

## Chapter 10 CVP and SWP Reservoir Operations

This chapter focuses on how the operations of the Central Valley Project (CVP) and State Water Project (SWP) affect flow and water temperature in the river reaches downstream of project reservoirs. The following discussion refers to the monthly reservoir release exceedence charts and monthly water temperature exceedence charts found in CALSIM Modeling Appendix D and Temperature Modeling Appendix H, respectively. Recommended temperature ranges and flows for various species are later compared to the exceedence charts. Variation in temperatures and flows within months and days are not available from these modeling results, but these variations will be similar to what occurs currently. The modeling results display net changes by month and show the general trend of change useful for comparing operational studies. Monthly exceedence charts are shown for critical locations, and compare the three modeling runs outlined in Chapter 9. With all models there are assumptions and limitations that are inherent within. Please refer to Chapter 9 for a list of model limitations on which this analysis was based.

### Integrated Upstream CVP Reservoir Operations

#### Modeling

The 2004 OCAP BA described and analyzed significant operations influences to CVP/SWP reservoir operations. The 2004 OCAP BA also analyzed the integrated management and operation of CVP reservoirs to reflect long-term operations criteria that included significant water policy changes of the previous decade. A short list of the significant water management policy changes that influenced how the integrated upstream CVP reservoir management was reflected in the 2004 OCAP BA includes:

- Changes to Trinity River flow requirements through implementation of the Trinity River Restoration Program.
- Changes to seasonal reservoir release timing and magnitudes through implementation of CVPIA section 3406(b)(2) management. These changes include the seasonal timing and magnitude of releases necessary to meet the CVP commitments to SWRCB D-1641.
- Initial implementation to the EWA program.

The above management changes have had and will continue to have broad influences as to how the CVP reservoirs are operated and managed as an integrated system of reservoirs towards meeting all CVP authorized purposes.

The most significant new operational assumptions that will influence the timing and magnitude of CVP reservoir releases are:

- Use of 3406(b)(2) water to create a flow regime consistent with the proposed Lower American Flow Standard.
- Projected future increases in central valley urban water demands. The largest changes in future demand patterns occur in the American River basin.

- Modification to New Melones Reservoir operations for improved drought management and to better reflect the changing water quality dynamics in the overall San Joaquin Basin upstream of the influence of the Stanislaus River.

Figure 10-1 illustrates integrated CVP storage facilities (Trinity+Shasta+Folsom) storage trends for each of the studies. The first plot shows the time-series traces for studies 7.0, 7.1, and 8.0. The other plots (Figure 10-2 and Figure 10-3) compare End-of-May and End-of-September exceedence storages. The end-of-May storages reflect the general high point in CVP storage for most years and the end-of-September storage is a good measure of reservoir conditions before the new water year begins. In general, the end-of-May storage exceedence plot shows a reduction to CVP storage conditions over time in the driest 30% to 40% of conditions. The end-of-September storage exceedence plot shows a reduction to CVP storage conditions over time in the driest 70% of conditions. The change to CVP storage conditions in September is a reflection of the increased water demands and operational changes introduced to CVP operations in study 7.1 and study 8.0. The less frequent depiction of change to CVP storage conditions for end-of-May storage reflects the potential for the CVP to refill reservoir storage between September and the following May.

Figure 10-4 to Figure 10-9 illustrate the major CVP reservoir releases in the central valley (Keswick+Nimbus) for each of the studies. There is a figure depicting average releases, as well as each release for yeartype. In general, these graphs depict the general seasonality of CVP reservoir releases, potential high release during winter months for flood control and the high releases during the peak of summer consumptive demand. In general, study 8 shows the highest overall releases for consumptive purposes and the least for flood control purposes. Figure 10-10 depicts this generalized trend between the studies as the increases in the median summertime consumptive releases for study 7.1 and study 8.0 and the changes to the frequency of flood control releases in January and February.

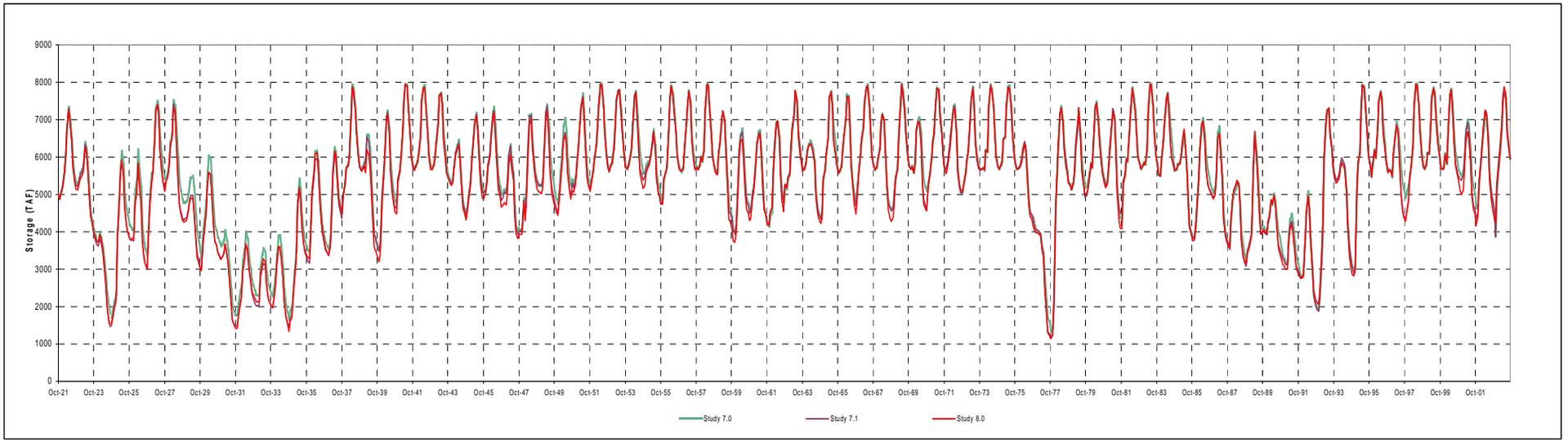


Figure 10-1 Trinity+Shasta+Folsom Storage Time-series



### Trinity+Shasta+Folsom Exceedence Storage

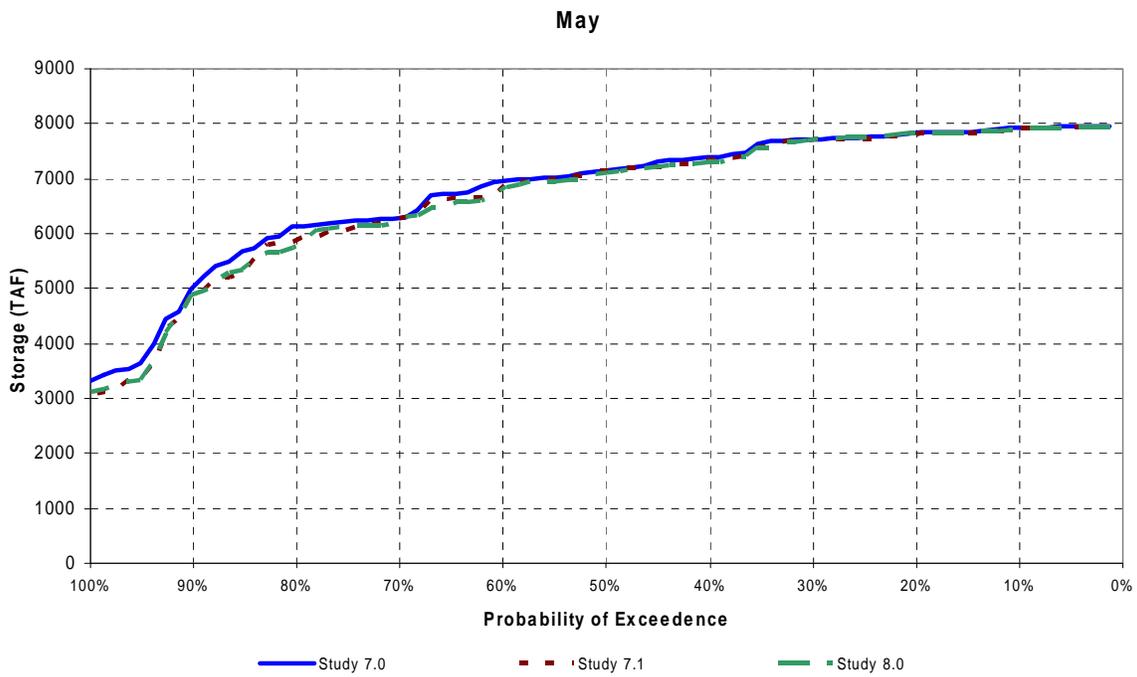


Figure 10-2 Trinity+Shasta+Folsom Exceedence Storage – End-of-May

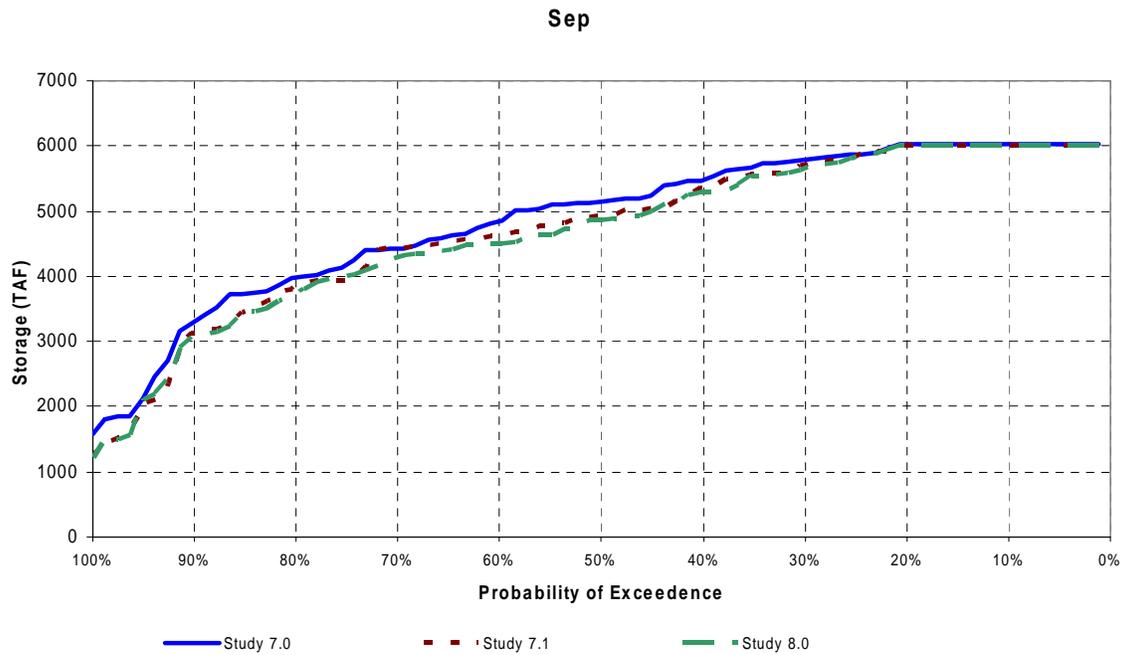


Figure 10-3 Trinity+Shasta+Folsom Exceedence Storage – End-of-September

### Keswick+Nimbus Releases by Yeartype

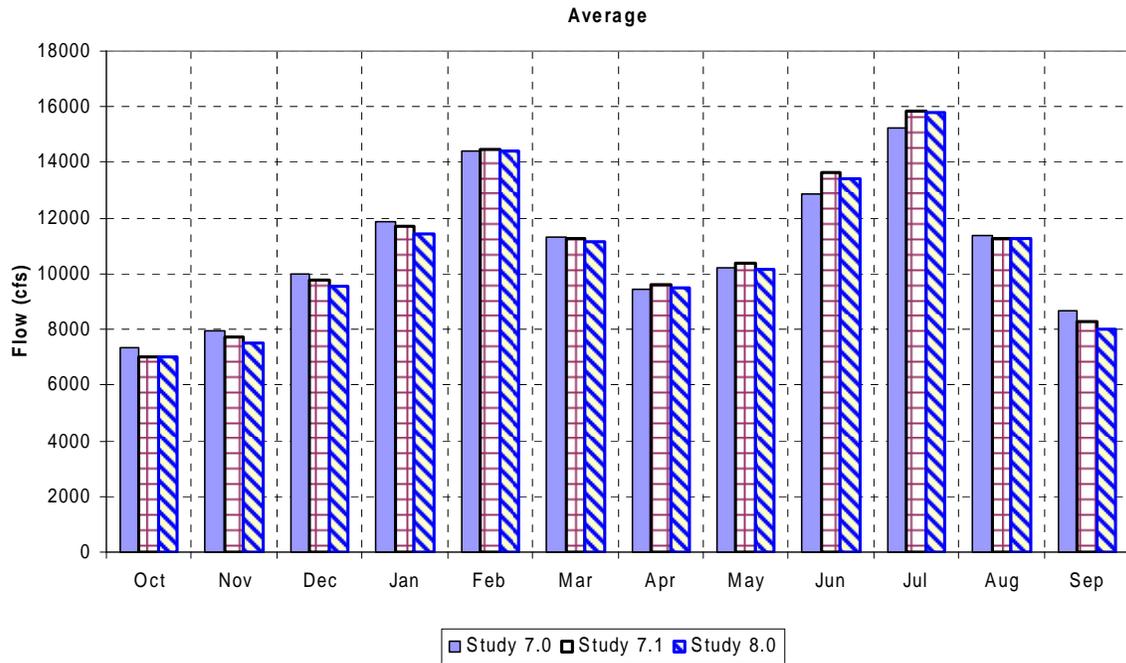


Figure 10-4 Keswick+Nimbus Releases - Average

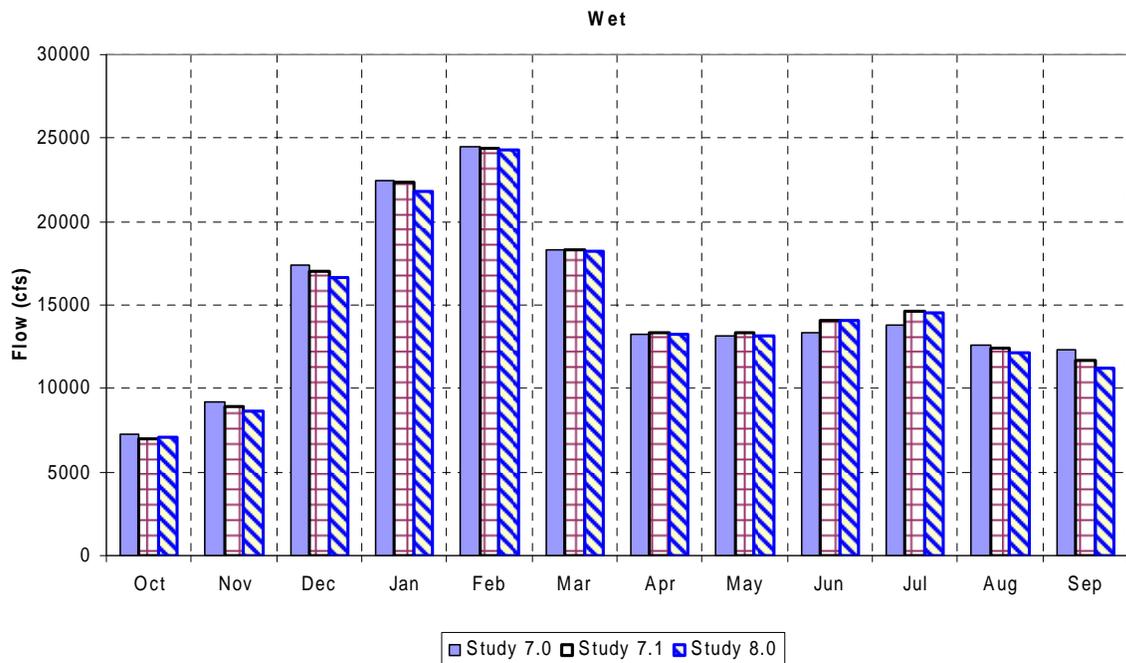


Figure 10-5 Keswick+Nimbus Releases - Wet

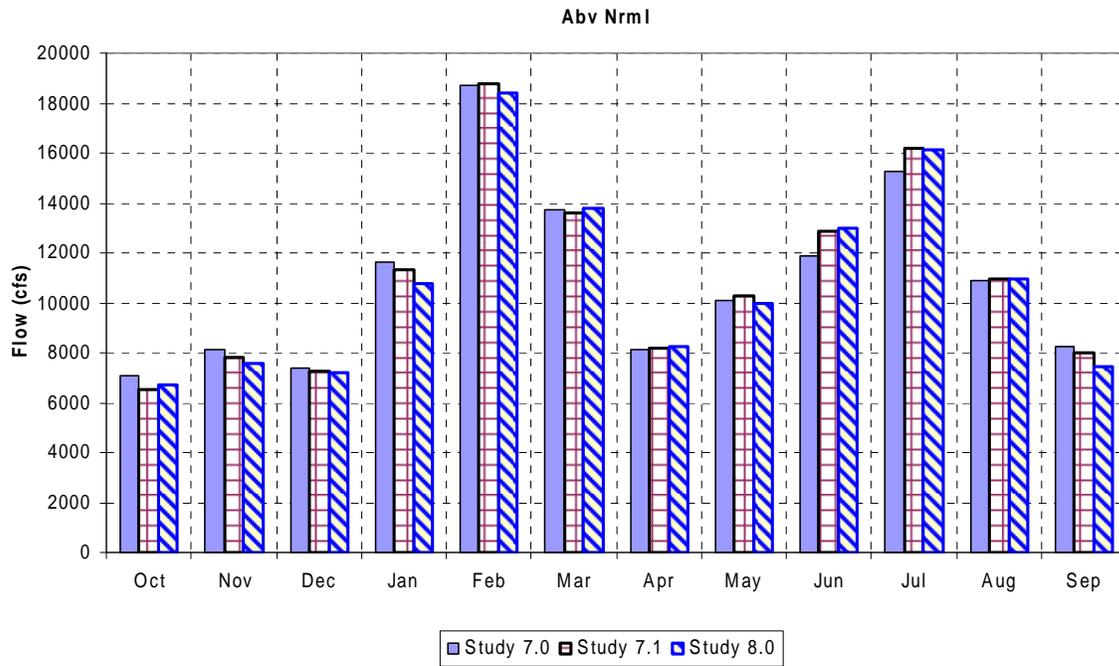


Figure 10-6 Keswick+Nimbus Releases – Above Normal

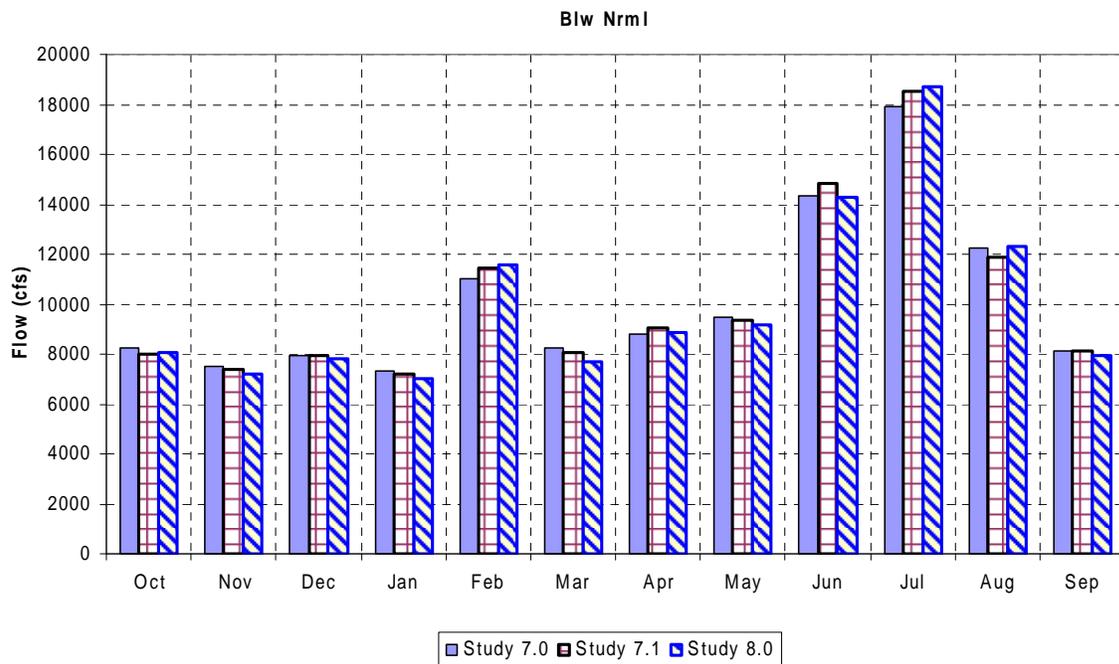
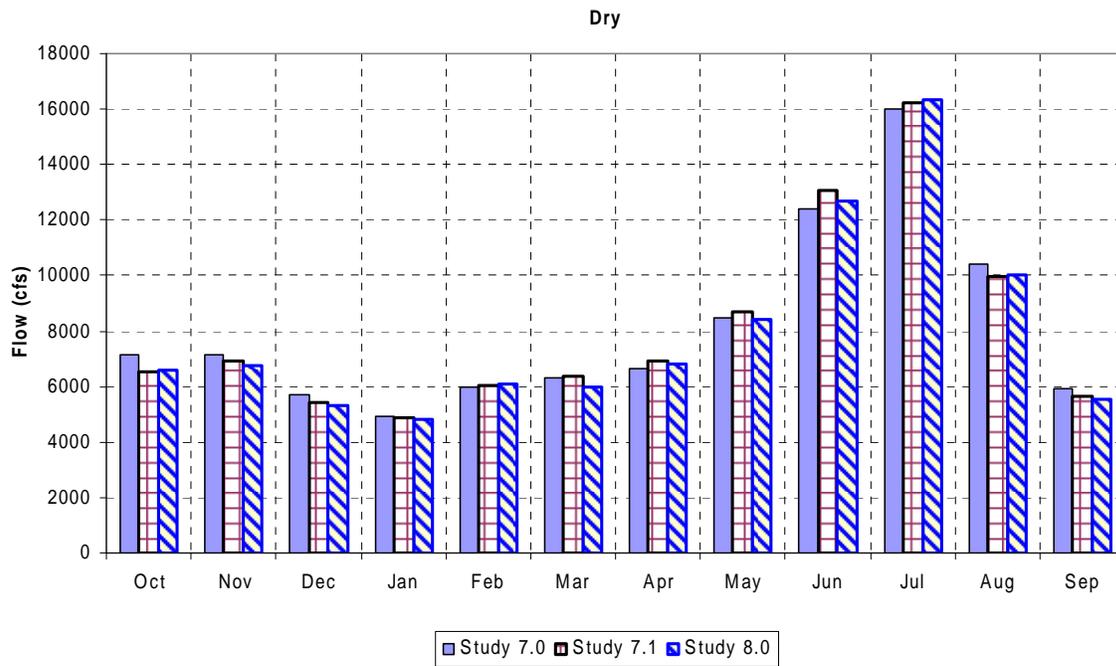
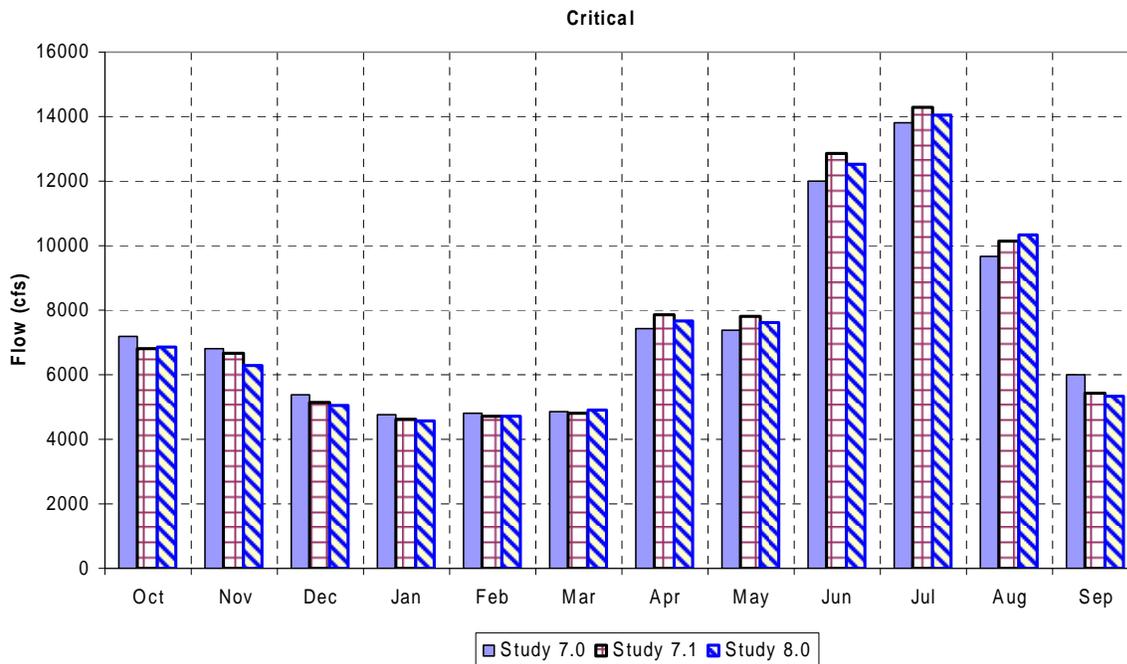


Figure 10-7 Keswick+Nimbus Releases – Below Normal



**Figure 10-8 Keswick+Nimbus Releases - Dry**



**Figure 10-9 Keswick+Nimbus Releases - Critical**

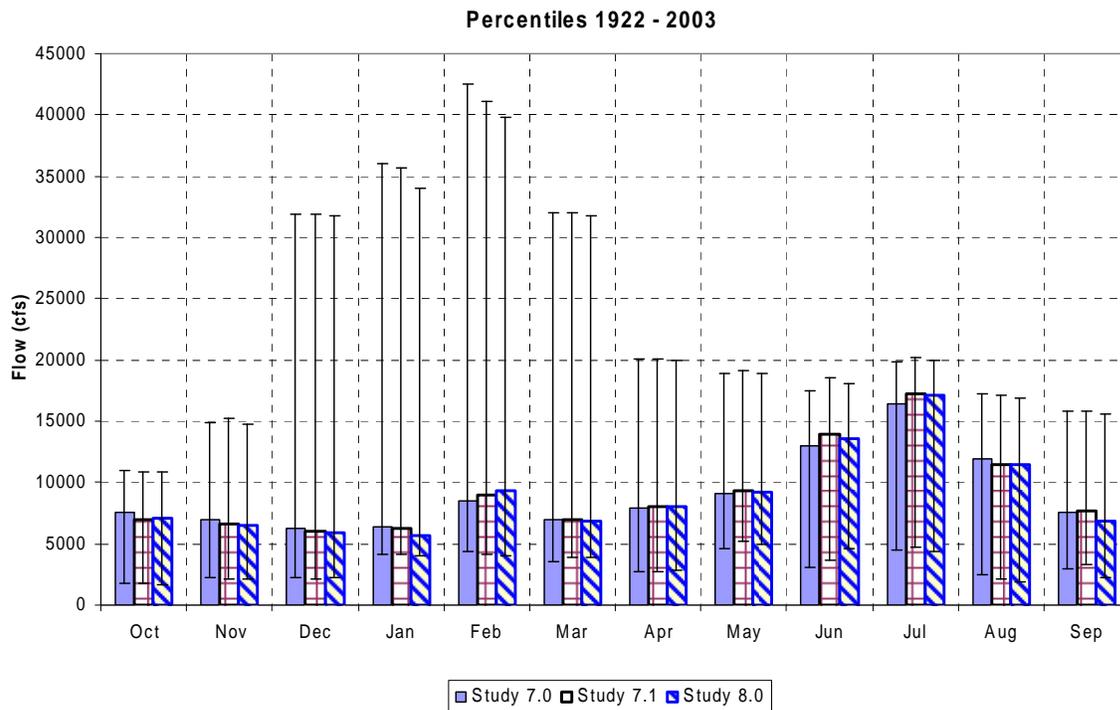


Figure 10-10 Keswick+Nimbus 50<sup>th</sup> Percentile Monthly Releases with the 5<sup>th</sup> and 95<sup>th</sup> as the Bars

## Trinity River

### Modeling

Figure 10-11 shows the chronology of Trinity storage using hydrologic data from October 1921 through September 2003. Figure 10-12 shows the end-of-September exceedence chart for Trinity.

All three studies have similar carryover performance, with the notable exception of slight decreases in carryover under very low storage conditions for studies 7.1 and 8. Other figures presented in this section are the percentile of Trinity Releases (Figure 10-13) and the monthly averages for Lewiston releases by long-term average and by 40-30-30 Index water-year type (Figure 10-14 through Figure 10-19). Figure 10-20 shows the monthly percentile from imports from the Trinity through Clear Creek Tunnel. The graphs of averages and percentiles show how the flows in the Trinity generally adhere to the flow standard on average. The monthly percentiles for imports from Clear Creek tunnel show the general variation trends and timing of water imported to the Sacramento Basin. The vast majority of water is imported during the July to October timeframe to coincide with water temperature and power production objectives in the Sacramento Basin.

**Table 10-1 Trinity River Longterm Annual Average****Trinity River**

## Longterm Annual Average

Difference in Thousands of Acre-feet [TAF]	Study 7.1 - Study 7.0	Study 8.0 - Study 7.0	Study 8.0 - Study 7.1
Trinity End-of-September Storage	-7	-16	-9
Annual Lewiston Release	-1	-3	-1
Annual Carr Powerplant Flows	2	2	1

## 29- 34 Difference

Difference in Thousands of Acre-feet [TAF]	Study 7.1 - Study 7.0	Study 8.0 - Study 7.0	Study 8.0 - Study 7.1
Trinity End-of-September Storage	-66	-58	8
Annual Lewiston Release	0	0	0
Annual Carr Powerplant Flows	14	19	5

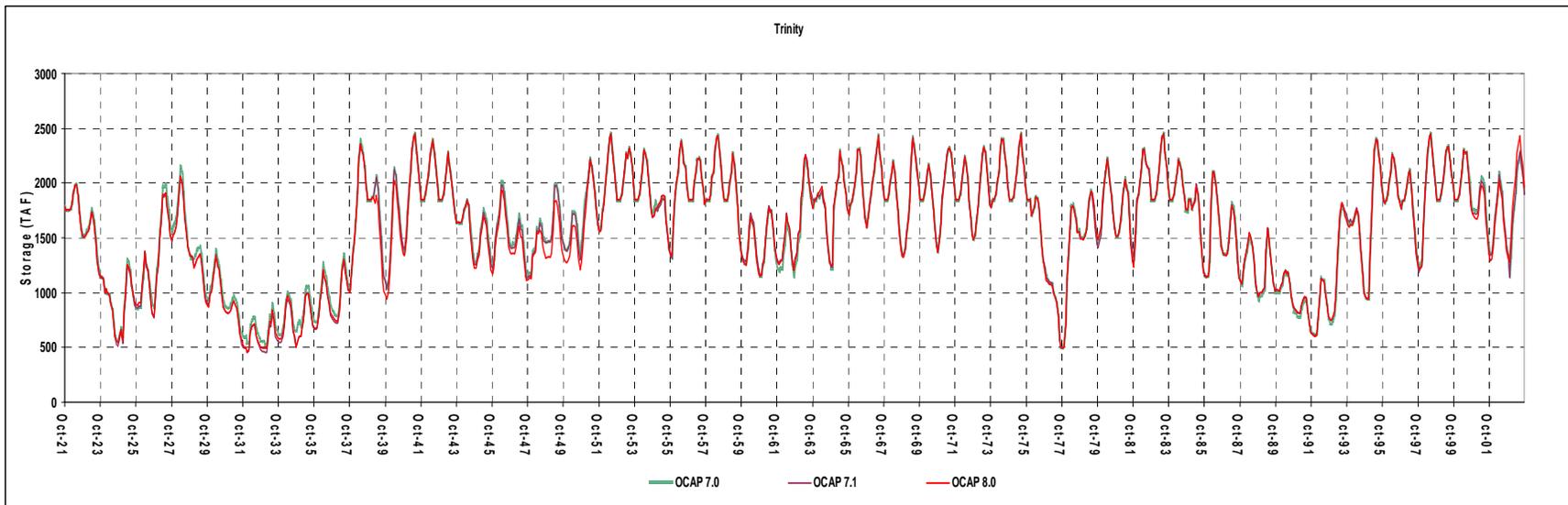


Figure 10-11 Chronology of Trinity Storage Water Year 1922 - 2003

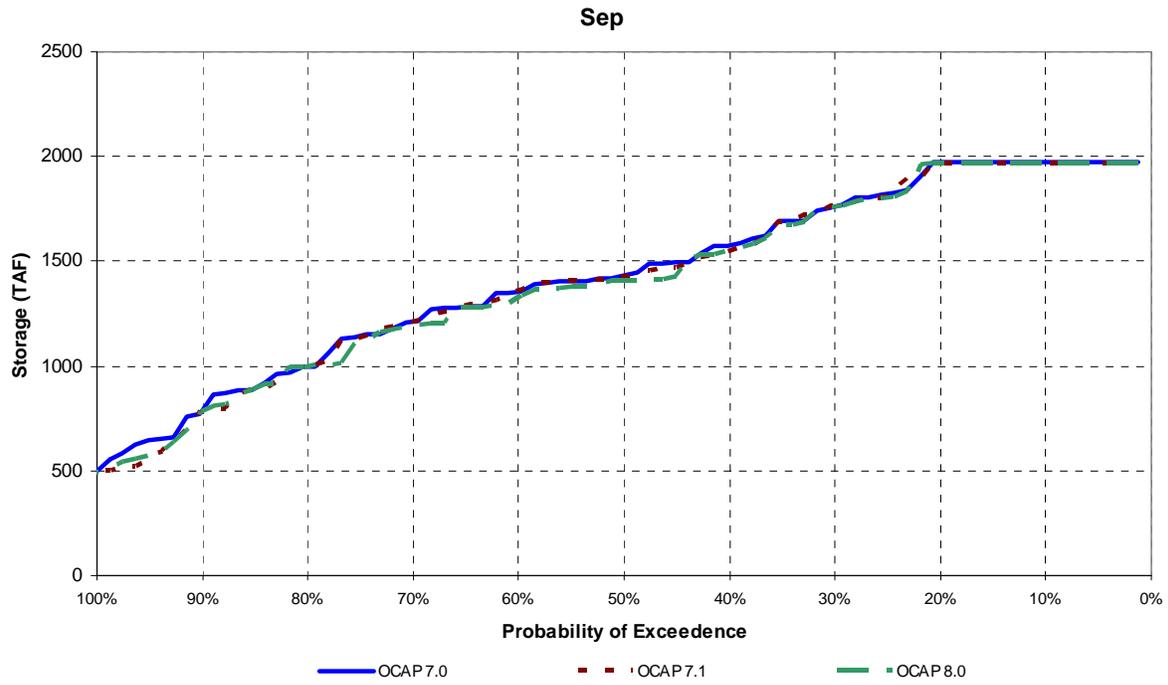


Figure 10-12 Trinity Reservoir End of September Exceedence

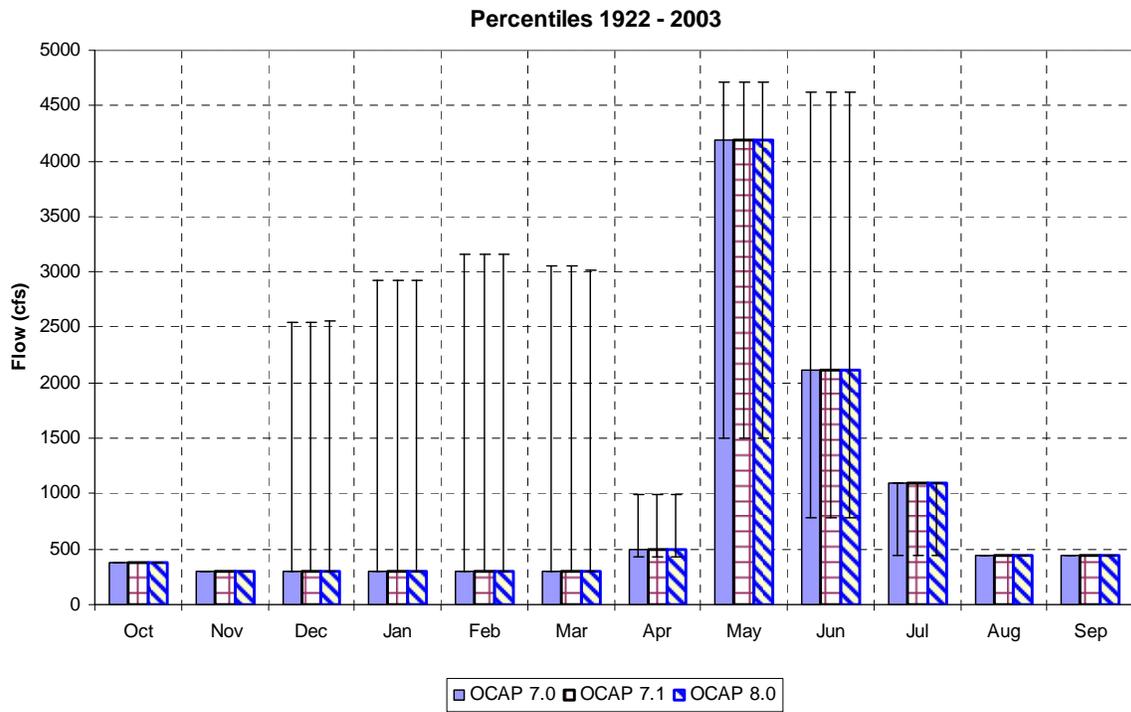


Figure 10-13 Lewiston 50<sup>th</sup> Percentile Monthly Releases with the 5<sup>th</sup> and 95<sup>th</sup> as the Bars

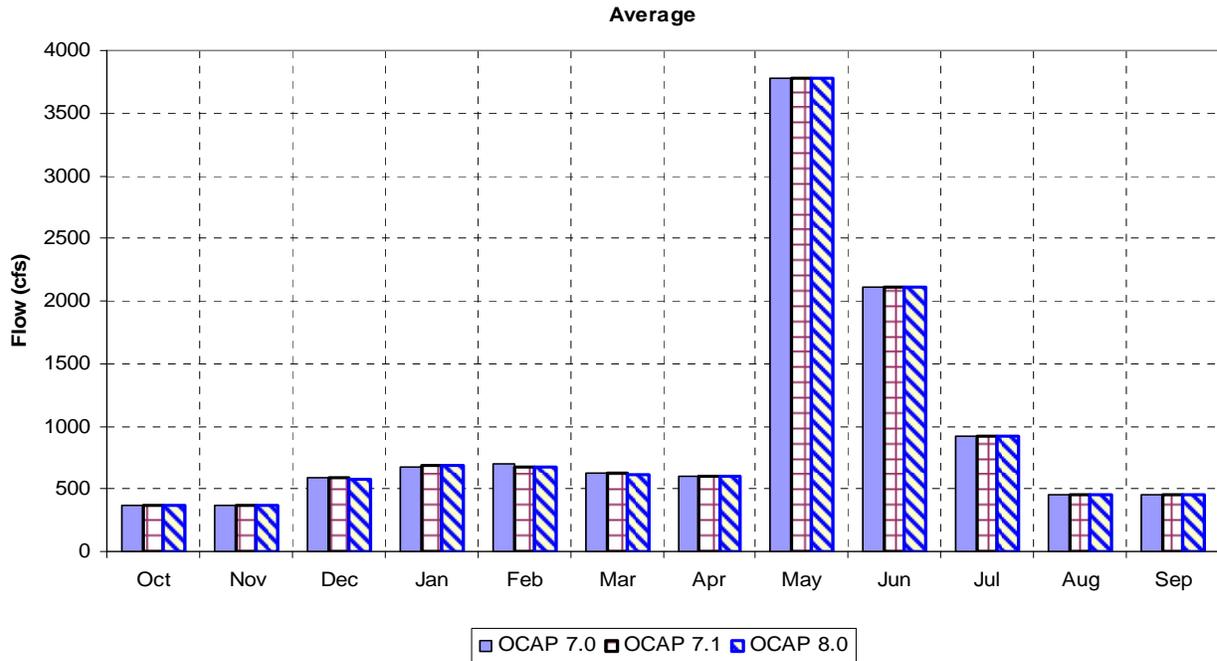


Figure 10-14 Average Monthly Releases to the Trinity from Lewiston

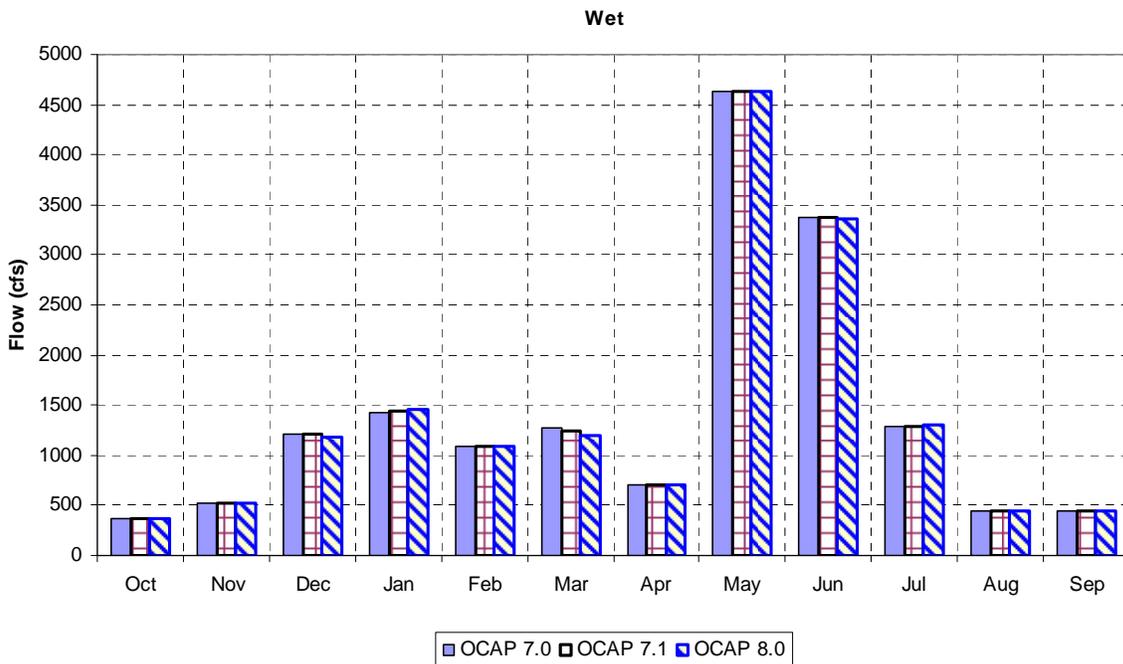


Figure 10-15 Average Wet Year (40-30-30 Classification) Monthly Releases to the Trinity

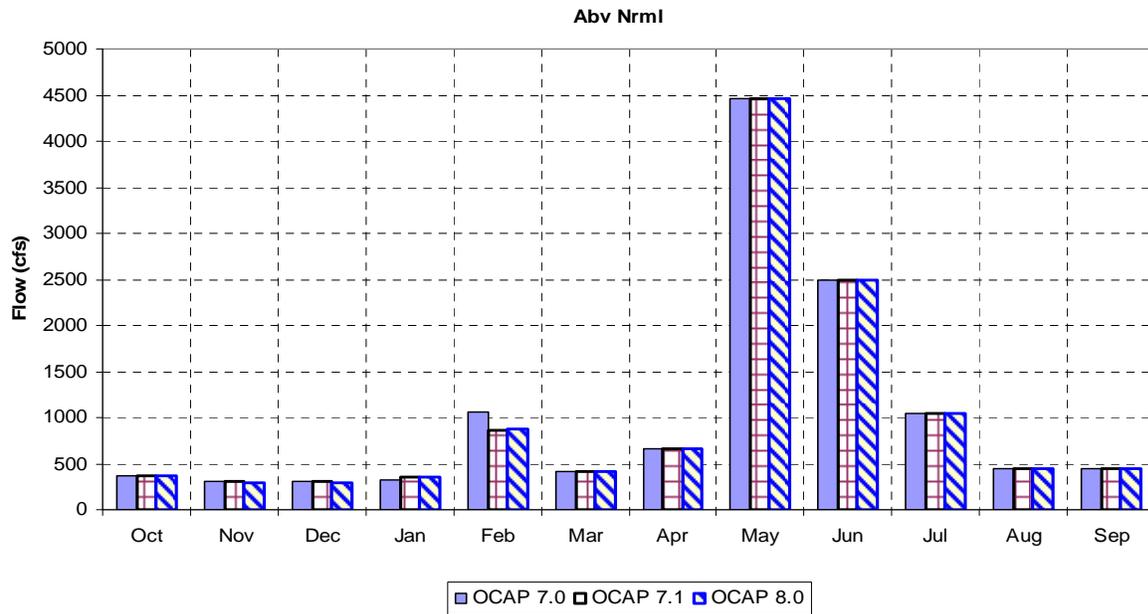


Figure 10-16 Average Above-normal Year (40-30-30 Classification) Monthly Releases to the Trinity

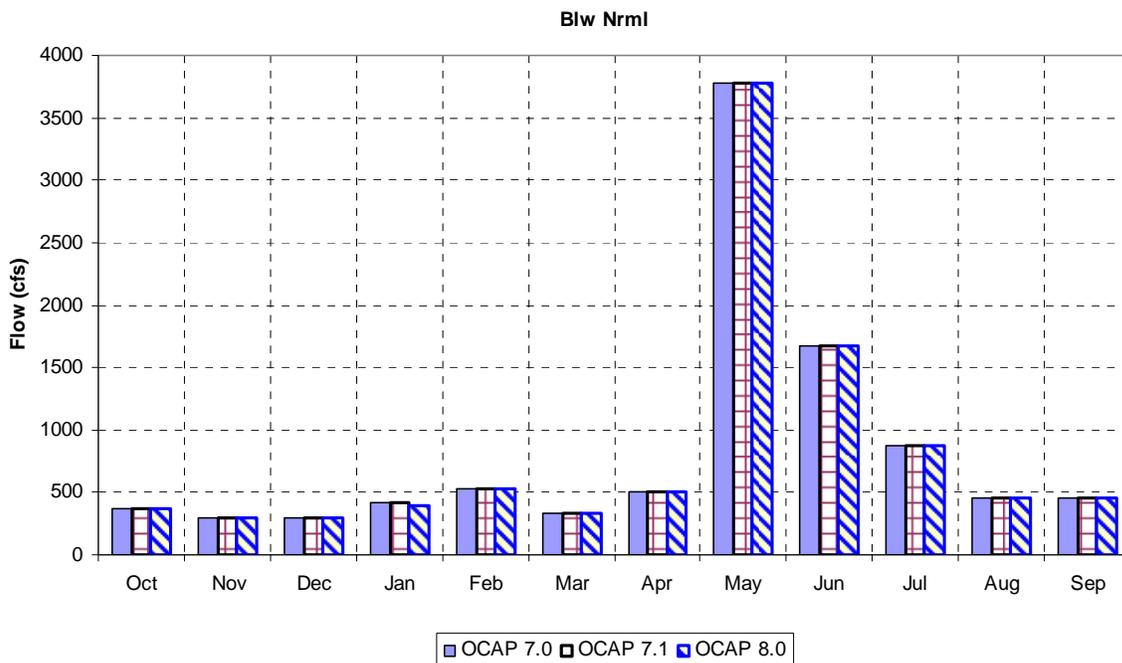


Figure 10-17 Average Below-normal Year (40-30-30 Classification) Monthly Releases to the Trinity

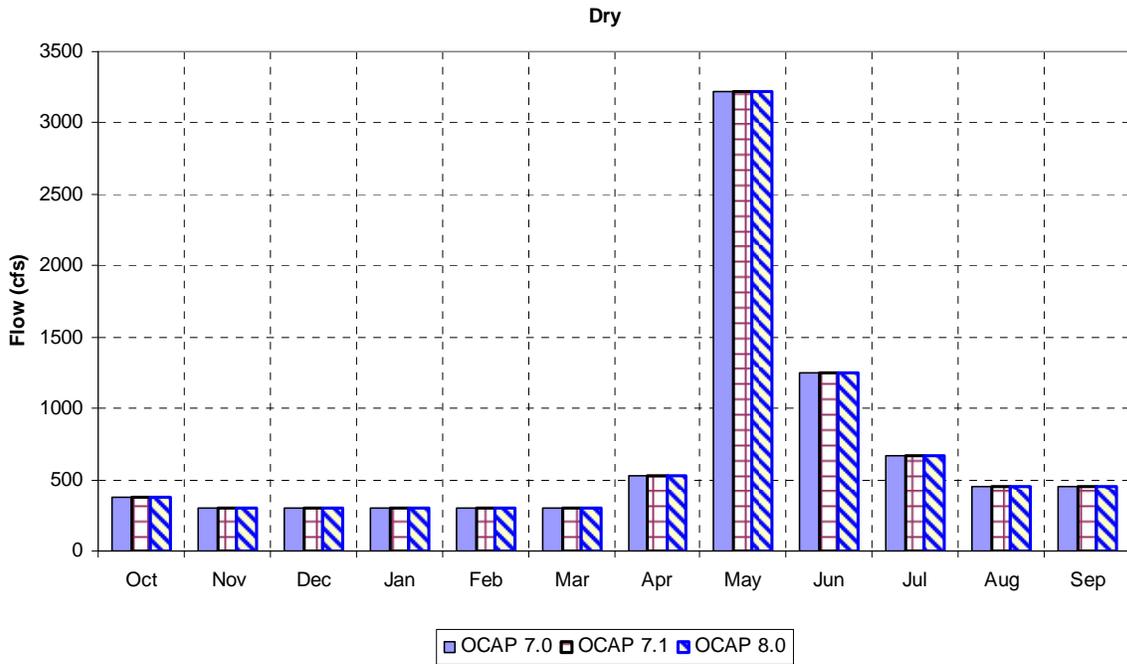


Figure 10-18 Average Dry-year (40-30-30 Classification) Monthly Releases to the Trinity

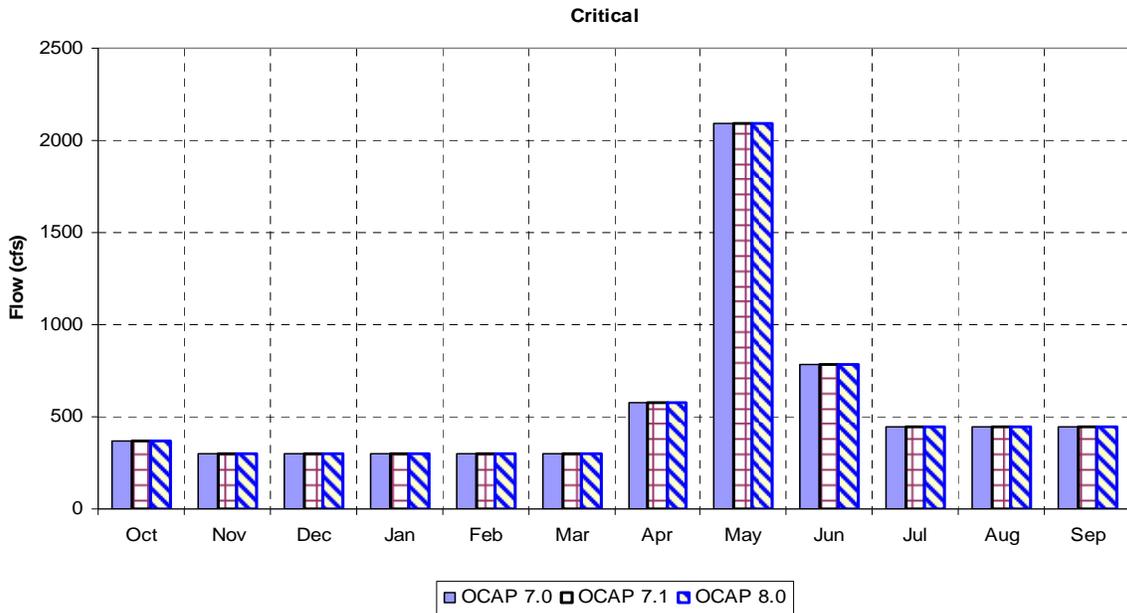
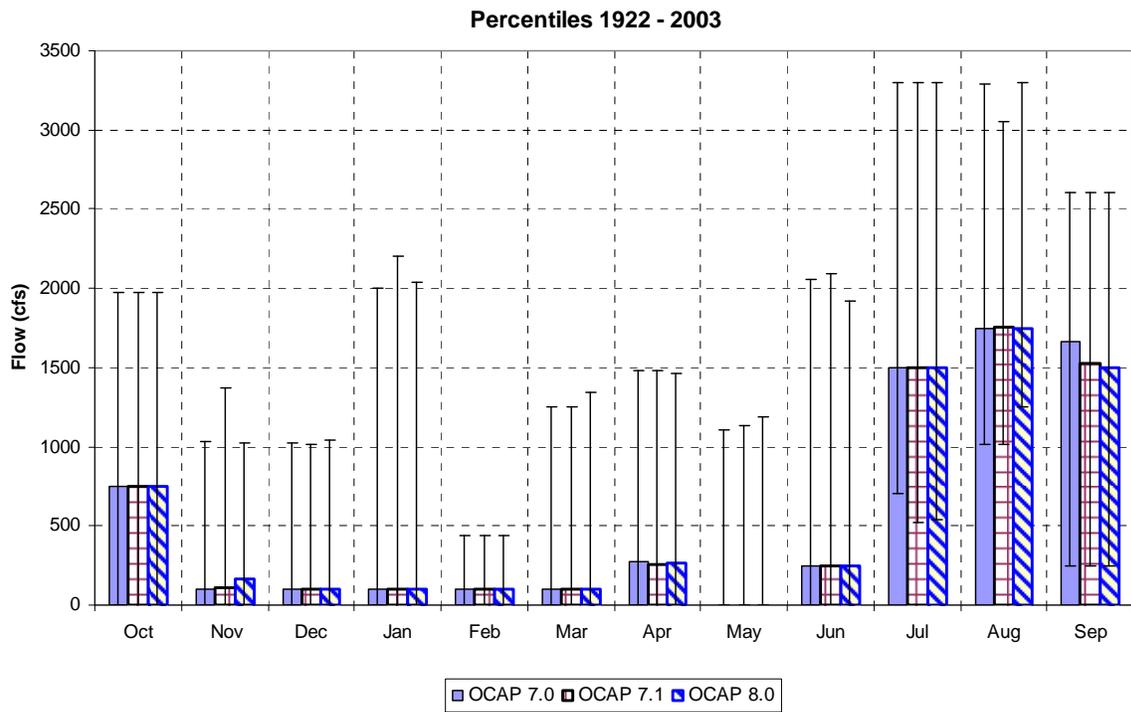


Figure 10-19 Average Critical-year (40-30-30 Classification) Monthly Releases to the Trinity



**Figure 10-20 Clear Creek Tunnel 50<sup>th</sup> Percentile Monthly Releases with the 5<sup>th</sup> and 95<sup>th</sup> as the Bars**

### Trinity River Temperature Analysis

Figure 10-21 - Figure 10-27 illustrates potential water temperatures provided to the Trinity River at Douglas City. In general, the water temperatures are very similar for each of the studies. Each study shows difficulty meeting Trinity Basin water temperature objectives in approximately 20% of the drier years during September.

### Douglas City Exceedence Plots

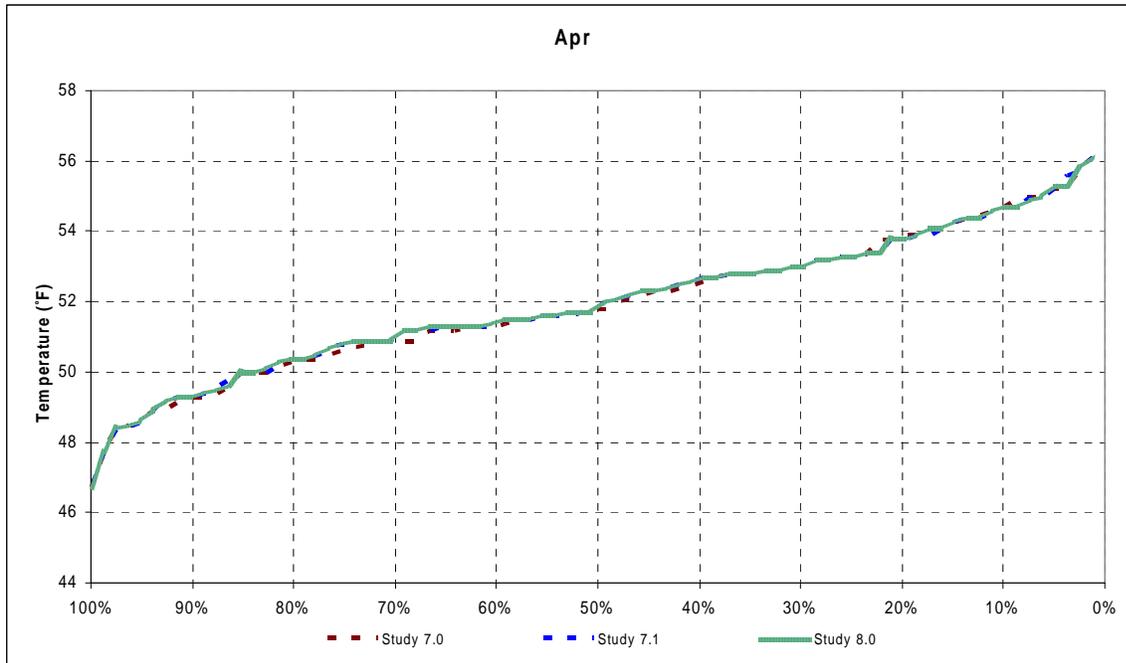


Figure 10-21 Douglas City Exceedence Plot – End-of-April

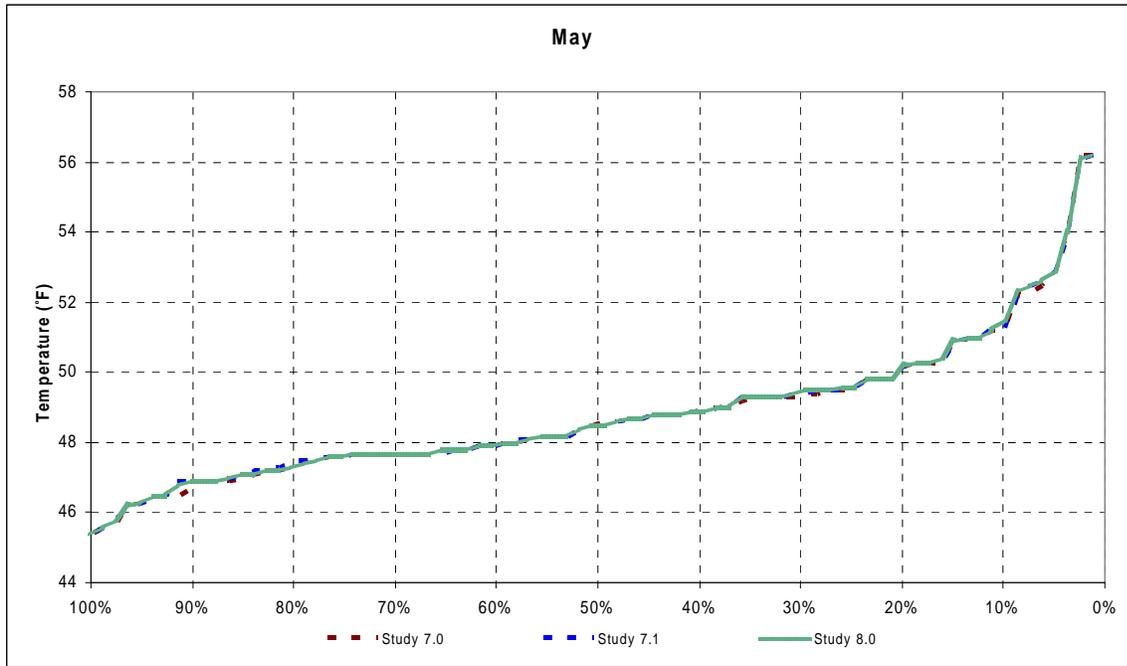


Figure 10-22 Douglas City Exceedence Plot – End-of-May

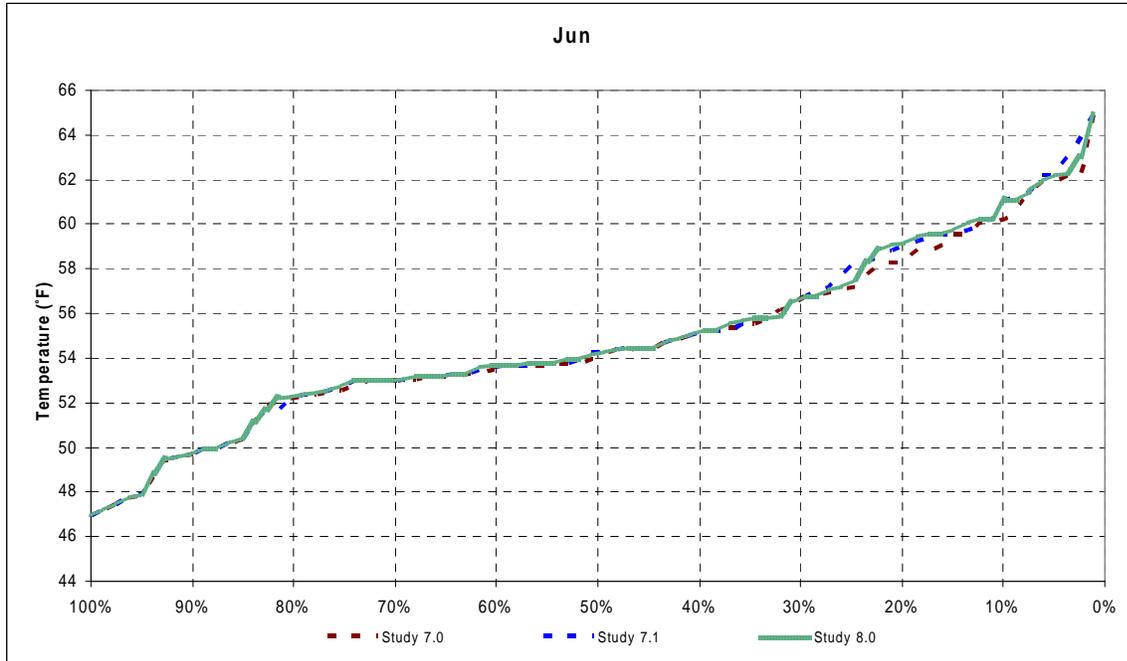


Figure 10-23 Douglas City Exceedence Plot – End-of-June

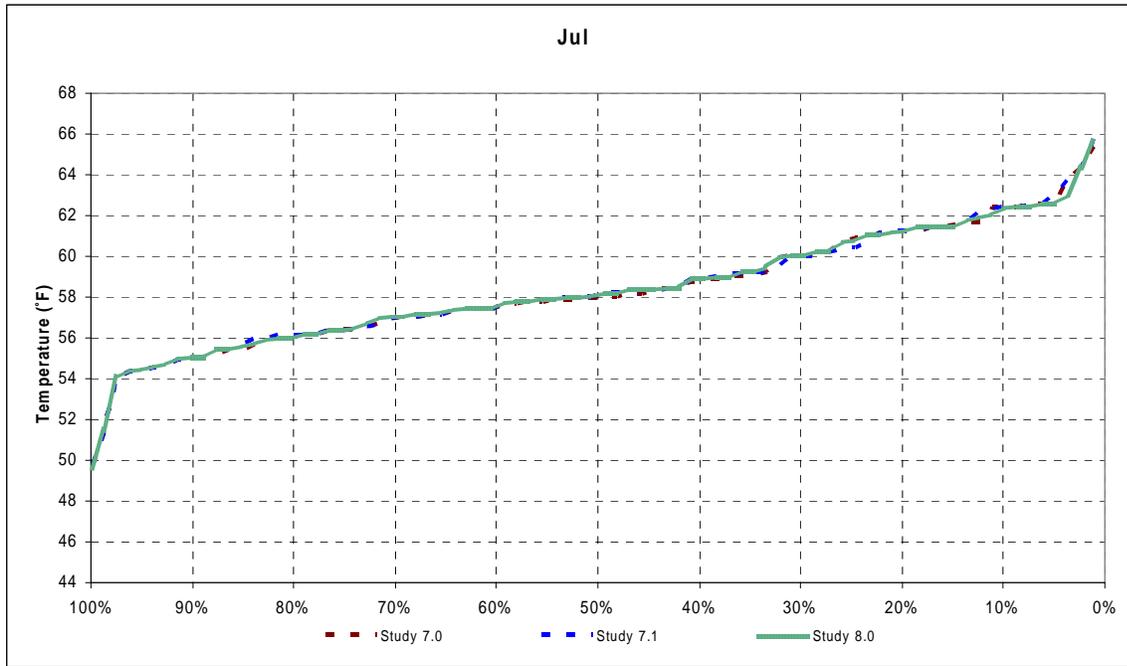


Figure 10-24 Douglas City Exceedence Plot – End-of-July

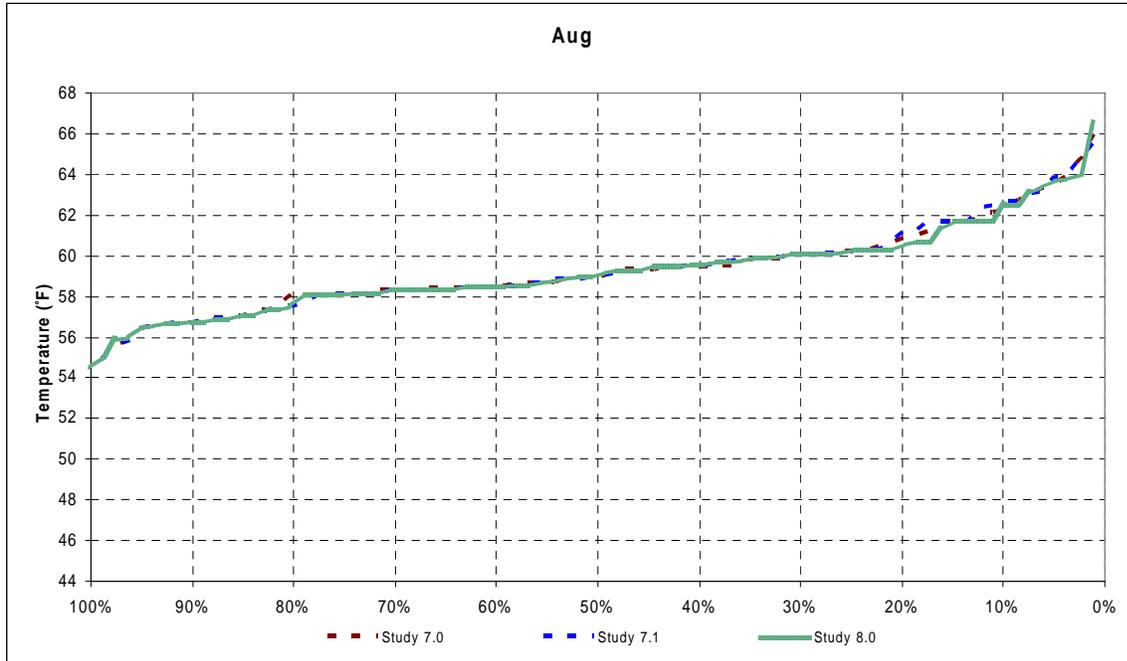


Figure 10-25 Douglas City Exceedence Plot – End-of-August

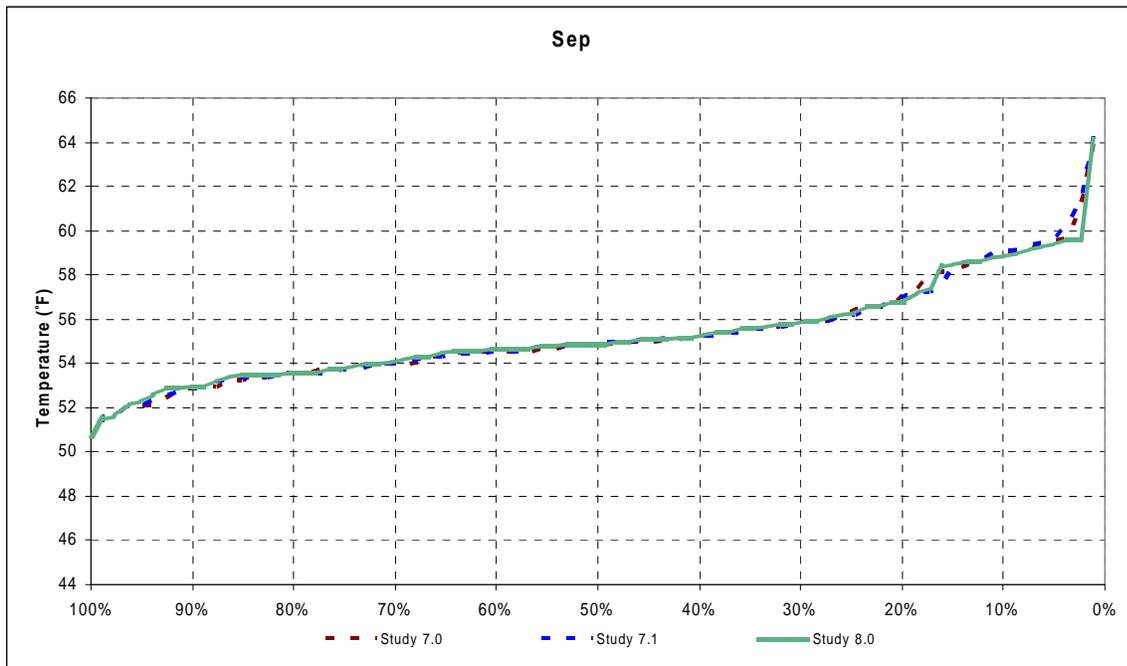


Figure 10-26 Douglas City Exceedence Plot – End-of-September

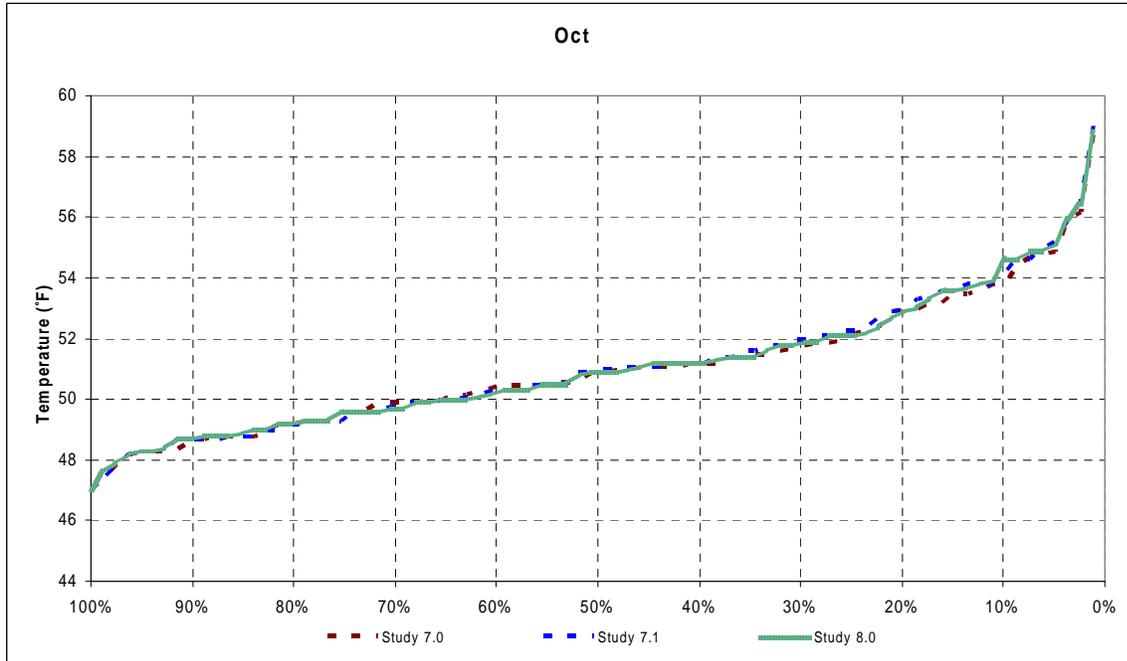


Figure 10-27 Douglas City Exceedence Plot – End-of-October

## Clear Creek

### Modeling

Whiskeytown Reservoir generally maintains a 235 thousand acre-feet (taf) end-of-September storage. Figure 10-28 shows that the end-of-September storage for Whiskeytown dropped from 235 taf to 180 taf only under the most extreme circumstances when Clear Creek inflows to Whiskeytown Reservoir and imports from the Clear Creek Tunnel could not support maintenance of Clear Creek release flows without some Whiskeytown Reservoir storage reduction.

Figure 10-29 shows that Clear Creek is mainly being driven by the 3406 (b)(2) management releases with the 50<sup>th</sup> and 95<sup>th</sup> percentiles for each month in all three studies. Figure 10-30 to Figure 10-35 illustrate the monthly averages by long-term average and by 40-30-30 Water Year Classification.

Figure 10-19 shows the Spring Creek Powerplant releases with the 50<sup>th</sup> and 95<sup>th</sup> percentiles for each month in all three studies. The seasonal pattern of releases reflects the goal to import water from the Trinity Reservoir system on a predominantly July to October pattern conducive with water temperature management and power generation needs. The variation during winter months generally reflects the movement of winter flows from the Trinity Reservoir system or winter flows produced as Clear Creek inflows to Whiskeytown Reservoir.

**Table 10-2 Clear Creek Long-term Annual Average**

#### Clear Creek

##### Longterm Annual Average

Difference in Thousands of Acre-feet [TAF]	Study 7.1 - Study 7.0	Study 8.0 - Study 7.0	Study 8.0 - Study 7.1
Annual Carr Powerplant Flows	2	2	1
Annual Clear Creek Release	-1	-1	0
Annual Spring Creek Powerplant Flows	2	3	0

##### 29- 34 Difference

Difference in Thousands of Acre-feet [TAF]	Study 7.1 - Study 7.0	Study 8.0 - Study 7.0	Study 8.0 - Study 7.1
Annual Carr Powerplant Flows	14	19	5
Annual Clear Creek Release	-12	-13	0
Annual Spring Creek Powerplant Flows	27	32	5

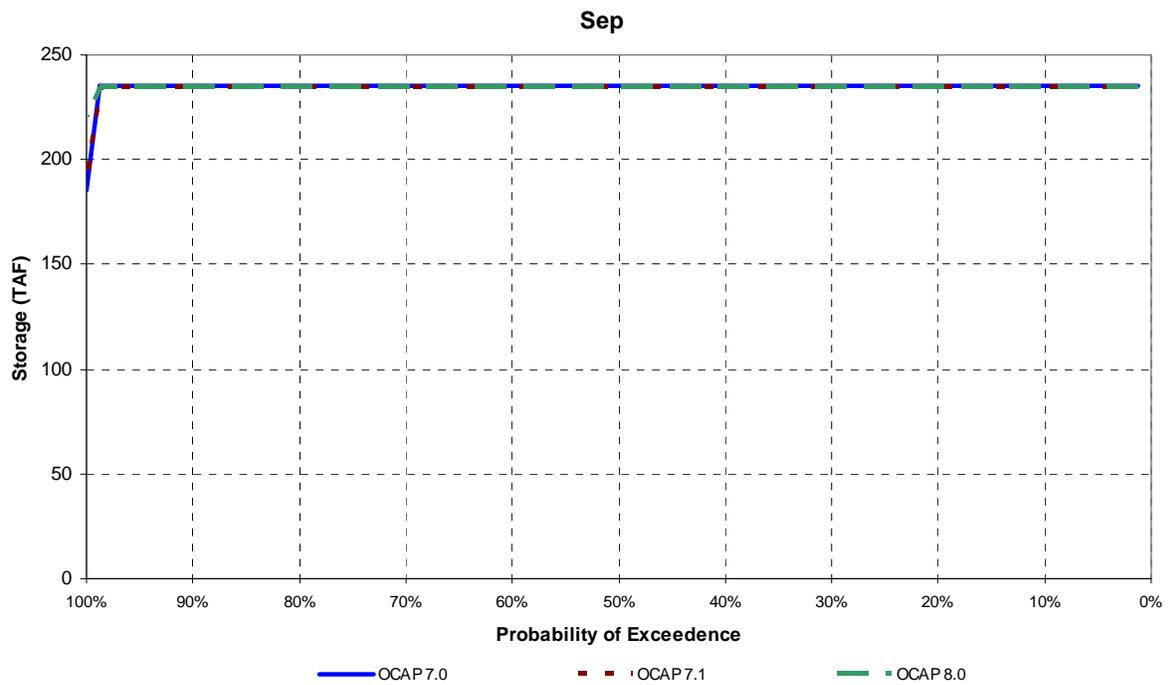


Figure 10-28. Whiskeytown Reservoir End-of-September Exceedence

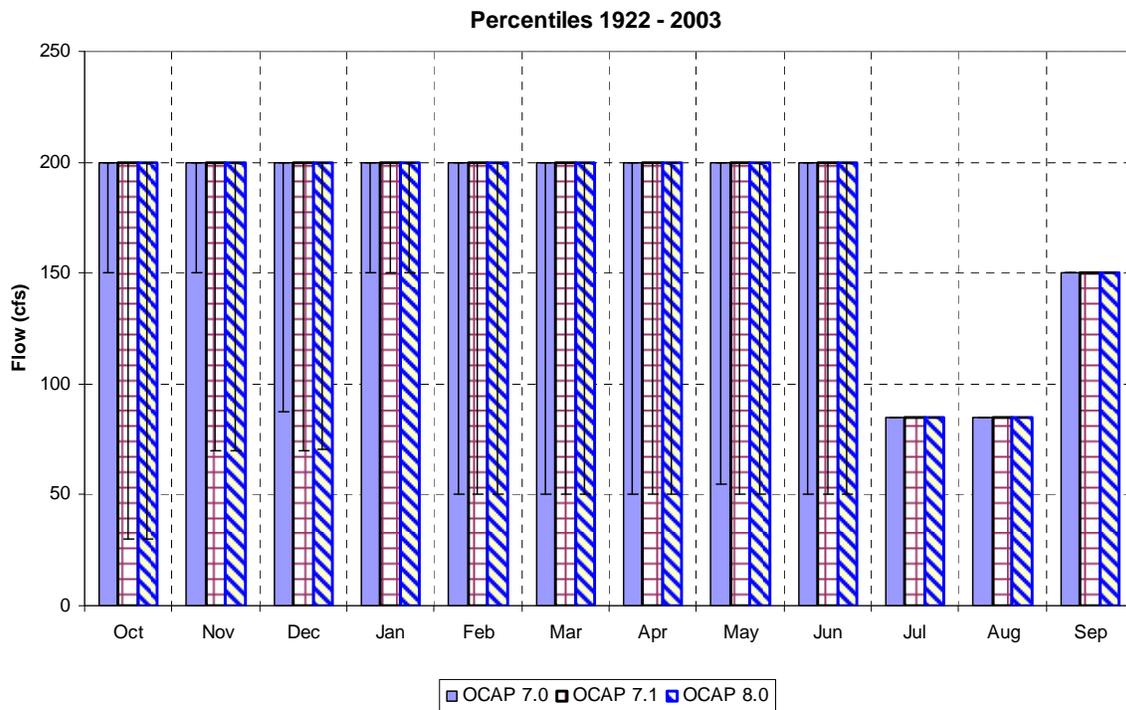


Figure 10-29 Clear Creek Releases 50<sup>th</sup> Percentile Monthly Releases with the 5<sup>th</sup> and 95<sup>th</sup> as the Bars

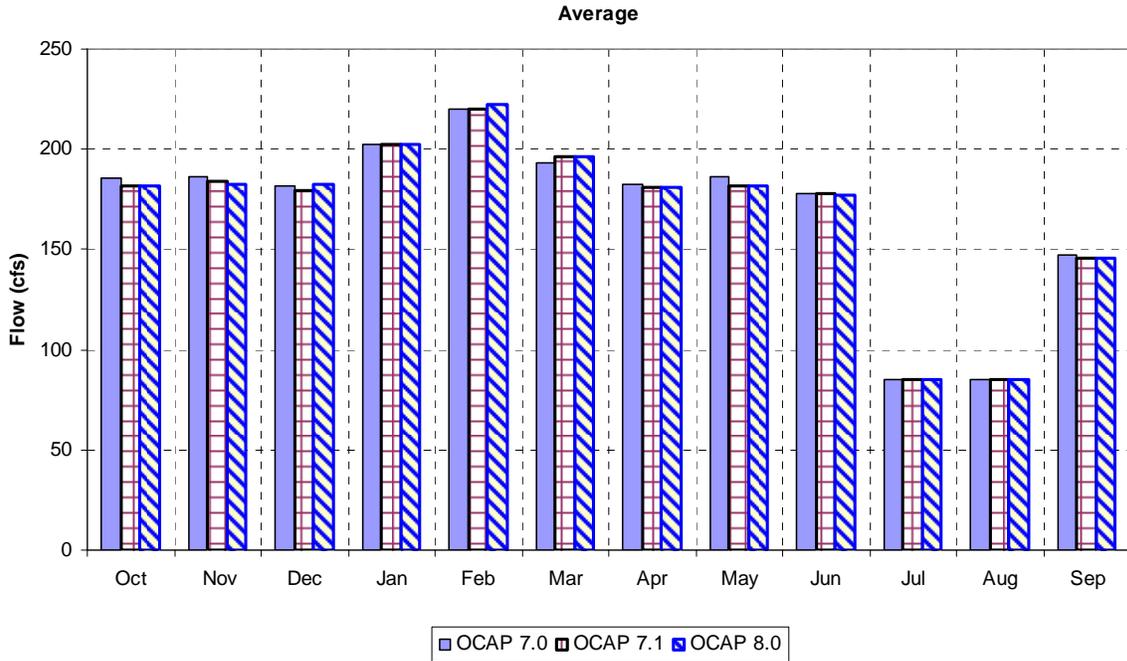


Figure 10-30 Long-term Average Monthly Releases to Clear Creek

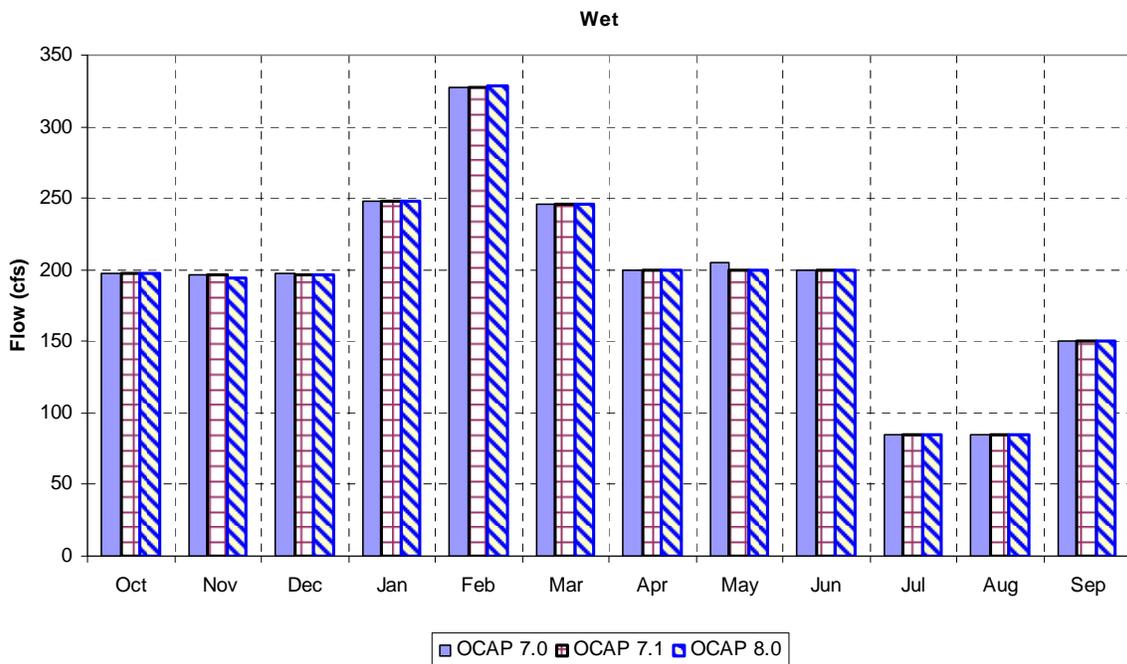


Figure 10-31 Average Wet Year (40-30-30 Classification) Monthly Releases to Clear Creek

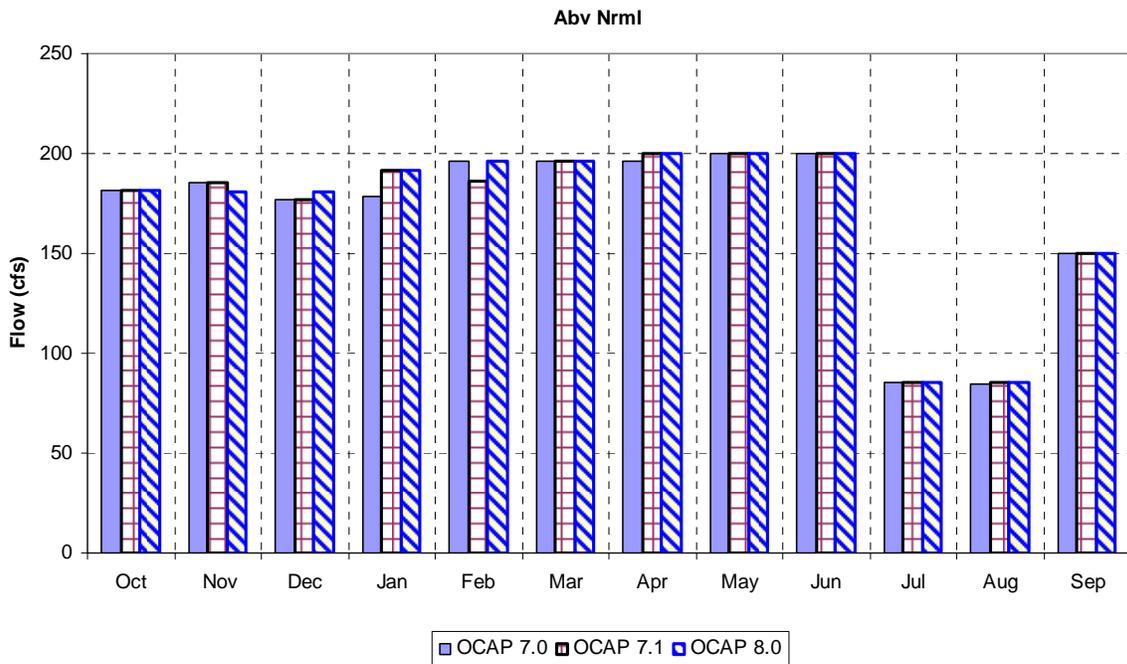


Figure 10-32 Average Above Normal Year (40-30-30 Classification) Monthly Releases to Clear Creek

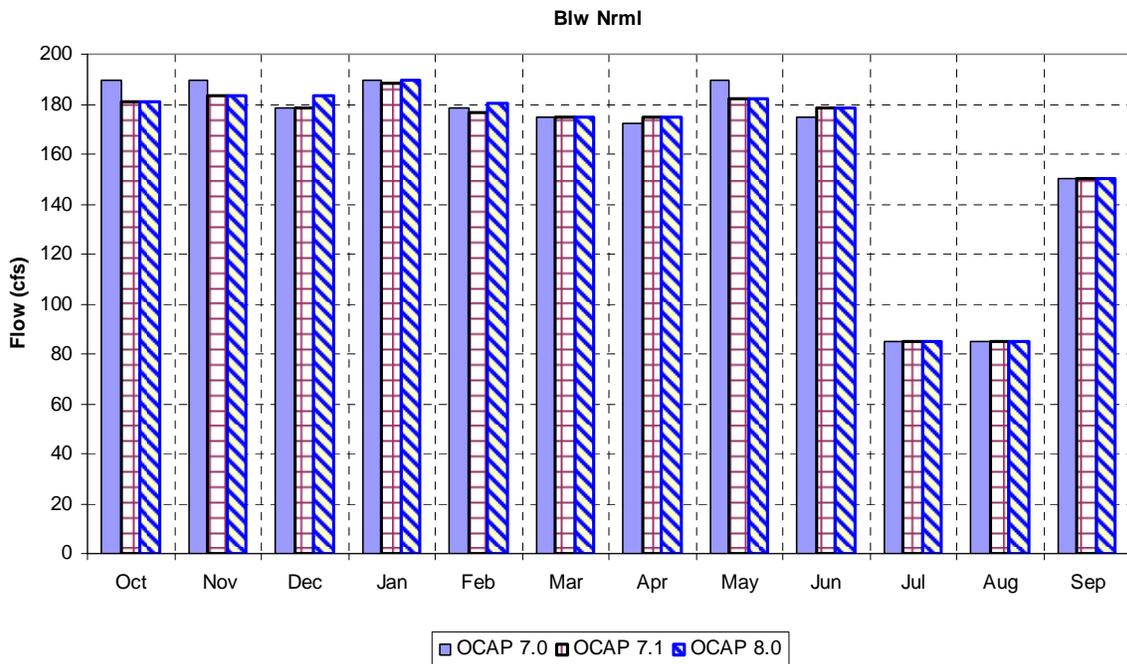


Figure 10-33 Average Below Normal Year (40-30-30 Classification) Monthly Releases to Clear Creek

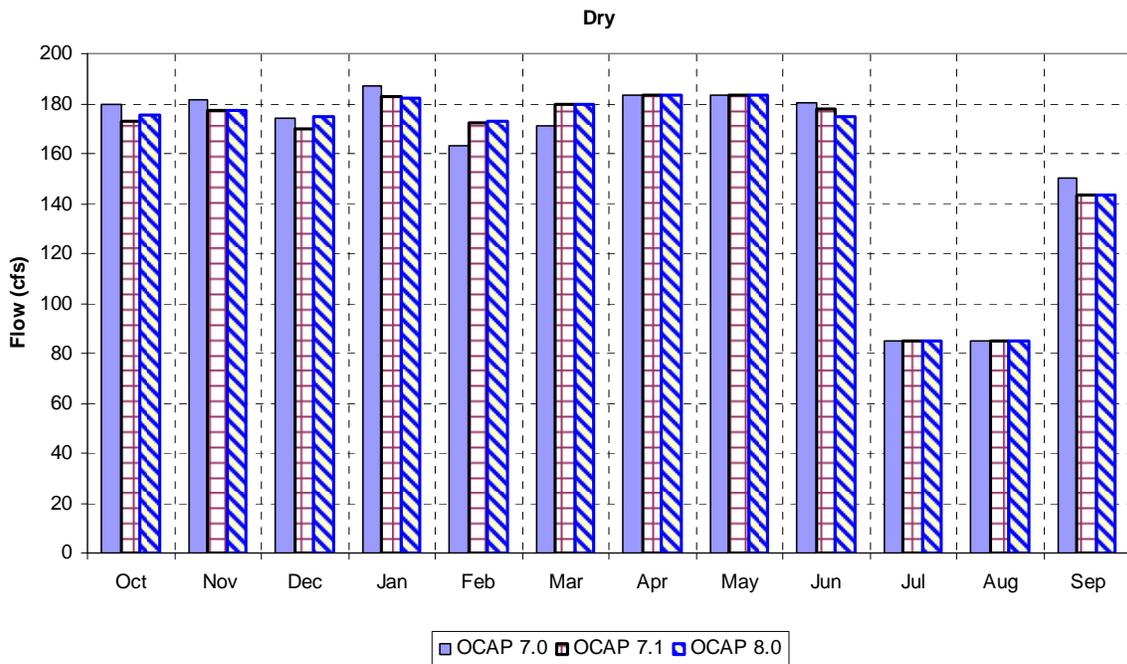


Figure 10-34 Average Dry Year (40-30-30 Classification) Monthly Releases to Clear Creek

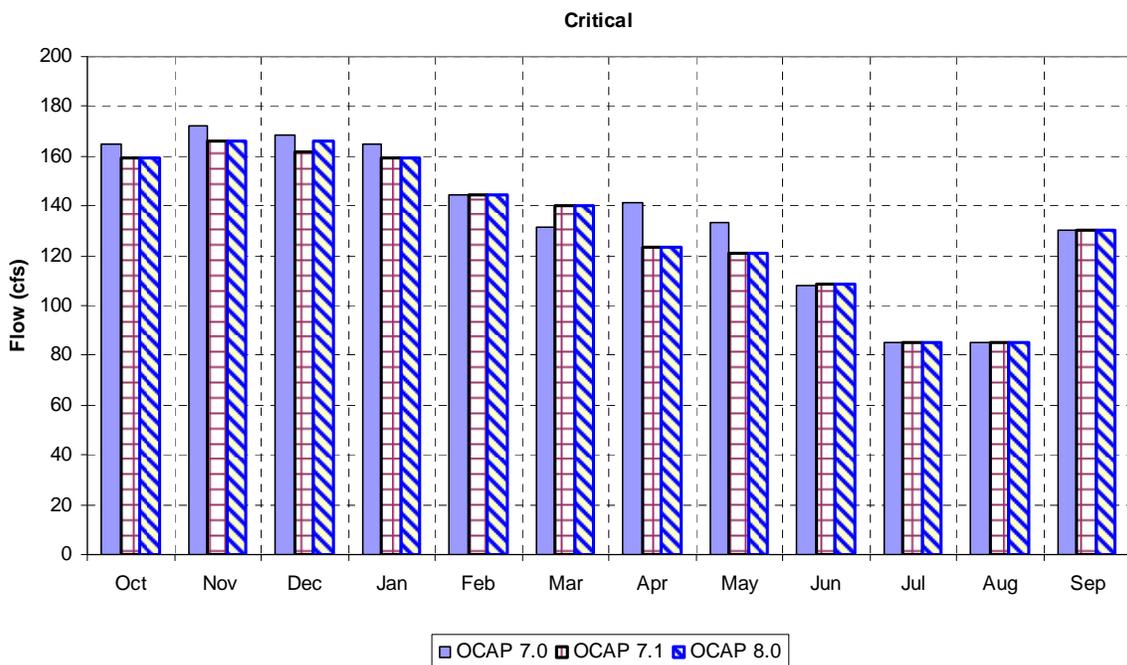


Figure 10-35 Average Critical Year (40-30-30 Classification) Monthly Releases to Clear Creek

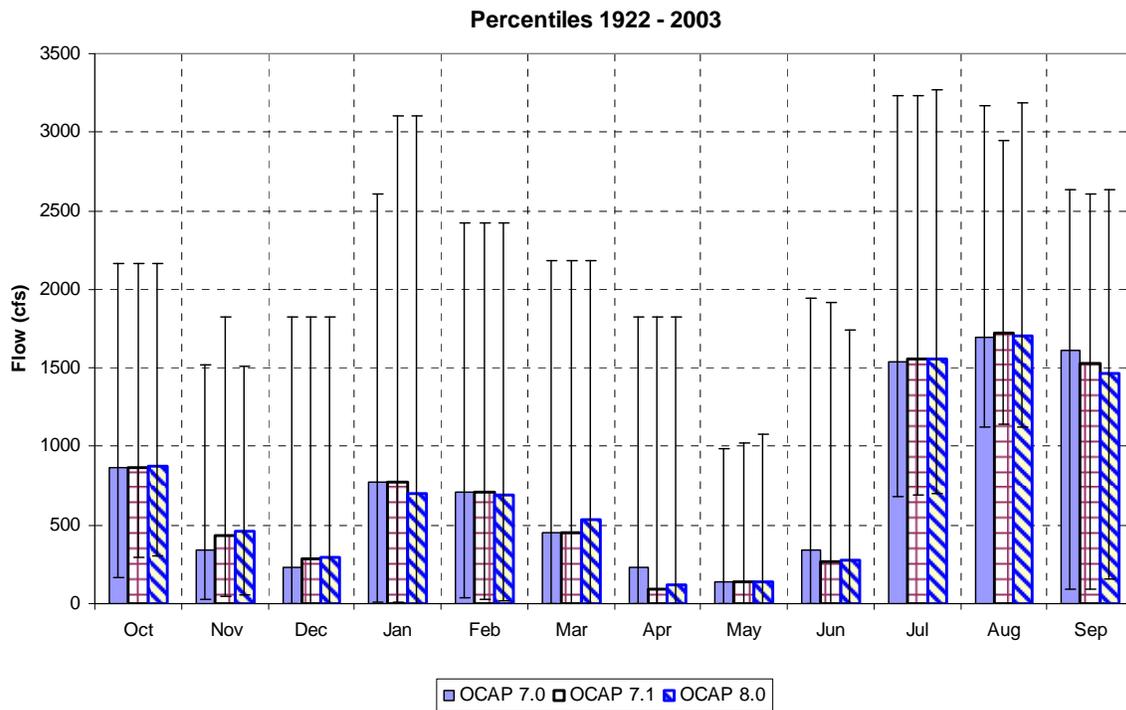


Figure 10-36 Spring Creek Tunnel 50<sup>th</sup> Percentile Monthly Releases with the 5<sup>th</sup> and 95<sup>th</sup> as the Bars

### Clear Creek Temperature Analysis

Figure 10-37 to Figure 10-43 illustrates potential water temperatures provided to Clear Creek at Igo. In general, the water temperatures are very similar for each of the studies. Each study shows relatively good performance to the Igo water temperature objective. This analysis shows difficulty meeting the Igo water temperature goals in roughly 5% to 10% of the conditions. It has been Reclamation’s recent experience that Igo water temperature goals have been more difficult to meet than planning modeling analysis suggests. Recent changes in the volume and temporal pattern of water imported from the Trinity River may not be well calibrated in the planning model as these parameters relate to changes to temperatures in Whiskeytown Reservoir.

### Igo Exceedence Plots

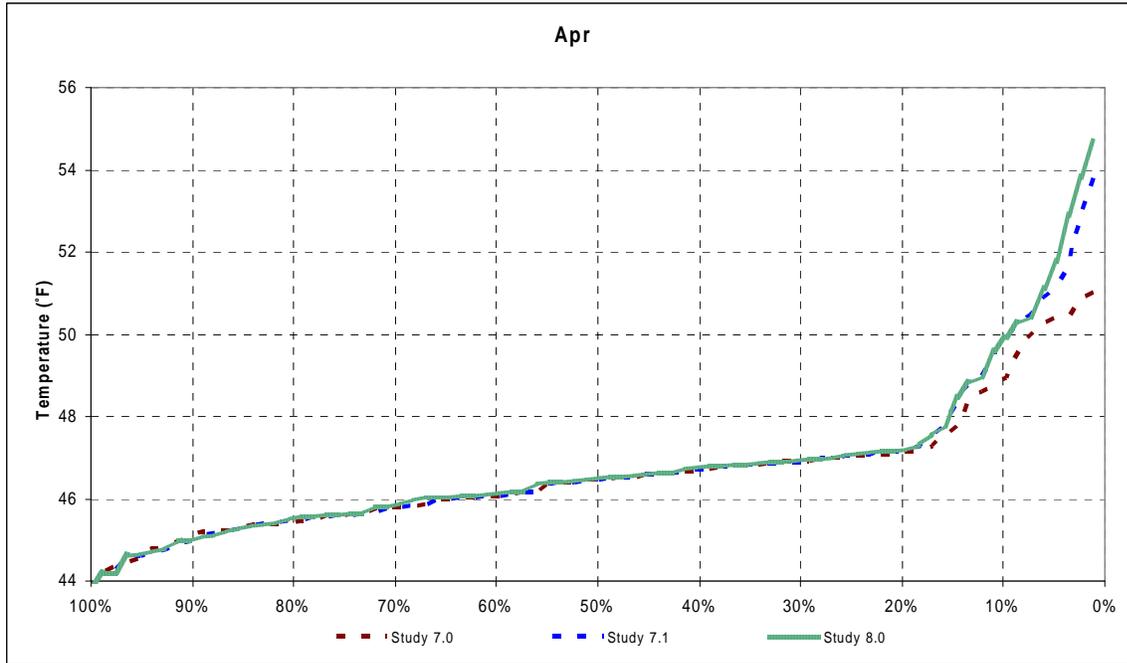


Figure 10-37 Igo Exceedence Plot – End-of-April

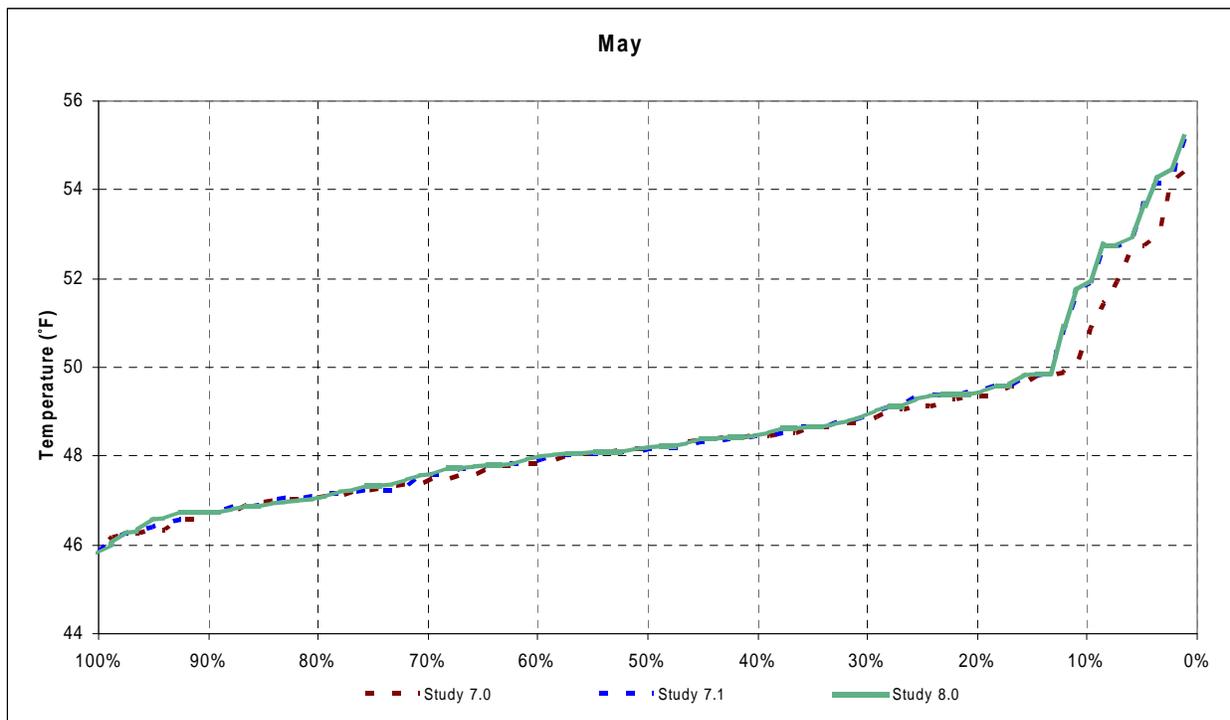


Figure 10-38 Igo Exceedence Plot – End-of-May

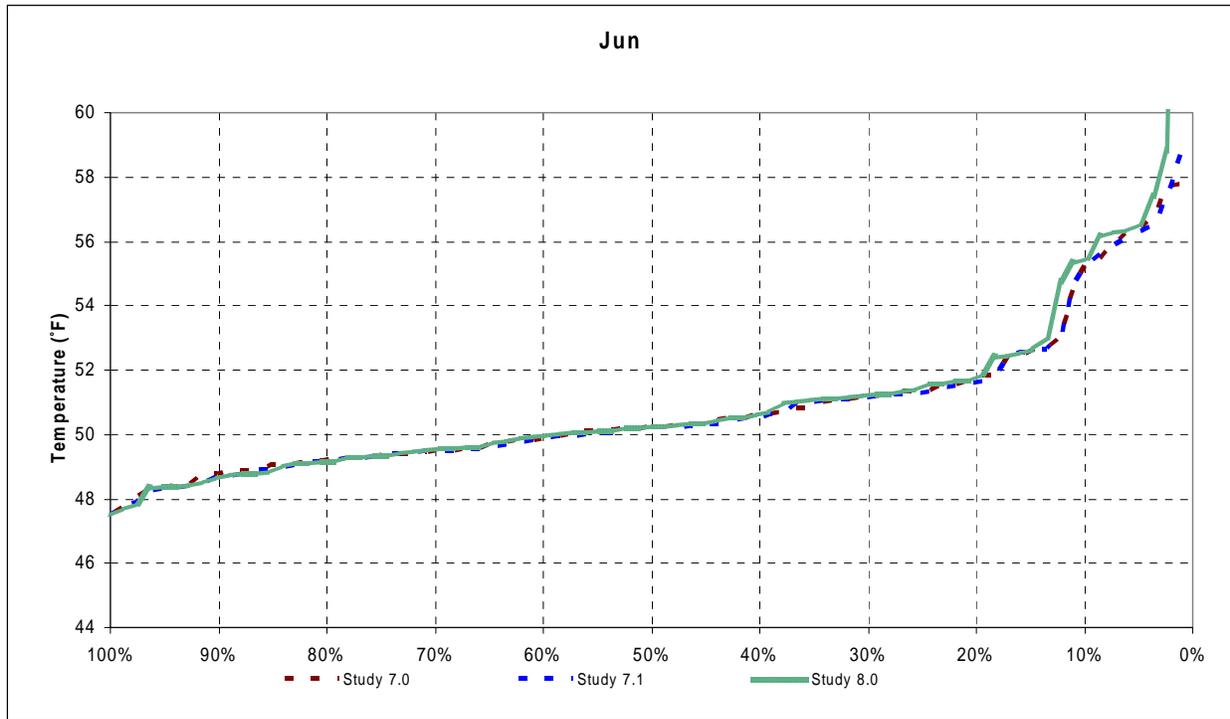


Figure 10-39 Igo Exceedence Plot – End-of-June

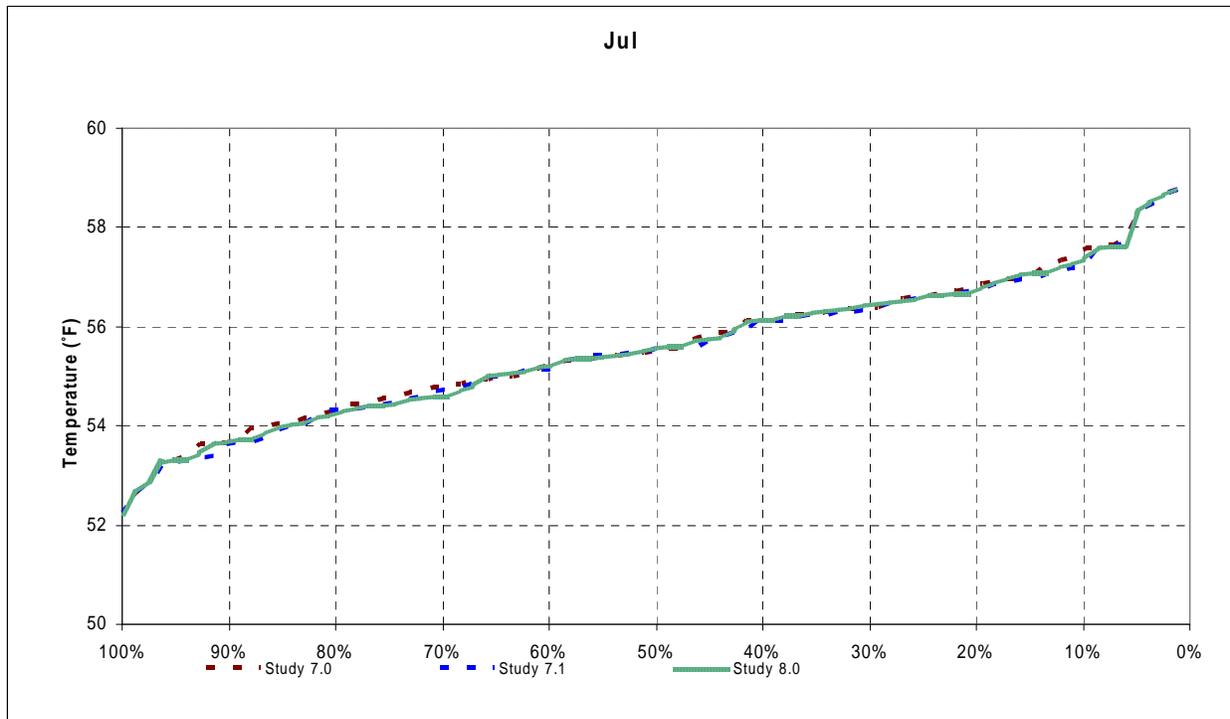


Figure 10-40 Igo Exceedence Plot – End-of-July

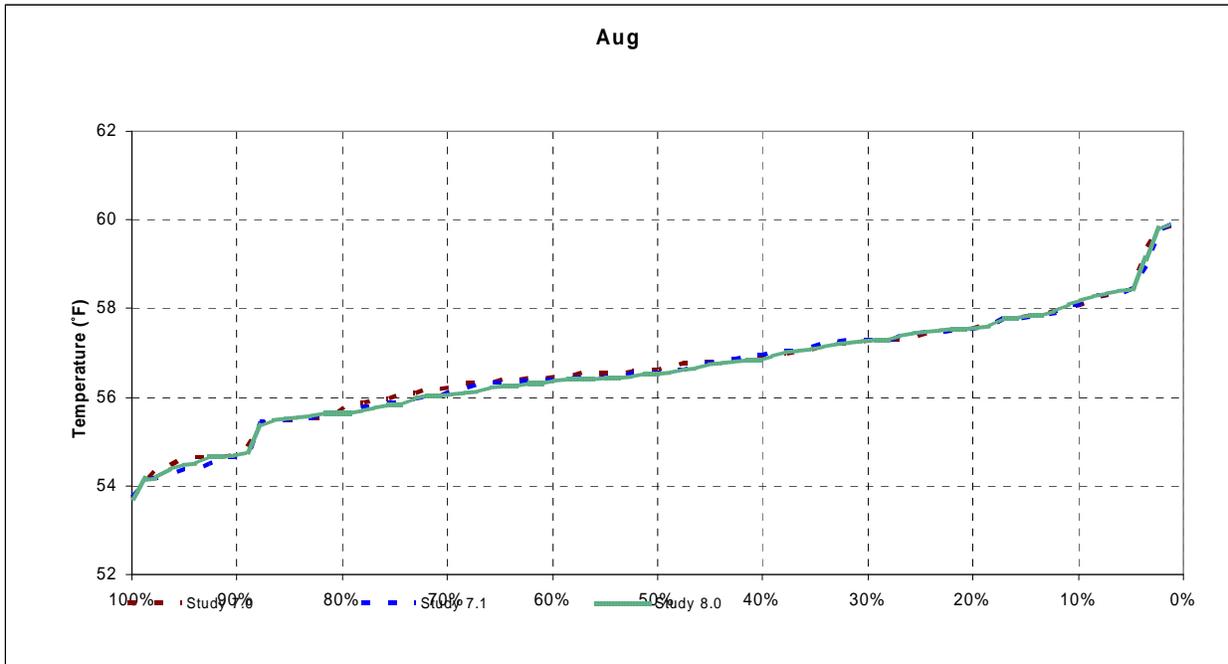


Figure 10-41 Igo Exceedence Plot – End-of-August

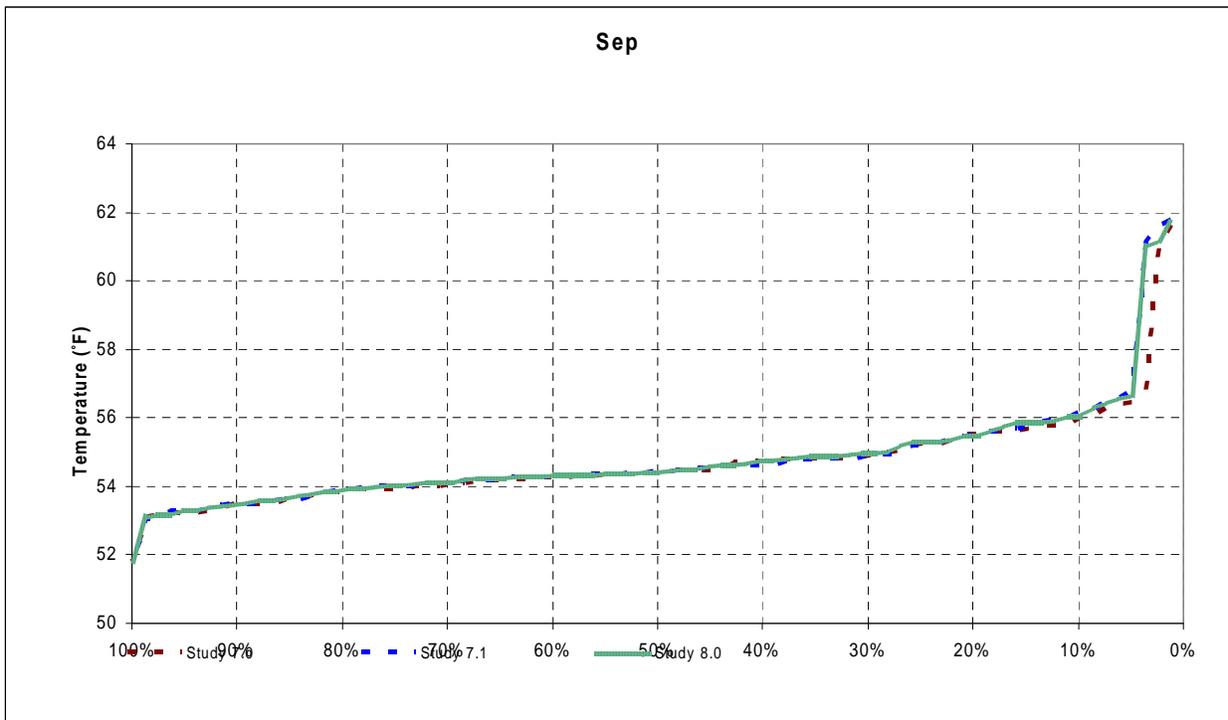


Figure 10-42 Igo Exceedence Plot – End-of-September

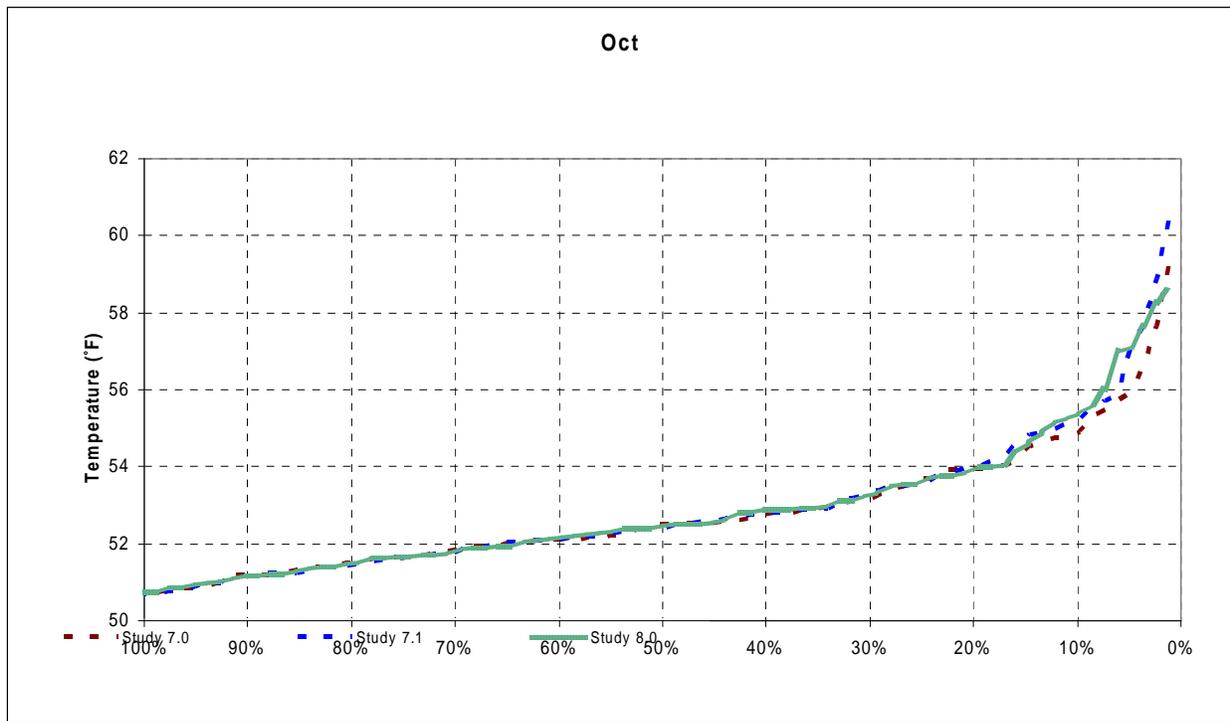


Figure 10-43 Igo Exceedence Plot – End-of-October

## Sacramento River

### Modeling

The most significant changes to Shasta reservoir operations are generally due to CVP reservoir integration and the changes occurring in the American Basin (Table 10-3, Table 10-4).

**Table 10-3. Long-term Average Annual and End of September Storage Differences for Shasta Storage, Spring Creek Tunnel Flow, and Keswick Release**

Longterm Annual Average

Difference in Thousands of Acre-feet [TAF]	Study 7.1 - Study 7.0	Study 8.0 - Study 7.0	Study 8.0 - Study 7.1
Shasta End-of-September Storage	-102	-123	-20
Annual Keswick Release	10	11	1
Annual Spring Creek Powerplant Flows	2	3	0

**Table 10-4. Average Annual and End of September Storage Differences for Shasta Storage, Spring Creek Tunnel Flow, and Keswick Release for the 1928 to 1934 Drought Period**

29- 34 Difference

Difference in Thousands of Acre-feet [TAF]	Study 7.1 - Study 7.0	Study 8.0 - Study 7.0	Study 8.0 - Study 7.1
Shasta End-of-September Storage	-275	-269	6
Annual Keswick Release	1	-2	-3
Annual Spring Creek Powerplant Flows	27	32	5

Figure 10-45 and Figure 10-46 shows the end-of-April and end-of-September exceedence for Shasta storage. The plots show that increased demands at other CVP reservoir facilities will influence Shasta Reservoir operations and storages.

This is the influence of the operationally integrated nature of CVP reservoirs. Shasta Reservoir metrics are most different between the studies during the summertime months. These differences reflect changed Keswick Reservoir releases due to changed conditions in the American Basin as well as increased water demand throughout the Central Valley. Figure 10-47 shows the monthly percentile flows for releases from Keswick Reservoir. Figure 10-48 to Figure 10-53 show the monthly average flows by long-term average and by Sacramento River Basin 40-30-30 Index water-year classification. The percentile and average charts indicate that as the overall water management changes occur at other CVP facilities and, as water demand increases, summertime releases from Keswick incrementally increase.

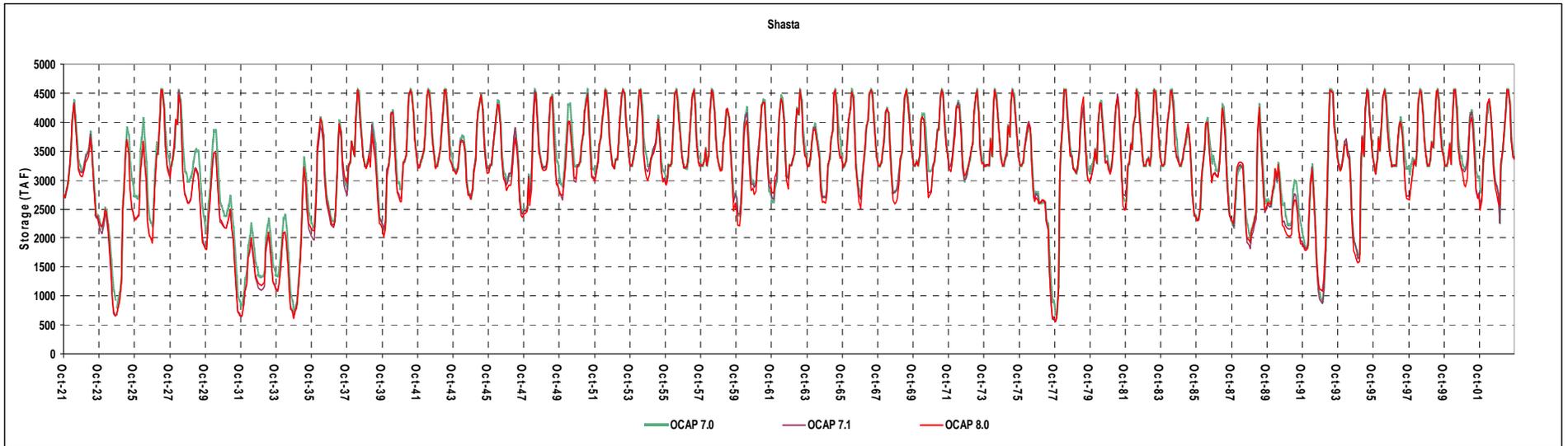


Figure 10-44. Chronology of Shasta Storage, Water Years 1922 – 2001

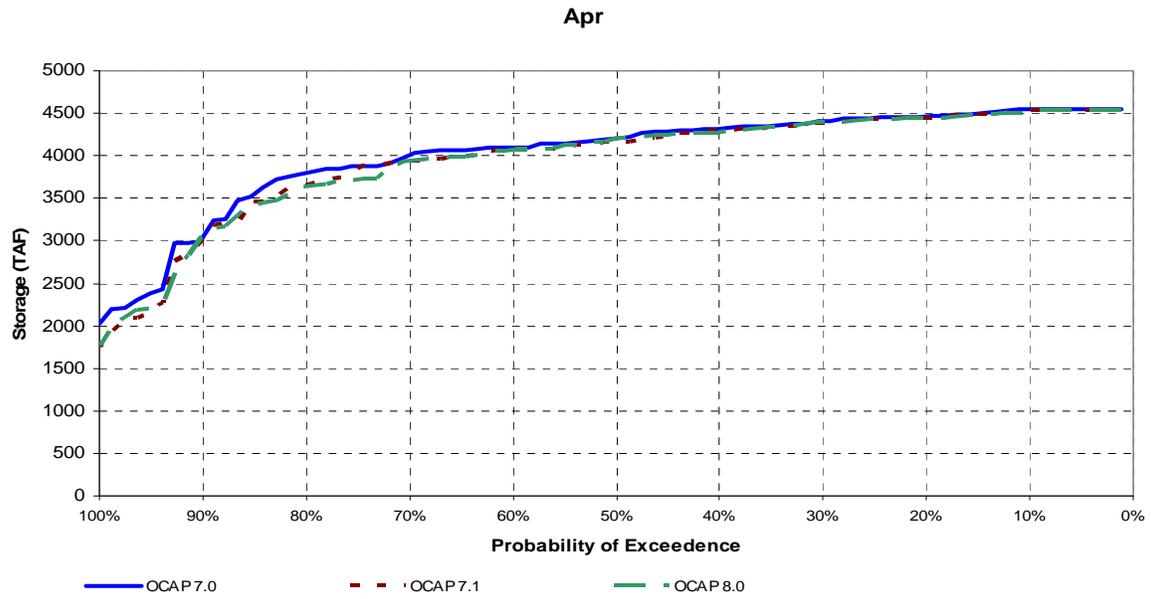


Figure 10-45 Shasta Reservoir End-of-April Exceedence

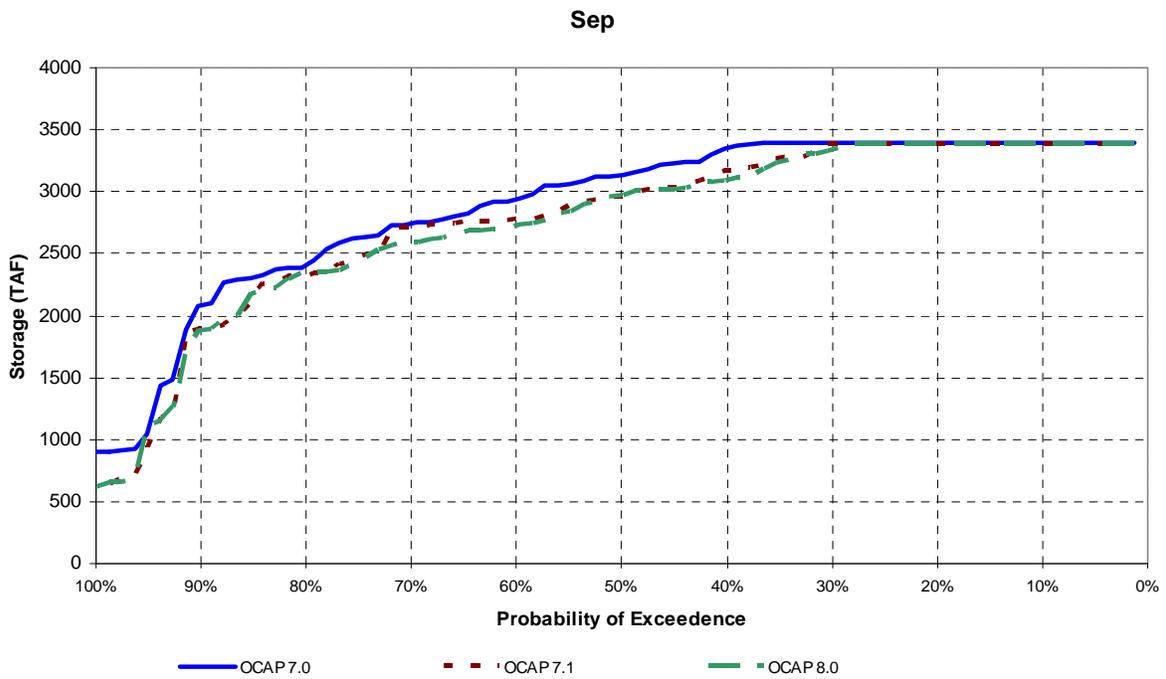


Figure 10-46 Shasta Reservoir End-of-September Exceedence

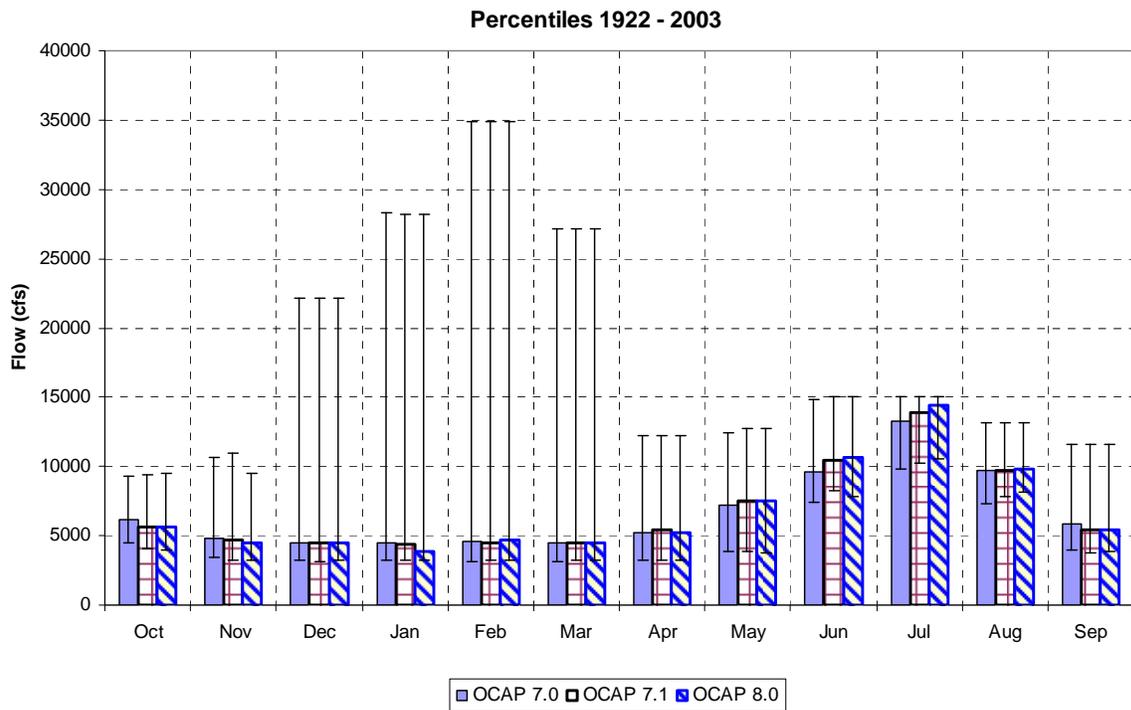


Figure 10-47 Keswick 50<sup>th</sup> Percentile Monthly Releases with the 5<sup>th</sup> and 95<sup>th</sup> as the Bars

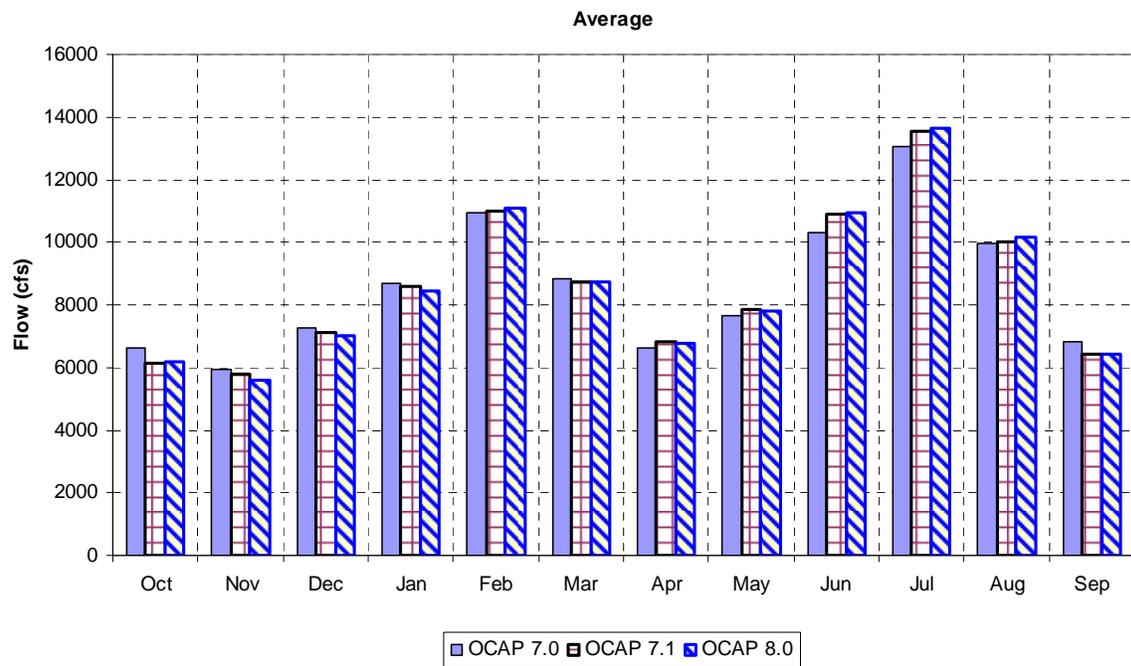


Figure 10-48 Average Monthly Releases from Keswick

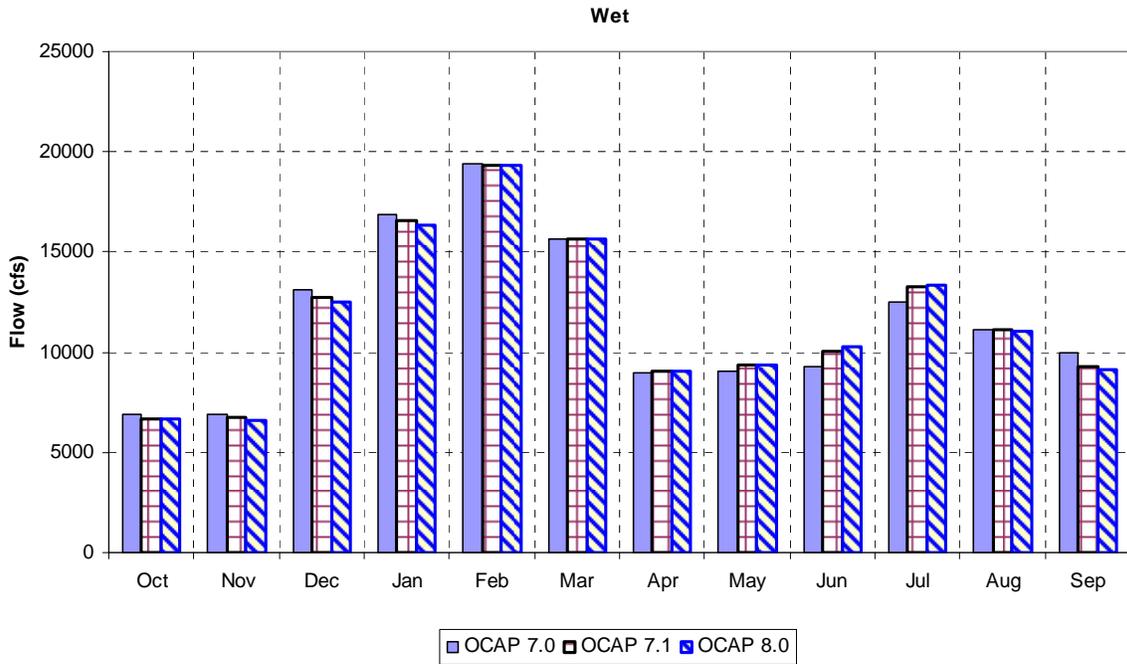


Figure 10-49 Average Wet Year (40-30-30 Classification) Monthly Releases from Keswick

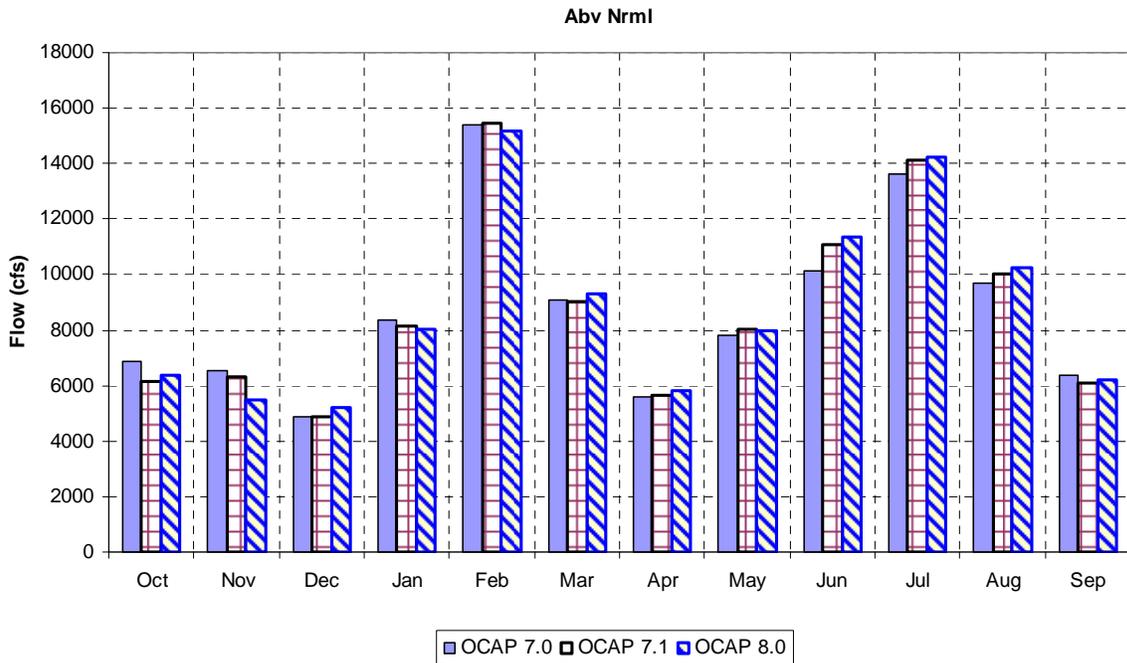


Figure 10-50 Average Above Normal Year (40-30-30 Classification) Monthly Releases from Keswick

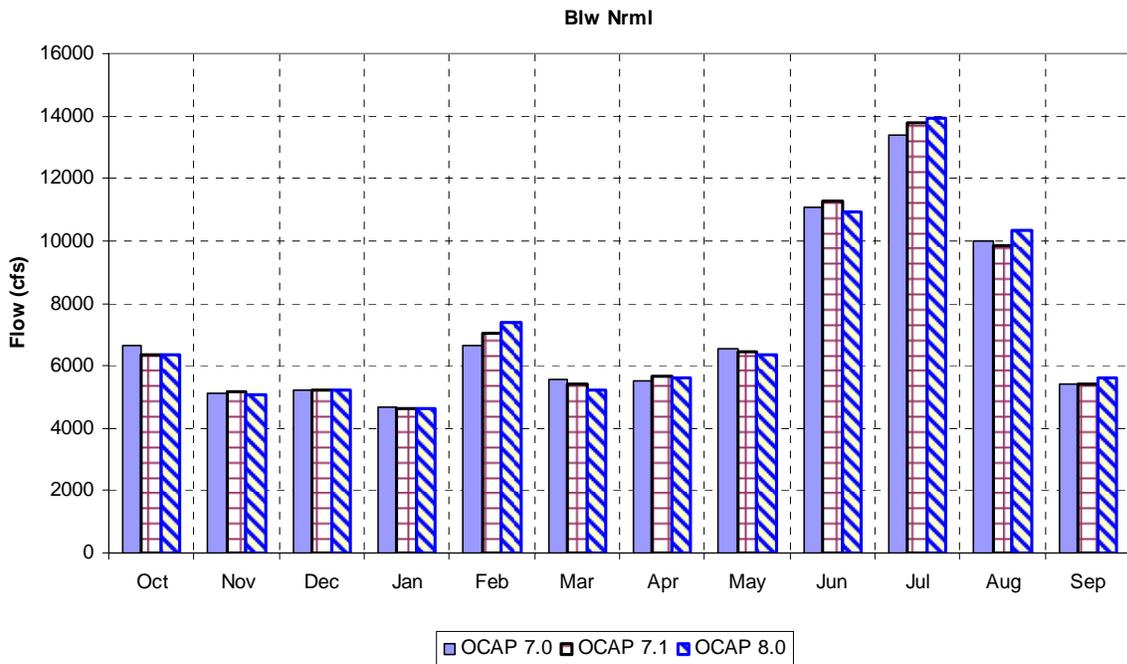


Figure 10-51 Average Below Normal Year (40-30-30 Classification) Monthly Releases from Keswick

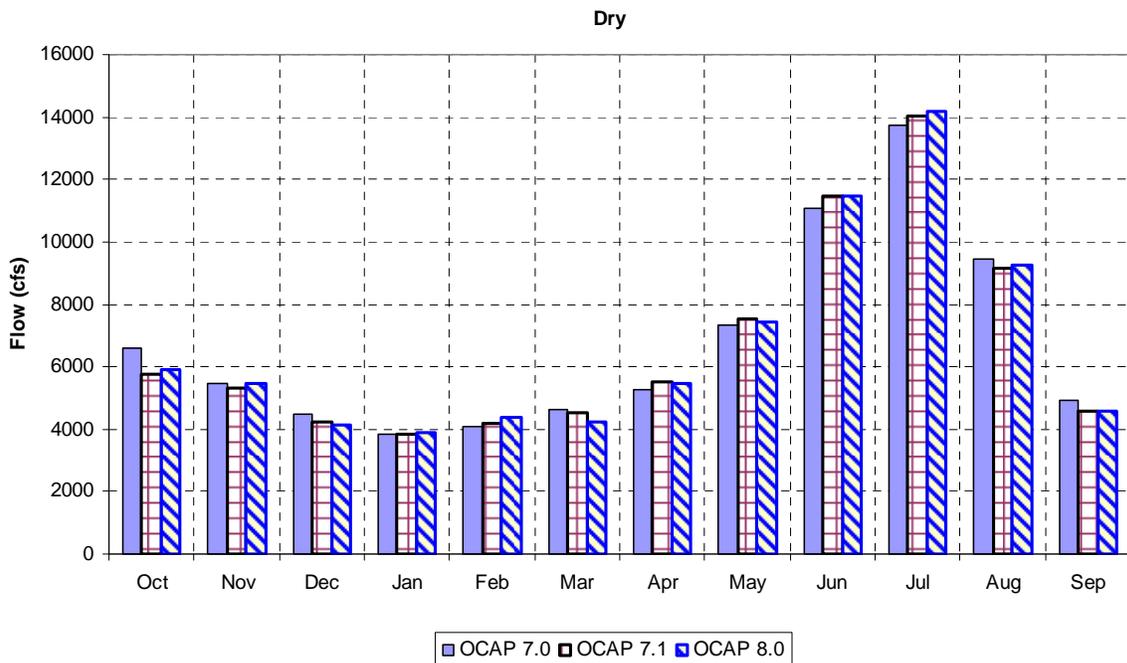


Figure 10-52 Average Dry Year (40-30-30 Classification) Monthly Releases from Keswick

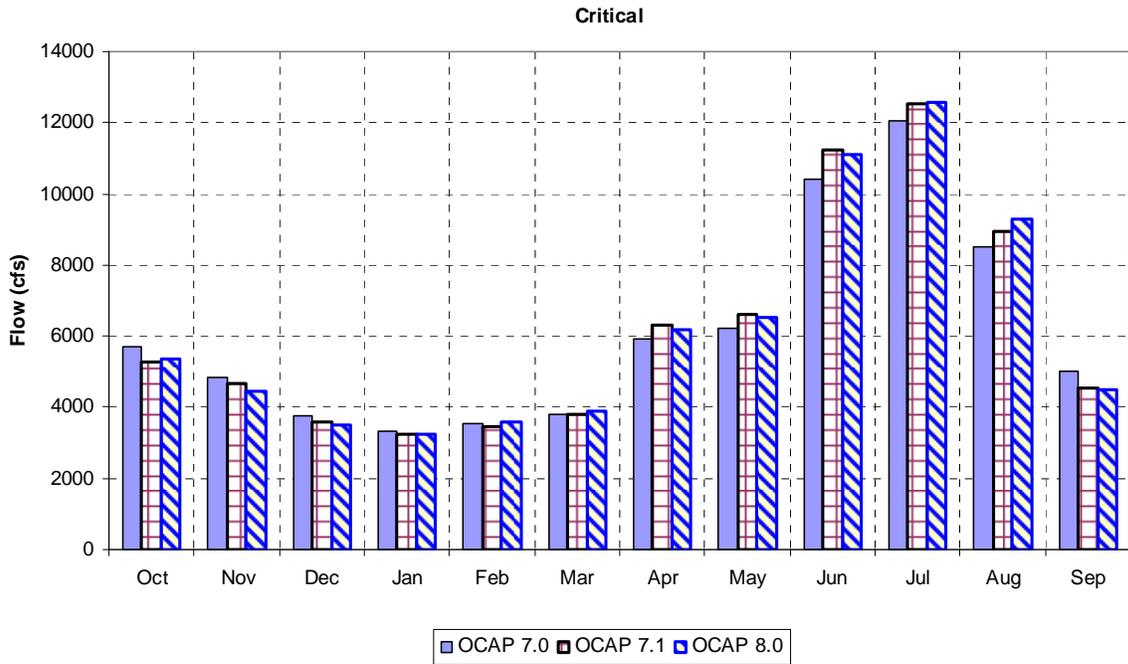


Figure 10-53 Average Critical Year (40-30-30 Classification) Monthly Releases from Keswick

## Upper Sacramento River Temperature Analysis

Successful management of water temperatures to protect the fishery in any given year for the upper Sacramento River requires close coordination and analysis of several factors that influence water temperature. The general operational factors that will influence water temperature management are:

- Volume of coldwater availability in the spring,
- Shasta Temperature Control Device operational flexibility
- Projected Keswick Reservoir release rate over the temperature control season
  - Too low of release rates may require significantly colder source water to meet a target location leading to faster depletion of available coldwater.
  - Too high of release rates may deplete coldwater availability faster than anticipated and lead to faster depletion of available coldwater
- Designation of a water temperature compliance target location that best integrates the above three factors with water temperature habitat needs for sensitive lifestages of fish.

As described in Chapter 2, the Sacramento River Temperature Task Group evaluates all the above factors for a given year and designates a compliance target location downstream of Keswick Reservoir that balances all the relevant information and factors into a seasonal strategy for water temperature management. This adaptive management process updates and evaluates current information in order to make significant choices and tradeoffs for seasonal or inter-seasonal water temperature performance management. Reclamation utilizes this adaptive management process in order to comply with SWRCB WRO 90-5 objectives for water temperature management in the upper Sacramento River environment.

The modeling results presented here cannot completely simulate how the Sacramento River Temperature Task Group adaptively manages to all available information about operations and cold water resources to designate of a temperature compliance location in any given year. The water temperature analysis presented here demonstrate the generalized relationships of cold water availability, generalized Shasta TCD operations and Keswick flow regimes associated with a specific set of assumptions for CVP operations. In this incremental sense, the modeled water temperature performance between different studies can be compared in a meaningful way to better understand the seasonal use of coldwater resources relative to each study framework. This water temperature analysis should not be construed as an absolute predictive analysis. The Sacramento River Temperature Task Group uses more detailed predictive management tools to designate a reasonable temperature compliance location in any given year.

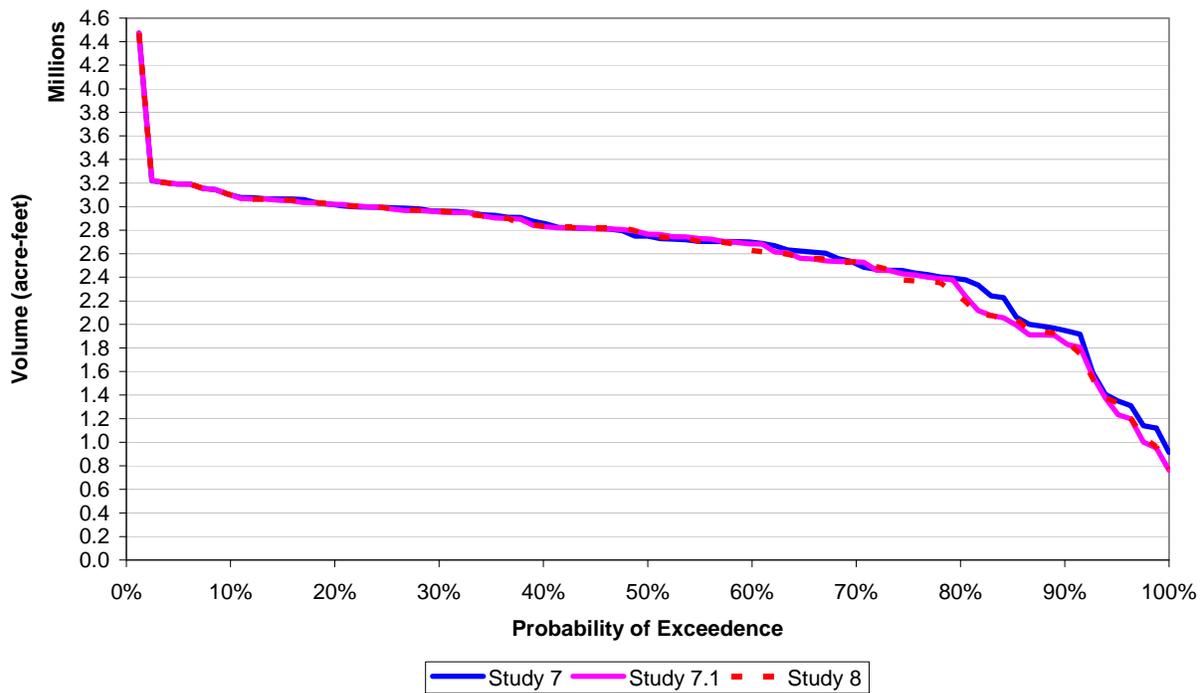
## Coldwater Availability

The most significant influence on water temperature is the volume of available cold water. The estimated volume of water colder than 52°F stored in Shasta Reservoir on or about May 1 is a very useful way to generally relate cold water availability to potential seasonal compliance strategies. Generally, the larger the volume of 52°F water in Shasta Reservoir, the greater potential to designate temperature control target locations farther downstream from Keswick

Reservoir, or the longer in time that a temperature control target location can be managed to 56° F over the temperature control season with a greater assurance of not over-extending the available coldwater resources.

Figure 10-54 illustrates the 52°F index of coldwater availability for all three studies. All three studies show similar coldwater availability conditions from the 0% to 80% exceedence range. The shape of this coldwater availability index is not the same as Figure 10-58 which shows the exceedence shape of total Shasta Reservoir storage at the end-of-April. The reason is the accumulation of coldwater storage in the spring months is influenced by many factors beyond just total storage in Shasta Reservoir. Figure 10-54 illustrates that the 52° F index of coldwater availability in the drier 80% to 100% exceedence range is closely related to overall storage in Shasta Reservoir.

**Cold Water Resource - Lake Shasta  
(End of April Lake Volume Less Than 52°F)**



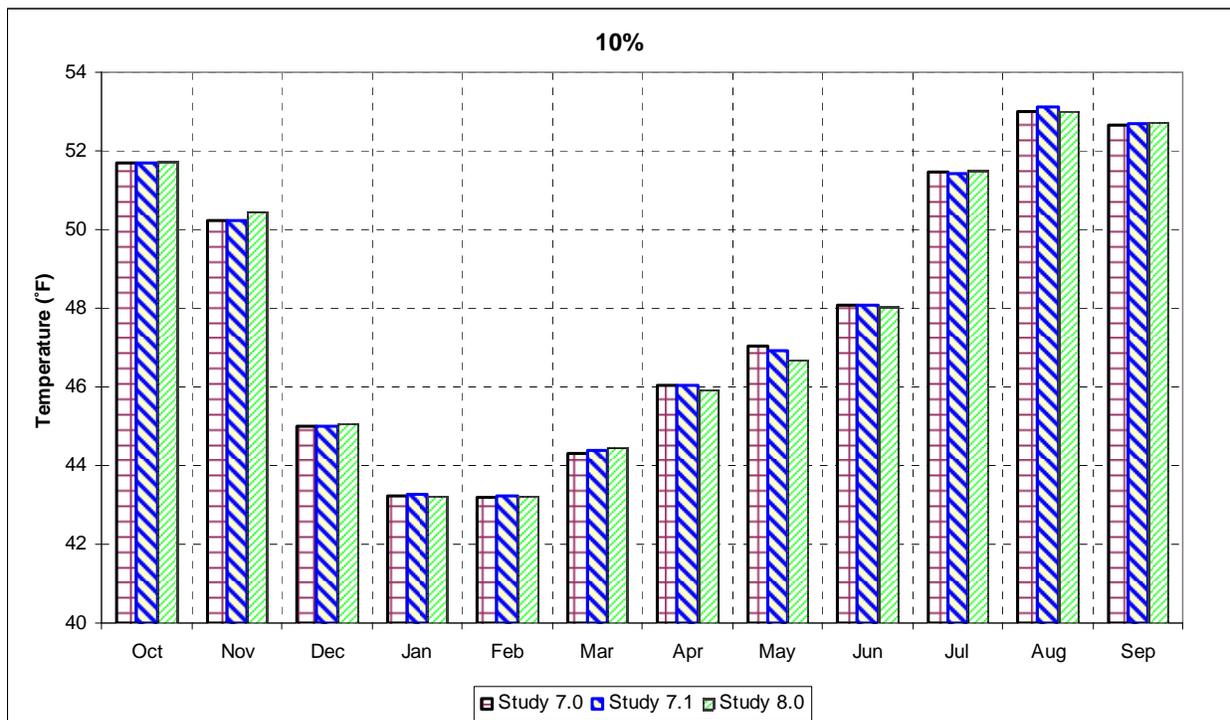
**Figure 10-54 52°F index of coldwater availability**

Figure 10-55 to Figure 10-57 characterize the seasonal water temperatures that can occur for Spring Creek Powerplant releases into Keswick Reservoir. The reader should refer to Figure 10-36 (Spring Creek Tunnel Probability Plot) to reference the general quantities of water being diverted in association with these water temperature distributions. Spring Creek Powerplant releases are a source of coldwater conservation to Shasta Reservoir. When Spring Creek Powerplant releases are made to Keswick Reservoir, Shasta Reservoir releases are reduced, thereby conserving coldwater reserves for later use. The cooler the Spring Creek Powerplant releases are, the greater the conservation of the overall thermal potential at Shasta Reservoir.

This operation releases from the Shasta TCD to thermally mix the combination of Shasta Reservoir storage and Spring Creek Powerplant releases to produce the desired Keswick water temperatures. Figure 10-57 (90% Spring Creek) shows high water temperatures in the months of April to June, this is a modeling anomaly of having nearly zero water moved through Spring Creek Powerplant under very dry conditions. Generally these plots illustrate that during the upper Sacramento River temperature control season and during the prime Spring Creek Powerplant release month of July through September, the water temperatures will range from the lower 50° F's to the mid 50° F's. All three studies show very similar water temperature characteristics at Spring Creek Powerplant.

The combination of coldwater availability below 52° F at Shasta Reservoir and expected seasonal volumes and water temperatures at Spring Creek Powerplant fully describe the coldwater availability Reclamation has to perform upper Sacramento River water temperature performance.

**Spring Creek Tunnel Water Temperatures Seasonal Exceedence Plots**



**Figure 10-55 Spring Creek Tunnel Water Temperatures 10% exceedence**

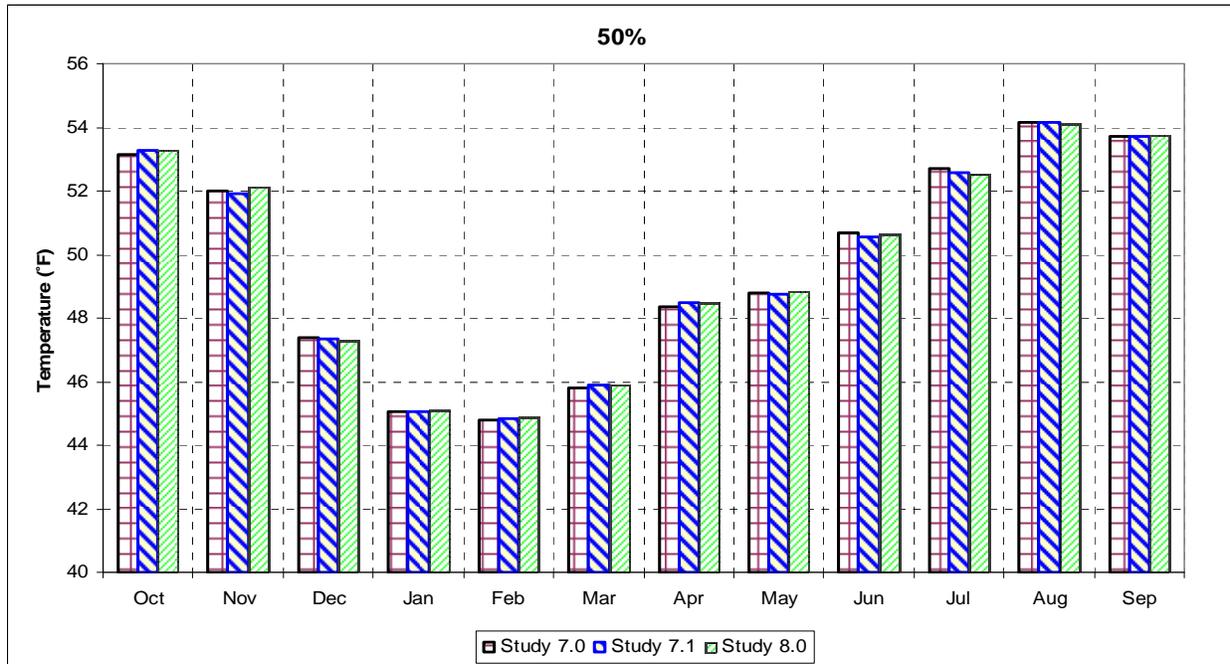


Figure 10-56 Spring Creek Tunnel Water Temperatures 50% exceedence

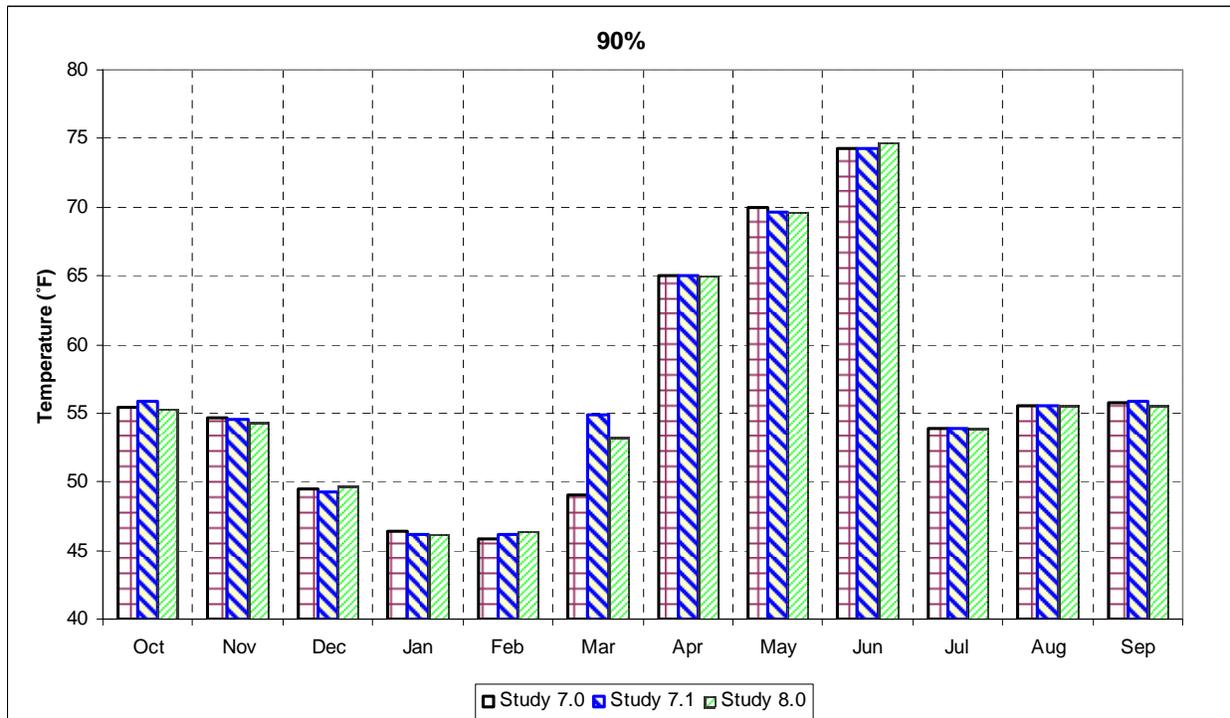


Figure 10-57 Spring Creek Tunnel Water Temperatures 90% exceedence

Figure 10-58 to Figure 10-65 illustrate the potential seasonal coldwater patterns for the three studies at the Shasta Reservoir tailbay location. Each of the studies has been modeled using the same Shasta TCD target temperature logic. Since each study utilizes the same TCD operations logic to generate water temperature values, the results of this analysis will only characterize how the depletion of the annual coldwater resources at Shasta Reservoir varies among the three studies. Given that the water temperature analysis uses of the same TCD operations logic in each study, the model makes no attempt to adjust the water temperature target location within the season based on the availability of coldwater. The Sacramento River Temperature Task Group would consider this kind of information and make choices as to how to manage the temporal distribution of coldwater resources differently than may be portrayed with this water temperature analysis.

The usefulness of this analysis is to characterize the water temperature utilization between studies in order to evaluate general coldwater management and water temperature trends for each study framework.

The plots begin to show potential differences in the utilization of coldwater resources in July for approximately 40% of the years between study 7 and study 7.1 and study 8.

Figure 10-66 to Figure 10-73 illustrate potential seasonal coldwater use patterns for the three studies at the Keswick Reservoir. Keswick Reservoir is the key management point to water temperature operations for the upper Sacramento River because this is the location CVP operators have significant influence to the temperature of the water released on a daily basis before reaching the water temperature compliance location.

In realtime water temperature operations, CVP operators manage Keswick release water temperatures by adjusting and balancing the following operational factors for water temperature purposes;

- Flow from Shasta Dam
- Shasta TCD gate configuration
- Flow from Spring Creek Powerplant into Keswick Reservoir
- Total flow released from Keswick Reservoir
  - Changes re-affect the above flow contributions and thermal mixing ratios
  - Changes the residence time of water in Keswick Reservoir from Shasta Dam

This temperature analysis shows for all three studies very similar water temperature performance characteristics at Keswick from April through July. Comparing the July graph for Keswick Releases (Figure 10-69) and the July graph for Shasta Tailbay (Figure 10-61) yields some useful information. The Keswick release water temperatures in July are very similar, yet the temperature of water released from Shasta Dam is generally warmer for Study 7.1 and Study 8. This relationship is due to generally higher Keswick Dam releases in study 7.1 and study 8, and the counter influence of Shasta TCD flexibility allowing for slightly warmer releases in order to conserve coldwater.

This temperature analysis shows for all three studies that at roughly the 10% exceedence level, each study has possible water temperature control problems by August. The difficulties are more

pronounced for study 7.1 and study 8. Referring back to the August Shasta Tailbay plot (Figure 10-62), the information shows that for study 7.1 and study 8, roughly 10% of the time Shasta Reservoir has been depleted of useful coldwater, while in study 7, it is roughly 5% of the time. This information is consistent with Figure 10-54 showing lesser coldwater availability for study 7.1 and study 8 at the 10% exceedence level. This water temperature analysis confirms that the change in availability of coldwater resource will eventually produce a temporal change in water temperature performance.

The illustrations of Keswick release water temperatures for September and October show similar trends for all three studies. Each study shows coldwater availability being a significant factor in 15 to 20% of the cases by September and 20-30% of cases in late October. There is a slight trend for better water temperature performance in study 7 relative to study 7.1 and study 8 in the non-depleted cases, this trend reflects the slightly improved coldwater availability and temporal coldwater conservation characteristics of study 7 relative to study 7.1 and study 8.

Figure 10-74 to Figure 10-81 and Figure 10-82 to Figure 10-89 illustrate how this water temperature analysis reflects water temperature performance characteristics at the Balls Ferry location and the Bend Bridge location respectively. In general, the two locations are showing the same water temperature/coldwater depletion characteristics as illustrated by the Keswick release water temperature issues.

Shasta Tailbay Water Temperatures Seasonal Exceedence Plots

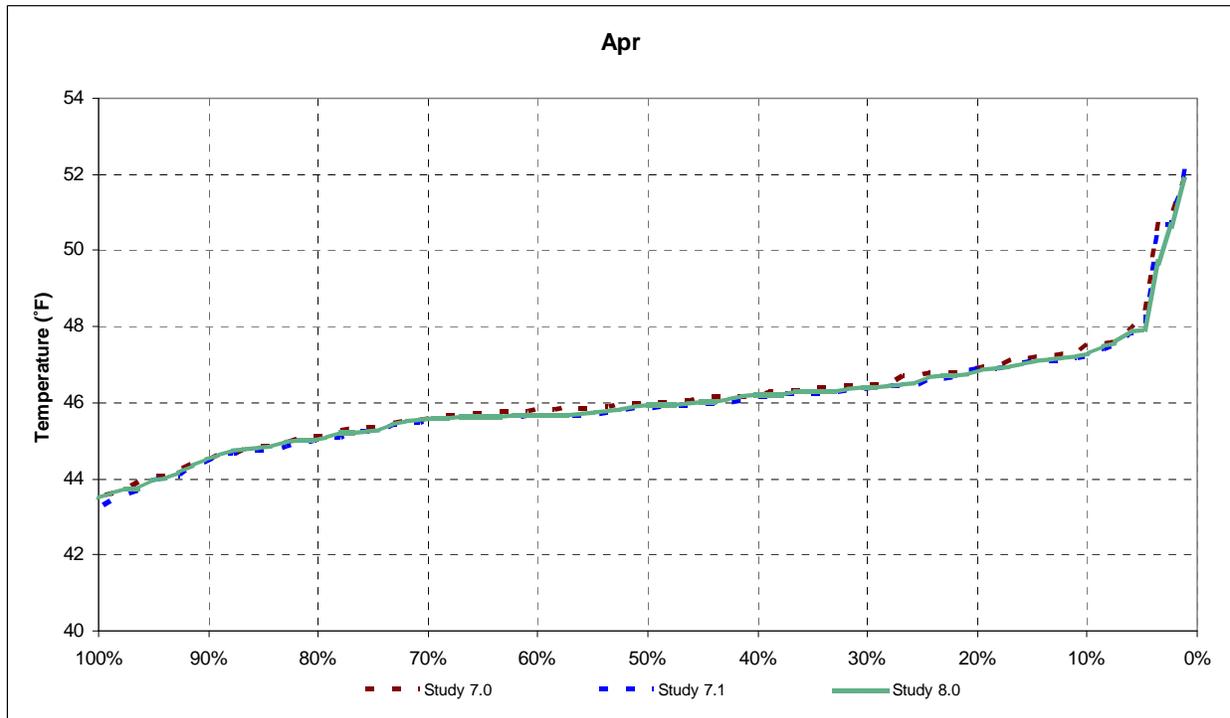


Figure 10-58 Shasta Tailbay End-of-April Exceedence

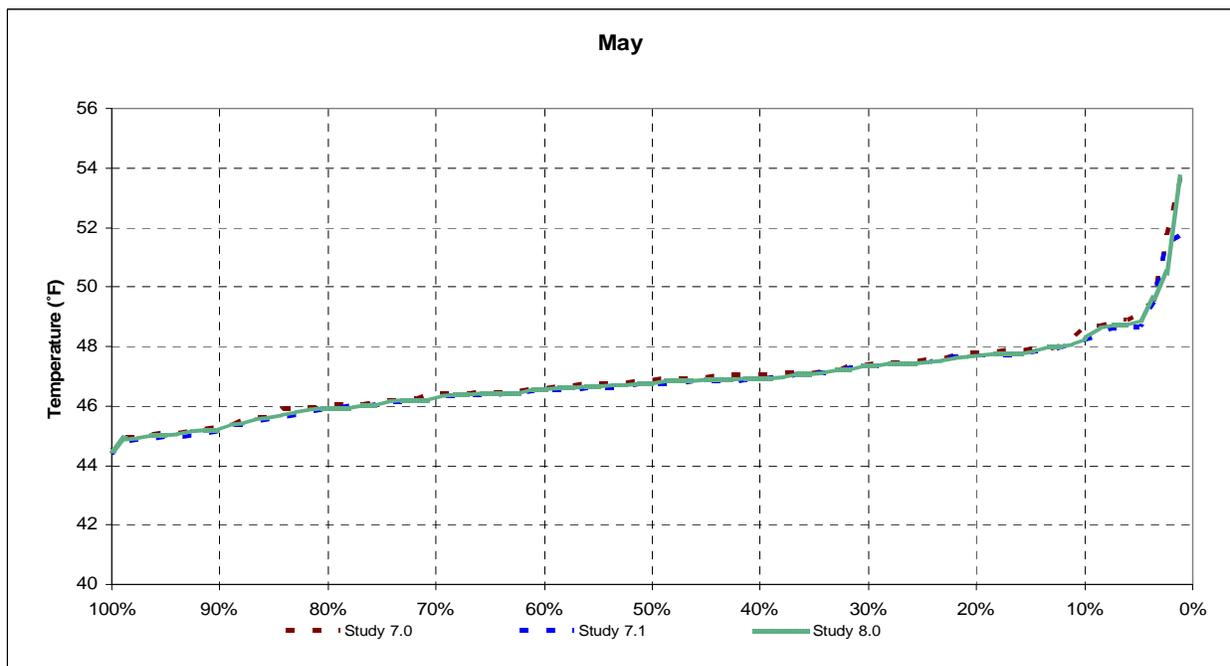


Figure 10-59 Shasta Tailbay End-of-May Exceedence

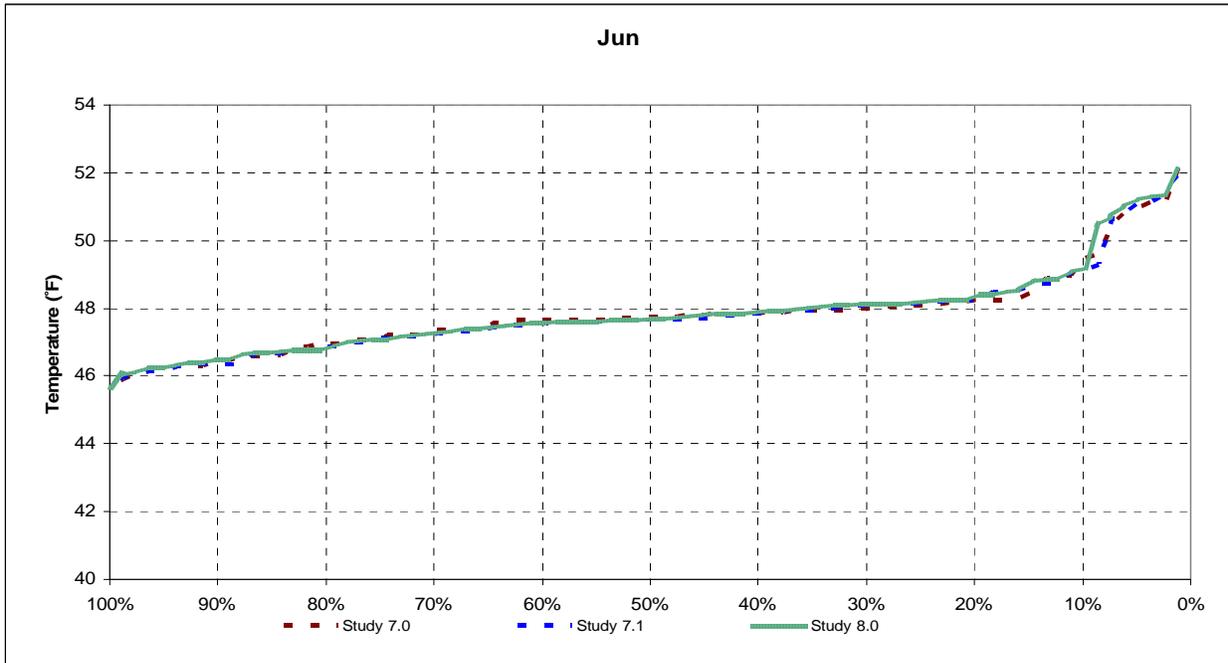


Figure 10-60 Shasta Tailbay End-of-June Exceedence

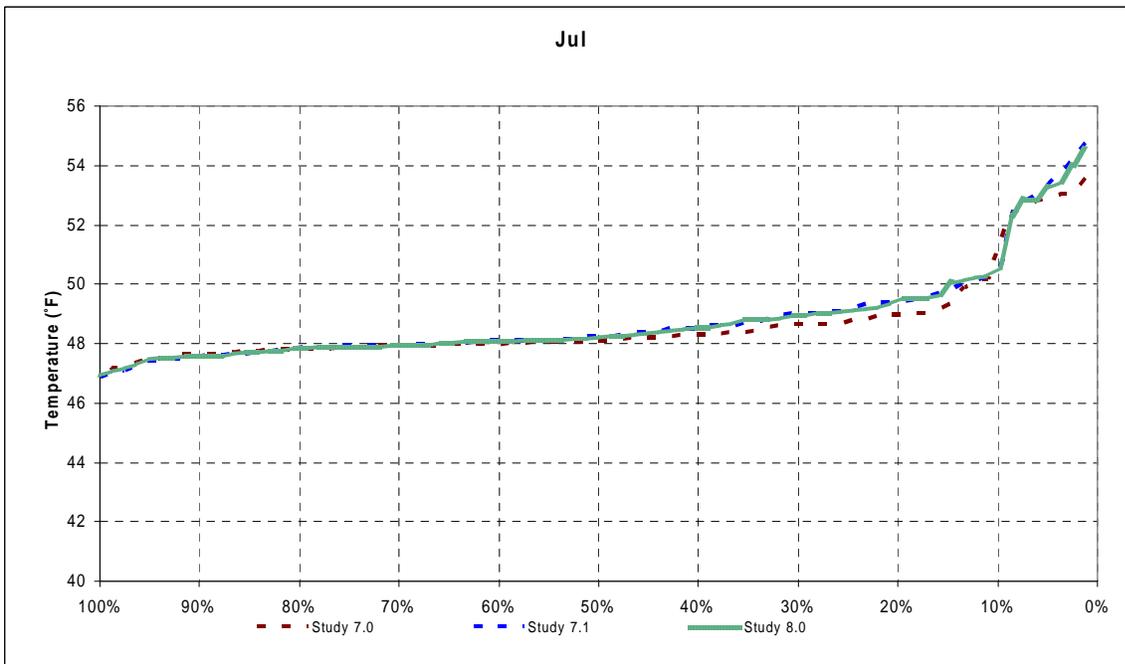


Figure 10-61 Shasta Tailbay End-of-July Exceedence

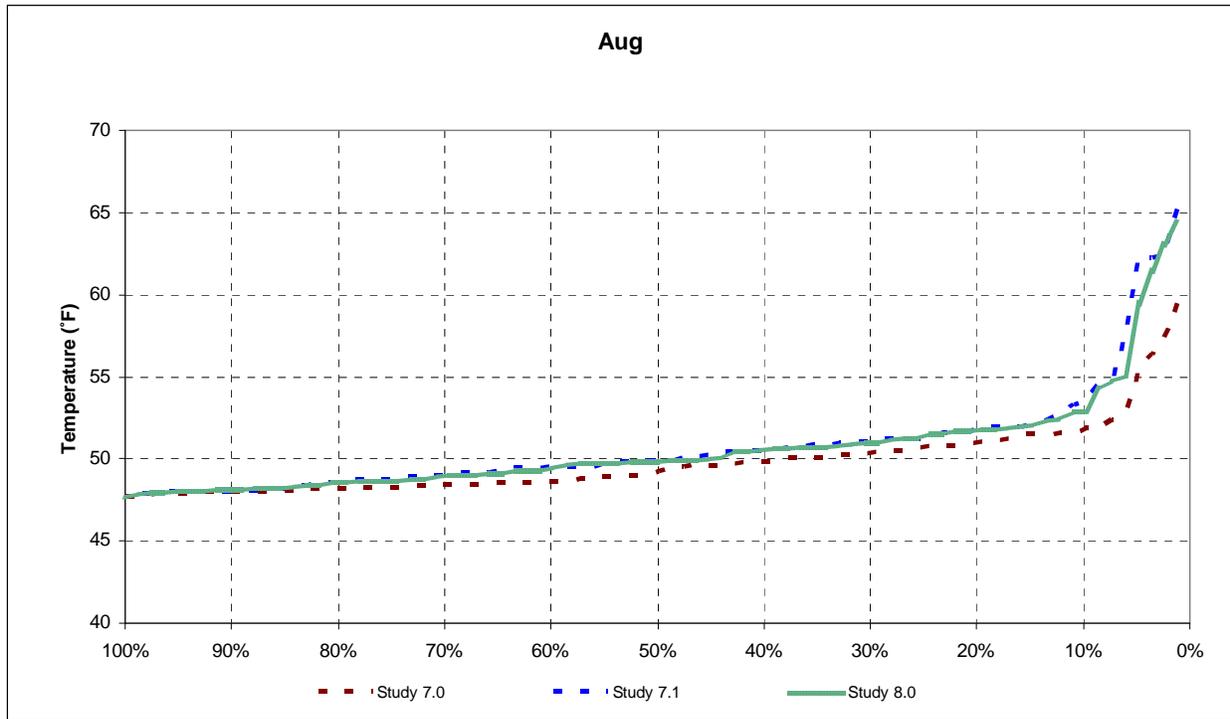


Figure 10-62 Shasta Tailbay End-of-Aug Exceedence

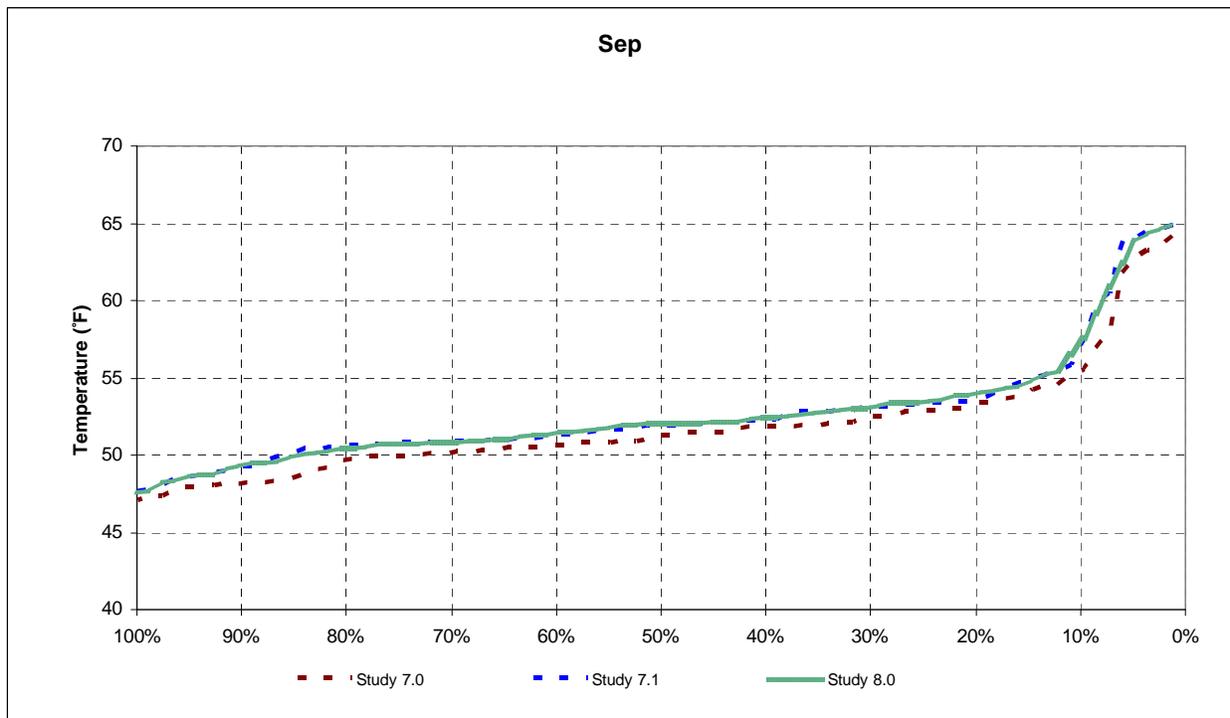


Figure 10-63 Shasta Tailbay End-of-September Exceedence

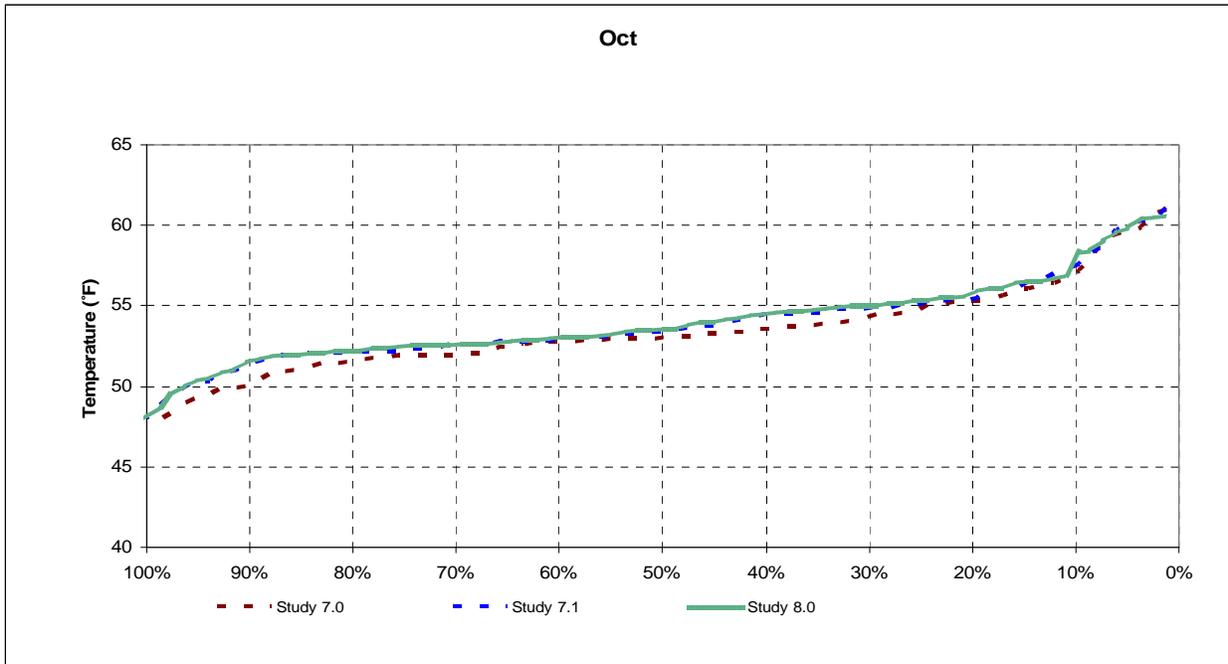


Figure 10-64 Shasta Tailbay End-of-October Exceedence

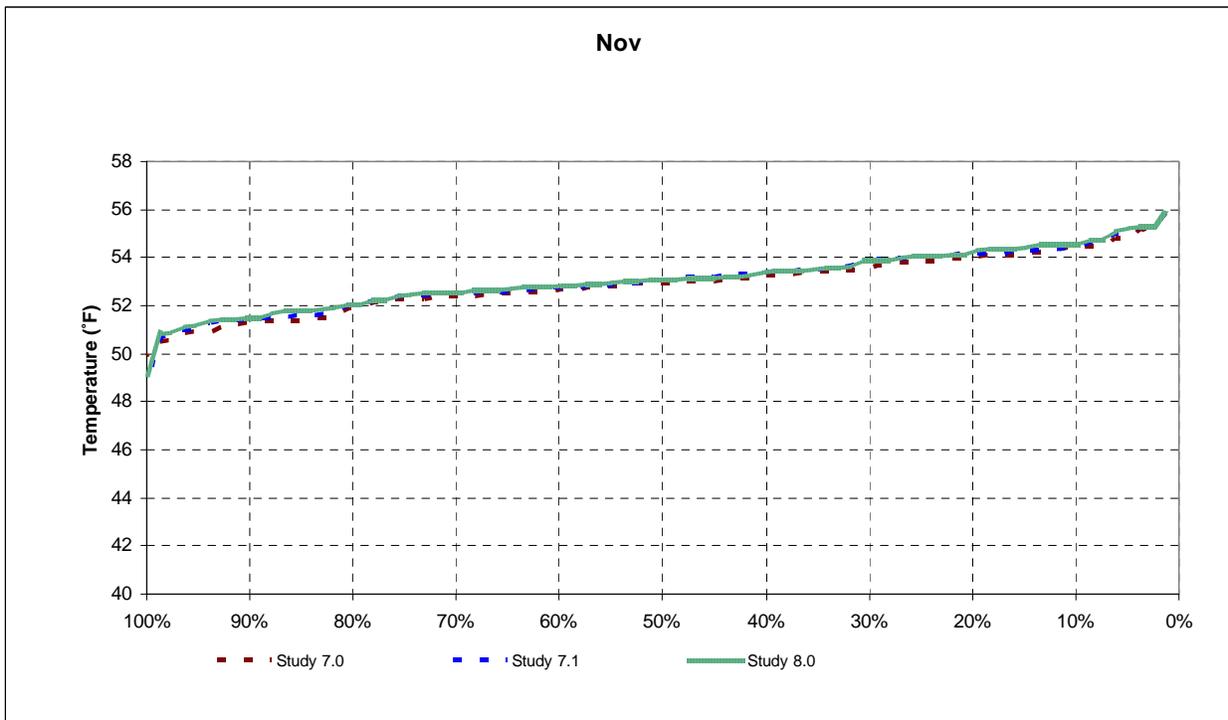


Figure 10-65 Shasta Tailbay End-of-November Exceedence

### Keswick Water Temperatures Seasonal Exceedence Plots

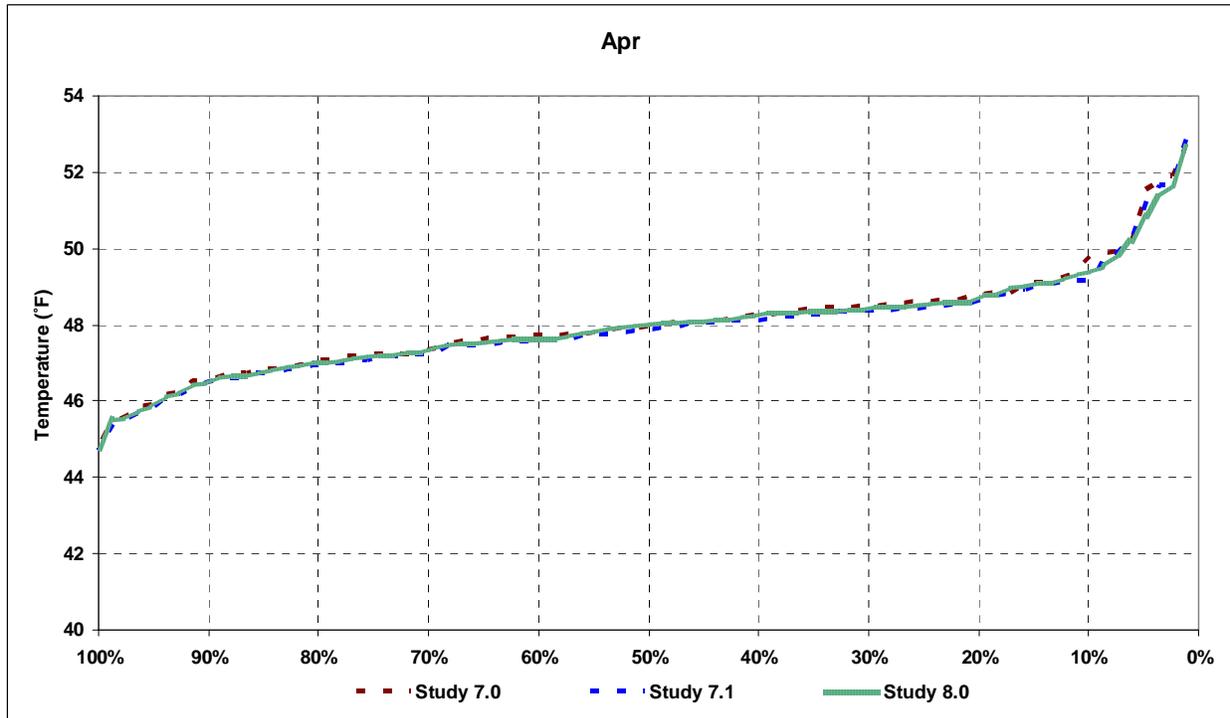


Figure 10-66 Keswick End-of-April Exceedence

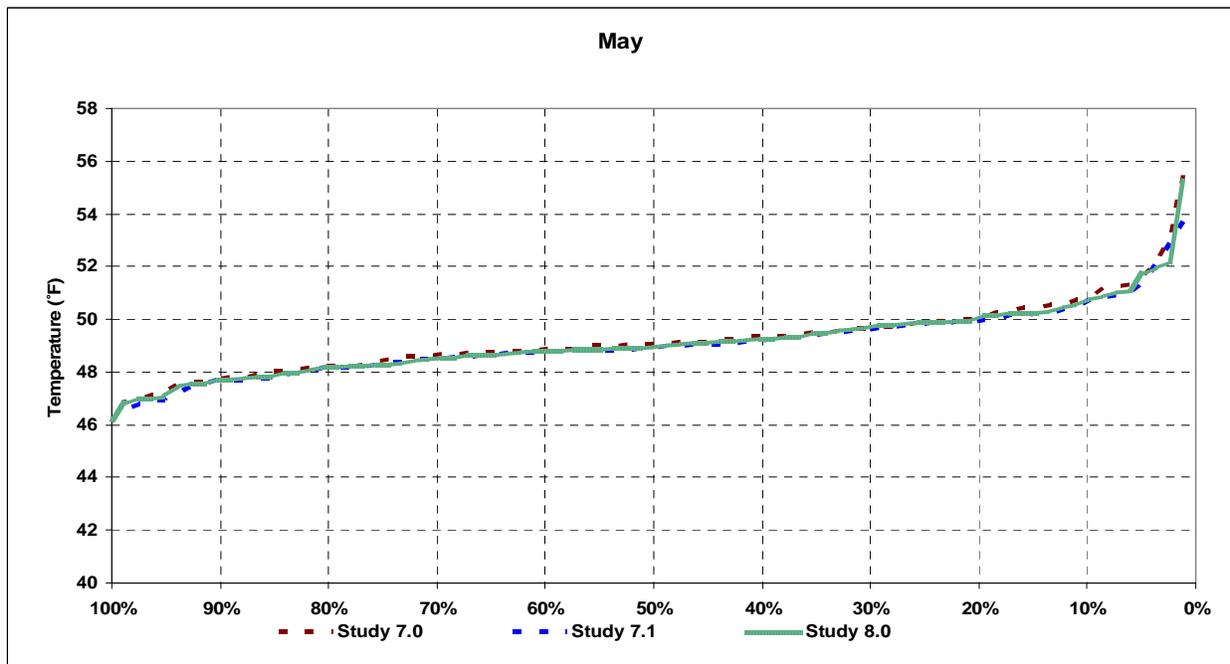


Figure 10-67 Keswick End-of-May Exceedence

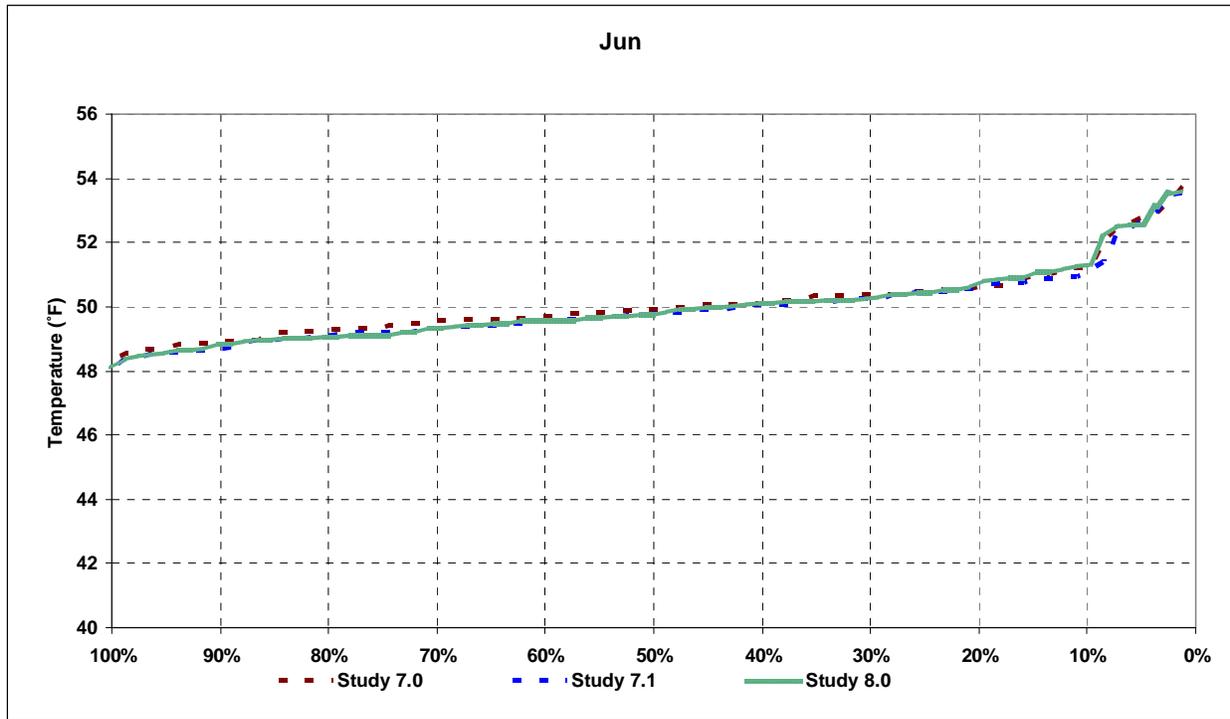


Figure 10-68 Keswick End-of-June Exceedence

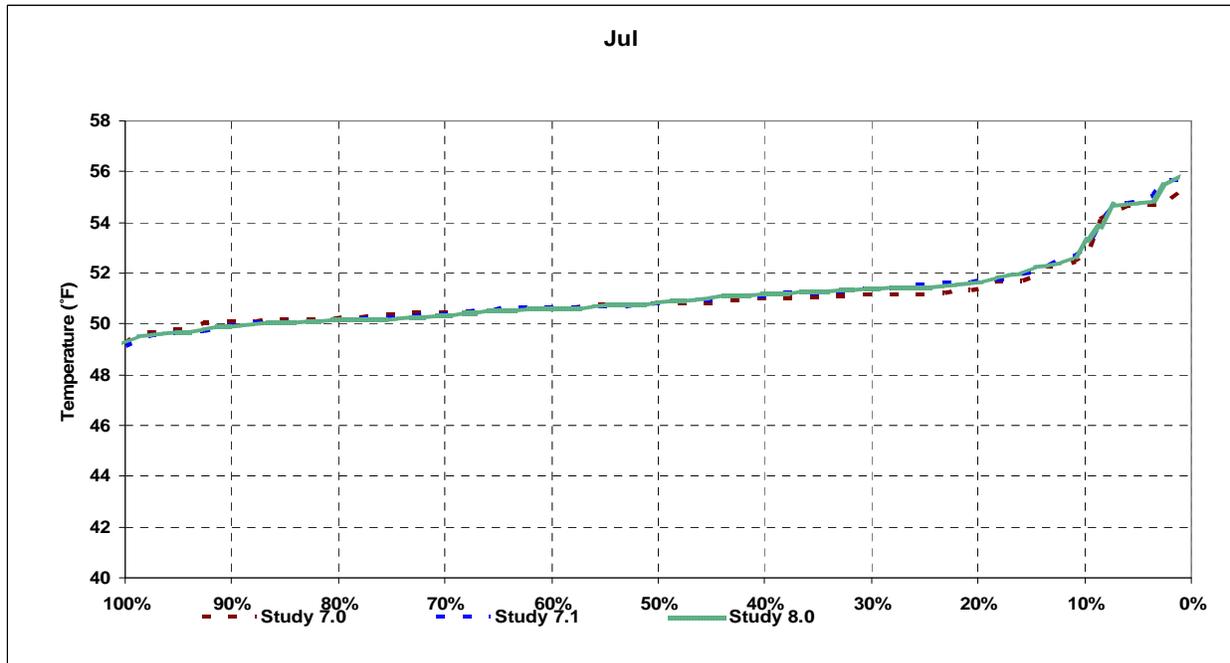


Figure 10-69 Keswick End-of-July Exceedence

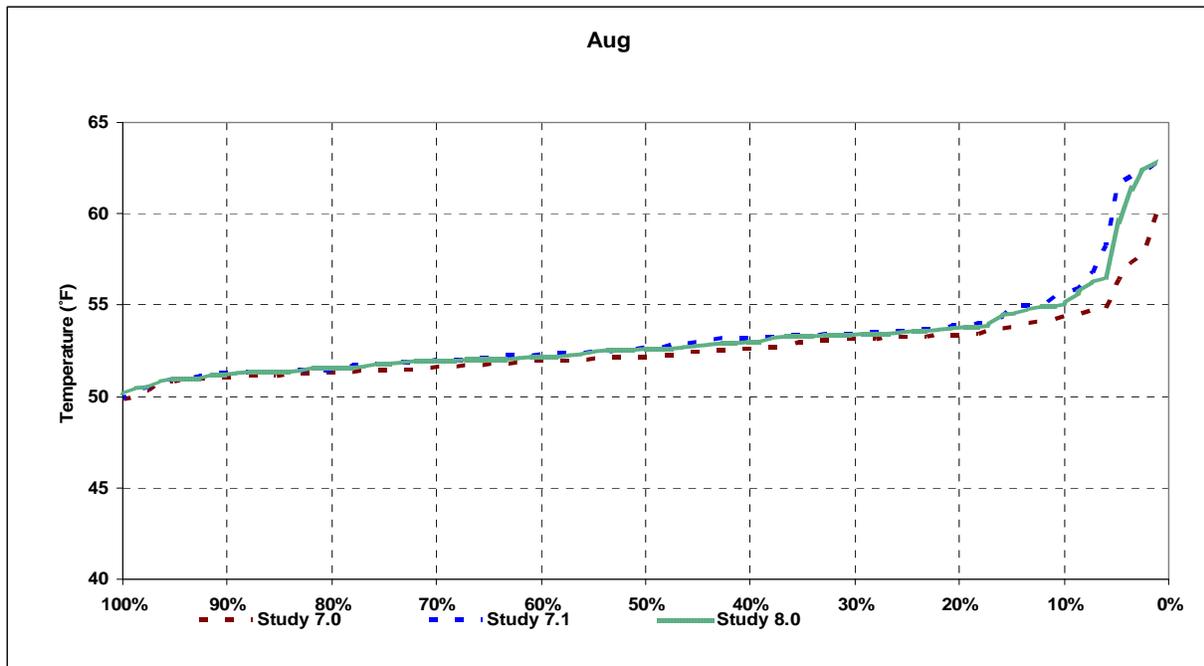


Figure 10-70 Keswick End-of-August Exceedence

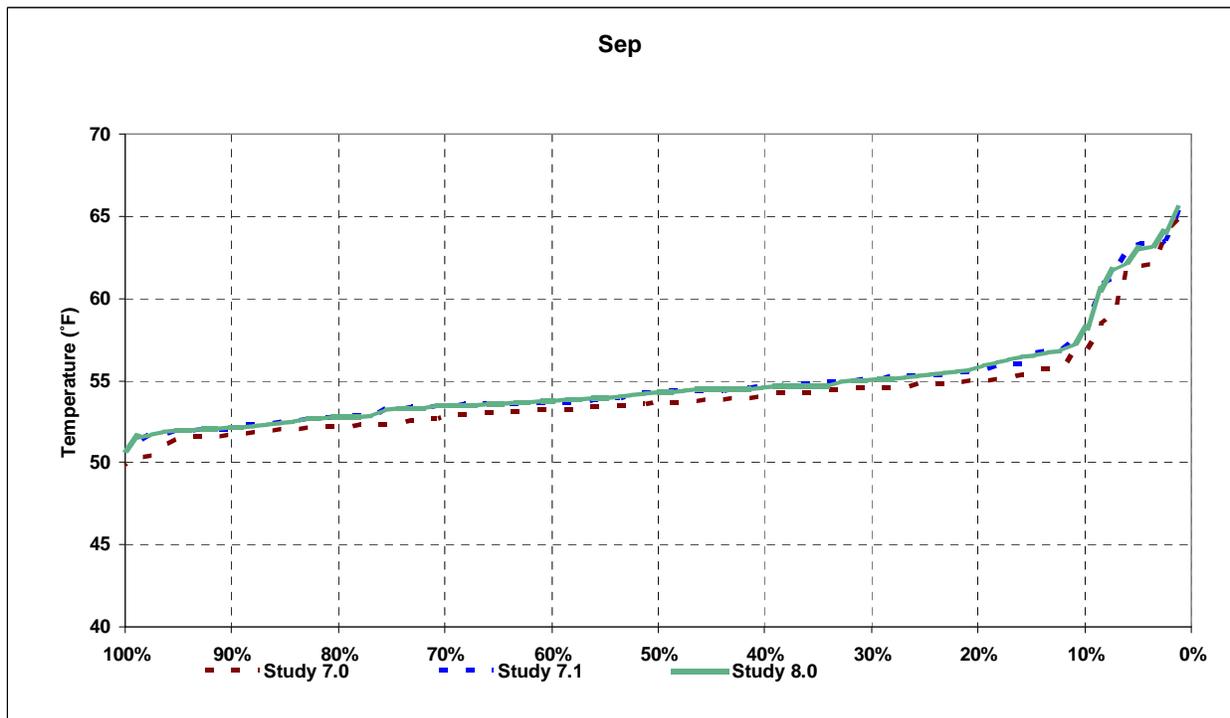


Figure 10-71 Keswick End-of-September Exceedence

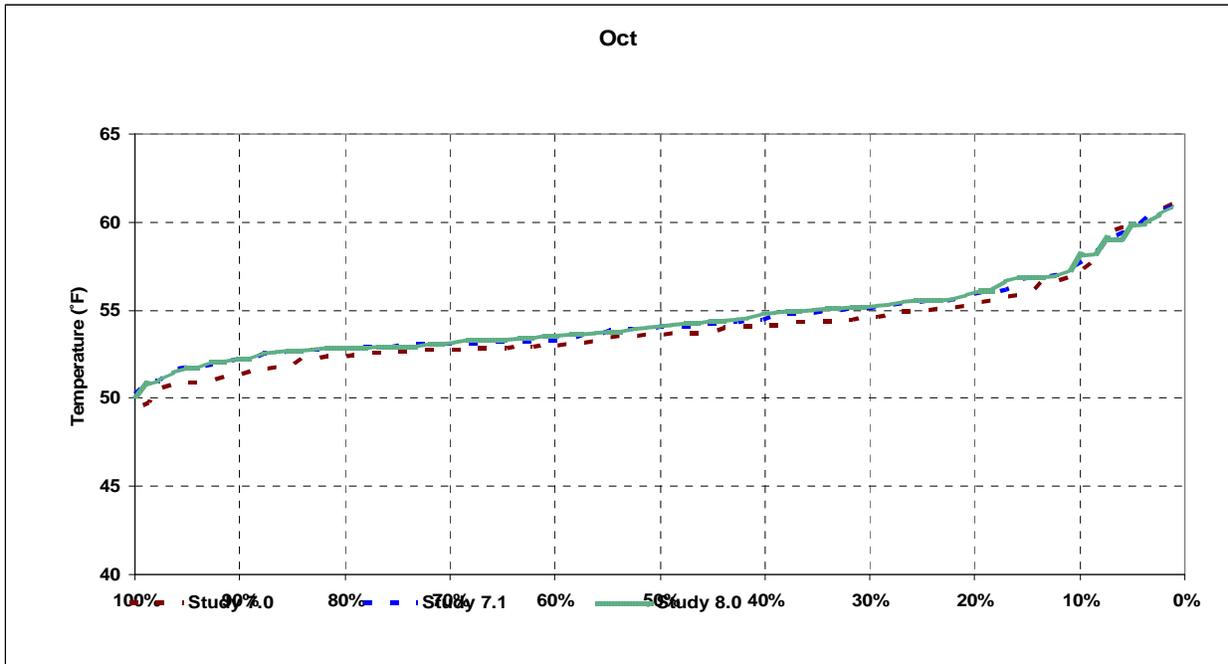


Figure 10-72 Keswick End-of-October Exceedence

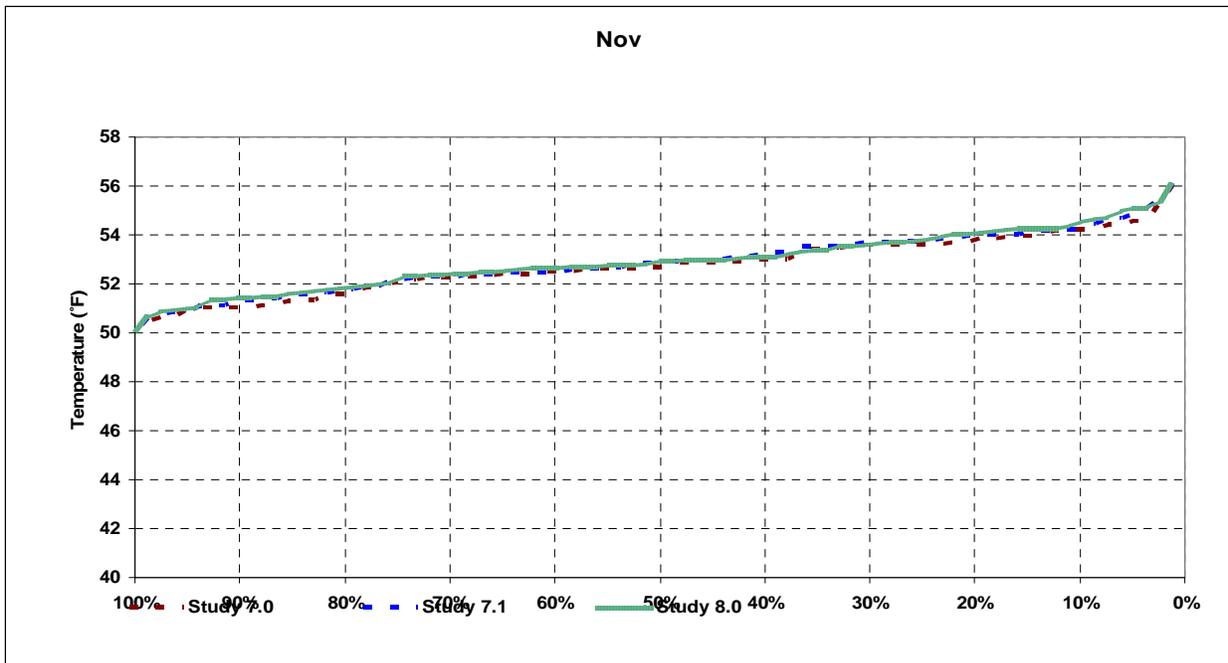


Figure 10-73 Keswick End-of-November Exceedence

Balls Ferry Water Temperatures Seasonal Exceedence Plots

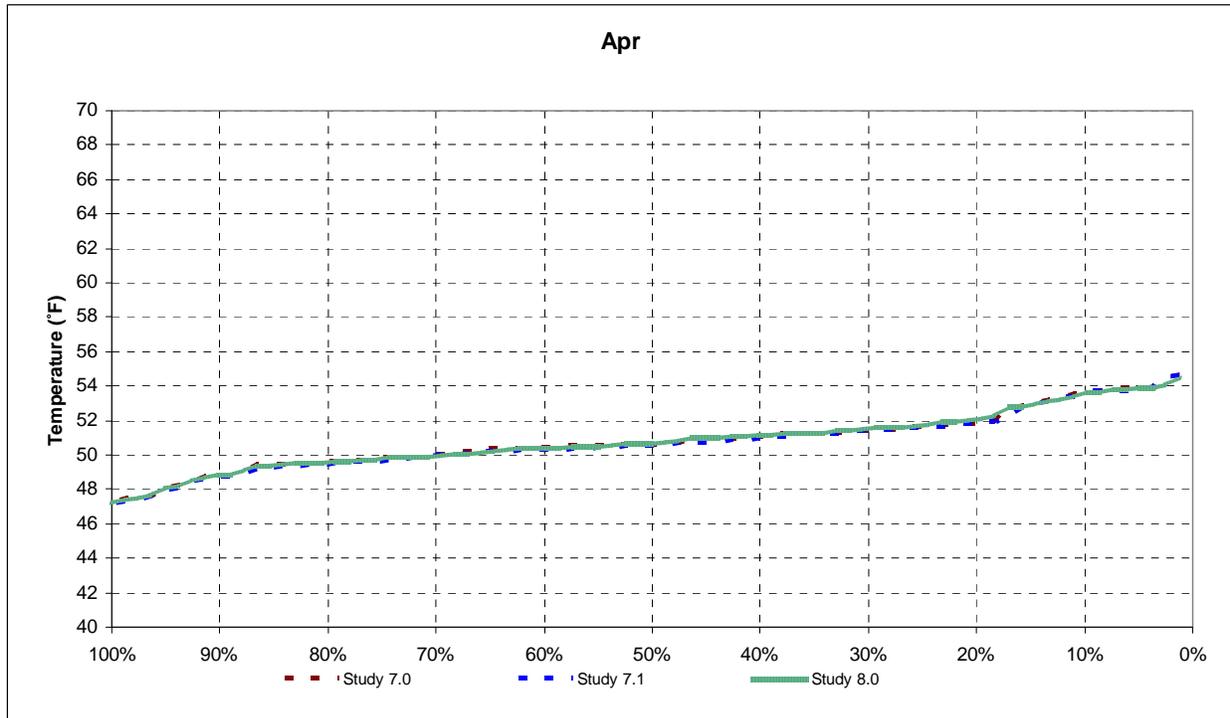


Figure 10-74 Balls Ferry End-of-April Exceedence

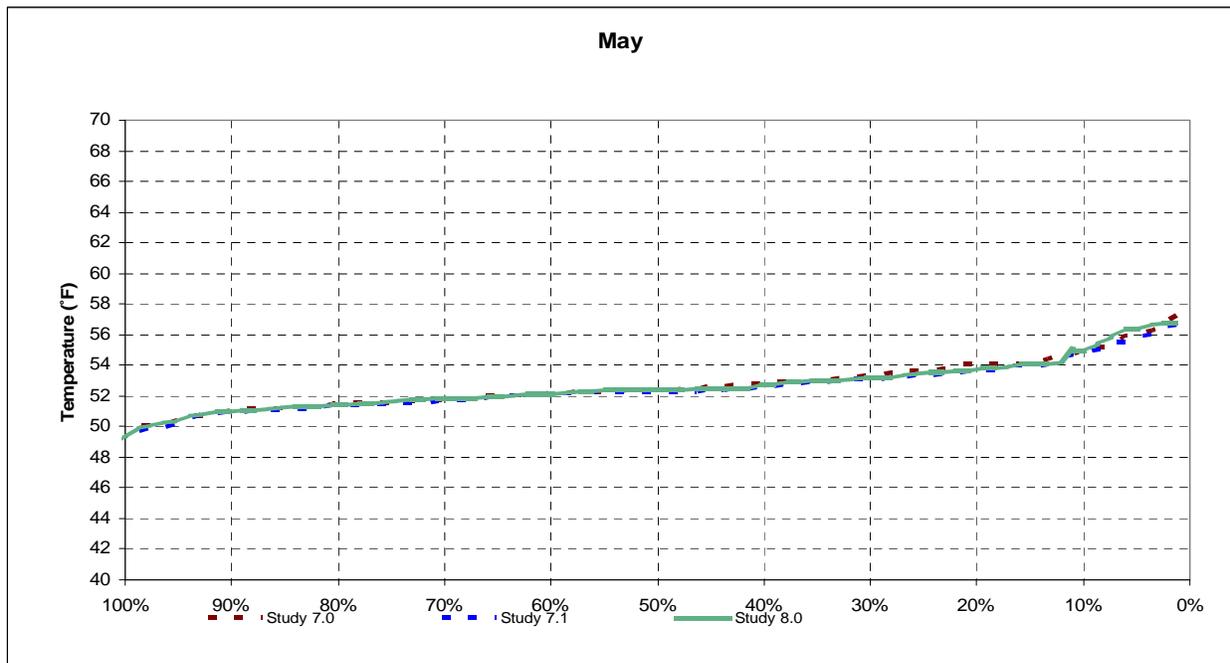


Figure 10-75 Balls Ferry End-of-May Exceedence

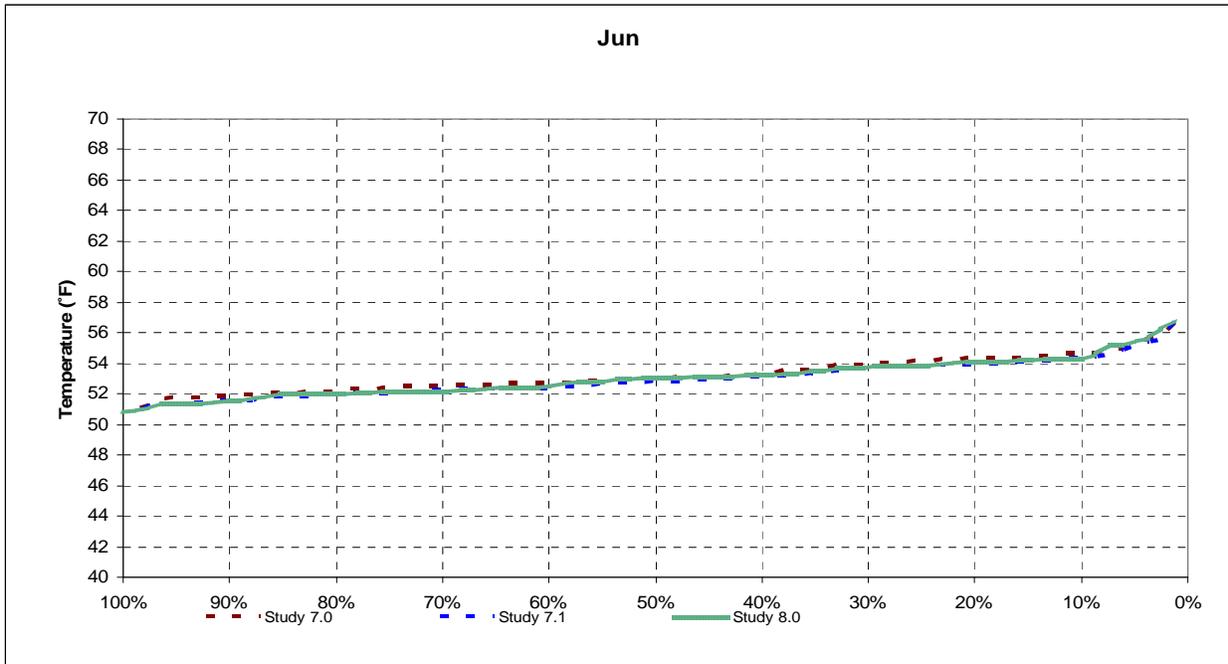


Figure 10-76 Balls Ferry End-of-June Exceedence

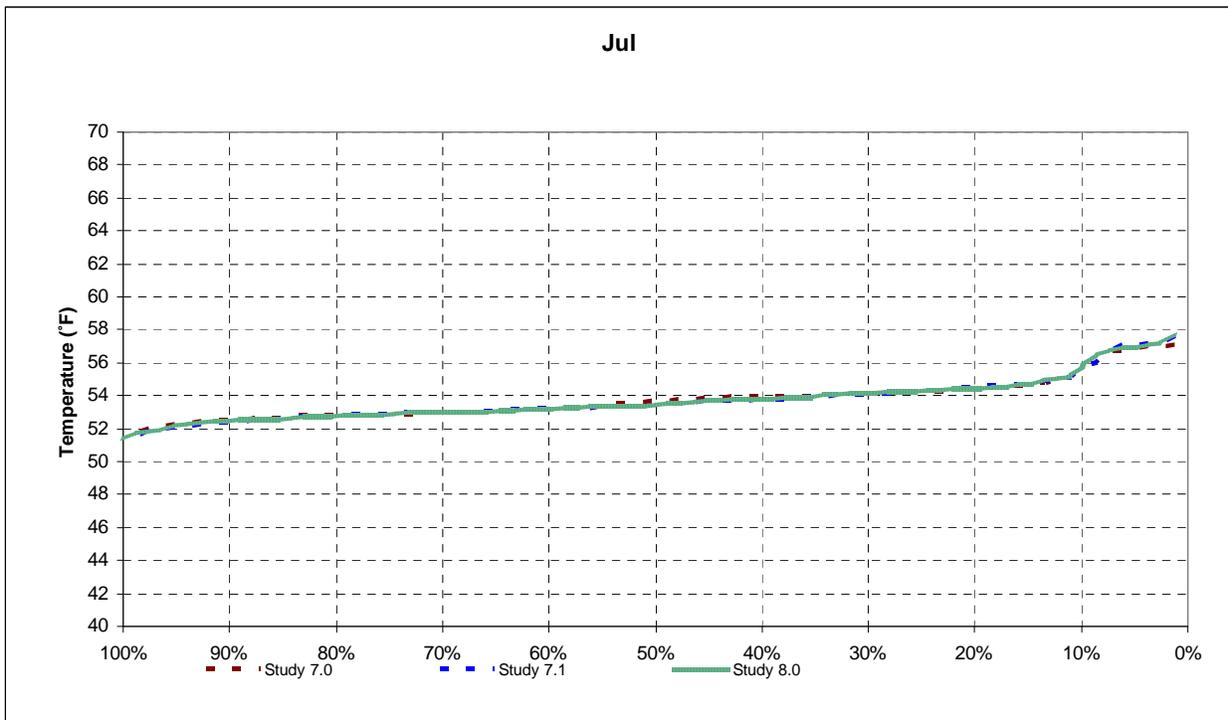


Figure 10-77 Balls Ferry End-of-July Exceedence

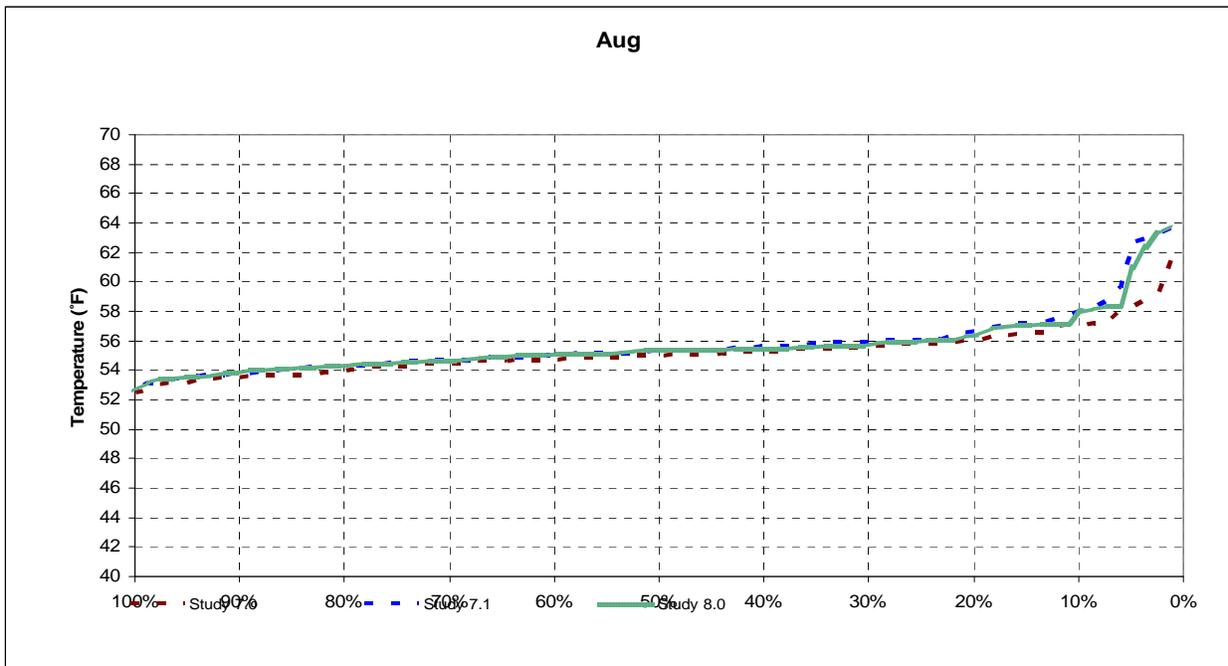


Figure 10-78 Balls Ferry End-of-August Exceedence

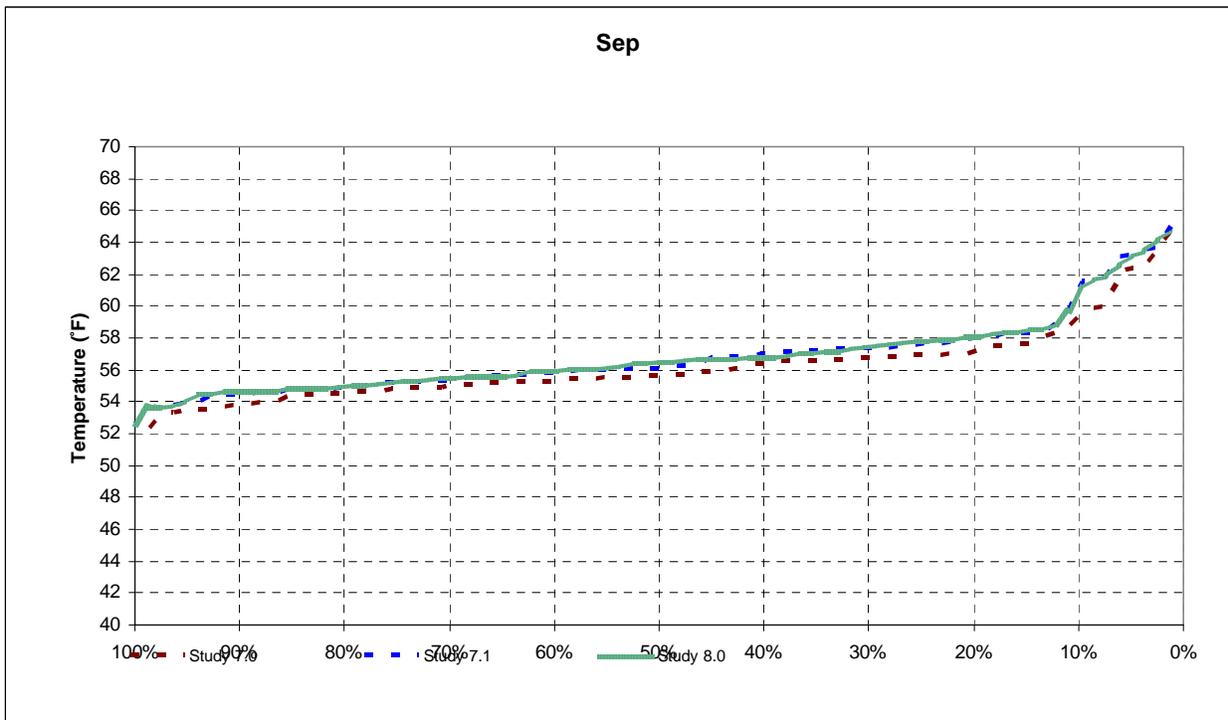


Figure 10-79 Balls Ferry End-of-September Exceedence

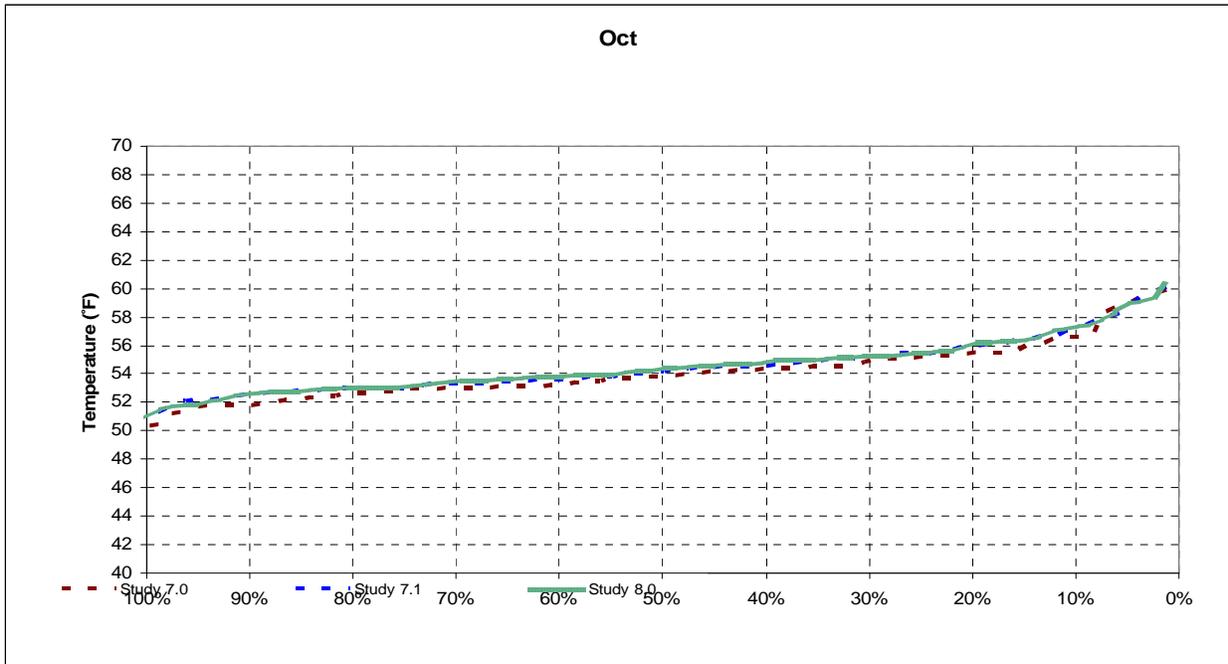


Figure 10-80 Balls Ferry End-of-October Exceedence

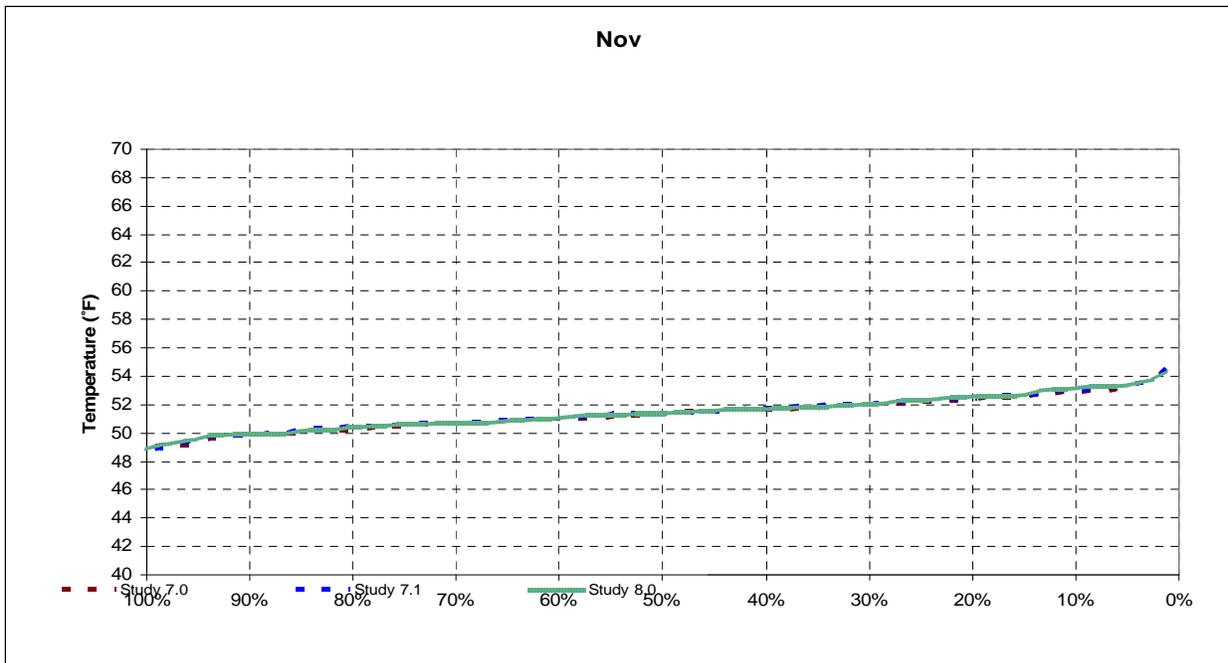


Figure 10-81 Balls Ferry End-of-November Exceedence

### Bend Bridge Water Temperatures Seasonal Exceedence Plots

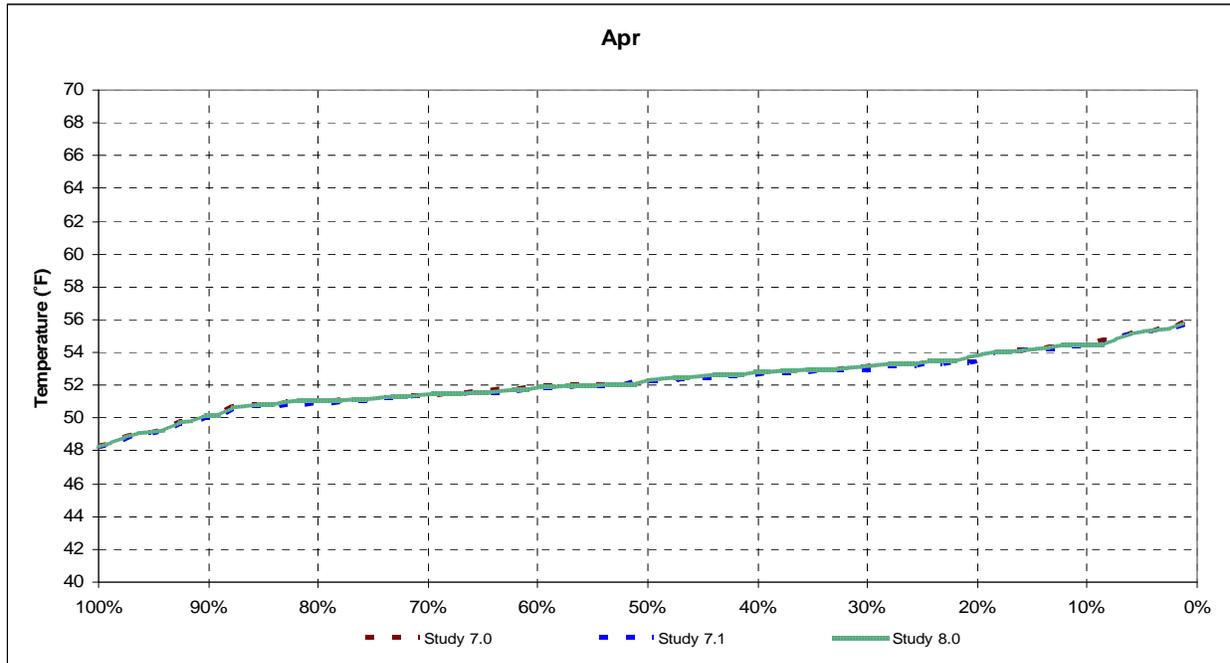


Figure 10-82 Bend Bridge End-of-April Exceedence

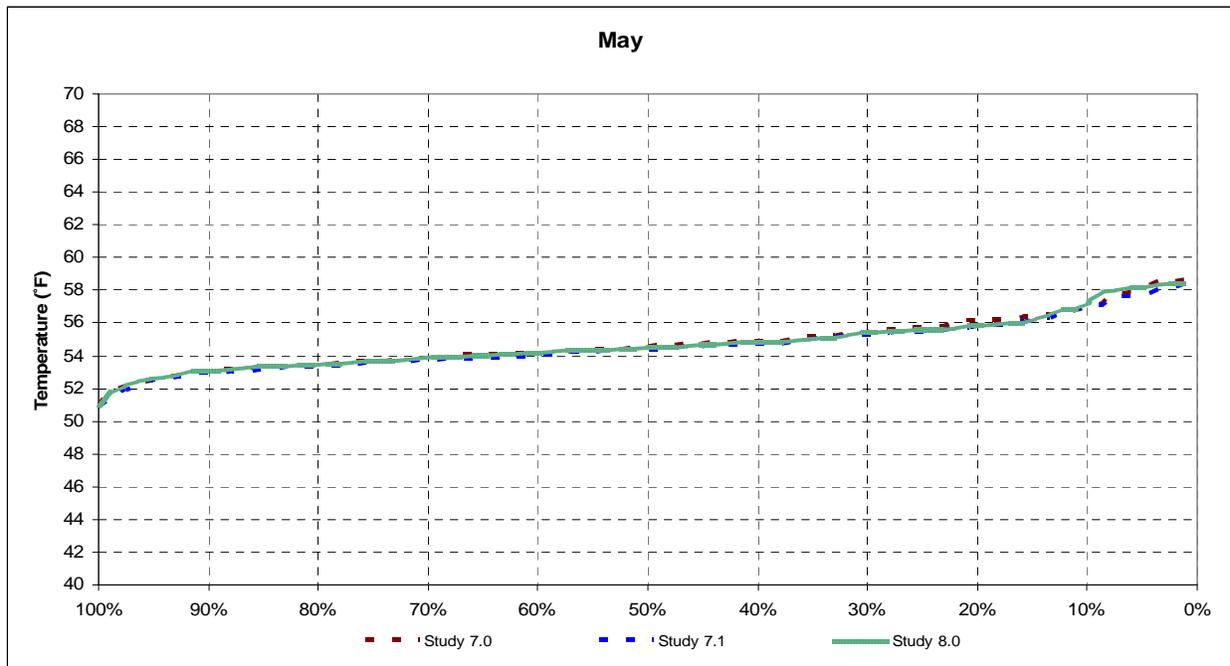


Figure 10-83 Bend Bridge End-of-May Exceedence

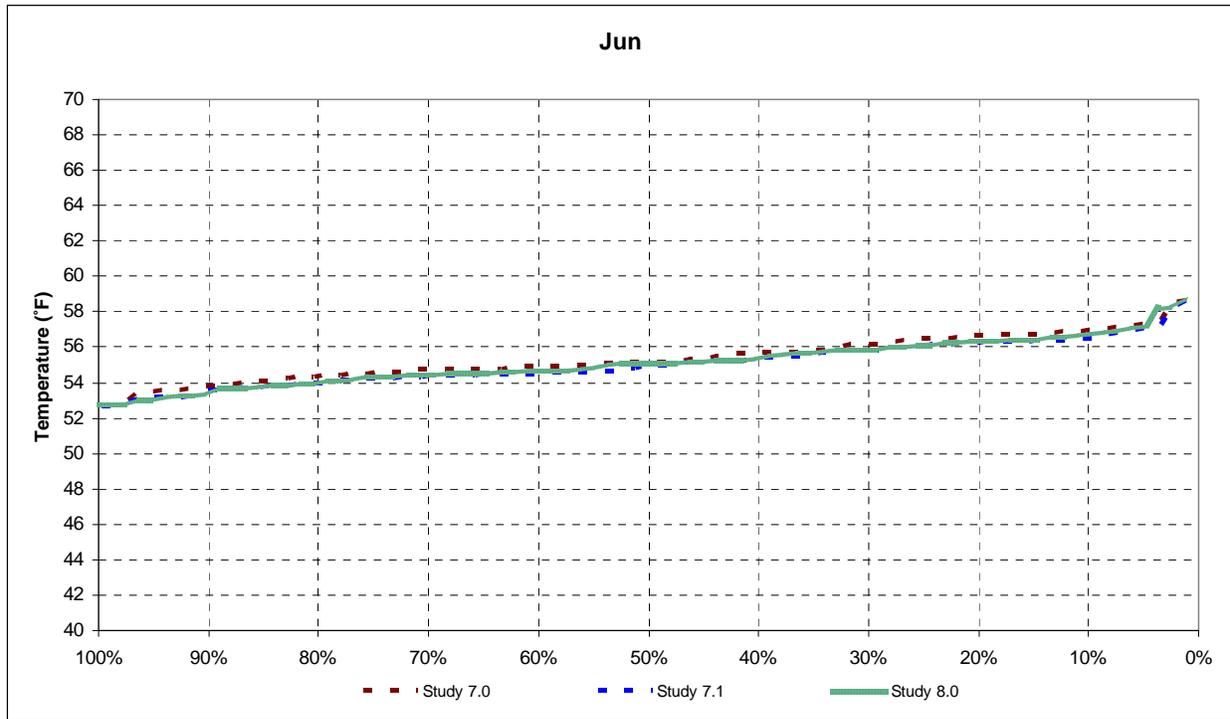


Figure 10-84 Bend Bridge End-of-June Exceedence

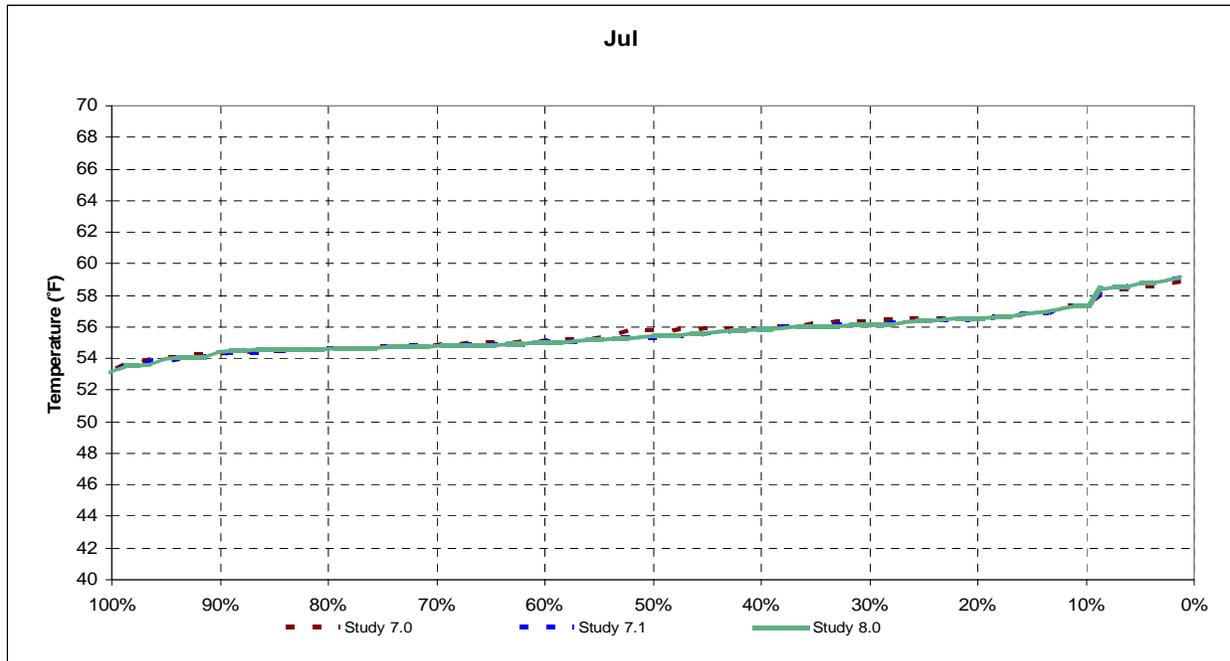


Figure 10-85 Bend Bridge End-of-July Exceedence

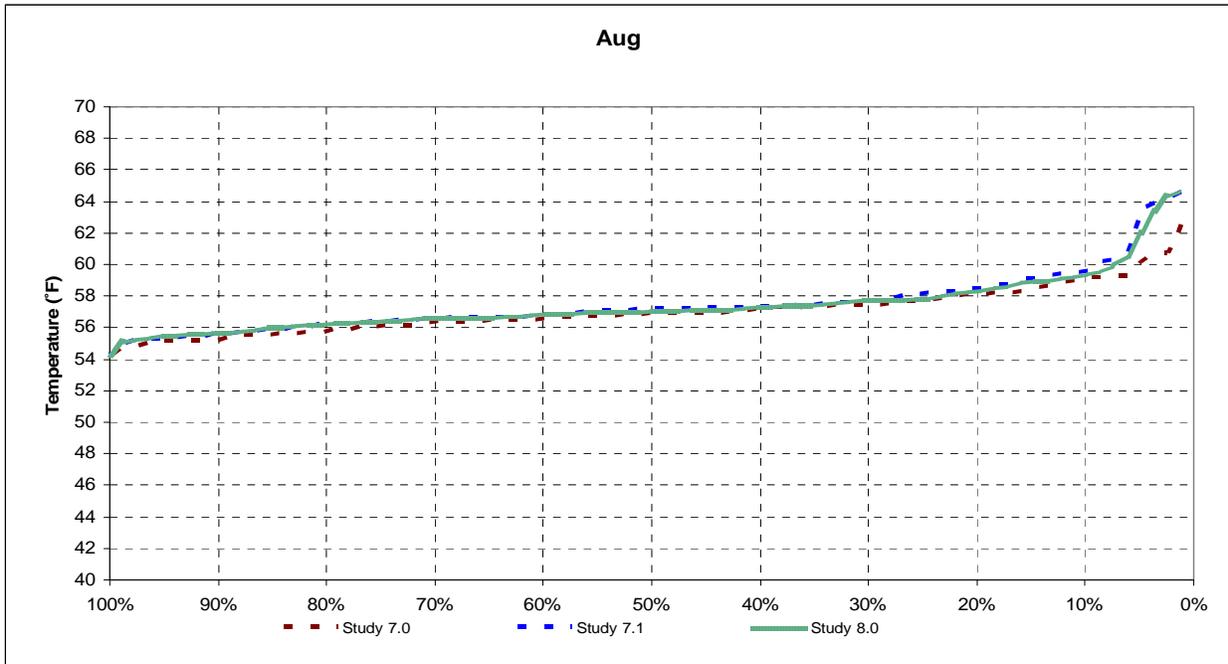


Figure 10-86 Bend Bridge End-of-August Exceedance

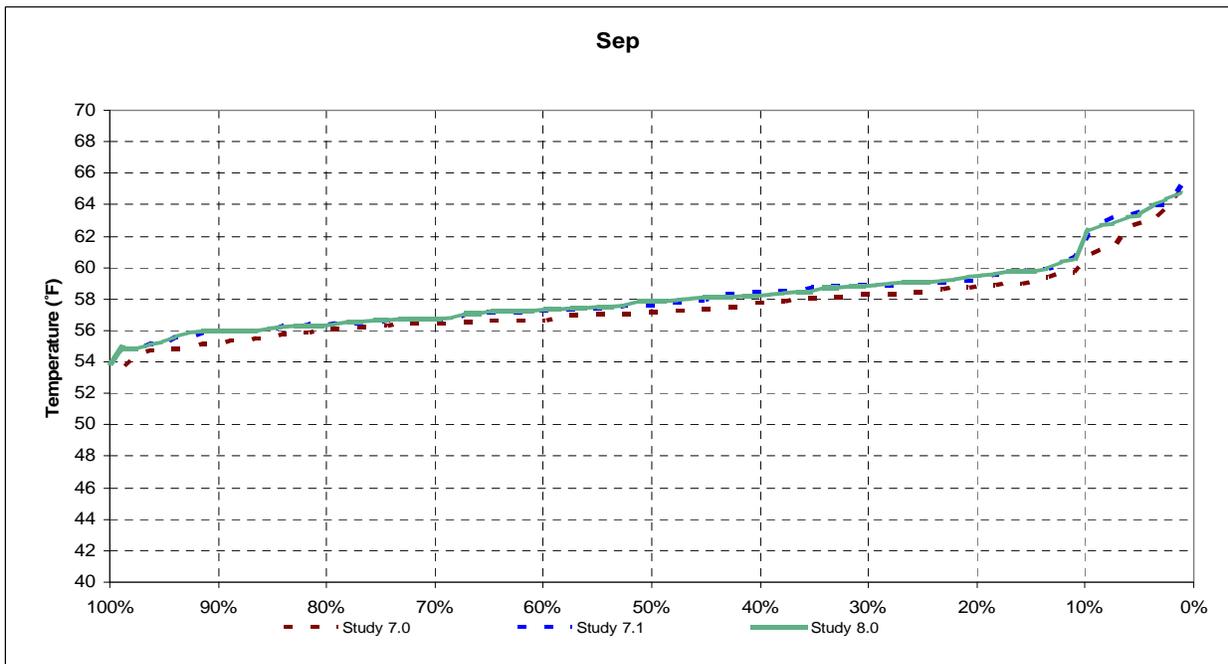


Figure 10-87 Bend Bridge End-of-September Exceedance

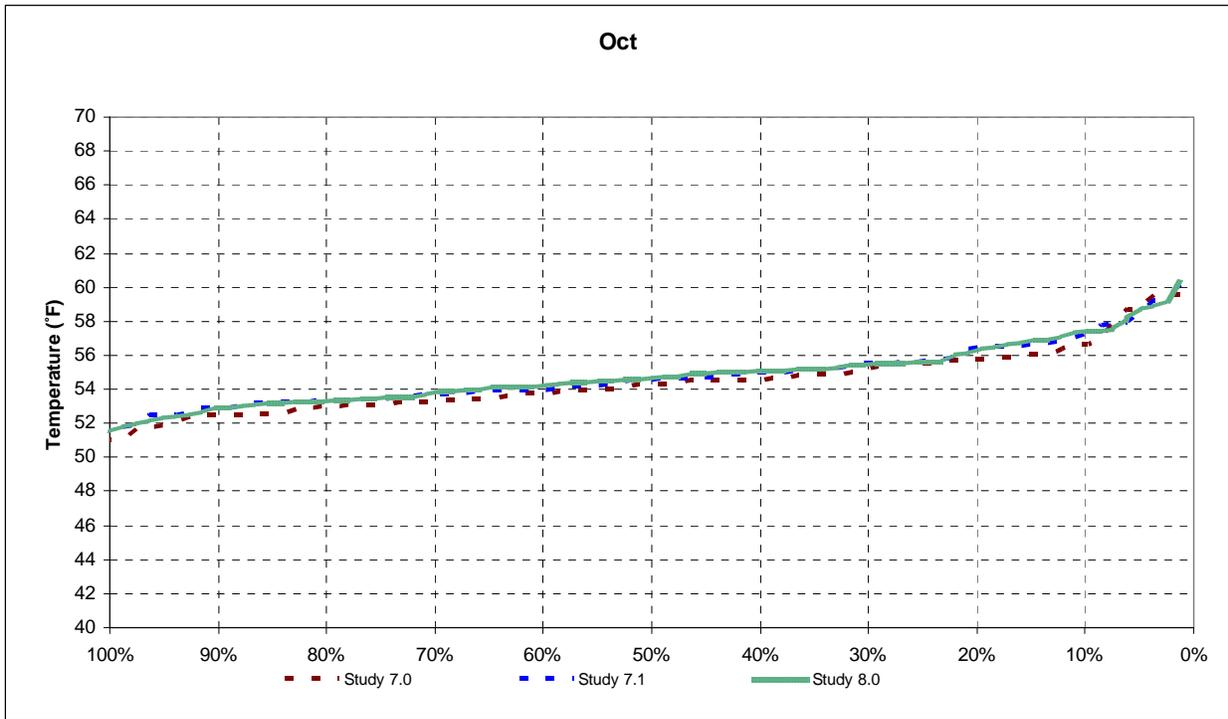


Figure 10-88 Bend Bridge End-of-October Exceedence

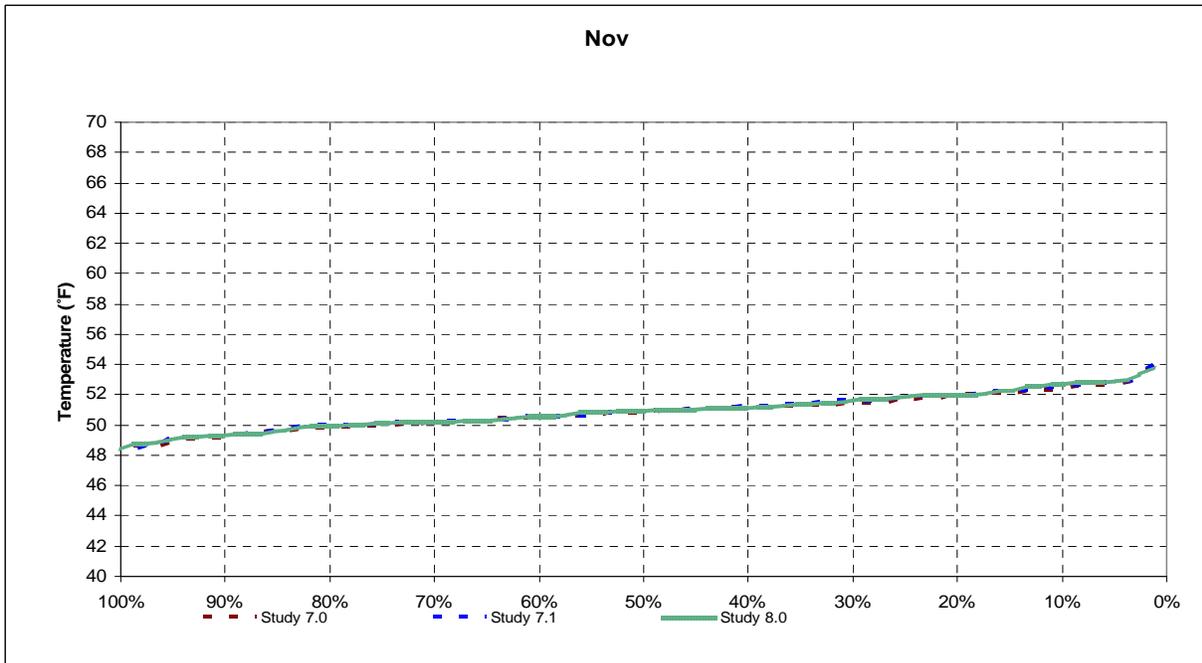


Figure 10-89 Bend Bridge End-of-November Exceedence

## Feather River

Feather River operations of the Oroville Facilities are currently being covered under a separate Section 7 ESA consultation process for the Federal Energy Regulatory Commission (FERC) relicensing process. The draft National Marine Fisheries Service (NMFS) Biological Opinion (BO) for the Oroville Facilities is scheduled for release in late May 2008. The Oroville Facilities Relicensing Draft Environmental Impact Report (DEIR) included evaluation of modeling output for three alternatives: the Existing Conditions, the No Project Alternative, and the Proposed Project Alternative. The Oroville Facilities Relicensing FERC Biological Assessment (FERC BA) included evaluation of Existing Conditions, a No Action Alternative, and a Proposed Action Alternative. The DEIR Existing Conditions Alternative was based on the 2004 OCAP Study 3a, and the No Project and Proposed Project alternatives were based on the 2004 OCAP Study 4a.

Operations under OCAP Study 7.0 include the same flow and water temperature requirements as both of the Existing Conditions Alternatives. While both the Proposed Action and Proposed Project alternatives evaluated conditions resulting from the March 2006 Settlement Agreement for Licensing of the Oroville Facilities (Settlement Agreement), as included in OCAP Study 7.1, evaluation of the Proposed Action Alternative focused on the effects of the flow and water temperature objectives, whereas analysis of the Proposed Project utilized a simulation including the flow and water temperature objectives to determine effects. Though no equivalent alternative was analyzed in either the FERC BA or DEIR, OCAP Study 8.0 would be similar to OCAP Study 7.1, with the exception of a facility modification to improve DWR's ability to manage Feather River water temperatures in OCAP Study 8.0. However, the specific configuration of a facility modification will be examined in a separate environmental process, so no water temperature modeling of a facility modification has been completed. Since the flow requirements and water temperature objectives for OCAP Studies 7.1 and 8.0 are the same, conditions under OCAP Study 8.0 at the two common water temperature compliance locations, the Feather River Fish Hatchery (FRFH) and Robinson Riffle, would be expected to be similar to that of the Proposed Project and Proposed Action alternatives and OCAP Study 7.1.

Operational changes in simulation of OCAP Study 7.1 as compared to OCAP Study 4a and the Proposed Project Alternative include an increased emphasis on storing SWP water in San Luis rather than Oroville Reservoir. These operational changes would result in a general increase in releases from the Oroville Facilities in June through October and a resulting lower Oroville Reservoir storage for OCAP Study 7.1 as compared to OCAP Study 4a and the Proposed Project Alternative. Lower storage would typically result in a decreased volume of cold water within Oroville Reservoir, and corresponding increases in temperature control actions (TCA) for the FRFH and Robinson Riffle. While storage conditions in Oroville Reservoir might be different in each alternative, OCAP Study 7.1, the Proposed Project Alternative, and the Proposed Action Alternative would each utilize TCA described in the Settlement Agreement. Since simulation of the Proposed Project Alternative did not require the use all available temperature control actions TCA, water temperatures at the FRFH and Robinson Riffle under OCAP Study 7.1 and the Proposed Action Alternative would likely be similar to the Proposed Project Alternative. Table 10-5 shows the availability of TCAs from the Proposed Project Alternative modeling. If needed, OCAP Studies 7.1 and 8.0 would utilize temperature management actions not exhausted in modeling for the Proposed Project Alternative.

**Table 10-5 Annual Availability of Oroville Facilities Temperature Management Actions in the Oroville Facilities Relicensing DEIR Proposed Project Alternative Simulation.**

Temperature Management Action	Number of Years Utilized	Remaining Years of Availability
Pumpback curtailment <sup>1</sup>	74	0
Remove all shutters on the Hyatt Intake <sup>2</sup>	2	72
Increase LFC flow to 1,500 cfs <sup>3</sup>	10	64
Release 1,500 cfs from the river valve <sup>4</sup>	3	71

Source: Oroville Facilities Relicensing DEIR Proposed Project Simulation

Period of Record: 1922-1994

<sup>1</sup>Pumpback curtailed for at least a portion of the year

<sup>2</sup>All 13 shutters are removed from the Hyatt Intake

<sup>3</sup>For Robinson Riffle water temperature objective only

<sup>4</sup>For Feather River Fish Hatchery water temperature objective only

With all models there are assumptions and limitations that are inherent within. Please refer to Chapter 9 for a list of model limitations on which this analysis was based.

In conclusion, based on a comparison of OCAP Study 7.1 and OCAP Study 4a and the Proposed Project Alternative, modeling and environmental analysis of the Oroville Facilities conducted as part of the Oroville Facilities Relicensing DEIR and BA is still usable and applicable for use in the 2008 draft OCAP BA. While the TCA taken to achieve the water temperatures could be different under 2008 OCAP BA modeling, flows and water temperatures in the LFC and at the FRFH under the 2008 draft OCAP BA would generally be similar to the Proposed Project.

## American River

### Modeling

When compared to modeling results provided from the 2004 OCAP BA, the most significant changes to the American River operations is the combination of increases in overall water demands from the 2005 to the 2030 Level of Development (LOD) and the implementation of higher minimum flows associated with the proposed Lower American River Flow Management Standard. The combination of these two factors have significant influence of how Folsom Reservoir is operated and ultimately how the integrated CVP overall is operated. In general, water demands for consumptive purposes are during the warm months of the year, late spring through summer. In addition, the higher minimum flow requirements from Nimbus Dam for fishery management objectives calls for higher flows during the fall and winter months than in previous studies.

Figure 10-90 shows the end-of-month Folsom Reservoir Storage for all three studies. Figure 10-91 and Figure 10-92 show the probability distribution for Folsom Reservoir Storage at the end-of-May and the end-of-September, generally the end of May is the high-point in storage at Folsom Reservoir. The end-of-May Folsom Reservoir storage shows some general differences between the studies in the 70% to 90% probability range. The differences appear to have a general magnitude of 50 TAF or less. The end-of-September Folsom Reservoir storage shows a much broader general difference between the studies in the 50% to 100% probability range. The differences have a general magnitude of 75 TAF to 100 TAF.

The differences between the end-of-May and the end-of-September probability plots can be explained by two general operations facts about the CVP reservoir system; 1) Folsom Reservoir has the highest refill probability in the CVP system – in most normal hydrologic or wetter hydrologic conditions Folsom Reservoir will need to release water for flood control purposes during the winter or spring months. Under this hydrologic scenario, the next year's end-of-May Folsom Reservoir storage will likely be very similar. 2) If hydrologic conditions are not normal or better, and Folsom Reservoir storage conditions become stressed, water storage from the much larger storage Shasta-Trinity system is used to meet CVP water demands and objectives that can be met by either CVP water source. The integrated nature of CVP reservoir operations will spread a storage shortage from one year at Folsom Reservoir to the Shasta-Trinity System. The result is that by the following May, Folsom Reservoir storages are nearly similar.

Figure 10-93 shows the monthly percentile distribution values for Nimbus releases. This plot illustrates the CVP operations discussed above by showing the seasonal median releases through the year for each study. As the studies progress towards higher water use from the American Basin, either a median decrease occurs in another subsequent month (Shasta-Trinity integration) or the wintertime probability of higher flood releases is reduced. Figure 10-94 to Figure 10-99 show the average monthly Nimbus releases by long-term average and Sacramento River Basin 40-30-30 Water Year Classification.

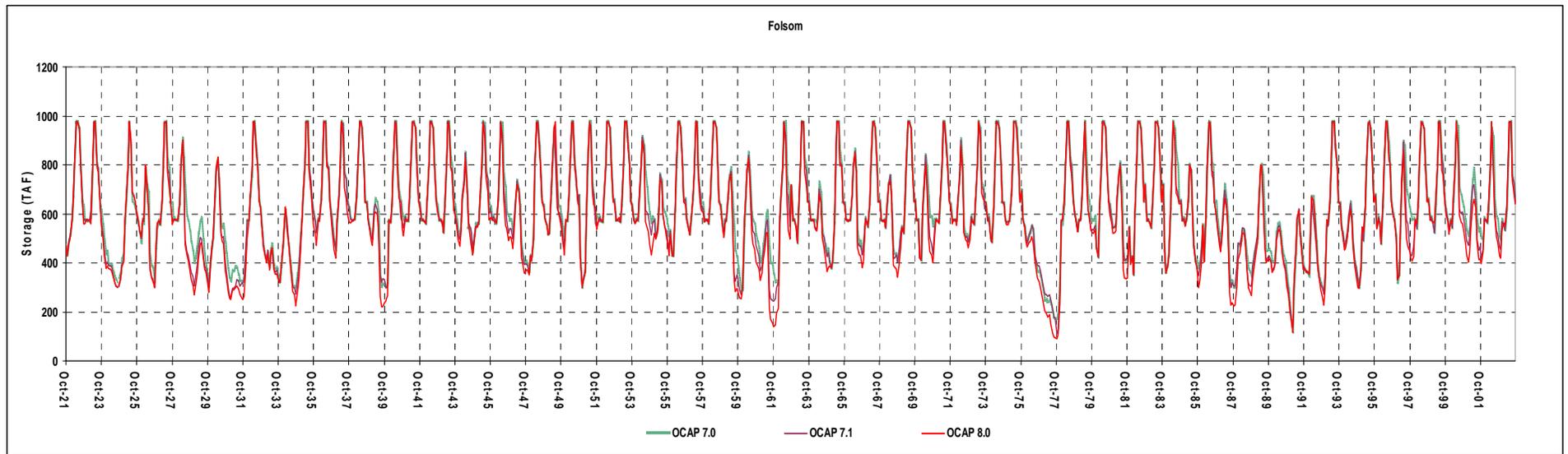


Figure 10-90. Chronology of Folsom Storage Water Years 1922 – 2003

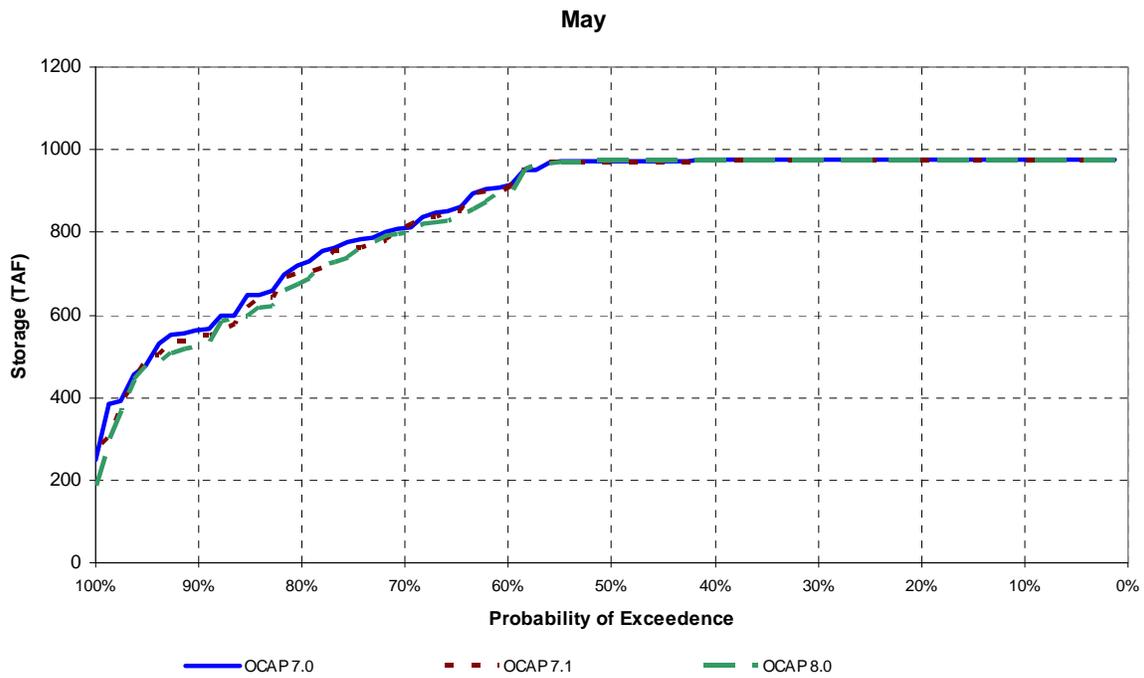


Figure 10-91 Folsom Reservoir End of May Exceedence

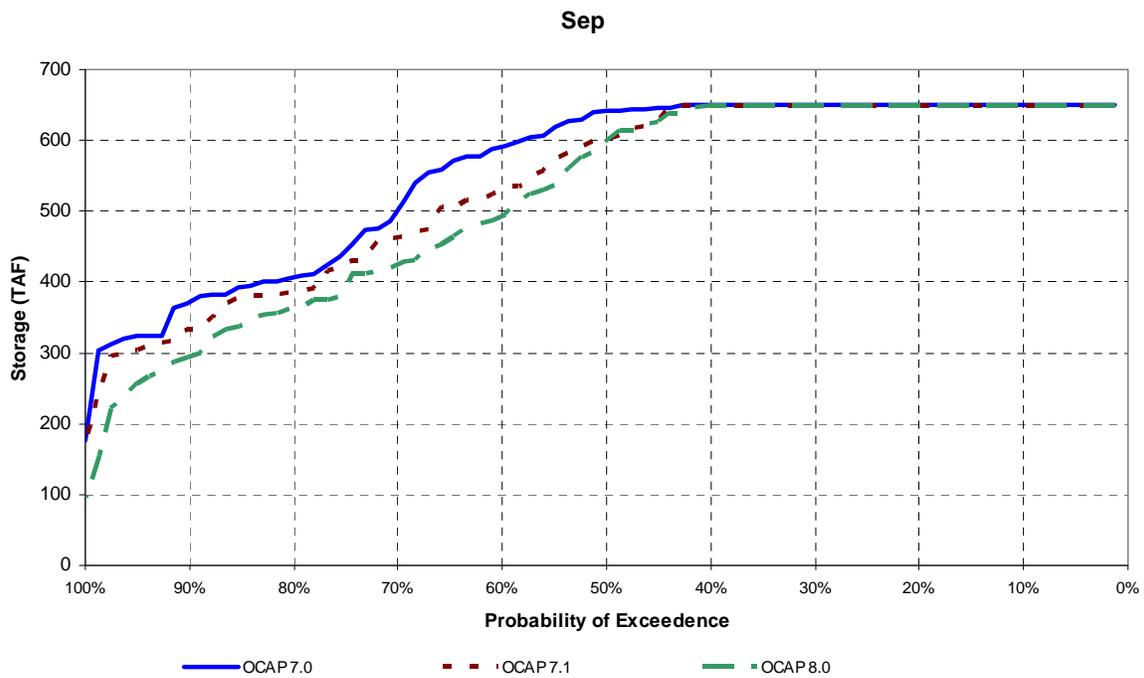


Figure 10-92 Folsom Reservoir End of September Exceedence

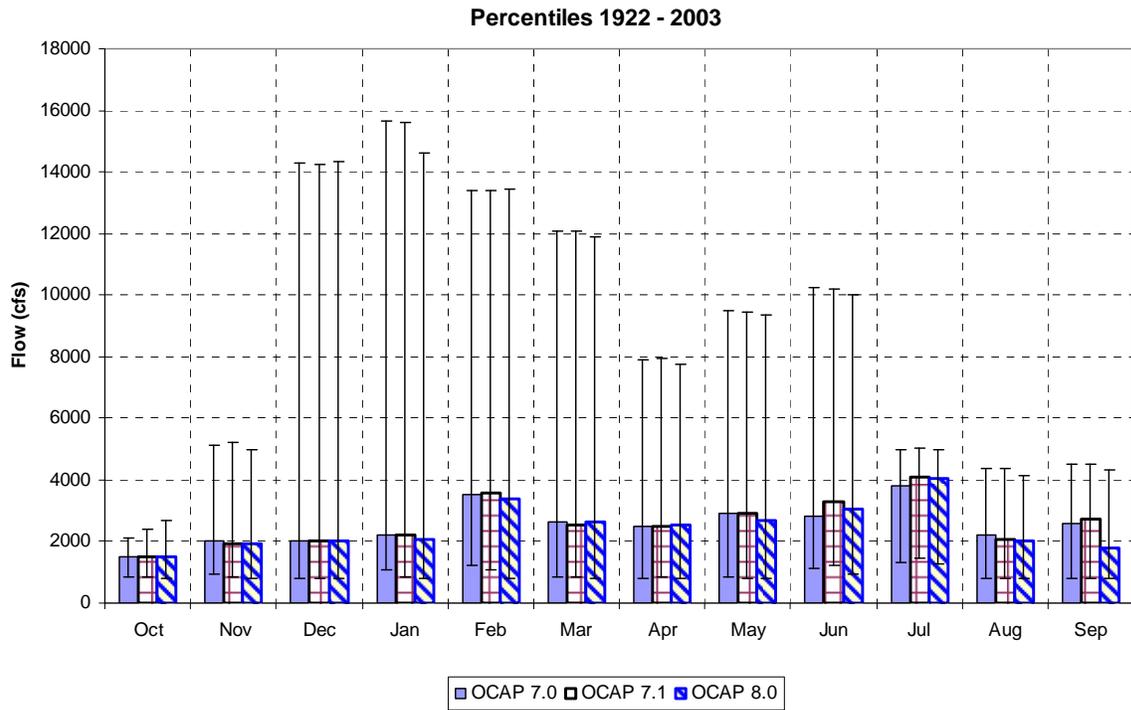


Figure 10-93 Nimbus Release 50<sup>th</sup> Percentile Monthly Releases with the 5<sup>th</sup> and 95<sup>th</sup> as the Bars

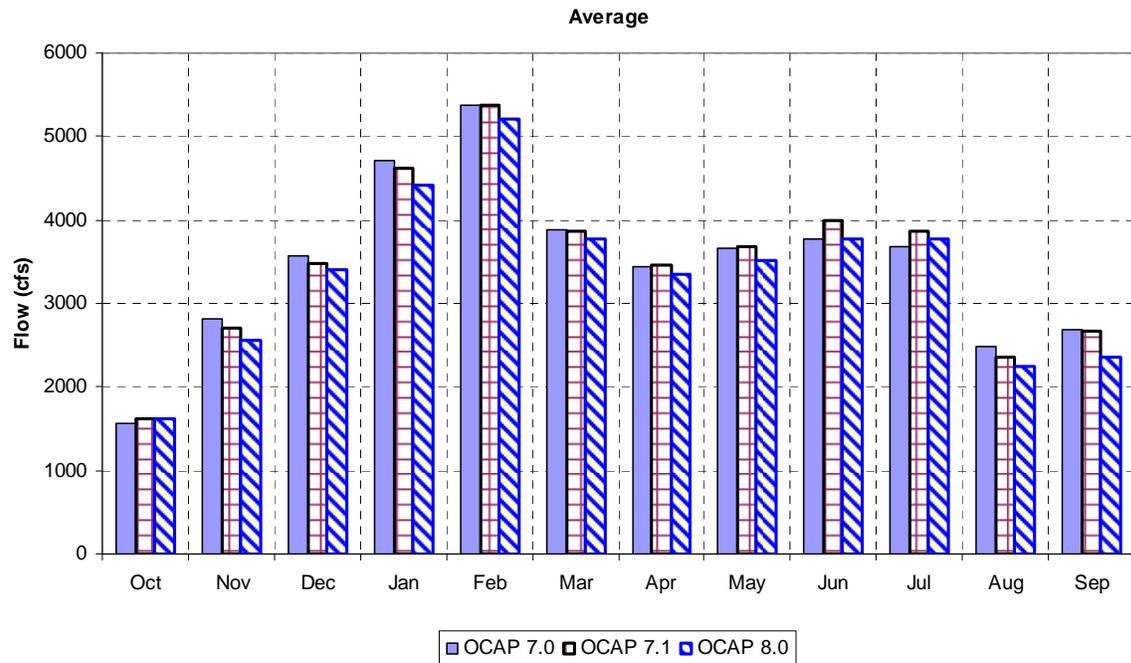


Figure 10-94 Average Monthly Nimbus Release

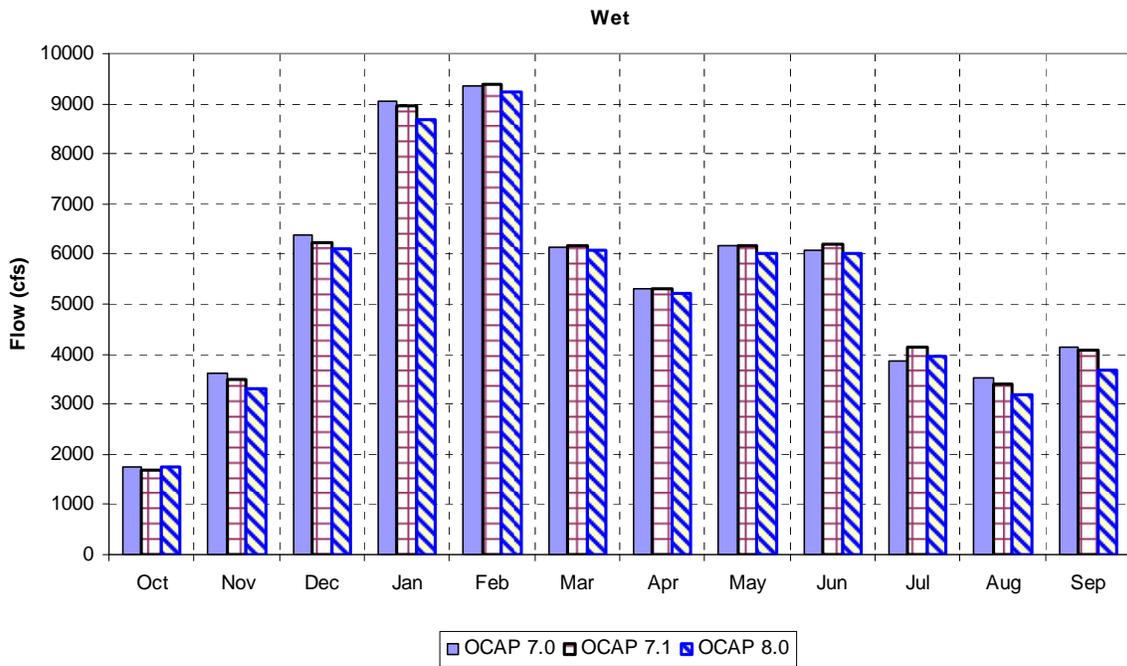


Figure 10-95 Average Wet Year (40-30-30 Classification) Monthly Nimbus Release

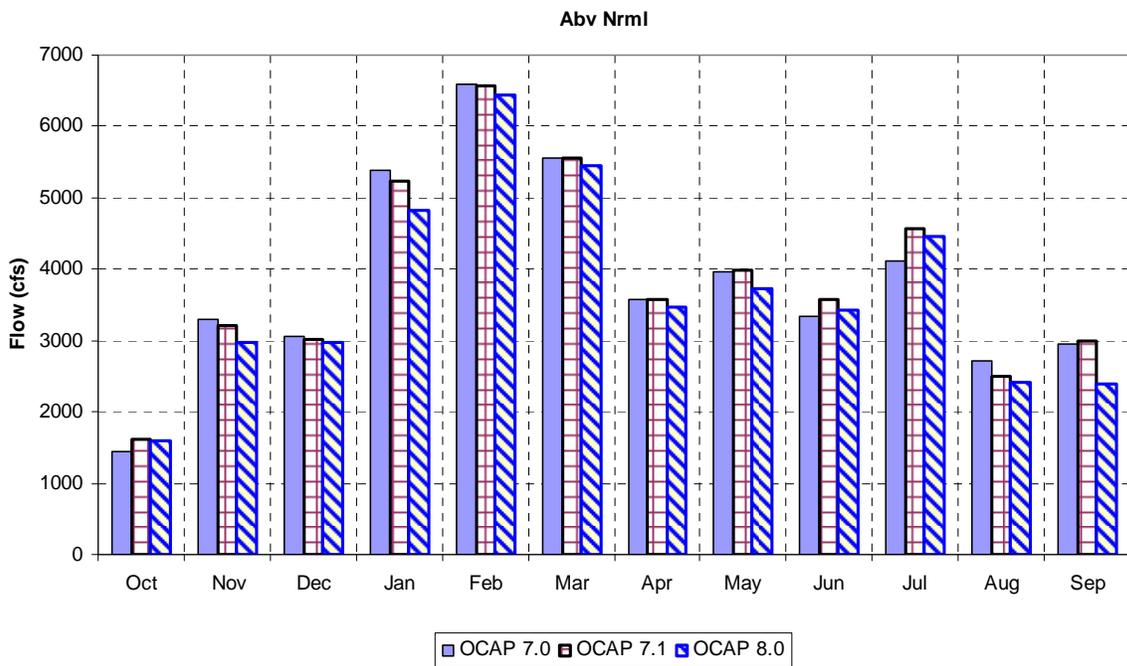


Figure 10-96 Average Above Normal Year (40-30-30 Classification) Monthly Nimbus Release

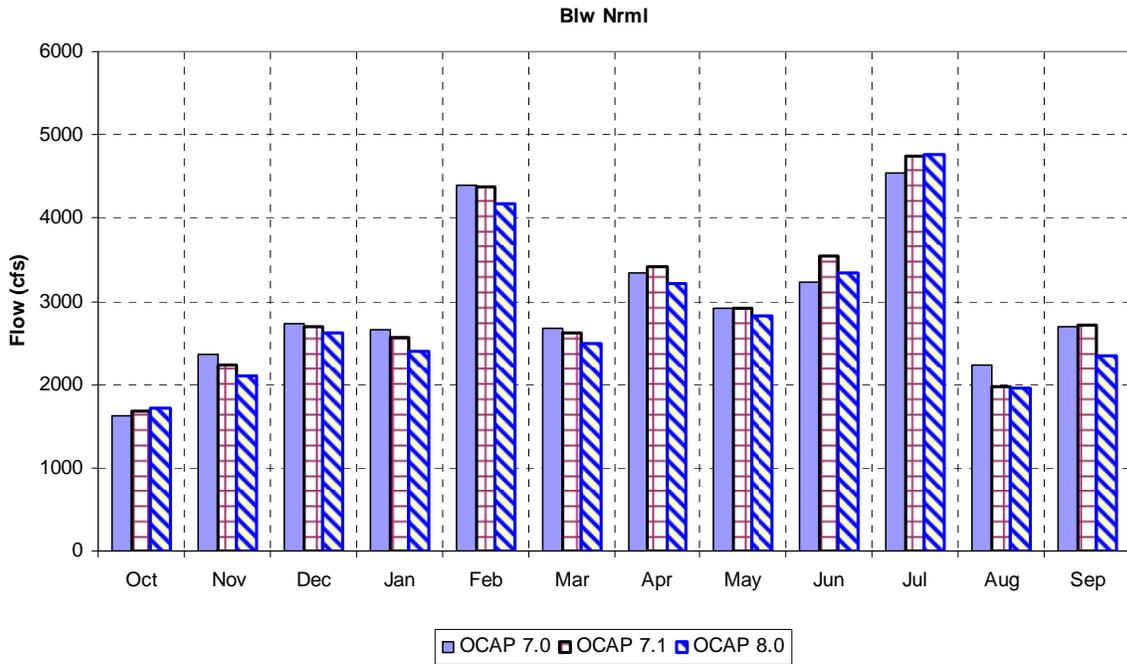


Figure 10-97 Average Below Normal Year (40-30-30 Classification) Monthly Nimbus Release

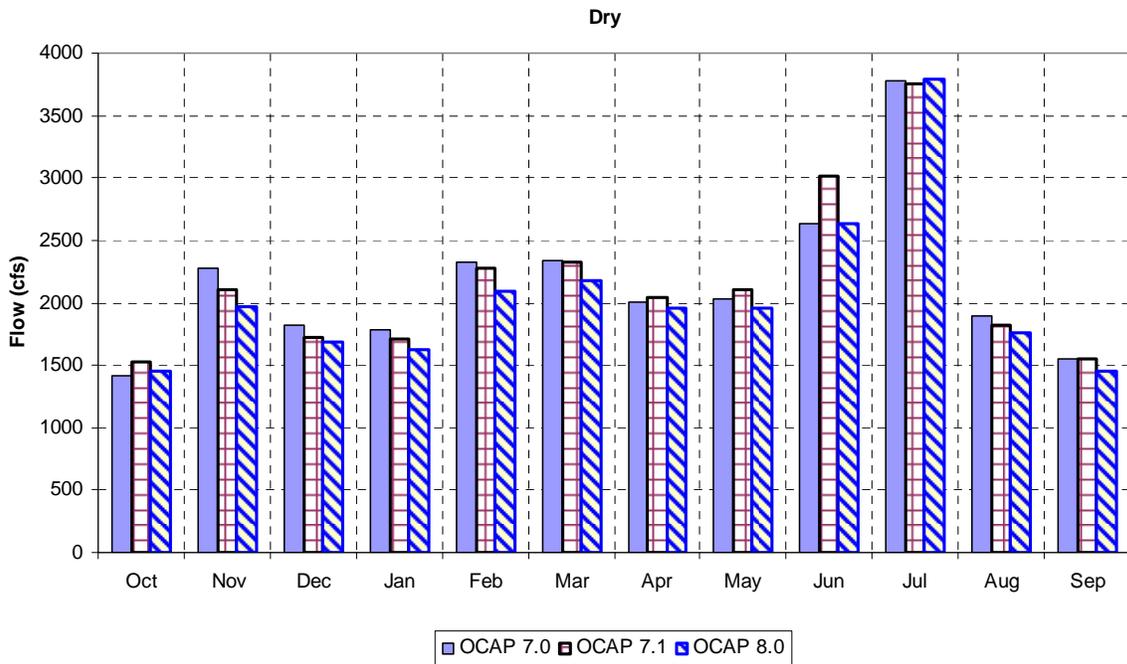


Figure 10-98 Average Dry Year (40-30-30 Classification) Monthly Nimbus Release

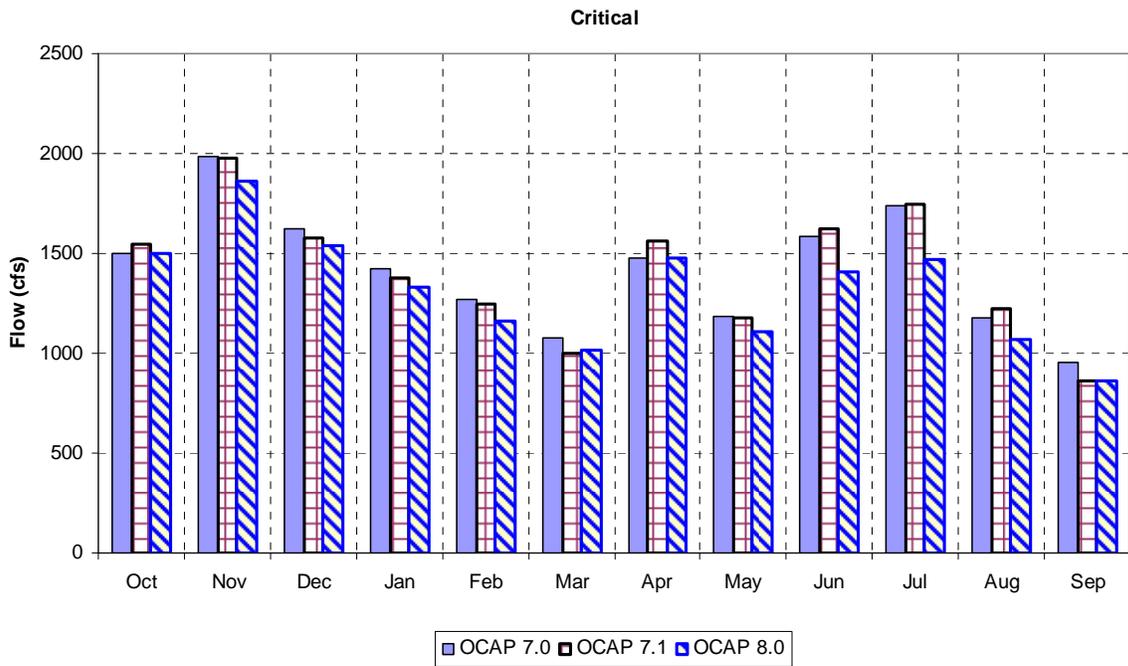


Figure 10-99 Average Critical Year (40-30-30 Classification) Monthly Nimbus Release

## American River Temperature Analysis

Successful management of water temperatures to protect the fishery in any given year for the lower American River requires close coordination and analysis of several factors that influence water temperature. The general operational factors that will influence water temperature management are:

- Volume of coldwater availability in the spring
- Folsom Shutter operational flexibility
- Projected Nimbus Reservoir release rate over the temperature control season
  - Too low of release rates may require significantly colder source water to meet a target temperature leading to faster depletion of available coldwater.
  - Too high of release rates may deplete coldwater availability faster than anticipated and lead to faster depletion of available coldwater
- Water Purveyor withdrawal rates from Folsom Lake and lake elevation of these withdrawal.
- Designation of a compliance water temperature target at Watt Ave. that best integrates the above factors with water temperature habitat needs for sensitive lifestages of fish.

As described in Chapter 2, the American River Group (ARG) and B2IT evaluates all the above factors for any given year designate a compliance water temperature target at Watt Avenue that balances all the relevant information and factors into a seasonal strategy for water management. The adaptive management process updates and evaluates current information in order to make significant choices and tradeoffs for seasonal or inter-seasonal water temperature performance goals. Reclamation utilizes this adaptive management process in a very similar manner as the Sacramento River Temperature Task Group is utilized in order to comply with SWRCB 90-05 water temperature objectives in the upper Sacramento River environment.

The modeling results presented here cannot completely simulate the adaptive management process to designate a compliance water temperature target at Watt Avenue in any given year. The water temperature analysis presented here does demonstrate the generalized relationships of coldwater availability, generalized Folsom Shutter management and Nimbus Reservoir flow regimes associated with a specific set of assumptions for CVP operations. In this incremental sense, the modeled water temperature performance between different studies can be compared in a meaningful way to better understand the seasonal use of coldwater resources relative to each study framework. This water temperature analysis should not be construed as an absolute predictive analysis. The American River Group and B2IT use more detailed management tools to designate a reasonable water temperature target in any given year.

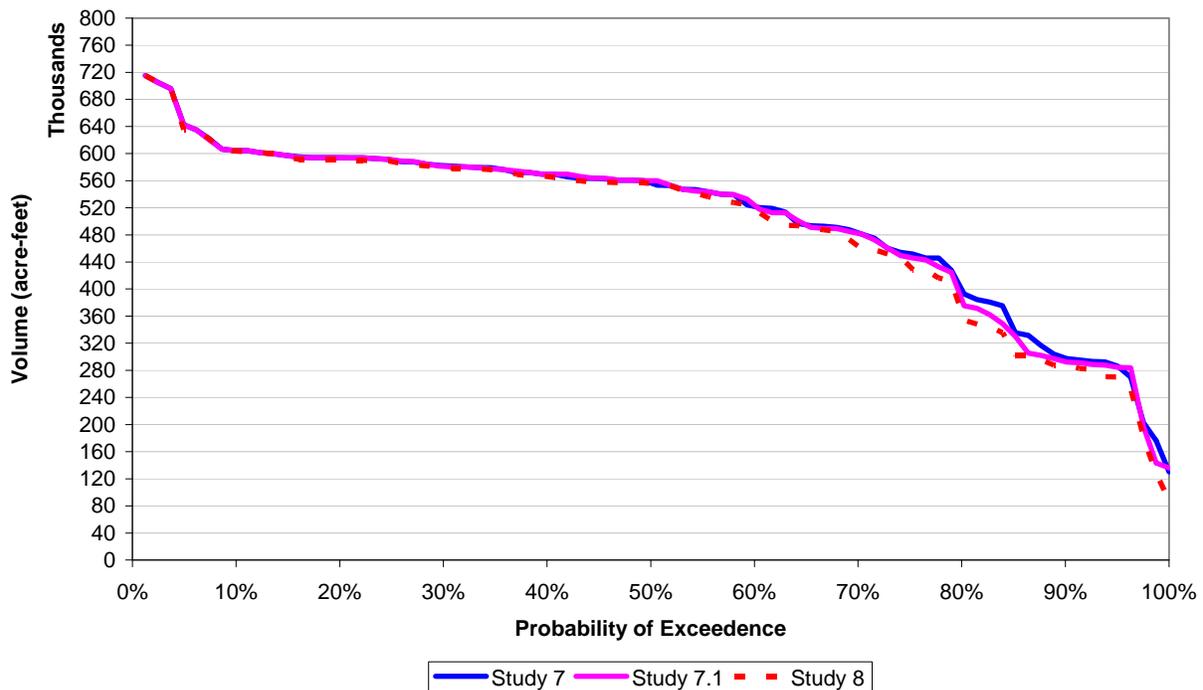
### Coldwater Availability

The most significant influence on water temperature management is the volume of available cold water. The estimated volume of water colder than 58° F stored in Folsom Reservoir on or about June 1 is a very useful way to generally relate coldwater availability to potential seasonal compliance strategies. Generally, the larger the volume of 58° F water in Folsom Reservoir, the

greater potential to designate a lower temperature target at Watt Ave., or the longer in time that a temperature target can be managed to over the temperature control season with a greater assurance of not over-extending the available coldwater resources.

Figure 10-100 illustrates the 58° F index of coldwater availability at Folsom Reservoir for all three studies. All three studies show similar coldwater availability conditions from the 0% to 70% exceedence range. The shape of this coldwater availability index is not the same as Figure 10-101 which shows the exceedence shape of total Folsom Reservoir storage at the end-of-May. The reason is the accumulation of coldwater storage in the spring months is influenced by many factors beyond just total storage in Folsom Reservoir. Figure 10-100 illustrates that the 58° F index of coldwater availability in the drier 70% to 100% exceedence range is closely related to overall storage in Folsom Reservoir.

**Cold Water Resource - Folsom Lake  
(End of May Lake Volume Less Than 58°F)**



**Figure 10-100 58°F index of coldwater availability**

Figure 10-101 to Figure 10-106 illustrate the potential seasonal coldwater patterns for the three studies at the Folsom Reservoir tailbay location. Each of the studies has been modeled using the same Folsom Shutter target temperature logic. Since each study utilizes the same shutter operations logic to generate water temperature values, the results of this analysis will only characterize how the depletion of the annual coldwater resources at Folsom Reservoir varies among the three studies. Given that the water temperature analysis uses the same shutter operations logic in each study, the model makes no attempt to adjust the water temperature target within the season based on the availability of coldwater. The American River Group would consider this kind of information and make choices as to how to manage the temporal distribution of coldwater resources differently than maybe portrayed with this water temperature analysis.

The usefulness of this analysis is to characterize the water temperature utilization between studies in order to evaluate general coldwater management and water temperature trends for each study framework, and should not be used as a predictive water temperature analysis.

The Folsom tailbay plots begin to show potential differences in the utilization of coldwater resources in May/July for approximately 10% of the years between study 7 and study 7.1 and study 8. This is reflective of the lower coldwater availability under the very dry conditions for study 7.1 and study 8. By June the potential difference in the use of coldwater increases to approximately 40% of the years between the studies, again reflective of the lower coldwater availability differences for study 7.1 and study 8. By July, the potential differences in the use of coldwater resources for study 8, increased future demand in the American basin, reflect increased depletion of coldwater resources relative to study 7 and study 7.1. This trend persists for the remainder of the temperature control season.

Figure 10-107 to Figure 10-112 illustrate potential seasonal coldwater use patterns for the three studies at Nimbus Reservoir. Nimbus Reservoir is the key management point to water temperature management operations for the lower American River because this is the location CVP operators have significant influence to the temperature of the water released on a daily basis before reaching the water temperature target at Watt Ave.

In realtime water temperature operations, CVP operators manage Nimbus release water temperatures by adjusting and balancing the following operational factors for water temperature purposes;

- Flow from Nimbus Dam
- Folsom shutter configuration
  - Shutter configuration changes are a one time event. Changes require a crane and are labor intensive. Changes must be scheduled and coordinated in advance of actual water temperature needs using forecast information.
- Daily “Blending” ratio of powerplant units when Folsom shutter are in an elevational stepped configuration.
  - When Folsom shutter are in an elevational stepped configuration, it is possible to schedule the daily releases at each Folsom powerplant unit to a desired water temperature blend and thereby conserve seasonal thermal resources.

This temperature analysis for Nimbus releases (Figure 10-107 to Figure 10-112) shows for all three studies the same general water temperature seasonal patterns as the Folsom tailbay information. Study 8, show the warmest Nimbus release patterns due to the lower initial coldwater availability and the increased water demand in the American basin. The temperature analysis shows Nimbus release temperatures in July to be consistently above 65 F. The July water temperatures at Nimbus are a reflection of the internal model logic for Folsom shutter management and temporal water temperature choices for summer water temperatures and fall water temperatures. The American River Group may choose to manage the coldwater resources differently than how this model distributes the resource. If the American River Group chooses to provide less than 65 F for Nimbus releases on a more frequent basis than this model portrayal, then the fall water temperatures would likely be warmer than this model portrayal.

This temperature analysis for Watt Avenue (Figure 10-113 to Figure 10-118) shows for all three studies the same general water temperature seasonal patterns as the Nimbus release information.

### Folsom Tailbay Exceedence Plots

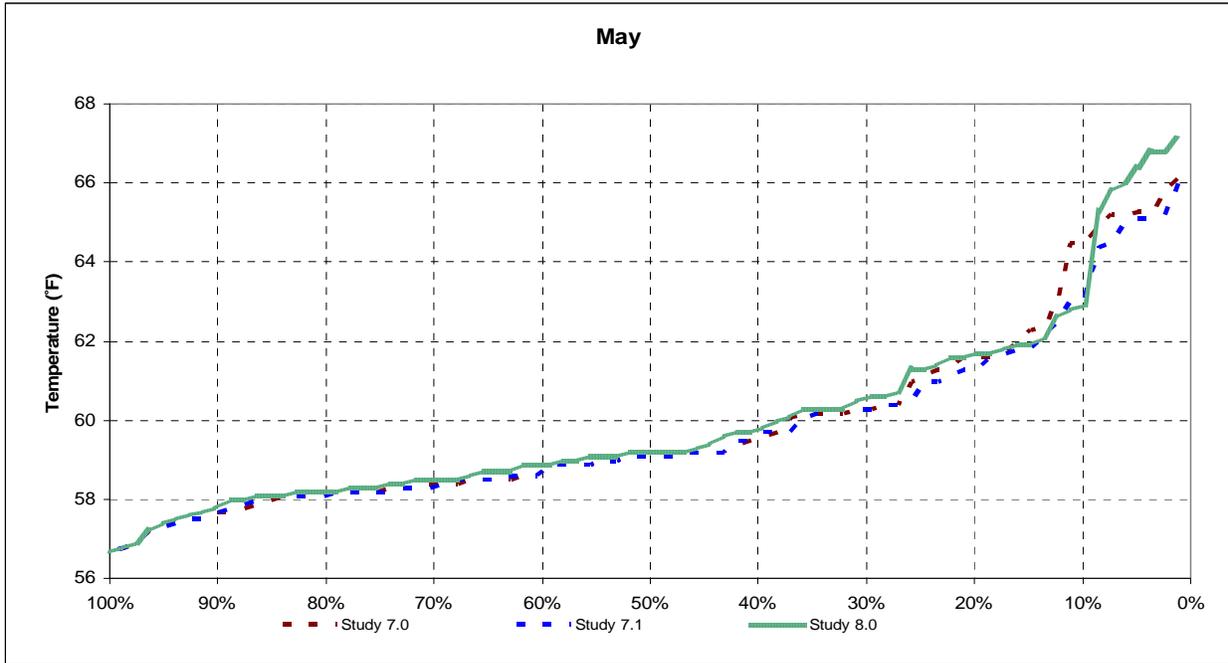


Figure 10-101 Folsom Tailbay End-of-May Exceedence

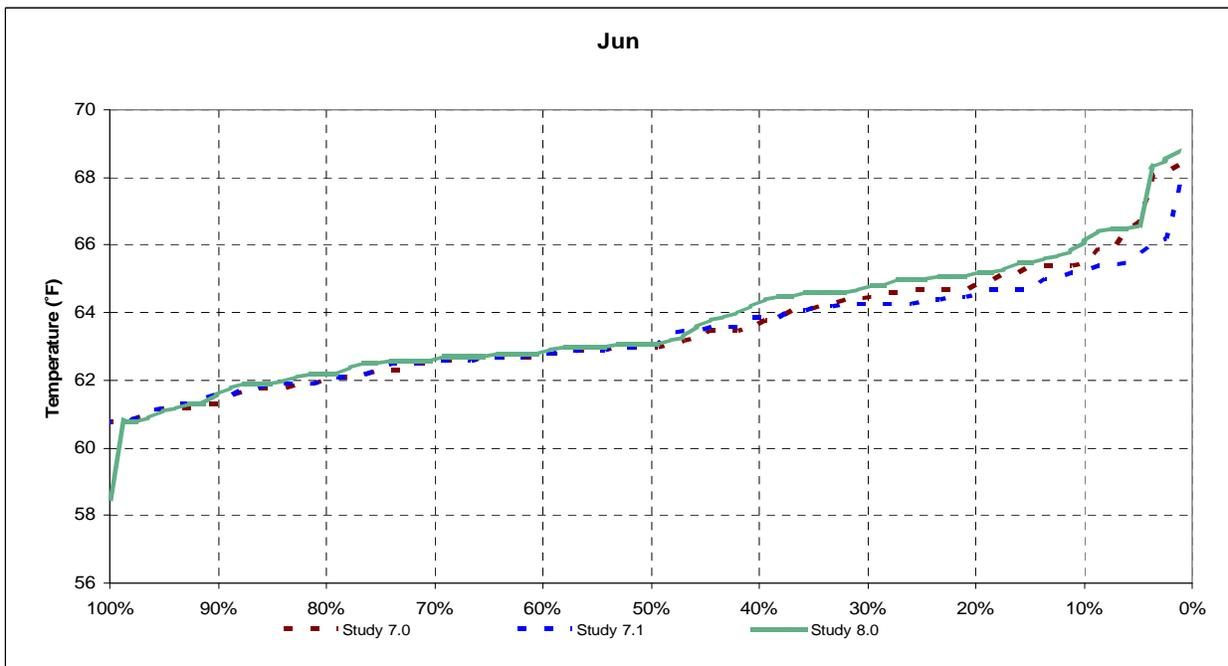


Figure 10-102 Folsom Tailbay End-of-June Exceedence

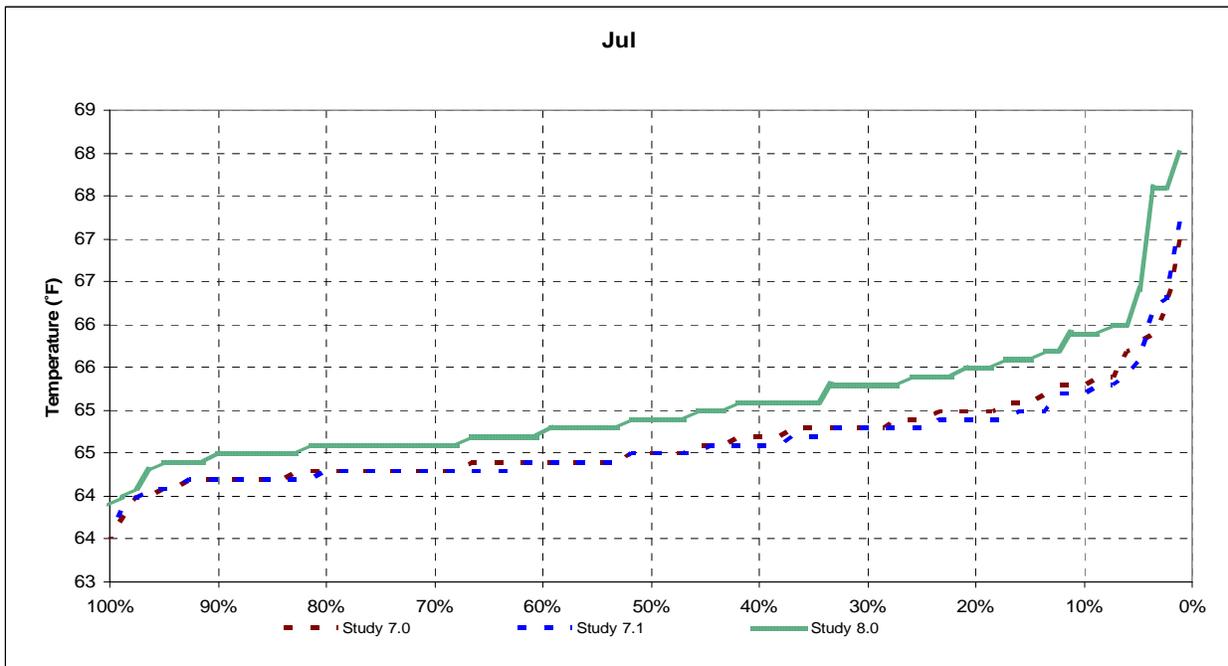


Figure 10-103 Folsom Tailbay End-of-July Exceedence

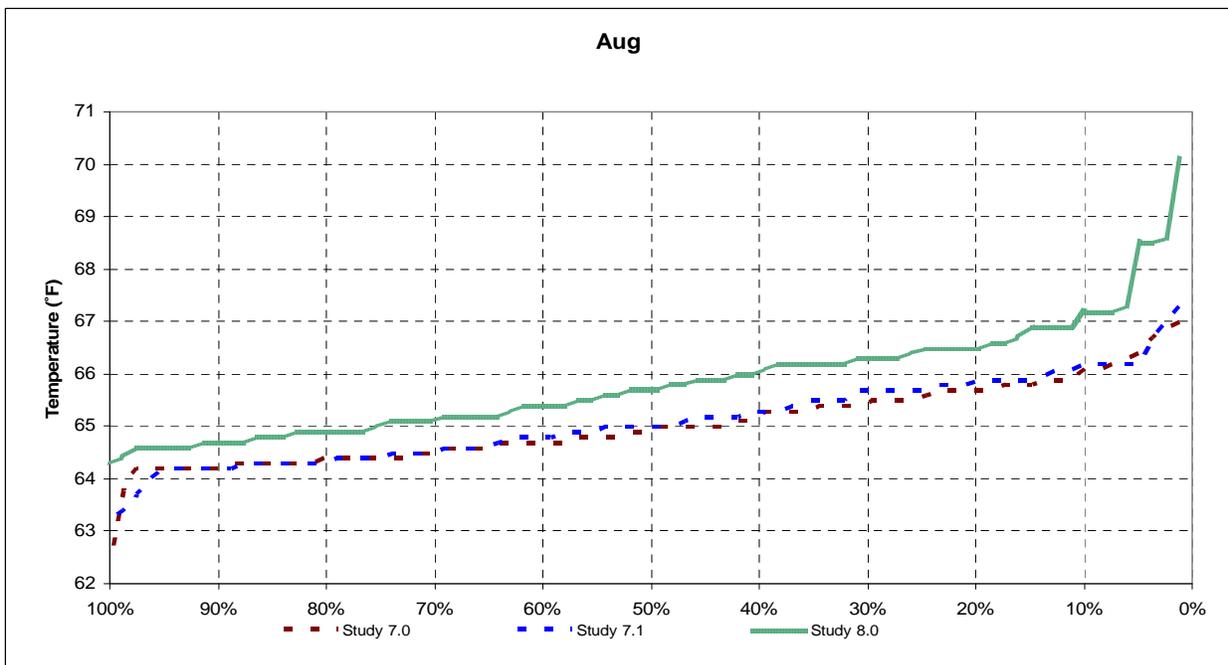


Figure 10-104 Folsom Tailbay End-of-August Exceedence

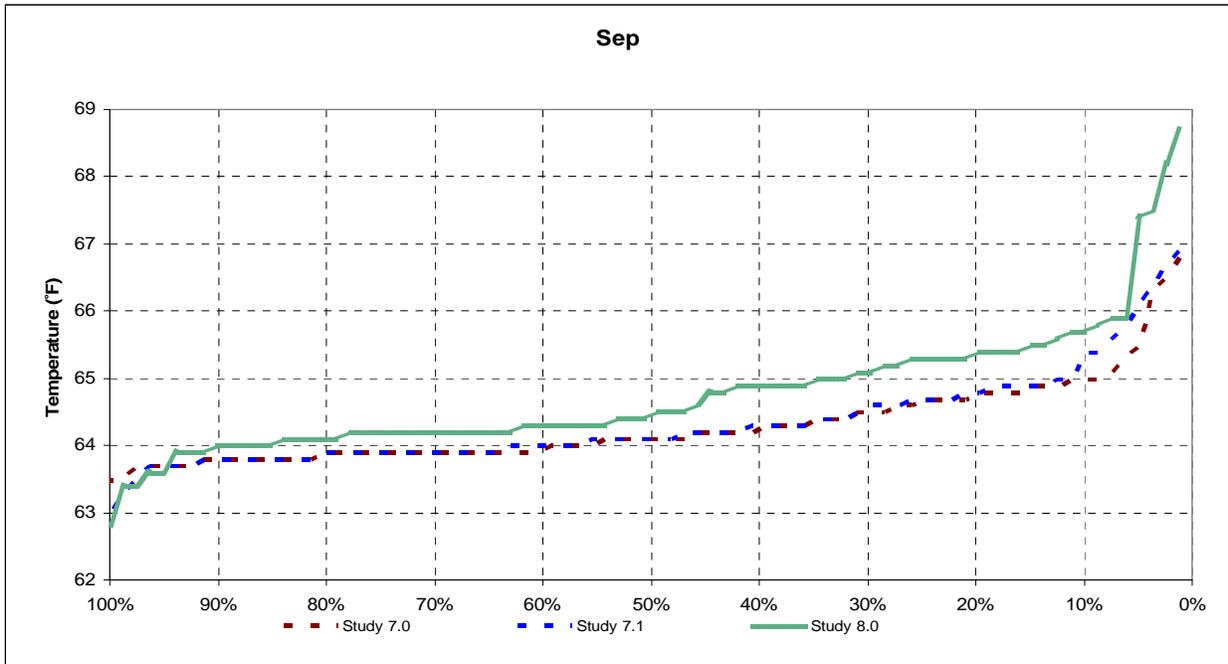


Figure 10-105 Folsom Tailbay End-of-September Exceedence

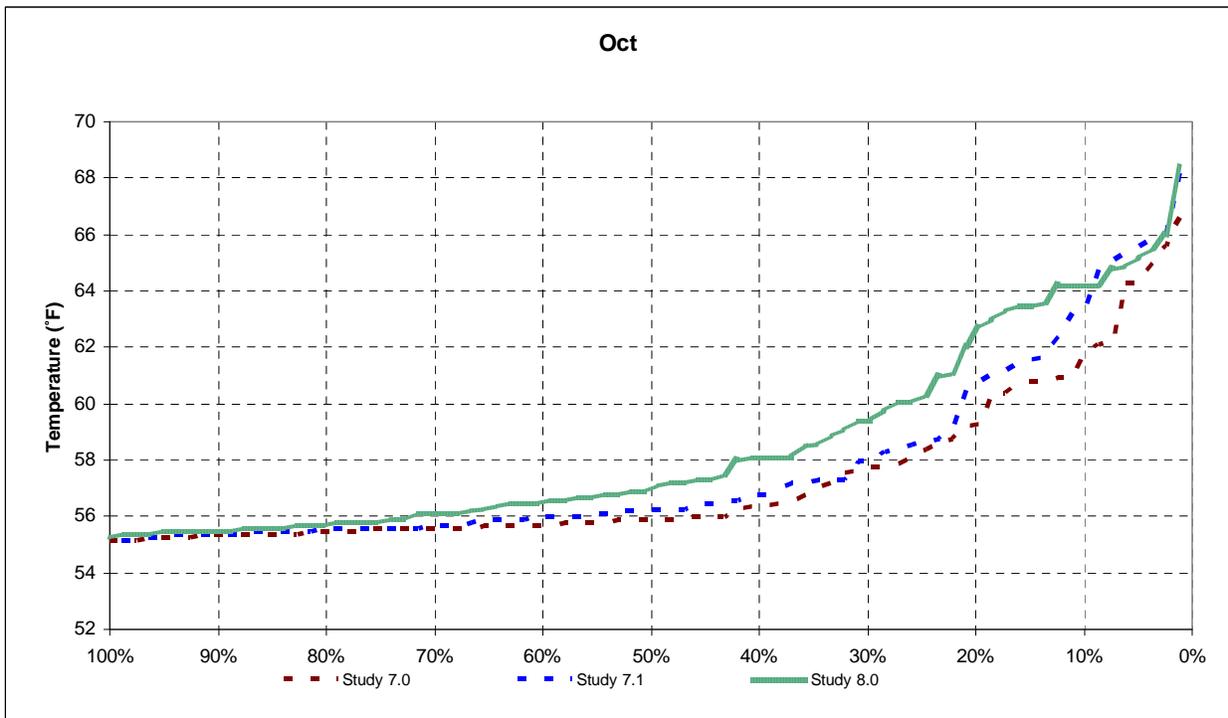


Figure 10-106 Folsom Tailbay End-of-October Exceedence

Nimbus Release Exceedence Plots

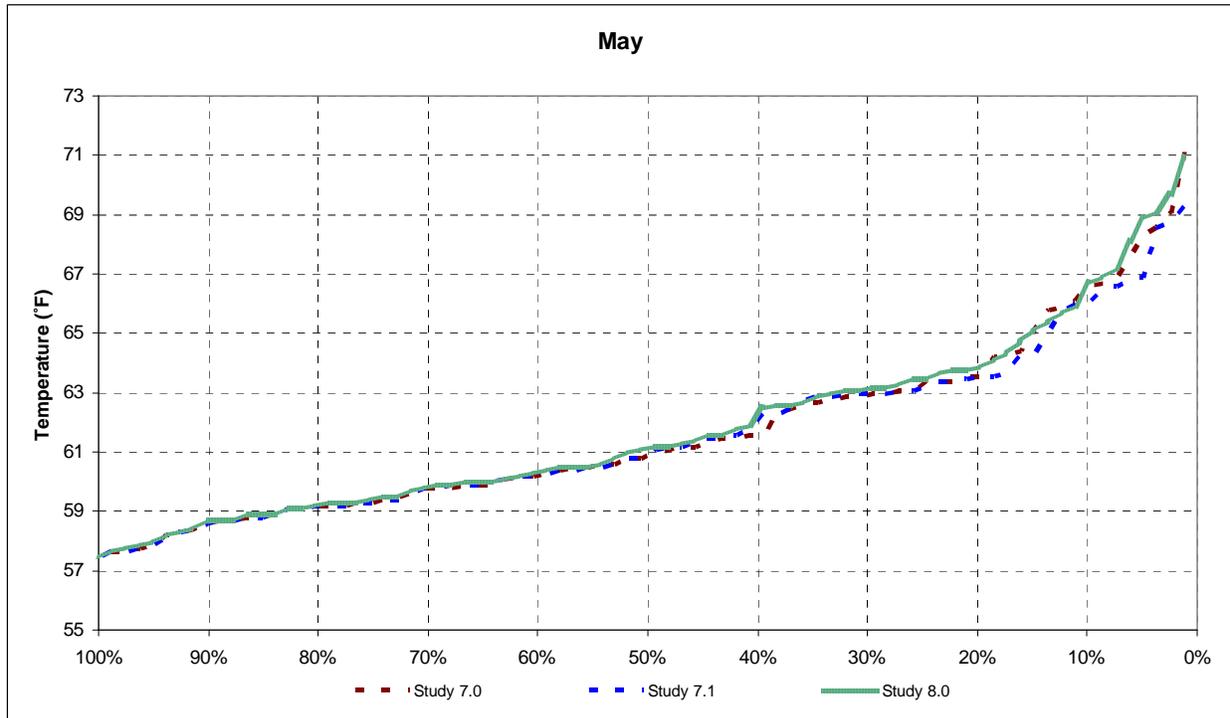


Figure 10-107 Nimbus End-of-May Exceedence

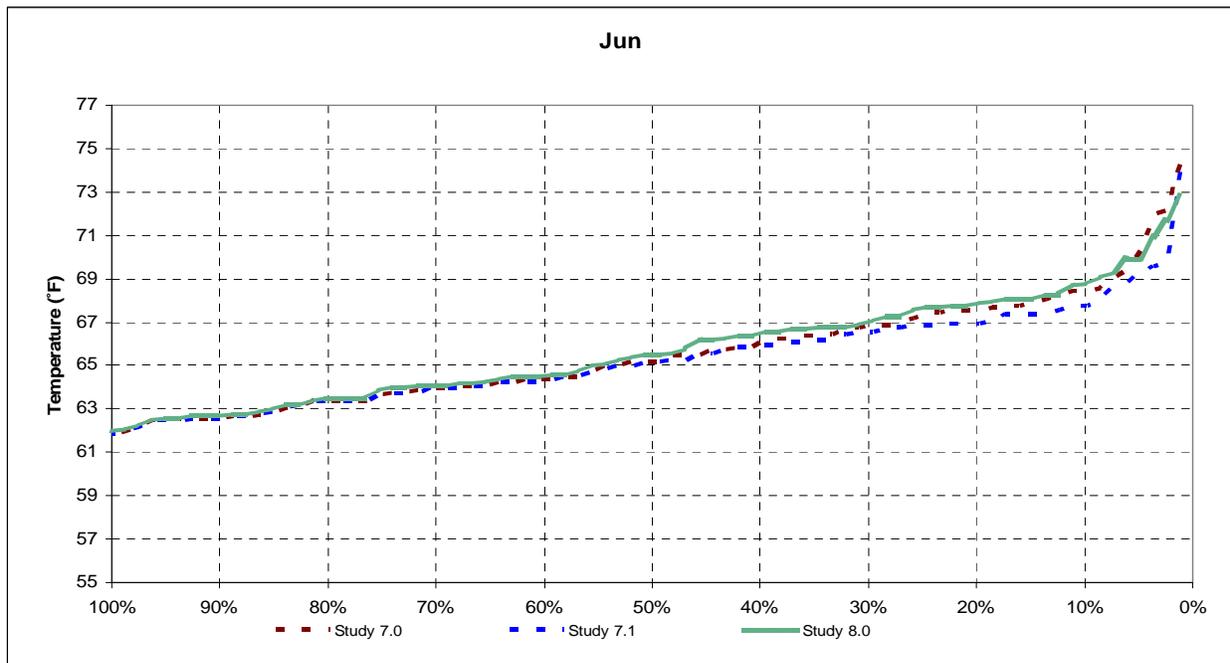


Figure 10-108 Nimbus End-of-June Exceedence

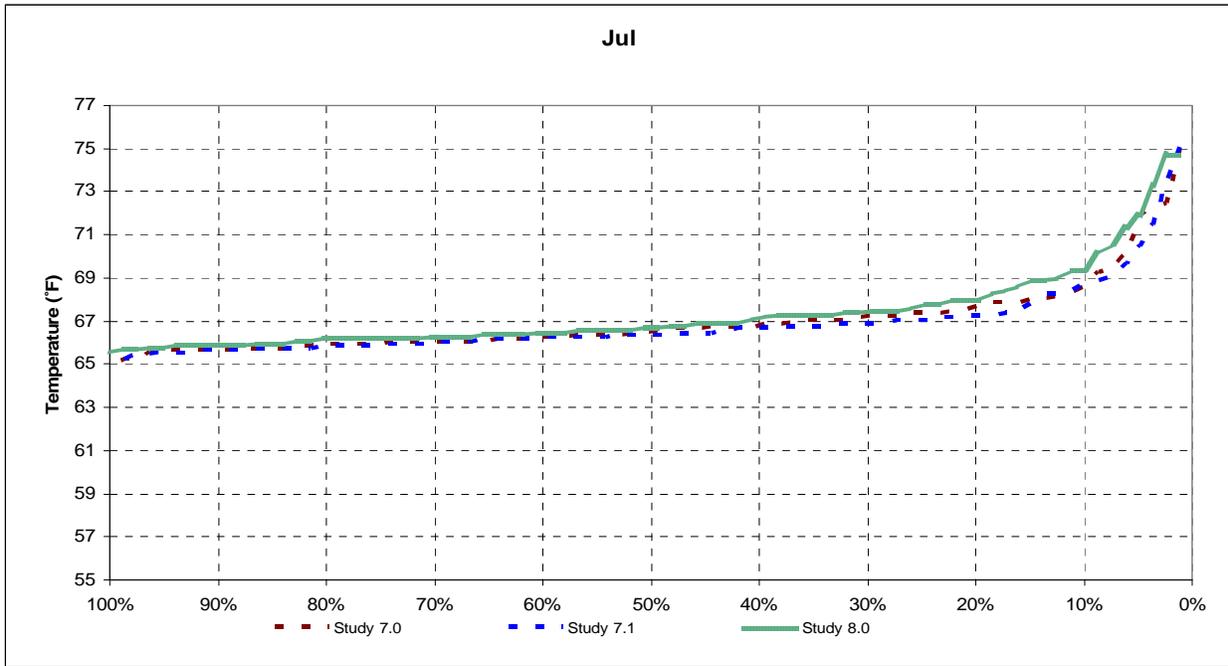


Figure 10-109 Nimbus End-of-July Exceedence

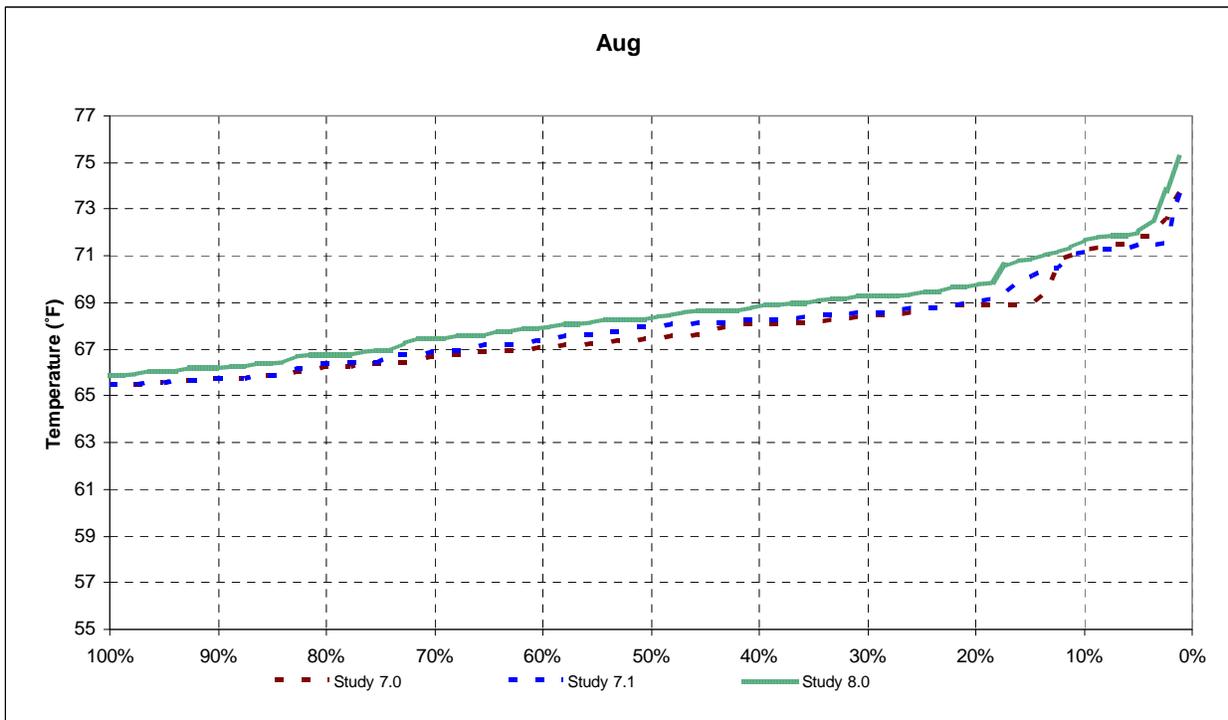


Figure 10-110 Nimbus End-of-August Exceedence

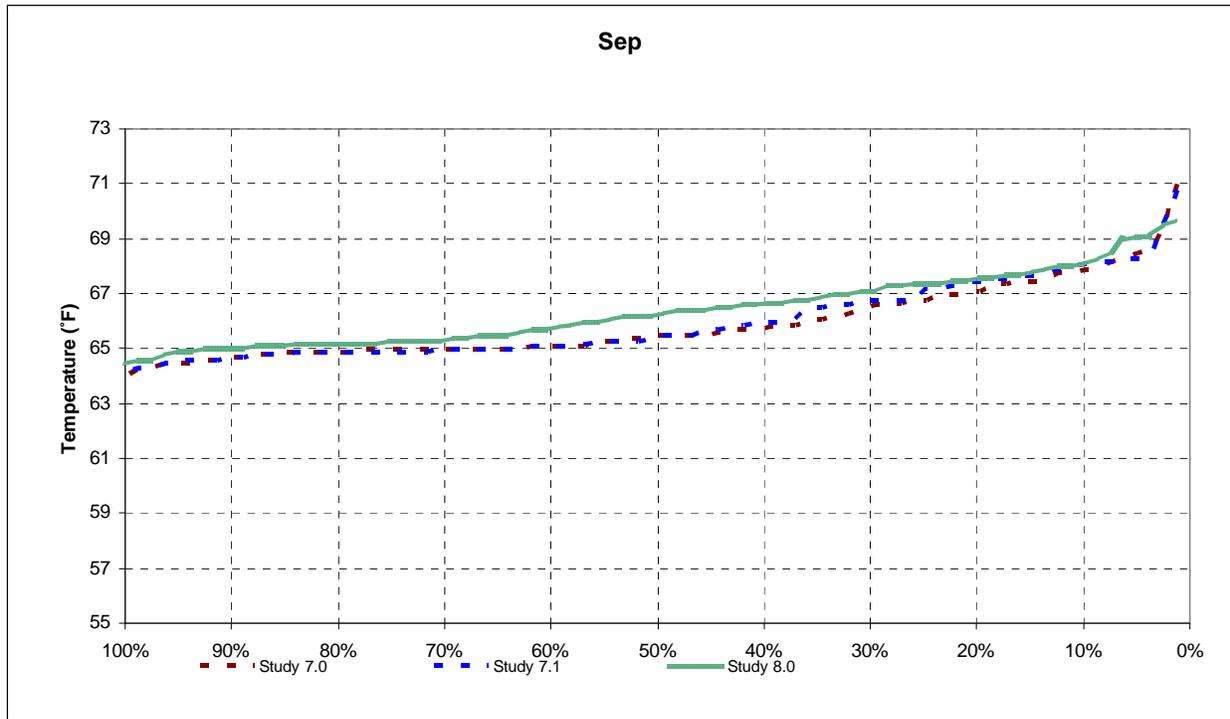


Figure 10-111 Nimbus End-of-September Exceedence

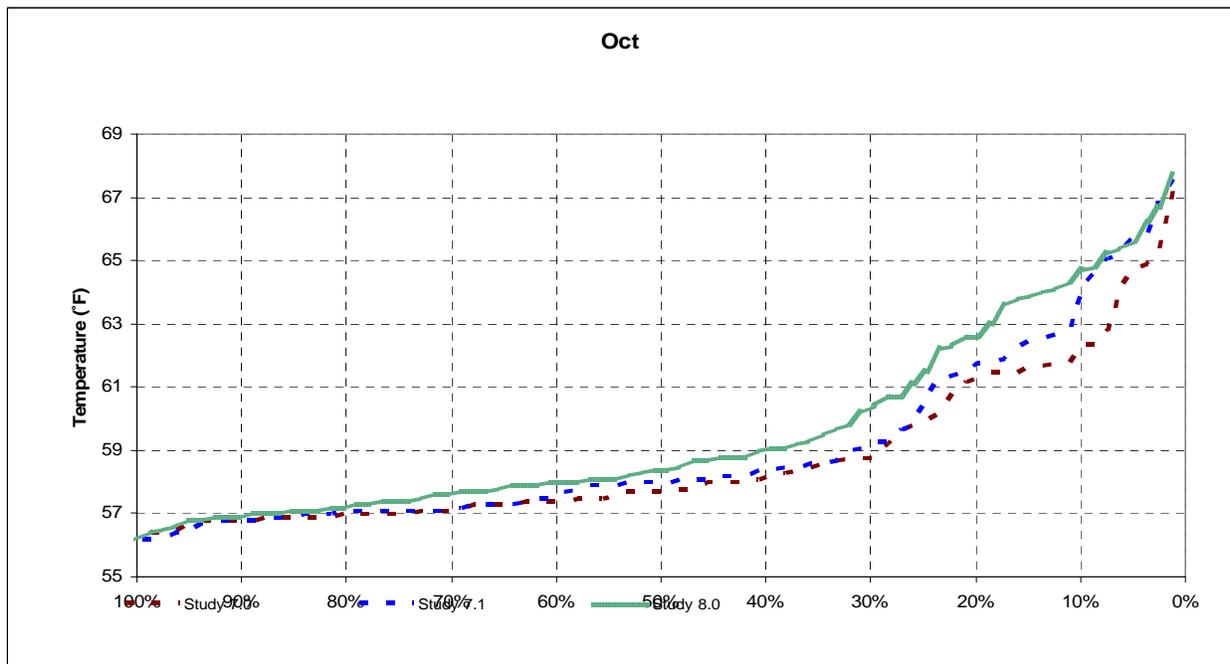


Figure 10-112 Nimbus End-of-October Exceedence

Watt Ave. Exceedence Plots

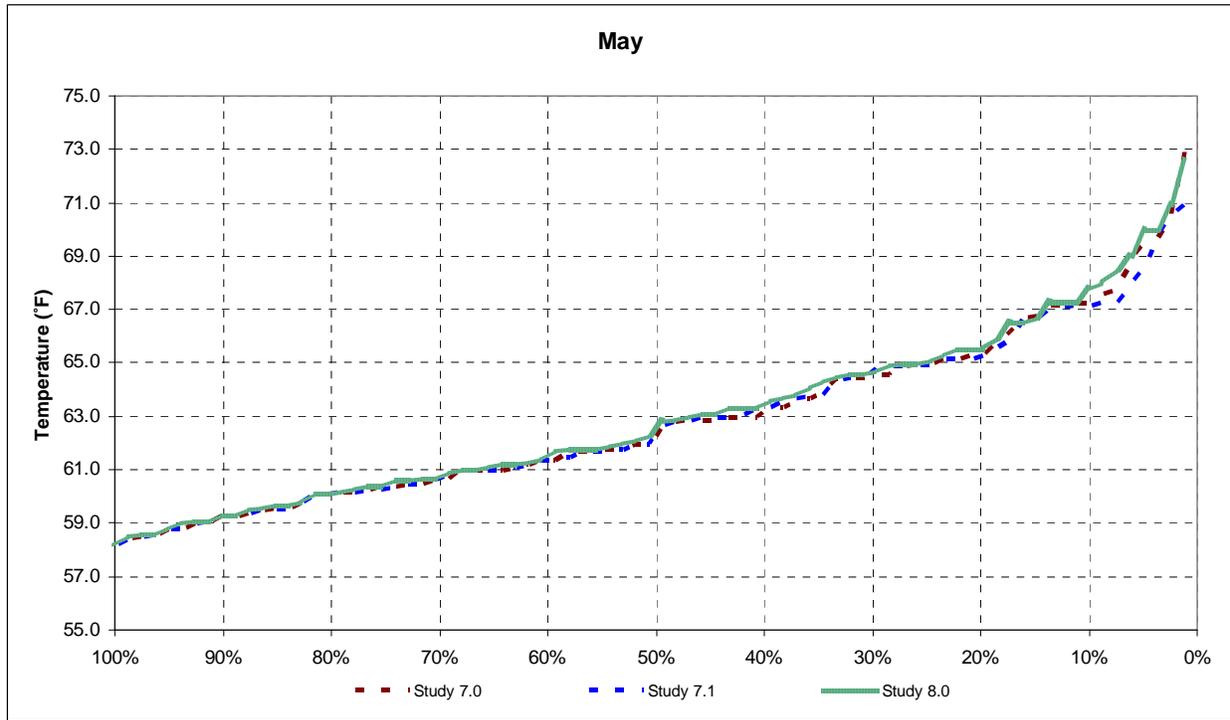


Figure 10-113 Watt Avenue End-of-May Exceedence

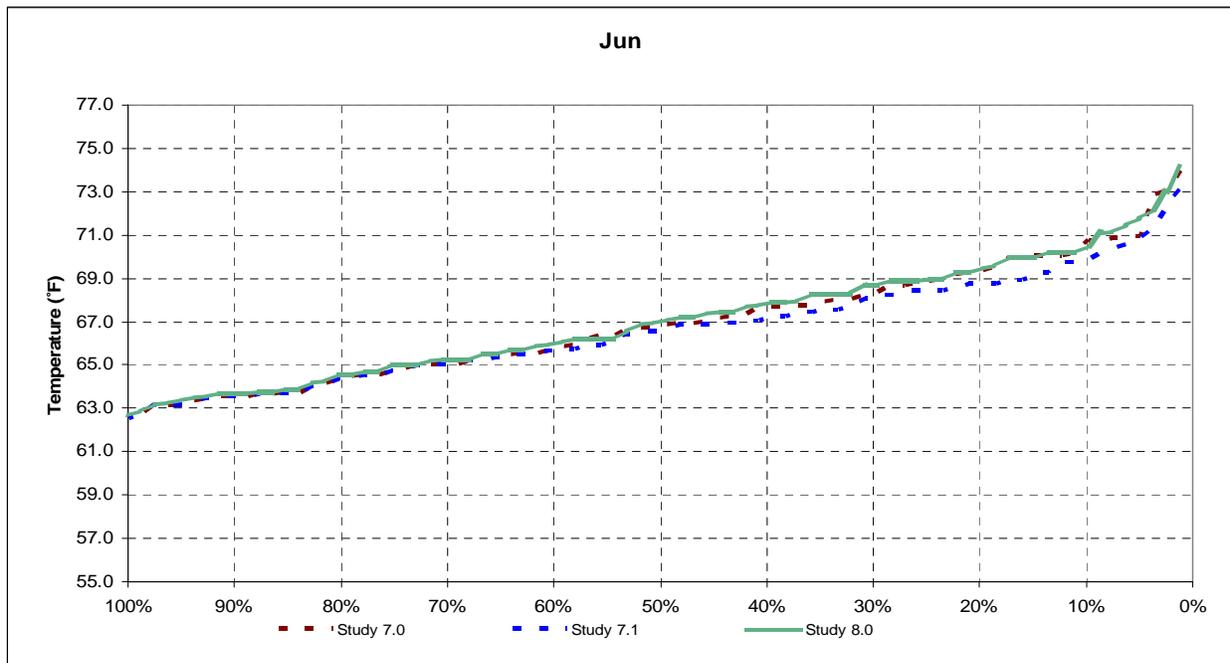


Figure 10-114 Watt Avenue End-of-June Exceedence

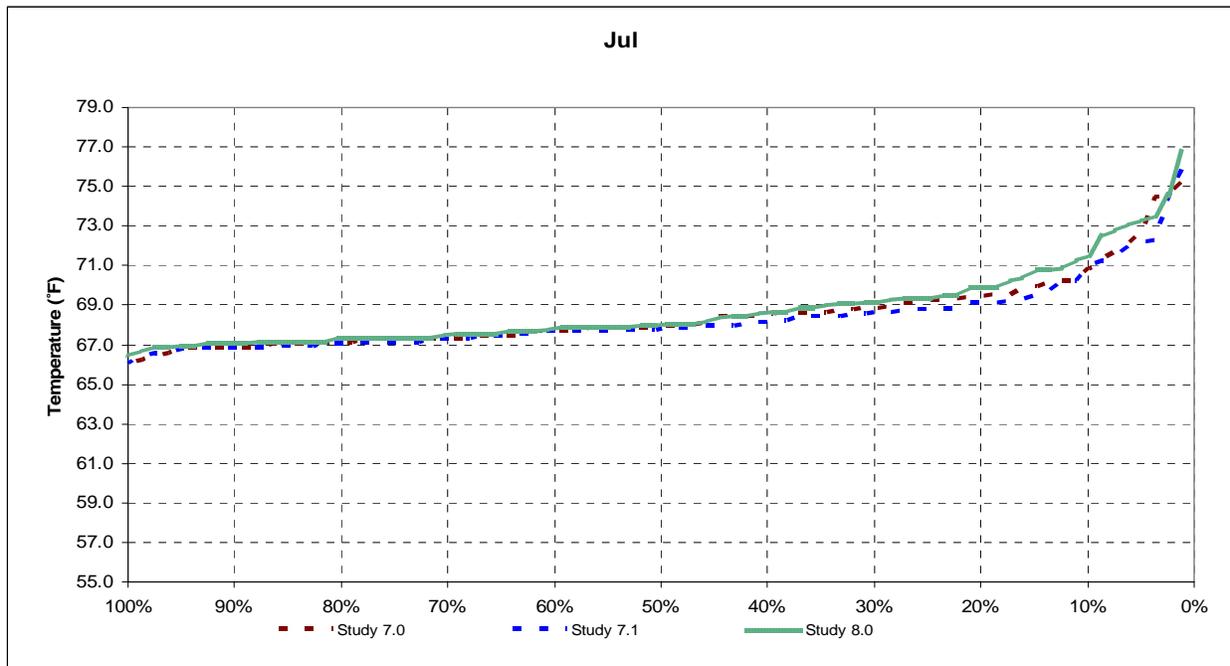


Figure 10-115 Watt Avenue End-of-July Exceedence

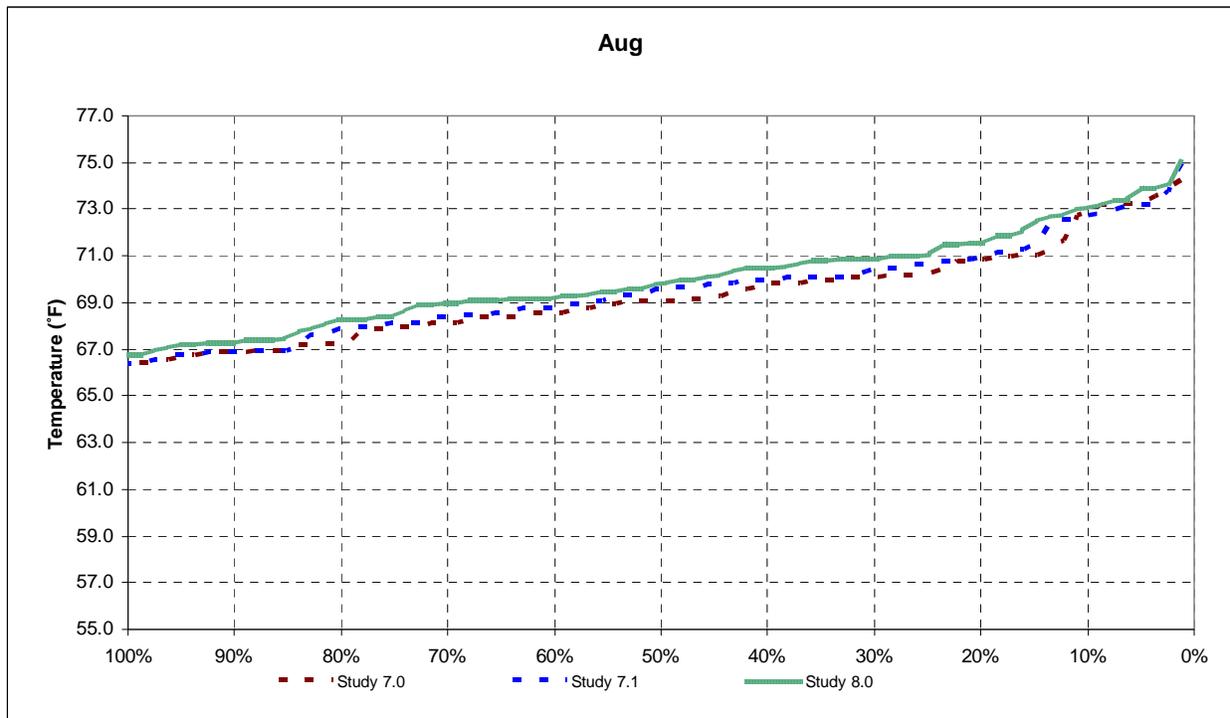


Figure 10-116 Watt Avenue End-of-August Exceedence

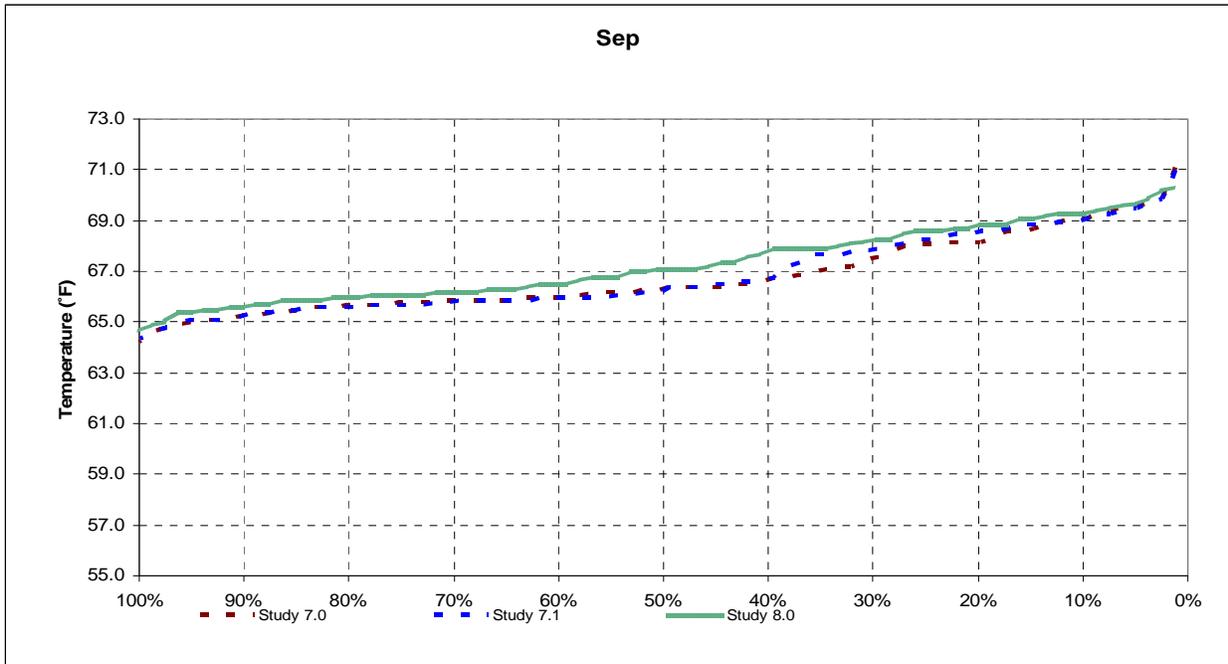


Figure 10-117 Watt Avenue End-of-September Exceedence

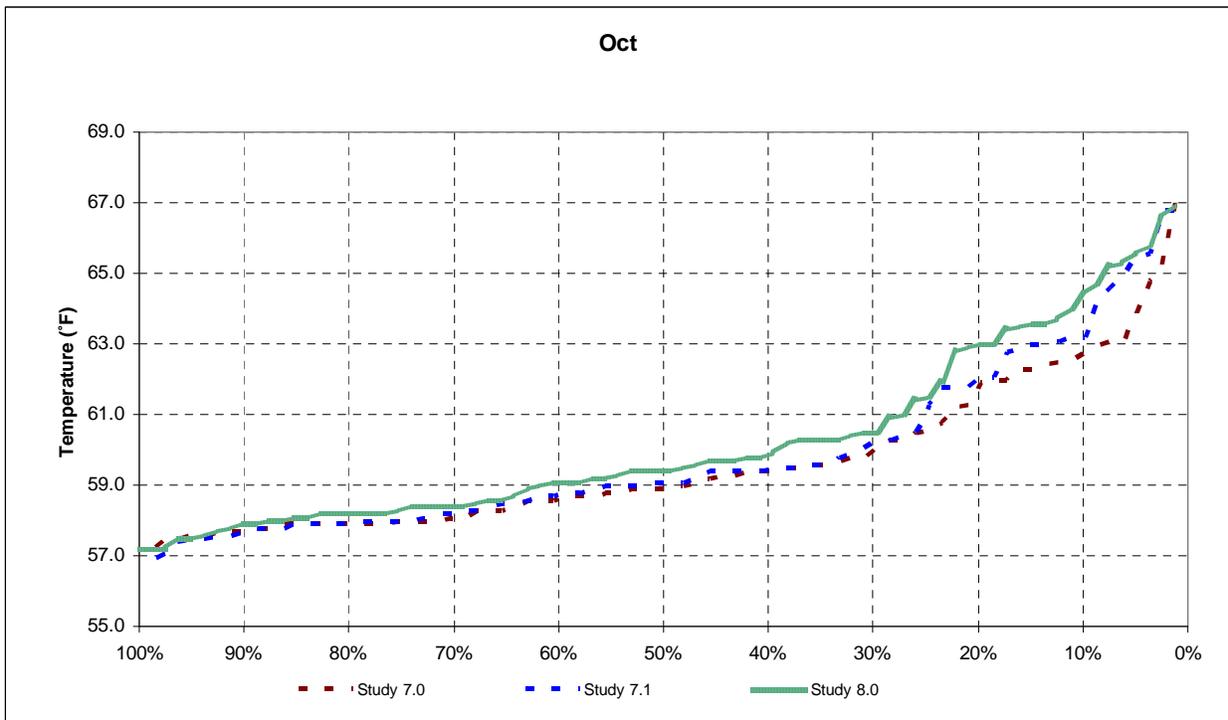


Figure 10-118 Watt Avenue End-of-October Exceedence

## Stanislaus River

### Modeling

Among the three studies, there is no change in operations on the Stanislaus River and no significant effects of the previously mentioned CalSim II modeling improvements. Figure 10-119 shows the chronology of New Melones. Figure 10-120 and Figure 10-121 and shows the end-of-May and end-of-September exceedence plots. Both figures show that there are no significant differences in storage among the five studies. Figure 10-122 shows the percentile values for the releases from Goodwin Reservoir, and Figure 10-123 to Figure 10-128 shows the monthly averages by 60-20-20 water-year types. The Goodwin release graphs also show no significant effect to operations among the three studies. Table 10-6 compares some of the annual average impacts to Stanislaus River flows between the studies.

**Table 10-6 Long-term Average Annual Impacts to Stanislaus River flows**

Longterm Annual Average

Difference in Thousands of Acre-feet [TAF]	Study 7.1 - Study 7.0	Study 8.0 - Study 7.0	Study 8.0 - Study 7.1
New Melones End-of-September Storage	10	71	61
Annual Tulloch Release	6	2	-4

29- 34 Difference

Difference in Thousands of Acre-feet [TAF]	Study 7.1 - Study 7.0	Study 8.0 - Study 7.0	Study 8.0 - Study 7.1
New Melones End-of-September Storage	-2	165	167
Annual Tulloch Release	45	9	-35

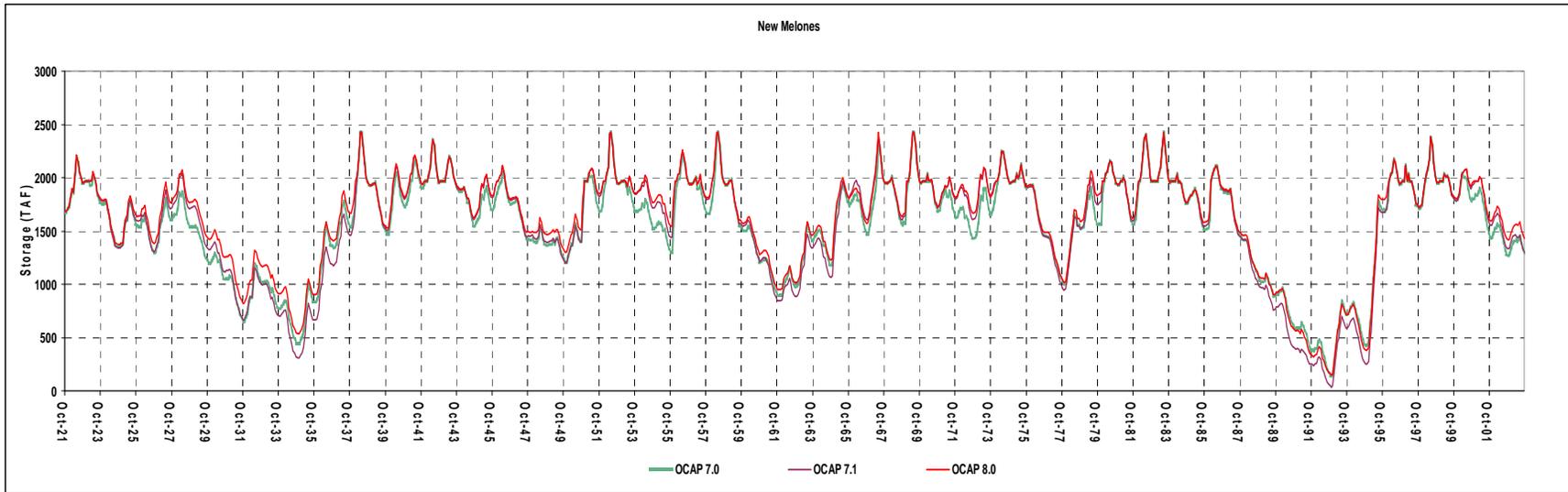


Figure 10-119 Chronology of New Melones Storage Water Years 1922 – 2003

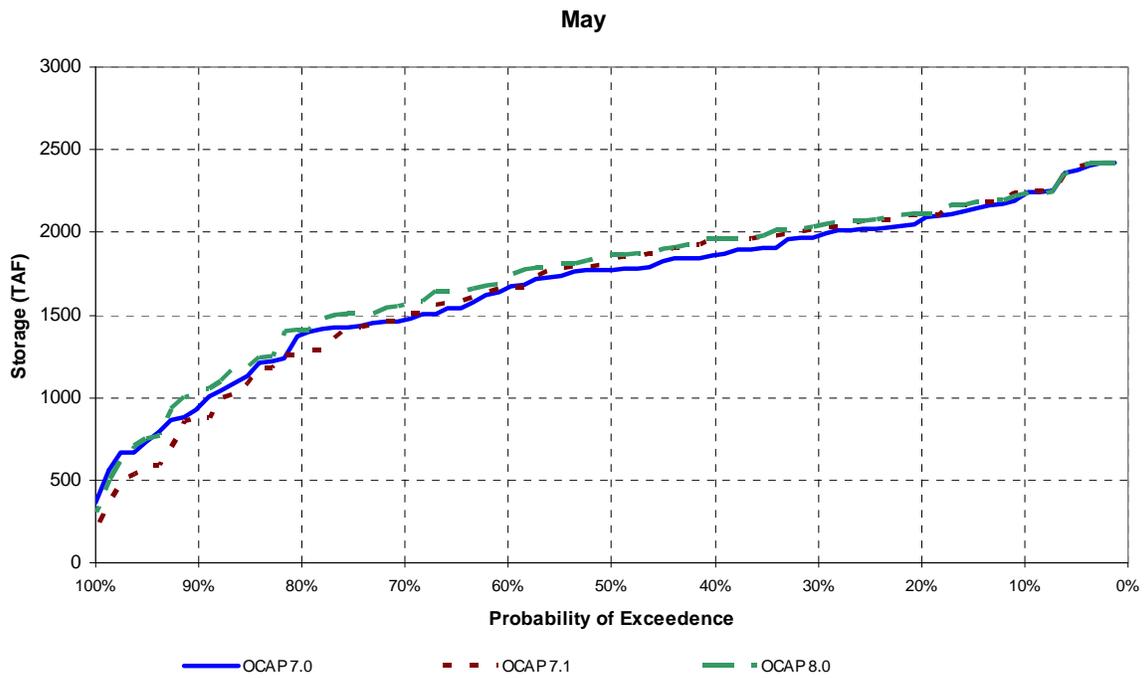


Figure 10-120 New Melones Reservoir End of May Exceedence

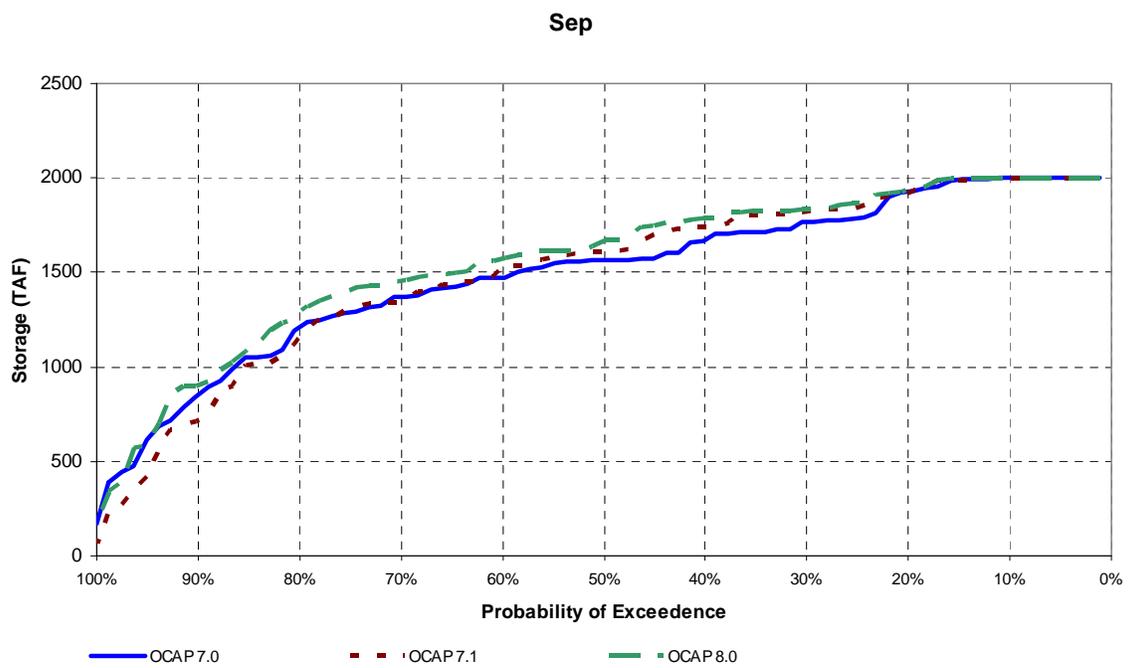


Figure 10-121 New Melones Reservoir End of September Exceedence

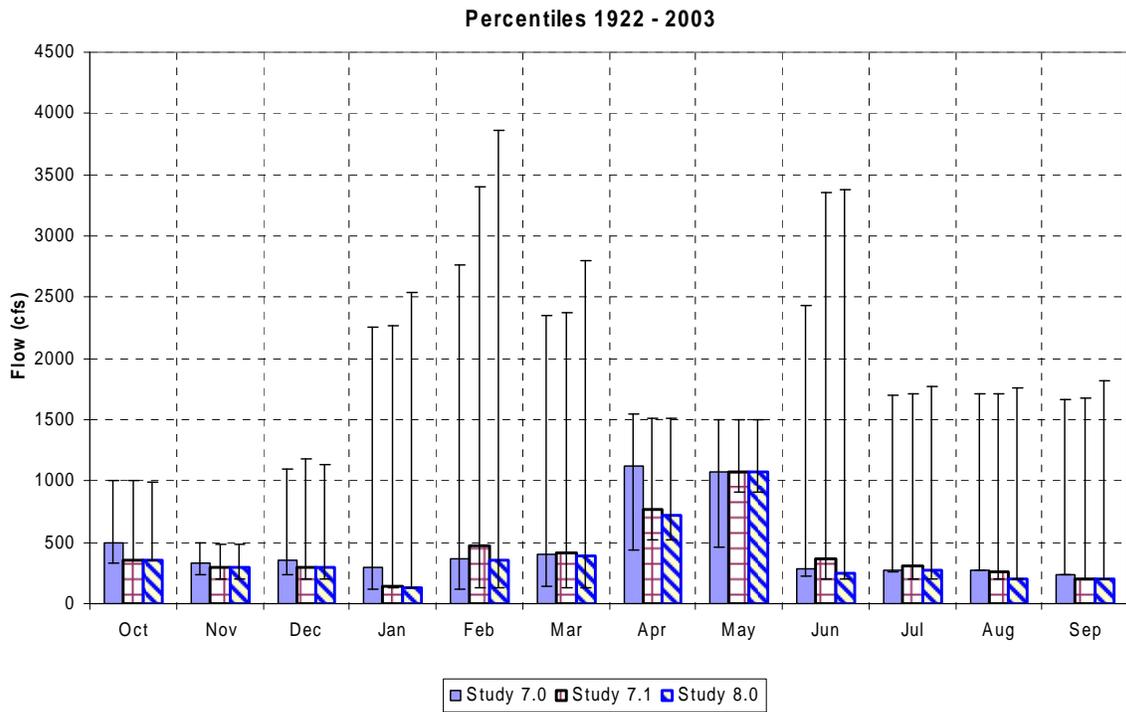


Figure 10-122 Goodwin Releases 50<sup>th</sup> Percentile Monthly Releases with the 5<sup>th</sup> and 95<sup>th</sup> as the Bars

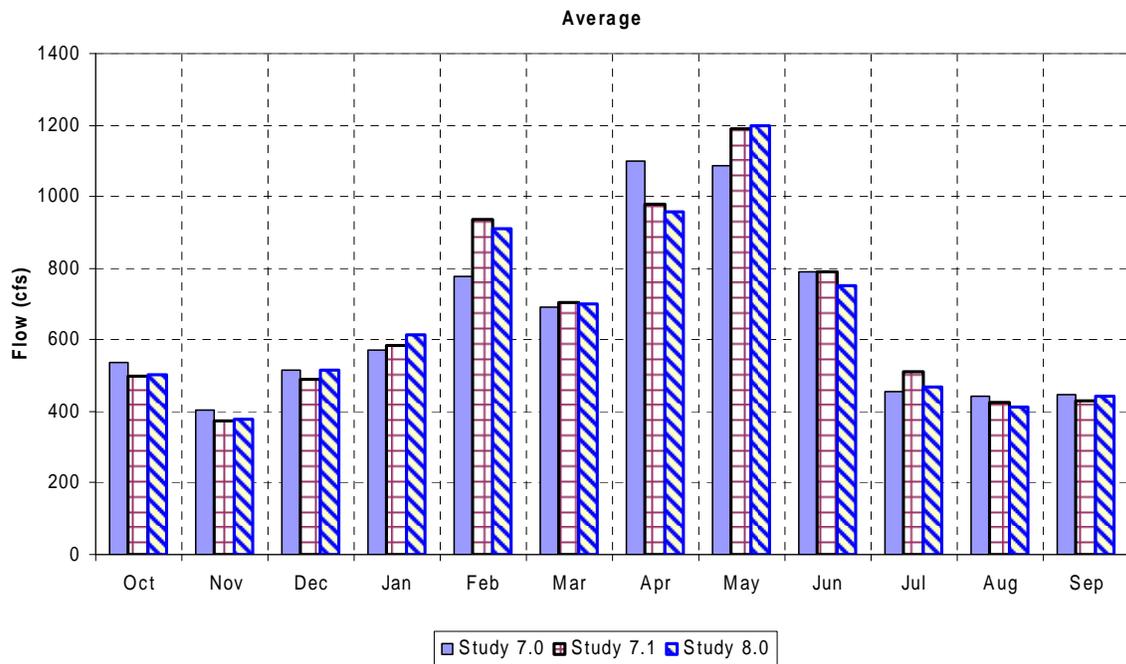


Figure 10-123 Average Monthly Goodwin Releases

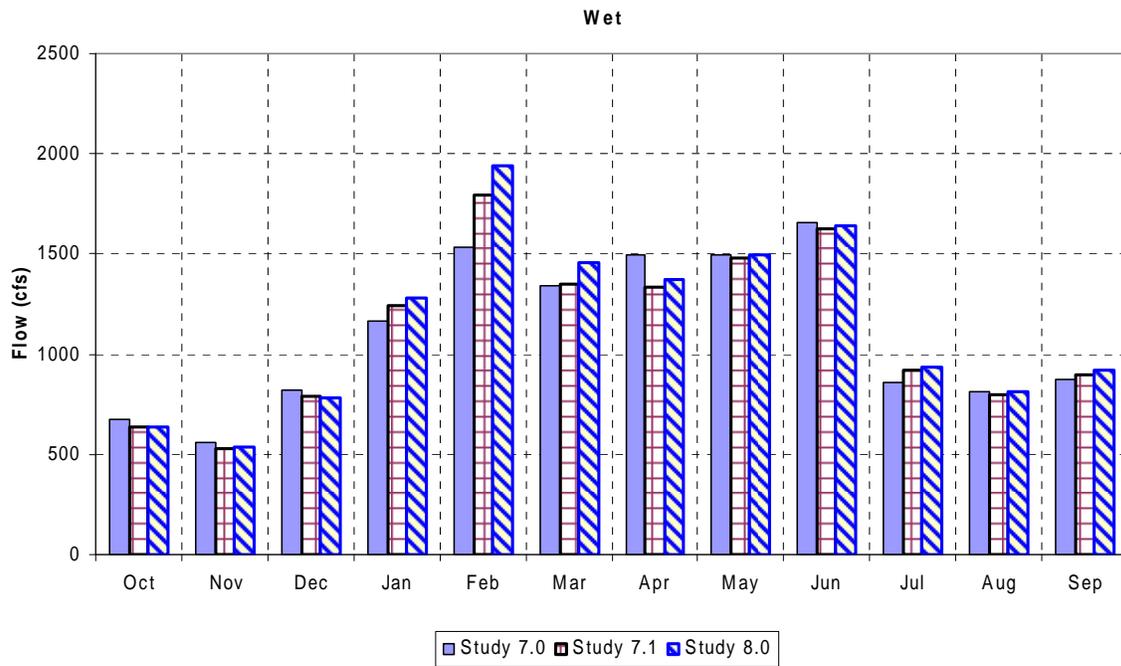


Figure 10-124 Average Wet Year (40-30-30 Classification) Monthly Goodwin Releases

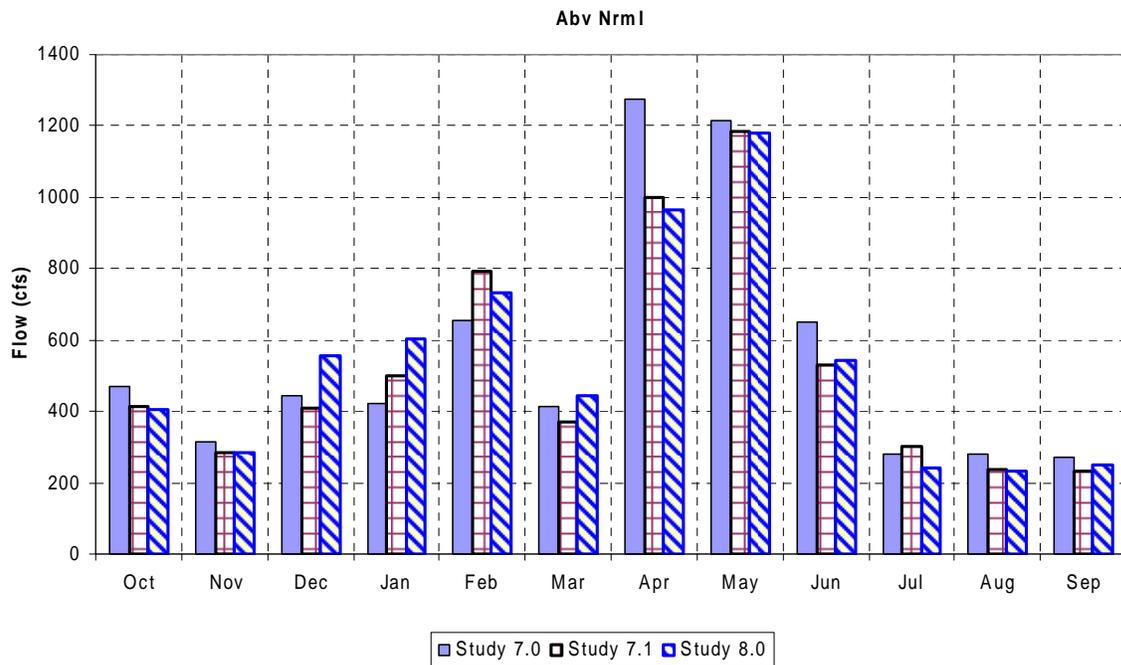


Figure 10-125 Average Above Normal Year (40-30-30 Classification) Monthly Goodwin Releases

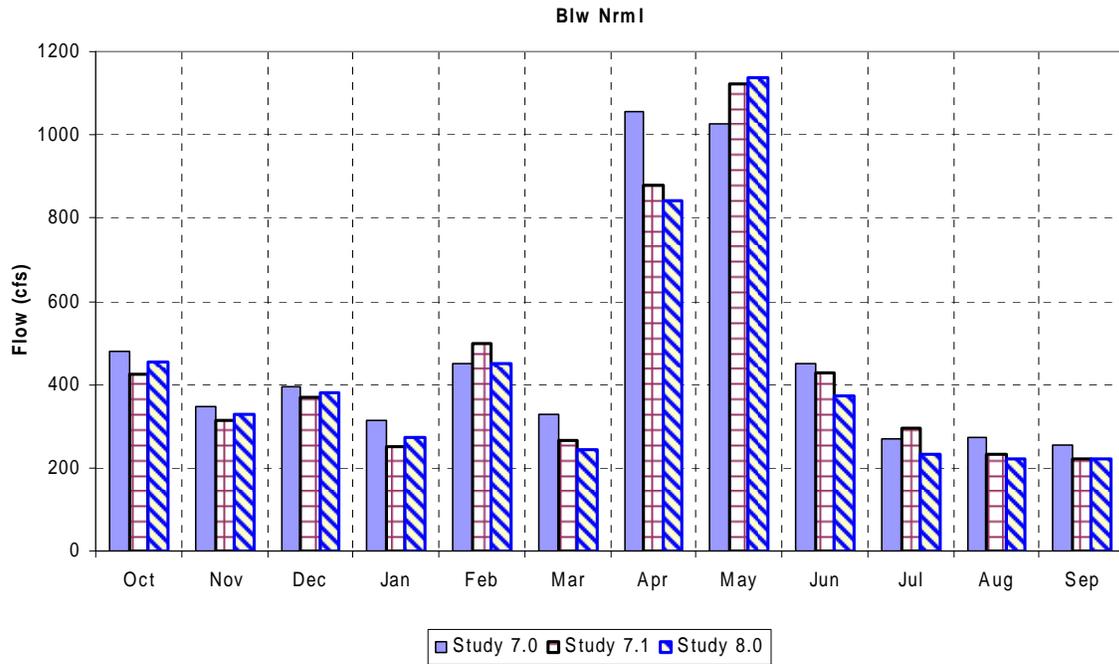


Figure 10-126 Average Below Normal Year (40-30-30 Classification) Monthly Goodwin Releases

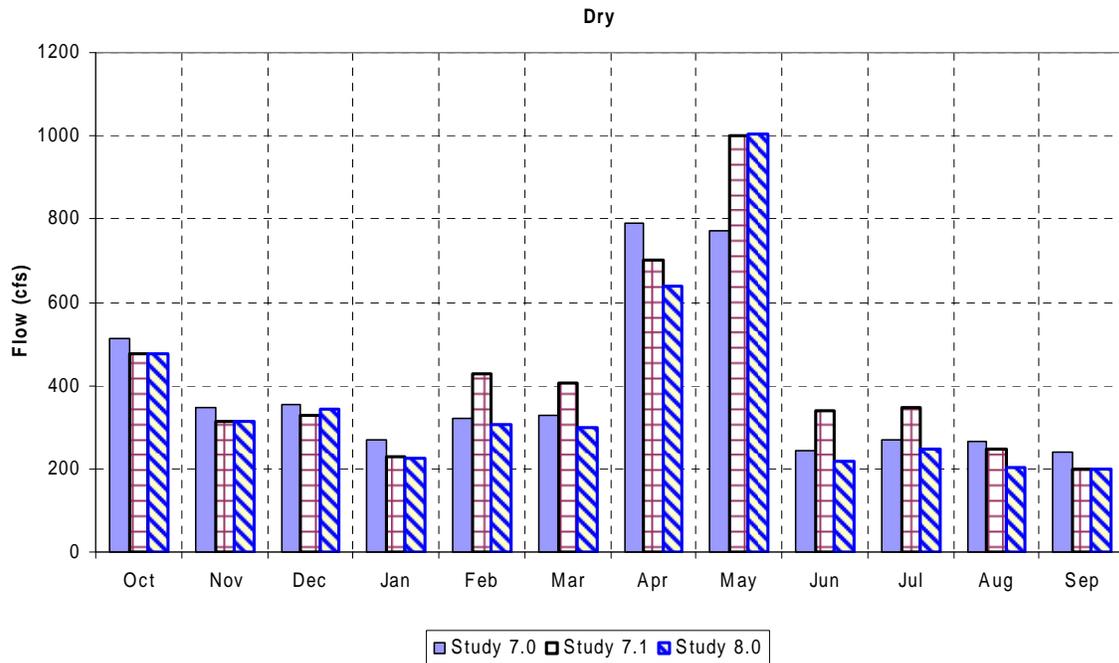
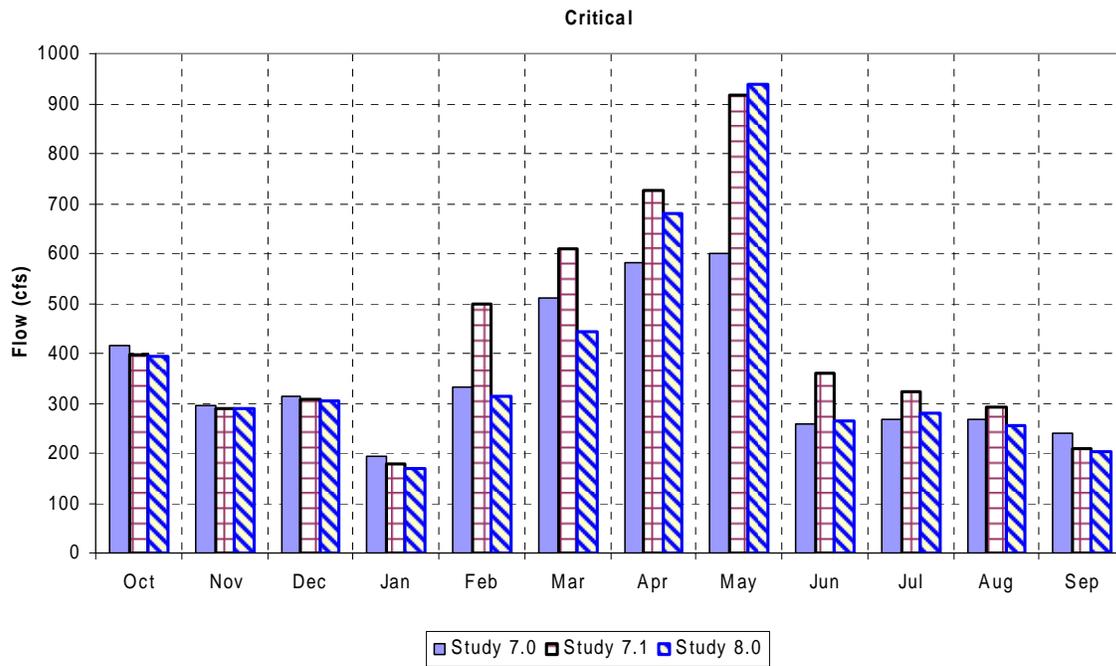


Figure 10-127 Average Dry Year (40-30-30 Classification) Monthly Goodwin Releases



**Figure 10-128 Average Critical Year (40-30-30 Classification) Monthly Goodwin Releases**

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