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16 November 2023

Subject: Comment Letter on the November 7, 2024, Preliminary Draft Emergency Regulation for the Scott River and Shasta River Watershed

Dear Chair Esquivel, Members of the State Water Board, and Members of the Staff,

On behalf of our research and Cooperative Extension group, I appreciate the opportunity to comment on the Preliminary Draft Emergency Regulation for the Scott River and Shasta River Watershed. Over the past decade, we have developed the Scott Valley Integrated Hydrologic Model, SVIHM (https://groundwater.ucdavis.edu/Research/ScottValley). Using SVIHM, we also have prepared a catalog of bookend scenarios, which has been extensively employed in the development of the Scott Valley Groundwater Sustainability Plan (SVGSP).

Comment 1: Outcomes of the 2012-2014 Studies by Steve Orloff, Farm Advisor in Siskiyou County, show that "Table 3" (and SVIHM) irrigation amounts for alfalfa reflect a highly efficient systems and significant variability between soils, sites, and from year to year.

The draft order cites Table 3 in Appendix 5.D of the Scott Valley Groundwater Sustainability Plan (University of California, Merced's Siskiyou County Agricultural Economics Analysis) as the irrigation amounts assumed to be the reference level. This comment is not to indicate that this is the right or wrong amount, but to a) supply further data on the underlying variability observed under real world conditions and b) to point out that Scott Valley irrigation systems are already highly efficient.

Until he passed away in October 2017, I had the fortune to be working with Steve Orloff, former Farm Advisor in Siskiyou County. He left behind unpublished research work on irrigation, soil moisture depletion and ET in several alfalfa (*Medicago sativa* L.) fields in Scott Valley, which he conducted between 2012 and 2014. Our colleague Richard Snyder at UC Davis has prepared a manuscript on the ET portion of that work that is about to be submitted. I also have copies of unpublished data that Steve had shared with me or that I was able to obtain from the Cooperative Extension office in Yreka. I want to take this opportunity to provide a summary of those data.

The work by Steve and Richard show that in-season total ET on these alfalfa fields may vary by one to several inches between fields and between years. The ET measurements were taken using the so-called surface renewal method (Shapland et al., 2013). Latent heat flux density was calculated using the residual of the energy balance. The latent heat flux density was converted from energy to mass flux density to determine half hourly and daily estimates of actual crop evapotranspiration (ETc). Reference ET was measured in Scott Valley over a large field of well-watered grass. All alfalfa fields with ET measurements were irrigated using a center pivot system.

Table 1 below is from the manuscript prepared by Dr. Rick Snyder and summarizes the in-season ET measured in three fields in each of three growing seasons (2012, 2013, and 2014). Starting from 15 March through the last cutting of the season, the ratio of seasonal crop ET, ETcs, to seasonal reference ET, ETos, for the nine alfalfa fields were Kcs=ETcs/ETos = 0.89±0.04. The seasonal Kcs ratio differences were likely due to variations in the time from cutting to the first irrigation after cutting, and due to microclimate contrasts between fields. The in-season crop ET, ETcs, varied from 27.7-29.8 inches, 25.6-34.8 inches, 28.8-32.8 inches for the 2012, 2013, and 2014 seasons, respectively. Average in-season crop ET over those three years was 30.1 inches. Based on Spatial CIMIS data (California DWR), average off-season ET in these Scott Valley alfalfa fields was estimated to be 9.8 inches, contributing significantly to the annual water mass balance of an alfalfa field.

Table 1: Seasonal reference ET, ETos, crop ET, ETcs, and crop coefficienc, Kcs, for three center-pivot irrigated alfalfa fields in each of three growing seasons (2012, 2013, and 2014) in Scott Valley (*from: Richard Snyder et al., manuscript in preparation, UC Davis*).

year	field	ET_{os}	ET_{cs}	K_{cs}	ending date
		in	in		
2012	A5	32.5	27.9	0.86	11-Sep
	A7	32.2	29.8	0.92	10-Sep
	A8	31.5	27.7	0.88	6-Sep
2013	A1	37.8	32.8	0.87	5-Oct
	A2	36.8	34.8	0.95	26-Sep
	A5	29.1	25.6	0.88	5-Sep
2014	A1	35.4	32.8	0.93	6-Sep
	A2	33.5	28.8	0.86	27-Aug
	A5	37.4	31.0	0.83	16-Sep
	Means	34.0	30.1	0.89	12-Sep
	Std.Dev.	2.99	2.99	0.04	

Steve's work also included measuring irrigation amounts and seasonal soil moisture depletion to 8 feet depth. The field study was performed in 13 commercial alfalfa field distributed across the Scott Valley, over a period of three years. In 2012 and 2013, eight fields were monitored, in 2014 only seven fields were monitored. Six sites were equipped with wheelline sprinkler irrigation, the seven remaining sites were equipped with center pivot irrigation. Sites were located on three different soil types: Atter very cobbly sandy loam (2 sites); Stoner gravelly sand (5 sites); and Settlemeyer loam (6 sites). In each year, three fields were equipped for the ET measurements reported above. In-season precipitation averaged 7.1, 7.7, and 5.1 inches in 2012, 2013, and 2014, respectively.

Soil moisture depletion measured from soil cores obtained before and after the growing season (mid-March and early October, respectively) averaged 6.6 inches over the upper 8 feet (range between sites, all years: 0 to 16 inches). Mean soil moisture depletion was highest in 2012, at the beginning of the drought (8.1 inches). It was lowest in 2013 (4.4 inches) and again higher in 2014 (7.3 inches). These changes in soil moisture depletion closely reflect winter precipitation from January 1 through March 15, immediately prior to the growing season, which were 6.1, 2.9, and 7.2 inches in those three years, with 2013 being an exceptionally dry winter.

Soil moisture depletion is slightly higher under wheelline irrigation than under center pivot irrigation perhaps reflecting longer dry-down period during cutting. With either irrigation method, more soil moisture depletion occurs from the finer-grained Settlemeyer silty loam than from the other two gravelly sandy loams (Atter, Stoner). This directly reflects differences in their water holding capacity, reported to be 9 inches for Settlemeyer silty loam and 3 to 5 inches for Atter and Stoner gravelly sandy loams (to five feet depth, https://casoilresource.lawr.ucdavis.edu/gmap/).

Significant year-to-year variations were observed for the annual mean irrigation amounts across sites varying from 18.8 inches in 2012 to 21.9 inches in 2014, as measured by flowmeter gages. At individual sites, measured seasonal irrigation varied from less than 18 inches to 30 inches (across sites and years). Tipping bucket measurements were also taken and averaged about 2 to 3 inches less, partly due to evaporation, but also due to limited sampling coverage. As expected, due to the lower water holding capacity, the gravelly soils at the margin of the valley floor (Atter, Stoner) receive slightly higher irrigations (one to two inches, on average) than the sites with Settlemeyer silty loam. Pivot irrigation totals were, on average, higher than wheelline irrigation totals, reflecting the longer non-irrigation period for the cuttings seen with wheellines.

In summary, the measured irrigation amounts reflect irrigation systems that are highly efficient. In-season precipitation as well as deep soil moisture profile depletion provides, on average, one-third of the in-season crop ET. Significant winter precipitation is needed to refill the depleted soil moisture storage pool. Recharge from these fields occurs – if at all – only during the wet winter season. Wide variability is observed in irrigation and soil moisture depletion between sites and across years, reflecting differences in management practices, soil conditions, and year-over-year and within-basin climate conditions.

Table 2: Selected means across years (2012, 2013, 2014) and sites of seasonal irrigation amount measured with flowmeters at 19 year-sites and differences to tipping bucket gaging data. Means are grouped by soil, by irrigation type, and by year; also showing mean and standard deviations across years and site for all soils (by irrigation type) and for all soils and irrigation types (bottom). This does not include variability within site-years.

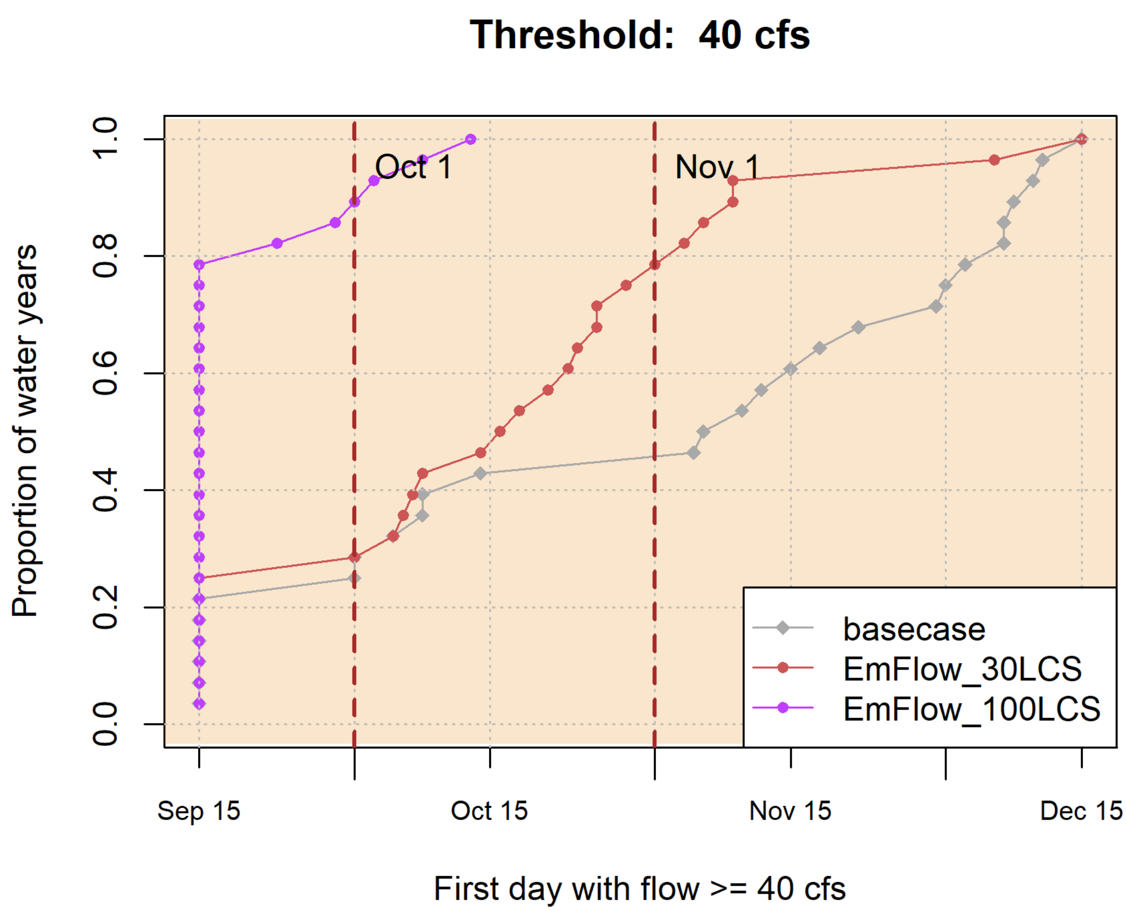
Soil or Year	Irrigation	Number of Site-Years	Annual Irrigation (Flowmeter)	Difference in Annual Irrigation to Tipping Bucket
Stoner	pivot	4	25.1	3.9
Settlemeyer	pivot	4	21.3	2.0
Atter	pivot	0		
Mean	***pivot***	***8***	***23.2***	***3.0***
StdDev	***pivot***	***8***	***4.9***	***2.2***
Stoner	wheelline	2	18.2	0.7
Settlemeyer	wheelline	7	16.9	1.7
Atter	wheelline	2	21.3	3.5
Mean	***wheelline***	***11***	***17.9***	***1.8***
StdDev	***wheelline***	***11***	***5.1***	***2.0***
2012	any	6	18.8	3.6
2013	any	6	19.4	0.6
2014	any	7	21.9	2.6
Mean	**any**	**19**	**20.1**	**2.3**
StdDev	**any**	**19**	**5.6**	**2.1**

Comment 2: LCS alternatives are promising options to improve fall flow and earlier stream connectivity.

The scenarios simulated with the Scott Valley Integrated Hydrologic Model (Scott Valley Groundwater Sustainability Plan, 2022) provide insightful "bookend" estimates of the effects of certain practices on the fall stream flow conditions of the Scott River at the Fort Jones gage.

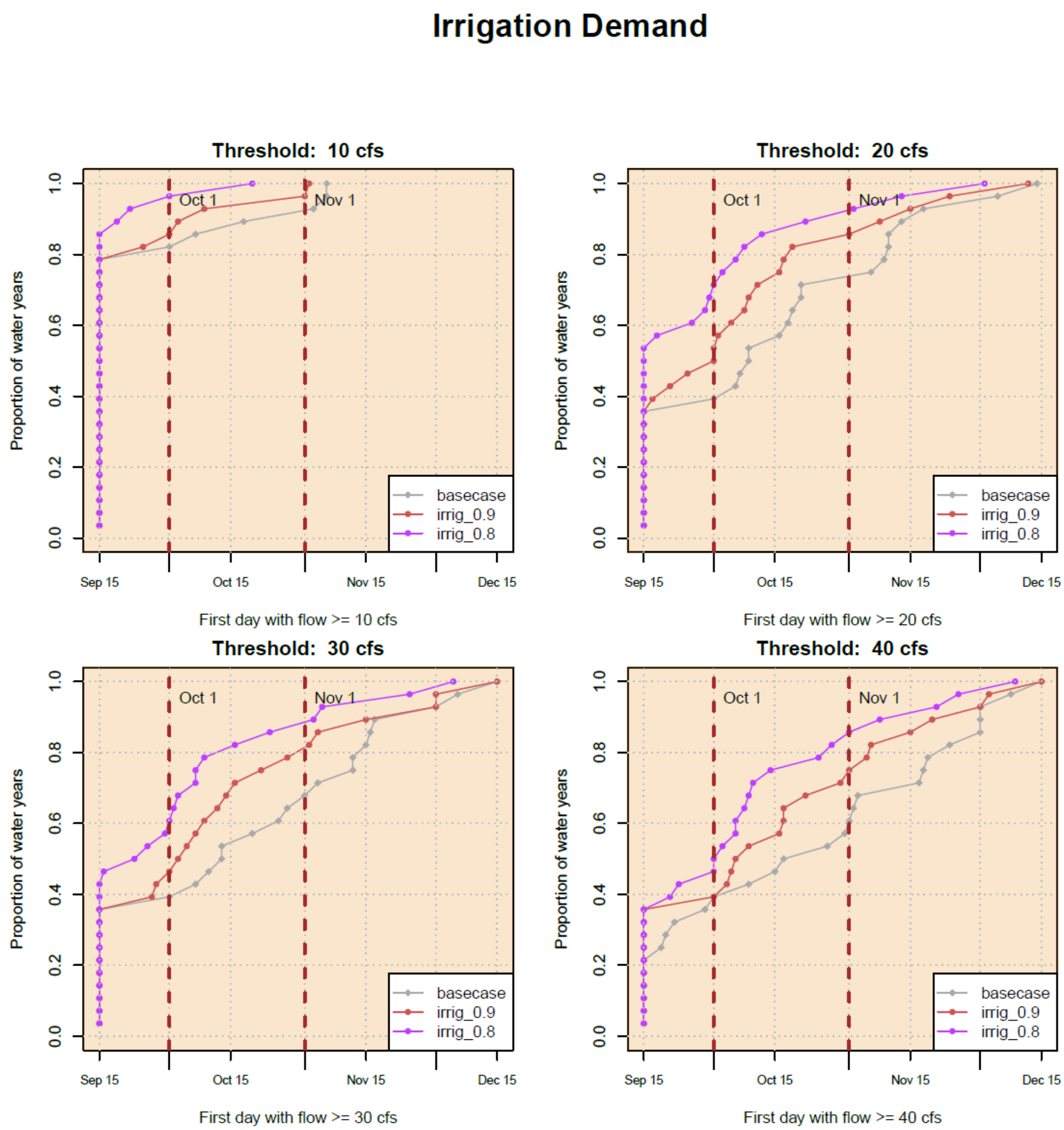
For the recent SWRCB hearing on October 6, 2023, we also prepared a scenario that simulates management conditions similar to 2022 in all years between 1991 and 2018: Surface water curtailments occur on the first date on which Scott River flows at the Fort Jones gage first fall below the required flows (draft order (c)(1)), through the end of the irrigation season; and groundwater pumping for the entire season is reduced by 30%. Curtailments of either surface water order groundwater were not simulated in eight years (1993, 1995, 1998, 1999, 2003, 2006, 2011, 2017). These years had sufficiently high summer and fall flows to mostly meet the proposed minimum in-stream flow requirements. Fall flows exceeded 40 cfs approximately one month earlier than under basecase conditions, in all but the two driest years, as shown in the cumulative distribution graph below (the graph also includes a scenario, EmFlow_100LCS, with no LCS but 100% curtailment on both surface water diversions and groundwater pumping on a date that varies from year to year according to actual streamflow falling below required minimum flows in the draft order).

Figure 1: Emergency flow regulation scenarios: cumulative distribution function of fall dates at which the Scott River at the Fort Jones gage first exceeds the threshold flow, 1991-2018.



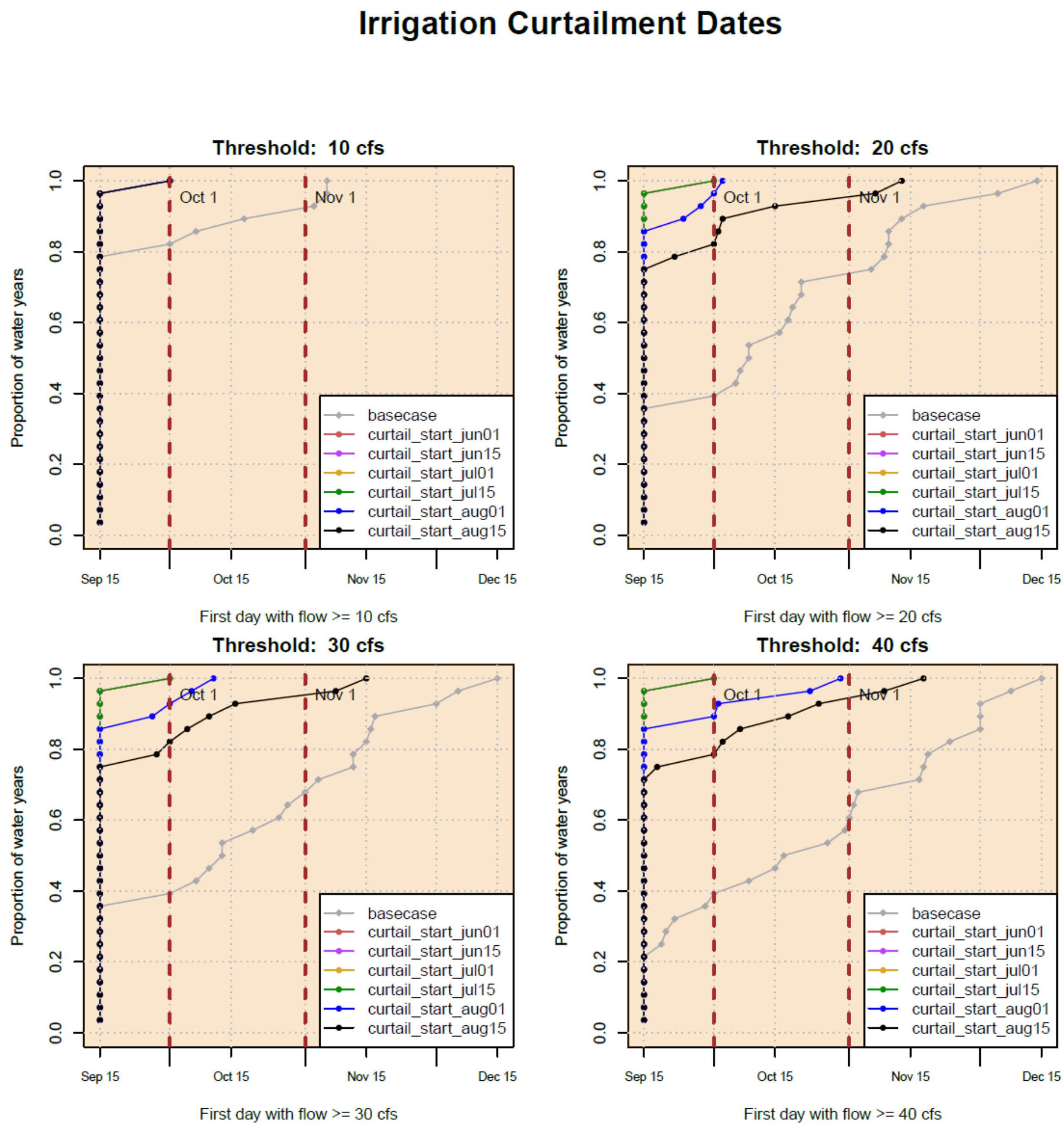
The above results are consistent with the more general scenarios that were developed for the groundwater sustainability plan. There, one set of scenarios was developed that reduced the overall irrigation demand in Scott Valley to 90% and 80% of historic (basecase) conditions. The latter 20% reduction in irrigation demand (across all crops) yields two to four week earlier flows above, e.g., the 40 cfs threshold, relative to the basecase

Figure 2: Irrigation demand scenarios: cumulative distribution function of fall dates at which the Scott River at the Fort Jones gage first exceeds the threshold flow, 1991-2018.



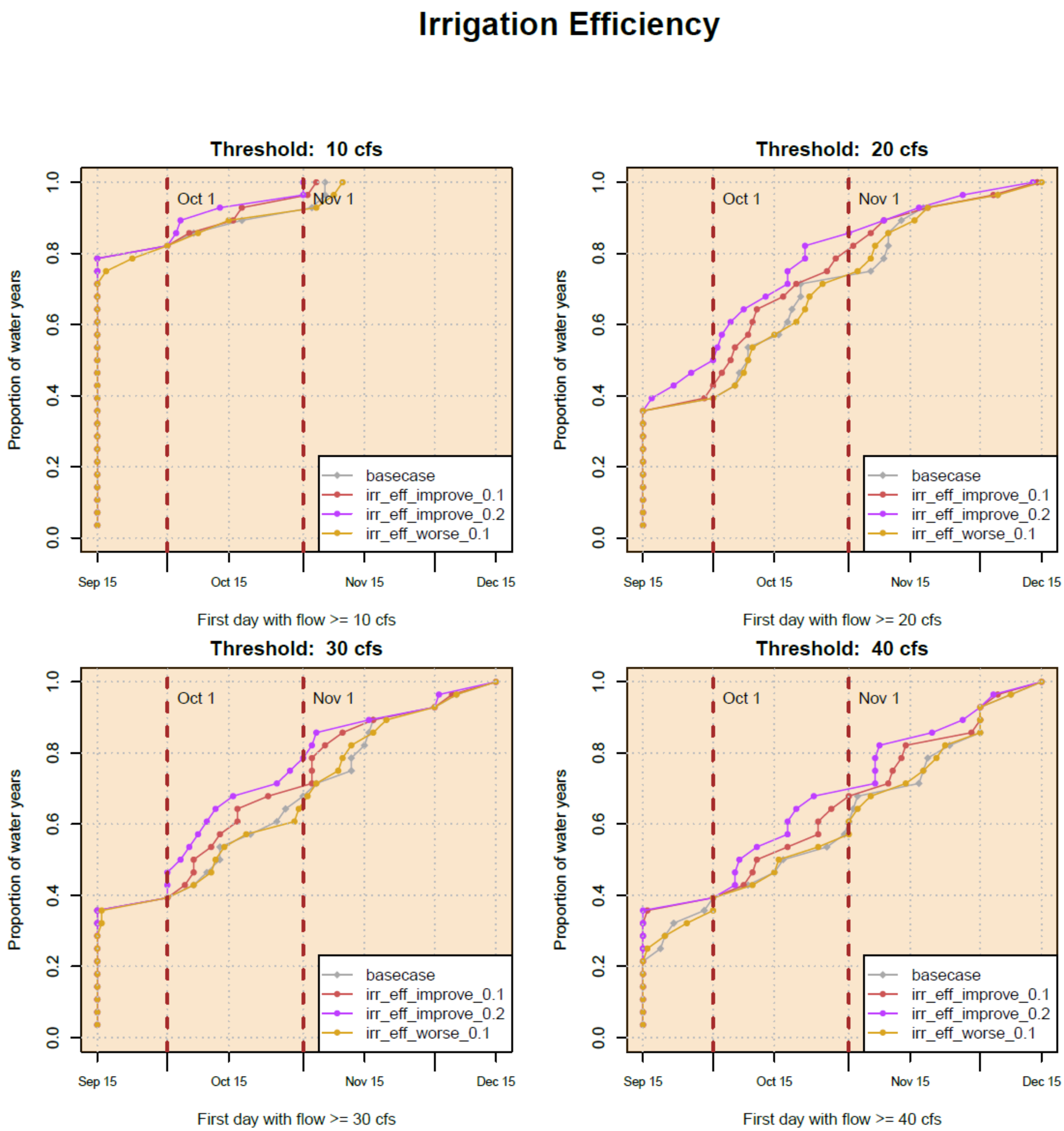
A “bookend” scenario from the GSP work that most closely represents the proposed “Graduated Overlying Groundwater Diversion Cessation Schedules” are the “curtailment on a specific date” scenarios. These scenarios simulate curtailment on all surface water and groundwater diversions on specific dates that are repeated during each year of the SVIHM simulation. One scenario that most closely approximates the proposed “Graduated […] Schedules” is the “curtailment start date August 15” (“curtail_start_aug15” in the below graph). The improvements in fall flow conditions, measured by the cumulative distribution of fall dates on which flows begin to exceed, e.g., 40 cfs, are similar to the regular LCS scenario above – yielding about 4 weeks earlier flow exceedance in most years with low flows.

Figure 3: Fixed irrigation curtailment date scenarios: cumulative distribution function of fall dates at which the Scott River at the Fort Jones gage first exceeds the threshold flow, 1991-2018.



Similarly, a set of "bookend" scenarios from the GSP development that most closely approximate the proposed "Best Management Practices LCS" are the scenarios that considered improvements in irrigation efficiency. A 20% improvement in irrigation efficiency (labeled "irr_eff_improve_0.2" in the below graph), with no other improvement in practices, regularly yields about two weeks earlier flow exceedance, e.g., of 40 cfs, at the Scott River Fort Jones gage.

Figure 4: Irrigation efficiency scenarios: cumulative distribution function of fall dates at which the Scott River at the Fort Jones gage first exceeds the threshold flow, 1991-2018.



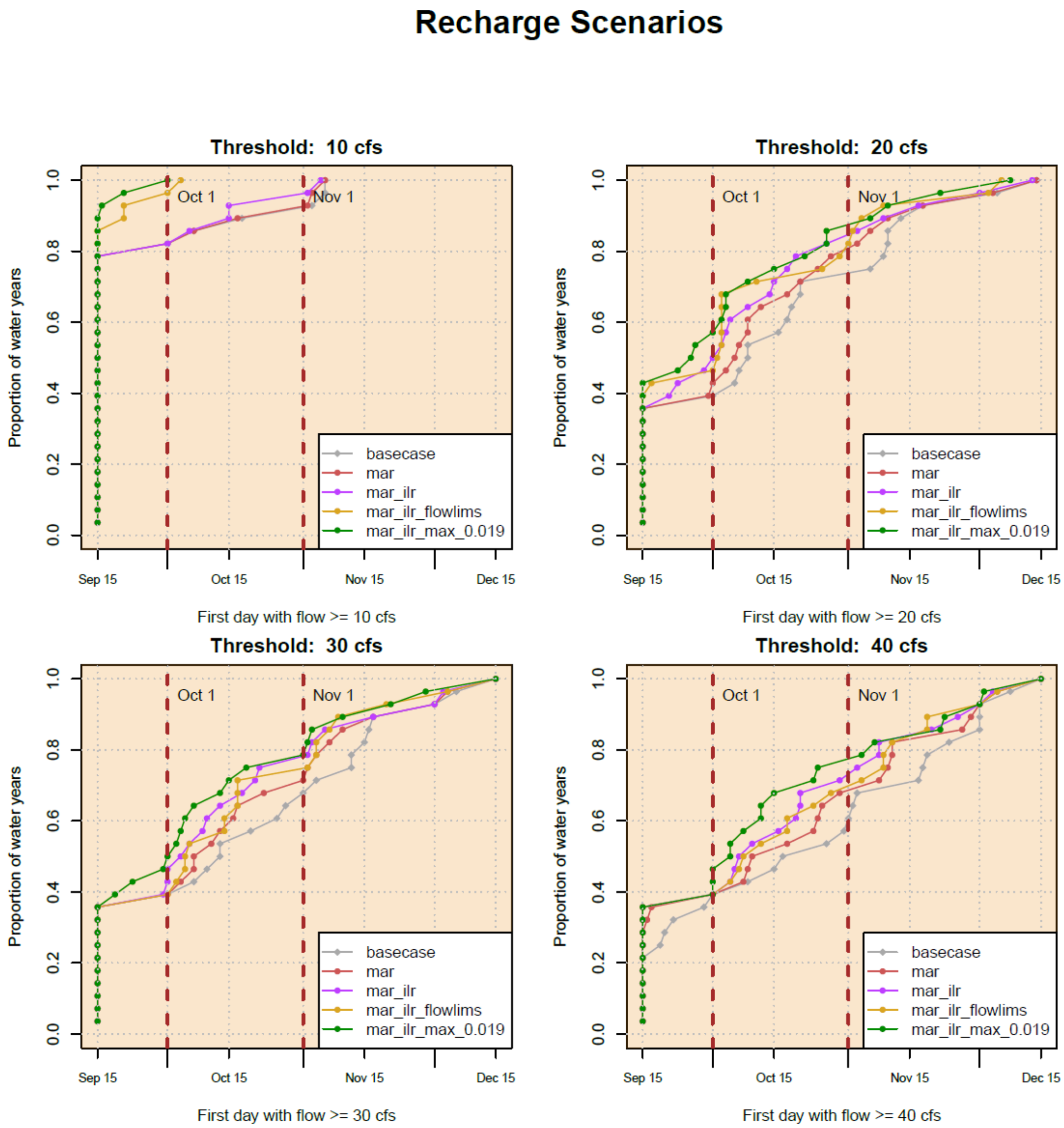
Comment 3: Winter stock water diversions and their ensuing ditch/canal recharge are an important pillar in support of summer and fall baseflow and must not be curtailed (or only minimally curtailed).

Winter stock water diversions into existing unlined ditches and canals have provided significant groundwater recharge on a nearly permanent basis. The recharge from these ditches most commonly occurs at a strategically very advantageous location of the Scott Valley: near the margins of the alluvial basin and away from streams. The recharge from ditches and canals effectively acts as a permanent "managed aquifer recharge" (MAR) operation that benefits return flows to the mainstem of the Scott River. Given their often relatively distant location from the main-stem of the Scott River, the temporal delay of the return flow benefit to the baseflow component of Scott River flow is relatively large, benefitting to a significant degree baseflow conditions throughout the year. Curtailing stock water diversions will lead to nearly full cessation of these incidental, continuous aquifer recharge events. This would only further reduce summer and fall baseflow. This further has the potential significantly counter-act the improvements in fall reconnection timing that are targeted with the LCS and other curtailment actions.

This can easily be shown by considering the various MAR scenarios developed for the development of the Scott Valley GSP. Even some of the most modest MAR practice scenarios ("mar" in the below legend) yields one to two weeks earlier reconnection above the, e.g., 40 cfs threshold, when compared to historic conditions ("basecase" in the below figure legend). For the same reason, it is not unreasonable to expect that a nearly permanent cessation of canal and ditch recharge would yield a delay of one or more weeks in the dates at which fall flows exceed, e.g., 40 cfs (in intermediate and dry years).

While stockwater diversions impact winter streamflow, their magnitude is relatively small and the consequences to the critical summer and fall streamflow conditions are potentially much more harmful than the gains to winter streamflow conditions. I propose that stockwater diversions are curtailed only prior to January 1 and then only when streamflow conditions are below the minimum conditions proposed in the draft order.

Figure 5: Recharge scenarios: cumulative distribution function of fall dates at which the Scott River at the Fort Jones gage first exceeds the threshold flow, 1991-2018.

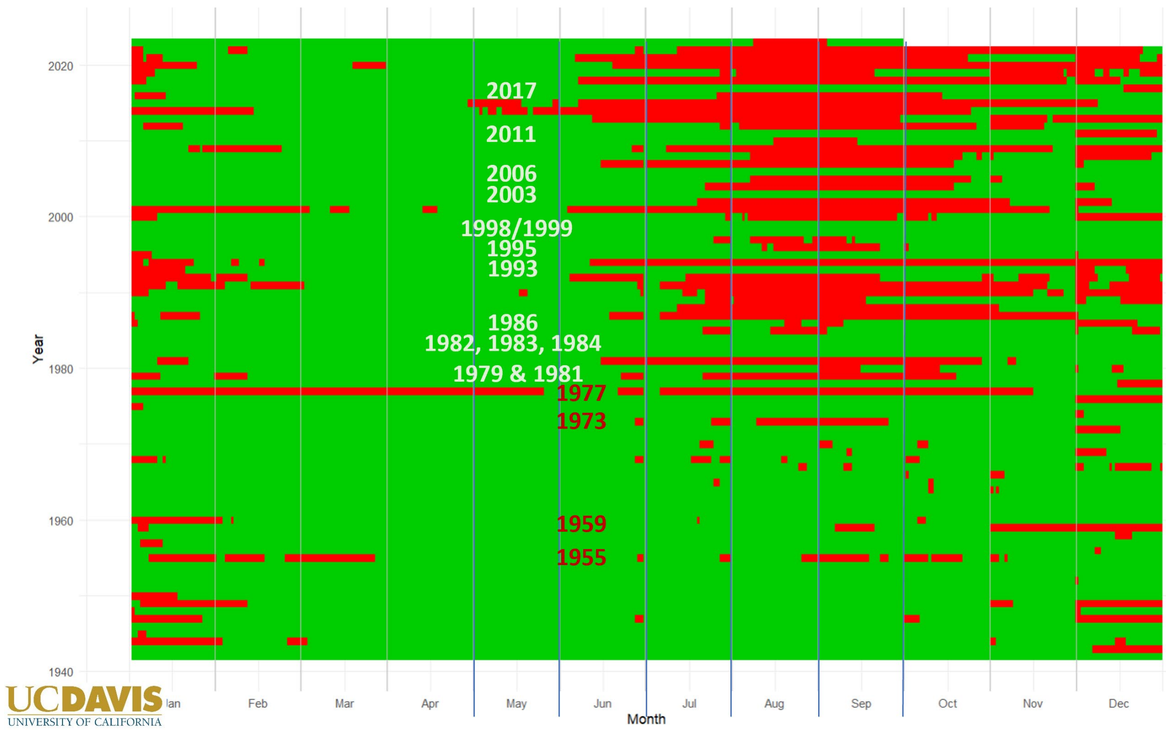


Comment 4: The order will have potentially very damaging economic impacts that must be addressed by allowing for adaptive management and a reasonable transition period to full implementation.

If the emergency order will be renewed until a permanent requirement is in place, and if the permanent requirement were the same as in the emergency order, 30% or more reductions in surface water diversions and groundwater pumping would be enforced in approximately 4 out of 5 years: Since 2000, only four years (2003, 2006, 2011, 2017) met the proposed flows throughout their summer and fall periods.

The economic analysis completed for the Scott Valley GSP by Medellin et al., 2021, shows that this represents a drastic impact on the economy of Scott Valley with potentially transforming impacts on the agricultural landscape. These types of structural changes to the agricultural sector, required to be implemented next year under the draft order, are of the same magnitude or larger as some of the anticipated land-repurposing changes needed in the most over-drafted groundwater basins in California under the implementation of California's 2014 Sustainable Groundwater Management Act (SGMA). Foreseeing the need to ease such economic transitions and to minimize the disruption to local economies, SGMA mandated a phased and adaptive management approach over a 20-year implementation period. Economic investment will occur over this 20 year period rather than instantaneously. Monitoring during this period informs refinements in implementation. For consistency with SGMA, the draft order best adopt a similarly phased, adaptive management approach to ultimately achieve its stated, desired outcomes. The current draft order entirely lacks such an approach and would be unnecessarily and inequitably disruptive.

Figure 6: The graph below shows, in green, days on which flows of the Scott River at the Fort Jones gage exceeded the flows required by the draft order and, in red, days on which flows were below the rates required by the draft order. Each day is a small square. All days of one year form a single line in the below graph, from January 1 on the left to December 31 on the right. Each year for which Scott River flow measurements are available at the Fort Jones gage is a row, beginning with 1942 at the bottom and continuing through 2023 at the top. Years with significant summer and fall periods below the draft order required flows are indicated in red, for the period prior to 1978. Years that do *not* have significant summer and fall periods below the draft order required flows are indicated in white, for the period after 1978.



If you require any further information or clarification, please do not hesitate to contact me.

With best regards,

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