Appendix AB-J, Winter and Spring Pulses and Delta Outflow

Attachment J.5 Flow Threshold Salmon Survival Model

J.5.1 Model Overview

A flow threshold model was used to assess potential effects of changes in flow in the Upper Sacramento River on juvenile Chinook salmon as a result of flow-survival relationships. The flow thresholds from Michel et al. (2021) were applied to Sacramento River at Wilkins Slough. The model estimates the annual mean probability of juvenile Chinook salmon survival in the Sacramento River between the confluence of Deer Creek and Feather River between March 15 and June 15, during the spring outmigration period. Annual mean survival was calculated from daily survival estimates.

J.5.2 Model Development

J.5.2.1 Methods

For this analysis, the following flow thresholds from Michel et al. (2021) were applied to Sacramento River at Wilkins Slough and corresponding survival probabilities (Deer Creek confluence to Feather River confluence) were used:

- 0 – 4,259 cubic feet per second (cfs): 0.030 (3%)
- 4,259 – 10,712 cfs: 0.189 (about 19%)
- 10,712 – 22,872 cfs: 0.508 (about 51%)

Note that the upper threshold of the 3rd range (22,872 cfs) does not represent realistic hydrology for the system. The 3rd range is summarized as any WLK flow value greater than 10,712 cfs.

Red Bluff Diversion Dam (RBDD) passage estimates are used in this analysis. RBDD passage estimates used include all runs of juvenile Chinook salmon from 2005 – 2022 Red Bluff RST subset from January 1st to July 1st removing any catch values greater than 80,000 and making a linear interpolation of missing RBDD sampling days. Catch values greater than 80,000 were removed from the dataset following Michel et al. (2021) since it may be indicative of a hatchery release prior to the date.

The model merges daily median flow from Wilkins Slough (WLK, flow) from the March 15th to June 15th spring period with RBDD catch data for each alternative. The code uses parametric bootstrapping where a logit-transformed survival distribution from the Michel et al. (2021) model, given a set of daily Wilkins Slough flow values, were resampled relative to the expanded daily RBDD Chinook salmon catch. A season-wide mean survival for March 15 to June 15 was calculated from mean logit-scale daily survival estimates and then rescaled (inverse-log transform). As an example, if the RBDD screw trap collected 1,500 juvenile Chinook on a single day, the model calculation produced 1,500 parametric bootstrapped estimates for survival on that day using the provided mean and standard error for the flow ranges provided in Michel et al. (2021). This is repeated for all days between March 15th and June 15th to generate an estimate of annual mean survival probability. 5th and 95th percentiles were calculated to present variability in yearly annual survival.

The mean annual proportional juvenile Chinook salmon survival based on Michel et al (2021) flow-survival threshold analysis was applied to modeled alternatives: EXP1, EXP3, NAA, Alternative 1, Alternative 2 With TUCP Without VA, Alternative 2 Without TUCP Without VA, Alternative 2 Without TUCP Delta VA, Alternative 2 Without TUCP Systemwide VA, Alternative 3 and Alternative 4. Modeled daily Wilkins Slough flows (1922-2021, USRDOM) were used in the analysis.

J.5.2.2 Assumptions / Uncertainty

This model allows for the simulation of population-level survival effects of flow operations over a 3-month long season using the somewhat rigid and approximate survival thresholds published in Michel et al (2021). Hydrology in the natural world does not follow rigid survival thresholds. It is more likely that there is a steep gradient in survival rates around these published thresholds.

USRDOM does not incorporate functional flow pulses, it creates daily flow patterns utilizing tributary inflow information and averaged monthly Sacramento flows to simulate daily flows. Flow volumes, which are part of certain alternatives are not shaped to achieve functional flows. There is uncertainty about how the duration, intensity, or rates of changes, which may influence fish outmigration behavior, would be implemented in alternatives.

J.5.2.3 Code and Data Repository

Fish inputs: Historic RBDD data available from Reclamation upon request.

Exports inputs: USRDOM modeled exports available from Reclamation upon request.

Analysis file: R script(s) Michel_FlowThresh_12.05.2023 available online at Michel_FlowThresh_12.05.2023.R.

J.5.3 Results

Average annual mean survival probability was highest during the Wet WYT across all alternatives and decreased as the WYT became drier (Table J.5-1). Average annual mean survival probability was the lowest during the Critical WYT across all alternatives.

During the **Wet WYT**, Alternative 3 had the highest mean survival (28.91%). Alternative 1, Alternative 2 With TUCP Without VA, Alternative 2 without TUCP without VA, Alternative 2 Without TUCP Systemwide VA, and Alternative 4 had a similar mean survival (26.19%, 26.11%, 26.12%, 26.05%, 26.13% respectively). Alternative 2 Without TUCP Delta VA had the lowest mean survival (25.87%).

During the **Above Normal WYT**, Alternative 3 had the highest mean survival (24.57%). Alternative 1 and Alternative 2 Without TUCP Systemwide VA had a similar mean survival (22.05% and 22.68% respectively). Alternative 2 Without TUCP Delta VA had the lowest mean survival (20.51%) but was only slightly lower than Alternative 2 With TUCP Without VA, Alternative 2 Without TUCP Without VA, and Alternative 4 (20.92%, 20.95% and 20.92% respectively).

During the **Below Normal WYT**, Alternative 2 Without TUCP Systemwide VA had the highest mean survival (17.66%), though this was only slightly higher than Alternative 1 (17.16%). Alternative 2 With TUCP Without VA, Alternative 2 Without TUCP Without VA, and Alternative 4 had similar mean survival (16.61%, 16.42%, and 16.34% respectively). Alternative 3 had the lowest survival (14.98%). Alternative 2 Without TUCP Delta VA had slightly higher survival (15.14%).

During the **Dry WYT**, Alternative 4 had the highest mean survival (14.9%), which was only slightly higher than Alternative 1, Alternative 2 with TUCP Without VA, and Alternative 2 Without TUCP Without VA (14.45%, 14.53%, 14.42% respectively). Alternative 2 Without TUCP Delta VA had the lowest mean survival (11.72%) which was only slightly lower than Alternative 3 (11.76%). Alternative 2 Without TUCP Systemwide VA had a mean survival rate of 12.24%.

During the **Critical WYT**, Alternative 2 Without TUCP Without VA had the highest mean survival (11.14%). Alternative 2 With TUCP Without VA had the lowest mean survival (6.98%), which was only slightly lower than Alternative 3 and Alternative 4 (7.32% and 7% respectively). Alternative 1, Alterative 2 Without TUCP Delta VA and Alternative 2 Without TUCP Systemwide VA had similar mean survival rates (9.64%, 9.97% and 10.09% respectively).

Michel et al. (2021) identified an optimal flow threshold of 10,712 cfs for Chinook salmon outmigration survival. This threshold was similar to the historical average of natural spring flow conditions. High flows may reduce predation pressures on out migrating juvenile salmon by increasing turbidity, which provides cover for juveniles (Gregory and Levings 1998), and by decreasing transit times thus limiting exposure to predators and other hazards (Michel et al. 2021, Notch et al. 2020). Michel et al. (2021) also noted that flow and temperature were highly correlated. While temperature was not analyzed in the Michel et al. (2021) study, high water temperatures have been shown to impact physiological health and survival (Lehman et al. 2017, Marine and Cech 2004).

During the Wet WYT, mean daily Sacramento River flow below Wilkins Slough (CFS) was similar across all alternatives except for Alternative 3 which had higher flow from May to early-June (Figure J.5-1). This explains higher survival under Alternative 3 (Table J.5-1). The pattern for the Above Normal WYT was similar to the Wet WYT, except for a short period of time (mid-April to end of April), Alternative 2 Without TUCP Systemwide VA had higher flows than all other alternatives which increased mean survival. Alternative 1 also had increased flows compared to all other alternatives except Alternative 3, from early to mid-May and late May to mid-June which increased mean survival. Alternative 3 had the highest mean survival across all alternatives. For the Below Normal WYT, Alternative 1 showed higher flows than all other alternatives from early April to early May and in early June to mid-June, while Alternative 2 without TUCP Systemwide VA had higher flows from early to late May which led to higher mean survival compared to all other alternatives. During the Dry WYT, Alternative 1, Alternative 2 with TUCP without VA, Alternative 2 without TUCP without VA, and Alternative 4 had a similar and higher outflow than other alternatives from late March to early May and again from late May to mid-June which result in the highest and similar mean survival. For the Critical WYT, Alternative 2 Without TUCP Without VA had the highest flow from late-March to mid-May and the highest mean survival.

J.5.3.1 Tables

Table J.5-1. Average mean annual seasonal survival percentage for different modeled scenarios by water year type. Percent difference from the NAA is in parentheses.

WYT	NAA	Alt1	Alt2wTUCP noVA	Alt2woTUCP noVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
Wet	24.91	26.19 (5.14%)	26.11 (4.82%)	26.12 (4.86%)	25.87 (3.85%)	26.05 (4.58%)	28.91 (16.06%)	26.13 (4.9%)
Above Normal	19.83	22.05 (11.2%)	20.92 (5.5%)	20.95 (5.65%)	20.51 (3.43%)	22.68 (14.37%)	24.57 (23.9%)	20.92 (5.5%)
Below Normal	15.2	17.16 (12.89%)	16.61 (9.28%)	16.42 (8.03%)	15.14 (-0.39%)	17.65 (16.12%)	14.98 (-1.45%)	16.34 (7.5%)
Dry	12.08	14.45 (19.62%)	14.53 (20.28%)	14.42 (19.37%)	11.72 (-2.98%)	12.24 (1.32%)	11.76 (-2.65%)	14.9 (23.34%)
Critical	5.87	9.64 (64.22%)	6.98 (18.91%)	11.14 (89.78%)	9.97 (69.85%)	10.09 (71.89%)	7.32 (24.7%)	7 (19.25%)

Table J.5-2. Average mean annual seasonal survival percent for different modeled scenarios by water year type.

WYT	EXP1	EXP3	NAA	Alt2wTUCP noVA	Alt2woTUCP noVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA
Wet	36.16	24.04	24.91	26.11	26.12	25.87	26.05
Above Normal	28.71	17.78	19.83	20.92	20.95	20.51	22.68
Below Normal	20.33	12.47	15.2	16.61	16.42	15.14	17.65
Dry	15.76	9.94	12.08	14.53	14.42	11.72	12.24
Critical	8.8	5.71	5.87	6.98	11.14	9.97	10.09

Table J.5-3. Mean seasonal survival for each alternative for each modelled CalSim3 year. WYT is the water year type for each modelled year. 95% confidence intervals are in parentheses.

WY	WYT	NAA	Alt1	Alt2woTUCP noVA	Alt2wTUCP noVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1922	Above Normal	12.86 (2.28–51.48)%	18.14 (2.81–51.49)%	12.86 (2.28–51.49)%	12.86 (2.28–51.49)%	12.85 (2.28–51.49)%	16.66 (2.57–51.49)%	12.61 (2.27–51.48)%	12.86 (2.28–51.49)%
1923	Below Normal	12.55 (2.41–21.17)%	8.08 (2.14–20.84)%	13.45 (2.5–21.2)%	13.45 (2.5–21.21)%	13.23 (2.48–21.2)%	13.61 (2.52–21.21)%	8.09 (2.14–20.85)%	8.1 (2.14–20.85)%
1924	Critical	3.77 (1.96–19.17)%	10.57 (2.27–21.06)%	12.42 (2.4–21.16)%	3.95 (1.97–19.45)%	12.42 (2.4–21.16)%	18.9 (16.64–21.38)%	5.12 (2.01–20.25)%	3.7 (1.96–19.03)%
1925	Dry	13.26 (2.24–52.24)%	18.62 (2.64–52.18)%	16.05 (2.39–52.25)%	18.84 (2.65–52.25)%	16.61 (2.43–52.25)%	16.04 (2.39–52.25)%	16.07 (2.4–52.19)%	16.44 (2.42–52.24)%
1926	Dry	21.73 (3.18–52.42)%	13.95 (2.26–52.32)%	16.27 (2.37–52.42)%	18.59 (2.56–52.42)%	13.99 (2.37–51.1)%	20.45 (16.05–51.1)%	11.16 (2.22–50.77)%	16.27 (2.37–52.42)%
1927	Wet	29.04 (16.96–53.08)%	28.49 (16.94–53.02)%	29.04 (16.96–53.08)%	29.04 (16.96–53.1)%	29.04 (16.96–53.08)%	33.1 (17.14–53.43)%	35.84 (17.19–53.62)%	29.04 (16.96–53.09)%
1928	Above Normal	24.25 (3.81–52.77)%	23.86 (3.8–52.69)%	24.25 (3.81–52.76)%	24.25 (3.81–52.76)%	24.25 (3.81–52.77)%	28.33 (16.74–53.08)%	15.53 (2.27–52.77)%	24.25 (3.81–52.77)%
1929	Critical	6.55 (2.07–20.62)%	9.2 (2.19–20.96)%	9.46 (2.2–20.98)%	5.49 (2.03–20.37)%	5.37 (2.02–20.34)%	5.52 (2.03–20.38)%	7.37 (2.1–20.75)%	7.6 (2.12–20.79)%
1930	Dry	8.03 (2.08–51.37)%	15.22 (2.46–51.23)%	14.6 (2.4–51.38)%	13.71 (2.35–51.22)%	8.03 (2.08–51.38)%	8.14 (2.08–51.37)%	8.79 (2.11–51.37)%	14.07 (2.36–51.37)%
1931	Critical	3.73 (1.96–19.09)%	4.47 (1.99–19.92)%	11.59 (2.33–21.12)%	3.79 (1.96–19.2)%	11.91 (2.36–21.14)%	17.35 (4.86–21.35)%	4.48 (1.99–19.93)%	3.85 (1.96–19.3)%
1932	Critical	4.83 (2–20.13)%	5.03 (2.01–20.21)%	5.15 (2.01–20.26)%	4.83 (2–20.12)%	4.83 (2–20.12)%	4.83 (2–20.12)%	6.72 (2.08–20.65)%	4.91 (2.01–20.16)%
1933	Critical	4.87 (2–20.43)%	6.65 (2.07–20.94)%	6.73 (2.07–20.96)%	5.02 (2–20.49)%	6.73 (2.07–20.95)%	4.78 (2–20.38)%	6.03 (2.05–20.52)%	5.02 (2–20.5)%

WY	WYT	NAA	Alt1	Alt2woTUCP noVA	Alt2wTUCP noVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1934	Critical	4.76 (2–20.09)%	18.9 (16.64–21.38)%	18.9 (16.64–21.39)%	4.76 (2–20.09)%	18.9 (16.64–21.38)%	7.61 (2.11–20.79)%	6.1 (2.05–20.53)%	5.33 (2.02–20.32)%
1935	Below Normal	32.11 (17.01–53.38)%	32.11 (17.01–53.38)%	32.11 (17.01–53.39)%	32.11 (17.01–53.38)%	32.39 (17.1–53.38)%	32.92 (17.12–53.42)%	32.34 (16.92–53.42)%	32.63 (17.03–53.42)%
1936	Below Normal	7.8 (2.12–20.82)%	8.68 (2.16–20.91)%	8 (2.13–20.83)%	11.36 (2.32–21.11)%	8 (2.13–20.84)%	10.5 (2.26–21.06)%	7.57 (2.11–20.78)%	11.36 (2.32–21.11)%
1937	Below Normal	11.18 (2.15–52.32)%	11.18 (2.15–52.31)%	11.18 (2.15–52.32)%	11.18 (2.15–52.32)%	11.18 (2.15–52.31)%	11.18 (2.15–52.31)%	11.18 (2.15–52.31)%	11.18 (2.15–52.31)%
1938	Wet	24.66 (2.41–53.55)%	24.66 (2.41–53.54)%	25.05 (2.41–53.57)%	24.67 (2.41–53.54)%	25.05 (2.41–53.56)%	25.05 (2.41–53.58)%	22.7 (2.31–53.57)%	25.06 (2.41–53.57)%
1939	Dry	16.3 (3.13–21.31)%	15.73 (2.91–21.3)%	15.02 (2.74–21.27)%	15.01 (2.73–21.27)%	14.65 (2.67–21.26)%	15.02 (2.74–21.27)%	11.62 (2.34–21.12)%	15.45 (2.84–21.28)%
1940	Above Normal	23.1 (2.41–53.42)%	32.92 (17.12–53.43)%	32.91 (17.12–53.42)%	32.92 (17.13–53.42)%	32.92 (17.12–53.42)%	27.61 (2.73–53.46)%	37.86 (17.12–53.75)%	32.92 (17.12–53.42)%
1941	Wet	38.66 (3.81–53.87)%	39.04 (4.48–53.87)%	39.1 (4.75–53.88)%	39.11 (4.76–53.87)%	39.1 (4.75–53.87)%	39.1 (4.76–53.87)%	38.7 (3.85–53.87)%	39.1 (4.75–53.87)%
1942	Wet	32.64 (17.11–53.41)%	32.71 (17.11–53.41)%	32.65 (17.11–53.41)%	32.64 (17.11–53.4)%	32.64 (17.11–53.4)%	32.64 (17.11–53.4)%	34.1 (17.18–53.5)%	32.64 (17.11–53.41)%
1943	Wet	15.92 (2.44–51.89)%	23.05 (16.76–51.89)%	23.05 (16.76–51.9)%	23.05 (16.76–51.89)%	18.27 (2.69–51.9)%	17.27 (2.56–51.9)%	22.35 (16.33–51.99)%	23.05 (16.76–51.89)%
1944	Dry	4.47 (1.99–19.92)%	4.35 (1.98–19.84)%	9.41 (2.2–20.97)%	9.41 (2.2–20.97)%	5.22 (2.02–20.28)%	5.37 (2.02–20.33)%	6.66 (2.08–20.64)%	9.13 (2.19–20.95)%
1945	Dry	8.6 (2.12–49.69)%	8.58 (2.12–49.69)%	8.6 (2.12–49.69)%	8.6 (2.13–49.68)%	8.6 (2.12–49.67)%	8.89 (2.14–49.68)%	7.62 (2.08–49.69)%	8.6 (2.13–49.68)%
1946	Below Normal	9.37 (2.2–20.97)%	11.19 (2.31–21.09)%	10.63 (2.27–21.07)%	10.63 (2.27–21.06)%	10.63 (2.27–21.06)%	11.61 (2.33–21.12)%	14.76 (2.69–21.26)%	10.63 (2.27–21.06)%

WY	WYT	NAA	Alt1	Alt2woTUCP noVA	Alt2wTUCP noVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1947	Dry	7.6 (2.11–20.89)%	9.13 (2.18–21.05)%	10.67 (2.27–21.17)%	10.67 (2.27–21.17)%	11.25 (2.3–21.21)%	7.27 (2.1–20.85)%	8.2 (2.14–20.97)%	11.25 (2.3–21.2)%
1948	Dry	40.28 (17.59–53.82)%	40.6 (17.62–53.83)%	40.28 (17.59–53.81)%	40.28 (17.59–53.81)%	40.28 (17.59–53.82)%	40.69 (17.63–53.83)%	40.61 (17.62–53.83)%	40.81 (17.64–53.84)%
1949	Dry	11.98 (2.22–51.77)%	15.75 (2.44–51.77)%	14.99 (2.39–51.78)%	14.61 (2.36–51.79)%	11.97 (2.22–51.78)%	10.58 (2.16–51.78)%	9.48 (2.12–51.78)%	15 (2.38–51.78)%
1950	Dry	8.32 (2.13–22.4)%	8.51 (2.13–48.91)%	8.32 (2.13–22.38)%	8.32 (2.13–22.39)%	8.32 (2.13–22.38)%	9.08 (2.16–22.46)%	8.32 (2.12–22.4)%	8.32 (2.12–22.39)%
1951	Above Normal	10.51 (2.17–51.49)%	10.05 (2.2–47.96)%	10.51 (2.17–51.49)%	10.51 (2.17–51.48)%	10.51 (2.17–51.48)%	10.38 (2.16–51.48)%	5.28 (2–50.09)%	10.51 (2.17–51.48)%
1952	Wet	16.43 (2.25–53.03)%	16.43 (2.25–53.02)%	16.43 (2.25–53.03)%	16.43 (2.25–53.03)%	16.44 (2.25–53.03)%	16.43 (2.25–53.03)%	18.83 (2.36–53.02)%	16.43 (2.25–53.03)%
1953	Above Normal	20.98 (16.3–51.29)%	23.43 (16.77–52.04)%	20.98 (16.3–51.29)%	20.98 (16.31–51.29)%	20.98 (16.3–51.29)%	21.76 (16.15–51.83)%	23.79 (16.78–52.15)%	20.98 (16.3–51.28)%
1954	Above Normal	17.03 (2.32–52.84)%	24.12 (3.33–52.84)%	22.46 (2.82–52.84)%	22.46 (2.82–52.84)%	17.29 (2.34–52.84)%	22.53 (2.75–52.91)%	26.81 (16.81–52.84)%	22.46 (2.82–52.84)%
1955	Dry	5.87 (2.04–20.48)%	6.06 (2.05–20.52)%	6.11 (2.05–20.54)%	6.11 (2.05–20.53)%	6.28 (2.06–20.57)%	6.72 (2.08–20.65)%	9.39 (2.2–20.97)%	6.11 (2.05–20.54)%
1956	Wet	15.36 (2.4–51.83)%	16.14 (2.48–51.78)%	14.97 (2.38–51.84)%	14.96 (2.38–51.84)%	14.69 (2.36–51.84)%	14.69 (2.36–51.84)%	17.04 (2.55–51.83)%	15.18 (2.39–51.84)%
1957	Below Normal	13.27 (2.28–51.74)%	15.05 (2.5–50.49)%	13.28 (2.29–51.75)%	13.28 (2.28–51.74)%	13.28 (2.29–51.74)%	18.79 (2.91–51.61)%	12.73 (2.25–51.85)%	13.28 (2.28–51.75)%
1958	Wet	29.78 (2.81–53.57)%	29.77 (2.81–53.57)%	29.78 (2.82–53.57)%	29.78 (2.81–53.57)%	29.78 (2.81–53.57)%	29.78 (2.81–53.57)%	29.13 (2.73–53.57)%	29.78 (2.81–53.57)%
1959	Below Normal	10.36 (2.25–21.05)%	14.66 (2.67–21.26)%	13.06 (2.46–21.19)%	13.06 (2.46–21.19)%	8.3 (2.15–20.87)%	13.06 (2.46–21.19)%	7.37 (2.1–20.75)%	13.06 (2.46–21.19)%

WY	WYT	NAA	Alt1	Alt2woTUCP noVA	Alt2wTUCP noVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1960	Dry	8.58 (2.13–46.93)%	14.2 (2.47–48.69)%	13.67 (2.43–46.94)%	13.54 (2.43–22.6)%	8.48 (2.13–46.93)%	8.48 (2.13–46.92)%	6.81 (2.06–46.93)%	13.46 (2.41–46.94)%
1961	Dry	11.58 (2.21–51.58)%	22.34 (16.74–51.57)%	22.34 (16.74–51.57)%	22.34 (16.74–51.57)%	11.49 (2.21–51.47)%	11.79 (2.22–51.56)%	11.17 (2.19–51.7)%	22.34 (16.74–51.57)%
1962	Dry	9.91 (2.17–50.74)%	16.48 (2.65–50.75)%	12.35 (2.28–50.75)%	12.35 (2.28–50.75)%	9.8 (2.16–50.75)%	15.75 (2.56–50.75)%	12.15 (2.27–50.75)%	12.35 (2.28–50.74)%
1963	Wet	24.89 (2.74–53.23)%	25.16 (2.77–53.23)%	24.89 (2.73–53.22)%	24.89 (2.73–53.23)%	24.89 (2.73–53.22)%	27.8 (3.12–53.32)%	24.16 (2.64–53.22)%	24.89 (2.73–53.23)%
1964	Dry	6.17 (2.05–20.55)%	10.97 (2.29–21.08)%	10.28 (2.25–21.04)%	9.41 (2.2–20.97)%	6.53 (2.07–20.62)%	6.44 (2.07–20.61)%	5.45 (2.03–20.36)%	11.72 (2.34–21.12)%
1965	Wet	16.42 (2.26–52.98)%	28.09 (16.93–52.97)%	28.09 (16.93–52.97)%	28.09 (16.93–52.97)%	28.09 (16.93–52.97)%	26.94 (16.42–52.97)%	39.2 (17.33–53.79)%	28.09 (16.93–52.97)%
1966	Below Normal	13.32 (2.32–51.22)%	13.32 (2.32–51.23)%	11.74 (2.23–51.22)%	11.74 (2.23–51.23)%	11.7 (2.23–51.37)%	16.45 (2.57–51.38)%	9.41 (2.13–51.31)%	11.87 (2.23–51.36)%
1967	Wet	42.79 (17.86–53.91)%	42.79 (17.86–53.92)%	43.12 (17.91–53.92)%	43.13 (17.91–53.93)%	43.12 (17.9–53.92)%	43.47 (17.96–53.94)%	43.13 (17.91–53.93)%	43.12 (17.9–53.93)%
1968	Below Normal	13.05 (2.29–51.48)%	18.23 (2.71–51.84)%	21.1 (16.16–51.49)%	21.1 (16.17–51.48)%	13.05 (2.29–51.49)%	17.68 (2.69–51.61)%	10.51 (2.16–51.61)%	21.1 (16.17–51.49)%
1969	Wet	16.51 (2.29–52.88)%	16.19 (2.25–52.96)%	16.76 (2.29–52.93)%	16.76 (2.29–52.93)%	16.76 (2.29–52.92)%	16.76 (2.29–52.93)%	17.64 (2.31–53)%	16.76 (2.29–52.93)%
1970	Wet	10.59 (2.2–50.5)%	11.79 (2.27–50.24)%	10.59 (2.2–50.5)%	10.59 (2.2–50.49)%	10.59 (2.2–50.49)%	10.59 (2.2–50.5)%	8 (2.1–50.24)%	10.59 (2.2–50.5)%
1971	Wet	18.58 (2.43–52.76)%	18.9 (2.46–52.77)%	19.39 (2.49–52.76)%	19.39 (2.5–52.77)%	19.06 (2.47–52.76)%	19.06 (2.47–52.76)%	18.02 (2.4–52.76)%	19.38 (2.49–52.76)%
1972	Below Normal	10.66 (2.18–51.43)%	14.72 (2.38–51.62)%	9.72 (2.14–51.43)%	9.72 (2.14–51.43)%	10.33 (2.16–51.42)%	15.53 (2.47–51.43)%	11.65 (2.2–51.8)%	9.44 (2.13–51.42)%

WY	WYT	NAA	Alt1	Alt2woTUCP noVA	Alt2wTUCP noVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1973	Above Normal	12.48 (2.24–51.84)%	13.36 (2.29–51.78)%	12.48 (2.24–51.83)%	12.48 (2.24–51.84)%	12.17 (2.22–51.83)%	15.91 (2.44–51.83)%	17.77 (2.62–51.89)%	12.48 (2.24–51.84)%
1974	Wet	23.37 (2.31–53.6)%	35.84 (17.28–53.61)%	34.62 (16.77–53.61)%	34.62 (16.77–53.6)%	34.62 (16.77–53.61)%	34.62 (16.77–53.6)%	46.91 (18.96–54.08)%	34.62 (16.77–53.61)%
1975	Above Normal	26.59 (15.98–52.99)%	26.59 (15.98–52.99)%	27.21 (15.45–53.1)%	27.21 (15.45–53.09)%	27.21 (15.45–53.1)%	32.89 (16.95–53.46)%	28.68 (16.33–53.19)%	27.21 (15.44–53.1)%
1976	Critical	5.74 (2.04–20.45)%	5.73 (2.03–20.44)%	5.38 (2.02–20.34)%	5.38 (2.02–20.34)%	5.38 (2.02–20.34)%	5.38 (2.02–20.33)%	6.79 (2.08–20.67)%	5.52 (2.03–20.38)%
1977	Critical	6.53 (2.07–20.62)%	11.25 (2.31–21.1)%	10.47 (2.26–21.05)%	7.24 (2.1–20.74)%	10.47 (2.26–21.05)%	9.32 (2.2–20.96)%	7.75 (2.12–20.81)%	6.79 (2.08–20.67)%
1978	Above Normal	26.39 (2.68–53.4)%	26.64 (2.71–53.4)%	26.4 (2.68–53.4)%	26.4 (2.68–53.41)%	26.39 (2.68–53.4)%	28.01 (2.72–53.5)%	46.26 (18.56–54.05)%	26.39 (2.68–53.4)%
1979	Dry	10 (2.21–22.19)%	11.91 (2.31–22.3)%	11.16 (2.26–23.35)%	11.16 (2.26–23.34)%	10.63 (2.23–23.33)%	10.63 (2.23–23.33)%	10 (2.2–22.19)%	12.03 (2.31–23.38)%
1980	Above Normal	12.26 (2.23–51.89)%	12.7 (2.25–51.78)%	12.26 (2.22–51.9)%	12.26 (2.22–51.9)%	12.26 (2.22–51.9)%	14.58 (2.34–51.91)%	20.46 (3.56–51.78)%	12.26 (2.22–51.9)%
1981	Dry	13.57 (2.38–50.35)%	21.27 (16.71–50.78)%	19.14 (4.25–50.36)%	19.14 (4.24–50.35)%	11.17 (2.23–50.36)%	11.34 (2.24–50.36)%	11.49 (2.25–50.35)%	18.22 (3.18–50.36)%
1982	Wet	22.8 (2.33–53.53)%	22.81 (2.33–53.53)%	22.81 (2.33–53.53)%	22.81 (2.33–53.53)%	22.81 (2.33–53.54)%	22.81 (2.33–53.54)%	22.01 (2.3–53.53)%	22.81 (2.33–53.53)%
1983	Wet	39.12 (3.07–53.95)%	38.61 (2.96–53.95)%	39.94 (3.22–53.96)%	39.94 (3.22–53.96)%	39.94 (3.22–53.96)%	39.94 (3.22–53.95)%	41.72 (4.71–53.97)%	39.94 (3.22–53.96)%
1984	Wet	10.54 (2.19–50.91)%	12.26 (2.27–50.9)%	10.67 (2.19–50.92)%	10.67 (2.2–50.91)%	10.54 (2.19–50.92)%	10.54 (2.19–50.92)%	17.32 (2.77–50.91)%	10.67 (2.2–50.91)%
1985	Below Normal	9.8 (2.22–21)%	8.36 (2.15–20.88)%	8.76 (2.17–20.92)%	8.75 (2.17–20.92)%	8.59 (2.16–20.9)%	10.88 (2.29–21.08)%	6.57 (2.07–20.63)%	8.75 (2.17–20.91)%

WY	WYT	NAA	Alt1	Alt2woTUCP noVA	Alt2wTUCP noVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1986	Wet	12.05 (2.21–51.97)%	12.16 (2.21–51.97)%	12.79 (2.24–51.97)%	12.78 (2.24–51.96)%	12.11 (2.21–51.96)%	12.12 (2.21–51.97)%	18.37 (2.63–52.14)%	12.78 (2.24–51.97)%
1987	Dry	21.57 (16.72–51.06)%	21.57 (16.72–51.06)%	21.57 (16.72–51.06)%	21.57 (16.72–51.06)%	21.57 (16.72–51.06)%	21.57 (16.72–51.06)%	18.58 (3.09–51.06)%	21.57 (16.72–51.06)%
1988	Critical	6.48 (2.07–20.61)%	7.58 (2.11–20.79)%	7.69 (2.12–20.8)%	7.69 (2.12–20.8)%	8.56 (2.16–20.89)%	13.6 (2.52–21.21)%	6.97 (2.09–20.7)%	7.9 (2.13–20.83)%
1989	Dry	13.54 (2.29–51.77)%	23.01 (16.68–51.97)%	22.05 (16.13–51.98)%	21.8 (15.85–51.97)%	13.7 (2.3–51.78)%	14.27 (2.33–51.83)%	14.27 (2.33–51.83)%	22.04 (16.13–51.97)%
1990	Critical	4.67 (1.99–20.05)%	7.61 (2.12–20.79)%	10.07 (2.24–21.03)%	9.94 (2.23–21.01)%	9.94 (2.23–21.01)%	11.47 (2.33–21.12)%	9.76 (2.22–21)%	9.94 (2.23–21.02)%
1991	Critical	8.98 (2.11–51.61)%	10.48 (2.16–51.61)%	11.15 (2.19–51.6)%	9.53 (2.13–51.6)%	11.15 (2.19–51.61)%	9.53 (2.13–51.61)%	9.25 (2.12–51.61)%	9.25 (2.12–51.62)%
1992	Critical	8.12 (2.1–50.54)%	18.15 (3.1–50.54)%	21.07 (16.7–50.55)%	12.02 (2.27–50.55)%	21.07 (16.71–50.53)%	13.58 (2.37–50.54)%	9.78 (2.16–50.55)%	9.5 (2.15–50.55)%
1993	Above Normal	22.9 (2.53–53.22)%	22.39 (2.49–53.22)%	21.72 (2.42–53.27)%	21.29 (2.42–53.22)%	21.72 (2.42–53.26)%	25.85 (2.75–53.3)%	37.4 (17.08–53.74)%	21.3 (2.42–53.22)%
1994	Critical	5.09 (2.01–20.23)%	13.34 (2.49–21.2)%	13.39 (2.49–21.21)%	13.59 (2.52–21.22)%	5.14 (2.01–20.25)%	5.45 (2.02–20.36)%	6.98 (2.09–20.7)%	13.34 (2.49–21.21)%
1995	Wet	36.53 (17.31–53.65)%	36.53 (17.31–53.64)%	36.53 (17.31–53.64)%	36.53 (17.31–53.64)%	36.53 (17.31–53.64)%	36.54 (17.32–53.64)%	36.53 (17.31–53.65)%	36.53 (17.31–53.64)%
1996	Wet	24.14 (3.36–52.83)%	24.14 (3.36–52.84)%	24.14 (3.36–52.83)%	24.15 (3.36–52.84)%	24.14 (3.35–52.83)%	24.14 (3.36–52.83)%	21.64 (2.69–52.83)%	24.14 (3.36–52.83)%
1997	Wet	9.86 (2.2–21.64)%	9.7 (2.22–21)%	9.85 (2.2–21.64)%	9.86 (2.21–21.64)%	9.85 (2.2–21.64)%	9.86 (2.2–21.64)%	10.15 (2.24–21.03)%	9.86 (2.21–21.64)%
1998	Wet	50.8 (47.43–54.16)%	50.8 (47.43–54.16)%	50.8 (47.43–54.16)%	50.8 (47.43–54.16)%	50.8 (47.43–54.16)%	50.8 (47.43–54.16)%	50.8 (47.43–54.16)%	50.8 (47.43–54.16)%

WY	WYT	NAA	Alt1	Alt2woTUCP noVA	Alt2wTUCP noVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
1999	Wet	17.06 (2.55–51.83)%	18.42 (2.74–51.84)%	17.18 (2.55–51.9)%	17.18 (2.55–51.9)%	17.17 (2.55–51.9)%	17.17 (2.55–51.9)%	22.23 (16.14–52.03)%	17.18 (2.55–51.89)%
2000	Above Normal	14.19 (2.29–52.2)%	15.69 (2.37–52.21)%	15.13 (2.33–52.25)%	15.13 (2.33–52.25)%	14.54 (2.3–52.25)%	17.93 (2.55–52.24)%	21.25 (3.24–52.25)%	15.13 (2.33–52.25)%
2001	Dry	13.63 (2.37–50.74)%	12.32 (2.3–50.24)%	20.39 (16.31–50.74)%	20.39 (16.3–50.73)%	12.57 (2.3–50.74)%	12.77 (2.31–50.75)%	15.24 (2.49–50.91)%	20.39 (16.3–50.75)%
2002	Below Normal	8.08 (2.13–20.95)%	18.58 (16.51–21.38)%	10.77 (2.27–21.18)%	10.77 (2.27–21.18)%	8.08 (2.13–20.96)%	11.34 (2.31–21.21)%	6.99 (2.08–20.81)%	10.77 (2.27–21.18)%
2003	Above Normal	40.12 (17.58–53.81)%	40.12 (17.57–53.81)%	40.12 (17.58–53.81)%	40.12 (17.58–53.82)%	40.13 (17.58–53.81)%	40.47 (17.61–53.82)%	38.5 (16.8–53.81)%	40.12 (17.57–53.82)%
2004	Above Normal	13.98 (2.3–51.97)%	18.71 (2.77–51.89)%	13.98 (2.3–51.97)%	13.98 (2.3–51.97)%	13.98 (2.3–51.97)%	14.58 (2.33–52.04)%	11.73 (2.2–51.96)%	13.98 (2.3–51.96)%
2005	Below Normal	31.22 (17.04–53.29)%	30.36 (17.01–53.22)%	32.58 (17.1–53.4)%	32.58 (17.11–53.4)%	32.12 (17.09–53.36)%	32.12 (17.09–53.36)%	32.75 (17.12–53.41)%	32.58 (17.11–53.4)%
2006	Wet	33.26 (3.13–53.69)%	33.26 (3.13–53.68)%	33.26 (3.13–53.69)%	33.26 (3.13–53.69)%	33.26 (3.13–53.68)%	33.26 (3.13–53.68)%	31.36 (2.76–53.69)%	33.26 (3.13–53.69)%
2007	Below Normal	11.18 (2.31–21.1)%	18.9 (16.64–21.39)%	17.73 (15.85–21.36)%	17.73 (15.85–21.35)%	9.63 (2.21–21)%	14.05 (2.58–21.23)%	12.41 (2.4–21.16)%	17.73 (15.85–21.35)%
2008	Dry	9.45 (2.13–51.36)%	5 (2.01–20.19)%	6.21 (2.02–51.36)%	6.21 (2.02–51.38)%	4.98 (2.01–20.19)%	5.06 (2.01–20.22)%	11.7 (2.34–21.12)%	15.55 (2.42–51.78)%
2009	Dry	6.25 (2.06–20.57)%	10.51 (2.26–21.06)%	5.4 (2.02–20.34)%	5.4 (2.02–20.35)%	6.63 (2.05–49.75)%	8.69 (2.13–49.75)%	10.19 (2.24–21.04)%	5.4 (2.02–20.34)%
2010	Below Normal	31.31 (17.05–53.3)%	31.31 (17.05–53.3)%	32.3 (17.09–53.38)%	32.3 (17.1–53.38)%	32.74 (17.11–53.41)%	32.3 (17.09–53.37)%	32.3 (17.1–53.38)%	32.3 (17.09–53.37)%
2011	Wet	34.01 (16.86–53.56)%	34.49 (17.06–53.55)%	34.01 (16.86–53.56)%	34.01 (16.86–53.56)%	33.79 (16.85–53.55)%	33.79 (16.85–53.54)%	35.84 (17.27–53.61)%	34.01 (16.86–53.56)%

WY	WYT	NAA	Alt1	Alt2woTUCP noVA	Alt2wTUCP noVA	Alt2woTUCP DeltaVA	Alt2woTUCP AllVA	Alt3	Alt4
2012	Below Normal	20.93 (4.09–51.83)%	20.57 (4.09–51.66)%	20.93 (4.09–51.83)%	20.93 (4.09–51.84)%	20.93 (4.1–51.84)%	23.34 (16.77–52)%	22.52 (16.75–51.66)%	20.93 (4.09–51.84)%
2013	Dry	9.8 (2.22–21)%	9.55 (2.21–20.99)%	10.07 (2.24–21.03)%	10.06 (2.23–21.02)%	10.65 (2.27–21.06)%	12.17 (2.38–21.15)%	10.54 (2.27–21.05)%	10.07 (2.24–21.02)%
2014	Critical	7.37 (2.1–21.15)%	8.36 (2.14–21.26)%	9.16 (2.18–21.34)%	7.87 (2.11–21.34)%	9.46 (2.19–21.36)%	7.59 (2.11–21.18)%	10.97 (2.27–21.59)%	7.42 (2.1–21.29)%
2015	Critical	6.76 (2.08–20.66)%	8.39 (2.15–20.88)%	14.28 (2.61–21.24)%	5.61 (2.03–20.41)%	8.85 (2.17–20.93)%	8.62 (2.16–20.91)%	6.31 (2.06–20.58)%	6.73 (2.08–20.66)%
2016	Below Normal	9.94 (2.14–51.71)%	16.22 (2.2–53.2)%	9.94 (2.14–51.71)%	9.94 (2.14–51.71)%	10.02 (2.14–51.78)%	10.33 (2.15–51.78)%	19.48 (3.02–51.78)%	9.94 (2.14–51.71)%
2017	Wet	23.04 (2.38–53.46)%	23.26 (2.39–53.46)%	23.26 (2.39–53.46)%	23.26 (2.39–53.47)%	23.26 (2.39–53.46)%	23.26 (2.39–53.46)%	47.53 (19.44–54.09)%	23.26 (2.39–53.46)%
2018	Below Normal	17.49 (2.7–51.44)%	17.3 (2.7–51.3)%	18.29 (2.85–51.44)%	18.29 (2.85–51.45)%	18.29 (2.85–51.44)%	22.11 (16.73–51.44)%	10.99 (2.2–51.3)%	18.48 (2.9–51.44)%
2019	Wet	28.59 (16.49–53.16)%	27.66 (5.48–53.15)%	28.59 (16.49–53.16)%	28.59 (16.49–53.15)%	27.96 (15.88–53.16)%	27.97 (15.88–53.16)%	38.3 (17.14–53.78)%	28.6 (16.49–53.16)%
2020	Dry	9.39 (2.2–20.97)%	11.11 (2.3–21.09)%	11.07 (2.3–21.09)%	11.07 (2.3–21.09)%	7.84 (2.13–20.81)%	6.51 (2.07–20.62)%	6.84 (2.08–20.68)%	11.07 (2.3–21.09)%
2021	Critical	5.62 (2.03–20.41)%	8.51 (2.16–20.89)%	11.35 (2.32–21.11)%	5.03 (2.01–20.21)%	9.29 (2.19–20.97)%	17.88 (16.03–21.36)%	6.72 (2.08–20.65)%	5.2 (2.02–20.28)%

Table J.5-4. Mean seasonal survival for each alternative for each modelled CalSim3 year. WYT is the water year type for each modelled year. 95% confidence intervals are in parentheses.

WY	WYT	EXP1	EXP3	NAA	Alt2 woTUCP noVA	Alt2 wTUCP noVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1922	Above Normal	28.57 (2.61–53.61)%	13.48 (2.29–51.83)%	12.86 (2.28–51.48)%	12.86 (2.28–51.49)%	12.86 (2.28–51.49)%	12.85 (2.28–51.49)%	16.66 (2.57–51.49)%
1923	Below Normal	14.61 (2.26–52.56)%	8.02 (2.13–20.84)%	12.55 (2.41–21.17)%	13.45 (2.5–21.2)%	13.45 (2.5–21.21)%	13.23 (2.48–21.2)%	13.61 (2.52–21.21)%
1924	Critical	3.87 (1.96–19.33)%	4.52 (1.99–19.95)%	3.77 (1.96–19.17)%	12.42 (2.4–21.16)%	3.95 (1.97–19.45)%	12.42 (2.4–21.16)%	18.9 (16.64–21.38)%
1925	Dry	29.56 (2.71–53.61)%	17.9 (2.32–53)%	13.26 (2.24–52.24)%	16.05 (2.39–52.25)%	18.84 (2.65–52.25)%	16.61 (2.43–52.25)%	16.04 (2.39–52.25)%
1926	Dry	14.44 (2.28–52.36)%	9.43 (2.14–51.1)%	21.73 (3.18–52.42)%	16.27 (2.37–52.42)%	18.59 (2.56–52.42)%	13.99 (2.37–51.1)%	20.45 (16.05–51.1)%
1927	Wet	27.84 (2.52–53.63)%	18.86 (2.22–53.46)%	29.04 (16.96–53.08)%	29.04 (16.96–53.08)%	29.04 (16.96–53.1)%	29.04 (16.96–53.08)%	33.1 (17.14–53.43)%
1928	Above Normal	22.81 (2.33–53.53)%	14.47 (2.17–53.07)%	24.25 (3.81–52.77)%	24.25 (3.81–52.76)%	24.25 (3.81–52.76)%	24.25 (3.81–52.77)%	28.33 (16.74–53.08)%
1929	Critical	10.63 (2.2–50.41)%	6.17 (2.05–20.55)%	6.55 (2.07–20.62)%	9.46 (2.2–20.98)%	5.49 (2.03–20.37)%	5.37 (2.02–20.34)%	5.52 (2.03–20.38)%
1930	Dry	13.22 (2.26–51.97)%	8.17 (2.08–51.49)%	8.03 (2.08–51.37)%	14.6 (2.4–51.38)%	13.71 (2.35–51.22)%	8.03 (2.08–51.38)%	8.14 (2.08–51.37)%
1931	Critical	4.57 (1.98–48.06)%	3.79 (1.96–19.2)%	3.73 (1.96–19.09)%	11.59 (2.33–21.12)%	3.79 (1.96–19.2)%	11.91 (2.36–21.14)%	17.35 (4.86–21.35)%
1932	Critical	15.45 (2.42–51.76)%	4.91 (2–20.16)%	4.83 (2–20.13)%	5.15 (2.01–20.26)%	4.83 (2–20.12)%	4.83 (2–20.12)%	4.83 (2–20.12)%
1933	Critical	13.88 (2.26–52.34)%	5.08 (2–20.75)%	4.87 (2–20.43)%	6.73 (2.07–20.96)%	5.02 (2–20.49)%	6.73 (2.07–20.95)%	4.78 (2–20.38)%
1934	Critical	9.1 (2.15–48.24)%	4.75 (2–20.08)%	4.76 (2–20.09)%	18.9 (16.64–21.39)%	4.76 (2–20.09)%	18.9 (16.64–21.38)%	7.61 (2.11–20.79)%

WY	WYT	EXP1	EXP3	NAA	Alt2 woTUCP noVA	Alt2 wTUCP noVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1935	Below Normal	27.46 (2.47–53.66)%	18.89 (2.23–53.43)%	32.11 (17.01–53.38)%	32.11 (17.01–53.39)%	32.11 (17.01–53.38)%	32.39 (17.1–53.38)%	32.92 (17.12–53.42)%
1936	Below Normal	14.93 (2.25–52.75)%	7.93 (2.13–20.83)%	7.8 (2.12–20.82)%	8 (2.13–20.83)%	11.36 (2.32–21.11)%	8 (2.13–20.84)%	10.5 (2.26–21.06)%
1937	Below Normal	24.36 (2.4–53.53)%	11.72 (2.15–52.55)%	11.18 (2.15–52.32)%	11.18 (2.15–52.32)%	11.18 (2.15–52.32)%	11.18 (2.15–52.31)%	11.18 (2.15–52.31)%
1938	Wet	42.62 (17.59–53.95)%	24.34 (2.38–53.57)%	24.66 (2.41–53.55)%	25.05 (2.41–53.57)%	24.67 (2.41–53.54)%	25.05 (2.41–53.56)%	25.05 (2.41–53.58)%
1939	Dry	7.37 (2.05–51.61)%	7.66 (2.12–20.8)%	16.3 (3.13–21.31)%	15.02 (2.74–21.27)%	15.01 (2.73–21.27)%	14.65 (2.67–21.26)%	15.02 (2.74–21.27)%
1940	Above Normal	26.63 (2.44–53.63)%	19.73 (2.25–53.47)%	23.1 (2.41–53.42)%	32.91 (17.12–53.42)%	32.92 (17.13–53.42)%	32.92 (17.12–53.42)%	27.61 (2.73–53.46)%
1941	Wet	46.6 (18.69–54.04)%	35.71 (3.32–53.78)%	38.66 (3.81–53.87)%	39.1 (4.75–53.88)%	39.11 (4.76–53.87)%	39.1 (4.75–53.87)%	39.1 (4.76–53.87)%
1942	Wet	43.74 (18–53.94)%	29.46 (16.98–53.13)%	32.64 (17.11–53.41)%	32.65 (17.11–53.41)%	32.64 (17.11–53.4)%	32.64 (17.11–53.4)%	32.64 (17.11–53.4)%
1943	Wet	24.57 (2.34–53.64)%	13.48 (2.33–51.25)%	15.92 (2.44–51.89)%	23.05 (16.76–51.9)%	23.05 (16.76–51.89)%	18.27 (2.69–51.9)%	17.27 (2.56–51.9)%
1944	Dry	10.72 (2.22–49.86)%	4.77 (2–20.09)%	4.47 (1.99–19.92)%	9.41 (2.2–20.97)%	9.41 (2.2–20.97)%	5.22 (2.02–20.28)%	5.37 (2.02–20.33)%
1945	Dry	15.83 (2.4–52.1)%	8.46 (2.12–50.08)%	8.6 (2.12–49.69)%	8.6 (2.12–49.69)%	8.6 (2.13–49.68)%	8.6 (2.12–49.67)%	8.89 (2.14–49.68)%
1946	Below Normal	18.08 (2.26–53.24)%	8.11 (2.14–20.85)%	9.37 (2.2–20.97)%	10.63 (2.27–21.07)%	10.63 (2.27–21.06)%	10.63 (2.27–21.06)%	11.61 (2.33–21.12)%
1947	Dry	10.3 (2.13–52.1)%	6.66 (2.07–20.75)%	7.6 (2.11–20.89)%	10.67 (2.27–21.17)%	10.67 (2.27–21.17)%	11.25 (2.3–21.21)%	7.27 (2.1–20.85)%
1948	Dry	46.15 (18.54–54.03)%	40.66 (17.63–53.83)%	40.28 (17.59–53.82)%	40.28 (17.59–53.81)%	40.28 (17.59–53.81)%	40.28 (17.59–53.82)%	40.69 (17.63–53.83)%

WY	WYT	EXP1	EXP3	NAA	Alt2 woTUCP noVA	Alt2 wTUCP noVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1949	Dry	19.53 (2.31–53.26)%	8.66 (2.09–51.78)%	11.98 (2.22–51.77)%	14.99 (2.39–51.78)%	14.61 (2.36–51.79)%	11.97 (2.22–51.78)%	10.58 (2.16–51.78)%
1950	Dry	14.44 (2.22–52.79)%	8.32 (2.13–22.39)%	8.32 (2.13–22.4)%	8.32 (2.13–22.38)%	8.32 (2.13–22.39)%	8.32 (2.13–22.38)%	9.08 (2.16–22.46)%
1951	Above Normal	15.16 (2.4–51.78)%	6.19 (2.05–20.56)%	10.51 (2.17–51.49)%	10.51 (2.17–51.49)%	10.51 (2.17–51.48)%	10.51 (2.17–51.48)%	10.38 (2.16–51.48)%
1952	Wet	40.55 (17.61–53.83)%	18.51 (2.34–53.03)%	16.43 (2.25–53.03)%	16.43 (2.25–53.03)%	16.43 (2.25–53.03)%	16.44 (2.25–53.03)%	16.43 (2.25–53.03)%
1953	Above Normal	32.95 (17.12–53.43)%	20.27 (16.68–48.64)%	20.98 (16.3–51.29)%	20.98 (16.3–51.29)%	20.98 (16.31–51.29)%	20.98 (16.3–51.29)%	21.76 (16.15–51.83)%
1954	Above Normal	25.28 (2.4–53.61)%	14.12 (2.19–52.89)%	17.03 (2.32–52.84)%	22.46 (2.82–52.84)%	22.46 (2.82–52.84)%	17.29 (2.34–52.84)%	22.53 (2.75–52.91)%
1955	Dry	15.35 (2.4–51.89)%	7.01 (2.09–20.7)%	5.87 (2.04–20.48)%	6.11 (2.05–20.54)%	6.11 (2.05–20.53)%	6.28 (2.06–20.57)%	6.72 (2.08–20.65)%
1956	Wet	33.12 (3.27–53.65)%	14.83 (2.39–51.61)%	15.36 (2.4–51.83)%	14.97 (2.38–51.84)%	14.96 (2.38–51.84)%	14.69 (2.36–51.84)%	14.69 (2.36–51.84)%
1957	Below Normal	31.24 (16.41–53.41)%	13.28 (2.29–51.74)%	13.27 (2.28–51.74)%	13.28 (2.29–51.75)%	13.28 (2.28–51.74)%	13.28 (2.29–51.74)%	18.79 (2.91–51.61)%
1958	Wet	41.3 (17.69–53.86)%	25.73 (2.45–53.57)%	29.78 (2.81–53.57)%	29.78 (2.82–53.57)%	29.78 (2.81–53.57)%	29.78 (2.81–53.57)%	29.78 (2.81–53.57)%
1959	Below Normal	12.34 (2.19–52.33)%	7.67 (2.12–20.8)%	10.36 (2.25–21.05)%	13.06 (2.46–21.19)%	13.06 (2.46–21.19)%	8.3 (2.15–20.87)%	13.06 (2.46–21.19)%
1960	Dry	18.52 (2.51–52.54)%	7.16 (2.08–46.95)%	8.58 (2.13–46.93)%	13.67 (2.43–46.94)%	13.54 (2.43–22.6)%	8.48 (2.13–46.93)%	8.48 (2.13–46.92)%
1961	Dry	18.94 (2.54–52.53)%	10.65 (2.17–51.57)%	11.58 (2.21–51.58)%	22.34 (16.74–51.57)%	22.34 (16.74–51.57)%	11.49 (2.21–51.47)%	11.79 (2.22–51.56)%
1962	Dry	19.23 (2.36–53.07)%	8.71 (2.12–50.5)%	9.91 (2.17–50.74)%	12.35 (2.28–50.75)%	12.35 (2.28–50.75)%	9.8 (2.16–50.75)%	15.75 (2.56–50.75)%

WY	WYT	EXP1	EXP3	NAA	Alt2 woTUCP noVA	Alt2 wTUCP noVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1963	Wet	40.36 (16.95–53.89)%	24.95 (2.68–53.27)%	24.89 (2.74–53.23)%	24.89 (2.73–53.22)%	24.89 (2.73–53.23)%	24.89 (2.73–53.22)%	27.8 (3.12–53.32)%
1964	Dry	6.5 (2.07–20.62)%	4.47 (1.99–19.91)%	6.17 (2.05–20.55)%	10.28 (2.25–21.04)%	9.41 (2.2–20.97)%	6.53 (2.07–20.62)%	6.44 (2.07–20.61)%
1965	Wet	23.39 (2.47–53.35)%	17.81 (2.33–52.98)%	16.42 (2.26–52.98)%	28.09 (16.93–52.97)%	28.09 (16.93–52.97)%	28.09 (16.93–52.97)%	26.94 (16.42–52.97)%
1966	Below Normal	17.99 (2.28–53.16)%	7.54 (2.07–50.49)%	13.32 (2.32–51.22)%	11.74 (2.23–51.22)%	11.74 (2.23–51.23)%	11.7 (2.23–51.37)%	16.45 (2.57–51.38)%
1967	Wet	47.29 (19–54.06)%	43.13 (17.91–53.93)%	42.79 (17.86–53.91)%	43.12 (17.91–53.92)%	43.13 (17.91–53.93)%	43.12 (17.9–53.92)%	43.47 (17.96–53.94)%
1968	Below Normal	11.87 (2.19–52.1)%	8.95 (2.12–51.22)%	13.05 (2.29–51.48)%	21.1 (16.16–51.49)%	21.1 (16.17–51.48)%	13.05 (2.29–51.49)%	17.68 (2.69–51.61)%
1969	Wet	32.48 (2.87–53.71)%	17.11 (2.31–52.89)%	16.51 (2.29–52.88)%	16.76 (2.29–52.93)%	16.76 (2.29–52.93)%	16.76 (2.29–52.92)%	16.76 (2.29–52.93)%
1970	Wet	11.16 (2.18–51.89)%	7.06 (2.07–48.68)%	10.59 (2.2–50.5)%	10.59 (2.2–50.5)%	10.59 (2.2–50.49)%	10.59 (2.2–50.49)%	10.59 (2.2–50.5)%
1971	Wet	34.18 (17.18–53.5)%	18.48 (2.43–52.77)%	18.58 (2.43–52.76)%	19.39 (2.49–52.76)%	19.39 (2.5–52.77)%	19.06 (2.47–52.76)%	19.06 (2.47–52.76)%
1972	Below Normal	16.86 (2.22–53.23)%	11.44 (2.22–51.29)%	10.66 (2.18–51.43)%	9.72 (2.14–51.43)%	9.72 (2.14–51.43)%	10.33 (2.16–51.42)%	15.53 (2.47–51.43)%
1973	Above Normal	19.86 (2.26–53.43)%	11.43 (2.19–51.84)%	12.48 (2.24–51.84)%	12.48 (2.24–51.83)%	12.48 (2.24–51.84)%	12.17 (2.22–51.83)%	15.91 (2.44–51.83)%
1974	Wet	38.09 (16.98–53.78)%	23.37 (2.31–53.6)%	23.37 (2.31–53.6)%	34.62 (16.77–53.61)%	34.62 (16.77–53.6)%	34.62 (16.77–53.61)%	34.62 (16.77–53.6)%
1975	Above Normal	41.38 (17.43–53.9)%	28.52 (2.95–53.43)%	26.59 (15.98–52.99)%	27.21 (15.45–53.1)%	27.21 (15.45–53.09)%	27.21 (15.45–53.1)%	32.89 (16.95–53.46)%
1976	Critical	10.16 (2.17–51.02)%	5.66 (2.03–20.43)%	5.74 (2.04–20.45)%	5.38 (2.02–20.34)%	5.38 (2.02–20.34)%	5.38 (2.02–20.34)%	5.38 (2.02–20.33)%

WY	WYT	EXP1	EXP3	NAA	Alt2 woTUCP noVA	Alt2 wTUCP noVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1977	Critical	3.56 (1.95–18.64)%	4.52 (1.99–19.95)%	6.53 (2.07–20.62)%	10.47 (2.26–21.05)%	7.24 (2.1–20.74)%	10.47 (2.26–21.05)%	9.32 (2.2–20.96)%
1978	Above Normal	32.19 (2.82–53.71)%	25.39 (2.49–53.5)%	26.39 (2.68–53.4)%	26.4 (2.68–53.4)%	26.4 (2.68–53.41)%	26.39 (2.68–53.4)%	28.01 (2.72–53.5)%
1979	Dry	18.54 (2.54–52.43)%	10.1 (2.21–23.32)%	10 (2.21–22.19)%	11.16 (2.26–23.35)%	11.16 (2.26–23.34)%	10.63 (2.23–23.33)%	10.63 (2.23–23.33)%
1980	Above Normal	23.69 (2.36–53.54)%	10.8 (2.18–51.61)%	12.26 (2.23–51.89)%	12.26 (2.22–51.9)%	12.26 (2.22–51.9)%	12.26 (2.22–51.9)%	14.58 (2.34–51.91)%
1981	Dry	12.72 (2.22–52.22)%	9.91 (2.16–50.9)%	13.57 (2.38–50.35)%	19.14 (4.25–50.36)%	19.14 (4.24–50.35)%	11.17 (2.23–50.36)%	11.34 (2.24–50.36)%
1982	Wet	35.6 (3.27–53.77)%	23.28 (2.33–53.57)%	22.8 (2.33–53.53)%	22.81 (2.33–53.53)%	22.81 (2.33–53.53)%	22.81 (2.33–53.54)%	22.81 (2.33–53.54)%
1983	Wet	48.76 (20.94–54.11)%	43.23 (17.92–53.93)%	39.12 (3.07–53.95)%	39.94 (3.22–53.96)%	39.94 (3.22–53.96)%	39.94 (3.22–53.96)%	39.94 (3.22–53.95)%
1984	Wet	20.63 (2.33–53.34)%	8.93 (2.12–50.73)%	10.54 (2.19–50.91)%	10.67 (2.19–50.92)%	10.67 (2.2–50.91)%	10.54 (2.19–50.92)%	10.54 (2.19–50.92)%
1985	Below Normal	7.95 (2.11–21.6)%	6.03 (2.05–20.52)%	9.8 (2.22–21)%	8.76 (2.17–20.92)%	8.75 (2.17–20.92)%	8.59 (2.16–20.9)%	10.88 (2.29–21.08)%
1986	Wet	21.55 (2.49–53.12)%	9.94 (2.12–51.97)%	12.05 (2.21–51.97)%	12.79 (2.24–51.97)%	12.78 (2.24–51.96)%	12.11 (2.21–51.96)%	12.12 (2.21–51.97)%
1987	Dry	11.43 (2.19–51.84)%	10.33 (2.17–51.07)%	21.57 (16.72–51.06)%	21.57 (16.72–51.06)%	21.57 (16.72–51.06)%	21.57 (16.72–51.06)%	21.57 (16.72–51.06)%
1988	Critical	7.31 (2.1–20.75)%	4.64 (1.99–20.03)%	6.48 (2.07–20.61)%	7.69 (2.12–20.8)%	7.69 (2.12–20.8)%	8.56 (2.16–20.89)%	13.6 (2.52–21.21)%
1989	Dry	16.35 (2.22–53.16)%	9.94 (2.13–51.97)%	13.54 (2.29–51.77)%	22.05 (16.13–51.98)%	21.8 (15.85–51.97)%	13.7 (2.3–51.78)%	14.27 (2.33–51.83)%
1990	Critical	7.88 (2.08–51.01)%	7.97 (2.13–20.83)%	4.67 (1.99–20.05)%	10.07 (2.24–21.03)%	9.94 (2.23–21.01)%	9.94 (2.23–21.01)%	11.47 (2.33–21.12)%

WY	WYT	EXP1	EXP3	NAA	Alt2 woTUCP noVA	Alt2 wTUCP noVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
1991	Critical	12.34 (2.19–52.34)%	8.98 (2.1–51.62)%	8.98 (2.11–51.61)%	11.15 (2.19–51.6)%	9.53 (2.13–51.6)%	11.15 (2.19–51.61)%	9.53 (2.13–51.61)%
1992	Critical	15.26 (2.26–52.73)%	8.43 (2.1–50.74)%	8.12 (2.1–50.54)%	21.07 (16.7–50.55)%	12.02 (2.27–50.55)%	21.07 (16.71–50.53)%	13.58 (2.37–50.54)%
1993	Above Normal	41.43 (17.7–53.86)%	22.74 (2.47–53.28)%	22.9 (2.53–53.22)%	21.72 (2.42–53.27)%	21.29 (2.42–53.22)%	21.72 (2.42–53.26)%	25.85 (2.75–53.3)%
1994	Critical	7.82 (2.13–20.81)%	5.06 (2.01–20.23)%	5.09 (2.01–20.23)%	13.39 (2.49–21.21)%	13.59 (2.52–21.22)%	5.14 (2.01–20.25)%	5.45 (2.02–20.36)%
1995	Wet	47.3 (19.01–54.07)%	36.88 (17.14–53.7)%	36.53 (17.31–53.65)%	36.53 (17.31–53.64)%	36.53 (17.31–53.64)%	36.53 (17.31–53.64)%	36.54 (17.32–53.64)%
1996	Wet	40.95 (17.38–53.88)%	21.18 (2.66–52.8)%	24.14 (3.36–52.83)%	24.14 (3.36–52.83)%	24.15 (3.36–52.84)%	24.14 (3.35–52.83)%	24.14 (3.36–52.83)%
1997	Wet	13.24 (2.22–52.44)%	8.08 (2.14–20.85)%	9.86 (2.2–21.64)%	9.85 (2.2–21.64)%	9.86 (2.21–21.64)%	9.85 (2.2–21.64)%	9.86 (2.2–21.64)%
1998	Wet	50.8 (47.43–54.16)%	50.8 (47.43–54.16)%	50.8 (47.43–54.16)%	50.8 (47.43–54.16)%	50.8 (47.43–54.16)%	50.8 (47.43–54.16)%	50.8 (47.43–54.16)%
1999	Wet	34.49 (16.26–53.64)%	23.01 (15.36–52.4)%	17.06 (2.55–51.83)%	17.18 (2.55–51.9)%	17.18 (2.55–51.9)%	17.17 (2.55–51.9)%	17.17 (2.55–51.9)%
2000	Above Normal	28.68 (2.88–53.46)%	12.62 (2.22–52.17)%	14.19 (2.29–52.2)%	15.13 (2.33–52.25)%	15.13 (2.33–52.25)%	14.54 (2.3–52.25)%	17.93 (2.55–52.24)%
2001	Dry	12.38 (2.22–52.04)%	9.82 (2.15–51.07)%	13.63 (2.37–50.74)%	20.39 (16.31–50.74)%	20.39 (16.3–50.73)%	12.57 (2.3–50.74)%	12.77 (2.31–50.75)%
2002	Below Normal	14.46 (2.22–52.8)%	7.93 (2.13–20.94)%	8.08 (2.13–20.95)%	10.77 (2.27–21.18)%	10.77 (2.27–21.18)%	8.08 (2.13–20.96)%	11.34 (2.31–21.21)%
2003	Above Normal	46.96 (18.93–54.07)%	38.84 (17.03–53.81)%	40.12 (17.58–53.81)%	40.12 (17.58–53.81)%	40.12 (17.58–53.82)%	40.13 (17.58–53.81)%	40.47 (17.61–53.82)%
2004	Above Normal	16.34 (2.3–52.8)%	10.33 (2.15–51.78)%	13.98 (2.3–51.97)%	13.98 (2.3–51.97)%	13.98 (2.3–51.97)%	13.98 (2.3–51.97)%	14.58 (2.33–52.04)%

WY	WYT	EXP1	EXP3	NAA	Alt2 woTUCP noVA	Alt2 wTUCP noVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
2005	Below Normal	47.55 (19.16–54.07)%	33.22 (17.14–53.44)%	31.22 (17.04–53.29)%	32.58 (17.1–53.4)%	32.58 (17.11–53.4)%	32.12 (17.09–53.36)%	32.12 (17.09–53.36)%
2006	Wet	45.91 (18.46–54.02)%	30.99 (2.72–53.68)%	33.26 (3.13–53.69)%	33.26 (3.13–53.69)%	33.26 (3.13–53.69)%	33.26 (3.13–53.68)%	33.26 (3.13–53.68)%
2007	Below Normal	10.88 (2.2–50.92)%	7.83 (2.13–20.82)%	11.18 (2.31–21.1)%	17.73 (15.85–21.36)%	17.73 (15.85–21.35)%	9.63 (2.21–21)%	14.05 (2.58–21.23)%
2008	Dry	10.67 (2.17–51.61)%	8.12 (2.14–20.85)%	9.45 (2.13–51.36)%	6.21 (2.02–51.36)%	6.21 (2.02–51.38)%	4.98 (2.01–20.19)%	5.06 (2.01–20.22)%
2009	Dry	18.86 (2.49–52.67)%	9.41 (2.16–49.12)%	6.25 (2.06–20.57)%	5.4 (2.02–20.34)%	5.4 (2.02–20.35)%	6.63 (2.05–49.75)%	8.69 (2.13–49.75)%
2010	Below Normal	39.81 (17.55–53.8)%	32.79 (17.11–53.41)%	31.31 (17.05–53.3)%	32.3 (17.09–53.38)%	32.3 (17.1–53.38)%	32.74 (17.11–53.41)%	32.3 (17.09–53.37)%
2011	Wet	44.1 (18.06–53.96)%	31.12 (3.69–53.49)%	34.01 (16.86–53.56)%	34.01 (16.86–53.56)%	34.01 (16.86–53.56)%	33.79 (16.85–53.55)%	33.79 (16.85–53.54)%
2012	Below Normal	23.57 (2.33–53.59)%	13.63 (2.28–52)%	20.93 (4.09–51.83)%	20.93 (4.09–51.83)%	20.93 (4.09–51.84)%	20.93 (4.1–51.84)%	23.34 (16.77–52)%
2013	Dry	8.4 (2.1–50.66)%	6.24 (2.06–20.57)%	9.8 (2.22–21)%	10.07 (2.24–21.03)%	10.06 (2.23–21.02)%	10.65 (2.27–21.06)%	12.17 (2.38–21.15)%
2014	Critical	8.45 (2.1–51.24)%	7.07 (2.08–21.11)%	7.37 (2.1–21.15)%	9.16 (2.18–21.34)%	7.87 (2.11–21.34)%	9.46 (2.19–21.36)%	7.59 (2.11–21.18)%
2015	Critical	5.18 (2.02–20.27)%	5.26 (2.02–20.3)%	6.76 (2.08–20.66)%	14.28 (2.61–21.24)%	5.61 (2.03–20.41)%	8.85 (2.17–20.93)%	8.62 (2.16–20.91)%
2016	Below Normal	15.92 (2.23–53.03)%	10.08 (2.14–51.84)%	9.94 (2.14–51.71)%	9.94 (2.14–51.71)%	9.94 (2.14–51.71)%	10.02 (2.14–51.78)%	10.33 (2.15–51.78)%
2017	Wet	38.9 (17.04–53.81)%	23.82 (2.4–53.51)%	23.04 (2.38–53.46)%	23.26 (2.39–53.46)%	23.26 (2.39–53.47)%	23.26 (2.39–53.46)%	23.26 (2.39–53.46)%
2018	Below Normal	16.16 (2.23–53.07)%	9.37 (2.13–51.29)%	17.49 (2.7–51.44)%	18.29 (2.85–51.44)%	18.29 (2.85–51.45)%	18.29 (2.85–51.44)%	22.11 (16.73–51.44)%

WY	WYT	EXP1	EXP3	NAA	Alt2 woTUCP noVA	Alt2 wTUCP noVA	Alt2 woTUCP DeltaVA	Alt2 woTUCP AllVA
2019	Wet	43.01 (17.89–53.93)%	29.03 (3.3–53.38)%	28.59 (16.49–53.16)%	28.59 (16.49–53.16)%	28.59 (16.49–53.15)%	27.96 (15.88–53.16)%	27.97 (15.88–53.16)%
2020	Dry	8.71 (2.14–22.57)%	6.03 (2.05–20.52)%	9.39 (2.2–20.97)%	11.07 (2.3–21.09)%	11.07 (2.3–21.09)%	7.84 (2.13–20.81)%	6.51 (2.07–20.62)%
2021	Critical	5.33 (2.02–20.32)%	4.56 (1.99–19.98)%	5.62 (2.03–20.41)%	11.35 (2.32–21.11)%	5.03 (2.01–20.21)%	9.29 (2.19–20.97)%	17.88 (16.03–21.36)%

J.5.3.2 Figures

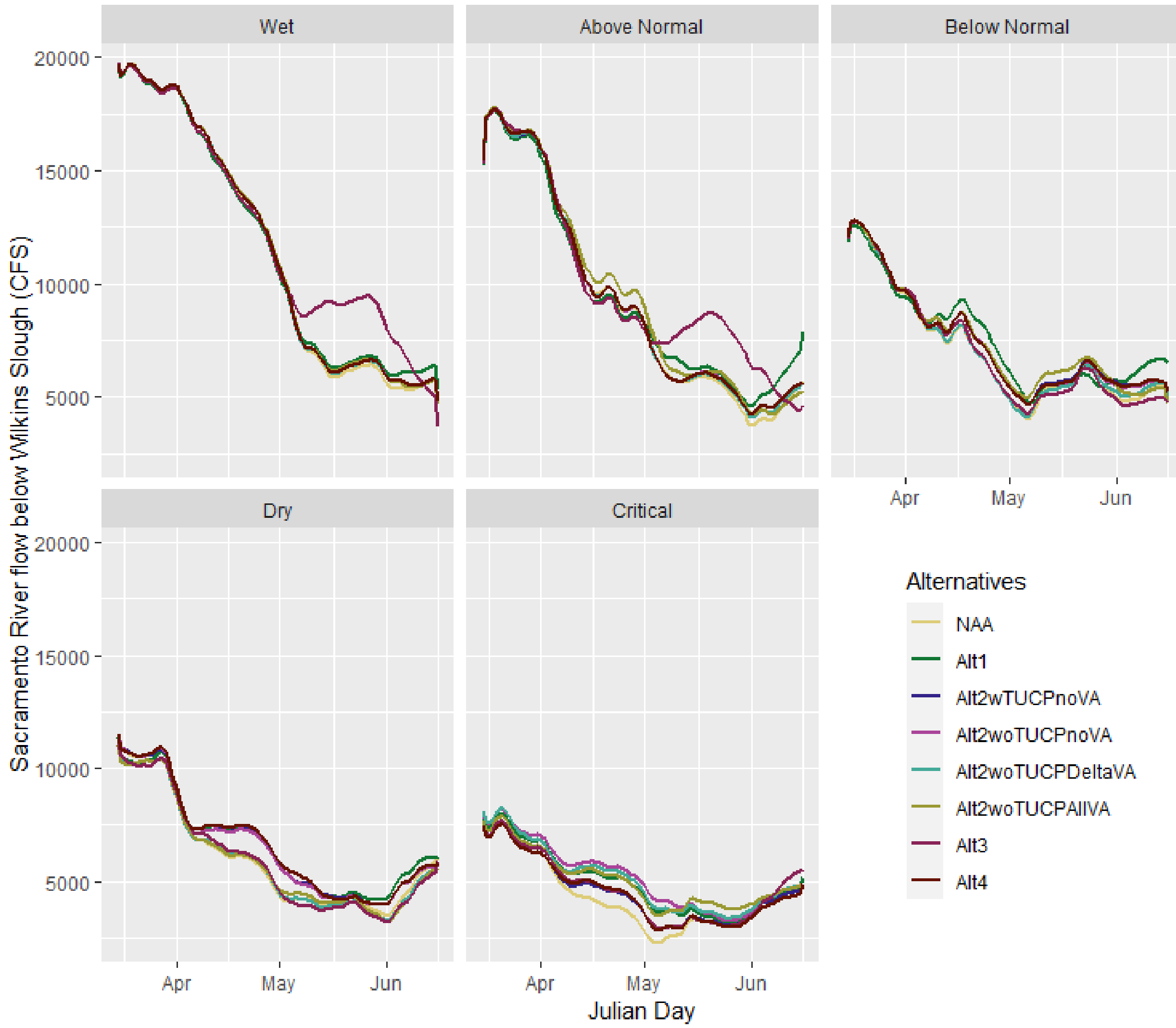

Figure J.5-1. Mean daily Sacramento River flow below Wilkins Slough (cfs) (March 15th to June 15th) of different alternatives by date across water year types (USRDOM, 1922-2021).

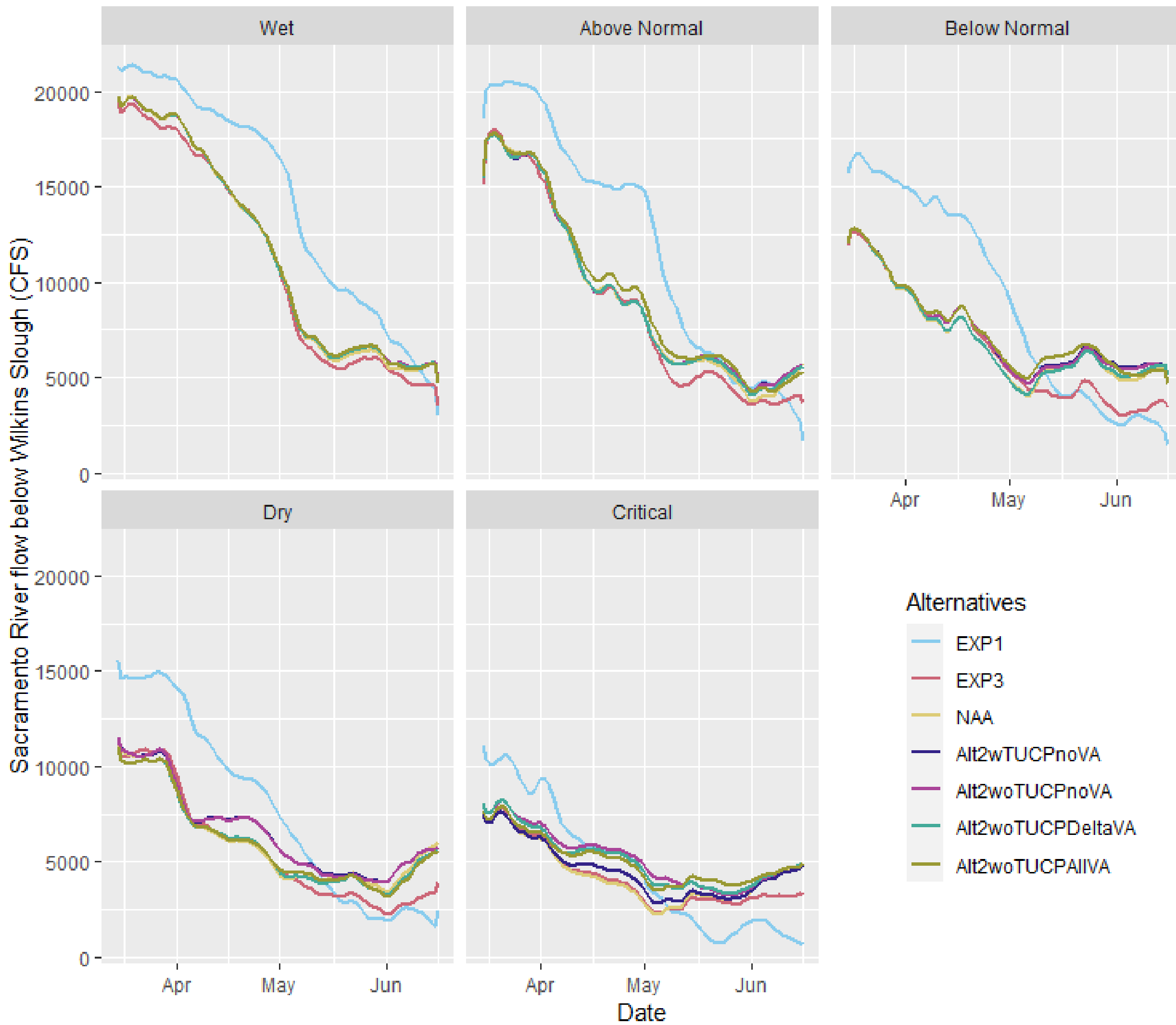

Figure J.5-2. Mean daily Sacramento River flow below Wilkins Slough (cfs) (March 15th to June 15th) of different alternatives by date across water year types (USRDOM, 1922-2021).

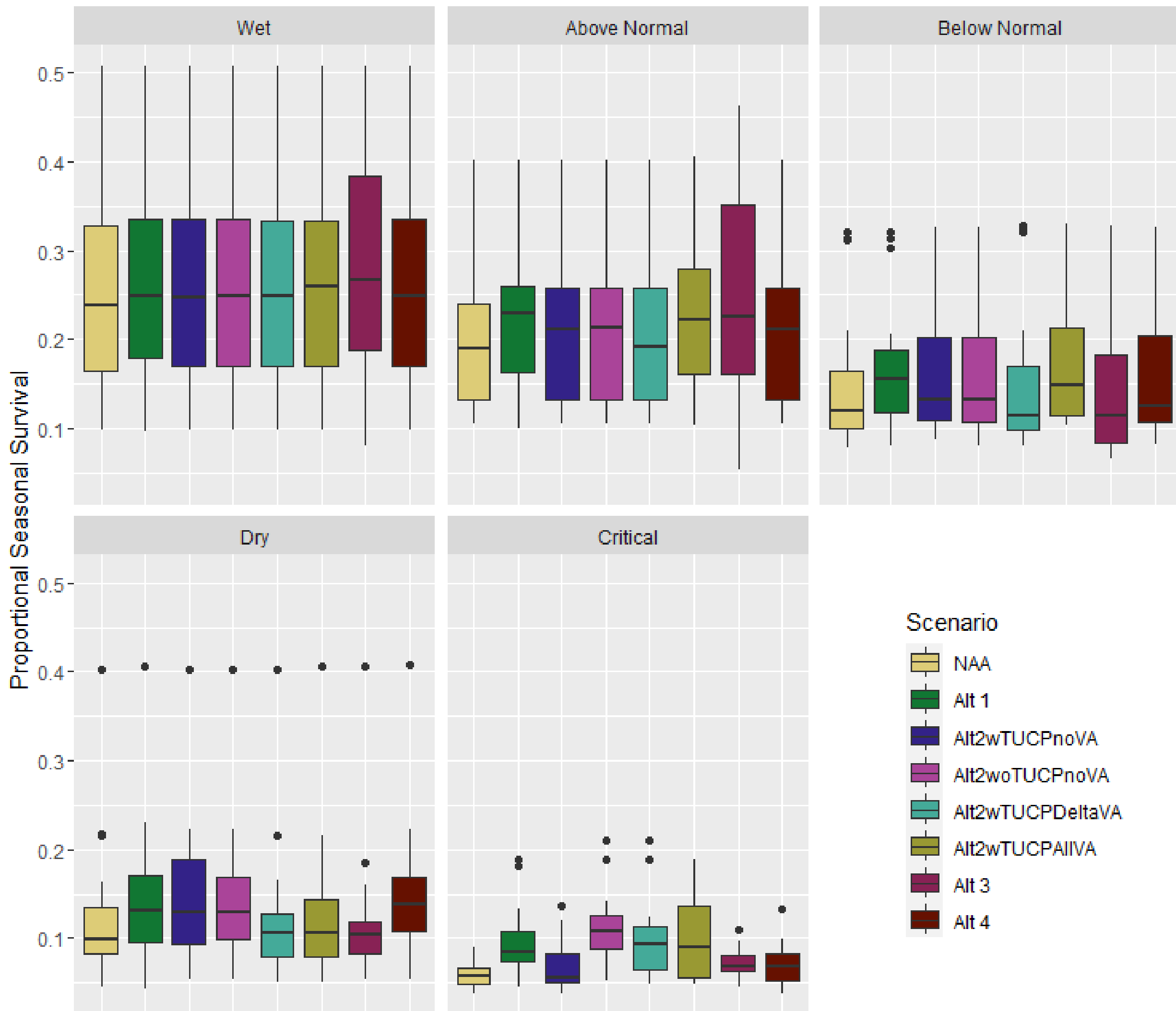

Figure J.5-3. Boxplots of mean annual seasonal March 15th through June 15th survival for different modeled scenarios by water year type.

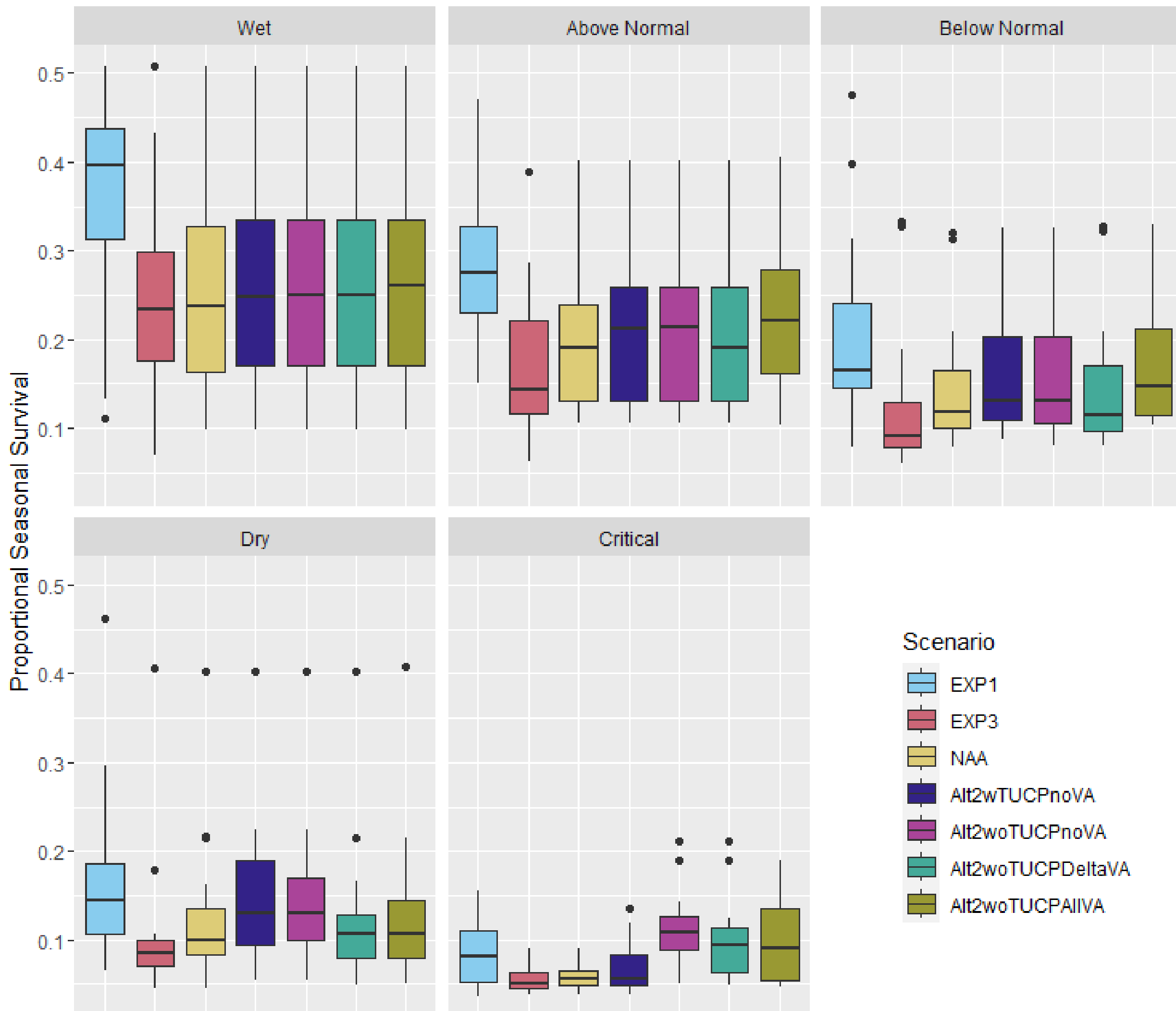

Figure J.5-4. Boxplots of mean annual seasonal March 15th through June 15th survival for different modeled scenarios by water year type.

J.5.4 References

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