Appendix H1c
Salmonid Tributary Habitat Analysis

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H1c.1 Salmonid Tributary Habitat Analysis Methods

Except where described below and in Section 13.5, *Beneficial Environmental Effects*, methods for this analysis were identical to those used in the Final Draft Scientific Basis Report Supplement (Appendix G2) for estimation of 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. Methods for existing tributary habitat area were used for the baseline and 55 w/WSAs scenarios and methods for VA habitat area were used for the VA scenario.

H1c.1.1 Temperature

Temperature analyses for the American River, Feather River, Mokelumne River, and Sacramento River use data and methodology as described in the Final Draft Scientific Basis Report Supplement. For the Yuba River, temperature data are now derived from the Yuba River temperature model as described in Appendix H1b, *Water Temperature Modeling and Fish Assessment for the Sacramento, Feather, American, and Yuba Rivers*. Temperatures are derived from Long Bar for spawning and Below Daguerre for rearing.

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 Final Draft Scientific Basis Report Supplement 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 Final Draft Scientific Basis Report Supplement. Rather, habitat was considered suitable if the temperature for the given month and year was below the temperature thresholds.

H1c.1.2 Habitat Data

The habitat analyses follow a similar methodology as described in the Final Draft Scientific Basis Report Supplement. For tributaries included in the VAs, the data sources are the same as in the Final Draft Scientific Basis Report Supplement. Methods and data sources for existing tributary habitat area were used for the baseline and 55 w/WSAs scenarios and methods and data sources for VA habitat area were used for the VA scenario.

For the tributaries not included in the VAs, habitat-to-flow functions (similar to those described in the Final Draft Scientific Basis Report Supplement) needed to be developed to apply to the regulatory pathway scenarios. All habitat data for these tributaries are from the Central Valley

Project Improvement Act (CVPIA) Decision Support Model (DSM) input called "DSMhabitat" (Rodriguez et al. 2023).. DSM habitat compiles data from multiple sources. The specific data sources for each tributary are noted in Table H1c.1-1 and listed in Section H1c.3, *References Cited*.

Table H1c.1-1. Spawning, Instream Rearing, and Floodplain Habitat Data Sources

River	Existing Habitat Source	VA Habitat Source
Antelope Creek	Spawning and Instream rearing – No watershed-specific data available. Used a regional approximation method (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). Habitat modeling last updated in 2020 (Gill and Tompkins 2020b).	
American River	Spawning – Bratovich et al. 2017; Gill and Thompkins 2020c Instream Rearing – Chris Hammersmark, CBEC Eco Engineering Floodplain – Chris Hammersmark, CBEC Eco Engineering	Spawning – Chris Hammersmark, CBEC Eco Engineering Assumptions: • CBEC provided the number of suitable acres for a number of flows, including minimum (34% of committed acres suitable at 500 cubic feet per second [cfs]), maximum (70% of committed acres suitable at 2,000 cfs), and target (75% of committed acres suitable at 1,500 cfs) flow. Added to existing spawning habitat. Instream Rearing – Chris Hammersmark, CBEC Eco Engineering Assumptions: • CBEC provided the number of suitable acres for a number of flows, including minimum (19% of committed acres suitable at 500 cfs), maximum (17% of committed acres suitable at 10,000 cfs), and target (37% of committed acres suitable at 4,000 cfs) flow. Added to existing instream habitat. Floodplain – *No floodplain habitat committed*.

River	Existing Habitat Source	VA Habitat Source
Battle Creek	Spawning and Instream rearing – Thomas R. Payne and Associates 1995 Floodplain – Scaled from a Deer Creek flow-to-floodplain area relationship generated with a 2D HEC-RAS hydraulic model (Hackenjos 2019). Habitat modeling last updated in 2020 (Gill and Tompkins 2020d).	
Bear River	Spawning and Instream Rearing – South Sutter Water District 2019 Floodplain – Central Valley Floodplain Evaluation and Delineation (CVFED) HEC-RAS hydraulic model (CDWR 2014) Habitat modeling last updated in 2020 (Gill and Tompkins 2020e).	
Big Chico Creek	Spawning and Instream Rearing – No watershed- specific data available. Used a regional approximation method (Gill and Tompkins 2020a). Floodplain – CVFED HEC-RAS hydraulic model (CDWR 2014) Habitat modeling last updated in 2020 (Gill and Tompkins 2020f).	
Butte Creek	Spawning and Instream Rearing – USFWS 2003a; FERC Relicensing DeSabla (PG&E 2007) Floodplain – CVFED HEC-RAS hydraulic model (CDWR 2014) Habitat modeling last updated in 2020 (Gill and Tompkins 2020g).	
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. 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). Habitat modeling last updated in 2020 (Gill and Tompkins 2020h).	
Clear Creek	Spawning – USFWS 2007; USFWS 2011a Instream Rearing – USFWS 2011b; USFWS 2013	

River	Existing Habitat Source	VA Habitat Source
	Floodplain – Scaled from a Cottonwood Creek flow-to-floodplain area relationship generated with a USFWS / FEMA 1D HEC-RAS hydraulic model (USFWS 2018). Habitat modeling last updated in 2020 (Gill and Tompkins 2020i).	
Cosumnes River	Spawning and Instream Rearing – FISHBIO Environmental, LLC and Thomas R. Payne and Associates, Fisheries Consultants 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) Habitat modeling last updated in 2020 (Gill and Tompkins 2020j).	
Cottonwood Creek	Spawning and Instream Rearing – CDFG and U.S. Corps of Engineers 1979; USFWS 2013 (USFWS 2014) Floodplain – USFWS 2017 / FEMA 1D HEC-RAS hydraulic model (USFWS 2018) Habitat modeling last updated in 2020 (Gill and Tompkins 2020k).	
Cow Creek	Spawning – No watershed specific data were available. Used a regional approximation method (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). Habitat modeling last updated in 2020 (Gill and Tompkins 2020l).	
Deer Creek	Spawning, Instream Rearing, and Floodplain – FlowWest 2021 (Hackenjos 2019) Habitat modeling last updated in 2021 (Gill and Tompkins 2020m).	
Elder Creek	Spawning and Instream Rearing – No watershed specific data were available. Used a regional approximation method (Gill and Tompkins 2020a). Floodplain – CVFED HEC-RAS hydraulic model (CDWR 2014)	

River	Existing Habitat Source	VA Habitat Source
	Habitat modeling last updated in 2020 (Gill and Tompkins 2020n).	
Feather River	Spawning – CDWR 2004 Instream Rearing – CDWR 2005; CVFED HEC-RAS hydraulic model. Floodplain – CVFED HEC-RAS hydraulic model CDWR 2014 Habitat modeling last updated in 2020 (Gill and Tompkins 2020o).	Spawning – Jason Kindopp, DWR Assumptions: • DWR provided the number of suitable acres at minimum (70% of committed acres suitable at 650 cfs), maximum (80% of committed acres suitable at 1,100 cfs), and target (90% of committed acres suitable at 850 cfs) flow. Added to existing habitat on the Low Flow Channel. Instream Rearing – Jason Kindopp, DWR Assumptions: • DWR provided the number of suitable acres at minimum (80% of committed acres suitable at 650 cfs), maximum (50% of committed acres suitable at 3,000 cfs), and target (90% of committed acres suitable at 725 cfs) flow. Added to existing habitat on the Low Flow Channel. Floodplain – Jason Kindopp, California DWR Assumptions: • DWR provided the number of suitable acres for minimum, target, and maximum flows for three types of project designed for different inundation flows: 3,000 cfs, 4,000 cfs, and 30,000 cfs. The flow-habitat curves for the three projects were added together into a composite curve after applying linear interpolation between points. • A total of 550 acres was expected to be inundated at 3,000 cfs with the following suitability: minimum (75% of total inundated acres [412.5 acres] suitable at 3,000 cfs), maximum (50% of total inundated acres [275 acres] suitable at 10,000 cfs), and target (80% of total inundated acres [440 acres] suitable at 4,000 cfs) flows.

River	Existing Habitat Source	VA Habitat Source
		• A total of 300 acres was expected to be inundated at 4,000 cfs with the following suitability: minimum (80% of total inundated acres [240 acres] suitable at 4,000 cfs), and maximum/target (80% of total inundated acres [240 acres] suitable at 25,000 cfs) flows. • A total of 805 acres was expected to be inundated at 30,000 cfs with the following suitability: minimum (80% of total inundated acres [644 acres] suitable at 30,000 cfs), maximum (50% of total inundated acres [402.5 acres] at 50,000 cfs), and target (90% of total inundated acres [724.5 acres] at 35,000 cfs) flows.
Mill Creek	Spawning and Instream Rearing – No watershed specific data were available. Used a regional approximation method (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). Habitat modeling last updated in 2020 (Gill and Tompkins 2020p).	
Mokelumne River	Spawning and Instream Rearing – East Bay Municipal Utility District (EBMUD) Floodplain – EBMUD	Spawning – *No spawning habitat committed*. Instream Rearing – Robyn Bilski, EBMUD Assumptions: • EBMUD provided the number of suitable acres for a number of flows including minimum (35% of committed acres suitable at 100 cfs) and maximum/target flows (85% of committed acres suitable at 1,000 cfs). Added to existing instream habitat. Floodplain – Robyn Bilski, EBMUD • EBMUD provided the number of suitable acres for a number of flows including minimum (50% of committed acres suitable at 800 cfs), maximum (100% of committed acres suitable at 1,700 cfs), and target (100% of committed acres suitable at 1,300 cfs) flows.

River	Existing Habitat Source	VA Habitat Source
		• Inundation beginning at 800 cfs.
Paynes Creek	Spawning and Instream Rearing – No watershed specific data were available. Used a regional approximation method (Gill and Tompkins 2020a). Floodplain – Scaled from a Deer Creek flow-to-floodplain relationship generated with a 2D HEC-RAS hydraulic model (Hackenjos 2019). Habitat modeling last updated in 2020 (Gill and Tompkins 2020q).	
Sacramento River	Spawning – USFWS 2003b Rearing – CVFED HEC-RAS hydraulic model refined for use in the NOAA-NMFS Winter Run Chinook Salmon life cycle model (Hendrix et al. 2017). Floodplain – CVFED HEC-RAS hydraulic model refined for use in the NOAA-NMFS Winter Run Chinook Salmon life cycle model (Hendrix et al. 2017).	Spawning – John Hannon, U.S. Bureau of Reclamation Assumptions: • VA habitat is all suitable habitat. • A flow-to-area relationship was not provided, and all 113.5 acres of VA habitat were added to existing habitat consistently across all flows. Added to existing habitat at the Red Bluff to Deer Creek reach. Instream Rearing – John Hannon, U.S. Bureau of Reclamation Assumptions: • Reclamation provided flow-habitat curves for two project types. The flow-habitat curves for the two project types were added together into a composite curve after applying linear interpolation between points. • Reclamation provided the number of suitable acres of new side-channel habitat (25 acres) at three flow levels (60% of acres [15 acres] suitable below 8,000 cfs; 100% suitable [25 acres] at 8,000 cfs; 80% suitable [20 acres] above 8,000 cfs). • Reclamation provided the number of suitable acres of new instream habitat (112.5 acres) at three flow levels (0% of acres suitable below 8,000 cfs; 25% suitable [28 acres] at 30,000 cfs; 100% suitable [112.5 acres] at 15,000 cfs). Added to existing instream habitat. Floodplain – *No floodplain habitat committed*.
Stony Creek	Spawning and Instream Rearing – No watershed specific data were available. Used a	

River	Existing Habitat Source	VA Habitat Source
	regional approximation method (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). Habitat modeling last updated in 2020 (Gill and Tompkins 2020r).	
Sutter Bypass	Floodplain – CVFED HEC-RAS hydraulic model refined for use in the NOAA-NMFS Winter Run life cycle model (Hendrix et al. 2017).	Floodplain – Lee Bergfeld, MBK Engineers Assumptions: • Flow and suitable area were not provided for VA habitat. • Number of suitable acres for VA habitat was assumed to have the same relative flow to suitable area relationship as existing habitat: minimum (3% of committed acres suitable at 10 cfs), maximum (75% of committed acres suitable at 10,000 cfs), and target (100% of committed acres suitable at 5,000 cfs) flows. Assumed habitat is accessible to fish.
Thomes Creek	Spawning and Instream Rearing – No watershed specific data were available. Used a regional approximation method (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). Habitat modeling last updated in 2020 (Gill and Tompkins 2020s).	
Yuba River	Spawning – Paul Bratovich, HDR; Steve Grinnel, SEG Water Instream Rearing – Paul Bratovich, Robertson-Bryan Floodplain – Paul Bratovich, Robertson-Bryan	Spawning – *No spawning habitat committed*. Instream Rearing -- Paul Bratovich, Robertson-Bryan. Assumptions: • Includes assumed suitable hydraulic rearing habitat availability in the lower Yuba River including within the grading footprints of the Hallwood, Lower Long Bar, Upper Long Bar, and Upper Rose Bar habitat enhancement projects. • Delineation of in-channel and floodplain habitat based on 1,500 cfs wetted extent below Daguerre Point

River	Existing Habitat Source	VA Habitat Source
		Dam and 1,750 cfs wetted extent above Daguerre Point Dam. • Robertson-Bryan provided the number of suitable acres at minimum (39% of committed acres suitable at 300 cfs), maximum (0% of committed acres suitable at 25,000 cfs), and target (71% of committed acres suitable at 2,500 cfs) flow. Floodplain – Paul Bratovich, Robertson-Bryan Assumptions: • Includes assumed suitable hydraulic rearing habitat availability in the lower Yuba River including within the grading footprints of the Hallwood, Lower Long Bar, Upper Long Bar, and Upper Rose Bar habitat enhancement projects. • Delineation of in-channel and floodplain habitat based on 1,500 cfs wetted extent below Daguerre Point Dam and 1,750 cfs wetted extent above Daguerre Point Dam. • Robertson-Bryan provided the number of suitable acres at minimum (0% of committed acres suitable at 300 cfs), maximum (0% of committed acres suitable at 25,000 cfs), and target (41% of committed acres suitable at 10,000 cfs) flow.

Sources identified in this table are included in Section H1c3, *References Cited*.

H1c.1.3 Meaningful Floodplain Event

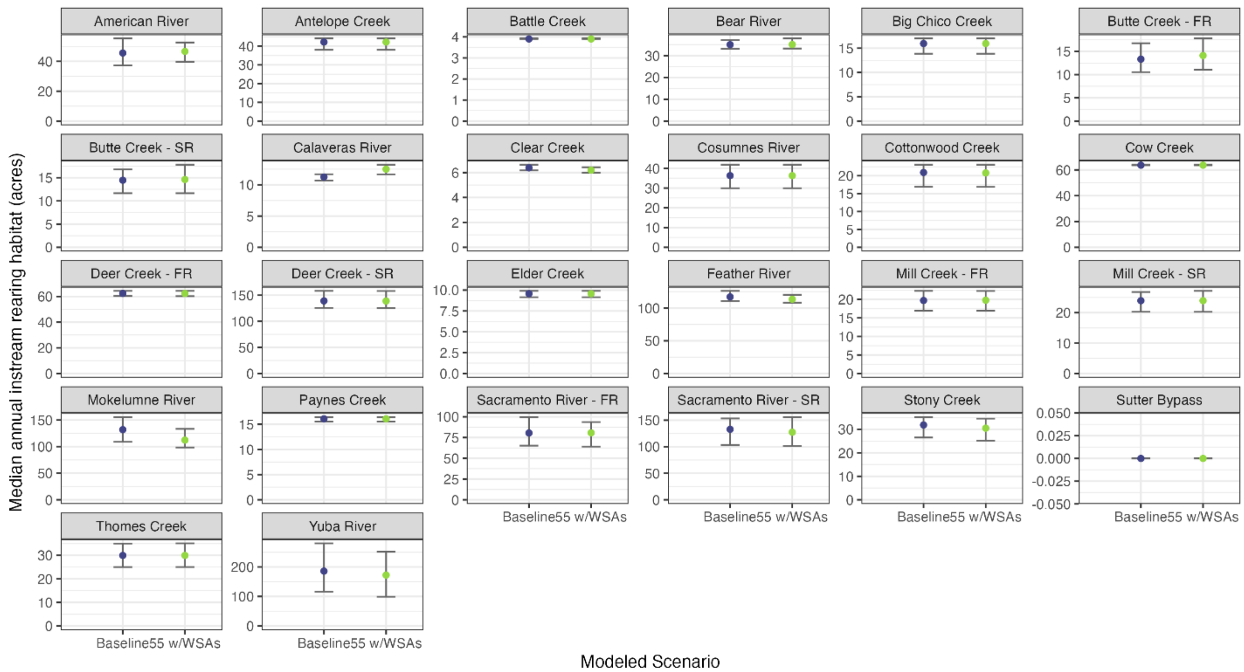
The meaningful floodplain event (MFE) methods used for non-VA tributaries are the same as those described in the Final Draft Scientific Basis Report Supplement, except in the following cases where a doubling goal[1] does not exist for a watershed: Elder Creek, Stony Creek, and Thomes Creek. In these 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.

[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.

H1c.2 Salmonid Tributary Habitat Analysis Supplemental Results Figures

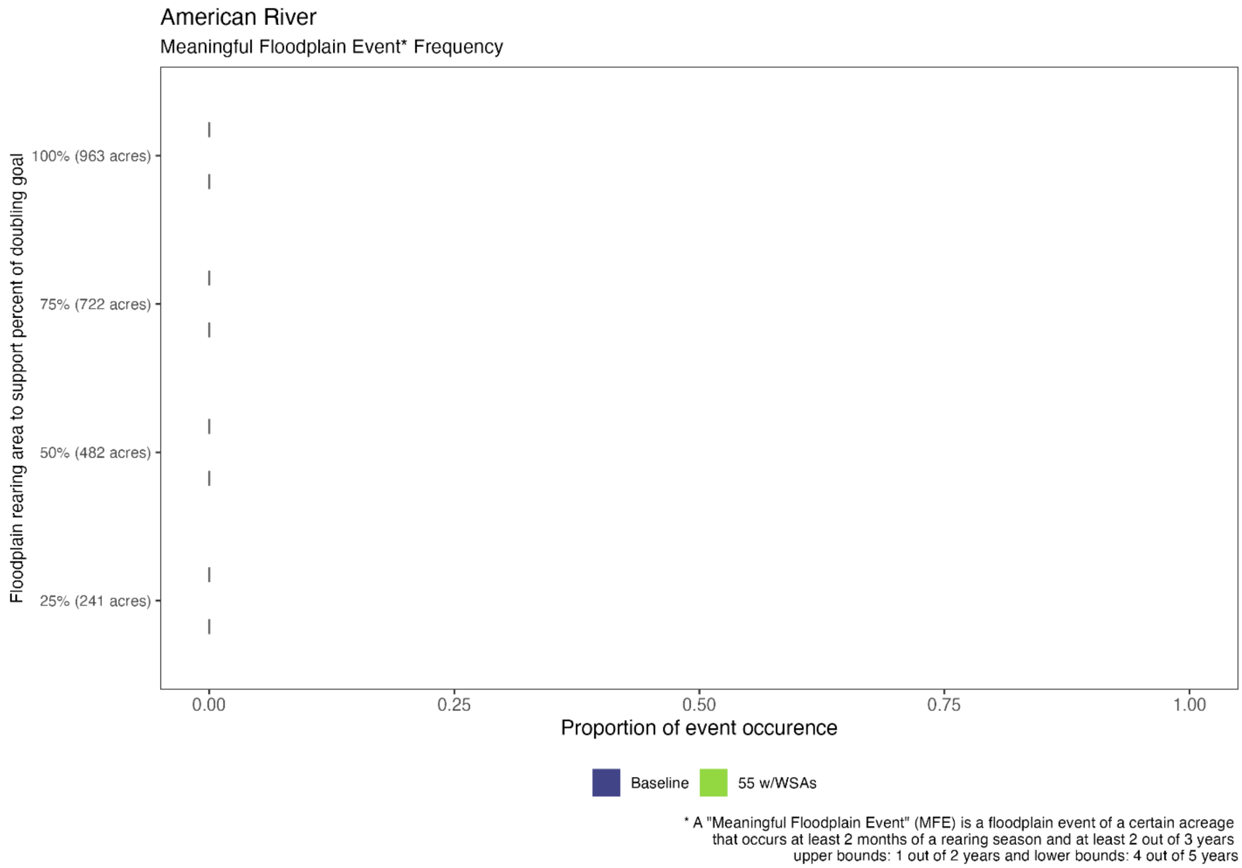
The following figures provide additional detail to the results presented in Section 13.5, *Beneficial Environmental Effects*.

H1c.2.1 Regulatory Pathway



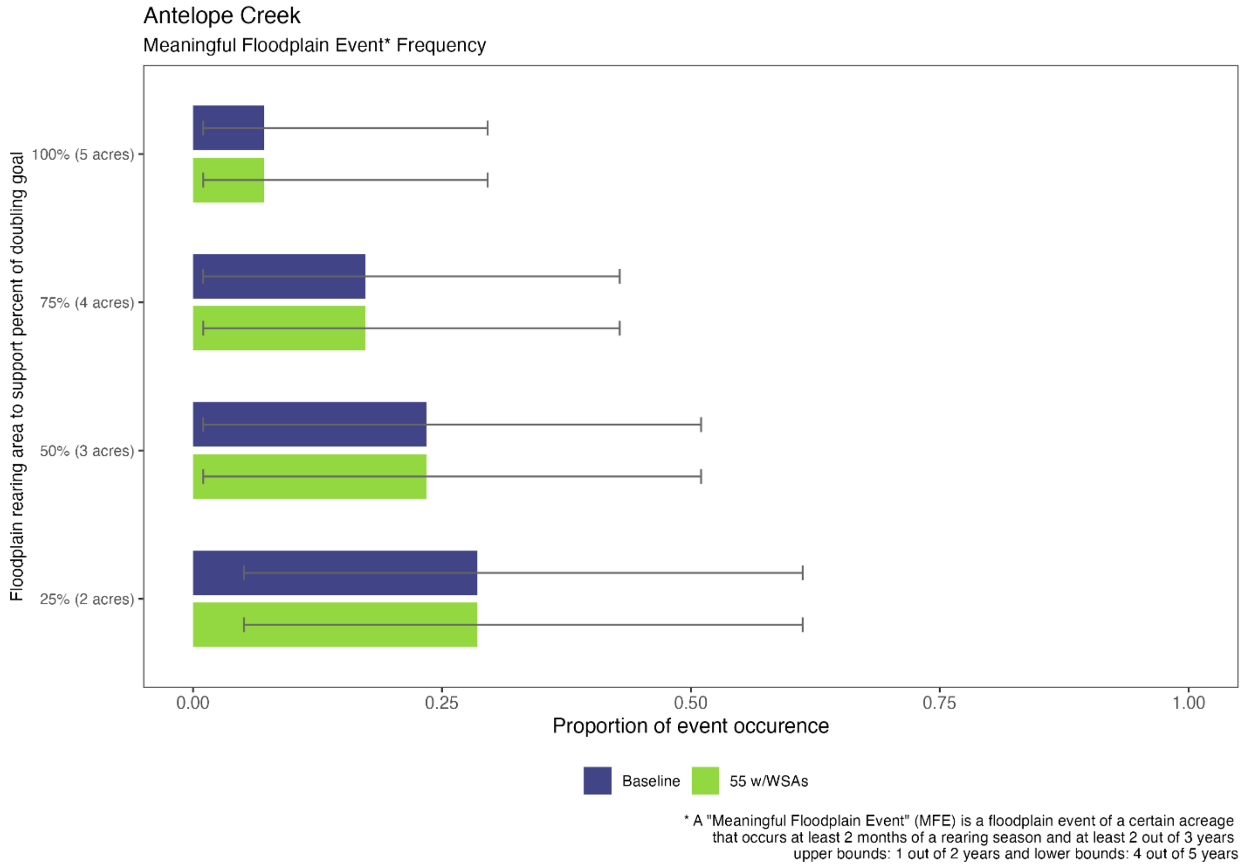
Note: Error bars represent the upper and lower quartiles. Medians and quantiles were calculated across all years; therefore, the quantiles represent year-to-year variability, not the full uncertainty in expected outcomes. FR = fall-run; SR = spring-run.

Figure H1c.2.1-1. Median (across All Years Modeled) Instream Rearing Habitat (acres) for Each Watershed



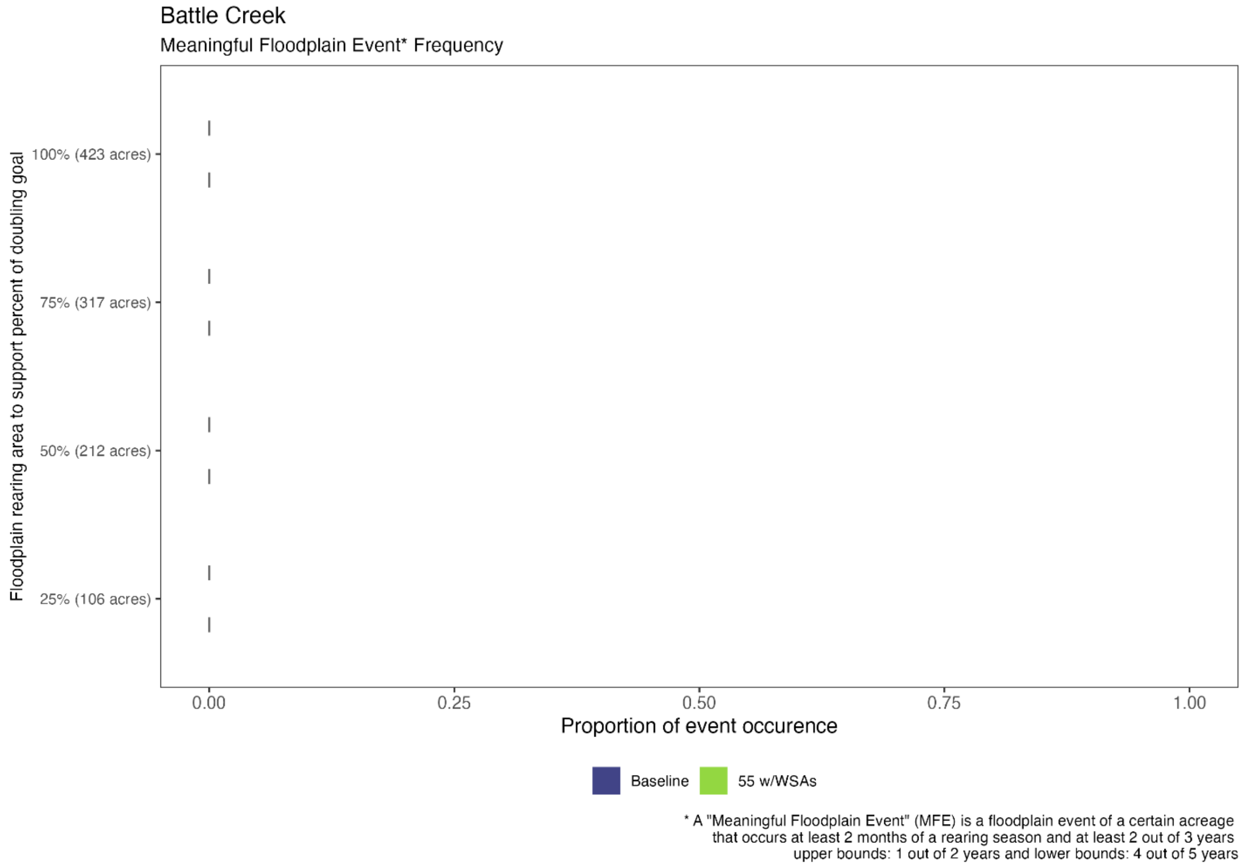
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require 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 H1c.2.1-2. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on the American River



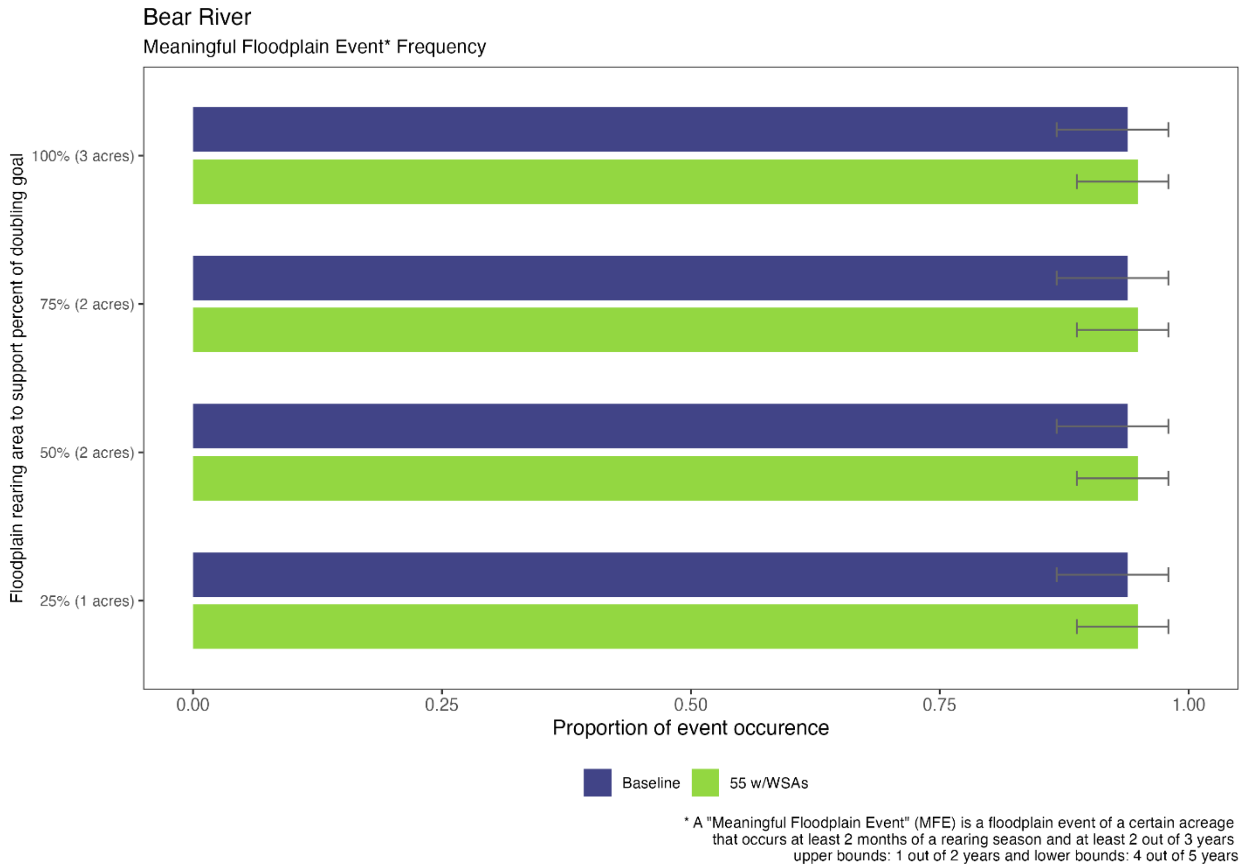
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require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

Figure H1c.2.1-3. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on Antelope Creek



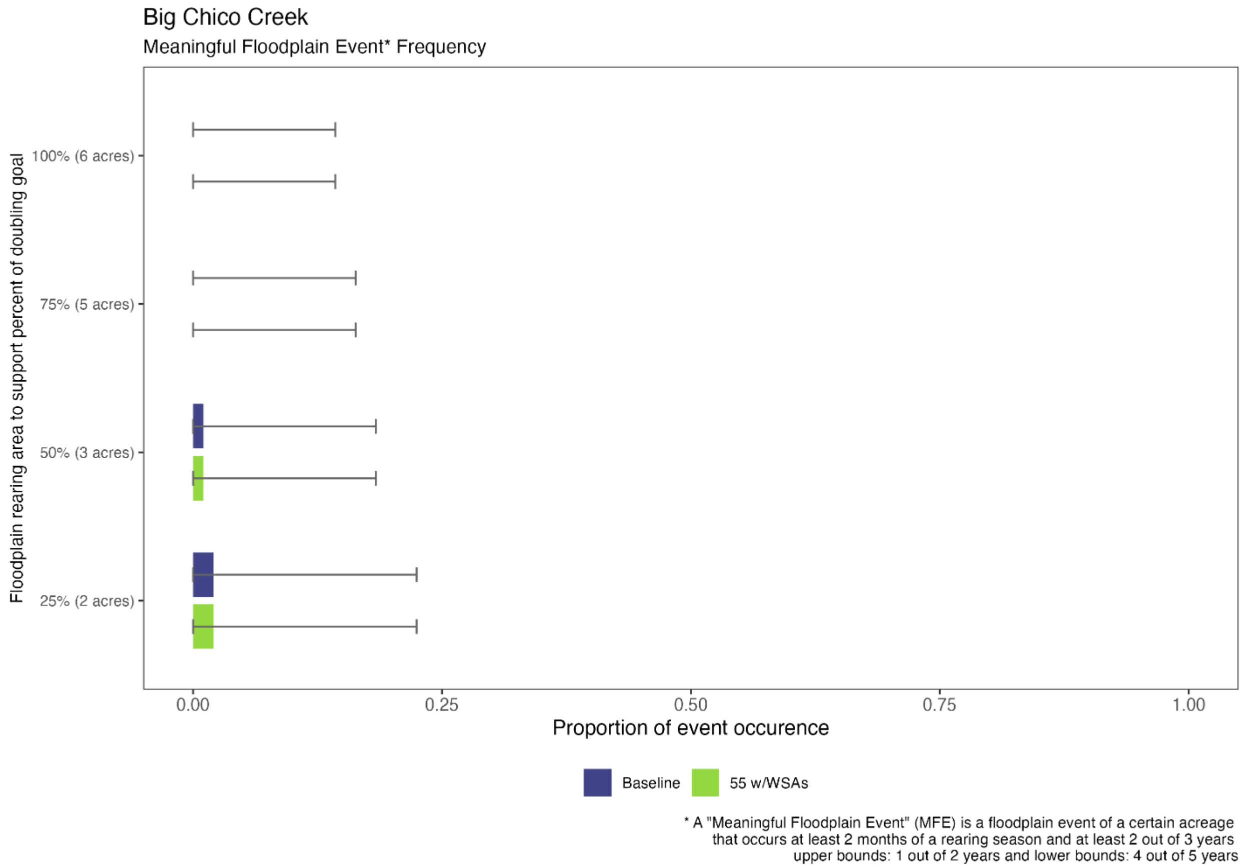
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require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

Figure H1c.2.1-4. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on Battle Creek



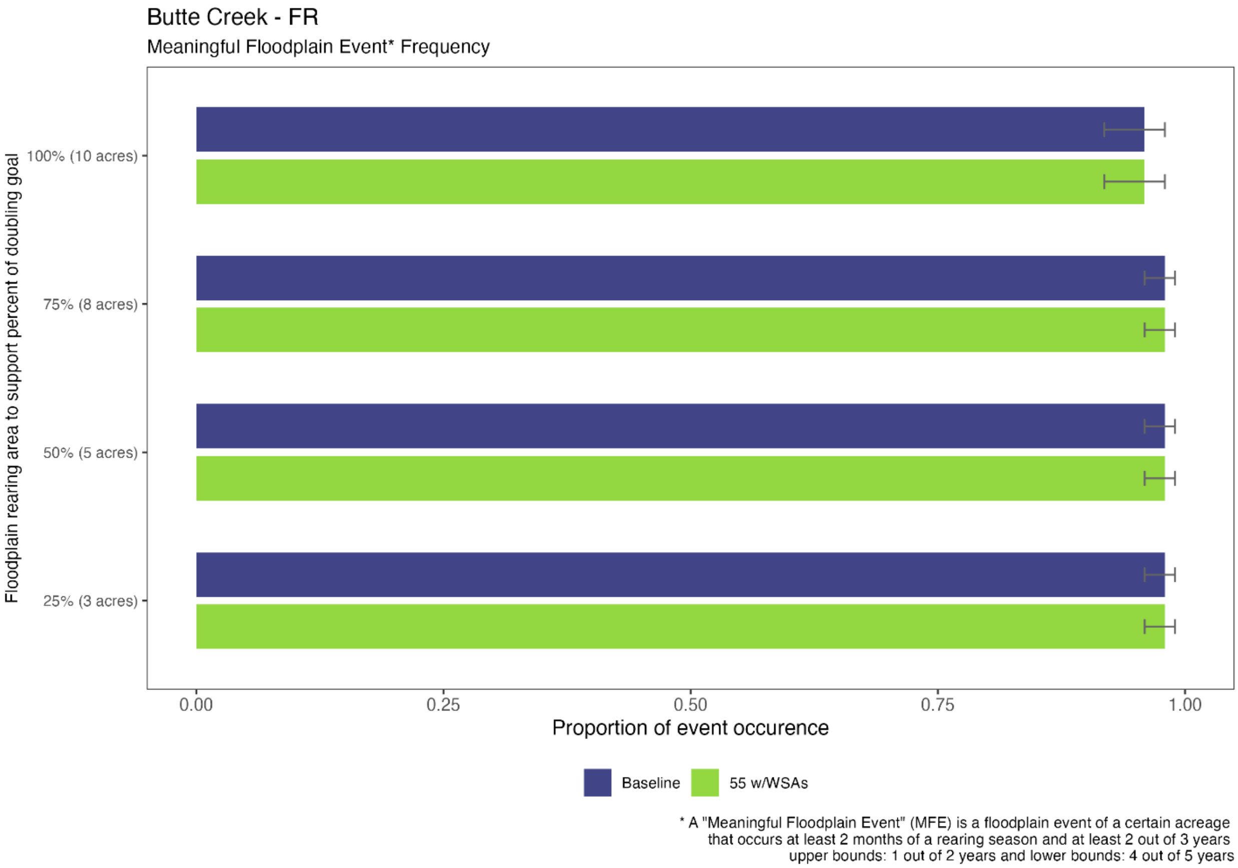
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require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

Figure H1c.2.1-5. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on the Bear River



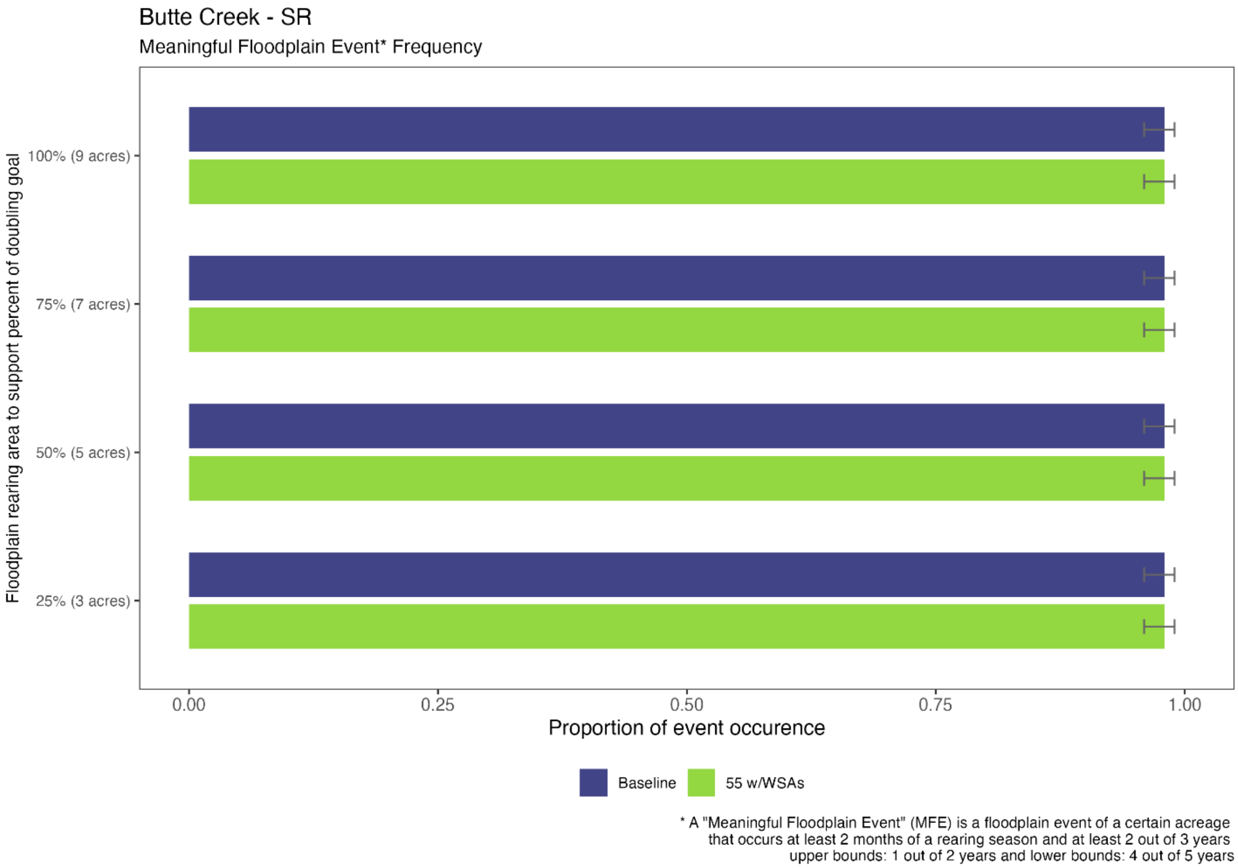
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require 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 H1c.2.1-6. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on Big Chico Creek



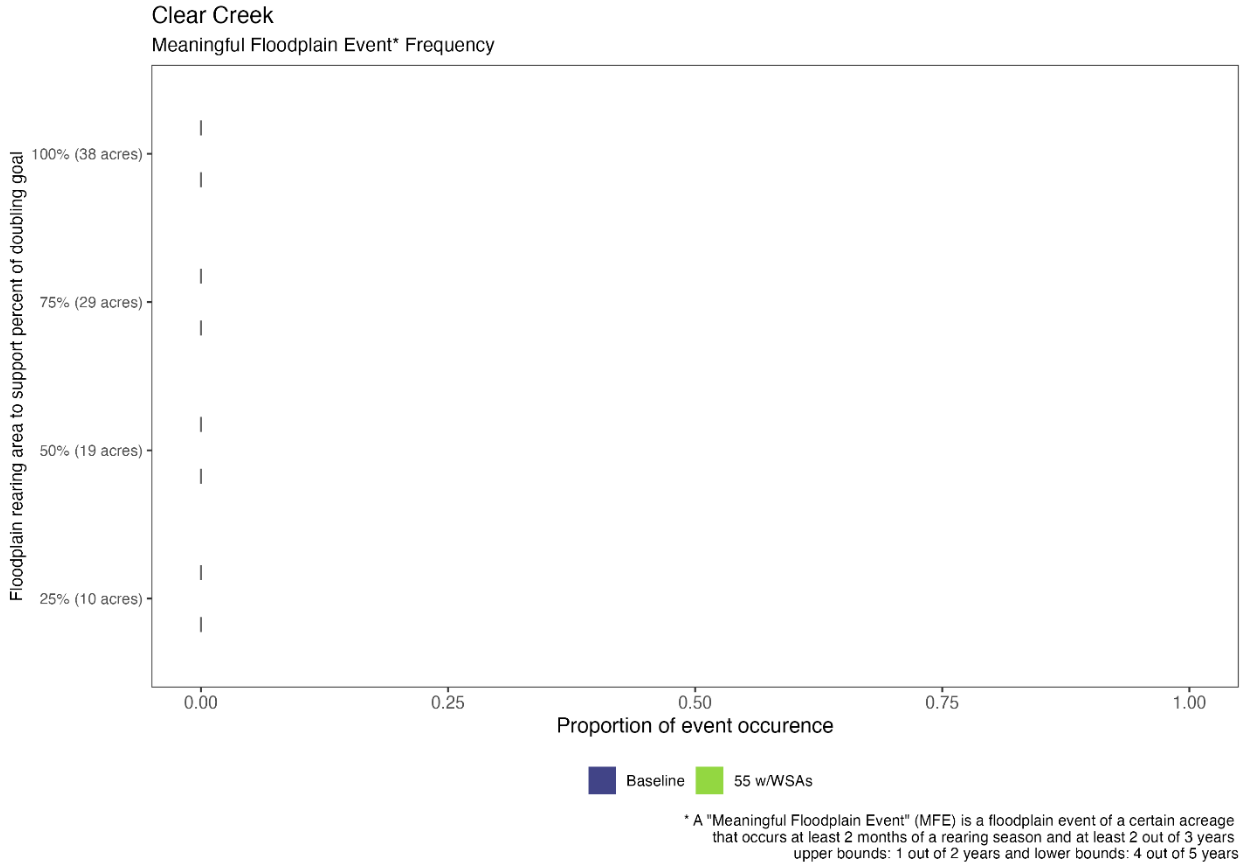
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require 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 H1c.2.1-7. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on Butte Creek (Fall-Run)



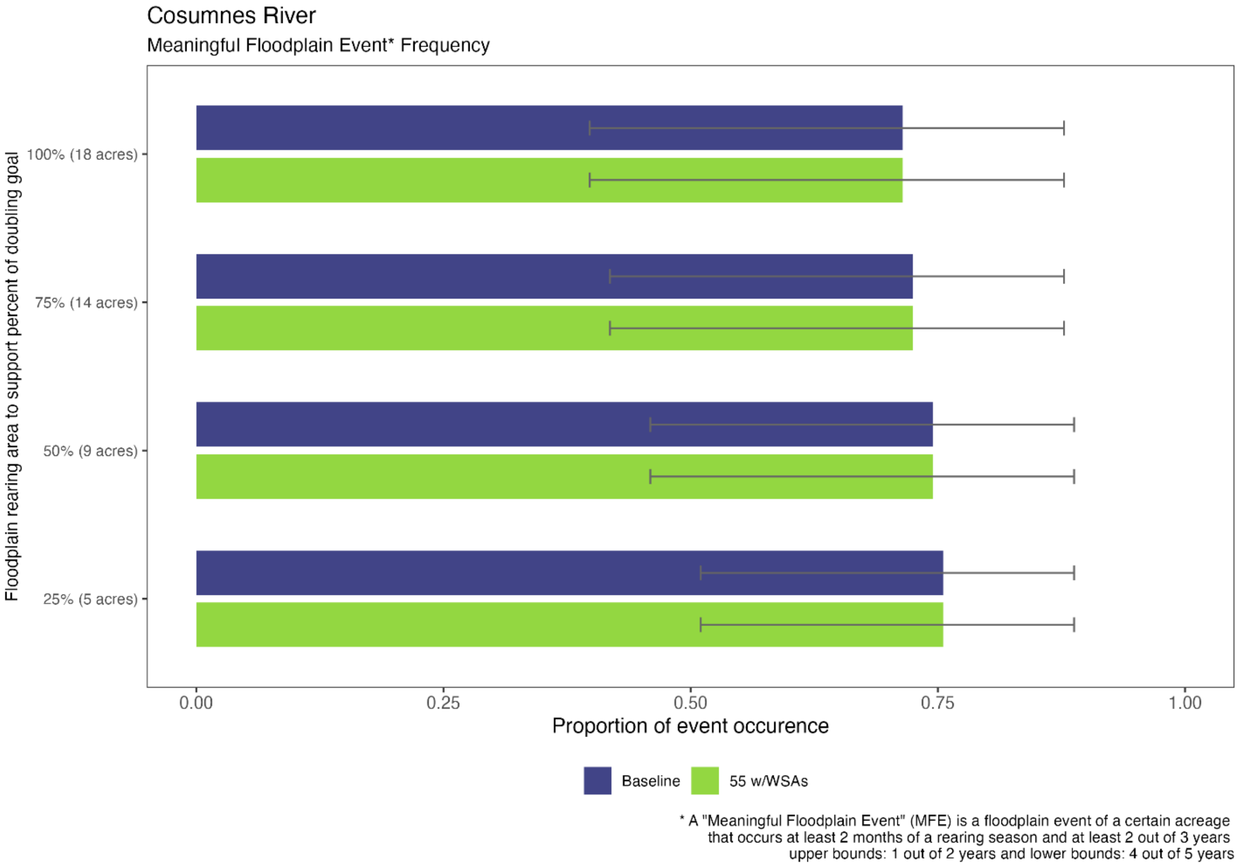
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require 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 H1c.2.1-8. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on Butte Creek (Spring-Run)



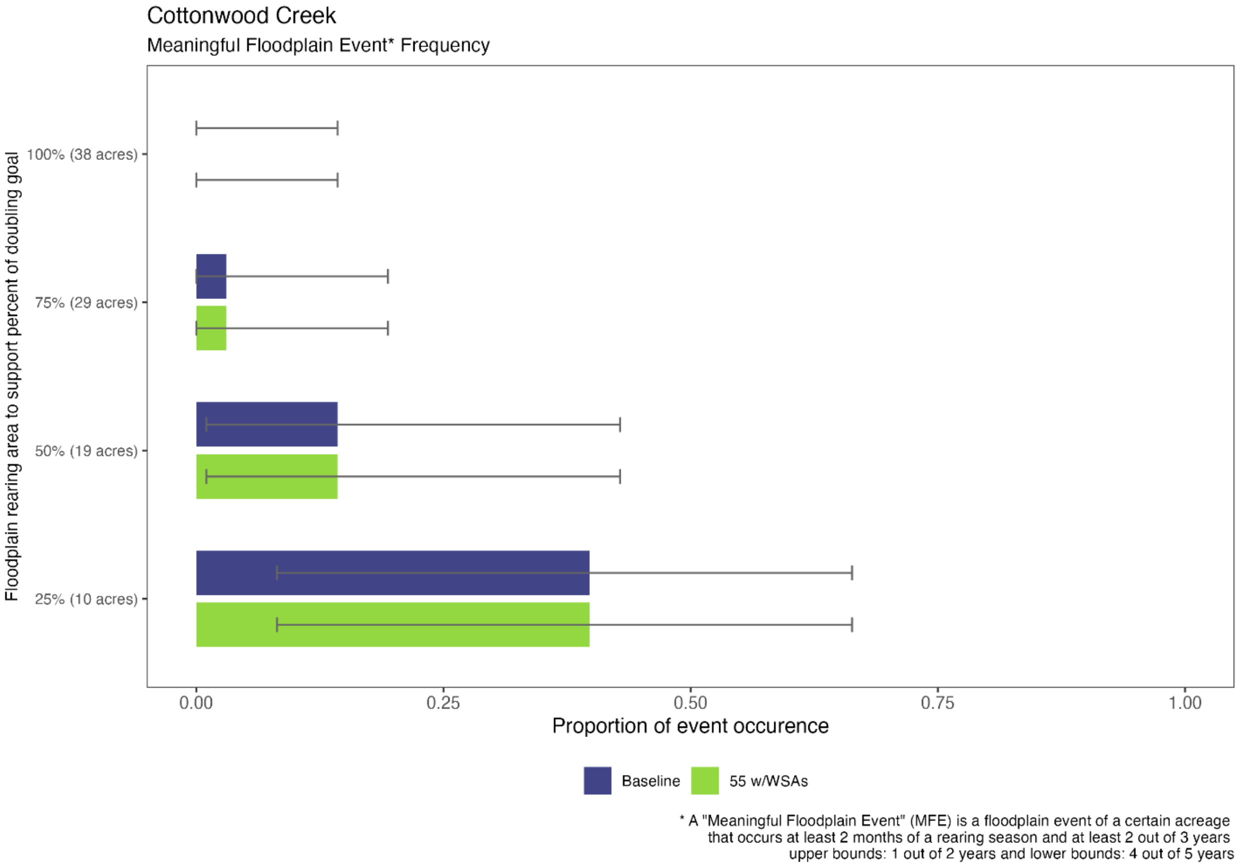
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require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

Figure H1c.2.1-9. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on Clear Creek



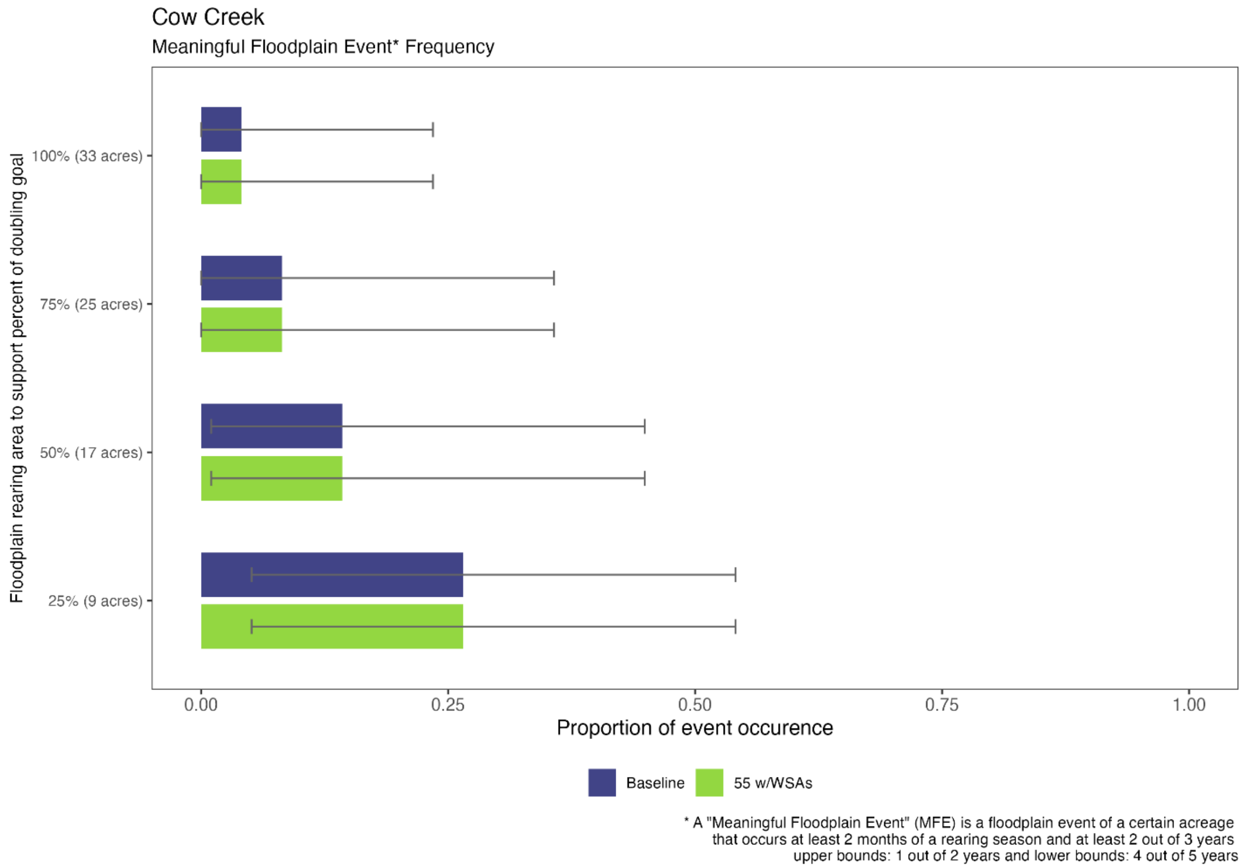
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require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

Figure H1c.2.1-10. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on the Cosumnes River



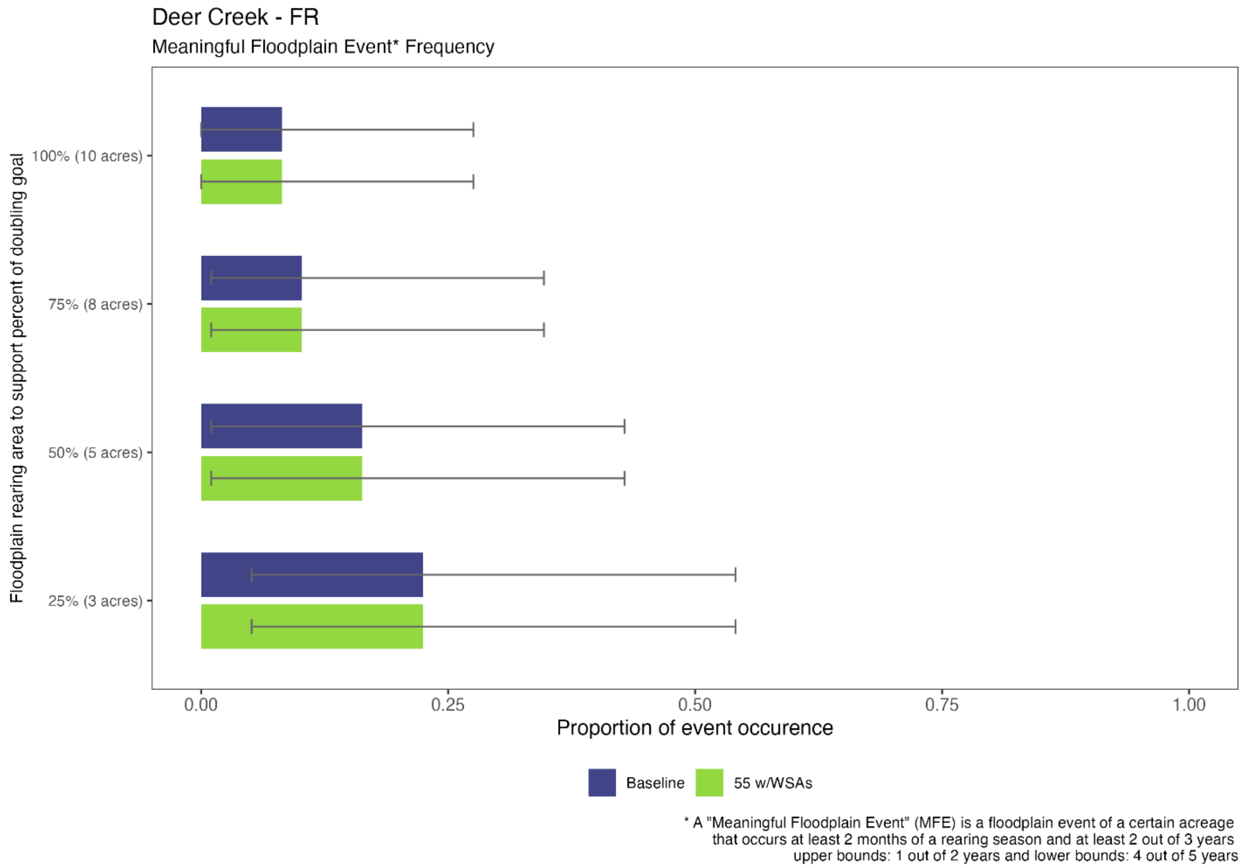
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require 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 H1c.2.1-11. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on Cottonwood Creek



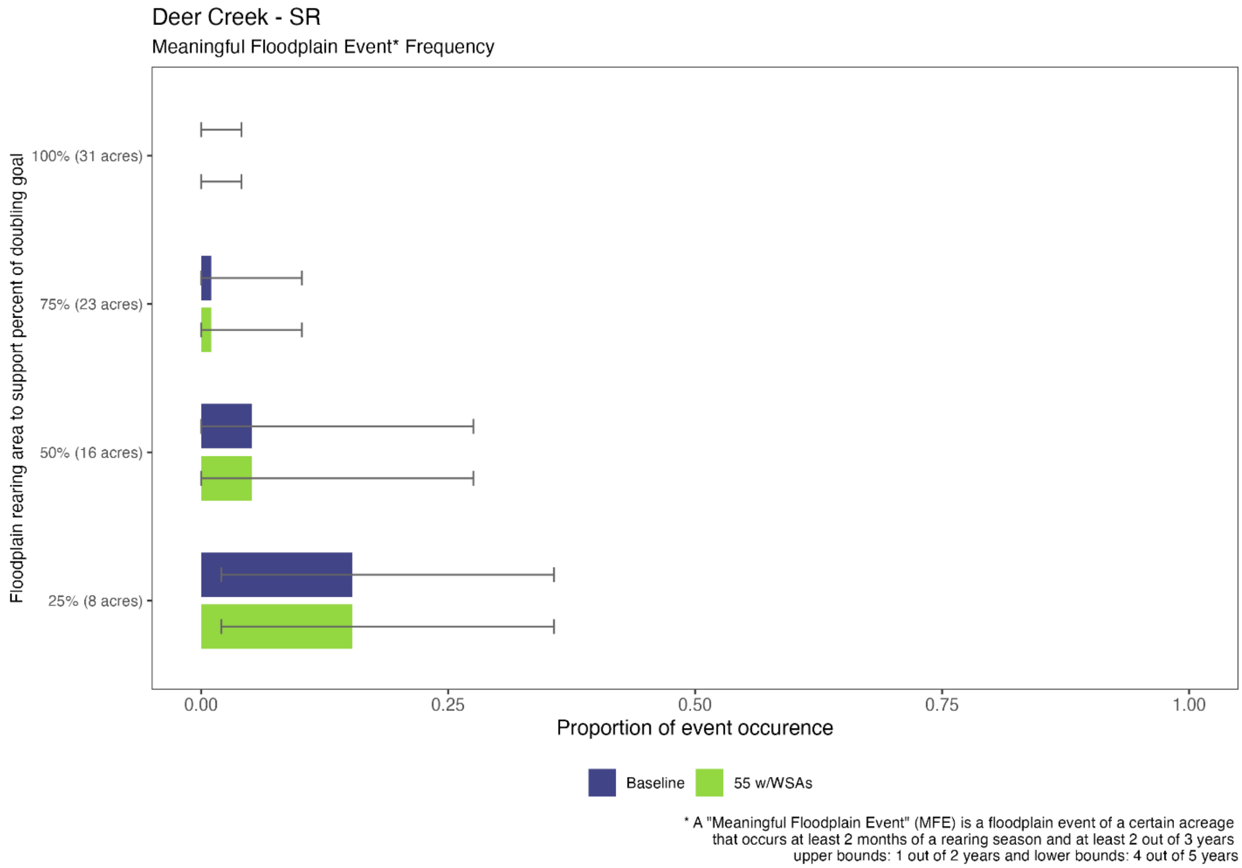
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require 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 H1c.2.1-12. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on Cow Creek



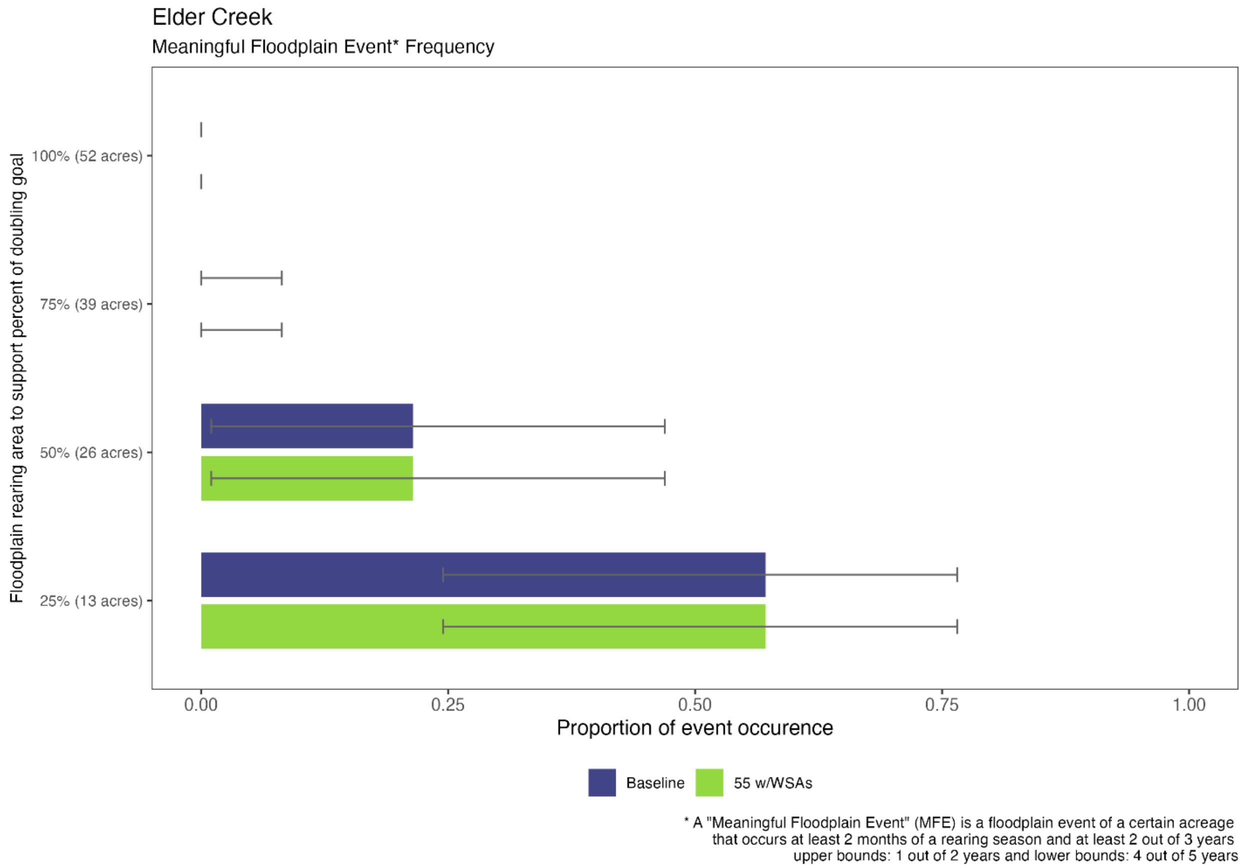
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require 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 H1c.2.1-13. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on Deer Creek (Fall-Run)



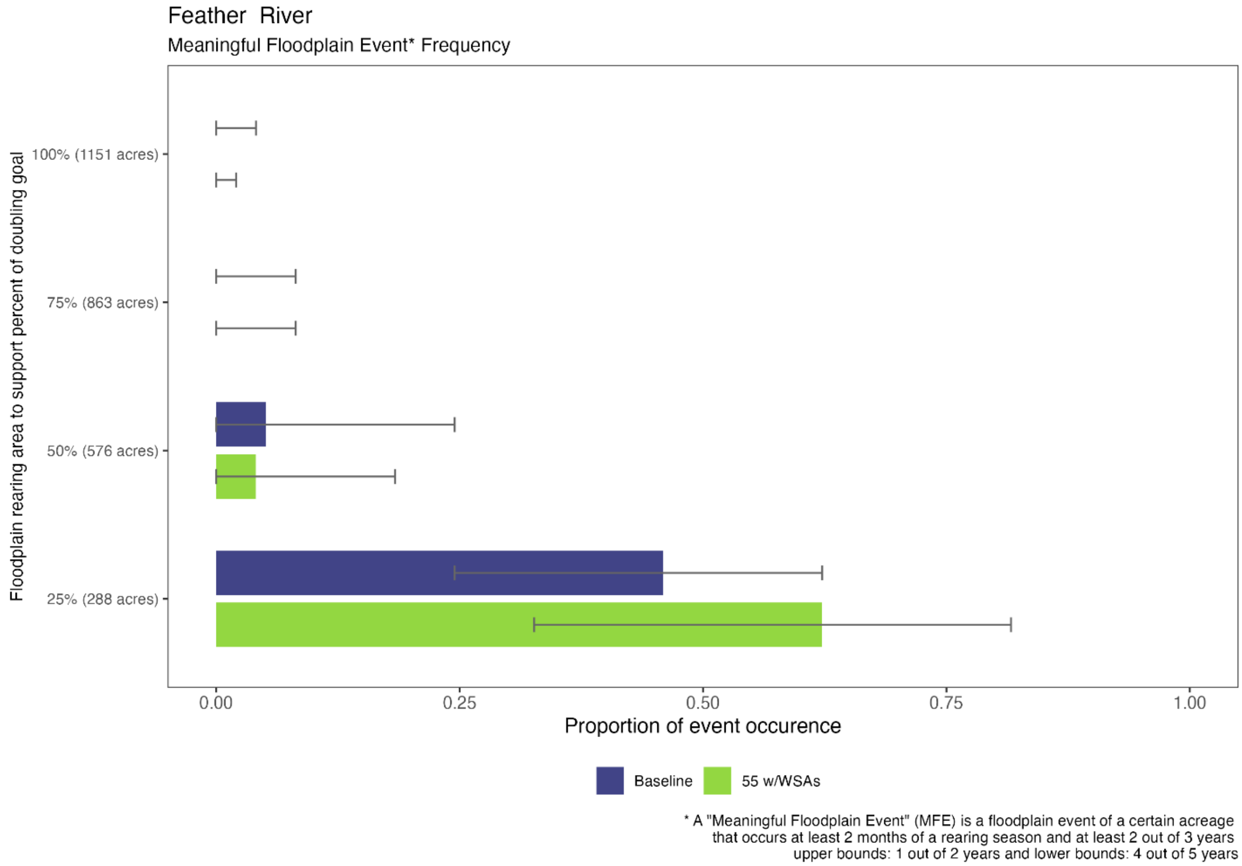
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require 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 H1c.2.1-14. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on Deer Creek (Spring-Run)



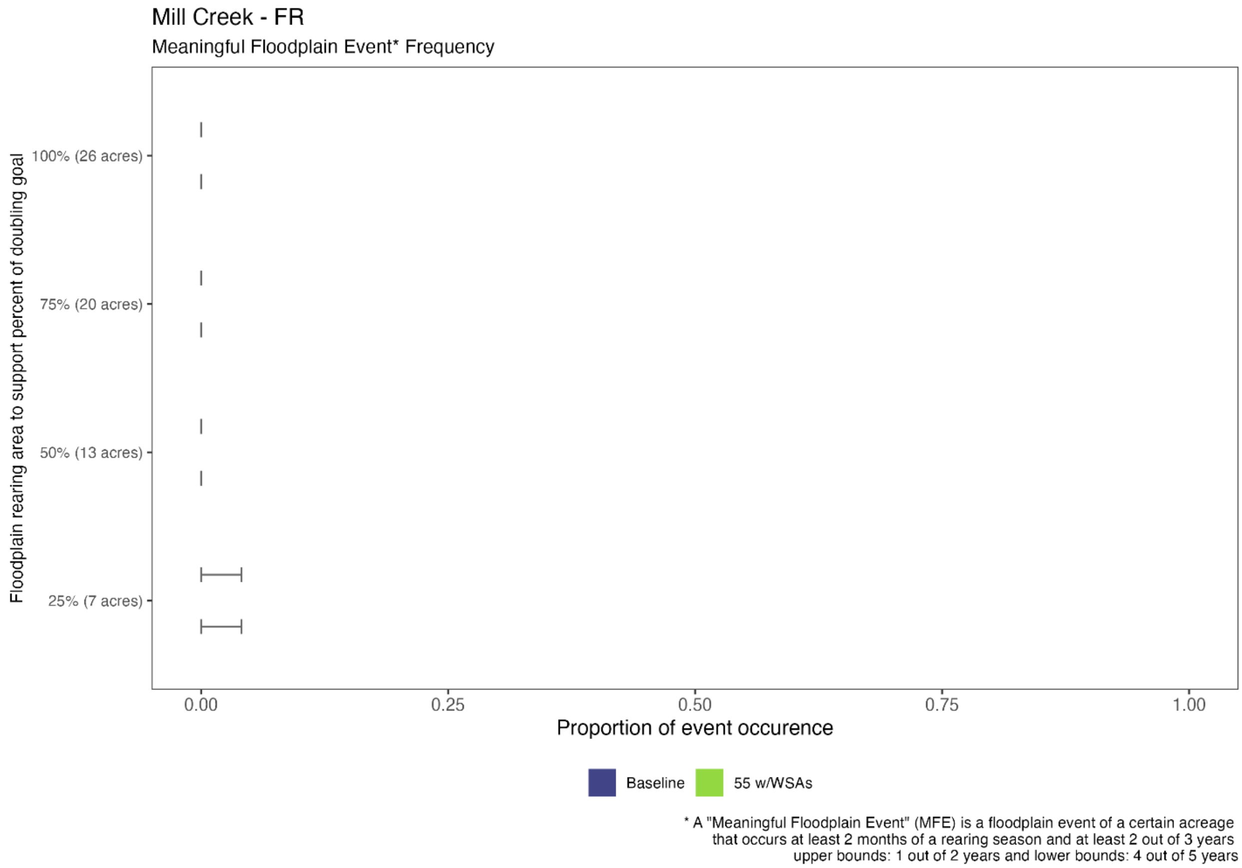
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require 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 H1c.2.1-15. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on Elder Creek



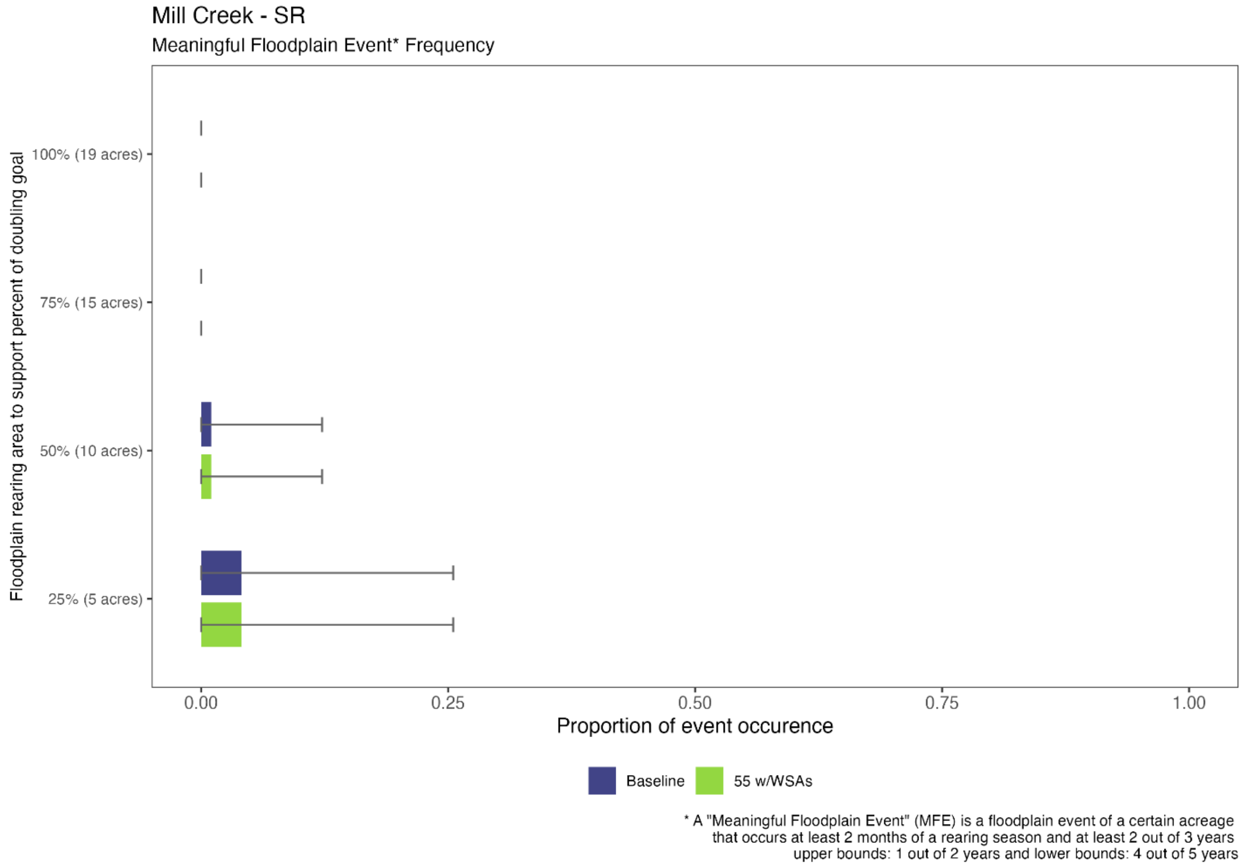
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require 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 H1c.2.1-16. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on the Feather River



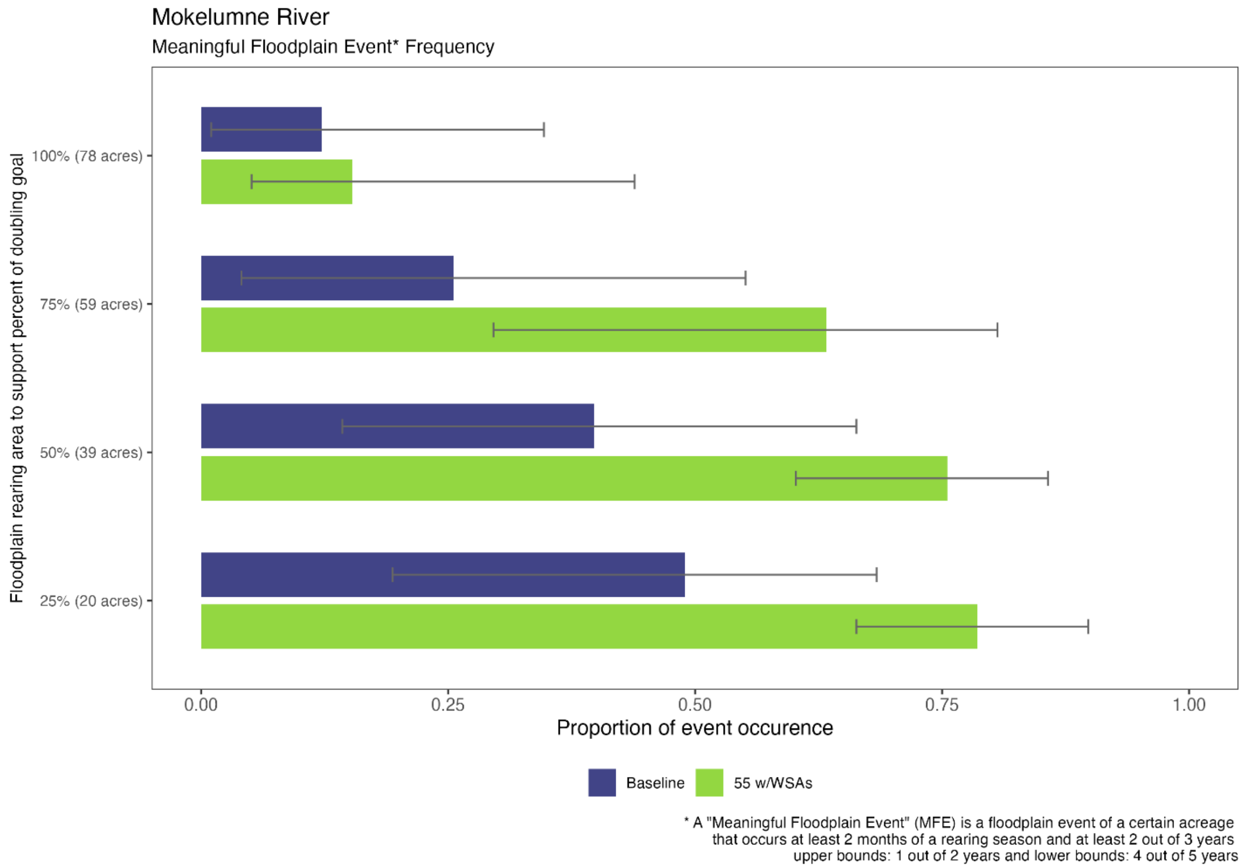
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require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

Figure H1c.2.1-17. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on Mill Creek (Fall-Run)



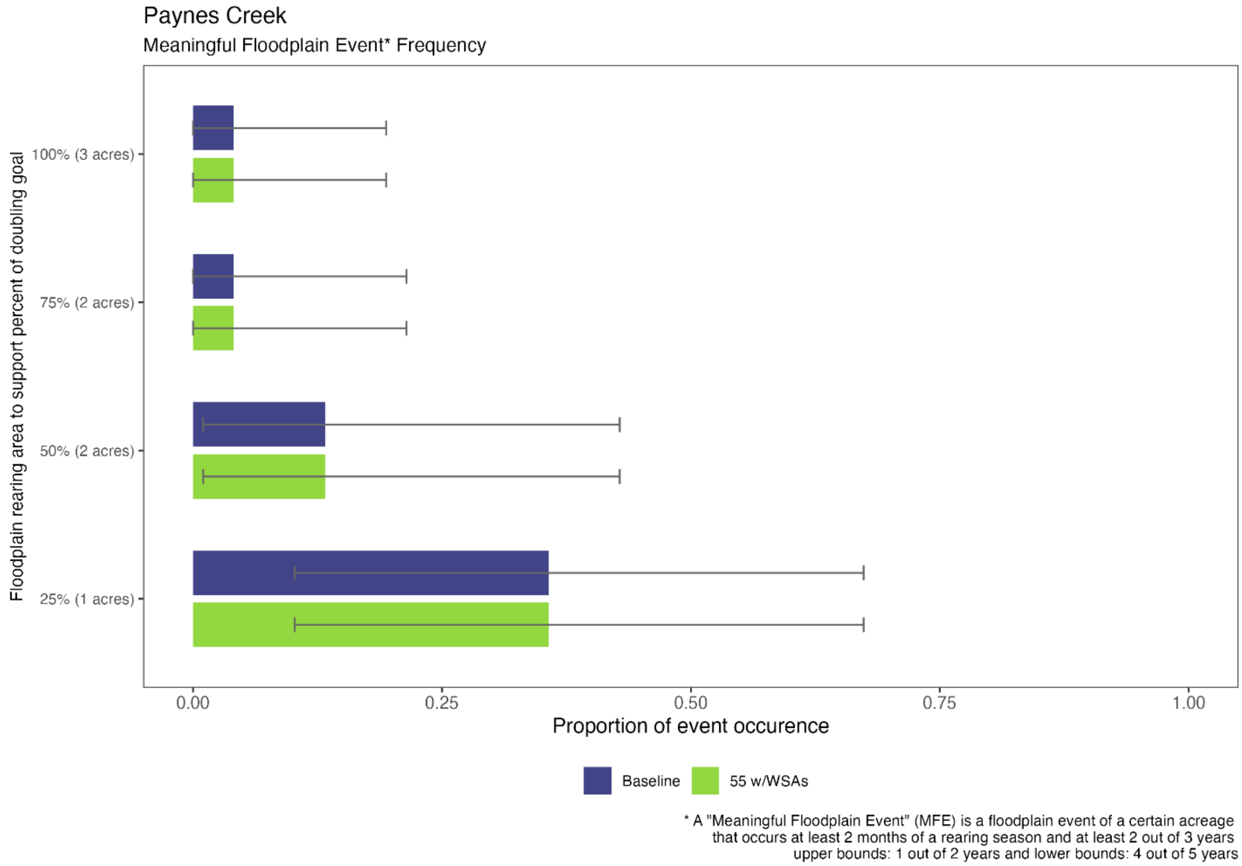
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require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

Figure H1c.2.1-18. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on Mill Creek (Spring-Run)



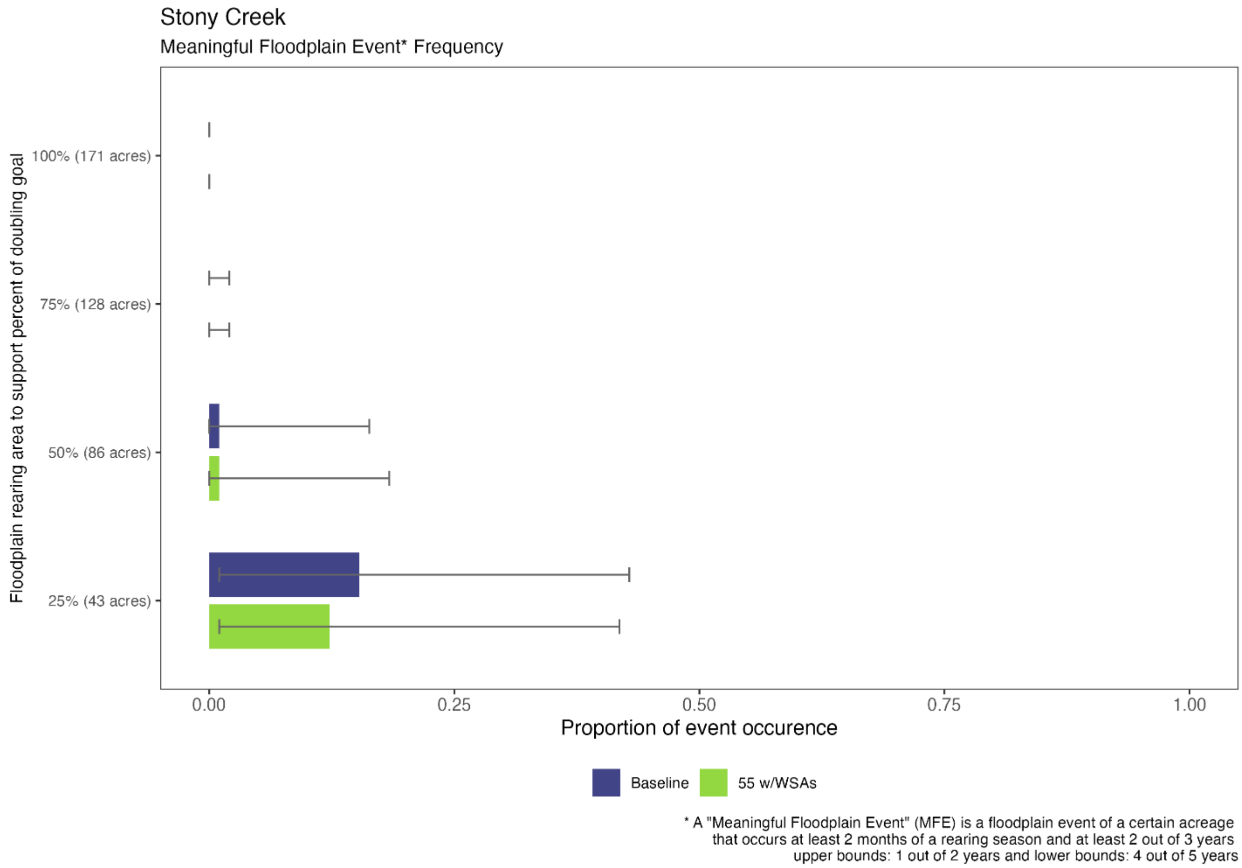
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require 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 H1c.2.1-19. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on the Mokelumne River



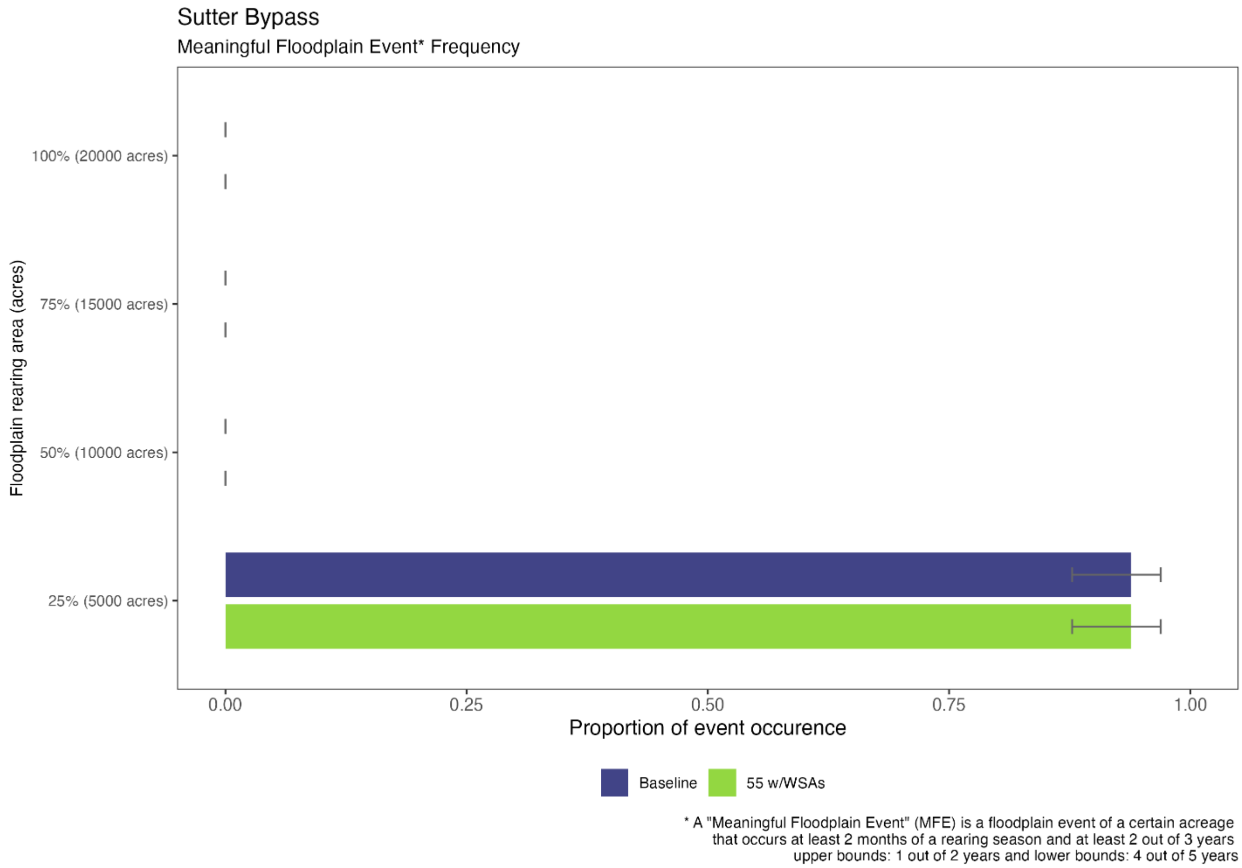
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require 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 H1c.2.1-20. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on Paynes Creek



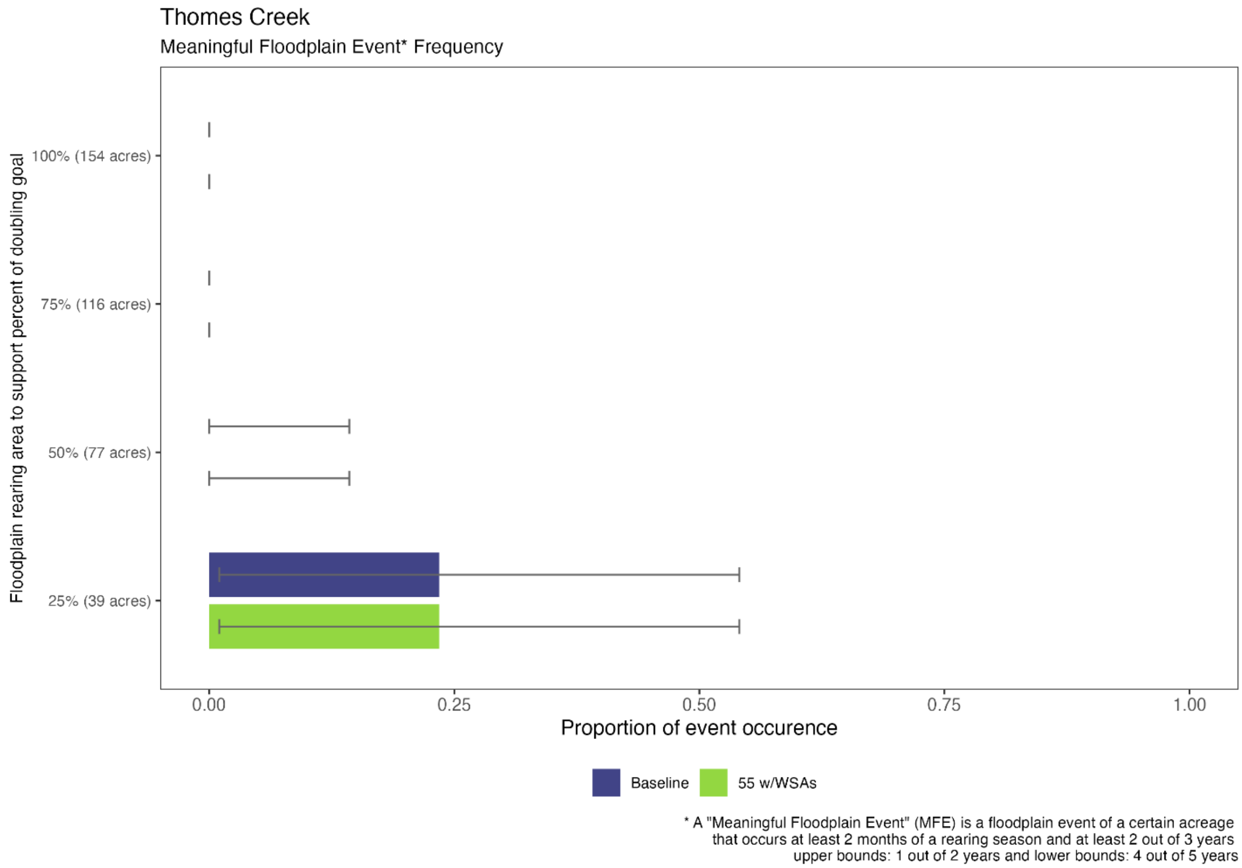
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require 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 H1c.2.1-21. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on Stony Creek



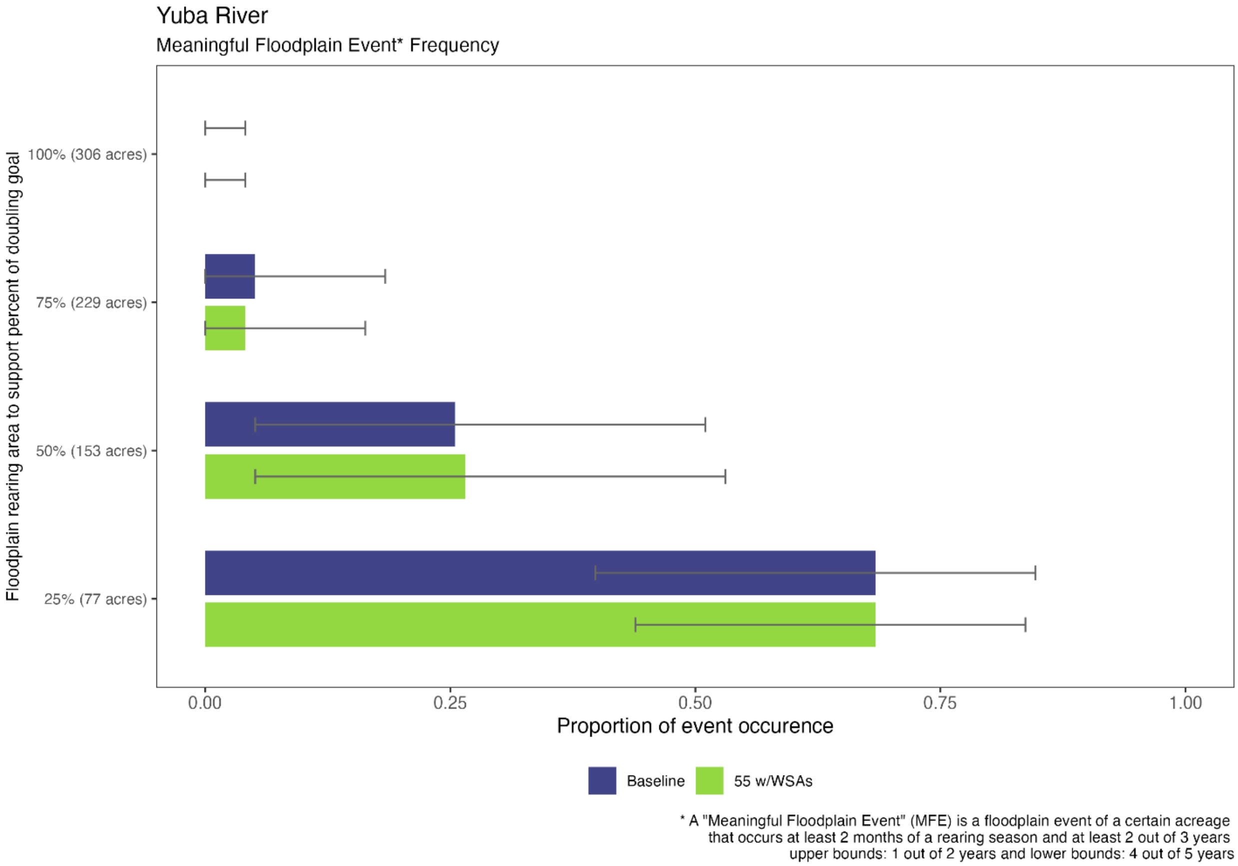
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require 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 H1c.2.1-22. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs 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.

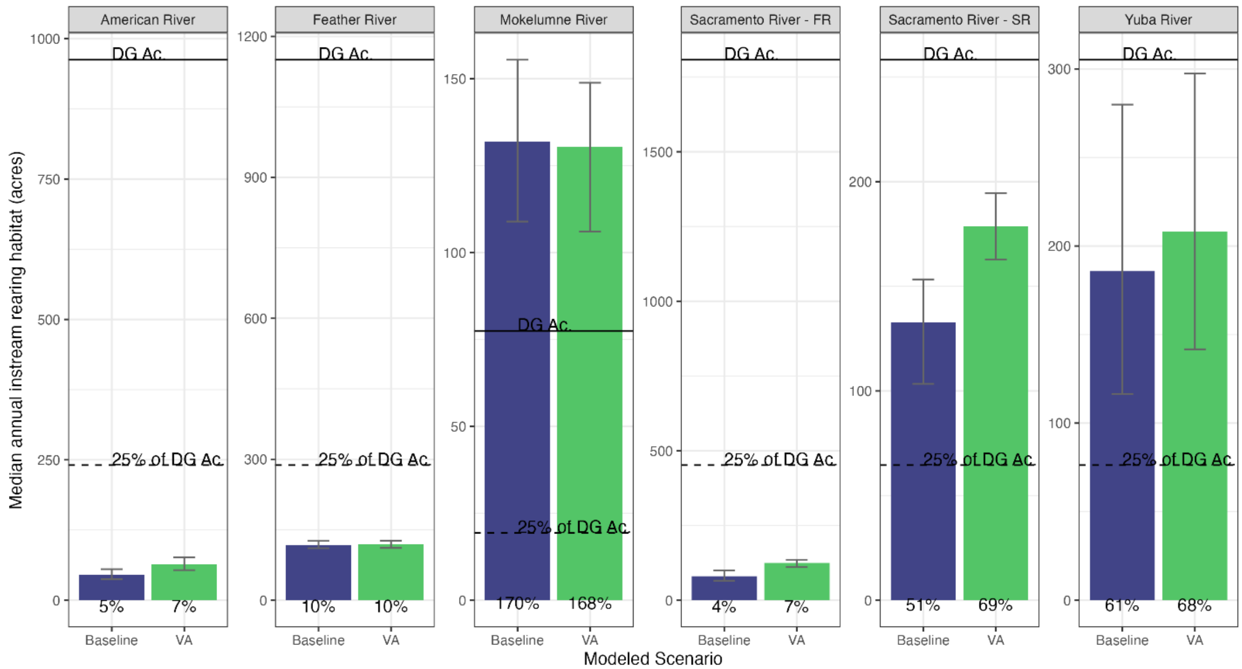
Figure H1c.2.1-23. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on Thomes Creek



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.

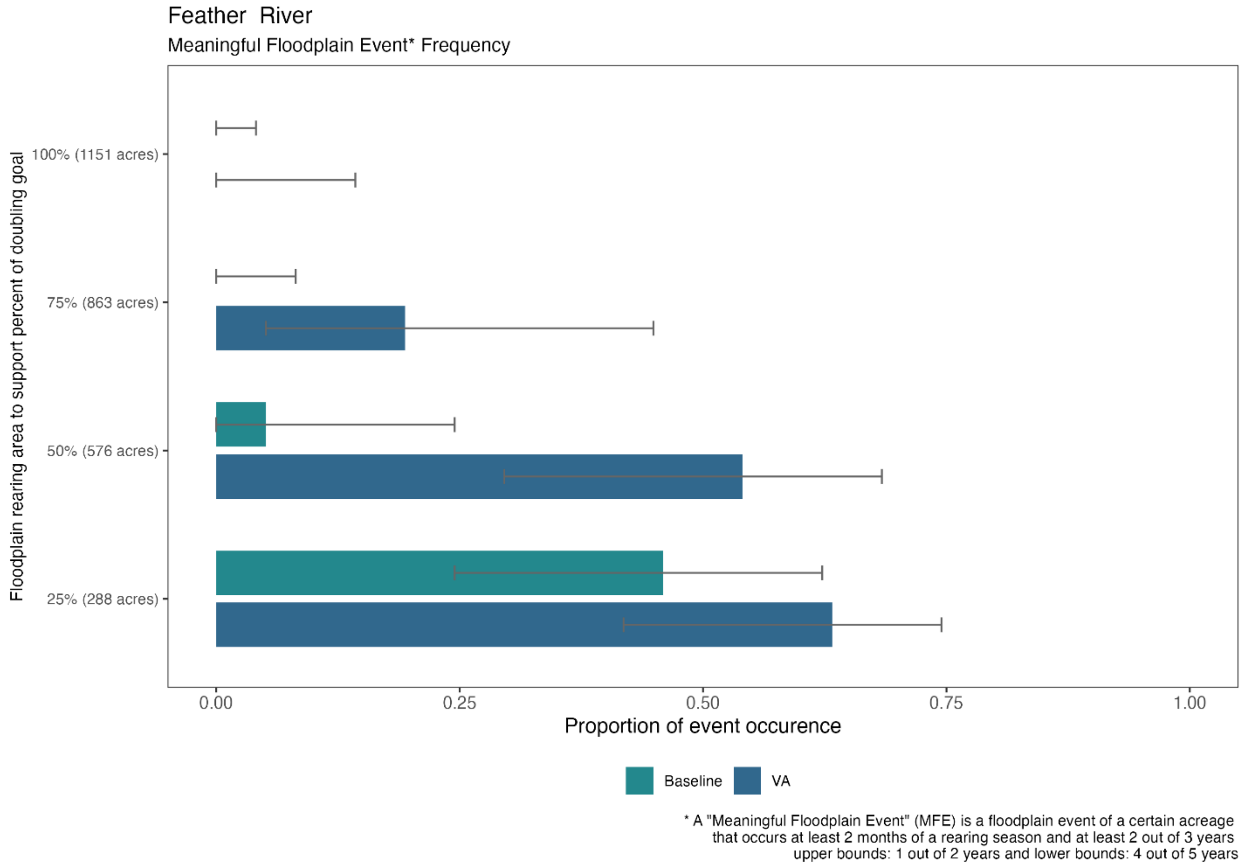
Figure H1c.2.1-24. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and 55 w/WSAs Scenarios on the Yuba River

H1c.2.2 Voluntary Agreement Pathway



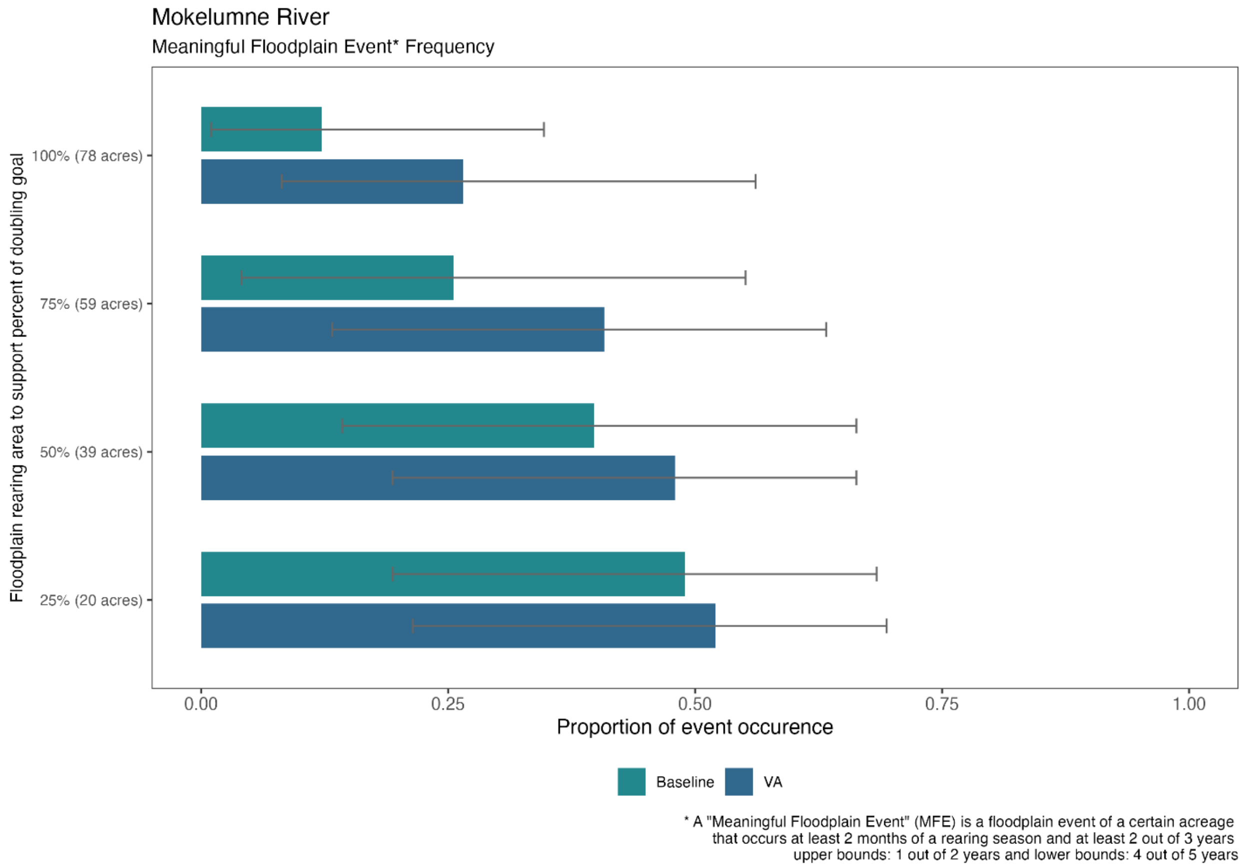
FR = fall-run; SR = spring-run.

Figure H1c.2.2-1. Median (across All Years Modeled) Instream Rearing Habitat (acres) for Each Watershed.



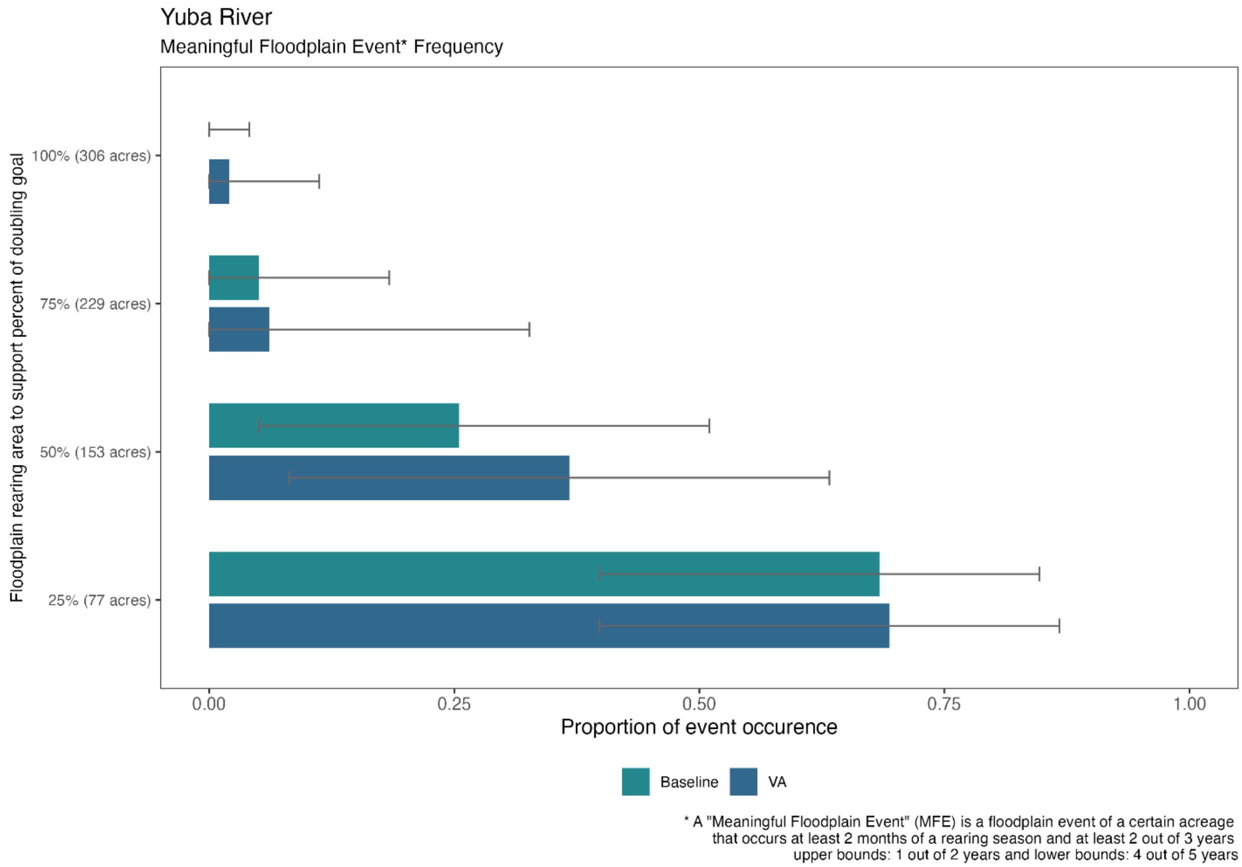
Note: A *meaningful floodplain event* (MFE) is defined as a floodplain event of a certain acreage that occurs at least 2 months of a rearing season and at least 2 out of 3 years. The lower bounds of the error bars represent the proportion of event occurrence when MFE criteria are restricted to require 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 H1c.2.2-2 Proportion of Meaningful Floodplain Event Occurrence for the Baseline and VA 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 H1c.2.2-3. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and VA Scenarios on the Mokelumne 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 H1c.2.2-4. Proportion of Meaningful Floodplain Event Occurrence for the Baseline and VA Scenarios on the Yuba River

H1c.3 References Cited

Bratovich, P., J. Weaver, C. Addley, and C. Hammersmark. 2017. *Lower American River Biological Rationale, Development and Performance of the Modified Flow Management Standard*. Sacramento Water Forum. November. Available: https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_waterfix/exhibits/docs/PCWA/part2/ARWA-702.pdf. Accessed: October 15, 2025.

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. Available: https://s3-us-west-2.amazonaws.com/cvpiahabitat-r-package/cvpia-sit-model-inputs/CDFW1979_CottonwoodSpawningIFIM.PDF. Accessed: October 20, 2025.

California Department of Fish and Game (CDFG). 1991. *Lower Mokelumne Fisheries Management Plan*. November. Available: https://s3-us-west-2.amazonaws.com/cvpiahabitat-r-package/cvpia-sit-model-inputs/Lower+Mokelumne+RIver+Fisheries+Management+Plan%2C+CDFG+1991.pdf. Accessed: October 20, 2025.

California Department of Water Resources (CDWR). 2004. *Phase 2 Report Evaluation of Project Effects on Instream Flows and Fish Habitat SP F-16*. Prepared by Mills, T., T. Sommer, B. Cavallo, T. Payne, and M. Allen. February. Available: https://s3-us-west-2.amazonaws.com/cvpiahabitat-r-package/cvpia-sit-model-inputs/Feather_FERC_IFIM_Phase_2.pdf. Accessed: October 27, 2025.

California Department of Water Resources (CDWR). 2005. *Addendum to Phase 2 Report Evaluation of Project Effects on Instream Flows and Fish Habitat SP F-16*. Prepared by Mills, T., T. Sommer, B. Cavallo, T. Payne, and M. Allen. January. Available: https://cvpiahabitat-r-package.s3-us-west-2.amazonaws.com/F16_phase_2_addendum.pdf. Accessed: October 27, 2025.

California Department of Water Resources (CDWR). 2014. *Central Valley Floodplain Evaluation And Delineation, Floodplain Management Branch Floodplain Mapping Section: Subtask 5 Combined Sacramento River System Model Technical Memorandum*. February. Available: https://s3-us-west-2.amazonaws.com/cvpiahabitat-r-package/cvpia-sit-model-inputs/CombinedTM_IQAR_Final-FULL-REPORT_20140206.pdf. Accessed: October 20, 2025.

FISHBIO Environmental, LLC and Thomas R. Payne and Associates, Fisheries Consultants. 2010. *Calveras River HCP: Appendix E- PHABSIM Habitat Index Analysis of the Calaveras River between Bellota and New Hogan Dam for Steelhead Fry and Juvenile Rearing and Adult Spawning*. Draft. Stockton, CA. Prepared for Stockton East Water District. July. Available: https://s3-us-west-2.amazonaws.com/cvpiahabitat-r-package/cvpia-sit-model-inputs/FishBio_Payne2009_CalaverasInstreamFlowStudy.pdf. Accessed: October 20, 2025.

Gill, S. and M. Tompkins. 2020a. *Upper-mid Sacramento Regional Approximation.* July. Available: http://cvpia-habitat-docs-markdown.s3-website-us-west-2.amazonaws.com/watershed/Regional_Approximation.html. Accessed: October 2, 2025.

Gill, S. and M. Tompkins. 2020b. *Antelope Creek.* July. Available: http://cvpia-habitat-docs-markdown.s3-website-us-west-2.amazonaws.com/watershed/antelope_creek.html. Accessed: October 15, 2025.

Gill, S. and M. Tompkins. 2020c. *American River.* July. Available: http://cvpia-habitat-docs-markdown.s3-website-us-west-2.amazonaws.com/watershed/american_river.html. Accessed: October 15, 2025.

Gill, S. and M. Tompkins. 2020d. *Battle Creek.* July. Available: http://cvpia-habitat-docs-markdown.s3-website-us-west-2.amazonaws.com/watershed/battle_creek.html. Accessed: October 15, 2025.

Gill, S. and M. Tompkins. 2020e. *Bear River.* July. Available: http://cvpia-habitat-docs-markdown.s3-website-us-west-2.amazonaws.com/watershed/bear_river.html. Accessed: October 15, 2025.

Gill, S. and M. Tompkins. 2020f. *Big Chico Creek.* July. Available: http://cvpia-habitat-docs-markdown.s3-website-us-west-2.amazonaws.com/watershed/big_chico_creek.html. Accessed: October 15, 2025.

Gill, S. and M. Tompkins. 2020g. *Butte Creek.* July. Available: http://cvpia-habitat-docs-markdown.s3-website-us-west-2.amazonaws.com/watershed/butte_creek.html. Accessed: October 20, 2025.

Gill, S. and M. Tompkins. 2020h. *Calaveras River.* July. Available: http://cvpia-habitat-docs-markdown.s3-website-us-west-2.amazonaws.com/watershed/calaveras_river.html. Accessed: October 20, 2025.

Gill, S. and M. Tompkins. 2020i. *Clear Creek.* July. Available: http://cvpia-habitat-docs-markdown.s3-website-us-west-2.amazonaws.com/watershed/clear_creek.html. Accessed: October 20, 2025.

Gill, S. and M. Tompkins. 2020j. *Cosumnes River.* July. Available: http://cvpia-habitat-docs-markdown.s3-website-us-west-2.amazonaws.com/watershed/cosumnes_river.html. Accessed: October 20, 2025.

Gill, S. and M. Tompkins. 2020k. *Cottonwood Creek.* July. Available: http://cvpia-habitat-docs-markdown.s3-website-us-west-2.amazonaws.com/watershed/cottonwood_creek.html. Accessed: October 21, 2025.

Gill, S. and M. Tompkins. 2020l. *Cow Creek.* July. Available: http://cvpia-habitat-docs-markdown.s3-website-us-west-2.amazonaws.com/watershed/cow_creek.html. Accessed: October 21, 2025.

Gill, S. and M. Tompkins. 2020m. *Deer Creek.* July. Available: http://cvpia-habitat-docs-markdown.s3-website-us-west-2.amazonaws.com/watershed/deer_creek.html. Accessed: October 21, 2025.

Gill, S. and M. Tompkins. 2020n. *Elder Creek.* July. Available: http://cvpia-habitat-docs-markdown.s3-website-us-west-2.amazonaws.com/watershed/elder_creek.html. Accessed: October 21, 2025.

Gill, S. and M. Tompkins. 2020o. *Feather River.* July. Available: http://cvpia-habitat-docs-markdown.s3-website-us-west-2.amazonaws.com/watershed/feather_river.html. Accessed: October 27, 2025.

Gill, S. and M. Tompkins. 2020p. *Mill Creek.* July. Available: http://cvpia-habitat-docs-markdown.s3-website-us-west-2.amazonaws.com/watershed/mill_creek.html. Accessed: October 27, 2025.

Gill, S. and M. Tompkins. 2020q. *Paynes Creek.* July. Available: http://cvpia-habitat-docs-markdown.s3-website-us-west-2.amazonaws.com/watershed/paynes_creek.html. Accessed: October 27, 2025.

Gill, S. and M. Tompkins. 2020r. *Stony Creek.* July. Available: http://cvpia-habitat-docs-markdown.s3-website-us-west-2.amazonaws.com/watershed/stony_creek.html. Accessed: October 27, 2025.

Gill, S. and M. Tompkins. 2020s. *Thomes Creek.* July. Available: http://cvpia-habitat-docs-markdown.s3-website-us-west-2.amazonaws.com/watershed/thomes_creek.html. Accessed: October 27, 2025.

Gill, S., Rodriguez, E., and E. Cain. 2022a. DSMtemperature: Modeled Temperature Data for the CVPIA SIT Model. R package version 2.0. Available: https://CVPIA-OSC.github.io/DSMtemperature/.

Gill, S., Rodriguez, E., and E. Cain. 2022b. DSMtemperature: Monthly Mean Water Temperature. Available: https://cvpia-osc.github.io/DSMtemperature/reference/stream_temperature.html.

Hackenjos, B. 2019. *Lower Deer Creek Flood and Ecosystem Improvement Project – 2d Hydrodynamic Model*. April. Prepared for Deer Creek Watershed Conservancy. Available: https://cvpiahabitat-r-package.s3.us-west-2.amazonaws.com/cvpia-sit-model-inputs/DeerCreek_2Dmodel_FlowWest_Final.pdf. Accessed: October 15, 2025.

HDR, Inc. and Stillwater Sciences. 2015. *Lower Tuolumne River Floodplain Hydraulic Assessment Study Report.* Don Pedro Hydroelectric Project, Ferc No. 2299. Prepared for Turlock Irrigation District, Turlock, CA and Modesto Irrigation District, Modesto, CA. September. Available: https://s3-us-west-2.amazonaws.com/cvpiahabitat-r-package/cvpia-sit-model-inputs/Tuolumne_W-AR_21__Study+Report.pdf. Accessed: October 20, 2025.

Hendrix, N., E. Jennings, A. Criss, E. Danner, V. Sridharan, C. Greene, H. Imaki, and S. Lindley. 2017. *Model Description for the Sacramento River Winter-Run Chinook Salmon Life Cycle Model.* January. Available: https://cvpiahabitat-r-package.s3-us-west-2.amazonaws.com/2017Hendrix.pdf. Accessed: October 27, 2025.

Pacific Gas and Electric Company (PG&E). 2007. *DeSabla-Centerville Project, FERC No. 803: License Application- Errata.* September. Available: https://s3-us-west-2.amazonaws.com/cvpiahabitat-r-package/cvpia-sit-model-inputs/DeSabla2008ButteIFIM.pdf. Accessed: October 20, 2025.

Rodriguez, E., E. Cain, M. Tompkins, and S. Gill. 2023. *DSMhabitat: Estimate Spawning and Rearing Habitat.* R package version 2.0, https://cvpia-osc.github.io/DSMhabitat/.

South Sutter Water District. 2019. *Application for New License: Camp Far West Hydroelectric Project, FERC Project No. 2997*. June. Available: https://cvpiahabitat-r-package.s3-us-west-2.amazonaws.com/cvpia-sit-model-inputs/SSWD_Bear_River_2019.pdf. Accessed: October 20, 2025.

Thomas R. Payne and Associates. 1995. *Battle Creek Instream Flow Study Specified Fisheries Investigations on Battle Creek Shasta and Tehama Counties*. Draft. Arcata, CA. Prepared for California Department of Fish and Game, Redding, CA. Available: https://s3-us-west-2.amazonaws.com/cvpiahabitat-r-package/cvpia-sit-model-inputs/Payne1995_BattleCreekIFIM.pdf. Accessed: October 15, 2025.

U.S. Fish and Wildlife Service (USFWS). 2003a. *Flow Habitat Relationships For Spring-Run chinook Salmon Spawning in Butte Creek.* Final. August. Prepared by The Energy Planning and Instream Flow Branch, Sacramento, CA. Available: https://cvpiahabitat-r-package.s3.us-west-2.amazonaws.com/Butte_Creek_Spring-run_chinook_salmon_spawning_8-29-2003.pdf. Accessed: October 20, 2025.

U.S. Fish and Wildlife Service (USFWS). 2003b. *Flow-Habitat Relationships for Steelhead and Fall, Late-Fall, and Winter-Run Chinook Salmon Spawning in the Sacramento River between Keswick Dam and Battle Creek. Prepared by staff of the Energy Planning and Instream Flow Branch, Sacramento, CA*. February. Available: https://dsm-docs.s3.us-west-2.amazonaws.com/Sacramento_River_Spawning_Final_Report_Feb_4_2003.pdf. Accessed: October 27, 2025.

U.S. Fish and Wildlife Service (USFWS). 2007. *Clear Creek (Whiskeytown Dam to Clear Creek Road) Spawning Final Report.* Final. Prepared by staff of The Energy Planning and Instream Flow Branch, Sacramento, CA. August. Available: https://s3-us-west-2.amazonaws.com/cvpiahabitat-r-package/cvpia-sit-model-inputs/FWS2007-2013_ClearCreekInstream.pdf. Accessed: October 20, 2025.

U.S. Fish and Wildlife Service (USFWS). 2011a. *Flow-Habitat Relationships for Fall-Run Chinook Salmon and Steelhead/Rainbow Trout Spawning in Clear Creek Between Clear Creek Road and the Sacramento River. Final. Prepared by staff of The Restoration and Monitoring Program, Sacramento, CA*. January. Available: https://cvpiahabitat-r-package.s3.us-west-2.amazonaws.com/cvpia-sit-model-inputs/Clear+Creek+Lower+Spawning+Final+Report.pdf. Accessed: October 20, 2025.

U.S. Fish and Wildlife Service (USFWS). 2011b*. Flow-Habitat Relationships for Juvenile Spring-Run Chinook Salmon and Steelhead/Rainbow Trout Rearing in Clear Creek Between Whiskeytown Dam and Clear Creek Road. Final. Prepared by staff of The Restoration and Monitoring Program, Sacramento, CA*. September. Available: https://cvpiahabitat-r-package.s3.us-west-2.amazonaws.com/cvpia-sit-model-inputs/Clear+Creek+Whiskeytown+to+Clear+Creek+Br+rearing+final+report.pdf. Accessed: October 20, 2025.

U.S. Fish and Wildlife Service (USFWS). 2011c. *South Cow Creek Habitat Assessment*. Prepared by staff of the Anadromous Fish Restoration Program, Sacramento, CA. Jully. Available: https://s3-us-west-2.amazonaws.com/cvpiahabitat-r-package/cvpia-sit-model-inputs/FWS2011_SouthCowrpt.pdf.pdf. Accessed: October 21, 2025.

U.S. Fish and Wildlife Service (USFWS). 2013. *Flow-Habitat Relationships for Juvenile Spring-Run and Fall-Run Chinook Salmon and Steelhead/Rainbow Trout Rearing in Clear Creek Between Clear Creek Road and The Sacramento River. Final*. Prepared by staff of The Restoration and Monitoring Program, Sacramento, CA. January. Available: https://cvpiahabitat-r-package.s3.us-west-2.amazonaws.com/cvpia-sit-model-inputs/Clear+Creek+Lower+Rearing+Final+Report-1.pdf. Accessed: October 20, 2025.

U.S. Fish and Wildlife Service (USFWS). 2014. *Identification Of The Instream Flow Requirements For Anadromous Fish in the Streams Within the Central Valley Of California And Fisheries Investigations: Annual Progress Report, Fiscal Year 2013*. Prepared by staff of The Restoration and Monitoring Program Sacramento, CA. January. Available: https://cvpiahabitat-r-package.s3-

us-west-2.amazonaws.com/cvpia-sit-model-inputs/CVPIA_Annual_Progress_Report_Fiscal_Year_2013.pdf. Accessed: October 20, 2025.

U.S. Fish and Wildlife Service (USFWS). 2018. *Central Valley Project Improvement Act Fisheries Investigations: Annual Progress Report, Fiscal Year 2017*. Prepared by staff of the Anadromous Fish Restoration Program, Lodi, CA. February. Available: https://s3-us-west-2.amazonaws.com/cvpiahabitat-r-package/cvpia-sit-model-inputs/CVPIA+Annual+Progress+Report+Fiscal+Year+2017.pdf. Accessed: October 20, 2025.

U.S. Fish and Wildlife Service (USFWS). 2019. *Central Valley Project Improvement Act, Fisheries Investigations: Annual Progress Report, Fiscal Year 2019*. Prepared by staff of the Anadromous Fish Restoration Program, Lodi, CA. November. Available: https://cvpiahabitat-r-package.s3.us-west-2.amazonaws.com/cvpia-sit-model-inputs/CVPIA+Annual+Progress+Report+Fiscal+Year+2019.pdf. Accessed: October 20, 2025.