Appendix 11K Weighted Usable Area Analysis

Appendix 11K Weighted Usable Area Analysis

11K.1 Introduction

Weighted usable area (WUA) analysis provides estimates of the amount of suitable spawning and rearing habitat of fishes available in rivers and streams at various levels of flow (Bovee et al. 1998). WUA is computed as the surface area of physical habitat available weighted by its suitability. Habitat suitability is determined from field studies of the distributions of redds or rearing juveniles with respect to flow velocities, depths, and substrate or cover characteristics in the river (Bovee et al. 1998). These data are used in hydraulic and habitat model simulations (PHABSIM and/or RIVER2D) that estimate the availability of suitable habitat in a portion of the river at a given flow. WUA curves showing suitable habitat availability versus flow are generated from the simulations.

For this Final Environmental Impact Report (EIR)/Environmental Impact Statement (EIS), spawning WUA was estimated for winter-run, spring-run, fall-run, and late fall–run Chinook salmon and California Central Valley steelhead in the Sacramento, Feather, and American Rivers. Fry and juvenile rearing WUA were estimated only for the Sacramento River because no acceptable rearing WUA curves are available for the Feather and American Rivers. Spawning and rearing WUA was estimated for the No Action Alternative (NAA)[1] and Alternatives 1A, 1B, 2, and 3 (hereinafter referred to as Alternatives 1, 2, and 3) from CALSIM II flow data for each month of the 82-year period of record.

11K.2 Methods

11K.2.1. Spawning Habitat Weighted Usable Area

11K.2.1.1. Sacramento River

The WUA curves used for Chinook salmon and steelhead spawning habitat in the Sacramento River were obtained from two U.S. Fish and Wildlife Service (USFWS) reports (U.S. Fish and Wildlife Service 2003a, 2006). Modeling assumptions used to derive spawning WUA curves include that the suitability of physical habitat for salmon and steelhead spawning is largely a function of substrate particle size, water depth, and flow velocity. The race- or species-specific suitability of the habitat with respect to these variables is determined by cataloguing conditions at active redds and is used to develop habitat suitability criteria (HSC) for each race or species of fish. Hydraulic modeling is then used to estimate the amount of habitat available for different

[1] The term *NAA*, which is identical to the No Project Alternative, is used throughout Chapter 11, *Aquatic Biological Resources*, and associated aquatic resources appendices in the presentation of modeled results and represents no material difference from the No Project Alternative as discussed in Chapter 3, *Environmental Analysis*.

HSC levels at different river flows, and the results are used to develop spawning habitat WUA curves (Bovee et al. 1998). The WUA curves and tables are used to look up the amount of spawning WUA available at different flows during the spawning periods of the race or species.

USFWS (2003a) provides WUA curves and tables for spawning winter-run, fall-run, and late fall–run Chinook salmon and steelhead for three segments of the Sacramento River encompassing the reach from Keswick Dam to Battle Creek (Figure 11K-1). The WUA tables were updated in 2006 (U.S. Fish and Wildlife Service 2006). No WUA curves were developed for spring-run Chinook salmon, but as discussed later, the fall-run curves were used to quantify spring-run spawning habitat. Also as further discussed below, the HSC used to develop the steelhead WUA curve for Sacramento River spawning were obtained from investigations of steelhead redds in the American River (U.S. Fish and Wildlife Service 2003b) because few steelhead redds were observed in the Sacramento River. Figure 11K-2 through Figure 11K-5 show the flow versus spawning WUA results for winter-run, fall-run, late fall–run, and steelhead in the three river segments (Segment 6 = Keswick to Anderson-Cottonwood Irrigation District [ACID] Dam, Segment 5 = ACID Dam to Cow Creek, and Segment 4 = Cow Creek to Battle Creek) as provided by USFWS (2006). Figure 11K-6 shows spawning WUA results for fall-run in an additional downstream segment (Segment 3 = Battle Creek to Red Bluff Pumping Plant [RBPP])[2] because spawning for fall-run occurs further downstream than it does for the other salmon runs. Note that for Segment 6, separate WUA curves were developed for periods when the ACID Dam boards were installed (April through October) and for when the boards were out because installation of the boards affects water depths and velocities for some of the sampling transects used to develop the curves.

Because several tributaries enter the Sacramento River between Keswick Dam and Battle Creek, flows generally differ among the segments. For the USFWS studies, Sacramento River flows were measured directly at the sampling transects and were estimated as the sum of Keswick Dam flow releases and tributary gauge readings upstream of the transects. To estimate WUA for the effects analysis, the segment flows were estimated using Sacramento River CALSIM II flows at Keswick Dam and the Clear Creek, Cow Creek, and Battle Creek confluences. Keswick Dam flows were used for Segment 6 and for Segment 5 upstream of the Clear Creek confluence. Flows at Clear Creek were used for Segment 5 downstream of the confluence. Flows at Cow Creek were used for Segment 4 and flows at Battle Creek were used for Segment 3. For Segment 6, the WUA curves for the months when the ACID Dam boards are installed (April through October) were used with the Keswick Dam flows for those months and the WUA curves for the months when the ACID Dam boards are out were used with the flows for the rest of the year. To evaluate the relative importance of results from the three segments (four segments for fall-run) for each race or species in the effects analysis, the typical spawning distributions of the salmon with respect to the segments (Table 11K-1) was estimated from aerial redd surveys conducted by California Department of Fish and Wildlife (ICF International 2016). All races other than fall-run primarily spawn upstream of the Battle Creek confluence, and most fall-run spawning occurs upstream of the RBPP. Little is known about steelhead spawning locations in the Sacramento

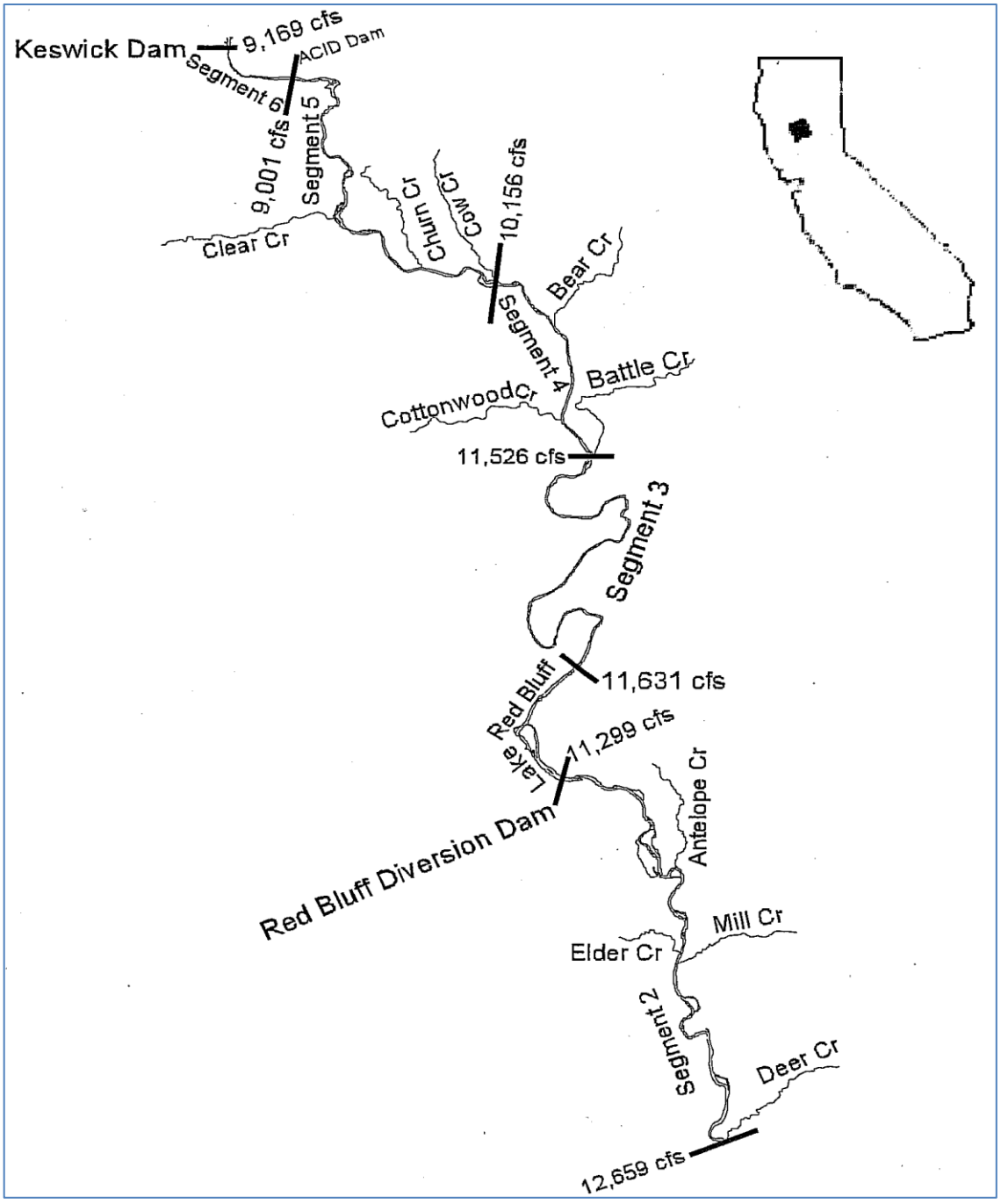
[2] The Red Bluff Diversion Dam (RBDD), which was decommissioned in 2013, and the Red Bluff Pumping Plant (RBPP) are co-located, and the names may be used interchangeably when referring to the geographic location.

River, although it was assumed for this analysis that, because of constraints on water temperature and other habitat features, individuals spawn between Keswick Dam and RBPP, where nearly all Chinook salmon spawn (Table 11K-1).

Table 11K-1. Distributions of Spawning Redds among WUA River Segments as Percent of Total in the Sacramento River for Chinook Salmon Runs.

Segment	Description	River Miles	Winter-Run	SPRING-RUN	Fall-Run	Late Fall–Run
6	Keswick to ACID	302-298.5	45.0%	12.4%	16.3%	67.6%
5	ACID to Cow Creek	298.5-280	54.6%	66.0%	25.9%	12.7%
4	Cow Creek to Battle Creek	280-271	0.4%	12.8%	18.4%	9.2%
3	Battle Creek to RBPP	271-243	0.0%	4.9%	22.8%	4.3%
—	Downstream of RBPP	—	0.0%	4.0%	16.6%	6.2%

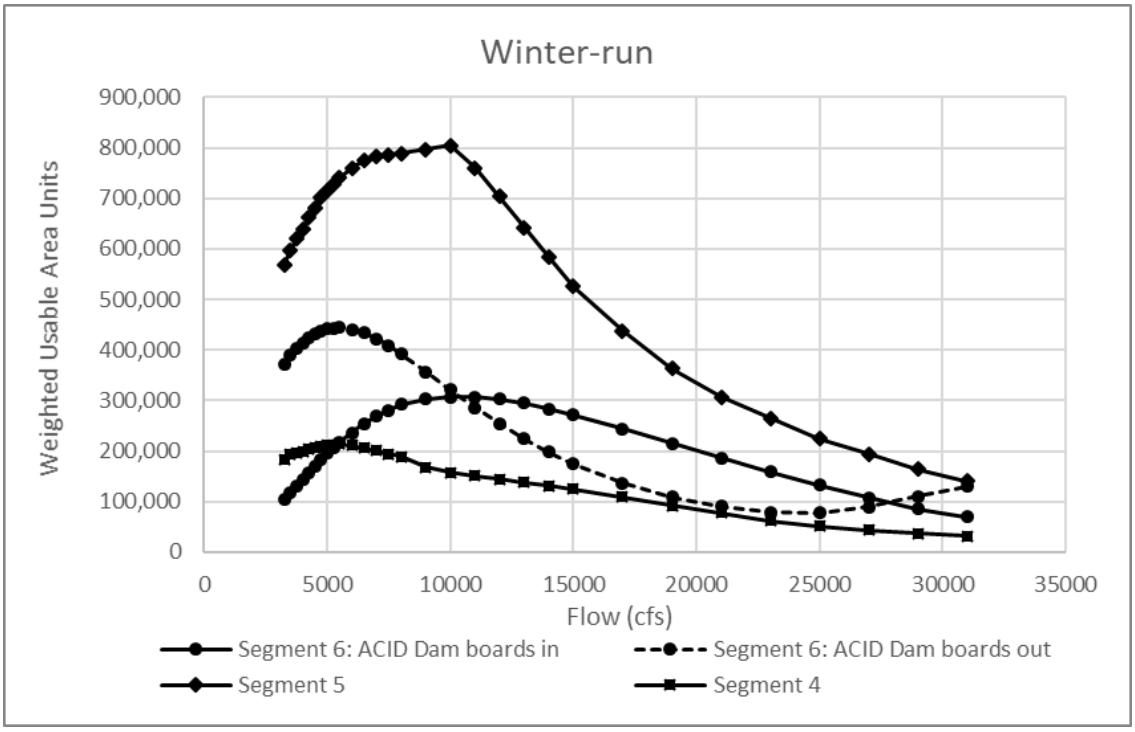
ACID = Anderson-Cottonwood Irrigation District
RBPP = Red Bluff Pumping Plant



Source: U.S. Fish and Wildlife Service 2003a.

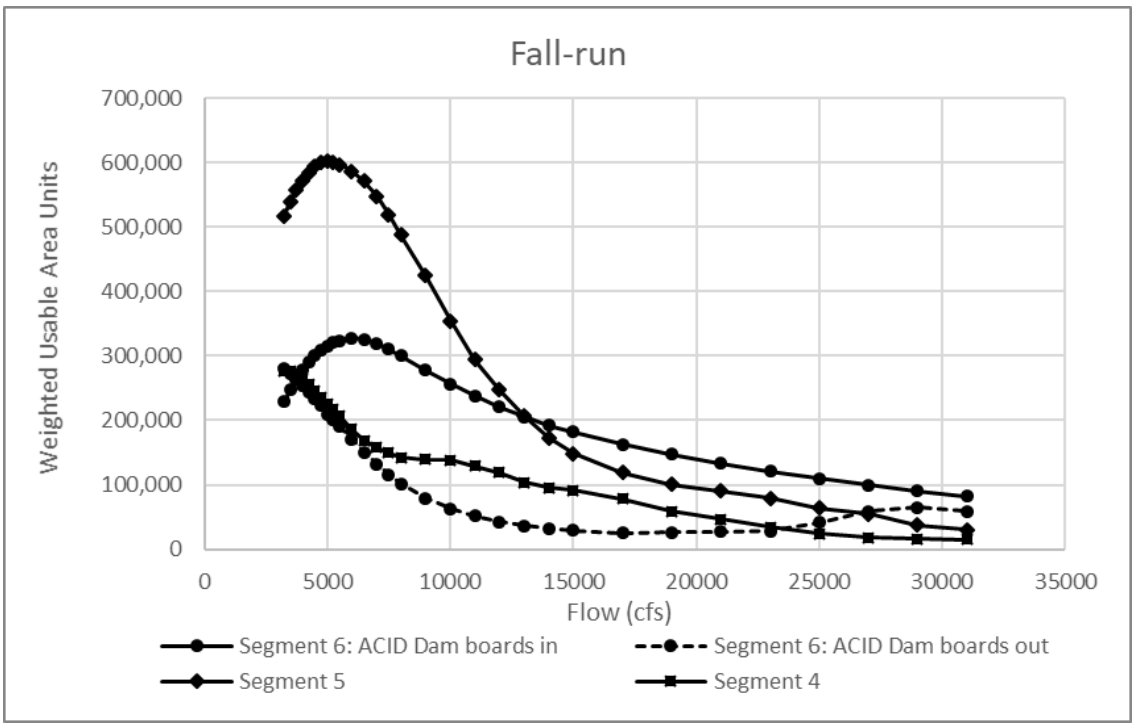
Figure 11K-1. Segments 2–6 of the Sacramento River Used in U.S. Fish and Wildlife Service Studies to Determine Spawning and Rearing WUA (flows in the figure are the average flows at the upstream boundary of each segment for October 1974 to September 1993).[3]

[3] The RBDD, which was decommissioned in 2013, and the RBPP are co-located, and the names may be used interchangeably when referring to the geographic location.



ACID = Anderson-Cottonwood Irrigation District.

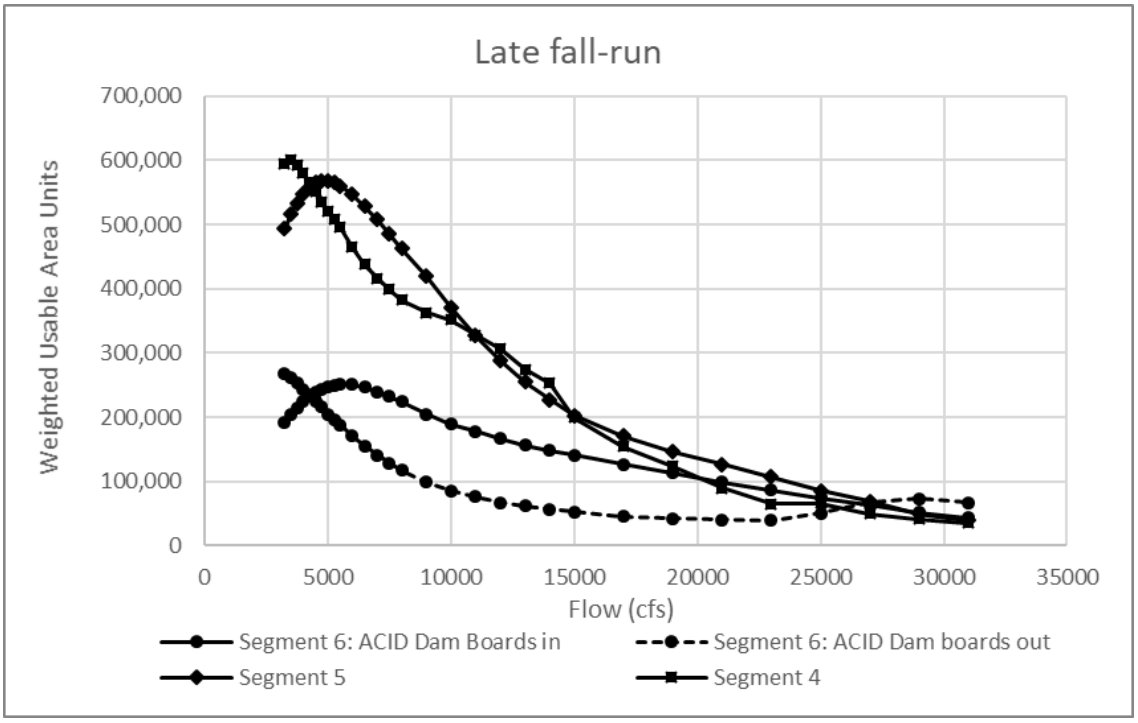
Figure 11K-2. Spawning WUA curves for Winter-Run Chinook Salmon in the Sacramento River, Segments 4 to 6.



ACID = Anderson-Cottonwood Irrigation District.

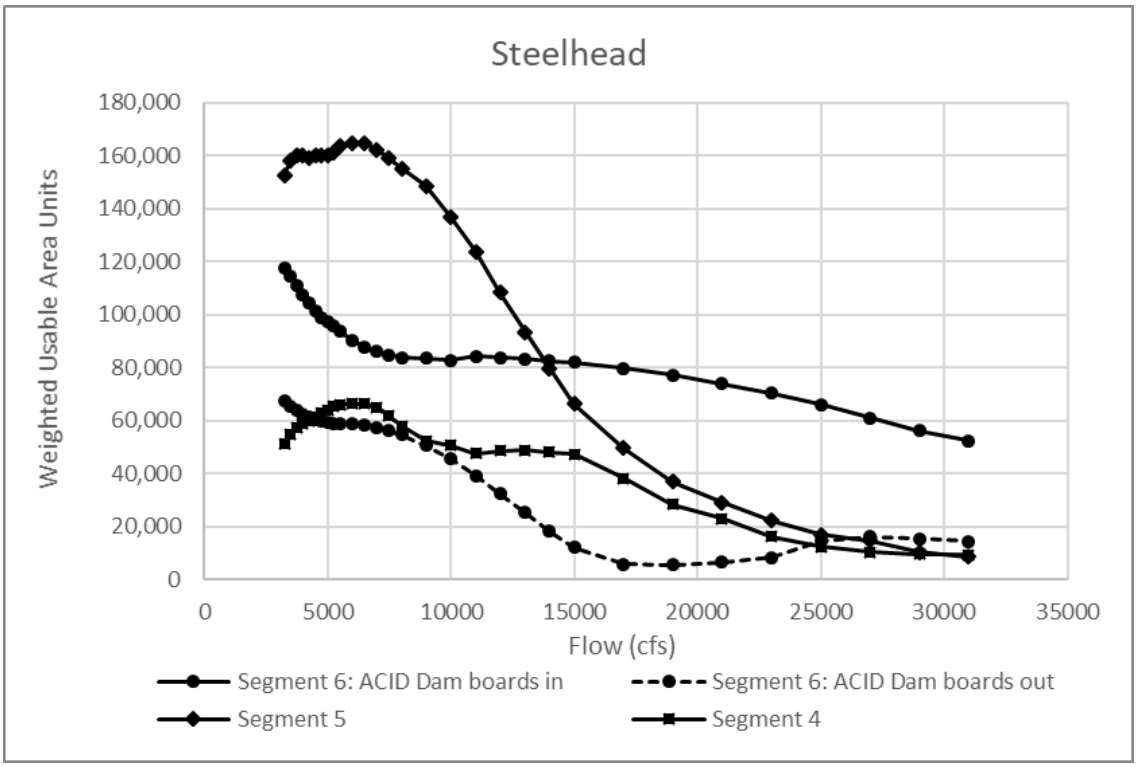
Note: The fall-run curves were also used to quantify spring-run Chinook salmon WUA, as discussed in the text.

Figure 11K-3. Spawning WUA Curves for Fall-Run Chinook Salmon in the Sacramento River, Segments 4 to 6.



ACID = Anderson-Cottonwood Irrigation District.

Figure 11K-4. Spawning WUA Curves for Late Fall–Run Chinook Salmon in the Sacramento River, Segments 4 to 6.



ACID = Anderson-Cottonwood Irrigation District.

Figure 11K-5. Spawning WUA curves for Steelhead in the Sacramento River, Segments 4 to 6.

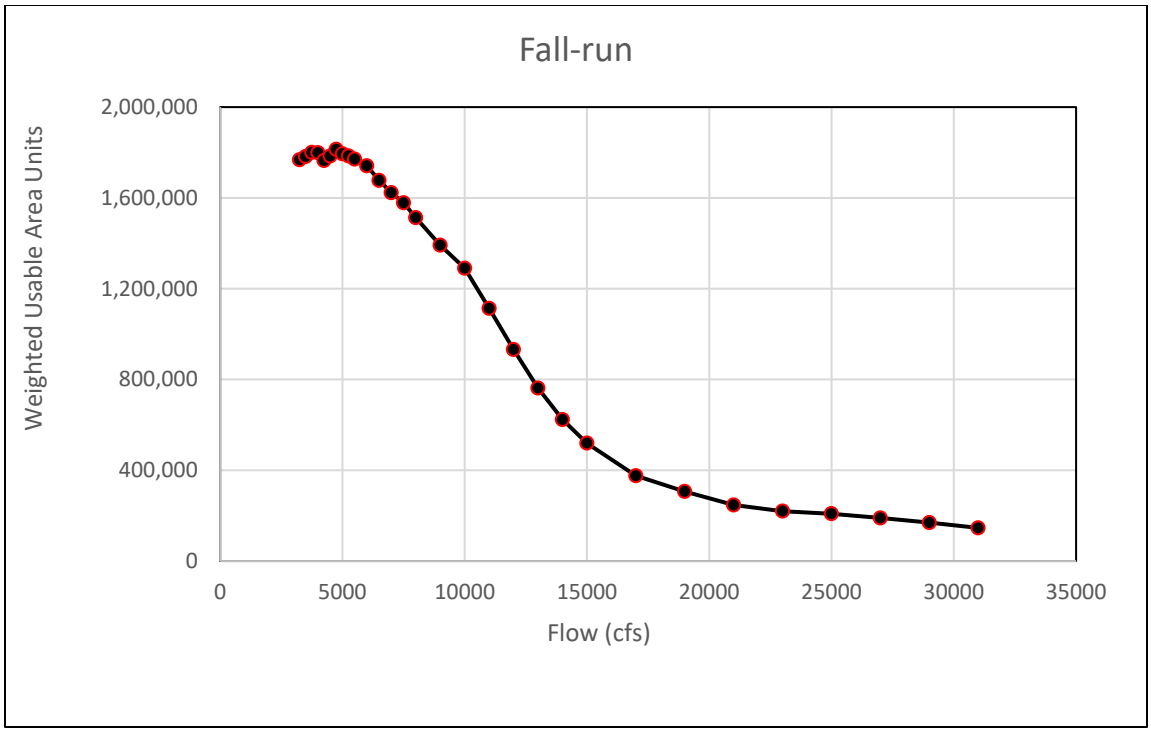


Figure 11K-6. Spawning WUA Curve for Fall-Run Chinook Salmon in the Sacramento River, Segment 3.

Because there are no spring-run Chinook salmon WUA curves in the USFWS documentation, the previous practice (described below) has been to use fall-run Chinook salmon WUA curves to model spring-run habitat. Two models that currently produce spawning WUA outputs for spring-run Chinook salmon, SALMOD and Sacramento River Ecological Flows Tool (SacEFT), derive the spring-run WUA results using the fall-run Chinook salmon spawning WUA curves as surrogates (Bartholow 2004; ESSA Technologies 2011). Mark Gard, who led the USFWS studies that produced the Sacramento River WUA curves, has endorsed this practice (Gard pers. comm.). However, this practice introduces uncertainty to the spring-run Chinook salmon results. Although fall-run spawning WUA curves were used as surrogates for spring-run spawning, CALSIM II flows for the months of spring-run spawning, not those of fall-run spawning, were used to compute the spring-run WUA results.

A potential limitation of the Sacramento River spawning WUA curves for steelhead is the use of previously obtained American River steelhead HSC used in developing the curves (U.S. Fish and Wildlife Service 2003b). HSC data were not collected by USFWS for steelhead in the Sacramento River because very few steelhead redds were observed and because the steelhead redds could not be distinguished from those of resident rainbow trout. The validity of this substitution could not be tested and is uncertain (U.S. Fish and Wildlife Service 2003a).

A further limitation of the WUA curves presented above, as of all such habitat-based studies, is that they assume the channel characteristics of the river during the time of field data collection by USFWS (1995–1999), such as proportions of mesohabitat types, have remained in dynamic equilibrium to the present time and would continue to do so through the life of the Project. If the channel characteristics substantially change, the shape of the curve may no longer be applicable.

Differences in the mean spawning WUA under Alternatives 1, 2, and 3 and the NAA were examined for the months of the spawning period under each water year type and all water year types combined.

11K.2.1.2. Feather River

The relationships between instream flows and Chinook salmon and steelhead spawning habitat availability (WUA) in the Feather River developed by Payne and Allen (2004) were used in this effects analysis to determine effects of changing flows on Chinook salmon (spring-run and fall-run) and steelhead spawning WUA in the lower Feather River (Figure 11K-7 and Figure 11K-8). Although spring-run, fall-run and steelhead spawn in both the upper Feather River between the Fish Barrier Dam and Thermalito Afterbay Outlet and the lower Feather River downstream of the Thermalito Afterbay Outlet, Alternatives 1, 2, and 3 would have no effect on flow in the upper river (low-flow channel), so differences in WUA between Alternatives 1, 2, and 3 and the NAA were estimated only for the lower river (high-flow channel).

Differences in the mean spawning WUA under Alternatives 1, 2, and 3 and the NAA and were examined for the months of the spawning period for each species and race under each water year type and all water year types combined.

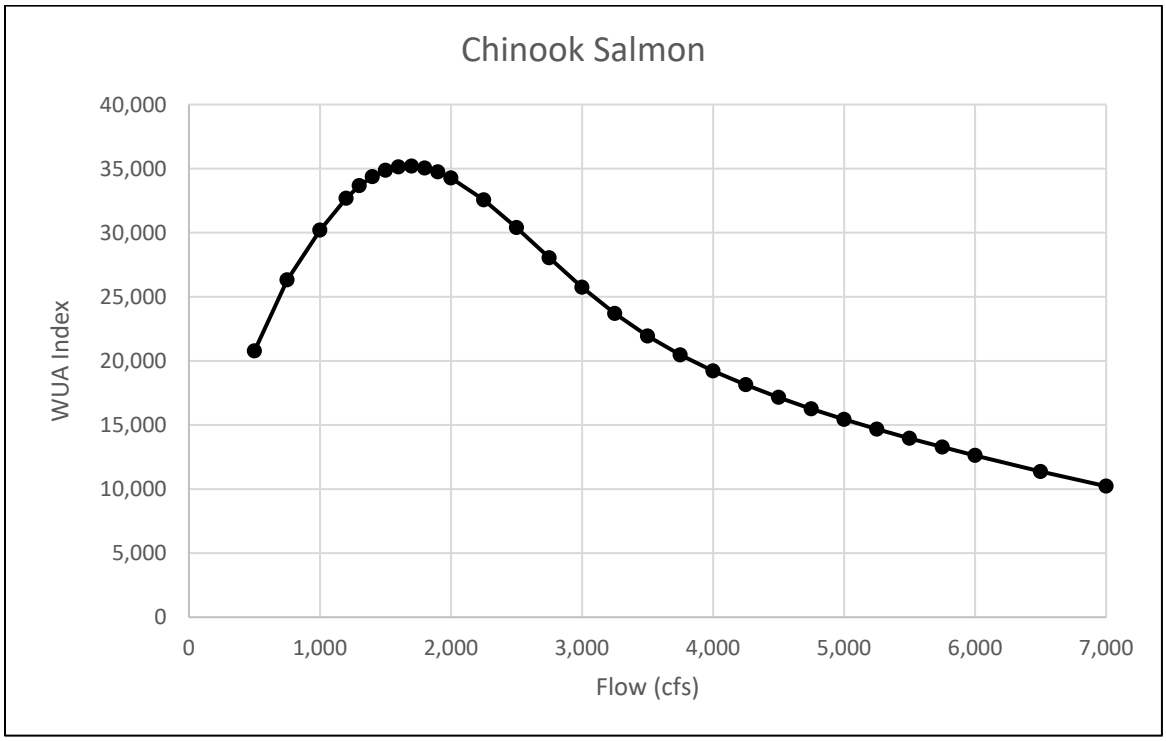


Figure 11K-7. Spawning WUA for Chinook Salmon (Spring-Run and Fall-Run) in the Feather River below Thermalito Afterbay Outlet.

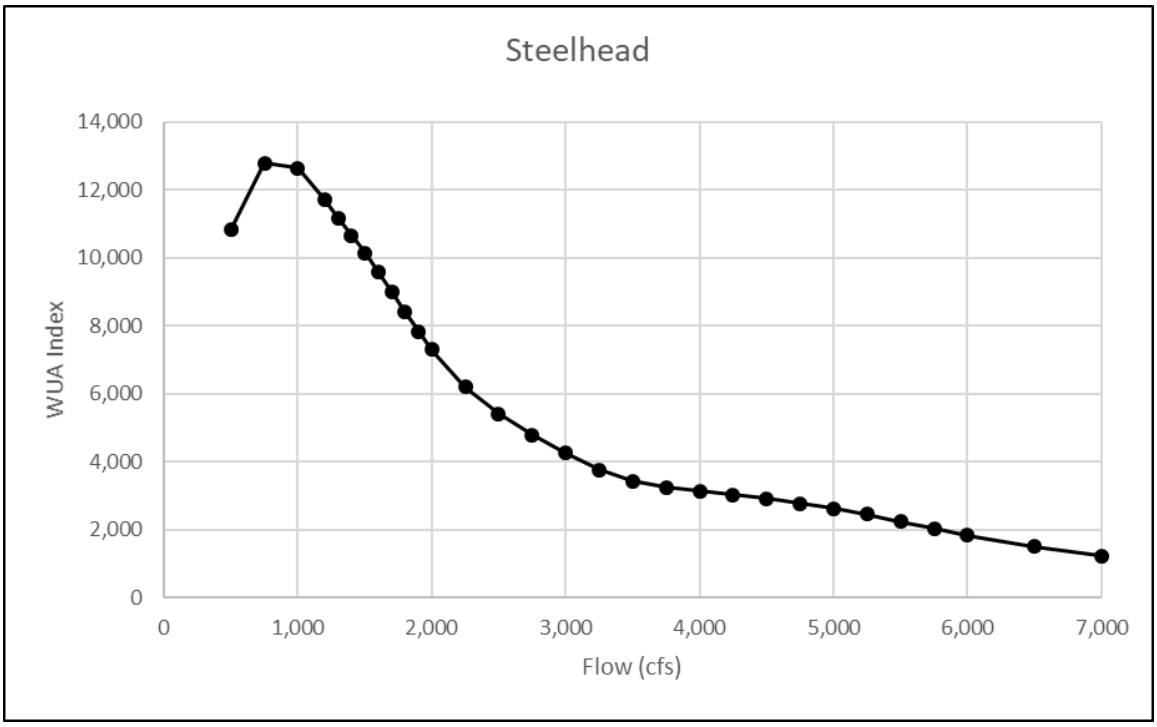


Figure 11K-8. Spawning WUA for California Central Valley Steelhead in the Feather River below Thermalito Afterbay Outlet.

11K.2.1.3. American River

The WUA curves used for fall-run Chinook salmon and steelhead spawning habitat in the American River were obtained from Bratovich et al. (2017), which provides spawning WUA curves for fall-run and steelhead in eight reaches of the American River. The eight reaches lie within the approximately 10-mile river reach from Nimbus Dam downstream to Riverbend Side Channel, where most salmon and steelhead spawning occurs. Figure 11K-9 and Figure 11K-10 show composite WUA curves for flow versus spawning that combine the WUA results for the eight reaches. For this effects analysis, CALSIM II flows at Nimbus Dam were used to compute fall-run and steelhead spawning WUA from the composite WUA curves and tables.

Differences in the mean spawning WUA under Alternatives 1, 2, and 3 and the NAA were examined for the months of the spawning period under each water year type and all water year types combined.

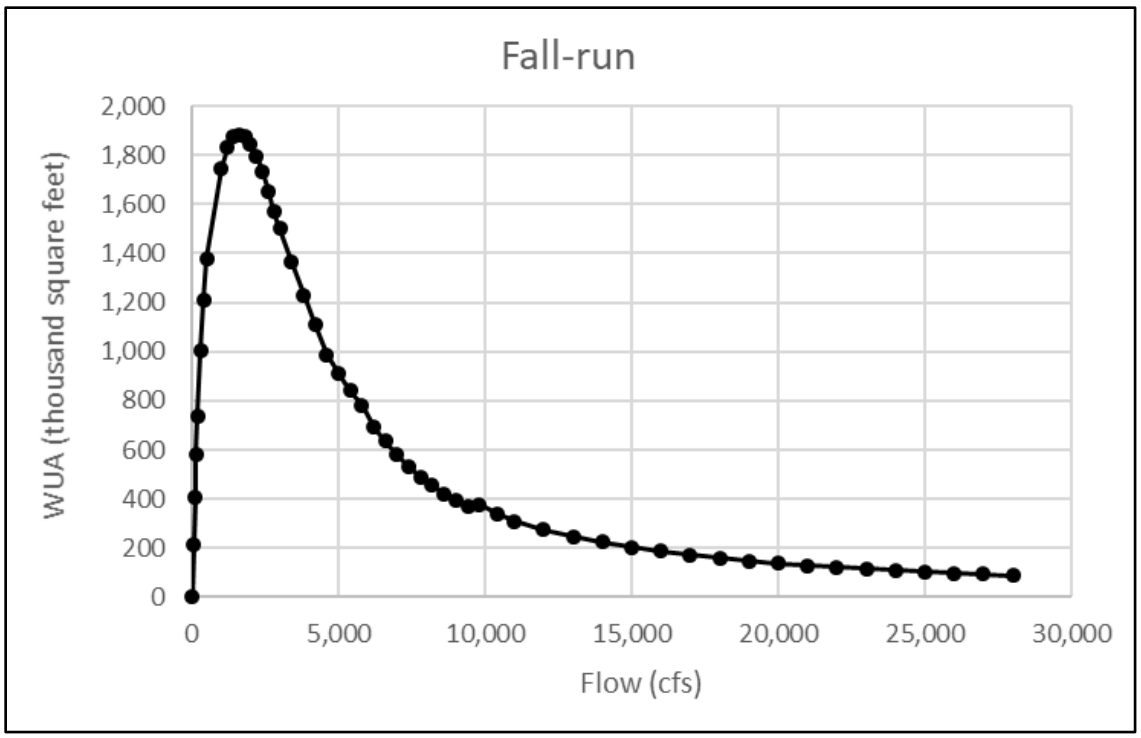


Figure 11K-9. Composite Spawning WUA for Fall-Run Chinook Salmon in the American River.

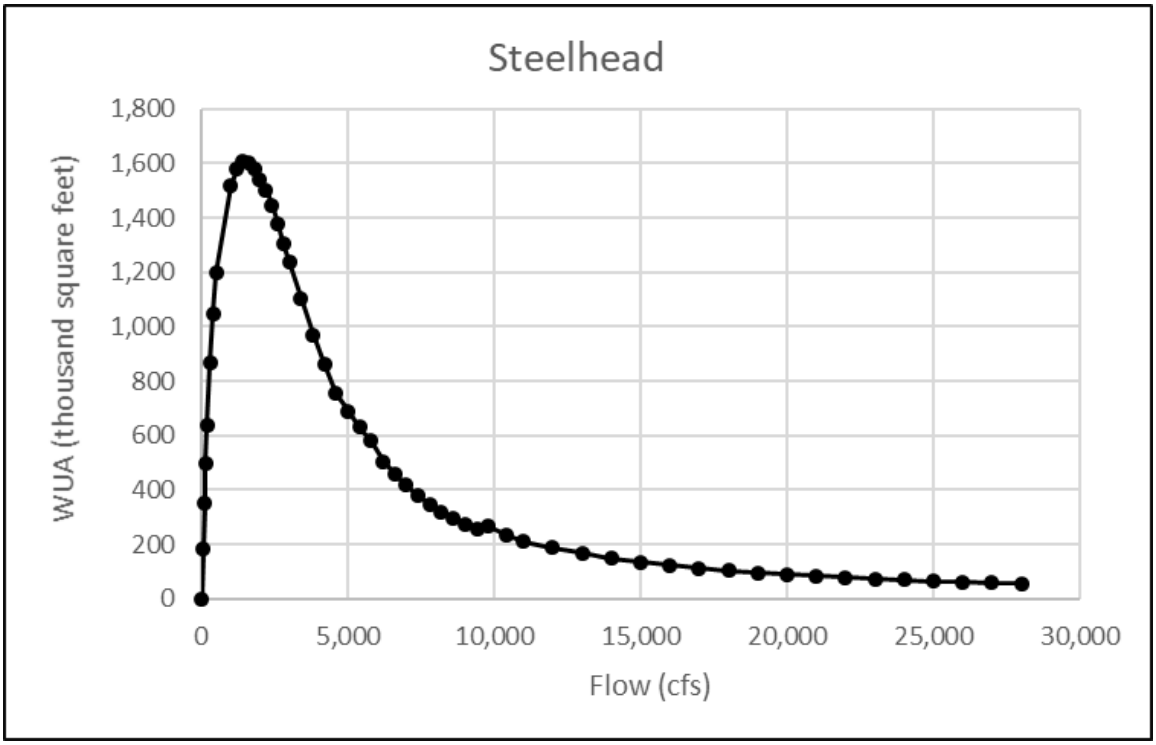


Figure 11K-10. Composite Spawning WUA for Steelhead in the American River.

11K.2.2. Rearing Habitat Weighted Usable Area

The availability of rearing habitat was estimated using WUA curves obtained from the literature (U.S. Fish and Wildlife Service 2005a). WUA is an index of the surface area of physical habitat available, weighted by the suitability of that habitat. WUA curves are normally developed as part of instream flow incremental methodology studies. Rearing habitat WUA was estimated only for the Sacramento River because the available flow versus rearing WUA curves for the Feather or American River were considered potentially flawed. The rearing WUA information for these rivers is old or potentially unreliable (U.S. Fish and Wildlife Service 1985; Thomas R. Payne & Associates 2002). In the case of the Feather River (Payne 2005), this uncertainty is discussed in the introduction of the study report:

> ….The results for this component of the analysis were more ambiguous and difficult to interpret than those for adult salmon and steelhead. In an effort to reach agreement on the meaning and applicability of the juvenile salmonid PHABSIM findings, an interagency meeting was held on June 3, 2004. At this meeting it was agreed that, given current channel conditions, the results did not support a clear alternative or ideal discharge level. Rearing habitat indexes for fry and juvenile Chinook salmon and steelhead did not respond clearly or significantly to changes in discharge. Furthermore, results differed markedly depending on how areas having no cover were treated in the model. Although the results appear to be valid (i.e. they correctly represent a simplified version of juvenile fish habitat), the amount of suitable habitat seems relatively insensitive to modeled discharge levels. Based on this interpretation, the group agreed that efforts to improve physical habitat for juvenile salmonids (e.g. increasing habitat complexity with side channels, mid-channel bars, riparian vegetation and/or instream objects) should be given primary consideration, and that any flow changes should be complimentary to these physical habitat enhancements. However, the group did recommend that juvenile salmonid PHABSIM results be used wherever possible to aide in the design and placement of future habitat enhancements.

11K.2.2.1. Sacramento River

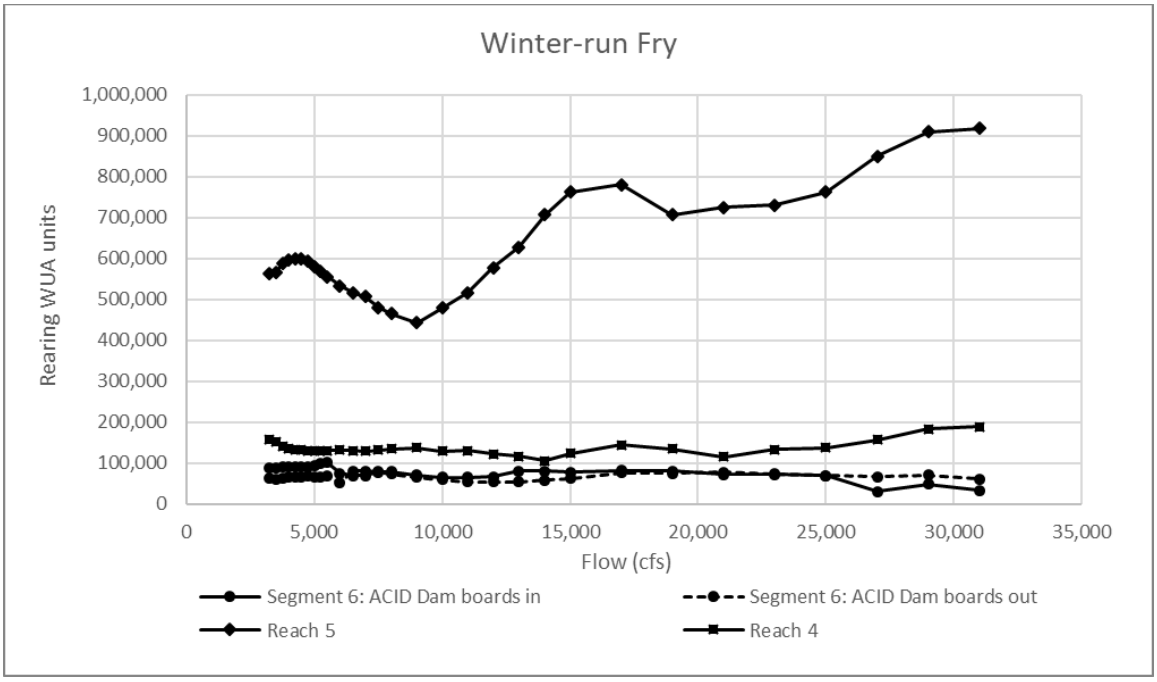
The rearing habitat WUA curves used for Chinook salmon rearing habitat in the Sacramento River were obtained from a USFWS report (U.S. Fish and Wildlife Service 2005a). As noted above for spawning habitat, WUA is computed as the surface area of physical habitat available weighted by its suitability. Modeling assumptions used to derive rearing WUA curves include that the suitability of physical habitat for salmon and steelhead rearing is largely a function of water depth, flow velocity, and the availability and type of cover. The race- or species-specific suitability of the habitat with respect to these variables is determined by observing the fish and is used to develop HSC for each race or species. Hydraulic modeling is then used to estimate the amount of rearing habitat available for different HSC levels at different river flows, and the results are used to develop rearing habitat WUA curves and tables (Bovee et al. 1998). These curves and tables are used to look up the amount of rearing WUA available at different flows.

USFWS (2005a) provides WUA curves and tables for rearing winter-run, fall-run, and late fall–run Chinook salmon for three segments of the Sacramento River encompassing the reach from Keswick Dam to Battle Creek (Figure 11K-1). Separate curves were developed for fry and juveniles, with fry defined as fish less than 60 millimeters and juveniles defined as greater than 60 millimeters. No WUA curves were developed for spring-run Chinook salmon or steelhead, but as discussed later, the fall-run curves were used to quantify spring-run rearing habitat and the late fall–run curves were used for steelhead. Figure 11K-11 through Figure 11K-16 show the flow versus rearing WUA results for fry and juvenile winter-run, fall-run, and late fall–run Chinook salmon in the three river segments (Segment 6 = Keswick to ACID Dam, Segment 5 =

ACID Dam to Cow Creek, and Segment 4 = Cow Creek to Battle Creek) as provided in USFWS (2006). Note that for Segment 6, separate WUA curves were developed for periods when the ACID Dam boards are installed (April through October) and for when the boards are out because installation of the boards affects water depths and velocities for some of the sampling transects used to develop the curves. All rearing WUA analyses were limited to juveniles less than a year old.

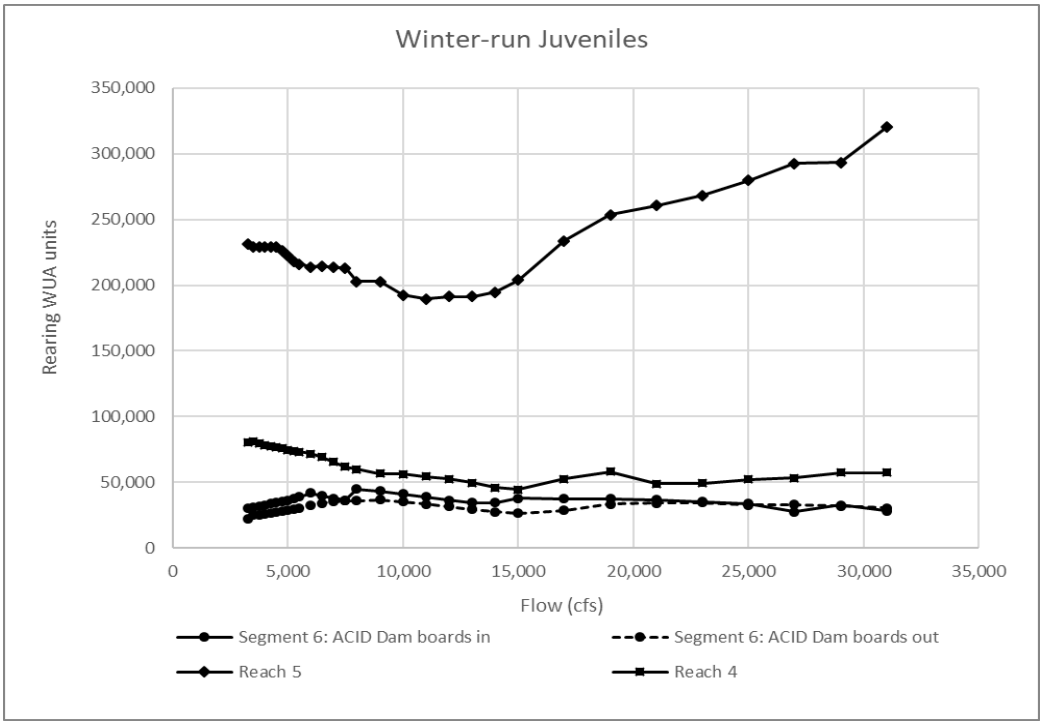
Because tributaries enter the Sacramento River between Keswick Dam and Battle Creek, flows are generally different among the three segments. For the USFWS studies, flows were measured directly at the sampling transects and were estimated as the sum of Keswick flow releases and tributary gauge readings upstream of the transects. To estimate WUA for the effects analysis, the segment flows were estimated using Sacramento River CALSIM II flows at Keswick Dam, the Clear Creek confluence, and Battle Creek for Segments 6, 5, and 4, respectively. Keswick Dam flows were used for Segment 5 upstream of the Clear Creek confluence. For Segment 6, the WUA curves for the months when the ACID Dam boards are installed (April through October) were used with the flows for those months and the WUA curves for the months when the ACID Dam boards are out were used with the flows for the rest of the year.

Although fall-run rearing WUA curves were used as surrogates for spring-run rearing, CALSIM II flows for the months of spring-run rearing, not those of fall-run rearing, were used to compute the spring-run WUA results. This caveat applies as well to the use of the late fall–run rearing WUA curves to compute steelhead WUA results.



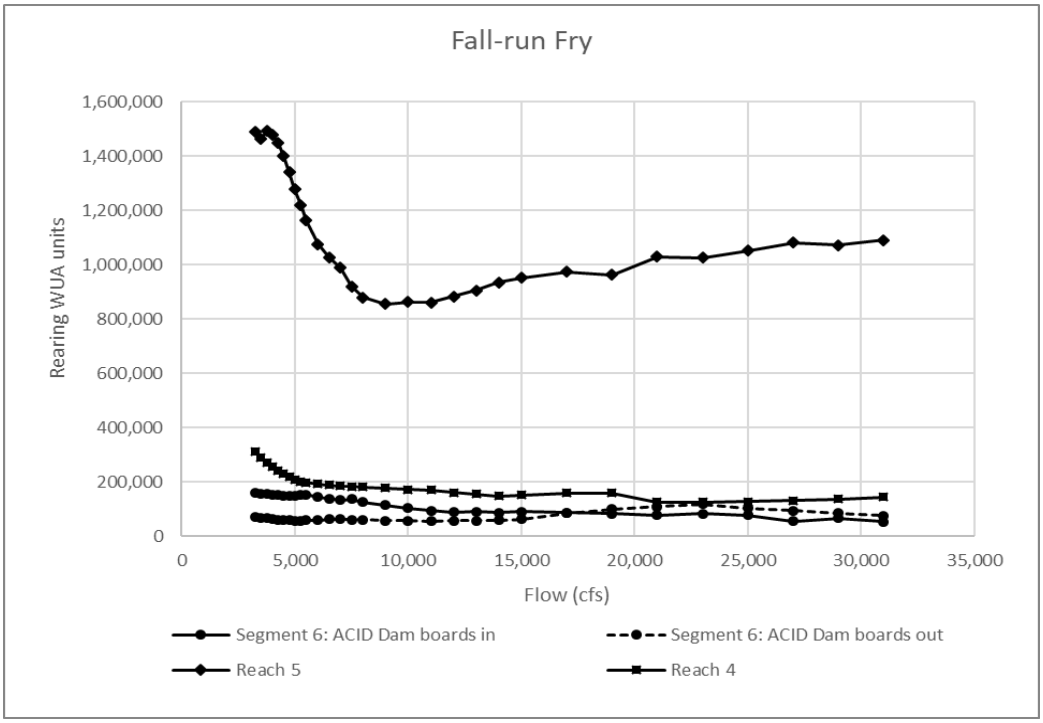
ACID = Anderson-Cottonwood Irrigation District.

Figure 11K-11. Rearing WUA Curves for Winter-Run Chinook Salmon Fry in the Sacramento River, Segments 4 to 6.



ACID = Anderson-Cottonwood Irrigation District.

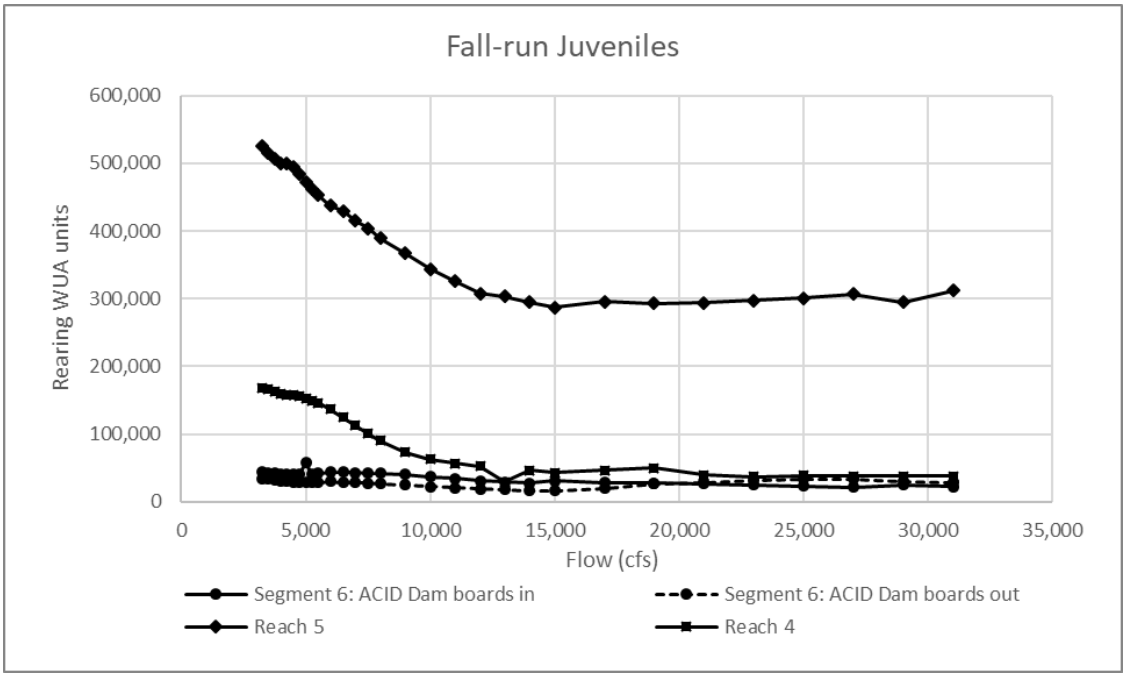
Figure 11K-12. Rearing WUA Curves for Winter-Run Chinook Salmon Juveniles in the Sacramento River, Segments 4 to 6.



ACID = Anderson-Cottonwood Irrigation District.

Note: The fall-run curves were used to quantify spring-run Chinook salmon WUA, as discussed in the text.

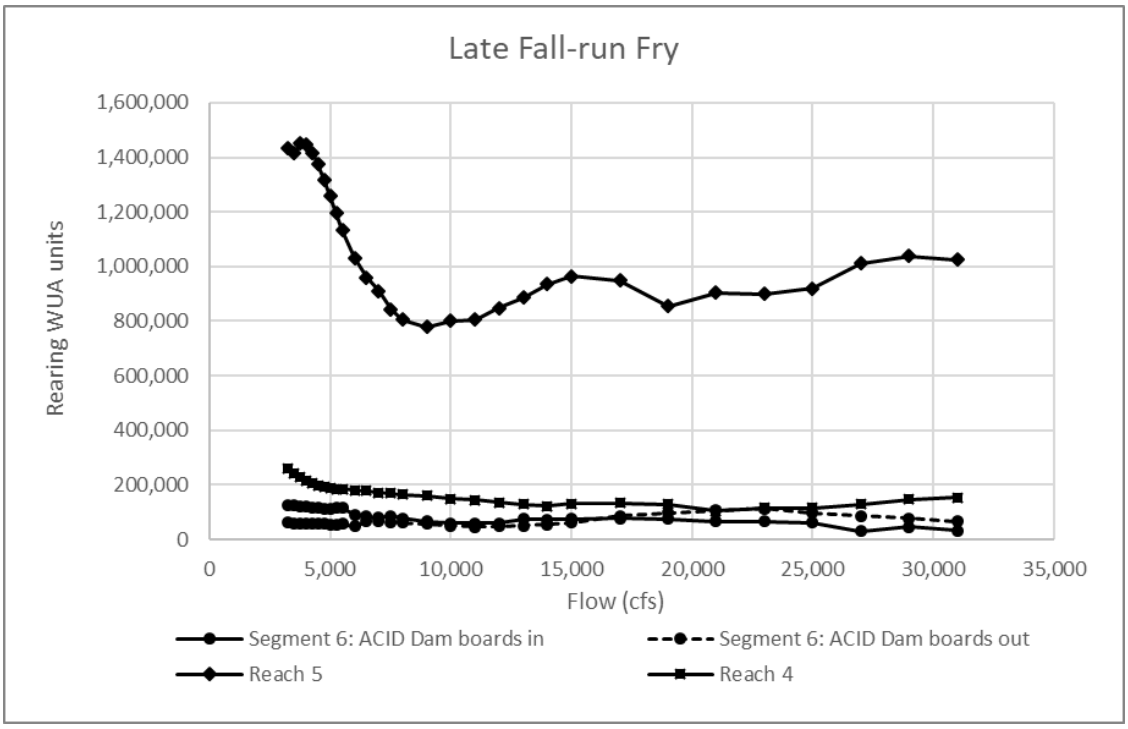
Figure 11K-13. Rearing WUA Curves for Fall-Run Chinook Salmon Fry in the Sacramento River, Segments 4 to 6.



ACID = Anderson-Cottonwood Irrigation District.

Note: The fall-run curves were used to quantify spring-run Chinook salmon WUA, as discussed in the text.

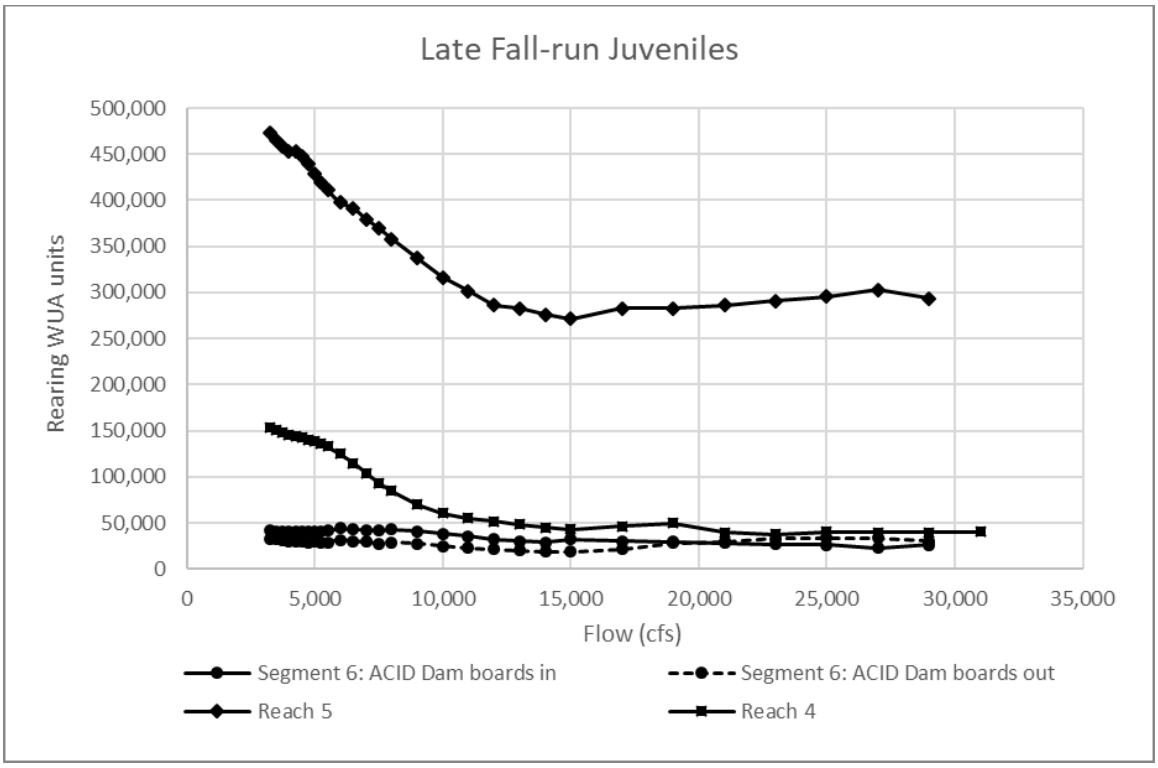
Figure 11K-14. Rearing WUA Curves for Fall-Run Chinook Salmon Juveniles in the Sacramento River, Segments 4 to 6.



ACID = Anderson-Cottonwood Irrigation District.

Note: The late fall–run rearing curves were used to quantify steelhead rearing WUA, as discussed in the text.

Figure 11K-15. Rearing WUA Curves for Late Fall–Run Chinook Salmon Fry in the Sacramento River, Segments 4 to 6.



ACID = Anderson-Cottonwood Irrigation District.

Note: The late fall–run rearing curves were used to quantify steelhead rearing WUA, as discussed in the text.

Figure 11K-16. Rearing WUA Curves for Late Fall–Run Chinook Salmon Juveniles in the Sacramento River, Segments 4 to 6.

As noted above, there are no spring-run or steelhead rearing WUA curves in the USFWS documentation, so the fall-run and late fall–run Chinook salmon rearing WUA curves were used as surrogates to model rearing habitat for spring-run and steelhead, respectively. Mark Gard, who led the USFWS studies that produced the Sacramento River WUA curves, has endorsed this practice for both spring-run Chinook salmon and steelhead (Gard pers. comm.). The use of these substitutions has been adopted in subsequent studies. For instance, the SacEFT model, which produces spawning and rearing WUA outputs for CV spring-run Chinook salmon and steelhead, derives the spring-run spawning and rearing WUA results using the fall-run WUA curves as surrogates and the steelhead rearing WUA results using the late fall–run WUA curves as surrogates (ESSA Technologies 2011; Robinson pers. comm.). It should be noted that this practice introduces additional uncertainty to the spring-run and steelhead results.

A potential limitation of the WUA curves presented above, as of all such habitat-based studies, is that they assume the channel characteristics of the river during the time of field data collection by USFWS (1995–1999), such as proportions of mesohabitat types, have remained in dynamic equilibrium to the present time and would continue to do so through the life of the Project. If the channel characteristics substantially change, the shape of the curves may no longer be applicable. A further limitation is that the curves were developed for the Sacramento River upstream of Battle Creek, but all races of Chinook salmon and steelhead spend time rearing downstream of this part of the river.

Differences in the mean rearing WUA under Alternatives 1, 2, and 3 and the NAA were examined for the months of the fry and juvenile rearing period under each water year type and all water year types combined.

11K.2.3. Discussion Regarding Validity of Weighted Usable Area Analysis

WUA analysis is among the most widely used and recognized analytical tools for assessing effects of flow on fish populations (Reiser and Hilgert 2018). Procedures for quantifying WUA were developed and standardized by USFWS in the 1970s and they have since been widely adopted by researchers (e.g., Bourgeois et al. 1996; Beecher et al. 2010; Railsback 2016; Naman et al. 2020). However, WUA analysis has received some criticism from instream flow analysis practitioners, especially in recent years. Many conclusions in this appendix and Chapter 11, *Aquatic Biological Resources*, regarding effects on fish of changes in flow resulting from Project operations are based on WUA analyses. Therefore, it is important to understand and evaluate the criticisms of WUA analysis and consider any potential limitations for assessing flow-related Project effects.

Two frequent criticisms of the WUA analysis that are most potentially relevant with regard to the results and conclusions of the Sites environmental documents are: (1) WUA analysis fails to directly evaluate many factors that are known to be important to fish population production, including water quality (especially temperature), predation, competition, and food supply (Beecher et al. 2010; Railsback 2016; Naman et al. 2019, 2020), and (2) the models employed to develop the WUA curves (especially PHABSIM) are antiquated, the field observations and measurements used to run the models are not sufficiently fine-grained to capture important highly localized factors, and the models do not adequately capture many dynamic properties of fish habitat use (Railsback 2016; Reiser and Hilgert 2018).

With regard to the first criticism, PHABSIM and the WUA curves they produce were never meant to address all factors affecting fish populations. As noted in a recent paper rebutting many of the criticisms of PHABSIM (Stalnaker et al. 2017): “PHABSIM is a component of instream flow incremental methodology (IFIM), which is a multifaceted decision support system that looks at riverine ecology for the purpose of making water management decisions.” The IFIM uses a suite of evaluation tools (including PHABSIM) and investigates water quality factors and other factors that affect fish in addition to the hydraulic-related habitat conditions analyzed using PHABSIM or other hydraulic habitat models (Beecher 2017). Analysis methods other than PHABSIM are used to evaluate the other factors, which may or may not be affected by flow. For the Project effects analyses, in addition to the spawning and rearing WUA analyses, evaluation tools include analyses of water temperatures, redd dewatering, juvenile stranding, adult migration passage, inundated floodplain and side-channel habitat availability, floodplain access opportunity for juvenile salmonids, migrating adult passage, emigrating juvenile salmonid flow-survival, water diversion entrainment, and other factors. Conclusions regarding effects of the Project on a species are based on evaluations of the results for all the factors analyzed.

The second criticism is more specific to the modeling tools used for WUA analyses. Many of the limitations of PHABSIM cited by critics are acknowledged by its defenders (Beecher 2017; Stalnaker et al. 2017; Reiser and Hilgert 2018). Some of the cited shortcomings are common to any model that attempts to simulate complex ecological systems. Others reflect that PHABSIM is antiquated; newer, more powerful procedures have been incorporated into new models. In fact,

many studies have replaced PHABSIM with more powerful tools in recent years, including the RIVER2D hydraulic and habitat model that was used by USFWS to develop the Sacramento River WUA curves used for the Project WUA analyses (U.S. Fish and Wildlife Service 2005b). The field data used for the hydraulic/habitat modeling have also been refined and improved. For instance, improvements have been made in the flow velocity data used to represent the full range of flow velocity conditions affecting drift-feeding juvenile salmonids (Naman et al. 2019). The USFWS studies of Sacramento River rearing WUA include such a modification to represent flow velocities (U.S. Fish and Wildlife Service 2005a). In addition, improvements have been developed to include a broader range of factors in the modeling, including some of those mentioned in the previous paragraph. One of these includes modeling of bioenergetic factors (Naman et al. 2020). Such methods are promising, but they are not currently available for use in analyzing flow effects on fish populations in the Sacramento River system. Some of the shortcomings of WUA analysis are more difficult to remedy. For instance, competition within a cohort of juvenile salmonids may affect habitat use such that dominant fish exclude sub-dominants from optimal habitat locations, resulting in the highest densities of fish occupying sub-optimal habitat (Beecher et al. 2010; Beecher 2017). Some such biases are inevitable in any effort to model fish populations, but improvements in sampling and modeling techniques can be expected to lead to more accurate models in the future. PHABSIM and similar models, despite their shortcomings, continue to be among the most used and useful analytical tools for assessing instream-flow-related issues (Reiser and Hilgert 2018).

11K.3 Results

11K.3.1. Spawning Habitat Weighted Usable Area

11K.3.1.1. Sacramento River

Winter-run Chinook Salmon

Spawning WUA for winter-run Chinook salmon was determined by USFWS (2003a) for a range of flows in the three segments of the Sacramento River between Keswick Dam and the Battle Creek confluence (Figure 11K-1). About 46% of winter-run redds occur with Segment 6, which stretches 2 miles from Keswick Dam to the ACID Dam (Table 11K-1), and most of the remainder occur within Segment 5, which lies between the ACID Dam and the Cow Creek confluence, a distance of 18.5 miles.

To estimate changes in winter-run spawning WUA that would result from Alternatives 1, 2, and 3, the flow versus spawning habitat WUA relationship developed for each of the three segments was used with mean monthly CALSIM II flows for the corresponding segments of the river under Alternatives 1, 2, and 3 and the NAA during the winter-run spawning period (April through July) (Appendix 11A, *Aquatic Species Life Histories*, Table 11A-2).

Differences in winter-run spawning WUA under Alternatives 1, 2, and 3 and the NAA were examined using the grand mean spawning WUA for each month of the spawning period under each water year type and all water year types combined. The means differ by less than 4% for most months and water year types, but mean WUA in Segment 6 under Alternatives 1A and 1B is 8% to 9% lower than WUA under the NAA in April of Critically Dry Water Years (Table

11K-2). In Segment 5, WUA consistently differs little between Alternatives 1, 2, and 3 and the NAA, except for a 9% increase in WUA under Alternative 3 in July of Above Normal Water Years (Table 11K-3). In Segment 4, spawning WUA is up to 7% higher under Alternative 3 than under the NAA in June and July of Above Normal and Below Normal Water Years (Table 11K-4).

These results indicate that in Segment 6, Alternatives 1A and 1B would result in reductions of spawning habitat during April of Critically Dry Water Years. In Segments 5 and 4, Alternative 3 would results in increases of spawning habitat during June and July of Above Normal and Below Normal Water Years. Note that spawning habitat conditions for winter-run are more important in Segments 6 and 5 than in Segment 4. Most differences in spawning WUA between Alternatives 1, 2, and 3 and the NAA in all three river segments are less than 3%, so the alternatives are not expected to substantially affect winter-run spawning WUA.

Table 11K-2. Winter-Run Spawning WUA[1] in the Sacramento River, Segment 6, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
April	Wet	198	198 (0%)	197 (-0.9%)	198 (0%)	195 (-1.9%)
	Above Normal	183	183 (0.3%)	184 (0.5%)	183 (0.3%)	180 (-1.7%)
	Below Normal	153	152 (-0.4%)	152 (-0.7%)	152 (-0.4%)	149 (-2.7%)
	Dry	154	155 (0.7%)	147 (-4.8%)	155 (0.7%)	150 (-2.7%)
	Critically Dry	156	142 (-8.9%)	143 (-7.8%)	151 (-2.9%)	152 (-2.3%)
	All	172	170 (-1.1%)	168 (-2.3%)	172 (-0.3%)	169 (-2.2%)
May	Wet	283	283 (0%)	288 (1.8%)	283 (0%)	287 (1.4%)
	Above Normal	280	281 (0.1%)	280 (-0.2%)	281 (0.1%)	284 (1.4%)
	Below Normal	270	270 (0%)	262 (-2.8%)	270 (0%)	261 (-3.2%)
	Dry	275	276 (0.5%)	273 (-0.9%)	276 (0.5%)	269 (-2.3%)
	Critically Dry	277	274 (-1%)	274 (-1.2%)	273 (-1.4%)	268 (-3.3%)
	All	278	278 (0%)	277 (-0.3%)	278 (-0.1%)	275 (-0.8%)
June	Wet	292	292 (0.1%)	292 (-0.1%)	292 (0.1%)	292 (-0.1%)
	Above Normal	305	305 (0%)	302 (-0.9%)	305 (0%)	300 (-1.5%)
	Below Normal	298	298 (0%)	298 (0%)	298 (0%)	296 (-0.8%)
	Dry	296	296 (0%)	297 (0.3%)	296 (0%)	299 (0.9%)
	Critically Dry	297	294 (-0.9%)	294 (-0.9%)	294 (-0.9%)	294 (-1%)
	All	297	296 (-0.1%)	296 (-0.2%)	296 (-0.1%)	296 (-0.3%)
July	Wet	291	291 (0%)	291 (0%)	291 (0%)	291 (0%)
	Above Normal	273	274 (0.4%)	274 (0.3%)	275 (0.7%)	282 (3.3%)
	Below Normal	286	288 (0.9%)	287 (0.3%)	288 (0.9%)	291 (1.9%)
	Dry	294	294 (0%)	294 (0.1%)	294 (0%)	295 (0.5%)
	Critically Dry	299	299 (0%)	299 (0.1%)	299 (0%)	300 (0.4%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	All	289	290 (0.2%)	290 (0.1%)	290 (0.2%)	292 (0.9%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-3. Winter-Run Spawning WUA[1] in the Sacramento River, Segment 5, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
April	Wet	627	627 (0%)	624 (-0.5%)	625 (-0.2%)	620 (-1.1%)
	Above Normal	666	666 (0.1%)	667 (0.1%)	667 (0.1%)	659 (-1%)
	Below Normal	640	638 (-0.2%)	637 (-0.4%)	638 (-0.3%)	632 (-1.2%)
	Dry	636	637 (0.1%)	627 (-1.4%)	632 (-0.6%)	631 (-0.8%)
	Critically Dry	646	627 (-2.9%)	630 (-2.4%)	635 (-1.6%)	642 (-0.6%)
	All	639	637 (-0.4%)	634 (-0.8%)	636 (-0.5%)	633 (-1%)
May	Wet	733	733 (0%)	739 (0.7%)	736 (0.4%)	738 (0.7%)
	Above Normal	751	752 (0.2%)	746 (-0.6%)	749 (-0.2%)	749 (-0.3%)
	Below Normal	768	768 (0%)	764 (-0.6%)	766 (-0.3%)	763 (-0.6%)
	Dry	778	779 (0.1%)	778 (-0.1%)	778 (-0.1%)	775 (-0.5%)
	Critically Dry	783	780 (-0.3%)	780 (-0.4%)	780 (-0.4%)	774 (-1.1%)
	All	759	759 (0%)	759 (-0.1%)	759 (0%)	757 (-0.2%)
June	Wet	768	769 (0%)	768 (0%)	768 (0%)	768 (0%)
	Above Normal	781	781 (0%)	795 (1.8%)	787 (0.8%)	794 (1.7%)
	Below Normal	745	744 (-0.1%)	752 (1%)	748 (0.4%)	771 (3.6%)
	Dry	723	723 (-0.1%)	727 (0.4%)	725 (0.2%)	747 (3.2%)
	Critically Dry	769	777 (1%)	781 (1.6%)	779 (1.2%)	783 (1.8%)
	All	756	757 (0.1%)	762 (0.8%)	760 (0.4%)	770 (1.8%)
July	Wet	663	663 (0%)	663 (0.1%)	663 (0%)	663 (0%)
	Above Normal	570	575 (0.9%)	582 (2.2%)	579 (1.6%)	620 (8.8%)
	Below Normal	636	644 (1.3%)	638 (0.4%)	641 (0.8%)	659 (3.7%)
	Dry	672	672 (0%)	674 (0.2%)	673 (0.1%)	685 (1.9%)
	Critically Dry	762	762 (0%)	765 (0.5%)	764 (0.3%)	773 (1.5%)
	All	661	663 (0.3%)	664 (0.5%)	664 (0.4%)	677 (2.4%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-4. Winter-Run Spawning WUA[1] in the Sacramento River, Segment 4, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
April	Wet	166	166 (0%)	166 (-0.3%)	166 (0%)	165 (-0.8%)
	Above Normal	191	190 (-0.2%)	190 (-0.2%)	190 (-0.2%)	189 (-1%)
	Below Normal	199	199 (-0.2%)	198 (-0.5%)	199 (-0.2%)	198 (-0.5%)
	Dry	197	197 (-0.1%)	198 (0.4%)	197 (-0.1%)	198 (0.3%)
	Critically Dry	201	199 (-1.1%)	200 (-0.6%)	201 (0%)	201 (0.2%)
	All	187	187 (-0.3%)	187 (-0.2%)	187 (-0.1%)	187 (-0.4%)
May	Wet	160	161 (0.1%)	159 (-0.9%)	161 (0.1%)	160 (-0.4%)
	Above Normal	175	176 (0.1%)	175 (-0.3%)	176 (0.1%)	172 (-1.9%)
	Below Normal	188	188 (-0.1%)	192 (2.2%)	188 (-0.1%)	193 (2.6%)
	Dry	183	183 (-0.3%)	186 (1.3%)	183 (-0.3%)	189 (3.1%)
	Critically Dry	187	189 (1.4%)	190 (1.9%)	191 (2.3%)	194 (3.7%)
	All	176	176 (0.2%)	177 (0.7%)	177 (0.3%)	179 (1.3%)
June	Wet	172	171 (-0.1%)	172 (0%)	171 (-0.1%)	172 (0%)
	Above Normal	160	160 (0%)	168 (4.8%)	160 (0%)	171 (6.6%)
	Below Normal	159	159 (-0.1%)	161 (1.1%)	159 (-0.1%)	170 (6.7%)
	Dry	154	153 (-0.1%)	154 (0.3%)	153 (-0.1%)	158 (3%)
	Critically Dry	170	174 (2.2%)	175 (2.8%)	174 (2.2%)	176 (3.2%)
	All	164	164 (0.3%)	166 (1.4%)	164 (0.3%)	169 (3.2%)
July	Wet	142	142 (0%)	142 (0.2%)	142 (0%)	142 (0.1%)
	Above Normal	131	132 (0.7%)	133 (1.3%)	133 (1%)	140 (6.9%)
	Below Normal	139	141 (0.9%)	140 (0.4%)	140 (0.8%)	142 (2.2%)
	Dry	146	146 (-0.1%)	146 (0.1%)	146 (-0.1%)	147 (0.8%)
	Critically Dry	167	166 (-0.1%)	167 (0.3%)	167 (0%)	168 (0.9%)
	All	144	145 (0.2%)	145 (0.3%)	145 (0.2%)	147 (1.6%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Spring-Run Chinook Salmon

Spawning habitat for spring-run Chinook salmon was not estimated directly by USFWS (2003a, 2006) and no spring-run Chinook salmon WUA curves for the Sacramento River have been located, so spring-run spawning habitat was modeled using the WUA curves provided by USFWS (2003b, 2006) for fall-run Chinook salmon. However, as noted by USFWS (2003a), the validity of using the fall-run WUA curves to characterize spring-run spawning habitat is uncertain.

To evaluate the effects of the NAA and Alternatives 1, 2, and 3 on spring-run spawning habitat, spring-run spawning WUA was estimated for flows during the August through October spawning period under Alternatives 1, 2, and 3 and the NAA in the same three segments of the Sacramento River that were used for winter-run (Figure 11K-1). The redd distribution data for spring-run indicate that about 12%, 66% and 13% of spring-run redds occur within Segments 6, 5, and 4, respectively (Table 11K-1).

Mean spawning WUA for spring-run under Alternatives 1, 2, and 3 differs from the NAA by more than about 3% for only a few months and water year types, with most of these differences occurring under Alternative 3 (Table 11K-5 through Table 11K-7). The largest difference is a 16% increase under Alternative 3 in Segment 5 for August of Above Normal Water Years (Table 11K-6) and the largest reduction is a 7% reduction under Alternative 3 in Segment 4 for October of Wet Water Years (Table 11K-7). Other relatively large differences in WUA between Alternatives 1, 2, and 3 and the NAA are 4%–6% reductions occurring in Critically Dry Water Years during August in Segment 5 and during September in Segment 4.

These results indicate that Alternatives 1, 2, and 3 would result in some reductions and increases of spawning habitat. As noted above, spawning habitat conditions for spring-run are most important in Segment 5, which has one large increase and several smaller increases and reductions (Table 11K-6). Most differences in spawning WUA between Alternatives 1, 2, and 3 and the NAA in Segments 6 and 5 are less than 3%, but almost half of the differences for Alternative 3 in Segment 4 are reductions of greater than 3%. However, relatively little spring-run spawning occurs in Segment 4 (Table 11K-1). On balance, Alternatives 1, 2, and 3 are not expected to substantially affect spring-run spawning WUA.

Table 11K-5. Spring-Run Spawning WUA[1] in the Sacramento River, Segment 6, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
August	Wet	235	235 (0%)	236 (0.5%)	235 (0%)	236 (0.4%)
	Above Normal	243	247 (1.8%)	245 (1%)	248 (2%)	259 (6.8%)
	Below Normal	260	264 (1.7%)	261 (0.7%)	264 (1.5%)	268 (3.1%)
	Dry	272	272 (0.2%)	273 (0.2%)	272 (0.2%)	274 (0.8%)
	Critically Dry	300	290 (-3.4%)	291 (-3.1%)	291 (-3.2%)	291 (-3%)
	All	258	258 (0%)	258 (-0.1%)	258 (0%)	261 (1.3%)
September	Wet	247	247 (0%)	249 (0.8%)	247 (0%)	248 (0.6%)
	Above Normal	279	284 (2.1%)	280 (0.4%)	285 (2.3%)	277 (-0.6%)
	Below Normal	320	319 (-0.3%)	320 (0%)	319 (-0.3%)	319 (-0.2%)
	Dry	307	307 (-0.1%)	307 (0.1%)	307 (-0.1%)	306 (-0.2%)
	Critically Dry	295	305 (3.3%)	305 (3.2%)	304 (3%)	302 (2.4%)
	All	284	286 (0.7%)	286 (0.8%)	286 (0.7%)	285 (0.4%)
October	Wet	294	296 (0.6%)	296 (0.6%)	296 (0.7%)	296 (0.6%)
	Above Normal	304	306 (0.6%)	306 (0.6%)	305 (0.4%)	309 (1.6%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Below Normal	305	303 (-0.5%)	303 (-0.6%)	303 (-0.5%)	306 (0.4%)
	Dry	313	311 (-0.6%)	313 (-0.2%)	311 (-0.6%)	312 (-0.4%)
	Critically Dry	295	296 (0%)	296 (0.3%)	296 (0%)	298 (0.7%)
	All	302	302 (0.1%)	302 (0.2%)	302 (0.1%)	303 (0.5%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-6. Spring-Run Spawning WUA[1] in the Sacramento River, Segment 5, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
August	Wet	304	304 (0%)	308 (1.1%)	304 (0%)	307 (1%)
	Above Normal	328	341 (4.2%)	336 (2.5%)	342 (4.5%)	379 (15.7%)
	Below Normal	379	394 (3.8%)	385 (1.5%)	392 (3.5%)	405 (6.8%)
	Dry	418	420 (0.3%)	420 (0.4%)	420 (0.3%)	426 (1.8%)
	Critically Dry	497	467 (-6%)	470 (-5.3%)	468 (-5.7%)	471 (-5.3%)
	All	374	374 (0.1%)	373 (-0.1%)	374 (0.2%)	385 (2.9%)
September	Wet	336	336 (0%)	342 (1.8%)	336 (0%)	341 (1.4%)
	Above Normal	433	449 (3.7%)	436 (0.7%)	452 (4.2%)	427 (-1.3%)
	Below Normal	585	586 (0.1%)	585 (0%)	586 (0.1%)	587 (0.3%)
	Dry	591	590 (-0.1%)	590 (0%)	590 (-0.1%)	590 (-0.1%)
	Critically Dry	584	589 (0.9%)	589 (0.9%)	589 (0.8%)	588 (0.6%)
	All	485	488 (0.6%)	488 (0.6%)	488 (0.7%)	486 (0.3%)
October	Wet	520	519 (-0.1%)	518 (-0.4%)	519 (-0.1%)	507 (-2.4%)
	Above Normal	542	545 (0.6%)	543 (0.3%)	542 (0.1%)	540 (-0.4%)
	Below Normal	551	551 (-0.1%)	548 (-0.5%)	551 (-0.1%)	547 (-0.8%)
	Dry	571	568 (-0.6%)	568 (-0.5%)	568 (-0.6%)	563 (-1.5%)
	Critically Dry	554	555 (0.1%)	556 (0.3%)	556 (0.2%)	555 (0.1%)
	All	545	544 (-0.1%)	543 (-0.2%)	544 (-0.1%)	538 (-1.3%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-7. Spring-Run Spawning WUA[1] in the Sacramento River, Segment 4, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
August	Wet	127	127 (0%)	127 (0.3%)	127 (0%)	127 (0.3%)
	Above Normal	132	134 (1.7%)	132 (0.4%)	134 (1.9%)	138 (5.1%)
	Below Normal	139	140 (1%)	140 (0.5%)	140 (1%)	142 (2.2%)
	Dry	141	142 (0.2%)	142 (0.3%)	142 (0.2%)	142 (0.3%)
	Critically Dry	152	146 (-3.9%)	147 (-3.5%)	146 (-4%)	147 (-3.7%)
	All	136	136 (-0.2%)	136 (-0.3%)	136 (-0.2%)	137 (0.6%)
September	Wet	136	136 (0%)	136 (0.3%)	136 (0%)	136 (0.1%)
	Above Normal	145	147 (1.1%)	145 (-0.5%)	147 (1.2%)	141 (-2.7%)
	Below Normal	206	210 (1.7%)	206 (0%)	210 (1.8%)	210 (1.8%)
	Dry	236	236 (-0.1%)	235 (-0.5%)	236 (-0.1%)	236 (0.2%)
	Critically Dry	250	236 (-5.3%)	237 (-5.2%)	237 (-4.9%)	240 (-4%)
	All	188	187 (-0.6%)	186 (-1.1%)	187 (-0.5%)	187 (-0.6%)
October	Wet	184	180 (-1.9%)	179 (-2.4%)	180 (-2%)	172 (-6.6%)
	Above Normal	182	182 (0%)	181 (-0.7%)	181 (-0.6%)	174 (-4.8%)
	Below Normal	188	190 (0.9%)	188 (0%)	190 (0.8%)	182 (-3.4%)
	Dry	192	192 (0.2%)	190 (-1.1%)	192 (0.2%)	186 (-3.3%)
	Critically Dry	209	209 (0%)	209 (0%)	209 (0.4%)	206 (-1.5%)
	All	190	189 (-0.4%)	188 (-1.1%)	189 (-0.5%)	182 (-4.3%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Fall-Run Chinook Salmon

Spawning habitat WUA for fall-run Chinook salmon was determined by USFWS (2003a, 2006) in the same manner that it was determined for winter-run Chinook salmon. To evaluate the effects of Alternatives 1, 2, and 3 on fall-run spawning habitat, fall-run spawning WUA was estimated for flows during the September through November spawning period under the NAA and Alternatives 1, 2, and 3 in the same three segments of the Sacramento River that were used for winter-run and spring-run Chinook salmon (Tables 11K-8 through 11K-10). However, because fall-run spawning occurs further downstream than spawning of the other runs, fall-run spawning WUA was estimated for an additional downstream segment (Segment 3) (Figure 11K-1; Table 11K-11).

Reductions in mean spawning WUA for fall-run are larger and more frequent under Alternatives 1, 2, and 3 than increases, especially in Segment 4 under Alternative 3, for which about half of the months and water year types have reductions of more than 3% (Table 11K-8 and Table 11K-10). Reductions of more than 3% are also frequent in November under Alternative 3 in Segment 6 (Table 11K-8). The largest differences are 7% reductions under Alternative 3 for November of

Critically Dry Water Years in Segment 6 (Table 11K-8) and October of Wet Water Years in Segment 4 (Table 11K-10). The largest increases are about 4% under Alternatives 1A and 2 in September of Above Normal Water Years in Segment 5. The spawning distribution of fall-run is more evenly distributed over the four river segments than that of the other runs (Table 11K-1), and therefore differences resulting from Alternatives 1, 2, and 3 would potentially affect fall-run spawning habitat in any of the segments.

As noted above, more than 3% reductions in fall-run spawning WUA are frequent under Alternative 3 in Segments 4 and 6. For Alternatives 1A, 1B, and 2, almost all differences in fall-run spawning WUA between the alternatives and the NAA in all four river segments are less than 3%. These results indicate that Alternative 3 would result in frequent reductions, ranging up to 7%, in fall-run spawning habitat WUA. However, these reductions are largely limited to Segments 6 and 4, so the effects are not expected to substantially affect overall fall-run spawning habitat availability. The results also indicate that Alternatives 1A, 1B, and 2 would have little effect on fall-run spawning habitat.

Table 11K-8. Fall-Run Spawning WUA[1] in the Sacramento River, Segment 6, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
September	Wet	247	247 (0%)	249 (0.8%)	247 (0%)	248 (0.6%)
	Above Normal	279	284 (2.1%)	280 (0.4%)	285 (2.3%)	277 (-0.6%)
	Below Normal	320	319 (-0.3%)	320 (0%)	319 (-0.3%)	319 (-0.2%)
	Dry	307	307 (-0.1%)	307 (0.1%)	307 (-0.1%)	306 (-0.2%)
	Critically Dry	295	305 (3.3%)	305 (3.2%)	304 (3%)	302 (2.4%)
	All	284	286 (0.7%)	286 (0.8%)	286 (0.7%)	285 (0.4%)
October	Wet	294	296 (0.6%)	296 (0.6%)	296 (0.7%)	296 (0.6%)
	Above Normal	304	306 (0.6%)	306 (0.6%)	305 (0.4%)	309 (1.6%)
	Below Normal	305	303 (-0.5%)	303 (-0.6%)	303 (-0.5%)	306 (0.4%)
	Dry	313	311 (-0.6%)	313 (-0.2%)	311 (-0.6%)	312 (-0.4%)
	Critically Dry	295	296 (0%)	296 (0.3%)	296 (0%)	298 (0.7%)
	All	302	302 (0.1%)	302 (0.2%)	302 (0.1%)	303 (0.5%)
November	Wet	174	177 (1.5%)	176 (0.6%)	177 (1.6%)	167 (-4.3%)
	Above Normal	176	170 (-3.7%)	169 (-3.9%)	169 (-3.7%)	165 (-6.2%)
	Below Normal	198	195 (-1.1%)	195 (-1.1%)	195 (-1.2%)	194 (-2%)
	Dry	184	183 (-0.3%)	176 (-4%)	183 (-0.3%)	176 (-4.1%)
	Critically Dry	205	205 (0.1%)	206 (0.7%)	207 (1.1%)	191 (-6.8%)
	All	185	184 (-0.3%)	183 (-1.3%)	185 (-0.1%)	177 (-4.5%)

[1] WUA results are given in thousands of WUA units to save space.

[2] Water year type sorting is by hydrologic water years.

Table 11K-9. Fall-Run Spawning WUA[1] in the Sacramento River, Segment 5, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
September	Wet	336	336 (0%)	342 (1.8%)	336 (0%)	341 (1.4%)
	Above Normal	433	449 (3.7%)	436 (0.7%)	452 (4.2%)	427 (-1.3%)
	Below Normal	585	586 (0.1%)	585 (0%)	586 (0.1%)	587 (0.3%)
	Dry	591	590 (-0.1%)	590 (0%)	590 (-0.1%)	590 (-0.1%)
	Critically Dry	584	589 (0.9%)	589 (0.9%)	589 (0.8%)	588 (0.6%)
	All	485	488 (0.6%)	488 (0.6%)	488 (0.7%)	486 (0.3%)
October	Wet	520	519 (-0.1%)	518 (-0.4%)	519 (-0.1%)	507 (-2.4%)
	Above Normal	542	545 (0.6%)	543 (0.3%)	542 (0.1%)	540 (-0.4%)
	Below Normal	551	551 (-0.1%)	548 (-0.5%)	551 (-0.1%)	547 (-0.8%)
	Dry	571	568 (-0.6%)	568 (-0.5%)	568 (-0.6%)	563 (-1.5%)
	Critically Dry	554	555 (0.1%)	556 (0.3%)	556 (0.2%)	555 (0.1%)
	All	545	544 (-0.1%)	543 (-0.2%)	544 (-0.1%)	538 (-1.3%)
November	Wet	502	503 (0.3%)	502 (0.1%)	503 (0.3%)	496 (-1.1%)
	Above Normal	554	549 (-0.9%)	549 (-0.9%)	549 (-0.9%)	544 (-1.8%)
	Below Normal	561	561 (0%)	561 (-0.1%)	561 (-0.1%)	559 (-0.4%)
	Dry	529	527 (-0.5%)	528 (-0.2%)	527 (-0.5%)	524 (-0.9%)
	Critically Dry	572	572 (-0.1%)	571 (-0.2%)	570 (-0.4%)	571 (-0.2%)
	All	536	535 (-0.2%)	535 (-0.2%)	535 (-0.2%)	531 (-0.9%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-10. Fall-Run Spawning WUA[1] in the Sacramento River, Segment 4, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
September	Wet	136	136 (0%)	136 (0.3%)	136 (0%)	136 (0.1%)
	Above Normal	145	147 (1.1%)	145 (-0.5%)	147 (1.2%)	141 (-2.7%)
	Below Normal	206	210 (1.7%)	206 (0%)	210 (1.8%)	210 (1.8%)
	Dry	236	236 (-0.1%)	235 (-0.5%)	236 (-0.1%)	236 (0.2%)
	Critically Dry	250	236 (-5.3%)	237 (-5.2%)	237 (-4.9%)	240 (-4%)
	All	188	187 (-0.6%)	186 (-1.1%)	187 (-0.5%)	187 (-0.6%)
October	Wet	184	180 (-1.9%)	179 (-2.4%)	180 (-2%)	172 (-6.6%)
	Above Normal	182	182 (0%)	181 (-0.7%)	181 (-0.6%)	174 (-4.8%)
	Below Normal	188	190 (0.9%)	188 (0%)	190 (0.8%)	182 (-3.4%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Dry	192	192 (0.2%)	190 (-1.1%)	192 (0.2%)	186 (-3.3%)
	Critically Dry	209	209 (0%)	209 (0%)	209 (0.4%)	206 (-1.5%)
	All	190	189 (-0.4%)	188 (-1.1%)	189 (-0.5%)	182 (-4.3%)
November	Wet	173	175 (1%)	173 (0.2%)	175 (1.1%)	168 (-2.9%)
	Above Normal	180	176 (-2%)	176 (-2.2%)	176 (-2.1%)	174 (-3%)
	Below Normal	200	198 (-1.1%)	198 (-1%)	197 (-1.2%)	196 (-1.6%)
	Dry	193	193 (-0.3%)	187 (-3.3%)	193 (-0.3%)	187 (-3.1%)
	Critically Dry	208	208 (0.3%)	209 (0.7%)	210 (1.1%)	195 (-6%)
	All	188	188 (-0.2%)	186 (-1%)	188 (-0.1%)	182 (-3.2%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-11. Fall-Run Spawning WUA[1] in the Sacramento River, Segment 3, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
September	Wet	1,152	1,152 (0%)	1,163 (0.9%)	1,152 (0%)	1,160 (0.7%)
	Above Normal	1,391	1,430 (2.7%)	1,395 (0.3%)	1,314 (-5.5%)	1,387 (-0.3%)
	Below Normal	1,733	1,740 (0.4%)	1,733 (0%)	1,740 (0.4%)	1,741 (0.4%)
	Dry	1,777	1,777 (0%)	1,776 (-0.1%)	1,777 (0%)	1,777 (0%)
	Critically Dry	1,779	1,772 (-0.4%)	1,772 (-0.4%)	1,771 (-0.4%)	1,772 (-0.4%)
	All	1,517	1,522 (0.3%)	1,519 (0.2%)	1,522 (0.4%)	1,519 (0.2%)
October	Wet	1,553	1,544 (-0.6%)	1,539 (-0.9%)	1,544 (-0.6%)	1,507 (-2.9%)
	Above Normal	1,610	1,615 (0.3%)	1,610 (0%)	1,609 (0%)	1,584 (-1.6%)
	Below Normal	1,639	1,642 (0.2%)	1,636 (-0.2%)	1,642 (0.2%)	1,620 (-1.2%)
	Dry	1,678	1,675 (-0.1%)	1,669 (-0.5%)	1,676 (-0.1%)	1,654 (-1.4%)
	Critically Dry	1,670	1,671 (0%)	1,673 (0.2%)	1,674 (0.2%)	1,666 (-0.3%)
	All	1,621	1,618 (-0.1%)	1,614 (-0.4%)	1,618 (-0.2%)	1,593 (-1.7%)
November	Wet	1,419	1,426 (0.5%)	1,421 (0.2%)	1,427 (0.6%)	1,392 (-1.9%)
	Above Normal	1,567	1,547 (-1.3%)	1,547 (-1.3%)	1,547 (-1.3%)	1,533 (-2.1%)
	Below Normal	1,654	1,650 (-0.3%)	1,650 (-0.3%)	1,649 (-0.3%)	1,642 (-0.7%)
	Dry	1,563	1,559 (-0.3%)	1,548 (-0.9%)	1,559 (-0.2%)	1,543 (-1.3%)
	Critically Dry	1,701	1,703 (0.2%)	1,704 (0.2%)	1,701 (0%)	1,674 (-1.6%)
	All	1,553	1,552 (-0.1%)	1,548 (-0.4%)	1,551 (-0.1%)	1,530 (-1.5%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Late Fall–Run Chinook Salmon

Spawning habitat WUA for late fall–run Chinook salmon was determined by USFWS (2003a, 2006) in the same manner that it was determined for winter-run and fall-run Chinook salmon. To

evaluate the effects of Alternatives 1, 2, and 3 on late fall–run spawning habitat, late fall–run spawning WUA was computed for flows during the December through March spawning period under Alternatives 1, 2, and 3 and the NAA in all three segments of the Sacramento River that were used for the other runs, but not Segment 3, which was used for the fall-run effects analysis only. About 90% of late fall–run redds occur in the three upstream segments, and 68% are found in Segment 6 (Table 11K-1).

Mean late fall–run spawning WUA under Alternatives 1, 2, and 3 generally differs little from that under the NAA (Tables 11K-12 through Table 11K-14). The largest differences are 6% reductions under Alternative 3 in Segment 6 for December of Wet and Dry Water Years (Table 11K-12). The largest increases are about 2% in Segment 6 for December of Above Normal Water Years under Alternatives 1, 2, and 3. Most differences in all river segments and all three alternatives are less than 3%. The result indicate that Alternatives 1A, 1B, and 2 would have little effect on late fall–run spawning WUA and Alternative 3 would have larger adverse effects, but none of the effects is expected to substantially affect late fall–run spawning habitat availability.

Table 11K-12. Late Fall–Run Spawning WUA[1] in the Sacramento River, Segment 6, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
December	Wet	117	116 (-1.3%)	114 (-3.2%)	115 (-2.2%)	110 (-6.1%)
	Above Normal	185	189 (2.2%)	189 (2.1%)	189 (2.2%)	189 (2.2%)
	Below Normal	219	218 (-0.4%)	218 (-0.5%)	218 (-0.4%)	219 (0%)
	Dry	228	224 (-1.7%)	224 (-2%)	224 (-1.7%)	215 (-6%)
	Critically Dry	242	245 (1.4%)	244 (1.1%)	245 (1.4%)	244 (0.9%)
	All	187	187 (-0.2%)	186 (-0.8%)	186 (-0.4%)	183 (-2.3%)
January	Wet	107	108 (0.3%)	108 (0.6%)	108 (0.3%)	107 (-0.8%)
	Above Normal	173	173 (-0.2%)	173 (-0.3%)	173 (-0.2%)	168 (-3%)
	Below Normal	234	235 (0.6%)	235 (0.5%)	235 (0.6%)	234 (0.3%)
	Dry	257	259 (0.8%)	259 (0.8%)	259 (0.8%)	259 (0.7%)
	Critically Dry	266	267 (0.4%)	267 (0.3%)	267 (0.3%)	266 (0%)
	All	195	195 (0.4%)	196 (0.5%)	195 (0.4%)	194 (-0.3%)
February	Wet	109	110 (0.7%)	108 (-1.6%)	110 (0.7%)	107 (-1.9%)
	Above Normal	132	131 (-0.6%)	131 (-1.2%)	132 (-0.3%)	130 (-1.7%)
	Below Normal	182	182 (-0.2%)	178 (-2%)	183 (0.3%)	177 (-2.9%)
	Dry	256	258 (0.5%)	256 (-0.1%)	258 (0.5%)	257 (0.1%)
	Critically Dry	259	259 (0%)	258 (-0.4%)	259 (-0.2%)	259 (0%)
	All	179	180 (0.2%)	178 (-0.9%)	180 (0.3%)	178 (-1%)
March	Wet	115	114 (-1.1%)	114 (-0.7%)	114 (-1.1%)	115 (0.2%)
	Above Normal	129	131 (1%)	131 (0.9%)	131 (0.9%)	130 (0.7%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Below Normal	238	239 (0.3%)	239 (0.3%)	239 (0.3%)	239 (0.3%)
	Dry	239	235 (-1.7%)	239 (-0.2%)	235 (-1.7%)	231 (-3.6%)
	Critically Dry	254	254 (0.2%)	248 (-2.1%)	254 (-0.1%)	247 (-2.5%)
	All	186	185 (-0.5%)	185 (-0.5%)	185 (-0.6%)	183 (-1.4%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-13. Late Fall–Run Spawning WUA[1] in the Sacramento River, Segment 5, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
December	Wet	314	312 (-0.4%)	308 (-1.8%)	310 (-1.1%)	299 (-4.7%)
	Above Normal	471	475 (0.9%)	474 (0.6%)	475 (0.8%)	473 (0.5%)
	Below Normal	516	517 (0.1%)	517 (0.1%)	517 (0.1%)	516 (-0.1%)
	Dry	528	524 (-0.7%)	522 (-1.2%)	524 (-0.8%)	514 (-2.7%)
	Critically Dry	538	537 (-0.2%)	535 (-0.6%)	537 (-0.2%)	532 (-1.2%)
	All	451	451 (-0.2%)	448 (-0.7%)	450 (-0.3%)	443 (-1.9%)
January	Wet	276	275 (-0.5%)	274 (-0.7%)	275 (-0.5%)	278 (0.9%)
	Above Normal	405	403 (-0.5%)	403 (-0.5%)	403 (-0.5%)	407 (0.7%)
	Below Normal	509	506 (-0.6%)	506 (-0.5%)	506 (-0.6%)	506 (-0.6%)
	Dry	504	501 (-0.7%)	501 (-0.7%)	501 (-0.7%)	501 (-0.6%)
	Critically Dry	512	511 (-0.4%)	511 (-0.3%)	511 (-0.3%)	513 (0.1%)
	All	419	417 (-0.5%)	417 (-0.6%)	417 (-0.5%)	419 (0%)
February	Wet	259	258 (-0.2%)	260 (0.3%)	258 (-0.2%)	259 (0.1%)
	Above Normal	290	284 (-2.2%)	281 (-3.2%)	286 (-1.4%)	278 (-4.3%)
	Below Normal	454	452 (-0.3%)	445 (-1.9%)	455 (0.3%)	437 (-3.6%)
	Dry	505	503 (-0.4%)	505 (0.1%)	503 (-0.4%)	505 (-0.1%)
	Critically Dry	515	522 (1.4%)	523 (1.5%)	522 (1.5%)	522 (1.4%)
	All	388	387 (-0.2%)	387 (-0.3%)	388 (0%)	385 (-0.9%)
March	Wet	314	307 (-2.2%)	309 (-1.6%)	307 (-2.2%)	308 (-1.9%)
	Above Normal	366	366 (-0.1%)	365 (-0.3%)	365 (-0.2%)	364 (-0.7%)
	Below Normal	469	468 (-0.4%)	468 (-0.4%)	468 (-0.3%)	468 (-0.4%)
	Dry	506	505 (-0.3%)	503 (-0.5%)	505 (-0.3%)	501 (-1%)
	Critically Dry	522	520 (-0.3%)	514 (-1.7%)	523 (0.1%)	513 (-1.7%)
	All	421	418 (-0.7%)	417 (-0.9%)	418 (-0.7%)	416 (-1.2%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-14. Late Fall–Run Spawning WUA[1] in the Sacramento River, Segment 4, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
December	Wet	273	268 (-1.7%)	264 (-3.2%)	267 (-2.1%)	259 (-5%)
	Above Normal	429	433 (0.9%)	432 (0.7%)	433 (0.9%)	432 (0.5%)
	Below Normal	488	487 (-0.2%)	486 (-0.4%)	487 (-0.2%)	488 (0%)
	Dry	516	513 (-0.6%)	514 (-0.5%)	513 (-0.6%)	504 (-2.4%)
	Critically Dry	544	549 (0.9%)	548 (0.8%)	549 (0.9%)	547 (0.7%)
	All	426	424 (-0.3%)	423 (-0.6%)	424 (-0.3%)	419 (-1.5%)
January	Wet	222	223 (0.4%)	222 (0.3%)	223 (0.4%)	217 (-2.3%)
	Above Normal	364	362 (-0.6%)	362 (-0.6%)	362 (-0.6%)	357 (-2%)
	Below Normal	493	495 (0.4%)	495 (0.4%)	495 (0.4%)	494 (0.2%)
	Dry	555	558 (0.6%)	558 (0.6%)	558 (0.6%)	558 (0.5%)
	Critically Dry	574	576 (0.3%)	576 (0.2%)	575 (0.2%)	574 (0%)
	All	414	415 (0.3%)	415 (0.3%)	415 (0.3%)	412 (-0.5%)
February	Wet	216	218 (0.6%)	214 (-1.1%)	218 (0.6%)	214 (-1.2%)
	Above Normal	257	251 (-2.2%)	249 (-3%)	254 (-1.2%)	247 (-4%)
	Below Normal	398	397 (-0.3%)	393 (-1.1%)	399 (0.2%)	390 (-1.9%)
	Dry	542	544 (0.4%)	541 (-0.1%)	544 (0.4%)	542 (0%)
	Critically Dry	566	560 (-0.9%)	559 (-1.2%)	560 (-1%)	560 (-0.9%)
	All	376	375 (-0.2%)	372 (-1%)	375 (-0.1%)	371 (-1.2%)
March	Wet	263	257 (-2.3%)	258 (-1.8%)	257 (-2.3%)	260 (-1.1%)
	Above Normal	312	314 (0.5%)	313 (0.3%)	314 (0.4%)	312 (-0.1%)
	Below Normal	507	509 (0.3%)	509 (0.3%)	509 (0.3%)	509 (0.3%)
	Dry	515	510 (-0.9%)	516 (0.2%)	510 (-0.9%)	506 (-1.7%)
	Critically Dry	558	560 (0.2%)	550 (-1.4%)	558 (-0.1%)	549 (-1.7%)
	All	410	408 (-0.6%)	408 (-0.5%)	408 (-0.6%)	406 (-1%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Steelhead

Spawning habitat WUA for steelhead in the Sacramento River was determined by USFWS (2003a, 2006) in the same manner that it was determined for winter-run, fall-run and late fall–run, except that HSC previously determined for steelhead in the American River (U.S. Fish and Wildlife Service 2003b) were used in developing the Sacramento River steelhead WUA curves (Section 11K.2, *Methods*). The spawning distribution of steelhead is uncertain, but most spawning is assumed to occur in the upper three segments (Segments 6, 5, and 4), where most salmon spawning occurs and where temperature conditions are most suitable.

To evaluate the effects of Alternatives 1, 2, and 3 on steelhead spawning habitat, steelhead spawning WUA was estimated for CALSIM II flows during the November through February spawning period under Alternatives 1, 2, and 3 and the NAA in the same three segments of the Sacramento River that were used for winter-run, spring-run and late fall–run (Tables 11K-15 through 11K-17).

There are few notable differences in steelhead mean spawning WUA between Alternatives 1, 2, and 3 and the NAA in Segments 6 and 5 (Table 11K-15 and Table 11K-16). The largest difference is a 7% reduction under Alternative 3 in Segment 6 for February of Above Normal Water Years (Table 11K-15). Other reductions ranging from 5% to 6% occur in Segment 6 during February of Above Normal Water Years under Alternative 1B, in Segment 6 during December of Wet Water Years under Alternative 3, and in Segment 5 in February of Above Normal Water Years under Alternative 3 (Table 11K-15 and Table 11K-16). Most differences in all river segments and all three alternatives are less than 3%. The results indicate that Alternatives 1A, 1B, and 2 would have little effect on steelhead spawning WUA. Alternative 3 would have more frequent larger negative effects, but these are not expected to substantially affect steelhead spawning habitat availability.

Table 11K-15. Steelhead Spawning WUA[1] in the Sacramento River, Segment 6, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
November	Wet	55	55 (0.4%)	55 (0.3%)	55 (0.4%)	54 (-1.5%)
	Above Normal	57	57 (-0.2%)	57 (-0.3%)	57 (-0.3%)	57 (-0.6%)
	Below Normal	60	59 (-0.1%)	59 (-0.1%)	59 (-0.1%)	59 (-0.4%)
	Dry	58	58 (-0.3%)	58 (-0.7%)	58 (-0.3%)	58 (-0.4%)
	Critically Dry	60	60 (0%)	60 (0.2%)	60 (0.3%)	59 (-0.9%)
	All	57	57 (0%)	57 (-0.1%)	58 (0%)	57 (-0.8%)
December	Wet	37	36 (-2%)	35 (-3.4%)	36 (-2.5%)	35 (-5.7%)
	Above Normal	54	54 (0.1%)	53 (-0.4%)	54 (0.1%)	53 (-0.8%)
	Below Normal	58	58 (-0.2%)	58 (-0.2%)	58 (-0.2%)	58 (0%)
	Dry	62	62 (-0.1%)	62 (-0.2%)	62 (0%)	61 (-1.2%)
	Critically Dry	63	64 (0.5%)	64 (0.6%)	64 (0.5%)	64 (0.9%)
	All	52	52 (-0.4%)	52 (-0.8%)	52 (-0.5%)	51 (-1.5%)
January	Wet	33	33 (-0.2%)	33 (0.1%)	33 (-0.2%)	33 (0.4%)
	Above Normal	49	48 (-0.9%)	48 (-0.8%)	48 (-0.9%)	48 (-2.3%)
	Below Normal	64	64 (0.5%)	64 (0.5%)	64 (0.5%)	64 (0.3%)
	Dry	66	66 (0.5%)	66 (0.6%)	66 (0.5%)	66 (0.5%)
	Critically Dry	67	67 (0.3%)	67 (0.3%)	67 (0.2%)	67 (-0.1%)
	All	53	53 (0.1%)	53 (0.2%)	53 (0.1%)	53 (0%)
February	Wet	32	32 (0.2%)	32 (-0.7%)	32 (0.2%)	32 (-0.9%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Above Normal	35	34 (-3.2%)	33 (-5.1%)	34 (-1.9%)	33 (-7.2%)
	Below Normal	52	52 (-0.4%)	51 (-1.6%)	52 (0.2%)	50 (-3.2%)
	Dry	66	66 (0.3%)	66 (-0.1%)	66 (0.3%)	66 (0.1%)
	Critically Dry	65	66 (0.2%)	66 (0.1%)	66 (0.1%)	66 (0.2%)
	All	48	48 (-0.2%)	48 (-1%)	48 (0%)	48 (-1.5%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-16. Steelhead Spawning WUA[1] in the Sacramento River, Segment 5, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
November	Wet	147	147 (0.1%)	147 (0.1%)	147 (0.1%)	147 (-0.5%)
	Above Normal	159	159 (0.1%)	159 (0.2%)	159 (0.1%)	158 (-0.1%)
	Below Normal	159	160 (0.2%)	159 (0.1%)	160 (0.2%)	160 (0.2%)
	Dry	156	156 (-0.2%)	156 (0.2%)	156 (-0.2%)	156 (0.1%)
	Critically Dry	161	160 (0%)	160 (0%)	160 (-0.1%)	161 (0.5%)
	All	155	155 (0%)	155 (0.1%)	155 (0%)	155 (0%)
December	Wet	100	99 (-1.2%)	98 (-2.3%)	99 (-1.6%)	96 (-4.3%)
	Above Normal	144	144 (-0.1%)	144 (-0.5%)	144 (-0.1%)	143 (-0.9%)
	Below Normal	150	150 (0%)	150 (0%)	150 (0%)	150 (0%)
	Dry	157	157 (0.2%)	157 (-0.2%)	157 (0.1%)	156 (-0.4%)
	Critically Dry	159	159 (-0.1%)	159 (-0.1%)	159 (-0.1%)	158 (-0.2%)
	All	136	136 (-0.3%)	135 (-0.7%)	136 (-0.4%)	134 (-1.3%)
January	Wet	85	84 (-0.3%)	84 (-0.5%)	84 (-0.3%)	85 (0.7%)
	Above Normal	129	128 (-0.8%)	128 (-0.8%)	128 (-0.8%)	128 (-0.6%)
	Below Normal	157	156 (-0.3%)	156 (-0.2%)	156 (-0.3%)	156 (-0.3%)
	Dry	155	155 (-0.2%)	155 (-0.2%)	155 (-0.2%)	155 (-0.2%)
	Critically Dry	156	156 (-0.2%)	156 (-0.2%)	156 (-0.2%)	156 (0.1%)
	All	129	129 (-0.3%)	129 (-0.4%)	129 (-0.3%)	129 (-0.1%)
February	Wet	78	78 (-0.1%)	78 (0.1%)	78 (-0.1%)	78 (0%)
	Above Normal	88	86 (-3%)	85 (-4.4%)	87 (-1.9%)	83 (-6.2%)
	Below Normal	139	139 (-0.3%)	137 (-1.4%)	140 (0.2%)	135 (-2.9%)
	Dry	155	155 (0%)	155 (0%)	155 (0%)	155 (0%)
	Critically Dry	156	157 (0.8%)	157 (0.8%)	157 (0.8%)	157 (0.8%)
	All	118	118 (-0.3%)	118 (-0.6%)	118 (0%)	117 (-1.1%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-17. Steelhead Spawning WUA[1] in the Sacramento River, Segment 4, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
Nov	Wet	59	59 (0.1%)	59 (0%)	59 (0.1%)	58 (-0.9%)
	Above Normal	62	62 (-1.1%)	62 (-1.1%)	62 (-1.1%)	61 (-1.8%)
	Below Normal	62	62 (0.1%)	62 (0%)	62 (0.1%)	62 (0%)
	Dry	60	60 (0%)	60 (0.1%)	60 (0%)	60 (-0.1%)
	Critically Dry	63	62 (-0.2%)	62 (-0.4%)	62 (-0.6%)	63 (0.9%)
	All	61	61 (-0.1%)	61 (-0.2%)	61 (-0.2%)	60 (-0.4%)
December	Wet	40	40 (-0.2%)	40 (-1.2%)	40 (-0.1%)	39 (-2.8%)
	Above Normal	57	58 (1.4%)	58 (1%)	58 (1.4%)	58 (0.4%)
	Below Normal	59	59 (0.1%)	59 (0.1%)	59 (0.1%)	59 (-0.1%)
	Dry	62	61 (-0.7%)	61 (-0.6%)	61 (-0.7%)	61 (-1.8%)
	Critically Dry	61	61 (-0.4%)	61 (-0.2%)	61 (-0.4%)	61 (-0.5%)
	All	54	54 (0%)	54 (-0.3%)	54 (0%)	53 (-1.2%)
January	Wet	34	34 (-0.5%)	34 (-0.5%)	34 (-0.5%)	34 (0%)
	Above Normal	52	52 (-0.9%)	52 (-0.9%)	52 (-0.9%)	51 (-2.3%)
	Below Normal	60	60 (0%)	60 (0.1%)	60 (0%)	60 (0.1%)
	Dry	59	59 (-0.5%)	59 (-0.5%)	59 (-0.5%)	59 (-0.5%)
	Critically Dry	59	59 (-0.4%)	59 (-0.3%)	59 (-0.3%)	59 (0%)
	All	50	50 (-0.4%)	50 (-0.4%)	50 (-0.4%)	50 (-0.5%)
February	Wet	32	32 (-0.1%)	32 (0.3%)	32 (-0.1%)	32 (0.2%)
	Above Normal	38	38 (-0.5%)	38 (-1.7%)	38 (-0.1%)	37 (-3.4%)
	Below Normal	56	56 (-0.1%)	56 (-0.8%)	56 (-0.1%)	56 (-0.9%)
	Dry	60	60 (-0.2%)	60 (0.1%)	60 (-0.2%)	60 (0.1%)
	Critically Dry	60	60 (0.8%)	60 (1.1%)	60 (0.9%)	60 (0.8%)
	All	47	47 (0%)	47 (-0.1%)	47 (0.1%)	47 (-0.4%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

11K.3.1.2. Feather River

Spring-Run and Fall-Run Chinook Salmon

Spring-run and fall-run are often difficult to distinguish in the Feather River, so a single WUA curve was developed for both runs (Payne and Allen 2004) (Figure 11K-7). The curve was used to compute spawning WUA with flows specific to the months of spawning for the run analyzed.

To evaluate the effects of Alternatives 1, 2, and 3 on spring-run spawning habitat in the Feather River, the spawning WUA was estimated under Alternatives 1, 2, and 3 and the NAA for CALSIM II flows below Thermalito Afterbay during September through November, the Feather River spring-run spawning period. The effects of Alternatives 1, 2, and 3 on fall-run spawning habitat were estimated the same way except that flows during the October through December spawning periods for fall-run were used. Differences in spawning WUA between Alternatives 1, 2, and 3 and the NAA for both runs were examined using the grand mean spawning WUA for each month of the spawning period under each water year type and all water year types combined (Table 11K-18 and Table 11K-19).

For both runs, the largest differences between Alternatives 1, 2, and 3 and the NAA means were 5% increases in WUA for October of Dry Water Years under Alternatives 1A, 1B, and 2, and 5% reductions for spring-run in September of Below Normal Water Years under Alternative 3. Most differences for both runs are less than 2%. These results suggest that Alternatives 1, 2, and 3 have little effect on spring-run or fall-run spawning WUA in the high-flow channel of the Feather River.

Table 11K-18. Spring-Run Spawning WUA[1] in the Feather River Downstream of the Thermalito Afterbay Outlet and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
September	Wet	14	14 (-2%)	13 (-3.5%)	14 (-2.3%)	14 (-1.6%)
	Above Normal	10	10 (0%)	10 (0%)	10 (0%)	10 (0%)
	Below Normal	27	27 (0%)	27 (-1.3%)	27 (-0.1%)	26 (-4.8%)
	Dry	30	31 (2.3%)	31 (2.3%)	31 (1.4%)	31 (2.6%)
	Critically Dry	31	31 (0.1%)	31 (-0.5%)	31 (-0.3%)	31 (1%)
	All	22	22 (0.3%)	22 (-0.4%)	22 (-0.1%)	22 (-0.3%)
October	Wet	26	26 (-2.1%)	26 (-1.7%)	26 (-1.5%)	26 (-1.5%)
	Above Normal	28	28 (-0.2%)	28 (-0.3%)	28 (-0.2%)	28 (0.1%)
	Below Normal	27	28 (1.8%)	28 (2%)	28 (1.7%)	28 (1.2%)
	Dry	26	27 (4.7%)	27 (4.6%)	27 (4.7%)	27 (3.3%)
	Critically Dry	30	31 (2.2%)	31 (2.2%)	31 (1.5%)	31 (1.9%)
	All	27	27 (1%)	27 (1.1%)	27 (1%)	27 (0.8%)
November	Wet	31	31 (-0.5%)	31 (-0.2%)	31 (-0.5%)	31 (-0.3%)
	Above Normal	33	33 (0%)	33 (0%)	33 (0%)	33 (0%)
	Below Normal	33	33 (1.6%)	33 (0.4%)	33 (0.8%)	33 (1.2%)
	Dry	32	32 (0.5%)	32 (0.4%)	32 (0.5%)	32 (0.8%)
	Critically Dry	32	32 (0.6%)	32 (1.6%)	32 (1%)	32 (0%)
	All	32	32 (0.3%)	32 (0.3%)	32 (0.2%)	32 (0.3%)

[1] WUA results are given in thousands of WUA units to save space.

[2] Water year type sorting is by hydrologic water years.

Table 11K-19. Fall-Run Spawning WUA[1] in the Feather River Downstream of the Thermalito Afterbay Outlet and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type [b]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
October	Wet	26	26 (-2.1%)	26 (-1.7%)	26 (-1.5%)	26 (-1.5%)
	Above Normal	28	28 (-0.2%)	28 (-0.3%)	28 (-0.2%)	28 (0.1%)
	Below Normal	27	28 (1.8%)	28 (2%)	28 (1.7%)	28 (1.2%)
	Dry	26	27 (4.7%)	27 (4.6%)	27 (4.7%)	27 (3.3%)
	Critically Dry	30	31 (2.2%)	31 (2.2%)	31 (1.5%)	31 (1.9%)
	All	27	27 (1%)	27 (1.1%)	27 (1%)	27 (0.8%)
November	Wet	31	31 (-0.5%)	31 (-0.2%)	31 (-0.5%)	31 (-0.3%)
	Above Normal	33	33 (0%)	33 (0%)	33 (0%)	33 (0%)
	Below Normal	33	33 (1.6%)	33 (0.4%)	33 (0.8%)	33 (1.2%)
	Dry	32	32 (0.5%)	32 (0.4%)	32 (0.5%)	32 (0.8%)
	Critically Dry	32	32 (0.6%)	32 (1.6%)	32 (1%)	32 (0%)
	All	32	32 (0.3%)	32 (0.3%)	32 (0.2%)	32 (0.3%)
December	Wet	27	27 (0%)	27 (0%)	27 (0%)	27 (0%)
	Above Normal	27	27 (0.7%)	27 (-0.1%)	27 (0.7%)	27 (0%)
	Below Normal	29	29 (0%)	30 (0.7%)	29 (0%)	30 (0.2%)
	Dry	29	29 (0%)	29 (0%)	29 (0%)	29 (-0.7%)
	Critically Dry	29	29 (-0.1%)	30 (0.4%)	29 (-0.1%)	30 (0.5%)
	All	28	28 (0.1%)	28 (0.2%)	28 (0.1%)	28 (0%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Steelhead

To evaluate the effects of Alternatives 1, 2, and 3 on steelhead spawning habitat, steelhead spawning WUA was computed from the steelhead spawning WUA curve for the Feather River (Payne and Allen 2004) (Figure 11K-8) for CALSIM II flows below Thermalito Afterbay under Alternatives 1, 2, and 3 and the NAA during the December through March Feather River steelhead spawning period.

There are few sizable differences between Alternatives 1, 2, and 3 and the NAA in steelhead spawning WUA (Table 11K-20). The largest difference is an 8% increase during March of Above Normal Water Years under Alternative 3. The largest reductions are 1.3% in February of Wet Water Years under Alternatives 1A and 2. Only three differences are more than 2%. These results indicate that Alternatives 1, 2, and 3 would have little effect on steelhead spawning WUA in the Feather River.

Table 11K-20. Steelhead Spawning WUA[1] in the Feather River Downstream of the Thermalito Afterbay Outlet and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
December	Wet	6	6 (0%)	6 (0%)	6 (0%)	6 (0.1%)
	Above Normal	7	7 (0.9%)	7 (-0.1%)	7 (0.9%)	7 (0%)
	Below Normal	9	9 (0%)	9 (0.6%)	9 (0%)	9 (0.2%)
	Dry	8	8 (0%)	8 (0%)	8 (0%)	8 (-0.9%)
	Critically Dry	9	9 (0.2%)	9 (-0.1%)	9 (0.2%)	9 (-0.1%)
	All	8	8 (0.2%)	8 (0.1%)	8 (0.2%)	8 (-0.2%)
January	Wet	5	5 (-0.1%)	5 (-0.1%)	5 (-0.1%)	5 (-0.1%)
	Above Normal	9	9 (0%)	9 (0%)	9 (0%)	9 (0%)
	Below Normal	9	9 (-0.1%)	10 (3.3%)	9 (-0.1%)	9 (-0.3%)
	Dry	10	10 (0%)	10 (0%)	10 (0%)	10 (0%)
	Critically Dry	12	12 (0%)	12 (0%)	12 (0%)	12 (0%)
	All	8	8 (0%)	8 (0.6%)	8 (0%)	8 (-0.1%)
February	Wet	3	3 (-1.3%)	3 (-0.3%)	3 (-1.3%)	3 (3.8%)
	Above Normal	7	7 (1.3%)	7 (0.1%)	7 (0.1%)	7 (0%)
	Below Normal	9	9 (0%)	9 (0%)	9 (0%)	9 (0%)
	Dry	10	10 (0%)	10 (0%)	10 (0%)	10 (0%)
	Critically Dry	11	11 (0%)	11 (0%)	11 (0%)	11 (0%)
	All	7	7 (0%)	7 (0%)	7 (-0.1%)	7 (0.5%)
March	Wet	2	2 (0.1%)	2 (0.1%)	2 (0%)	2 (0%)
	Above Normal	5	5 (1.2%)	5 (1.6%)	5 (1.3%)	5 (8.3%)
	Below Normal	10	10 (0%)	10 (-0.6%)	10 (0%)	10 (0%)
	Dry	10	10 (-0.2%)	10 (-0.2%)	10 (-0.2%)	10 (-0.2%)
	Critically Dry	10	10 (0.1%)	10 (0.1%)	10 (0.1%)	10 (0.3%)
	All	7	7 (0.1%)	7 (0%)	7 (0.1%)	7 (0.9%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

11K.3.1.3. American River

The WUA curves used for fall-run Chinook salmon and steelhead spawning habitat in the American River (Figure 11K-9 and Figure 11K-10) were produced using data obtained from Bratovich et al. (2017), which provides composite spawning WUA tables for fall-run and steelhead downstream of Nimbus Dam.

Fall-Run Chinook Salmon

To evaluate the effects of Alternatives 1, 2, and 3 on fall-run spawning habitat in the American River, fall-run spawning WUA was estimated for CALSIM II flows at Nimbus Dam under the NAA and Alternatives 1, 2, and 3 during the October through December spawning period using the composite fall-run spawning WUA curve (Figure 11K-9).

Differences in fall-run spawning WUA between Alternatives 1, 2, and 3 and the NAA were examined using the grand mean spawning WUA for each month of the spawning period under each water year type and all water year types combined (Table 11K-21). The largest difference is a 5% increase in November of Critically Dry Water Years under Alternative 1A. The largest reduction is 3% in November of Below Normal Water Years under Alternative 3. Almost all other differences are less than 2%. These results indicate that Alternatives 1, 2, and 3 would have little effect on fall-run spawning WUA in the American River.

Table 11K-21. Fall-Run Spawning WUA[1] in the American River Downstream of Nimbus Dam and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
October	Wet	1,787	1,782 (-0.2%)	1,784 (-0.1%)	1,782 (-0.3%)	1,785 (-0.1%)
	Above Normal	1,762	1,762 (0%)	1,761 (-0.1%)	1,762 (0%)	1,751 (-0.6%)
	Below Normal	1,749	1,745 (-0.2%)	1,746 (-0.2%)	1,755 (0.3%)	1,752 (0.1%)
	Dry	1,731	1,730 (0%)	1,730 (0%)	1,732 (0.1%)	1,736 (0.3%)
	Critically Dry	1,719	1,719 (0%)	1,719 (0%)	1,719 (0%)	1,723 (0.2%)
	All	1,755	1,752 (-0.1%)	1,753 (-0.1%)	1,754 (0%)	1,754 (0%)
November	Wet	1,324	1,316 (-0.6%)	1,321 (-0.3%)	1,314 (-0.8%)	1,308 (-1.2%)
	Above Normal	1,426	1,426 (0%)	1,425 (-0.1%)	1,426 (0%)	1,422 (-0.3%)
	Below Normal	1,491	1,488 (-0.2%)	1,503 (0.8%)	1,488 (-0.2%)	1,444 (-3.2%)
	Dry	1,617	1,617 (0%)	1,618 (0.1%)	1,617 (0%)	1,578 (-2.4%)
	Critically Dry	1,607	1,695 (5.4%)	1,661 (3.4%)	1,633 (1.6%)	1,626 (1.2%)
	All	1,473	1,483 (0.7%)	1,482 (0.6%)	1,473 (0%)	1,454 (-1.3%)
December	Wet	1,070	1,071 (0%)	1,073 (0.2%)	1,070 (-0.1%)	1,054 (-1.5%)
	Above Normal	1,478	1,478 (0%)	1,464 (-1%)	1,478 (0%)	1,451 (-1.8%)
	Below Normal	1,530	1,530 (0%)	1,521 (-0.6%)	1,530 (0%)	1,511 (-1.3%)
	Dry	1,697	1,701 (0.2%)	1,697 (0%)	1,701 (0.2%)	1,687 (-0.6%)
	Critically Dry	1,689	1,689 (0%)	1,689 (0%)	1,689 (0%)	1,689 (0%)
	All	1,437	1,438 (0.1%)	1,434 (-0.2%)	1,437 (0%)	1,422 (-1%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Steelhead

To evaluate the effects of Alternatives 1, 2, and 3 on steelhead spawning habitat in the American River, steelhead spawning WUA was estimated for CALSIM II flows at Nimbus Dam under the

NAA and Alternatives 1, 2, and 3 during the December through March spawning period using the steelhead composite spawning WUA curve (Bratovich et al. 2017) (Figure 11K-10).

The largest differences in steelhead mean spawning WUA between Alternatives 1, 2, and 3 and the NAA are 2% reductions and increases, both under Alternative 3, in December of Above Normal Water Years and February of Above Normal Water Years, respectively. Almost all other differences are less than 1% (Table 11K-22). These results indicates that Alternatives 1, 2, and 3 would have little effect on steelhead spawning WUA in the American River.

Table 11K-22. Steelhead Spawning WUA[1] in the American River Downstream of Nimbus Dam and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
December	Wet	866	867 (0.1%)	867 (0.2%)	866 (0%)	850 (-1.8%)
	Above Normal	1,237	1,237 (0%)	1,223 (-1.1%)	1,237 (0%)	1,211 (-2.1%)
	Below Normal	1,282	1,283 (0%)	1,275 (-0.6%)	1,283 (0%)	1,266 (-1.3%)
	Dry	1,435	1,438 (0.2%)	1,435 (0%)	1,438 (0.2%)	1,426 (-0.7%)
	Critically Dry	1,436	1,437 (0%)	1,436 (0%)	1,436 (0%)	1,436 (0%)
	All	1,200	1,201 (0.1%)	1,197 (-0.2%)	1,200 (0.1%)	1,186 (-1.1%)
January	Wet	516	515 (-0.1%)	514 (-0.4%)	515 (-0.2%)	515 (-0.1%)
	Above Normal	971	969 (-0.1%)	971 (0%)	969 (-0.2%)	974 (0.4%)
	Below Normal	1,322	1,324 (0.2%)	1,324 (0.1%)	1,318 (-0.3%)	1,319 (-0.2%)
	Dry	1,479	1,480 (0.1%)	1,471 (-0.6%)	1,480 (0.1%)	1,476 (-0.2%)
	Critically Dry	1,478	1,477 (-0.1%)	1,477 (-0.1%)	1,477 (-0.1%)	1,477 (-0.1%)
	All	1,072	1,072 (0%)	1,070 (-0.2%)	1,071 (-0.1%)	1,071 (-0.1%)
February	Wet	422	422 (0%)	422 (0%)	422 (0%)	422 (0.1%)
	Above Normal	717	717 (0%)	721 (0.5%)	717 (0%)	733 (2.2%)
	Below Normal	1,015	1,015 (0%)	1,015 (0%)	1,016 (0.1%)	1,018 (0.3%)
	Dry	1,436	1,435 (-0.1%)	1,433 (-0.2%)	1,435 (-0.1%)	1,430 (-0.4%)
	Critically Dry	1,529	1,532 (0.2%)	1,533 (0.3%)	1,532 (0.2%)	1,536 (0.4%)
	All	951	951 (0%)	951 (0.1%)	951 (0%)	954 (0.3%)
March	Wet	860	860 (0%)	860 (0%)	860 (0%)	860 (0%)
	Above Normal	962	962 (0%)	962 (0%)	962 (0%)	962 (0%)
	Below Normal	1,527	1,527 (0%)	1,527 (0%)	1,527 (0%)	1,527 (0%)
	Dry	1,495	1,495 (0%)	1,495 (0%)	1,495 (0%)	1,495 (0%)
	Critically Dry	1,469	1,459 (-0.6%)	1,455 (-0.9%)	1,460 (-0.6%)	1,455 (-0.9%)
	All	1,217	1,216 (-0.1%)	1,215 (-0.2%)	1,216 (-0.1%)	1,215 (-0.2%)

[1] WUA results are given in thousands of WUA units to save space.

[2] Water year type sorting is by hydrologic water years.

11K.3.2. Rearing Habitat Weighted Usable Area

11K.3.2.1. Sacramento River

Winter-run Chinook Salmon

Rearing habitat WUA provides an index of instream rearing habitat availability that takes into consideration the rearing requirements of fish with respect to water depth, flow velocity, and cover. Rearing WUA was separately determined for winter-run fry and juveniles by USFWS (2005b) for a range of flows in three segments of the Sacramento River between Keswick Dam and the Battle Creek confluence. The three river segments are the same as those described above for winter-run spawning habitat WUA: Segment 4 (Battle Creek to the confluence with Cow Creek), Segment 5 (Cow Creek to the ACID Dam), and Segment 6 (ACID Dam to Keswick Dam). To estimate changes in rearing WUA that would result from Alternatives 1, 2, and 3 relative to the NAA, the fry and juvenile rearing habitat WUA curves developed for each of these segments was used with mean monthly CALSIM II flow estimates for corresponding segments of the river under Alternatives 1, 2, and 3 and the NAA during the winter-run fry and juvenile rearing periods. For this analysis, fry are defined as fish less than 60 mm and juveniles are young fish (young-of-the-year) greater than 60 mm.

Differences in winter-run fry and juvenile rearing habitat WUA in each river segment under Alternatives 1, 2, and 3 compared to the NAA were examined using the grand mean rearing WUA for each month of the fry (July through October) and juvenile (September through November) rearing periods under each water year type and all water year types combined (Table 11K-23 through Table 11K-28). In Segment 6, the largest differences in mean fry rearing WUA between Alternatives 1, 2, and 3 and the NAA include a 5% reduction in October of Dry Water Years and a 5% increase in September of Below Normal Water Years, both under Alternative 3. In Segment 5, the largest differences are 6% reductions in July and August of Above Normal Water Years under Alternative 3 (Table 11K-23 and Table 11K-24). In Segment 4 during July of Above Normal and Below Normal Water Years, rearing WUA is about 5% lower under Alternative 3 than the NAA (Table 11K-25). All means in all three river segments differ by less than 3% under Alternatives 1A, 1B, and 2, while about one in six of the means under Alternative 3 differ by more than 3%, with all but one of these differences constituting reductions in rearing WUA (Table 11K-23). These results indicate that Alternative 3 would have a negative effect on rearing habitat for winter-run fry in the Sacramento River and the other alternatives would have little effect.

All the means for juvenile rearing WUA differ by less than 3% between Alternatives 1, 2, and 3 and the NAA, except for a 4% increase in Segment 6 for November of Critically Dry Water Years under Alternative 3 and a 3% reduction in Segment 4 for October of Wet Water Years under Alternative 3 (Table 11K-26 and Table 11K-28). These results indicate that Alternatives 1, 2, and 3 would have little effect on rearing habitat availability for winter-run juveniles in the Sacramento River.

Table 11K-23. Winter-Run Fry Rearing WUA[1] in the Sacramento River, Segment 6, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
July	Wet	73	73 (0%)	73 (0%)	73 (0%)	73 (0%)
	Above Normal	76	76 (-0.2%)	76 (-0.2%)	76 (-0.3%)	75 (-1.6%)
	Below Normal	75	74 (-0.4%)	75 (0.1%)	74 (-0.8%)	75 (0.2%)
	Dry	76	76 (0%)	76 (-0.2%)	76 (0%)	74 (-2%)
	Critically Dry	72	72 (-0.1%)	72 (-0.5%)	72 (-0.5%)	71 (-1.4%)
	All	74	74 (-0.1%)	74 (-0.1%)	74 (-0.3%)	74 (-0.8%)
August	Wet	71	71 (0%)	71 (0.2%)	71 (0%)	71 (0.2%)
	Above Normal	67	67 (-0.8%)	68 (0.4%)	67 (-0.8%)	68 (0.6%)
	Below Normal	68	68 (0.1%)	68 (0%)	68 (-0.2%)	68 (1%)
	Dry	70	70 (-0.1%)	70 (-0.2%)	70 (-0.1%)	70 (0.2%)
	Critically Dry	74	73 (-1.2%)	73 (-0.8%)	73 (-0.9%)	74 (-0.2%)
	All	70	70 (-0.3%)	70 (0%)	70 (-0.3%)	70 (0.3%)
September	Wet	68	68 (0%)	68 (0.8%)	68 (0%)	68 (0.6%)
	Above Normal	71	71 (0.3%)	71 (0.5%)	72 (0.6%)	71 (-0.4%)
	Below Normal	87	89 (2.3%)	89 (1.8%)	89 (2.3%)	92 (4.8%)
	Dry	92	92 (-0.1%)	92 (0.4%)	92 (-0.1%)	92 (0%)
	Critically Dry	91	92 (0.8%)	92 (0.7%)	92 (1%)	92 (0.3%)
	All	80	81 (0.6%)	81 (0.8%)	81 (0.6%)	81 (1%)
October	Wet	84	84 (-0.2%)	83 (-1%)	84 (-0.3%)	81 (-3.2%)
	Above Normal	81	82 (1.4%)	81 (0.6%)	81 (1.1%)	79 (-1.4%)
	Below Normal	85	85 (0.1%)	84 (-1.6%)	85 (0.1%)	81 (-4.4%)
	Dry	86	86 (0.2%)	85 (-1%)	86 (0.3%)	82 (-5.1%)
	Critically Dry	88	87 (-1.3%)	87 (-0.5%)	87 (-0.6%)	86 (-2.5%)
	All	85	85 (0%)	84 (-0.8%)	85 (0.1%)	82 (-3.5%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-24. Winter-Run Fry Rearing WUA[1] in the Sacramento River, Segment 5, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
July	Wet	613	613 (0%)	612 (-0.1%)	613 (0%)	613 (0%)
	Above Normal	699	697 (-0.3%)	687 (-1.8%)	696 (-0.5%)	657 (-6.1%)
	Below Normal	638	635 (-0.5%)	638 (0.1%)	635 (-0.4%)	621 (-2.6%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Dry	603	603 (0%)	602 (-0.2%)	603 (0%)	591 (-2%)
	Critically Dry	505	505 (0.1%)	501 (-0.7%)	504 (-0.2%)	493 (-2.3%)
	All	612	611 (-0.1%)	609 (-0.4%)	611 (-0.2%)	598 (-2.2%)
August	Wet	537	537 (0%)	535 (-0.3%)	537 (0%)	535 (-0.3%)
	Above Normal	507	496 (-2.1%)	502 (-1%)	496 (-2.3%)	479 (-5.5%)
	Below Normal	478	473 (-1.1%)	475 (-0.5%)	472 (-1.2%)	475 (-0.6%)
	Dry	469	467 (-0.5%)	467 (-0.5%)	467 (-0.5%)	463 (-1.3%)
	Critically Dry	490	481 (-1.8%)	481 (-1.8%)	480 (-1.9%)	477 (-2.6%)
	All	501	497 (-0.9%)	497 (-0.7%)	496 (-0.9%)	493 (-1.7%)
September	Wet	511	511 (0%)	511 (0%)	511 (0%)	509 (-0.3%)
	Above Normal	478	480 (0.4%)	477 (-0.2%)	479 (0.2%)	464 (-3%)
	Below Normal	551	555 (0.7%)	551 (-0.1%)	555 (0.7%)	555 (0.8%)
	Dry	581	580 (-0.1%)	579 (-0.3%)	580 (-0.1%)	581 (-0.1%)
	Critically Dry	590	582 (-1.3%)	583 (-1.2%)	583 (-1.2%)	584 (-1%)
	All	540	540 (-0.1%)	538 (-0.3%)	539 (-0.1%)	537 (-0.5%)
October	Wet	523	519 (-0.9%)	518 (-1%)	519 (-0.8%)	508 (-3%)
	Above Normal	526	525 (-0.1%)	524 (-0.2%)	524 (-0.3%)	517 (-1.8%)
	Below Normal	531	531 (-0.1%)	529 (-0.4%)	531 (-0.1%)	523 (-1.6%)
	Dry	541	540 (-0.2%)	539 (-0.4%)	540 (-0.1%)	534 (-1.4%)
	Critically Dry	551	551 (0%)	551 (0.1%)	551 (0.2%)	549 (-0.3%)
	All	533	531 (-0.3%)	530 (-0.5%)	531 (-0.3%)	523 (-1.8%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-25. Winter-Run Fry Rearing WUA[1] in the Sacramento River, Segment 4, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
July	Wet	124	124 (0%)	124 (0%)	124 (0%)	124 (0%)
	Above Normal	127	126 (-0.9%)	128 (0.3%)	126 (-1.5%)	121 (-4.6%)
	Below Normal	125	122 (-1.8%)	124 (-0.8%)	122 (-1.9%)	119 (-4.7%)
	Dry	122	122 (-0.1%)	122 (0%)	122 (-0.1%)	123 (0.9%)
	Critically Dry	130	130 (0%)	130 (0.2%)	130 (0.1%)	131 (0.8%)
	All	125	125 (-0.5%)	125 (-0.1%)	124 (-0.5%)	124 (-1.1%)
August	Wet	127	127 (0%)	127 (0.1%)	127 (0%)	127 (0.1%)
	Above Normal	130	131 (0.7%)	130 (0.4%)	131 (0.7%)	132 (1.7%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Below Normal	132	132 (0.5%)	132 (0.1%)	132 (0.5%)	132 (0.4%)
	Dry	133	134 (0.1%)	133 (-0.1%)	134 (0.1%)	134 (0.5%)
	Critically Dry	132	133 (0.7%)	133 (0.8%)	133 (0.7%)	133 (1.1%)
	All	130	131 (0.3%)	130 (0.2%)	131 (0.3%)	131 (0.6%)
September	Wet	130	130 (0%)	130 (0.1%)	130 (0%)	130 (0.2%)
	Above Normal	133	133 (-0.2%)	133 (0%)	133 (-0.1%)	134 (0.4%)
	Below Normal	131	131 (0%)	131 (-0.1%)	131 (0%)	131 (-0.2%)
	Dry	132	132 (0.1%)	132 (0%)	132 (0.1%)	132 (0.2%)
	Critically Dry	134	132 (-1.2%)	132 (-1.3%)	132 (-1.1%)	133 (-1%)
	All	132	131 (-0.2%)	131 (-0.2%)	131 (-0.2%)	132 (0%)
October	Wet	133	133 (0%)	133 (0%)	133 (0%)	133 (0.1%)
	Above Normal	132	132 (0.2%)	132 (0%)	132 (0.1%)	132 (0.1%)
	Below Normal	132	133 (0.1%)	133 (0.1%)	133 (0.1%)	132 (0%)
	Dry	131	132 (0.1%)	131 (-0.1%)	132 (0%)	131 (-0.1%)
	Critically Dry	133	133 (0%)	133 (-0.1%)	133 (0%)	132 (-0.3%)
	All	132	132 (0%)	132 (0%)	132 (0%)	132 (0%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-26. Winter-Run Juvenile WUA[1] in the Sacramento River, Segment 6, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
September	Wet	39	39 (0%)	39 (0.1%)	39 (0%)	39 (0.4%)
	Above Normal	42	42 (-0.5%)	42 (-0.7%)	42 (-0.3%)	42 (0.1%)
	Below Normal	39	39 (-0.3%)	39 (0.4%)	39 (-0.3%)	39 (-0.5%)
	Dry	36	36 (0%)	36 (0.3%)	36 (0%)	36 (0%)
	Critically Dry	35	36 (3%)	36 (2.8%)	36 (2.8%)	35 (2.1%)
	All	38	38 (0.3%)	38 (0.4%)	38 (0.3%)	38 (0.3%)
October	Wet	39	39 (1%)	39 (1%)	39 (1%)	40 (2.8%)
	Above Normal	39	39 (1.2%)	39 (0.8%)	39 (0.7%)	39 (1.6%)
	Below Normal	39	39 (-0.2%)	39 (-0.5%)	39 (-0.1%)	39 (1%)
	Dry	38	38 (-0.7%)	38 (-0.3%)	38 (-0.7%)	38 (-0.6%)
	Critically Dry	36	36 (0%)	36 (0.2%)	36 (0%)	37 (1%)
	All	38	38 (0.3%)	38 (0.3%)	38 (0.3%)	39 (1.3%)
November	Wet	30	30 (-0.4%)	30 (-0.2%)	30 (-0.6%)	30 (1.5%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Above Normal	31	32 (1.7%)	32 (1.8%)	32 (1.7%)	32 (2.5%)
	Below Normal	30	30 (0.5%)	30 (0.4%)	30 (0.5%)	30 (0.9%)
	Dry	30	30 (-0.2%)	31 (2%)	30 (-0.2%)	31 (1.9%)
	Critically Dry	30	29 (-0.3%)	29 (-0.3%)	29 (-0.5%)	31 (3.8%)
	All	30	30 (0.1%)	30 (0.7%)	30 (0.1%)	31 (2%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-27. Winter-Run Juvenile WUA[1] in the Sacramento River, Segment 5, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
September	Wet	195	195 (0%)	195 (0.3%)	195 (0%)	195 (0.3%)
	Above Normal	202	203 (0.4%)	203 (0.3%)	203 (0.5%)	201 (-0.3%)
	Below Normal	218	218 (0.1%)	217 (-0.3%)	218 (0.1%)	218 (0.1%)
	Dry	224	224 (0%)	224 (-0.2%)	224 (0%)	224 (0%)
	Critically Dry	227	224 (-1.1%)	225 (-1%)	225 (-1%)	225 (-0.8%)
	All	211	211 (-0.1%)	211 (-0.1%)	211 (-0.1%)	211 (-0.1%)
October	Wet	213	212 (-0.4%)	212 (-0.5%)	212 (-0.4%)	210 (-1.3%)
	Above Normal	215	215 (-0.3%)	215 (-0.3%)	215 (-0.3%)	214 (-0.8%)
	Below Normal	216	216 (0%)	216 (0%)	216 (0%)	214 (-0.5%)
	Dry	217	217 (0%)	217 (-0.1%)	217 (0%)	217 (-0.1%)
	Critically Dry	218	219 (0.1%)	219 (0.1%)	219 (0.1%)	218 (-0.1%)
	All	215	215 (-0.2%)	215 (-0.2%)	215 (-0.2%)	214 (-0.6%)
November	Wet	219	220 (0.3%)	219 (0.1%)	220 (0.3%)	219 (-0.1%)
	Above Normal	215	214 (-0.3%)	214 (-0.4%)	214 (-0.3%)	213 (-0.8%)
	Below Normal	219	219 (-0.3%)	218 (-0.3%)	219 (-0.3%)	218 (-0.4%)
	Dry	216	216 (-0.1%)	215 (-0.3%)	216 (-0.1%)	215 (-0.4%)
	Critically Dry	221	220 (-0.1%)	221 (0.2%)	221 (0.2%)	218 (-1%)
	All	218	218 (0%)	218 (-0.1%)	218 (0%)	217 (-0.5%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-28. Winter-Run Juvenile WUA[1] in the Sacramento River, Segment 4, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type [b]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
September	Wet	56	56 (0%)	56 (0.4%)	56 (0%)	56 (0.2%)
	Above Normal	59	60 (1.6%)	59 (0%)	60 (1.8%)	58 (-2%)
	Below Normal	73	73 (0.3%)	72 (-0.1%)	73 (0.3%)	73 (0.3%)
	Dry	76	76 (0%)	76 (-0.1%)	76 (0%)	76 (0.1%)
	Critically Dry	77	76 (-1.6%)	76 (-1.6%)	76 (-1.5%)	76 (-1.3%)
	All	67	67 (0%)	67 (-0.2%)	67 (0%)	67 (-0.3%)
October	Wet	67	66 (-0.6%)	66 (-0.9%)	66 (-0.7%)	65 (-3.2%)
	Above Normal	67	68 (0.6%)	67 (0.1%)	67 (0%)	66 (-1.6%)
	Below Normal	69	69 (0.4%)	69 (-0.3%)	69 (0.3%)	68 (-1.5%)
	Dry	71	70 (-0.3%)	70 (-0.7%)	70 (-0.3%)	69 (-1.8%)
	Critically Dry	72	72 (0.1%)	72 (0.1%)	72 (0.2%)	71 (-0.5%)
	All	69	69 (-0.1%)	68 (-0.5%)	69 (-0.2%)	67 (-2%)
November	Wet	67	67 (0.3%)	67 (0.3%)	67 (0.4%)	66 (-0.8%)
	Above Normal	68	67 (-1.4%)	67 (-1.5%)	67 (-1.4%)	67 (-2.2%)
	Below Normal	70	70 (-0.2%)	70 (-0.2%)	70 (-0.2%)	70 (-0.3%)
	Dry	69	68 (-0.1%)	68 (-1.3%)	68 (-0.1%)	68 (-1.4%)
	Critically Dry	72	72 (0.2%)	72 (0.2%)	72 (0.3%)	71 (-1.8%)
	All	69	69 (-0.1%)	68 (-0.4%)	69 (-0.1%)	68 (-1.2%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Spring-Run Chinook Salmon

Rearing habitat WUA for spring-run was not estimated directly, but was modeled using the fry and juvenile rearing habitat WUA curves obtained for fall-run Chinook salmon in Segments 4, 5, and 6 (U.S. Fish and Wildlife Service 2005a). The validity of using the fall-run Chinook salmon rearing WUA curves to characterize spring-run Chinook salmon rearing habitat is uncertain (U.S. Fish and Wildlife Service 2005a).

Rearing WUA in the Sacramento River was separately determined for spring-run fry and juveniles for a range of flows in Segments 4, 5, and 6. To estimate changes in rearing WUA that would result from Alternatives 1, 2, and 3 relative to the NAA, the fall-run fry and juvenile rearing habitat WUA curves developed for each of these segments were used with mean monthly CALSIM II flow estimates for the corresponding segments of the river under Alternatives 1, 2, and 3 and the NAA during the spring-run fry and juvenile rearing periods.

Differences in spring-run fry and juvenile rearing habitat WUA in each river segment under Alternatives 1, 2, and 3 compared to the NAA were examined using the grand mean rearing

WUA for each month of the fry (November through February) and juvenile (year-round) rearing periods under each water year type and all water year types combined (Table 11K-29 through Table 11K-34).

The largest reductions and increases in mean fry rearing WUA between Alternatives 1, 2, and 3 and the NAA are 5% reductions in November of Critically Dry Water Years and December of Dry Water Years in Segment 5 under Alternative 3, and 2% increases in January of Above Normal Water Years in Segment 6 under Alternatives 1A, 1B, and 2 (Table 11K-29 and Table 11K-30). All differences for Alternatives 1A, 1B, and 2 and most for Alternative 3 are less than 3%. In Segment 4, all differences are less than 3% for all the alternatives. These results indicate that Alternatives 1, 2, and 3 would have little effect on rearing habitat availability for spring-run fry in the Sacramento River.

Because some rearing by spring-run juveniles occurs throughout the year, all months are included in the spring-run juvenile rearing WUA analysis (Table 11K-32 through Table 11K-34). In Segment 6, few or none of the means for Alternatives 1A, 1B, and 2, but many of the means for Alternative 3, differ from the NAA by more than 3% (Table 11K-32). All but one of the more than 3% differences constitute increases in rearing WUA. The largest differences are a 7% increase in June of Above Normal Water Years under Alternative 3 and the largest reduction is 3% in September of Dry Water Years under Alternative 3. In Segment 5, relatively few of the differences in rearing WUA between Alternatives 1, 2, and 3 and the NAA are more than 3%. The largest differences are 5% and 6% increases in June of Above Normal and Below Normal Water Years under Alternative 3 (Table 11K-33). The largest reduction is a 3% reduction in October of Wet Water Years under Alternative 3. Segment 4 has more and larger differences between Alternatives 1, 2, and 3 and the NAA than the other two river segments (Table 11K-34). The largest increases are 17% in June of Above Normal and Below Normal Water Years under Alternative 3, 16% in August of Above Normal Water Years under Alternative 3, 15% in July of Above Normal Water Years under Alternative 3, and 12% increase in June of Above Normal Water Years under Alternative 1B. The largest reductions in Segment 4 are 8% to 9% reductions in August of Critically Dry Years under all the alternatives. In all segments combined, increases in rearing WUA of more than 3% greatly outnumber reductions of more than 3%, especially for Alternative 3.

The results for spring-run juvenile rearing WUA indicate that Alternatives 1, 2, and 3 would generally have little effect on rearing habitat in Segments 6 and 5 (Table 11K-32 and Table 11K-33), but Alternative 3 would have relatively large effects in Segment 4, including substantial increases during late spring and summer and smaller reductions during late summer and fall (Table 11K-34). Increases in rearing WUA outnumber reductions and more of them are especially large (>10%). Furthermore, the increases occur during spring and summer, when the juveniles are younger and perhaps more vulnerable to reductions in habitat availability. On balance, Alternatives 1, 2, and 3 are expected to have a little effect on spring-run fry rearing habitat availability and to increase spring-run juvenile rearing habitat WUA.

Table 11K-29. Spring-Run Fry Rearing WUA[1] in the Sacramento River, Segment 6, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
November	Wet	63	63 (0%)	63 (-0.1%)	63 (-0.1%)	62 (-1.2%)
	Above Normal	60	60 (0.7%)	60 (0.6%)	60 (0.6%)	60 (0.4%)
	Below Normal	62	62 (-0.1%)	62 (-0.1%)	62 (-0.1%)	62 (-0.2%)
	Dry	62	62 (0%)	62 (-0.6%)	62 (0%)	62 (0.8%)
	Critically Dry	61	61 (0%)	61 (0.3%)	62 (0.6%)	61 (-0.5%)
	All	62	62 (0.1%)	62 (-0.1%)	62 (0.1%)	62 (-0.3%)
December	Wet	75	75 (-0.4%)	75 (0%)	75 (-0.5%)	75 (-0.4%)
	Above Normal	64	64 (-0.6%)	64 (-0.3%)	64 (-0.7%)	65 (1%)
	Below Normal	67	67 (-0.2%)	67 (-0.3%)	67 (-0.2%)	67 (0%)
	Dry	64	64 (0.4%)	64 (0.4%)	64 (0.4%)	64 (-0.1%)
	Critically Dry	66	66 (0.7%)	66 (1%)	66 (0.7%)	67 (1.9%)
	All	68	68 (-0.1%)	69 (0.1%)	68 (-0.1%)	69 (0.3%)
January	Wet	76	76 (0.4%)	76 (-0.1%)	76 (0.4%)	76 (-0.5%)
	Above Normal	67	68 (2.1%)	68 (2.1%)	68 (2.1%)	67 (0.4%)
	Below Normal	68	69 (0.8%)	69 (0.8%)	69 (0.8%)	68 (0.7%)
	Dry	71	71 (0.9%)	71 (1%)	71 (0.9%)	71 (0.9%)
	Critically Dry	71	72 (0.5%)	72 (0.5%)	72 (0.4%)	71 (-0.1%)
	All	71	72 (0.8%)	72 (0.7%)	72 (0.8%)	72 (0.2%)
February	Wet	79	79 (0.1%)	78 (-0.6%)	79 (0.1%)	78 (-0.6%)
	Above Normal	76	76 (0%)	76 (-0.2%)	76 (0%)	77 (0.9%)
	Below Normal	65	66 (0.2%)	66 (0.3%)	66 (0.3%)	65 (-0.2%)
	Dry	71	71 (0.5%)	71 (-0.1%)	71 (0.5%)	71 (0.1%)
	Critically Dry	70	69 (-0.2%)	69 (-0.4%)	69 (-0.4%)	69 (-0.2%)
	All	73	73 (0.1%)	73 (-0.3%)	73 (0.1%)	73 (-0.1%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-30. Spring-Run Fry Rearing WUA[1] in the Sacramento River, Segment 5, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
November	Wet	1,155	1,166 (0.9%)	1,157 (0.2%)	1,167 (1%)	1,132 (-2%)
	Above Normal	1,131	1,106 (-2.2%)	1,104 (-2.4%)	1,106 (-2.2%)	1,089 (-3.7%)
	Below Normal	1,207	1,195 (-0.9%)	1,196 (-0.9%)	1,194 (-1.1%)	1,189 (-1.5%)
	Dry	1,172	1,170 (-0.2%)	1,146 (-2.2%)	1,170 (-0.2%)	1,142 (-2.6%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Critically Dry	1,237	1,240 (0.2%)	1,248 (0.8%)	1,249 (1%)	1,176 (-4.9%)
	All	1,176	1,174 (-0.2%)	1,167 (-0.8%)	1,175 (-0.1%)	1,144 (-2.7%)
December	Wet	1,072	1,069 (-0.3%)	1,062 (-0.9%)	1,066 (-0.6%)	1,056 (-1.5%)
	Above Normal	1,209	1,226 (1.4%)	1,227 (1.5%)	1,226 (1.4%)	1,230 (1.7%)
	Below Normal	1,342	1,339 (-0.2%)	1,337 (-0.4%)	1,339 (-0.2%)	1,340 (-0.1%)
	Dry	1,328	1,303 (-1.9%)	1,303 (-1.9%)	1,303 (-1.9%)	1,263 (-4.9%)
	Critically Dry	1,399	1,419 (1.4%)	1,406 (0.5%)	1,419 (1.4%)	1,405 (0.4%)
	All	1,242	1,241 (-0.1%)	1,236 (-0.5%)	1,240 (-0.2%)	1,226 (-1.3%)
January	Wet	1,071	1,073 (0.2%)	1,073 (0.2%)	1,073 (0.2%)	1,066 (-0.4%)
	Above Normal	1,200	1,202 (0.1%)	1,202 (0.1%)	1,202 (0.1%)	1,187 (-1.1%)
	Below Normal	1,358	1,358 (0%)	1,357 (-0.1%)	1,358 (0%)	1,355 (-0.2%)
	Dry	1,441	1,444 (0.2%)	1,444 (0.2%)	1,444 (0.2%)	1,444 (0.2%)
	Critically Dry	1,476	1,478 (0.1%)	1,477 (0.1%)	1,477 (0.1%)	1,477 (0.1%)
	All	1,279	1,281 (0.2%)	1,281 (0.1%)	1,281 (0.2%)	1,276 (-0.2%)
February	Wet	1,085	1,090 (0.5%)	1,081 (-0.4%)	1,090 (0.5%)	1,080 (-0.5%)
	Above Normal	1,151	1,156 (0.5%)	1,159 (0.7%)	1,155 (0.3%)	1,160 (0.8%)
	Below Normal	1,205	1,205 (0%)	1,197 (-0.7%)	1,205 (0%)	1,202 (-0.3%)
	Dry	1,442	1,445 (0.2%)	1,442 (-0.1%)	1,445 (0.2%)	1,444 (0.1%)
	Critically Dry	1,460	1,464 (0.3%)	1,459 (0%)	1,462 (0.2%)	1,464 (0.3%)
	All	1,249	1,252 (0.3%)	1,247 (-0.2%)	1,252 (0.3%)	1,249 (0%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-31. Spring-Run Fry Rearing WUA[1] in the Sacramento River, Segment 4, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
November	Wet	191	192 (0.4%)	192 (0.6%)	192 (0.4%)	189 (-0.9%)
	Above Normal	192	191 (-0.4%)	191 (-0.4%)	191 (-0.4%)	191 (-0.7%)
	Below Normal	202	201 (-0.3%)	201 (-0.2%)	201 (-0.3%)	201 (-0.5%)
	Dry	202	202 (0%)	198 (-1.7%)	202 (0%)	201 (-0.7%)
	Critically Dry	207	208 (0.3%)	209 (0.8%)	210 (1.3%)	202 (-2.6%)
	All	198	198 (0.1%)	197 (-0.2%)	198 (0.2%)	196 (-1%)
December	Wet	170	170 (-0.3%)	170 (-0.3%)	169 (-0.5%)	169 (-0.7%)
	Above Normal	200	200 (0.2%)	200 (0.3%)	200 (0.3%)	200 (0.3%)
	Below Normal	213	212 (-0.5%)	212 (-0.5%)	212 (-0.4%)	213 (0.1%)
	Dry	225	224 (-0.5%)	224 (-0.5%)	224 (-0.5%)	221 (-1.8%)
	Critically Dry	234	236 (0.7%)	235 (0.3%)	236 (0.7%)	237 (1.3%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	All	203	203 (-0.1%)	203 (-0.2%)	203 (-0.2%)	203 (-0.3%)
January	Wet	164	165 (0.2%)	165 (0.3%)	165 (0.2%)	163 (-0.8%)
	Above Normal	190	189 (-0.5%)	189 (-0.5%)	189 (-0.5%)	189 (-0.9%)
	Below Normal	213	214 (0.4%)	214 (0.3%)	214 (0.4%)	213 (0.1%)
	Dry	243	245 (0.9%)	245 (1%)	245 (0.9%)	245 (0.9%)
	Critically Dry	254	256 (0.7%)	256 (0.6%)	256 (0.6%)	254 (-0.2%)
	All	207	208 (0.4%)	208 (0.4%)	208 (0.4%)	207 (-0.1%)
February	Wet	164	164 (0.1%)	162 (-0.9%)	164 (0.1%)	162 (-0.9%)
	Above Normal	167	167 (0.3%)	168 (0.4%)	167 (0.1%)	168 (0.5%)
	Below Normal	190	190 (-0.2%)	190 (-0.5%)	190 (0%)	189 (-1%)
	Dry	233	234 (0.3%)	233 (-0.2%)	234 (0.3%)	232 (-0.3%)
	Critically Dry	247	243 (-1.8%)	242 (-2.1%)	242 (-1.9%)	243 (-1.8%)
	All	196	196 (-0.2%)	195 (-0.7%)	196 (-0.2%)	195 (-0.7%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-32. Spring-Run Juvenile Rearing WUA[1] in the Sacramento River, Segment 6, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
January	Wet	28	28 (0.2%)	28 (0.2%)	28 (0.2%)	28 (0.2%)
	Above Normal	27	28 (0.7%)	28 (0.7%)	28 (0.7%)	27 (-1.1%)
	Below Normal	32	32 (0.6%)	32 (0.6%)	32 (0.6%)	32 (0.4%)
	Dry	33	34 (0.7%)	34 (0.8%)	34 (0.7%)	34 (0.7%)
	Critically Dry	34	34 (0.4%)	34 (0.3%)	34 (0.3%)	34 (-0.1%)
	All	31	31 (0.5%)	31 (0.5%)	31 (0.5%)	31 (0.1%)
February	Wet	29	29 (0.2%)	29 (-0.5%)	29 (0.2%)	29 (-0.6%)
	Above Normal	28	28 (-0.8%)	28 (-1.2%)	28 (-0.4%)	28 (-1.2%)
	Below Normal	28	28 (-0.1%)	28 (-0.8%)	28 (0.4%)	27 (-2.1%)
	Dry	33	34 (0.5%)	33 (-0.1%)	34 (0.5%)	33 (0.1%)
	Critically Dry	33	33 (0%)	33 (-0.2%)	33 (-0.2%)	33 (0%)
	All	30	30 (0%)	30 (-0.5%)	30 (0.1%)	30 (-0.7%)
March	Wet	26	26 (1.1%)	26 (0.9%)	26 (1.1%)	26 (1.2%)
	Above Normal	26	26 (-0.2%)	26 (0.1%)	26 (-0.1%)	26 (0.6%)
	Below Normal	32	32 (0.3%)	32 (0.3%)	32 (0.3%)	32 (0.3%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Dry	33	32 (-0.5%)	33 (0%)	32 (-0.5%)	32 (-1.2%)
	Critically Dry	33	33 (0.3%)	33 (0%)	33 (-0.1%)	33 (-0.3%)
	All	29	29 (0.2%)	29 (0.3%)	29 (0.2%)	29 (0.1%)
April	Wet	38	38 (0%)	39 (0.2%)	38 (0%)	39 (0.8%)
	Above Normal	43	43 (-0.2%)	42 (-1.9%)	43 (-0.2%)	42 (-2.4%)
	Below Normal	44	44 (0.1%)	44 (0.1%)	44 (0.1%)	44 (0.5%)
	Dry	43	43 (-0.1%)	43 (0.6%)	43 (-0.1%)	43 (0.5%)
	Critically Dry	44	43 (-2%)	44 (0.1%)	43 (-1.6%)	44 (0.6%)
	All	42	42 (-0.3%)	42 (-0.1%)	42 (-0.3%)	42 (0.2%)
May	Wet	37	37 (0.1%)	37 (0.3%)	37 (0.1%)	37 (0.5%)
	Above Normal	39	39 (0.1%)	39 (-0.4%)	39 (0.1%)	38 (-1.1%)
	Below Normal	41	41 (0%)	42 (0.7%)	41 (0%)	42 (0.8%)
	Dry	41	40 (-0.2%)	41 (1.1%)	40 (-0.2%)	42 (3.5%)
	Critically Dry	42	42 (1%)	42 (1.3%)	42 (1.4%)	43 (4.1%)
	All	39	39 (0.1%)	40 (0.6%)	39 (0.2%)	40 (1.6%)
June	Wet	40	40 (-0.1%)	40 (0.1%)	40 (-0.1%)	40 (0%)
	Above Normal	37	37 (0.1%)	39 (5.6%)	37 (0.1%)	39 (7%)
	Below Normal	36	36 (-0.1%)	36 (1.4%)	36 (-0.1%)	38 (6.2%)
	Dry	34	34 (0%)	34 (-0.1%)	34 (0%)	35 (2.8%)
	Critically Dry	38	39 (2.3%)	39 (3.3%)	39 (2.3%)	39 (3.7%)
	All	37	37 (0.3%)	38 (1.5%)	37 (0.3%)	38 (3.2%)
July	Wet	31	31 (0%)	31 (0.3%)	31 (0%)	31 (0.2%)
	Above Normal	30	31 (0.6%)	31 (2.5%)	31 (0.8%)	32 (5.8%)
	Below Normal	31	31 (0.7%)	31 (0.3%)	31 (0.5%)	31 (0.1%)
	Dry	31	31 (0%)	31 (0.1%)	31 (0%)	31 (1.8%)
	Critically Dry	37	37 (-0.1%)	37 (0.5%)	37 (0%)	37 (1.5%)
	All	32	32 (0.2%)	32 (0.6%)	32 (0.2%)	32 (1.5%)
August	Wet	33	33 (0%)	34 (0.5%)	33 (0%)	34 (0.5%)
	Above Normal	35	35 (2.1%)	35 (1.2%)	35 (2.3%)	37 (7.2%)
	Below Normal	37	38 (1.6%)	38 (0.7%)	38 (1.5%)	38 (2.7%)
	Dry	39	39 (0.3%)	39 (0.3%)	39 (0.3%)	39 (1.1%)
	Critically Dry	42	41 (-2.1%)	41 (-1.8%)	41 (-1.9%)	41 (-1.4%)
	All	37	37 (0.3%)	37 (0.2%)	37 (0.3%)	37 (1.6%)
September	Wet	35	35 (0%)	35 (0.6%)	35 (0%)	35 (0.6%)
	Above Normal	39	40 (1.5%)	40 (0.4%)	40 (1.8%)	40 (0.3%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Below Normal	43	43 (0.8%)	44 (1.2%)	43 (0.8%)	43 (0.9%)
	Dry	45	45 (-0.2%)	46 (0.5%)	45 (-0.2%)	44 (-3.1%)
	Critically Dry	42	43 (3%)	43 (2.6%)	43 (2.4%)	44 (4.5%)
	All	40	41 (0.8%)	41 (1%)	41 (0.7%)	40 (0.3%)
October	Wet	42	42 (-0.2%)	42 (0.2%)	42 (-0.2%)	42 (-0.2%)
	Above Normal	42	42 (1.3%)	43 (1.9%)	43 (1.5%)	44 (4.1%)
	Below Normal	42	42 (0.2%)	42 (0.2%)	42 (0.2%)	43 (0.7%)
	Dry	42	42 (-0.2%)	42 (-0.1%)	42 (-0.2%)	42 (0.2%)
	Critically Dry	43	43 (0.2%)	43 (0.2%)	43 (0.2%)	43 (0.3%)
	All	42	42 (0.2%)	42 (0.4%)	42 (0.2%)	42 (0.8%)
November	Wet	29	29 (0.1%)	29 (-0.1%)	29 (0%)	28 (-1.7%)
	Above Normal	28	28 (-0.2%)	28 (-0.2%)	28 (-0.2%)	28 (-0.1%)
	Below Normal	29	29 (-0.2%)	29 (-0.3%)	29 (-0.2%)	29 (-0.5%)
	Dry	29	29 (-0.2%)	29 (-0.9%)	29 (-0.2%)	29 (-0.1%)
	Critically Dry	29	29 (-0.3%)	30 (0.3%)	30 (0.6%)	29 (-0.4%)
	All	29	29 (-0.1%)	29 (-0.2%)	29 (0%)	29 (-0.7%)
December	Wet	27	27 (-0.9%)	27 (-1%)	27 (-1.2%)	26 (-2.3%)
	Above Normal	28	28 (0.1%)	28 (0%)	28 (0.1%)	29 (0.7%)
	Below Normal	31	31 (-0.2%)	31 (-0.3%)	31 (-0.2%)	31 (0.1%)
	Dry	31	31 (0%)	31 (0%)	31 (0%)	31 (-1.2%)
	Critically Dry	32	32 (0.7%)	32 (1%)	32 (0.7%)	32 (1.4%)
	All	29	29 (-0.2%)	29 (-0.2%)	29 (-0.3%)	29 (-0.6%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-33. Spring-Run Juvenile Rearing WUA[1] in the Sacramento River, Segment 5, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
January	Wet	360	360 (0%)	360 (0%)	360 (0%)	359 (-0.2%)
	Above Normal	423	423 (0.1%)	423 (0.1%)	423 (0.1%)	419 (-0.8%)
	Below Normal	489	490 (0.3%)	490 (0.3%)	490 (0.3%)	490 (0.2%)
	Dry	508	510 (0.3%)	510 (0.3%)	510 (0.3%)	510 (0.3%)
	Critically Dry	517	518 (0.2%)	518 (0.1%)	518 (0.1%)	517 (-0.1%)
	All	447	448 (0.2%)	448 (0.2%)	448 (0.2%)	446 (-0.1%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
February	Wet	361	362 (0.2%)	360 (-0.4%)	362 (0.2%)	360 (-0.5%)
	Above Normal	381	380 (-0.2%)	380 (-0.4%)	380 (-0.2%)	379 (-0.5%)
	Below Normal	434	433 (-0.1%)	429 (-0.9%)	434 (0.2%)	427 (-1.6%)
	Dry	507	508 (0.1%)	507 (-0.1%)	508 (0.1%)	507 (0%)
	Critically Dry	512	513 (0.1%)	512 (0%)	513 (0%)	513 (0.1%)
	All	431	431 (0.1%)	429 (-0.3%)	431 (0.1%)	429 (-0.4%)
March	Wet	367	366 (-0.3%)	366 (-0.1%)	366 (-0.3%)	367 (0%)
	Above Normal	383	384 (0.2%)	385 (0.3%)	384 (0.3%)	385 (0.4%)
	Below Normal	488	489 (0.2%)	489 (0.2%)	489 (0.2%)	489 (0.2%)
	Dry	494	490 (-0.8%)	494 (-0.1%)	490 (-0.8%)	486 (-1.5%)
	Critically Dry	509	509 (0.1%)	504 (-0.9%)	508 (-0.1%)	503 (-1.1%)
	All	439	438 (-0.2%)	438 (-0.1%)	438 (-0.2%)	436 (-0.5%)
April	Wet	421	420 (0%)	421 (0.1%)	420 (0%)	421 (0.1%)
	Above Normal	464	463 (-0.2%)	463 (-0.3%)	463 (-0.2%)	464 (0%)
	Below Normal	492	492 (0.1%)	492 (0%)	492 (0.1%)	493 (0.3%)
	Dry	489	488 (-0.2%)	495 (1.1%)	488 (-0.2%)	492 (0.6%)
	Critically Dry	494	502 (1.6%)	502 (1.5%)	497 (0.6%)	496 (0.4%)
	All	465	466 (0.2%)	467 (0.5%)	465 (0%)	466 (0.3%)
May	Wet	362	362 (0.1%)	357 (-1.1%)	362 (0.1%)	359 (-0.8%)
	Above Normal	378	378 (0%)	378 (-0.1%)	378 (0%)	373 (-1.4%)
	Below Normal	405	405 (0%)	413 (2%)	405 (0%)	414 (2.2%)
	Dry	395	394 (-0.3%)	399 (1.1%)	394 (-0.3%)	406 (2.8%)
	Critically Dry	397	402 (1.2%)	403 (1.4%)	404 (1.7%)	409 (3.1%)
	All	384	384 (0.1%)	386 (0.5%)	385 (0.2%)	388 (1.1%)
June	Wet	374	374 (-0.1%)	374 (0%)	374 (-0.1%)	374 (0%)
	Above Normal	346	347 (0.1%)	362 (4.4%)	347 (0.1%)	367 (5.9%)
	Below Normal	345	345 (0%)	349 (1.1%)	345 (0%)	363 (5.3%)
	Dry	333	333 (0%)	333 (0.1%)	333 (0%)	341 (2.3%)
	Critically Dry	361	368 (2.2%)	371 (2.8%)	368 (2.2%)	372 (3.2%)
	All	354	355 (0.3%)	359 (1.3%)	355 (0.3%)	364 (2.7%)
July	Wet	311	311 (0%)	311 (0.1%)	311 (0%)	311 (0%)
	Above Normal	299	299 (0.1%)	303 (1.4%)	299 (0.1%)	310 (3.6%)
	Below Normal	308	307 (-0.1%)	307 (-0.1%)	307 (-0.3%)	310 (0.7%)
	Dry	313	312 (0%)	313 (0%)	312 (0%)	315 (0.9%)
	Critically Dry	353	353 (-0.1%)	354 (0.3%)	353 (0%)	356 (0.9%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	All	315	315 (0%)	316 (0.3%)	315 (0%)	318 (1%)
August	Wet	329	329 (0%)	330 (0.3%)	329 (0%)	330 (0.3%)
	Above Normal	336	340 (1.2%)	339 (0.8%)	340 (1.3%)	353 (5%)
	Below Normal	353	358 (1.4%)	355 (0.6%)	357 (1.2%)	362 (2.6%)
	Dry	366	367 (0.1%)	367 (0.1%)	367 (0.1%)	368 (0.6%)
	Critically Dry	397	385 (-3%)	386 (-2.7%)	385 (-3%)	386 (-2.7%)
	All	352	352 (-0.1%)	352 (-0.1%)	352 (-0.1%)	355 (0.9%)
September	Wet	341	341 (0%)	344 (0.6%)	341 (0%)	343 (0.5%)
	Above Normal	373	378 (1.6%)	373 (0.2%)	379 (1.8%)	369 (-1%)
	Below Normal	453	455 (0.5%)	452 (-0.2%)	455 (0.5%)	455 (0.6%)
	Dry	480	480 (0%)	479 (-0.2%)	480 (0%)	480 (0.1%)
	Critically Dry	492	481 (-2.2%)	482 (-2.1%)	482 (-2%)	484 (-1.7%)
	All	417	417 (-0.1%)	416 (-0.2%)	417 (0%)	417 (-0.2%)
October	Wet	429	425 (-0.8%)	424 (-1%)	425 (-0.8%)	416 (-3.1%)
	Above Normal	433	433 (0%)	432 (-0.3%)	432 (-0.3%)	425 (-1.9%)
	Below Normal	439	440 (0.3%)	439 (0%)	440 (0.2%)	433 (-1.4%)
	Dry	446	446 (-0.1%)	444 (-0.4%)	446 (-0.1%)	441 (-1.2%)
	Critically Dry	456	456 (0.1%)	456 (0.1%)	456 (0.2%)	454 (-0.4%)
	All	439	438 (-0.2%)	437 (-0.5%)	438 (-0.3%)	431 (-1.8%)
November	Wet	434	436 (0.5%)	434 (0.1%)	436 (0.5%)	428 (-1.4%)
	Above Normal	439	434 (-1.1%)	434 (-1.2%)	434 (-1.1%)	431 (-1.9%)
	Below Normal	457	455 (-0.4%)	455 (-0.4%)	455 (-0.5%)	453 (-0.8%)
	Dry	445	444 (-0.2%)	440 (-1.2%)	444 (-0.2%)	439 (-1.3%)
	Critically Dry	463	463 (0%)	464 (0.3%)	464 (0.4%)	453 (-2.2%)
	All	445	445 (-0.1%)	443 (-0.4%)	445 (-0.1%)	439 (-1.5%)
December	Wet	369	368 (-0.5%)	366 (-1.1%)	367 (-0.8%)	361 (-2.2%)
	Above Normal	441	444 (0.7%)	444 (0.7%)	444 (0.7%)	444 (0.8%)
	Below Normal	476	475 (-0.1%)	475 (-0.2%)	476 (-0.1%)	476 (0%)
	Dry	482	478 (-0.9%)	478 (-1%)	478 (-0.9%)	469 (-2.8%)
	Critically Dry	498	501 (0.6%)	500 (0.3%)	501 (0.6%)	500 (0.3%)
	All	442	441 (-0.1%)	440 (-0.4%)	441 (-0.2%)	437 (-1.1%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-34. Spring-Run Juvenile Rearing WUA[1] in the Sacramento River, Segment 4, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
January	Wet	68	68 (0.4%)	68 (0.4%)	68 (0.4%)	66 (-2.2%)
	Above Normal	95	95 (-0.2%)	95 (-0.2%)	95 (-0.2%)	92 (-3.3%)
	Below Normal	134	135 (0.6%)	135 (0.6%)	135 (0.6%)	135 (0.5%)
	Dry	153	154 (0.4%)	154 (0.4%)	154 (0.4%)	154 (0.4%)
	Critically Dry	160	160 (0.2%)	160 (0.1%)	160 (0.1%)	160 (-0.1%)
	All	115	116 (0.3%)	116 (0.3%)	116 (0.3%)	115 (-0.6%)
February	Wet	67	67 (0.7%)	66 (-0.9%)	67 (0.7%)	66 (-1.2%)
	Above Normal	79	80 (1.6%)	80 (1.7%)	80 (1.7%)	80 (1.8%)
	Below Normal	108	108 (-0.6%)	107 (-1%)	109 (0.8%)	107 (-0.9%)
	Dry	151	151 (0.3%)	151 (-0.1%)	151 (0.3%)	151 (0.2%)
	Critically Dry	159	158 (-0.5%)	158 (-0.7%)	158 (-0.6%)	158 (-0.5%)
	All	108	108 (0.2%)	107 (-0.4%)	108 (0.4%)	107 (-0.2%)
March	Wet	76	75 (-0.5%)	76 (-0.1%)	75 (-0.5%)	76 (0.2%)
	Above Normal	80	81 (0.3%)	81 (0.4%)	81 (0.3%)	81 (0.6%)
	Below Normal	141	141 (0.1%)	141 (0.1%)	141 (0.1%)	141 (0.1%)
	Dry	141	138 (-1.8%)	140 (-0.3%)	138 (-1.8%)	136 (-3.7%)
	Critically Dry	158	158 (0.1%)	153 (-2.7%)	158 (-0.1%)	153 (-3.1%)
	All	114	113 (-0.5%)	113 (-0.6%)	113 (-0.5%)	112 (-1.5%)
April	Wet	102	102 (0%)	103 (0.2%)	102 (0%)	103 (0.4%)
	Above Normal	127	126 (-0.2%)	126 (-0.4%)	126 (-0.2%)	126 (-0.3%)
	Below Normal	144	144 (0%)	144 (-0.1%)	144 (0%)	145 (0.5%)
	Dry	146	145 (-0.4%)	150 (2.4%)	145 (-0.4%)	148 (1.4%)
	Critically Dry	155	158 (2.2%)	159 (2.4%)	157 (1.3%)	157 (1.3%)
	All	130	131 (0.3%)	132 (1%)	130 (0.1%)	131 (0.7%)
May	Wet	71	72 (0.2%)	68 (-4.3%)	72 (0.2%)	69 (-2.9%)
	Above Normal	83	84 (0.6%)	84 (1.5%)	84 (0.6%)	80 (-3.7%)
	Below Normal	99	99 (-0.1%)	106 (6.9%)	99 (-0.1%)	107 (8%)
	Dry	95	94 (-1.1%)	98 (3.2%)	94 (-1.1%)	102 (7.6%)
	Critically Dry	96	99 (3.3%)	100 (4.2%)	101 (4.7%)	104 (8.7%)
	All	87	87 (0.4%)	88 (1.9%)	87 (0.6%)	90 (3.5%)
June	Wet	79	79 (-0.4%)	79 (0.2%)	79 (-0.3%)	79 (0.1%)
	Above Normal	65	65 (0%)	73 (11.6%)	65 (0%)	76 (16.5%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Below Normal	64	64 (-0.6%)	65 (0.8%)	64 (-0.6%)	75 (16.8%)
	Dry	59	59 (-0.3%)	60 (0.4%)	59 (-0.3%)	62 (4.7%)
	Critically Dry	76	80 (5.7%)	81 (6.9%)	80 (5.7%)	82 (7.9%)
	All	70	70 (0.6%)	72 (3%)	70 (0.6%)	75 (7.1%)
July	Wet	49	49 (0%)	50 (0.3%)	49 (0%)	50 (0.3%)
	Above Normal	46	46 (0.1%)	48 (4.7%)	46 (0%)	53 (15.1%)
	Below Normal	48	48 (-0.1%)	48 (-0.3%)	48 (-0.6%)	48 (0.5%)
	Dry	50	50 (-0.1%)	50 (0.8%)	50 (-0.1%)	51 (2.3%)
	Critically Dry	71	71 (-0.3%)	72 (0.6%)	71 (0%)	73 (2.8%)
	All	52	52 (-0.1%)	53 (0.9%)	52 (-0.1%)	54 (3%)
August	Wet	58	58 (0%)	59 (0.9%)	58 (0%)	59 (0.8%)
	Above Normal	61	64 (5.3%)	62 (1.6%)	64 (5.5%)	71 (16.1%)
	Below Normal	70	73 (3.8%)	72 (1.5%)	73 (3.3%)	77 (9%)
	Dry	79	79 (0%)	79 (0%)	79 (0%)	80 (1.1%)
	Critically Dry	101	92 (-9.2%)	93 (-8.3%)	92 (-9.1%)	92 (-8.9%)
	All	72	71 (-0.6%)	71 (-1%)	71 (-0.7%)	73 (2%)
September	Wet	65	65 (0%)	66 (2.2%)	65 (0%)	66 (1.4%)
	Above Normal	84	89 (5.3%)	85 (0.5%)	89 (6%)	79 (-6.2%)
	Below Normal	142	144 (1%)	142 (0.1%)	144 (1%)	144 (1.2%)
	Dry	154	154 (-0.1%)	154 (-0.2%)	154 (-0.1%)	154 (0%)
	Critically Dry	157	153 (-2.3%)	153 (-2.4%)	154 (-2.2%)	154 (-1.8%)
	All	114	115 (0.2%)	114 (-0.1%)	115 (0.3%)	114 (-0.5%)
October	Wet	116	114 (-1.5%)	114 (-2.2%)	114 (-1.6%)	107 (-7.5%)
	Above Normal	120	121 (1%)	120 (0.1%)	120 (-0.1%)	115 (-3.8%)
	Below Normal	126	127 (0.6%)	125 (-0.7%)	127 (0.5%)	122 (-3.3%)
	Dry	133	132 (-0.7%)	131 (-1.4%)	132 (-0.7%)	127 (-4.1%)
	Critically Dry	136	136 (0.1%)	136 (0.2%)	137 (0.5%)	135 (-1.2%)
	All	125	124 (-0.3%)	124 (-1%)	124 (-0.5%)	119 (-4.4%)
November	Wet	115	116 (1.2%)	116 (0.5%)	117 (1.3%)	112 (-2.7%)
	Above Normal	122	119 (-3.2%)	118 (-3.3%)	119 (-3.2%)	116 (-5.2%)
	Below Normal	132	131 (-0.7%)	131 (-0.7%)	131 (-0.8%)	130 (-1.3%)
	Dry	123	123 (-0.3%)	120 (-2.8%)	123 (-0.3%)	119 (-3.3%)
	Critically Dry	139	139 (0.1%)	139 (0.2%)	139 (0.2%)	133 (-4.2%)
	All	124	124 (-0.3%)	123 (-1%)	124 (-0.2%)	120 (-3.2%)
December	Wet	73	72 (-0.9%)	72 (-2.2%)	72 (-1.3%)	70 (-4.6%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Above Normal	118	121 (2.2%)	121 (2.3%)	121 (2.2%)	122 (2.6%)
	Below Normal	141	141 (-0.2%)	141 (-0.3%)	141 (-0.2%)	141 (0%)
	Dry	144	142 (-1.3%)	143 (-1.2%)	142 (-1.3%)	138 (-4.2%)
	Critically Dry	154	156 (0.8%)	155 (0.8%)	156 (0.8%)	155 (0.2%)
	All	119	119 (-0.1%)	119 (-0.3%)	119 (-0.2%)	117 (-1.6%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Fall-Run Chinook Salmon

Rearing habitat WUA for fall-run fry and juveniles was determined by USFWS (2005b) in the same manner that it was determined for winter-run. To estimate changes in rearing WUA that would result from Alternatives 1, 2, and 3, the fall-run WUA curve developed for each of the three river segments was used with the mean monthly CALSIM II flow estimate for the corresponding river segment under Alternatives 1, 2, and 3 and the NAA during the rearing periods for fry (December through March) and juveniles (February through June).

Differences in fall-run fry and juvenile rearing habitat WUA in each river segment under Alternatives 1, 2, and 3 compared to the NAA were examined using the grand mean rearing WUA for each month of the fry and juvenile rearing periods under each water year type and all water year types combined (Table 11K-35 through Table 11K-40).

Most of the means for fry rearing WUA differ by less than 2% between Alternatives 1A, 1B, and 2 and the NAA (Table 11K-35 and Table 11K-36). However, under Alternative 3 in Segment 5, half of the means for water year type by month differ from the NAA by more than 2%, although none of these differences is very large (Table 11K-37). The largest differences for all three river segments and alternatives are 6% reductions under Alternative 3 in Segment 5 during October of Wet Water Years (Table 11K-36) and under Alternatives 1A and 1B in Segment 4 during September of Critically Dry Water Years (Table 11K-37). The maximum increase in fry rearing WUA is about 2% for Alternatives 1A and 2 during September of Above Normal Water Years in Segment 6 (Table 11K-35).

For the juvenile rearing WUA means in Segments 6 and 5, most differences between the NAA and Alternatives 1A, 1B, and 2 are less than 2%, while about a third of the differences for Alternative 3 are more than 2% (Table 11K-38 and Table 11K-39). Almost all of these differences occur in May and June and constitute increase in rearing WUA. For Segment 4, many more of the means differ by more than 2%, especially under Alternatives 1B and 3, and as noted for Segments 5 and 6, most of these differences occur in May and June and constitute increases in rearing WUA (Table 11K-40). The largest differences over all river segments and alternatives are in Segment 4 and include 17% increases in June of Above Normal and Below Normal Water Years under Alternative 3 and a 12% increase in June of Above Normal Water Years under Alternative 1B. The largest reduction in juvenile rearing WUA, 4%, is in Segment 4 during May of Wet Water Years under Alternative 1B. Note that the rearing WUA results for fall-run (Table 11K-35 through Table 11K-40) are identical to those for spring-run (Table 11K-

29 through Table 11K-34) where the rearing periods overlap because both runs use the fall-run rearing WUA curves for the WUA computations.

The results for fall-run rearing WUA show small reductions in fry rearing WUA and substantial increases in juvenile rearing habitat WUA, especially in May and June and under Alternatives 1B and 3 in Segment 4.

Table 11K-35. Fall-Run Fry Rearing WUA[1] in the Sacramento River, Segment 6, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
September	Wet	101	101 (0%)	102 (1.1%)	101 (0%)	102 (0.8%)
	Above Normal	116	119 (2.3%)	117 (0.8%)	119 (2.6%)	115 (-0.7%)
	Below Normal	147	147 (0.5%)	147 (0.2%)	147 (0.5%)	148 (0.9%)
	Dry	151	151 (0%)	151 (0.1%)	151 (0%)	151 (0%)
	Critically Dry	152	151 (-0.7%)	151 (-0.8%)	151 (-0.6%)	151 (-0.6%)
	All	130	130 (0.3%)	130 (0.3%)	130 (0.3%)	130 (0.2%)
October	Wet	137	137 (-0.1%)	137 (-0.4%)	137 (-0.1%)	134 (-2.4%)
	Above Normal	139	140 (0.8%)	139 (0.2%)	139 (0.3%)	137 (-1%)
	Below Normal	142	143 (0.3%)	142 (-0.3%)	143 (0.3%)	140 (-1.3%)
	Dry	146	145 (-0.2%)	145 (-0.7%)	145 (-0.2%)	143 (-2%)
	Critically Dry	147	146 (-0.2%)	147 (-0.1%)	147 (0%)	146 (-0.7%)
	All	142	142 (0%)	141 (-0.3%)	142 (0%)	139 (-1.7%)
November	Wet	63	63 (0%)	63 (-0.1%)	63 (-0.1%)	62 (-1.2%)
	Above Normal	60	60 (0.7%)	60 (0.6%)	60 (0.6%)	60 (0.4%)
	Below Normal	62	62 (-0.1%)	62 (-0.1%)	62 (-0.1%)	62 (-0.2%)
	Dry	62	62 (0%)	62 (-0.6%)	62 (0%)	62 (0.8%)
	Critically Dry	61	61 (0%)	61 (0.3%)	62 (0.6%)	61 (-0.5%)
	All	62	62 (0.1%)	62 (-0.1%)	62 (0.1%)	62 (-0.3%)
December	Wet	75	75 (-0.4%)	75 (0%)	75 (-0.5%)	75 (-0.4%)
	Above Normal	64	64 (-0.6%)	64 (-0.3%)	64 (-0.7%)	65 (1%)
	Below Normal	67	67 (-0.2%)	67 (-0.3%)	67 (-0.2%)	67 (0%)
	Dry	64	64 (0.4%)	64 (0.4%)	64 (0.4%)	64 (-0.1%)
	Critically Dry	66	66 (0.7%)	66 (1%)	66 (0.7%)	67 (1.9%)
	All	68	68 (-0.1%)	69 (0.1%)	68 (-0.1%)	69 (0.3%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-36. Fall-Run Fry Rearing WUA[1] in the Sacramento River, Segment 5, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
September	Wet	886	886 (0%)	888 (0.2%)	886 (0%)	886 (0%)
	Above Normal	896	903 (0.8%)	892 (-0.4%)	903 (0.8%)	872 (-2.7%)
	Below Normal	1,167	1,182 (1.3%)	1,164 (-0.2%)	1,182 (1.4%)	1,183 (1.4%)
	Dry	1,323	1,320 (-0.2%)	1,314 (-0.6%)	1,320 (-0.2%)	1,323 (0%)
	Critically Dry	1,396	1,334 (-4.4%)	1,337 (-4.2%)	1,339 (-4.1%)	1,350 (-3.3%)
	All	1,106	1,100 (-0.5%)	1,095 (-1%)	1,101 (-0.5%)	1,099 (-0.7%)
October	Wet	1,102	1,082 (-1.8%)	1,078 (-2.2%)	1,082 (-1.9%)	1,037 (-6%)
	Above Normal	1,102	1,098 (-0.4%)	1,093 (-0.8%)	1,093 (-0.8%)	1,055 (-4.2%)
	Below Normal	1,126	1,129 (0.3%)	1,123 (-0.3%)	1,128 (0.2%)	1,091 (-3.1%)
	Dry	1,140	1,143 (0.2%)	1,133 (-0.6%)	1,143 (0.3%)	1,117 (-2%)
	Critically Dry	1,215	1,216 (0.1%)	1,216 (0.1%)	1,219 (0.3%)	1,203 (-1%)
	All	1,131	1,125 (-0.5%)	1,120 (-1%)	1,125 (-0.5%)	1,091 (-3.6%)
November	Wet	1,155	1,166 (0.9%)	1,157 (0.2%)	1,167 (1%)	1,132 (-2%)
	Above Normal	1,131	1,106 (-2.2%)	1,104 (-2.4%)	1,106 (-2.2%)	1,089 (-3.7%)
	Below Normal	1,207	1,195 (-0.9%)	1,196 (-0.9%)	1,194 (-1.1%)	1,189 (-1.5%)
	Dry	1,172	1,170 (-0.2%)	1,146 (-2.2%)	1,170 (-0.2%)	1,142 (-2.6%)
	Critically Dry	1,237	1,240 (0.2%)	1,248 (0.8%)	1,249 (1%)	1,176 (-4.9%)
	All	1,176	1,174 (-0.2%)	1,167 (-0.8%)	1,175 (-0.1%)	1,144 (-2.7%)
December	Wet	1,072	1,069 (-0.3%)	1,062 (-0.9%)	1,066 (-0.6%)	1,056 (-1.5%)
	Above Normal	1,209	1,226 (1.4%)	1,227 (1.5%)	1,226 (1.4%)	1,230 (1.7%)
	Below Normal	1,342	1,339 (-0.2%)	1,337 (-0.4%)	1,339 (-0.2%)	1,340 (-0.1%)
	Dry	1,328	1,303 (-1.9%)	1,303 (-1.9%)	1,303 (-1.9%)	1,263 (-4.9%)
	Critically Dry	1,399	1,419 (1.4%)	1,406 (0.5%)	1,419 (1.4%)	1,405 (0.4%)
	All	1,242	1,241 (-0.1%)	1,236 (-0.5%)	1,240 (-0.2%)	1,226 (-1.3%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-37. Fall-Run Fry Rearing WUA[1] in the Sacramento River, Segment 4, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
September	Wet	173	173 (0%)	173 (0.2%)	173 (0%)	173 (0.2%)
	Above Normal	179	181 (0.7%)	179 (0%)	181 (0.8%)	179 (-0.4%)
	Below Normal	202	203 (0.4%)	201 (-0.7%)	203 (0.5%)	202 (0.1%)
	Dry	223	223 (0%)	222 (-0.4%)	223 (0%)	224 (0.3%)
	Critically Dry	237	224 (-5.5%)	224 (-5.5%)	225 (-5.1%)	227 (-4.2%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	All	200	198 (-0.8%)	197 (-1.1%)	198 (-0.7%)	198 (-0.6%)
October	Wet	198	196 (-0.8%)	196 (-0.9%)	196 (-0.9%)	192 (-2.8%)
	Above Normal	195	194 (-0.2%)	194 (-0.5%)	194 (-0.4%)	190 (-2.4%)
	Below Normal	198	199 (0.7%)	199 (0.5%)	199 (0.7%)	196 (-1.2%)
	Dry	199	199 (0.5%)	198 (-0.3%)	199 (0.5%)	197 (-0.8%)
	Critically Dry	212	212 (0%)	211 (-0.4%)	212 (0.1%)	210 (-1.1%)
	All	200	199 (0%)	199 (-0.4%)	199 (-0.1%)	196 (-1.8%)
November	Wet	191	192 (0.4%)	192 (0.6%)	192 (0.4%)	189 (-0.9%)
	Above Normal	192	191 (-0.4%)	191 (-0.4%)	191 (-0.4%)	191 (-0.7%)
	Below Normal	202	201 (-0.3%)	201 (-0.2%)	201 (-0.3%)	201 (-0.5%)
	Dry	202	202 (0%)	198 (-1.7%)	202 (0%)	201 (-0.7%)
	Critically Dry	207	208 (0.3%)	209 (0.8%)	210 (1.3%)	202 (-2.6%)
	All	198	198 (0.1%)	197 (-0.2%)	198 (0.2%)	196 (-1%)
December	Wet	170	170 (-0.3%)	170 (-0.3%)	169 (-0.5%)	169 (-0.7%)
	Above Normal	200	200 (0.2%)	200 (0.3%)	200 (0.3%)	200 (0.3%)
	Below Normal	213	212 (-0.5%)	212 (-0.5%)	212 (-0.4%)	213 (0.1%)
	Dry	225	224 (-0.5%)	224 (-0.5%)	224 (-0.5%)	221 (-1.8%)
	Critically Dry	234	236 (0.7%)	235 (0.3%)	236 (0.7%)	237 (1.3%)
	All	203	203 (-0.1%)	203 (-0.2%)	203 (-0.2%)	203 (-0.3%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-38. Fall-Run Juvenile Rearing WUA[1] in the Sacramento River, Segment 6, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
February	Wet	29	29 (0.2%)	29 (-0.5%)	29 (0.2%)	29 (-0.6%)
	Above Normal	28	28 (-0.8%)	28 (-1.2%)	28 (-0.4%)	28 (-1.2%)
	Below Normal	28	28 (-0.1%)	28 (-0.8%)	28 (0.4%)	27 (-2.1%)
	Dry	33	34 (0.5%)	33 (-0.1%)	34 (0.5%)	33 (0.1%)
	Critically Dry	33	33 (0%)	33 (-0.2%)	33 (-0.2%)	33 (0%)
	All	30	30 (0%)	30 (-0.5%)	30 (0.1%)	30 (-0.7%)
March	Wet	26	26 (1.1%)	26 (0.9%)	26 (1.1%)	26 (1.2%)
	Above Normal	26	26 (-0.2%)	26 (0.1%)	26 (-0.1%)	26 (0.6%)
	Below Normal	32	32 (0.3%)	32 (0.3%)	32 (0.3%)	32 (0.3%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Dry	33	32 (-0.5%)	33 (0%)	32 (-0.5%)	32 (-1.2%)
	Critically Dry	33	33 (0.3%)	33 (0%)	33 (-0.1%)	33 (-0.3%)
	All	29	29 (0.2%)	29 (0.3%)	29 (0.2%)	29 (0.1%)
April	Wet	38	38 (0%)	39 (0.2%)	38 (0%)	39 (0.8%)
	Above Normal	43	43 (-0.2%)	42 (-1.9%)	43 (-0.2%)	42 (-2.4%)
	Below Normal	44	44 (0.1%)	44 (0.1%)	44 (0.1%)	44 (0.5%)
	Dry	43	43 (-0.1%)	43 (0.6%)	43 (-0.1%)	43 (0.5%)
	Critically Dry	44	43 (-2%)	44 (0.1%)	43 (-1.6%)	44 (0.6%)
	All	42	42 (-0.3%)	42 (-0.1%)	42 (-0.3%)	42 (0.2%)
May	Wet	37	37 (0.1%)	37 (0.3%)	37 (0.1%)	37 (0.5%)
	Above Normal	39	39 (0.1%)	39 (-0.4%)	39 (0.1%)	38 (-1.1%)
	Below Normal	41	41 (0%)	42 (0.7%)	41 (0%)	42 (0.8%)
	Dry	41	40 (-0.2%)	41 (1.1%)	40 (-0.2%)	42 (3.5%)
	Critically Dry	42	42 (1%)	42 (1.3%)	42 (1.4%)	43 (4.1%)
	All	39	39 (0.1%)	40 (0.6%)	39 (0.2%)	40 (1.6%)
June	Wet	40	40 (-0.1%)	40 (0.1%)	40 (-0.1%)	40 (0%)
	Above Normal	37	37 (0.1%)	39 (5.6%)	37 (0.1%)	39 (7%)
	Below Normal	36	36 (-0.1%)	36 (1.4%)	36 (-0.1%)	38 (6.2%)
	Dry	34	34 (0%)	34 (-0.1%)	34 (0%)	35 (2.8%)
	Critically Dry	38	39 (2.3%)	39 (3.3%)	39 (2.3%)	39 (3.7%)
	All	37	37 (0.3%)	38 (1.5%)	37 (0.3%)	38 (3.2%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-39. Fall-Run Juvenile Rearing WUA[1] in the Sacramento River, Segment 5, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
February	Wet	361	362 (0.2%)	360 (-0.4%)	362 (0.2%)	360 (-0.5%)
	Above Normal	381	380 (-0.2%)	380 (-0.4%)	380 (-0.2%)	379 (-0.5%)
	Below Normal	434	433 (-0.1%)	429 (-0.9%)	434 (0.2%)	427 (-1.6%)
	Dry	507	508 (0.1%)	507 (-0.1%)	508 (0.1%)	507 (0%)
	Critically Dry	512	513 (0.1%)	512 (0%)	513 (0%)	513 (0.1%)
	All	431	431 (0.1%)	429 (-0.3%)	431 (0.1%)	429 (-0.4%)
March	Wet	367	366 (-0.3%)	366 (-0.1%)	366 (-0.3%)	367 (0%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Above Normal	383	384 (0.2%)	385 (0.3%)	384 (0.3%)	385 (0.4%)
	Below Normal	488	489 (0.2%)	489 (0.2%)	489 (0.2%)	489 (0.2%)
	Dry	494	490 (-0.8%)	494 (-0.1%)	490 (-0.8%)	486 (-1.5%)
	Critically Dry	509	509 (0.1%)	504 (-0.9%)	508 (-0.1%)	503 (-1.1%)
	All	439	438 (-0.2%)	438 (-0.1%)	438 (-0.2%)	436 (-0.5%)
April	Wet	421	420 (0%)	421 (0.1%)	420 (0%)	421 (0.1%)
	Above Normal	464	463 (-0.2%)	463 (-0.3%)	463 (-0.2%)	464 (0%)
	Below Normal	492	492 (0.1%)	492 (0%)	492 (0.1%)	493 (0.3%)
	Dry	489	488 (-0.2%)	495 (1.1%)	488 (-0.2%)	492 (0.6%)
	Critically Dry	494	502 (1.6%)	502 (1.5%)	497 (0.6%)	496 (0.4%)
	All	465	466 (0.2%)	467 (0.5%)	465 (0%)	466 (0.3%)
May	Wet	362	362 (0.1%)	357 (-1.1%)	362 (0.1%)	359 (-0.8%)
	Above Normal	378	378 (0%)	378 (-0.1%)	378 (0%)	373 (-1.4%)
	Below Normal	405	405 (0%)	413 (2%)	405 (0%)	414 (2.2%)
	Dry	395	394 (-0.3%)	399 (1.1%)	394 (-0.3%)	406 (2.8%)
	Critically Dry	397	402 (1.2%)	403 (1.4%)	404 (1.7%)	409 (3.1%)
	All	384	384 (0.1%)	386 (0.5%)	385 (0.2%)	388 (1.1%)
June	Wet	374	374 (-0.1%)	374 (0%)	374 (-0.1%)	374 (0%)
	Above Normal	346	347 (0.1%)	362 (4.4%)	347 (0.1%)	367 (5.9%)
	Below Normal	345	345 (0%)	349 (1.1%)	345 (0%)	363 (5.3%)
	Dry	333	333 (0%)	333 (0.1%)	333 (0%)	341 (2.3%)
	Critically Dry	361	368 (2.2%)	371 (2.8%)	368 (2.2%)	372 (3.2%)
	All	354	355 (0.3%)	359 (1.3%)	355 (0.3%)	364 (2.7%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-40. Fall-Run Juvenile Rearing WUA[1] in the Sacramento River, Segment 4, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
February	Wet	67	67 (0.7%)	66 (-0.9%)	67 (0.7%)	66 (-1.2%)
	Above Normal	79	80 (1.6%)	80 (1.7%)	80 (1.7%)	80 (1.8%)
	Below Normal	108	108 (-0.6%)	107 (-1%)	109 (0.8%)	107 (-0.9%)
	Dry	151	151 (0.3%)	151 (-0.1%)	151 (0.3%)	151 (0.2%)
	Critically Dry	159	158 (-0.5%)	158 (-0.7%)	158 (-0.6%)	158 (-0.5%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	All	108	108 (0.2%)	107 (-0.4%)	108 (0.4%)	107 (-0.2%)
March	Wet	76	75 (-0.5%)	76 (-0.1%)	75 (-0.5%)	76 (0.2%)
	Above Normal	80	81 (0.3%)	81 (0.4%)	81 (0.3%)	81 (0.6%)
	Below Normal	141	141 (0.1%)	141 (0.1%)	141 (0.1%)	141 (0.1%)
	Dry	141	138 (-1.8%)	140 (-0.3%)	138 (-1.8%)	136 (-3.7%)
	Critically Dry	158	158 (0.1%)	153 (-2.7%)	158 (-0.1%)	153 (-3.1%)
	All	114	113 (-0.5%)	113 (-0.6%)	113 (-0.5%)	112 (-1.5%)
April	Wet	102	102 (0%)	103 (0.2%)	102 (0%)	103 (0.4%)
	Above Normal	127	126 (-0.2%)	126 (-0.4%)	126 (-0.2%)	126 (-0.3%)
	Below Normal	144	144 (0%)	144 (-0.1%)	144 (0%)	145 (0.5%)
	Dry	146	145 (-0.4%)	150 (2.4%)	145 (-0.4%)	148 (1.4%)
	Critically Dry	155	158 (2.2%)	159 (2.4%)	157 (1.3%)	157 (1.3%)
	All	130	131 (0.3%)	132 (1%)	130 (0.1%)	131 (0.7%)
May	Wet	71	72 (0.2%)	68 (-4.3%)	72 (0.2%)	69 (-2.9%)
	Above Normal	83	84 (0.6%)	84 (1.5%)	84 (0.6%)	80 (-3.7%)
	Below Normal	99	99 (-0.1%)	106 (6.9%)	99 (-0.1%)	107 (8%)
	Dry	95	94 (-1.1%)	98 (3.2%)	94 (-1.1%)	102 (7.6%)
	Critically Dry	96	99 (3.3%)	100 (4.2%)	101 (4.7%)	104 (8.7%)
	All	87	87 (0.4%)	88 (1.9%)	87 (0.6%)	90 (3.5%)
June	Wet	79	79 (-0.4%)	79 (0%)	79 (-0.3%)	79 (0.1%)
	Above Normal	65	65 (0%)	73 (11.6%)	65 (0%)	76 (16.5%)
	Below Normal	64	64 (-0.6%)	65 (0.8%)	64 (-0.6%)	75 (16.8%)
	Dry	59	59 (-0.3%)	60 (0.4%)	59 (-0.3%)	62 (4.7%)
	Critically Dry	76	80 (5.7%)	81 (6.9%)	80 (5.7%)	82 (7.9%)
	All	70	70 (0.6%)	72 (3%)	70 (0.6%)	75 (7.1%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Late Fall–Run Chinook Salmon

Rearing habitat WUA for late fall–run Chinook salmon fry and juveniles was determined by USFWS (2005a) in the same manner that it was determined for winter-run and fall-run Chinook salmon. To estimate changes in rearing WUA that would result from Alternatives 1, 2, and 3, the late fall–run Chinook salmon WUA curves developed for the three river segments were used with mean monthly CALSIM II flow estimates for corresponding river segments under Alternatives 1, 2, and 3 and the NAA during the rearing periods for late fall–run fry (March through June) and juveniles (May through October).

Differences in late fall–run fry and juvenile rearing habitat WUA in each river segment under Alternatives 1, 2, and 3 compared to the NAA were examined using the grand mean rearing WUA for each month of the fry and juvenile rearing periods under each water year type and all water year types combined (Table 11K-41 through Table 11K-46).

Few of the differences between Alternatives 1, 2, and 3 and the NAA means for late fall–run fry rearing WUA in all river segments are more than 3% (Table 11K-41 through Table 11K-43). The largest differences are increases of 8% and 9% in May of Critically Dry Water Years and June of Above Normal Water Years in Segment 6 under Alternative 3 (Table 11K-41). The largest reduction is 3% and occurs in March of Dry Water Years under Alternative 3 in Segment 5 (Table 11K-42). These results indicate that Alternatives 1, 2, and 3 would have a small beneficial effect on late fall–run fry rearing habitat availability.

Late fall–run mean juvenile rearing WUA differs between Alternatives 1A, 1B, and 2 and the NAA by less than 2% for most months and water year types in Segments 6 and 5 (Table 11K-44 and Table 11K-45). However, more than half of the mean differences are more than 2% for Alternative 3 in these river segments, and most of them result from increases in rearing WUA. The largest of these increases is 7% in August of Above Normal Water Years in Segment 6 (Table 11K-44). Segment 4 has many more >2% differences in means between Alternatives 1, 2, and 3 and the NAA than Segments 6 and 5 (Table 11K-46). The largest differences include 15% increases in rearing WUA in June of Above Normal and Below Normal Water Years under Alternative 3 and 8% to 9% reductions in rearing WUA in August of Critically Dry Water Years under all three alternatives.

The results for juvenile rearing WUA indicate largely minor differences between Alternatives 1, 2, and 3 and the NAA for Segments 6 and 5, but substantial differences for Segment 4. This segment generally has increased juvenile rearing habitat WUA under Alternatives 1B and 3 during late spring and summer, and has some reduction in habitat during August of Critically Dry Water Years. Alternative 3 has the most and largest differences and, on balance, it is expected to benefit late fall–run rearing habitat availability. Alternatives 1A, 1B, and 2 are expected to have little effect.

Table 11K-41. Late Fall–Run Fry Rearing WUA[1] in the Sacramento River, Segment 6, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
March	Wet	63	65 (3.1%)	65 (3%)	65 (3.1%)	65 (2.9%)
	Above Normal	66	65 (-0.7%)	66 (0.2%)	65 (-0.3%)	67 (1.9%)
	Below Normal	61	62 (0.4%)	62 (0.4%)	62 (0.4%)	62 (0.4%)
	Dry	61	62 (1.5%)	62 (1.9%)	62 (1.5%)	62 (1.7%)
	Critically Dry	61	61 (0.4%)	62 (1.5%)	61 (0%)	62 (1%)
	All	62	63 (1.3%)	63 (1.7%)	63 (1.3%)	63 (1.8%)
April	Wet	94	94 (0%)	94 (0.3%)	94 (0%)	94 (0.8%)
	Above Normal	107	107 (-0.5%)	107 (-0.4%)	107 (-0.5%)	107 (0.1%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Below Normal	114	114 (0%)	114 (0%)	114 (0%)	115 (0.5%)
	Dry	114	114 (0.1%)	114 (0.4%)	114 (0.1%)	114 (0.1%)
	Critically Dry	117	117 (-0.1%)	119 (1.2%)	117 (-0.5%)	117 (-0.6%)
	All	107	107 (0%)	107 (0.3%)	107 (-0.1%)	107 (0.2%)
May	Wet	73	73 (0.1%)	71 (-1.7%)	73 (0.1%)	71 (-1.5%)
	Above Normal	77	77 (-0.4%)	78 (1.1%)	77 (-0.4%)	76 (-1.8%)
	Below Normal	83	83 (-0.1%)	86 (3.2%)	83 (-0.1%)	85 (2.9%)
	Dry	79	78 (-1%)	80 (1.3%)	78 (-1%)	82 (3.9%)
	Critically Dry	80	82 (2.1%)	82 (2.6%)	83 (3.3%)	86 (8%)
	All	77	77 (0%)	78 (0.9%)	78 (0.2%)	79 (1.9%)
June	Wet	72	72 (0%)	72 (0.3%)	72 (0%)	72 (0.3%)
	Above Normal	62	62 (0%)	66 (5.7%)	62 (0%)	68 (8.8%)
	Below Normal	68	68 (-0.1%)	69 (0.9%)	68 (0%)	70 (2.8%)
	Dry	67	67 (0%)	67 (-0.6%)	67 (0%)	66 (-1%)
	Critically Dry	69	70 (1.4%)	70 (1.7%)	70 (1.4%)	70 (2.4%)
	All	68	69 (0.2%)	69 (1.2%)	69 (0.2%)	70 (1.9%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-42. Late Fall–Run Fry Rearing WUA[1] in the Sacramento River, Segment 5, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
March	Wet	1,044	1,045 (0.1%)	1,046 (0.2%)	1,045 (0.1%)	1,049 (0.5%)
	Above Normal	1,033	1,041 (0.8%)	1,041 (0.8%)	1,041 (0.8%)	1,040 (0.7%)
	Below Normal	1,353	1,352 (-0.1%)	1,352 (-0.1%)	1,352 (-0.1%)	1,352 (-0.1%)
	Dry	1,316	1,294 (-1.7%)	1,313 (-0.2%)	1,294 (-1.7%)	1,280 (-2.8%)
	Critically Dry	1,388	1,386 (-0.1%)	1,355 (-2.4%)	1,387 (0%)	1,353 (-2.5%)
	All	1,205	1,202 (-0.3%)	1,201 (-0.3%)	1,202 (-0.3%)	1,195 (-0.9%)
April	Wet	1,131	1,130 (0%)	1,131 (0.1%)	1,130 (0%)	1,126 (-0.4%)
	Above Normal	1,210	1,209 (-0.1%)	1,206 (-0.3%)	1,209 (-0.1%)	1,203 (-0.5%)
	Below Normal	1,311	1,310 (-0.1%)	1,308 (-0.2%)	1,310 (-0.1%)	1,308 (-0.2%)
	Dry	1,285	1,280 (-0.3%)	1,307 (1.7%)	1,280 (-0.3%)	1,292 (0.6%)
	Critically Dry	1,317	1,362 (3.4%)	1,358 (3.1%)	1,333 (1.2%)	1,328 (0.8%)
	All	1,234	1,239 (0.4%)	1,244 (0.8%)	1,235 (0.1%)	1,234 (0%)
May	Wet	881	882 (0%)	867 (-1.6%)	882 (0%)	872 (-1%)
	Above Normal	890	889 (-0.1%)	893 (0.4%)	889 (-0.1%)	875 (-1.7%)
	Below Normal	920	920 (-0.1%)	953 (3.5%)	920 (-0.1%)	958 (4.1%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Dry	904	898 (-0.6%)	910 (0.7%)	898 (-0.6%)	924 (2.2%)
	Critically Dry	879	886 (0.8%)	888 (1%)	889 (1.1%)	914 (4%)
	All	894	894 (0%)	898 (0.5%)	894 (0%)	905 (1.2%)
June	Wet	823	822 (-0.1%)	823 (0%)	822 (-0.1%)	823 (0.1%)
	Above Normal	801	801 (0%)	802 (0.1%)	801 (0%)	806 (0.6%)
	Below Normal	828	828 (0%)	826 (-0.2%)	828 (0%)	827 (-0.1%)
	Dry	848	848 (0%)	845 (-0.4%)	848 (0%)	830 (-2%)
	Critically Dry	822	827 (0.6%)	827 (0.6%)	828 (0.7%)	828 (0.7%)
	All	826	826 (0.1%)	826 (0%)	826 (0.1%)	824 (-0.3%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-43. Late Fall–Run Fry Rearing WUA[1] in the Sacramento River, Segment 4, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
March	Wet	151	151 (-0.5%)	151 (-0.2%)	151 (-0.5%)	152 (0.1%)
	Above Normal	151	152 (0.1%)	152 (0%)	152 (0.1%)	151 (-0.1%)
	Below Normal	194	195 (0.2%)	195 (0.2%)	195 (0.2%)	195 (0.2%)
	Dry	197	197 (-0.4%)	197 (0%)	197 (-0.4%)	195 (-1%)
	Critically Dry	208	209 (0.2%)	207 (-0.5%)	208 (0%)	207 (-0.7%)
	All	177	177 (-0.2%)	177 (-0.1%)	177 (-0.2%)	177 (-0.3%)
April	Wet	168	169 (0.1%)	169 (0.6%)	169 (0.1%)	172 (2%)
	Above Normal	189	189 (-0.1%)	189 (-0.2%)	189 (-0.1%)	191 (1.3%)
	Below Normal	202	202 (0.1%)	203 (0.4%)	202 (0.1%)	205 (1.7%)
	Dry	209	208 (-0.1%)	212 (1.6%)	208 (-0.1%)	211 (1%)
	Critically Dry	214	221 (3%)	219 (2.5%)	216 (0.8%)	216 (0.7%)
	All	193	194 (0.5%)	195 (1%)	193 (0.1%)	195 (1.4%)
May	Wet	151	151 (0%)	149 (-1.5%)	151 (0.1%)	149 (-1.3%)
	Above Normal	157	157 (0.1%)	156 (-0.4%)	157 (0.1%)	155 (-1.3%)
	Below Normal	168	168 (0%)	170 (1.3%)	168 (0%)	170 (1.5%)
	Dry	165	165 (-0.3%)	167 (0.9%)	165 (-0.3%)	169 (2.2%)
	Critically Dry	167	168 (1%)	169 (1.2%)	169 (1.3%)	170 (2.1%)
	All	160	160 (0.1%)	160 (0.1%)	160 (0.2%)	161 (0.5%)
June	Wet	159	159 (-0.1%)	159 (0.1%)	159 (-0.1%)	159 (0%)
	Above Normal	150	150 (0%)	156 (3.4%)	150 (0%)	157 (4.6%)
	Below Normal	148	148 (0%)	150 (1%)	148 (0%)	155 (4.9%)
	Dry	144	144 (0%)	145 (0.3%)	144 (0%)	148 (2.6%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Critically Dry	155	158 (1.8%)	159 (2.2%)	158 (1.7%)	159 (2.5%)
	All	152	152 (0.2%)	154 (1.1%)	152 (0.2%)	156 (2.4%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-44. Late Fall–Run Juvenile Rearing WUA[1] in the Sacramento River, Segment 6, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
May	Wet	37	37 (0.1%)	37 (0%)	37 (0.1%)	37 (0%)
	Above Normal	39	39 (0.1%)	39 (-0.4%)	39 (0.1%)	39 (-0.9%)
	Below Normal	41	41 (0%)	41 (0.2%)	41 (0%)	41 (0.4%)
	Dry	41	41 (-0.3%)	41 (1%)	41 (-0.3%)	42 (1.8%)
	Critically Dry	42	42 (0.9%)	42 (1.2%)	42 (1.1%)	42 (1%)
	All	40	40 (0.1%)	40 (0.4%)	40 (0.1%)	40 (0.5%)
June	Wet	41	41 (-0.1%)	41 (0.1%)	41 (-0.1%)	41 (0%)
	Above Normal	38	38 (0.1%)	39 (4.9%)	38 (0.1%)	40 (5.8%)
	Below Normal	37	37 (-0.1%)	37 (1.2%)	37 (-0.1%)	39 (5%)
	Dry	35	35 (0%)	35 (-0.1%)	35 (0%)	36 (2.6%)
	Critically Dry	39	39 (2%)	40 (2.9%)	39 (1.9%)	40 (3.2%)
	All	38	38 (0.3%)	39 (1.3%)	38 (0.3%)	39 (2.7%)
July	Wet	32	32 (0%)	32 (0.3%)	32 (0%)	32 (0.2%)
	Above Normal	32	32 (0.6%)	32 (2.3%)	32 (0.7%)	33 (5.2%)
	Below Normal	32	32 (0.5%)	32 (0.3%)	32 (0.3%)	32 (0%)
	Dry	32	32 (0%)	32 (0.1%)	32 (0%)	32 (1.7%)
	Critically Dry	38	38 (-0.2%)	38 (0.3%)	38 (-0.1%)	38 (1.4%)
	All	33	33 (0.1%)	33 (0.5%)	33 (0.1%)	33 (1.4%)
August	Wet	35	35 (0%)	35 (0.5%)	35 (0%)	35 (0.4%)
	Above Normal	36	37 (2%)	36 (1.2%)	37 (2.2%)	38 (6.7%)
	Below Normal	38	39 (1.2%)	38 (0.5%)	39 (1.1%)	39 (2.3%)
	Dry	40	40 (0.3%)	40 (0.4%)	40 (0.3%)	40 (1.1%)
	Critically Dry	42	41 (-1%)	41 (-0.7%)	41 (-0.8%)	42 (-0.2%)
	All	38	38 (0.4%)	38 (0.3%)	38 (0.4%)	38 (1.7%)
September	Wet	36	36 (0%)	36 (0.5%)	36 (0%)	36 (0.6%)
	Above Normal	40	41 (1.1%)	40 (0.2%)	41 (1.4%)	40 (0.2%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Below Normal	42	42 (-0.5%)	42 (-0.1%)	42 (-0.5%)	42 (-0.7%)
	Dry	41	41 (0.1%)	41 (0.2%)	41 (0.1%)	41 (0.1%)
	Critically Dry	41	41 (0.4%)	41 (0.3%)	41 (0.4%)	41 (0.3%)
	All	39	40 (0.2%)	40 (0.2%)	40 (0.2%)	40 (0.1%)
October	Wet	41	41 (0.5%)	41 (0.5%)	41 (0.5%)	42 (0.9%)
	Above Normal	42	42 (0.5%)	42 (0.2%)	42 (0.2%)	42 (0.5%)
	Below Normal	42	42 (0.1%)	42 (0.1%)	42 (0.2%)	42 (0.8%)
	Dry	42	42 (-0.3%)	42 (-0.2%)	42 (-0.3%)	42 (0%)
	Critically Dry	41	41 (0.1%)	41 (0%)	41 (0%)	41 (0.5%)
	All	42	42 (0.2%)	42 (0.2%)	42 (0.1%)	42 (0.6%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-45. Late Fall–Run Juvenile Rearing WUA[1] in the Sacramento River, Segment 5, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
May	Wet	333	333 (0.1%)	330 (-1.1%)	333 (0.1%)	331 (-0.7%)
	Above Normal	347	347 (0%)	347 (-0.1%)	347 (0%)	343 (-1.3%)
	Below Normal	370	370 (0%)	377 (1.8%)	370 (0%)	378 (2.1%)
	Dry	361	360 (-0.3%)	365 (1.1%)	360 (-0.3%)	371 (2.7%)
	Critically Dry	364	368 (1.1%)	368 (1.4%)	369 (1.6%)	374 (2.9%)
	All	352	353 (0.1%)	354 (0.4%)	353 (0.2%)	356 (1%)
June	Wet	344	344 (-0.1%)	344 (0%)	344 (-0.1%)	344 (0%)
	Above Normal	319	319 (0%)	333 (4.2%)	319 (0%)	337 (5.6%)
	Below Normal	318	318 (0%)	322 (1%)	318 (0%)	334 (4.9%)
	Dry	308	308 (0%)	309 (0%)	308 (0%)	315 (2.1%)
	Critically Dry	332	339 (2%)	341 (2.6%)	339 (2%)	342 (3%)
	All	327	327 (0.3%)	330 (1.2%)	327 (0.3%)	335 (2.5%)
July	Wet	289	289 (0%)	290 (0.1%)	289 (0%)	290 (0%)
	Above Normal	281	281 (0%)	285 (1.2%)	281 (0%)	289 (2.9%)
	Below Normal	288	287 (-0.3%)	287 (-0.2%)	286 (-0.4%)	289 (0.4%)
	Dry	291	291 (0%)	291 (0%)	291 (0%)	293 (0.8%)
	Critically Dry	326	325 (-0.1%)	327 (0.3%)	326 (0%)	328 (0.8%)
	All	294	293 (-0.1%)	294 (0.2%)	293 (-0.1%)	296 (0.8%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
August	Wet	305	305 (0%)	306 (0.3%)	305 (0%)	306 (0.3%)
	Above Normal	310	314 (1.1%)	313 (0.8%)	314 (1.2%)	325 (4.7%)
	Below Normal	325	329 (1.3%)	326 (0.5%)	328 (1.2%)	333 (2.5%)
	Dry	337	337 (0.1%)	337 (0.1%)	337 (0.1%)	339 (0.6%)
	Critically Dry	363	353 (-2.8%)	354 (-2.5%)	353 (-2.8%)	354 (-2.5%)
	All	325	324 (0%)	324 (-0.1%)	324 (0%)	327 (0.9%)
September	Wet	315	315 (0%)	317 (0.6%)	315 (0%)	316 (0.5%)
	Above Normal	342	347 (1.5%)	343 (0.2%)	348 (1.7%)	339 (-0.9%)
	Below Normal	411	413 (0.5%)	410 (-0.2%)	413 (0.5%)	413 (0.5%)
	Dry	435	435 (0%)	434 (-0.2%)	435 (0%)	435 (0.1%)
	Critically Dry	445	436 (-2.1%)	437 (-2%)	437 (-2%)	438 (-1.6%)
	All	381	381 (-0.1%)	380 (-0.2%)	381 (0%)	380 (-0.1%)
October	Wet	391	388 (-0.8%)	387 (-1%)	388 (-0.8%)	379 (-2.9%)
	Above Normal	395	395 (-0.1%)	394 (-0.3%)	394 (-0.3%)	388 (-1.8%)
	Below Normal	400	401 (0.2%)	400 (0%)	401 (0.2%)	394 (-1.3%)
	Dry	406	405 (-0.1%)	404 (-0.4%)	405 (-0.1%)	401 (-1.1%)
	Critically Dry	414	414 (0.1%)	414 (0.1%)	414 (0.2%)	412 (-0.4%)
	All	400	399 (-0.2%)	398 (-0.4%)	399 (-0.3%)	393 (-1.7%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-46. Late Fall–Run Juvenile Rearing WUA[1] in the Sacramento River, Segment 4, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
May	Wet	70	70 (0.2%)	67 (-3.9%)	70 (0.2%)	68 (-2.6%)
	Above Normal	81	81 (0%)	81 (-0.4%)	81 (0%)	77 (-5.1%)
	Below Normal	92	92 (-0.1%)	98 (6.4%)	92 (-0.1%)	99 (7.5%)
	Dry	89	88 (-1%)	91 (3%)	88 (-1%)	95 (7.1%)
	Critically Dry	90	92 (3%)	93 (3.9%)	93 (4.3%)	97 (8.1%)
	All	82	83 (0.3%)	84 (1.5%)	83 (0.5%)	85 (3%)
June	Wet	75	74 (-0.3%)	75 (0.2%)	74 (-0.3%)	75 (0.1%)
	Above Normal	63	63 (0%)	69 (10.6%)	63 (0%)	72 (15%)
	Below Normal	63	63 (-0.1%)	64 (2.3%)	63 (-0.1%)	72 (14.6%)
	Dry	60	60 (-0.1%)	60 (0.4%)	60 (-0.1%)	63 (5.1%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Critically Dry	72	76 (5.3%)	77 (6.4%)	76 (5.3%)	77 (7.3%)
	All	67	68 (0.7%)	69 (2.9%)	68 (0.7%)	72 (6.5%)
July	Wet	51	51 (0%)	51 (0.1%)	51 (0%)	51 (0.1%)
	Above Normal	47	47 (0.2%)	48 (2.7%)	47 (0.1%)	52 (9.5%)
	Below Normal	50	50 (-0.2%)	50 (-0.3%)	50 (-0.6%)	51 (1.7%)
	Dry	53	53 (-0.1%)	53 (0.1%)	53 (-0.1%)	54 (1.2%)
	Critically Dry	69	69 (-0.2%)	70 (0.7%)	69 (0.1%)	70 (1.5%)
	All	54	54 (-0.1%)	54 (0.5%)	54 (-0.1%)	55 (2%)
August	Wet	59	59 (0%)	59 (0.8%)	59 (0%)	59 (0.7%)
	Above Normal	60	62 (3%)	61 (1.4%)	62 (3.2%)	68 (12.5%)
	Below Normal	67	70 (3.5%)	68 (1.3%)	69 (3%)	73 (8.2%)
	Dry	74	74 (0%)	74 (0.1%)	74 (0%)	75 (1%)
	Critically Dry	94	86 (-8.6%)	86 (-7.7%)	86 (-8.5%)	86 (-8.3%)
	All	69	69 (-0.8%)	68 (-0.9%)	68 (-0.8%)	70 (1.6%)
September	Wet	63	63 (0%)	64 (2%)	63 (0%)	64 (1.2%)
	Above Normal	79	83 (4.9%)	79 (0.4%)	83 (5.6%)	75 (-5.7%)
	Below Normal	129	131 (0.9%)	130 (0%)	131 (0.9%)	131 (1.1%)
	Dry	140	140 (-0.1%)	139 (-0.2%)	140 (-0.1%)	140 (0%)
	Critically Dry	143	139 (-2.3%)	139 (-2.4%)	139 (-2.2%)	140 (-1.8%)
	All	105	106 (0.2%)	105 (-0.1%)	106 (0.3%)	105 (-0.5%)
October	Wet	107	105 (-1.4%)	105 (-2%)	105 (-1.5%)	99 (-7.1%)
	Above Normal	110	111 (1%)	110 (0.1%)	110 (-0.1%)	106 (-3.6%)
	Below Normal	115	116 (0.6%)	115 (-0.6%)	116 (0.5%)	112 (-3.1%)
	Dry	121	120 (-0.7%)	120 (-1.4%)	121 (-0.6%)	117 (-3.8%)
	Critically Dry	124	124 (0.1%)	125 (0.2%)	125 (0.4%)	123 (-1.1%)
	All	115	114 (-0.3%)	113 (-1%)	114 (-0.4%)	110 (-4.2%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Steelhead

Rearing habitat WUA for steelhead was not estimated directly by USFWS (2005b), but was modeled using the rearing WUA curves obtained for late fall–run Chinook salmon, in the same three Sacramento River segments that were used for the winter-run, fall-run and late fall–run spawning and rearing habitat WUA studies (U.S. Fish and Wildlife Service 2003a, 2005b). The rearing WUA curves for late fall–run Chinook salmon were used because the fry rearing period of late fall–run is similar to that of steelhead in the Sacramento River, and because this substitution follows previous practice (Section 11K.2, *Methods*). The validity of using the late fall–run Chinook salmon WUA curves to characterize Central Valley steelhead rearing habitat is

uncertain. For this analysis, fry are defined as fish less than 60 mm, and juveniles are young fish (young-of-year) greater than 60 mm.

To estimate changes in rearing WUA that would result from Alternatives 1, 2, and 3, the late fall–run fry and juvenile WUA curves developed for each of the three river segments was used with mean monthly CALSIM II flow estimates for corresponding river segments under Alternatives 1, 2, and 3 and the NAA during the rearing periods for steelhead fry (February through May) and juveniles (year-round) in the Sacramento River (Table 11A-8 in Appendix 11A).

Differences in steelhead fry and juvenile rearing habitat WUA in each river segment under Alternatives 1, 2, and 3 compared to the NAA were examined using the grand mean rearing WUA for each month of the fry and juvenile rearing periods under each water year type and all water year types combined (Table 11K-47 through Table 11K-52). Note that because the late fall–run fry and juvenile rearing WUA curves were used for the steelhead rearing analyses, as described above, and because the rearing periods for late fall–run and steelhead substantially overlap, the results for steelhead presented here are mostly the same as those presented above for late fall–run fry and juveniles.

Few of the differences between Alternatives 1, 2, and 3 and the NAA means for steelhead fry rearing WUA in all river segments are more than 3% (Table 11K-47 through Table 11K-49). The largest difference is an 8% increase in May of Critically Dry Water Years in Segment 6 under Alternative 3 (Table 11K-47). The largest reduction is 3% and occurs in March of Dry Water Years under Alternative 3 in Segment 5 (Table 11K-48). These results indicate that Alternatives 1, 2, and 3 would have a little effect on steelhead fry rearing habitat availability.

Steelhead mean juvenile rearing WUA differs between Alternatives 1, 2, and 3 and the NAA by less than 2% for most months and water year types under Alternatives 1A and 1B in Segments 6 and 5 (Table 11K-50 and Table 11K-51). Many more >2% differences occur for Alternative 3 in these river segments, including 25% of the means for Segment 5, and the majority of them result from increases in rearing WUA. The largest of these increases is 7% in August of Above Normal Water Years in Segment 6 (Table 11K-50). Segment 4 has many more >2% differences in means between Alternatives 1, 2, and 3 and the NAA than Segments 6 and 5 (Table 11K-52). The largest differences include 15% increases in rearing WUA in June of Above Normal and Below Normal Water Years under Alternative 3 and 8% to 9% reductions in rearing WUA in August of Critically Dry Water years under all alternatives. The results for juvenile rearing WUA indicate largely minor differences between Alternatives 1, 2, and 3 and the NAA for Segments 6 and 5, but substantial differences for Segment 4. This segment generally has increased juvenile steelhead rearing habitat WUA under Alternatives 1B and 3 during late spring and summer and some reduction in habitat during August of Critically Dry Water Years. Alternative 3 has the most and largest differences and, on balance, it is expected to benefit steelhead rearing habitat availability. Alternatives 1A, 1B, and 2 are expected to have little effect.

Table 11K-47. Steelhead Fry Rearing WUA[1] in the Sacramento River, Segment 6, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
February	Wet	74	74 (-0.1%)	73 (-0.5%)	74 (-0.1%)	73 (-0.5%)
	Above Normal	70	70 (0%)	70 (0.1%)	70 (-0.1%)	71 (1.6%)
	Below Normal	61	61 (0%)	61 (-0.1%)	61 (0.6%)	60 (-1.7%)
	Dry	62	62 (0.2%)	62 (-0.1%)	62 (0.2%)	62 (0.1%)
	Critically Dry	61	62 (0.2%)	61 (0.1%)	62 (0.1%)	62 (0.2%)
	All	67	67 (0.1%)	66 (-0.2%)	67 (0.1%)	66 (-0.2%)
March	Wet	63	65 (3.1%)	65 (3%)	65 (3.1%)	65 (2.9%)
	Above Normal	66	65 (-0.7%)	66 (0.2%)	65 (-0.3%)	67 (1.9%)
	Below Normal	61	62 (0.4%)	62 (0.4%)	62 (0.4%)	62 (0.4%)
	Dry	61	62 (1.5%)	62 (1.9%)	62 (1.5%)	62 (1.7%)
	Critically Dry	61	61 (0.4%)	62 (1.5%)	61 (0%)	62 (1%)
	All	62	63 (1.3%)	63 (1.7%)	63 (1.3%)	63 (1.8%)
April	Wet	94	94 (0%)	94 (0.3%)	94 (0%)	94 (0.8%)
	Above Normal	107	107 (-0.5%)	107 (-0.4%)	107 (-0.5%)	107 (0.1%)
	Below Normal	114	114 (0%)	114 (0%)	114 (0%)	115 (0.5%)
	Dry	114	114 (0.1%)	114 (0.4%)	114 (0.1%)	114 (0.1%)
	Critically Dry	117	117 (-0.1%)	119 (1.2%)	117 (-0.5%)	117 (-0.6%)
	All	107	107 (0%)	107 (0.3%)	107 (-0.1%)	107 (0.2%)
May	Wet	73	73 (0.1%)	71 (-1.7%)	73 (0.1%)	71 (-1.5%)
	Above Normal	77	77 (-0.4%)	78 (1.1%)	77 (-0.4%)	76 (-1.8%)
	Below Normal	83	83 (-0.1%)	86 (3.2%)	83 (-0.1%)	85 (2.9%)
	Dry	79	78 (-1%)	80 (1.3%)	78 (-1%)	82 (3.9%)
	Critically Dry	80	82 (2.1%)	82 (2.6%)	83 (3.3%)	86 (8%)
	All	77	77 (0%)	78 (0.9%)	78 (0.2%)	79 (1.9%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-48. Steelhead Fry Rearing WUA[1] in the Sacramento River, Segment 5, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
February	Wet	1,015	1,020 (0.5%)	1,011 (-0.4%)	1,020 (0.5%)	1,010 (-0.5%)
	Above Normal	1,091	1,098 (0.7%)	1,102 (1%)	1,096 (0.4%)	1,103 (1.1%)
	Below Normal	1,167	1,168 (0%)	1,159 (-0.7%)	1,167 (0%)	1,166 (-0.1%)
	Dry	1,394	1,396 (0.1%)	1,393 (0%)	1,396 (0.1%)	1,396 (0.1%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Critically Dry	1,414	1,420 (0.4%)	1,416 (0.1%)	1,418 (0.3%)	1,420 (0.4%)
	All	1,194	1,198 (0.3%)	1,193 (-0.1%)	1,197 (0.3%)	1,195 (0.1%)
March	Wet	1,044	1,045 (0.1%)	1,046 (0.2%)	1,045 (0.1%)	1,049 (0.5%)
	Above Normal	1,033	1,041 (0.8%)	1,041 (0.8%)	1,041 (0.8%)	1,040 (0.7%)
	Below Normal	1,353	1,352 (-0.1%)	1,352 (-0.1%)	1,352 (-0.1%)	1,352 (-0.1%)
	Dry	1,316	1,294 (-1.7%)	1,313 (-0.2%)	1,294 (-1.7%)	1,280 (-2.8%)
	Critically Dry	1,388	1,386 (-0.1%)	1,355 (-2.4%)	1,387 (0%)	1,353 (-2.5%)
	All	1,205	1,202 (-0.3%)	1,201 (-0.3%)	1,202 (-0.3%)	1,195 (-0.9%)
April	Wet	1,131	1,130 (0%)	1,131 (0.1%)	1,130 (0%)	1,126 (-0.4%)
	Above Normal	1,210	1,209 (-0.1%)	1,206 (-0.3%)	1,209 (-0.1%)	1,203 (-0.5%)
	Below Normal	1,311	1,310 (-0.1%)	1,308 (-0.2%)	1,310 (-0.1%)	1,308 (-0.2%)
	Dry	1,285	1,280 (-0.3%)	1,307 (1.7%)	1,280 (-0.3%)	1,292 (0.6%)
	Critically Dry	1,317	1,362 (3.4%)	1,358 (3.1%)	1,333 (1.2%)	1,328 (0.8%)
	All	1,234	1,239 (0.4%)	1,244 (0.8%)	1,235 (0.1%)	1,234 (0%)
May	Wet	881	882 (0%)	867 (-1.6%)	882 (0%)	872 (-1%)
	Above Normal	890	889 (-0.1%)	893 (0.4%)	889 (-0.1%)	875 (-1.7%)
	Below Normal	920	920 (-0.1%)	953 (3.5%)	920 (-0.1%)	958 (4.1%)
	Dry	904	898 (-0.6%)	910 (0.7%)	898 (-0.6%)	924 (2.2%)
	Critically Dry	879	886 (0.8%)	888 (1%)	889 (1.1%)	914 (4%)
	All	894	894 (0%)	898 (0.5%)	894 (0%)	905 (1.2%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-49. Steelhead Fry Rearing WUA[1] in the Sacramento River, Segment 4, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
February	Wet	154	154 (0.1%)	153 (-0.5%)	154 (0.1%)	153 (-0.6%)
	Above Normal	154	154 (0.4%)	154 (0.4%)	154 (0.1%)	154 (0.3%)
	Below Normal	169	169 (-0.2%)	167 (-0.9%)	169 (0%)	167 (-1.3%)
	Dry	201	202 (0.2%)	201 (-0.1%)	202 (0.2%)	201 (-0.2%)
	Critically Dry	212	210 (-1.1%)	209 (-1.3%)	210 (-1.2%)	210 (-1.1%)
	All	175	175 (-0.1%)	174 (-0.5%)	175 (-0.1%)	174 (-0.6%)
March	Wet	151	151 (-0.5%)	151 (-0.2%)	151 (-0.5%)	152 (0.1%)
	Above Normal	151	152 (0.1%)	152 (0%)	152 (0.1%)	151 (-0.1%)
	Below Normal	194	195 (0.2%)	195 (0.2%)	195 (0.2%)	195 (0.2%)
	Dry	197	197 (-0.4%)	197 (0%)	197 (-0.4%)	195 (-1%)
	Critically Dry	208	209 (0.2%)	207 (-0.5%)	208 (0%)	207 (-0.7%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	All	177	177 (-0.2%)	177 (-0.1%)	177 (-0.2%)	177 (-0.3%)
April	Wet	168	169 (0.1%)	169 (0.6%)	169 (0.1%)	172 (2%)
	Above Normal	189	189 (-0.1%)	189 (-0.2%)	189 (-0.1%)	191 (1.3%)
	Below Normal	202	202 (0.1%)	203 (0.4%)	202 (0.1%)	205 (1.7%)
	Dry	209	208 (-0.1%)	212 (1.6%)	208 (-0.1%)	211 (1%)
	Critically Dry	214	221 (3%)	219 (2.5%)	216 (0.8%)	216 (0.7%)
	All	193	194 (0.5%)	195 (1%)	193 (0.1%)	195 (1.4%)
May	Wet	151	151 (0%)	149 (-1.5%)	151 (0.1%)	149 (-1.3%)
	Above Normal	157	157 (0.1%)	156 (-0.4%)	157 (0.1%)	155 (-1.3%)
	Below Normal	168	168 (0%)	170 (1.3%)	168 (0%)	170 (1.5%)
	Dry	165	165 (-0.3%)	167 (0.9%)	165 (-0.3%)	169 (2.2%)
	Critically Dry	167	168 (1%)	169 (1.2%)	169 (1.3%)	170 (2.1%)
	All	160	160 (0.1%)	160 (0.1%)	160 (0.2%)	161 (0.5%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-50. Steelhead Juvenile Rearing WUA[1] in the Sacramento River, Segment 6, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
January	Wet	28	28 (0.1%)	28 (0.1%)	28 (0.1%)	29 (0.3%)
	Above Normal	27	28 (0.7%)	28 (0.7%)	28 (0.7%)	27 (-0.4%)
	Below Normal	31	31 (0.3%)	31 (0.3%)	31 (0.3%)	31 (0.1%)
	Dry	32	32 (0.5%)	32 (0.5%)	32 (0.5%)	32 (0.4%)
	Critically Dry	32	32 (0.2%)	32 (0.2%)	32 (0.1%)	32 (0%)
	All	30	30 (0.3%)	30 (0.3%)	30 (0.3%)	30 (0.2%)
February	Wet	30	30 (0.1%)	29 (-0.3%)	30 (0.1%)	29 (-0.2%)
	Above Normal	29	28 (-1.1%)	28 (-1.7%)	28 (-0.8%)	28 (-1.6%)
	Below Normal	28	28 (-0.1%)	28 (-0.7%)	28 (0.3%)	28 (-1.9%)
	Dry	32	32 (0.4%)	32 (-0.1%)	32 (0.4%)	32 (0.1%)
	Critically Dry	32	32 (0.3%)	32 (0.1%)	32 (0.2%)	32 (0.3%)
	All	30	30 (0%)	30 (-0.4%)	30 (0.1%)	30 (-0.5%)
March	Wet	27	27 (0.9%)	27 (0.7%)	27 (0.9%)	27 (0.9%)
	Above Normal	27	27 (-0.3%)	27 (0%)	27 (-0.2%)	27 (0.5%)
	Below Normal	31	31 (0.1%)	31 (0.1%)	31 (0.1%)	31 (0.1%)
	Dry	32	31 (-0.2%)	32 (0.1%)	31 (-0.2%)	31 (-0.6%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Critically Dry	32	32 (0.1%)	31 (-0.3%)	32 (-0.1%)	32 (-0.1%)
	All	29	29 (0.2%)	29 (0.2%)	29 (0.2%)	29 (0.2%)
April	Wet	38	38 (0%)	38 (0.1%)	38 (0%)	38 (0.4%)
	Above Normal	41	41 (-0.2%)	41 (-0.2%)	41 (-0.2%)	41 (0.4%)
	Below Normal	42	42 (0%)	42 (0%)	42 (0%)	42 (0.4%)
	Dry	42	42 (-0.1%)	42 (0.5%)	42 (-0.1%)	42 (0.4%)
	Critically Dry	41	42 (0.6%)	41 (0.2%)	42 (0.7%)	42 (0.9%)
	All	40	40 (0%)	40 (0.1%)	40 (0.1%)	40 (0.5%)
May	Wet	37	37 (0.1%)	37 (0%)	37 (0.1%)	37 (0%)
	Above Normal	39	39 (0.1%)	39 (-0.4%)	39 (0.1%)	39 (-0.9%)
	Below Normal	41	41 (0%)	41 (0.2%)	41 (0%)	41 (0.4%)
	Dry	41	41 (-0.3%)	41 (1%)	41 (-0.3%)	42 (1.8%)
	Critically Dry	42	42 (0.9%)	42 (1.2%)	42 (1.1%)	42 (1%)
	All	40	40 (0.1%)	40 (0.4%)	40 (0.1%)	40 (0.5%)
June	Wet	41	41 (-0.1%)	41 (0.1%)	41 (-0.1%)	41 (0%)
	Above Normal	38	38 (0.1%)	39 (4.9%)	38 (0.1%)	40 (5.8%)
	Below Normal	37	37 (-0.1%)	37 (1.2%)	37 (-0.1%)	39 (5%)
	Dry	35	35 (0%)	35 (-0.1%)	35 (0%)	36 (2.6%)
	Critically Dry	39	39 (2%)	40 (2.9%)	39 (1.9%)	40 (3.2%)
	All	38	38 (0.3%)	39 (1.3%)	38 (0.3%)	39 (2.7%)
July	Wet	32	32 (0%)	32 (0.3%)	32 (0%)	32 (0.2%)
	Above Normal	32	32 (0.6%)	32 (2.3%)	32 (0.7%)	33 (5.2%)
	Below Normal	32	32 (0.5%)	32 (0.3%)	32 (0.3%)	32 (0%)
	Dry	32	32 (0%)	32 (0.1%)	32 (0%)	32 (1.7%)
	Critically Dry	38	38 (-0.2%)	38 (0.3%)	38 (-0.1%)	38 (1.4%)
	All	33	33 (0.1%)	33 (0.5%)	33 (0.1%)	33 (1.4%)
August	Wet	35	35 (0%)	35 (0.5%)	35 (0%)	35 (0.4%)
	Above Normal	36	37 (2%)	36 (1.2%)	37 (2.2%)	38 (6.7%)
	Below Normal	38	39 (1.2%)	38 (0.5%)	39 (1.1%)	39 (2.3%)
	Dry	40	40 (0.3%)	40 (0.4%)	40 (0.3%)	40 (1.1%)
	Critically Dry	42	41 (-1%)	41 (-0.7%)	41 (-0.8%)	42 (-0.2%)
	All	38	38 (0.4%)	38 (0.3%)	38 (0.4%)	38 (1.7%)
September	Wet	36	36 (0%)	36 (0.5%)	36 (0%)	36 (0.6%)
	Above Normal	40	41 (1.1%)	40 (0.2%)	41 (1.4%)	40 (0.2%)
	Below Normal	42	42 (-0.5%)	42 (-0.1%)	42 (-0.5%)	42 (-0.7%)
	Dry	41	41 (0.1%)	41 (0.2%)	41 (0.1%)	41 (0.1%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Critically Dry	41	41 (0.4%)	41 (0.3%)	41 (0.4%)	41 (0.3%)
	All	39	40 (0.2%)	40 (0.2%)	40 (0.2%)	40 (0.1%)
October	Wet	41	41 (0.5%)	41 (0.5%)	41 (0.5%)	42 (0.9%)
	Above Normal	42	42 (0.5%)	42 (0.2%)	42 (0.2%)	42 (0.5%)
	Below Normal	42	42 (0.1%)	42 (0.1%)	42 (0.2%)	42 (0.8%)
	Dry	42	42 (-0.3%)	42 (-0.2%)	42 (-0.3%)	42 (0%)
	Critically Dry	41	41 (0.1%)	41 (0%)	41 (0%)	41 (0.5%)
	All	42	42 (0.2%)	42 (0.2%)	42 (0.1%)	42 (0.6%)
November	Wet	29	29 (0%)	29 (0%)	29 (-0.1%)	29 (-0.7%)
	Above Normal	29	29 (0.2%)	29 (0.2%)	29 (0.2%)	29 (0.3%)
	Below Normal	30	30 (-0.1%)	30 (0%)	30 (-0.1%)	30 (-0.1%)
	Dry	29	29 (-0.2%)	29 (-0.8%)	29 (-0.2%)	29 (0.1%)
	Critically Dry	30	30 (-0.5%)	30 (0.1%)	30 (0.3%)	30 (0.1%)
	All	29	29 (-0.1%)	29 (-0.1%)	29 (0%)	29 (-0.2%)
December	Wet	28	28 (-0.5%)	28 (-0.5%)	28 (-0.7%)	27 (-1.3%)
	Above Normal	29	29 (-0.2%)	29 (-0.3%)	29 (-0.3%)	29 (0.2%)
	Below Normal	30	30 (-0.2%)	30 (-0.2%)	30 (-0.1%)	30 (0.1%)
	Dry	30	30 (0.1%)	30 (-0.1%)	30 (0.2%)	30 (-0.6%)
	Critically Dry	31	31 (0.4%)	31 (0.7%)	31 (0.4%)	31 (1.1%)
	All	29	29 (-0.1%)	29 (-0.2%)	29 (-0.2%)	29 (-0.3%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-51. Steelhead Juvenile Rearing WUA[1] in the Sacramento River, Segment 5, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
January	Wet	339	339 (0%)	339 (0%)	339 (0%)	339 (-0.2%)
	Above Normal	386	387 (0.2%)	387 (0.2%)	387 (0.2%)	384 (-0.7%)
	Below Normal	442	444 (0.3%)	444 (0.3%)	444 (0.3%)	443 (0.2%)
	Dry	459	460 (0.3%)	460 (0.3%)	460 (0.3%)	460 (0.2%)
	Critically Dry	467	468 (0.1%)	467 (0.1%)	467 (0.1%)	467 (-0.1%)
	All	409	409 (0.2%)	409 (0.2%)	409 (0.2%)	409 (-0.1%)
February	Wet	342	343 (0.2%)	341 (-0.3%)	343 (0.2%)	341 (-0.4%)
	Above Normal	357	356 (-0.2%)	356 (-0.2%)	357 (-0.1%)	356 (-0.3%)
	Below Normal	395	395 (-0.1%)	392 (-0.9%)	396 (0.2%)	389 (-1.5%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Dry	458	459 (0.1%)	458 (-0.1%)	459 (0.1%)	458 (0%)
	Critically Dry	463	463 (0.1%)	463 (0%)	463 (0.1%)	463 (0.1%)
	All	397	397 (0.1%)	395 (-0.3%)	397 (0.1%)	395 (-0.4%)
March	Wet	343	342 (-0.1%)	343 (0%)	342 (-0.1%)	343 (0.1%)
	Above Normal	354	355 (0.2%)	355 (0.3%)	355 (0.3%)	355 (0.4%)
	Below Normal	442	443 (0.2%)	443 (0.2%)	443 (0.1%)	443 (0.2%)
	Dry	447	444 (-0.7%)	446 (-0.1%)	444 (-0.7%)	440 (-1.5%)
	Critically Dry	460	460 (0.1%)	456 (-0.8%)	459 (-0.1%)	455 (-1.1%)
	All	401	401 (-0.1%)	401 (-0.1%)	401 (-0.2%)	400 (-0.4%)
April	Wet	386	385 (0%)	386 (0.1%)	385 (0%)	386 (0.1%)
	Above Normal	421	420 (-0.2%)	420 (-0.3%)	420 (-0.2%)	421 (-0.1%)
	Below Normal	445	445 (0.1%)	445 (0%)	445 (0.1%)	446 (0.2%)
	Dry	443	442 (-0.1%)	447 (1.1%)	442 (-0.1%)	445 (0.6%)
	Critically Dry	447	454 (1.5%)	453 (1.5%)	450 (0.6%)	449 (0.4%)
	All	422	423 (0.2%)	424 (0.5%)	422 (0%)	423 (0.3%)
May	Wet	333	333 (0.1%)	330 (-1.1%)	333 (0.1%)	331 (-0.7%)
	Above Normal	347	347 (0%)	347 (-0.1%)	347 (0%)	343 (-1.3%)
	Below Normal	370	370 (0%)	377 (1.8%)	370 (0%)	378 (2.1%)
	Dry	361	360 (-0.3%)	365 (1.1%)	360 (-0.3%)	371 (2.7%)
	Critically Dry	364	368 (1.1%)	368 (1.4%)	369 (1.6%)	374 (2.9%)
	All	352	353 (0.1%)	354 (0.4%)	353 (0.2%)	356 (1%)
June	Wet	344	344 (-0.1%)	344 (0%)	344 (-0.1%)	344 (0%)
	Above Normal	319	319 (0%)	333 (4.2%)	319 (0%)	337 (5.6%)
	Below Normal	318	318 (0%)	322 (1%)	318 (0%)	334 (4.9%)
	Dry	308	308 (0%)	309 (0%)	308 (0%)	315 (2.1%)
	Critically Dry	332	339 (2%)	341 (2.6%)	339 (2%)	342 (3%)
	All	327	327 (0.3%)	330 (1.2%)	327 (0.3%)	335 (2.5%)
July	Wet	289	289 (0%)	290 (0.1%)	289 (0%)	290 (0%)
	Above Normal	281	281 (0%)	285 (1.2%)	281 (0%)	289 (2.9%)
	Below Normal	288	287 (-0.3%)	287 (-0.2%)	286 (-0.4%)	289 (0.4%)
	Dry	291	291 (0%)	291 (0%)	291 (0%)	293 (0.8%)
	Critically Dry	326	325 (-0.1%)	327 (0.3%)	326 (0%)	328 (0.8%)
	All	294	293 (-0.1%)	294 (0.2%)	293 (-0.1%)	296 (0.8%)
August	Wet	305	305 (0%)	306 (0.3%)	305 (0%)	306 (0.3%)
	Above Normal	310	314 (1.1%)	313 (0.8%)	314 (1.2%)	325 (4.7%)
	Below Normal	325	329 (1.3%)	326 (0.5%)	328 (1.2%)	333 (2.5%)

Month	Water Year Type[2]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Dry	337	337 (0.1%)	337 (0.1%)	337 (0.1%)	339 (0.6%)
	Critically Dry	363	353 (-2.8%)	354 (-2.5%)	353 (-2.8%)	354 (-2.5%)
	All	325	324 (0%)	324 (-0.1%)	324 (0%)	327 (0.9%)
September	Wet	315	315 (0%)	317 (0.6%)	315 (0%)	316 (0.5%)
	Above Normal	342	347 (1.5%)	343 (0.2%)	348 (1.7%)	339 (-0.9%)
	Below Normal	411	413 (0.5%)	410 (-0.2%)	413 (0.5%)	413 (0.5%)
	Dry	435	435 (0%)	434 (-0.2%)	435 (0%)	435 (0.1%)
	Critically Dry	445	436 (-2.1%)	437 (-2%)	437 (-2%)	438 (-1.6%)
	All	381	381 (-0.1%)	380 (-0.2%)	381 (0%)	380 (-0.1%)
October	Wet	391	388 (-0.8%)	387 (-1%)	388 (-0.8%)	379 (-2.9%)
	Above Normal	395	395 (-0.1%)	394 (-0.3%)	394 (-0.3%)	388 (-1.8%)
	Below Normal	400	401 (0.2%)	400 (0%)	401 (0.2%)	394 (-1.3%)
	Dry	406	405 (-0.1%)	404 (-0.4%)	405 (-0.1%)	401 (-1.1%)
	Critically Dry	414	414 (0.1%)	414 (0.1%)	414 (0.2%)	412 (-0.4%)
	All	400	399 (-0.2%)	398 (-0.4%)	399 (-0.3%)	393 (-1.7%)
November	Wet	396	398 (0.5%)	396 (0.1%)	398 (0.5%)	391 (-1.3%)
	Above Normal	400	395 (-1%)	395 (-1.1%)	395 (-1%)	392 (-1.8%)
	Below Normal	415	413 (-0.4%)	413 (-0.4%)	413 (-0.5%)	412 (-0.8%)
	Dry	405	404 (-0.2%)	401 (-1.1%)	404 (-0.2%)	400 (-1.2%)
	Critically Dry	420	420 (0%)	421 (0.3%)	421 (0.4%)	411 (-2.1%)
	All	405	405 (-0.1%)	404 (-0.4%)	405 (-0.1%)	400 (-1.4%)
December	Wet	344	343 (-0.4%)	341 (-0.9%)	342 (-0.7%)	337 (-2%)
	Above Normal	401	404 (0.7%)	404 (0.7%)	404 (0.7%)	405 (0.9%)
	Below Normal	432	432 (-0.1%)	432 (-0.2%)	432 (-0.1%)	432 (0%)
	Dry	437	433 (-0.9%)	432 (-0.9%)	433 (-0.9%)	425 (-2.7%)
	Critically Dry	451	453 (0.6%)	452 (0.3%)	453 (0.6%)	452 (0.3%)
	All	403	403 (-0.1%)	402 (-0.4%)	403 (-0.2%)	399 (-1%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

Table 11K-52. Steelhead Juvenile Rearing WUA[1] in the Sacramento River, Segment 4, and Percent Differences (in parentheses) between the NAA and Alt 1A, Alt 1B, Alt 2, and Alt 3.

Month	Water Year Type [b]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
January	Wet	65	65 (0.4%)	65 (0.4%)	65 (0.4%)	64 (-2%)
	Above Normal	89	89 (-0.2%)	89 (-0.2%)	89 (-0.2%)	86 (-3.1%)

Month	Water Year Type [b]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Below Normal	123	123 (0.6%)	123 (0.6%)	123 (0.6%)	123 (0.4%)
	Dry	139	140 (0.4%)	140 (0.4%)	140 (0.4%)	140 (0.4%)
	Critically Dry	145	146 (0.2%)	146 (0.1%)	146 (0.1%)	145 (-0.1%)
	All	106	107 (0.3%)	107 (0.3%)	107 (0.3%)	106 (-0.6%)
February	Wet	65	65 (0.6%)	64 (-0.9%)	65 (0.6%)	64 (-1.1%)
	Above Normal	76	76 (-0.1%)	76 (0.1%)	76 (0%)	76 (0.2%)
	Below Normal	101	101 (-0.1%)	100 (-1%)	101 (0.1%)	99 (-1.4%)
	Dry	137	138 (0.3%)	137 (-0.1%)	138 (0.3%)	138 (0.2%)
	Critically Dry	144	144 (-0.5%)	143 (-0.7%)	143 (-0.6%)	144 (-0.5%)
	All	100	100 (0.1%)	100 (-0.5%)	100 (0.1%)	100 (-0.5%)
March	Wet	73	72 (-0.4%)	73 (-0.1%)	72 (-0.4%)	73 (0.2%)
	Above Normal	77	78 (0.7%)	78 (0.8%)	78 (0.7%)	78 (1%)
	Below Normal	129	129 (0.1%)	129 (0.1%)	129 (0.1%)	129 (0.1%)
	Dry	129	126 (-1.8%)	128 (-0.4%)	126 (-1.8%)	124 (-3.6%)
	Critically Dry	143	143 (0.1%)	139 (-2.5%)	143 (-0.1%)	139 (-2.9%)
	All	105	105 (-0.4%)	105 (-0.5%)	105 (-0.5%)	104 (-1.4%)
April	Wet	96	96 (0%)	96 (0.2%)	96 (0%)	96 (0.4%)
	Above Normal	116	116 (-0.2%)	116 (-0.4%)	116 (-0.2%)	116 (-0.2%)
	Below Normal	131	132 (0%)	131 (-0.1%)	132 (0%)	132 (0.6%)
	Dry	133	133 (-0.4%)	136 (2.3%)	133 (-0.4%)	135 (1.4%)
	Critically Dry	141	144 (2.2%)	144 (2.4%)	143 (1.3%)	143 (1.3%)
	All	120	120 (0.3%)	121 (1%)	120 (0.1%)	121 (0.7%)
May	Wet	70	70 (0.2%)	67 (-3.9%)	70 (0.2%)	68 (-2.6%)
	Above Normal	81	81 (0%)	81 (-0.4%)	81 (0%)	77 (-5.1%)
	Below Normal	92	92 (-0.1%)	98 (6.4%)	92 (-0.1%)	99 (7.5%)
	Dry	89	88 (-1%)	91 (3%)	88 (-1%)	95 (7.1%)
	Critically Dry	90	92 (3%)	93 (3.9%)	93 (4.3%)	97 (8.1%)
	All	82	83 (0.3%)	84 (1.5%)	83 (0.5%)	85 (3%)
June	Wet	75	74 (-0.3%)	75 (0.2%)	74 (-0.3%)	75 (0.1%)
	Above Normal	63	63 (0%)	69 (10.6%)	63 (0%)	72 (15%)
	Below Normal	63	63 (-0.1%)	64 (2.3%)	63 (-0.1%)	72 (14.6%)
	Dry	60	60 (-0.1%)	60 (0.4%)	60 (-0.1%)	63 (5.1%)
	Critically Dry	72	76 (5.3%)	77 (6.4%)	76 (5.3%)	77 (7.3%)
	All	67	68 (0.7%)	69 (2.9%)	68 (0.7%)	72 (6.5%)
July	Wet	51	51 (0%)	51 (0.1%)	51 (0%)	51 (0.1%)
	Above Normal	47	47 (0.2%)	48 (2.7%)	47 (0.1%)	52 (9.5%)

Month	Water Year Type [b]	NAA	Alt 1A	Alt 1B	Alt 2	Alt 3
	Below Normal	50	50 (-0.2%)	50 (-0.3%)	50 (-0.6%)	51 (1.7%)
	Dry	53	53 (-0.1%)	53 (0.1%)	53 (-0.1%)	54 (1.2%)
	Critically Dry	69	69 (-0.2%)	70 (0.7%)	69 (0.1%)	70 (1.5%)
	All	54	54 (-0.1%)	54 (0.5%)	54 (-0.1%)	55 (2%)
August	Wet	59	59 (0%)	59 (0.8%)	59 (0%)	59 (0.7%)
	Above Normal	60	62 (3%)	61 (1.4%)	62 (3.2%)	68 (12.5%)
	Below Normal	67	70 (3.5%)	68 (1.3%)	69 (3%)	73 (8.2%)
	Dry	74	74 (0%)	74 (0.1%)	74 (0%)	75 (1%)
	Critically Dry	94	86 (-8.6%)	86 (-7.7%)	86 (-8.5%)	86 (-8.3%)
	All	69	69 (-0.8%)	68 (-0.9%)	68 (-0.8%)	70 (1.6%)
September	Wet	63	63 (0%)	64 (2%)	63 (0%)	64 (1.2%)
	Above Normal	79	83 (4.9%)	79 (0.4%)	83 (5.6%)	75 (-5.7%)
	Below Normal	129	131 (0.9%)	130 (0%)	131 (0.9%)	131 (1.1%)
	Dry	140	140 (-0.1%)	139 (-0.2%)	140 (-0.1%)	140 (0%)
	Critically Dry	143	139 (-2.3%)	139 (-2.4%)	139 (-2.2%)	140 (-1.8%)
	All	105	106 (0.2%)	105 (-0.1%)	106 (0.3%)	105 (-0.5%)
October	Wet	107	105 (-1.4%)	105 (-2%)	105 (-1.5%)	99 (-7.1%)
	Above Normal	110	111 (1%)	110 (0.1%)	110 (-0.1%)	106 (-3.6%)
	Below Normal	115	116 (0.6%)	115 (-0.6%)	116 (0.5%)	112 (-3.1%)
	Dry	121	120 (-0.7%)	120 (-1.4%)	121 (-0.6%)	117 (-3.8%)
	Critically Dry	124	124 (0.1%)	125 (0.2%)	125 (0.4%)	123 (-1.1%)
	All	115	114 (-0.3%)	113 (-1%)	114 (-0.4%)	110 (-4.2%)
November	Wet	107	107 (0.9%)	107 (0.3%)	108 (1%)	104 (-2.7%)
	Above Normal	112	109 (-3%)	109 (-3.2%)	109 (-3%)	107 (-4.9%)
	Below Normal	121	120 (-0.6%)	120 (-0.6%)	120 (-0.7%)	119 (-1.2%)
	Dry	113	113 (-0.2%)	110 (-2.6%)	113 (-0.2%)	110 (-3%)
	Critically Dry	126	126 (0.1%)	127 (0.2%)	127 (0.3%)	121 (-4%)
	All	114	114 (-0.3%)	113 (-1%)	114 (-0.3%)	111 (-3%)
December	Wet	70	69 (-1.3%)	69 (-2.3%)	69 (-1.5%)	67 (-4%)
	Above Normal	109	111 (2.1%)	111 (2.2%)	111 (2.1%)	112 (2.5%)
	Below Normal	129	129 (-0.2%)	129 (-0.3%)	129 (-0.2%)	129 (0%)
	Dry	131	130 (-1.3%)	130 (-1.1%)	130 (-1.3%)	126 (-4%)
	Critically Dry	140	141 (0.8%)	141 (0.7%)	141 (0.8%)	140 (0.2%)
	All	110	109 (-0.2%)	109 (-0.4%)	109 (-0.2%)	108 (-1.5%)

[1] WUA results are given in thousands of WUA units to save space.
[2] Water year type sorting is by hydrologic water years.

11K.4 Conclusions

WUA analysis was used to estimate the amount of spawning and rearing habitat available to the Chinook salmon races and steelhead in the upper Sacramento River downstream of Keswick Dam. Spawning habitat WUA analysis was also used to estimate spawning habitat in the Feather River High Flow Channel (downstream of Thermalito Afterbay outlet) and the American River downstream of Nimbus Dam. The results of the analyses suggest that Alternatives 1, 2, and 3 would cause few large changes in spawning WUA in any of the rivers and would generally result in more increases than reductions in rearing WUA in the Sacramento River, especially for juveniles and especially under Alternative 3. Fall-run had the most reductions in spawning WUA, but all reductions were less than 8% (Table 11K-8 through Table 11K-10). The largest increase in spawning WUA was a 16% increase for spring-run under Alternative 3 (Table 11K-6). Alternatives 1A and 2 would lead to the fewest changes in spawning or rearing WUA and Alternative 3 would result in the most frequent large changes, both reductions and increases.

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