. The downside of such a program is that the benefit may not justify the cost of administering this program, because the inspection of property-specific improvements is expensive and time consuming. Nonetheless, a couple of public agencies including the cities of Portland, Oregon, South Lake Tahoe, and Palo Alto have successfully implemented discount programs on their storm drainage fees. The community's interest level for a discount mechanism will be evaluated as part of the mail survey opinion research.

III. RECOMMENDATIONS FOR IMPLEMENTATION OF FUNDING MECHANISMS

Following is a "Game Plan" outline of the recommended steps for implementation of funding for the GSA's GSP implementation. Most of the steps have been discussed above – a discussion of community public opinion surveying and community outreach is included below.

GAME PLAN

1. Conduct community outreach regarding the Plan and its implementation.
2. Pursue use of existing revenue sources to fund implementation.
3. Pursue Grants and Loan Opportunities to fund implementation.
4. Implement Regulatory Fees to offset eligible implementation costs.

If additional revenue is needed:

5. Conduct a survey and stakeholder outreach to better evaluate:
   a. Community priorities and associated messaging.
   b. Optimal rate.
   c. Preference of non-balloted property related fee versus special tax.
6. Use results of surveys, stakeholder input and other analyses to develop a community outreach plan.
7. Implement the community outreach.
8. Implement a property related fee or special tax balloting:
   a. Include a cost escalator schedule or mechanism.
   b. Include the use of rate zones or other distinguishing factors.
   c. Do not include a rate expiration date (also known as a "Sunset Clause").
   d. Include a Discount Program to encourage better groundwater management by well owners.

CONSIDER A PUBLIC OPINION SURVEY

The primary purpose of the public opinion survey is to produce an unbiased, statistically reliable evaluation of voters' and property owners' interest in supporting a local revenue measure. Should the Agency decide to move forward with a revenue measure (property-related fee or special tax), the survey data provides guidance as to how to structure the measure so that it is consistent with the community's priorities and expressed needs. Agencies typically engage specialized survey firms to conduct surveys.

Specifically, the survey should:

- Gauge current, baseline support for a local revenue measure associated with specific dollar amounts. (How much are well owners/property owners willing to pay?)
- Identify the types of services and projects that voters and property owners are most interested in funding.
- Identify the issues voters and property owners are most responsive to (e.g., preventing subsidence, maintaining water availability, reducing pumping costs, protecting water quality, etc.).

- Expose respondents to arguments in favor of—and against—the proposed revenue measure to gauge how information affects support for the measure.
- Identify whether local residents prefer the measure as a property related fee or a special tax.

As the nation struggles with the COVID-19 pandemic, it is more important than ever to measure a community's position on all of these elements. What community leaders thought they knew about public opinion may no longer be accurate in a post-COVID world. And while a survey can provide the Agency with valuable information, it will also be an opportunity to begin getting the groundwater "brand" out into the community – a valuable early step in this process.

COMMUNITY SUPPORT AND ENGAGEMENT

Clear, concise, and appropriate community outreach is one of the most important elements for successful implementation of a funding mechanism. The basic message components need to be simple, clear, and transparent, and need to be well supported with detailed and substantive information. Credibility is the most important factor in this outreach.

Agencies often, but not always, will engage specialized consultants to assist with community outreach in support of implementation of funding mechanisms. A community outreach plan should be developed and implemented. Three major steps are described blow.

Develop Communication Infrastructure
The GSA should carefully evaluate and develop potential communication infrastructure, ultimately coordinating with existing communication infrastructure, including stakeholder contacts, print media, website, social media, print publications, neighborhood groups, and newsletters, etc. Use of e-mail contacts (with HOA, neighborhood and stakeholder groups and leaders, and web-based platforms like nextdoor.com is encouraged). Develop a schedule of community stakeholder meetings, due dates for local group newsletters, etc.

In most cases, the most effective communication mechanisms for this type of infrastructure are small, local, and neighborhood-based, with personal communication or face-to-face (as appropriate in COVID-19 environment). This approach is not expensive, but it is a significant amount of work and is very effective when well-executed.

Develop Communication Messaging
The development of the messaging and supporting information is an iterative process with staff, consultant, and community members. (If a community survey is conducted, it can be extremely helpful in developing the most effective messaging.) Throughout this process, the Agency and consultant will analyze and refine messaging associated with groundwater sustainability management benefits. In this task, the Agency should develop draft communications of various types, including Frequently Asked Questions documents, social media content, mailers and brochures, PowerPoint presentations, and e-mails, scripts, and other adaptable messages.

Communications Rollout and Implementation
Once the outreach plan is well-vetted, reviewed, and refined, the Agency should coordinate the plan's rollout and implementation.

Appendix 5-D Siskiyou County Agricultural Economics Analysis Considering Groundwater Regulation

University of California, Merced

Siskiyou County Agricultural Economics Analysis Considering Groundwater Regulation

Supplementary Information for the Groundwater Sustainability Plan

Spencer A. Cole & Josué MedellÍn-Azuara
9-2-2021

1. Introduction

1.1. Background

This economic analysis estimates potential impacts in gross revenues from changing cropping patterns in Siskiyou County's three agricultural valleys namely Butte Valley (Butte), Scott River Valley (Scott), and Shasta Valley (Shasta). This analysis provides insight on economic costs of benefits of land and water use decisions, while identifying areas that may benefit from intervention and stakeholder processes.

Below, we outline the structure and basis for an agricultural production and water use economic model whose purpose is to estimate impacts of land and water use policies on agricultural value in Siskiyou County. Model coverage includes most of the agriculture by irrigated area within the county, with the notable exception of the greater Tulelake area located in the northeast corner of the county (Figure 1) which contains some valuable commodities such potatoes. The Butte, Scott River, and Shasta Valleys were the most distinct agricultural regions within the county and showing significant differences in production factors such as access to groundwater and crop mix. The agricultural model is calibrated using 2018 as a baseline water year because it represents a relatively recent water year with most crop demands fulfilled in comparison to the drier 2014 and 2016 water years (Department of Water Resources, 2021), which are also available at the Department of Water Resources streamflow indices (Department of Water Resources, 2020).

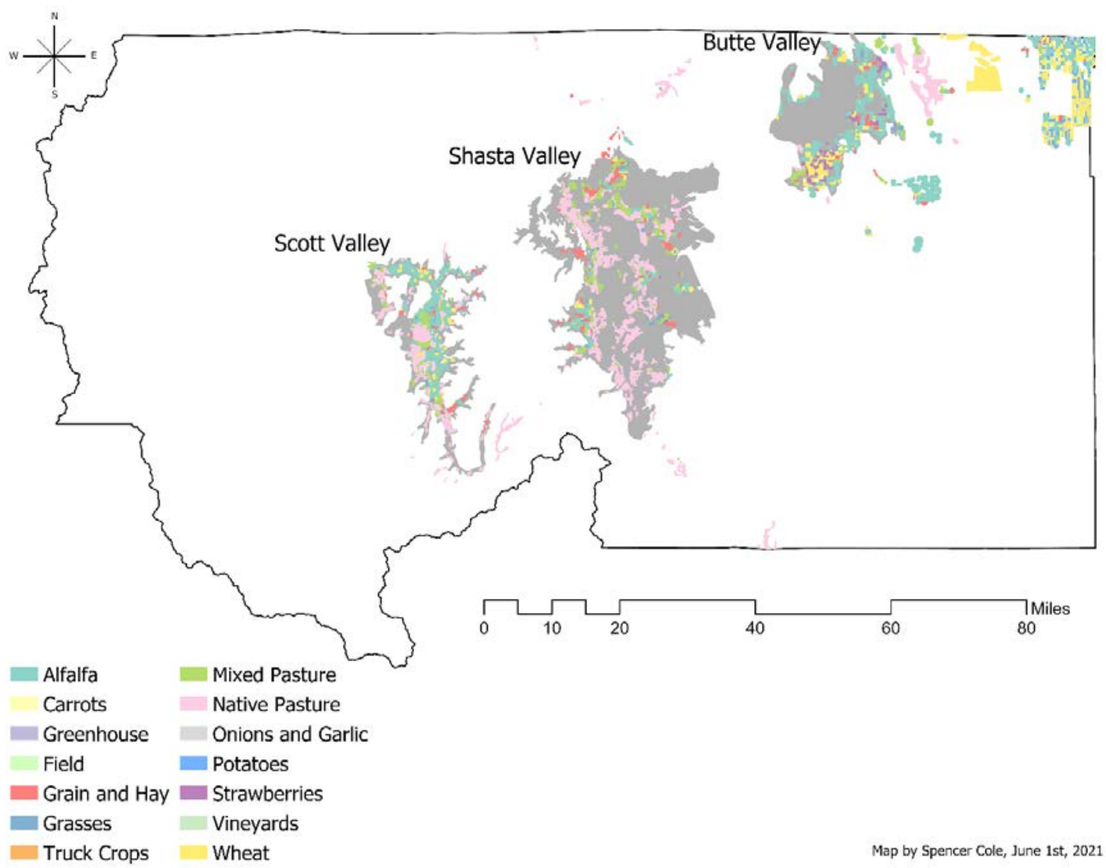

Figure 1: Region delineations and crop coverage represented in the agricultural model. Parcels located outside grey valley boundaries are not included in the model. ***Source: 2018 LandIQ land use survey (Department of Water Resources, 2021).***

1.2. Data sources

Information employed for defining the base case for production in the three valleys is summarized in Table 1. Land use calibration is based on 2018 data for land use and crop production economics where available. Recent cost information for crop commodities is prioritized when available and relevant to the production in Siskiyou County. Applied water requirements for crops are based on specific estimates at the valley scale for use in the integrated valley models. Whereas the model is calibrated using land use information from the LandIQ 2018 land use survey deployed through the California Land Use Viewer (Department of Water Resources, 2021), crop mix across the county and in individual valleys were cross-checked with parcel scale Department of Water Resources surveys for 2000 and 2010, the LandIQ 2016 survey, and the total agricultural footprint represented in the Siskiyou County Agricultural Commissioner's Report to ensure capture of key crops in the region.

Table 1: Summary of data sources for modeling of Siskiyou agricultural production.

Data type	Source	Spatial resolution	Temporal resolution
Valley boundaries	Department of Water Resources[1]	Polygon layer	N/A
Agricultural land use	LandIQ[2]	Parcel	Annual
Crop prices	Siskiyou County Agricultural Commissioner Reports[3]	County	Annual
Crop yields	Siskiyou County Agricultural Commissioner Reports[3]	County	Annual
Crop production costs	UC Davis Cost and Return Studies[4]	Regional	Varies
Applied water	Scott Valley Integrated Hydrologic Model[5], Butte Valley Integrated Hydrologic Model[1], Shasta Valley Integrated Hydrologic Model[6]	Valley	Annual

[1] Provided by Bill Rice.
[2] https://gis.water.ca.gov/app/CADWRLandUseViewer/.
[3] https://www.co.siskiyou.ca.us/agriculture/page/crop-report.
[4] https://coststudies.ucdavis.edu/en/.
[5] Provided by Claire Kouba.
[6] Provided by Cab Esposita.

1.3. Baseline conditions

Tables 2 to 4, below summarize the 2018 base conditions across each of the valleys in the model in terms of land and water use as well as crop revenues. Data is taken directly from the data sources described in section 1.2. above, apart from minor additions and adjustments when necessary to support the model function or to reflect farmer feedback during the workshop stakeholder meetings in June 2021. For example, in Butte Valley, 400 acres of onions and garlic were added to the model because the 2018 land use dataset did not identify any of these crops within the valley boundaries; farmers provided feedback noting that there was cultivation in areas within the valley. Currently, production cost information and crop water demand for nursery berries (raspberries and strawberries) is unavailable and is estimated based on the assumption that returns yield a 15% profit margin over total costs. Cost information available for carrot production is outdated and represents only fresh market cultivation, which does not represent the seed production in Siskiyou County; thus, costs for carrots are scaled to account for these differences. It is assumed that average profit margins for most crops range between zero and five percent of the crop gross revenues, thus some minor adjustments in selected crop prices were implemented in case negative profits from using the cost and return studies data were identified.

Table 2: Butte Valley base conditions. ***Source:*** **Author calculations using data listed in Table 1.**

Crop	**Land (ac)**	**Applied water (AF/ac)**	**Price ($/ton)**	**Yield (ton/ac)**	**Labor cost ($/ac)**	**Supply cost ($/ac)**	**Land cost ($/ac)**	**Gross revenue ($ million)**
Alfalfa	14,015	2.22	193	6.4	187	437	482	17.42 (10.6%)
Barley	1,460	1.51	286	2.3	122	285	204	0.97 (0.6%)
Carrots	313	2.09	56	66.7	976	2,278	248	1.16 (0.7%)
Onions and garlic	400	2.09	166	25.0	792	1,849	1,193	1.66 (1.0%)
Other hay	529	2.22	260	4.5	187	437	482	0.62 (0.4%)
Pasture	1,215	2.70	200	3.5	109	254	255	0.85 (0.5%)
Raspberries†	140	3.32	14	4,286	31,945	15,734	1,500	8.10 (4.9%)
Strawberries†	2,537	3.32	0.14	37,0000	28,495	14,035	1,500	131.39 (79.6%)
Wheat	4,502	1.51	203	3.2	122	285	204	2.90 (1.8%)
Total	**25,112**	**-**	**-**	**-**	**-**	**-**	**-**	**165.06 (100%)**

† Units in terms of plants rather than tons.

Table 3: Scott River Valley base conditions. ***Source:*** **Author calculations using data listed in Table 1.**

Crop	**Land (ac)**	**Applied water (AF/ac)**	**Price ($/ton)**	**Yield (ton/ac)**	**Labor cost ($/ac)**	**Supply cost ($/ac)**	**Land cost ($/ac)**	**Gross revenue ($ million)**
Alfalfa	12,267	1.97	193	6.4	187	437	482	15.25 (54.9%)
Barley	1,415	1.08	284	2.3	122	285	204	0.92 (3.3%)
Other hay	546	1.97	260	4.5	187	437	482	0.64 (2.3%)
Pasture	13,948	2.30	200	3.5	109	254	255	9.76 (35.1%)
Wheat	1,883	1.08	203	3.2	122	285	204	1.21 (4.4%)
Total	**30,060**	**-**	**-**	**-**	**-**	**-**	**-**	**27.79 (100%)**

Table 4: Shasta Valley base conditions. ***Source:*** **Author calculations using data listed in Table 1.**

Crop	**Land (ac)**	**Applied water (AF/ac)**	**Price ($/ton)**	**Yield (ton/ac)**	**Labor cost ($/ac)**	**Supply cost ($/ac)**	**Land cost ($/ac)**	**Gross revenue ($ million)**
Alfalfa	4,584	2.22	193	6.4	187	437	482	5.70 (14.7%)
Barley	3,780	1.51	286	2.3	122	285	204	2.49 (6.4%)
Other hay	1,660	2.22	260	4.5	187	437	482	1.95 (5.0%)
Pasture	30,642	2.70	200	3.5	109	254	255	21.45 (55.2%)
Strawberries†	125	3.32	0.14	370,000	28,495	14,035	1,500	6.49 (16.7%)
Wheat	1,273	1.51	203	3.2	122	285	204	0.83 (2.1%)
Total	**42,063**	**-**	**-**	**-**	**-**	**-**	**-**	**38.89 (100%)**

† Units in terms of plants rather than tons.

Table 5 summarizes overall land use, gross revenue, and water use summed across the three valleys. Following the modifications outlined above. The baseline dataset suggests the gross economic value within the three valleys totals $231.8 million, with $164.8 million, $27.6 million, and $38.4 million allocated to Butte, Scott River, and Shasta Valleys, respectively. Total agricultural land use in the study area is estimated to be about 97,000 acres, with 25,000 acres, 30,000 acres, and 42,000 acres in Butte, Scott River, and Shasta Valleys, respectively. Water use from irrigation is estimated at 220,000 acre-feet per year, of which 55,000 acre-feet, 61,000 acre-feet, and 104,000 acre-feet are used in Butte, Scott River, and Shasta Valleys, respectively on an annual basis. Agricultural value in Butte Valley is dominated by the small but extremely valuable berry plant transplant industry, which contributes $139.5 million of the region's $164.8 million gross revenue on only 11% of land (Siskiyou County Agricultural Commissioner, 2018). Both agricultural land and value in Scott River Valley consist of roughly 85% alfalfa and pasture in combination, with nearly equal area of each crop and small acres of other miscellaneous crops. About 75% of agricultural land and 50% of value in Shasta Valley is composed of pasture, with only about 125 acres of nursery strawberries making up a significant portion of remaining value.

Table 5: Baseline conditions across all three valleys. *Source:* Author calculations using data listed in Table 1.

Crop	Land (ac)	Water use (AF)	Gross revenue ($ million)
Alfalfa	30,866 (31.7%)	65,511 (29.7%)	38.4 (16.6%)
Barley	6,655 (6.8%)	9,424 (4.3%)	4.4 (1.9%)
Carrots	313 (0.3%)	653 (0.3%)	1.2 (0.5%)
Onions and garlic	400 (0.4%)	834 (0.4%)	1.7 (0.7%)
Other hay	2,734 (2.8%)	5,942 (2.7%)	3.2 (1.4%)
Pasture	45,805 (47.1%)	118,017 (53.5%)	32.0 (13.8%)
Raspberries	139 (0.1%)	465 (0.2%)	8.1 (3.5%)
Strawberries	2,661 (2.7%)	8,837 (4.0%)	137.9 (59.5%)
Wheat	7,657 (7.9%)	10,735 (4.9%)	4.9 (2.1%)
Total	**97,236 (100%)**	**217,121 (100%)**	**231.8 (100%)**

2. Model calibration and assumptions

Calibration of the model is based on the concept of Positive Mathematical Programming (PMP; Howitt, 1995), a self-calibrating technique to economically represent agricultural production and water use based on profit maximization theory and capturing non-linearities in production. PMP modeling avoids overspecialization in land allocation decisions which is common in linear programming. Thus, highly profitable crops which are produced in limited amounts do not expand at the expense of low-value crops in a way that is inconsistent with observations. The PMP calibration method consists of three steps as described in Howitt et al. (2012): (1) constrained linear optimization to derive shadow values of crop land; (2) parametrization of a constant elasticity of substitution (CES) production function and non-linear cost function; and (3) specification of the model objective function and check for calibration quality. Once the model is fully calibrated, constraint and objective function modifications can be used to examine scenarios of interest. Each of the three regions in the model (Butte, Scott River, Shasta) are calibrated and run independently from one another with an annual decision period. The calibrated model employs the equations listed below which include a CES production function and a non-linear exponential cost function (Howitt et al. 2012).

Box 1: Specification of calibrated model.

$$max\ \{x_{i,land}\} \prod = \sum_i \left(p_i \tau_i \left(\sum_j \beta_{i,j}\, x_{i,j}^{\rho_i} \right)^{\frac{1}{\rho_i}} - \delta_i e^{\gamma_i x_{i,land}} - \sum_{labor,supplies,water} \alpha_{i,j} \omega_{i,j} x_{i,land} \right)$$

$$s.t.$$

$$\sum_i x_{i,land} \leq \sum_i \tilde{x}_{i,land}$$

$$\sum_i x_{i,land} \tilde{x}_{i,water} \leq \sum_i \tilde{x}_{i,land} \tilde{x}_{i,water}$$

$$\frac{x_{i,water}}{x_{i,land}} \leq 0.99\tilde{x}_{i,water}$$

$$\forall\ i\ \in \begin{bmatrix} alfalfa, barley, carrots, onions\ and\ garlic, other\ hay, pasture, raspebrries, \\ strawberries, wheat \end{bmatrix}$$

$$\forall\ j\ \in [land, labor, supplies, water]$$

The first equation is the profit maximization objective function, which is followed by the land and water availability constraint sets, and an irrigation stress constraint to avoid deficit irrigation of crops. Parameters in the three constraint sets above can be modified, including the limit of land and/or water available for crops and use of deficit irrigation as a potential adaptation to drought or water rationing policies.

2.4. Model assumptions

Interpretation of model function and output is contingent on several assumptions employed in the model framework. Agriculture is represented in the model as a "snapshot" of cropping patterns and economics observed across one or more years and pertains only to annual decision-making processes. In many cases, agriculture follows rotation cycles which are not captured explicitly in the model; land use data employed in model calibration is assumed to represent an pseudo-equilibrium state for rotating crops which is representative of a typical annual crop mix, with some portion of cropland in each cycle of their rotation. Farm-scale decisions for plantings oftentimes depend on multi-year investments and production conditions which are not captured in the annual structure of the model. As such, the model's purpose is not to suggest planting decisions for individual parcels, but rather to present possible impacts on agriculture at the aggregate scale. To predict annual cropping patterns at the regional scale, the model assumes that some degree of water trading occurs within each region to retain more profitable crops when resource shortages are in place.

3. Scenarios Overview

The calibrated model was applied in seven scenarios which are designed to establish preliminary measure for the effects of land management policies on agricultural value across the three valleys. Table 6 below, summarizes the context and implementation of the scenarios in the model.

Table 6: Summary of model scenarios.

Scenario number / name	Description
Scenario 1a: 15% fallowing of pasture and alfalfa	All alfalfa and pasture are fallowed by 15%, with no ability to re-operationalize land and water use reductions with other crops.
Scenario 1b: 30% fallowing of pasture and alfalfa	All alfalfa and pasture are fallowed by 30%, with no ability to re-operationalize land and water use reductions with other crops.
Scenario 1c: 60% fallowing of pasture and alfalfa	All alfalfa and pasture are fallowed by 60%, with no ability to re-operationalize land and water use reductions with other crops.
Scenario 2: forego third alfalfa cutting	Simulate ceasing half of irrigation for alfalfa by July 1st, represented in the model as 33% deficit irrigation for alfalfa and a corresponding reduction

	in yield of 33%. Water use reductions from deficit irrigating alfalfa are retained.
Scenario 3: 15% fallowing (adaptive)	Total agricultural land undergoes 15% fallowing, and model given flexibility to optimize distribution of cutbacks across individual crops.
Scenario 4: 15% fallowing ("worst case")	Total agricultural land undergoes 15% fallowing, distributed evenly across all crops (area of all crop reduced by 15%).
Scenario 5: 15% water shortage (adaptive)	Total agricultural water use cutback by 15%, and model given flexibility to optimize distribution of cutbacks across individual crops.
Scenario 6: exploring economic tradeoffs between alfalfa and strawberries in Butte Valley	Comparison of marginal value and unit water use for alfalfa and berry plant transplant strawberries conducted to assess viability of converting between the two crops.
Scenario 7: exploring lower water use alternatives to alfalfa and pasture	Crop portfolio is assessed to locate water saving opportunities through crop conversion, with high retention or expansion of crop value.

4. Scenario Model Outcomes

4.1. Direct agricultural impacts (model results)

4.1.1. Scenario 1a: 15% fallowing of pasture and alfalfa

In this scenario, we simulate prescribed fallowing of pasture and alfalfa by 15% of baseline conditions within each region. Land and water previously devoted to these crops are treated as savings and thus are not allowed to be utilized in the model for the expansion of other crops. Under this land management policy, a total of 11,502 acres are fallowed (11.8%), of which 4,630 acres are alfalfa and 6,871 acres are pasture. Greatest cutbacks in land use occur in Shasta due to the exceptionally high baseline acreage of pasture, resulting in fallowing of 4,596 acres of pasture, nearly half of the total fallowed land. Slack water in lieu of irrigating the fallowed land total 27,530 acre-feet per year across the three valleys (12.5%). Gross revenue losses across all valleys together total $10.56 million (4.6%), concentrated in Scott ($3.75 million; 13.5%) and Shasta ($4.07 million; 10.5%). Economic losses in Butte – 1.7% as a percentage of baseline revenues – are weathered because of the high contribution of other crops such as nursery strawberries to overall agricultural value in the valley. Figure 2 and Table 7 below provide more detailed model outcomes of the cropping patterns, water use reductions, and value associated with this scenario.

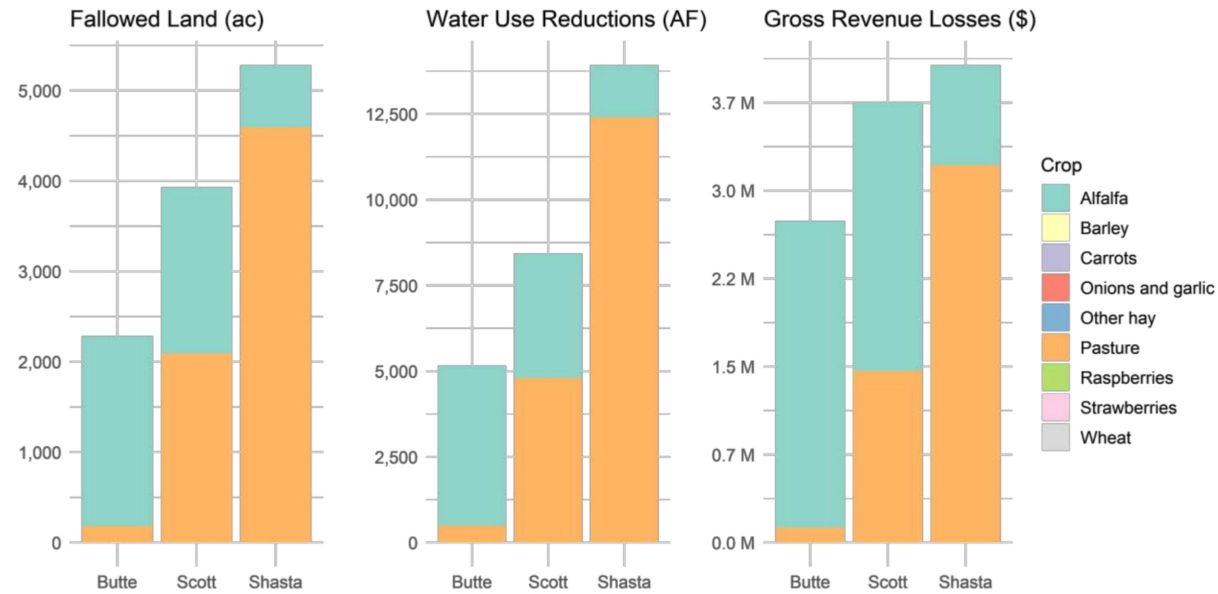

Figure 2: Results of land allocations, water use, and gross revenue differences from base for scenario 1a, 15% fallowing of pasture and alfalfa.

Table 7: Tabulated results of land allocations, water use, and gross revenues for scenario 1a, 15% fallowing of pasture and alfalfa.

Region	Crop	Land (ac)	Water use (AF)	Gross revenue ($ million)
Butte	Alfalfa	11,913	26,495	14.81
	Barley	1,460	2,199	0.96
	Carrots	313	654	1.16
	Onions and garlic	400	834	1.66
	Other hay	529	1,177	0.62
	Pasture	1,033	2,789	0.72
	Raspberries	140	465	8.10
	Strawberries	2,537	8,421	131.39
	Wheat	4,502	6,780	2.90
	Subtotal	**22,828 (-9.1%)**	**49,813 (-9.4%)**	**162.32 (-1.7%)**
Scott	Alfalfa	10,427	20,525	12.96
	Barley	1,415	1,532	0.92
	Other hay	546	1,076	0.64
	Pasture	11,856	27,229	8.30
	Wheat	1,883	2,039	1.21
	Subtotal	**26,128 (-13.1%)**	**52,400 (-13.9%)**	**24.04 (-13.5%)**
Shasta	Alfalfa	3,896	8,665	4.84
	Barley	3,780	5,693	2.49
	Other hay	1,660	3,691	1.95
	Pasture	26,046	70,298	18.23
	Strawberries	125	416	6.49
	Wheat	1,273	1,917	0.82
	Subtotal	**36,780 (-12.6%)**	**90,679 (-13.3%)**	**34.82 (-10.5%)**
Three valleys	**Total**	**85,735 (-11.8%)**	**192,892 (-12.5%)**	**221.18 (-4.6%)**

4.1.2. Scenario 1b: 30% fallowing of pasture and alfalfa

Scenario 1b is an upscaled version of scenario 1a, wherein the model prescribes a more severe fallowing of 30% of all pasture and alfalfa. As expected, the results follow the same trends as in scenario 1a but with more significant reductions in all categories. A total of 23,002 acres are fallowed (23.7%), of which 4,569 acres are in Butte, 7,865 acres are in Scott, and the remaining 10,568 acres are in Shasta. Cutbacks in land use represent about one-quarter of all land in Scott and Shasta as individual regions, and about one-fifth of total land in Butte. Water use reductions total 55,060 acre-feet across the three valleys (25.0%). Compared with scenario 1a gross revenue losses are doubled, valuing $21.13 million in total (9.1%) and distributed similarly to each valley (3.3%, 27.7%, and 20.9% loss for Butte, Scott, and Shasta, respectively). Figure 3 and Table 8 below provide more detailed predictions of the cropping patterns, water use reductions, and value associated with this scenario.

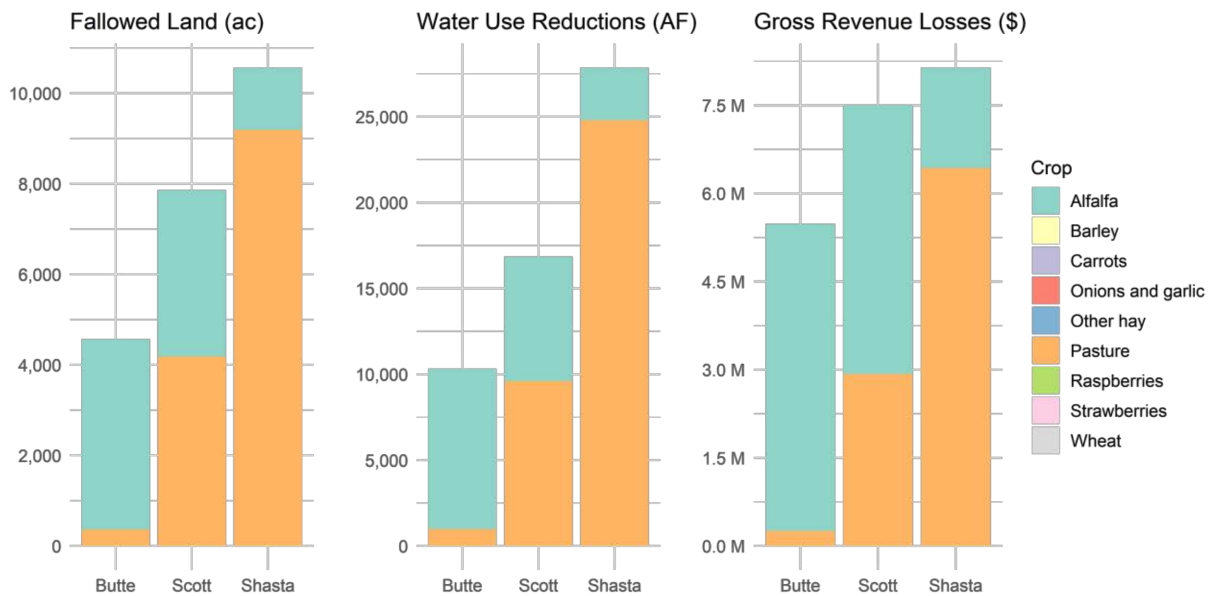

Figure 3: Results of land allocations, water use, and gross revenue differences from base for scenario 1b, 30% fallowing of pasture and alfalfa.

Table 8: Tabulated results of land allocations, water use, and gross revenues for scenario 1b, 30% fallowing of pasture and alfalfa.

Region	Crop	Land (ac)	Water use (AF)	Gross revenue ($ million)
Butte	Alfalfa	9,811	21,819	12.20
	Barley	1,460	2,199	0.96
	Carrots	313	654	1.16
	Onions and garlic	400	834	1.66
	Other hay	529	1,177	0.62
	Pasture	851	2,296	0.59
	Raspberries	140	465	8.10
	Strawberries	2,537	8,421	131.39
	Wheat	4,502	6,780	2.90
	Subtotal	**20,543 (-18.2%)**	**43,973 (-18.8%)**	**159.58 (-3.3%)**
Scott	Alfalfa	8,587	16,903	10.68
	Barley	1,415	1,532	0.92

	Other hay	546	1,076	0.64
	Pasture	9,764	22,424	6.83
	Wheat	1,883	2,039	1.21
	Subtotal	**22,196 (-26.2%)**	**43,973 (-27.7%)**	**20.29 (-27.7%)**
Shasta	Alfalfa	3,209	7,136	3.99
	Barley	3,780	5,693	2.49
	Other hay	1,660	3,691	1.95
	Pasture	21,449	57,892	15.01
	Strawberries	125	416	6.49
	Wheat	1,273	1,917	0.82
	Subtotal	**31,496 (-25.1%)**	**76,745 (-26.6%)**	**30.75 (-20.9%)**
Three valleys	**Total**	**74,234 (-23.7%)**	**165,363 (-25.0%)**	**210.63 (-9.1%)**

4.1.3. Scenario 1c: 60% fallowing of pasture and alfalfa

Scenario 1c further extends the fallowing cutbacks from the previous two scenarios and simulates a 60% fallowing of pasture and alfalfa. Total fallowing totals 46,003 acres (47.3%) with 9,139 acres, 15,729, and 21,136 acres occurring in Butte, Scott, and Shasta, respectively. Reductions in land represent over half of the agricultural acreage in Scott and Shasta but roughly one-third of Butte land use. Water use reductions in the three valleys total 110,117 acre-feet or about 50% of total estimated baseline irrigation demands. Gross revenue losses total $42.26 million (18.2%); Butte experiences the least value loss at $10.97 million (6.6%), followed by Scott at $15.01 million (54.0%), and lastly Shasta with $16.29 million (41.9%). Figure 4 and Table 9 below provide more detailed predictions of the cropping patterns changes, water use reductions, and value associated with this scenario.

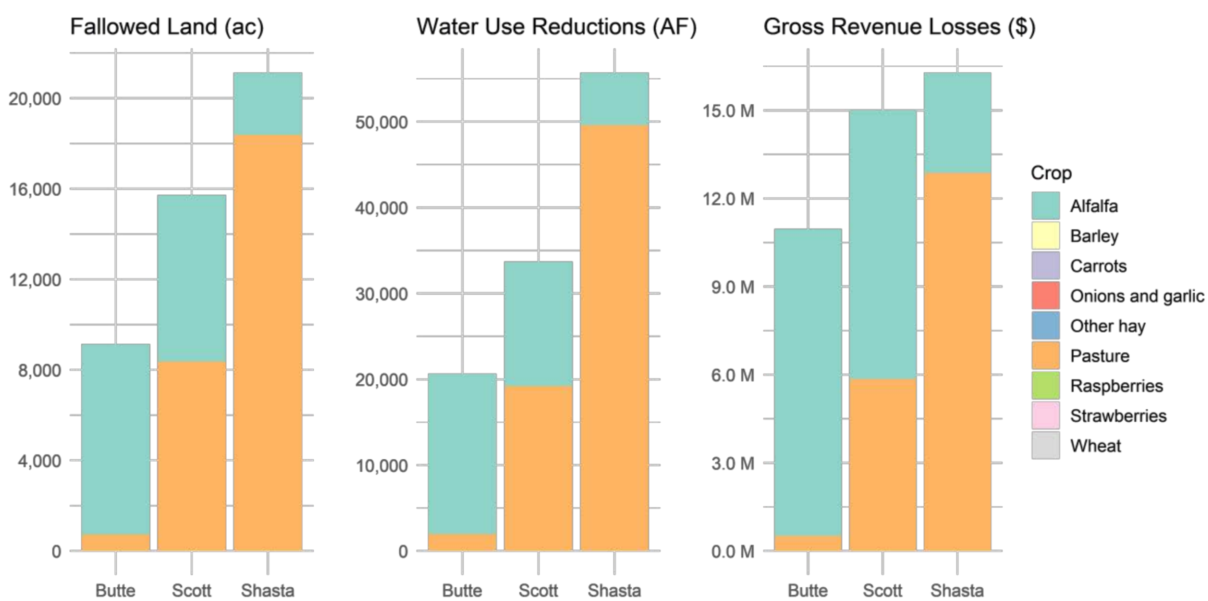

Figure 4: Results of land allocations, water use, and gross revenue differences from base for scenario 1c, 60% fallowing of pasture and alfalfa.

Table 9: Tabulated results of land allocations, water use, and gross revenues for scenario 1c, 60% fallowing of pasture and alfalfa.

Region	Crop	Land (ac)	Water use (AF)	Gross revenue ($ million)
Butte	Alfalfa	5,006	12,468	6.97
	Barley	1,460	2,199	0.96
	Carrots	313	654	1.16
	Onions and garlic	400	834	1.66
	Other hay	529	1,177	0.62
	Pasture	486	1,177	0.34
	Raspberries	140	465	8.10
	Strawberries	2,537	8,421	131.39
	Wheat	4,502	6,780	2.90
	Subtotal	**15,974 (-36.4%)**	**34,310 (-37.6%)**	**154.10 (-6.6%)**
Scott	Alfalfa	4,907	9,659	6.10
	Barley	1,415	1,532	0.92
	Other hay	546	1,076	0.64
	Pasture	5,579	12,814	3.91
	Wheat	1,883	2,039	1.21
	Subtotal	**14,331 (-52.3%)**	**27,118 (-55.4%)**	**12.78 (-54.0%)**
Shasta	Alfalfa	1,834	4,078	2.28
	Barley	3,780	5,693	2.49
	Other hay	1,660	3,691	1.95
	Pasture	12,257	33,081	8.58
	Strawberries	125	416	6.49
	Wheat	1,273	1,917	0.82
	Subtotal	**20,928 (-50.2%)**	**48,875 (-53.3%)**	**22.60 (-41.9%)**
Three valleys	**Total**	**51,233 (-47.3%)**	**110,304 (-50.0%)**	**189.49 (-18.2%)**

4.1.4. Scenario 2: forego third alfalfa cutting

Scenario 2 presents results of a less constrained case as compared with scenario 1. The model simulates deficit irrigation of alfalfa during the summer and consequentially a reduction in the number of cuttings harvested from the crop. Total annual irrigation for alfalfa is reduced by one-third (33%) to reflect these conditions, and crop yield is assumed to respond linearly to deficit irrigation. Changes in yield are accounted for in the profitability of alfalfa when land allocations are made by the model and are also applied to the final assessment of gross crop revenues. To reflect changes in harvesting and cultural costs, all costs are also scaled linearly with yield reductions. Reductions in water use connected to deficit irrigation are assumed to be retained in the model, meaning that the water cannot be reallocated to the expansion of other crops beyond what is otherwise used.

This scenario results in minor fallowing of alfalfa land (2.9% of baseline alfalfa) due to the steep decrease in marginal value making it less attractive to grow in comparison with other options, a factor that also lowers the returns of the allocated alfalfa land. Some compensation occurs to account for profitability shifts, leading to minor expansions of some select crops (Figure 5). Fallowing totals 117 acres across the three valleys (0.1%) after considering alfalfa losses and expansion in other crops. Water use reductions total 21,620 acre-feet (9.8%) of which most occur in Butte and Scott where alfalfa is plentiful. Total net gross revenue losses after accounting for combined cropping pattern shifts come to $12.8 million (5.5%), distributed as $5.7 million, $5.1 million, and $1.9 million in Butte, Scott, and Shasta, respectively. As compared with scenario 1a, both gross revenue losses and water use reductions are similar, but total changes in agricultural land use are much lower. Figure 5 and Table 10 below provide more detailed results of the cropping patterns, water use reductions, and value associated with this scenario.

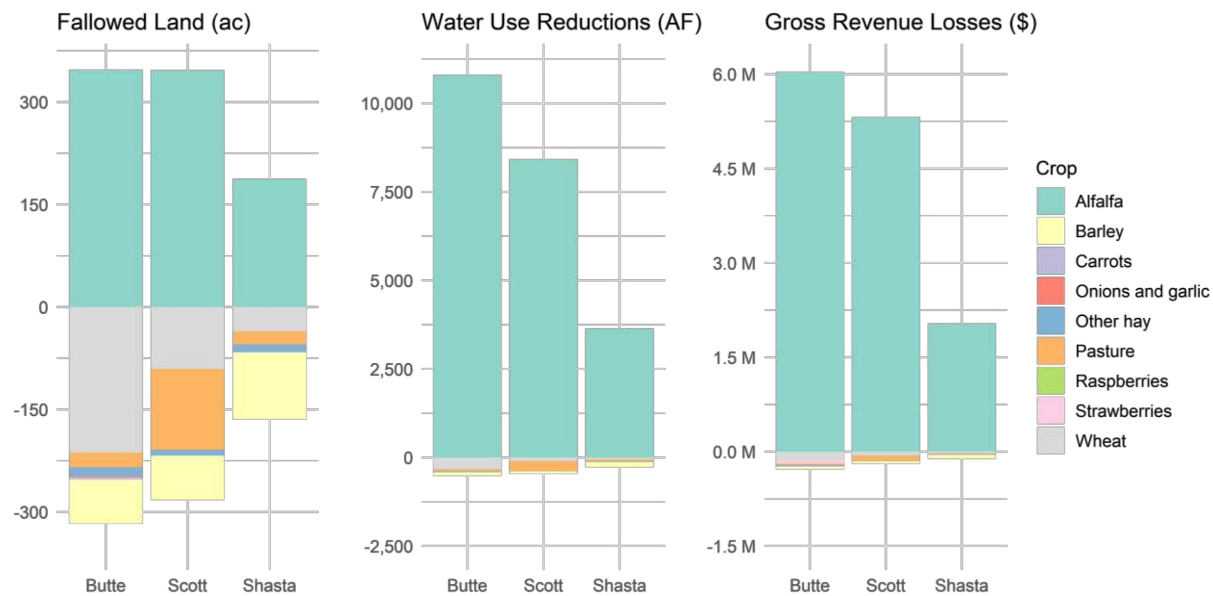

Figure 5: Results of land allocations, water use, and gross revenue differences from base for scenario 2, foregoing third cutting of alfalfa.

Table 10: Tabulated results of land allocations, water use, and gross revenues for scenario 2, foregoing third cutting of alfalfa.

Region	Crop	Land (ac)	Water use (AF)	Gross revenue ($ million)
Butte	Alfalfa	13,668	20,367	11.39
	Barley	1,525	2,296	1.00
	Carrots	317	662	1.17
	Onions and garlic	401	837	1.67
	Other hay	542	1,206	0.64
	Pasture	1,237	3,339	0.87
	Raspberries	140	465	8.10
	Strawberries	2,537	8,424	131.46
	Wheat	4,714	7,099	3.03
	Subtotal	**25,083 (-0.1%)**	**44,695 (-18.7%)**	**159.32 (-3.5%)**
Scott	Alfalfa	11,921	15,721	9.93
	Barley	1,480	1,602	0.97
	Other hay	555	1,092	0.65
	Pasture	14,067	32,307	9.85
	Wheat	1,974	2,136	1.27
	Subtotal	**29,996 (-0.2%)**	**52,859 (-13.1%)**	**22.66 (-18.5%)**
Shasta	Alfalfa	4,396	6,551	3.66
	Barley	3,879	5,841	2.55
	Other hay	1,671	3,717	1.96
	Pasture	30,661	82,754	21.46
	Strawberries	125	416	6.50

	Wheat	1,308	1,970	0.84
	Subtotal	**42,041 (-0.1%)**	**101,250 (-3.2%)**	**36.97 (-4.9%)**
Three valleys	**Total**	**97,120 (-0.1%)**	**198,803 (-9.8%)**	**218.94 (-5.5%)**

4.1.5. Scenario 3: 15% fallowing (adaptive)

Scenario 3 examines the expected impacts under a 15% land fallowing policy wherein cropping patterns can adapt to reduce the economic impacts. This scenario constrains the total land available to be allocated but does not prescribe fallowing in any given crop, meaning that the model is able to cut back in crops in such a way that minimizes farmer profit losses. Adaptive fallowing in this way assumes that there is some form of water trading which allows valuable crops to resist cutbacks because of some willingness to pay for scarce resources such as water.

Land fallowing totals 14,585 acres (15%) of which a large percentage (6,031 acres, 41.3%) consists of pasture reduction mostly in Shasta or Scott; remaining losses come in the form of alfalfa (4,101 acres, 28.1%), wheat (2,201 acres, 15.1%), barley (1,795 acres, 12.3%), and other crops (457 acres, 3.1%). Reductions in water use are slightly lower than land reductions by percentage, totaling 30,850 acre-feet (14.0%) across the three valleys. Gross revenue losses are in the order of $12.9 million (5.6%), distributed approximately equally across each of the valleys. Alfalfa receives the largest revenue loss of any crop ($5.1 million) followed by pasture ($4.2 million), and other minor crop losses representing the remaining economic impacts. Figure 6 and Table 11 below provide more detailed results of the cropping patterns, water use reductions, and value associated with this scenario.

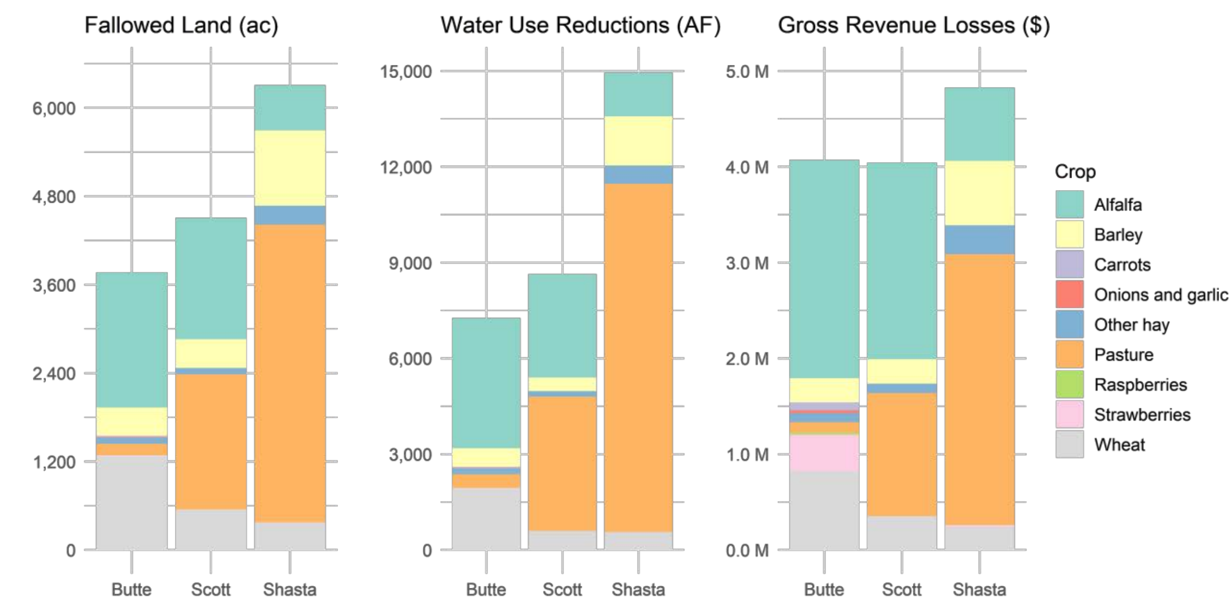

Figure 6: Results of land allocations, water use, and gross revenue differences from base for scenario 3, 15% fallowing of all cropland with adaptive management.

Table 11: Tabulated results of land allocations, water use, and gross revenues for scenario 3, 15% fallowing of all cropland with adaptive management.

Region	Crop	Land (ac)	Water use (AF)	Gross revenue ($ million)
Butte	Alfalfa	12,181	27,091	15.14

	Barley	1,078	1,623	0.71
	Carrots	291	607	1.08
	Onions and garlic	393	819	1.63
	Other hay	449	1,000	0.53
	Pasture	1,060	2,861	0.74
	Raspberries	140	463	8.08
	Strawberries	2,529	8,421	131.01
	Wheat	3,224	4,856	2.08
	Subtotal	**21,345 (-15.0%)**	**47,717 (-13.2%)**	**160.99 (-2.5%)**
Scott	Alfalfa	10,617	20,899	13.20
	Barley	1,025	1,109	0.67
	Other hay	462	909	0.54
	Pasture	12,114	27,822	8.48
	Wheat	1,333	1,443	0.86
	Subtotal	**25,551 (-15.0%)**	**52,182 (-14.2%)**	**23.75 (-14.5%)**
Shasta	Alfalfa	3,967	8,823	4.93
	Barley	2,758	4,154	1.81
	Other hay	1,403	3,120	1.64
	Pasture	26,601	71,796	18.62
	Strawberries	125	415	6.47
	Wheat	900	1,355	0.58
	Subtotal	**35,754 (-15.0%)**	**89,663 (-14.3%)**	**34.07 (-12.4%)**
Three valleys	**Total**	**82,651 (-15.0%)**	**189,562 (-14.0%)**	**218.81 (-5.6%)**

4.1.6. Scenario 4: 15% fallowing ("worst case")

Scenario 4 examines a similar land policy to that of scenario 3 (15% fallowing of all cropland) but restricts the model's ability to minimize losses. In this case all crop types are equally cut back by 15% without an implicit water trading potential. Removing the potential to shift cutbacks between crops leads to much more drastic economic losses compared to the previous scenario.

As a result of the restrictions imposed on the model, cutbacks across all categories (land, water use, and gross revenues) are all equal to the total fallowing percentage (15%) and do not change based on crop or region. Total fallow land remains at 14,585 acres as in scenario 3, distributed as 3,767 acres, 4,509 acres, and 6,310 acres lost in Butte, Scott, and Shasta, respectively. Water use reductions are slightly higher than the previous scenario, at 33,063 acre-feet. Agricultural revenue losses, however, are nearly three times higher than the adaptive scenario, totaling $34.8 million. Most revenue loss is attributed to reductions in strawberries and raspberries which value $21.9 million (62.9%) in combination; alfalfa and pasture make up most remaining value loss. Figure 7 and Table 12 below provide more detailed results of the cropping patterns, water use reductions, and value associated with this scenario.

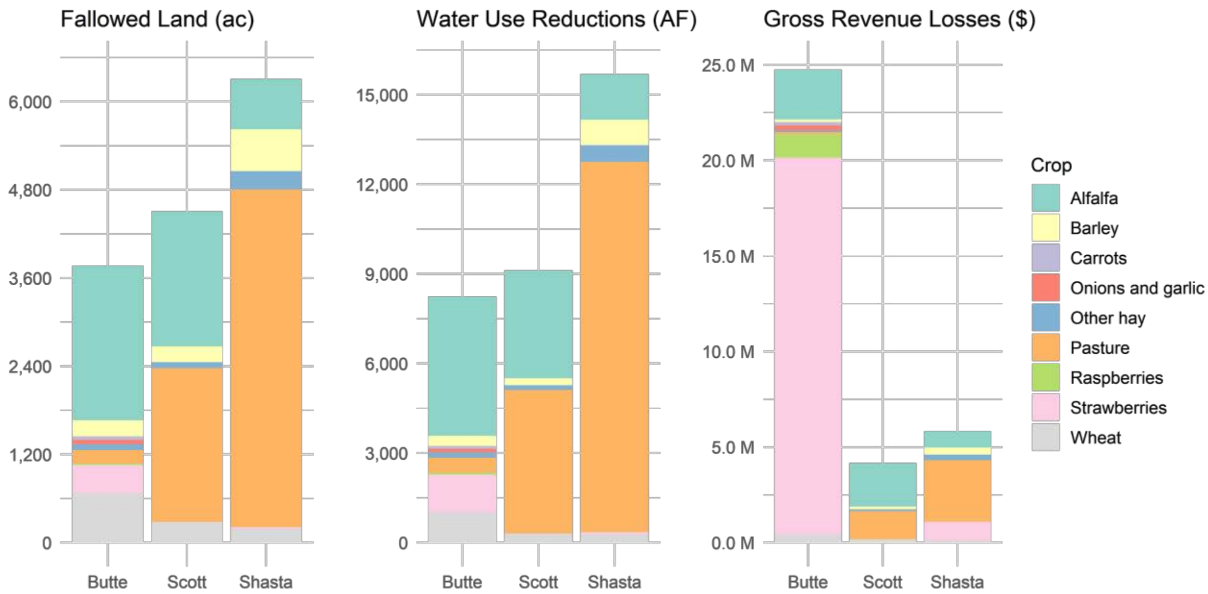

Figure 7: Results of land allocations, water use, and gross revenue differences from base for scenario 4, 15% fallowing of all cropland without adaptive management.

Table 12: Tabulated results of land allocations, water use, and gross revenues for scenario 4, 15% fallowing of all cropland without adaptive management.

Region	Crop	Land (ac)	Water use (AF)	Gross revenue ($ million)
Butte	Alfalfa	11,913	26,495	14.81
	Barley	1,241	1,869	0.82
	Carrots	266	556	0.99
	Onions and garlic	340	709	1.41
	Other hay	450	1,000	0.53
	Pasture	1,033	2,789	0.72
	Raspberries	119	395	6.88
	Strawberries	2,156	7,158	111.68
	Wheat	3,827	5,763	2.46
	Subtotal	**21,345 (-15.0%)**	**46,734 (-15.0%)**	**140.30 (-15.0%)**
Scott	Alfalfa	10,427	20,525	12.96
	Barley	1,203	1,302	0.79
	Other hay	464	914	0.54
	Pasture	11,856	27,229	8.30
	Wheat	1,601	1,733	1.03
	Subtotal	**25,551 (-15.0%)**	**51,703 (-15.0%)**	**23.62 (-15.0%)**
Shasta	Alfalfa	3,896	8,665	4.84
	Barley	3,213	4,839	2.11
	Other hay	1,411	3,137	1.65
	Pasture	26,046	70,298	18.23
	Strawberries	107	354	5.52
	Wheat	1,082	1,629	0.70
	Subtotal	**35,754 (-15.0%)**	**88,922 (-15.0%)**	**33.06 (-15.0%)**
Three valleys	**Total**	**82,651 (-15.0%)**	**187,358 (-15.0%)**	**196.99 (-15.0%)**

4.1.7. Scenario 5: 15% water shortage (adaptive)

Scenario 5 follows a similar concept and realization to that of scenario 3, however, restrictions are made more broadly to water as opposed to land availability. Under this scenario the model is again allowed flexibility in allocating land to crops and minimizing economic losses. Trends in overall resource use remain roughly the same as they were in the results of scenario 3 with minor differences in land allocation due to variability in unit water demand across crop types.

Fallowed land totals 13,848 acres across the three valleys and is composed primarily of alfalfa and pasture, with less severe cutbacks in barley and wheat owing to the lower unit water demands of these crops. In summary, total land fallowing is reduced compared with scenario 3, but targets towards higher water use crops. Water use reductions total of 32,760 acre-feet (15%). Changes in gross revenue losses are minimal compared with the land-limited scenario, and total $13.0 million. Both scenario 3 and 5 see much more evenly distributed economic impacts as compared to scenario 4, which experiences almost all effects in Butte Valley because of losses in berry plant transplant crops.

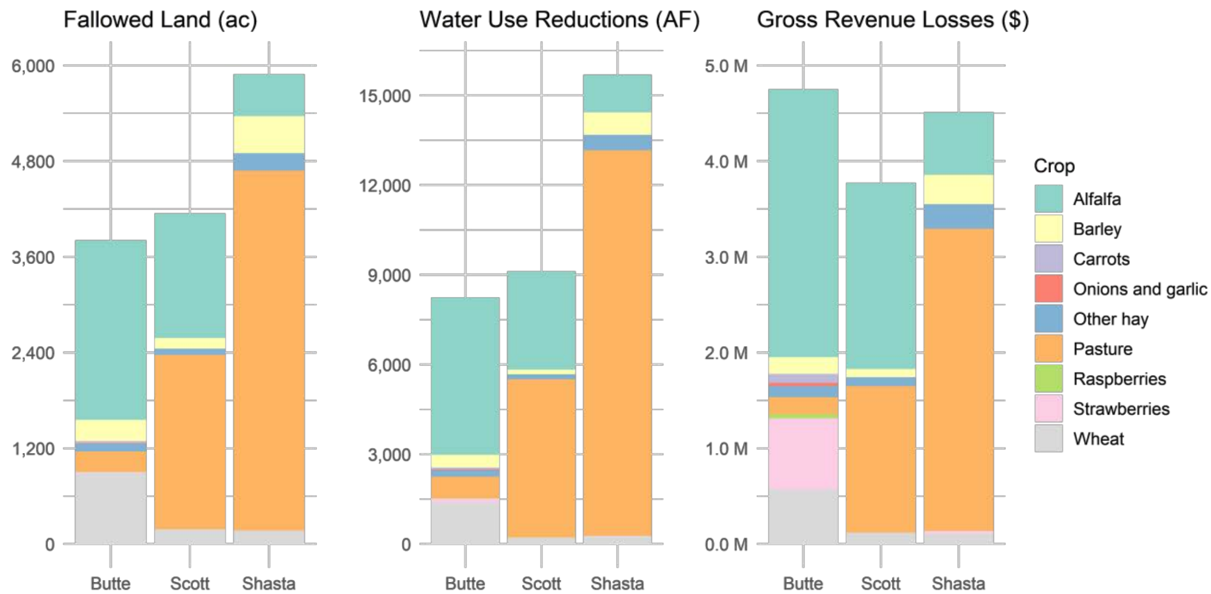

Figure 8: Results of land allocations, water use, and gross revenue differences from base for scenario 5, 15% total water shortage with adaptive management.

Table 13: Tabulated results of land allocations, water use, and gross revenues for scenario 5, 15% total water shortage with adaptive management.

Region	Crop	Land (ac)	Water use (AF)	Gross revenue ($ million)
Butte	Alfalfa	11,765	25,903	14.63
	Barley	1,193	1,779	0.78
	Carrots	288	595	1.07
	Onions and garlic	392	809	1.63
	Other hay	431	949	0.51
	Pasture	959	2,563	0.67
	Raspberries	139	458	8.06
	Strawberries	2,522	8,290	130.65
	Wheat	3,614	5,388	2.33

	Subtotal	**21,303** **(-15.2%)**	**46,734** **(-15.0%)**	**160.31** **(-2.9%)**
Scott	Alfalfa	10,702	20,854	13.31
	Barley	1,284	1,376	0.84
	Other hay	466	909	0.55
	Pasture	11,761	26,742	8.23
	Wheat	1,700	1,822	1.09
	Subtotal	**25,914** **(-13.8%)**	**51,703** **(-15.0%)**	**24.02** **(-13.6%)**
Shasta	Alfalfa	4,057	8,933	5.04
	Barley	3,316	4,943	2.18
	Other hay	1,441	3,172	1.69
	Pasture	26,129	69,817	18.29
	Strawberries	125	410	6.47
	Wheat	1,104	1,647	0.71
	Subtotal	**36,172** **(-14.0%)**	**88,922** **(-15.0%)**	**34.38** **(-11.6%)**
Three valleys	**Total**	**83,389** **(-14.2%)**	**187,358** **(-15.0%)**	**218.71** **(-5.6%)**

4.1.8. Scenario 6: exploring economic tradeoffs between alfalfa and strawberries in Butte Valley

Strawberry plants for transplant are a particularly unique specialty crop grown in Butte Valley due to their high value and importance in supporting downstream berry production on the Central Coast. As such, these crops pose an opportunity for generating great economic value with less land and water resource use – suggesting that conversion of other crops to strawberries may have benefits for managing water use while maintaining agricultural value. Given that alfalfa is the dominant crop by area in the valley (55.8%) and is relatively low value compared to nursery berries, this scenario explores tradeoffs in converting between these two crops.

In this analysis, the marginal revenue of an acre of transplant strawberry plants is estimated to be about $51,800 and the crop is estimated to operate with a 15% profit margin after costs are considered. Irrigation needs for strawberries are estimated at 3.32 AF/ac per year. Alfalfa is estimated to have a marginal revenue of $1,240/ac with a 5% profit margin and irrigation needs of 2.22 AF/ac per year in Butte Valley. Assuming constant returns to scale within both crop groups, about 42 acres of alfalfa produce the same gross revenue as 1 acre of nursery strawberries but use significantly more water in the aggregate.

Tables 14 and 15, below, outline possible options for retiring alfalfa in favor of transplant strawberries. The first strategy focuses on maintaining or expanding value while maximizing resource reductions (1:40 ratio of strawberries to alfalfa). The second strategy replaces alfalfa with strawberries at a higher rate (5:40 ratio of strawberries to alfalfa) in favor of economic expansion. These scenarios recognize the rotations exercised in growing transplant strawberry plants, which are understood to typically operate in 3-year rotations of strawberry-grain-fallow with roughly equivalent acreages of each at any given time. Based on this production model, for each acre of transplant strawberries planted, 1 acre of grain is planted, and 1 acre is set aside as fallow for the rotation with land, water use, and revenue impacts reflecting these conditions.

Table 14: Conservative strategy for converting alfalfa to strawberries (1:40 ratio of strawberries to alfalfa) focused on water use reductions.

Alfalfa fallowed (ac)	Strawberries planted (ac)	Grain planted (ac)	Fallow reserved (ac)	Land reductions (ac)	Water reductions (AF)	Revenue impact ($)
200	5	5	5	185	421	+13,570
400	10	10	10	222	505	+16,284
600	15	15	15	259	589	+18,998
800	20	20	20	296	673	+21,712
1000	25	25	25	333	757	+24,426

Table 15: Progressive strategy for converting alfalfa to strawberries (5:40 ratio of strawberries to alfalfa) focused on economic expansion.

Alfalfa fallowed (ac)	Strawberries planted (ac)	Grain planted (ac)	Fallow reserved (ac)	Land reductions (ac)	Water reductions (AF)	Revenue impact ($)
200	25	25	25	125	324	+1,062,443
400	50	50	50	150	389	+1,274,931
600	75	75	75	175	454	+1,487,420
800	100	100	100	200	519	+1,699,909
1000	125	125	125	225	583	+1,912,397

One consideration to make when examining conversion of alfalfa to higher value crops such as strawberries is the limit on strawberry expansion; consistent with PMP modeling which limits crop specialization, it is typically assumed that valuable crops that are observed to be grown in relatively low amounts are constrained by production conditions and upfront costs aside from profitability. For example, soils used in pasture are often less suitable to grow more sensitive crops such as vegetables because of nutrient deficiencies or soil composition. However, because transplant strawberries in Butte Valley are grown in nursery conditions, this may lend itself to better control of production conditions that might otherwise prevent expansion under natural cultivation practices. Expansion of nursery strawberry production is limited by several additional factors including labor availability and high upfront investment in technical knowledge and infrastructure. Many of the farmers currently involved in this sector have accumulated generational knowledge pertaining to management and business practice which are seen for other crops in the county but require fewer capital investments. These scenarios propose minor expansion of transplant berries by area in recognition of the challenges noted by farmers in this sector that currently prevent significant expansion from occurring.

4.1.9. Scenario 7: exploring lower water use alternatives to alfalfa and pasture

Among the crops cultivated in the three valleys examined for this study of Siskiyou County agriculture, pasture and alfalfa are the largest drivers of water demand, both at the aggregated and unit production scales. There is an interest in exploring the role that these crops play in the context of water use as well as economic value. This scenario examines potential for land use tradeoffs involving these crops with the goal of reducing water use while maintaining gross returns. It is worthwhile noticing alfalfa and pasture support downstream agricultural sectors such as the dairy and beef cattle industry, which may be impacted by higher feed crop costs resulting from a reduction in the local supply of irrigated pasture and alfalfa. Intermountain alfalfa is also known for its higher quality and is used as feed in more specialized animal operations beyond dairies and beef cattle.

Under baseline conditions, alfalfa covers roughly 32% of agricultural land across the three valleys while pasture makes up an additional 47% of crop cover. Alfalfa is mostly concentrated in Butte and Scott and pasture composes a majority of land use in Shasta. Unit water use for alfalfa is estimated at 2.22 acre-feet/acre in Butte and Shasta and 1.97 acre-feet/acre in Scott. Pasture is estimated to require 2.70 acre-feet/acre in Butte and Shasta and 2.30 acre-feet/acre in Scott. In the aggregate, these two crops contribute 83% of total water demand for the three valleys, of which 30% is attributed to alfalfa and 53% to irrigated pasture. Siskiyou does not have as stark of contrasts in unit water use between crops as other regions in California, where it is common to see grains with sub- 2 acre-feet/acre irrigation needs grown alongside alfalfa or almonds requiring over 4.5 acre-feet/acre in annual irrigation. However, there is still significant differences in unit demands which suggest opportunities for improving economic efficiency in applied water.

Table 16 below provides a baseline for comparison between water use and value for crops grown within each of the three valleys. This table serves to highlight opportunities for conversion between crop types in the interest of water management benefits. For example, wheat and barley offer some tradeoff from pasture and alfalfa for lowering total water demand at the expense of reduced agricultural revenue. Alfalfa demands roughly 1.5 times the irrigation of wheat or barley (per acre) but has nearly double the marginal value of these crops. In the Scott River Valley, where irrigation demands tend to be lower, each of these crops has comparable value per unit of applied water ($/acre-feet), however, in Butte and Shasta the economic return of water for grain crops is about 25% lower than that of alfalfa. Pasture, on the other hand, has both the highest unit water demands of any crop in the three valleys as well as the lowest value per unit of applied water. Marginal values for pasture are comparable to grain crops. Crops such as carrots and onions are suitable to be grown in Butte and have higher marginal value both per unit of land and water as compared with alfalfa or pasture. However, these crops are observed to be grown in only small amounts (approximately 400 acres at most), suggesting that other production factors may constrain their expansion despite higher value than alternatives. Likewise, transplant berries have higher water demands than alfalfa, carrots, or onions, but are vastly more valuable than other crops grown within the valley.

Table 16: Unit water use, marginal value, and economic efficiency of applied water for crops in Butte Valley.

Crop	Region	Unit water use (AF/ac)	Marginal value ($/ac)	Marginal value / unit water ($/AF)
Alfalfa	Butte/Shasta	2.22	1,243	559
Alfalfa	Scott	1.97	1,243	632
Barley	Butte/Shasta	1.51	658	437
Barley	Scott	1.08	653	603
Carrots	Butte	2.09	3,699	1,773
Onions and garlic	Butte	2.09	4,150	1,989
Other hay	Butte/Shasta	2.22	1,172	527
Other hay	Scott	1.97	1,172	596
Pasture	Butte/Shasta	2.70	700	259
Pasture	Scott	2.30	700	305
Raspberries	Butte	3.32	57,857	17,427
Strawberries	Butte/Shasta	3.32	51,800	15,602

Wheat	Butte	1.51	644	427
Wheat	Scott	1.08	644	595

4.2. Spillover effects of land and water use decisions

Table 17 lists spillover effects related to changes in the agricultural sector revenues within the County's economy based on the scenarios outlined above. We employed IMPLAN (https://www.implan.com/), an input-output model which allows estimation of broader impacts on employment, gross revenues and after sector-specific economic events, such as land fallowing or crop shifting. IMPLAN estimates direct, indirect, and induced effects. The direct effects correspond to the changes in revenues with respect to baseline (2018) conditions in crop farming. As various crops see reductions or changes in acreage, such changes indirectly affect production inputs including farm labor, agrochemicals, farm services and others. These are known as indirect effects. As agriculture and agriculture-related sectors face some impacts in gross revenues, households and government also face income impacts in what is known as an induced or second round effect. Altogether, direct, indirect, and induced impacts constitute the total or multiplier effect which is reported in this section for gross revenues (or output), value added (close to gross domestic product), and employment (full and part time jobs).

Scenario 1c shows the highest losses in all economic categories, resulting in $56 million in direct, indirect, and induced revenue losses, nearly $43 million in value added losses, and 393 fewer jobs in agriculture and all other sectors. Scenarios such as 3 or 4 are likely more realistic because they do not prescribe responses in specific crop categories, with scenario 3 assuming water trading allows retentions of higher value crops at the cost of deeper cutbacks in low value crops, and scenario 4 assuming all crops receive equal cutbacks. Management practices under water shortages would likely fall somewhere between these cases, representing slightly less aggressive water trading. Scenario 3 suggests total output losses of $17 million, $13 million in value added losses, and 120 fewer jobs. Meanwhile, scenario 4 falls closer to the extreme of scenario 1c with $46 million total revenue losses, $35 million in value added losses, and 323 fewer jobs. Other scenarios tend to fall within a similar range of economic impacts as those suggested by scenario 3.

Table 17: Combined direct and indirect regional economic impacts (IMPLAN results) for all scenarios.

Scenario	**Region**	**Lost output ($ million)**		**Lost value added ($ million)**		**Lost jobs (#)**	
		Direct	**Total**	**Direct**	**Total**	**Direct**	**Total**
Scenario 1a	Three valleys	10.57	14.05	5.82	10.68	71	98
	Butte	2.74	3.65	1.51	2.77	18	25
	Scott	3.75	4.99	2.07	3.79	25	35
	Shasta	4.07	5.42	2.24	4.12	27	38
Scenario 1b	Three valleys	21.13	28.11	11.65	21.36	142	197
	Butte	5.48	7.29	3.02	5.54	37	51
	Scott	7.50	9.98	4.14	7.59	51	70
	Shasta	8.14	10.83	4.49	8.23	55	76
Scenario 1c	Three valleys	42.26	56.21	23.30	42.72	285	393
	Butte	10.97	14.58	6.04	11.08	74	102
	Scott	15.01	19.96	8.27	15.17	101	140
	Shasta	16.29	21.66	8.98	16.46	110	151
Scenario 2	Three valleys	12.79	17.01	7.05	12.93	86	119
	Butte	5.74	7.63	3.16	5.80	39	53

	Scott	5.13	6.82	2.83	5.18	35	48
	Shasta	1.92	2.55	1.06	1.94	13	18
Scenario 3	Three valleys	12.94	17.21	7.13	13.08	87	120
	Butte	4.07	5.42	2.24	4.12	27	38
	Scott	4.04	5.38	2.23	4.09	27	38
	Shasta	4.83	6.42	2.66	4.88	33	45
Scenario 4	Three valleys	34.76	46.23	19.16	35.14	234	323
	Butte	24.76	32.93	13.65	25.03	167	230
	Scott	4.17	5.54	2.30	4.21	28	39
	Shasta	5.83	7.76	3.22	5.90	39	54
Scenario 5	Three valleys	13.04	17.34	7.19	13.18	88	121
	Butte	4.75	6.32	2.62	4.80	32	44
	Scott	3.77	5.02	2.08	3.82	25	35
	Shasta	4.51	6.00	2.49	4.56	30	42

Figure 9 summarizes the economic losses considering spillover effects in the regional economy for each scenario along with the average value lost per unit of water reductions. Scenario 1c, prescribing a large cutback (60%) in alfalfa and pasture cultivation, shows the greatest total economic output reduction at $56 million. Following closely in total output reduction is scenario 4 with $46 million, in which all crops receive an equal cutback of 15%. Scenarios 1a, 2, 3, and 5 are all found to have similar output impacts in the order of about $15-20 million. Average output losses per unit of reduced water is consistent across most scenarios at approximately $500/acre-foot. Scenario 2 has slightly higher value losses per unit of water because of the additional value lost from reduced alfalfa yield. Scenario 4 exhibits almost triple the average value lost per unit of water compared with other scenarios ($1,400/acre-foot) because of the higher marginal value of transplant berries.

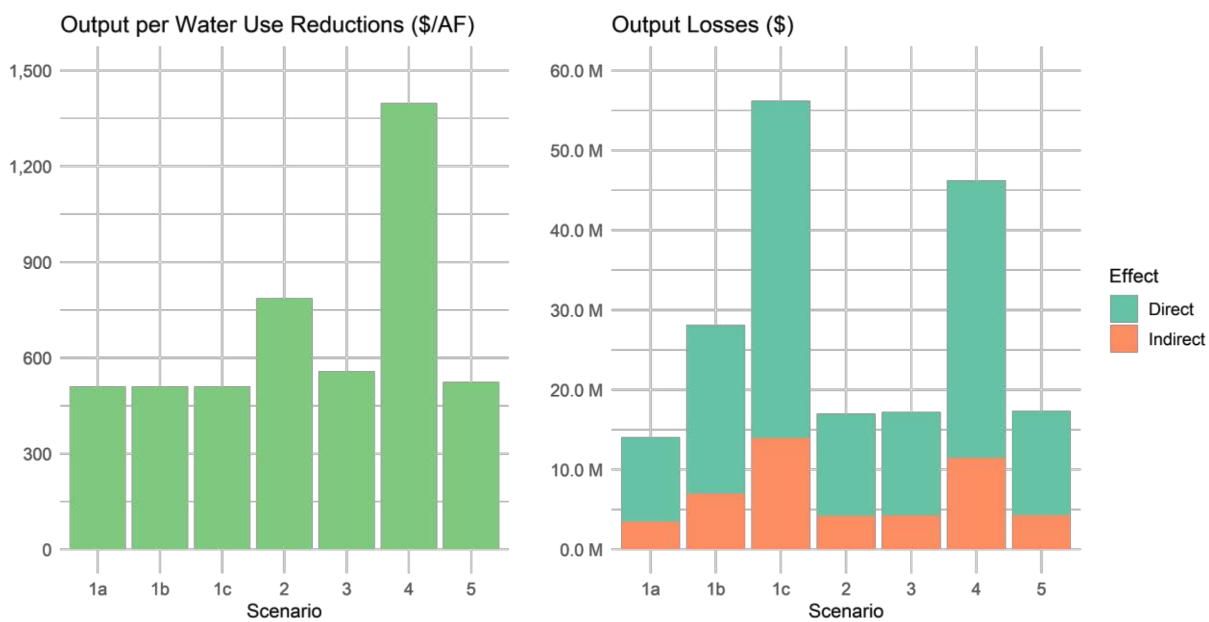

Figure 9: IMPLAN combined spillover effects and average value per unit of water reductions by scenario.

4.3. Economic value of instream flows in the Klamath Basin

Various studies and research reports exist for estimating value of water instream flows in the Klamath River Basin. Kruse and Scholz (2006) estimate a range of net costs for the removal of 4 dams in the Klamath Basin and benefits from temporary employment in the removal and non-use water value with many other costs and benefits unknown. The authors provide an estimate of $172 million in benefits from dam deconstructions, and increased tourism and visitors, and a cost of $2 million for the loss of jobs from the hydropower project. In addition, it is estimated a $104 million benefit from non-use value per year. Considering a flow mean annual flow of 13 million acre-feet in the Klamath River, the estimate in use value is in the order of $8 per acre-foot. This figure does not include the benefits of groundwater dependent ecosystems, fisheries, tourism, tribal, water supply increased reliability and other beneficial uses included in the $172 million above that do not have a direct association to the instream flow gains or change in patterns from dam removal. Yet the study demonstrates values exist for environmental flows and should be weighed against costs of water diversions.

4.4. Limitations of analysis

As with most models, the scenario results shown in this report merit recognition of some limitations. First, data availability on crop production represents average production conditions which rarely occur in specific commodities. Size distribution of farms influences activities and productivity and crop attributes that might also have an influence on crop prices and yields in specific market niches. This also influences the profits from farming. Nevertheless, a representation of the aggregate of production at the county level can still provide useful insights for planning and policy analysis. Second, a profit maximizing behavior and costless water exchanges within each of the valleys are assumed to occur. Thus, results may represent a reasonable lower bound for economic costs of water reductions. Lastly, crops in Siskiyou County have an influence that extends beyond the county boundaries as these are exported or serve as inputs to other sectors including animal operations and food processing. Estimates of these impacts is not estimated in this study yet for most of the scenarios modeled decreases in feed crops will result in higher costs to local ranchers in the dairies and beef cattle sectors which may intermittently or permanently reduce herd sizes to cope with higher production costs and maintain profitability. Animal operations represent roughly 20% of both crops and animal agricultural value in Siskiyou County, thus reductions in their total output due to higher costs should not be ignored. Something similar occurs for transplant berries, which provide inputs to other areas that grow specific commodities into end-products for wholesale or retail. Yet due to their value and profit margins, water shortage price increases from traded water or more expensive water could be absorbed easier than in other sectors. With these limitations in mind, this report may provide insights for discussion of paths forward in water management for Siskiyou County.

5. Conclusions

This report provides costs of agricultural land and water use decisions in selected cropping regions within Siskiyou County and contributes to an improved quantitative understanding of tradeoffs associated with such decisions. Some conclusions arise from this work.

1) Agriculture in Siskiyou County within the Butte, Scott River and Shasta Valleys in our baseline year accounts for 97,000 acres, using roughly 220,000 acre-feet of water per year and generating $231 million in direct gross revenues.

2) The agricultural crop mosaic in these three valleys differ substantially both in the selection of crops and access to water resources. Butte Valley holds the smallest agricultural footprint by area with about 25,000 acres but contributes the greatest value of the three regions owing to the production of berry plants for transplant. Scott River Valley contains about 30,000 acres of cropland consisting primarily of alfalfa and pasture. Shasta Valley has about 42,000 acres of cropland and is mostly pasture. Across the three valleys together, alfalfa and pasture account for 32% and 47%, respectively, of total cropland.
3) A range of scenarios for land and water management was analyzed. Scenarios 1a (15% fallowing alfalfa and pasture), 2 (forego third alfalfa cutting), 3 (15% fallowing, adaptive), and 5 (15% water shortage, adaptive) are expected to result in comparable revenues losses in the order of $10-13 million before considering spillover effects or $15-20 million in related sectors. Scenario 4 (15% fallowing, "worst case") results in the most extreme economic impact with an estimated $35 million in losses stemming in large part from transplant berry reductions. Scenarios 1b and 1c form an intermediate between other scenarios but concentrate impacts on alfalfa and pasture.
4) A 15% reduction in water across the board for all crops can potentially result in direct costs of $35 million for Butte, Scott River, and Shasta Valleys, and 234 jobs lost. When the multiplier effects are accounted for, sector output losses total $46 million and 323 jobs. The cost of applied water reductions in this scenario is about $1,400 per acre-foot when considering direct and indirect sectors.
5) Allowing trading within the valleys for up to 15% applied water reductions substantially decreases economic costs of water use reductions down to $13 million in sector output, and when spillover effects are accounted for such impacts can be as high as $17 million for sector output and 120 jobs. This highlights the potential gains from trading water across commodities to lower economic impacts.
6) Scenarios focusing on resource use reductions in alfalfa and pasture tend to concentrate economic impacts on Shasta Valley, followed by Scott River Valley and finally Butte Valley which generates much of its value from berries for transplant. However, when assessing alfalfa centric scenarios such as foregoing a third cutting (scenario 2), this trend reverses and Butte and Scott River Valleys experience much of the losses. Scenarios which prescribe general reductions in land or water use and allow for adaptive fallowing (scenarios 3 and 5) have nearly equal impacts across each of the regions. When water trading is prohibited and crops experience equal reductions (scenario 4), aggregate impacts become highly concentrated in Butte Valley owing to the exceptional value of berry plants for propagation.
7) Effects from crop production changes into downstream sectors such as dairies and beef cattle and the food processing industry can be sizeable for large enough reductions in crop production and depending on the downstream sector's response to local crop commodity shortages these estimates may merit further investigation.

6. References

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