

Appendix 12N

Yolo and Sutter Bypass Flow and Weir Spill Analysis

Line items and numbers identified or noted as “No Action Alternative” represent the “Existing Conditions/No Project/No Action Condition” (described in Chapter 2 Alternatives Analysis). Table numbering may not be consecutive for all appendixes.”

APPENDIX 12N

Yolo and Sutter Bypass Flow and Weir Spill Analysis

12N.1 Overview

This appendix describes the approach used to compute the number of years that contain events with flows greater than a given threshold for a specified number of consecutive days, for analysis of the Sites Reservoir Project (Project) action alternatives (alternatives) for the Draft Environmental Impact Report/Environmental Impact Statement (DEIR/EIS). It includes a summary of the methodology and results used in the detailed evaluation of the alternatives. Results were used or referenced in Chapter 12 Aquatic Biological Resources.

12N.1.1 Introduction

The analytical framework used to evaluate the alternatives is summarized in Chapter 5 Guide to the Resource Analyses and Appendix 6B Water Resources System Modeling. Assumptions used in modeling the alternatives were summarized in Appendix 6A Modeling of Alternatives. The methodology described provides an approach to quantify the potential number of years that contain events with flows greater than a given threshold for a specified number of consecutive days.

12N.1.2 Yolo Bypass Flow and Fremont Weir Spill Analysis Methodology

This analysis examines the frequency and duration of spills over the Fremont Weir as well as the total flows in the Yolo Bypass that would provide rearing habitat for salmonids and splittail. The number of years in the 82-year simulation period where there is at least one event of spill over the Fremont Weir into the Yolo Bypass of varying amounts (0, 2,000, 4,000, 6,000, 8,000, and 10,000 cfs) with a duration of 0 to 10 days, 11 to 20 days, 21 to 30 days, 31 to 45 days, and greater than 45 days are calculated from the daily results. Similarly, the number of years with at least one event where total Yolo flow exceeded these flows for frequency and duration is examined for the entire 82-year simulation period. This analysis was limited to the Oct – Apr months in which juvenile salmonids and spawning splittail are anticipated to be present in the Yolo Bypass.

Daily Fremont Weir spill output from CalSim II was used in this analysis. Daily spill outputs from CalSim II were based on a monthly-to-daily flow mapping technique applied in the model for a better estimate of the spills at the Fremont Weir and the Sacramento Weir. The technique applies historical daily patterns, based on the hydrology of the year, to transform the monthly volumes into daily flows. Daily patterns are “borrowed” from the observed DAYFLOW period of 1956-2008. In all cases, the monthly volumes are preserved between the daily and monthly flows. It is important to note that this daily mapping approach does not in any way represent the flows resulting from operational responses on a daily time step. It is simply a technique to incorporate representative daily variability into the flows resulting from CalSim II’s monthly operational decisions.

Daily total Yolo Bypass flow results used in the current analysis were estimated using the daily CalSim II outputs of flow spills at Fremont and Sacramento Weirs, and monthly west-side stream flows disaggregated into daily flows using the historical flow patterns.

The daily spill and total Yolo flow results were analyzed for spills/flows above a specified flow threshold. If the gap between two events was less than seven days, then it was treated as one continuous event. The duration of these events were then calculated, and categorized by length. This analysis allows to assess the effects of Sites Reservoir alternatives on the duration and magnitude of flows in the Yolo Bypass in comparison to the No Action Alternative.

12N.1.3 Sutter Bypass Flow and Weir Spill Analysis Methodology

Similar to the methodology used for the Yolo Bypass, modeled daily spill into the Sutter Bypass from the Sacramento River at Ord Ferry and the Moulton, Colusa, and Tisdale weirs is used to examine the frequency and duration of total spill into the Sutter Bypass that could provide rearing habitat for salmonids and splittail. Spill (flow) at Ord Ferry, Moulton Weir, and Colusa Weir were combined to assess potential changes in the northern portion of the Sutter Bypass; total spill at Ord Ferry, Moulton, Colusa, and Tisdale weirs was combined to assess potential impacts in the central portion of the bypass; and total flow through the bypass was used as an indicator of potential changes in floodplain habitat in the southern portion of Sutter Bypass. The number of years where there is at least one event of spill over the weirs into the Sutter Bypass of varying amounts (0, 2,000, 4,000, 6,000, 8,000, and 10,000 cfs) with a duration of 0-10 days, 11-20 days, 21-30 days, 31-45 days, and greater than 45 days was calculated from the daily results. This analysis was limited to the Oct – Apr months in which juvenile salmonids and spawning splittail are anticipated to be present in the Sutter Bypass.

12N.2 Results

This section includes the results of the Yolo and Sutter Bypass Flow and Weir Spill Analysis for the alternatives evaluated in the DEIR/EIS.

12N.2.1 Introduction

Modeling results are presented in tabular format for the flow analysis. The results show the number of years in the CalSim II study that flow/spill events are greater than a given threshold flow (in cfs) for a specified duration (in days).

12N.2.2 Comparisons

Summary tables of the Yolo and Sutter Bypass Flow and Weir Spill Analysis are provided for the following four comparisons:

- Alternative A compared to No Action Alternative
- Alternative B compared to No Action Alternative
- Alternative C compared to No Action Alternative
- Alternative D compared to No Action Alternative

Alternative A Compared to No Action Alternative

This page intentionally left blank.

Table SF-1a

Count of years that exceed flow magnitude and duration thresholds between
1921-2003 Fremont Weir Spill Results - Alternative A Compared to No Action Alternative

Number of years that contain events with consecutive days of spills (max 7 day gap to count as new event)	> 0 days		>10 days		> 20 days		> 30 days		> 45 days	
	No Action Alternative	Alternative A								
> 0 cfs	48	43	39	39	27	27	23	21	16	15
> 1,000 cfs	47	43	38	35	27	27	22	20	14	13
> 2,000 cfs	46	42	37	34	27	26	22	20	14	13
> 3,000 cfs	46	41	35	34	27	25	21	19	12	12
> 4,000 cfs	46	41	35	32	27	25	19	19	12	12
> 6,000 cfs	46	41	35	31	26	25	18	18	11	11
> 8,000 cfs	44	41	32	29	24	24	18	18	10	10
> 10,000 cfs	41	39	32	28	23	21	16	15	10	9

Table SF-1b

Count of years that exceed flow magnitude and duration thresholds between 1921-2003
 Total Yolo Flow Results - Alternative A Compared to No Action Alternative

Number of years that contain events with consecutive days of spills (max 7 day gap to count as new event)	> 0 days		>10 days		> 20 days		> 30 days		> 45 days	
	No Action Alternative	Alternative A								
> 0 cfs	82	82	82	82	82	82	82	82	81	81
> 1,000 cfs	73	70	63	60	55	53	48	46	43	42
> 2,000 cfs	68	65	58	51	43	43	39	39	31	31
> 3,000 cfs	65	57	54	48	38	36	32	32	26	26
> 4,000 cfs	63	54	47	46	35	33	30	29	24	22
> 6,000 cfs	58	50	41	39	31	30	26	25	16	14
> 8,000 cfs	54	48	37	35	28	27	23	21	15	14
> 10,000 cfs	49	48	34	33	27	26	20	19	14	14

Table SF-1c
 Count of years that exceed flow magnitude and duration thresholds between 1921-2003
 Ord, Moulton, and Colusa Weir Spill Results - Alternative A Compared to No Action Alternative

Number of years that contain events with consecutive days of spills (max 7 day gap to count as new event)	> 0 days		>10 days		> 20 days		> 30 days		> 45 days	
	No Action Alternative	Alternative A								
> 0 cfs	65	62	43	39	27	27	20	18	9	8
> 1,000 cfs	64	60	43	37	27	25	17	16	8	6
> 2,000 cfs	61	59	39	36	27	24	15	16	6	5
> 3,000 cfs	58	56	38	36	23	21	15	14	5	4
> 4,000 cfs	58	55	37	35	21	20	13	14	5	4
> 6,000 cfs	54	52	33	32	20	19	12	10	3	4
> 8,000 cfs	52	48	30	30	17	19	9	10	2	4
> 10,000 cfs	49	45	28	28	15	17	9	9	1	2

Table SF-1d
 Count of years that exceed flow magnitude and duration thresholds between 1921-2003
 Total Weir Spill Results - Alternative A Compared to No Action Alternative

Number of years that contain events with consecutive days of spills (max 7 day gap to count as new event)	> 0 days		>10 days		> 20 days		> 30 days		> 45 days	
	No Action Alternative	Alternative A								
> 0 cfs	72	72	48	46	36	32	25	23	14	13
> 1,000 cfs	69	69	48	42	33	30	24	23	14	13
> 2,000 cfs	69	66	47	42	31	29	22	22	14	12
> 3,000 cfs	67	63	45	40	29	28	22	20	12	12
> 4,000 cfs	65	61	43	39	28	27	21	18	9	9
> 6,000 cfs	61	60	43	37	27	25	17	17	7	6
> 8,000 cfs	58	57	38	36	24	23	15	15	6	4
> 10,000 cfs	56	54	38	36	21	20	14	14	5	4

Table SF -1e
 Count of years that exceed flow magnitude and duration thresholds between 1921-2003
 Total Sutter Bypass Flow Results - Alternative A Compared to No Action Alternative

Number of years that contain events with consecutive days of spills (max 7 day gap to count as new event)	> 0 days		>10 days		> 20 days		> 30 days		> 45 days	
	No Action Alternative	Alternative A								
> 0 cfs	72	72	56	53	44	40	31	30	22	19
> 1,000 cfs	69	68	48	43	36	33	24	23	14	13
> 2,000 cfs	69	63	47	43	31	30	22	22	14	13
> 3,000 cfs	66	63	46	41	31	28	22	20	12	12
> 4,000 cfs	63	60	44	40	29	27	22	19	9	11
> 6,000 cfs	59	58	43	39	28	26	19	17	8	6
> 8,000 cfs	57	56	40	37	26	24	15	15	6	5
> 10,000 cfs	53	51	38	36	24	23	15	14	5	4

Alternative B Compared to No Action Alternative

This page intentionally left blank.

Table SF-2a

Count of years that exceed flow magnitude and duration thresholds between
1921-2003 Fremont Weir Spill Results - Alternative B Compared to No Action Alternative

Number of years that contain events with consecutive days of spills (max 7 day gap to count as new event)	> 0 days		>10 days		> 20 days		> 30 days		> 45 days	
	No Action Alternative	Alternative B								
> 0 cfs	48	45	39	37	27	27	23	22	16	15
> 1,000 cfs	47	45	38	37	27	27	22	20	14	14
> 2,000 cfs	46	44	37	37	27	27	22	18	14	13
> 3,000 cfs	46	42	35	36	27	27	21	18	12	11
> 4,000 cfs	46	41	35	36	27	26	19	18	12	10
> 6,000 cfs	46	41	35	32	26	24	18	18	11	10
> 8,000 cfs	44	41	32	31	24	22	18	17	10	9
> 10,000 cfs	41	40	32	27	23	21	16	15	10	8

Table SF-2b

Count of years that exceed flow magnitude and duration thresholds between 1921-2003
 Total Yolo Flow Results - Alternative B Compared to No Action Alternative

Number of years that contain events with consecutive days of spills (max 7 day gap to count as new event)	> 0 days		>10 days		> 20 days		> 30 days		> 45 days	
	No Action Alternative	Alternative B								
> 0 cfs	82	82	82	82	82	82	82	82	81	81
> 1,000 cfs	73	70	63	61	55	53	48	47	43	43
> 2,000 cfs	68	66	58	56	43	42	39	39	31	30
> 3,000 cfs	65	59	54	51	38	36	32	31	26	26
> 4,000 cfs	63	57	47	47	35	34	30	27	24	21
> 6,000 cfs	58	54	41	41	31	30	26	25	16	16
> 8,000 cfs	54	50	37	37	28	26	23	21	15	14
> 10,000 cfs	49	48	34	35	27	26	20	19	14	12

Table SF-2c
 Count of years that exceed flow magnitude and duration thresholds between 1921-2003
 Ord, Moulton, and Colusa Weir Spill Results - Alternative B Compared to No Action Alternative

Number of years that contain events with consecutive days of spills (max 7 day gap to count as new event)	> 0 days		>10 days		> 20 days		> 30 days		> 45 days	
	No Action Alternative	Alternative B								
> 0 cfs	65	62	43	40	27	26	20	18	9	7
> 1,000 cfs	64	60	43	37	27	25	17	16	8	6
> 2,000 cfs	61	59	39	36	27	23	15	16	6	5
> 3,000 cfs	58	57	38	35	23	21	15	15	5	5
> 4,000 cfs	58	55	37	35	21	21	13	13	5	4
> 6,000 cfs	54	51	33	33	20	20	12	10	3	4
> 8,000 cfs	52	49	30	30	17	19	9	7	2	2
> 10,000 cfs	49	46	28	27	15	17	9	7	1	1

Table SF-2d
 Count of years that exceed flow magnitude and duration thresholds between 1921-2003
 Total Weir Spill Results - Alternative B Compared to No Action Alternative

Number of years that contain events with consecutive days of spills (max 7 day gap to count as new event)	> 0 days		>10 days		> 20 days		> 30 days		> 45 days	
	No Action Alternative	Alternative B								
> 0 cfs	72	70	48	46	36	35	25	23	14	13
> 1,000 cfs	69	69	48	43	33	30	24	22	14	13
> 2,000 cfs	69	68	47	43	31	30	22	22	14	13
> 3,000 cfs	67	64	45	41	29	28	22	21	12	12
> 4,000 cfs	65	61	43	40	28	26	21	19	9	8
> 6,000 cfs	61	60	43	37	27	24	17	16	7	6
> 8,000 cfs	58	57	38	35	24	22	15	15	6	4
> 10,000 cfs	56	54	38	35	21	21	14	14	5	4

Table SF- 2e
 Count of years that exceed flow magnitude and duration thresholds between 1921-2003
 Total Sutter Bypass Flow Results - Alternative B Compared to No Action Alternative

Number of years that contain events with consecutive days of spills (max 7 day gap to count as new event)	> 0 days		>10 days		> 20 days		> 30 days		> 45 days	
	No Action Alternative	Alternative B								
> 0 cfs	72	70	56	54	44	40	31	30	22	20
> 1,000 cfs	69	68	48	44	36	34	24	22	14	13
> 2,000 cfs	69	68	47	43	31	30	22	22	14	13
> 3,000 cfs	66	63	46	40	31	29	22	21	12	10
> 4,000 cfs	63	60	44	40	29	27	22	19	9	10
> 6,000 cfs	59	58	43	40	28	26	19	17	8	7
> 8,000 cfs	57	56	40	36	26	24	15	15	6	5
> 10,000 cfs	53	52	38	35	24	21	15	14	5	4

Alternative C Compared to No Action Alternative

This page intentionally left blank.

Table SF-3a

Count of years that exceed flow magnitude and duration thresholds between
1921-2003 Fremont Weir Spill Results - Alternative C Compared to No Action Alternative

Number of years that contain events with consecutive days of spills (max 7 day gap to count as new event)	> 0 days		>10 days		> 20 days		> 30 days		> 45 days	
	No Action Alternative	Alternative C								
> 0 cfs	48	43	39	38	27	27	23	21	16	15
> 1,000 cfs	47	43	38	36	27	26	22	20	14	13
> 2,000 cfs	46	43	37	36	27	25	22	20	14	13
> 3,000 cfs	46	41	35	34	27	25	21	19	12	12
> 4,000 cfs	46	41	35	33	27	25	19	19	12	12
> 6,000 cfs	46	41	35	31	26	25	18	18	11	10
> 8,000 cfs	44	41	32	30	24	22	18	17	10	9
> 10,000 cfs	41	41	32	28	23	21	16	15	10	8

Table SF-3b

Count of years that exceed flow magnitude and duration thresholds between 1921-2003
 Total Yolo Flow Results - Alternative C Compared to No Action Alternative

Number of years that contain events with consecutive days of spills (max 7 day gap to count as new event)	> 0 days		>10 days		> 20 days		> 30 days		> 45 days	
	No Action Alternative	Alternative C								
> 0 cfs	82	82	82	82	82	82	82	82	81	81
> 1,000 cfs	73	69	63	59	55	52	48	46	43	42
> 2,000 cfs	68	65	58	51	43	43	39	38	31	30
> 3,000 cfs	65	58	54	48	38	35	32	31	26	26
> 4,000 cfs	63	54	47	46	35	33	30	27	24	21
> 6,000 cfs	58	50	41	41	31	29	26	25	16	14
> 8,000 cfs	54	48	37	35	28	27	23	21	15	13
> 10,000 cfs	49	48	34	34	27	26	20	19	14	13

Table SF-3c
 Count of years that exceed flow magnitude and duration thresholds between 1921-2003
 Ord, Moulton, and Colusa Weir Spill Results - Alternative C Compared to No Action Alternative

Number of years that contain events with consecutive days of spills (max 7 day gap to count as new event)	> 0 days		>10 days		> 20 days		> 30 days		> 45 days	
	No Action Alternative	Alternative C								
> 0 cfs	65	62	43	38	27	27	20	18	9	8
> 1,000 cfs	64	60	43	37	27	25	17	16	8	6
> 2,000 cfs	61	59	39	35	27	23	15	16	6	5
> 3,000 cfs	58	56	38	35	23	21	15	14	5	4
> 4,000 cfs	58	55	37	34	21	20	13	14	5	4
> 6,000 cfs	54	52	33	32	20	19	12	10	3	4
> 8,000 cfs	52	48	30	29	17	18	9	9	2	3
> 10,000 cfs	49	45	28	28	15	15	9	8	1	2

Table SF-3d
 Count of years that exceed flow magnitude and duration thresholds between 1921-2003
 Total Weir Spill Results - Alternative C Compared to No Action Alternative

Number of years that contain events with consecutive days of spills (max 7 day gap to count as new event)	> 0 days		>10 days		> 20 days		> 30 days		> 45 days	
	No Action Alternative	Alternative C								
> 0 cfs	72	70	48	45	36	31	25	23	14	13
> 1,000 cfs	69	69	48	42	33	30	24	23	14	13
> 2,000 cfs	69	66	47	42	31	29	22	22	14	11
> 3,000 cfs	67	63	45	41	29	28	22	20	12	11
> 4,000 cfs	65	61	43	39	28	27	21	19	9	9
> 6,000 cfs	61	60	43	37	27	25	17	17	7	6
> 8,000 cfs	58	57	38	35	24	23	15	15	6	4
> 10,000 cfs	56	54	38	35	21	20	14	14	5	4

Table SF-3e
 Count of years that exceed flow magnitude and duration thresholds between 1921-2003
 Total Sutter Bypass Flow Results - Alternative C Compared to No Action Alternative

Number of years that contain events with consecutive days of spills (max 7 day gap to count as new event)	> 0 days		>10 days		> 20 days		> 30 days		> 45 days	
	No Action Alternative	Alternative C								
> 0 cfs	72	70	56	52	44	40	31	30	22	17
> 1,000 cfs	69	68	48	43	36	32	24	23	14	13
> 2,000 cfs	69	63	47	42	31	30	22	22	14	13
> 3,000 cfs	66	63	46	40	31	28	22	20	12	11
> 4,000 cfs	63	60	44	40	29	27	22	19	9	11
> 6,000 cfs	59	58	43	39	28	27	19	18	8	6
> 8,000 cfs	57	56	40	37	26	23	15	15	6	5
> 10,000 cfs	53	51	38	35	24	23	15	14	5	4

Alternative D Compared to No Action Alternative

This page intentionally left blank.

Table SF-4a

Count of years that exceed flow magnitude and duration thresholds between 1921-2003
 Fremont Weir Spill Results - Alternative D Compared to No Action Alternative

Number of years that contain events with consecutive days of spills (max 7 day gap to count as new event)	> 0 days		>10 days		> 20 days		> 30 days		> 45 days	
	No Action Alternative	Alternative D								
> 0 cfs	48	42	39	38	27	27	23	22	16	15
> 1,000 cfs	47	42	38	36	27	27	22	20	14	13
> 2,000 cfs	46	42	37	36	27	26	22	20	14	13
> 3,000 cfs	46	41	35	35	27	25	21	19	12	12
> 4,000 cfs	46	41	35	33	27	25	19	19	12	12
> 6,000 cfs	46	41	35	32	26	25	18	18	11	10
> 8,000 cfs	44	41	32	30	24	22	18	17	10	10
> 10,000 cfs	41	41	32	28	23	21	16	15	10	9

Table SF-4b

Count of years that exceed flow magnitude and duration thresholds between 1921-2003
 Total Yolo Flow Results - Alternative D Compared to No Action Alternative

Number of years that contain events with consecutive days of spills (max 7 day gap to count as new event)	> 0 days		>10 days		> 20 days		> 30 days		> 45 days	
	No Action Alternative	Alternative D								
> 0 cfs	82	82	82	82	82	82	82	82	81	81
> 1,000 cfs	73	69	63	59	55	52	48	46	43	42
> 2,000 cfs	68	65	58	51	43	43	39	39	31	30
> 3,000 cfs	65	57	54	48	38	37	32	31	26	26
> 4,000 cfs	63	54	47	46	35	33	30	27	24	21
> 6,000 cfs	58	50	41	40	31	30	26	26	16	15
> 8,000 cfs	54	48	37	37	28	27	23	21	15	14
> 10,000 cfs	49	48	34	33	27	26	20	19	14	14

Table SF-4c
 Count of years that exceed flow magnitude and duration thresholds between 1921-2003
 Ord, Moulton, and Colusa Weir Spill Results - Alternative D Compared to No Action Alternative

Number of years that contain events with consecutive days of spills (max 7 day gap to count as new event)	> 0 days		>10 days		> 20 days		> 30 days		> 45 days	
	No Action Alternative	Alternative D								
> 0 cfs	65	62	43	40	27	27	20	18	9	8
> 1,000 cfs	64	60	43	38	27	26	17	16	8	6
> 2,000 cfs	61	59	39	36	27	24	15	16	6	5
> 3,000 cfs	58	56	38	36	23	21	15	14	5	4
> 4,000 cfs	58	55	37	36	21	20	13	14	5	4
> 6,000 cfs	54	52	33	34	20	18	12	9	3	3
> 8,000 cfs	52	48	30	30	17	18	9	9	2	3
> 10,000 cfs	49	46	28	28	15	16	9	8	1	2

Table SF-4d
 Count of years that exceed flow magnitude and duration thresholds between 1921-2003
 Total Weir Spill Results - Alternative D Compared to No Action Alternative

Number of years that contain events with consecutive days of spills (max 7 day gap to count as new event)	> 0 days		>10 days		> 20 days		> 30 days		> 45 days	
	No Action Alternative	Alternative D								
> 0 cfs	72	70	48	46	36	33	25	23	14	13
> 1,000 cfs	69	69	48	42	33	30	24	22	14	13
> 2,000 cfs	69	66	47	42	31	29	22	22	14	11
> 3,000 cfs	67	63	45	41	29	27	22	20	12	11
> 4,000 cfs	65	61	43	40	28	26	21	18	9	9
> 6,000 cfs	61	60	43	37	27	26	17	17	7	6
> 8,000 cfs	58	58	38	36	24	23	15	15	6	4
> 10,000 cfs	56	54	38	36	21	20	14	14	5	4

Table SF-4e
 Count of years that exceed flow magnitude and duration thresholds between 1921-2003
 Total Sutter Bypass Flow Results - Alternative D Compared to No Action Alternative

Number of years that contain events with consecutive days of spills (max 7 day gap to count as new event)	> 0 days		>10 days		> 20 days		> 30 days		> 45 days	
	No Action Alternative	Alternative D								
> 0 cfs	72	70	56	53	44	40	31	30	22	19
> 1,000 cfs	69	68	48	44	36	33	24	23	14	13
> 2,000 cfs	69	63	47	43	31	30	22	22	14	13
> 3,000 cfs	66	63	46	42	31	28	22	20	12	11
> 4,000 cfs	63	60	44	40	29	27	22	18	9	11
> 6,000 cfs	59	58	43	40	28	26	19	17	8	6
> 8,000 cfs	57	56	40	37	26	23	15	15	6	5
> 10,000 cfs	53	52	38	36	24	23	15	14	5	4