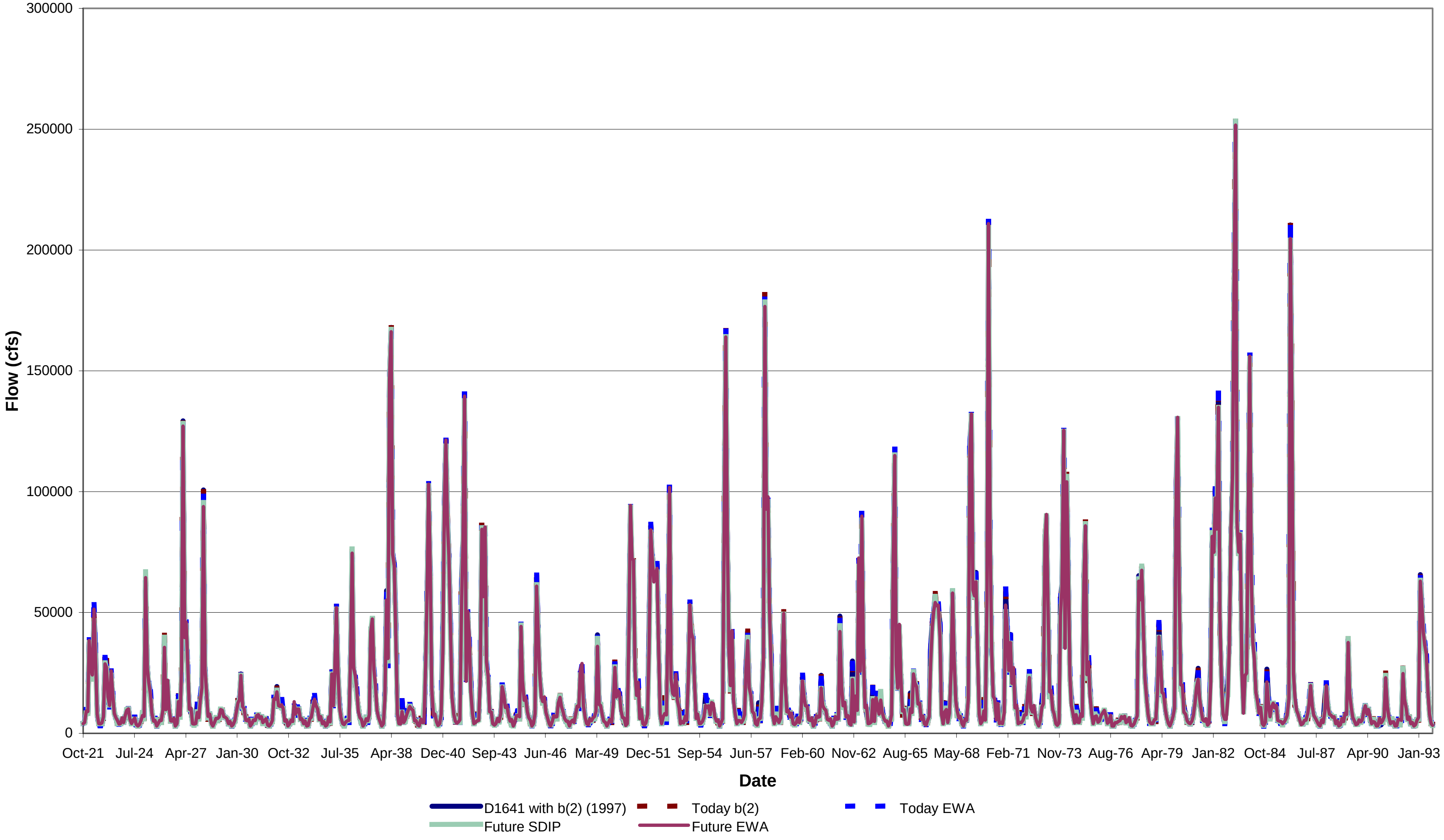


Figure 10-25 Chronology of Total Delta Outflow

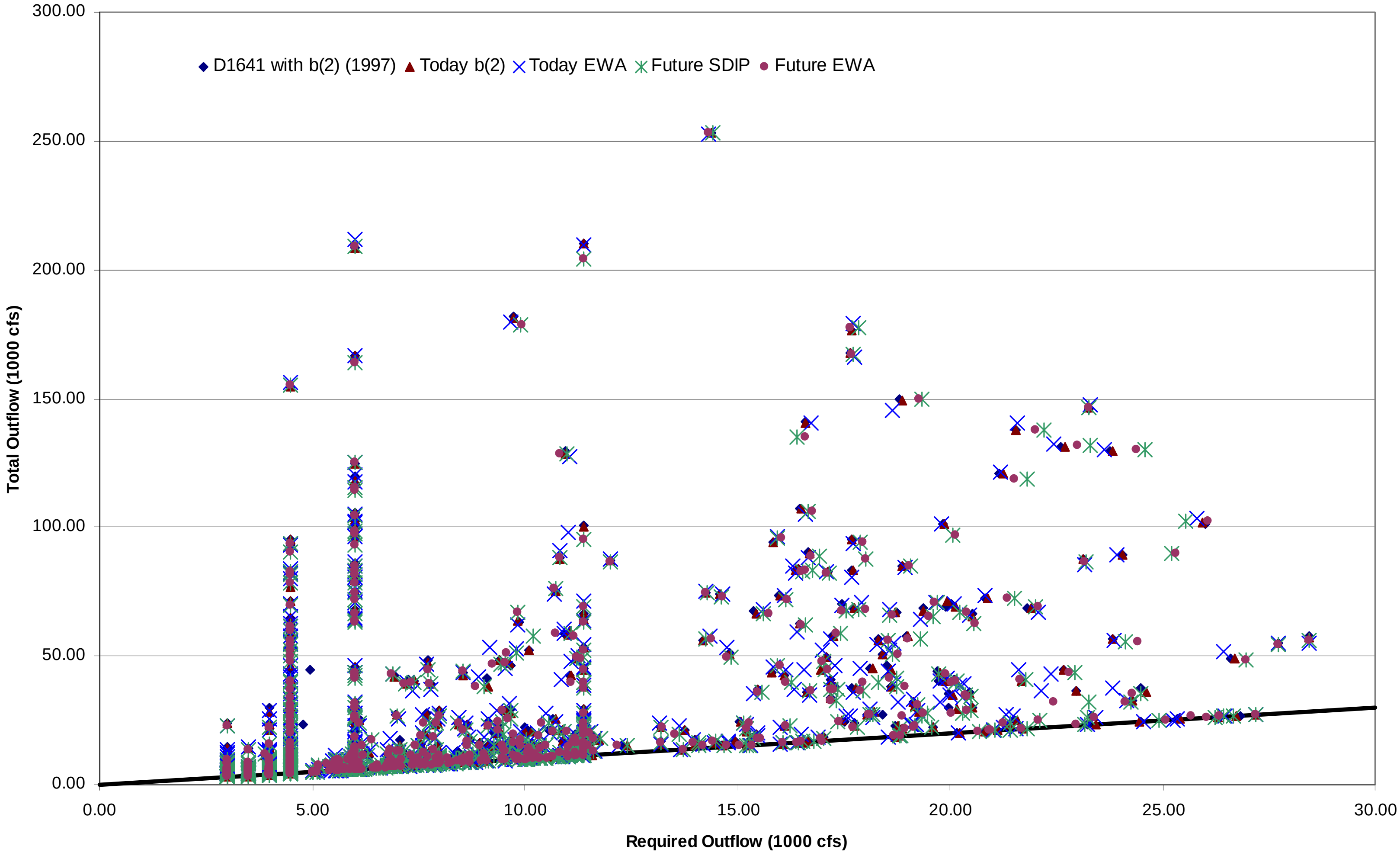


Figure 10-26 Total Delta Outflow versus Required Delta Outflow for the Oct 1921 to Sep 1993 simulation period

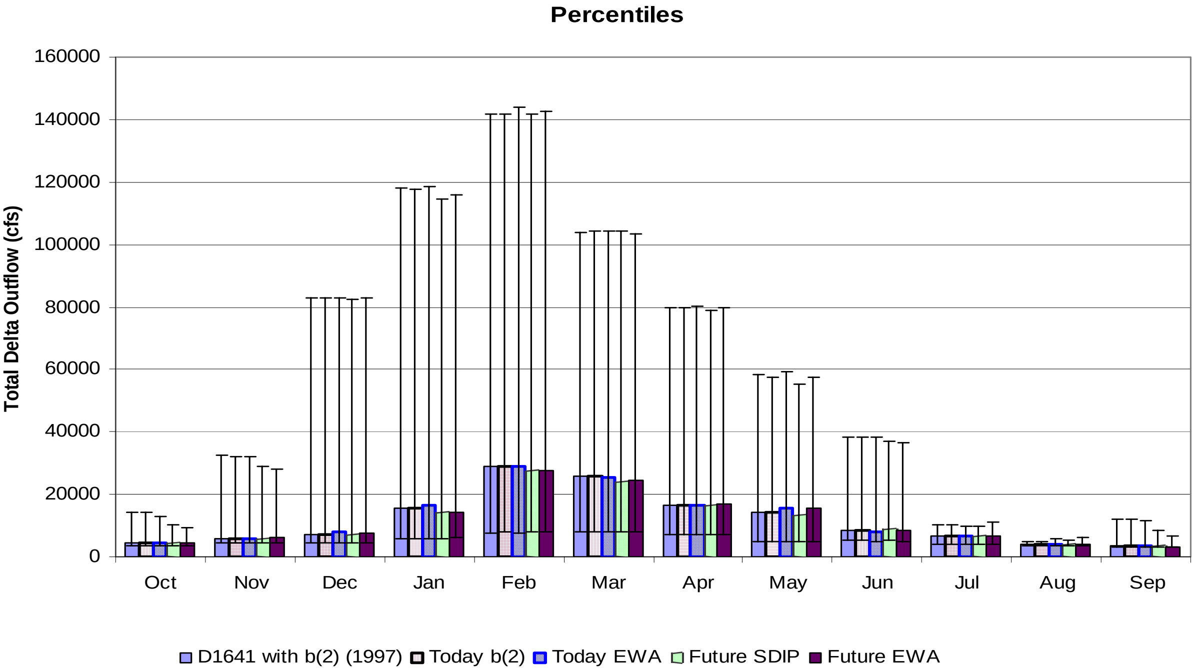


Figure 10-27 Total Delta Outflow 50th Percentile Monthly Releases with the 5th and 95th as the bars

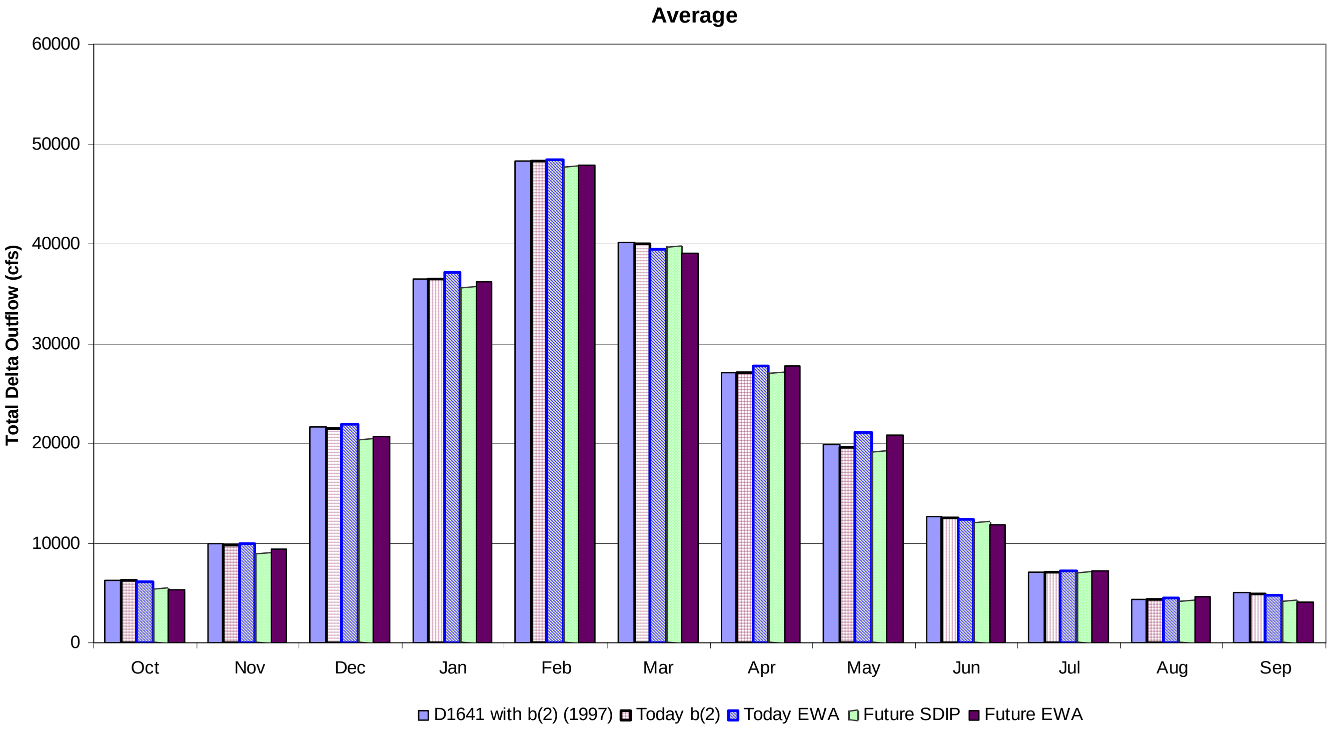


Figure 10-28 Average Monthly Total Delta Outflow

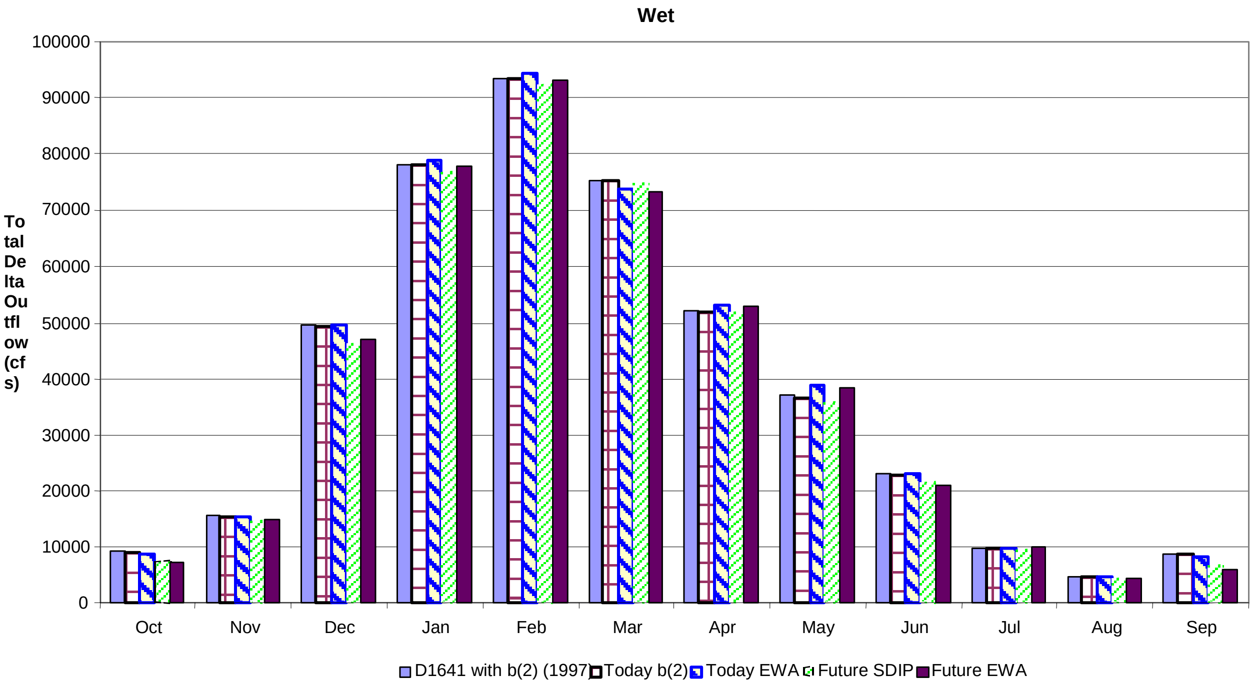


Figure 10-29 Average wet year (40-30-30 Classification) monthly Delta Outflow

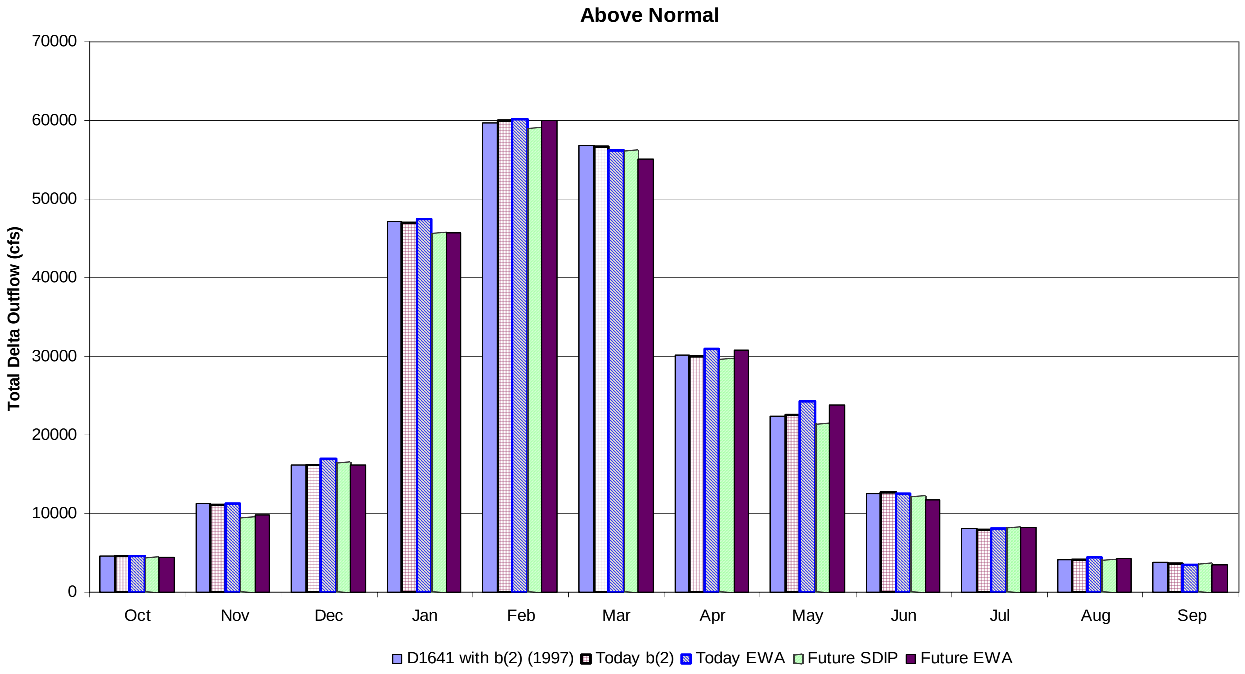


Figure 10-30 Average above normal year (40-30-30 Classification) monthly Delta Outflow

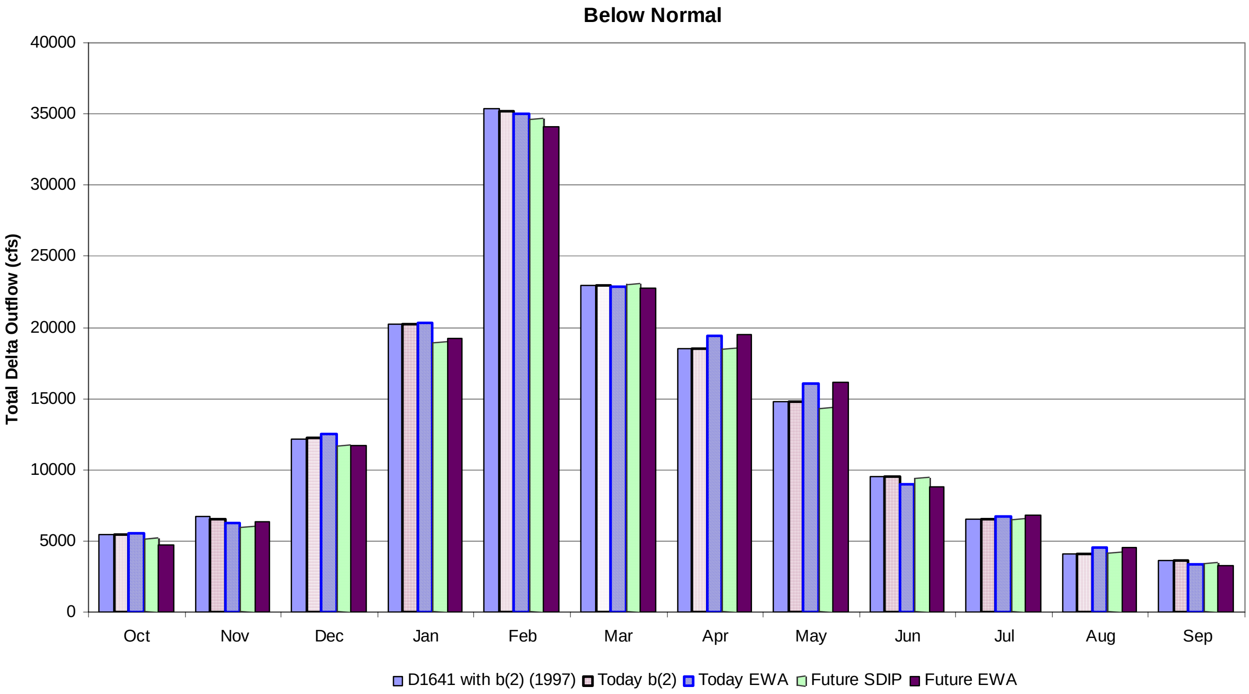


Figure 10-31 Average below normal year (40-30-30 Classification) monthly Delta Outflow

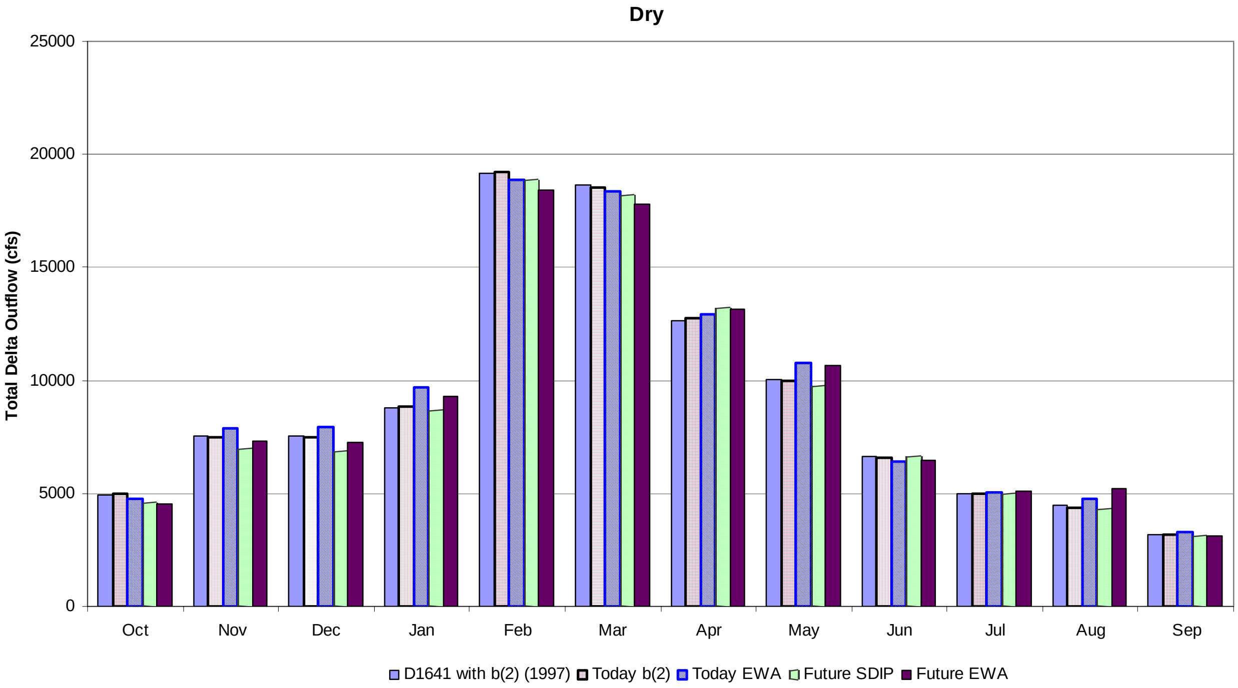


Figure 10-32 Average dry year (40-30-30 Classification) monthly Delta Outflow

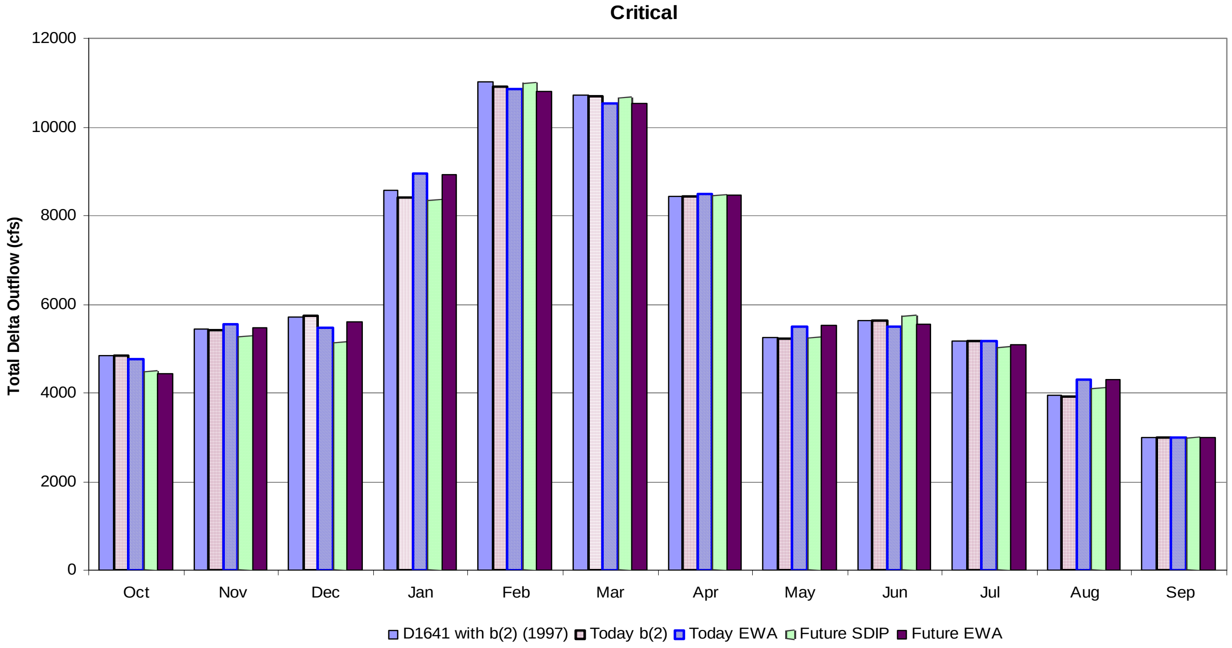


Figure 10-33 Average critical year (40-30-30 Classification) monthly Delta Outflow

Export-to-Inflow Ratio

The same general trend in monthly export-to-inflow ratio is found based on a monthly long-term average basis and averaged monthly by 40-30-30 index has the same general monthly trend (Figure 10-34 toFigure 10-39). From Figure 10-34 to Figure 10-39 during months where EWA actions are taken the export-to-inflow ratio decreases (December, January, February, April, May and June) in Studies 3 and 5 compared 1, 2 and 4. The later summer months show increases in export-to-inflow due to increased pumping with the exception of some dry and critical years in the Future runs due to either reduced storage or worsening salinity requirements from the more aggressive deliveries in Studies 4 and 5.

Figure 10-40 to Figure 10-51 show the monthly export-to-inflow ratios sorted from wettest to driest by 40-30-30 Index. The Studies 3 and 5 show lower export-to-inflow Ratios when EWA actions are taken and then increased export-to-inflow ratios in the late summer and fall periods. Studies 4 and 5 show increased export-to-inflow ratios when compared to Studies 1, 2 and 3. In Figure 10-42 the December 1940 values drops off significantly from the others in Study 4 (Future SDIP) due to the Rock Slough salinity standard.

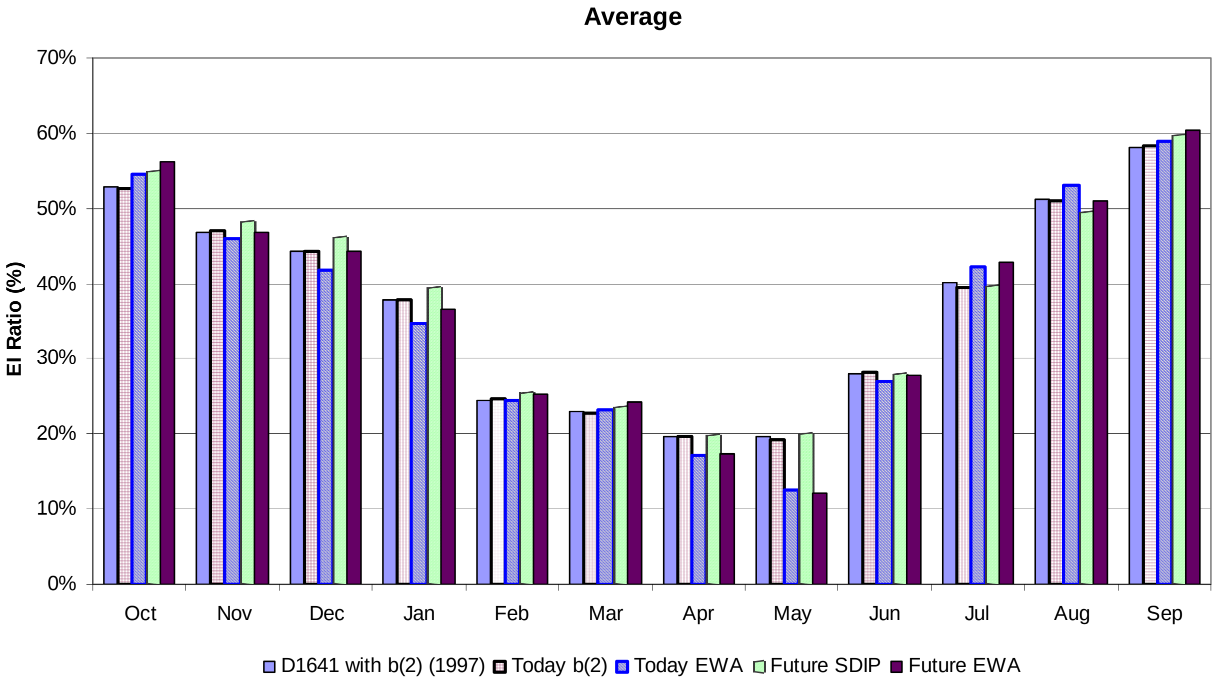


Figure 10-34 Average Monthly export-to-inflow ratio

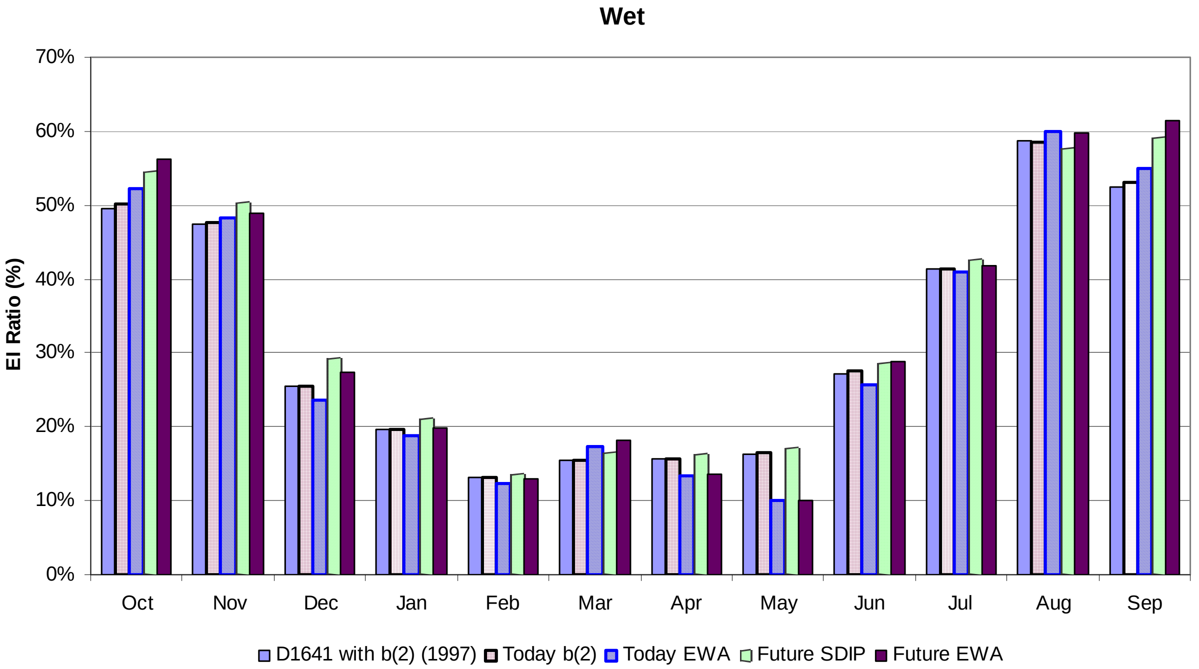


Figure 10-35 Average wet year (40-30-30 Classification) monthly export-to-inflow ratio

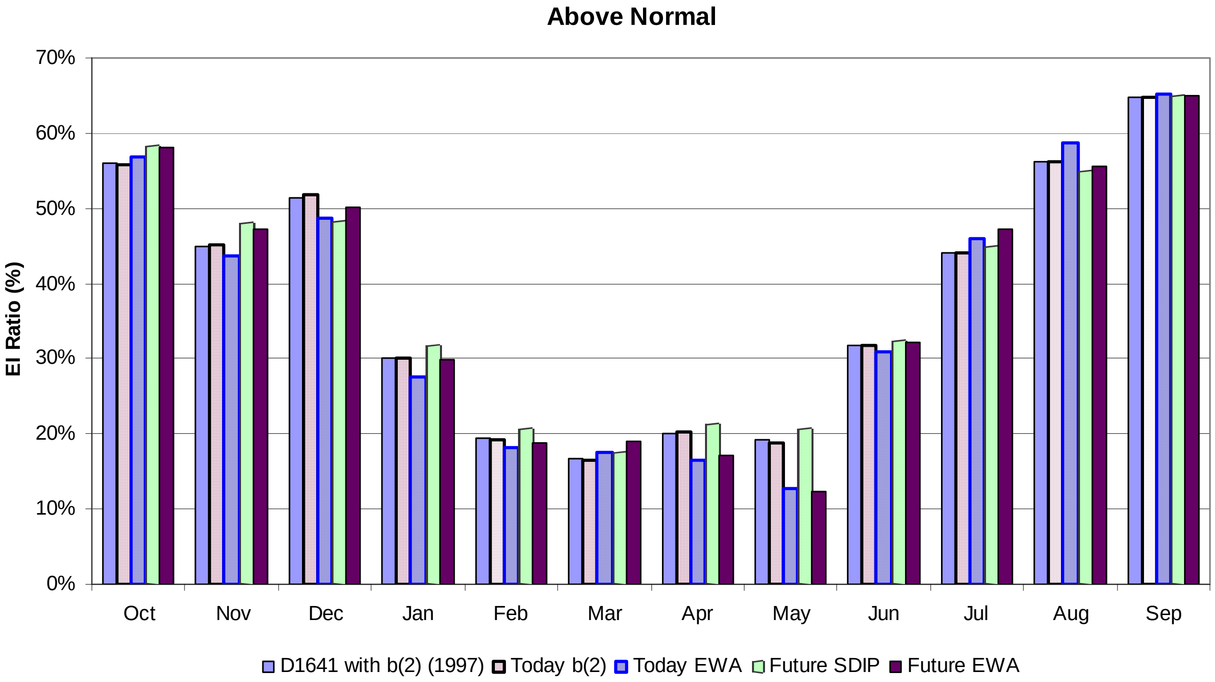


Figure 10-36 Average above normal year (40-30-30 Classification) monthly export-to-inflow ratio

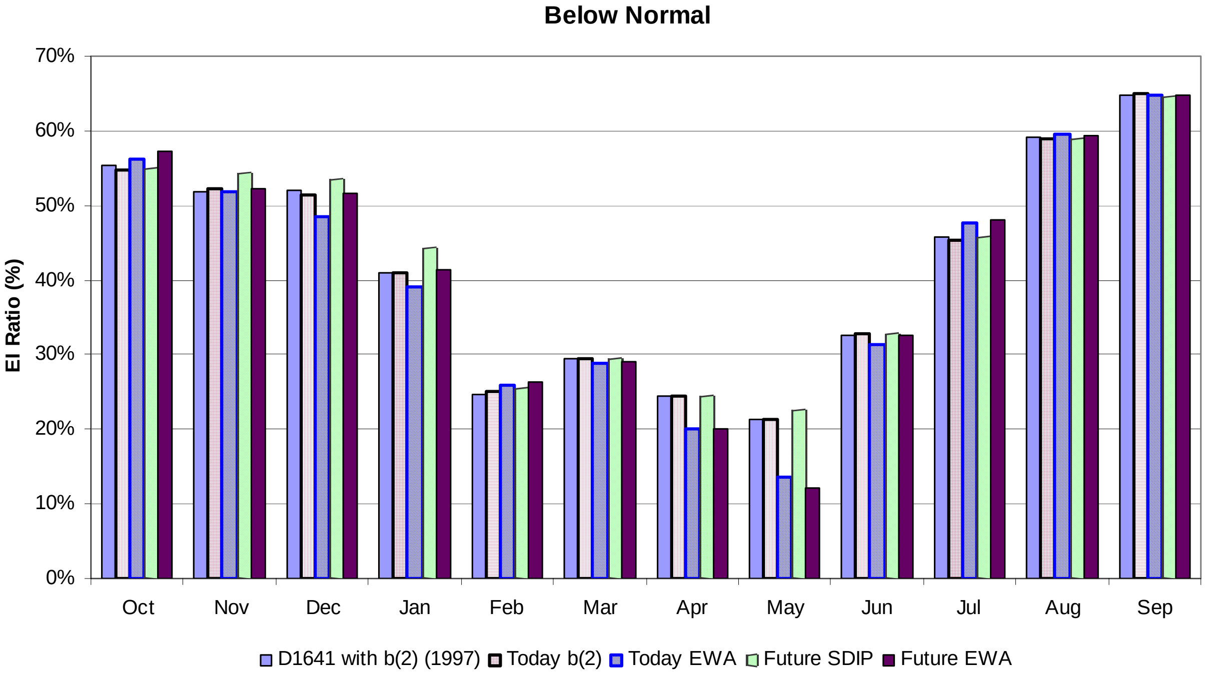


Figure 10-37 Average below normal year (40-30-30 Classification) monthly export-to-inflow ratio

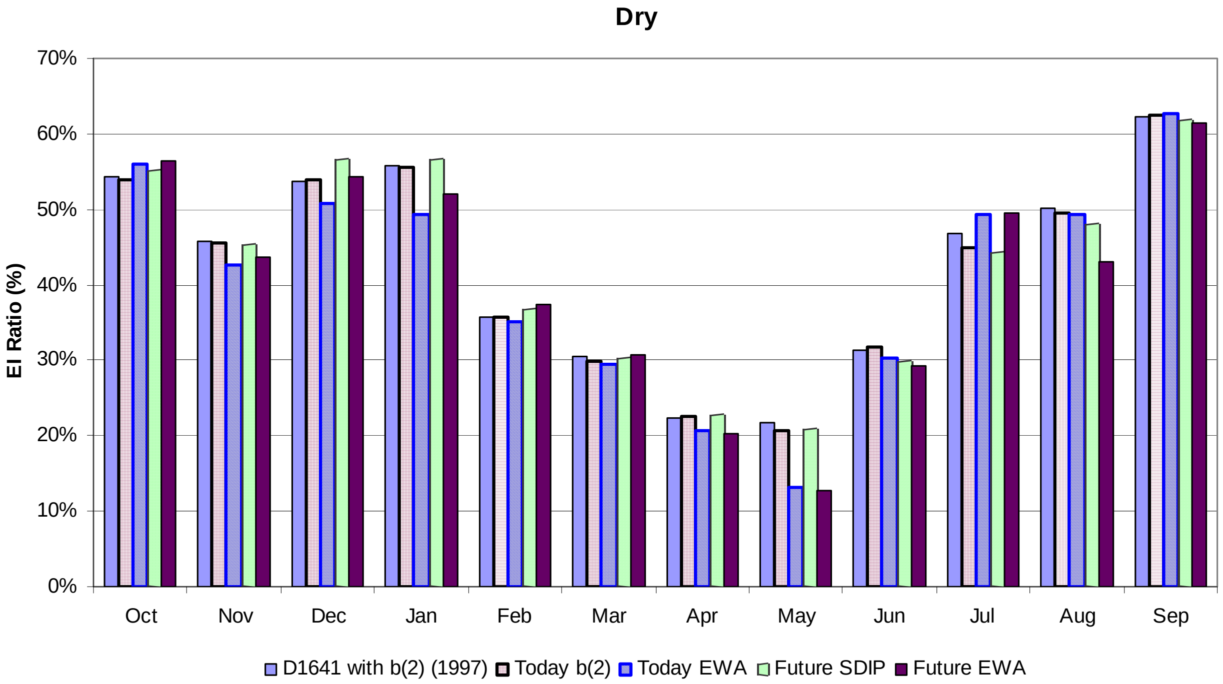


Figure 10-38 Average dry year (40-30-30 Classification) monthly export-to-inflow ratio

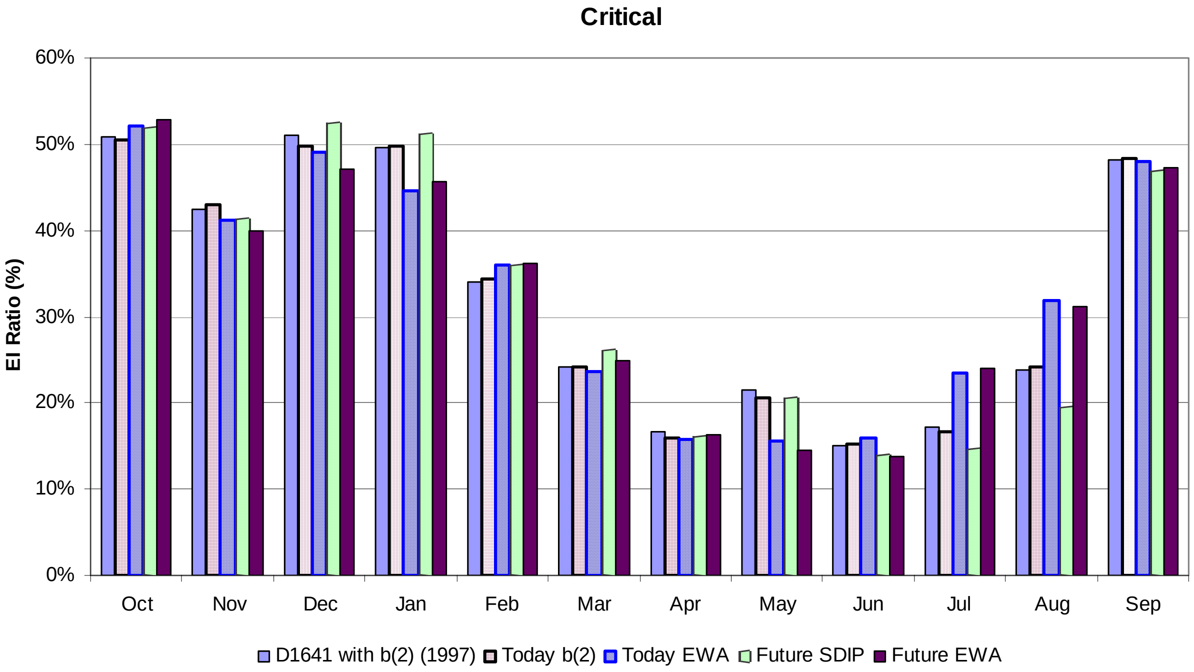


Figure 10-39 Average critical year (40-30-30 Classification) monthly export-to-inflow ratio

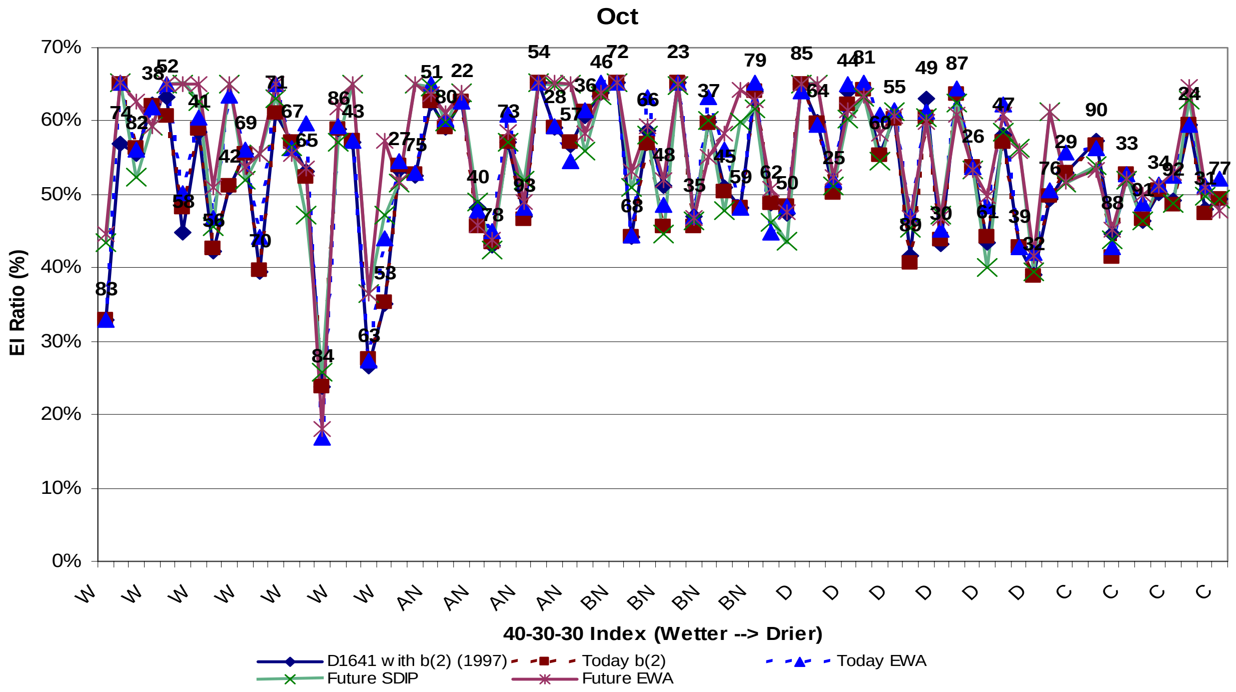


Figure 10-40 October export-to-inflow ratio sorted by 40-30-30 Index

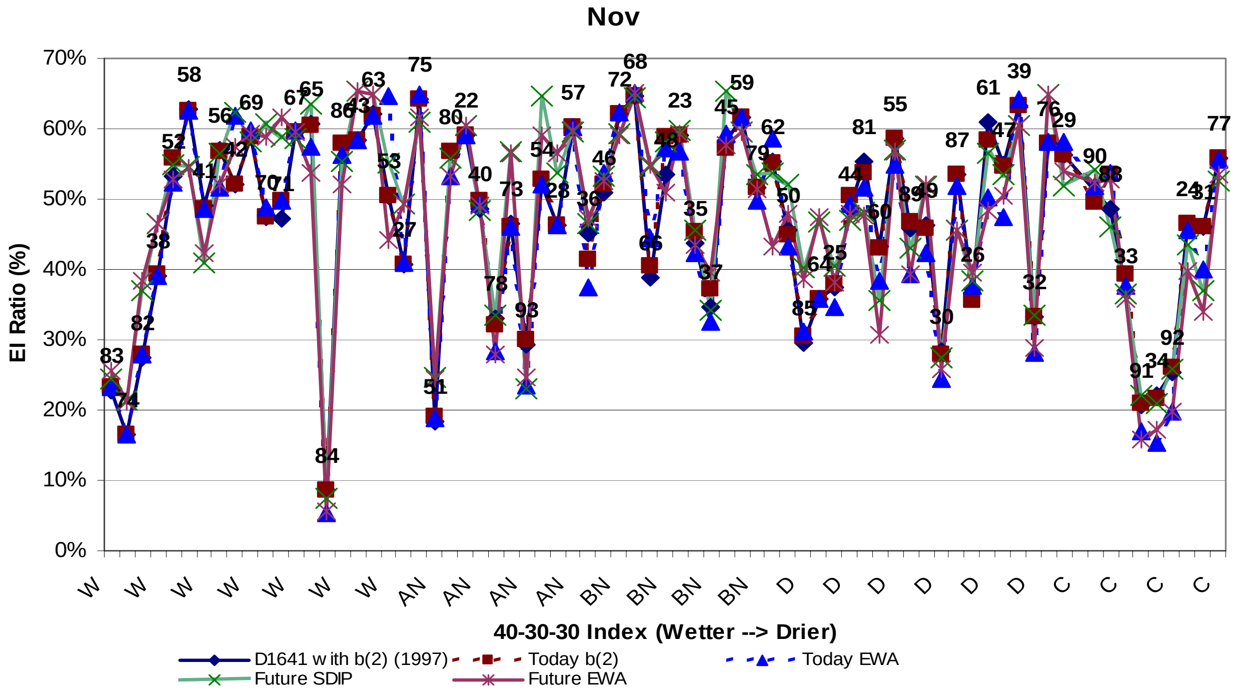


Figure 10-41 November export-to-inflow ratio sorted by 40-30-30 Index

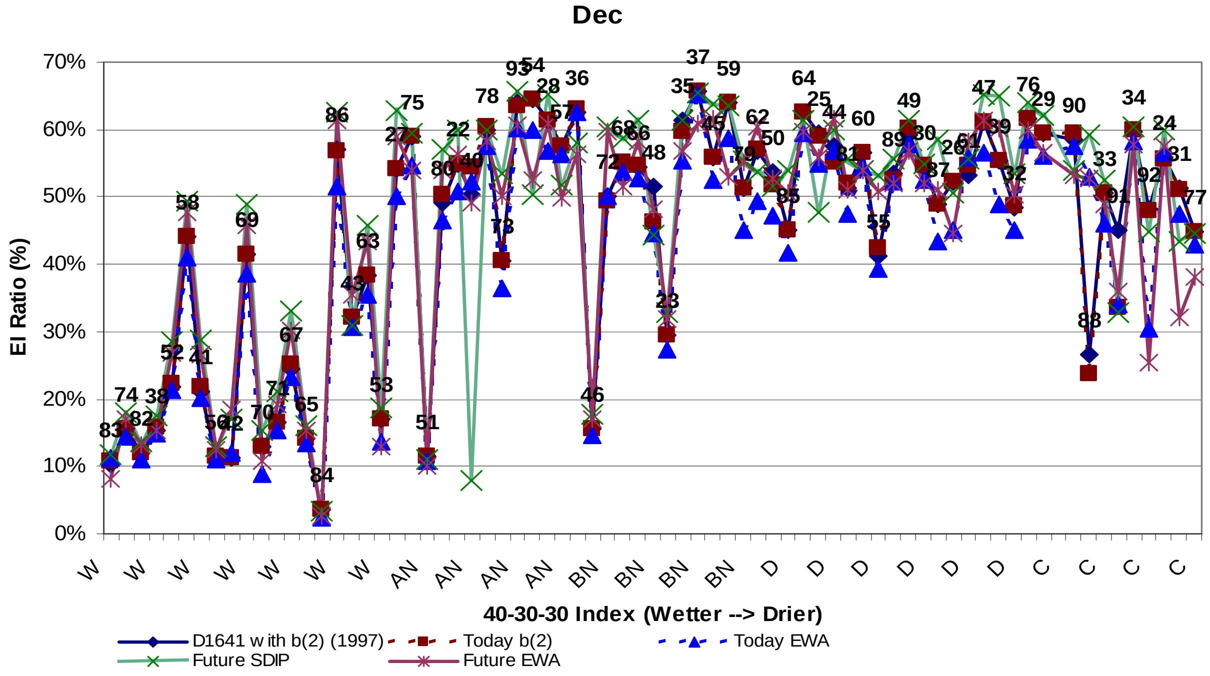


Figure 10-42 December export-to-inflow ratio sorted by 40-30-30 Index

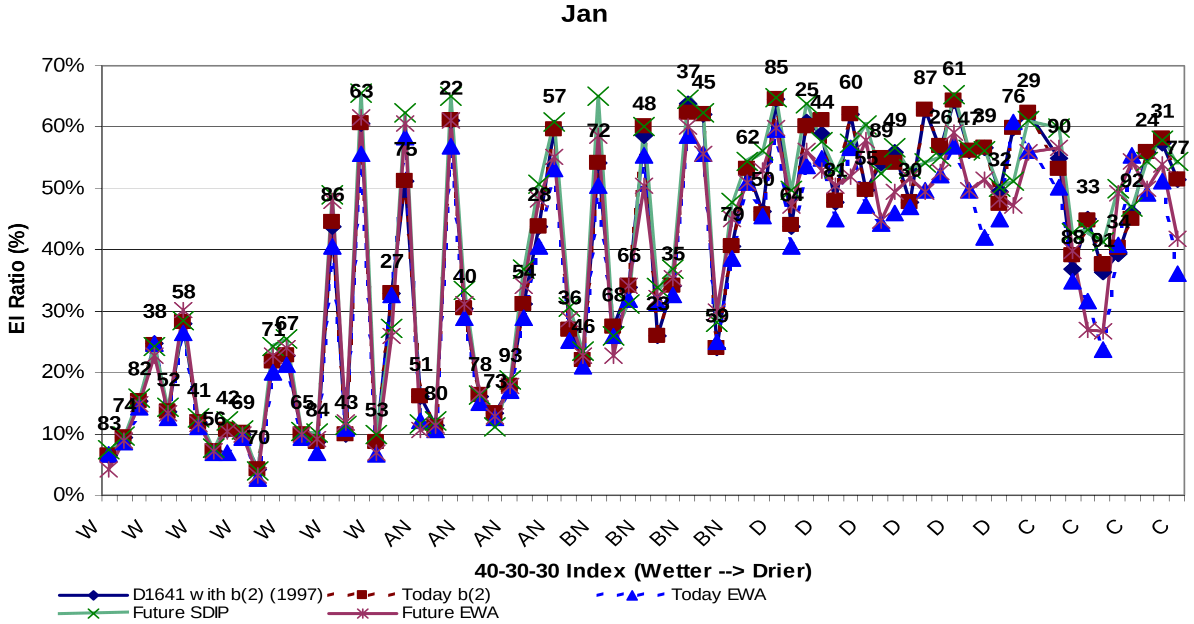


Figure 10-43 January export-to-inflow ratio sorted by 40-30-30 Index

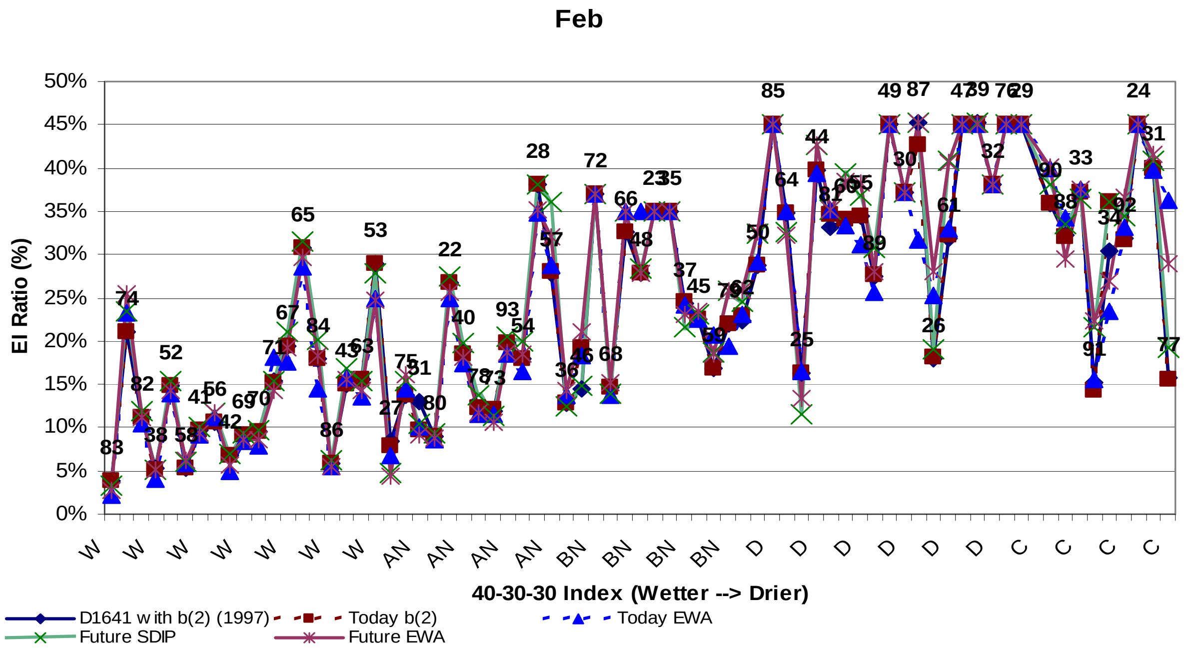


Figure 10-44 February export-to-inflow ratio sorted by 40-30-30 Index

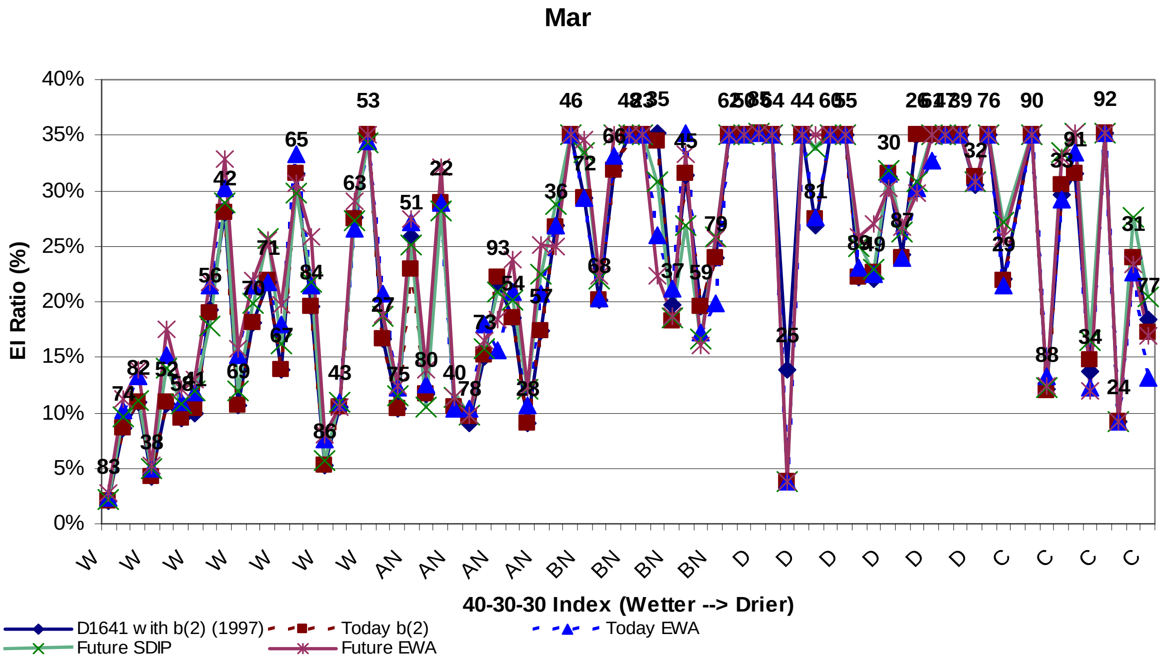


Figure 10-45 March export-to-inflow ratio sorted by 40-30-30 Index

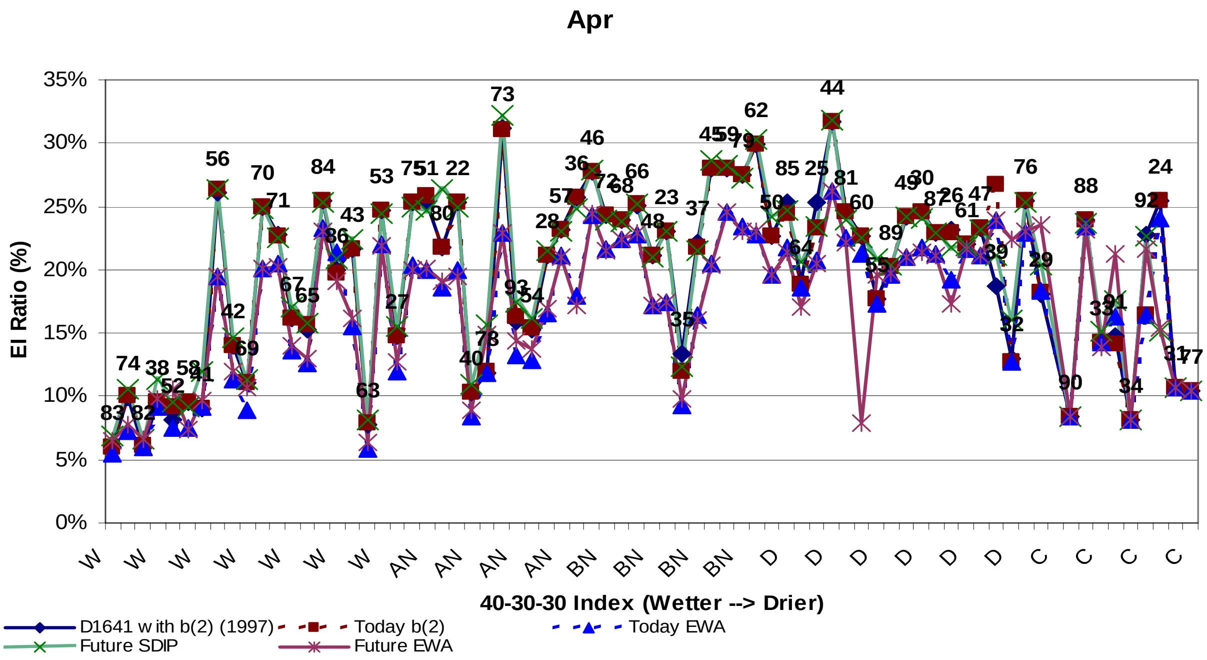


Figure 10-46 April export-to-inflow ratio sorted by 40-30-30 Index

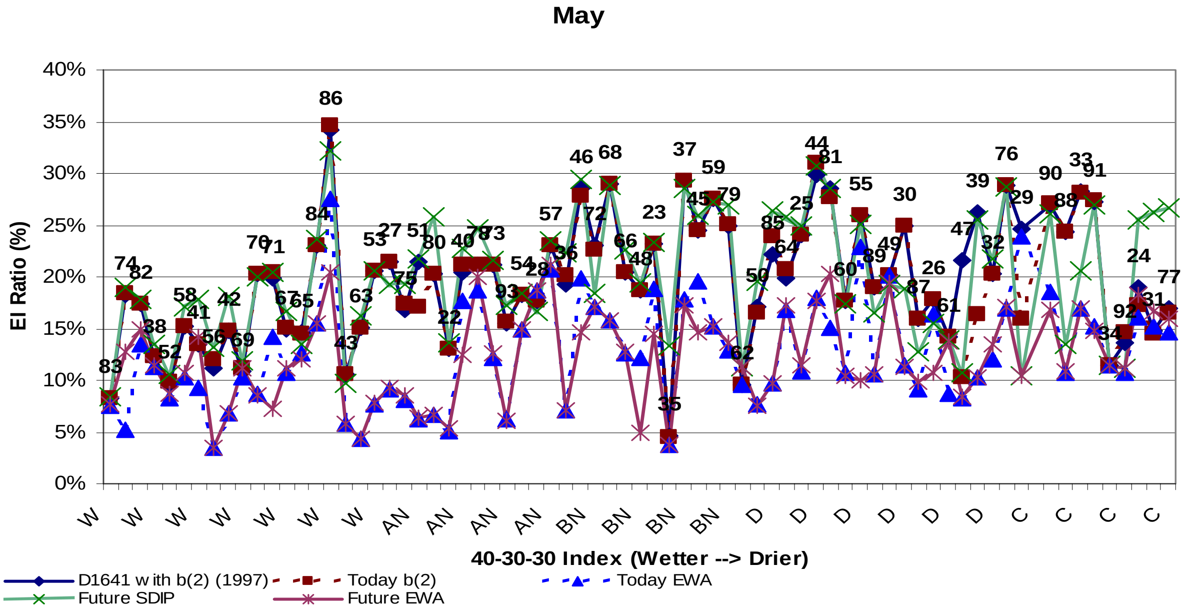


Figure 10-47 May export-to-inflow ratio sorted by 40-30-30 Index

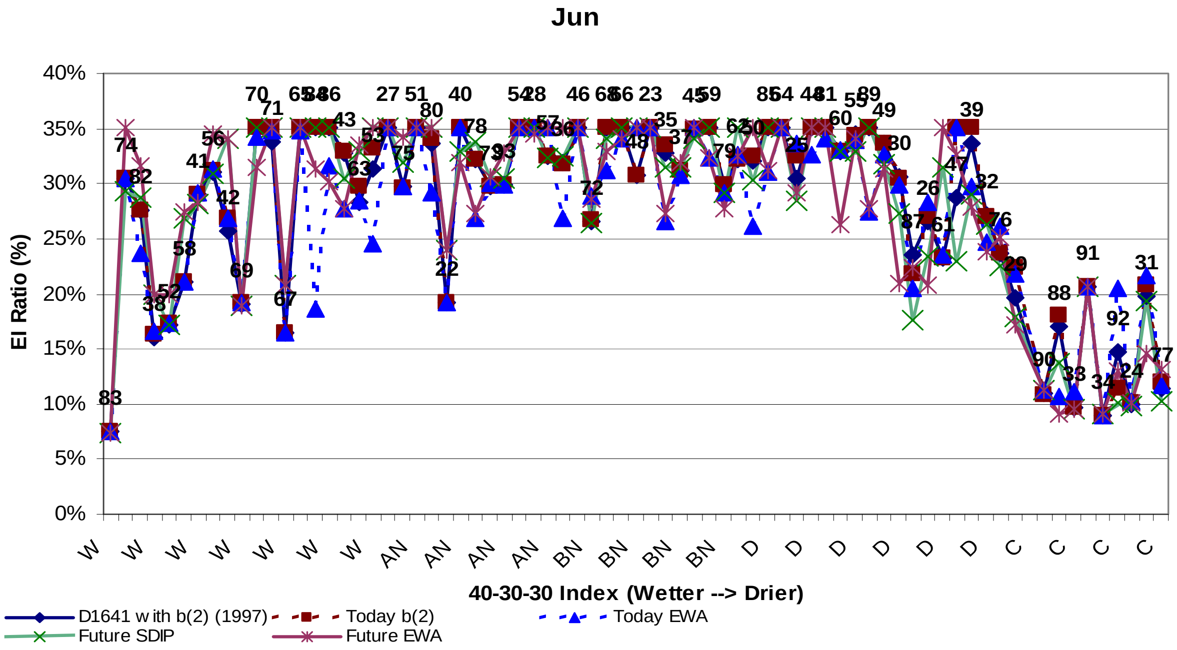


Figure 10-48 June export-to-inflow ratio sorted by 40-30-30 Index

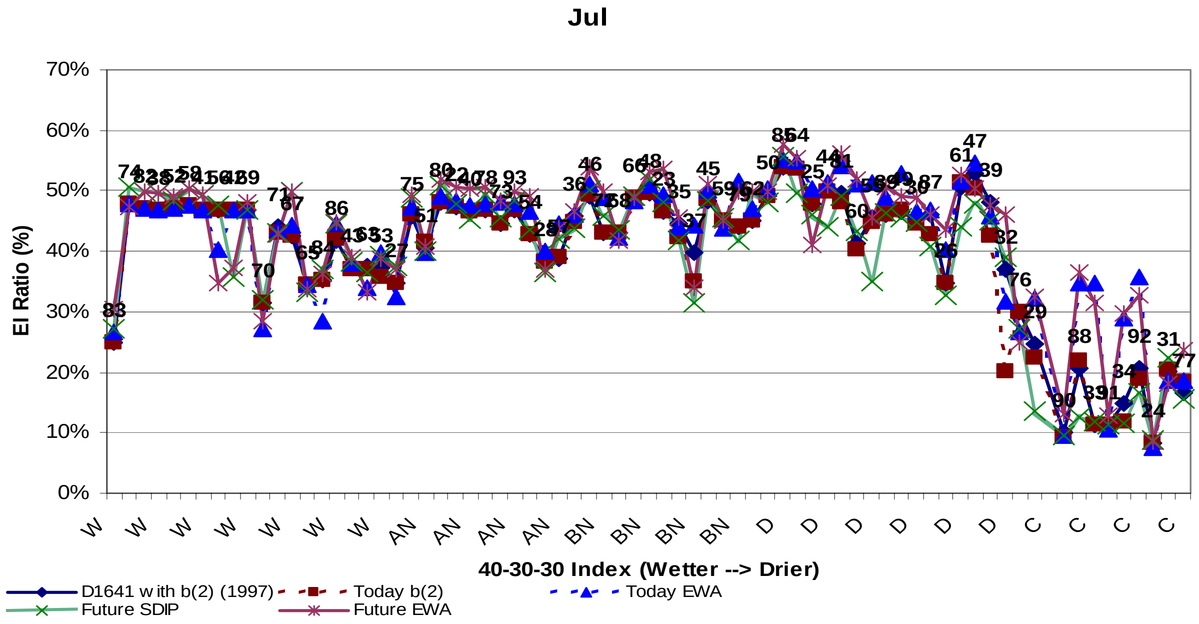


Figure 10-49 July export-to-inflow ratio sorted by 40-30-30 Index

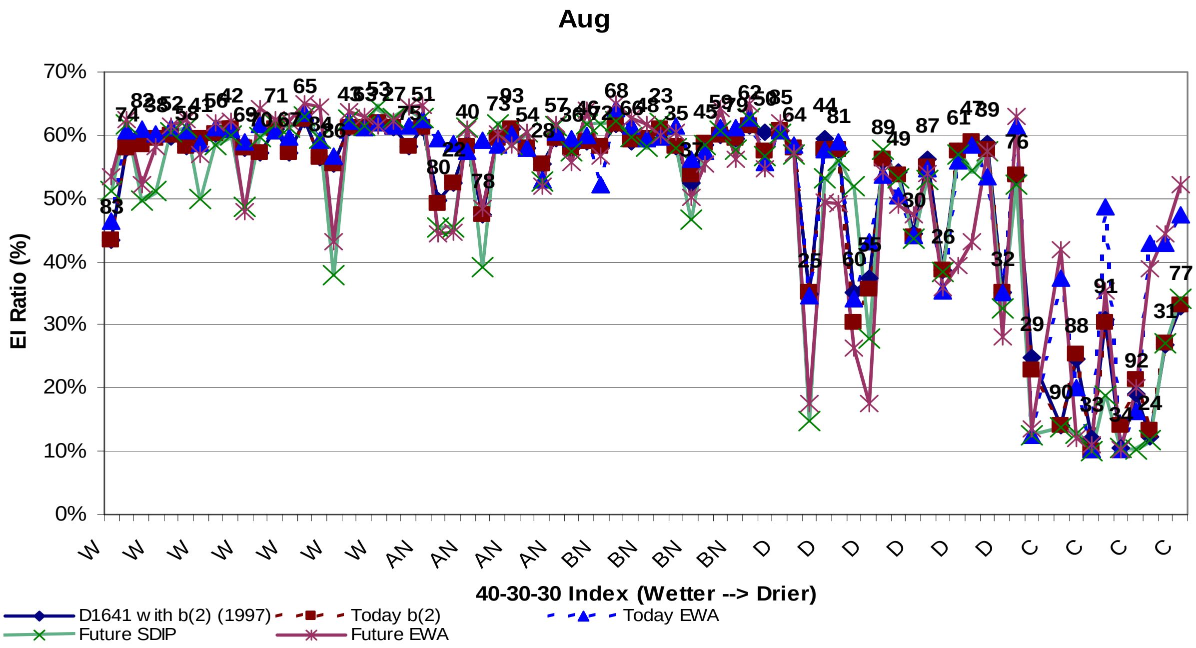


Figure 10-50 August export-to-inflow ratio sorted by 40-30-30 Index

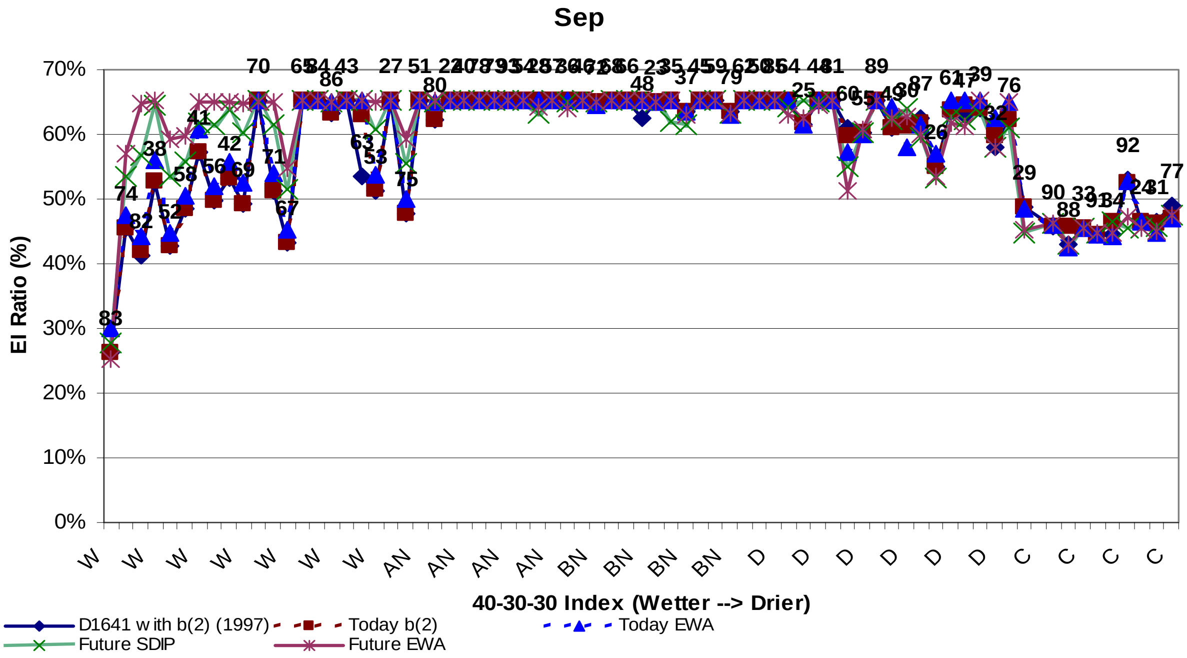


Figure 10-51 September export-to-inflow ratio sorted by 40-30-30 Index

X2 Position

The X2 position in CALSIM II represents where 2 ppt isohaline lies in the Delta calculated from the monthly average NDO (Net Delta Outflow). Since the model represents the end of month X2 position, the day to day effect of CVP/SWP operations are not resolved in this representation.

Figure 10-52 shows the exceedance plot for monthly differences in X2 position between the Studies for all February to June values simulated. Operational changes in Study 2 – Study 1 have minor influence on the X2 position. Operational changes in Study 3 have a greater effect than those in Study 2 due to EWA effects on pumping operations. The largest effect on X2 is in Study 5 compared to Study 1 this comparison shows the cumulative effect on X2 with 0.5 km shifts occurring about equal on either side of the curve. The relative X2 position in the Study 4 – Study 2 and Study 5 – Study 3 cases show relatively the same frequency of shifts in X2 position.

The monthly average X2 position based on long-term and on type dependent averages are shown in Figure 10-53 toFigure 10-58. The six Figures generally indicate the same trend from Feb to June in the X2 position on average as it moves more upstream into the delta. Also in the months Feb, Apr, May, and June the X2 position shifts slightly downstream in Studies 3 and 5 when compared to the other Studies.

Figure 10-59 to Figure 10-63. show the X2 position sorted from wettest to driest 40-30-30 Index and show the variability within a particular group of water years. These results show that X2 moves upstream as the water years get drier. Figure 10-64 to Figure 10-66. show the total number of days annually that the X2 position is downstream of one of the three compliance points (Confluence, Chipps Island and Roe Island). These latter results represent gross approximations because CALSIM II must estimate "the total number of days" values based on monthly simulation results and does not simulate the daily position of X2.

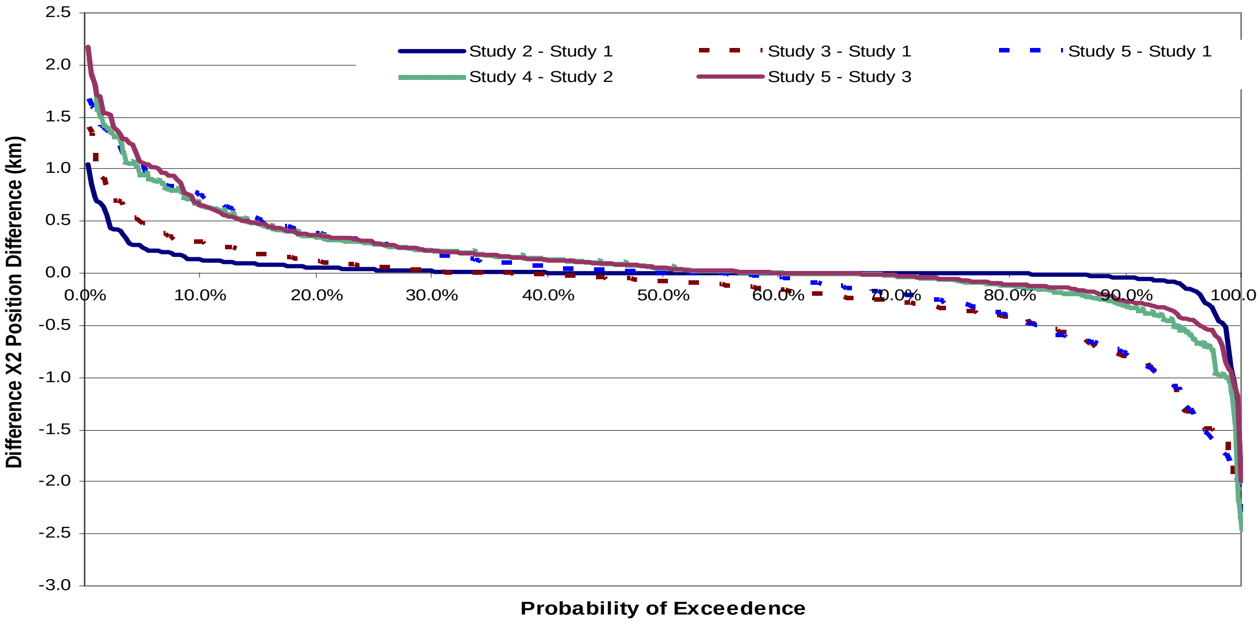


Figure 10-52 Probability of Exceedance for Monthly Shifts in X2 Position for the Feb – June Period

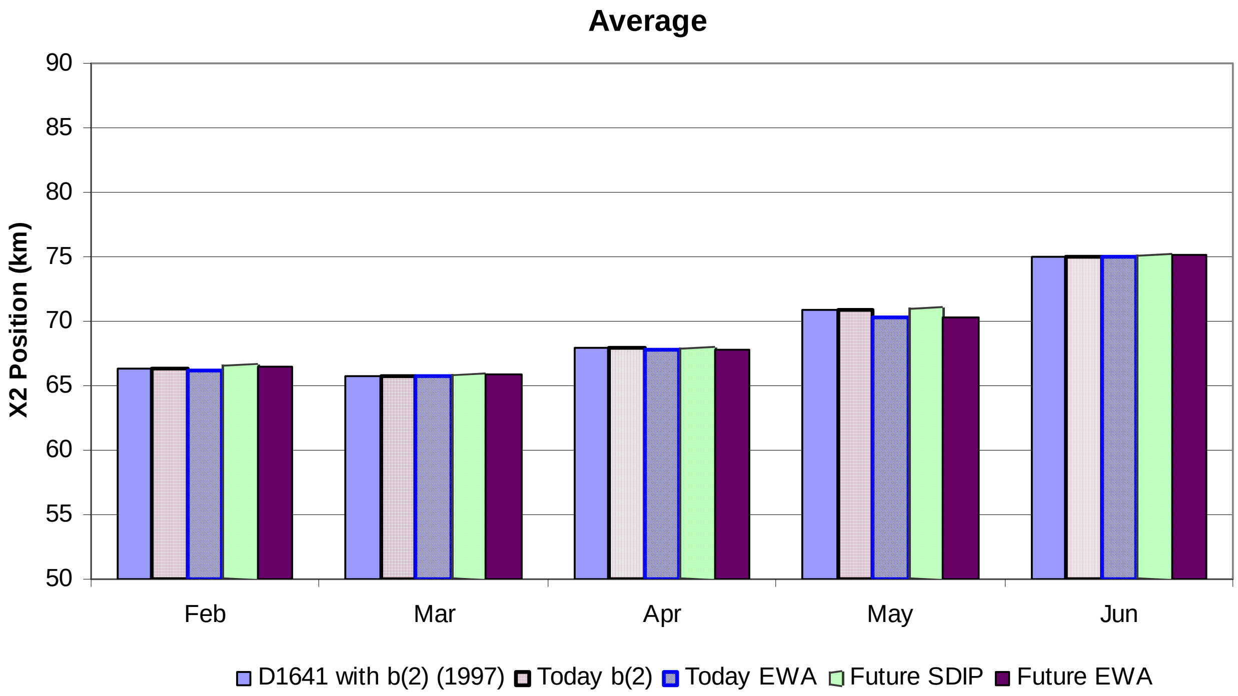


Figure 10-53 Average Monthly X2 Position

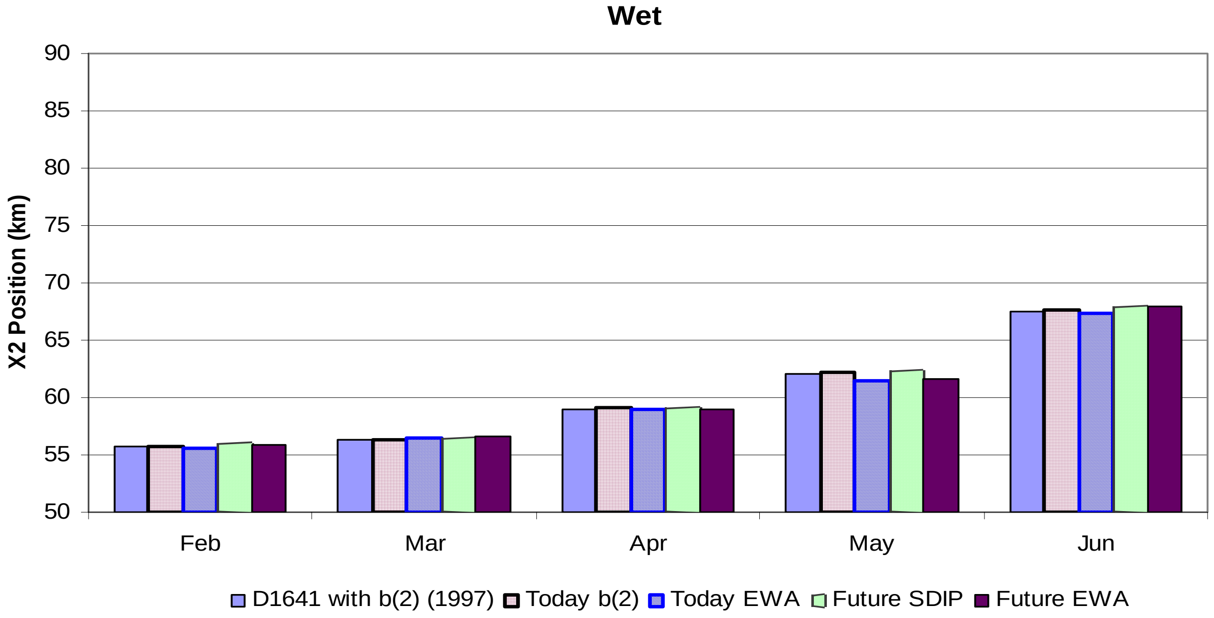


Figure 10-54 Average wet year (40-30-30 Classification) monthly X2 Position

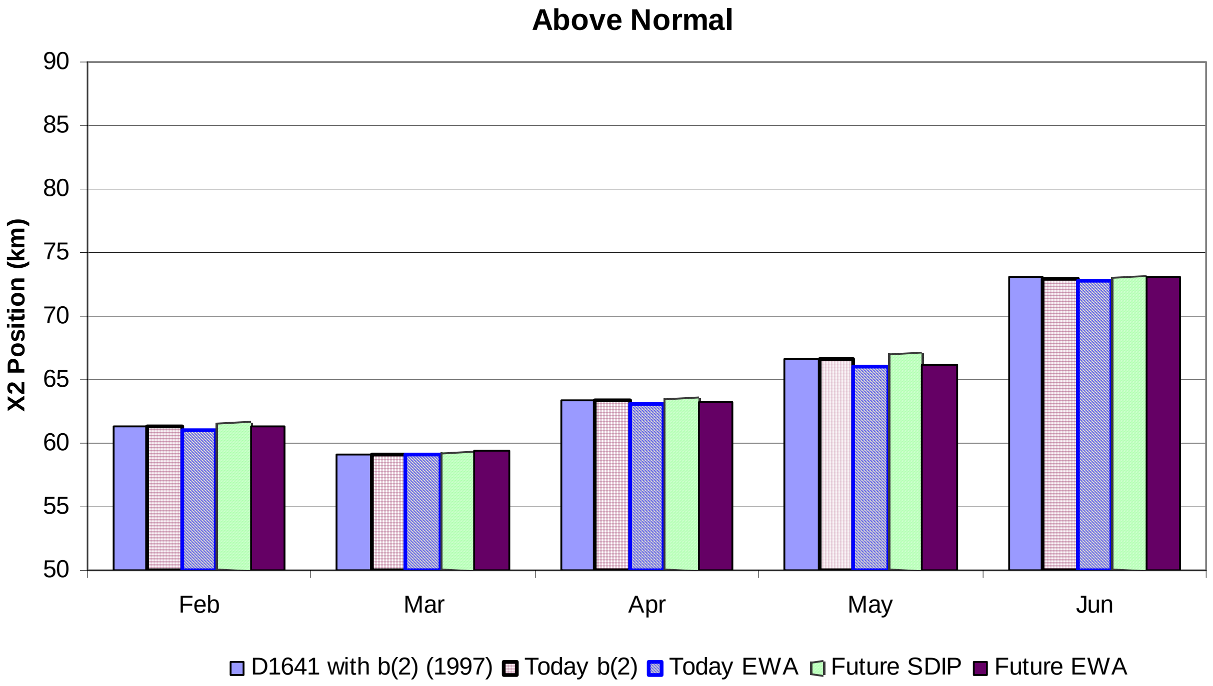


Figure 10-55 Average above normal year (40-30-30 Classification) monthly X2 Position

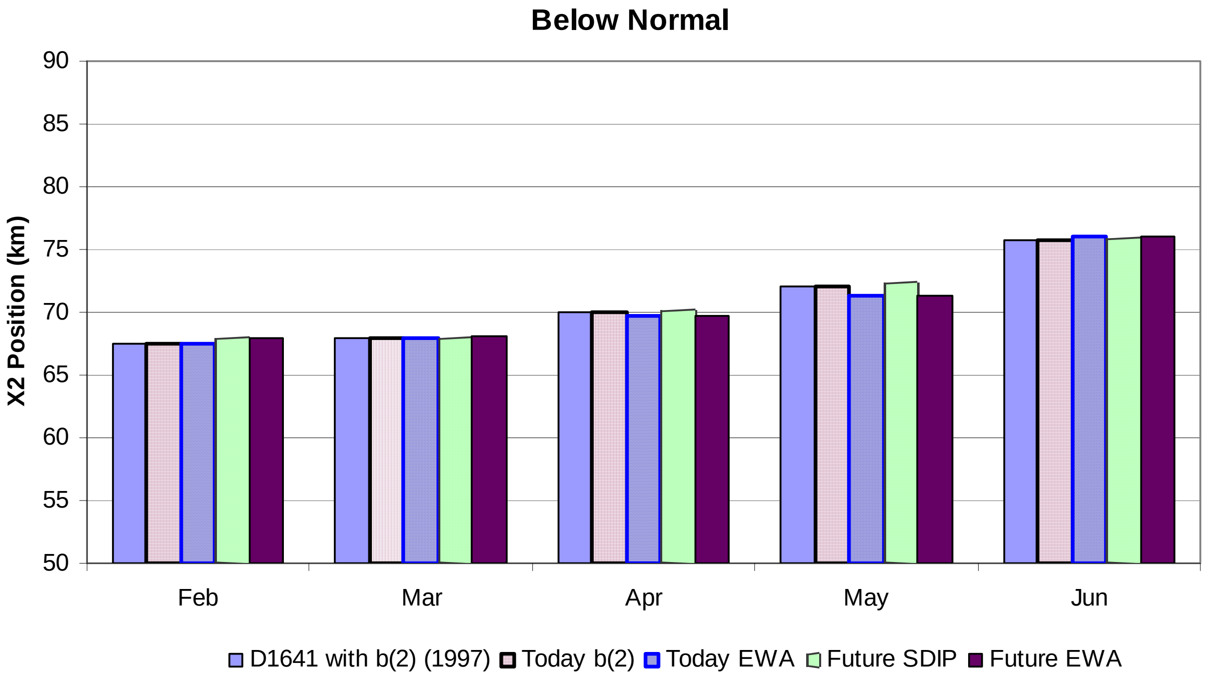


Figure 10-56 Average below normal year (40-30-30 Classification) monthly X2 Position

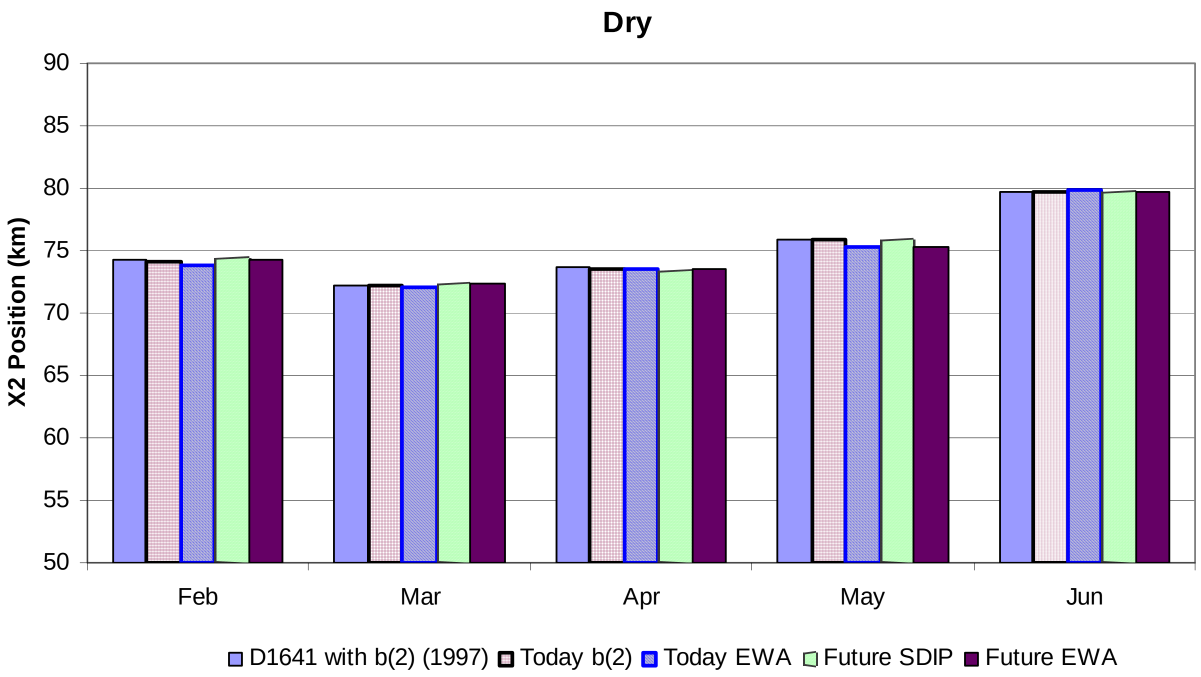


Figure 10-57 Average dry year (40-30-30 Classification) monthly X2 Position

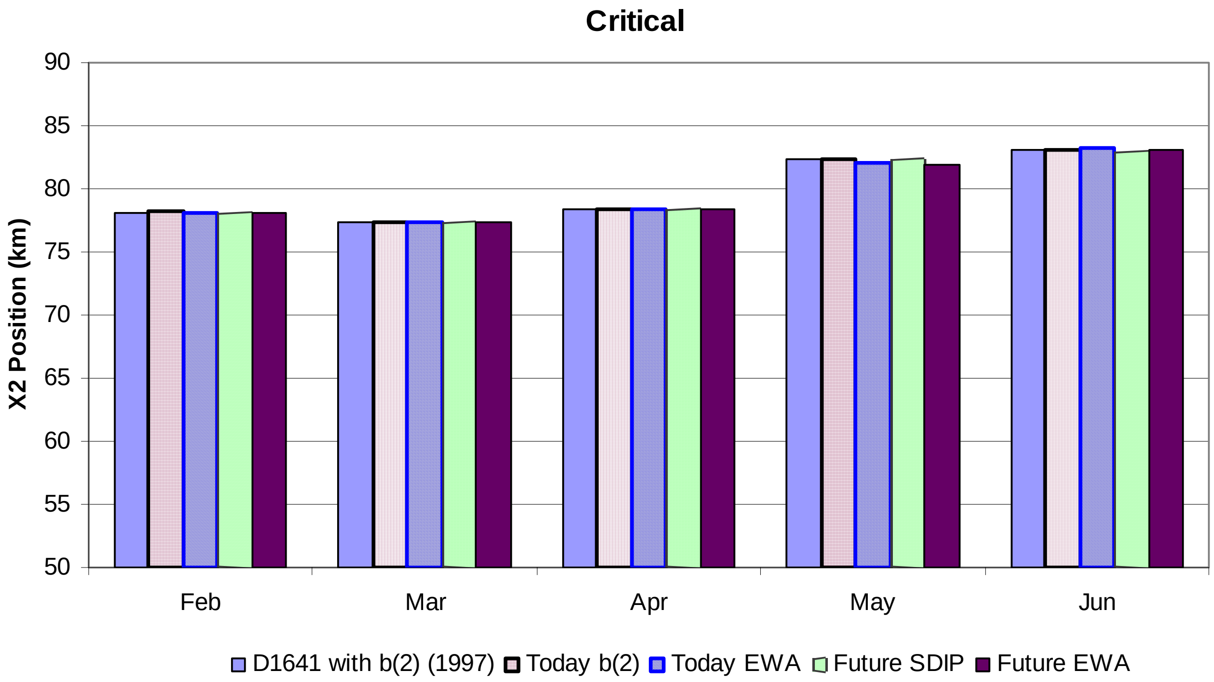


Figure 10-58 Average critical year (40-30-30 Classification) monthly X2 Position

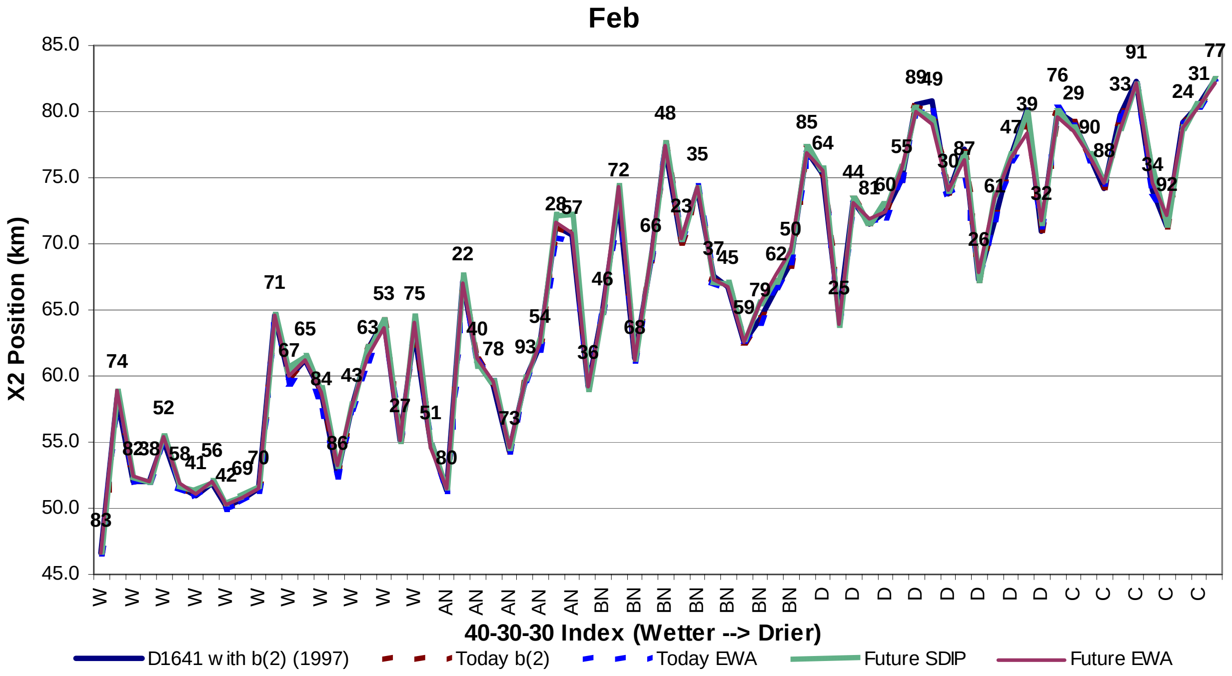


Figure 10-59 February X2 Position sorted by 40-30-30 Index

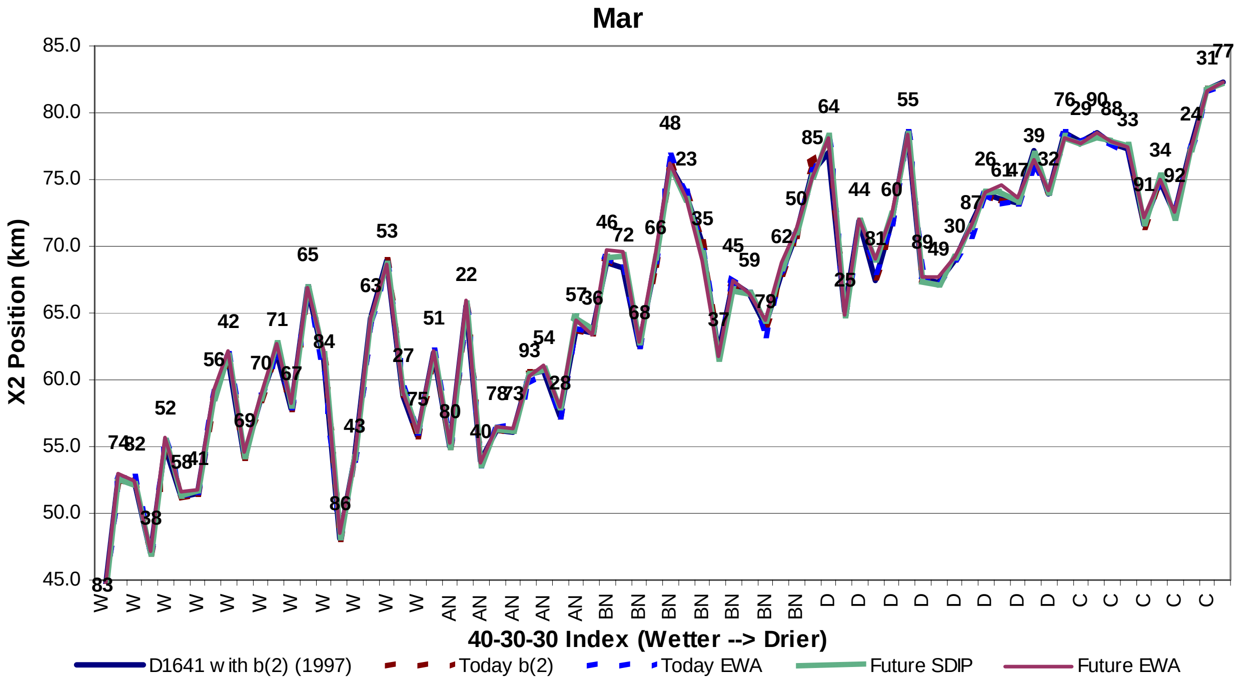


Figure 10-60 March X2 Position sorted by 40-30-30 Index

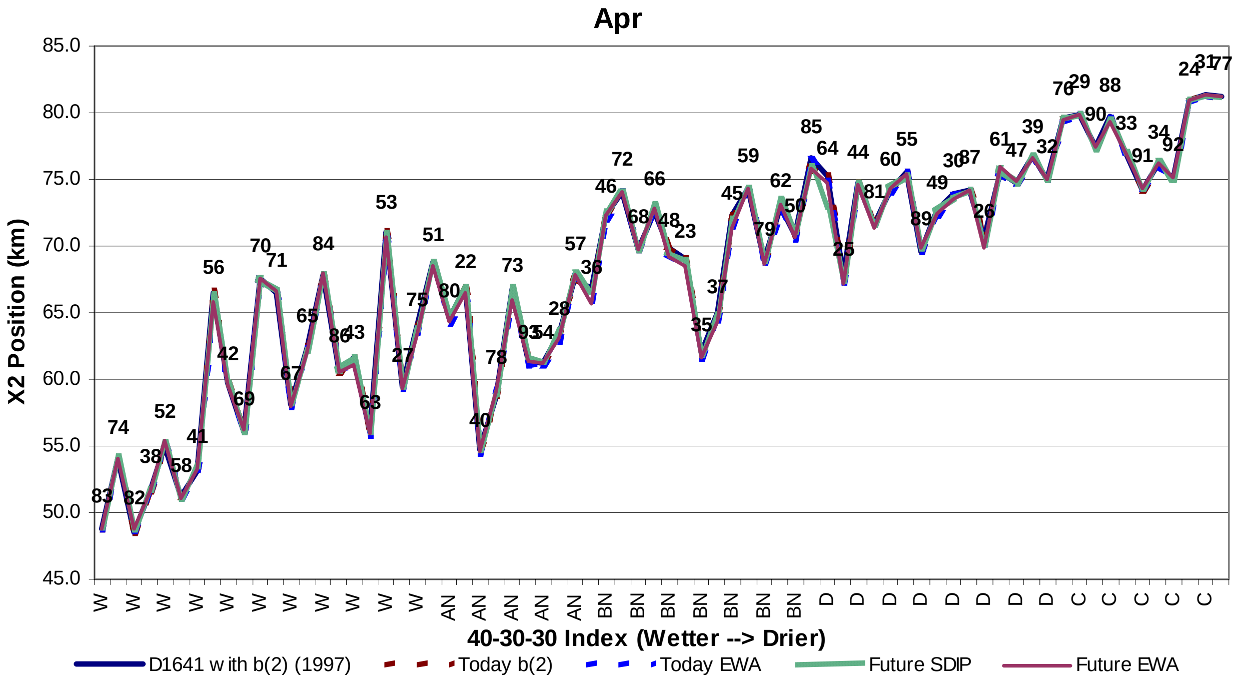


Figure 10-61 April X2 Position sorted by 40-30-30 Index

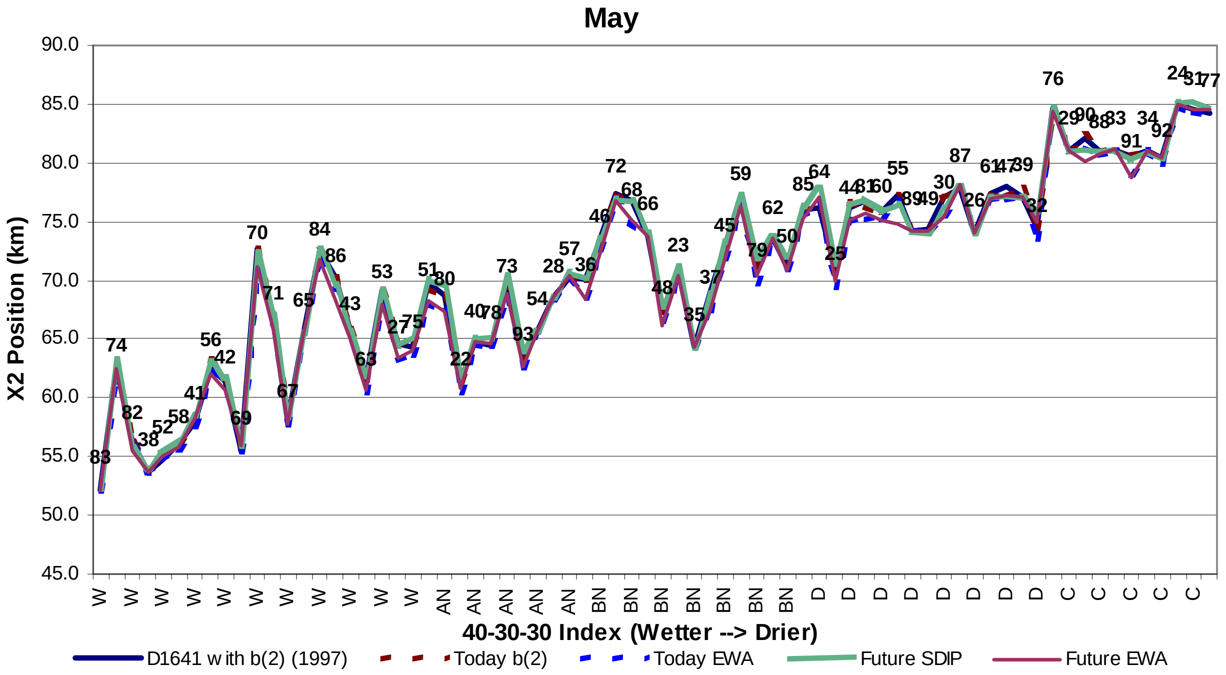


Figure 10-62 May X2 Position sorted by 40-30-30 Index

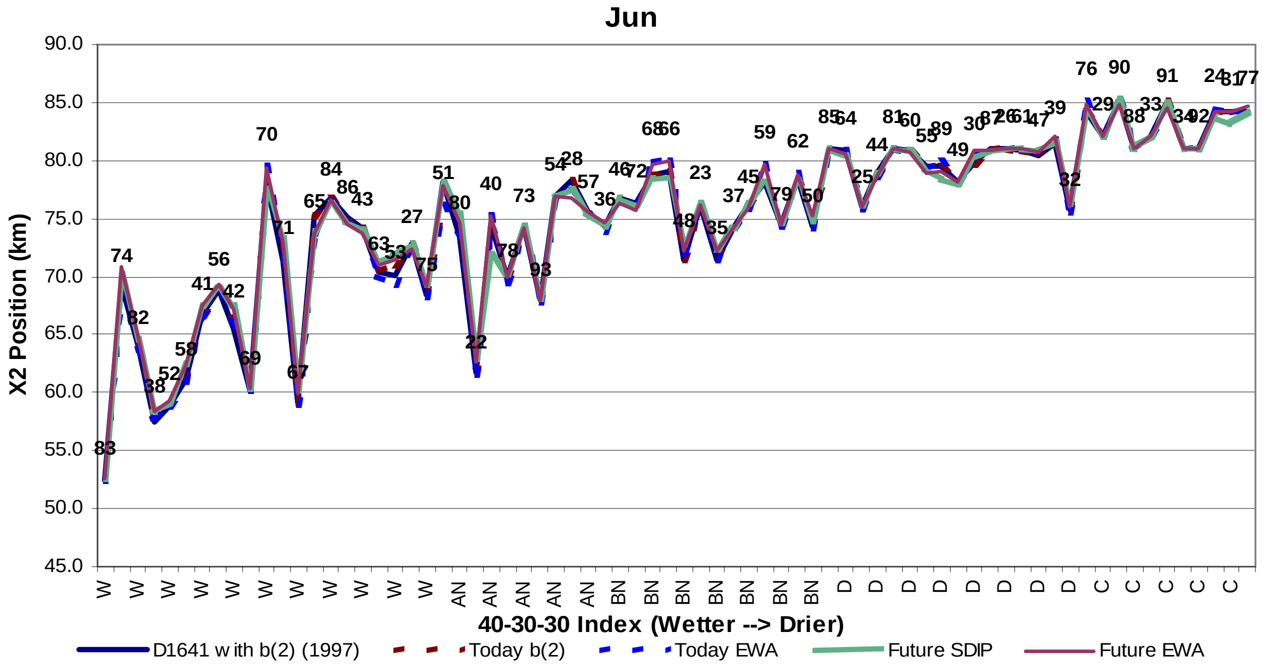


Figure 10-63 June X2 Position sorted by 40-30-30 Index

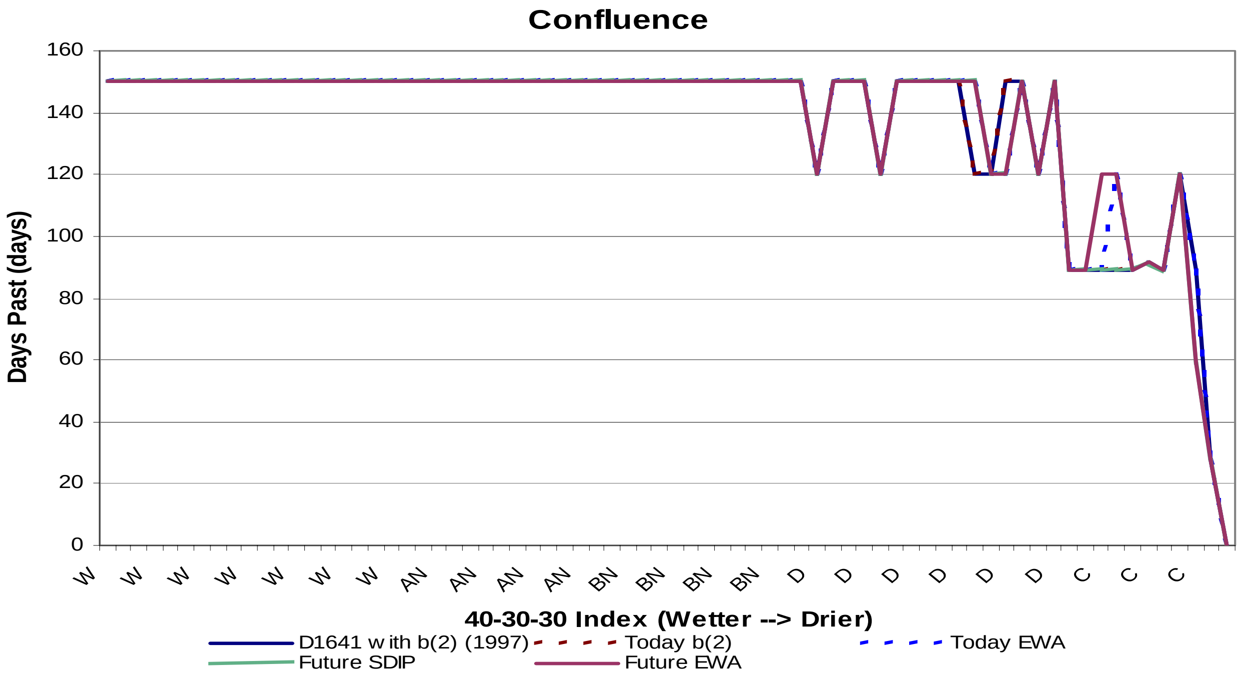


Figure 10-64 Total number of days average monthly X2 position is past the Confluence 40-30-30 Index
(Note: that the total days for a month are assigned if the average X2 position is past the confluence)

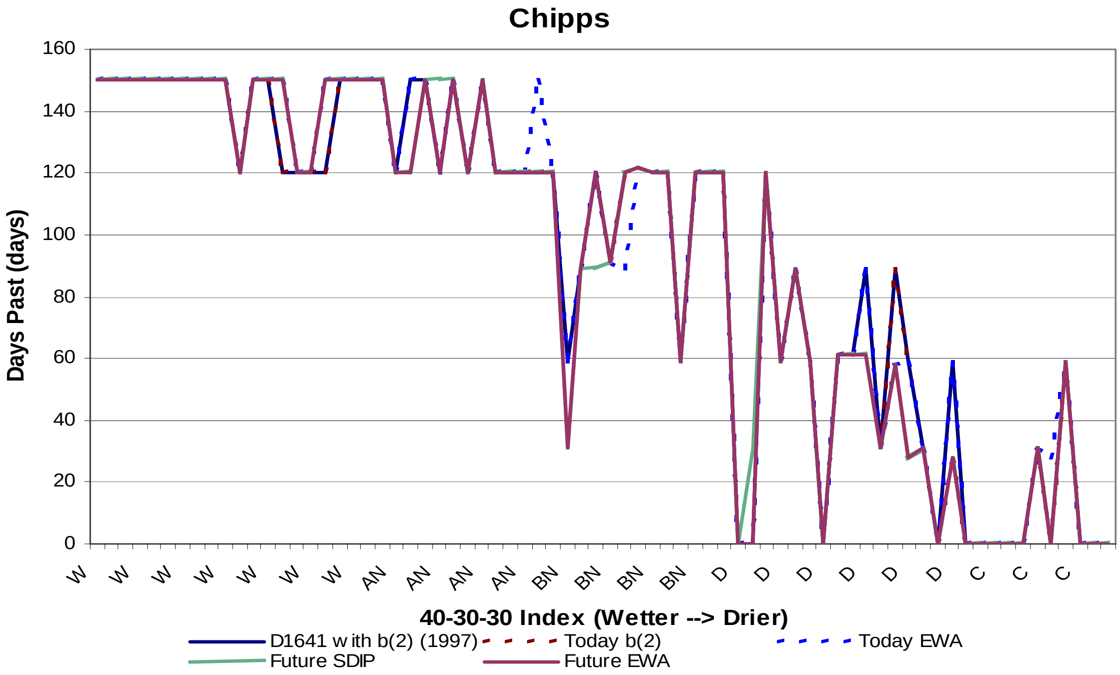


Figure 10-65 Total number of days average monthly X2 position is past the Chipps Island 40-30-30 Index
(Note: that the total days for a month are assigned if the average X2 position is past the Chipps Island)

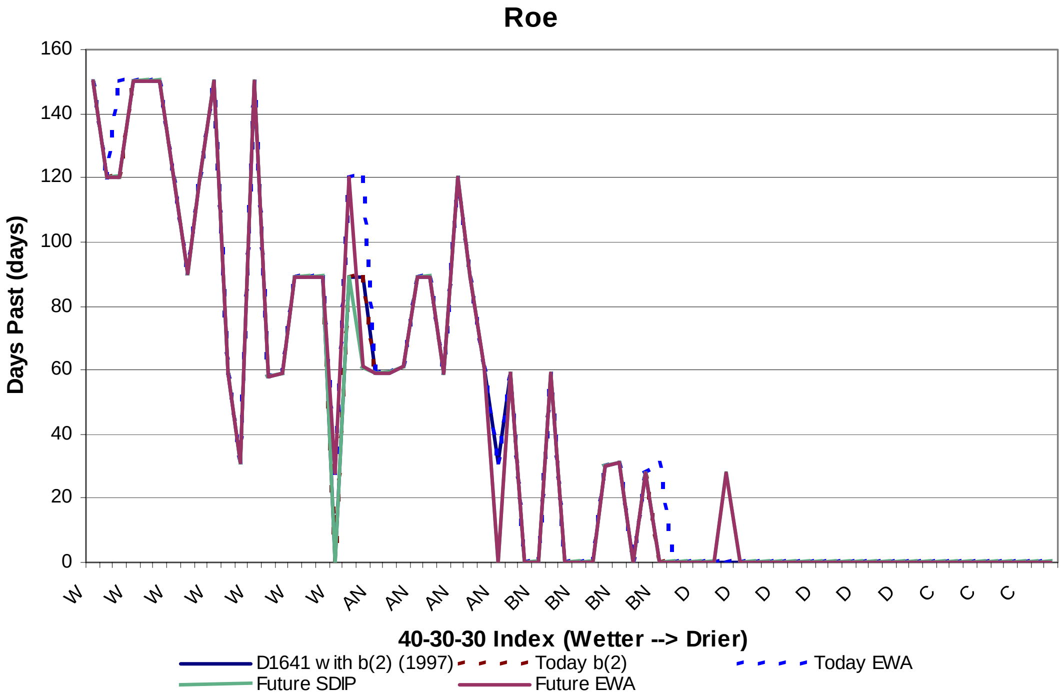


Figure 10-66 Total number of days average monthly X2 position is past the Roe Island 40-30-30 Index
(Note: that the total days for a month are assigned if the average X2 position is past the Roe Island)

Exports

The exports discussed in this section are Tracy pumping, Banks pumping, Federal Banks pumping and diversions for Contra Costa Water District (CCWD) and the North Bay Aqueduct. Figure 10-67 shows the total annual pumping of Tracy and Banks facilities. The study with the most available pumping is the Future SDIP that includes the intertie at Tracy, 8500 cfs at Banks pumping plant and does not include EWA reductions in pumping. Study 3 generally has the least amount of pumping as Tracy and Banks have existing permitted and physical capacities due to the constriction in the Delta Mendota Canal while EWA imposes restrictions on pumping.

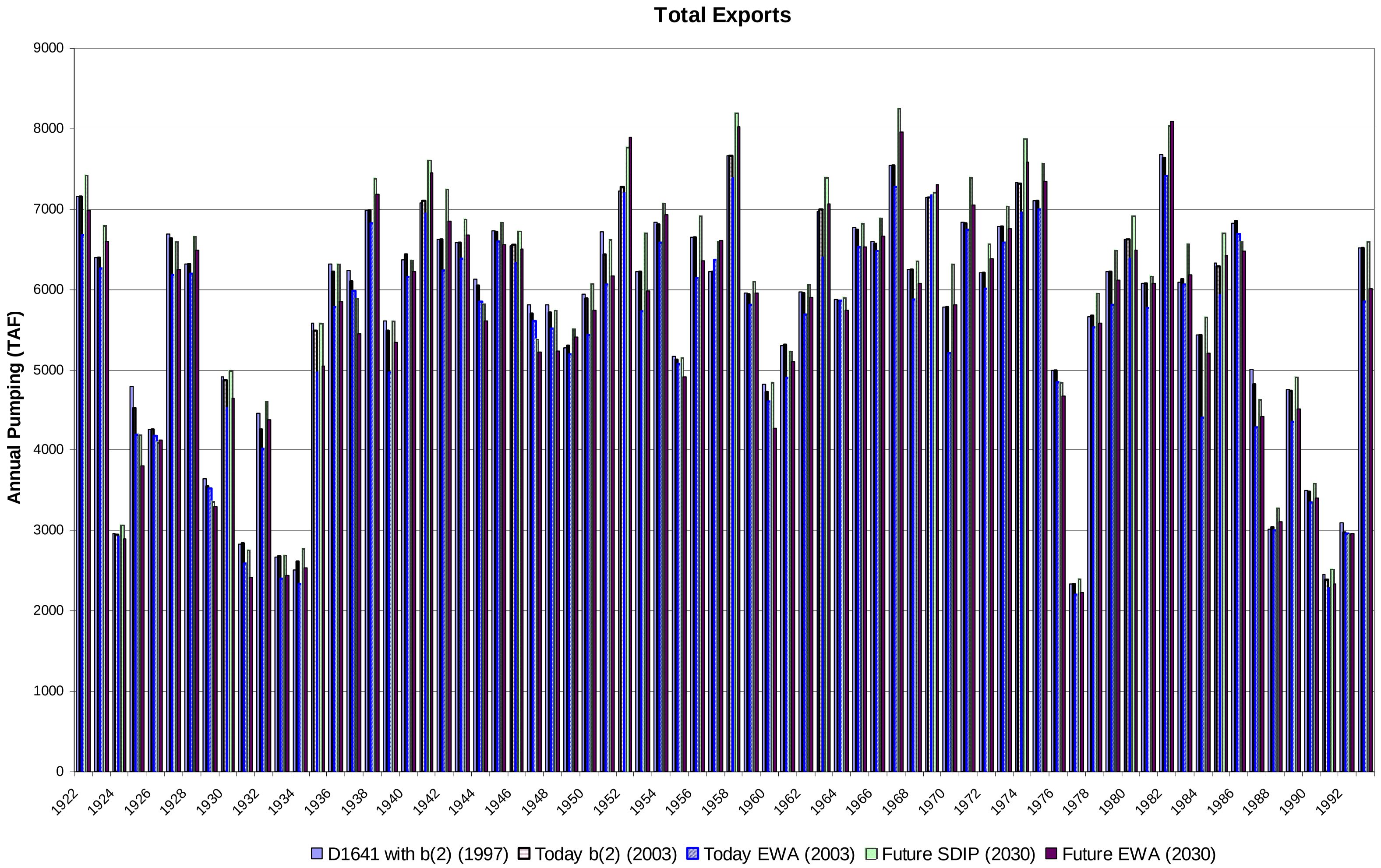


Figure 10-67 Total Annual Tracy + Banks Pumping

Tracy Pumping

The Tracy pumps in Studies 1, 2 and 3 are limited to 4200 cfs plus the diversions upstream of the constriction in the Delta Mendota Canal. In studies 4 and 5 the intertie allows pumping to increase to the facility design capacity of 4600 cfs. Figure 10-68 shows the percentile values for monthly pumping at Tracy. November through February are the months when Tracy most frequently pumps at 4600 cfs with the 50th percentile at that level for most of the months in Study 4. Wet years tend to be when Tracy can more utilitze the 4600 cfs pumping in Study 4 and Study 5, seeFigure 10-70.

From Figure 10-68 December through February the pumping is decreased during this time frame in Studies 3 and 5 due to the 25 TAF/month pumping restriction from the EWA program. April, May and June see reductions from the other months because of the VAMP restrictions and May has further reductions in the EWA studies due to EWA spending some assets to supplement the May Shoulder pumping redcution. June is limited by the 3000 cfs limit for in all studies which affects the amount of reduction in the 50th percentile. July through September see pumping increase generally for irrigation deliveries. July and August have the 5th percentiles down to the 800 cfs minimum pumping (assumption of pumping rate with one pump on) and to 600 cfs when Shasta gets below 1500 TAF in storage.

Figure 10-69 to Figure 10-74. show similar trends in monthly average exports by year type with pumping being greatest December through February and July through September. The exception is in the Critical year, Figure 10-74, when the pumping stays between 1000 cfs and 1500 cfs through August due to reduced storage and salinity conditions in the Delta.

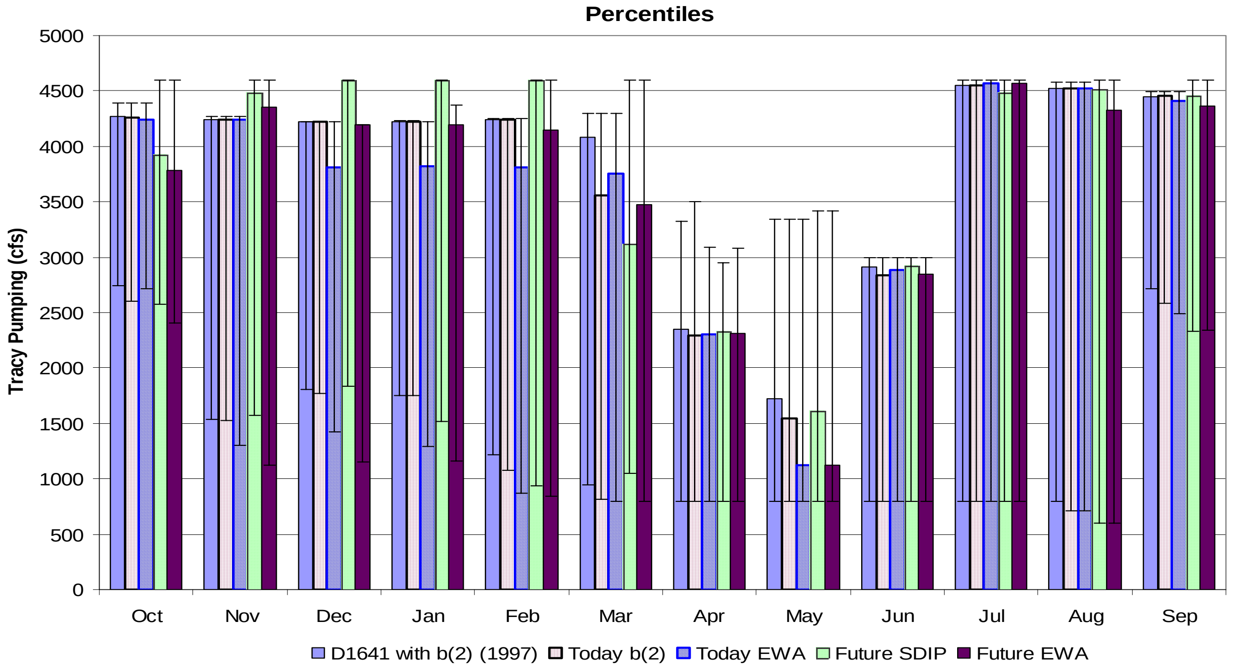


Figure 10-68 Tracy Pumping 50th Percentile Monthly Releases with the 5th and 95th as the bars

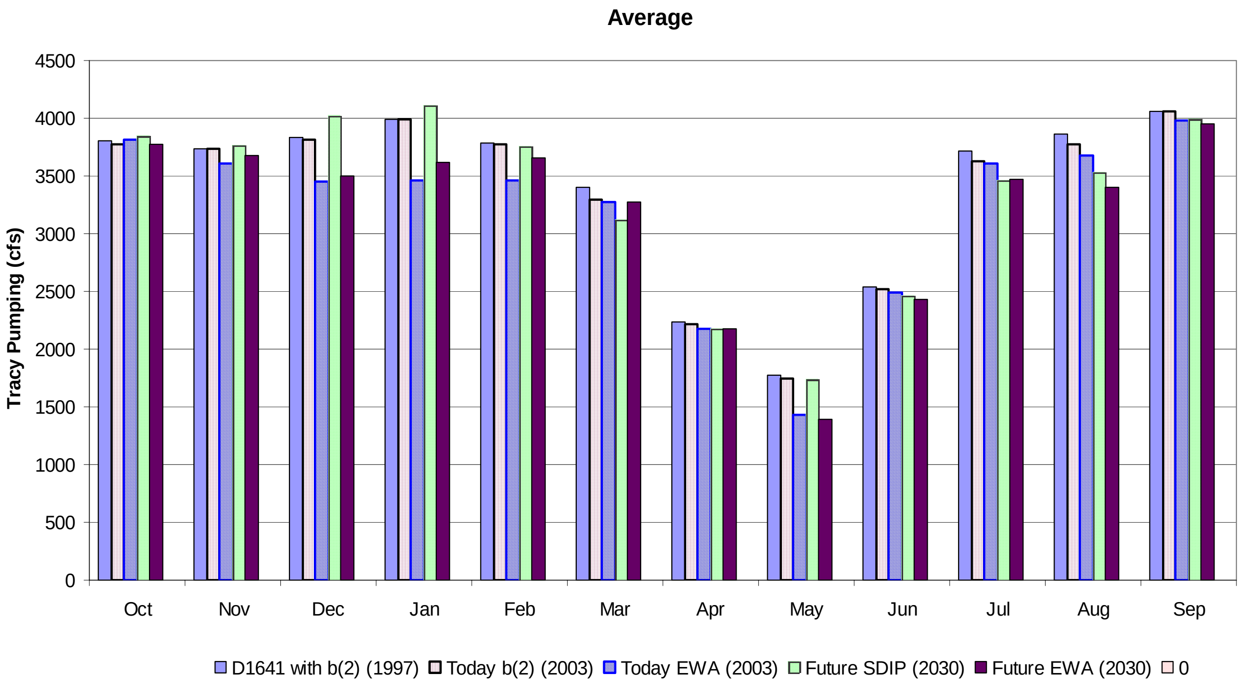


Figure 10-69 Average Monthly Tracy Pumping

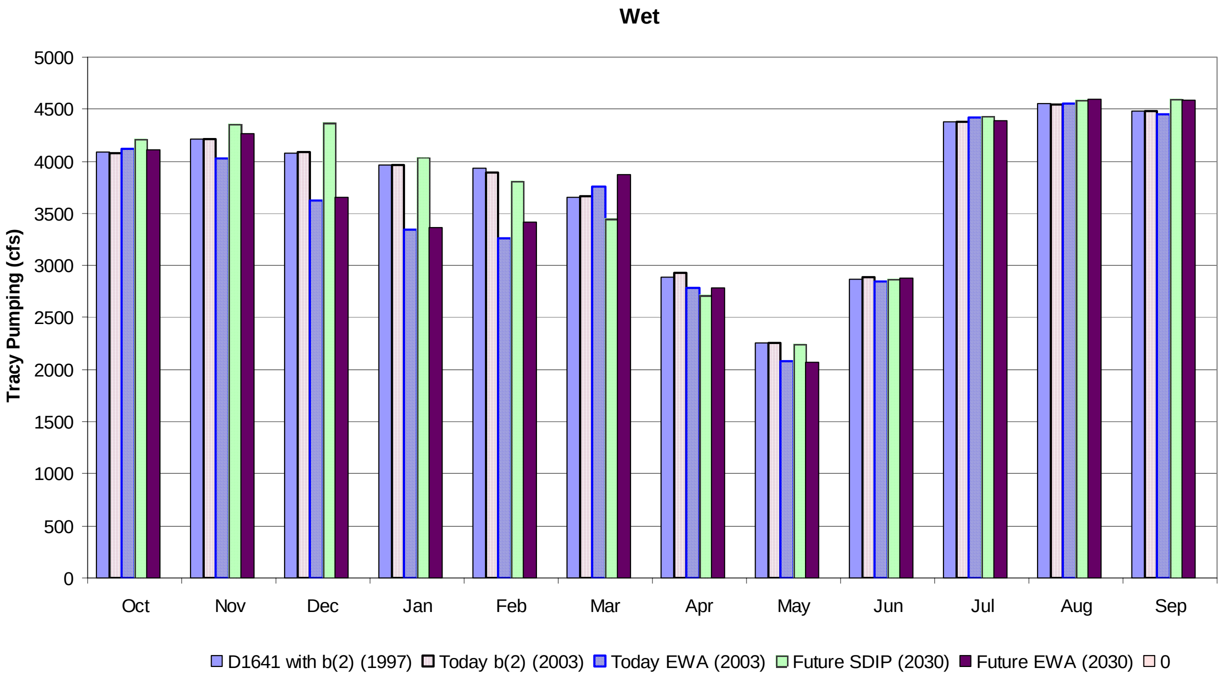


Figure 10-70 Average wet year (40-30-30 Classification) monthly Tracy Pumping

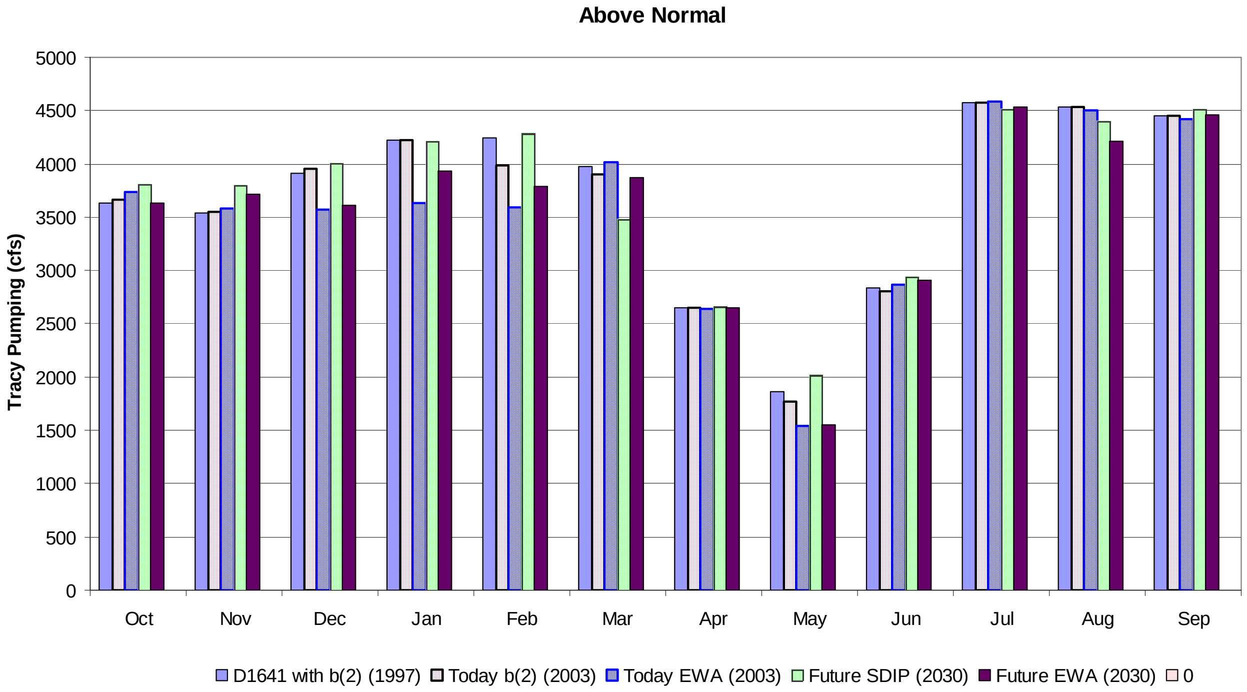


Figure 10-71 Average above normal year (40-30-30 Classification) monthly Tracy Pumping

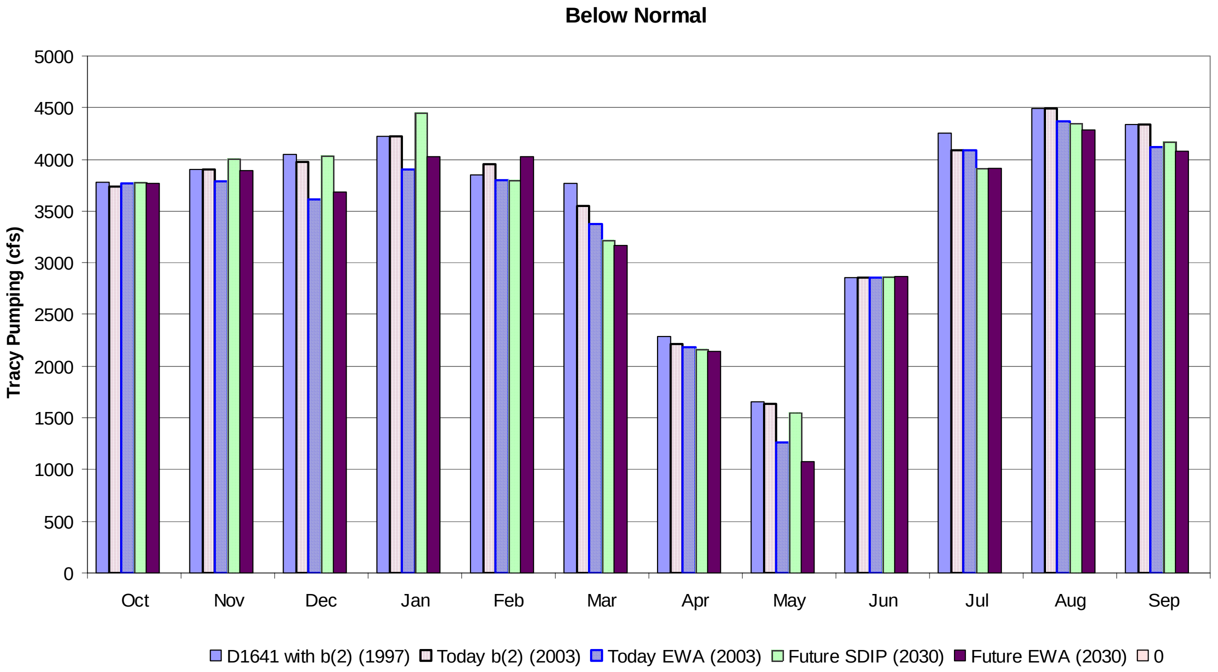


Figure 10-72 Average below normal year (40-30-30 Classification) monthly Tracy Pumping

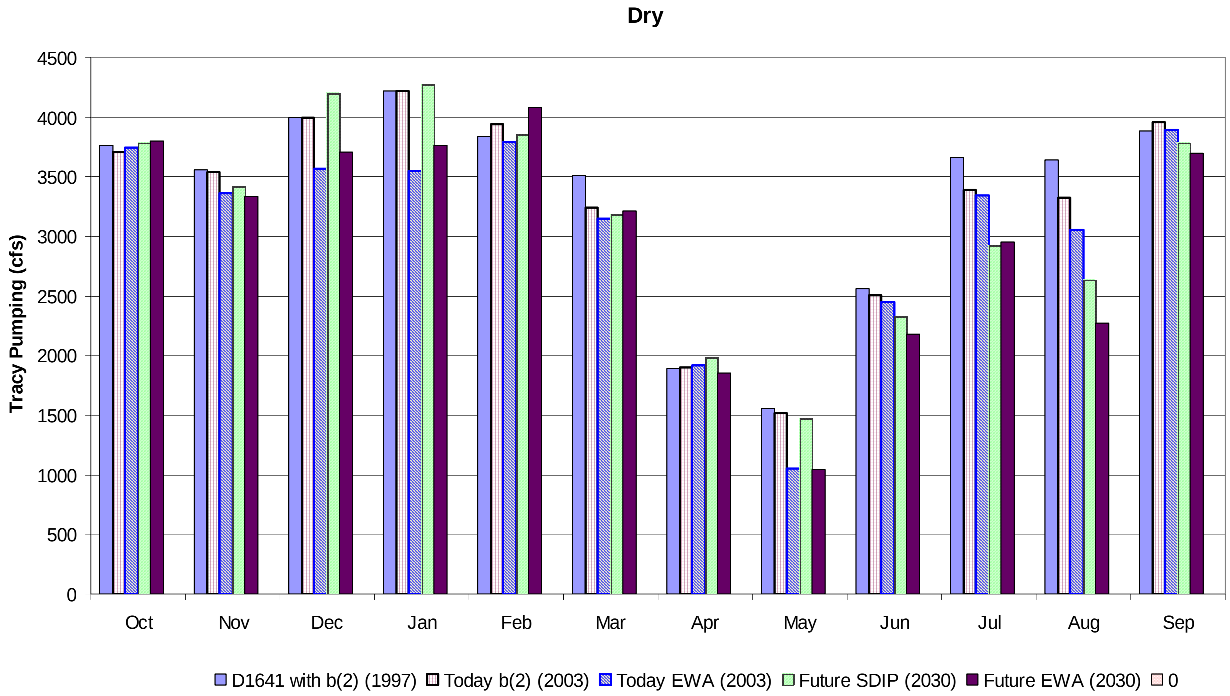


Figure 10-73 Average dry year (40-30-30 Classification) monthly Tracy Pumping

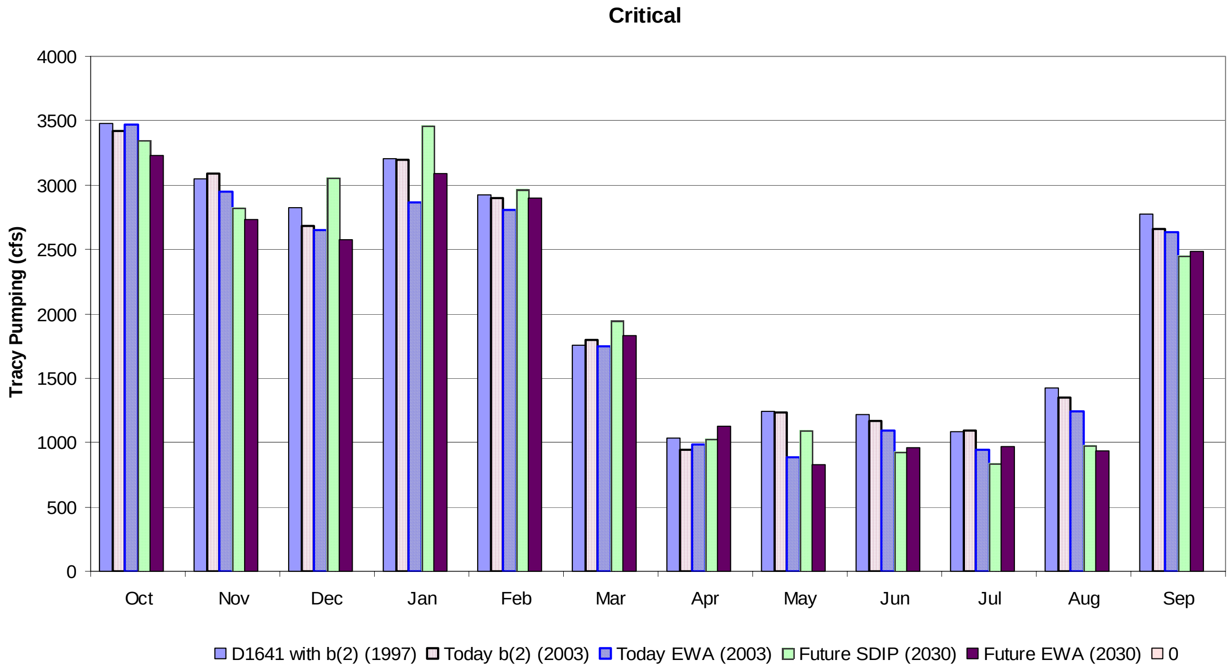


Figure 10-74 Average critical year (40-30-30 Classification) monthly Tracy Pumping

Banks Pumping

Figure 10-75 through Figure 10-81 represent simulated total Banks exports for the five studies. Figure 10-75 shows that export levels in Studies 3, 4 and 5 are greater export levels than Studies 1 and 2 which are the (b)(2) scenarios. The SDIP case shows higher pumping over almost all months even during the April-May period. The Today EWA and Future EWA export levels are higher most months except for April and May. The whisker plot (Figure 10-75) also shows that a 8500 export level is reached at least 5% of the time in the SDIP and the EWA future cases

While EWA and SDIP implementation in Studies 3 and 5 result in higher export levels in all months except for April and May, the percentage of the summer time increases vary as a function of year type (Figure 10-69 toFigure 10-74.).

In the driest years EWA related exports more than double the July, August, and September exports when compared to the (b)(2) cases modeled in Studies 1 and 2.

Most of the time EWA exports are increased primarily during the summertime to make up for reduced exports due to EWA export reductions in April and May. In all scenarios April and May EWA exports are lower than either of the (b)(2) cases.

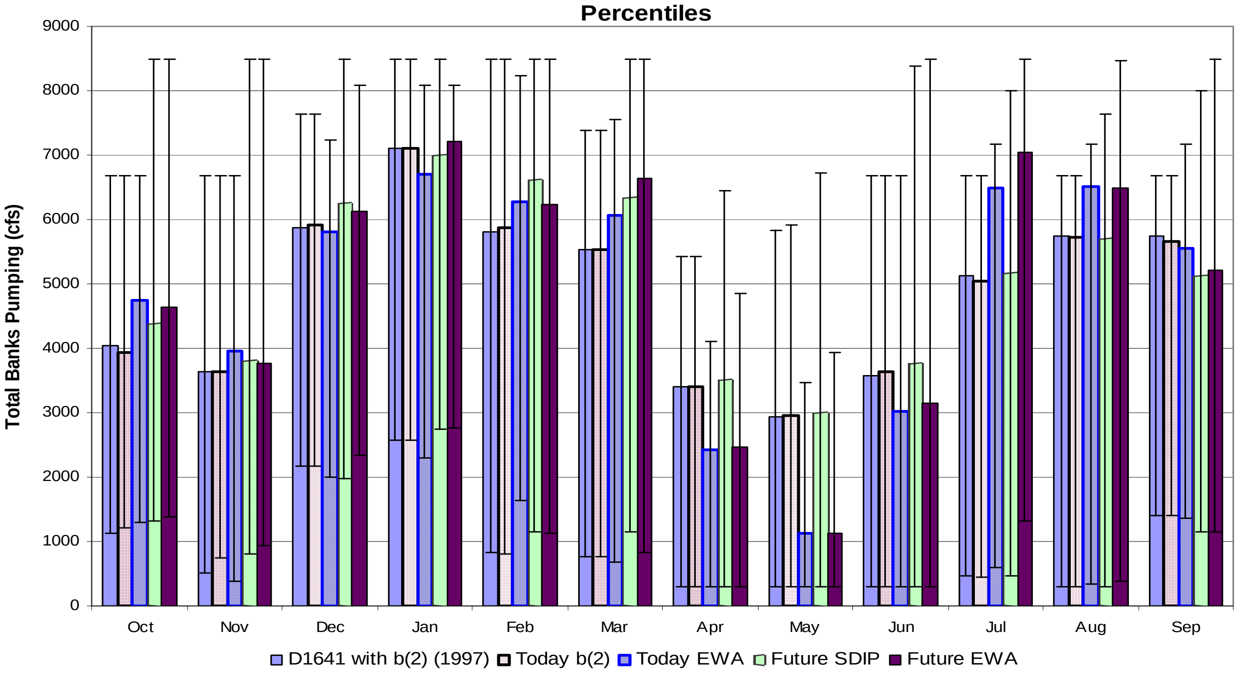


Figure 10-75 Banks Pumping 50th Percentile Monthly Releases with the 5th and 95th as the bars

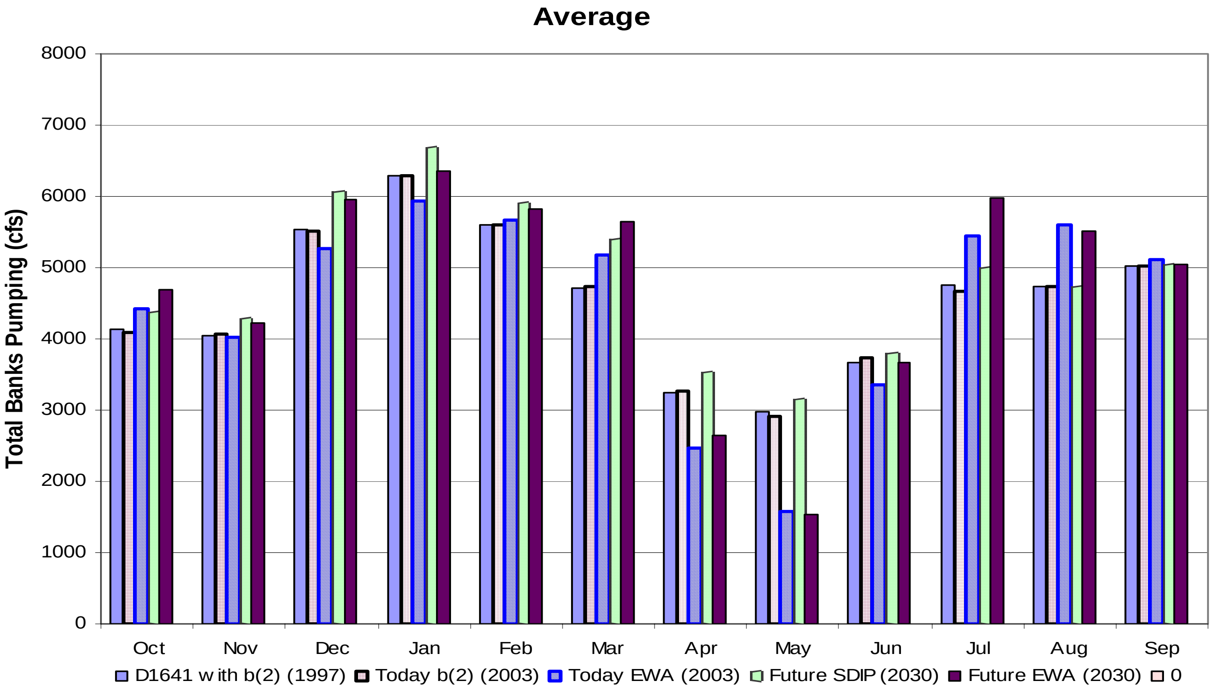


Figure 10-76 Average Monthly Banks Pumping

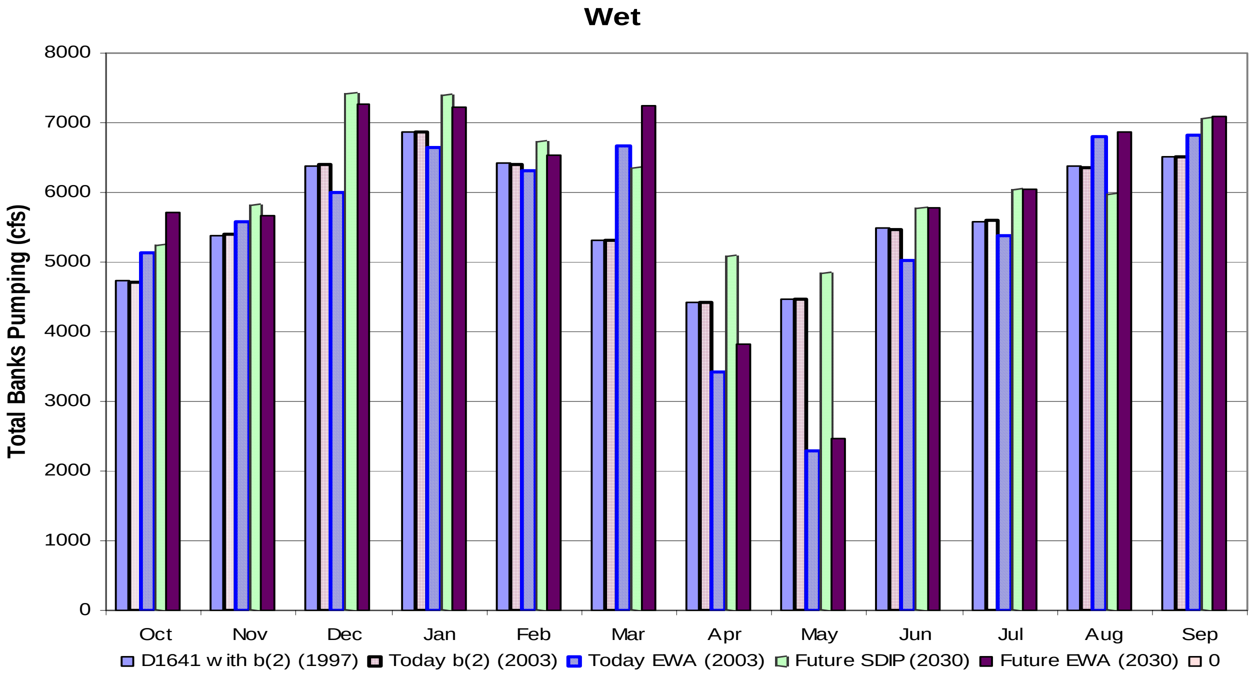


Figure 10-77 Average wet year (40-30-30 Classification) monthly Banks Pumping

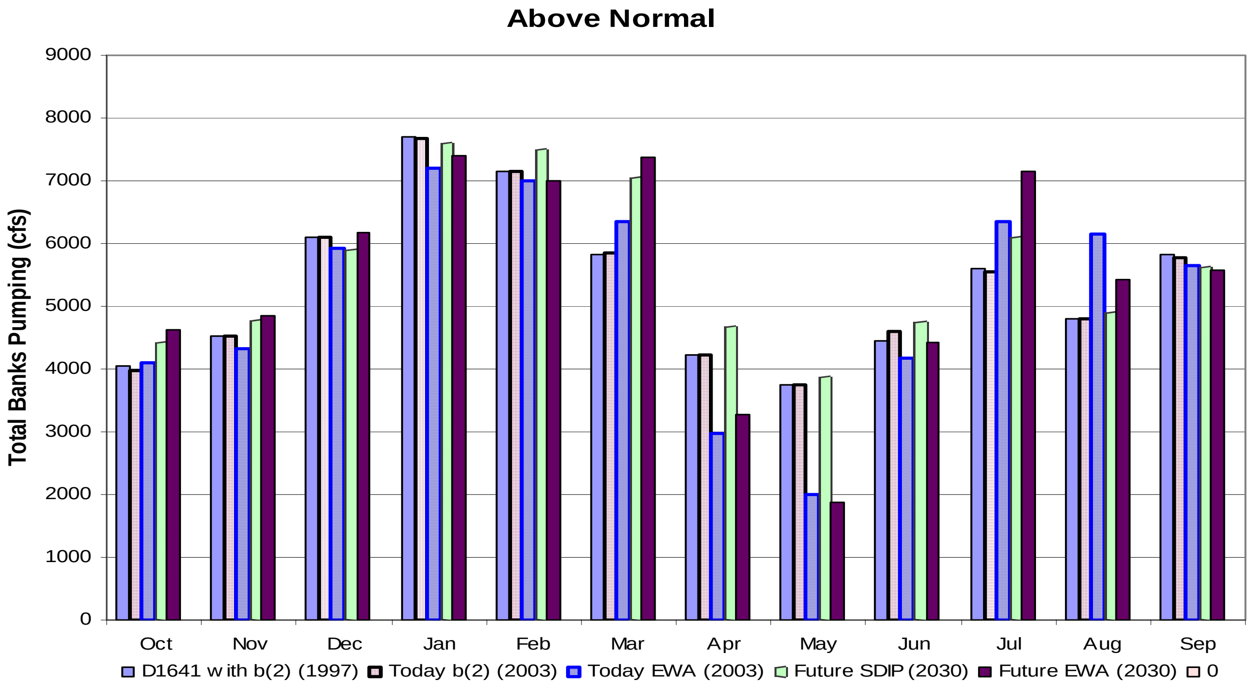


Figure 10-78 Average above normal year (40-30-30 Classification) monthly Banks Pumping

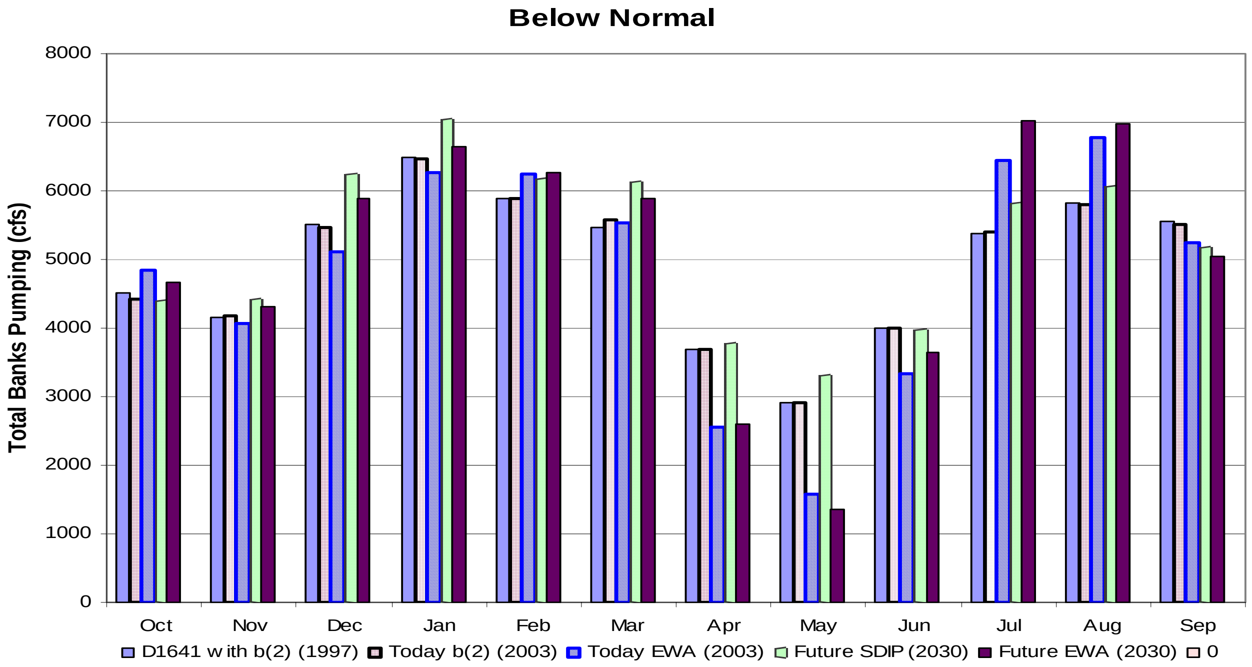


Figure 10-79 Average below normal year (40-30-30 Classification) monthly Banks Pumping

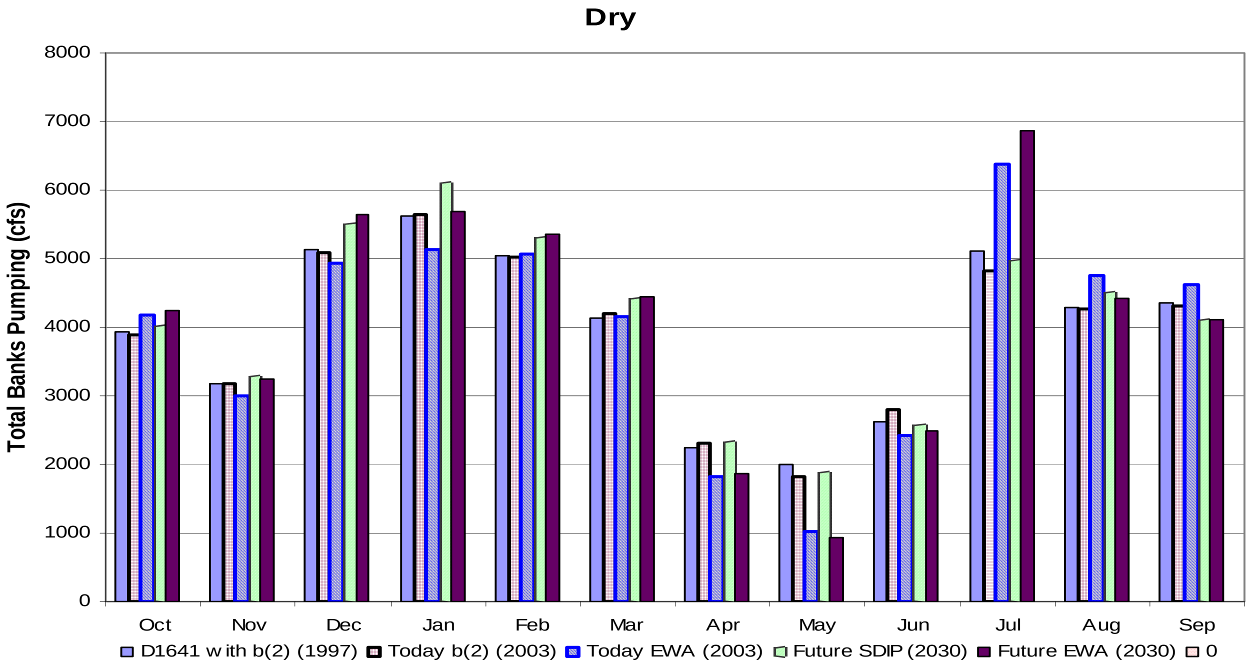


Figure 10-80 Average dry year (40-30-30 Classification) monthly Banks Pumping

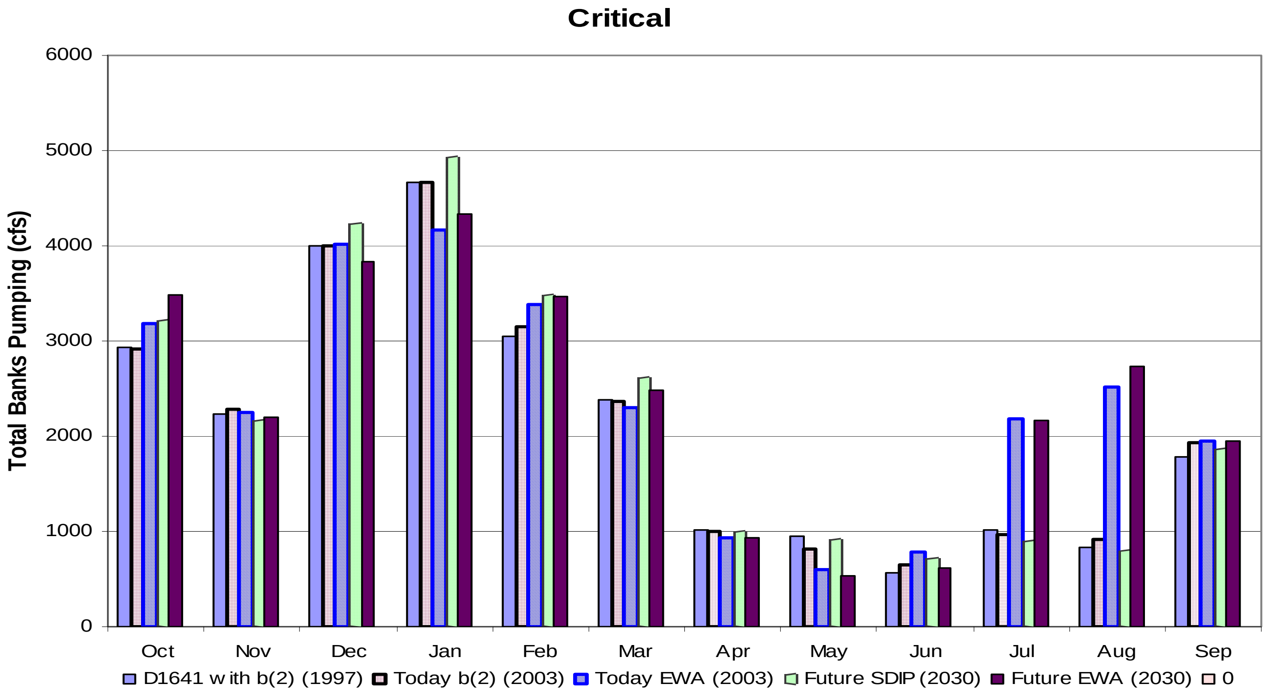
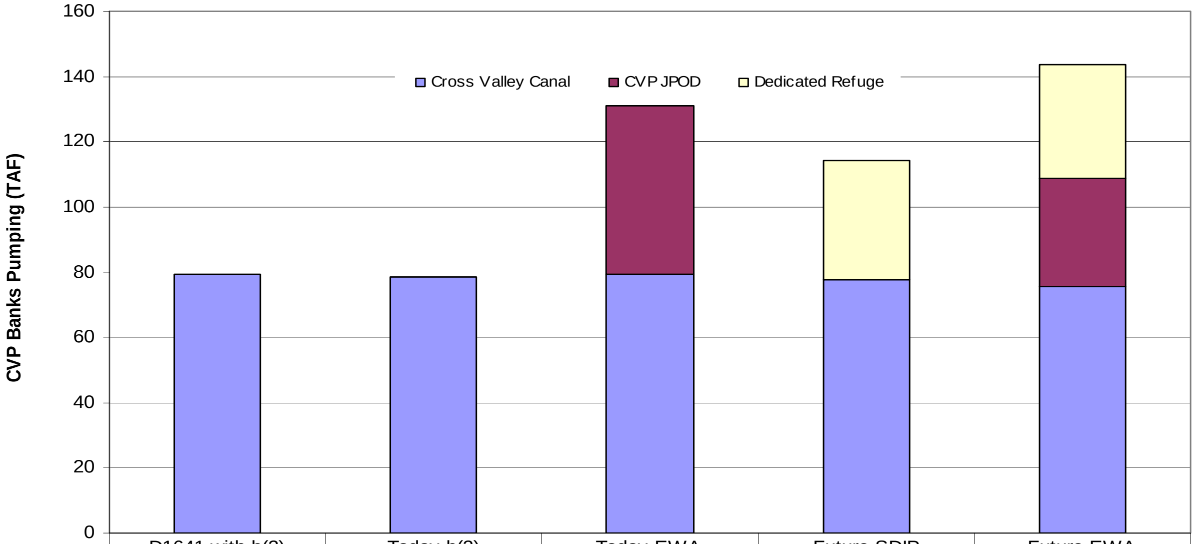


Figure 10-81 Average critical year (40-30-30 Classification) monthly Banks Pumping

Federal Banks Pumping

Federal pumping at Banks generally occurs in the late Summer months, see Figure 10-83. Some Federal pumping occurs during October through March for Cross Valley Contractors. Pumping is generally higher in Studies 4 and 5 due to increased pumping capacity from 6680 cfs to 8500 cfs and the dedicated 100,000 af/Yr. Wet years show the most pumping at Banks with pumping averages decreasing as the years get drier.

Figure 10-82 shows the annual average use of Banks pumping for the CVP by study. The average JPOD pumping in the Today EWA and Future EWA was 52 TAF and 33 TAF respectively. If the Future EWA JPOD includes the dedicated 100,000 af/yr the number is 68 TAF. Pumping for Cross Valley Canal (Tier 1 JPOD pumping) ranges from 75 TAF to 79 TAF between the studies.



	D1641 with b(2)	Today b(2)	Today EWA	Future SDIP	Future EWA
🟨 Dedicated Refuge	0	0	0	37	35
🟥 CVP JPOD	0	0	52	0	33
🟪 Cross Valley Canal	79	78	79	78	75

Figure 10-82 Average use of Banks pumping for the CVP

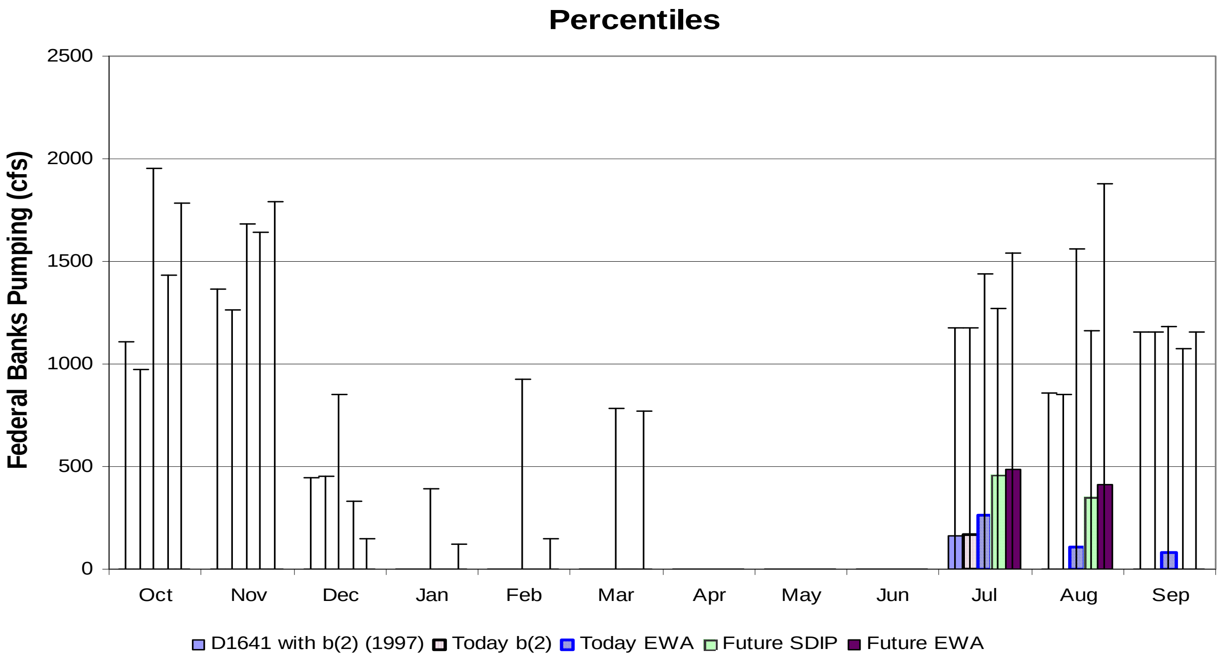


Figure 10-83 Federal Banks Pumping 50th Percentile Monthly Releases with the 5th and 95th as the bars

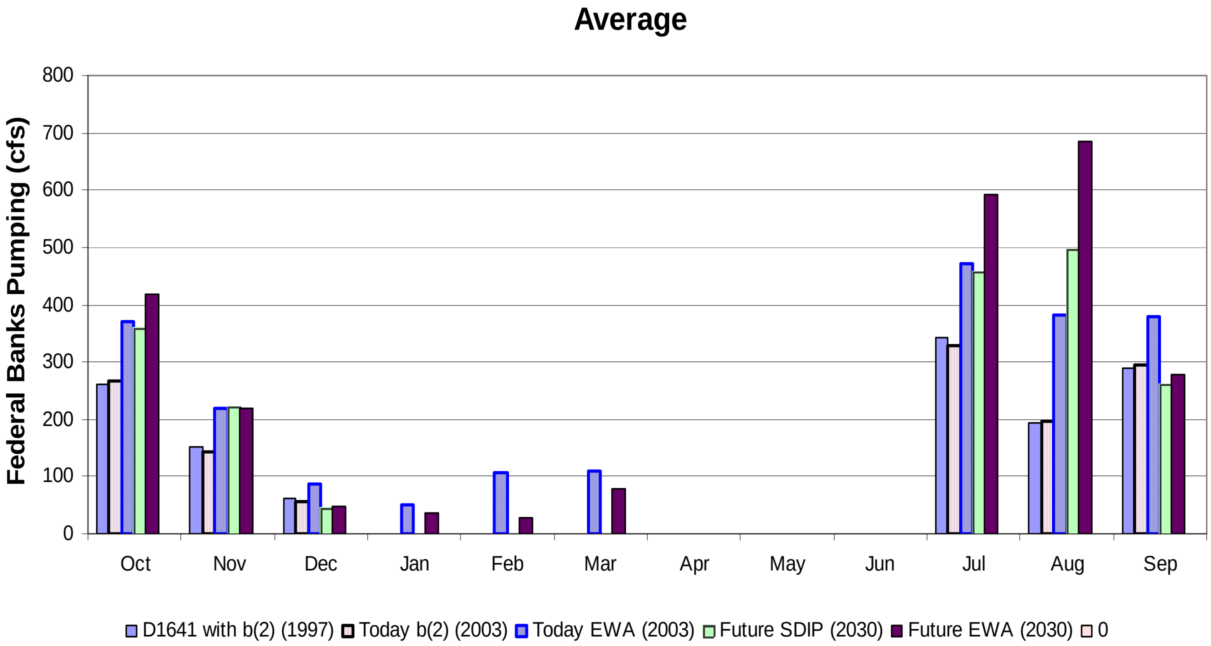


Figure 10-84 Average Monthly Federal Banks Pumping

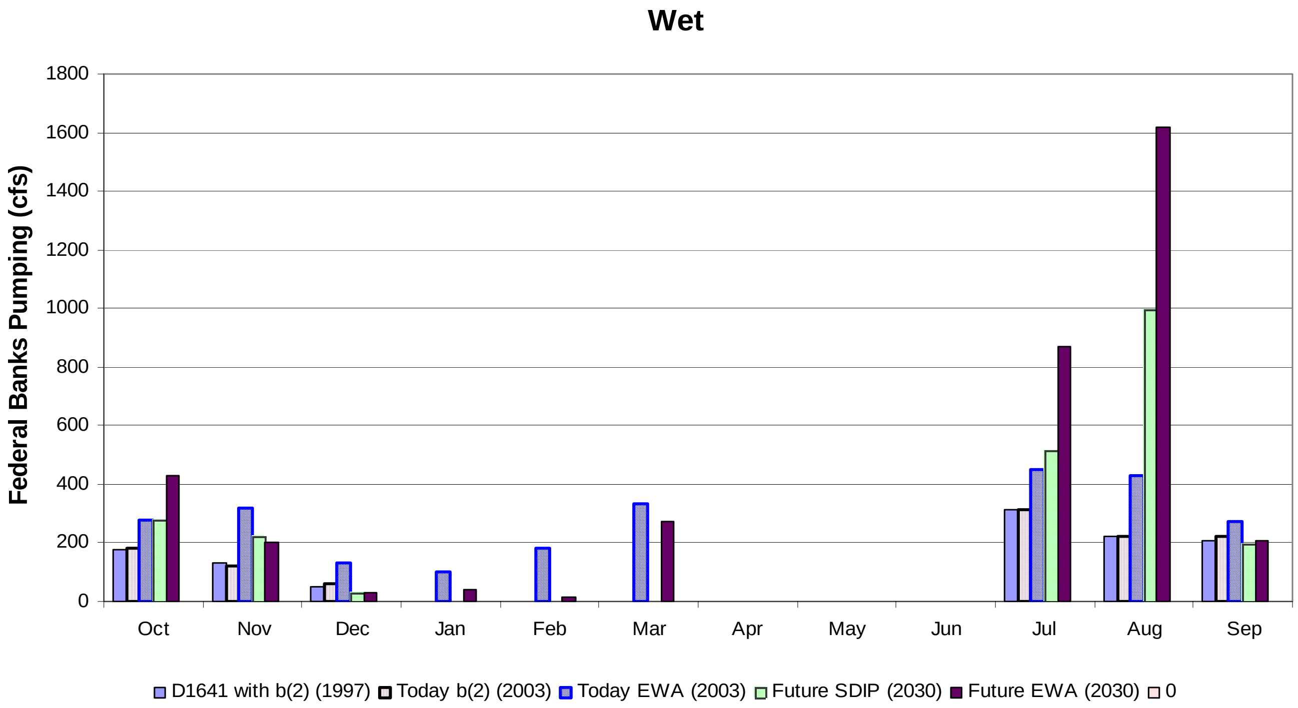


Figure 10-85 Average wet year (40-30-30 Classification) monthly Federal Banks Pumping

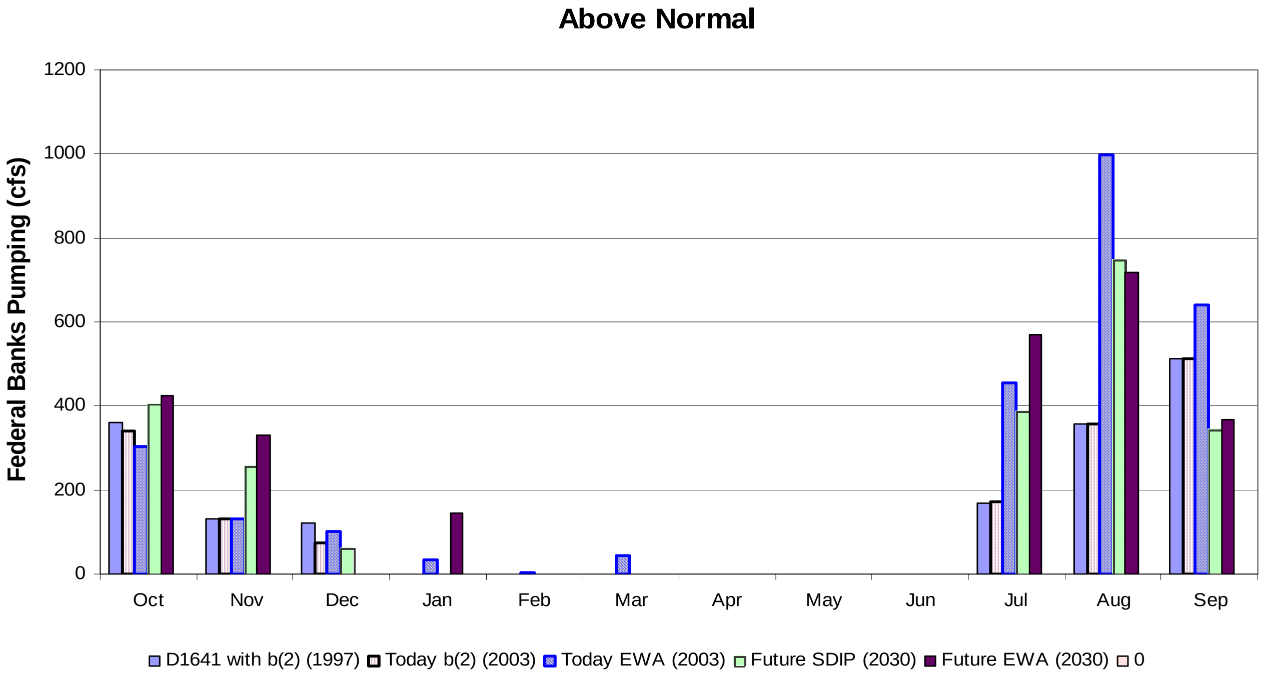


Figure 10-86 Average above normal year (40-30-30 Classification) monthly Federal Banks Pumping

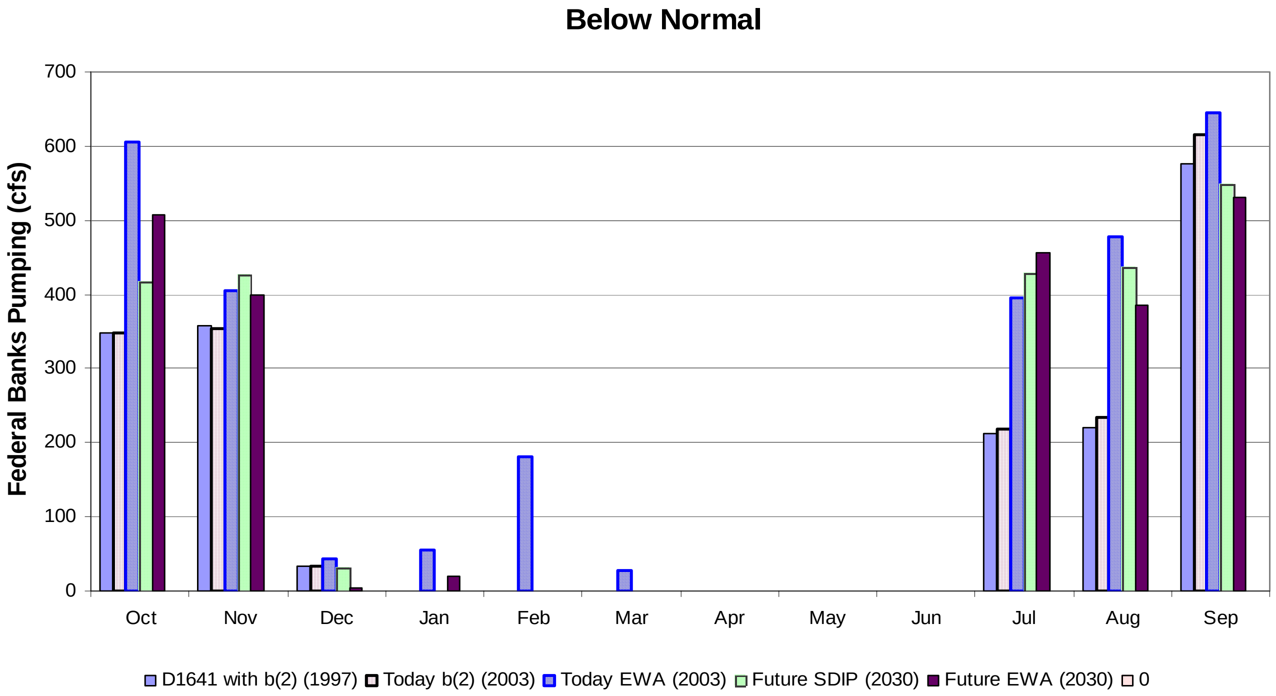


Figure 10-87 Average below normal year (40-30-30 Classification) monthly Federal Banks Pumping

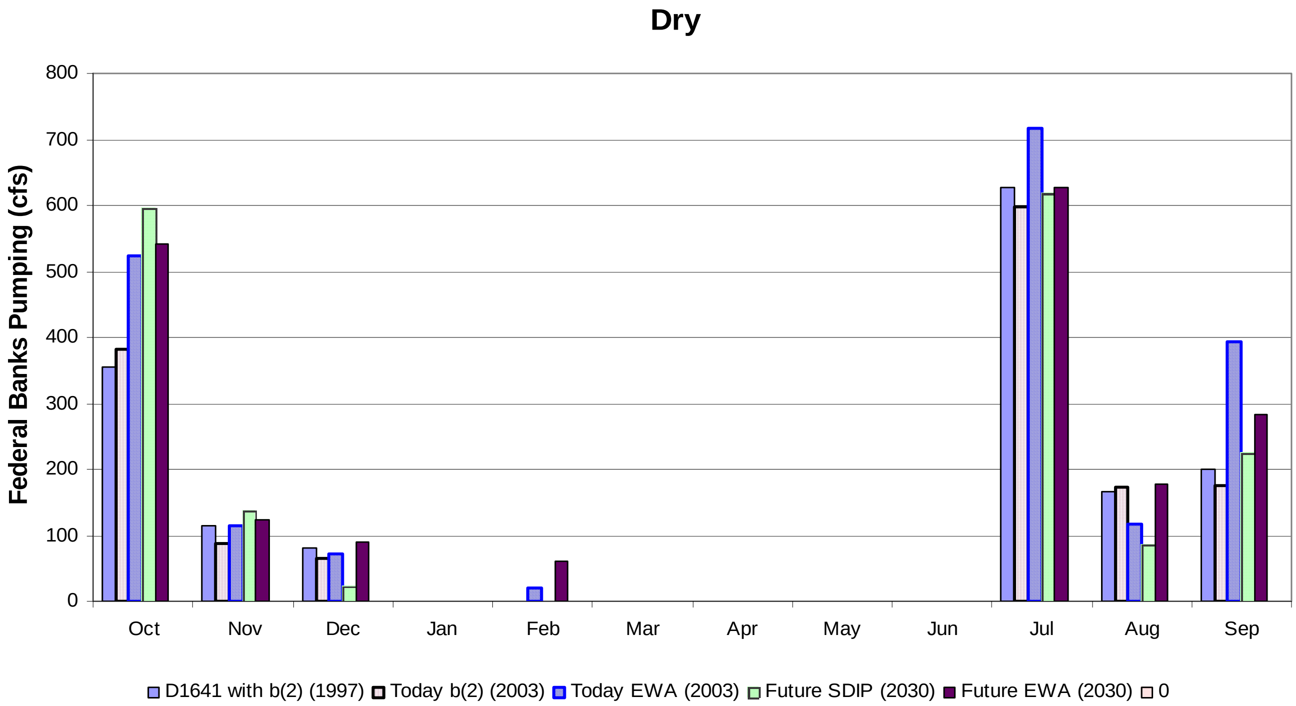


Figure 10-88 Average dry year (40-30-30 Classification) monthly Federal Banks Pumping

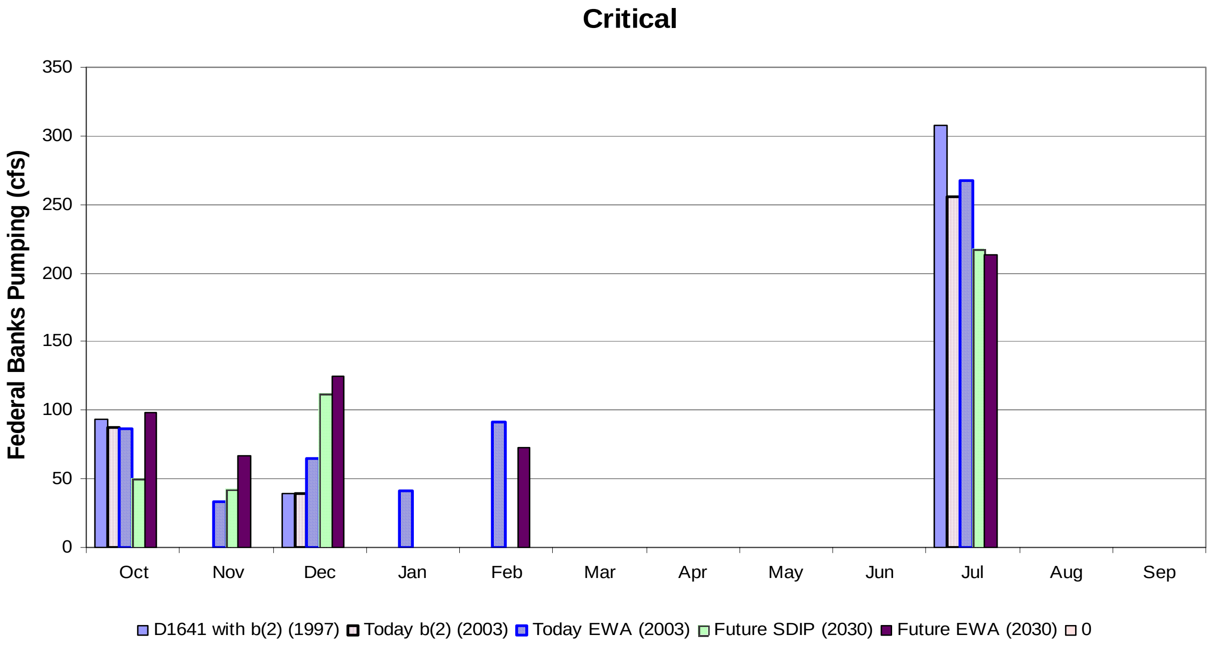


Figure 10-89 Average critical year (40-30-30 Classification) monthly Federal Banks Pumping

Contra Costa Water District and North Bay Aqueduct Diversions

Diversions from Contra Costa Water District and North Bay Aqueduct increased from the 2001 LOD to the 2020 LOD seeTable 10-17. Monthly average diversions at North Bay Aqueduct increased 20 cfs on a long-term average basis for the 72 years of simulation and 15 cfs on average during the 1928 to 1934 drought period. CCWD diversions increased by 47 cfs long-term and 40 cfs during the 1928 to 1934 drought, see Table 8-5 and Figure 10-90 to Figure 10-91. Most of the diversions occur during the late summer months and extend into October for the North Bay Aqueduct. CCWD's pattern peaks in June decreases during the summer and then stays around 200 cfs during the winter period.

Table 10-17 Average Anuual and Long-term Drought Differences in North Bay Aqueduct and CCWD Diversions

Differences (TAF)	Study 2 - Study 1	Study 3 - Study 1	Study 5 - Study 1	Study 4 - Study 2	Study 5 - Study 3
North Bay Aqueduct Long-term Average	0	0	14	14	14
North Bay Aqueduct 28-34 Anuual Average	0	0	11	11	11
CCWD Long-term Average	0	0	34	34	34
CCWD 28-34 Anuual Average	0	0	29	29	29

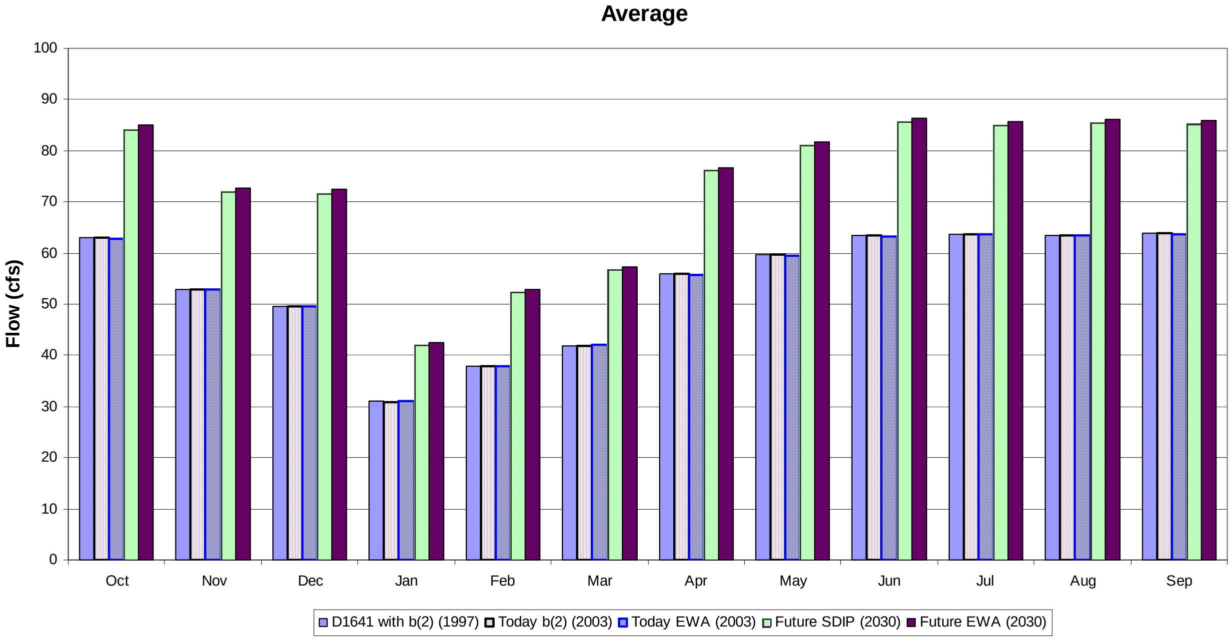


Figure 10-90 Average Monthly North Bay Aqueduct Diversions from the Delta

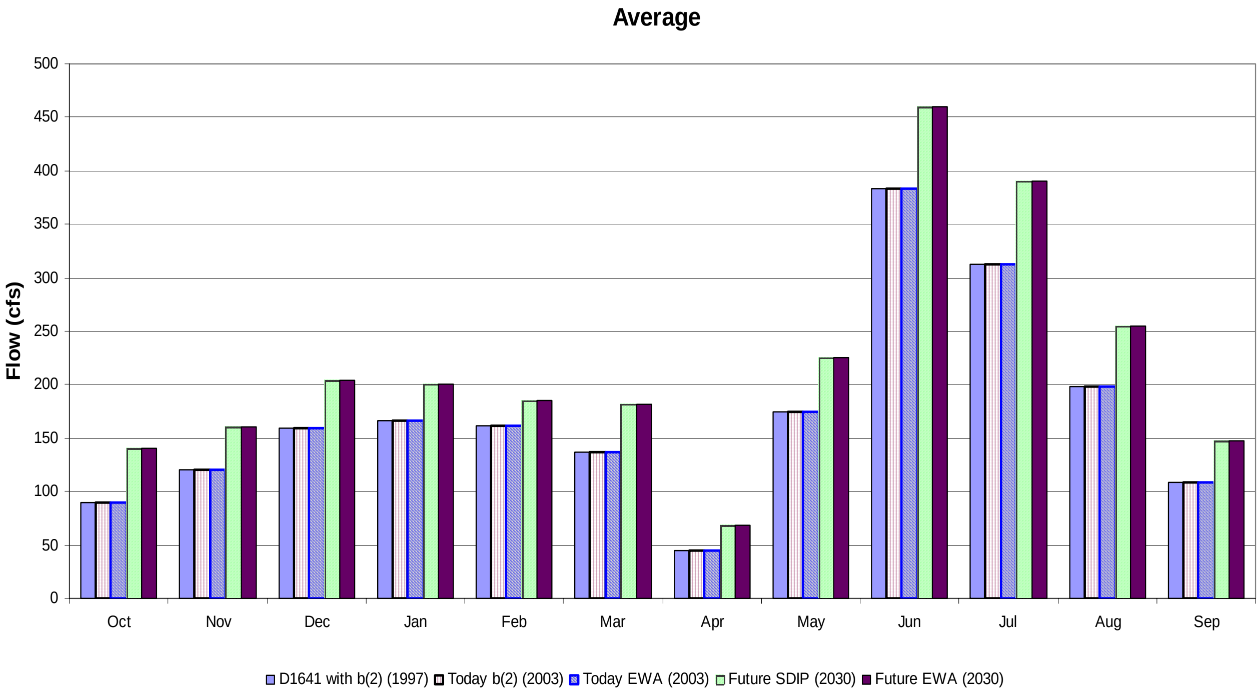


Figure 10-91 Average Monthly Contra Costa Water District Diversions from the Delta

Chapter 11 Summary of Effects Analysis and Effects Determination

Proposed Actions

Trinity Effects

Upsteam effects of Trinity are summarized in Chapter 9. Trinity information begins on page 9-1 to 9-11. Clear Creek information begins on page 9-12 to 9-19 and Sacramento information begins on page 9-20 to 9-41. In the FWS October 12, 2000 B.O. for Trinity there is a RPM about maintaining X2 in the February through June 30 at no more than 0.5 km from the base condition. When we had finished the modeling we looked at the months when X2 was 0.5 km from the base condition. FWS went through the years and we had CH2M Hill do the maps of the delta like they did for the Trinity analyses. An analyses of X2 was also done, see Chapter 10.

American River Effects and Freeport Project

Summarized modeling on page 9-55 to page 9-72. There is a summary of deliveries on the American River in Table 9-12. Figures 9-56 and 9-57 summarized the Freeport project deliveries. Mokelumne summary information is found on page 9-73 .

Intertie Effects

Summarized in Chapter 10 under Tracy Exports, see page 10-37 to page 10-40. Intertie is added in the future model runs to bring Tracy to the full capacity of 4600 cfs.

Delta Effects

Inflow is found on page 10-43 to page 10-50. Outflow is found on page 10-50 to page 10-58. With changes in the upstream system both in the Trinity and American upstream systems there are changes to the delta inflow and outflow. E/I Ratio is found on page 10-58 to page 10-67.

X2 Changes found on page 10-68 to 10-75. As discussed above in the Trinity there was a more extensive look at X2. A comparison between study 1 and both study 4 and study 5 was used. Then differences of 0.5 km or more were made into maps by a GIS person at CH2M Hill. A review of the data reduced the list of concern timeframes.

North Bay Aqueduct see figure 10-90 and Rock Slough, Old River Diversions see figure 10-91. Discussion of the NBA and CCWD diversions is found on page 10-91 to page 10-92.

JPOD also called Federal Banks pumping, see page 10-45 to 10-49. Although we don’t show it in the modeling there is also JPOD for the state to pump at Tracy.

Water Transfers Effects

See summary in Chapter 10 at the end.

Early consultation Items

Banks at 8500 cfs is in the future study, summary information on pages 10-83 to 10-86. The CALSIM modeling doesn't include the permanent barriers.

There is an assumption of EWA in the future, this may not be the long-term EWA.

Project Integration is also part of the early consultation. The only items explicitly modeled are the 100,000 acre-feet of CVP pumping at Banks for refuges and up to 75,000 acre-feet of CVP releases made for the SWP delta water quality.

Summary of Effects Analysis

We evaluated potential effects of CVP and SWP operations into the future by examining modeled river flows and temperatures with respect to life history stage, timing of occurrence, and temperature requirements of Central Valley steelhead, Central Valley Chinook salmon, Trinity River coho salmon, and delta smelt . Operations of diversions and facilities affecting migrations were included in the analysis.

Central Valley Steelhead

Upper Sacramento River

Keswick Reservoir releases are expected to provide suitable flows for adult steelhead passage and spawning. The minimum release of 3,250 cfs will sustain the population through dry years. Red Bluff Diversion Dam operations allow most steelhead to pass unimpeded. Operations agreements already in place will help to ameliorate effects due to flood control releases should they occur. Water temperatures provided through operation of the Shasta temperature control device in the upper Sacramento River will be appropriate for all steelhead life history stages present in the upper river year-round. We project that steelhead populations in the upper Sacramento River will be maintained through continued operation of the project. The steelhead life history includes anadromous and resident forms of the species (O. mykiss) allowing populations to persist during periods of poor ocean conditions and periods of low freshwater in streams. The nature of straying allows steelhead to repopulate areas of local disturbance, although no such disturbances requiring straying to repopulate areas are likely to occur due to project operations.

Clear Creek

Whiskeytown Reservoir releases will provide adequate flows for passage and spawning in most years. During some years additional CVPIA (b)(2) water may be needed for better attraction and upstream migration conditions for steelhead. Water temperatures should generally be adequate for all steelhead and Chinook life stages throughout the year in the upper river where Whiskeytown releases have the most effect on water temperature. Whiskeytown project releases will not result in scour of redds. Some minor stranding of juveniles could potentially occur, similar to that which occurs in unregulated rivers. We project that steelhead populations in Clear Creek will be maintained through continued operation of the project. The steelhead life history includes anadromous and resident forms of the species (O. mykiss) allowing populations to persist both during periods of poor ocean conditions and periods of low freshwater in streams.

The nature of straying allows steelhead to repopulate areas of local disturbance, although no such disturbances requiring straying to repopulate areas are likely to occur due to project operations.

Feather River

Flow, habitat, and water temperature conditions should be generally suitable for all steelhead life history stages all year in the low flow channel. The reach below the Thermalito outlet will be less suitable. Water temperatures generally begin exceeding the spawning and emergence recommendations during March. However, this is the latter part of the spawning/emergence season in the Feather River. Summer temperatures will generally exceed 65° F below the Thermalito outlet by June, and will remain too warm for steelhead rearing throughout the summer months. We project that steelhead populations in the Feather River will be maintained through continued operation of the project. The steelhead life history includes anadromous and resident forms of the species (O. mykiss) allowing populations to persist both during periods of poor ocean conditions and periods of low freshwater in streams. The nature of straying allows steelhead to repopulate areas of local disturbance, although no such disturbances requiring straying to repopulate areas are likely to occur due to project operations.

American River

Nimbus Reservoir releases are expected to provide suitable flows for adult steelhead passage and spawning. Operations agreements already in place should ameliorate effects due to flood control releases should they occur. Water temperatures should be generally appropriate for steelhead spawning and emergence from December through March. However, temperatures may be marginal for spawning and emergence during March through May of some years. May through mid-October water temperatures will be marginal for steelhead rearing at times and will be higher in the future. The survival of some juveniles through summer under similar conditions during previous years indicates the conditions are tolerable for some fish. Water temperatures should be appropriate for yearling emigration between December and March. Temperatures will be higher in June through November under the future operations scenarios. The steelhead run in the American will likely continue to be supported primarily by the hatchery with limited successful in-river smolt production in dry water years.

Stanislaus River

No changes in Stanislaus River operations are proposed. Conditions for steelhead in the Stanislaus River should generally be favorable for completion of the life cycle. Goodwin Dam releases will provide suitable flows for adult steelhead passage and spawning. Water temperatures are suitable for adult migration and spawning and juvenile rearing. Water temperatures between Goodwin Dam and Orange Blossom Bridge should be suitable for all steelhead life history stages present most of the year. Temperatures at and below Oakdale may exceed the preferred range for rearing at times during the summer months, but the presence of a large resident trout population in the river indicates suitable in-river conditions. This resident population will be maintained and provide a source of the anadromous form of the species for when San Joaquin migratory conditions are poor at times. The steelhead life history includes anadromous and resident forms of the species (O. mykiss) allowing populations to persist both during periods of poor ocean conditions and periods of low freshwater in streams. The nature of straying allows steelhead to repopulate areas of local disturbance, although no such disturbances requiring straying to repopulate areas are likely to occur due to project operations.

Mokelumne River

Under current operations, conditions for steelhead in the Mokelumne River will be unchanged. Under future operations the Freeport diversion project will be implemented. Twenty percent (up to 20,000 acre-feet) of the amount of water diverted at Freeport will be made available for Camanche Reservoir releases to the Mokelumne on a schedule determined by CDFG and USFWS. Based on this information conditions for steelhead in the river upstream of Woodbridge Dam should improve in the future. Delta inflow from the Mokelumne will increase slightly in the future so that, although still low, conditions will be slightly improved if the water from Freeport that is released into the Mokelumne River is released at a time and is of adequate quality to benefit steelhead.

Sacramento-San Joaquin Delta

Previous plans in place to protect spring- and winter–run Chinook salmon and delta smelt have helped reduce steelhead salvage, and help to minimize CVP and SWP Delta effects on steelhead. The DAT team will continue to monitor conditions in the Delta so that actions can be taken when higher numbers of steelhead are more vulnerable to being taken at the pumps. Projected operation of other Delta facilities (for example, the North Bay Aquaduct, the Delta Cross Channel, Rock Slough Diversion, and the Suisun Marsh Salinity Control Gates) are not expected to substantially impact steelhead. Steelhead take at these facilities has historically been low relative to the Central Valley Steelhead population as a whole.

Steelhead Summary

CVP and SWP operations result in take of some steelhead. The magnitude and effects on population trends are unknown but the effects on the Central Valley steelhead population should be small relative to the population as a whole. Steelhead population trends in the Central Valley are largely unknown in comparison with Chinook salmon because of the greater difficulty and lower effort occurring to monitor steelhead populations, thus hampering the ability to evaluate effects. Effects of water operations on steelhead populations will be greater during dry years when cold water supplies are not high enough to maintain suitable rearing conditions throughout the habitat generally used by steelhead. Wild steelhead are consistently captured in smolt outmigration monitoring programs and observed in snorkel surveys. This information along with increased efforts to enhance conditions for wild steelhead since they were listed in 1998 suggests that protections and enhancements in freshwater habitats and the Delta are sufficient to maintain populations of Central Valley Steelhead at a level similar to the current population. The steelhead life history includes anadromous and resident forms of the species (O. mykiss) allowing populations to persist both during periods of poor ocean conditions and periods of low freshwater in streams. The nature of straying allows steelhead to repopulate areas of local disturbance, although no such disturbances requiring straying to repopulate areas are likely to occur due to project operations.

Central Valley Winter–run, Spring–run (and Fall/late fall–run for EFH) Chinook Salmon

Upper Sacramento River

Keswick Reservoir releases are expected to provide suitable flows for adult Chinook salmon passage and spawning. The minimum release of 3,250 cfs can sustain the population through dry years if suitable temperatures are maintained in the upper river. Operations agreements already in place will ameliorate effects due to flood control releases when they occur. Water temperatures will be appropriate for most Chinook salmon life history stages year-round during most years in the upper river, but during dry years temperatures during late summer and fall will be above preferred ranges for spawning and rearing so will likely result in lower production than during wet years. Temperatures will increase in the future because less water will be available from the Trinity River. Winter–run spawning has shifted upstream with passage enhancements so that although water temperature will be higher, upper river temperatures will maintain incubation conditions for 98% of winter–run spawning. The few spring–run that spawn in the Sacramento River spawn further downstream than winter–run so effects will be greater on them. During critically dry years most spring–run eggs could suffer mortality due to high water temperature during incubation. A small proportion of the Central Valley spring-run population spawns in the Sacramento River so overall population effects of low spring run production in the mainstem river will be minor. The entire winter-run population spawns in the upper Sacramento River.

Clear Creek

Whiskeytown Reservoir releases should provide adequate flows for passage and spawning most years. During some years additional CVPIA (b)(2) water may be needed for better attraction and upstream migration conditions for spring–run and fall–run. Summer water temperatures are expected to be suitable for adult holding in the upper river. Water temperatures will be suitable for most life history stages above Igo, but spawning and rearing temperatures near the mouth of the creek will be slightly above the preferred range during the summer. A very small proportion of the Central Valley spring-run population enters Clear Creek so overall population level effects of low spring run production in the Clear Creek will be minor.

American River

No listed Chinook runs spawn in the American River. Flows are projected to be adequate for fall–run Chinook spawning in normal water conditions but if dry conditions occur, flows are projected to provide less than optimal spawning habitat for Chinook. Flows in the spring should be adequate for outmigration. Temperature goals for fall–run Chinook spawning and incubation are projected to be met in November of almost every year but meeting the goals will likely involve trade-offs between providing cool water for better steelhead rearing conditions during the summer and providing it for Chinook spawning in the fall. Water temperatures for Chinook rearing are forecast to exceed the preferred range generally starting in April. Most Chinook leave the river by early April. Temperatures will be higher in June through November under future operations due to increased upstream diversions, causing more temperature stress on migrating and holding adults in the fall.

Stanislaus River

No listed Chinook runs spawn in the Stanislaus River. Flows are projected to be adequate for fall–run Chinook spawning in nearly all years. Water temperatures will be warm in the lower part of the river during the early part of the immigration period but should be suitable for spawning and rearing in the upper river during the entire spawning and rearing period. Temperatures should be suitable for outmigration of fry and smolts, but when dry conditions occur, flows can be less than desired for optimal outmigration prior to the VAMP period. No changes in operations are proposed for the Stanislaus River.

Feather River

Flow and water temperature conditions should be generally suitable for all spring–run Chinook salmon life history stages all year in the low flow channel, particularly in the upper low flow channel. However, superimposition on spring–run Chinook salmon redds by fall–run Chinook may continue to be a problem. The reach below the Thermalito outlet will be less suitable. Water temperatures below Thermalito will be too warm for adult holding and spawning, but will be appropriate for juvenile rearing and emigration during winter and early spring.

Sacramento-San Joaquin Delta

Increases in loss due to export changes are less than 10% in all year types except for during wet years at Banks without EWA when spring run sized loss increases by an average of 14.6% and steelhead loss increases by 10.2% (mostly March through May). Loss is generally less with EWA than without EWA. Actions taken in the past to protect winter–run and spring–run Chinook and delta smelt provide protection during the winter and spring, thereby reducing the impact of CVP and SWP Delta operations. Emigrating yearling Chinook salmon will receive protection from actions triggered through the Salmon Protection Decision Process during the emigration period. The DAT team will continue to keep an eye on fish monitoring data throughout the system so that operational adjustments can be made during times of high salvage.

Winter-run and spring-run Chinook Summary

Chinook losses due to CVP and SWP operations may be substantial. However, the cohort replacement rate methodology discussed in Chapter 4 indicates Chinook salmon populations are generally increasing. The CRR data from the Sacramento River, Deer, Mill and Butte creeks suggest existing protections and enhancements in the upper watershed and the Delta are sufficient to maintain populations of Central Valley winter–run, Central Valley spring–run and fall/late fall–run Chinook salmon during the continued operations of the CVP and SWP considered in this consultation. The spring run population utilizes primarily non-project tributaries for spawning and rearing and uses the Sacramento River and Delta as a migratory corridor. Migratory conditions will be adequate to maintain the spring run and winter-run populations.

Southern Oregon/Northern California Coasts Coho Salmon

The southern Oregon/northern California coasts coho salmon occurs in the Trinity River. Under todays operations Reclamation is proposing no changes in Trinity River flows. These flows will provide habitat and temperature conditions similar to the recent past and should not negatively affect the existing coho population. Under future operations Reclamation would implement higher flows for the Trinity River Restoration Program in the Trinity River during wet years. The net effect of future CVP operations on coho salmon in the Trinity River should be a benefit to the population through the habitat values provided as outlined in the Trinity River Restoration Program.

Delta Smelt

We have considered (1) changes in expected direct entrainment loss at the CVP and SWP export facilities, (2) changes in X2, and (3) changes in the Export-Inflow ratio (E/I).

(1) Potential changes in entrainment are important indices of the effects of facility operations because entrainment directly reduces the pool of delta smelt available to replenish the population. Under the future scenarios considered we expect increases in the entrainment of unspent adults at the SWP and CVP export facilities in some months. Whether these entrainment increases will cause subsequent year classes to be smaller in size is unclear. We conclude that increased entrainment of unspent adult delta smelt at the export pumps may sometimes adversely affect the species. There is a net decrease in entrainment of juvenile delta smelt under the future scenarios considered. We conclude that changes in entrainment of juvenile delta smelt at the export pumps presents no threat to the species.

(2) Changes in X2 may not in themselves increase mortality, but may modify the proportion of the delta smelt population at risk of becoming entrained into the export facilities. Changes in X2 in drier years, when X2 is farther upstream to begin with, are sufficiently small and uncommon that we do not expect them to adversely affect delta smelt in most years. However, in a few years the movements of X2 during critical months may adversely affect the delta smelt population.

(3) The export-inflow ratio can index the extent to which export operations influence the pattern of flow through the delta, and may be useful where comparisons can be made at constant inflow. The index does not, however, tell us which areas of the delta are influenced by the pumps, nor is it reliable when comparisons cannot be made at constant inflow. Differences in E/I between the base model case and both future scenarios are sufficiently small that we do not expect them to adversely affect delta smelt.

Summary of Beneficial Effects

CVPIA (b)(2) and EWA, VAMP. Adaptive Management. See Chapter 13 for more.

Cumulative Effects

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area of this biological assessment. Future Federal actions that are unrelated to the proposed action are not included because they require separate ESA consultation.

Non-Federal actions that may affect the action area include State angling regulation changes, commercial fishing management changes, voluntary State or private habitat restoration, State hatchery practices, agricultural practices, water withdrawals/diversions, increased population growth, mining activities, and urbanization. State angling regulations are generally moving towards greater restrictions on sport fishing to protect listed fish species. Commercial fishing regulations are designed to target the abundant fall–run Chinook and avoid fishing during times and in areas where listed species are more likely to be caught. Habitat restoration projects may have short term negative effects associated with construction but the outcome is generally a benefit to listed species. State hatchery practices may have negative effects on naturally produced salmon and steelhead through genetic introgression, competition, and disease transmission from hatchery introductions. Farming activities may have negative effects on Sacramento and San Joaquin water quality due to runoff laden with agricultural chemicals. Water diversions may result in entrainment into diversions and may result in reduced flows necessary for migration, spawning, rearing, and habitat maintenance. The increased temperatures in the American River in the future are primarily the result of an increase in upstream diversions lowering the coldwater pool in Folsom. Urban development and mining may adversely affect water quality, riparian function, and stream productivity.

Determination of Effects

The following determination of effects for Central Valley Steelhead, Central California Coast Steelhead, winter–run Chinook salmon, spring–run Chinook salmon, coho salmon, and delta smelt considers direct and indirect effects of the proposed action on the listed species together with the effect of other activities that are interrelated or interdependent with the action. These effects are considered along with the environmental baseline and the predicted cumulative effects. The reasoning for the effects determinations is presented in the summary of effects above.

Central Valley Steelhead

Storage and release of water for project purposes will affect river flows and temperatures downstream of project reservoirs and may affect, and is likely to adversely affect Central Valley steelhead.

Diversion of water downstream of reservoirs and in the Delta may affect and is likely to adversely affect Central Valley steelhead at fish screens and pumps.

Effects of project operations on the central Valley steelhead population as a whole are not likely to jeopardize the continued existence of Central Valley steelhead. Wild steelhead reproduce and rear in additional tributaries with no CVP or SWP facilities.

Central California Coast Steelhead

Central California Coast Steelhead may be present in Suisun Bay streams (Suisun Creek and Green Valley Creek) and points to the west. Because this area is at the downstream influence of CVP and SWP operations no effect on steelhead of this ESU is anticipated. Changes in operations in the Delta are not great enough to affect these steelhead that migrate through the lower end of the Delta.

Winter–run Chinook salmon

Storage and release of water for project purposes will affect river flows and temperatures downstream of project reservoirs and may affect, and is likely to adversely affect winter–run Chinook salmon.

Diversion of water downstream of reservoirs and in the Delta may affect, and is likely to adversely affect winter–run Chinook salmon at fish screens and pumps.

Effects of project operations on winter-run Chinook salmon are not likely to jeopardize the continued existence of the species and should be able to provide for additional population increases above existing population levels.

Spring–run Chinook salmon

Storage and release of water for project purposes will affect river flows and temperatures downstream of project reservoirs and may effect, and is likely to adversely affect spring–run Chinook salmon.

Diversion of water downstream of reservoirs and in the Delta may affect, and is likely to adversely affect spring–run Chinook salmon at fish screens and pumps.

Effects of project operations on the spring run Chinook population as a whole are not likely to jeopardize the continued existence of Central Valley steelhead. Most spring run reproduce in tributaries without CVP or SWP facilities.

Coho salmon in Trinity River

Release of water into the Trinity River will affect flows and temperatures downstream of Lewiston Reservoir and may affect and is not likely to adversely affect coho salmon in the Trinity River.

Delta Smelt

We conclude that changes in entrainment of juvenile delta smelt at the export pumps presents no threat to the species. In a few years the movements of X2 during critical months may adversely affect the delta smelt population. Differences in E/I between the base model case and both future scenarios are sufficiently small that we do not expect them to adversely affect delta smelt.

Chapter 12 Essential Fish Habitat Assessment

Essential Fish Habitat Background

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) mandates Federal action agencies which fund, permit, or carry out activities that may adversely impact the essential fish habitat (EFH) of Federally managed fish species to consult with the NOAA Fisheries regarding the potential adverse effects of their actions on EFH (Section 305 (b)(2). Section 600.920(a)(1) of the EFH final regulations state that consultations are required of Federal action agencies for renewals, reviews, or substantial revisions of actions if the renewal, review, or revision may adversely affect EFH. The EFH regulations require that Federal action agencies obligated to consult on EFH also provide NOAA Fisheries with a written assessment of the effects of their action on EFH (50 CFR Section 600.920). The statute also requires Federal action agencies receiving NOAA Fisheries EFH Conservation Recommendations to provide a detailed written response to NOAA Fisheries within 30 days upon receipt detailing how they intend to avoid, mitigate or offset the impact of the activity on EFH (Section 305(b)(4)(B).

The objective of this EFH assessment is to describe potential adverse effects to designated EFH for Federally-managed fisheries species within the proposed action area. It also describes conservation measures proposed to avoid, minimize, or otherwise offset potential adverse effects to designated EFH resulting from the proposed action.

The northern anchovy and starry flounder are managed as “monitored species” by the Coastal Pelagic Species Fishery Management Plan and the Pacific Coast Groundfish Fishery Management Plan of the Pacific Fishery Management Council (PFMC), respectively, and are subject to Essential Fish Habitat consultation as a result (PFMC 1998a, 1998c).

The fall/late fall-run Chinook salmon is a candidate species and information is found in the salmon Chapters 4 and 5 of this document for EFH.

Identification of Essential Fish Habitat

Essential fish habitat is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of EFH, “waters” include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; “substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities; “necessary” means habitat required to support a sustainable fishery and a healthy ecosystem; and “spawning, breeding, feeding, or growth to maturity” covers a species full life cycle.

The Coastal Pelagic Species Fishery Management Plan has designated essential fish habitat for all coastal pelagic species, including the central subpopulation of the northern anchovy (PFMC 1998a). Essential fish habitat is defined to be all marine and estuarine waters along the Pacific coast from Washington to California. The specific limits of this area are defined by temperature-based thermoclines and isotherms, which vary seasonally and annually (PFMC 1998a). The level of EFH information is 1 (Presence/absence distribution data are available) for this species (PFMC 1998a).

Reclamation's proposed operation is described in Chapter 3 of the BA for the CVP OCAP. The Bay/Delta provides habitat for northern anchovy (*Engraulis mordax*) and starry flounder (*Platichthys stellatus*), which are covered under the EFH provisions of Magnuson-Stevens Act, but are not listed under the ESA. DWR's proposed operation is described in Chapter 4 of the OCAP. Chapter 2 of OCAP has the overall operations of both projects.

Essential Fish Habitat Requirements for Northern Anchovy

The northern anchovy occurs from Suisun Bay to South San Francisco Bay and occasionally in the lower Delta. This species is most abundant downstream of the Carquinez Strait and outside the Bay in the California Current (Herbold et al. 1992, Goals Project 2000).

The east-west geographic boundary of EFH for the northern anchovy is defined to be all marine and estuarine waters from the shoreline along the coasts of California, Oregon, and Washington offshore to the limits of the exclusive economic zone and above the thermocline where sea surface temperatures range between 10° C to 26° C (50 ° F to 78.8 ° F). The southern extent of EFH for the anchovy is the United States-Mexico maritime boundary. The northern boundary of the anchovy's EFH is the position of the 10° C (50 ° F) isotherm which varies both seasonally and annually (PFMC 1998b).

The adults and juveniles of the northern anchovy are pelagic and form tightly packed schools that range from the water surface to 164 fathoms deep (McCrae 1994). This species is found from seawater to mesohaline (moderately brackish water with salinity range of 5 to 18 ppt) and occasionally found in oligohaline (brackish water with low salinity range of 0.5 to 5 ppt) areas. Adults are found in estuaries, near-shore areas, and out to 300 miles offshore, although most are found within 100 miles of shore (Airame 2000). Juveniles are abundant in shallow near-shore areas and estuaries.

The northern anchovy does not migrate extensively but does have inshore-offshore, along-shore, and daily movements (McCrae 1994). Although northern anchovy are found in the San Francisco Bay area throughout the year, they tend to peak there from April to October (Goals Project 2000). The spring influx to the bay areas may result from higher temperatures and increasing plankton production in the bay and coastal upwelling; the autumn exodus may be linked to cooler temperatures in the bay. Larvae and juveniles that were spawned in late summer tend to overwinter in the bay. In the summer and fall months, anchovy larvae follow the salt wedge into warm, productive shallows of Suisun Bay and the lower Delta (Berkeley Elibrary 2002). Schooling juveniles are found in sea- and freshwater in the Sacramento-San Joaquin estuary, especially in July and August. During the summer, adults and juveniles have daily movements from 60 to 100 fathoms deep in the day to surface waters at night (Bergen and Jacobson 2001).

Anchovies feed diurnally either by filter feeding or biting, depending on the size of the food (Berkeley Elibrary 2002). Juvenile and adult northern anchovies are considered secondary and higher consumers, selectively eating larger zooplankton, fish eggs, and fish larvae. First-feeding larvae eat phytoplankton and dinoflagellates, while larger larvae pick up copepods and other zooplankton. Female anchovies need to eat approximately 4 to 5 percent of their wet weight per day for growth and reproduction (Goals Project 2000).

The northern anchovy spawns in batches throughout the year and the timing of spawning varies by area. This species is a broadcast spawner and females can produce up to 30,000 eggs a year in batches of about 6,000. Most spawning takes place in channels or within 60 miles of the coast in the upper mixed layers at night, in water temperatures of 54º F to 59º F. The San Francisco Bay is thought to provide favorable reproductive habitat for the anchovy because abundant food exists for both adults and larvae and coastal upwelling keeps eggs and larvae in productive areas. Spawning in the bay occurs at higher temperatures and lower salinities than spawning in coastal areas (McCrae 1994, Bergen and Jacobson 2001).

Northern anchovy eggs are oval, pelagic, and approximately 1.5 by 0.75 millimeters (mm) in size. Larvae range in size from 2.5 to 25 mm in length and begin schooling at 11 to 12 mm in length. Juveniles range in size from 25 to 140 mm in length. Some fish mature at less than one year of age (71 to 100 mm) and all are nature at two to three years. Maximum age is seven years, but most live for four years. Maximum size is about 230 mm, although most are not over 158 mm in length (McCrae 1994, Bergen and Jacobson 2001).

The northern anchovy is one of the most abundant and productive fishes in the San Francisco Bay area (Berkeley Elibrary 2002). All life stages of the northern anchovy are important prey for virtually every predatory fish, bird, and mammal in the California current, including California halibut, Chinook and Coho salmon, rockfishes, yellowtail, tunas, sharks, squid, harbor seal, northern fur seal, sea lions, common murre, brown pelican, sooty shearwater, and cormorants. The breeding success of California brown pelicans is correlated with anchovy abundance (Bergen and Jacobson 2001). Competitors with the anchovy include sardines and other schooling planktivores, such as jacksmelt and topsmelt. These species are also potential predators on young anchovy life stages (Goals Project 2000).

Essential Fish Habitat Requirements for Starry Flounder

The starry flounder is covered by the West Coast Groundfish Fishery Management Plan (PFMC 1998c). Starry flounder range from the Sea of Japan, north to the Bering Sea and the Arctic coast of Alaska, and southward down the coast of North America to southern California (Haugen and Thomas 2001). Starry flounder can be found in Suisun Bay and the lower portion of the San Joaquin River in the Delta. The distribution of the starry flounder tends to shift with growth. Young juveniles are commonly found in fresh or brackish water of Suisun Bay, Suisun Marsh, and the Delta, older juveniles range from brackish to marine water of Suisun and San Pablo Bays, and adults tend to live in shallow marine waters within and outside the San Francisco Bay before returning to estuaries to spawn (Goals Project 2000).

The starry flounder was a common species in commercial and recreational fisheries of California prior to the 1980s, but has declined dramatically in the 1990s. This flounder is generally not targeted by commercial fishers, except in Puget Sound, but is mostly taken as by-catch by bottom trawl, gill nets, and trammel nets. Recreational catch occurs by angling from piers, boats, and shore in estuarine and rocky areas (PFMC 1998d). Commercial catch trends suggest that populations of this flounder are at extremely low levels, reduced from more than million pounds of annual landings in the 1970s to an average of 62,225 pounds of annual landings in the 1990s (Haugen and Thomas 2001). SWP/CVP fish salvage facilities in the Sacramento-San Joaquin Delta recorded average monthly salvage records for the starry flounder for the period from 1981 to 2002 as 187 fish per month at CVP and 77 at SWP (Foss 2003).

Starry flounder is an important member of the inner continental shelf and shallow sublittoral communities, and is one of the most common flatfish in the San Francisco Bay and Delta (Haugen and Thomas 2001). Older juveniles and adults are found from 120 km up coastal rivers to the outer continental shelf at 375 m, but most adults are found within 150 m. Spawning occurs in estuaries or sheltered inshore bays in water less than 45 m deep (Goals Project 2000). Juveniles prefer sandy and muddy substrates and adults prefer sandy and coarse substrates. Eggs are found in polyhaline (brackish water with moderate salinity range from 18 to 30 ppt) to euhaline (brackish water with high salinity range from 30 to 40 ppt) waters; juveniles are found in mesohaline (brackish water with moderate salinity range from 5 to 18 ppt) to fresh waters; adults and larvae are found in euhaline to fresh waters. All life stages can survive and grow at temperatures below 0º C to 12.5º C (32º F to 54.5º F) (Orcutt 1950).

Starry flounder is not considered to be a migratory species. Adults move inshore in winter or early spring to spawn and offshore and deeper in the summer and fall, but these coastal movements are generally less than 5 km. Some starry flounder have shown movements of greater than 200 km, but this is not considered typical. Adults and juveniles are known to swim great distances up major coastal rivers (greater than 120 km) but this is not a migratory trend. Larvae may be transported great distances by oceanic currents (CDFG 2001).

Starry flounder are oviparous; eggs are fertilized externally. Spawning occurs annually in a short time frame in winter and spring, with the exact timing depending on location. In central California, starry flounder spawn from November to February, peaking in December and January (Orcutt 1950). The number of eggs produced by females depends on fish size; a 56 cm fish can produce 11,000,000 eggs (CDFG 2001). Fertilized eggs are spherical and between 0.89 and 1.01 mm in diameter (Orcutt 1950). Eggs hatch in 2.8 days at 12.5º C (54.5º F), 4.6 days at 10.0ºC (50º F), and 14.7 days at 2.0° C to 5.4º C (35.6º F to 41.7º F). Eggs are pelagic and occur at or near the surface over water 20 to 70 m deep (CDFG 2001).

Eggs and larvae of the starry flounder are epipelagic, while juveniles and adults are demersal. Larvae are approximately 2 mm long at hatching and they start settling to the bottom after two months at approximately 7 mm in length. Metamorphosis to the benthic juvenile form occurs at 10 to 12 mm and sexually immature juveniles range in size from 10 mm to 45 cm, depending on sex (Orcutt 1950). Transforming larvae and juveniles depend on ocean currents to keep them in rearing areas near estuarine areas and the lower reaches of major coastal rivers (Goals Project 2000). Starry flounder tend to rear for up to two years in estuarine areas before moving to shallow coastal marine waters. Adults occur in estuaries or their freshwater sources year-round in Puget Sound. Females begin maturing at 24 cm and three years, but some may not mature until 45 cm and four to six years. Males begin maturing at two years and 22 cm, but some may not reach maturity until four years and 36 cm (Orcutt 1950). Maximum age is reported as 21 years and maximum length is 915 mm.

Starry flounder change their diet as they develop from pelagic to demersal stages (Orcutt 1950). Larvae tend to be planktivorous and eat copepods, amphipods, eggs and nauplii as well as barnacle larvae and diatoms. Juveniles and adults are primary to secondary carnivores on larger benthic invertebrates. Newly metamorphosed juveniles feed on copepods, amphipods, annelid worms, and the siphon tubes of clams. Larger fish with jaws and teeth feed on a wider variety of items, including clams, crabs, polychaete worms, sand dollars, brittle stars, and other more mobile foods (Orcutt 1950). Starry flounder do not feed during spawning or coldwater periods.

Starry flounder larvae and juveniles are eaten by larger fish, and wading and diving seabirds (e.g., herons and cormorants). Adults are eaten by pinnipeds, larger fishes, sharks and marine mammals.

The starry flounder probably competes with other soft-bottom benthic fishes of estuaries and shallow nearshore bays. Individuals with characteristics intermediate between starry flounder and English sole are evidence of possible hybridization between those species (Haugen and Thomas 2001).

The Pacific Coast Groundfish Fishery Management Plan (PFMC 1998c) has designated EFH for 83 species of groundfish, which taken together include all waters from the high water line, and the upriver extent of saltwater intrusion in river mouths along the coast from Washington to California. Composite habitats most important for the starry flounder are estuarine (for all life stages), non-rocky shelf (for juveniles and adults), and neritic habitats (for eggs and larvae), as defined by the fishery management plan (PFMC 1998d). The level of EFH information is 1 (Presence/absence distribution data are available) for all life stages of this species. When Level 1 information is available, EFH for a species' life stage is its general distribution, the geographic area of known habitat associations containing most (e.g., about 95 percent) of the individuals (PFMC 1998d). The National Marine Fisheries Service is proposing to amend the fishery plan to identify and describe essential fish habitat for each managed groundfish species (PFMC 1998c).

Potential Adverse Effects of Proposed Project

Northern Anchovy

Because Northern anchovy is primarily a marine species and CVP and SWP operations have little effect on marine conditions, there are not expected to be any adverse effects from the proposed project on EFH for the northern anchovy.

Starry Flounder

The withdrawal of seawater can create unnatural conditions to the EFH of starry flounder. Various life stages can be affected by water intake operations such as entrapment through water withdrawal and impingement on intake screens. Starry flounder salvage occurs at the CVP and SWP export facilities (Table 12–1). Most salvage occurs in May, June, and July. High approach velocities along with intake structures can create unnatural conditions to the EFH of starry flounder. These structures may withdraw most larval and post-larval organisms, and some proportion of more advanced life stages. Periods of low light (e.g., turbid waters, nocturnal periods) may also entrap adult and subadults. Freshwater withdrawal also reduces the volume and perhaps timing of freshwater reaching estuarine environments, thereby potentially altering circulation patterns, salinity, and the upstream migration of saltwater.

Starry flounder is primarily a marine and estuarine species. CVP and SWP operations do not significantly affect marine conditions, although they can affect estuarine conditions and some take occurs at the pumping plants. The proposed CVP OCAP can affect EFH of the starry flounder in the Delta by changing flow and water quality. Starry flounder is a widespread species not directly targeted by commercial fisheries. Effects to starry flounder habitat are minor relative to flounder habitat as a whole and no commercial fisheries will be affected by localized effects on the habitat or population.

Table 12–1 Starry flounder salvage at the SWP and CVP export facilities, 1981 – 2002.

Starry Flounder Salvage at the SWP and CVP Delta Fish Salvage Facilities, 1981 - 2002

Sum of SALVAGE	
MONTH	Total
1	24
2	181
3	33
4	325
5	1733
6	7188
7	2242
8	295
9	51
10	76
11	6
12	12
Grand Total	12166

	1 = SWP, 2 = CVP		
Sum of SA	FACILITY		
MONTH	1	2	Grand Total
1		24	24
2		181	181
3	33		33
4	294	31	325
5	795	938	1733
6	6174	1014	7188
7	1849	393	2242
8	154	141	295
9	27	24	51
10		76	76
11	6		6
12		12	12
Grand Tot	9332	2834	12166

Sum of SALVAGE	MONTH												
YEAR	1	2	3	4	5	6	7	8	9	10	11	12	Grand Total
1981				169	405			48	19				641
1983						60							60
1984						294							294
1985					154	2429	78						2661
1986				31	46	66	615						758
1987				64				168					232
1988		128			49	2707	829						3713
1989					3								3
1990						267	143						410
1991		53			63	43	119			28			306
1992			25	6	29					36		12	108
1994				1	18	24	24						67
1995						12							12
1996						126	170	15	8				319
1997				45	816	854	42	36		12			1805
1998	24				102	80	30		24				260
1999					12	94	96	4			6		212
2000			8	9	24	72	24	24					161
2001							24						24
2002					12	60	48						120
Grand Total	24	181	33	325	1733	7188	2242	295	51	76	6	12	12166

Essential Fish Habitat Conservation Measures

The Coastal Pelagic Species Fishery Management Plan (PFMC 1998a) requires a permit to commercially harvest coastal pelagic finfish species, such as the northern anchovy, south of Point Arena, California. The fishery management plan includes the northern anchovy as a “monitored species” because of low fishery demand and high stock size and thus does not impose harvest limits based on biomass estimates. There is no limit on live bait catch for this species.

The Pacific Coast Groundfish Fishery Management Plan (PFMC 1998c) outlines measures to reduce negative impacts on essential fish habitat. These measures include fishing gear restrictions, seasonal and area closures, harvest limits, among others. There are currently no harvest limits specific to the starry flounder. Conservation measures include recommending that all intake structures be designed to minimize entrainment or impingement of fish, and mitigation should be provided for the net loss of habitat from placement of the intake structure and delivery pipeline.

Conclusion for Northern Anchovy and Starry Flounder

Upon review of the effects of Reclamation’s proposed CVP OCAP, the proposed project will not affect EFH of the northern anchovy and may affect the EFH of starry flounder.

Essential Fish Habitat for Central Valley Fall and Late Fall-run Chinook

Note: The following information is background data on fall and late fall-run Chinook. The effects for these runs are included in chapter 9 and summarized at the end of this chapter..

On September 16, 1999, NOAA Fisheries determined that listing was not warranted for this ESU (NOAA Fisheries 1999). However, the ESU is designated as a candidate for listing due to concerns over specific risk factors. The ESU includes all naturally spawned populations of fall-run Chinook salmon in the Sacramento and San Joaquin River basins and their tributaries, east of Carquinez Strait, California. Major river basins containing spawning and rearing habitat for this ESU comprise approximately 13,760 square miles in California.

Effects on spring run and winter run Chinook salmon, coho salmon, and steelhead habitat are described in the biological assessment.

Population Trends-Central Valley Fall-run Chinook Salmon

Central Valley Chinook salmon constitute the majority of salmon produced in California and at times have accounted for 70 percent or more of the statewide commercial harvest (Yoshiyama et al. 2001). Chinook salmon populations in the Central Valley are monitored in a number of ways. Adult Chinook production is estimated using tributary escapement counts and adding this number to the estimated ocean harvest. Tributary counts come from carcass counts, fish ladder counts, aerial redd surveys, hatchery returns and in-river harvest. The total escapement (in-river plus hatchery) of fall-run Chinook in the Central Valley from 1952-2001 is shown in Figure 12–1.

Figure 12–2 shows Chinook salmon in-river escapement estimates by watershed from 1995-2001. The watershed specific component of the ocean harvest of fall-run Chinook salmon is calculated by multiplying the total ocean harvest by the watershed-specific proportion of the total in-river run size. Tagging programs have not been sufficiently implemented Central Valley wide to provide more exact commercial harvest estimates by watershed. During 1999, ocean harvest accounted for 41 percent (335,700) of the total Central Valley Chinook production of 822,352 (all runs combined). The total production includes both natural in-river and hatchery production estimates.

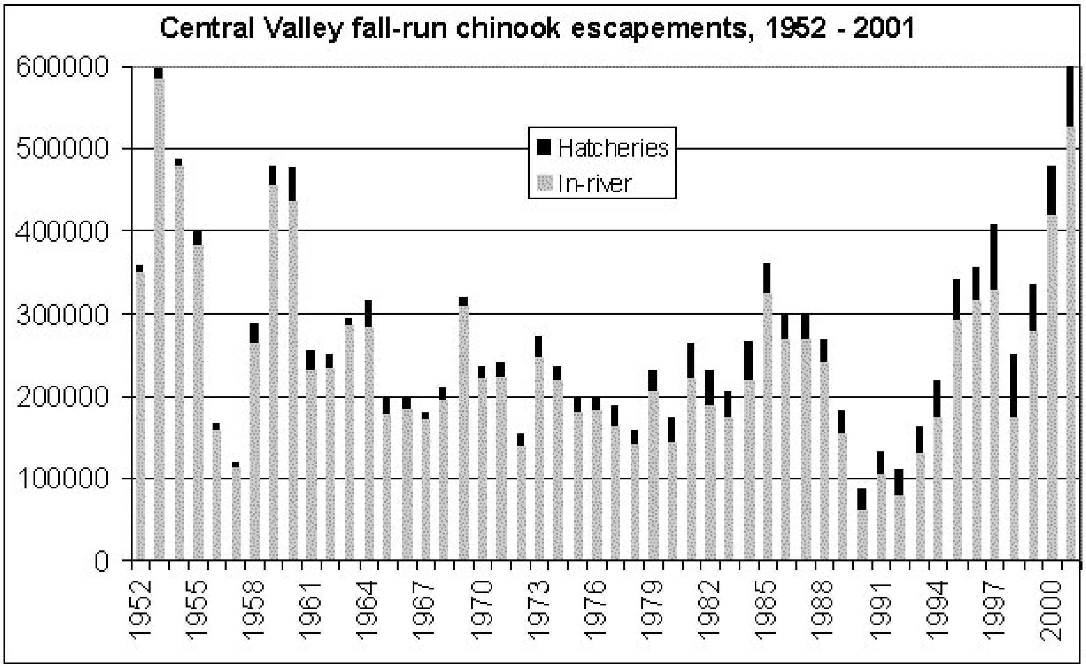


Figure 12–1 Central Valley fall-run Chinook salmon escapements, 1952-2001. Source: DFG data.

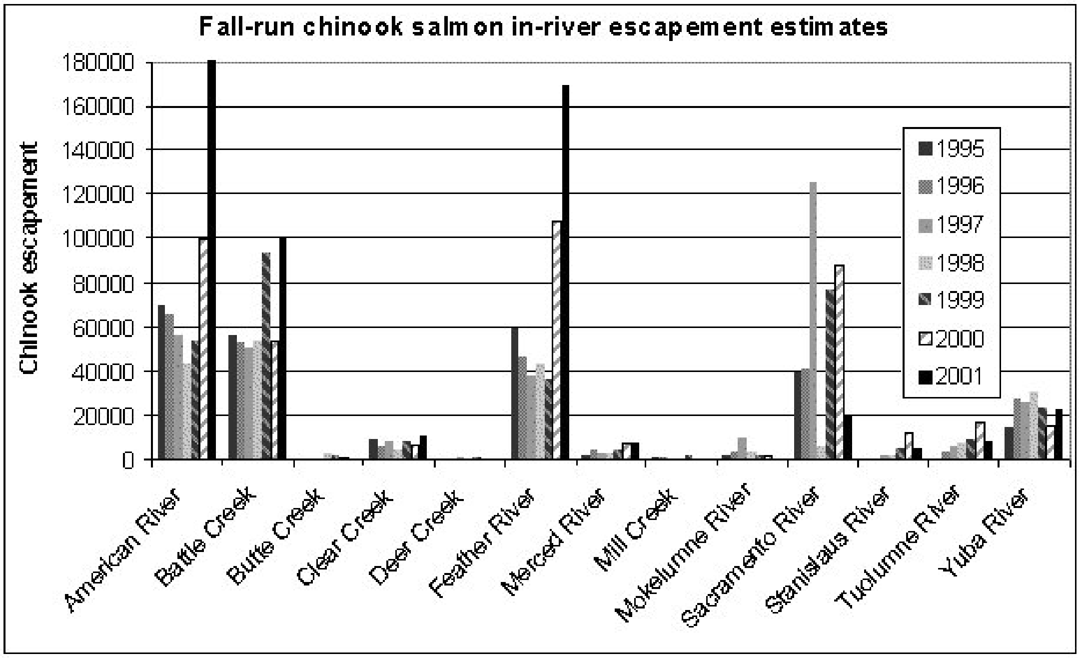


Figure 12–2 Fall-run Chinook salmon in-river escapement estimates in the California Central Valley, 1995-2001. Source: Interior (2001).

The Comprehensive Assessment and Monitoring Program (CAMP) annual report (Interior 2001) summarizes results of monitoring anadromous fisheries production in the Central Valley relative to the CVPIA doubling goal. The CVPIA set the baseline anadromous fisheries production level as the average attained during 1967-91. Progress toward production targets is assessed using a modification of the Pacific Salmon Commission's (1996) rebuilding assessment methods when a minimum of five years of monitoring data is available. Indicator races or species are classified into three categories: (1) those at or above their production target; (2) those meeting their rebuilding schedule; and (3) those not rebuilding. Results based on past escapement estimates need to be qualified due to the vagaries of the estimation methods used over the years (DFG 2003).

Battle Creek, Clear Creek, and Mokelumne River populations of fall-run Chinook salmon and Butte Creek spring-run salmon are classified as meeting restoration goals. Fall-run salmon from the Yuba watershed are classified as Rebuilding. All other races and watershed-specific runs of Chinook salmon are classified as Not Rebuilding, except for American River fall-run salmon classified as Indeterminate. Table 12–2 shows the 1995-99 mean Chinook salmon production expressed as a percent of the goal, which is the mean of the 1967-91 production.

Many variables affect yearly salmon production including ocean conditions and water supplies, which have recently been at good levels for California salmon runs. The 2000, 2001, and 2002 Chinook salmon runs were outstanding in many Central Valley watersheds.

Table 12–2 Status of CAMP-monitored Central Valley stocks of Chinook salmon races using Pacific Salmon Commission methodology.

Watershed	*Race*	*1995-99 mean Chinook production as percent of goal*	*Watershed status through 1999 Chinook run*
American	Fall-run	77 percent	Indeterminate, declines halted
Battle	Fall-run	235 percent	Above goal
Butte	Spring-run	551 percent	Above goal
Clear	Fall-run	218 percent	Above goal
Deer	Spring-run	44 percent	Not Rebuilding
Feather	Fall-run	63 percent	Not Rebuilding
Merced	Fall-run	49 percent	Not Rebuilding
Mill	Spring-run	22 percent	Not Rebuilding
Mokelumne	Fall-run	169 percent	Above goal
Sacramento	Fall-run	48 percent	Not Rebuilding
	Spring-run	2 percent	Not Rebuilding
	Winter-run	5 percent	Not Rebuilding
Stanislaus	Fall-run	17 percent	Not Rebuilding
Tuolumne	Fall-run	30 percent	Not Rebuilding
Yuba	Fall-run	91 percent	Rebuilding, declines halted
Total (all CAMP streams)	Fall-run	66 percent	Not Rebuilding
	Spring-run	22 percent	Not Rebuilding
	Winter-run	5 percent	Not Rebuilding

Clear Creek

Clear Creek originates on the eastern side of the Trinity Alps and flows south to its confluence with the Sacramento River. The Clear Creek watershed is approximately 35 miles long, ranges from five to 12 miles wide, and covers a total area of approximately 249 square miles, or 159,437 acres. Maximum elevation in the watershed is 6,209 feet at the top of Shasta Bally. Clear Creek channel morphology varies from steep confined bedrock reaches above Clear Creek Road bridge to wide meandering alluvial reaches from the bridge to its confluence with the Sacramento River. Fish passage through ladders on Saeltzer Dam (constructed in 1903), six miles upstream of the Sacramento River confluence, was poor so the dam was removed in 2000. Upstream of Saeltzer Dam at river mile 9.9 and 12 are two series of natural falls which could be barriers to upstream migrants (DFG 1984b).

Fall and late fall-run Chinook salmon use the creek during the fall, winter and spring, when water temperatures are cooler. Therefore, fall and late fall-run Chinook were not as severely impacted by the loss of habitat upstream. In 1995, an unusually large run of 9,298 fall-run Chinook salmon spawned in Clear Creek (Figure 12–3). Increased minimum flow releases are thought to be one factor responsible for the increased number of spawners during that year (Figure 12–4). Late fall-run Chinook spawn in January through April. High seasonal flows and turbid water hinder the ability to conduct escapement surveys during that time of year. Fry and juvenile Chinook rear from January through May. Some late fall-run Chinook juveniles may remain in stream through June, depending on flow and water temperature conditions that occur during the season.

Pulse flows have been proposed for Clear Creek to provide an attraction flow to spring-run Chinook in the mainstem Sacramento River. A release of 1,200 cfs for one day (plus ramping) was proposed in 2000 but was not implemented due to concerns over attracting winter-run into Clear Creek. Because there has been no significant spring-run in Clear Creek in the recent past, pulse flows may aid re-establishment of spring-run in Clear Creek by attracting some fish that would otherwise remain in the Sacramento River.

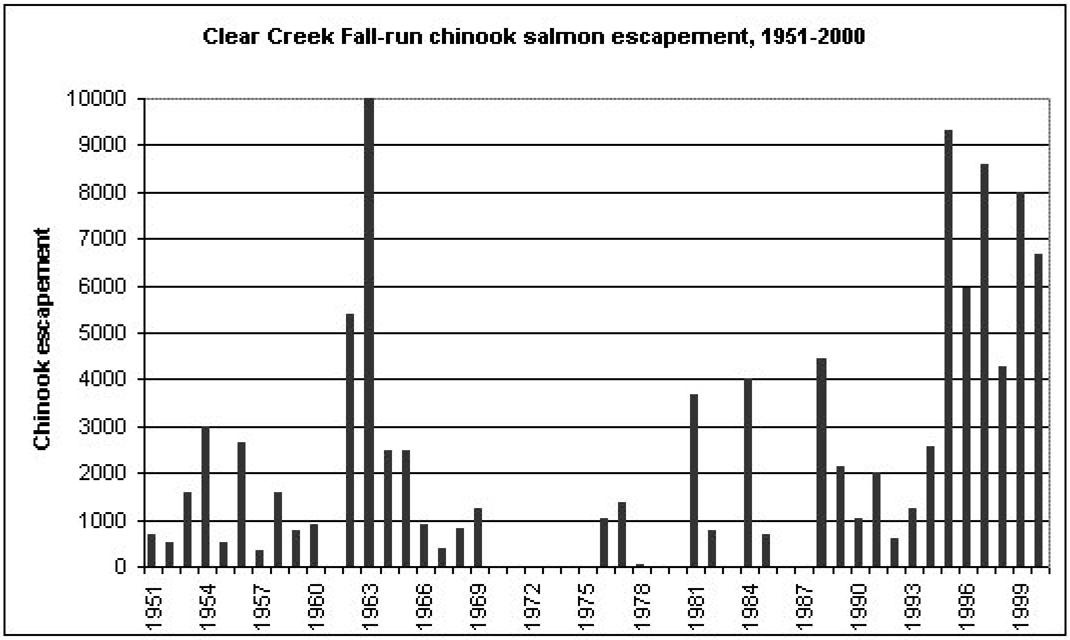


Figure 12–3 Clear Creek fall-run Chinook salmon escapement, 1951-2000. Source: DFG data.

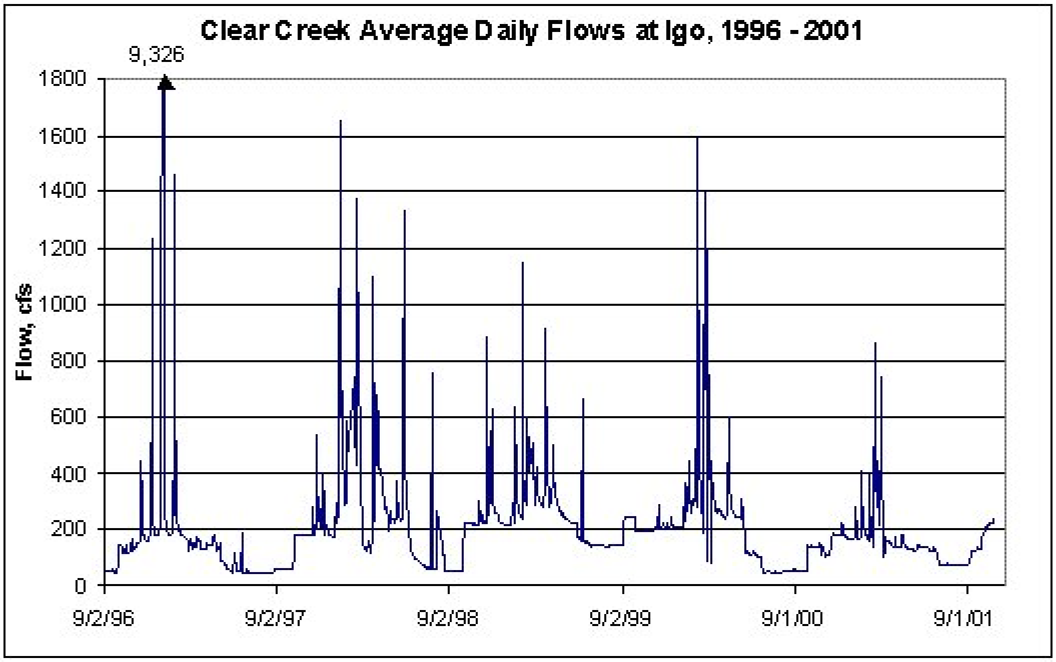


Figure 12–4 Average daily flow in Clear Creek, 1996-2001.

Sacramento River

The Sacramento River drains a watershed area of 21,250 square miles. Keswick Dam at river mile 302 serves as the upstream limit to anadromous habitat. The river is constrained by levees along much of the lower reaches. Stressors identified in the Sacramento River include high water temperatures, a modified hydrograph, simplified instream habitat, diversion dams, predation, and harvest. Water temperature and flow fluctuation are the main short-term factors affected by operation of the water projects.

Escapement of fall-run in the Sacramento River exceeded 100,000 fish every year except one between 1959 and 1970. Escapement has not exceeded 100,000 since 1970. The primary spawning area used by Chinook salmon is in the area from the city of Red Bluff upstream to Keswick Dam. Spawning densities for each of the four runs are generally highest in this reach. This reach is where operations of the Shasta/Keswick and Trinity Divisions of the CVP have the most significant effects on salmon spawning and rearing habitat in the mainstream Sacramento River. Rapid flow fluctuations can dewater edge and backwater habitat and strand fry and juvenile salmon. Redds can also be dewatered as a result of flow fluctuations. Approximately 15 to 30 percent of the total number of fall and late fall-run Chinook spawn downstream of Red Bluff when water quality is good (Vogel and Marine 1991).

Run timing for all Chinook salmon runs and life stages in the Sacramento River is depicted in Figure 12–5. All life stages are present in the river essentially at all times through the year. Abundance of adult Chinook peaks in the fall during the fall-run spawning migrations and then tapers off as fish considered late fall-run spawn. Winter-run enter the river as the late fall-run fish are spawning, starting in January. The winter-run then spawn with the peak in spawning activity in June. Spring-run enter the river soon after the winter run, starting in March and April. They then hold out until spawning in August and September, during the lowest water flows and highest water temperatures of the year.

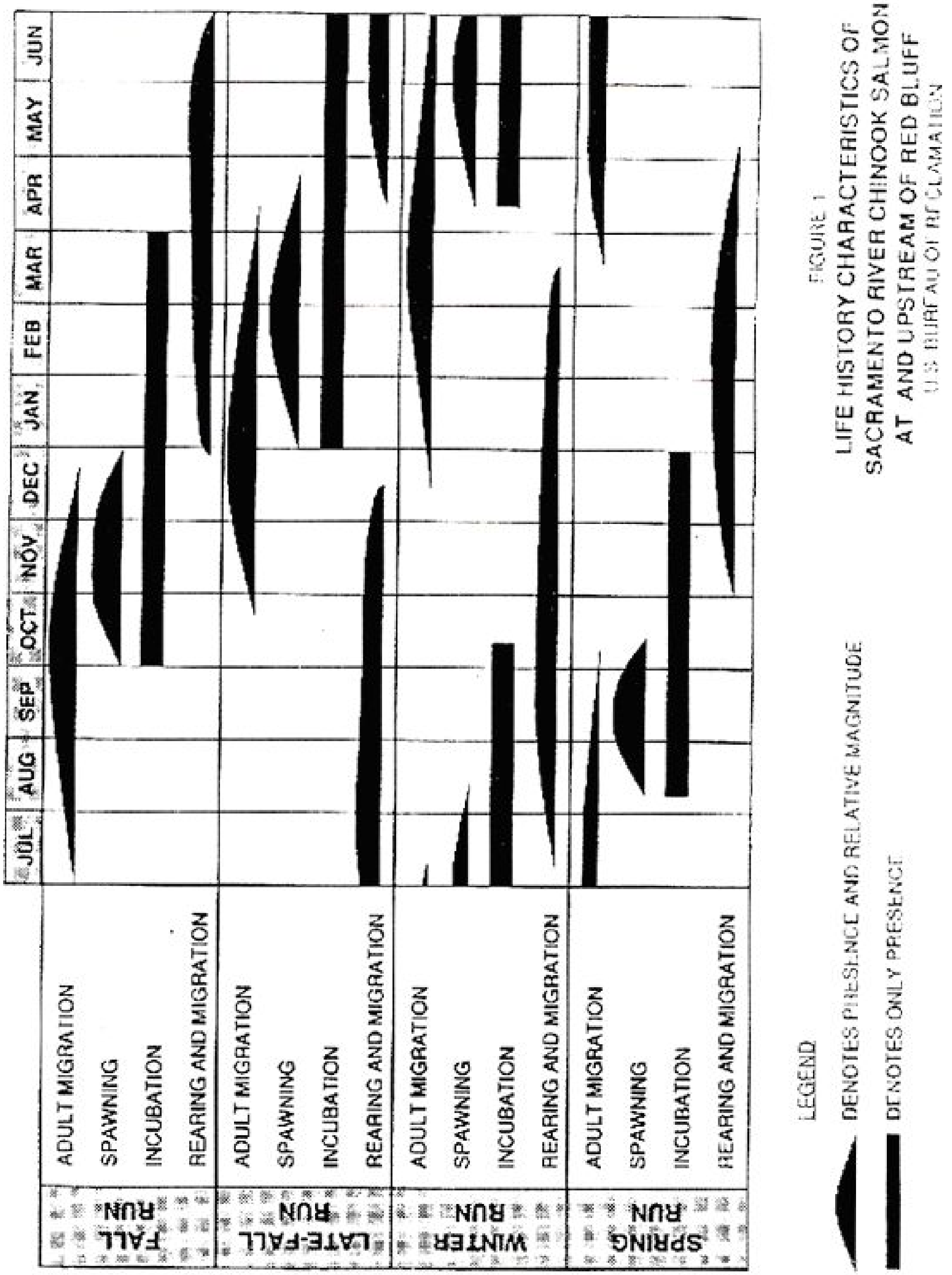


Figure 12–5 Life cycle timing for Sacramento River Chinook salmon. Adapted from Vogel and Marine (1991).

Fall-run are entering the river as spring-run are spawning. Fall-run Chinook salmon escapement is shown in Figure 12–6, the hydrograph since 1993 is in Figure 12–7.

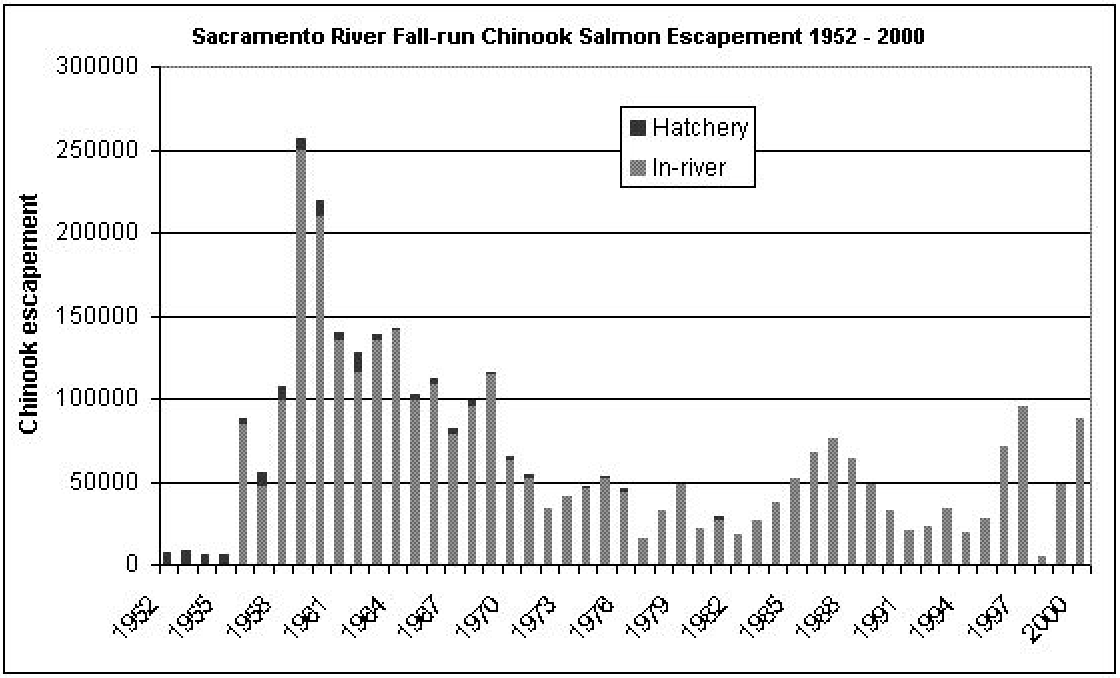


Figure 12–6 Fall-run Chinook salmon escapement in the Sacramento River.

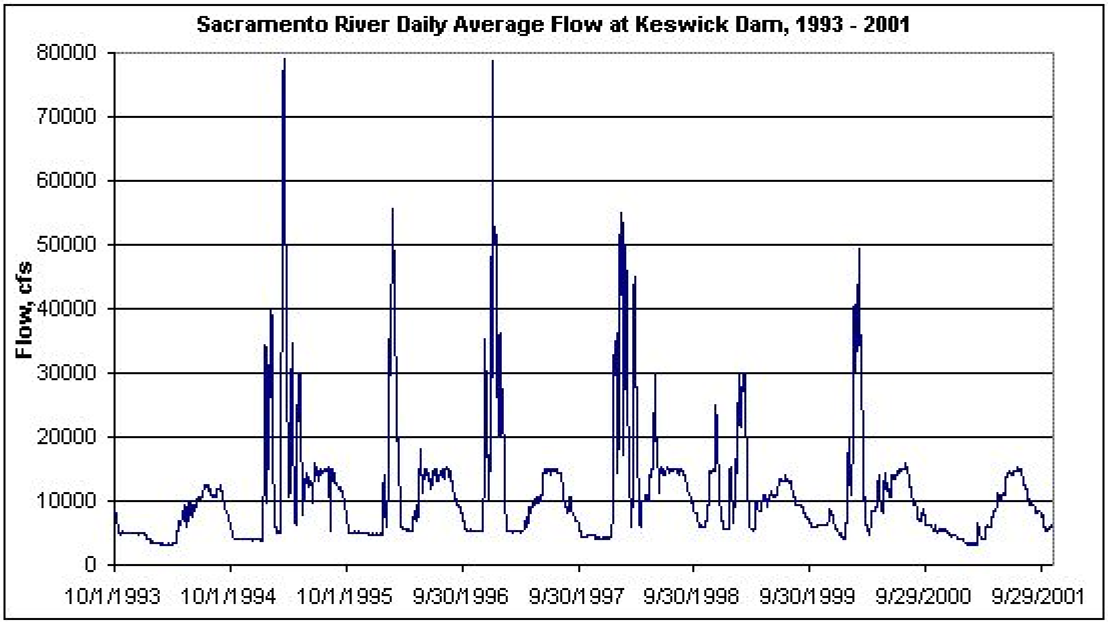


Figure 12–7 Sacramento River daily average flow at Keswick Dam from 1993-2001.

Sacramento River water temperature is controlled primarily by using releases from Shasta Lake through the TCD and also by diversions from Trinity River. The TCD was installed in 1997. Prior to 1997 low level releases were made by opening the lower river outlets, which bypasses power. The TCD enabled power bypasses to be greatly reduced while maintaining desired water temperatures in downstream fish habitat.

Flows in the Sacramento River generally peak during winter and spring storm events. Sustained moderately high releases (greater than 10,000 cfs) occur during the major irrigation season of June through September. These flows help to meet water temperature criteria for winter-run Chinook spawning and incubation. They also maintain suitable habitat for spring-run and early returning fall-run fish.

American River

The American River drains a roughly triangular watershed covering 1,895 square miles that is widest at the crest of the Sierra Nevada, and narrows almost to the width of the river at its confluence with the Sacramento River at the City of Sacramento. Elevations range from 10,400 feet at the headwaters to about 200 feet at Folsom Dam. Folsom Dam, completed in 1956, provides flood control, hydropower generation and water supply storage. The reservoir is kept partly empty during the winter so that temporary storage is available to regulate the runoff from major storms, preventing flooding in the downstream urban area. Nimbus Dam is seven miles downstream from Folsom Dam. It serves as the limit to upstream migration for anadromous fish. Available anadromous habitat in the American River watershed has been reduced from 161 miles to 23 miles.

Adult Chinook salmon begin to enter the American River in August. Upstream migration peaks in October. Spawning generally commences close to November 1 and peaks in late November. Early spawning success is low if water temperature in early November is above 60° F . American River Chinook salmon escapement has averaged 41,895 since 1952 and ranged from 6,437 to 110,903 (Figure 4–18). Peaks in escapement over 60,000 fish occurred in 1973, 1974, 1981, 1985, 1995, 1996, 1998, and 2000. Low escapements, less than 20,000, fish occurred in 1955, 1956, 1957, 1990, and 1992.

Juvenile Chinook emigration from the American River generally begins in December, peaks in February and March and tails off into June. Nearly all (>99 percent) of the emigrating Chinook salmon from the American River moving past the smolt traps at Watt Avenue are pre-smolts. This suggests that the smolting process is not completed in the lower American River but will continue downstream, likely in the Delta and estuary (Snider and Titus 2000). The 2001 outmigration past Watt Avenue was estimated to be 25 million fish, the largest measured from the American River since rotary screw trapping began (Bill Snider, personal communication, 2001).

The main stressors identified in the American River include an altered flow regime, high water temperatures, hatchery operations and reduced habitat complexity and diversity. The operation of Folsom and Nimbus Dams for water delivery and flood control can affect all of the stressors directly or indirectly.

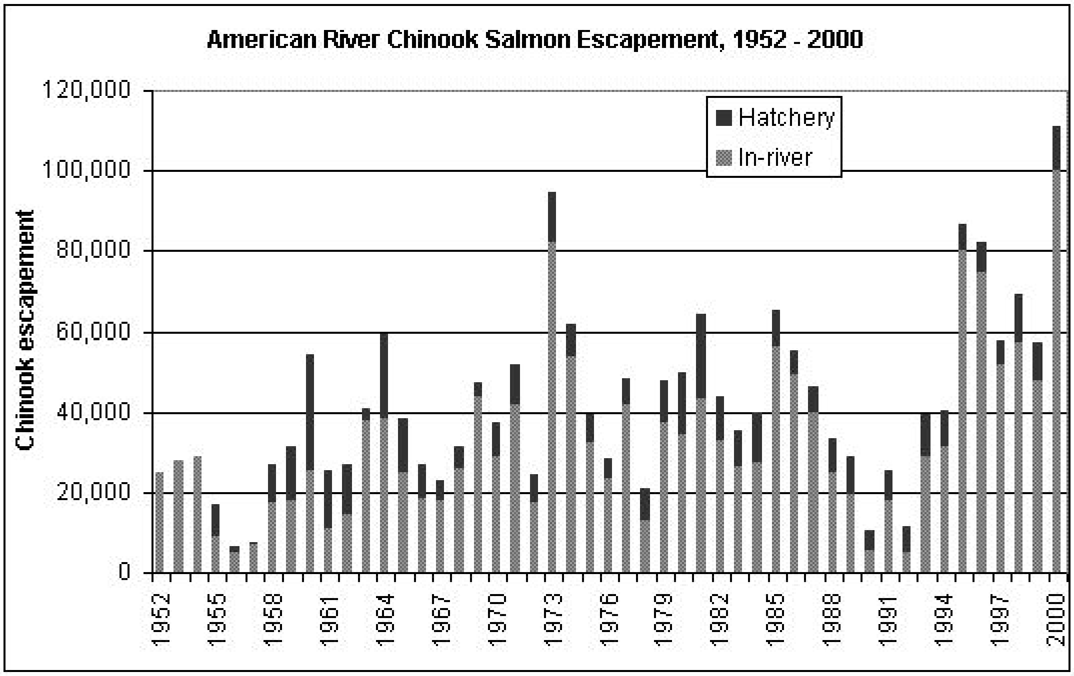


Figure 12–8 American River Chinook salmon escapement estimates, 1952-2000.

Dam operations store water runoff during winter and spring to be released for instream flows, water delivery, and water quality during late spring, summer and fall. Historical high flows in the river have been dampened for flood control and water storage. Moderate flows of around 1,500 to 2,500 cfs have been extended throughout much of the year to provide appropriate instream flows for fish, water quality in the Delta and water for pumping in the Delta. The long-term effect of the lack of high flows is the simplification of instream habitat. High channel forming flows maintain high quality spawning habitat and riparian floodplain conditions. High flows mobilize spawning sized gravels from streambanks and incorporate them into the active channel. Low flows that typically occurred in late summer and fall do not occur because of the dampening effect of the dam operations. High flows are not as high as occurred under natural conditions but the duration of high flows is longer because flood control operations spread them out over time. The longer duration of moderately high flows may be sufficient enough to wash quality spawning gravel out of riffles and deposit it in deeper water where it is unavailable for spawning but not high enough to mobilize new gravel supplies from the extensive gravel bars, banks, and floodplain. Ayres Associates (2001) used detailed topography of the river to model sediment mobilization at various flows in the American River. They found that at 115,000 cfs (the highest flow modeled) particles up to 70 mm median diameter would be moved in the high density spawning areas around Sailor Bar and Sunrise Avenue. Preferred spawning gravel size is 50-125 mm (2-5 inches) in diameter.

Flow fluctuations (below flood release flows) occur as a result of Delta water quality conditions requiring increased releases to maintain water quality for the desired pumping rates. Flow fluctuations can cause stranding of fish and dewatering of redds when the flows are reduced. Based on cross sections measured in 1998 by the FWS, flow changes of 100 cfs generally change the water depth by about 1 inch in a flow range of 1,000 to 3,000 cfs and by about 0.5 inch in a flow range from about 3,000 to 11,000 cfs. These depth changes vary throughout the river depending on the channel configuration at a location. Decreases in water depth of about 6 inches following spawning can begin to dry up the shallowest redds and will change water velocity over and through the redds.

Snider (2001) is evaluating the effects of flow fluctuations on salmon stranding in the American River. Aerial photos and ground truthing were used to measure areas isolated during flow changes. The greatest area isolated occurs at flows around 11,000 cfs (183 acres) and 8,000 cfs (85 acres). Smaller areas of isolation occur around 4,000 cfs (3.6 acres), 3,000 cfs (14.5 acres), 2,000 cfs (13.3 acres), and 1,000 cfs (12.7 acres). Although off-channel areas are important salmon habitat, when salmonids become isolated in off-channel areas for extended periods mortality occurs.

The period of concern for flow fluctuations causing stranding of redds and juvenile Chinook in the American River extends from the initiation of spawning at about the beginning of November until juveniles have emigrated from the river, generally by the end of June. Figure 4–22 shows American River flows from 1993-2001.

FWS (1997) measured 21 cross sections of the American River in high density Chinook spawning areas. They estimated the flows at which the greatest usable spawning area would be available based on water velocity, water depth, and substrate size. Most cross sections showed the greatest usable spawning area available to be in a flow range between 1,600 and 2,400 cfs. Table 12–3 shows the average of the weighted usable spawning area from the 21 cross sections expressed as 1,000 square feet of spawning area per 1,000 feet of stream. Weighted usable spawning area peaked at a flow of 1,800 cfs.

In order to maximize survival from egg to fry, flows need to be maintained near or above the level at which spawning occurred. Chinook spawning occurs at water depths greater than about 6 inches. Drops in flow greater than about 500 cfs from the preferred spawning flows following spawning need to be carefully considered. A 500 cfs drop will lower water level in most areas by about 5 inches. Some mortality could occur when water flow over redds drops as flow drops but mortality is greatest when redds begin to become dewatered. Because most Chinook do not spend much time rearing in the American River, spawning habitat may be a limiting factor to Chinook production. Most spawning occurs upstream of the Goethe Park side channels, where river channel gradients are generally higher and riffles more frequent.

Folsom Dam storage capacity is small relative to the annual runoff from the watershed. Because of this, the amount of cold water that can be stored during the winter for release during the summer and fall is limited. Chinook typically begin to show up in the American River in August. Spawning usually initiates about November 1 or when water temperature reaches a daily average of 60° F . A temperature of 56° F or below is best for survival of incubating eggs. In dry years, such as 2001, water temperature does not reach 60° F until mid-November. A dense school of Chinook holds below the hatchery diversion weir from October until spawning commences. The hatchery opens the fish ladder when water temperature reaches 60° F , typically late October to mid-November. If spawning is delayed past mid-November, the typical peak in spawning, then significant mortality of eggs or pre-spawning mortality may occur. Fish holding in high densities are particularly vulnerable to the effects of high water temperatures, which when coupled with low streamflow can deplete dissolved oxygen and increase disease.

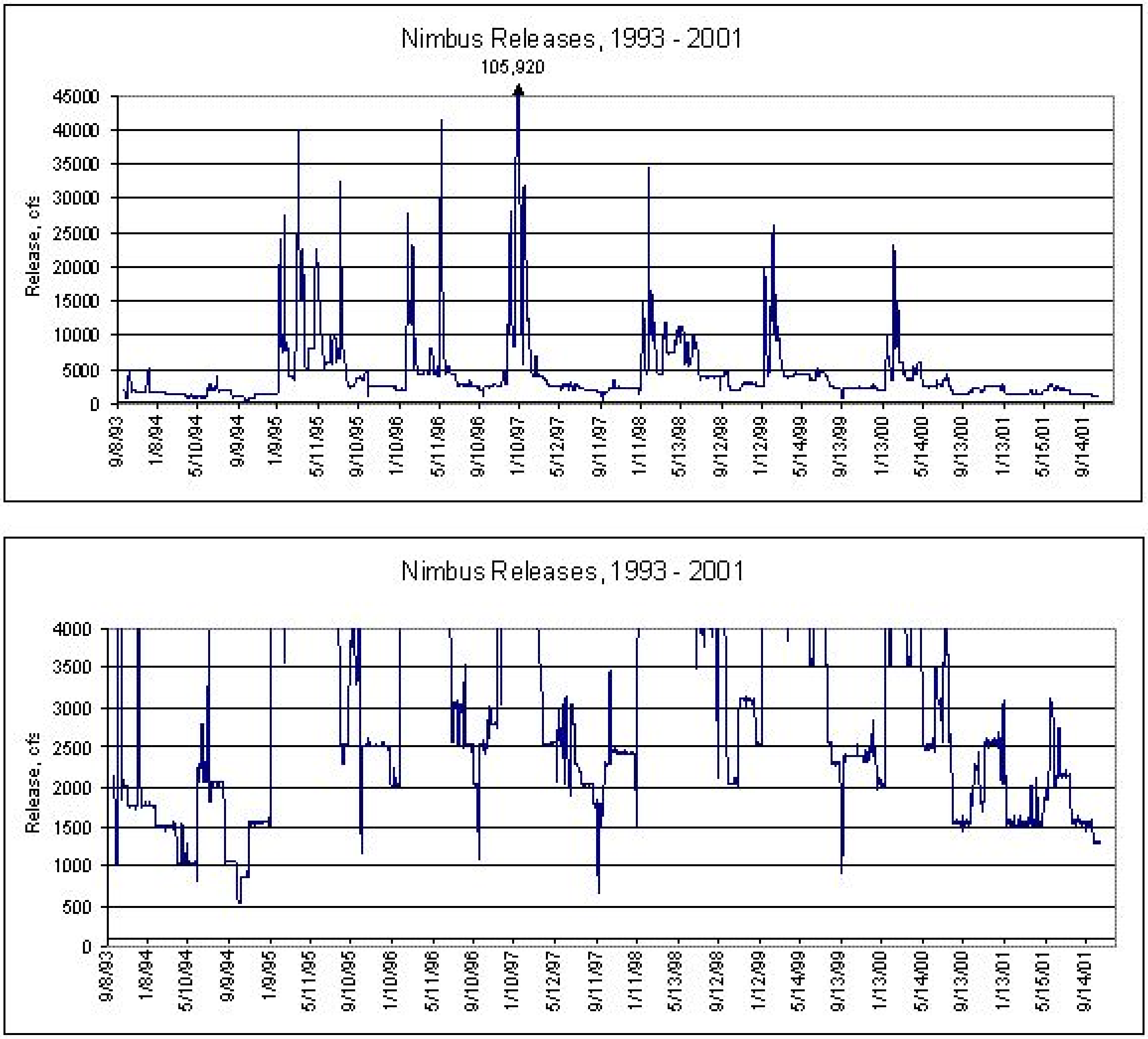


Figure 12–9 American River flows as released from Nimbus Dam, 1993-2001. The top chart shows the entire hydrograph. The bottom chart shows a close-up of the 0 to 4000 cfs range.

Table 12–3 Average weighted usable spawning area in the American River (expressed as 1,000 square feet of spawning area per 1,000 feet of stream) from 21 cross sections measured in 1996. Summarized from FWS 1997.

Flow (cfs)	*Average Weighted Usable Area, 1996*
1000	62
1200	71
1400	78
1600	82
1800	84
2000	83
2200	81
2400	78

Flow (cfs)	*Average Weighted Usable Area, 1996*
2600	74
2800	69
3000	65
3200	60
3400	56
3600	52
3800	48
4000	45
4200	42
4400	38
4600	36
4800	33
5000	31
5200	28
5400	26
5600	25
5800	23
6000	21

American River water temperatures are typically suitable for egg incubation once water temperature cools to 56° F . Before cooling to 56° F , temperature-related mortality of spawned Chinook eggs may occur. Generally temperatures reach 56° F by early December. Cool water temperatures are then sustained through winter egg incubation and juvenile rearing and emigration through the spring.

Efforts are underway by various groups coordinated by the Water Forum to improve American River water temperatures for salmonids. A funding proposal has been submitted for temperature curtains in Lake Natoma. Temperature curtains may lower water temperatures in the river by 3° F during summer and fall. Mechanization and reconfiguration of the temperature shutters on Folsom Dam has also been proposed. The temperature shutter work is expected to improve flexibility in operation of the shutters to spread out cold water availability for a longer period of the year. Construction is underway on Folsom Dam water supply intake to reduce depletions from the coldwater pool. El Dorado Irrigation District is also pursuing a new water intake which would be constructed so that water would not be taken from the cold water pool. Efforts are underway to raise Folsom Dam to provide better flood protection to downstream urban areas. If the dam is raised then the increased storage capacity may alleviate the water temperature concerns in many years.

Reclamation funds operation of Nimbus Salmon and Steelhead Hatchery as mitigation for the habitat blocked by construction of Nimbus and Folsom Dams. An average of 9,370 adults, 22 percent of the average in-river escapement, have been taken at the hatchery each year since 1955. The hatchery production goal is for 4,000,000 fall Chinook salmon smolts each year. The smolts are released into San Pablo Bay to increase survival over in-river releases. A recent review of hatchery practices in California (DFG and NOAA Fisheries 2001) recommended discontinuing releases downstream of the American River. They recommended instead to consider releasing Chinook smolts at the hatchery during periods when flow releases can be obtained to maximize smolt survival through the Delta. No consistent coded wire tagging program has been in place so the proportion of the returning salmon that are of hatchery origin v. in-river spawned is unknown. A portion of the release group was coded wire tagged in 2001. This should allow estimates of contribution to commercial and sports fisheries to be made. The proportion of hatchery production contributing to in-river spawning should be able to be determined by comparing the proportion of adipose clipped fish in the carcass mark-recapture survey escapement estimate to the proportion of the release group tagged. Coded wire tagging is recommended to continue to determine contribution to commercial and sports fisheries and survival to spawning.

Stanislaus River

The Stanislaus River is the northern most major tributary to the San Joaquin River. Average monthly unimpaired flows at New Melones Dam are approximately 96,000 af. These flows are reduced to approximately 57,000 af at Ripon, near the confluence with the San Joaquin River, due to flow diversion and regulation at Goodwin Dam.

Goodwin Dam is about 15 miles below New Melones. It serves as the limit to upstream migration for anadromous fish. Anadromous habitat has been reduced from 113 miles to 46 miles. There are approximately forty small, unscreened pump diversions (for agricultural purposes) along the river. New Melones Reservoir is operated to store water during the winter and spring and release it during the summer (San Joaquin River Group Authority 1999).

Adult Chinook salmon begin to return to the Stanislaus River in August with the peak in returns occurring in October. Spawning activity peaks in November and continues into January. Adult Chinook have occasionally been observed in the Stanislaus as early as May. Stanislaus River Chinook escapements have averaged 5,556 and ranged from 0 to 35,000 between 1947 and 2000 (Figure 12–10). Peaks in escapement of over 10,000 fish occurred in the late 1940s, early 50s, late 60s and early 70s, and mid 80s.

The downstream migration of Chinook salmon fry and smolts in the Stanislaus River generally begins in December with newly emergent fry and continues into June. A majority emigrate as fry in January through March. A smaller proportion rear for about one to four months in the river before emigrating. While out-migration of smolts does not appear to be triggered by high flows (Demko et al. 2000), peaks in movement of fry are often correlated with high flow events. When high flow events do not occur, a greater proportion of fry establish rearing territories in the river and remain there longer. Figure 12–11 shows recent Chinook outmigration estimates and prior fall spawning escapement estimates. Higher escapements appeared to result in higher juvenile outmigration until 2001 when outmigration was low. This may be due to the lack of freshets during the outmigration period in 2001 resulting in more fish remaining in the river longer, decreasing in-river survival.

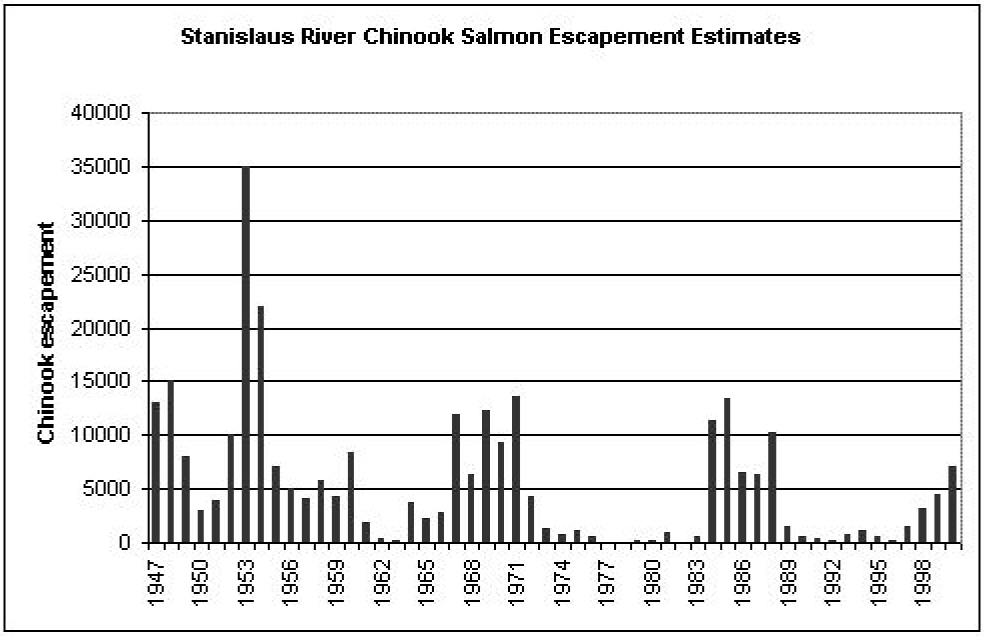


Figure 12–10 Chinook salmon escapement in the Stanislaus River, 1947-2000.

The main Chinook salmon stressors identified in the Stanislaus River include an altered hydrograph lacking significant peak flows, high water temperatures during summer and fall, predation by striped bass and pikeminnows, and a shortage of high quality spawning gravel. Operation of New Melones and Goodwin Dam for water delivery and flood control can affect all of these stressors, directly or indirectly.

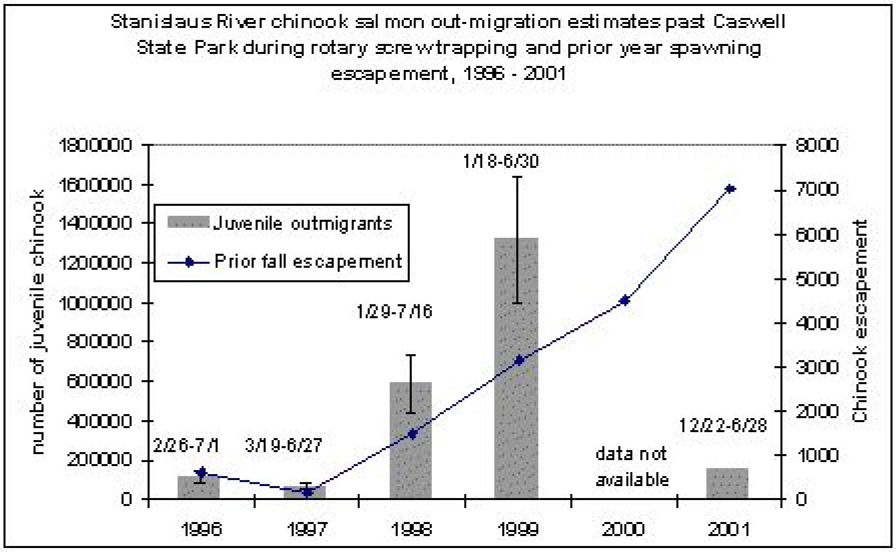


Figure 12–11 Stanislaus River Chinook salmon out-migration estimates past Caswell State Park during rotary screw trapping and prior year spawning escapement, 1996-2001.

Error bars are 95 percent confidence intervals. Dates of trapping are shown above the bars. 1996-97 trapping captured only the latter part of the run. 1996-99 data is from Demko et al. (2000). 2001 estimate calculated from data provided by S.P. Cramer & Associates.

Dam operations store water during winter and spring for releases to irrigators during late spring, summer, and fall. Historical high flows in the river have been dampened for flood control and water storage (Figure 12–12). The 20-year flood flow has been decreased by eight times compared to the historic flow. Moderate flows of around 300-600 cfs have been extended out through much of the year to provide better water quality in the Stanislaus for fish and in the Delta for pumping operations. The long-term effect of the lack of high flows is the simplification of instream habitat. High channel forming flows maintain high quality spawning habitat and riparian floodplain conditions. With reduced flows, riparian vegetation along the banks has become more stable. When high flows do occur they are unable to reshape the channel as occurred historically when high flood flows were more frequent events. High flows mobilize spawning sized gravels from streambanks and incorporate them into the active channel. In the absence of high flows, spawning habitat quality has decreased. In addition, the dams have eliminated recruitment of spawning gravel from upstream sources. Based on an aerial photo analysis 161,400 square feet (30 percent) of spawning gravel was lost between 1961 and 1972 and 150,600 square feet was lost between 1972 and 1994. Spawning gravel additions have occurred regularly in an attempt to maintain good spawning habitat.

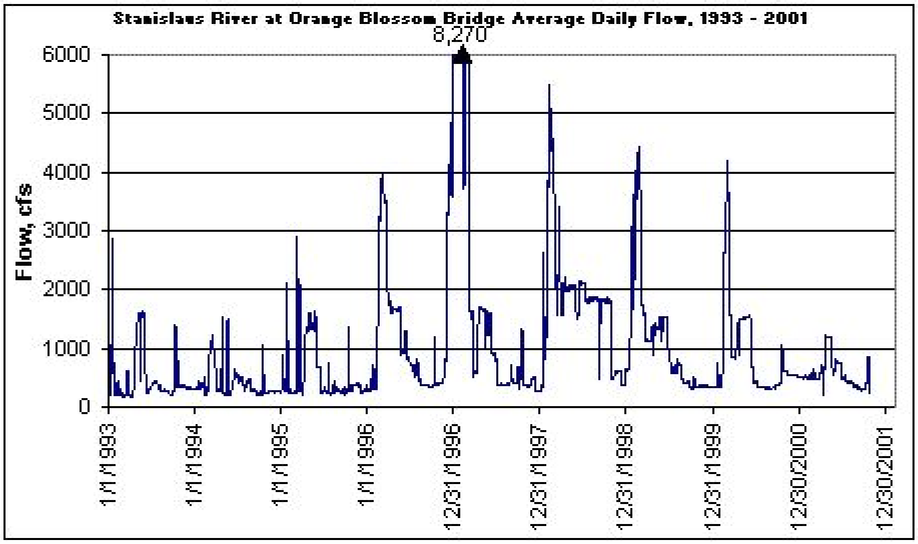


Figure 12–12 Stanislaus River flow at Orange Blossom Bridge, 1993-2001.

Access to upstream habitat, where water temperatures are cooler, has been blocked by the dams. Therefore, cool water temperatures are critical in the available anadromous habitat. The summer time release of water stored in upstream reservoirs provides late summer flows higher than those that occurred historically. These releases have allowed anadromous fisheries populations to persist in the remaining accessible habitat below Goodwin Dam.

Predation by introduced striped bass and native pikeminnows may be a significant stressor to juvenile fish rearing in the river. Cooler water lowers the metabolic rate of predators and likely reduces the effect of predation. Gravel mining along the river has created backwater areas where there is no flow, allowing the water to become warmer. Predators such as striped bass, pikeminnows, and largemouth bass do well in these backwater areas and may use them as refuge habitat from the cooler water areas.

Aceituno (1993) applied the instream flow incremental methodology to the Stanislaus River between Riverbank and Goodwin Dam (24 river miles) to help to determine instream flow needs for Chinook salmon and steelhead. Table 12–4 gives the resulting instream flow recommendations for Chinook salmon.

Studies are underway in the Stanislaus to determine the best spring time flow regimes to maximize survival of juvenile Chinook. The studies utilize survival estimates from marked hatchery fish released at various flows(Table 12–5). These tests took place during the VAMP flows which occur after the peak outmigration period from the Stanislaus River.

Table 12–4 Instream flows (cfs) that would provide the maximum weighted usable area of habitat for Chinook salmon in the Stanislaus River between Goodwin Dam and Riverbank[23].

Life Stage	*Dates*	*Number of days*	*Flow at Goodwin (cfs)*	*Dam release (af)*
Spawning	October 15 - December 31	78	200	46,414
Egg Incubation/Fry Rearing	January 1 - February 15	46	150	13,686
Juvenile Rearing	February 15 - October 15	241	200	95,605
Total		365		155,705

Table 12–5 Stanislaus River summary of past smolt survival tests.

Stanislaus River Summary of Past Smolt Survival Tests

Year	tag codes	Rel. Start	Rel. End	Flow at OBB (cfs)	Avg. Temp at Ripon1	Rel. Location	# Released	Release Length (mm)	Recoveries at Oakdale	Survival to Oak RST	Recoveries at Caswell	Survival to Cas RST	Recoveries at Mossdale2	Riverwide Survival
1986		28-Apr	28-Apr	1200	62	Knights Ferry			na	na	na	na		
		28-Apr	28-Apr	1200	62	Naco West			na	na	na	na		0.59
1988	b6-11-05, -06	26-Apr	26-Apr	900	60	Knights Ferry	71,675	75.2	na	na	na	na	278	0.54
	b6-11-03, -04	26-Apr	26-Apr	900	60	Naco West	68,788	79.6	na	na	na	na	828	
1989	b6-14-09,-10	20-Apr	20-Apr	900	64	Knights Ferry	103,863	77.4	na	na	na	na	471	0.37
	b6-01-01, -14-11	19-Apr	19-Apr	900	64	Naco West	74,073	76.5	na	na	na	na	860	
	b6-14-12	3-May	3-May			Naco West	46,169	72.4	na	na	na	na	173	
1999		1-Jun	1-Jun	1300	60	Knights Ferry	25,536		156	0.77	35	0.07		
		1-Jun	1-Jun	1300	60	RM 40	4,975	84.4	na	na	10	0.10		
		2-Jun	2-Jun	1300	60	RM 40	4,403	83.2	na	na	7	0.08		
					60	RM 40 (combined)	9,378	83.8	na	na	17	0.09		
		1-Jun	1-Jun	1300	60	RM 38	4,981	85.3	na	na	8	0.08		
		2-Jun	2-Jun	1300	60	RM 38	5,007	84.8	na	na	8	0.08		
					60	RM 38 (combined)	9,998	85.1	na	na	16	0.08		
2000		18-May	19-May	1500	61	Knights Ferry	77,438		546	0.73	127	0.13		
		20-May	20-May	1500	61	Two Rivers	50,547		na	na	na	na		0.57

1 1986-1989 from CDFG reports. 1999 and 2000 from SPCA Caswell.

2 1988 & 1989 from Demko's files of Mossdale catch.

Feather River

The lower Feather River has two runs of Chinook salmon, the fall-run and spring-run. Adult fall-run typically return to the river to spawn during September through December, with a peak from mid-October through early December. Spring-run enter the Feather River from March through June and spawn the following autumn (Painter et al. 1977). Fry from both races of salmon

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[23] Source: Aceituno 1993.

emerge from spawning gravels as early as November (Painter et al. 1977; DWR unpublished data) and generally rear in the river for at least several weeks. Emigration occurs from December to June, with a typical peak between January and March (Figure 12–13). The vast majority of these fish emigrate as fry (DWR unpublished data), suggesting that rearing habitat is limiting or that conditions later in the season are less suitable. Risks for late migrating salmon include higher predation rates and high temperatures. The primary location(s) where these fish rear is unknown, however in wetter years it appears that many young salmon rear for weeks to months in the Yolo Bypass floodplain immediately downstream of the Feather River before migrating to the estuary (Sommer et al. 2001b).

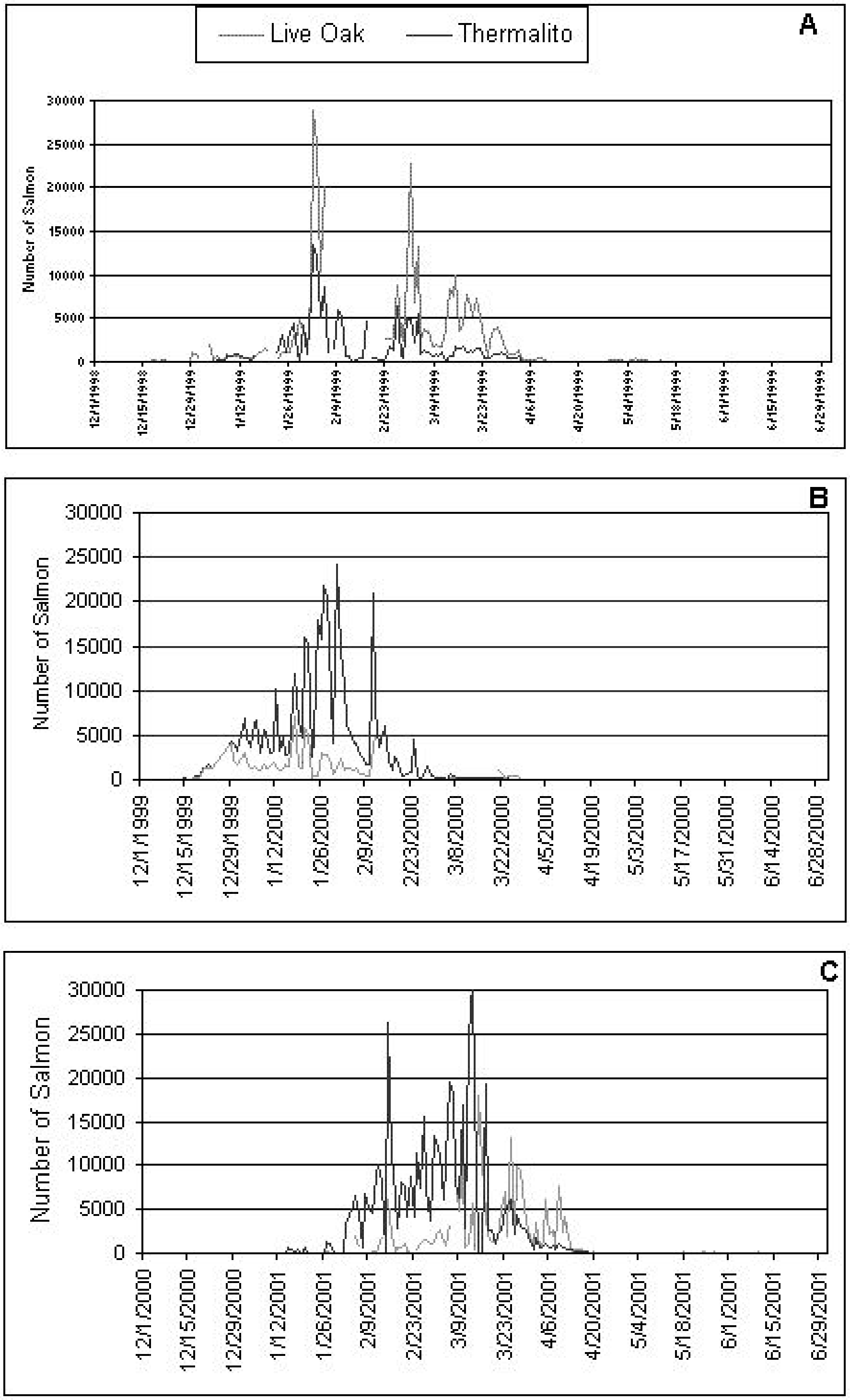

Figure 12–13 Daily catch distribution of fall-run Chinook salmon caught at Live Oak and Thermalito rotary screw traps during 1998, 1999, and 2000 (trapping years a, b, and c, respectively).

Historical distribution and abundance of Chinook salmon in the Feather River is reviewed by Yoshiyama et al. (2001). They note that fall-run historically spawned primarily in the mainstem river downstream of the present site of Lake Oroville, while spring-run ascended all three upstream branches. Fry (1961) reported fall-run escapement estimates of 10,000 to 86,000 for 1940-59, compared to 1,000 to about 4,000 for spring-run. Recent fall-run population trends continue to show annual variability, but are more stable than before Oroville Dam was completed (Figure 12–14). Pre-dam escapement levels have averaged approximately 41,000 compared to about 46,000 thereafter (see also Reynolds et al. 1993). This increase appears to be a result of hatchery production in the system.

Hatchery History and Operations

Feather River Hatchery was opened in 1967 to compensate for the loss of upstream habitat by the construction of Oroville Dam. The facility is operated by the DFG and typically spawns approximately 10,000 adult salmon each year (Figure 12–14). Until the 1980s, the majority of the young hatchery salmon was released into the Feather River (Figure 12–15). However, the release location was shifted to the Bay-Delta Estuary to improve survival. DFG is now considering shifting the release of at least a portion of the hatchery fish back to the Feather River to reduce the potential for straying into other watersheds.

Hydrology

The Feather River drainage is located within the Central Valley, draining about 3,600 square miles of the western slope of the Sierra Nevada (Sommer et al. 2001a). The reach between Honcut Creek and Oroville Dam is of low gradient. The river has three forks, the North Fork, Middle Fork, and South Fork, which meet at Lake Oroville. Lake Oroville, created by the completion of Oroville Dam in 1967, has a capacity of about 3.5 million acre-feet (MAF) of water and is used for flood control, water supply, power generation, and recreation. The lower Feather River below the reservoir is regulated by Oroville Dam, Thermalito Diversion Dam, and Thermalito Afterbay Outlet. Under normal operations, the majority of the Feather River flow is diverted at Thermalito Diversion Dam into Thermalito Forebay. The remainder of the flow, typically 600 cfs, flows through the historical river channel, the “low flow channel” (LFC). Water released by the forebay is used to generate power before discharge into Thermalito Afterbay. Water is returned to the Feather River through Thermalito Afterbay Outlet, then flows southward through the valley until the confluence with the Sacramento River at Verona. The Feather River is the largest tributary of the Sacramento River.

The primary area of interest for salmon spawning is the low flow channel, which extends from the Fish Barrier Dam (river mile 67) to Thermalito Afterbay Outlet (river mile 59), and a lower reach from Thermalito Afterbay Outlet to Honcut Creek (river mile 44). There is little spawning activity in the Feather River below Honcut Creek.

The hydrology of the river has been considerably altered by the operation of the Oroville complex. The major change is that flow that historically passed through the LFC is now diverted into the Thermalito complex. Mean monthly flows through the LFC are now 5 percent to 38 percent of pre-dam levels (Figure 12–16). Mean total flow is presently lower than historical levels during February through June, but higher during July through January.

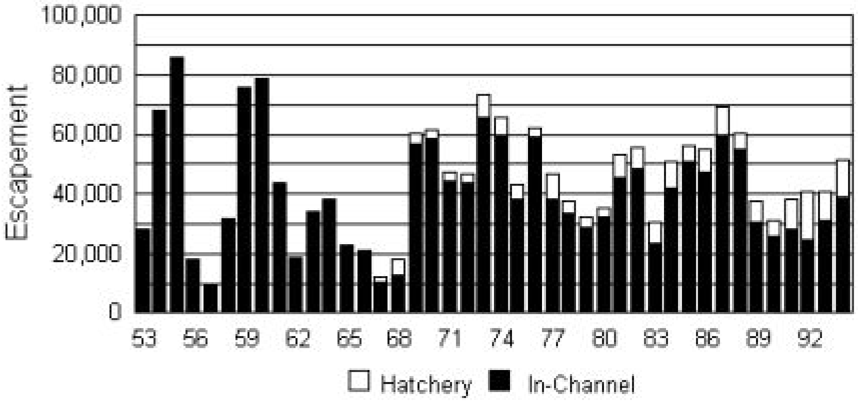

Figure 12–14 Escapement of fall-run Chinook salmon (1953-94) in the FRH and channel.

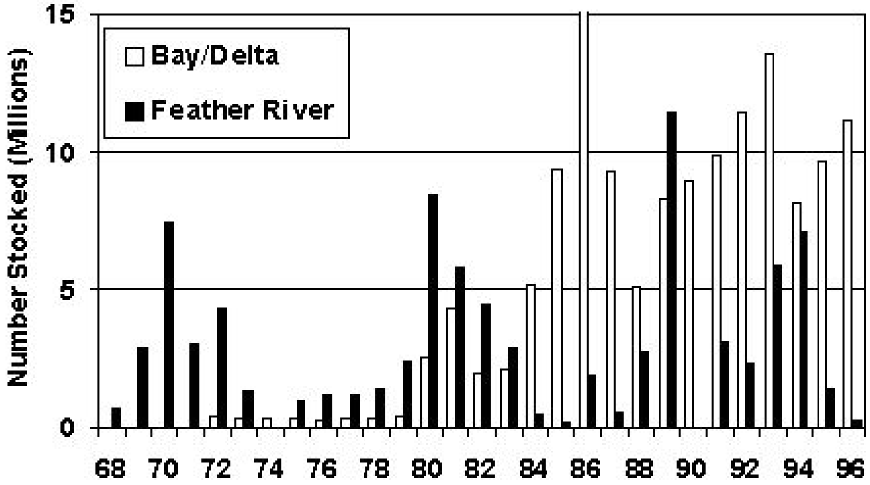

Figure 12–15 Stocking rates of juvenile salmon from the FRH into river and Bay-Delta locations.

Project operations have also changed water temperatures in the river. Compared to historical levels, mean monthly water temperatures in the LFC at Oroville are 2° F to 14° F cooler during May through October and 2° F to 7° F warmer during November through April. Pre-project temperature data are not available for the reach below Thermalito Afterbay Outlet, but releases from the broad, shallow Thermalito Afterbay reservoir probably create warmer conditions than historical levels for at least part of the spring and summer.

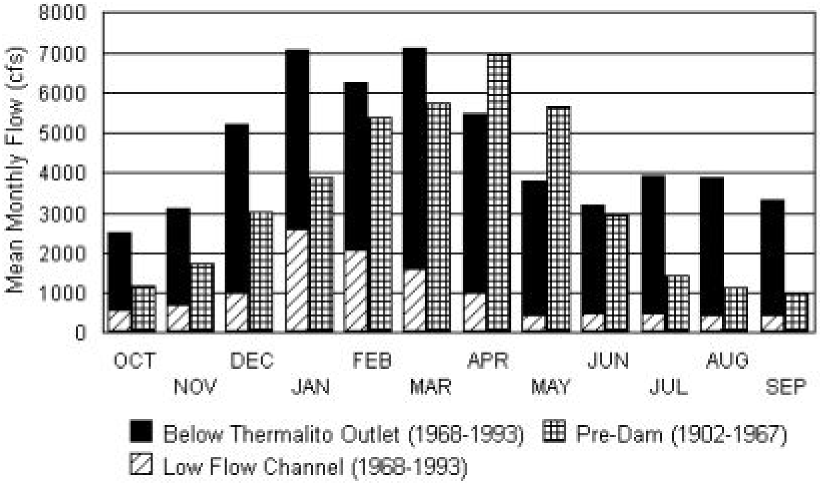

Figure 12–16 Mean monthly flows (cfs) in the Feather River for the pre-Oroville Dam (1902-67) and post-Oroville Dam (1968-93) periods.

Total flow in the post-dam period includes the portion from the low flow channel and the portion diverted through the Thermalito complex.

Spawning Distribution

Since the construction of Oroville Dam and FRH, there has been a marked shift in the spawning distribution of Chinook salmon in the lower Feather River. Salmon have shifted their spawning activity from predominantly in the reach below Thermalito Afterbay Outlet to the LFC (Figure 12–17) (Sommer et al. 2001a).

An average of 75 percent of spawning activity now occurs in the LFC with the greatest portion crowded in the upper three miles of the LFC. While there is evidence that this upper section of the LFC was also intensively used after the construction of the dam and hatchery, the shift in the spawning distribution has undoubtedly increased spawning densities. The high superimposition indices in the LFC suggest that there is not enough spawning habitat for the large numbers of salmon attempt to utilize the area. It must be observed; however, that the very success of the hatchery is responsible for the large population of adult fall-run spawners. Without the production of the FRH it would be impossible for salmon populations to regularly exceed the river's post-dam carry capacity. Therefore, the high density of hatchery produced salmon spawning at the upstream end of the low flow channel may be attributed to hatchery production levels, and potentially, to a tendency among hatchery fish to return to their place of origin.

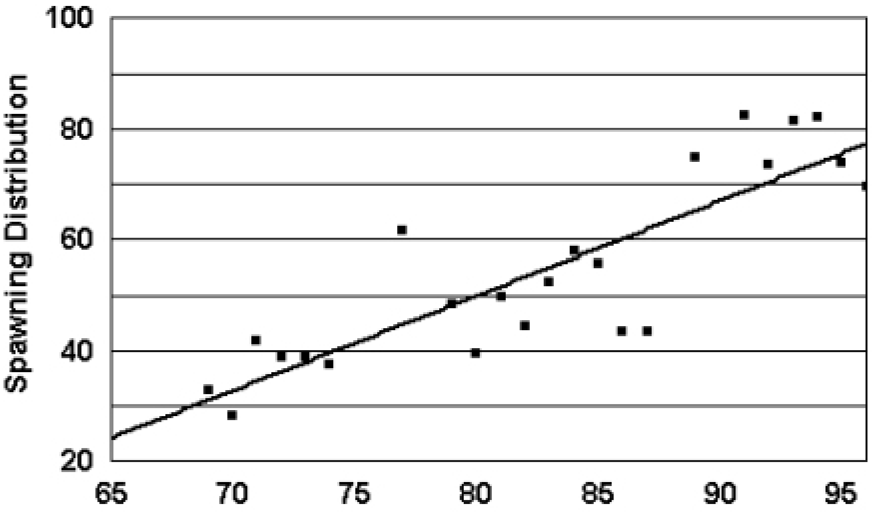

Figure 12–17 The percentage of salmon spawning in the Feather River low flow channel for 1969-96. The increase is significant at the *P* < 0.001 level.

Currently several studies are underway to evaluate salmon and steelhead populations in the Feather River. Since fall 2000, DWR in cooperation with DFG has conducted salmon spawning escapement data on the Feather River. This survey takes place from September through December. The purpose of this survey is to measure the abundance and distribution of spawning effort among fall-run salmon on the Feather River. The escapement surveys also collects information about the size and sex distribution among the population, and on the rates of pre-spawning mortality among female salmon. DWR staff also operate two rotary screw traps on the Feather River. These traps are located upstream of the Thermalito Outlet and near Live Oak. These traps are operated from November throughJune and collect information about the abundance of juvenile salmonids and the factors which may influence their migration timing. During the spring and summer DWR also conducts snorkel surveys on the Feather River. The purpose of these surveys is to document abundance, distribution and habitat use among juvenile salmonids during this period of time when the effects of environmental stressors may be most acute.

Trinity River Chinook Salmon EFH

The increased flows in the spring for the restoration program would aid outmigrating Chinook so smolt survival should increase. The habitat benefits provided through more natural geomorphic processes should benefit Chinook salmon.

Temperatures in the Trinity during the fall Chinook spawning period will be slightly increased in the future because more water would be released early in the season. The result will be slightly higher egg mortality, mostly in critically dry years (Figure 9–11).

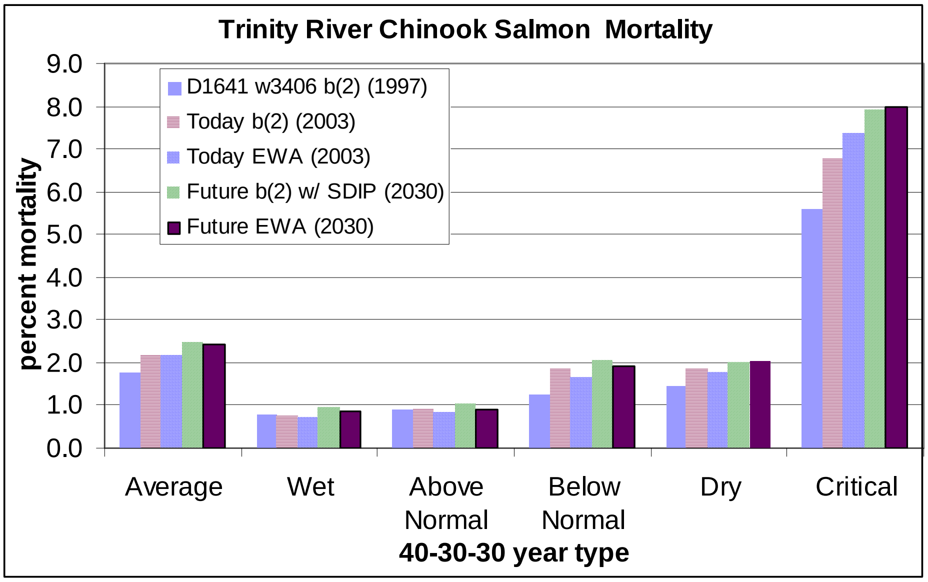

Figure 12–18 Percent mortality of Chinook salmon from egg to fry in the Trinity River based on water temperature by water year type.

Summary of effects on EFH for Fall run and Late Fall Run Chinook Salmon

Mortality model outputs for fall run and late fall run Chinook are included at the end of this section. See Figure 12–19 to Figure 12–23.

Upper Sacramento River

Fall/late fall-run spawning in the upper Sacramento River may be affected in some years when flows are dropped off in the fall as water demands decrease. Redd dewatering is possible in some years. This may be the most significant effect of project operations on fall/late fall-run in the upper Sacramento.

Clear Creek

Temperatures and flows are generally suitable year round in Clear Creek for fall run Chinook. No effects to EFH for fall run in Clear Creek are anticipated.

Feather River

Flow and water temperature conditions should be generally suitable for all fall–run Chinook salmon life history stages all year in the low flow channel, particularly in the upper low flow channel. Superimposition on spring–run Chinook salmon redds by fall–run Chinook may continue to be a problem. The reach below the Thermalito outlet will be less suitable. Water temperatures below Thermalito will be too warm for adult holding and spawning, but will be appropriate for juvenile rearing and emigration during winter and early spring.

American River

Flows are projected to be adequate for fall–run Chinook spawning in normal water conditions but if dry conditions occur, flows are projected to provide less than optimal spawning habitat for Chinook. Flows in the spring should be adequate for outmigration. Temperature goals for fall–run Chinook spawning and incubation are projected to be met in November of almost every year but meeting the goals will likely involve trade-offs between providing cool water for better steelhead rearing conditions during the summer and providing it for Chinook spawning in the fall. Water temperatures for Chinook rearing are forecast to exceed the preferred range generally starting in April. Most Chinook leave the river by early April. Temperatures will be higher in June through November under future operations due to increased upstream diversions, causing more temperature stress on migrating and holding adults in the fall.

Stanislaus River

No listed Chinook runs spawn in the Stanislaus River. Flows are projected to be adequate for fall–run Chinook spawning in nearly all years. Water temperatures will be warm in the lower part of the river during the early part of the immigration period but should be suitable for spawning and rearing in the upper river during the entire spawning and rearing period. Temperatures should be suitable for outmigration of fry and smolts, but when dry conditions occur, flows can be less than desired for optimal outmigration prior to the VAMP period. No changes in operations are proposed for the Stanislaus River.

Delta

Fall and late fall-run Chinook take occurs at the Delta pumping facilities. Protective measures target winter run and spring run Chinook, but the VAMP period is intended to focus on the fall and late-fall run through Delta migration peak.

Conclusion for Fall and late fall-run Chinook

CVP and SWP operations will affect the EFH of fall run and late fall run Chinook. Chinook salmon EFH in the Trinity River should benefit from the Trinity River Restoration Program flows and other habitat improvement measures.

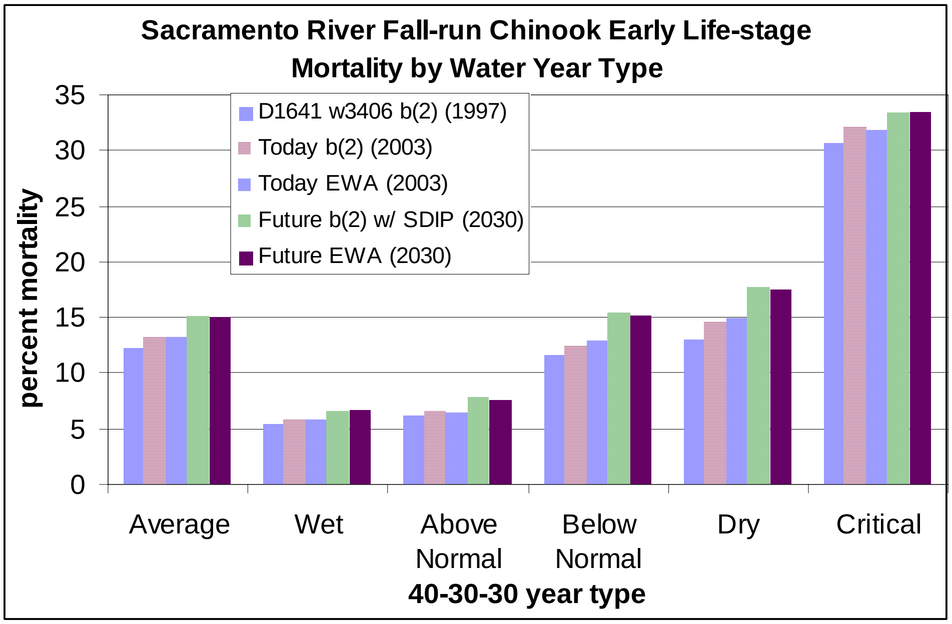

Figure 12–19 Sacramento River Fall-run Chinook Early Life-stage Mortality by Water Year Type

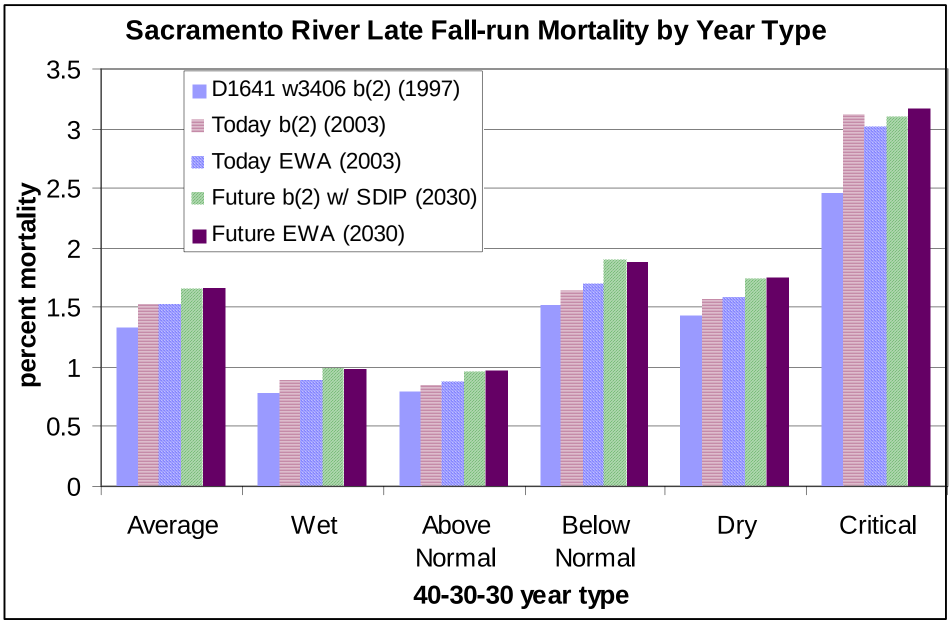

Figure 12–20 Sacramento River Late Fall-run Mortality by Year Type

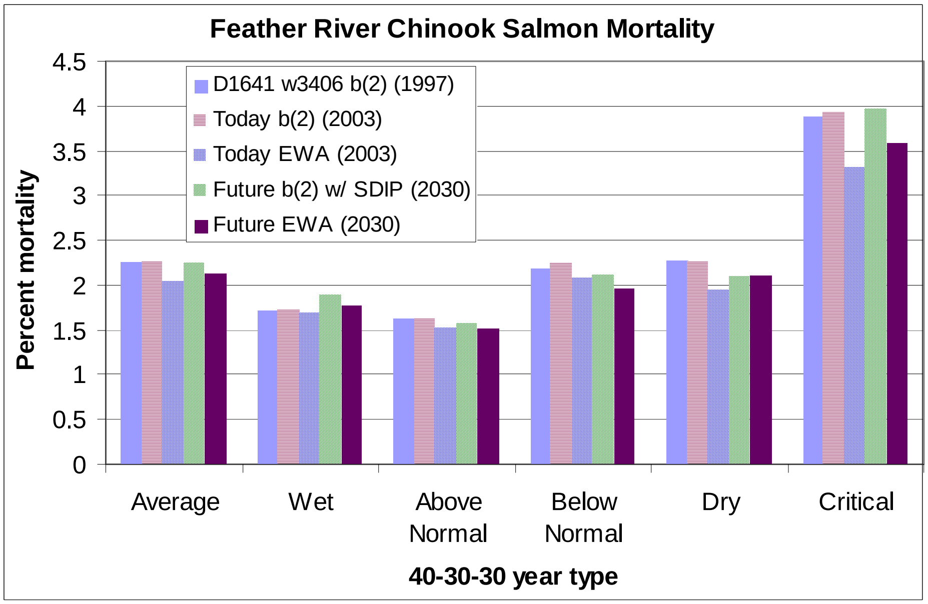

Figure 12–21 Feather River Chinook Salmon Mortality

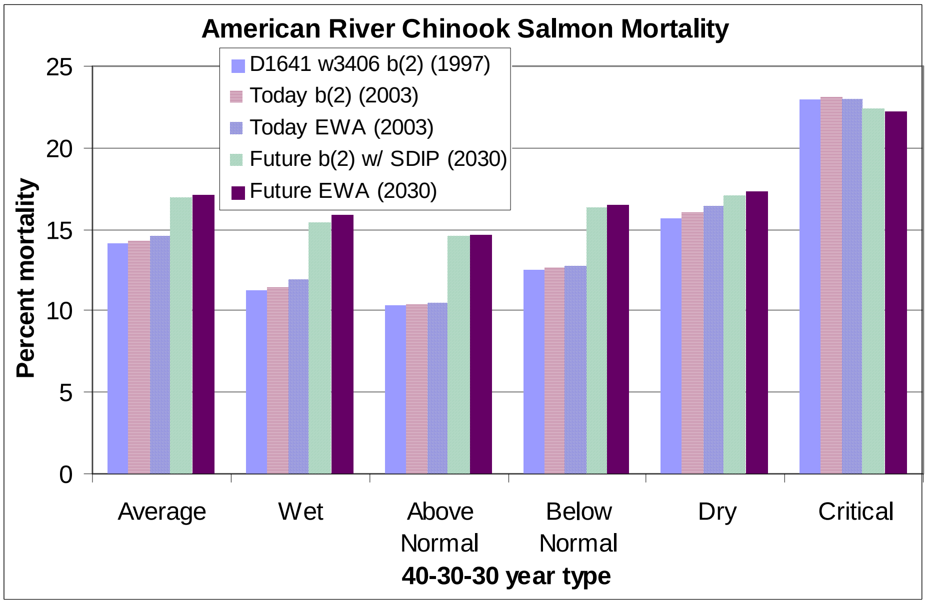

Figure 12–22 American River Chinook Salmon Mortality

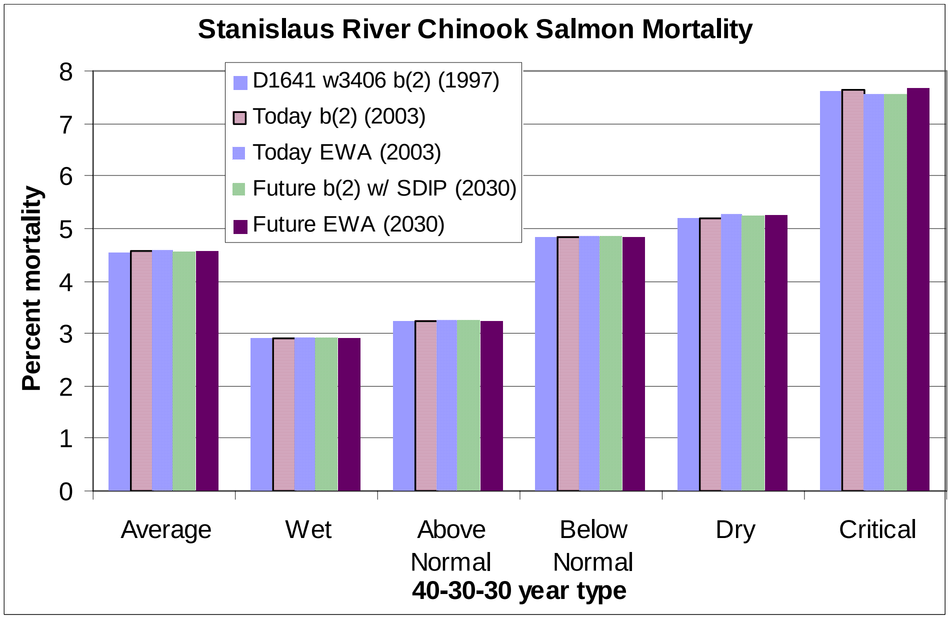

Figure 12–23 Stanislaus River Chinook Salmon Mortality

Chapter 13 Ongoing Actions to Address State Water Project and Central Valley Project Impacts

DWR and Reclamation work with DFG, FWS, and NOAA Fisheries to mitigate losses of salmon, delta smelt, and steelhead that cannot be reasonably avoided. Several agreements and programs are in place that mitigate for direct losses at the SWP and CVP and help improve and restore fishery resources. Chinook salmon, delta smelt, and steelhead are among the species that benefit from the mitigation actions provided under these agreements and programs.

Central Valley Project Improvement Act

On October 30, 1992, the Reclamation Projects Authorization and Adjustment Act of 1992 (Public Law 102–575) was signed into law, including Title XXXIV, the CVPIA. The CVPIA amends the authorization of the CVP to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic uses, and fish and wildlife enhancement as a purpose equal to power generation. Implementation of CVPIA measures to double anadromous fish populations, improve habitat, and reduce losses of steelhead, spring-run salmon, and other salmon races include habitat restoration, improving fish passage, and diversion screening.

DFG has identified the CVPIA as one of the two major restoration plans addressing habitat restoration projects to benefit Chinook salmon, with great potential to successfully fund and implement restoration actions needed to protect and restore the run (DFG 1998). The other major restoration plan is DFG’s action plan for restoring Central Valley streams (DFG 1993).

Since passage of the CVPIA, Reclamation and the FWS, with the assistance of the State of California and the cooperation of many partners, have completed many of the necessary administrative requirements, conducted numerous studies and investigations, implemented hundreds of measures, and have generally made significant progress towards achieving the goals and objectives established by the CVPIA. Positive effects in the Central Valley ecosystem are being observed in many species and habitat types. Clearly, much more needs to be done, and it will be many years before all goals can be achieved.

CVPIA Sections 3406 (b)(1) through (21) authorize and direct actions that will ultimately assist in protecting and restoring salmon and steelhead. These actions include modification of CVP operations, management and acquisition of water for fish and wildlife needs, and mitigation for pumping plant operations. Also included are actions to minimize and resolve fish passage problems, improve fish migration and passage (pulse flows, increased flows, seasonal fish barriers), replenish spawning gravels, restore riparian habitat, and a diversion screening program.

A summary of the actions completed in these past 10 years is provided below in Table 13–1. A more detailed narrative discussion of these efforts and of the progress towards achieving CVPIA goals follows. This discussion contains information from a draft 10-year Report being prepared by Reclamation and FWS.

Table 13–1 SUMMARY OF CVPIA ACCOMPLISHMENTS - 1992-2002.

PROGRAM OR PROJECT	STATUS
Anadromous Fish - Habitat Restoration	
Anadromous Fish Restoration Program	Established AFRP, developed Restoration Plan to guide implementation of efforts; partnered with local watershed groups; acquired over 8,200 acres and enhanced over 1,000 acres of riparian habitat; restored over 5.6 miles of stream channel and placed 62,300 tons of spawning gravels; eliminated predator habitat in San Joaquin River tributaries; and provided for fish protective devices at 7 diversion structures on Butte Creek
Dedicated CVP Yield	Implemented management of 800,000 acre-feet of water dedicated to CVPIA purposes; ongoing
Water Acquisition Program (Anadromous Fish Focus)	Acquired 913,952 acre-feet of water for anadromous fish from 1993-2002
Clear Creek Fishery Restoration	Removed Saeltzer Dam and diversion; increased flows; restored 2.0 miles of stream channel and 68 acres of floodplain; added 54,000 tons of spawning gravel; 152 acres of shaded fuelbreak have been constructed and 12 miles of roadway treated to control erosion.
Gravel Replenishment and Riparian Habitat Protection	Developed long-term plans for CVP streams; placed 111,488 tons of gravel in Sacramento, American and Stanislaus Rivers.
Trinity River Fishery Flow Evaluation Program	Conducted flow evaluation studies; completed EIR/EIS to analyze range of alternatives for restoring and maintaining fish populations downstream from Lewiston Dam; Record of Decision signed December 2000; construction underway on improvements to infrastructure to accommodate increased streamflows
Anadromous Fish - Structural Measures	
Tracy Pumping Plant Mitigation	Improved predator removal; increased biological oversight of pumping; developed better research program, new lab and aquaculture facilities; improved and modified existing facilities
Contra Costa Canal Pumping Plant Mitigation	Established cooperative program for fish screen project for Rock Slough intake of Contra Costa Canal; 90 % designs and environmental evaluation completed. New short-term, low-cost mitigation measures are being developed to allow for an extension of the construction completion date. Final design and construction pending results of CALFED Stage 1 and other studies.
Shasta Temperature Control Device	Completed 2/28/97; since operated to reduce river temperatures without stopping power generation operations [cost $80 million; loss in power generation pre-TCD was $35 million over 7 years]
Red Bluff Dam Fish Passage Program	Completed interim actions and modification of Red Bluff Diversion Dam to meet needs of fish and water users; studies of fish passage alternatives is ongoing.

PROGRAM OR PROJECT	STATUS
Coleman National Fish Hatchery Restoration and Keswick Fish Trap Modification	Installed ozone water treatment system; installed fish trap improvements; improved raceways and barrier weir and ladders; installed interim screens at intakes. Established Livingston Stone National Fish Hatchery.
Anderson-Cottonwood I.D. Fish Passage	Modified dam and operations to improve fish passage; designed new fish ladders and screens.
Glenn-Colusa I.D. Pumping Plant	Constructed fish screen for 3,000 cfs diversion; completed water control structure and access bridge. Completed improvements on side channel.
Anadromous Fish Screen Program	Established program; installed 17 screens and 3 fish ladders at diversions totaling 3,200 cfs capacity; removed 4 dams and 14 diversions. Three screens under construction: others in design.
Other Fish and Wildlife	
Habitat Restoration Program	Established Habitat Restoration Program and San Joaquin River Riparian Habitat Restoration Program; helped acquire 88,364 acres of native habitat and restore 1,111 acres.
Land Retirement Program	Established land retirement program to decrease drainage problems in San Joaquin Valley and enhance wildlife habitat and recovery of endangered species; acquired over 10,000 acres from willing sellers; demonstration project underway with various land treatments applied on over 2200 acres of retired lands to date.
Monitoring	
Comprehensive Assessment and Monitoring Program	Established program to evaluate success of restoration efforts; ongoing
Studies, Investigations and Modeling	
Flow Fluctuation	Coordinated management of CVP facilities; developed standards to minimize fishery impacts from flow fluctuation; studies on American and Stanislaus Rivers are ongoing
Shasta and Trinity Reservoir Carryover Storage Studies	Ongoing studies [related studies funded under 3406(b)(9)]
San Joaquin River Comprehensive Plan	Initiated evaluation to reestablish anadromous fish from Friant Dam to Bay-Delta Estuary; due to public opposition to continued study, Congress dropped funding
Stanislaus River Basin Water Needs	Prepared Stanislaus and Calaveras River water use program and ESA report; additional studies ongoing concurrent with development of Stanislaus River long-term management plans

PROGRAM OR PROJECT	STATUS
Central Valley Wetlands Water Supply Investigations	Report completed that identified private wetlands and water needs, alternative supplies and potential water supplies for supplemental wetlands. Developed GIS database to identify potential water supply sources.
Investigation on Maintaining Temperatures for Anadromous Fish	Completed field investigations on interaction between riparian forests and river water temperatures and on the general effects on water temperature of vegetation, irrigation return flow and sewage effluent discharge; ongoing
Investigations on Tributary Enhancement	Completed report in 1998 on investigations to eliminate fish barriers and improve habitat on all Central Valley tributary streams
Report on Fishery Impacts	Completed report in 1995 describing major impacts of CVP reservoir facilities and operations on anadromous fish
Ecological and Hydrologic Models	Developing models and data to evaluate effects of various operations of water facilities and systems in Sacramento, San Joaquin and Trinity River watersheds (to evaluate potential impacts of various CVP actions; cooperative effort with DWR, USGS, others); ongoing
Project Yield Increase (Water Augmentation Program)	Developed least-cost plan considering supply increase and demand reduction opportunities

Delta Pumping Plant Fish Protection Agreement

On December 30, 1986, the Directors of DWR and DFG signed an agreement to provide for offsetting direct losses of fish caused by the diversion of water at the Banks Pumping Plant. The agreement is commonly referred to as the Four Pumps Agreement because it was adopted as part of the mitigation package for four new pumps at the Banks Pumping Plant. Among its provisions, the Agreement provides for the estimation of annual fish losses and mitigation credits, and for the funding and implementation of mitigation projects. The Agreement gives priority to mitigation measures for habitat restoration and other non-hatchery measures to help protect the genetic diversity of fish stocks and avoid over reliance on hatcheries. In the case of chinook salmon, priority is given to salmon measures in the San Joaquin River system.

The Four Pumps Program has approved about $49 million for projects that benefit salmon and steelhead production in the Sacramento-San Joaquin Basins and Delta since 1986. About $39 million of these approved funds have been expended, with the remaining funds allocated for new or longer-term salmon projects. Projects that have been completed, are on-going, or will be implemented in future years are listed by project type as follows:

1. Screening of unscreened water diversions in Suisun Marsh (8 screens), Butte Creek (2 screens), and San Joaquin tributaries (6 to 10 screens).
2. Enhanced law enforcement efforts to reduce illegal harvest in the Bay-Delta and upstream in the Sacramento-San Joaquin Basins (2 projects).

3. Seasonal barriers to guide salmon away from undesirable spawning habitat or migration pathways (2 projects).
4. Water exchange projects on Mill and Deer Creeks to provide salmonid passage flows for adult spawners and out-migrant young (2 projects).
5. Fish ladders for improved upstream passage on Butte Creek (2 projects).
6. Spawning gravel replacement and maintenance on the Sacramento system (2 projects) and San Joaquin tributaries (7 projects).
7. Other salmonid habitat enhancement projects that combine spawning and rearing habitat improvement, elimination of salmonid predator habitat, and improved channel, floodplain, and riparian areas (6 projects).
8. Salmon and steelhead hatchery production projects (3 projects).
9. Salmon acclimation pens to improve survival of hatchery salmon released In Carquinez Strait (1 project).

Four Pumps projects that benefit spring-run Chinook salmon and steelhead include water exchange projects on Mill and Deer Creeks; enhanced law enforcement efforts from San Francisco Bay upstream into the Sacramento and San Joaquin Rivers and their tributaries; and design and construction of fish screens and ladders on Butte Creek. Predator habitat isolation and removal and spawning habitat enhancement projects on the San Joaquin tributaries benefit fall-run Chinook salmon and steelhead. About a third of approved funding for salmonid projects are specifically targeting spring-run salmon in the upper Sacramento tributaries. Most of these projects also benefit steelhead and fall-run salmon.

The water exchange projects on Mill and Deer Creeks provide for new wells that enable irrigators to switch from stream diversions to groundwater, thus leaving water in the creeks during critical migration periods. Spring-run Chinook salmon are the primary benefactors of this project, with secondary benefits to fall-run Chinook salmon and steelhead. Costs for construction and 15-year operations for both projects are estimated to be $4.6 million. The Mill Creek project has operated since 1990. A pilot project using one of the 10 pumps originally proposed for Deer Creek was tested in summer 2003. Another run of testing is scheduled for summer 2004.

Enhanced law enforcement activities continue to be implemented throughout the fall-run, spring-run, and steelhead range. The Spring-run Salmon Increased Protection Project provides overtime wages for DFG wardens to focus on spring-run salmon protection, reducing illegal take and illegal diversions on upper Sacramento River tributaries and adult holding areas, where they are very vulnerable to poaching. The project covers Mill, Deer, Antelope, Butte, Big Chico, Cottonwood, and Battle Creeks, and has been in effect since 1995. The Delta-Bay Enhanced Enforcement Program (DBEEP) is a larger effort, initiated in 1994, that also provides increased salmonid enforcement from the San Francisco Bay Estuary upstream into the Sacramento and San Joaquin Basins. This program (which has been partially funded by Reclamation) has a team of 10 wardens that focus enforcement efforts to protect salmon, steelhead, and striped bass. The Sacramento River program continues to focus specific enforcement during the spring-run migration and summer holding period. The combined cost of these programs through 2005 is $9.6 million.

Four Pumps has provided about $400,000 in cost-share funds for several projects to improve passage for adult and juvenile spring-run salmon on Butte Creek, with secondary benefits to fall-run and steelhead. These funds played an important role in completing these projects because they were readily available at crucial points of project implementation. Funds were made available to expedite design and engineering on three priority passage problem sites until Tracy Mitigation Funds were in place for these costs, thus preventing unnecessary fish losses if corrective measures had been postponed a season. Four Pumps also helped fund construction of the Parrot-Phelan Fish Ladder and the Durham Mutual Fish Ladder and Screens. The passage projects have improved salmon survival by allowing adult spawners to pass upstream during low water periods, through the quick passage of salmon progeny downstream, and by decreased injury of adults during all water years.

Several other projects funded by Four Pumps also provide benefits to fall-run and spring-run salmon and steelhead. About $2.5 million have been spent on eight fish screens in Suisun Marsh and $1.2 million for the eradication of northern pike. Steelhead will also benefit from the numerous projects completed or planned on the San Joaquin tributaries to remove or isolate salmonid predator habitat and enhance spawning habitat, particularly on the Stanislaus River. About $12 million has been provided for these projects. A quantitative analysis of Four Pumps mitigation for spring-run Chinook salmon follows.

Chinook Salmon Delta Losses

Estimations of both the losses and benefits to salmon for Four Pumps mitigation are based on the best available information and assumptions mutually agreed to by DFG and DWR. For purposes of the agreement, direct losses are defined as losses occurring from the time fish enter Clifton Court Forebay until surviving salvaged fish are returned to Delta channels. Direct losses include those fish that are eaten by predators or otherwise lost in the forebay, those that pass through the Skinner fish screens, and those that die as a result of handling and trucking stresses during the salvage process.

Quantification of overall spring-run losses in the Delta due to SWP operation is difficult. This is due both to our inability to distinguish spring-run from other salmon races in the Delta and our uncertainty about the relative importance of the variety of factors affecting spring-run survival in the Delta. However, there are several sources of information that can be used to determine the general magnitude of these losses.

The first source of information is the DFG annual estimate of salmon losses at the SWP’s south Delta pumping facilities, which is provided in accordance to the provisions of the Four Pumps Agreement. DFG’s annual salmon loss estimate includes all the losses of salmon occurring from the time the fish enter Clifton Court Forebay to the time salvaged fish are returned to the Delta. During the last five years, the total salmon losses have ranged between about 53,000 and 273,000 smolt equivalents and averaged about 178,000 smolt equivalents.

Only a small percent of the total salmon losses at the SWP’s south Delta pumping facilities are spring-run salmon. DFG and DWR believe most of the salmon losses are San Joaquin River fall-run, and have reflected that belief in the Four Pumps Agreement by giving priority to mitigation projects in the San Joaquin Basin. For this analysis we assume that the spring-run losses are 3 percent of the total losses at the south Delta facilities.

Over the years, mark and recapture studies suggest that losses of juvenile spring-run salmon in Delta channels may be several times the losses estimated at the SWP pumping facility. It is not known how much of these Delta channel losses are due to SWP operations. However, for this analysis we assume that the indirect losses in the Delta channels are five times those at the south Delta facilities. Using (1) DFG estimates of direct salmon losses at the SWP pumping facility, (2) the assumption that 3 percent of these are spring-run, and (3) the assumption that indirect losses are five times those of the direct losses, we calculated the spring-run losses due to SWP Delta operations during the last five years. These calculated spring-run losses are shown in Table 13–2.

Table 13–2 Spring-run salmon losses due to SWP's Delta operations (in smolt equivalents).

	1999	*2000*	*2001*	*2002*	*2003*
Pumping losses (3% actual)	8,200	7,200	5,300	1,600	4,200
Channel losses (5X actual)	41,000	36,500	26,500	8,000	21,000
Total losses	49,200	43,800	31,800	9,600	25,200

Chinook Salmon Mitigation

DFG and DWR have approved four projects that have been totally or partly funded through the Four Pumps Agreement, which include quantified benefits to spring-run salmon. These projects and DFG estimates of how many additional spring-run they will produce in the Delta to offset losses at Banks Pumping Plant are presented below (Table 13–3). The DFG estimates reflect the average annual benefits of each project over its life based on recent historical conditions.

Table 13–3 Predicted annual spring-run benefits of approved Four Pumps mitigation projects (in smolt equivalents).

Project	*Credits*
Warden overtime (Revised Estimate for 2003-4)	122,622
Durham Mutual/Parrott-Phelan screen and ladders	5,518
Mill Creek water exchange	35,915
Deer Creek water exchange	76,715
Total predicted credits	240,770

The warden, Durham Mutual/Parrot Phelan and Mill Creek projects have been implemented. DFG expects them to produce an annual average of over 164,000 additional spring-run in the Delta. As described above, a pilot Deer Creek Project is tested in summer 2003 with a second test scheduled for summer 2004

DFG has also agreed that two other Four Pumps salmon projects would offset spring-run losses at the Delta Pumping Plant. DFG has credited DWR with offsetting losses of two million salmon at the Delta Pumping Plant for funding the reduction of the northern pike population in Lake Davis, and with 250,000 salmon per year for funding 10 additional game wardens to reduce poaching in the Delta. One of these wardens was to focus primarily on protecting spring-run in Delta tributaries. DFG did not quantify the spring-run benefits of these two projects, and we have therefore not included them in this analysis.

The Four Pumps Agreement also provides $15 million for the implementation of additional fish improvement projects beyond those needed to replace the annual losses. These include screening of seven diversions in the Suisun Marsh and the cost sharing in the screening of an eighth diversion. The specific spring-run benefits of these screens were also not quantified and have not been included in this analysis.

The actual mitigation benefits of the Four Pumps spring-run projects are expected to vary from year to year, depending on the actual size and distribution of the stock in each tributary, the hydrology and other factors in a particular year. Overall, the three spring-run projects that have been implemented have provided substantially more spring-run mitigation credits during the last several years than expected based on historical conditions. This has been due primarily to a relatively high spring-run escapement in recent years. Following are the actual Four Pumps spring-run mitigation credits that have been produced by each of implemented projects during the last six years (Table 13–4).

Table 13–4 Actual annual spring-run salmon mitigation credits produced by Four Pumps projects in smolt equivalents.

Project	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*
Warden overtime	344,931	94,743	82,341	191,393	197,764	143,017
Durham Mutual/Parrott-Phelan	78,086	17,548	19,642	45,814	41,903	20,978
Mill Creek water exchange	5,890	26,548	24,249	104,699	207,565	179,369
Total credits	428,907	138,839	126,232	341,906	447,232	343,363

The three fishery improvement projects already implemented under the Four Pumps Program appear likely to have produced between 3 and 3.5 times more spring-run salmon between 1999 and 2003 than lost due to the direct and indirect effects of the SWP Delta operations. Over the entire five years, DFG specifically credited these projects producing six times more spring-run salmon than were likely lost due to SWP Delta operations. These figures do not reflect the significant, but unquantified benefits to spring-run salmon that DFG has attributed to the DBEEP or the Suisun Marsh fish screen projects.

Table 13–5 Spring-run salmon losses and mitigation credits in smolt equivalents.

	1999	*2000*	*2001*	*2002*	*2003*	*Total*
Credits	428,907	138,839	126,232	191,393	197,764	1,083,135
Potential losses	49,200	43,800	31,800	9,600	25,200	159,600
Extra mitigation	379,707	95,039	94,432	181,793	172,564	923,535
Percent extra	772%	217%	297%	1,894%	685%	%

The Warden Overtime Program, the Durham Mutual/Parrot Phelan Screen and Ladder Project and the Mill Creek Water Exchange Project continue to provide spring-run credits in 2004, which, based on the last five years experience, are likely to more than replace the number of fish lost in the Delta due to SWP operations. The DBEEP and Suisun Marsh screens would provide additional but unquantified benefits. It therefore appears that the effects of the SWP Delta operations on spring-run salmon are being fully mitigated and are unlikely to jeopardize the survival of the species.

Tracy Fish Collection Facility Direct Loss Mitigation Agreement/Tracy Fish Facility Improvement Program

On March 7, 2000, Reclamation and DFG signed the revised Tracy Agreement to reduce and offset direct losses of Chinook salmon and striped bass associated with the operation of the Tracy Pumping Plant and the Tracy Fish Collection Facility (TFCF). The Tracy Agreement provides for improving operations at TFCF, making necessary structural modifications, and annual funding to DFG for mutually agreed upon programs to offset and replace direct losses. Approximately $2.65 million of mitigation funding was provided for projects to offset losses in Federal fiscal years 1993 through 1997. The Tracy Agreement also provides for an additional $7.67 million in funding during Federal fiscal years 1998 through 2004 to DFG to be used for projects that offset and replace direct losses of fishery resources resulting from the operation of the Tracy Pumping Plant.

The Tracy Fish Facility Improvement Program (TFFIP) is identifying and making physical improvements and operational changes, assessing fishery conditions, and monitoring salvage operations at the TFCF per agreements with DFG in 1992 and Section 3406(b)(4) of the CVPIA. Research and evaluation efforts to date have included predator removals, louver efficiency estimates, holding tank surveys, biology and movements of local native species (splittail), secondary louver netting, water quality monitoring, egg and larvae density studies, improved fish handling, and improved fish identification. Facility improvements have included new fish hauling trucks, new louver cleaner rakes, predator removal screens, improved instrumentation, and surface painting of holding tanks to minimize fish abrasion. All activities accomplished under the TFFIP are documented in Reclamation reports as part of the Tracy report series. To date approximately 20 reports have been completed or currently under preparation. Reclamation’s research efforts are coordinated with the other water and regulatory agencies through the IEP and CALFED. ESA considerations are covered either through language contained in the biological opinions or application of ESA Section 10 permits.

In addition to the research efforts on-site at Tracy and in Reclamation's lab in Denver, Reclamation is proposing construction of a test/demonstration facility to test and demonstrate new technologies to be used in the south Delta for improved fish protection. The facility is currently under review by the CALFED South Delta Fish Facility Forum (SDFF) due primarily to concerns over size and cost. It is anticipated that a final decision on the fate of the facility will be made soon.

Chinook Salmon and Steelhead Benefits

The Tracy Agreement provides for a mechanism to identify, develop, and implement habitat restoration measures for anadromous fish in a manner similar to the Agreement. The program has funded about $2.5 million in projects that provide benefits to spring-run Chinook salmon and steelhead. This funding source is particularly important because it can provide start-up funds for preliminary design and engineering work needed to develop proposals for other funding sources. Most other funding sources do not generally fund these types of activities.

Among the projects funded with spring-run benefits, about $100,000 was provided for the design, environmental documentation, and permitting for the Western Canal Siphon Project on Butte Creek. This project removed four dams to improve salmon passage, and replaced them with a siphon to move irrigation water under Butte Creek. The Tracy Agreement has also funded the preliminary engineering and design of salmon passage improvements at six other sites on important spring-run Chinook salmon tributaries at the cost of $390,000. These sites include Battle Creek (Eagle Canyon Diversion), Clear Creek (McCormick-Saeltzer Dam), Butte Creek (Adams, Gorrill, and Durham Mutual dams), and the Yuba River.

The Tracy Agreement has cost shared in several projects with the Four Pumps Program which provide benefits to spring-run salmon and steelhead as discussed in the Four Pumps Agreement section. Cost-share funding was provided for the DBEEP enhanced law enforcement program for five years for a total of $1 million though 1999. Also, Reclamation has contributed $310,000 toward the construction and maintenance of the Grizzly Island Fish Screen.

Primary Louver Bypass Modification at TFCF

Existing fish bypass transition boxes have deteriorated and will be replaced. Current schedule calls for the replacement to occur in the spring of 2004. The new transition boxes were previously modeled in Reclamation's lab in Denver and will be modeled again for velocity field conditions after installation.

Tracy Mitten Crab Screen Debris Studies

The existing traveling water screen used for removal of Chinese mitten crabs at the TFCF will be further studied for debris removal strategies in the secondary channel while assessing any fish impacts. Other research will be conducted on-site to explore improved debris removal at various points in the system.

TFCF Full Facility Evaluation

Reclamation will be conducting full facility evaluations of the TFCF as it relates to the various species of fish entering the facility, especially those that are listed species, and how well the system can effectively louver fish into the holding tanks for release back into the Delta. Research has already been conducted within the secondary louver system for several different species.

Evaluation of 10 Minute Count Screen for Collecting Small Fish at the TFCF

Reclamation is evaluating the count screens used in the 10 minute sampling operations to determine if improvements can be made in regards to loss of small fish.

Improve Removal Procedures from Fish Holding Tanks

Recently conducted studies indicate that survival of fish in holding tanks could be improved with new fish removal procedures, especially during high debris events. The studies will consider new designs that would have application to both the Tracy and Federal fish facilities. Tank and valve development, fish separation strategies, and consideration of fish pumping will be analyzed.

California Bay-Delta Authority

NOTE: Information in this section is from the 2003 California Bay-Delta Authority Annual Report.

Now in its fourth year of implementation, the Bay-Delta Program is delivering on its promise to break through years of gridlock and litigation by providing a balanced, collaborative approach to the state’s most challenging water issues. Fish populations are improving, water supplies are becoming more dependable and several large-scale water quality projects are underway.

The California legislature established the California Bay-Delta Authority as a new governance structure to oversee the Program and the CALFED agencies. Collectively these agencies have allocated nearly $2 billion for local projects to expand groundwater storage, ensure efficient water use, increase water recycling, stabilize levees and restore ecosystems.

Highlights of Accomplishments in Years 1 – 3

CALFED agencies have achieved major progress on **groundwater storage**, with more than $180 million in grants and loans awarded for local projects that will improve groundwater management and increase the water supply yield from groundwater storage and conjunctive use by more than 200,000 acre-feet a year. Groundwater storage projects are increasingly providing multiple benefits, including water quality improvements, environmental enhancement and flood control.

Surface storage feasibility studies are well underway on all five potential projects under investigation. The projects could increase the state’s water storage capacity and add flexibility needed to protect at-risk species, meet water quality standards and ensure reliable water supplies for cities and farms. Decisions on which projects, if any, will move ahead are expected in 2005/06.

State and federal agencies continue to make progress on **conveyance** improvements proposed in the South Delta, including an intertie between the State Water Project and Central Valley Project canals and other actions that will improve water quality for water users in and near the Delta. The South Delta Improvements Program includes plans to increase State Water Project pumping in the Delta to 8,500 cfs and install operable barriers at key locations. Actions planned for Veale and Byron tracts will reduce the effects of agricultural drainage on drinking water quality.

On **water transfers**, CALFED agencies have made strides on streamlining the approval process and assisted in the transfer of more than 500,000 acre-feet of water in 2003 (including 277,000 acre-feet for the Environmental Water Account). Meanwhile, work is underway on an environmental impact report on state-sponsored water transfer activities.

Significant investments have been made in **water use efficiency** and recycling projects, particularly in Southern California and the San Joaquin Valley. To date, nearly $46 million in state and federal funds have been invested that will conserve an estimated 46,000 acre-feet of water per year. Another $122 million has been invested in local recycling programs that will produce more than 400,000 acre-feet of recycled water each year.

Launched initially as a four-year experiment, work is underway to renew the **EWA** as a long-term program. So far, state and federal agencies have spent about $219 million on EWA efforts and provided over 900,000 acre-feet of water to protect at-risk species and maintain deliveries to water users.

Bay-Delta agencies to date have invested $34 million in 21 **drinking water quality** projects, including source water protection, monitoring and treatment technology. In addition, a drinking water framework is under development to help factor water quality considerations into the planning process for all Bay-Delta Program areas.

More than 700 miles of **Delta levees** have been preserved and improved. CALFED agencies have awarded $37 million in funding since 2001 to improve Delta levees, and more than 324,000 cubic yards of dredge material has been reused to increase levee stability and enhance habitat in the Delta.

Ecosystem restoration efforts continue to improve habitat and address the needs of key species. To date, $476 million has been invested in over 400 ecosystem projects. 100,000 acres of habitat have been protected or restored. CALFED agencies have funded projects to install 68 new or improved fish screens and launched 23 comprehensive studies to answer important scientific questions linked to implementation of the program.

The **Watersheds** Program awarded 83 grants totaling $25.5 million to 50 community-based organizations for projects addressing watershed health, drinking water quality, non-point sources of pollution and watershed protection. Twenty watershed coordinators are now in place throughout the Bay-Delta system.

Through the **Science** Program, the Authority has brought together many of the nation’s most distinguished scientists to work on Bay-Delta issues. An Independent Science Board is up and running to make recommendations on science issues to the Authority. A new Science Consortium is integrating related research topics and scientific resources.

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Long-term Central Valley Project and State Water Project Operations Criteria and Plan Biological Assessment for Terrestrial Species Protected Under the State Endangered Species Act

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Table of Contents

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Acronyms and Abbreviations

BA	Biological Assessment
Reclamation	U. S. Bureau of Reclamation
DFG	California Department of Fish and Game
CESA	California Endangered Species Act
CVP	Central Valley Project
CVP-OCAP	Long-term Central Valley Project Operations Criteria and Plan
Delta	Sacramento-San Joaquin Delta
DWR	California Department of Water Resources
FESA	Federal Endangered Species Act
USF&WS	U. S. Fish and Wildlife Service
SWP	State Water Project
EWA	Environmental Water Account
SDIP	South Delta Improvement Program

Introduction

The Bureau of Reclamation (Reclamation) and the California Department of Water Resources (DWR) operate the Central Valley Project (CVP) and State Water Project (SWP) to divert, store, and convey CVP and SWP water consistent with applicable law. The CVP and the SWP are two major inter-basin water storage and delivery systems that divert water from the southern portion of the Sacramento-San Joaquin Delta (Delta). Both projects include major reservoirs north of the Delta and transport water via natural watercourses and canal systems to areas south and west of the Delta. The CVP also includes facilities and operations on the Stanislaus and San Joaquin Rivers.

Reclamation has prepared a Biological Assessment (Long-term Central Valley Project Operations Criteria and Plan [CVP-OCAP] Biological Assessment) addressing the effects of operating the CVP and SWP in accord with the CVP-OCAP on listed fish species including:

- Winter-run Chinook salmon
- Spring-run Chinook salmon
- Central Valley steelhead
- Delta smelt
- Coho Salmon

Reclamation has also prepared a Biological Assessment (Long-term Central Valley Project Operations Criteria and Plan [CVP-OCAP] Biological Assessment) addressing the effects of operating the CVP and SWP on wildlife and plant species that are listed or proposed for listing under the federal Endangered Species Act (FESA). These species include:

- bald eagle
- California clapper rail
- salt marsh harvest mouse
- riparian brush rabbit
- riparian woodrat
- California red-legged frog
- giant garter snake
- valley elderberry longhorn beetle
- Suisun thistle
- soft bird’s-beak

DWR has prepared this Biological Assessment (Long-term Central Valley Project Operations Criteria and Plan [CVP-OCAP] Biological Assessment) addressing the effects of operating the SWP on wildlife species that are listed or proposed for listing under the State Endangered Species Act (CESA) and not already addressed by Reclamation's assessment. These species include:

- Bank swallow
- Swainson's hawk
- Western yellow-billed cuckoo

Description of the Action Considered

DWR's proposed action is to operate the SWP in the future, as described in the CVP-OCAP. The CVP-OCAP provides a comprehensive description of the proposed action. A summary of the proposed action is provided in Chapter 1 of the *Long-term CVP-OCAP Biological Assessment* that addresses effects to listed fish species.

Other Actions Not Included in the Proposed Action

The proposed action is limited to DWR's operation of SWP facilities for the purpose of diverting, storing, and conveying project water. The proposed action does not include diversion of water through non-SWP facilities or use of diverted water. Furthermore, the proposed action does not include maintenance activities associated with Oroville facilities. Impacts associated with maintenance activities are being addressed in a separate consultation process.

Action Area

The action area covered under this BA consists of the Oroville Reservoir complex, the Feather River downstream of Oroville, the Sacramento River downstream of the Feather River, the Sacramento-San Joaquin Delta, and adjacent habitats that are dependent on or influenced by the hydrologic or water quality conditions of these waterways.

Threatened and Endangered Species Considered

Per DFG recommendation, this BA will focus on evaluation of current and future SWP operational impacts to three State listed species including bank swallow, Swainson's hawk, and western yellow-billed cuckoo.

The purpose and need of Reclamation's and DWR's actions is to implement CVP-OCAP, which consists of operating CVP and SWP facilities primarily to:

- Deliver water to diversion points
- Provide flood control
- Release water to meet instream flow and water quality requirements.

The proposed action does not include the actual diversion of water (i.e., direct effects of diversion) or use of diverted water. Potential effects of the proposed action, therefore, consist of:

- Changes in flows in waterways downstream of the Oroville Reservoir complex
- Changes in water surface elevations in the Oroville reservoirs
- Changes in water quality of downstream waterways

Because the potential effects of the proposed action are limited to hydrologic and water quality changes, species potentially affected by the action are limited to species that are aquatic or require the resources supported by the affected waterways. All three species recommended by DFG for impact assessment can potentially be affected by hydrologic conditions of these waterways.

Study Period

This BA evaluates the future effects of operation of the SWP in accordance with CVP-OCAP. The study period encompasses the current (circa 2001) level of development through a projected future level of development expected in approximately 2020.

Consultations to Date

DWR has recently initiated consultation with DFG concerning potential current and future impacts to nesting bank swallows related to SWP operations. This potential impact is based on modeling results developed for and presented in this assessment. To date, take of bank swallow due to SWP operations has not been documented.

Species Accounts

Bank Swallow

The State of California listed the bank swallow as a threatened species during March 1989. This species is not listed under the Federal Endangered Species Act. However, bank swallows are protected under the Federal Migratory Bird Treaty Act.

Historically, bank swallows nested in suitable habitat throughout lowland California (Grinnell and Miller 1944). The bank swallow's range in California has decreased significantly with only four known populations south of San Francisco Bay and about 70 percent of the statewide population currently occurs along the Sacramento and Feather rivers (California Department of Fish and Game 1992).

Bank swallows are a migratory species and begin to arrive back in the Sacramento Valley in late March and early April, with the bulk of the birds arriving in late April and early May (Garrison 2001). Juveniles begin to disperse from the nest colonies around mid-June and early July and are absent from the nest colonies by mid-July (Garrison 2001).

Bank swallows occur in riverine habitat and require a sandy or silty vertical bluff or riverbank for nesting (Zeiner and others 1990). Bank erosion is required to create and maintain the eroded banks favored by this migratory, colonial species. The principal threat to bank swallows is bank protection projects (Remsen 1978). Over 133 miles of rip-rap bank protection have been installed along the Sacramento River since 1960 (Jones and Stokes Associates 1987).

Swainson's Hawk

The Swainson's hawk was listed as a threatened species by the State in 1983. This species is not listed under the Federal Endangered Species Act. However, Swainson's hawks are protected under the Federal Migratory Bird Treaty Act.

Current distribution is limited to northeast California (primarily Modoc, Siskiyou and Lassen counties) and the Central Valley. Swainson's hawks arrive in California from wintering areas in South America, Central America, and Mexico between mid-March and early April (Estep 1989). Nesting is initiated by mid-April with most chicks fledge by mid-July. This species begins its southern migration during August and are generally absent from California by mid-September.

Swainson's hawks currently use a variety of agricultural crops for foraging including alfalfa, fallow fields, beet, tomato, irrigated pasture, rice (non-flooded), and cereal grains. Diet consists primarily of small mammals although birds and insects are also frequently consumed. Nesting habitat includes isolated trees, small groupings of trees, and linear groupings of trees associated with roadsides or narrow riparian zones near foraging areas.

Western Yellow-billed Cuckoo

The western yellow-billed cuckoo was listed as a State threatened species in 1971 and reclassified to endangered in 1987. This species is not currently listed under the Federal Endangered Species Act. However, this species is protected under the Federal Migratory Bird Treaty Act.

Cuckoos are a neotropical migratory species wintering in South and Central America. This species arrives in California in late May and June. Nesting generally occurs in late-June or July with most cuckoos initiating fall migration out of the State by mid-September.

Cuckoos are a riparian obligate-forest interior species. Suitable cuckoo nesting habitat is described as deciduous riparian thickets or forests with dense low understory near slow moving waterways (Zeiner et al 1990). Preferred habitat is a mosaic of riparian habitats including willows, cottonwoods, and open water. Nesting cuckoos appear to require a block of suitable habitat at least 20 acres in size and 100 to 200 yards in width while habitat blocks of 80 acres is size and 600 yards in width are considered optimal (Laymon and Halterman 1988).

Foraging cuckoos appear to selectively prey on larger sized prey within riparian habitats including green caterpillars, katydids, tree frogs, and grasshoppers (Laymon 1998).

Environmental Baseline and Status of the Species in the Action Area

2002 and 2003 survey results indicate that bank swallows, Swainson's hawks, and western yellow-billed cuckoos are absent from Oroville facility reservoirs.. This assessment focuses on evaluation of proposed OCAP changes in the magnitude, timing, and duration of project water releases to the Feather River.

Bank Swallow

Current Population-2002 survey results indicate that eight active bank swallow colonies were present on the Feather River between Oroville Dam and Verona totaling 2,274 burrows (Table 1). An additional six inactive colonies were also identified within the same survey area totaling 813 burrows.

Table 1 Bank swallow occurrence on the Feather River below Oroville Dam during 2002 and 2003.

Category	2002	2003
# of colonies	14	18
# of active colonies	8	15
Total # of burrows	3,087	4,179
Total # of active burrows	2,274	3,594

The 2003 survey results documented the presence of 15 bank swallow colonies on the Feather River between Oroville Dam and Verona totaling 3,594 burrows (Figures 1 and 2). Three inactive colonies were identified totaling 585 burrows.

In 2003, inactive colony size ranged from 43 to 375 burrows. Active colony size ranged from 18 burrows to 1,164 burrows. An occupancy rate of 47 percent was applied to the number of burrows in active colonies yielding an adult population estimate of 1,056 pairs in 2002 and 1,689 pairs in 2003.

During 2002, five colonies were identified between Oroville Dam and Yuba City with an estimated population of 890 pairs. An additional 3 colonies were present between Yuba City and Verona with an estimated adult population of 166 pairs. In 2003, 9 colonies were present between Oroville Dam and Yuba City with an estimated adult population of 1,411 pairs. Six additional colonies were present downstream from Yuba City with an estimated adult population of 278 pairs.

Comparison with historic nest survey information indicate that the 2002 and 2003 bank swallow nesting populations on the Feather River is substantially lower than those collected in 1987 which identified seven colonies ranging in size from 140 to 2,000 burrows (Humphrey and Garrison 1987). During the 1988 survey, 18 colonies containing a total of 6,592 burrows were recorded (Laymon and others 1988). The 1987 and 1988 DFG surveys are the most recent previous complete surveys of the entire Feather River.

FIGURE 1

Bank Swallow Colony Locations

Lower Feather River Above Yuba City

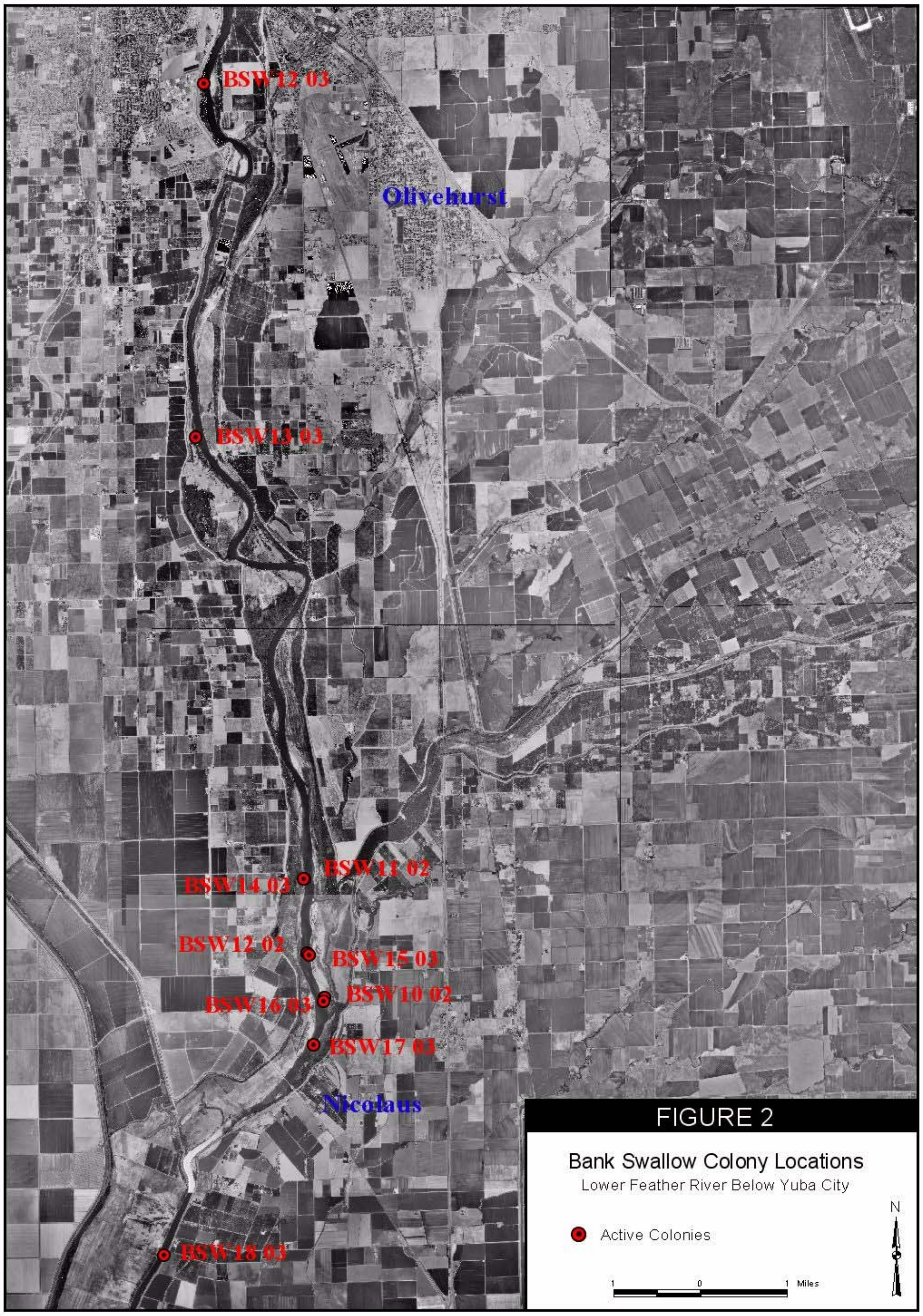


FIGURE 2

Bank Swallow Colony Locations

Lower Feather River Below Yuba City

Swainson’s Hawk

Swainson’s hawks were historically common throughout most of lowland California (Grinnell and Miller 1944). By 1979, it was estimated that this migratory species had experienced a 91 percent population decline in California (Bloom 1980). The Statewide population was estimated at 550 pairs in 1989 with approximately 80 percent of the population occurring in the Central Valley (Estep

1989). This species decline is believed to be related to agricultural and urban land conversions which have virtually eliminated native grassland foraging habitat (Estep 1989).

In addition to habitat losses associated with conversion of native grasslands to agriculture, recent trends in agricultural land use have further diminished potential foraging habitat. These changes include conversion of croplands suitable for Swainson's hawk foraging to unsuitable crops including vineyards, orchards, cotton, and rice.

Historical survey data indicate that Swainson's hawks nest within strips of riparian habitat in the Feather River floodplain between Marysville and Verona (DFG 2003). Two recently discovered nests were present between the Thermalito Afterbay outfall and Sunset Pumps during 2003. Complete nesting surveys of the Feather River floodplain have not occurred. However, potentially suitable nesting habitat is present along a substantial portion of the approximately 55 mile reach of the Feather River downstream from the Oroville Wildlife Area. In most areas, a thin strip of potential nest trees are present on levees adjacent to agricultural fields.

Western Yellow-billed Cuckoo

Historic records indicate that this species was common in the Central Valley (Belding 1890). However by the 1940's the species is described as rare (Grinnell and Miller 1944). Today its distribution is limited to several small isolated areas of the State. The two largest remaining populations in the State are near the Kern and Sacramento rivers. The 1977 statewide population was estimated at between 122 and 163 pairs (Gaines and Laymon 1984). A subsequent statewide survey in 1988 estimated that only 31 to 33 pairs remained (Laymon and Halterman 1988). Loss and fragmentation of riparian habitat accounts for most of the population decline (Laymon 1980).

The 1988 statewide survey identified 900 acres of potentially suitable cuckoo nesting habitat along the Feather River. One pair of cuckoos was identified within this potentially suitable habitat.

Both direct and indirect effects of pesticide use have been identified as a potential factor in this species population decline (Laymon 1998). Another potential threat to the species is the establishment and spread of exotic/invasive plant species into riparian habitats including salt cedar, giant reed, and domestic fig.

Effects of Proposed Action

Bank Swallow

The SWP has the potential to impact bank swallow populations on the Feather River below Oroville Dam through flood control and water supply operations.

Flood Control- Bank swallows are dependent upon vertical eroded banks of a proper friable soil composition. High flows and associated bank erosion can result in both positive and negative impacts on this species. Flooding causes bank erosion and soil deposition. Erosion produces the vertical banks, while soil deposition is the source of the friable soils needed for burrow construction. Lack of high flows results in decreased slope of eroded banks and subsequent abandonment by nesting bank swallows. However, bank erosion and flooding can also result in the need for flood control, bank protection, and channelization which reduce the quantity and quality of bank swallow habitat.

Bank erosion does occur at certain locations on the Feather River at flows as low as 10,000 cfs. However, major flows in the 20,000 to 30,000 cfs range are generally required to create and maintain significant amounts of bank swallow nesting habitat. These channel forming events can create extensive amounts of high quality bank swallow habitat for a period of time. Data analyses indicate that flows > 20,000 cfs have occurred post-project on the average at a 2.3 year return intervals (Gridley Gage data). Further, data analyses indicate that flows greater than 20,000 cfs occurred pre-project on the average of 0.09 year return interval (Oroville gage data). Project related flood control activities have substantially altered the reoccurrence interval of flows in the 20,000 cfs range. Further, the reoccurrence interval of major flood flows (>than 50,000 cfs) have also been substantially reduced from a 1.9 year return interval pre-project (Oroville gage data) to a 3.1 year return interval post-project (Gridley gage data). Streamflow is not the only factor controlling bank erosion rates. Bank saturation, length of the period of high flow, bank vegetative cover, channel geometry, soil composition, geologic structure, and bank protection measures can also influence erosion rates. Bank protection measures are currently in place along 11.2 percent of the Feather River channel below the Thermalito Outlet (DWR unpublished data). In general, these bank protection measures prevent bank erosion at flows up to bank full events. Both bank protection measures and project related flood control activities serve to limit/restrict the quantity and quality of bank swallow habitat created and maintained. Further, U.S. Army Corps of Engineers mandated flood releases have occasionally occurred during the bank swallow nesting season resulting in increased river stage and possible inundation of nests and eggs.

Water Supply Operations- The SWP also has the potential to impact bank swallow production through water supply operations. Bank swallows are a migratory species and begin to arrive back in the Sacramento Valley in late March and early April, with the bulk of the birds arriving in late April and early May (Garrison 2001). Juveniles begin to disperse from the nest colonies around mid-June and early July and are absent from the nest colonies by mid-July (Garrison 2001). Excluding uncommon spring emergency flood releases, project operations historically have resulted in relatively low flows (<2500 cfs releases) during April, May and June. However, water supply deliveries frequently result in much higher releases during July (>9,000 cfs). Historic data indicate that July pre-project flows of 9,000 cfs did not occur. However, pre-project flows in this range occurred about 14 percent of the time during June. The operational pattern of relatively low Feather River flows throughout the majority of the nesting season with greatly increased flows at the end of the nesting season could result in losses of prefledged nestlings.

To evaluate the potential for project-related inundation of pre-fledged nestlings, stage discharge relationships were modeled for each of the 2003 active colony locations. These stage/discharge relationships were compared to the elevation of the lowest burrow in each colony with a 1-foot buffer (Figures 3 through 17). This modeling indicates that current (2003) project operations during early July have the potential to inundate at least a portion of nine of the fifteen active colonies while pre-fledged young are potentially present within the nest burrows. This modeling does not take into account potential losses related to flow induced bank collapse or saturation which could also potentially induce losses of adults and pre-fledged young.

Projected flow increases in July under the OCAP 2020 SDIP scenario of 400 to 800 cfs (depending on water year type) could result in increased potential for take of bank swallows over and above current losses as they would result in a higher percentage of the burrows being flooded prior to fledging. Projected flow increases in July under the OCAP future Environmental Water Account (EWA) scenario would further exacerbate this potential problem with SWP project releases increasing by as much as 1400 cfs over current conditions. These increased July future EWA flows could increase river stage an additional 1.5 feet at some bank swallow colony locations. Further, the OCAP proposes to continue the existing operational pattern of relatively low flows throughout the majority of the bank swallow nesting cycle (allows burrow excavation and nesting on the lower portions of eroding river banks) followed by significant increases in stream flow and water surface elevation at the end of the nesting season.

Figure 3. 2003 stage/discharge relationship at bank swallow colony #1 - RM 54.95

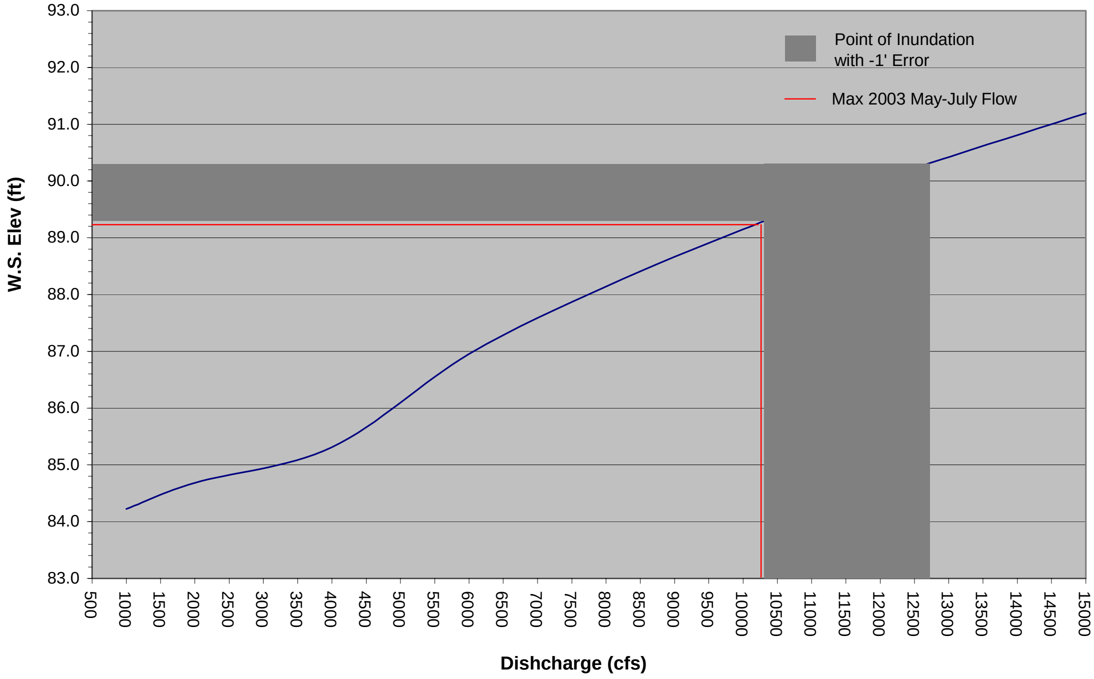


Figure 4. 2003 stage/discharge relationship at bank swallow colony #4- RM 45.05

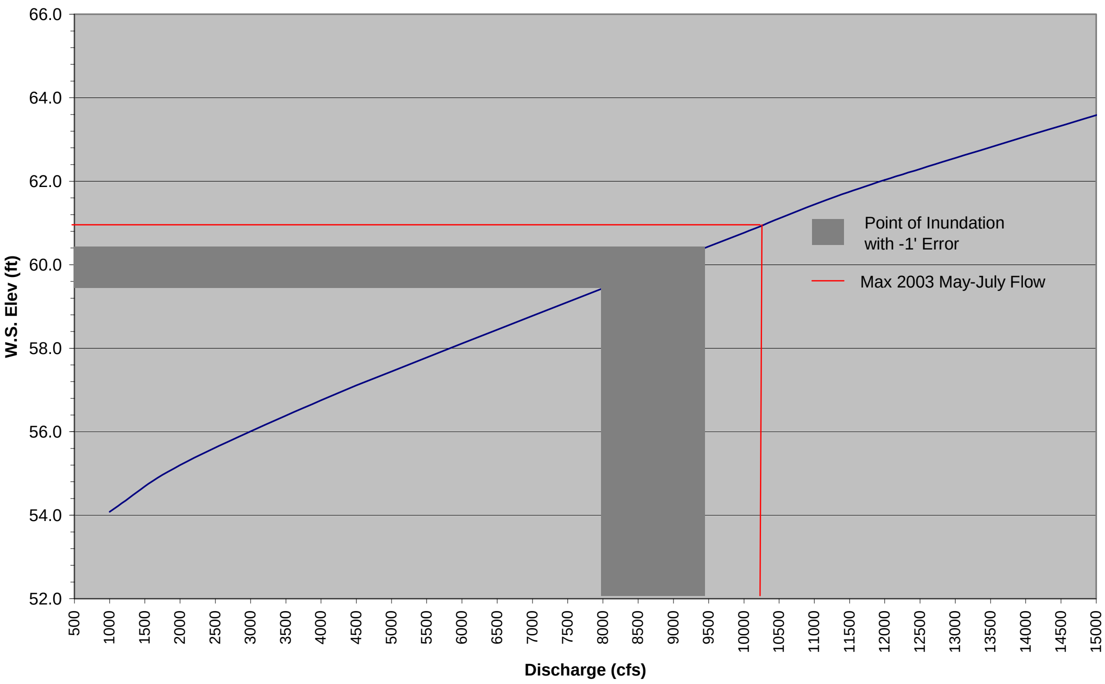


Figure 5. 2003 stage/discharge relationship at bank swallow colony #5 - RM 44.5

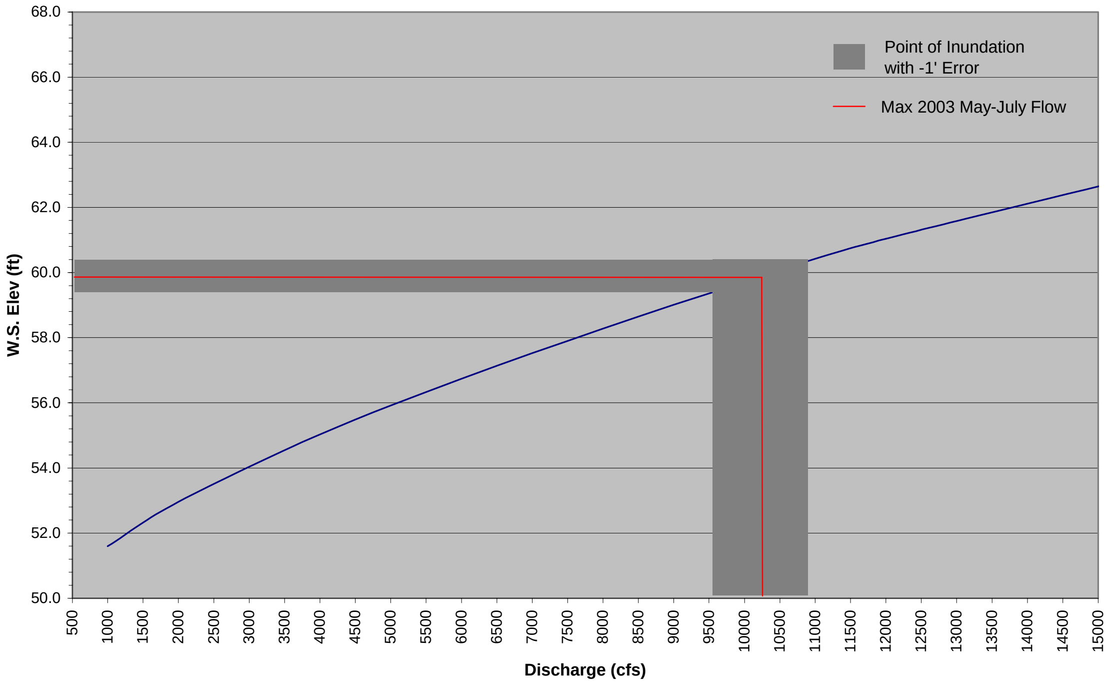


Figure 6. 2003 stage/discharge relationship at bank swallow colony #7 - RM 40.5

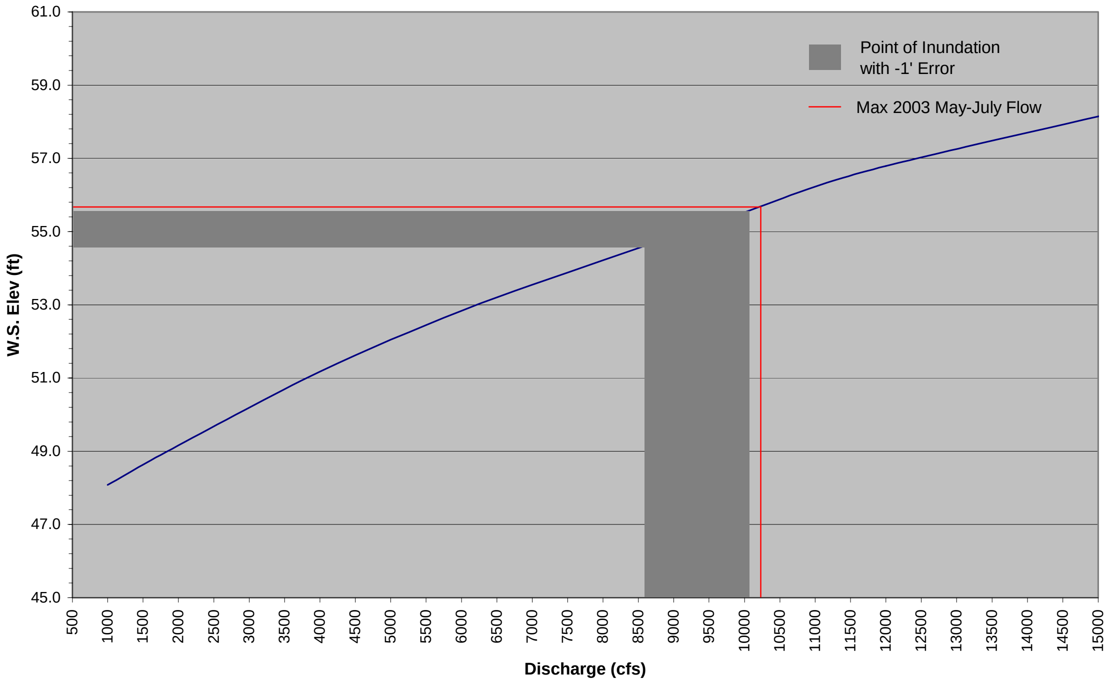


Figure 7. 2003 stage/discharge relationship at bank swallow colony #8- RM 40.4

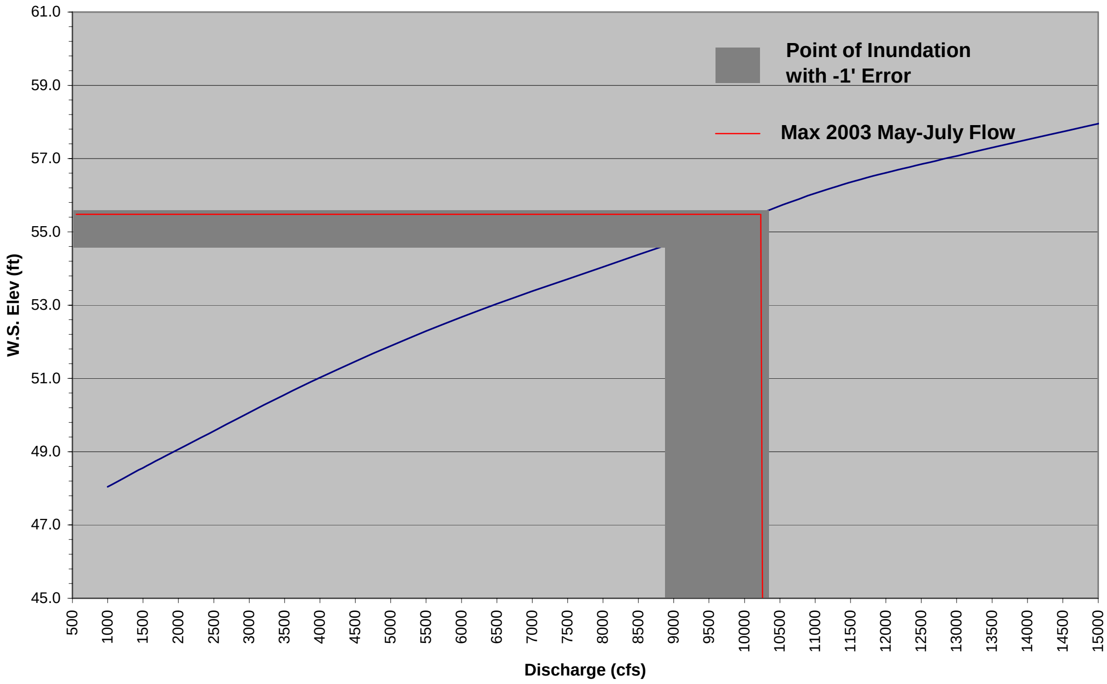


Figure 8. 2003 stage/discharge relationship at Bank Swallow Colony #9 - RM 35.6

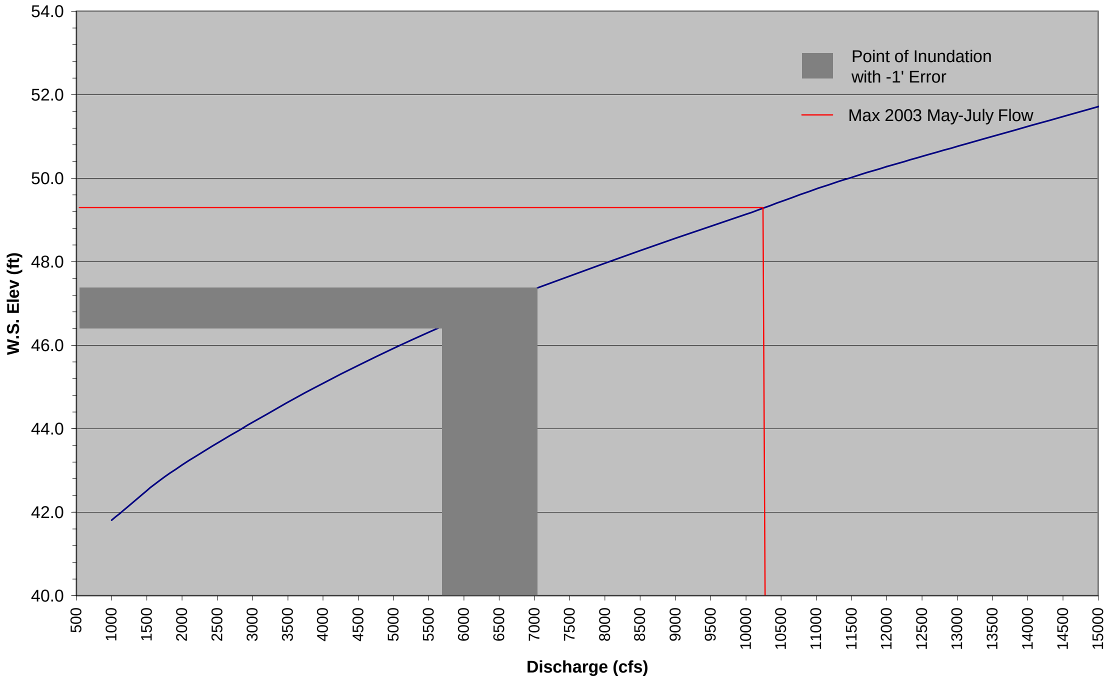


Figure 9. 2003 stage discharge relationship at bank swallow colony #10- RM 34.5

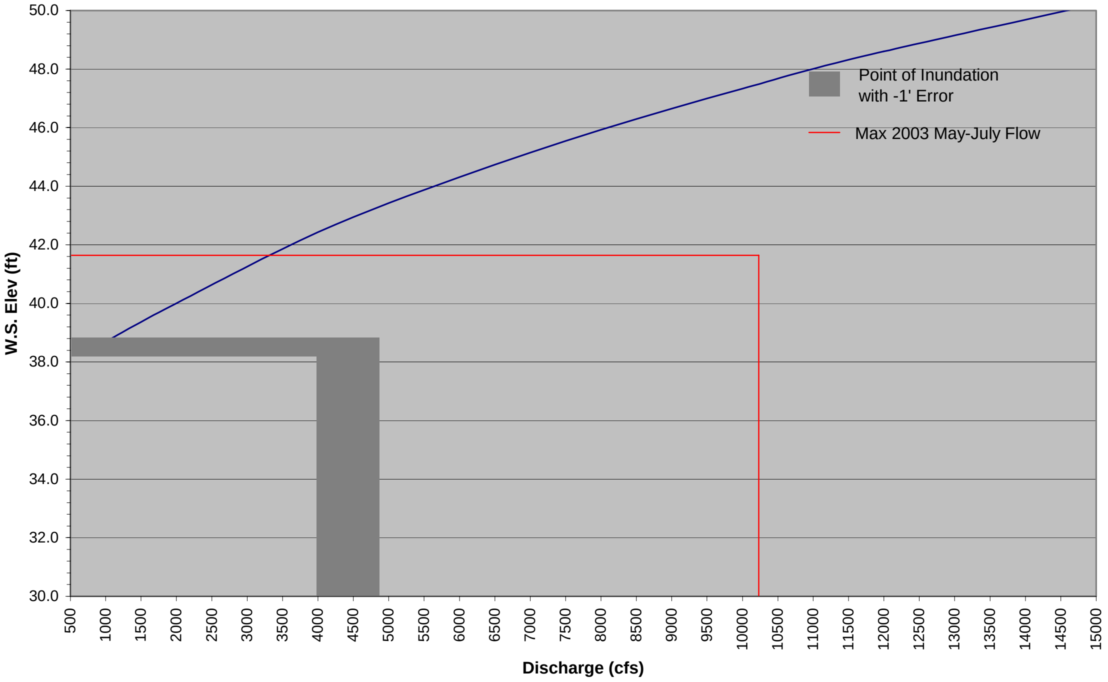


Figure 10. 2003 stage/discharge relationship at bank swallow colony #11 - RM 34.15

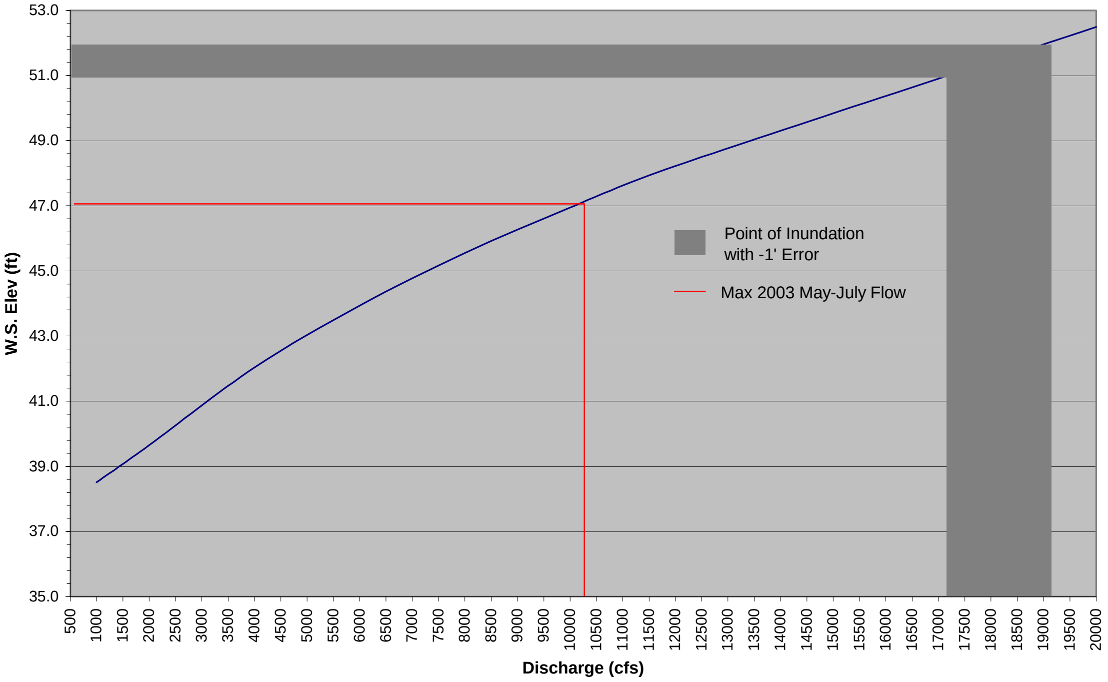


Figure 11. 2003 stage/discharge relationship at bank swallow colony #12 - RM 26.1

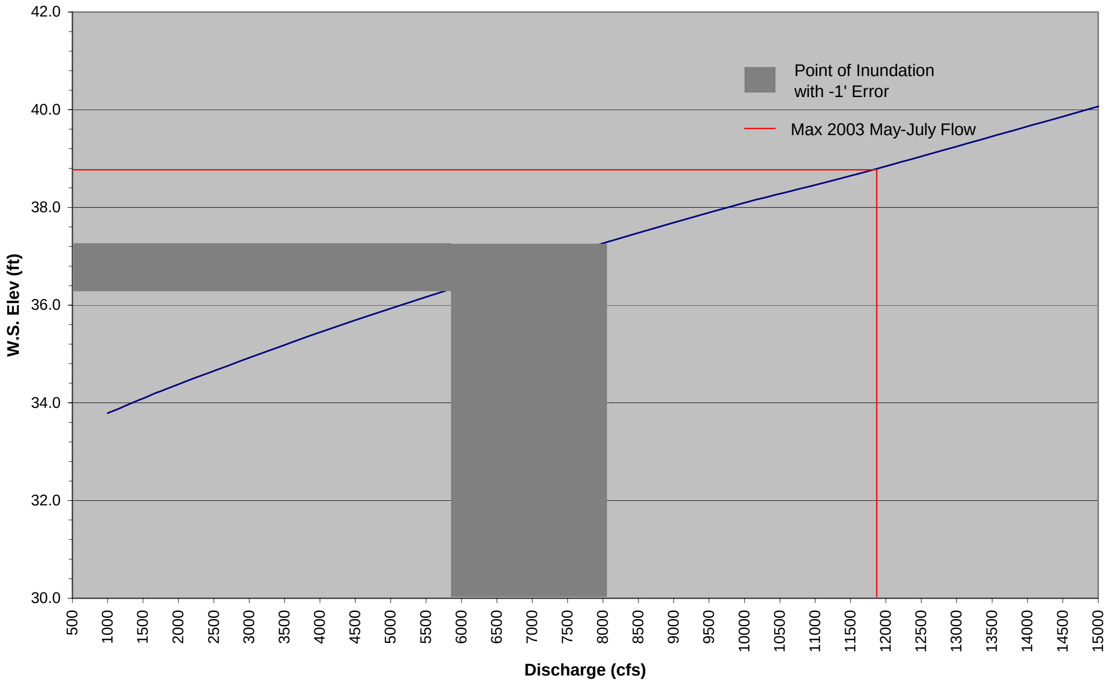


Figure 12. 2003 stage/discharge relationship at bank swallow colony #13 - RM 20.45

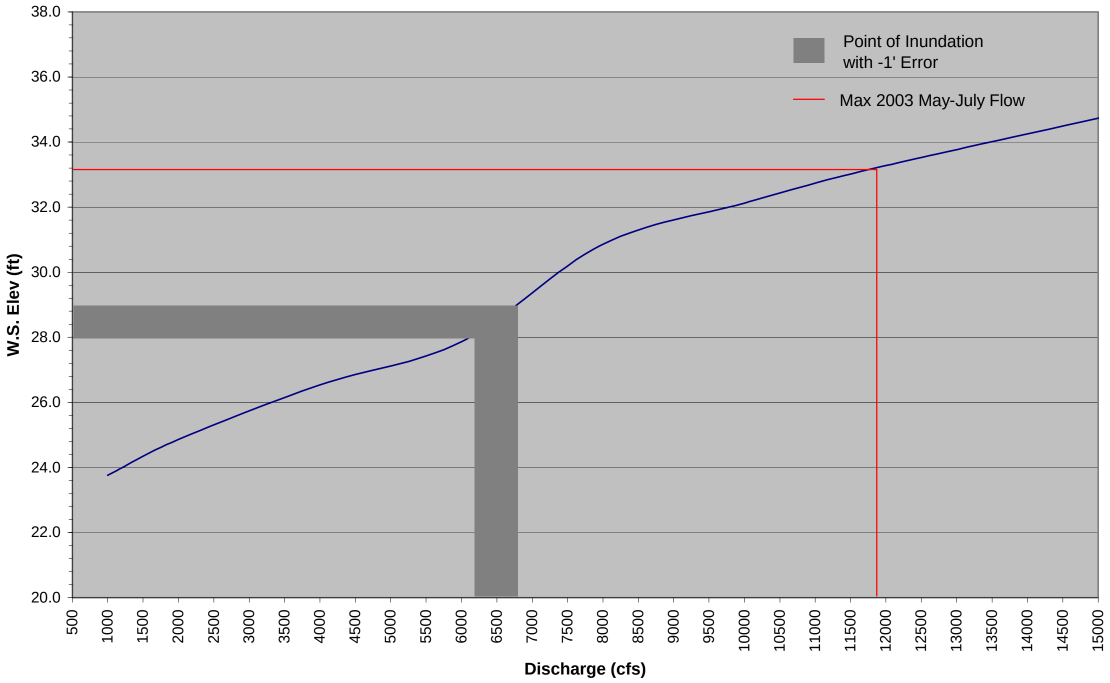


Figure 13. 2003 stage/discharge relationship at bank swallow colony #14 - RM 12.3

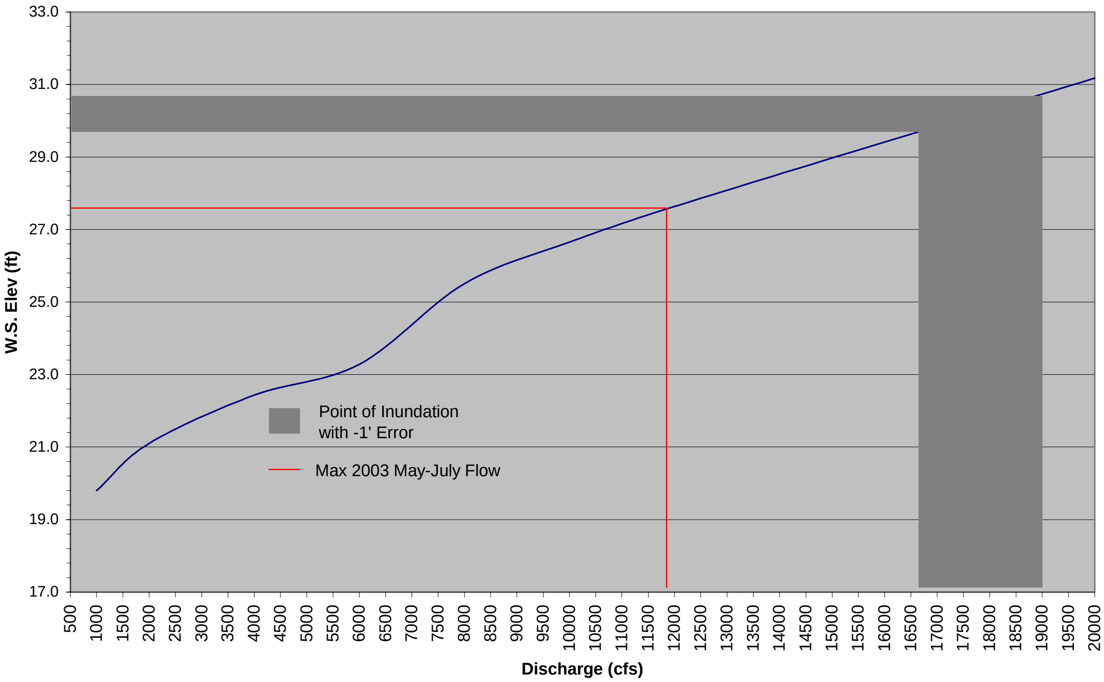


Figure 14. 2003 stage/discharge relationship at bank swallow colony #15 - RM 11.2

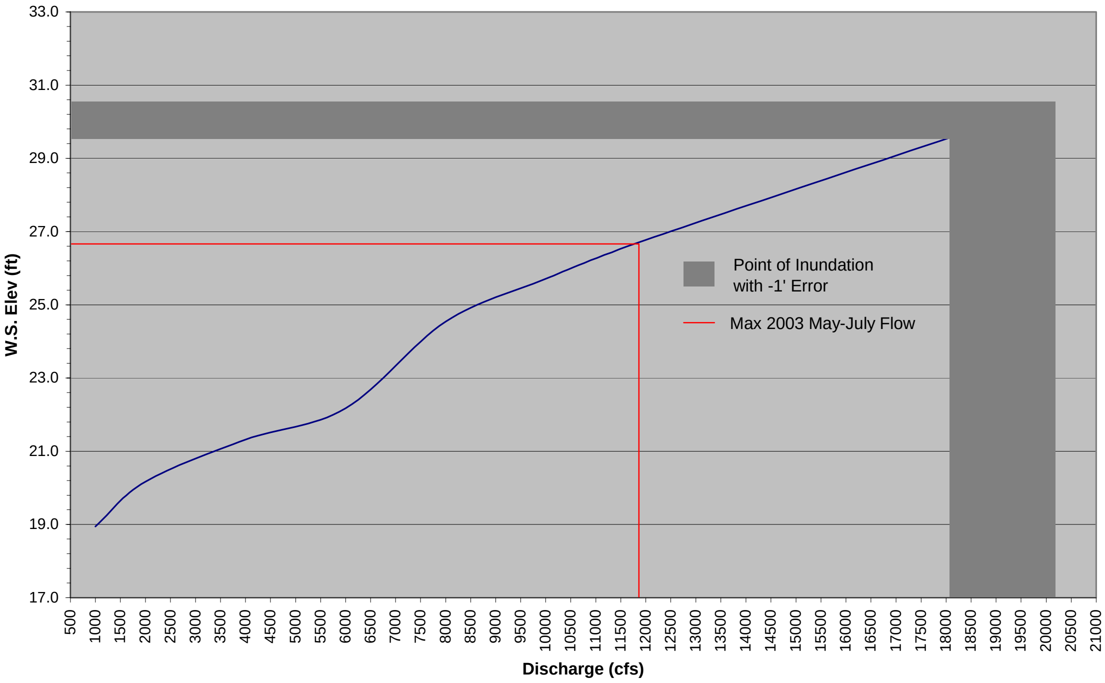


Figure 15. 2003 stage/discharge relationship at bank swallow colony #16 - RM 10.5

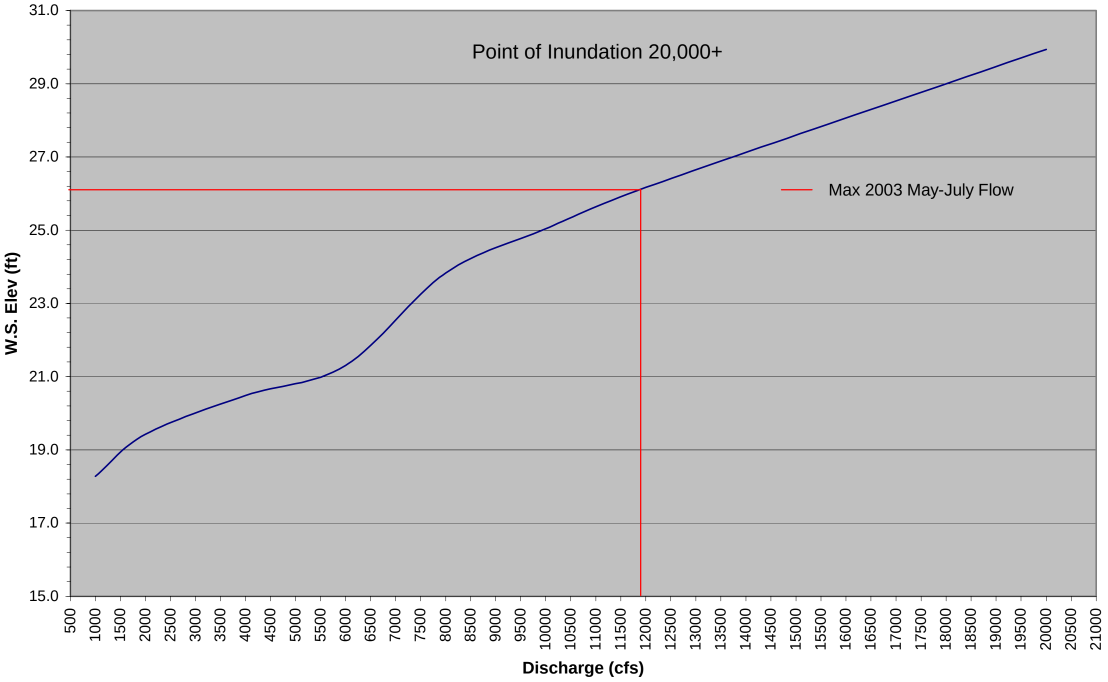


Figure 16. 2003 stage/discharge relationship at bank swallow colony #17 - RM 9.9

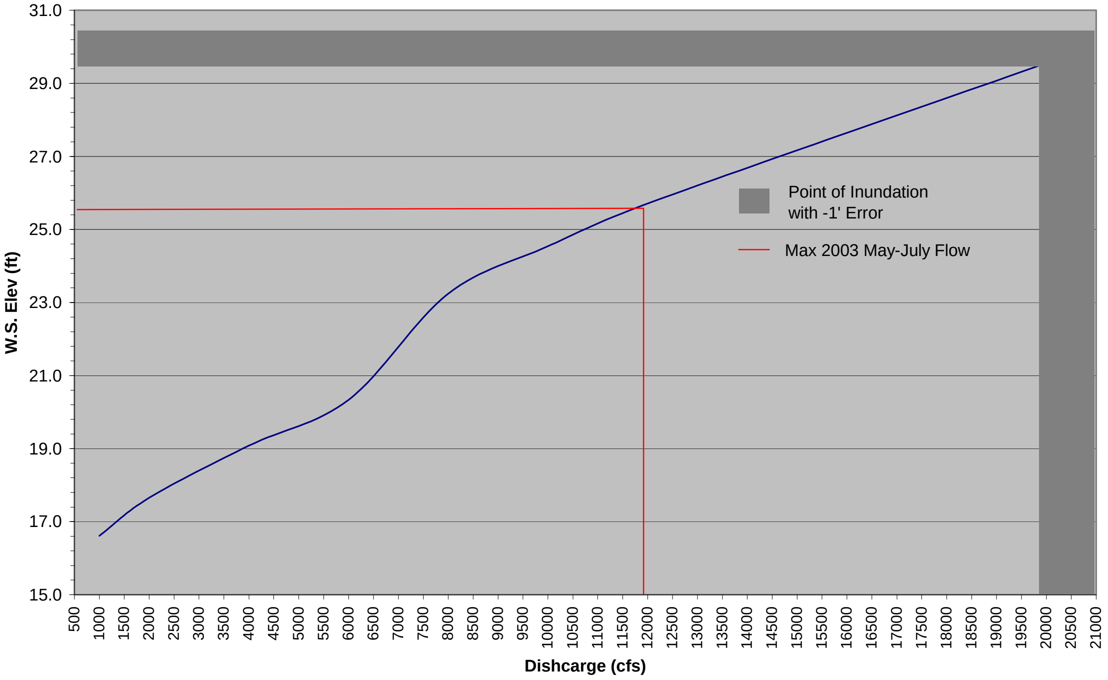
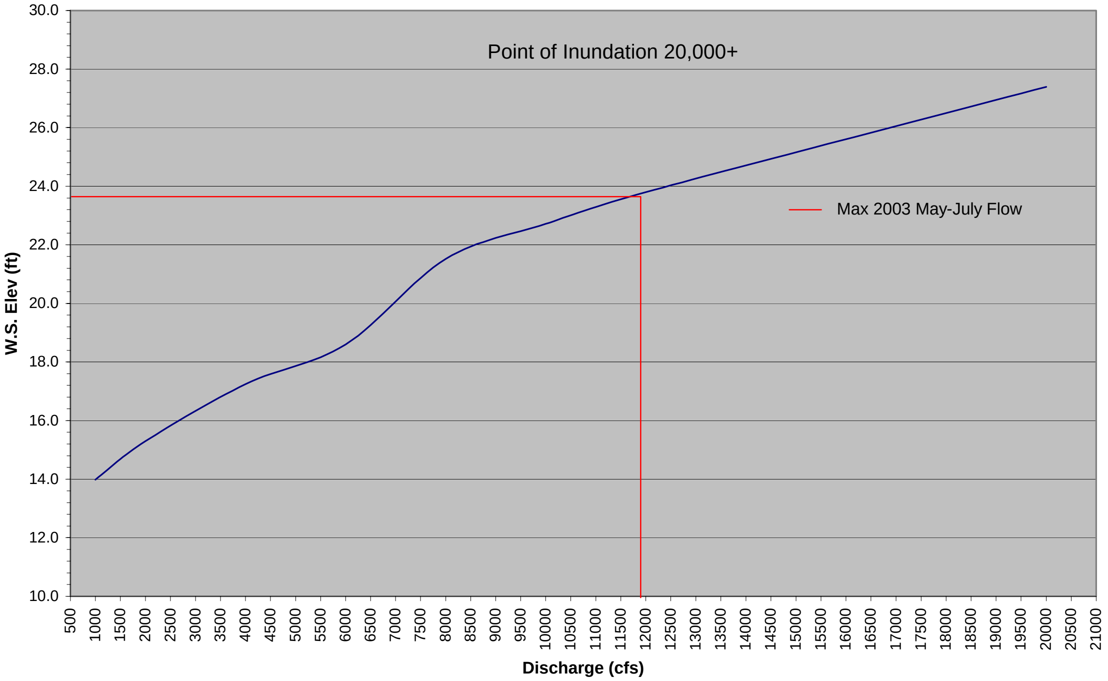


Figure 17. 2003 stage/discharge relationship at bank swallow colony #18 - RM 5.95



Swainson's Hawk

Current and future project operations as described in the OCAP have little or no potential to result in take of Swainson's hawk. Flood releases (both controlled and uncontrolled) have the potential to remove nest trees. However, floods of the magnitude required to remove mature trees have historically occurred outside of the breeding season when the birds are absent from California, thus flood related take is unlikely. Flow regime changes proposed in the OCAP are relatively minor and generally within the historical range of operations.

The current and future project operations described in the OCAP are unlikely to result in benefits to Swainson's hawks or aide in the species recovery.

Western Yellow-billed Cuckoo

Current and future project operations as described in the OCAP have little or no potential to result in take of cuckoos. Flood releases (both controlled and uncontrolled) have the potential to inundate potential nesting habitat. However, flows of the magnitude required to inundate nesting habitat have historically occurred outside of the breeding season when the birds are absent from California, thus flood related take is unlikely. Flow related changes in channel geomorphology and riparian succession have the potential to enhance the quantity and quality of cuckoo habitat by creating the habitat mosaic preferred by cuckoos. However, the flow related changes proposed in the OCAP are unlikely to produce any measurable benefits to cuckoo habitat.

The current and future project operations described in the OCAP are unlikely to result in benefits to western yellow-billed cuckoos or aide in the species recovery.

Cumulative Effects

Cumulative effects are those effects of State, local, and private actions on endangered and threatened species or critical habitat that are reasonably certain to occur in the action area. Future federal actions that are unrelated to the proposed action are not considered in this section because they will be subject to separate consultations pursuant to Section 7 of the federal ESA.

Numerous activities continue to affect the amount, distribution, and quality of habitat for State listed endangered and threatened species within the Feather River watershed. Habitat loss and degradation affecting State listed species continues as a result of urbanization, flood control, bank protection, changes in agricultural practices, spread of non-native plant species, and agricultural expansion.

Bank Swallow

Bank swallows continue to be cumulatively affected by flood control and bank protection measures. Flood control activities continue to affect the quantity and quality of bank swallow nesting habitat created and maintained annually. Private and local government bank protection measures continue to permanently eliminate suitable nesting habitat along the length of the Feather River to protect private and public infrastructure and farmlands. These habitat losses are the greatest long-term threat to bank swallow populations in the Sacramento Valley.

Swainson’s Hawk

Swainson’s hawks continue to be cumulatively affected by habitat loss or degradation associated with rapid urbanization, agricultural expansion, and changes in agricultural cropping patterns. Pesticide poisoning in wintering areas has been documented to result in significant mortality. Shooting remains a cause of direct mortality.

Ongoing and future project operations in the form of land fallowing associated with water transfers and water banking has the potential to adversely impact Swainson’s hawk nesting success and production in localized areas. Swainson’s hawks largely rely on agricultural habitats for foraging including: alfalfa, fallow fields, beet, tomato, irrigated pasture, rice (non-flooded), and cereal grains. DWR requires that lands fallowed under the Water Transfer and Water Banking programs be disked and maintained throughout the growing season in an unvegetated condition to minimize evapotranspiration losses. Replacement of suitable Swainson’s hawk foraging habitat with barren habitat can affect individual Swainson’s hawks foraging success and energetics and ultimately can reduce nestling survival and production. Due to the nature of the Water Transfer and Water Banking programs the potential impacts to individual Swainson's hawks are difficult to predict or quantify.

Western Yellow-billed Cuckoo

Western yellow-billed cuckoos continue to be cumulatively affected by habitat loss related to urbanization, flood control, pest management, and agricultural conversion. The rate of agricultural conversion may have slowed significantly in the last decade as extensive riparian restoration has occurred within the Sacramento Valley. Pest management activities, primarily mosquito abatement activities, may serve to reduce food resources for cuckoos. Control of West Nile virus may require increased mosquito control activities.

Conclusions and Determinations

Bank Swallow

Under the future level of development, the proposed action would result in higher SWP releases during the nesting season. These increased releases will result in increased Feather River stage during July and potentially increased loss of bank swallow nestlings. These changes are likely to adversely affect bank swallow populations.

Swainson's Hawk

The proposed changes are unlikely to affect Swainson's hawk nesting or foraging habitat and will not result in direct mortality. The proposed action is not likely to affect Swainson's hawks.

Western Yellow-billed Cuckoo

The proposed changes are unlikely to affect western yellow-billed cuckoo nesting or foraging habitat and will not result in direct mortality. The proposed action is not likely to affect western yellow-billed cuckoos.

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