

Appendix A8

Salmonid Tributary Habitat Analysis

A8.1 Salmonid Tributary Habitat Analysis Methods

Except where described below, methods for this analysis were identical to those used in the Scientific Basis Report Supplement (Appendix G2) for estimation of existing tributary habitat area (Section 5.1, Tributary Habitat Analysis). Most analyses were focused on fall-run Chinook salmon, but some were focused on spring-run. Results tables and figures identify fall-run and spring-run results only for tributaries for which spring-run were evaluated; all other tributaries represent only fall-run results.

A8.1.1 Temperature

Temperature data for tributaries included in the analyses for the proposed voluntary agreements (VAs) (American River, Feather River, Mokelumne River, Sacramento River, Yuba River) use data and methodology as described in the Scientific Basis Report.

The temperature analysis method for tributaries not included in the VAs differs. Temperature data used in these analyses are from the Central Valley Project Improvement Act (CVPIA) Decision Support Model (DSM) input called “DSMtemperature” (Gill et al. 2022a). Details about the methods used for each tributary are provided by Gill et al. (2022b). Data from DSMtemperature are available at a monthly timestep for 1980–2000. As this does not cover the entire Sacramento Water Allocation Model (SacWAM) modeling period, a subsampling approach, similar to what was used in the Scientific Basis Report analysis for VA tributaries, was used. Additionally, as data are at a monthly timestep, the “proportion suitable” metric could not be calculated as is done in the Scientific Basis Report. Rather, habitat was considered suitable if the temperature for the given month and year was below the temperature thresholds.

A8.1.2 Habitat Data

The habitat analyses for the unimpaired flow scenarios follow a similar methodology as described in the Scientific Basis Report. For tributaries included in the VAs, the data sources are the same as in the Scientific Basis Report. The unimpaired flow scenarios do not consider the impact of additional habitat created through the VAs and use habitat data described as “existing.”

For the tributaries not included in the VAs, habitat-to-flow functions (similar to those described in the Scientific Basis Report) needed to be developed to apply to the unimpaired flow scenarios. All habitat data for these tributaries are from the Central Valley Project Improvement Act (CVPIA) Decision Support Model (DSM) input called “DSMhabitat” (described here: https://cvpia-osc.github.io/DSMhabitat/reference/habitat_data.html; source code: <https://github.com/CVPIA-OSC/DSMhabitat>). DSM habitat compiles data from multiple sources. The specific data sources for the tributaries not included in the VAs are described in Table 1.

Table A8-1. Spawning, Instream Rearing, and Floodplain Habitat Data Sources for Tributaries not Included in the Voluntary Agreements, and Links to Documentation Describing Habitat Modeling

Watershed	Data Source	Link to Habitat Modeling Description
Antelope Creek	Spawning and Instream Rearing – No watershed-specific data available. Used a regional approximation method (Gill and Tompkins 2020a)	(Gill and Tompkins 2020b)
	Floodplain – Scaled from a Deer Creek flow-to-floodplain area relationship generated with a 2D HEC-RAS hydraulic model (Hackenjos 2019)	
Battle Creek	Spawning and Instream Rearing – Thomas R. Payne and Associates 1995 (Thomas R. Payne and Associates 1995)	(Gill and Tompkins 2020c)
	Floodplain – Scaled from a Deer Creek flow-to-floodplain area relationship generated with a 2D HEC-RAS hydraulic model (Hackenjos 2019)	
Bear River	Spawning and Instream Rearing – South Sutter Water District 2019 (SSWD 2019)	(Gill and Tompkins 2020d)
	Floodplain – Central Valley Floodplain Evaluation and Delineation (CVFED) HEC-RAS hydraulic model (DWR 2014)	
Big Chico Creek	Spawning and Instream Rearing – No watershed-specific data available. Used a regional approximation method (Gill and Tompkins 2020a)	(Gill and Tompkins 2020e)
	Floodplain – CVFED HEC-RAS hydraulic model (DWR 2014)	
Butte Creek	Spawning and Instream Rearing – (USFWS 2003); FERC Relicensing DeSabra (PG&E 2008)	(Gill and Tompkins 2020f)
	Floodplain – CVFED HEC-RAS hydraulic model (DWR 2014)	
Calaveras River	Spawning and Instream Rearing – (FISHBIO Environmental and Thomas R. Payne & Associates 2010); No habitat modeling is available for fall-run Chinook salmon on the Calaveras River. Instream spawning and rearing habitat for steelhead in the Calaveras River is used as a proxy for Chinook.	(Gill and Tompkins 2020g)
	Floodplain – Scaled from a Tuolumne River flow-to-floodplain area relationship generated with a TUFLOW hydraulic model with 1D channel and 2D overbank components (HDR, Inc. and Stillwater Sciences 2015)	
Clear Creek	Spawning and Instream Rearing – (USFWS 2007); rearing, (USFWS 2011b); spawning, (USFWS 2011a); rearing, (USFWS 2013)	(Gill and Tompkins 2020h)
	Floodplain – Scaled from a Cottonwood Creek flow-to-floodplain area relationship generated	

Watershed	Data Source	Link to Habitat Modeling Description
	with a USFWS / FEMA 1D HEC-RAS hydraulic model (USFWS 2018)	
Cosumnes River	Spawning and Instream Rearing – Calaveras, FISHBIO Environmental and Thomas R. Payne & Associates 2010 (FISHBIO Environmental and Thomas R. Payne & Associates 2010); Mokelumne, (CDFG 1991). No watershed-specific salmonid habitat data were available for the Cosumnes River. A regional weighted usable area (WUA) and flow relationship was derived for the Cosumnes River by averaging the WUA values on the Calaveras River and the Mokelumne River. Floodplain – CVPIA Annual Progress Report Fiscal Year 2019 (USFWS 2019)	(Gill and Tompkins 2020i)
Cottonwood Creek	Spawning and Instream Rearing – (CDFG and U.S. Corps of Engineers 1979); (USFWS 2014)) Floodplain – USFWS 2018 / FEMA 1D HEC-RAS hydraulic model (USFWS 2018)	(Gill and Tompkins 2020j)
Cow Creek	Spawning – No watershed specific data were available. Used a regional approximation method (described here: Gill and Tompkins 2020a Instream Rearing – USFWS 2011c) Floodplain – Scaled from a Deer Creek flow-to-floodplain area relationship generated with a 2D HEC-RAS hydraulic model (Hackenjos 2019)	(Gill and Tompkins 2020k)
Deer Creek	Spawning and Instream Rearing – (Hackenjos 2019) Floodplain – Same data source as Spawning and Instream Rearing	(Gill and Tompkins 2020l)
Elder Creek	Spawning and Instream Rearing – No watershed specific data were available. Used a regional approximation method (described here: Gill and Tompkins 2020a) Floodplain – CVFED HEC-RAS hydraulic model (DWR 2014)	(Gill and Tompkins 2020m)
Mill Creek	Spawning and Instream Rearing – No watershed specific data were available. Used a regional approximation method (described here: Gill and Tompkins 2020a) Floodplain – Scaled from a Deer Creek flow-to-floodplain area relationship generated with a 2D HEC-RAS hydraulic model (Hackenjos 2019)	(Gill and Tompkins 2020n)
Paynes Creek	Spawning and Instream Rearing – No watershed specific data were available. Used a regional approximation method (described here: Gill and Tompkins 2020a)	(Gill and Tompkins 2020o)

Watershed	Data Source	Link to Habitat Modeling Description
Stony Creek	Floodplain – Scaled from a Deer Creek flow-to-floodplain area relationship generated with a 2D HEC-RAS hydraulic model (Hackenjos 2019)	(Gill and Tompkins 2020p)
	Spawning and Instream Rearing – No watershed specific data were available. Used a regional approximation method (described here: Gill and Tompkins 2020a)	
Thomes Creek	Floodplain – Scaled from a Cottonwood Creek flow-to-floodplain area relationship generated with a USFWS / FEMA 1D HEC-RAS hydraulic model (USFWS 2018)	(Gill and Tompkins 2020q)
	Spawning and Instream Rearing – No watershed specific data were available. Used a regional approximation method (described here: Gill and Tompkins 2020a)	
	Floodplain – Scaled from a Cottonwood Creek flow-to-floodplain area relationship generated with a USFWS / FEMA 1D HEC-RAS hydraulic model (USFWS 2018)	

A8.1.3 Meaningful Floodplain Event

The meaningful floodplain event (MFE) methods used for non-VA tributaries are the same as those described in the Scientific Basis Report, except in the following cases where a doubling goal¹ does not exist for a watershed: Elder Creek, Stony Creek, and Thomes Creek. In these cases, the magnitude levels for the MFE analysis were set at 25 percent, 50 percent, 75 percent, and 100 percent of the maximum habitat area. MFE analyses were not conducted for the Calaveras River because maximum floodplain habitat is estimated to be less than 1 acre (0.07 acre). MFE analyses have not yet been developed for the Yolo Bypass.

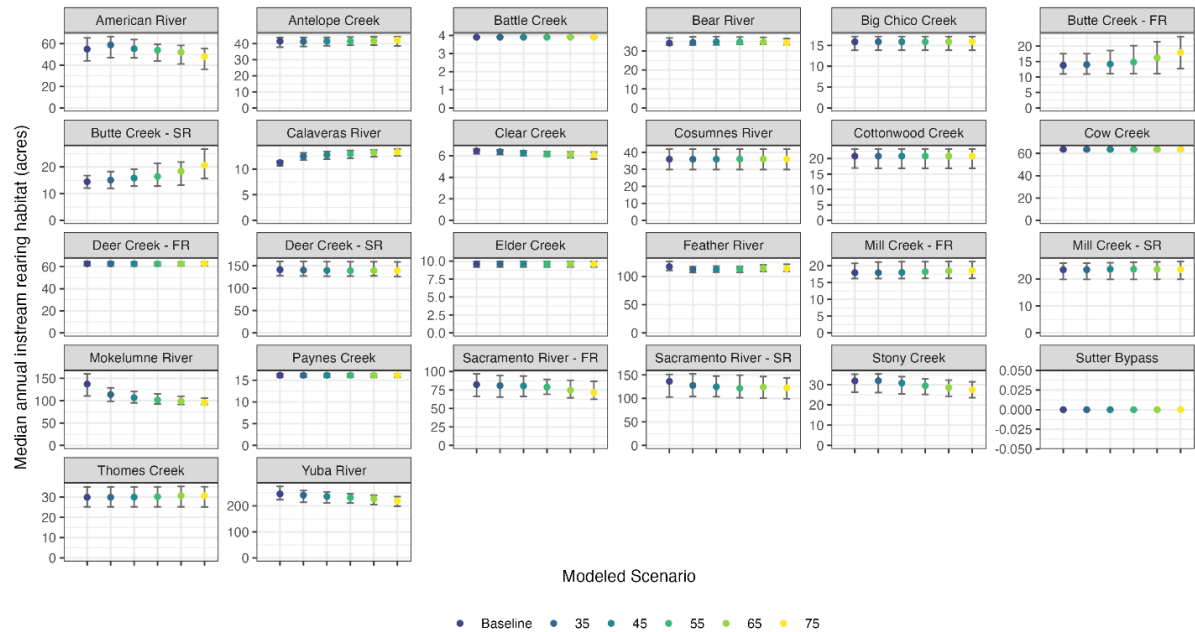
A8.2 Salmonid Tributary Habitat Analysis Supplemental Results Figures

The following figures (Figures A.8-1 through A.8-24) provide additional detail to the results presented in Chapter 3, *Scientific Knowledge to Inform Fish and Wildlife Flow Recommendations*.

¹ The goal of doubling natural production of chinook salmon from the average production of 1967–1991, consistent with provisions of state and federal law.

A8.2.1 In-Stream Rearing Habitat

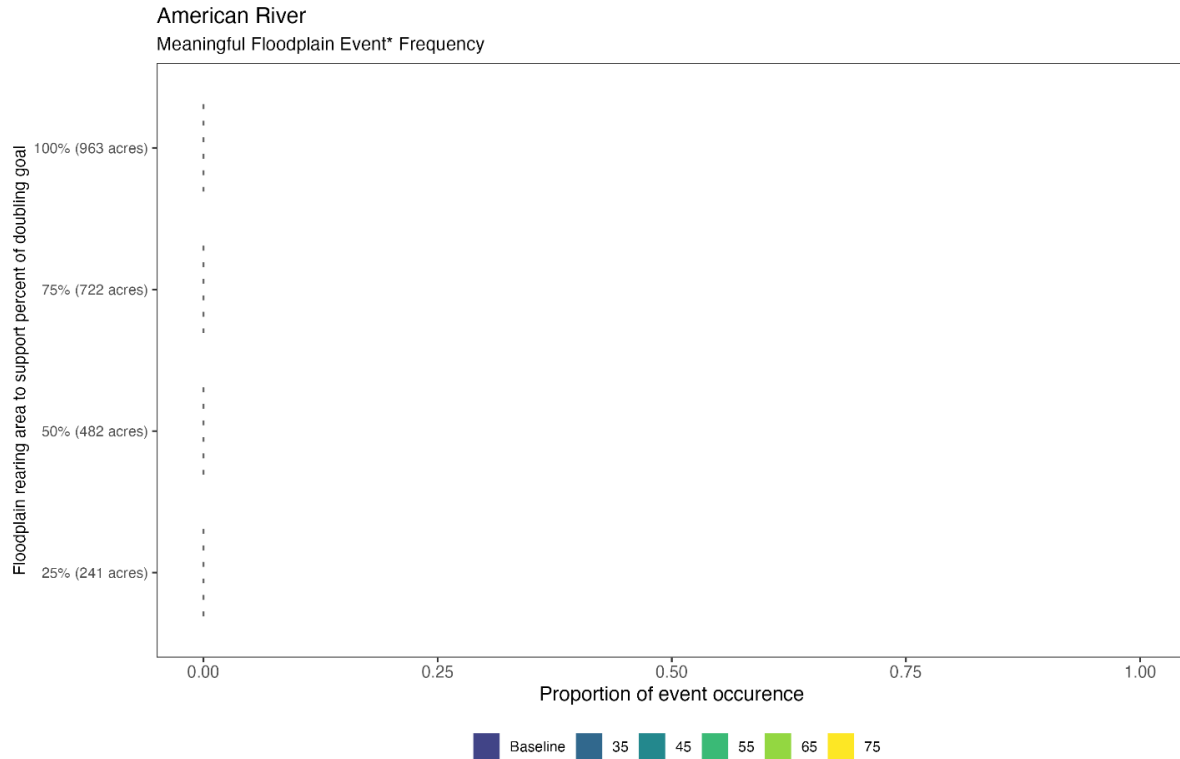
Figure A8-1. Median (across All Years Modeled) Instream Rearing Habitat (acres) for Each Watershed



Note: Error bars represent the upper and lower quartiles. Medians and quartiles were calculated across all years; therefore, the quartiles represent year-to-year variability, not the full uncertainty in expected outcomes.

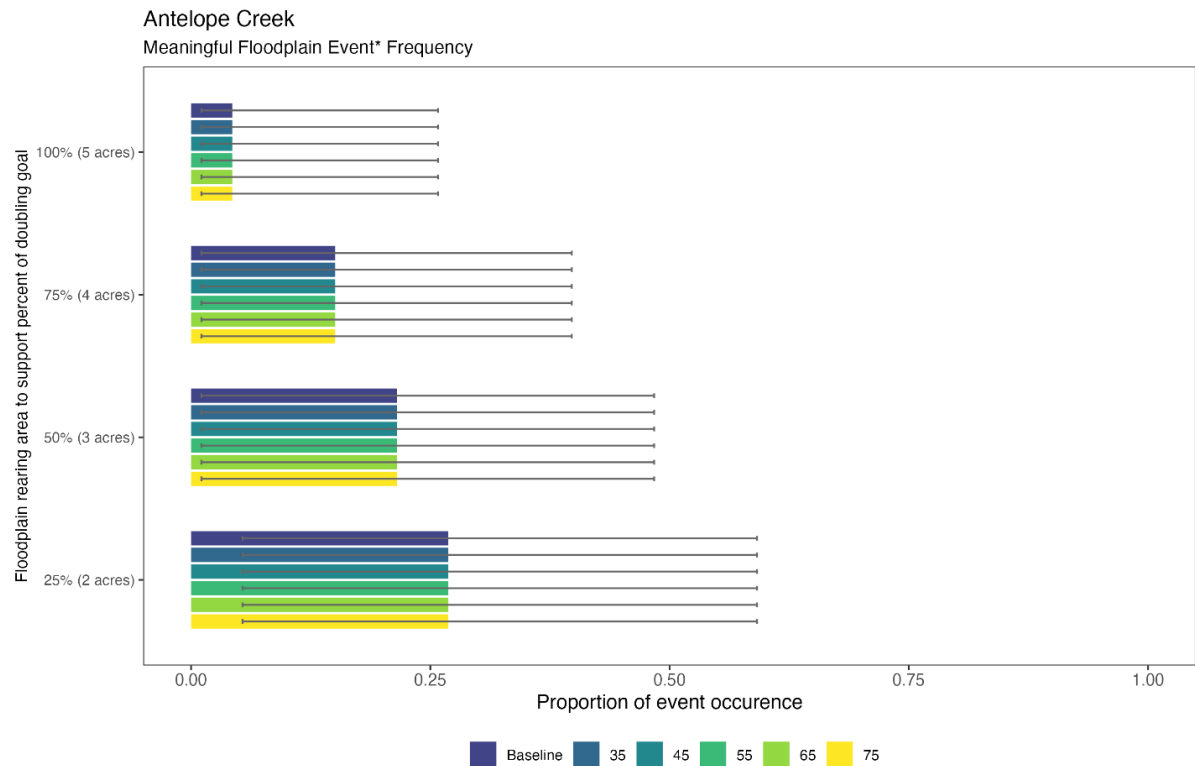
A8.2.2 Meaningful Floodplain Event

Figure A8-2. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on the American River



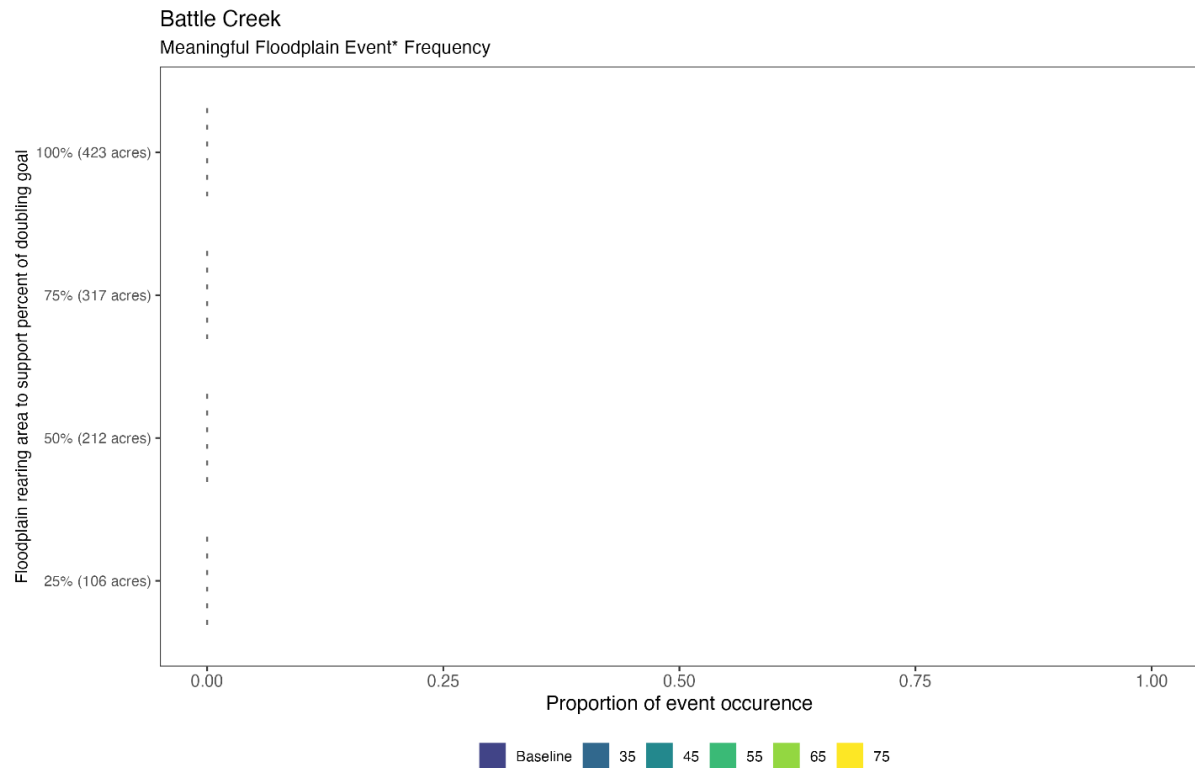
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years. All results are at 0 because there were no MFEs in any scenarios for the American River.

Figure A8-3. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on Antelope Creek



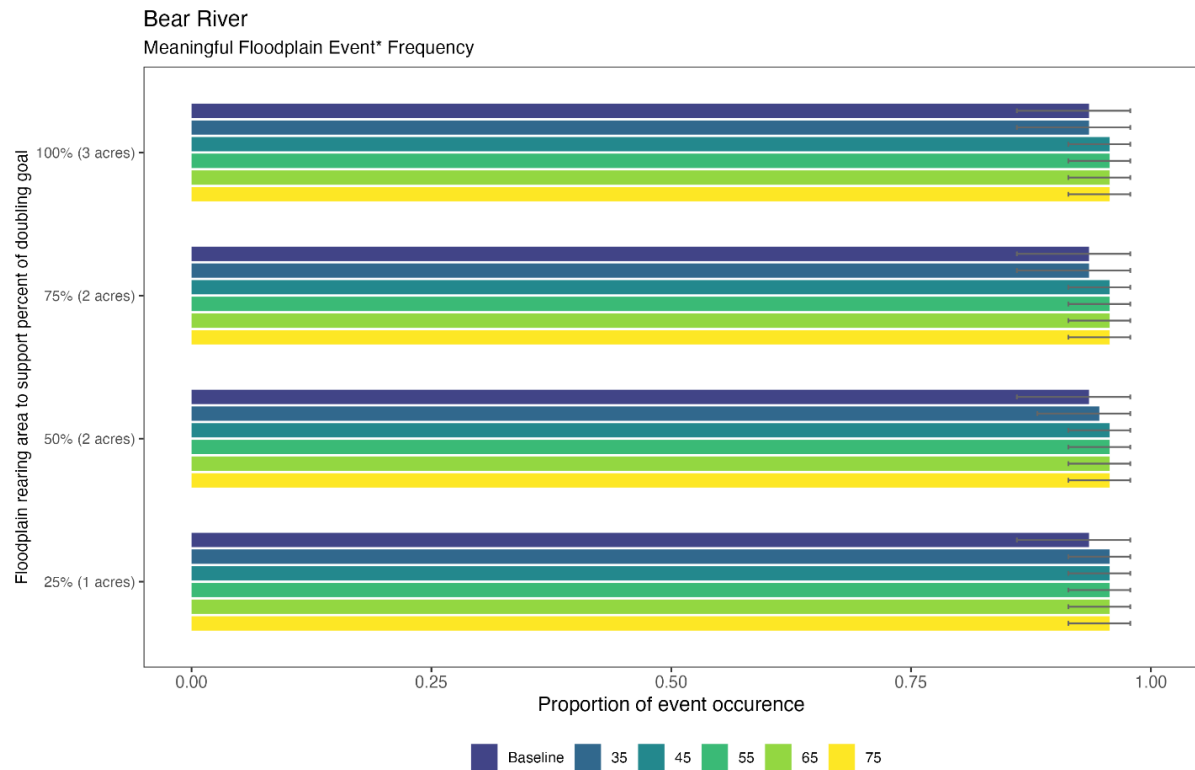
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years.

Figure A8-4. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on Battle Creek



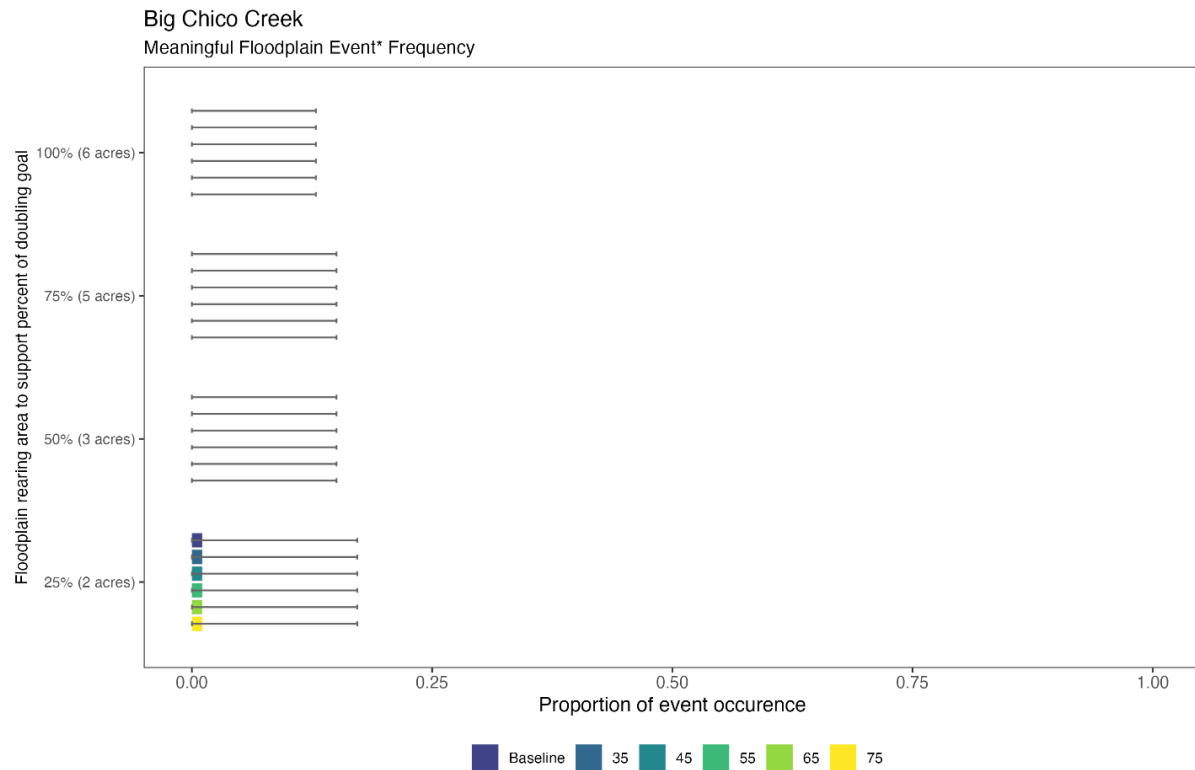
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years. All results are at 0 because there were no MFEs in any scenarios for Battle Creek.

Figure A8-5. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on the Bear River



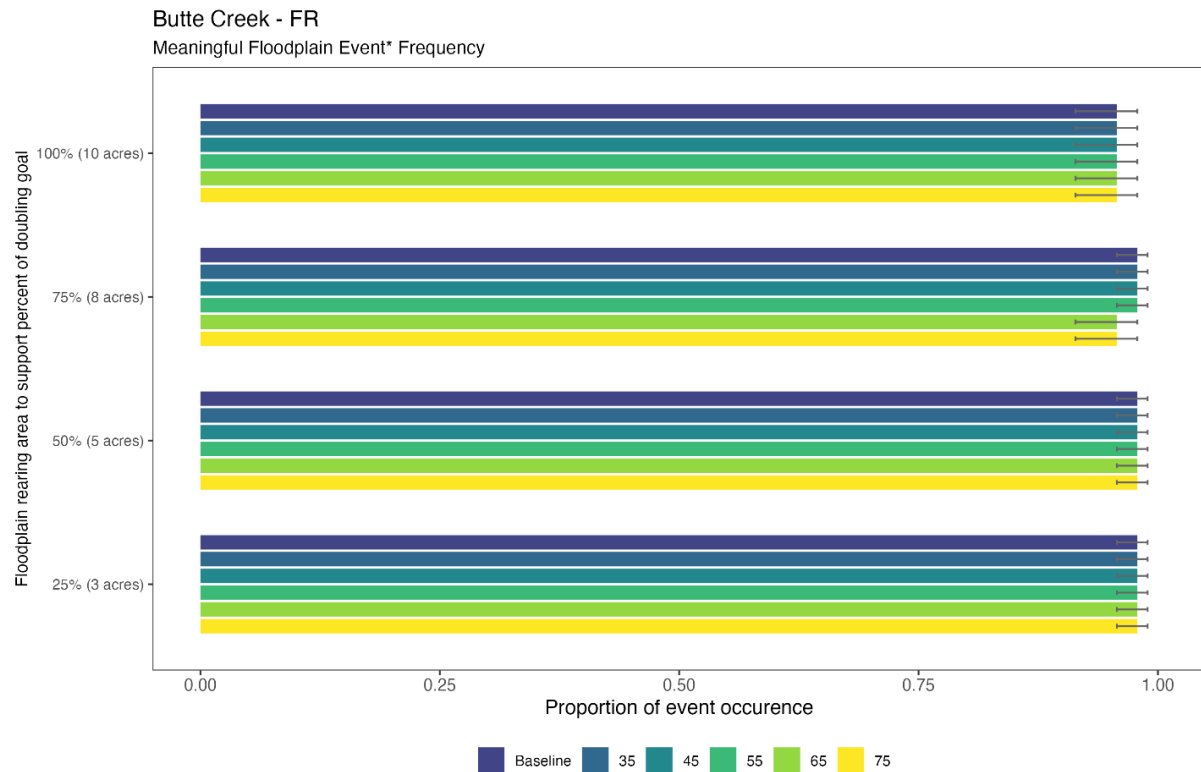
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years.

Figure A8-6. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on Big Chico Creek



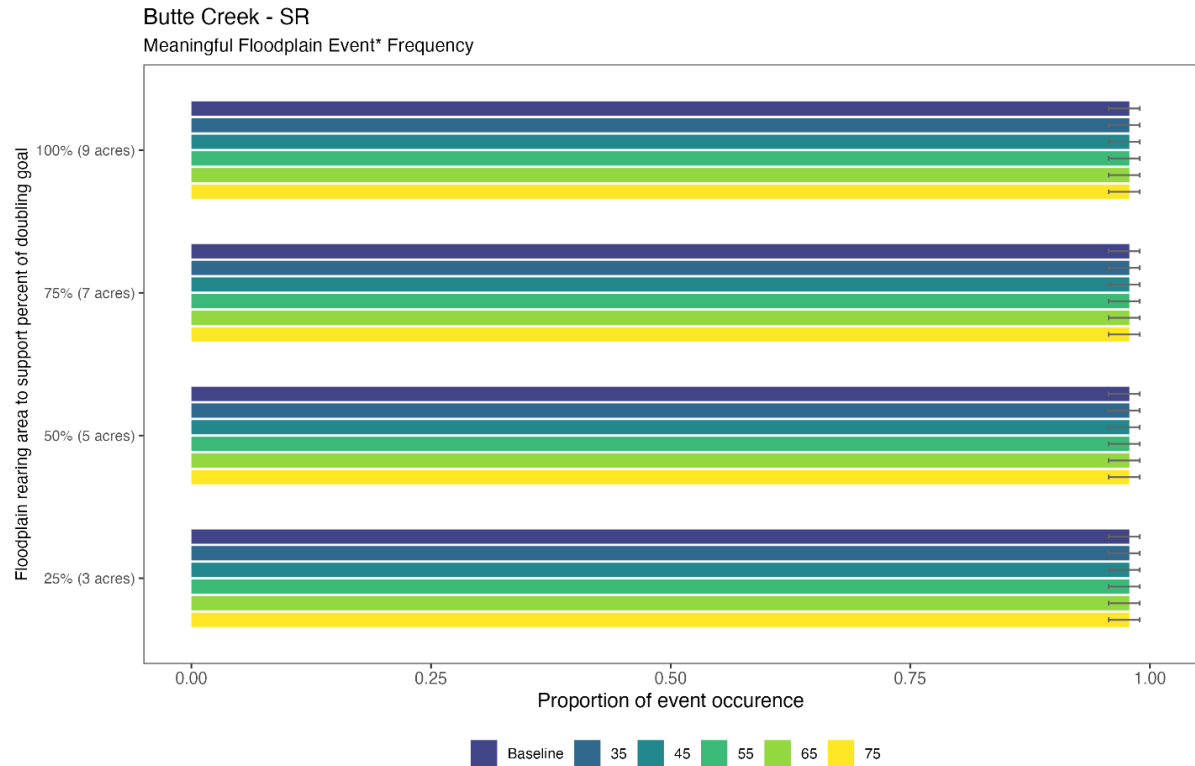
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years.

Figure A8-7. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on Butte Creek (Fall Run)



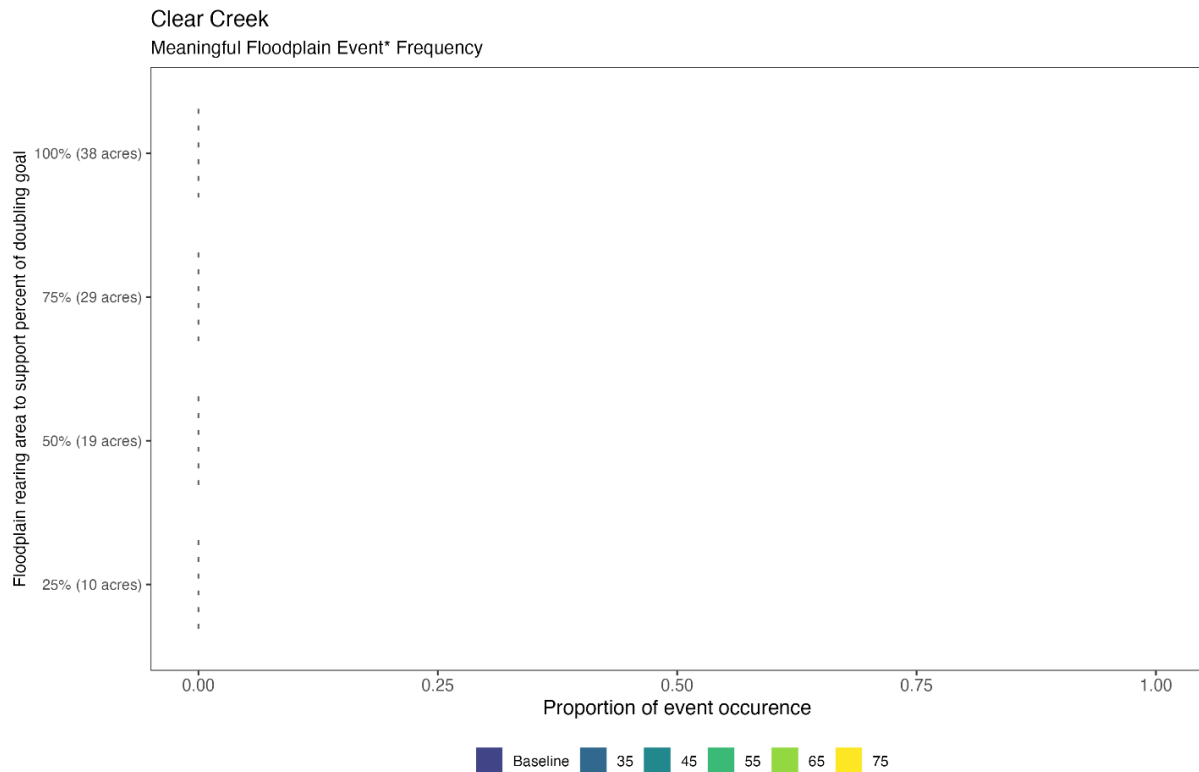
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years.

Figure A8-8. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on Butte Creek (Spring Run)



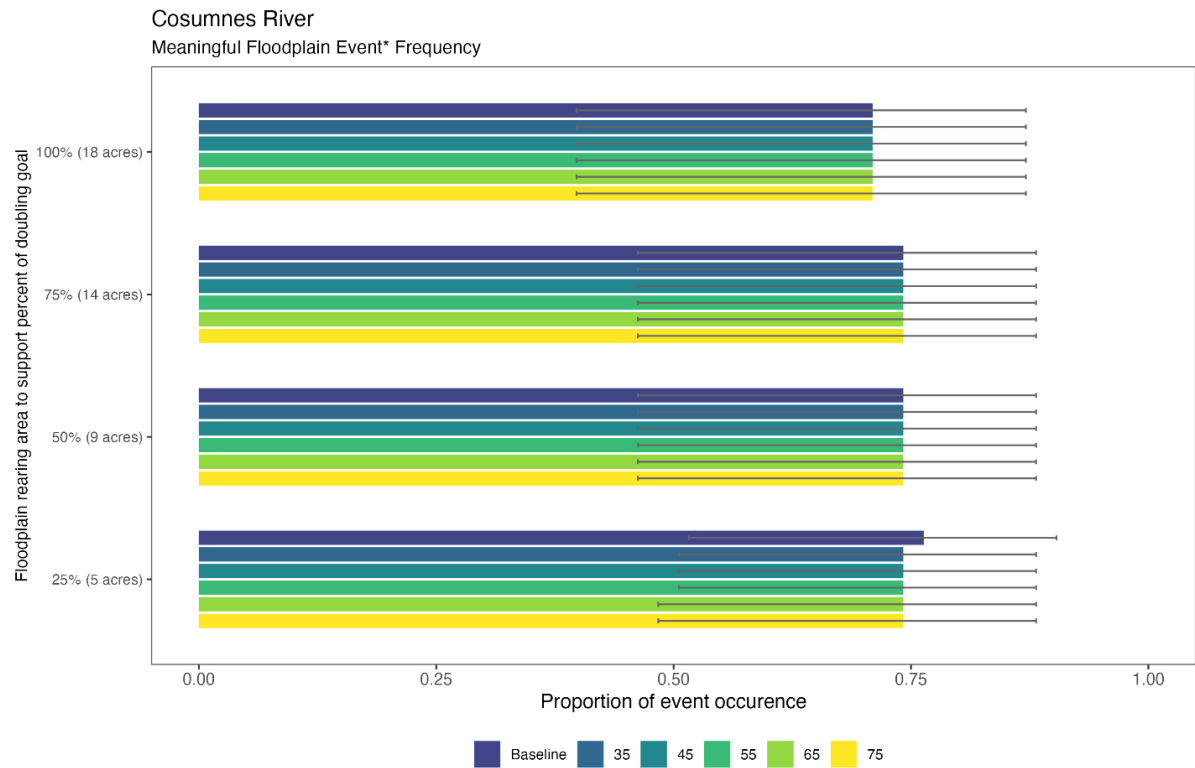
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years.

Figure A8-9. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on Clear Creek



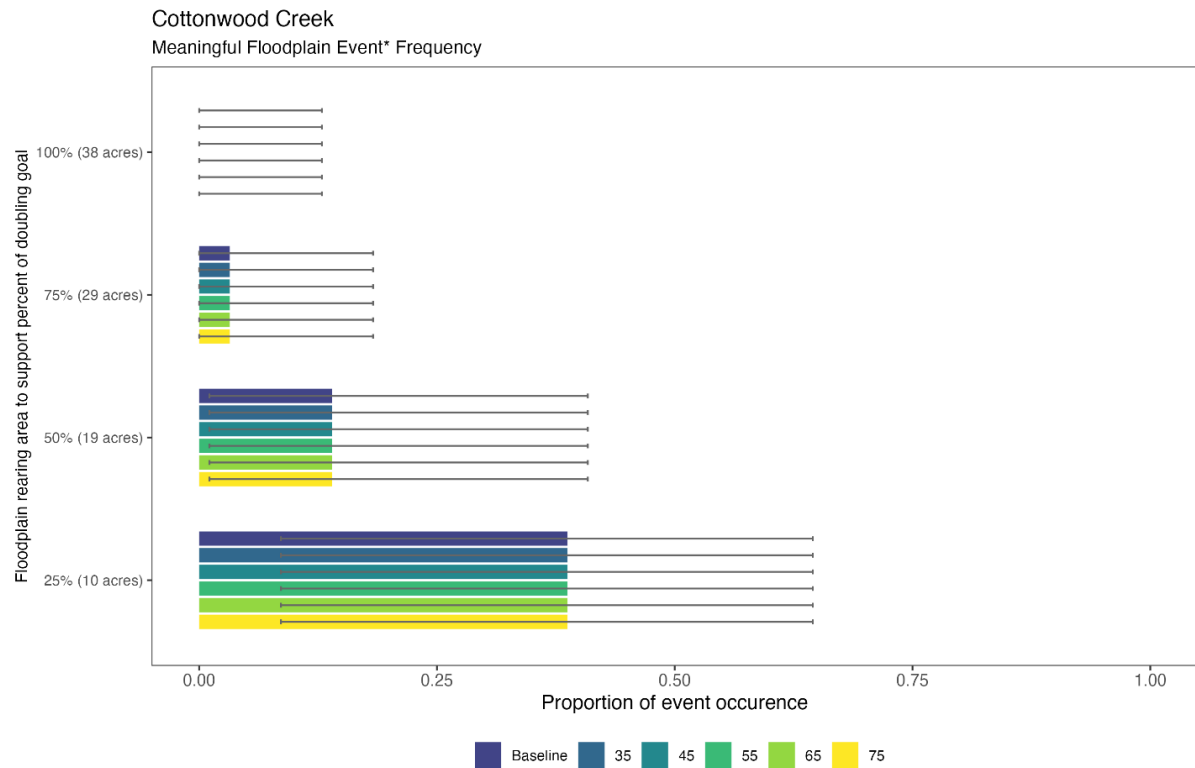
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years. All results are at 0 because there were no MFEs in any scenarios for Clear Creek.

Figure A8-10. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on the Cosumnes River



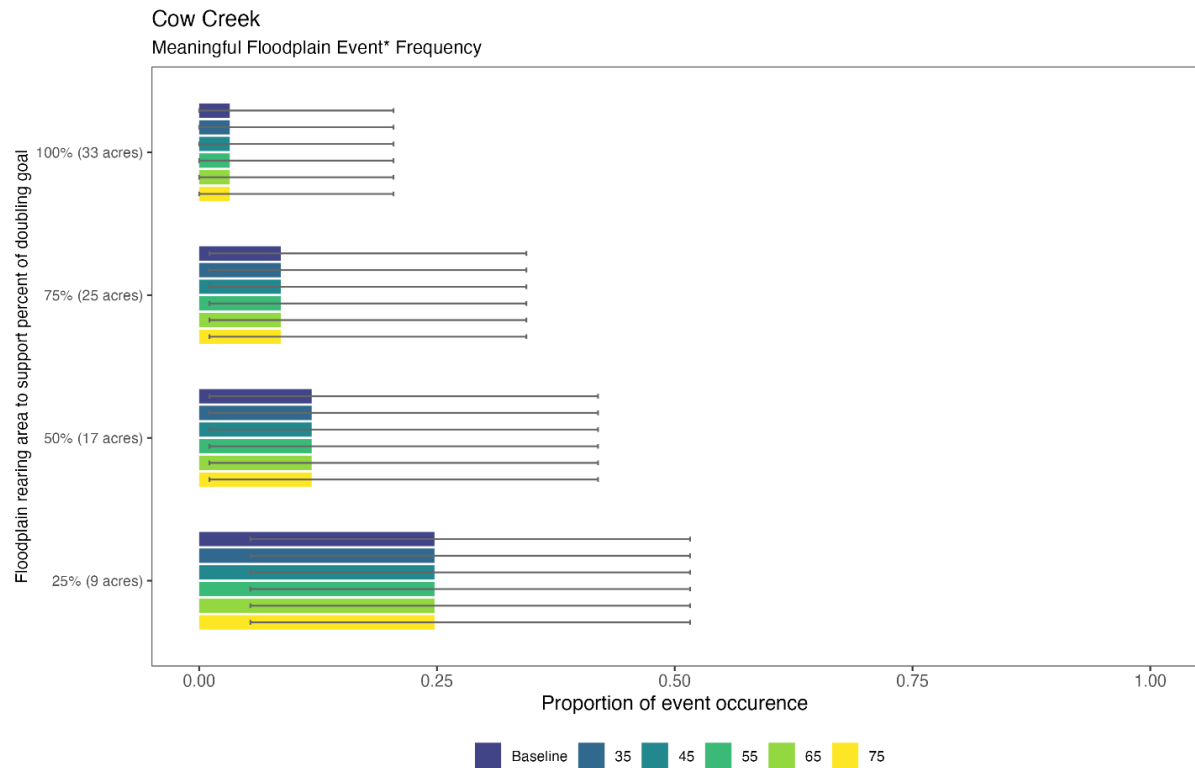
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years.

Figure A8-11. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on Cottonwood Creek



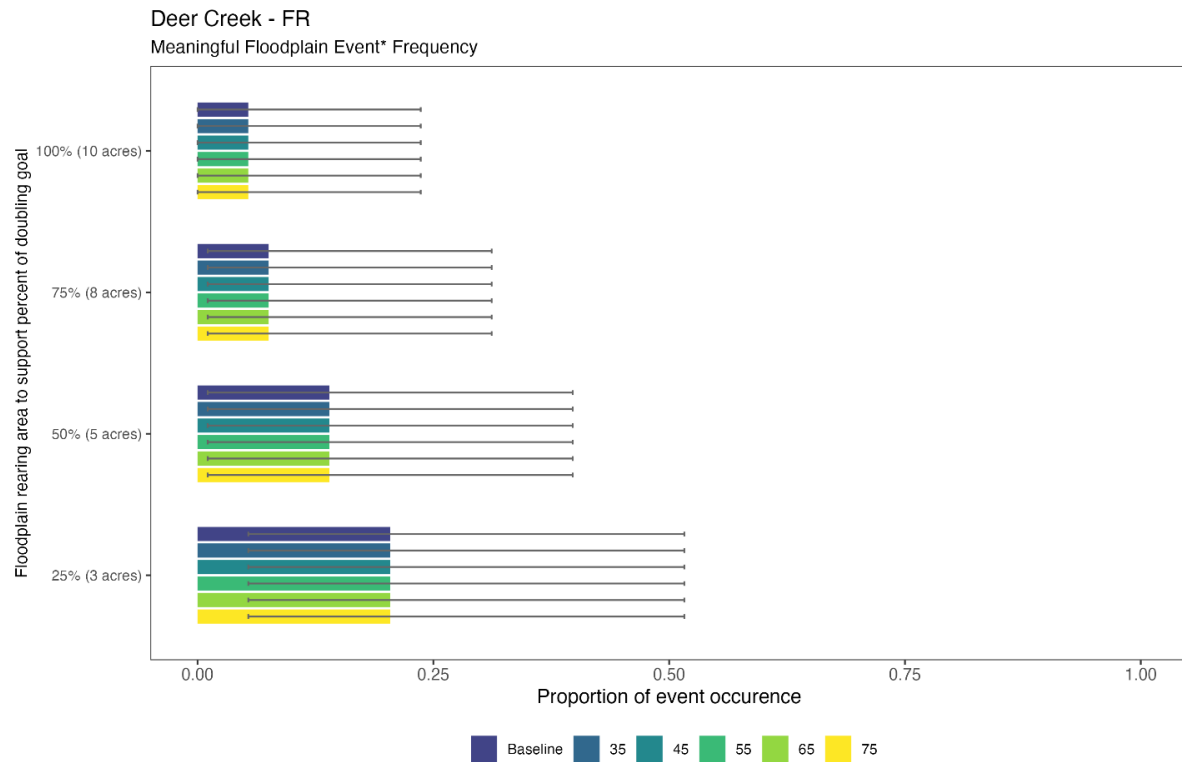
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years.

Figure A8-12. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on Cow Creek



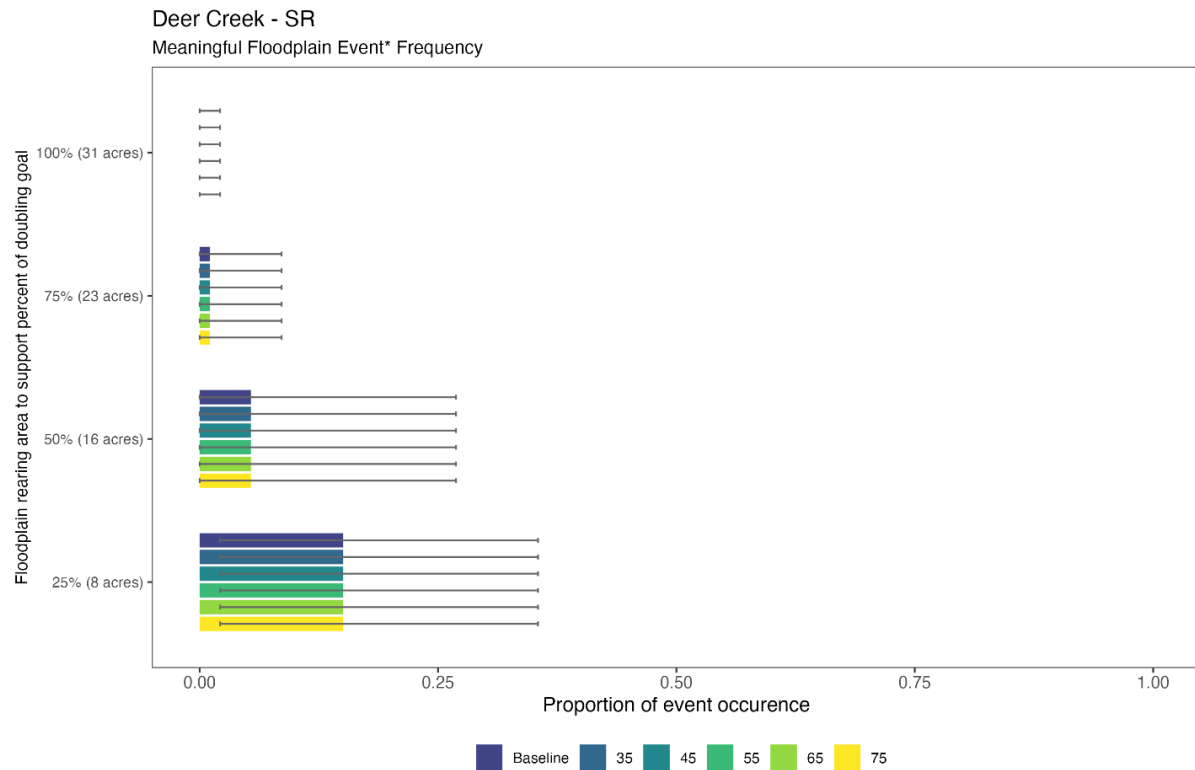
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years.

Figure A8-13. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on Deer Creek (Fall Run)



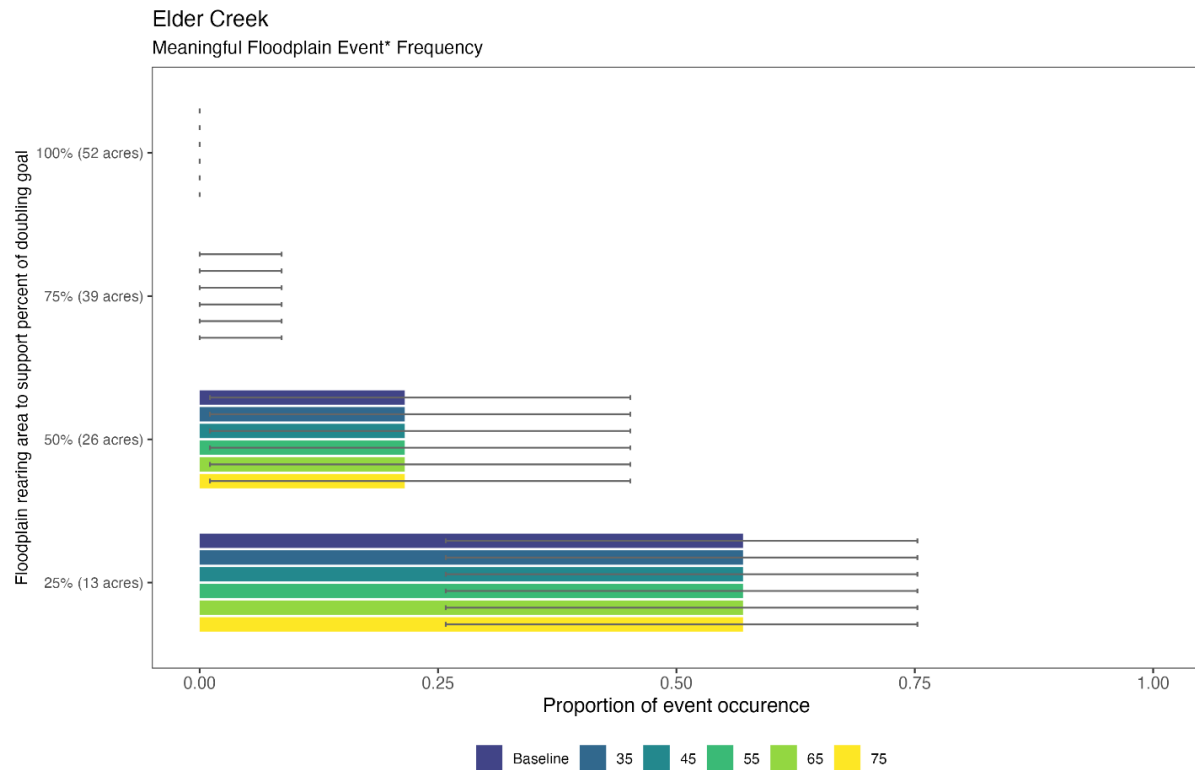
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years.

Figure A8-14. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on Deer Creek (Spring Run)



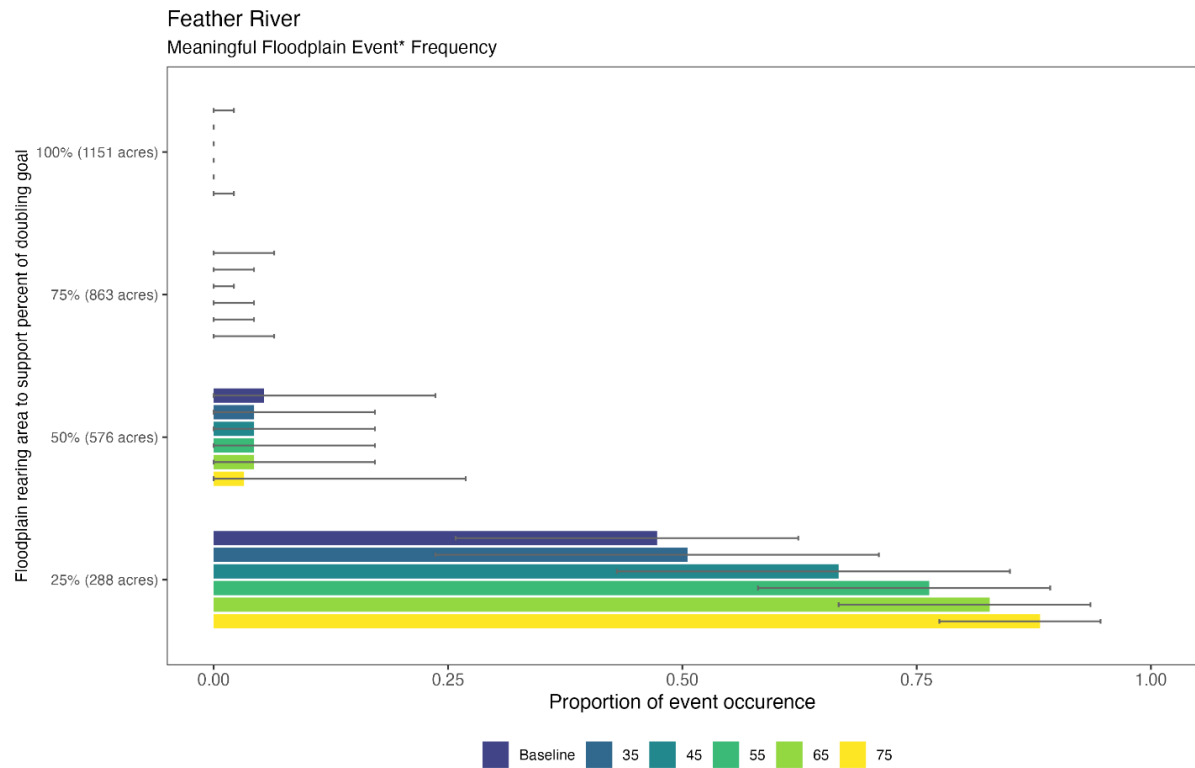
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years.

Figure A8-15. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on Elder Creek



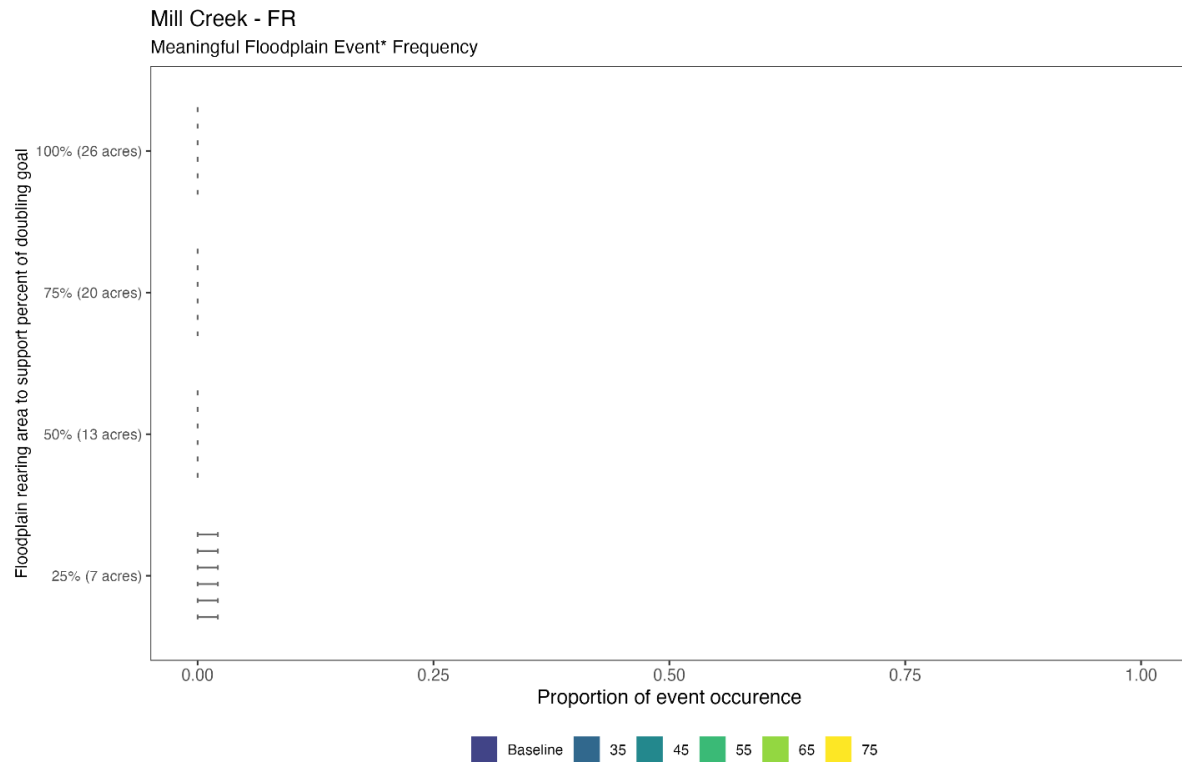
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years.

Figure A8-16. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on the Feather River



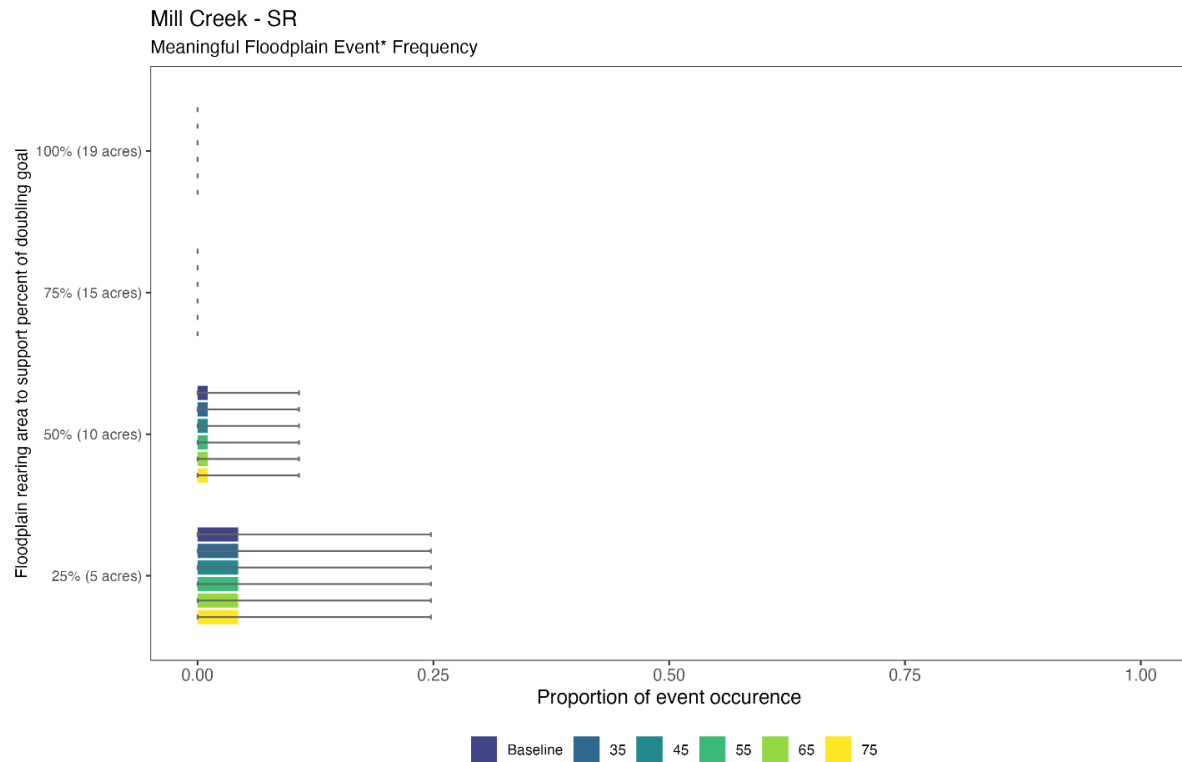
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years.

Figure A8-17. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on Mill Creek (Fall Run)



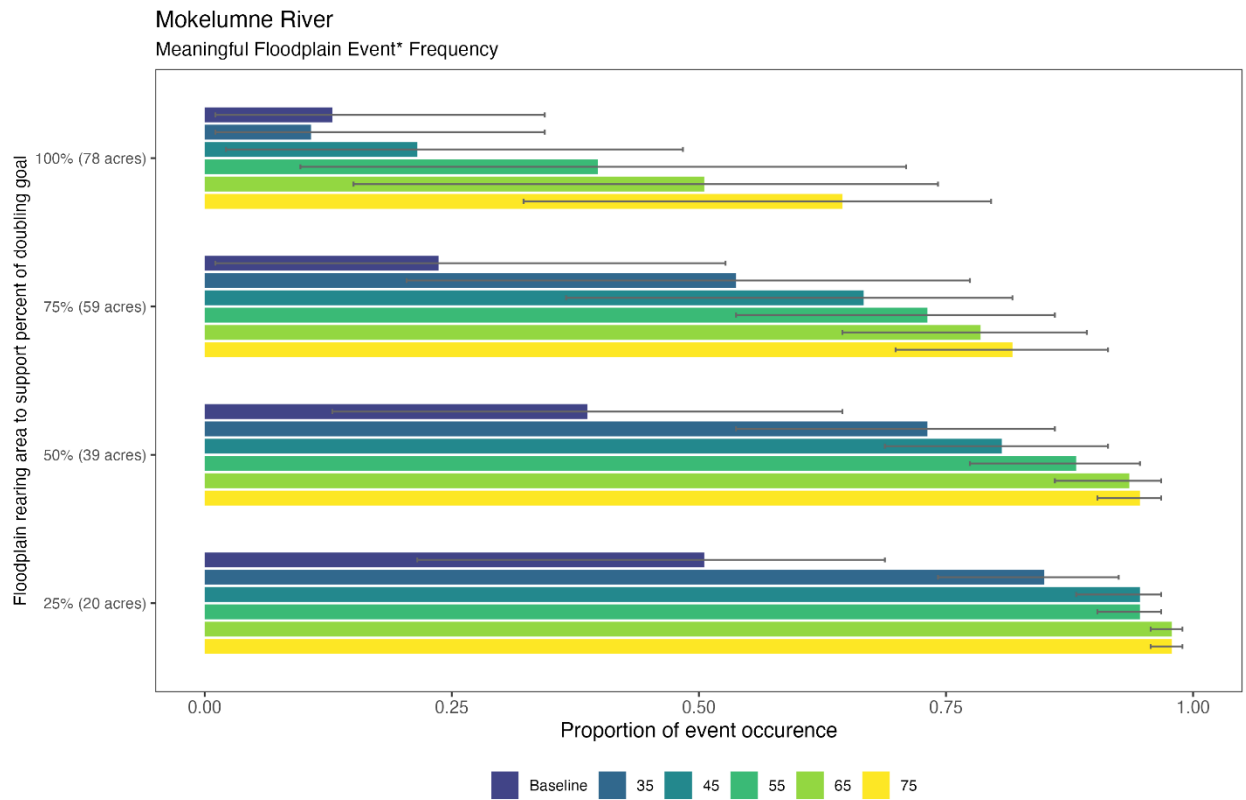
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years. MFEs occur for only 25% of the doubling goal and only in 2% of years.

Figure A8-18. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on Mill Creek (Spring Run)



Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years.

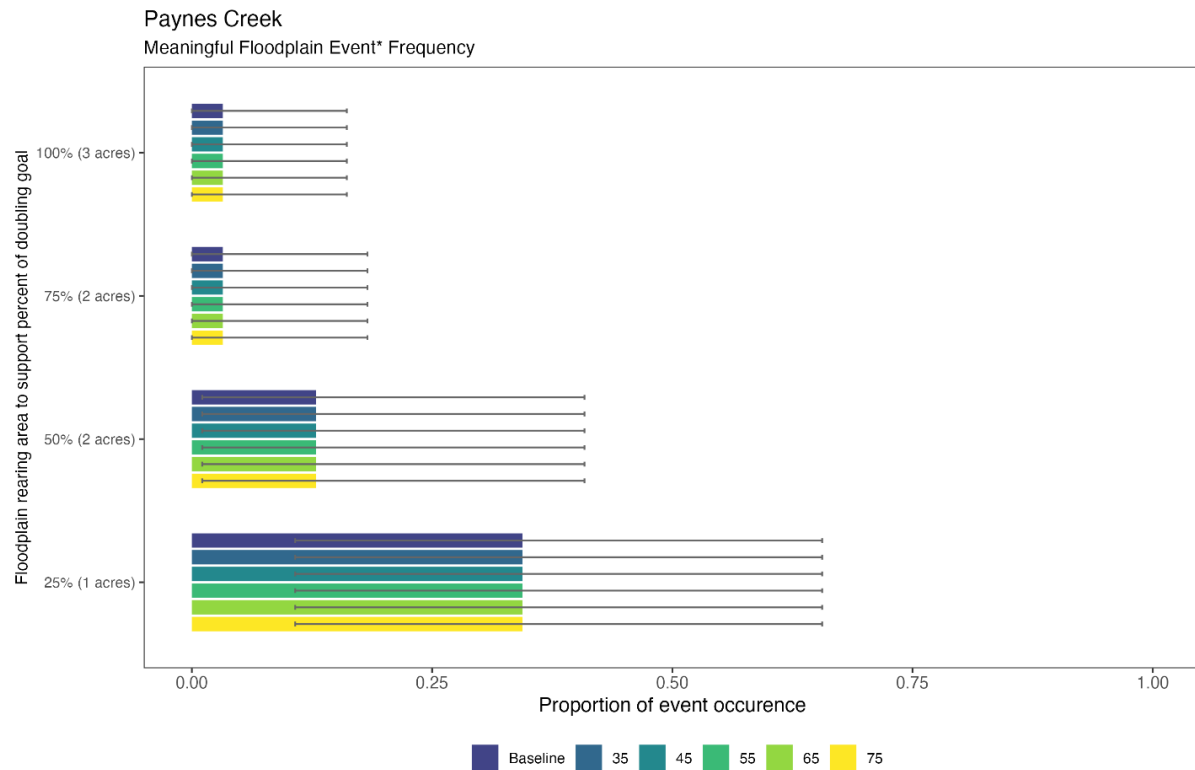
Figure A8-19. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on the Mokelumne River



* A "Meaningful Floodplain Event" (MFE) is a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years.

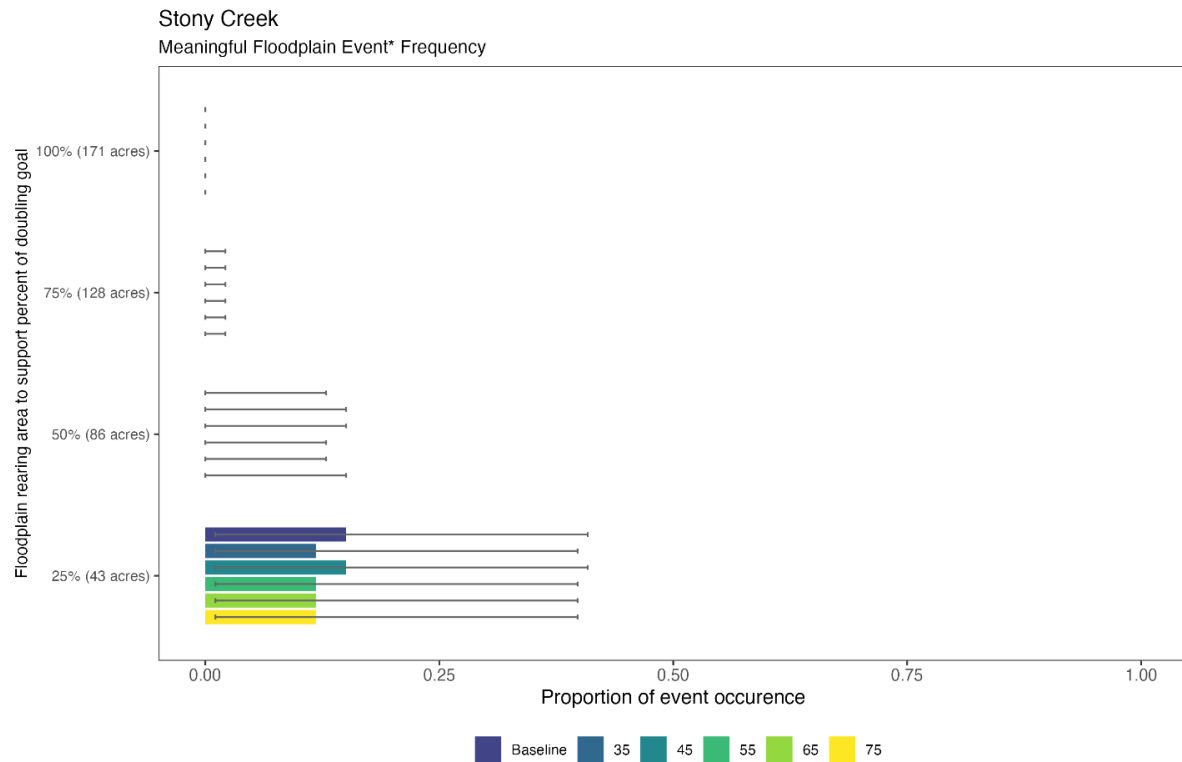
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years.

Figure A8-20. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on Paynes Creek



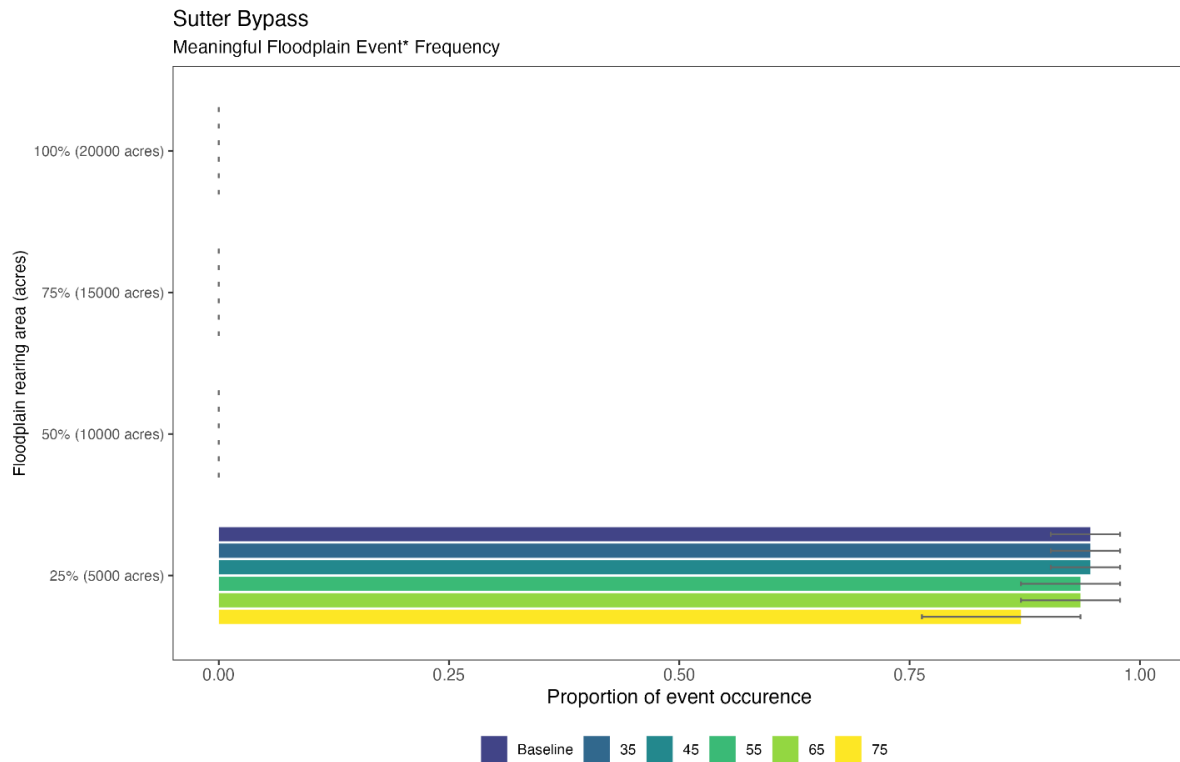
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years.

Figure A8-21. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on Stony Creek



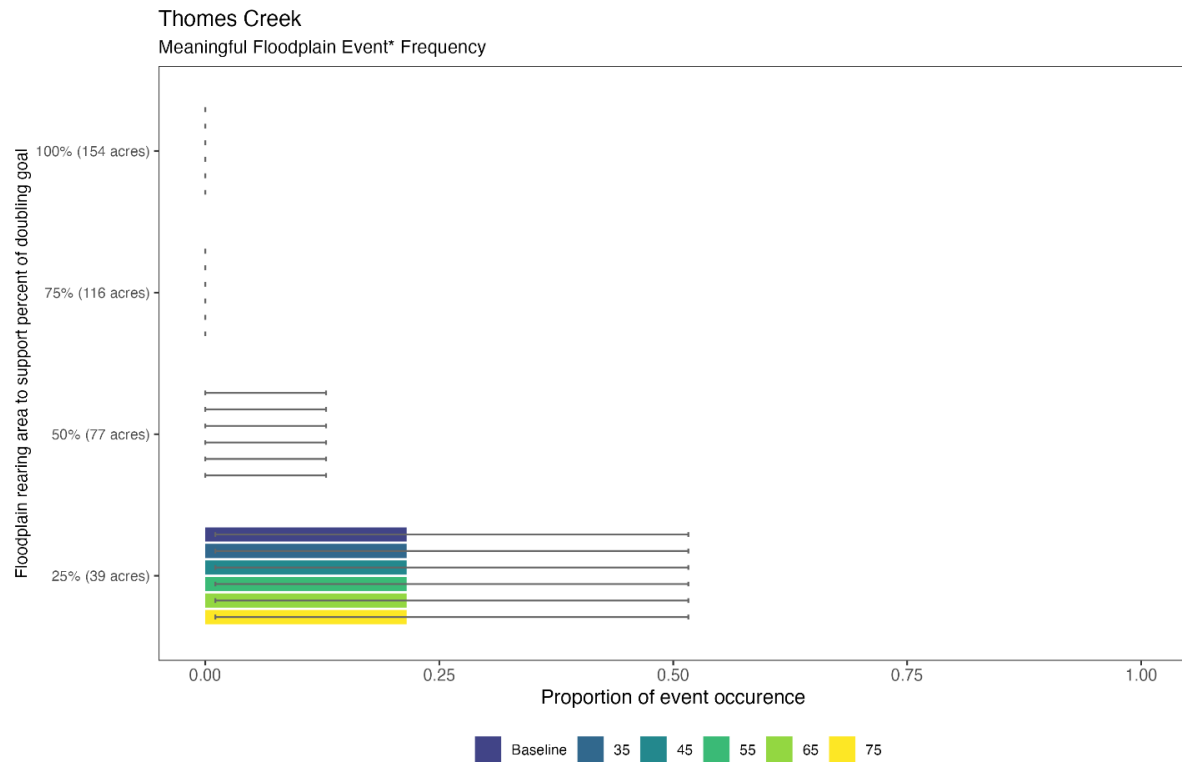
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years.

Figure A8-22. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on the Sutter Bypass



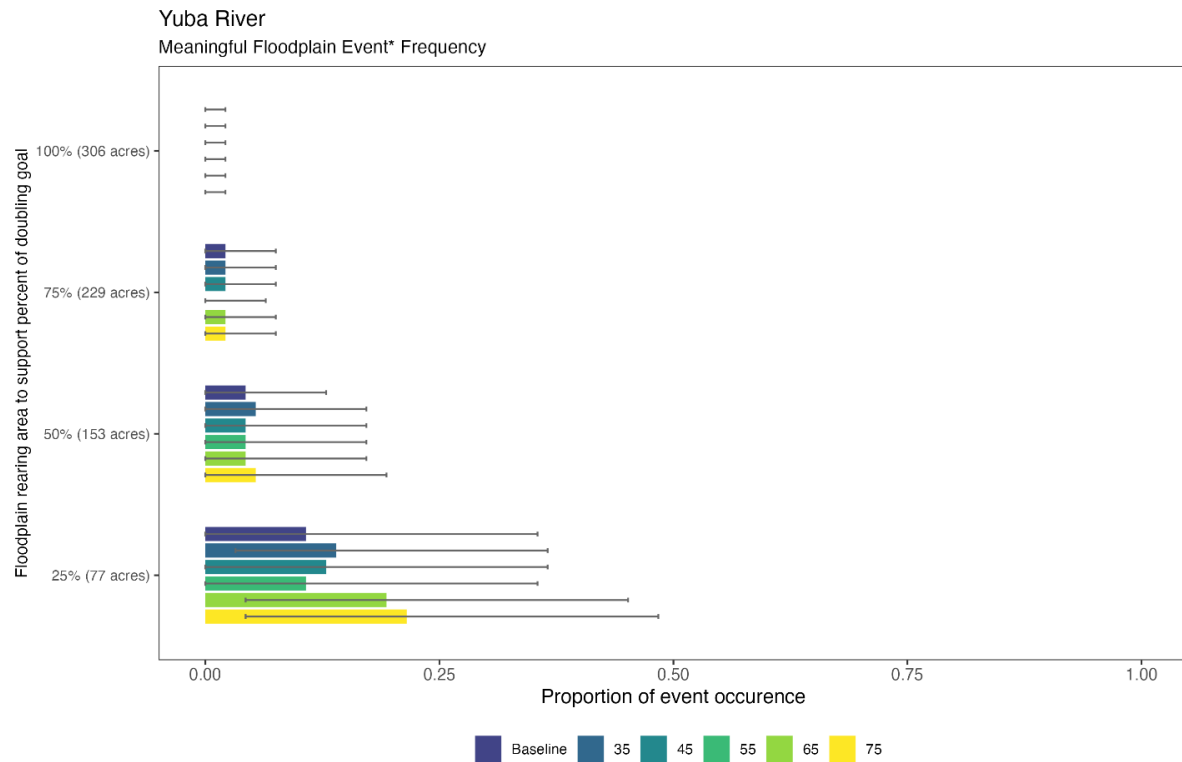
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years.

Figure A8-23. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on Thames Creek



Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years.

Figure A8-24. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and Flow Scenarios on the Yuba River



Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require floodplain events 4 out of 5 years. The upper bounds of the error bars represent the proportion of event occurrence when MFE criteria are loosened to require floodplain events 1 out of 2 years.

A8.3 References Cited

- California Department of Fish and Game (CDFG) and U.S. Corps of Engineers. 1979. *An Analysis of Streamflows for Fishes of Cottonwood Creek, California*. Draft. December.
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