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Figure 7 - 28. MINIMUM ELEVATIONS AT WEST POINT FOR VARYING LEVELS OF AUGMENTATION AND NO DREDGING

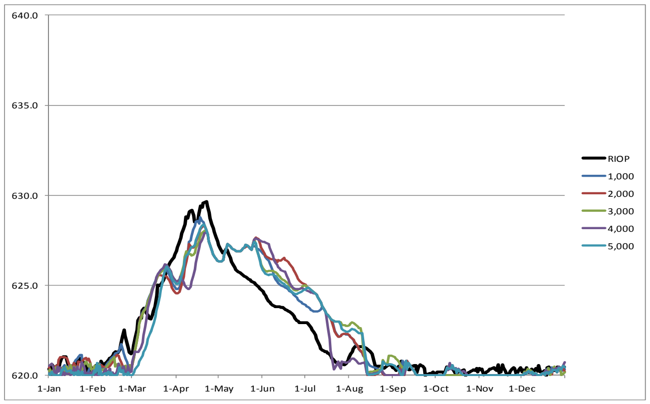

Figure 7 - 29. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT WEST POINT FOR VARYING LEVELS OF AUGMENTATION AND NO DREDGING (1970)

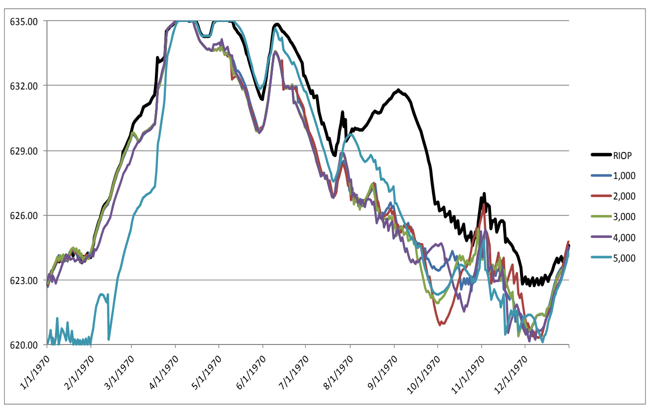

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Figure 7 - 30. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT WEST POINT FOR VARYING LEVELS OF AUGMENTATION AND NO DREDGING (1977)

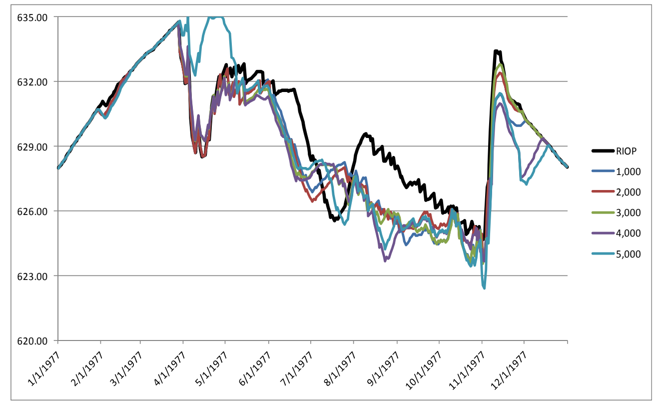

Figure 7 - 31. ANNUAL TIME SERIES OF LOW FLOW YEAR ELEVATIONS AT WEST POINT FOR VARYING LEVELS OF AUGMENTATION AND NO DREDGING (1981)

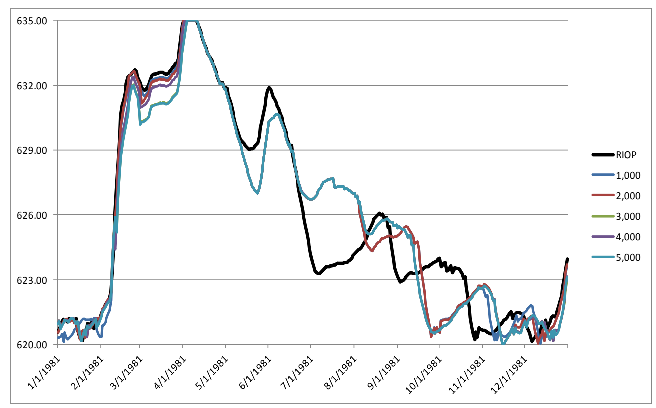

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Figure 7 - 32. ANNUAL TIME SERIES OF LOW FLOW YEAR ELEVATIONS AT WEST POINT FOR VARYING LEVELS OF AUGMENTATION AND NO DREDGING (1988)

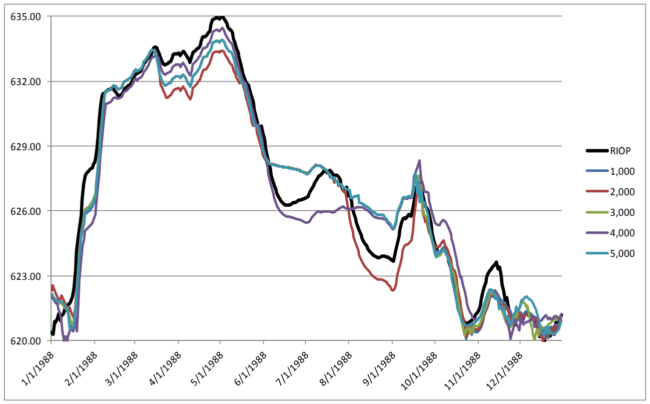

Figure 7 - 33. ANNUAL TIME SERIES OF EXTREME LOW FLOW YEAR ELEVATIONS AT WEST POINT FOR VARYING LEVELS OF AUGMENTATION AND NO DREDGING (2002)

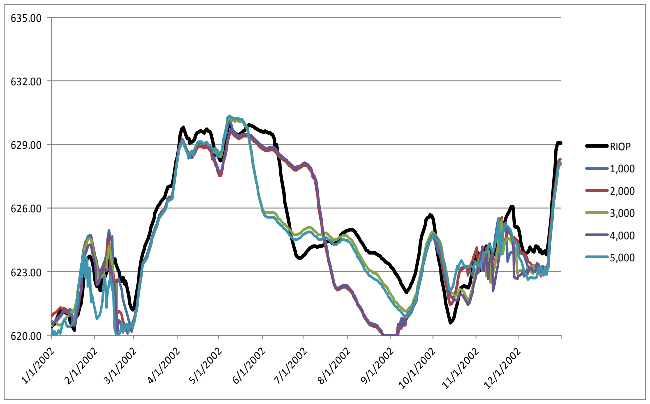

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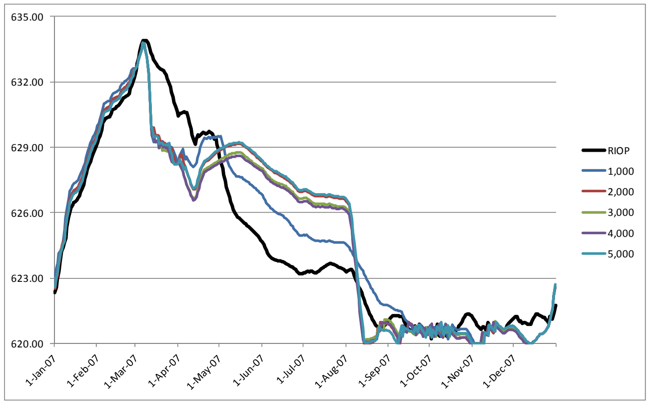
Figure 7 - 34. ANNUAL TIME SERIES OF EXTREME LOW FLOW YEAR ELEVATIONS AT WEST POINT FOR VARYING LEVELS OF AUGMENTATION AND NO DREDGING (2007)



W.F. GEORGE

Figures 7-35, 7-36, 7-37 and 7-38 show the period of record data for elevations at W.F. George and figures 7-39, 7-40, 7-41, 7-42, 7-43 and 7-44 show the annual time series data for elevations at W.F. George.

Figure 7-35 shows that at median elevations W.F. George has elevations that are identical under alternate levels of augmentation releases and under the RIOP until May, but are sensitive to augmentation levels and navigation releases for the balance of the year. Similar reactions are evident at the 75% exceeded elevation, but the differences are not as large. Differences between the RIOP elevations and elevations under alternative augmentation levels are not as pronounced for the 90% exceeded and minimum elevations. For the median elevations the average annual elevation for the RIOP was 187.8, whereas for the 1,000 cfs augmentation option the average annual elevation was 187.1 and for the 5,000 cfs augmentation option the average annual elevation was 186.7. For the 75% exceeded elevations the average annual elevation for the RIOP was 186.4, whereas for the 1,000 cfs augmentation option the average annual elevation was 186.3 and for the 5,000 cfs augmentation option the average annual elevation was 186.1. For the 90% exceeded elevations the average annual elevation for the RIOP was 185.6, whereas for the 1,000 cfs augmentation option the average annual elevation was 185.6 and for the 5,000 cfs augmentation option the average annual elevation was 185.5. For the minimum elevations the average annual elevation for the RIOP was 184.5, whereas for the 1,000 cfs augmentation option the average annual elevation was 184.6 and for the 5,000 cfs augmentation option the average annual elevation was 184.6.

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Figures 7-39 to 7-44 show that the response of George to changing augmentation limits is similar to that of West Point, the greatest variation is seen in the median flow years and smaller differences are noted in the extreme low flow years. In some years there are minimal differences while in others there are notable differences.

Figure 7 - 35. MEDIAN ELEVATIONS AT W.F. GEORGE FOR VARYING LEVELS OF AUGMENTATION AND NO DREDGING

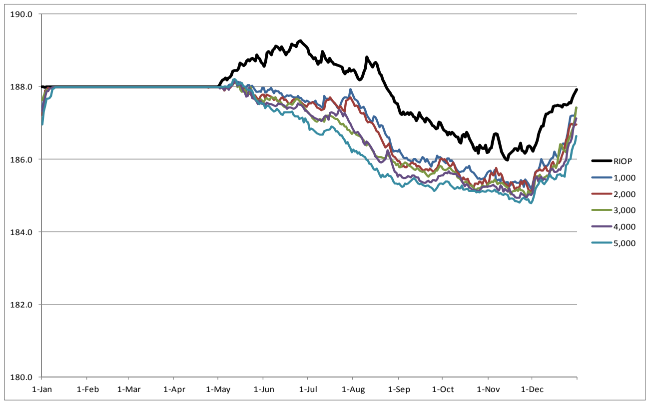

Figure 7 - 36. 75% EXCEEDED ELEVATIONS AT W.F. GEORGE FOR VARYING LEVELS OF AUGMENTATION AND NO DREDGING

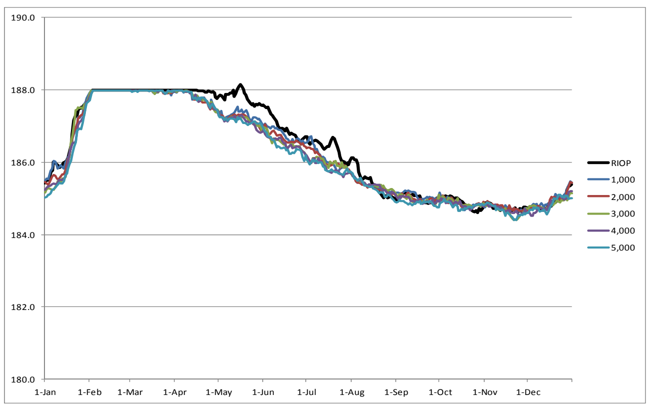

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Figure 7 - 37. 90% EXCEEDED ELEVATIONS AT W.F. GEORGE FOR VARYING LEVELS OF AUGMENTATION AND NO DREDGING

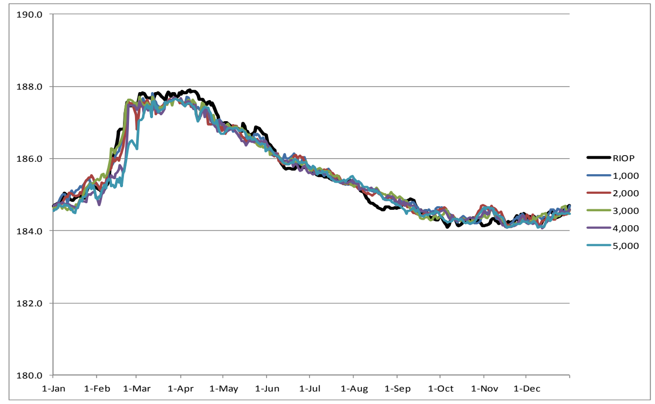

Figure 7 - 38. MINIMUM ELEVATIONS AT W.F. GEORGE FOR VARYING LEVELS OF AUGMENTATION AND NO DREDGING

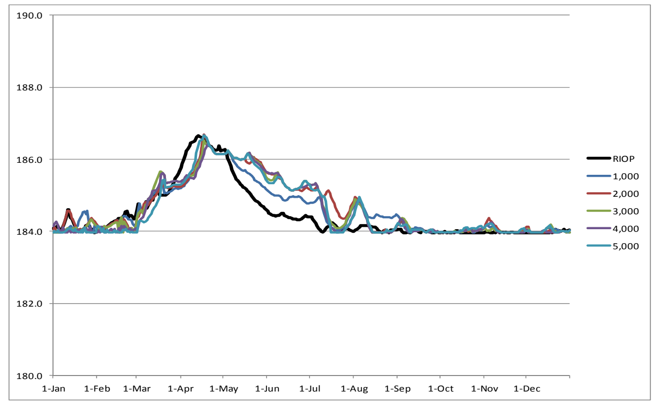

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Figure 7 - 39. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT W.F. GEORGE FOR VARYING LEVELS OF AUGMENTATION AND NO DREDGING (1970)

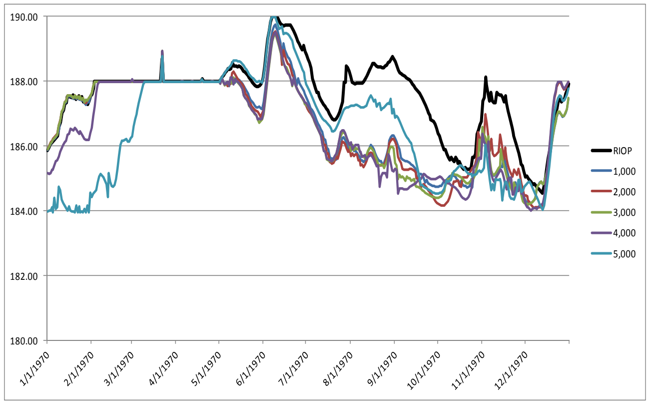

Figure 7 - 40. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT W.F. GEORGE FOR VARYING LEVELS OF AUGMENTATION AND NO DREDGING (1977)

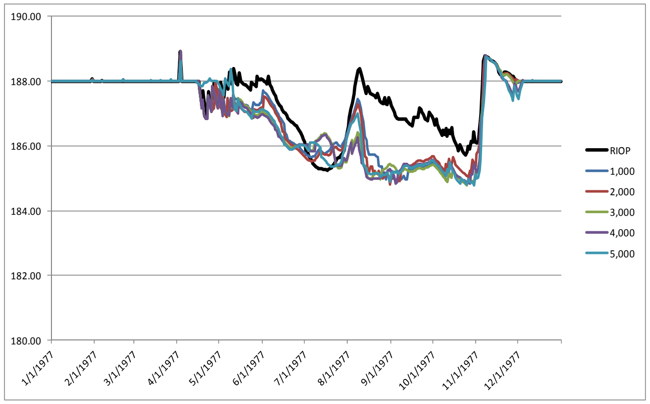

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Figure 7 - 41. ANNUAL TIME SERIES OF LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE FOR VARYING LEVELS OF AUGMENTATION AND NO DREDGING (1981)

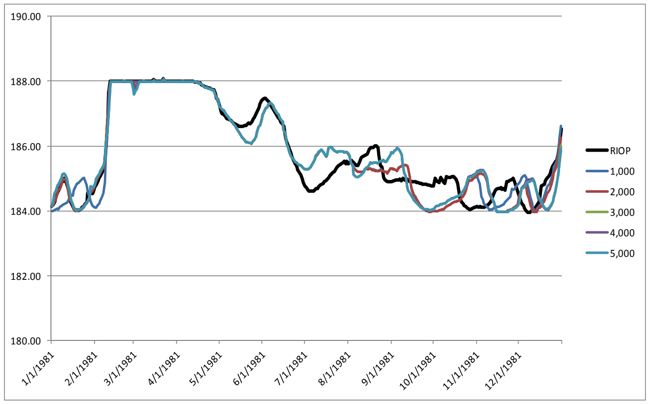

Figure 7 - 42. ANNUAL TIME SERIES OF LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE FOR VARYING LEVELS OF AUGMENTATION AND NO DREDGING (1988)

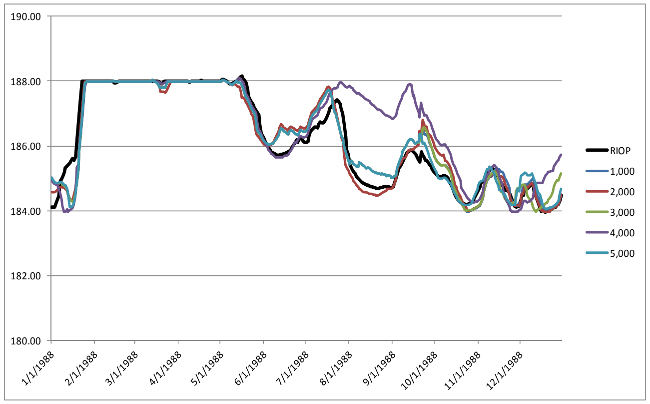

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Figure 7 - 43. ANNUAL TIME SERIES OF EXTREME LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE FOR VARYING LEVELS OF AUGMENTATION AND NO DREDGING (2002)

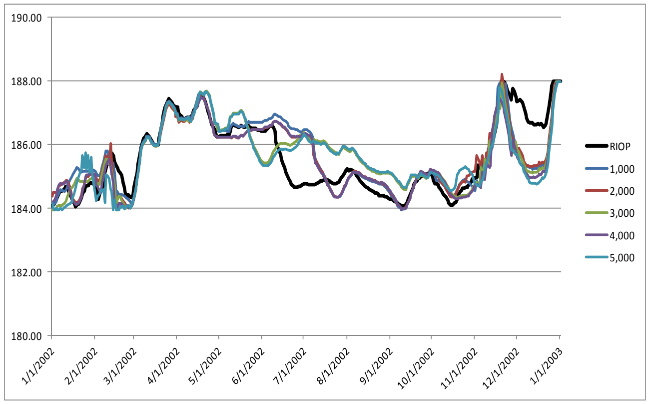
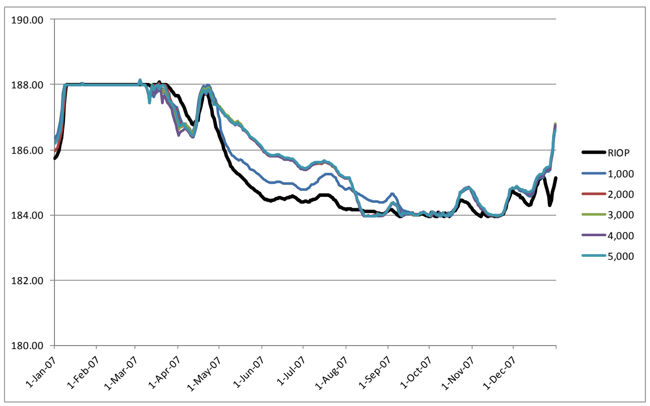


Figure 7 - 44. ANNUAL TIME SERIES OF EXTREME LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE FOR VARYING LEVELS OF AUGMENTATION AND NO DREDGING (2007)



CHATTAHOOCHEE RIVER MINIMUM FLOW PERFORMANCE MEASURES

In Chapter 6 it was noted that there were minimum flow criteria for the Chattahoochee River for Peachtree Creek, Columbus and the Farley nuclear plant (Andrews outflow). The daily minimum flow value for Peachtree Creek is 750 cfs, for Columbus 1,350 cfs (7-day average) and

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for the Farley plant 2,000 cfs. As was explained in Chapter 6, in the first series of sensitivity analyses the minimum flow requirements for the Farley plant will be considered as a "passive target", that is, the reservoirs will not be required in the model to meet the target but an evaluation of how well they met the target incidentally will be done. If there are a fair number of violations of the target, the model logic will be modified to require releases to meet the target.

Table 7-1 shows the percent of time each of these three targets were not met in the 70 year model run period. From this table it can be seen that the amount of time flow is below the minimum values for the Farley plant was far too frequently in all of the examples (over 800 times in the 70 year model run period), whereas there are some violations for Columbus and none for Peachtree Creek. The failures at Columbus were due to the fact that West Point storage was drawn down to a point that it could not augment the Columbus minimum flow requirement the targets were not hard wired as release requirements in the models. The failures to meet the Farley minimum could either be due to the fact that the targets were not hard wired as release requirements in the models or that there was inadequate water in either West Point or W.F. George to make the releases necessary to meet the target. These issues will be examined more closely in Chapter 9. It should be noted that for Columbus the number of failures to meet the minimum requirement was less than for the RIOP in all instances whereas for Andrews there were more failures than the RIOP at higher levels of augmentation.

Table 7 - 1. PERCENT OF TIME THAT FLOW IS BELOW THE MINIMUM VALUE FOR THE PERFORMANCE MEASURES FOR PEACHTREE CREEK, COLUMBUS AND FARLEY PLANT

AUGMENTATION LIMIT	PEACHTREE CREEK	COLUMBUS	ANDREWS
RIOP	0.00%	1.63%	4.08%
1000	0.00%	0.13%	3.49%
2000	0.00%	0.24%	3.51%
3000	0.00%	0.21%	3.48%
4000	0.00%	0.17%	3.63%
5000	0.00%	0.22%	3.86%
6000	0.00%	0.35%	4.14%
7000	0.00%	0.32%	4.43%

SUMMARY OF FINDINGS FOR PROVIDING THE CHANNEL WITH NO DREDGING

In this sensitivity analysis the effects of modifying the volume of augmentation released from the federal storage reservoirs to meet downstream flow needs is analyzed. The model was set up so that a 9-foot navigation channel would be provided at 21,000 cfs, an 8-foot channel at 19,000 cfs and a 7-foot channel at 17,000 cfs. The results of the analysis showed that for providing a 9-foot channel there is little difference among the various operational changes for the reservoirs from January through May, but for the rest of the year the availability of the channel is sensitive to the level of augmentation provided, with higher levels of availability provided as augmentation releases are increased. The same relationship is evident with a 7-foot channel except that the differences become evident earlier in the year. The availability of

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the 9-foot and 7-foot channel is greater when navigation releases are specifically provided for when compared with the RIOP releases where releases are incidental with the RIOP operations.

For the environmental flows the sensitivity analyses showed that there was limited variability in flows among the individual years and large variations at certain times from Apalachicola Riverkeeper's performance measure baseline. Time lags in the phasing of flows are evident in some of the figures as the level of augmentation is changed. Minimal differences are evident between the RIOP values and the values for navigation releases with augmentation. When the amount of time key floodplain inundation thresholds are exceeded is evaluated the sensitivity analyses showed that for the 15,000 cfs and 17,000 cfs thresholds for May through November the extent of inundation is sensitive to amount of augmentation release provided, with greater frequency of inundation as augmentation releases are increased. Minimal differences are evident for the 29,000 cfs threshold. For the comparison with the 15,000 cfs and 17,000 cfs thresholds the frequency of inundation is either comparable with or greater than the frequency with RIOP operations.

Median elevations at Lanier in the first half of the year are sensitive to level of augmentation provided, but these differences go away in the latter half of the year. Minimal differences are evident in the 75% exceeded elevations, but for the 90% exceeded elevations more sensitivity is evident. The 4,000 cfs and 5,000 cfs augmentation levels begin to show evidence of reaching the limits of augmentation. For the minimum elevations the same is true only to a greater extent. In all of the charts elevations at Lake Lanier are lower than they would have been under the RIOP.

Median elevations at West Point show that there are not many differences between elevations as the level of augmentation is changed before June, but after June there are major differences with the augmentation runs with several feet of difference as the level of augmentation is increased. Median elevations are either equal to or less than elevations under the RIOP. The sensitivity of West Point elevations to changes in augmentation levels is far less for the 75% exceeded and 90% exceeded elevations with the elevations in the 75% exceeded either being equal to or less than elevations under the RIOP. In September through December, elevations under the navigation release operations were greater than those under the RIOP for the 90% exceeded elevations. Minimum elevations were greater than under the RIOP for the summer months.

W.F. George has median elevations that are identical under alternate levels of augmentation releases and under the RIOP until May, but are sensitive to augmentation levels and navigation releases for the balance of the year. Similar reactions are evident at the 75% exceeded elevation, but the differences are not as large. Differences between the RIOP elevations and elevations under alternative augmentation levels are not as pronounced for the 90% exceeded and minimum elevations.

Analyses showed that the minimum flow targets for Columbus and Andrews were not met too frequently and that sensitivity analyses which met the target actively were justified.

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ANALYSES OF THE WITH DREDGING OPTION

Under this option releases of 14,000 cfs were made to provide a 9-foot channel, 12,000 cfs to provide an 8-foot channel and 10,000 cfs to provide a 7-foot channel. No changes were made to the model input data except to modify the volume of augmentation which the federal reservoirs would release to meet releases required to support the navigation channel/sustain the aquatic ecosystem. The releases made were staggered so that if a 10,000 cfs augmentation limit was placed on a composite Zone 1 release, then a 9,500 cfs limit was placed on a composite Zone 2 release and a 9,000 cfs release on a composite Zone 3 release. The same change was made as the augmentation limits were changed. From these analyses it was found that when dredging is provided and the flow needed to provide a 9-foot channel is 14,000 cfs the limit of augmentation which can be sustained by the reservoirs is 4,000 cfs.

NAVIGATION PERFORMANCE MEASURES

Figure 7-45 shows the availability of the 9-foot navigation channel with 215,000 cubic yards of dredging in the Chipola Cutoff reach (14,000 cfs release) at differing levels of augmentation limits ranging from 1,000 to 10,000 cfs and also for the RIOP. As explained earlier, in all of our analyses we have chosen to use current operations as the baseline against which to compare changes and that current operations do not included releases for either navigation or environmental flows except as provided for in the RIOP. Figure 7-46 shows the availability of a 7-foot channel. It should be noted that the level of availability of the navigation channel under RIOP operations is based on providing the channel with dredging occurring. From these two figures it can be seen that when the navigation target is set at 14,000 cfs for a 9-foot channel that changing the level of augmentation makes a major difference in the availability of the navigation when dredging is being done. For the availability of a 9-foot channel the level of augmentation allowed can make up to a 15% difference in the amount of time the channel is available in some months. For a 7-foot channel the difference is minimal. The operations used show significant improvement in the availability of the 9-foot navigation channel over the RIOP and no improvements over the availability of the 7-foot channel. Figure 7-45 shows that the greater the amount of augmentation release, the greater the availability of the 9-foot channel. The average annual availability of the 9-foot channel ranges from nearly 63% with 1,000 cfs augmentation to 68.7% with 4,000 cfs augmentation compared with 58.2% for the RIOP. The average annual availability of the 7-foot channel ranges from 82.5% with 1,000 cfs augmentation to 83.3% with 4,000 cfs augmentation compared with 82.4% with the RIOP. This result occurs because the flows needed to provide the navigation channel would be provided naturally by local inflow much more regularly in the first half of the year and that augmentation would be needed to provide the channel more frequently in the latter six months of the year.

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Figure 7 - 45. AVAILABILITY OF A NINE-FOOT CHANNEL WITH VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS

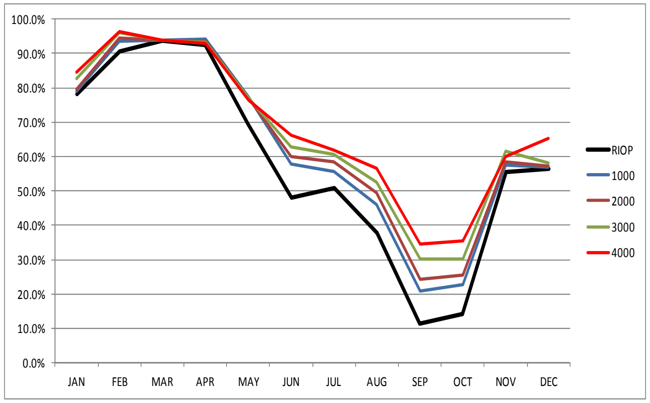
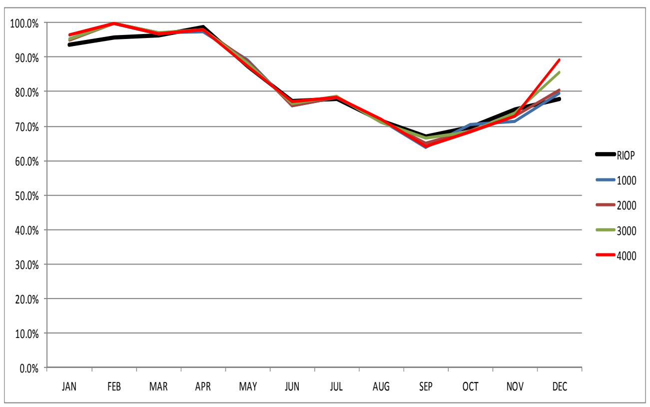


Figure 7 - 46. AVAILABILITY OF A SEVEN-FOOT CHANNEL WITH VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS



ENVIRONMENTAL PERFORMANCE MEASURES

Chapter 4 discusses the basis of the environmental performance measures. In chapter 4 it was concluded that two separate measures of environmental performance measures will be used: one which is flow based and another which considers the extent of inundation of the

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Apalachicola River floodplain. In this section the flow based performance measures will be considered first and then the floodplain inundation performance measure will be evaluated. Figures 7-47, 7-48 and 7-49 show the comparisons of median, 75% exceeded flows and 90% exceeded flows for model runs relative to the RIOP for the entire model run period (1939 – 2008) and figures 7-50, 7-51, 7-52, 7-53, 7-54 and 7-55 show the same data for individual years chosen to represent normal flows, low flows and extreme low flows.

Figure 7-47 shows that there are limited differences in the availability of median flow among the augmentation options and between the augmentation operations and the RIOP in the period of record figures at the scale used. Figures 7-48 and 7-49 show greater differences in the 75% exceeded and 90% exceeded flows. All releases showed differences from the AR performance measure.

Figures 7-50, 7-51, 7-52, 7-53, 7-54 and 7-55 show some differences in flow in some of the individual years. Many of the differences are phase changes in the timing of when certain flow events occur as the level of the augmentation limit changes. At certain times there are significant deviations from Apalachicola Riverkeeper's performance measure baseline. Minimal differences are evident between the RIOP values and the values for navigation releases with augmentation.

Figure 7 - 47. MEDIAN FLOWS FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS FOR THE PERIOD OF RECORD (1939 – 2008)

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Figure 7 - 48. 75% EXCEEDED FLOWS FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS FOR THE PERIOD OF RECORD (1939 – 2008)

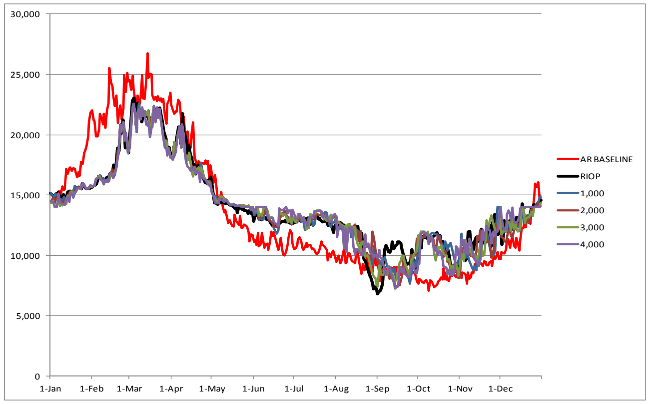

Figure 7 - 49. 90% EXCEEDED FLOWS FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS FOR THE PERIOD OF RECORD (1939 – 2008)

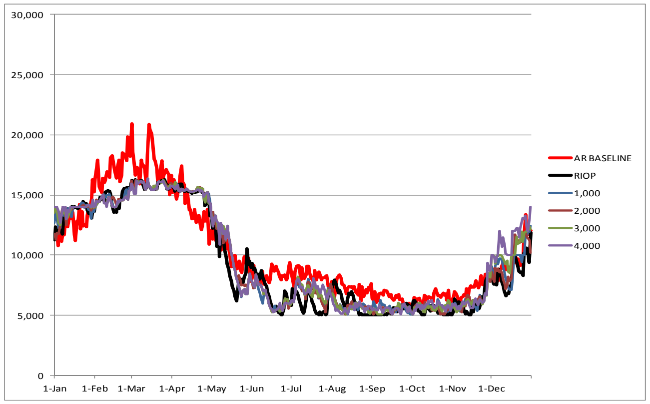

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Figure 7 - 50. ANNUAL TIME SERIES FOR NORMAL FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (1970)

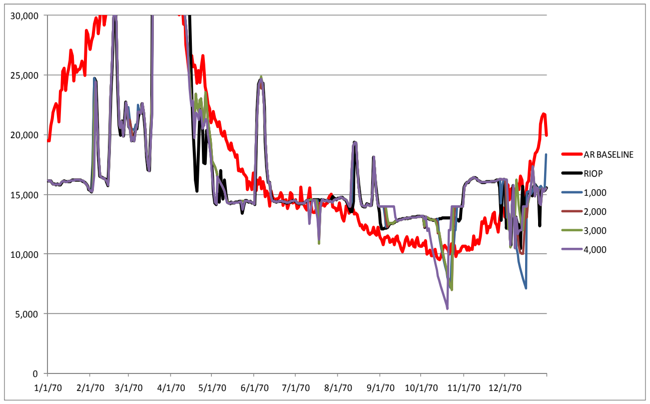

Figure 7 - 51. ANNUAL TIME SERIES FOR NORMAL FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (1977)

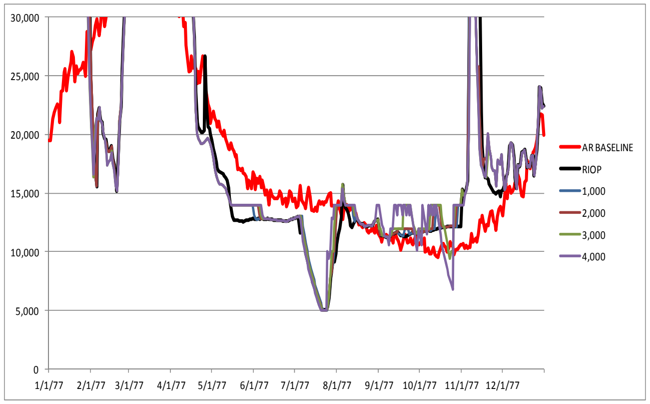

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Figure 7 - 52. ANNUAL TIME SERIES FOR LOW FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (1981)

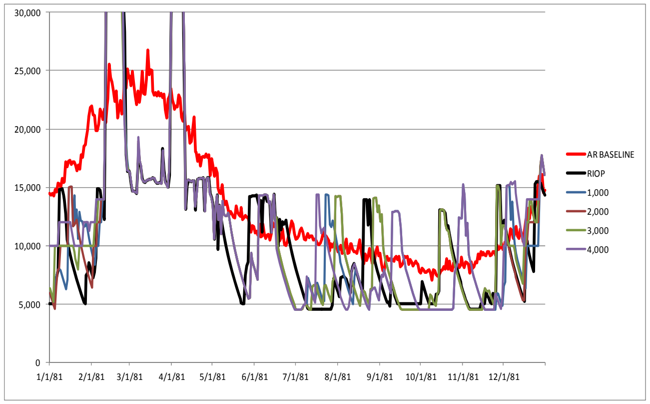

Figure 7 - 53. ANNUAL TIME SERIES FOR LOW FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (1988)

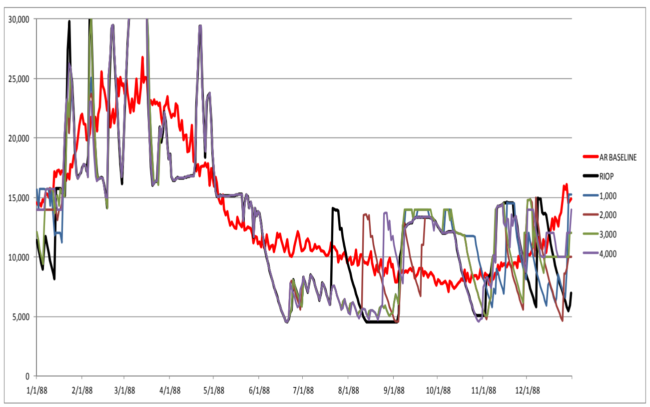

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Figure 7 - 54. ANNUAL TIME SERIES FOR EXTREME LOW FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (2002)

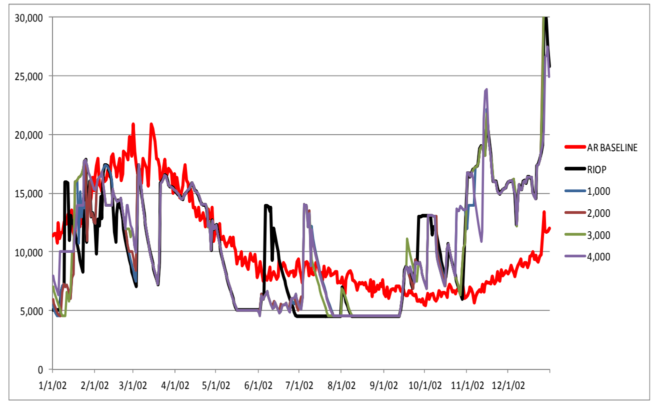
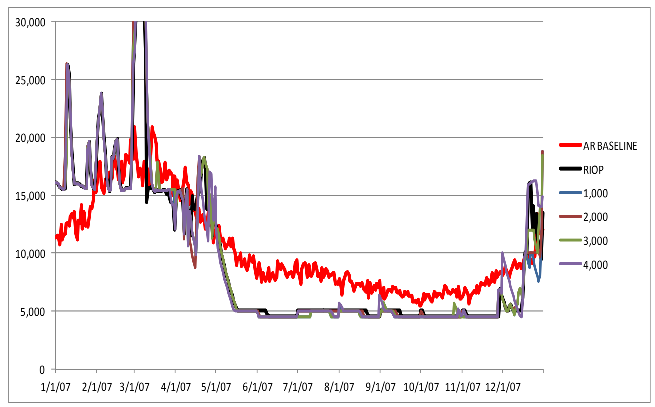


Figure 7 - 55. ANNUAL TIME SERIES FOR EXTREME LOW FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (2007)



The other performance measure defined in Chapter 4 was the extent of flooding the Apalachicola River floodplain and this was defined by the amount of time that flow exceeded three flow thresholds which were keyed to floodplain inundation based on data from Light and others work. Figure 7-56 shows the amount of time 15,000 cfs was exceeded in the model

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output, figure 7-57 the amount of time 17,000 cfs was exceeded, and figure 7-58 the amount of time 29,000 cfs was exceeded.

From these three figures it can be seen that including navigation operations has a minimal effect on the extent of flooding for all three thresholds. Figures 7-56, 7-57 and 7-58 show that when the navigation release is 14,000 cfs providing navigation releases has a very limited effect on the amount of time flows exceed the threshold levels. In all three charts the percent of time the flow thresholds are exceeded are the same as with the RIOP. The reason for these limited changes is that the flow needed to provide a 9-foot and 7-foot channel which defines reservoir release rules is less than the floodplain inundation thresholds used.

Figure 7 - 56. PERCENT OF TIME 15,000 CFS WAS EXCEEDED FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS

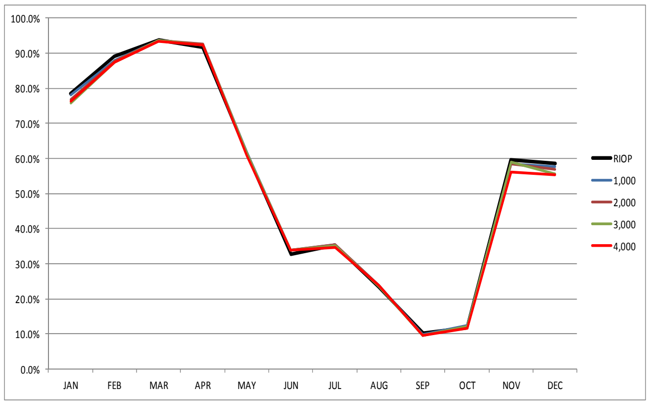

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Figure 7 - 57. PERCENT OF TIME 17,000 CFS WAS EXCEEDED FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS

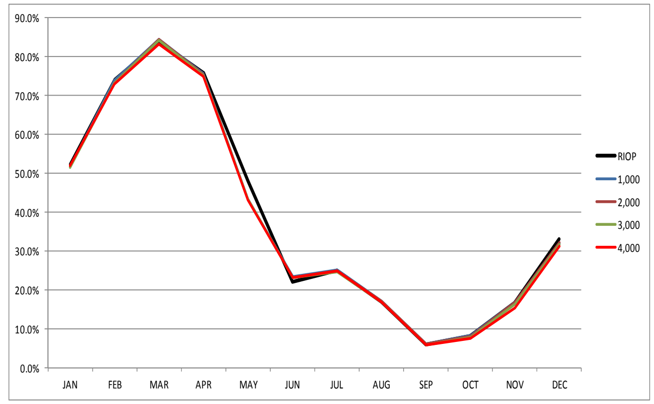
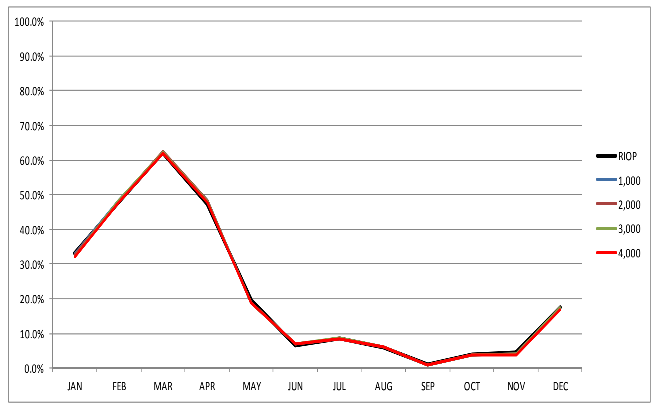


Figure 7 - 58. PERCENT OF TIME 29,000 CFS WAS EXCEEDED FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS



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RESERVOIR ELEVATION PERFORMANCE MEASURES

LAKE LANIER

Figures 7-59, 7-60, 7-61 and 7-62 show the elevations at Lake Lanier for the period of record and figures 7-63, 7-64, 7-65, 7-66, 7-67 and 7-68 show annual time series charts comparing the elevations at Lake Lanier for various levels of augmentation. Figure 7-59 shows that at median elevations, the elevation at Lake Lanier was sensitive to changes to the level of augmentation and that they were lower than elevations under the RIOP over the entire year. Figure 7-60 shows that at the 75% exceeded elevation the elevations at Lanier were lower and sensitive to changes from January to August and then comparable after that. Figure 7-61 shows that elevations were lowered for all options for most of the year at the 90% exceeded elevations and much lower for the 4,000 cfs augmentation option. Figure 7-62 documents the 4,000 cfs augmentation option minimum elevations at Lanier tend to be drawn down significantly. For all options the minimum elevation at Lake Lanier is lower than under the RIOP operations. For median elevations the average annual elevation under the RIOP was 1064.2, with 1,000 cfs augmentation 1063.88 and with 4,000 cfs augmentation 1062.9. For the 75% exceeded elevations the average annual elevation under the RIOP was 1060.35, with 1,000 cfs augmentation 1060.14 and with 4,000 cfs augmentation 1059.1. For the 90% exceeded elevations the average annual elevation under the RIOP was 1058.6, with 1,000 cfs augmentation 1058.00 and with 4,000 cfs augmentation 1055.3. For minimum elevations the average annual elevation under the RIOP was 1054.5, with 1,000 cfs augmentation 1053.5 and with 4,000 cfs augmentation 1044.9. Figures 7-63 to 7-68 show in the lower flow years there is some variation in differences in the elevation at Lake Lanier and that for the 3,000 cfs and 4,000 cfs options the elevations at Lanier are drawn down more.

Figure 7 - 59. MEDIAN ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS

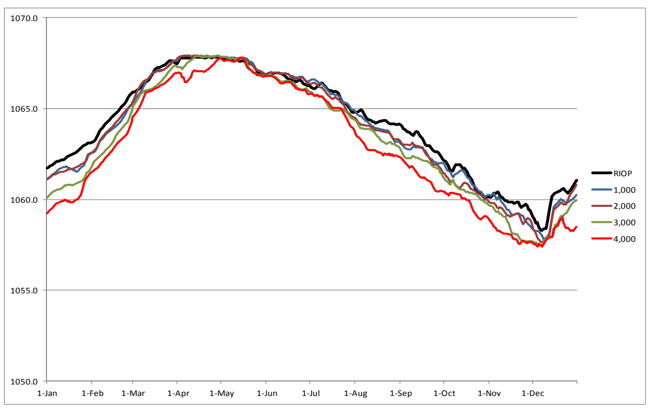

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Figure 7 - 60. 75% EXCEEDED ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS

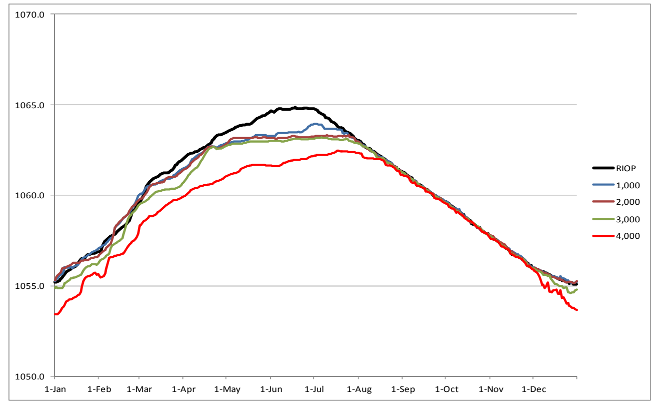

Figure 7 - 61. 90% EXCEEDED ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS

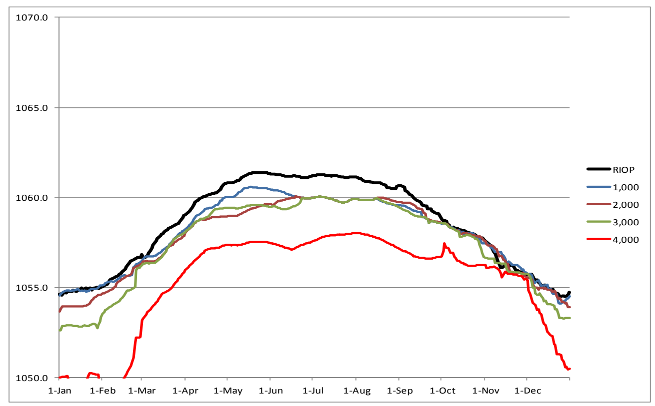

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Figure 7 - 62. MINIMUM ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS

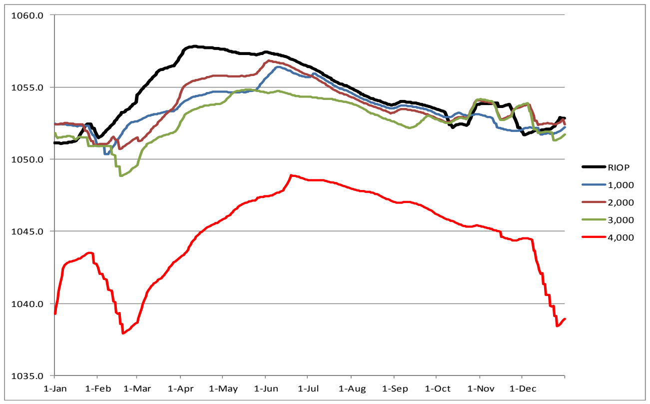

Figure 7 - 63. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (1970)

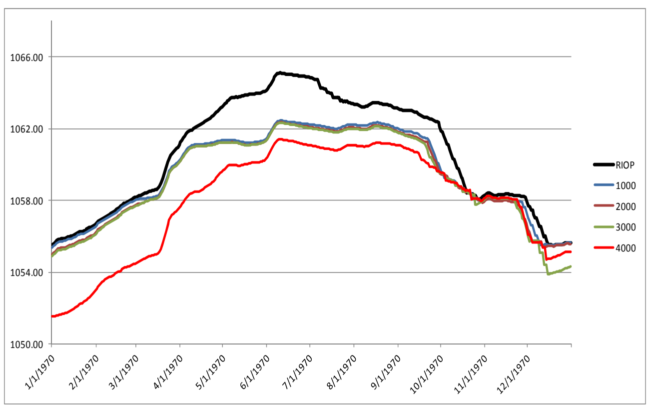

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Figure 7 - 64. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (1977)

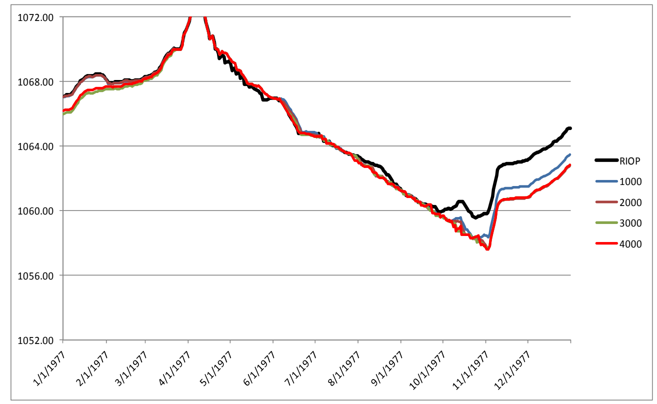

Figure 7 - 65. ANNUAL TIME SERIES OF LOW FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (1981)

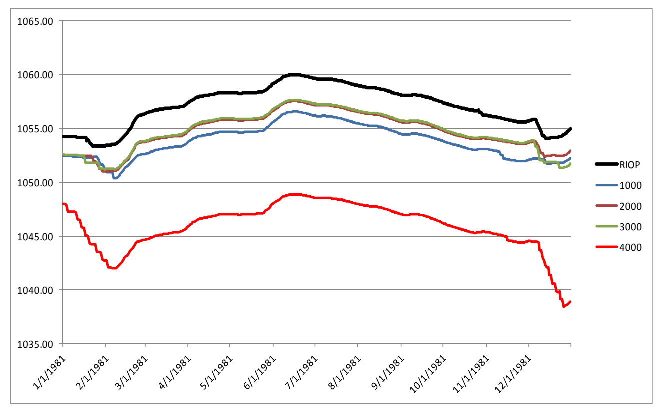

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Figure 7 - 66. ANNUAL TIME SERIES OF LOW FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (1988)

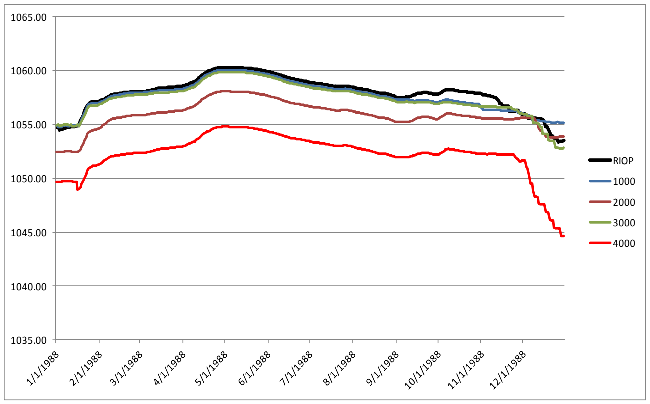

Figure 7 - 67. ANNUAL TIME SERIES OF EXTREME LOW FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (2002)

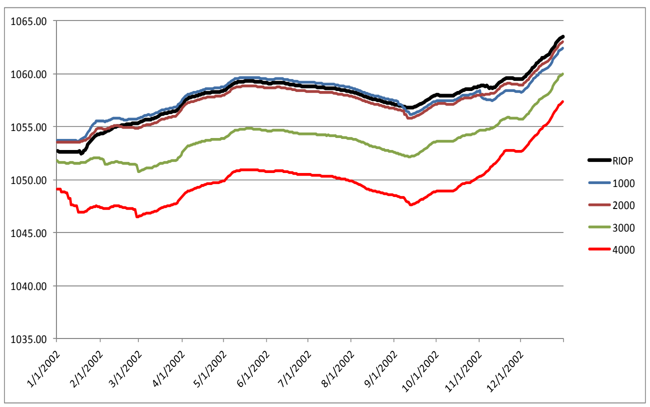

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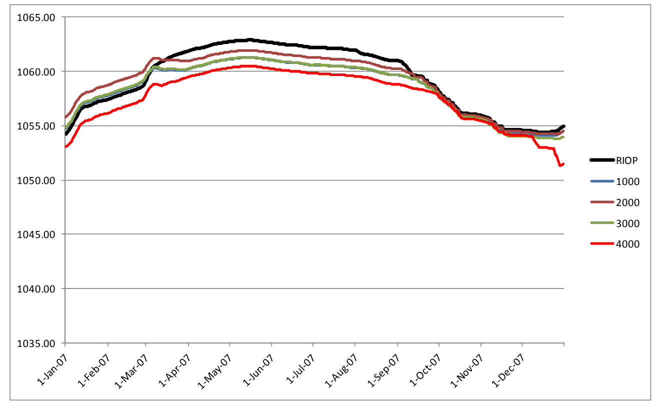
Figure 7 - 68. ANNUAL TIME SERIES OF EXTREME LOW FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (2007)



WEST POINT

Figures 7-69, 7-70, 7-71 and 7-72 show the period of record data for West Point elevations and Figures 7-73, 7-74, 7-75, 7-76, 7-77 and 7-78 show the annual time series data for selected years for elevations at West Point reservoir.

Figures 7-69 to 7-72 show limited sensitivity of the elevations at West Point to the changes in the level of augmentation. At median elevations the levels are below the RIOP, but at the 75% exceeded, 90% exceeded and minimum elevations the resultant elevations are both above and below the RIOP elevations. For median elevations the average annual elevation under the RIOP was 630.29, with 1,000 cfs augmentation 630.21 and with 4,000 cfs augmentation 629.89. For the 75% exceeded elevations the average annual elevation under the RIOP was 627.4, with 1,000 cfs augmentation 627.34 and with 4,000 cfs augmentation 627.14. For the 90% exceeded elevations the average annual elevation under the RIOP was 625.18, with 1,000 cfs augmentation 624.97 and with 4,000 cfs augmentation 624.87. For minimum elevations the average annual elevation under the RIOP was 622.30, with 1,000 cfs augmentation 622.04 and with 4,000 cfs augmentation 622.05.

Figures 7-73 to 7-78 show more variation in the individual years than was evident in the period of record figures, but the differences are not major.

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Figure 7 - 69. MEDIAN ELEVATIONS AT WEST POINT FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS

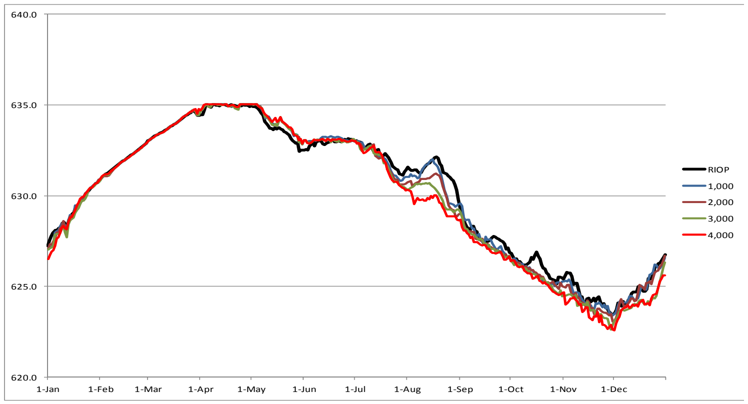

Figure 7 - 70. 75% EXCEEDED ELEVATIONS AT WEST POINT FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS

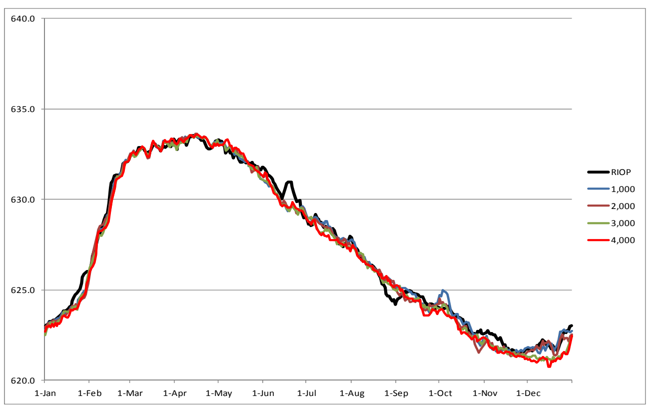

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Figure 7 - 71. 90% EXCEEDED ELEVATIONS AT WEST POINT FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS

Figure 7 - 72. MINIMUM ELEVATIONS AT WEST POINT FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS

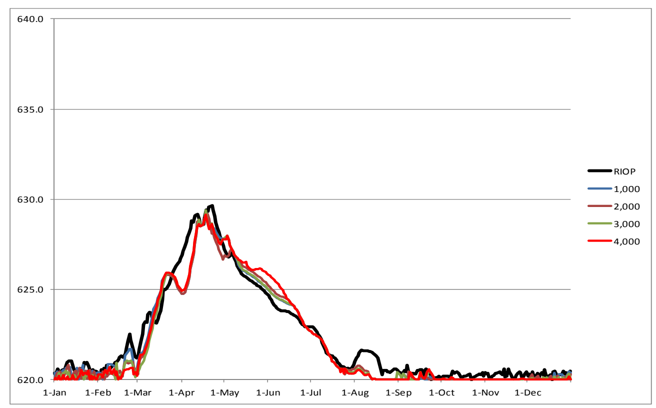

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Figure 7 - 73. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT WEST POINT FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (1970)

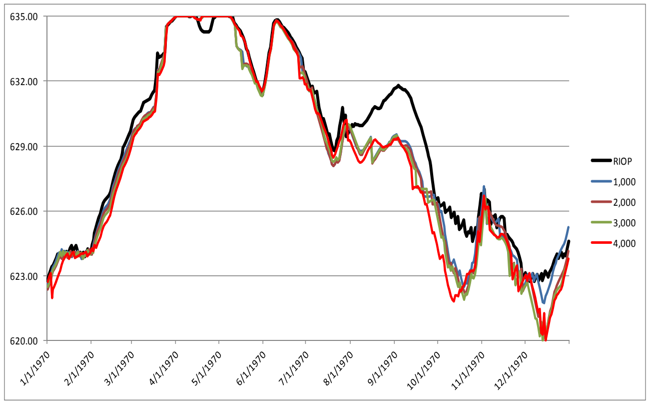

Figure 7 - 74. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT WEST POINT FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (1977)

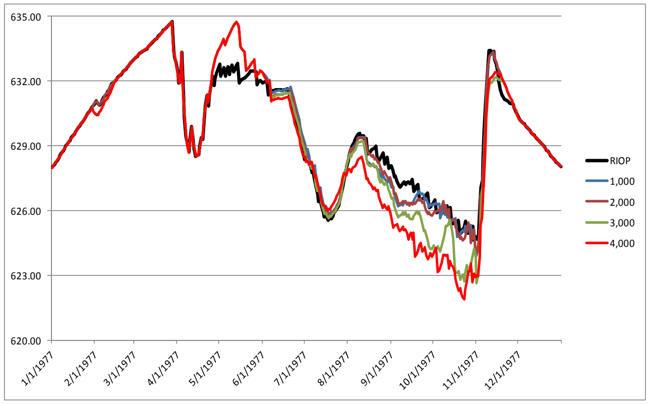

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Figure 7 - 75. ANNUAL TIME SERIES OF LOW FLOW YEAR ELEVATIONS AT WEST POINT FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (1981)

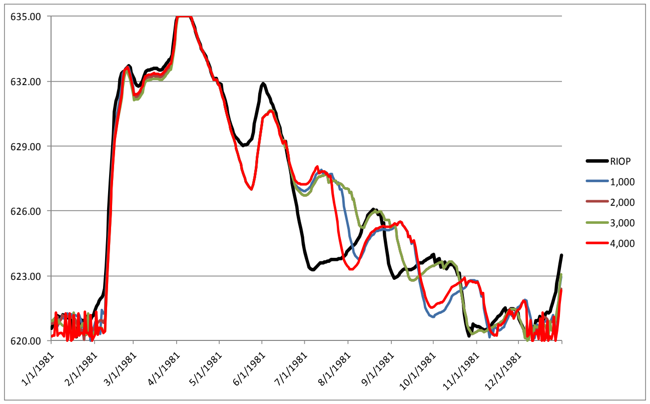

Figure 7 - 76. ANNUAL TIME SERIES OF LOW FLOW YEAR ELEVATIONS AT WEST POINT FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (1988)

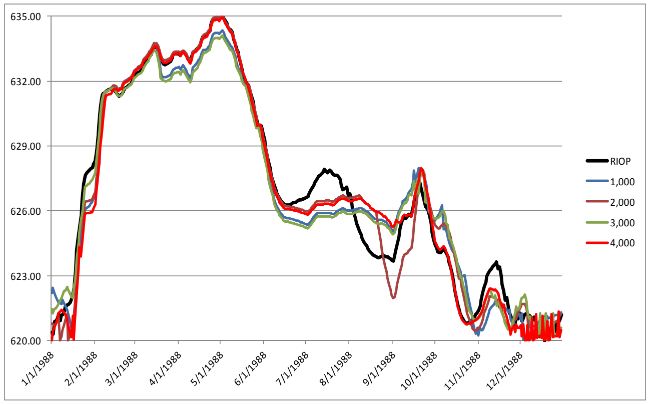

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Figure 7 - 77. ANNUAL TIME SERIES OF EXTREME LOW FLOW YEAR ELEVATIONS AT WEST POINT FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (2002)

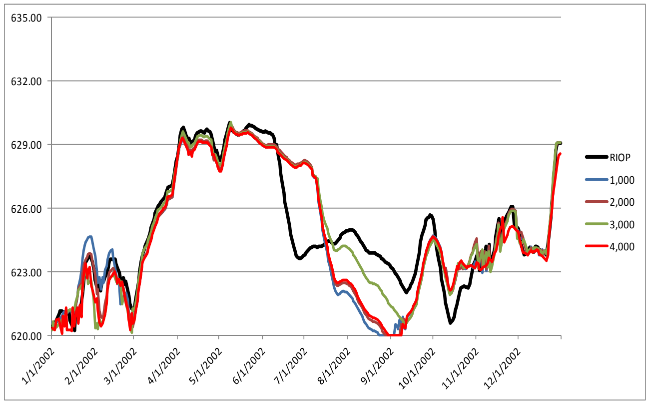
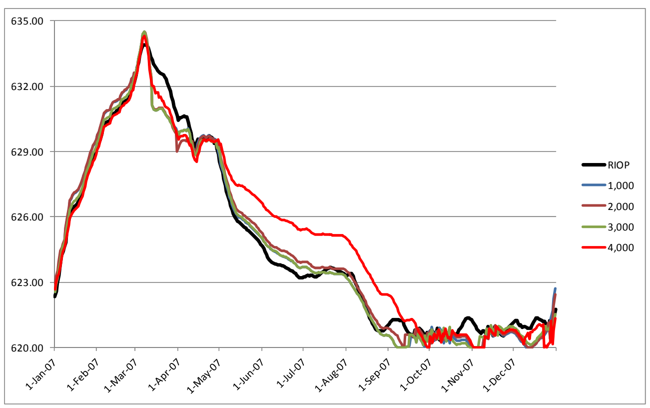


Figure 7 - 78. ANNUAL TIME SERIES OF EXTREME LOW FLOW YEAR ELEVATIONS AT WEST POINT FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (2007)



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W.F. GEORGE

Figures 7-79, 7-80, 7-81 and 7-82 show the period of record data for elevations at W.F. George and figures 7-83, 7-84, 7-85, 7-86, 7-87 and 7-88 show the annual time series data for elevations at W.F. George.

Figures 7-79 to 7-82 show limited variations in elevations at W.F. George for the median, 75% exceeded, 90% exceeded and minimum elevations as the maximum augmentation limits are changed. For the median elevations the average annual elevation for the RIOP was 187.8, whereas for the 1,000 cfs augmentation option the average annual elevation was 187.78 and for the 4,000 cfs augmentation option the average annual elevation was 186.62. For the 75% exceeded elevations the average annual elevation for the RIOP was 186.37, whereas for the 1,000 cfs augmentation option the average annual elevation was 186.47 and for the 4,000 cfs augmentation option the average annual elevation was 186.38. For the 90% exceeded elevations the average annual elevation for the RIOP was 185.59, whereas for the 1,000 cfs augmentation option the average annual elevation was 185.67 and for the 4,000 cfs augmentation option the average annual elevation was 185.61. For the minimum elevations the average annual elevation for the RIOP was 184.46, whereas for the 1,000 cfs augmentation option the average annual elevation was 184.52 and for the 4,000 cfs augmentation option the average annual elevation was 184.53.

Figures 7-83 to 7-88 showed more variation as the augmentation limits are changed in the individual years time series figures than was evident in the period of record figures, but the differences are not major.

Figure 7 - 79. MEDIAN ELEVATIONS AT W.F. GEORGE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS

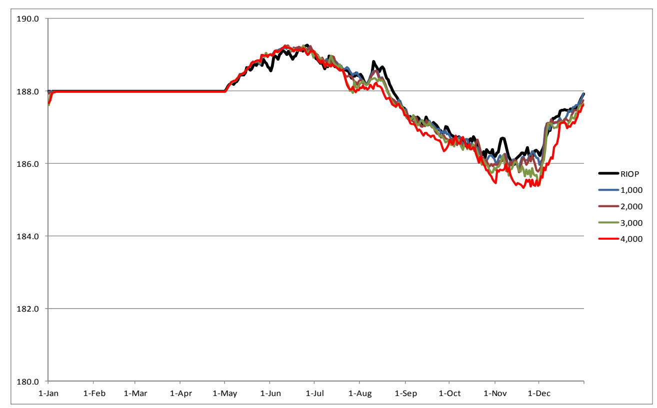

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Figure 7 - 80. 75% EXCEEDED ELEVATIONS AT W.F. GEORGE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS

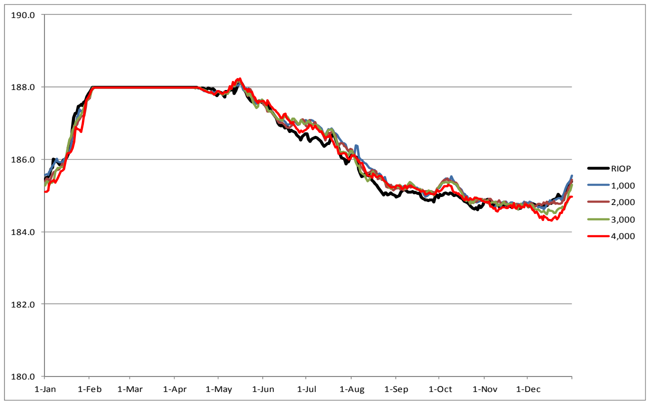

Figure 7 - 81. 90% EXCEEDED ELEVATIONS AT W.F. GEORGE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS

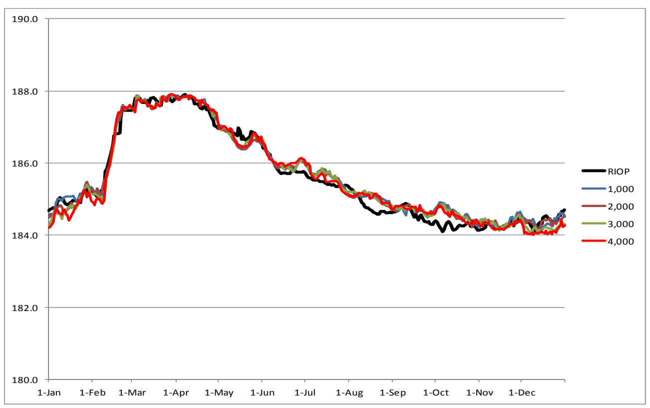

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Figure 7 - 82. MINIMUM ELEVATIONS AT W.F. GEORGE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS

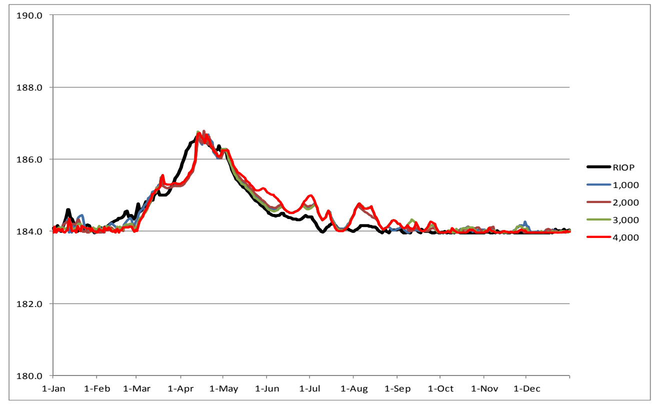

Figure 7 - 83. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT W.F. GEORGE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (1970)

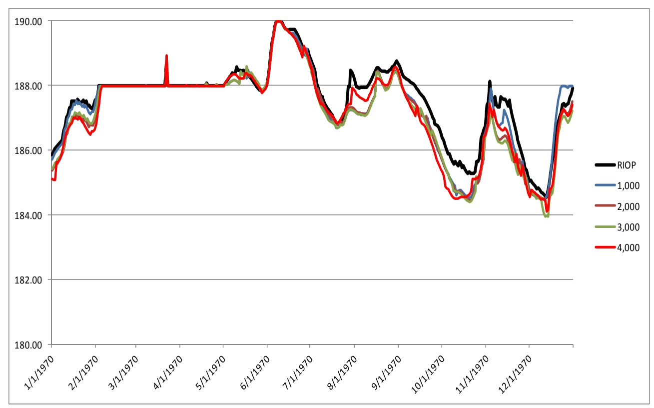

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Figure 7 - 84. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT W.F. GEORGE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (1977)

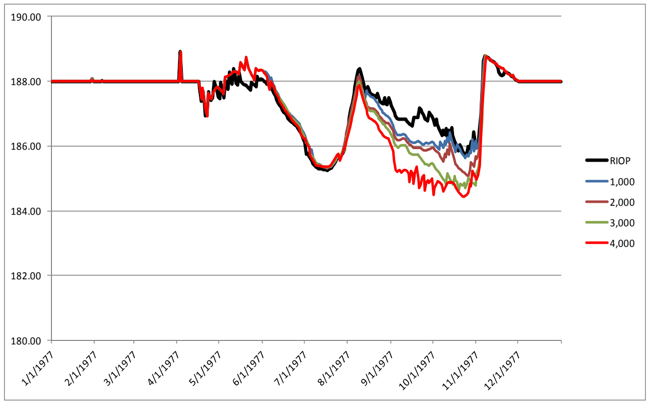

Figure 7 - 85. ANNUAL TIME SERIES OF LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (1981)

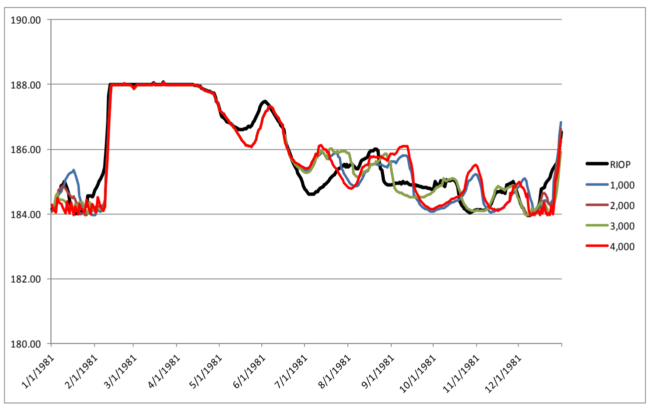

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Figure 7 - 86. ANNUAL TIME SERIES OF LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (1988)

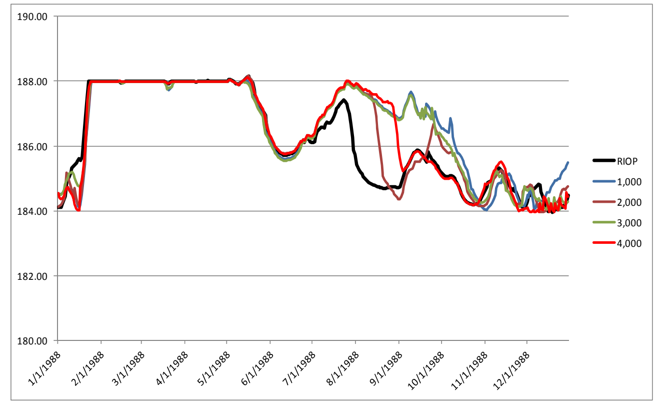

Figure 7 - 87. ANNUAL TIME SERIES OF EXTREME LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (2002)

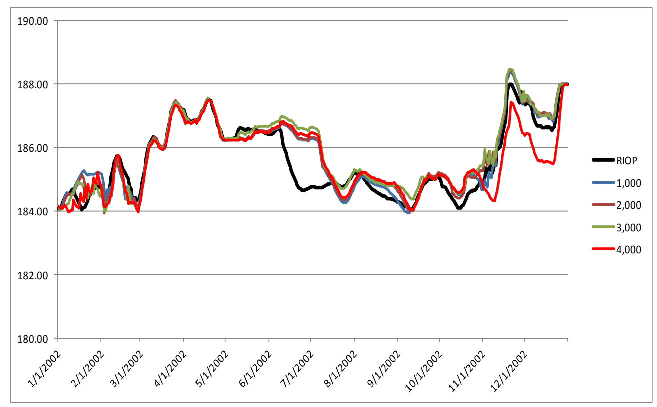

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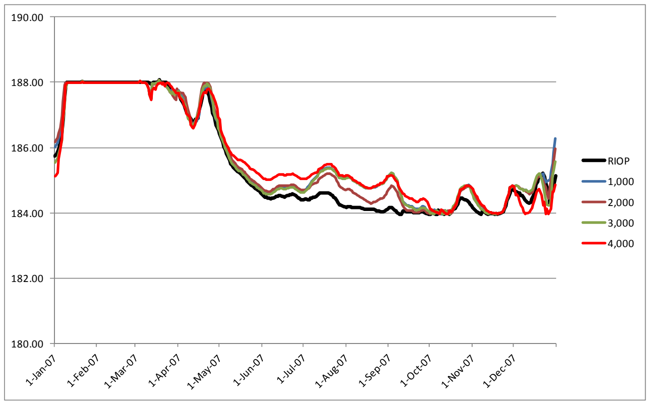
Figure 7 - 88. ANNUAL TIME SERIES OF EXTREME LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE FOR VARYING LEVELS OF AUGMENTATION AND DREDGING TO PROVIDE A NINE-FOOT CHANNEL AT 14,000 CFS (2007)



CHATTAHOOCHEE RIVER MINIMUM FLOW PERFORMANCE MEASURES

In Chapter 6 it was noted that there were minimum flow criteria for the Chattahoochee River for Peachtree Creek, Columbus and the Farley nuclear plant (Andrews outflow). The daily minimum flow value for Peachtree Creek is 750 cfs, for Columbus a 7-day flow of 1,350 cfs and for the Farley plant 2,000 cfs. As was explained in Chapter 6, in the first series of sensitivity analyses the minimum flow requirements for Columbus and Farley plant will be considered as "passive targets", that is, the reservoirs will not be required in the model to meet the target but an evaluation of how well they met the target incidentally will be done. If there are a significant number of violations of the target, the model logic will be modified to require releases to meet the target. Table 7-2 shows the percent of time each of these three targets were not met in the 70 year model run period. From this table it can be seen that the amount of time flow is below the minimum values for the Farley Plant was far too frequently (over 800 times in the 70 year model run period) in all of the examples, whereas there were some violations for Columbus and none for Peachtree Creek. The failures at Columbus were due to the fact that the targets were not hard wired as release requirements in the models or that West Point's storage was drawn down to a point that it could not augment the Columbus minimum flow requirement. The failures to meet the Farley minimum could either be due to the fact the targets were not hard wired as release requirements in the models or that there was inadequate water in either West point or W.F. George to make the releases necessary to meet the target. These issues will be examined more closely in Chapter 9. It should be noted that for Columbus and Andrews the number of failures to meet the minimum requirement was less than for the RIOP in all instances.

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Table 7-2. PERCENT OF TIME THAT FLOW IS BELOW THE MINIMUM VALUE FOR THE PERFORMANCE MEASURES FOR PEACHTREE CREEK, COLUMBUS AND FARLEY PLANT

AUGMENTATION LIMIT	PEACHTREE CREEK	COLUMBUS	ANDREWS
RIOP	0.00%	1.63%	4.08%
1000	0.00%	0.19%	3.44%
2000	0.00%	0.22%	3.33%
3000	0.00%	0.24%	3.43%
4000	0.00%	0.20%	3.41%
5000	0.00%	0.18%	3.44%

SUMMARY OF FINDINGS FOR PROVIDING THE CHANNEL WITH DREDGING

This sensitivity analysis examined the effects of modifying the amount of augmentation to meet downstream flow needs for providing a 9-foot navigation channel at 14,000 cfs, an 8-foot channel at 12,000 cfs and a 7-foot channel at 10,000 cfs. In this sensitivity analysis it was found that when the navigation target is set at 14,000 cfs for a 9-foot channel that changing the level of augmentation makes a major difference in the availability of the navigation when dredging is being done. For the availability of a 9-foot channel the level of augmentation allowed can make up to 15% difference in the amount of time the channel is available in some months. For a 7-foot channel the difference is minimal. The operations used shows significant improvement in the availability of the 9-foot navigation channel over the RIOP and no improvements over the availability of the 7-foot channel.

In evaluating the differences in environmental flow it was found that that there are limited differences in the availability of flow in the period of record figures at the scale used among the augmentation options and between the augmentation operations and the RIOP. All releases showed differences from the AR performance measure. In evaluating the extent of floodplain inundation it was found that when the navigation release is 14,000 cfs providing navigation releases has a very limited effect on the amount of time flows exceed the threshold levels. In all three charts the percent of time the flow thresholds are exceeded are the same as with the RIOP.

Median elevations at Lake Lanier are sensitive to changes to the maximum level of augmentation and the elevations are lower than the elevations under the RIOP over the entire year. The 75% exceeded elevations at Lanier were lower and sensitive to changes from January to August and then comparable after that. The 90% exceeded elevations were lowered for all options for most of the year and much lower for the 4,000 cfs augmentation option. When minimum elevations are considered, the 4,000 cfs augmentation option resulted in the elevations being drawn down considerably.

West Point showed limited sensitivity to changing the augmentation limits when the 14,000 cfs release was the flow needed to provide a 9-foot channel. At median elevations the levels are below the RIOP, but at the 75% exceeded, 90% exceeded and minimum elevations the resultant elevations are both above and below the RIOP elevations. W.F. George showed limited

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variations in elevations at W.F. George for the median, 75% exceeded, 90% exceeded and minimum elevations as the maximum augmentation limits were changed.

Analyses showed that the minimum flow targets for Columbus and Andrews were not met far too frequently (over 800 times in the 70-year model run period and that the number of times they were not met was generally less than the RIOP.

CONCLUSIONS FROM SENSITIVITY TESTS ON AUGMENTATION LIMITS

In the sensitivity analyses done in this chapter the volume of augmentation allowed from reservoir releases was evaluated for two conditions: 1) no maintenance dredging is conducted in the Apalachicola River and the flow necessary to provide a 9-foot channel is 21,000 cfs and the flow necessary to provide a 7-foot channel is 17,000 cfs, and 2) an annual average of about 215,000 cubic yards of material is dredged each year in the Chipola Cutoff reach and the flow necessary to provide a 9-foot channel is reduced to 14,000 cfs after the channel is maintained and 10,000 cfs is needed to provide a 7-foot channel. A series of sensitivity runs were done evaluating model output for a maximum augmentation ranging from 1,000 cfs to 10,000 cfs. For the case with no dredging the storage reservoirs could not support augmentation releases greater than 5,000 cfs and for the case with dredging the maximum augmentation release that could be supported was only 4,000 cfs. Although this seem counter-intuitive, one would expect that the lower the release (14,000 cfs vs. 21,000 cfs) the greater the augmentation that could be supported, there is a good explanation for these results. With the 14,000 cfs release the reservoir system would support augmentation releases far more frequently than with the 21,000 cfs release. At an augmentation level of 5,000 cfs with a 21,000 cfs release target releases would be supported until the basin inflow fell to 16,000 cfs (e.g. 21,000 - 5,000) whereas with a 14,000 cfs release target releases would be supported to a 10,000 cfs release target (e.g. 14,000 - 4,000). The 10,000 cfs flow is exceeded far more times in the 70 year flow period than the 16,000 cfs flow, the 10,000 cfs flow is exceeded about 80% of the time whereas the 16,000 cfs flow is exceeded over 52% of the time. Therefore, even though the release target is lower, the volume of the releases is comparable and the frequency of the releases is greater with the lower release target.

When comparing the results of the augmentation release sensitivity evaluation for the no dredging option (21,000 cfs release for a 9-foot channel) and the with-dredging option (14,000 cfs release for a 9-foot channel) the following conclusions can be made:

- For the no dredging option there were minor increases in the availability of the of the 9-foot and 7-foot channel as the level of augmentation was increased for the first half of the year at median flows, but major differences in the latter half of the year. For the with dredging option there were major increases for the 9-foot channel in the latter half of the year, but minimal differences for the 7-foot channel. All options showed an improvement over the availability of the channel with the RIOP operations in place. For the without dredging option (21,000 cfs release) the 9-foot channel was available about 33% of the time with the navigation releases and 26% of the time under the RIOP and the 7-foot channel was available about 41% of the time compared to 36% of the time with the RIOP operations. For the with dredging option the 9-foot channel was available

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about 65% of the time with the navigation releases whereas for the RIOP releases it was available about 58% of the time and the 7-foot channel was available 82% of the time whereas under the RIOP operations it was available about 82% of the time. In sum, these results suggest that the availability of the navigation channel is improved for all options with releases greater than 14,000 cfs relative to the RIOP operations and that there is direct relationship between the availability of the navigation channel and the level of augmentation with greater channel availability being associated with greater levels of augmentation.

- With both options there were little differences with the availability of water in the Apalachicola River when Jim Woodruff outflow was evaluated from both the period-of-record and annual time series perspective, this is most likely due to the scale at which the flows were analyzed and should not be interpreted to mean that flows in the river are the same. The approach used to analyzing the flow changes is not adequate to understand changes need to be evaluated in a more sophisticated manner which is beyond the scope of this project.

- For the no dredging options there were major differences in the frequency of floodplain inundation at 15,000 cfs and 17,000 cfs as augmentation releases were changed, but these differences were not evident for the with dredging option. No differences could be seen with the 29,000 cfs exceeded option for either dredging scenario. These results were expected because the release to provide the navigation channel for the no dredging option was below the threshold for topping the floodplain levee and the 29,000 cfs target was too large to be influenced by the navigation target release levels.

- For the no dredging option, median elevations at Lake Lanier showed a high sensitivity to the amount of augmentation provided for the first half of the year, but this sensitivity was reduced for the latter half of the year and in the 75% and 90% exceeded elevations. Minimum elevations at Lake Lanier for the no dredging option began to be drawn down for the 4,000 cfs and 5,000 cfs augmentation threshold options. In all of the charts, elevations at Lake Lanier are lower than they would have been under the RIOP. For the with dredging option, median elevations at Lake Lanier are sensitive to changes to the maximum level of augmentation and the elevations are lower than the elevations under the RIOP over the entire year.

- For the no dredging option, West Point elevations were drawn down at median elevations for the latter half of the year as the augmentation levels were increased and they were drawn down to a lesser extent for the 75% and 90% exceeded elevations. Minimum elevations showed that in the fall of the year West Point was drawn down to the bottom of its pool. West Point showed limited sensitivity to changing the augmentation limits when the 14,000 cfs release was the flow needed to provide a 9-foot channel. At median elevations the levels are below the RIOP, but at the 75% exceeded, 90% exceeded and minimum elevations the resultant elevations are both above and below the RIOP elevations

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- For the no dredging option, median elevations at W.F. George were identical under alternate levels of augmentation releases and under the RIOP until May, but are sensitive to augmentation levels and navigation releases for the balance of the year. Similar reactions are evident at the 75% exceeded elevation, but the differences are not as large. Differences between the RIOP elevations and elevations under alternative augmentation levels are not as pronounced for the 90% exceeded and minimum elevations. For the with dredging option W.F. George showed limited variations in elevations for the median, 75% exceeded, 90% exceeded and minimum elevations as the augmentation limits were changed.

- For both the dredging and no dredging options there were multiple incidents where the Columbus and Andrews outflow minimum release requirements were not met. This is was due to both the fact these release targets were passively targeted in these sensitivity runs and because the reservoirs upstream of the targets were drawn to the bottom of their conservation pools under some of the options evaluated.

In summary several major conclusions can be drawn from this first set of sensitivity analyses:

5. The limit of augmentation that can be sustained by ACF basin when balancing effects on the availability of the navigation channel, floodplain inundation and reservoir elevations is about 2,000 to 3,000 cfs.
6. The sensitivity of increasing the performance measures is greater for the no dredging option (14,000 cfs to provide a 9-foot channel) than for the no dredging option (21,000 cfs to provide a 9-foot channel). Although this appears counter-intuitive it makes sense when it is realized that the level of augmentation is the same regardless of the flow needed to provide the 9-foot channel and that with the lower release option the frequency of augmentation events is increased.
7. Providing a 9-foot channel at 14,000 cfs with dredging increases the availability of the navigation channel relative to the no dredging option but does not improve the environmental performance measures.
8. For the with-dredging options most of the impacts from decreased reservoir elevations occur at Lake Lanier. Elevation differences at West Point and W.F. George are limited.

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CHAPTER 8 – SENSITIVITY ANALYSIS OF THE NAVIGATION RELEASE FLOWS FROM THE FEDERAL RESERVOIRS

INTRODUCTION

In Chapter 3 it was explained that with using the HEC-RAS evaluation of the existing channel dimensions, with an average of about 215,000 cubic yards of dredging in the Chipola Cutoff reach a nine-foot channel could be provided with about 14,000 cfs at the Chattahoochee gage on the Apalachicola River and with no dredging a 9-foot channel could be provided with 21,000 cfs. A 7-foot channel in turn would be provided with 17,000 cfs with no dredging and 14,000 cfs with dredging. In Chapter 7 a sensitivity analysis was conducted on the level of augmentation which could be sustained by the ACF storage reservoirs. In that chapter it was found that the reservoirs could sustain an augmentation release of 2,000 cfs to 3,000 cfs for no dredging and with dredging options. In this chapter, the next question to be addressed is:

What level of maintenance and flow releases can be sustained and provided from the federal storage reservoirs?

To examine this question a sensitivity analysis of the flows needed to provide a 9-foot channel at flows ranging from 14,000 cfs (the 215,000 cubic yards of dredging option) to 21,000 cfs (the no dredging option) at 1,000 cfs increments was performed. To provide the 9-foot channel at an intermediate level would ultimately reduce the average annual volume of dredging needed to provide the channel. After this first sensitivity analysis is done a second analysis which considers what is concluded to be the more preferable range of navigation releases with multiple augmentation thresholds will be done. In the initial sensitivity analysis an augmentation value of 3,000 cfs is used with the targeted flow to provide the 9-foot channel ranging from 14,000 cfs to 21,000 cfs.

ANALYSIS OF VARYING RELEASES NEEDED TO PROVIDE A 9-FOOT CHANNEL IN THE APALACHICOLA RIVER

NAVIGATION PERFORMANCE MEASURES

Figure 8-1 shows the availability of the 9-foot navigation channel with a range of flows needed to provide a 9-foot navigation channel. The range considered was from 14,000 cfs (215,000 cubic yards of dredging in the Chipola Cutoff reach) to 21,000 cfs (no dredging). As explained earlier, in all of our analyses we have chosen to use current operations (RIOP) as the baseline against which to compare changes and that current operations do not included releases for navigation flows. Figure 8-2 shows the availability of a 7-foot channel.

From figure 8-1 it can be seen that the availability of the 9-foot channel is very dependent on the flow needed to provide the 9-foot channel and the lower the flow needed to provide the 9-foot channel (the more dredging which is done), the greater the availability of the channel. Figure 8-2 shows that the same is true for the 7-foot channel. For the 9-foot differences in the availability of the channel can be as great as 50% in some months depending on the flow to provide the channel and for the 7-foot channel differences can be as great as 60%.

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The average annual availability of the 9-foot channel ranges from 33.3% when 21,000 cfs is needed to provide a 9-foot channel to 66.3% when 14,000 cfs is needed to provide the 9-foot channel. These compare with 26.5% for the RIOP. The average annual availability of the 7-foot channel ranges from 42.1% when 21,000 cfs is needed to provide a 7-foot channel to 82.1% when 14,000 cfs is needed to provide the 7-foot channel. These compare with 35.5% for the RIOP. When the time period of January through May is considered, the average annual availability of the 9-foot channel ranges from 55.8% when 21,000 cfs is needed to provide a 9-foot channel to 86.3% when 14,000 cfs is needed to provide the 9-foot channel. These compare with 48.7% for the RIOP. The average annual availability of the 7-foot channel ranges from 65.0% when 21,000 cfs is needed to provide a 7-foot channel to 93.1% when 14,000 cfs is needed to provide the 7-foot channel. These compare with 61.3% for the RIOP.

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Figure 8 - 1. AVAILABILITY OF A NINE-FOOT CHANNEL WITH VARYING LEVELS OF DREDGING TO PROVIDE THE CHANNEL AND AN AUGMENTATION LIMIT OF 3,000 CFS

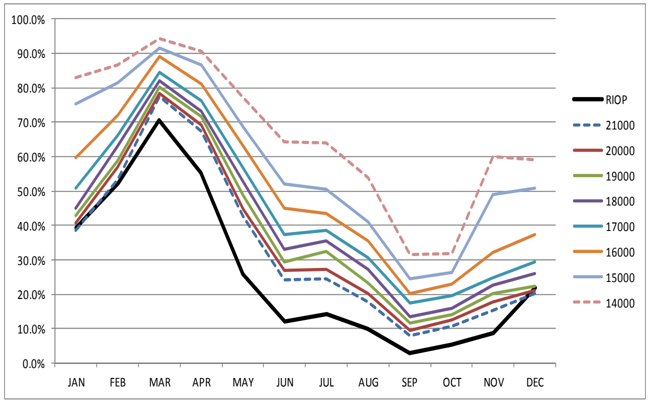
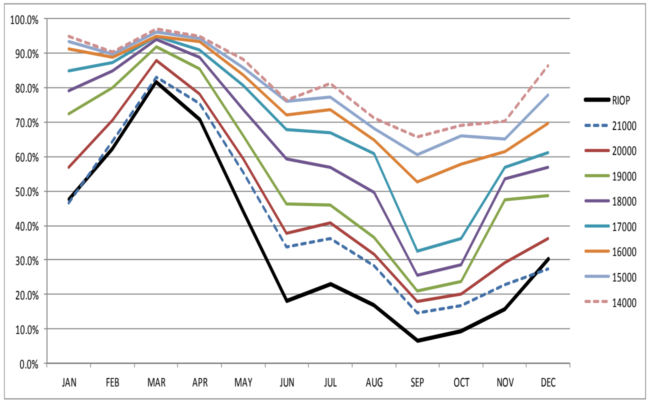


Figure 8 - 2. AVAILABILITY OF A SEVEN-FOOT CHANNEL WITH VARYING LEVELS OF DREDGING TO PROVIDE THE CHANNEL AND AN AUGMENTATION LIMIT OF 3,000 CFS



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ENVIRONMENTAL PERFORMANCE MEASURES

Chapter 4 discusses the basis of the environmental performance measures. In chapter 4 it was concluded that two separate measures of environmental performance measures will be used: one which is flow based and another which considers the extent of inundation of the Apalachicola River floodplain. In this section the flow based performance measures will be considered first and then the floodplain inundation performance measure will be evaluated. Figures 8-3, 8-4 and 8-5 show the comparisons of median, 75% exceeded flows and 90% exceeded flows for model runs relative to the RIOP for the entire model run period (1939 – 2008) and figures 8-6, 8-7, 8-8, 8-9, 8-10 and 8-11 show the same data for individual years chosen to represent normal flows, low flows and extreme low flows. In the annual time series data the flow values shown were truncated to the 0 to 30,000 cfs range to better display differences between model runs.

Figures 8-3, 8-4, and 8-5 show that for the period of record median flows showed minor effects to modifying the flow needed to provide the navigation channel for most of the year, but some differences were noted in May and June. In the 75% exceeded figure large differences were noted for most of the year and in the 90% exceeded figure the differences were less pronounced. For the 75% exceed flow for the 14,000 cfs option, the average annual outflow at Jim Woodruff outflow was nearly 400 cfs greater than the 75% exceeded outflow for 21,000 cfs option. This compares with a difference of about 270 cfs for the 90% exceeded option. Median outflow from Jim Woodruff is not that different for the period of record data than the RIOP outflow. However, outflow for the 75% exceeded output is less than for the RIOP, but for the 90% exceeded option the RIOP outflow is less.

Variations among individual year time series analyses generally showed some limited differences in many years, but the largest differences were in the two normal flow years (1970 and 1977), one of the low flow years (1981) and one of the extreme low years (2002). Some of the differences resulted from a shift in the response due to the change in release rules.

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Figure 8 - 3. MEDIAN FLOWS FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF DREDGING TO PROVIDE A NINE-FOOT CHANNEL AND AN AUGMENTATION LIMIT OF 3,000 CFS: PERIOD OF RECORD (1939 – 2008)

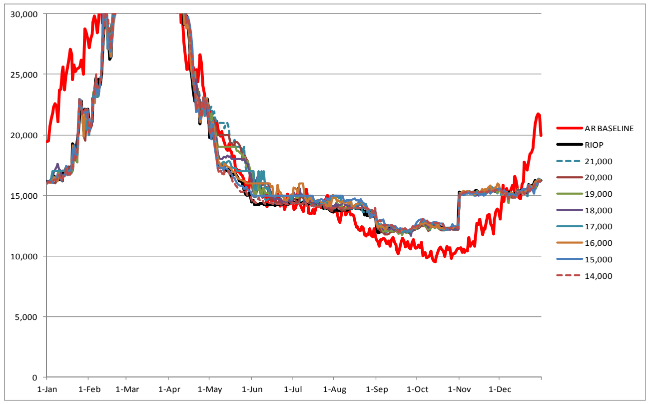

Figure 8 - 4. 75% EXCEEDED FLOWS FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF DREDGING TO PROVIDE A NINE-FOOT CHANNEL AND AN AUGMENTATION LIMIT OF 3,000 CFS: PERIOD OF RECORD (1939 – 2008)

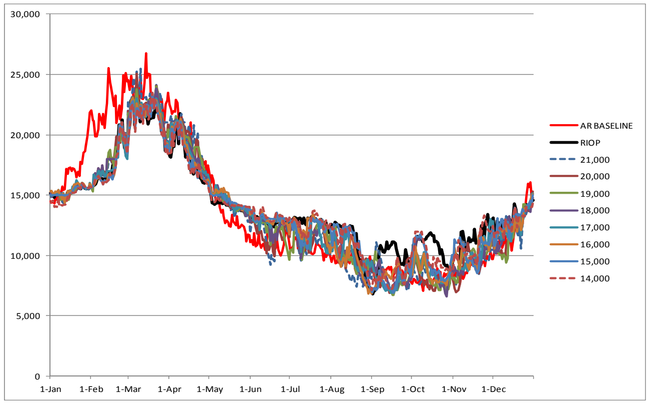

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Figure 8 - 5. 90% EXCEEDED FLOWS FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF DREDGING TO PROVIDE A NINE-FOOT CHANNEL AND AN AUGMENTATION LIMIT OF 3,000 CFS: PERIOD OF RECORD (1939 – 2008)

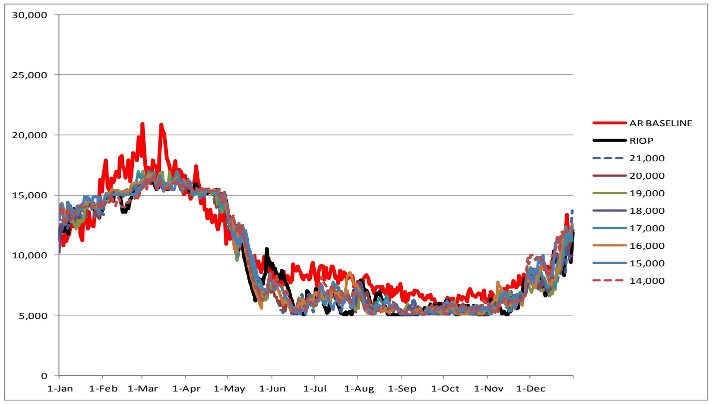

Figure 8 - 6. ANNUAL TIME SERIES FOR NORMAL FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF FLOW RELEASES NECESSARY TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AND AN AUGMENTATION LIMIT OF 3,000 CFS (1970)

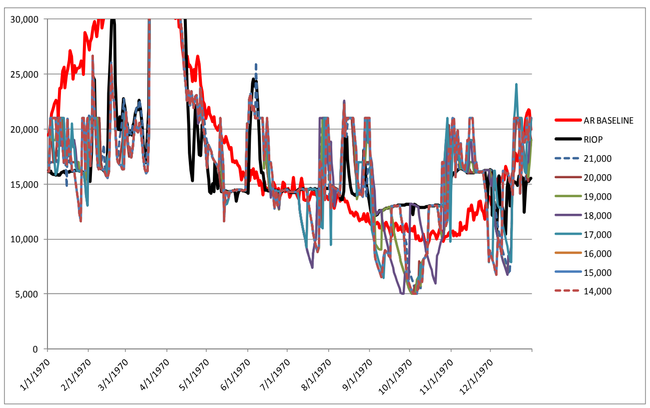

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Figure 8 - 7. ANNUAL TIME SERIES FOR NORMAL FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF FLOW RELEASES NECESSARY TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AND AN AUGMENTATION LIMIT OF 3,000 CFS (1977)

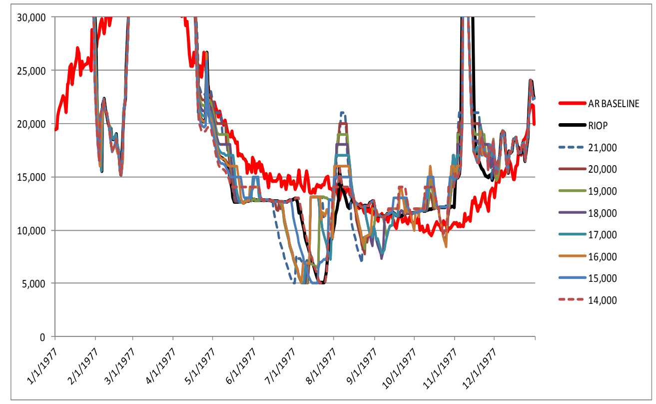

Figure 8 - 8. ANNUAL TIME SERIES FOR LOW FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF FLOW RELEASES NECESSARY TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AND AN AUGMENTATION LIMIT OF 3,000 CFS (1981)

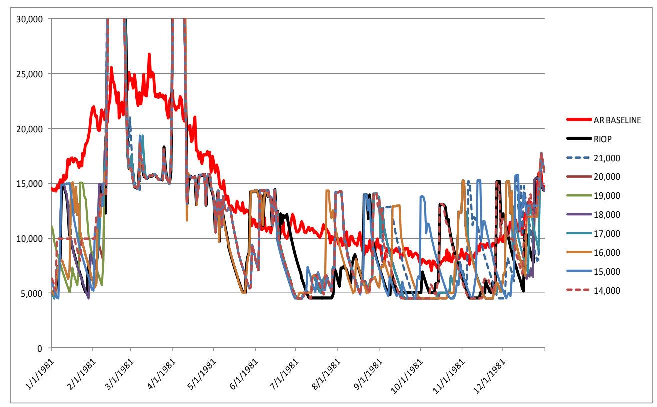

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Figure 8 - 9. ANNUAL TIME SERIES FOR LOW FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF FLOW RELEASES NECESSARY TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AND AN AUGMENTATION LIMIT OF 3,000 CFS (1988)

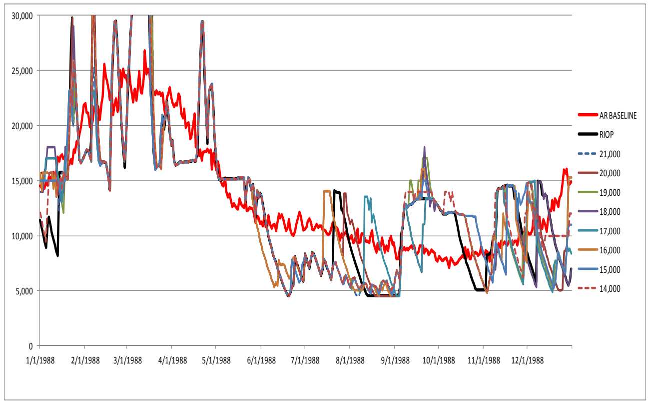

Figure 8 - 10. ANNUAL TIME SERIES FOR EXTREME LOW FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF FLOW RELEASES NECESSARY TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AND AN AUGMENTATION LIMIT OF 3,000 CFS (2002)

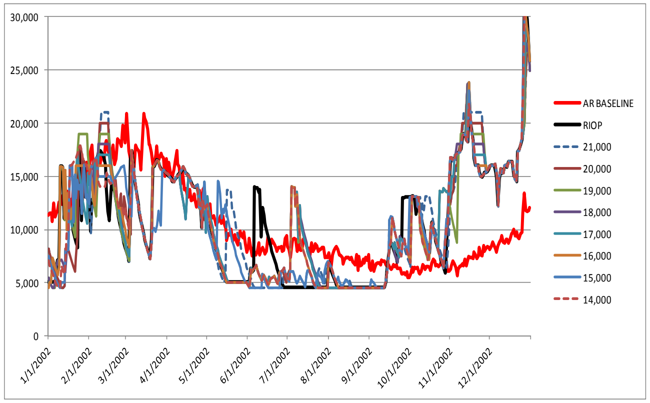

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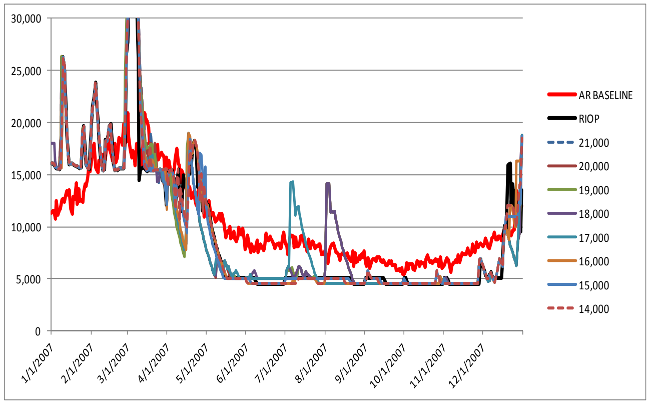
Figure 8 - 11. ANNUAL TIME SERIES FOR EXTREME LOW FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF FLOW RELEASES NECESSARY TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AND AN AUGMENTATION LIMIT OF 3,000 CFS (2007)



The other performance measure defined in Chapter 4 was the extent of flooding in the Apalachicola River floodplain. Figure 8-12 shows the amount of time 15,000 cfs was exceeded; figure 8-13 the amount of time 17,000 cfs was exceeded and figure 8-14 the amount of time 29,000 cfs was exceeded. From these figures it can be seen that the extent of floodplain inundation is sensitive to the flow release needed to provide the 9-foot channel. With the greater the release, the greater the inundation for both the 15,000 cfs and 17,000 cfs thresholds so long as the release level necessary to provide the 9-foot channel is greater than the floodplain inundation threshold. The 29,000 cfs threshold showed little sensitivity. For the 15,000 cfs exceeded threshold the flow threshold was exceeded 53.9 % of the time under the RIOP, 56.9% of the time with a 21,000 release to provide the 9-foot channel and 53.3% of the time when the release value to provide the 9-foot channel is 14,000 cfs. This value increases abruptly to 63.8% when the release value to provide the 9-foot channel is increased to 15,000 cfs. For the 17,000 cfs threshold the flow threshold was exceeded 38.5 % of the time under the RIOP, 42.8% of the time when the release target to provide the 9-foot channel was 21,000 cfs and 48.5% of the time when the release target to provide the 9-foot channel was 17,000 cfs. It can be observed that as long as the flow needed to provide the 9-foot channel is greater than the floodplain inundation threshold that the lower the release to provide the channel the more frequently the value is exceeded.

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Figure 8 - 12. PERCENT OF TIME 15,000 CFS WAS EXCEEDED FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF FLOW SUPPORT TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS

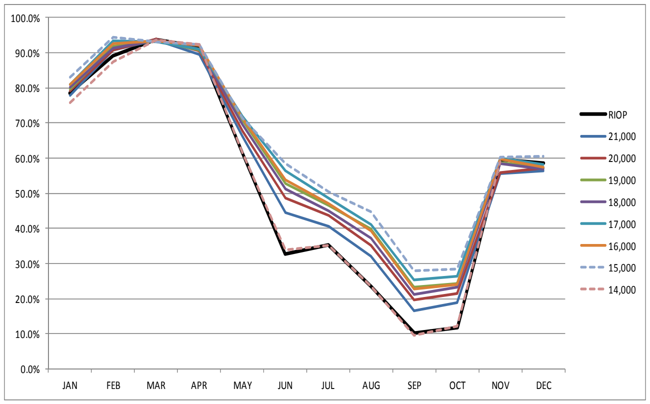

Figure 8 - 13. PERCENT OF TIME 17,000 CFS WAS EXCEEDED FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF FLOW SUPPORT TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS

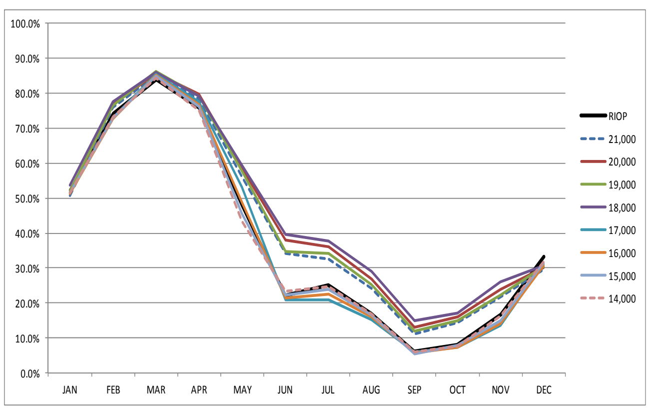

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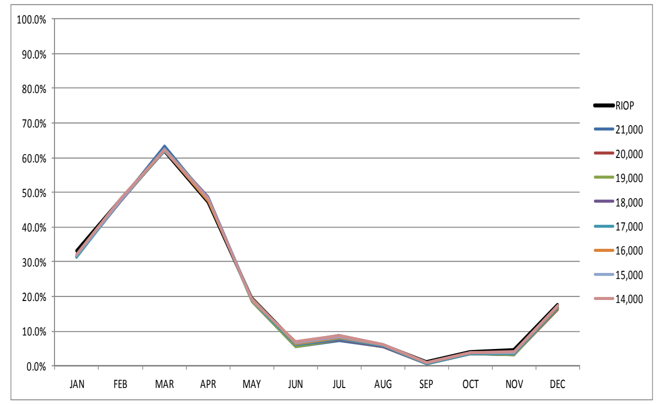
Figure 8 - 14. PERCENT OF TIME 29,000 CFS WAS EXCEEDED FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF FLOW SUPPORT TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS



RESERVOIR ELEVATION PERFORMANCE MEASURES

The next set of performance measures to be considered is the effects on reservoir elevations. Background on these performance measures can be found in Chapter 5.

LAKE LANIER

Figures 8-15, 8-16, 8-17 and 8-18 show the elevations at Lake Lanier for the period of record and figures 8-19, 8-20, 8-21, 8-22, 8-23 and 8-24 show annual time series charts comparing the elevations at Lake Lanier for various levels of augmentation.

These figures show elevations at Lake Lanier are sensitive to the release needed to provide the 9-foot channel and the greater the release, the lower the elevation. Elevations at Lake Lanier are decreased relative to the RIOP. The degree of sensitivity to changing the release to provide the 9-foot channel is evident in all of the period of record figures but is greatest in the median and minimum elevation figures. In the period of record figure for median elevation (figure 8-15) the average annual elevation under the RIOP was 1064.05. With a release to provide the 9-foot channel at 21,000 cfs the average annual elevation was 1062.09 and with a release to provide the 9-foot channel at 14,000 cfs the average annual elevation was 1063.1. For the 75% exceeded elevations, the average annual elevation under the RIOP was 1060.35. With a release of 21,000 cfs to provide the 9-foot channel the average annual elevation exceeded 75% of the time was 1059.77 and with a release of 14,000 cfs to provide a 9-foot channel the average annual elevation was 1059.75. For the 90% exceeded elevations the average annual elevation under the RIOP was 1058.33. With a release of 21,000 cfs to provide the 9-foot channel the average annual elevation exceeded 90% of the time was 1057.93 and with a release of 14,000 cfs to provide the 9-foot channel the average annual release exceeded 90% of the time was

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1057.52. For minimum elevations the average annual elevation under the RIOP was 1054.55. With a release of 21,000 cfs to provide the 9-foot channel the average annual minimum elevation was 1053.62 and with a 14,000 cfs release to provide the 9-foot channel the average annual minimum elevation was 1052.84.

In reviewing the annual time series figures (figures 8-19 to 8-24) it can be seen that there are limited differences in the average flow years (1970 and 1977) but in the low flow years (1981 and 1988) the elevations are drawn down for the 14,000 cfs and 15,000 cfs releases to provide the 9-foot channel. This phenomenon is due to the fact that there is a greater frequency of augmentation releases made at these release levels.

Figure 8 - 15. MEDIAN ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS

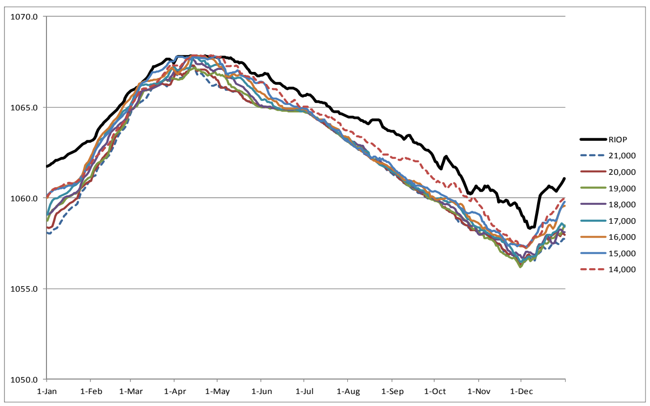

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Figure 8 - 16. 75% EXCEEDED ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS

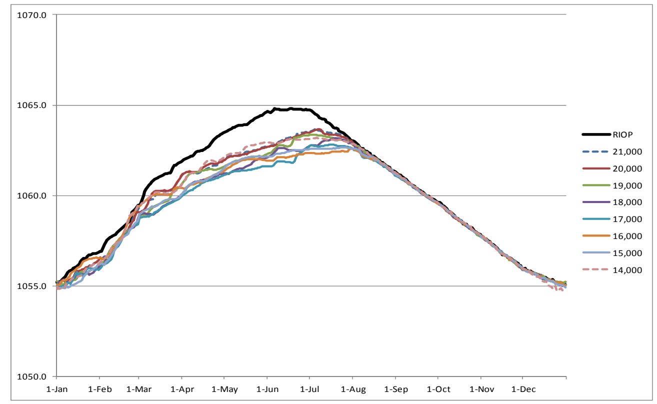

Figure 8 - 17. 90% EXCEEDED ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS

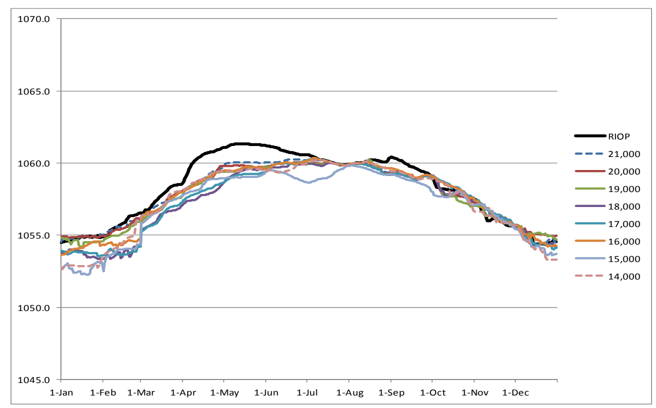

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Figure 8 - 18. MINIMUM ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS

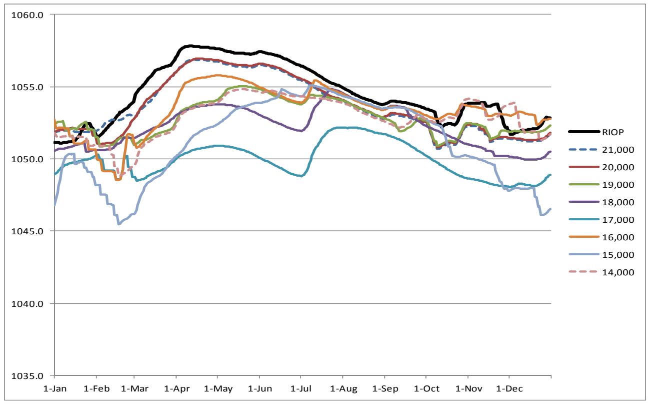

Figure 8 - 19. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS (1970)

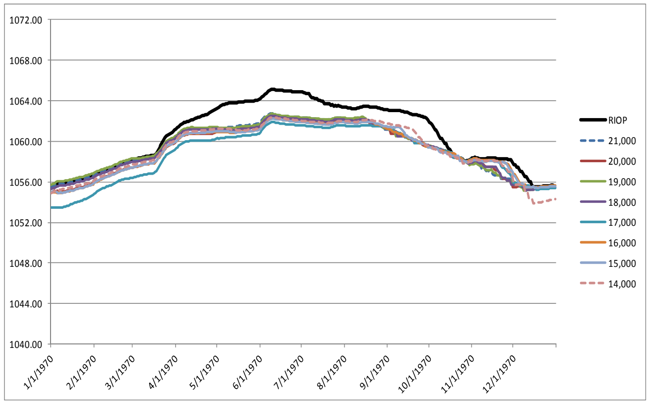

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Figure 8 - 20. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS (1977)

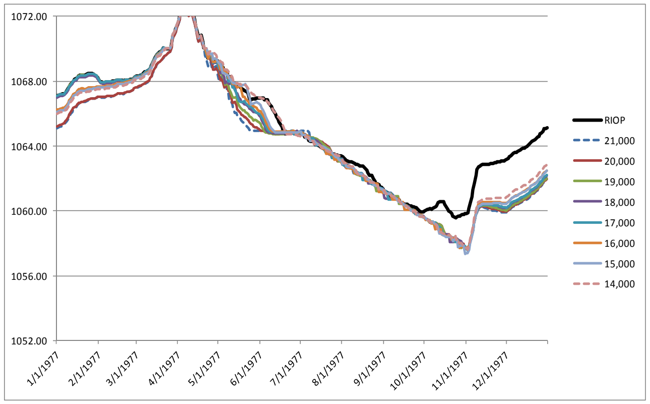

Figure 8 - 21. ANNUAL TIME SERIES OF LOW FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS (1981)

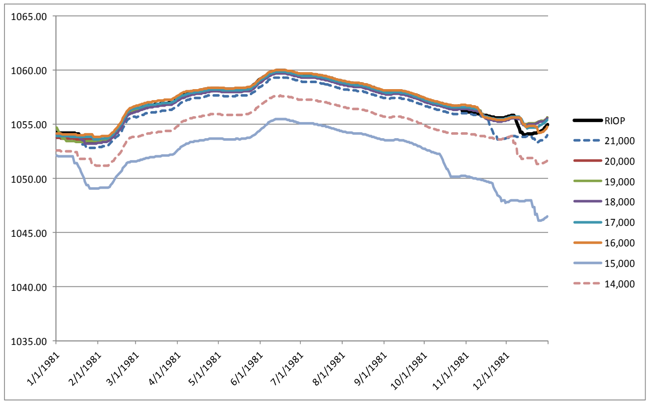

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Figure 8 - 22. ANNUAL TIME SERIES OF LOW FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS (1988)

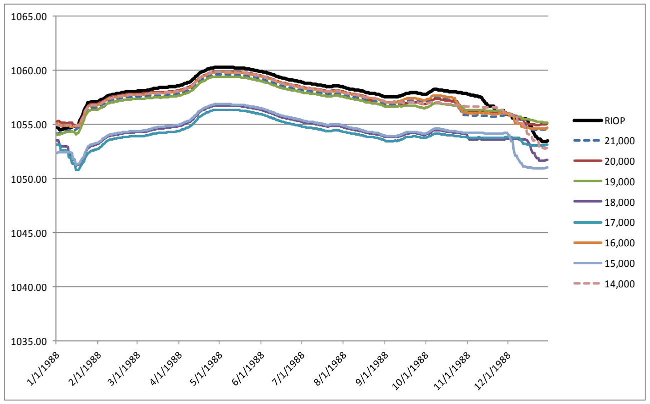

Figure 8 - 23. ANNUAL TIME SERIES OF EXTREME LOW FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS (2002)

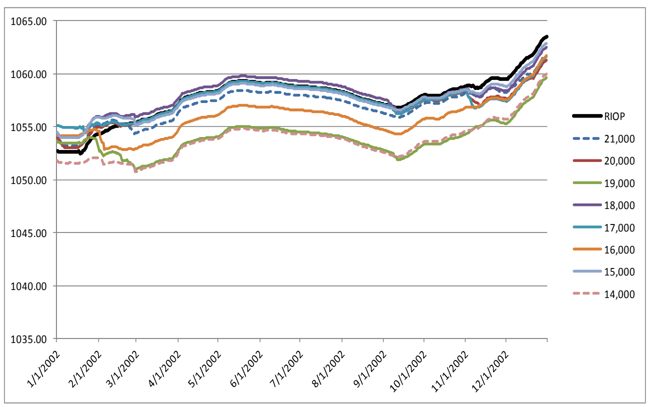

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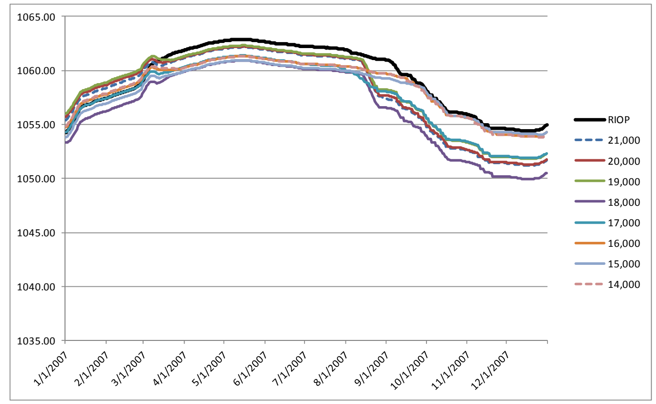
Figure 8 - 24. ANNUAL TIME SERIES OF EXTREME LOW FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS (2007)



WEST POINT

Figures 8-25, 8-26, 8-27 and 8-28 show the period of record data for West Point elevations and Figures 8-29, 8-30, 8-31, 8-32, 8-33 and 8-34 show the annual time series data for selected years for elevations at West Point reservoir.

For the period of record figures variations are greatest for the median elevations from May through December, with the range of variation being nearly three feet. Elevations at West Point were lowered relative to the RIOP elevations. Changes for the 75% exceeded and 90% exceeded figures were not as large as those for the median elevations. From the minimum elevation figure it can seen that for much of the time from July to December West Point was drawn down to the bottom of its conservation pool during the model run period. The average annual median elevation for the RIOP was 630.29, whereas the median average annual elevation when 21,000 cfs was the release required to provide a 9-foot channel was 628.8. When 14,000 cfs was the release required to provide a 9-foot channel the median average annual elevation was 629.82. For the 75% exceeded elevations, the 75% exceeded average annual elevation for the RIOP was 627.4, whereas the 75% exceeded annual elevation when the release required to provide a 9-foot channel was 21,000 cfs was 626.67. When 14,000 cfs was the release required to provide a 9-foot channel, the 75% exceeded average annual elevation was 627.02. For the 90% exceeded elevations, the 90% exceeded average annual elevation for the RIOP was 625.18, whereas the 90% exceeded annual elevation when the release required to provide a 9-foot channel was 21,000 cfs was 624.79. When 14,000 cfs was the release required to provide the 9-foot channel, the 90% exceeded average annual elevation was 624.80. For the minimum elevations the average annual elevation for the RIOP was 622.3, whereas the minimum average elevation when the release required to provide the 9-foot

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channel was 21,000 cfs was 621.88. When 14,000 cfs was the release required to provide the 9-foot channel the average annual minimum elevation was 621.82.

For the annual time series elevation figures considerable variations were evident for each of the years included in the analysis with the greatest variations occurring in the normal years. In the daily time series elevations at West Point were generally lower than for the RIOP releases.

Figure 8 - 25. MEDIAN ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS

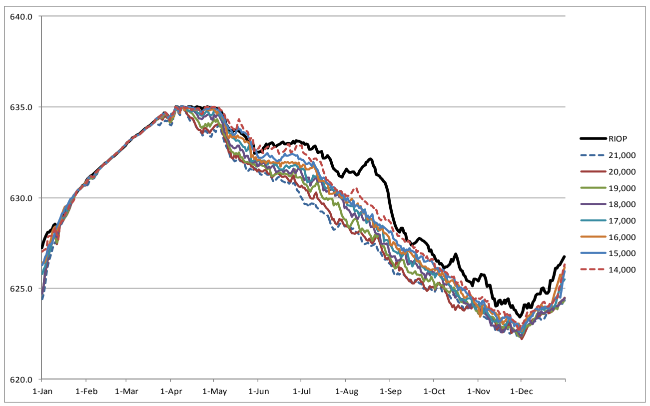

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Figure 8 - 26. 75% EXCEEDED ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS

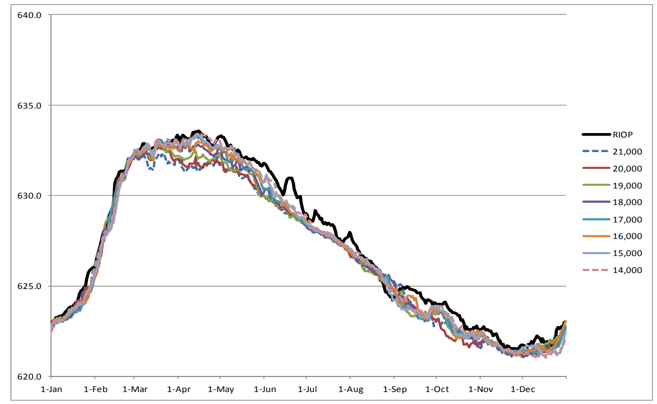

Figure 8 - 27. 90% EXCEEDED ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS

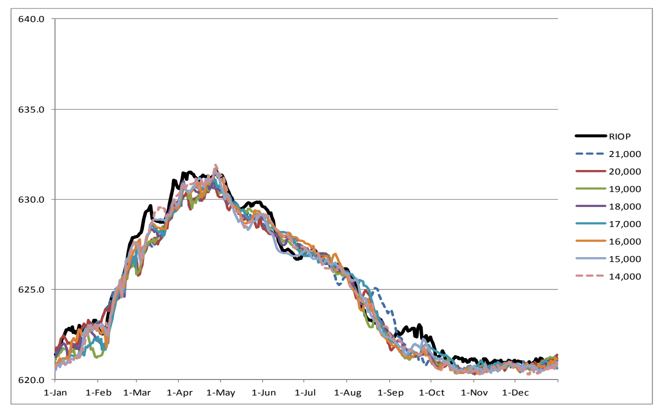

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Figure 8 - 28. MINIMUM ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS

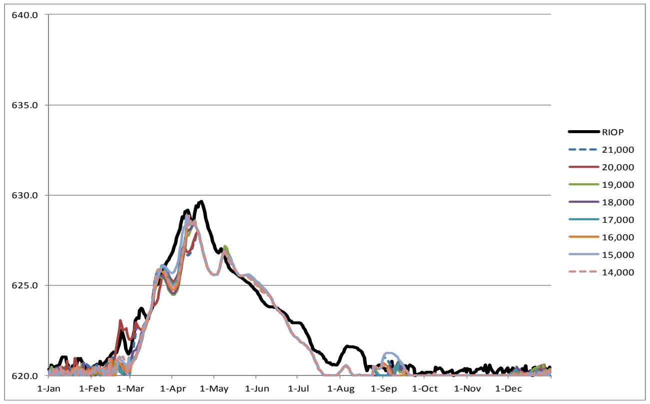

Figure 8 - 29. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS (1970)

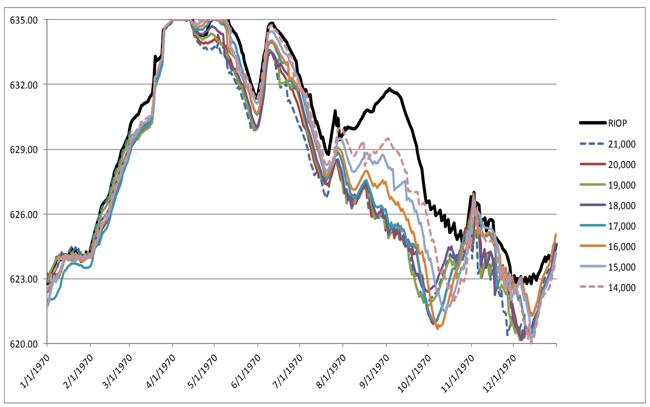

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Figure 8 - 30. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS (1977)

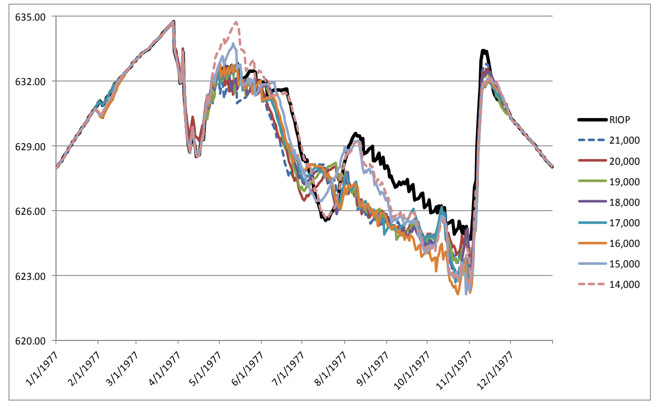

Figure 8 - 31. ANNUAL TIME SERIES OF A LOW FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS (1981)

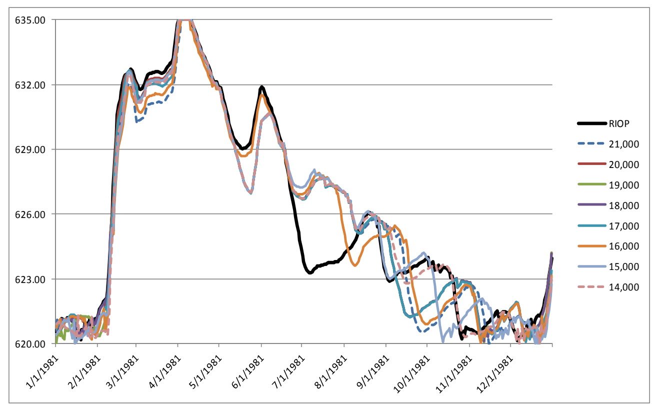

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Figure 8 - 32. ANNUAL TIME SERIES OF A LOW FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS (1988)

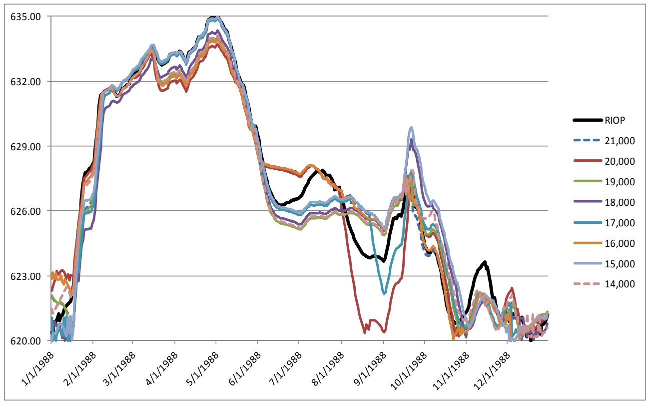

Figure 8 - 33. ANNUAL TIME SERIES OF EXTREME LOW FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS (2002)

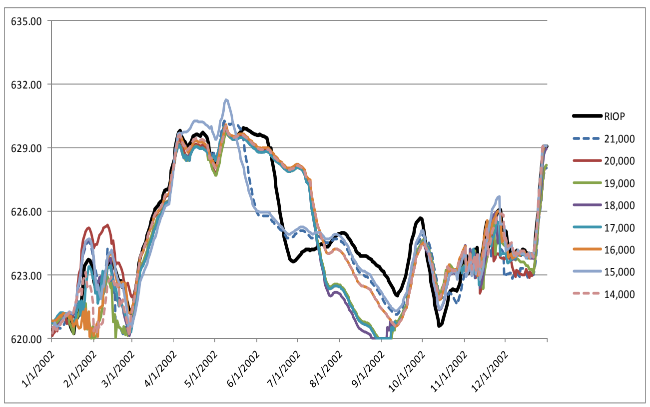

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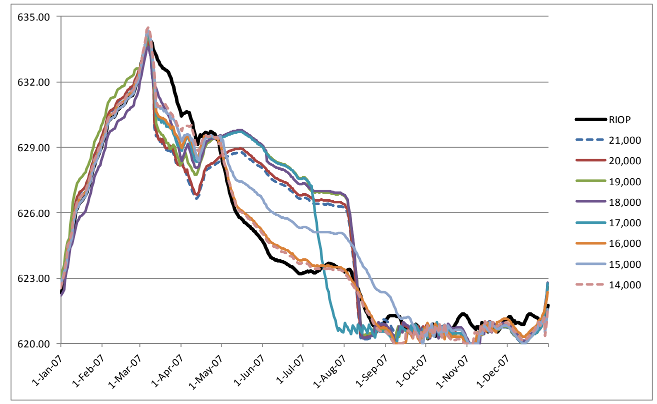
Figure 8 - 34. ANNUAL TIME SERIES OF EXTREME LOW FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS (2007)



W.F. GEORGE

Figures 8-35, 8-36, 8-37 and 8-38 show the period of record data for elevations at W.F. George and figures 8-39, 8-40, 8-41, 8-42, 8-43 and 8-44 show the annual time series data for elevations at W.F. George.

For the period of record figures large differences in W.F. George elevations are evident after early May in the median elevations, with differences of over two feet occurring. Differences for the 75% exceeded, 90% exceeded and minimum elevations show a lot less sensitivity to changes in releases needed to provide the 9-foot channel with the minimum elevations showing that the reservoir does get lowered to the bottom of its conservation pool. Median and 75% exceeded elevations are lower than those for the RIOP. The average annual median elevation for the RIOP was 187.80, whereas the median average annual elevation when 21,000 cfs was the release required to provide a 9-foot channel was 186.9. When 14,000 cfs was the release required to provide a 9-foot channel the median average annual elevation was 187.63. For the 75% exceeded elevations, the 75% exceeded average annual elevation for the RIOP was 186.37, whereas the 75% exceeded annual elevation when the release required to provide a 9-foot channel was 21,000 cfs was 186.19. When 14,000 cfs was the release required to provide a 9-foot channel, the 75% exceeded average annual elevation was 186.35. For the 90% exceeded elevations, the 90% exceeded average annual elevation for the RIOP was 185.59, whereas the 90% exceeded annual elevation when the release required to provide a 9-foot channel was 21,000 cfs was 185.57. When 14,000 cfs was the release required to provide the 9-foot channel, the 90% exceeded average annual elevation was 185.62. For the minimum

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elevations the average annual elevation for the RIOP was 184.46, whereas the minimum average elevation when the release required to provide the 9-foot channel was 21,000 cfs was 184.49. When 14,000 cfs was the release required to provide the 9-foot channel the average annual minimum elevation was 184.48.

Similarly to what was seen at West Point, some variation was seen in the annual time series figures with the greatest differences occurring in the normal flow years (1970 and 1977).

Figure 8 - 35. MEDIAN ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS

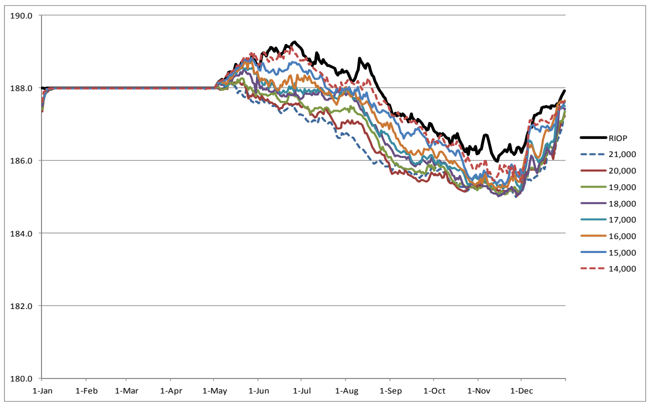

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Figure 8 - 36. 75% EXCEEDED ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL WITH AN AUGMENTATION LIMIT OF 3,000 CFS

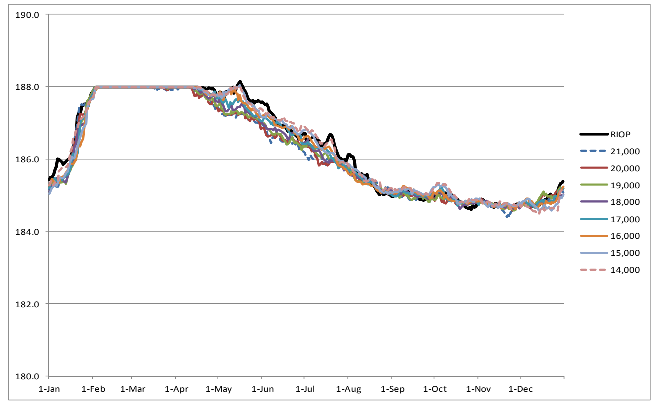

Figure 8 - 37. 90% EXCEEDED ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AN AUGMENTATION LIMIT OF 3,000 CFS

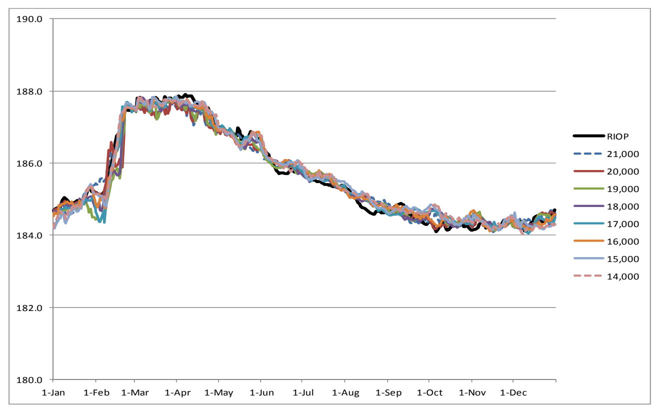

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Figure 8 - 38. MINIMUM ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AN AUGMENTATION LIMIT OF 3,000 CFS

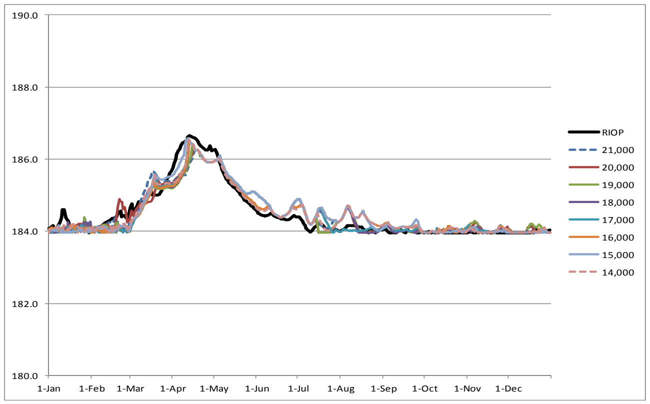

Figure 8 - 39. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AN AUGMENTATION LIMIT OF 3,000 CFS (1970)

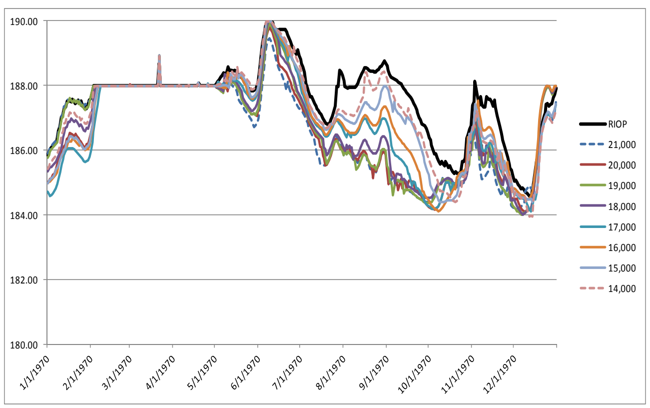

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Figure 8 - 40. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AN AUGMENTATION LIMIT OF 3,000 CFS (1977)

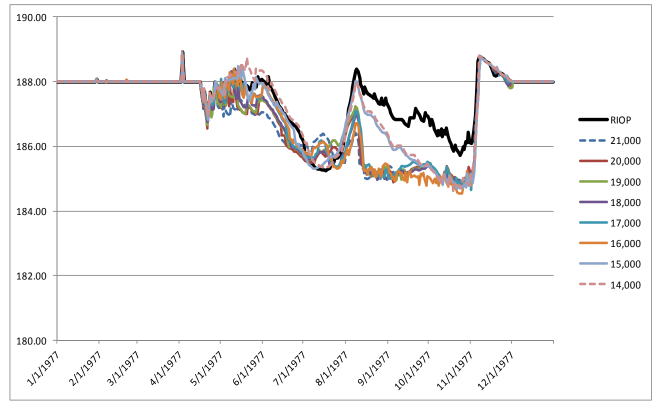

Figure 8 - 41. ANNUAL TIME SERIES OF A LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AN AUGMENTATION LIMIT OF 3,000 CFS (1981)

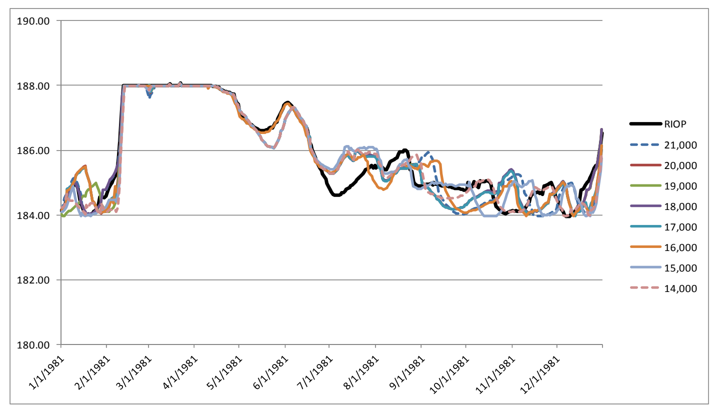

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Figure 8 - 42. ANNUAL TIME SERIES OF A LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AN AUGMENTATION LIMIT OF 3,000 CFS (1988)

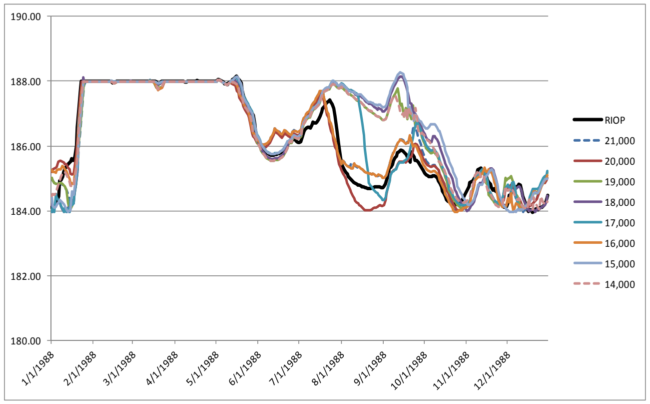

Figure 8 - 43. ANNUAL TIME SERIES OF AN EXTREME LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AN AUGMENTATION LIMIT OF 3,000 CFS (2002)

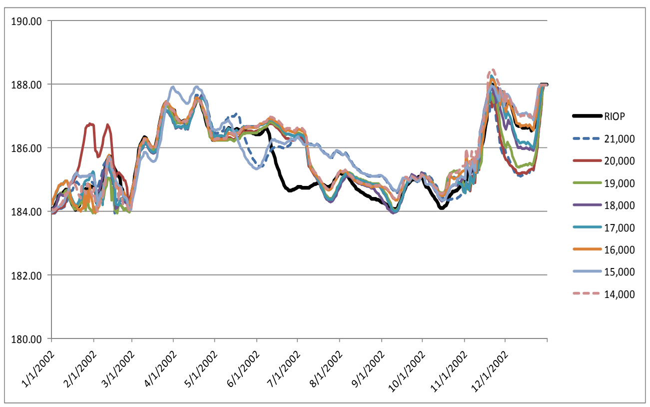

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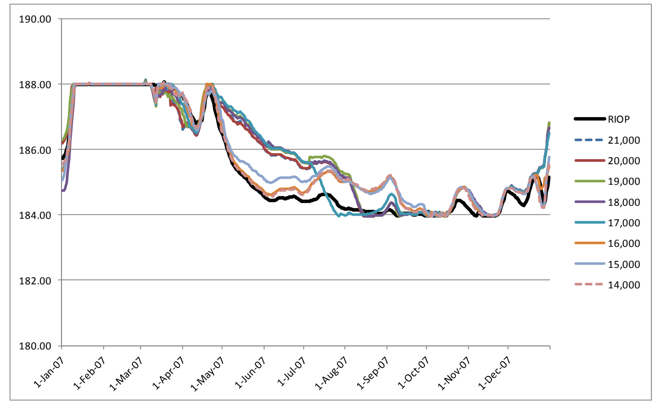
Figure 8 - 44. ANNUAL TIME SERIES OF AN EXTREME LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AN AUGMENTATION LIMIT OF 3,000 CFS (2007)



CHATTAHOOCHEE RIVER MINIMUM FLOW PERFORMANCE MEASURES

In Chapter 6 it was noted that there were minimum flow criteria for the Chattahoochee River for Peachtree Creek, Columbus and the Farley nuclear plant (Andrews outflow). The daily minimum flow value for Peachtree Creek is 750 cfs, for Columbus 1,850 cfs and for the Farley plant 2,000 cfs. As was explained in Chapter 6, in the first series of sensitivity analyses the minimum flow requirements for Columbus and Farley plant will be considered as "passive targets", that is, the reservoirs will not be required in the model to meet the target but an evaluation of how well they met the target incidentally will be done. If there are a lot of violations of the target, the model logic will be modified to require releases to meet the target.

Table 8-1 show the number of times each of these three targets were not met in the 70 year model run period. From this table it can be seen that flow is below the minimum values for Columbus and the Farley Plant far too frequently in all of the examples. This failure could either be due to the fact the targets were not hard wired as release requirements in the models or that there was inadequate water in either West point or W.F. George to make the releases necessary to meet the target. This issue will be examined in Chapter 9.

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Table 8 - 1. PERCENT OF TIME THAT FLOW IS BELOW THE MINIMUM VALUE FOR THE PERFORMANCE MEASURES FOR PEACHTREE CREEK, COLUMBUS AND FARLEY PLANT

AUGMENTATION LIMIT	COLUMBUS	ANDREWS	PEACHTREE CREEK
RIOP	2.81%	3.25%	0.00%
21000	3.43%	3.76%	0.00%
20000	3.27%	3.87%	0.00%
19000	3.75%	4.10%	0.00%
18000	3.72%	3.89%	0.00%
17000	3.70%	3.83%	0.00%
16000	3.67%	3.88%	0.00%
15000	3.57%	3.64%	0.00%
14000	3.72%	3.46%	0.00%

SUMMARY OF FINDINGS FOR CHANGING THE FLOWS AT WHICH THE 9-FOOT CHANNEL IS PROVIDED

In this portion of the sensitivity analysis the effects of alternative levels of dredging, and hence volume of dredging, needed to provide the 9-foot channel was evaluated using an augmentation limit of 3,000 cfs. The options evaluated ranged from the no dredging option (21,000 cfs to provide the 9-foot channel) to amount of dredging necessary to provide the channel at 14,000 cfs.

Figure 8-1 showed that the availability of the 9-foot channel is very dependent on the flow needed to provide the channel and the lower the flow needed to provide the 9-foot channel (the more dredging which is done), the greater the availability of the channel. Figure 8-2 shows that the same is true for the 7-foot channel. For the 9-foot, differences in the availability of the channel can be as great as 50% in some months depending on the flow to provide the channel and for the 7-foot channel differences can be as great as 60%. The average annual availability of the 9-foot channel ranged from 33% when the channel was provided at 21,000 cfs to 66% when the channel was provided at 14,000 cfs. These compare favorably with the 27% level of availability for the RIOP. The average annual availability of the 7-foot channel ranged from 42% when the channel was provided at 21,000 cfs to 82% when the channel was provided at 14,000 cfs. These also compare favorably with the 35% level of availability for the RIOP.

In evaluating the flow differences for the Jim Woodruff outflow at Chattahoochee the period of record median flows showed minor effects to modifying the flow needed to provide the navigation channel for most of the year, but some differences were noted in May and June. In the 75% exceeded figure large differences were noted for most of the year and in the 90% exceeded figures the differences were less pronounced. For the 75% exceeded figure the flow for the 14,000 cfs option, the average annual outflow at Jim Woodruff outflow was nearly 400 cfs greater than the outflow for 21,000 cfs option. This compares with a difference of about 270 cfs for the 90% exceeded option.

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When flow is compared with critical values linked to the inundation of the floodplain, an important variable in sustaining ecosystem vitality in the Apalachicola River, it can be seen that the extent of floodplain inundation is sensitive to the flow release needed to provide the 9-foot channel. With the greater the release, the greater the inundation for both the 15,000 cfs and 17,000 cfs thresholds so long as the release level necessary to provide the 9-foot channel is greater than the floodplain inundation threshold. The 29,000 cfs threshold showed little sensitivity. From this sensitivity analysis it can be seen that the real benefit to floodplain inundation is the duration of time that the floodplain is inundated when the flow needed to provide the 9-foot channel meets or exceeds the threshold value, which in turn would extend the amount of time that the habitat is available to young of the year and juvenile aquatic species. It is observed that as long as the flow needed to provide the 9-foot channel is greater than the floodplain inundation threshold that the lower the release to provide the channel the more frequently the value is exceeded.

In evaluating reservoir elevations at Lake Lanier the sensitivity analysis revealed that elevations at Lake Lanier are sensitive to the release needed to provide the 9-foot channel and the greater the release, the lower the elevation. The differences in median elevations can range greater than several feet between a 14,000 cfs and 21,000 cfs flow needed to provide a 9-foot channel. This difference is far less pronounced at the 75% exceeded and 90% exceeded elevations and for the less exceeded elevations were higher with the greater flow needed to provide the 9-foot channel. This is the result of the fact that the time period when Lanier is actively augmenting is when it is at median elevations and implies a higher release threshold when the reservoir will cease to be augmenting. Elevations at Lake Lanier are decreased relative to the RIOP. In reviewing the annual time series figures (figures 8-19 to 8-24) it can be seen that there are limited differences in the average flow years (1970 and 1977) but in the low flow years (1981 and 1988) the elevations are drawn down for the 14,000 cfs and 15,000 cfs releases to provide the 9-foot channel. This phenomenon is due to the fact that there is a greater frequency of augmentation releases made at these release levels.

At West Point the period of record figures' variations are greatest for the median elevations from April through December, with the range of variation being nearly three feet and elevations at West Point were lowered relative to the RIOP elevations. Changes for the 75% exceeded and 90% exceeded figures were not as large as those for the median elevations. For the 75% exceeded elevations, the elevations in general continued to decline as the volume of flow needed to provide the navigation channel was increased, but for the 90% exceeded elevations the same trend as was seen at Lanier was evident at West Point: elevations tended to increase at certain times of the year as the volume of flow needed to provide the channel increased. From the minimum elevation figure it can seen that for much of the time from July to December West Point was drawn down to the bottom of its conservation pool during the model run period. For the annual time series elevation figures considerable variations were evident for each of the years included in the analysis with the greatest variations occurring in the normal years. In the daily time series elevations at West Point were generally lower than for the RIOP releases.

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At W.F. George for the period of record figures large differences in elevations are evident after early May in the median elevations, with differences of over two feet occurring. When it is considered that the depth of the conservation pool at W.F. George is only 8 feet, these differences are major. Differences for the 75% exceeded, 90% exceeded and minimum elevations show a lot less sensitivity to changes in releases needed to provide the 9-foot channel with the minimum elevations showing that the reservoir does get lowered to the bottom of its conservation pool. W.F. George did not respond in the same manner as Lanier and West Point in regard to having its 90% exceeded elevations increase as the volume of flow needed to provide the 9-foot channel increased. Median and 75% exceeded elevations are lower than those for the RIOP. Similarly to what was seen at West Point, some variation was seen in the annual time series figures with the greatest differences occurring in the normal flow years (1970 and 1977).

From the respective model runs and comparison to performance measures it can be seen that as the flow needed to provide a 9-foot channel increases the availability of the navigation channel decreases, the elevation at the storage reservoir declines (except at the lower range of elevations) and the duration of flood plain inundation increases. Therefore, in the second part of this chapter the middle ground in this analysis, providing the navigation channel at a 17,000 cfs and 18,000 cfs flow will be evaluated with augmentation limits of both 2,000 cfs and 3,000 cfs. This would result in a decrease in the amount of dredging necessary to provide the channel at a 14,000 cfs flow and consequently less environmentally related problems which could be offset by increased inundation of the floodplain

ANALYSIS OF SELECTED RELEASES NEEDED TO PROVIDE A 9-FOOT CHANNEL IN THE APALACHICOLA RIVER WITH SELECTED AUGMENTATION LIMITS

In this section the effects of having a 17,000, 18,000 and 19,000 cfs release needed to provide a 9-foot channel with augmentation limits ranging from 2,000 cfs to 3,000 cfs will be evaluated. These values were selected because they provide a balance between providing the navigation channel, providing flows which are beneficial to the environment and the lowering of elevations at the federal storage reservoirs.

NAVIGATION PERFORMANCE MEASURES

Figure 8-45 shows the availability of the 9-foot navigation channel with a range of flows needed to provide a 9-foot navigation channel. As explained earlier, in all of our analyses we have chosen to use current operations (RIOP) as the baseline against which to compare changes and that current operations do not included releases for either navigation or environmental flows. Figure 8-46 shows the availability of a 7-foot channel.

From figure 8-45 it can seen that there are significant improvements over the RIOP release rules (RIOP evaluated at providing the channel at 19,000 cfs) and that as the level of augmentation increases and the flow needed to provide the 9-foot channel decreases the level of availability of the 9-foot channel increases. Figure 8-46 shows that the same is true for the 7-foot channel. The average annual availability of the 9-foot channel ranges from 36.8% when the release to provide the 9-foot channel was 19,000 cfs and the augmentation limit was 2,000 cfs to 44.4% when 17,000 cfs is needed to provide the 9-foot channel and the augmentation limit is 3,000

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cfs. These compare with 26.5% for the RIOP. The average annual availability of the 7-foot channel ranges from 54% when the release to provide the 9-foot channel was 19,000 cfs and the augmentation limit was 2,000 cfs to 68.4% when 17,000 cfs is needed to provide the 9-foot channel and the augmentation limit is 3,000 cfs. These compare with 49.4% for the RIOP.

When the time period of January through May is considered the average annual availability of the navigation channel ranges from 60.4% when the release to provide the 9-foot channel was 19,000 cfs and the augmentation limit was 2,000 cfs to 66.9% when 17,000 cfs is needed to provide the 9-foot channel and the augmentation limit is 3,000 cfs. These compare with 48.7% for the RIOP. When the availability of the 7-foot channel from January through May is considered the average annual availability of the navigation channel ranges from 78.7% when the release to provide the 9-foot channel was 19,000 cfs and the augmentation limit was 2,000 cfs to 87.7% when 17,000 cfs is needed to provide the 9-foot channel and the augmentation limit is 3,000 cfs. These compare with 77.1% for the RIOP.

Figure 8 - 45. AVAILABILITY OF A NINE-FOOT CHANNEL WITH VARYING LEVELS OF DREDGING TO PROVIDE THE CHANNEL AND VARYING AUGMENTATION

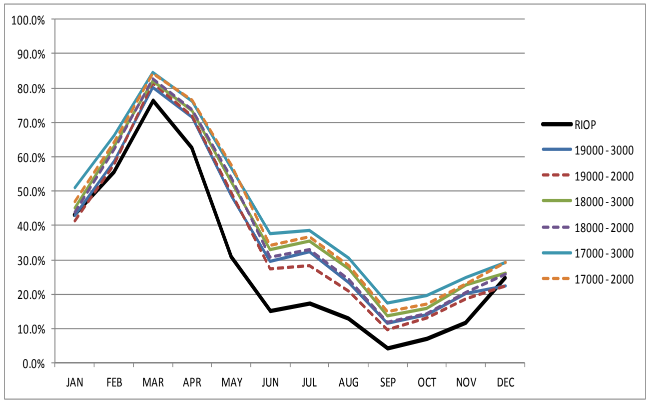

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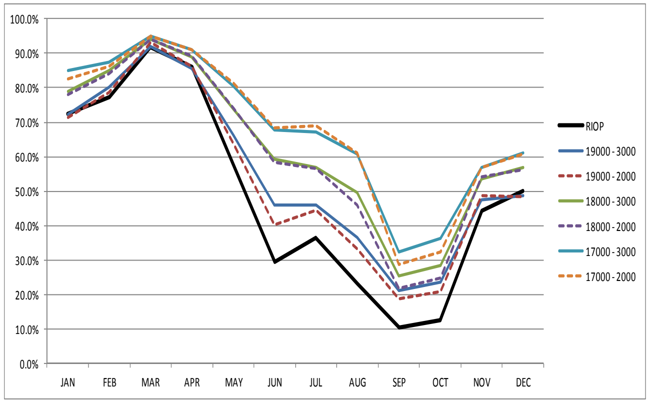
Figure 8 - 46. AVAILABILITY OF A SEVEN-FOOT CHANNEL WITH VARYING LEVELS OF DREDGING TO PROVIDE THE CHANNEL AND VARYING AUGMENTATION



ENVIRONMENTAL PERFORMANCE MEASURES

Figures 8-47, 8-48 and 8-49 show the comparisons of median, 75% exceeded flows and 90% exceeded flows for model runs relative to the RIOP for the entire model run period (1939 – 2008) and figures 8-50, 8-51, 8-52, 8-53, 8-54 and 8-55 show the same data for individual years chosen to represent normal flows, low flows and extreme low flows. In the annual time series data the flow values shown were truncated to the 0 to 30,000 cfs range to better display differences between model runs.

From these figures it can seen that when comparing the period of record figures (figures 8-47 - 8-49) at the scale it is evaluated for, there are minimal differences for median flows in whether 17,000 cfs, 18,000 or 19,000 cfs is released to provide the 9-foot channel and whether the augmentation limit is set at 2,000 or 3,000 cfs. For the 75% exceeded flows larger differences are evident. The 75% exceeded average annual flow ranges from 13,425 cfs for a 19,000 cfs flow to provide the 9-foot channel and an augmentation limit of 3,000 cfs to 13,635 cfs flow for a 17,000 cfs flow to provide the 9-foot navigation channel and an augmentation limit of 2,000 cfs. This resulted in a difference of just over 200 cfs. For the 75% exceeded flows all of the annual averages were less than the annual average flow at Jim Woodruff outflow for the RIOP. For the 90% exceeded flows larger differences are also evident. The 90% exceeded average annual flow ranges from 9,410 cfs for a 19,000 cfs flow to provide the 9-foot channel and an augmentation limit of 3,000 cfs to 9,557 cfs flow for a 17,000 cfs flow to provide the 9-foot navigation channel and an augmentation limit of 3,000 cfs. This resulted in a difference of just over 145 cfs. For the 90% exceeded flows all of the annual averages were greater than the annual average flow at Jim Woodruff outflow for the RIOP.

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In reviewing the annual time series figures (figures 8-50 - 8-55) it can be seen that more differences are apparent and that there is a phase shift in timing where events happen later as the magnitude of the release to provide the 9-foot channel is decreased.

Figure 8 - 47. MEDIAN FLOWS FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF DREDGING TO PROVIDE A NINE-FOOT CHANNEL FOR THE PERIOD OF RECORD (1939 – 2008) AND VARYING AUGMENTATION

Figure 8 - 48. 75% EXCEEDED FLOWS FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF DREDGING TO PROVIDE A NINE-FOOT CHANNEL FOR THE PERIOD OF RECORD (1939 – 2008) AND VARYING AUGMENTATION

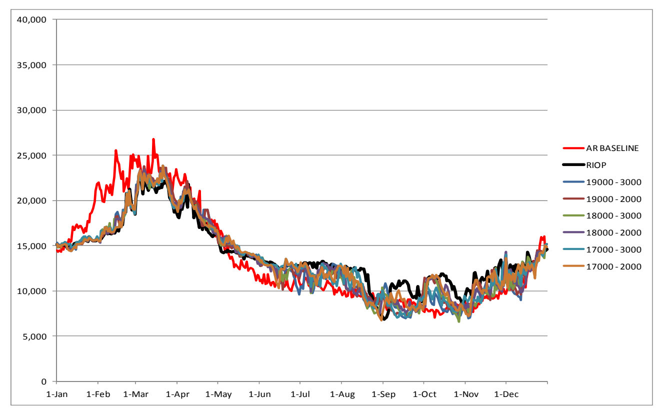

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Figure 8 - 49. 90% EXCEEDED FLOWS FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF DREDGING TO PROVIDE A NINE-FOOT CHANNEL FOR THE PERIOD OF RECORD (1939 – 2008) AND VARYING AUGMENTATION

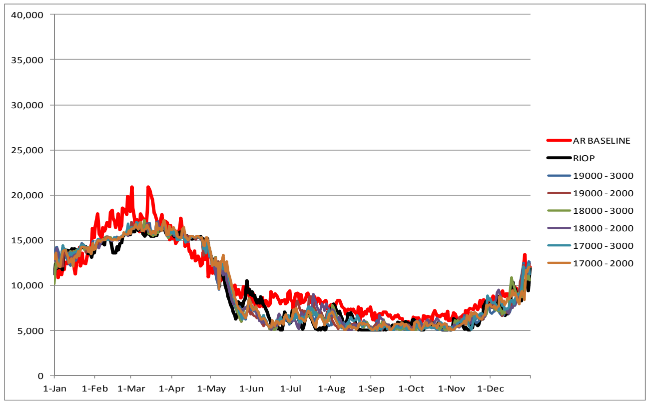

Figure 8 - 50. ANNUAL TIME SERIES FOR NORMAL FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF FLOW RELEASES NECESSARY TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (1970) AND VARYING AUGMENTATION

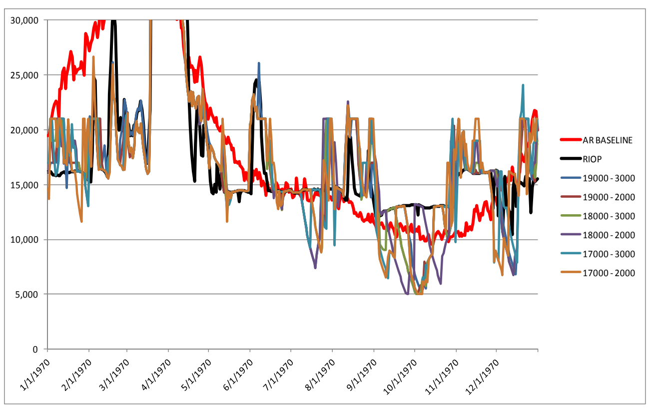

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Figure 8 - 51. ANNUAL TIME SERIES FOR NORMAL FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF FLOW RELEASES NECESSARY TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (1977) AND VARYING AUGMENTATION

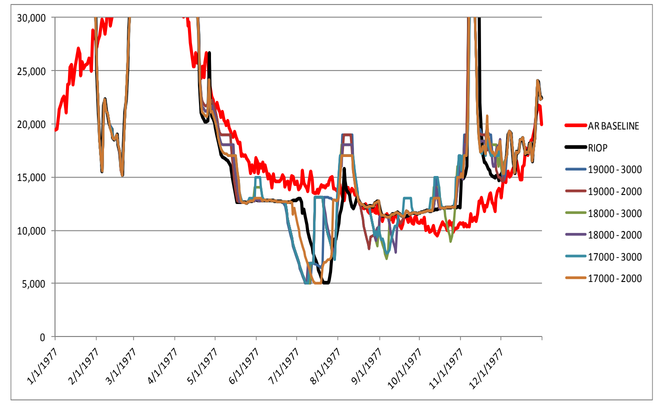

Figure 8 - 52. ANNUAL TIME SERIES FOR LOW FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF FLOW RELEASES NECESSARY TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (1981) AND VARYING AUGMENTATION

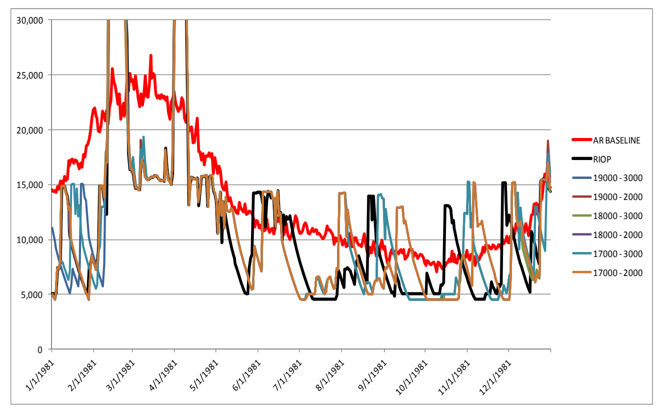

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Figure 8 - 53. ANNUAL TIME SERIES FOR LOW FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF FLOW RELEASES NECESSARY TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (1988) AND VARYING AUGMENTATION

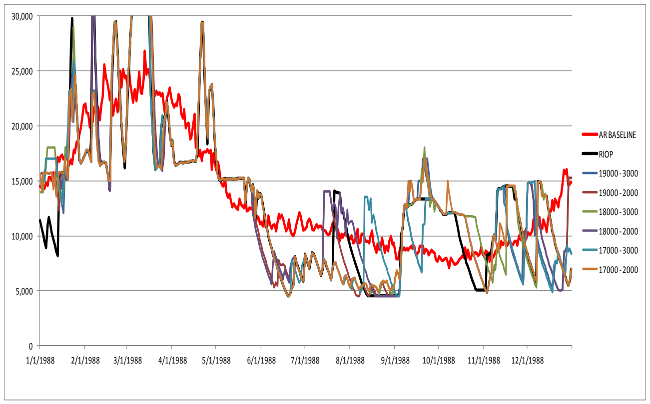

Figure 8 - 54. ANNUAL TIME SERIES FOR EXTREME LOW FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF FLOW RELEASES NECESSARY TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (2002) AND VARYING AUGMENTATION

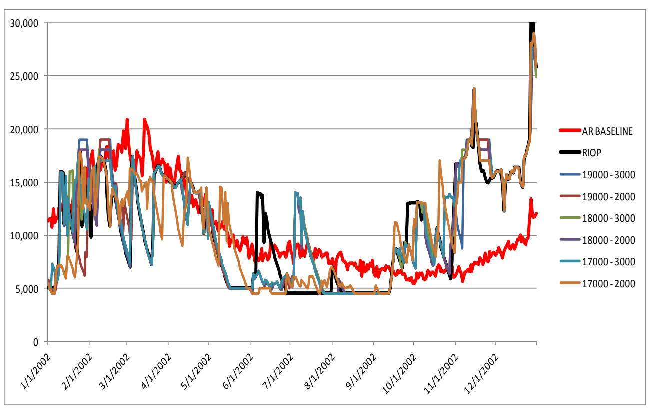

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Figure 8 - 55. ANNUAL TIME SERIES FOR EXTREME LOW FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF FLOW RELEASES NECESSARY TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (2007) AND VARYING AUGMENTATION

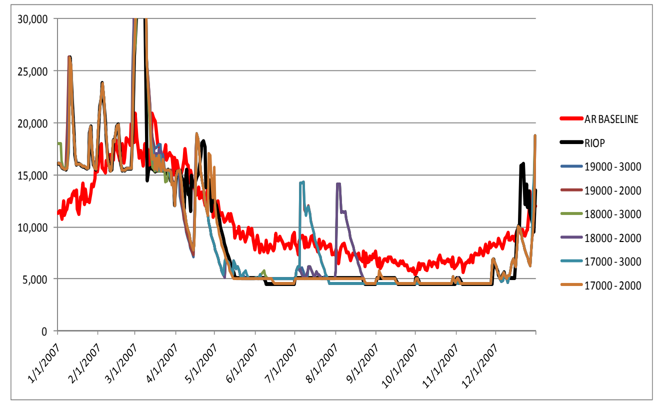

Figure 8-56 shows the amount of time 15,000 cfs was exceeded; figure 8-57 the amount of time 17,000 cfs was exceeded and figure 8-58 the amount of time 29,000 cfs was exceeded. For the 15,000 cfs exceeded threshold the flow threshold was exceeded 53.9 % of the time under the RIOP. The values under the model runs ranged from 59.0% of the time with a 19,000 cfs release to provide the 9-foot channel and 2,000 cfs augmentation to 62.2% of the time with a 17,000 cfs release to provide the 9-foot navigation channel with 3,000 cfs augmentation limit. When the spawning season is considered (February through May) these values are about 85% for the RIOP to 86.2%for a 19,000 cfs release to provide a 9-foot channel with a 2,000 cfs augmentation limit to 87.3% for a 17,000 cfs release to provide the 9-foot channel and a 3,000 cfs augmentation limit. For the 17,000 cfs exceeded threshold the flow threshold was exceeded 38.5 % of the time under the RIOP. The values under the model runs ranged from 44.9% of the time with a 19,000 cfs release to provide the 9-foot channel and a 2,000 cfs augmentation to 48.5% of the time with 17,000 cfs release to provide the 9-foot navigation channel with 3,000 cfs augmentation limit. When the spawning season is considered (February through May) these values range from 70.4% for the RIOP to 75.9% for a 19,000 cfs release to provide a 9-foot channel with a 2,000 cfs augmentation limit to 76.7% for a 17,000 cfs release to provide the 9-foot channel and a 3,000 cfs augmentation limit. From these figures it can be seen that the extent of floodplain inundation is highly sensitive to flow release and amount of flow augmentation provided from the reservoirs for both the 15,000 cfs and 17,000 cfs thresholds so long as the release necessary to provide a 9-foot channel is greater than the flow threshold whose exceedance is being evaluated. For these two figures the closer the flow needed to provide the 9-foot channel is to the desired threshold and the greater the amount of augmentation provided the federal reservoirs, the greater the amount of time the threshold is

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exceeded. Therefore, in Figure 8-56 the line which shows the greatest amount of time that the 15,000 cfs threshold is met or exceeded is when the 9-foot channel is provided at a 17,000 cfs/3,000 cfs augmentation flow and for the 17,000 cfs threshold the greatest amount of time is for the 17,000/3,000 cfs threshold. The 29,000 cfs threshold showed little sensitivity to alternate flows needed to provide the 9-foot channel since the evaluated releases were all below the threshold level.

Figure 8 - 56. PERCENT OF TIME 15,000 CFS WAS EXCEEDED FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF FLOW SUPPORT TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AND VARYING AUGMENTATION

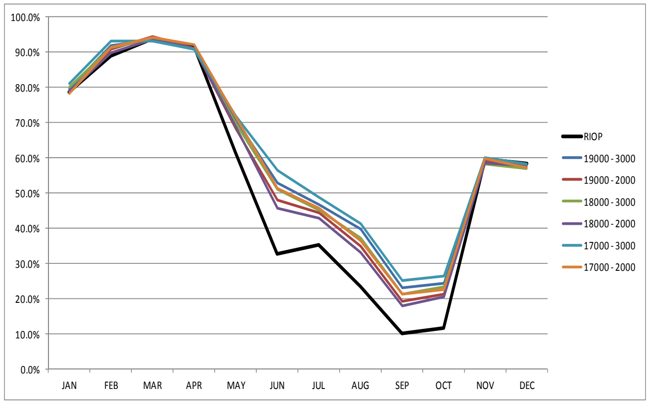

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Figure 8 - 57. PERCENT OF TIME 17,000 CFS WAS EXCEEDED FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF FLOW SUPPORT TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AND VARYING AUGMENTATION

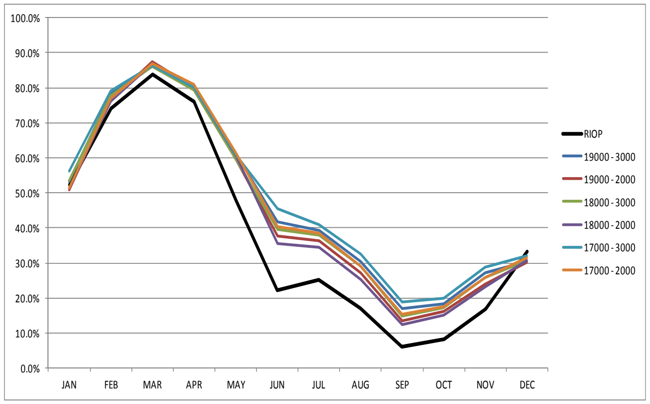
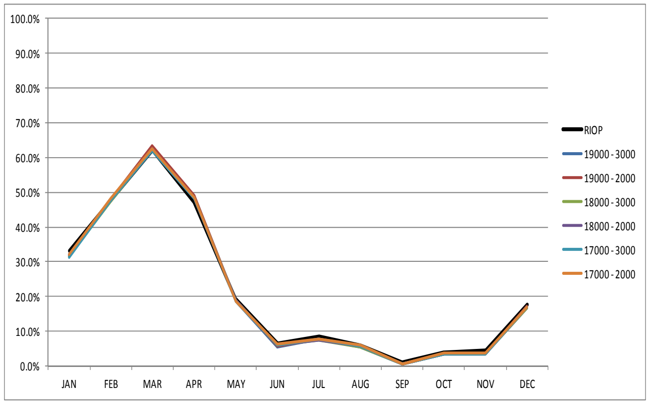


Figure 8 - 58. PERCENT OF TIME 29,000 CFS WAS EXCEEDED FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF FLOW SUPPORT TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AND VARYING AUGMENTATION



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RESERVOIR ELEVATION PERFORMANCE MEASURES

LAKE LANIER

Figures 8-59, 8-60, 8-61 and 8-62 show the elevations at Lake Lanier for the period of record and figures 8-63, 8-64, 8-65, 8-66, 8-67 and 8-68 show annual time series charts comparing the elevations at Lake Lanier for various levels of augmentation. The period of record figures show that these operations will result in a lowering of Lanier elevations relative to the RIOP. The period of record figures also show that at median elevations in the fall of the year the differences can be over two feet between the RIOP operations and operations which provide the navigation channel. Sensitivity to changes in flow to provide the navigation channel and in level of augmentation is more evident in the 75% exceeded, 90% exceeded and minimum elevations. In the period of record figure for median elevation (figure 8-59) the average annual elevation under the RIOP was 1064.05. In the sensitivity analyses the median average annual elevation ranged from 1062.25 for a 19,000 cfs release to provide the 9-foot channel with an augmentation limit of 3,000 cfs to 1062.85 for the 17,000 cfs release to provide a 9-foot channel with an augmentation limit of 2,000 cfs augmentation limit. In the period of record figure for 75% exceeded elevation (figure 8-60) the average annual elevation under the RIOP was 1060.35. In the sensitivity analyses the 75% exceeded elevations average annual elevation ranged from 1059.33 for a 17,000 cfs release to provide the 9-foot channel with an augmentation limit of 3,000 cfs to 1059.93 for the 17,000 cfs release to provide a 9-foot channel with an augmentation limit of 3,000 cfs augmentation limit. In the sensitivity analyses the 90% exceeded elevations average annual elevation ranged from 1056.97 for a 18,000 cfs release to provide the 9-foot channel with an augmentation limit of 3,000 cfs to 1057.84 for the 19,000 cfs release to provide a 9-foot channel with an augmentation limit of 2,000 cfs augmentation limit. For the 90% exceeded elevations the average annual elevation under the RIOP was 1058.58. For minimum elevations the average annual elevation under the RIOP was 1054.55. In the sensitivity analyses the minimum elevations average annual elevation ranged from 1049.90 for a 17,000 cfs release to provide the 9-foot channel with an augmentation limit of 3,000 cfs to 1054.06 for the 19,000 cfs release to provide a 9-foot channel with an augmentation limit of 2,000 cfs augmentation limit.

In examining the differences in the annual time series data it can be seen that reservoir elevations at Lanier showed little sensitivity to changes in the individual years except for during the 2002 and 2007 drought years.

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Figure 8 - 59. MEDIAN ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AND VARYING AUGMENTATION

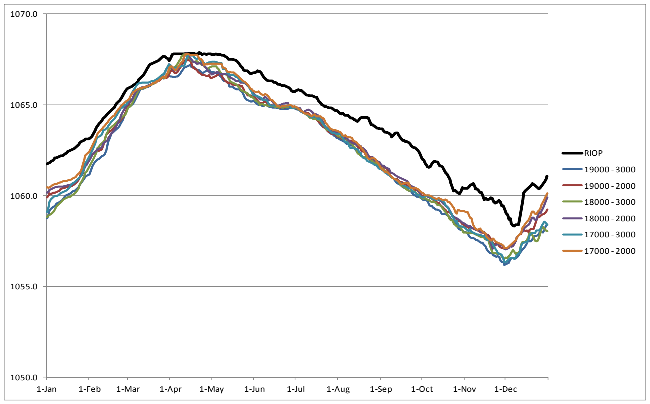

Figure 8 - 60. 75% EXCEEDED ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AND VARYING AUGMENTATION

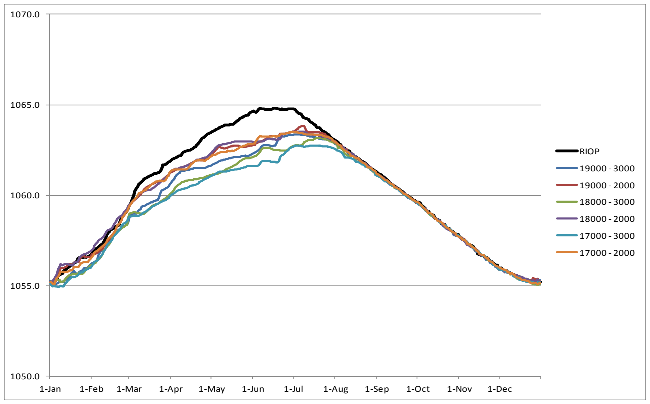

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Figure 8 - 61. 90% EXCEEDED ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AND VARYING AUGMENTATION

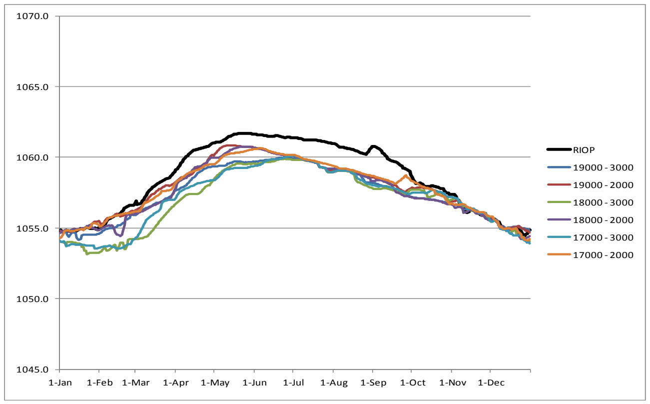

Figure 8 - 62. MINIMUM ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AND VARYING AUGMENTATION

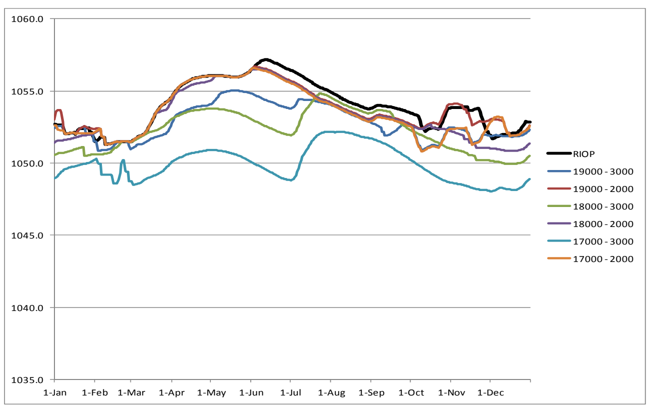

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Figure 8 - 63. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (1970) AND VARYING AUGMENTATION

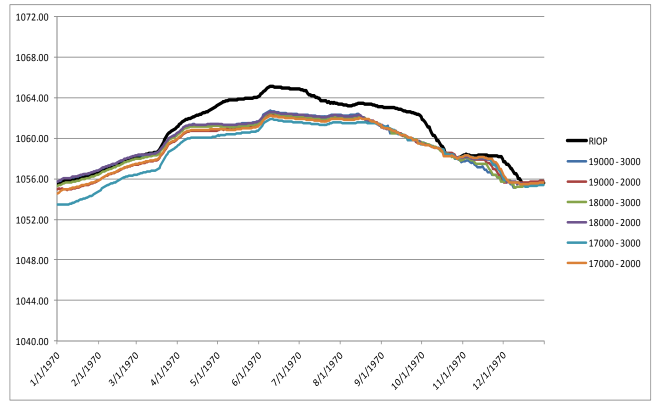

Figure 8 - 64. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (1977) AND VARYING AUGMENTATION

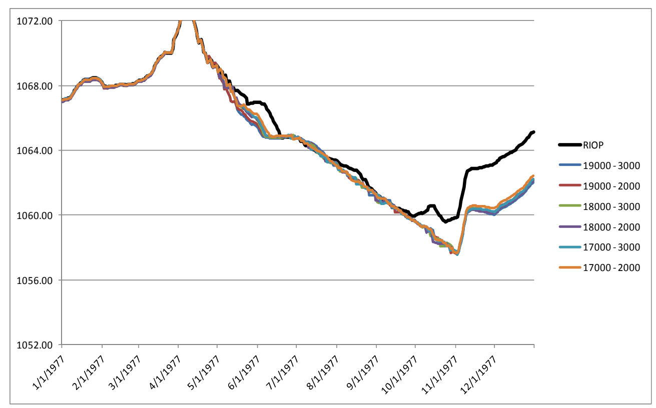

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Figure 8 - 65. ANNUAL TIME SERIES OF LOW FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (1981) AND VARYING AUGMENTATION

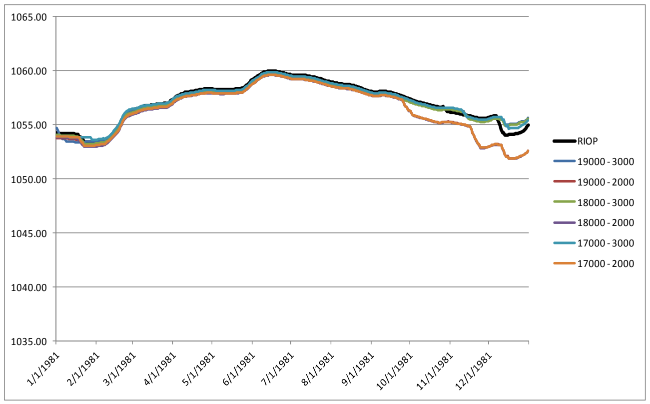

Figure 8 - 66. ANNUAL TIME SERIES OF LOW FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (1988) AND VARYING AUGMENTATION

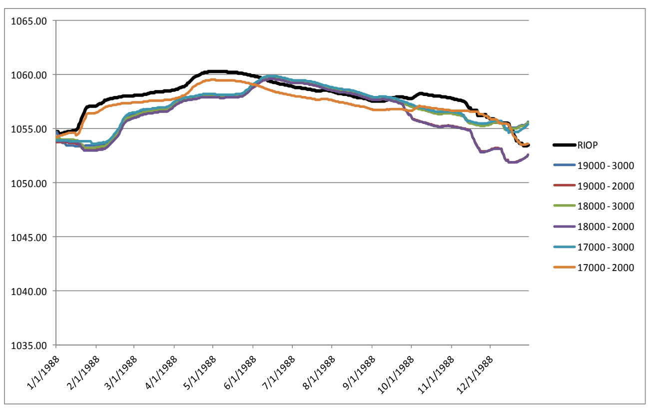

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Figure 8 - 67. ANNUAL TIME SERIES OF EXTREME LOW FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (2002) AND VARYING AUGMENTATION

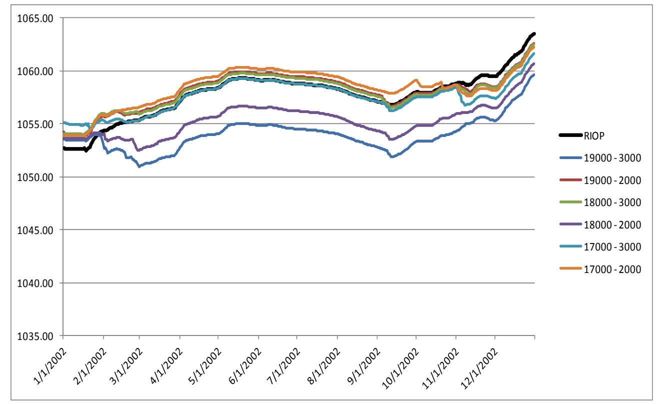
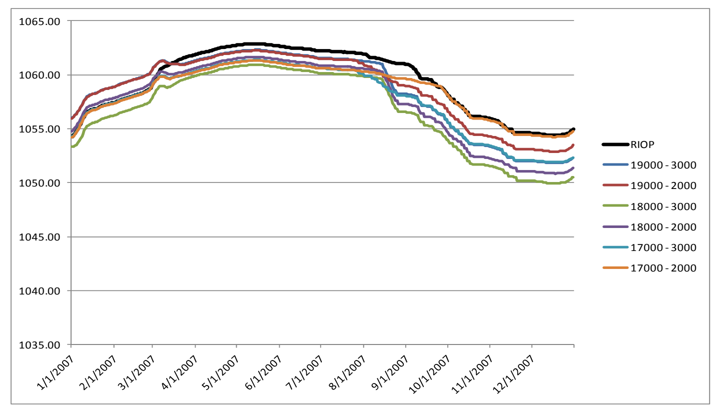


Figure 8 - 68. ANNUAL TIME SERIES OF EXTREME LOW FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (2007) AND VARYING AUGMENTATION



WEST POINT

Figures 8-69, 8-70, 8-71 and 8-72 show the period of record data for West Point elevations and Figures 8-73, 8-74, 8-75, 8-76, 8-77 and 8-78 show the annual time series data for selected years for elevations at West Point reservoir.

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The period of record figures show that West Point reservoir shows limited sensitivity to the changes in flow needed to provide a 9-foot channel in the 17,000 to 19,000 cfs range and changes in augmentation from 2,000 cfs to 3,000 cfs. Median and 75% exceeded elevations are in general less than elevations under the RIOP, although at the 75% exceeded level the differences are relatively minor. In the period of record figure for median elevation (figure 8-69) the average annual elevation under the RIOP was 630.29. In the sensitivity analyses the median average annual elevation ranged from 629.06 for a 19,000 cfs release to provide the 9-foot channel with an augmentation limit of 3,000 cfs to 629.49 for the 17,000 cfs release to provide a 9-foot channel with an augmentation limit of 2,000 cfs augmentation limit. In the period of record figure for 75% exceeded elevation (figure 8-70) the average annual elevation under the RIOP was 627.40. In the sensitivity analyses the 75% exceeded elevations average annual elevation ranged from 626.78 for a 17,000 cfs release to provide the 9-foot channel with an augmentation limit of 3,000 cfs to 626.91 for the 17,000 cfs release to provide a 9-foot channel with an augmentation limit of 3,000 cfs augmentation limit. In the sensitivity analyses the 90% exceeded elevations average annual elevation ranged from 624.67 for a 19,000 cfs release to provide the 9-foot channel with an augmentation limit of 3,000 cfs to 624.89 for the 19,000 cfs release to provide a 9-foot channel with an augmentation limit of 2,000 cfs augmentation limit. For the 90% exceeded elevations the average annual elevation under the RIOP was 625.18. For minimum elevations the average annual elevation under the RIOP was 622.3. In the sensitivity analyses the minimum elevations average annual elevation ranged from 621.75 for a 19,000 cfs release to provide the 9-foot channel with an augmentation limit of 3,000 cfs to 621.93 for the 19,000 cfs release to provide a 9-foot channel with an augmentation limit of 2,000 cfs.

The annual time series figures show little variation with the changes in flow needed to provide the 9-foot channel and changes in augmentation level in the more normal flow years (1970 and 1977), but a greater range of variability in the low flow and extreme low flow years.

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Figure 8 - 69. MEDIAN ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AND VARYING AUGMENTATION

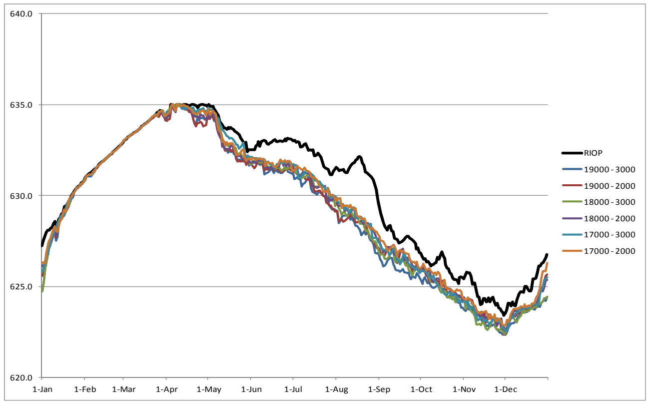

Figure 8 - 70. 75% EXCEEDED ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AND VARYING AUGMENTATION

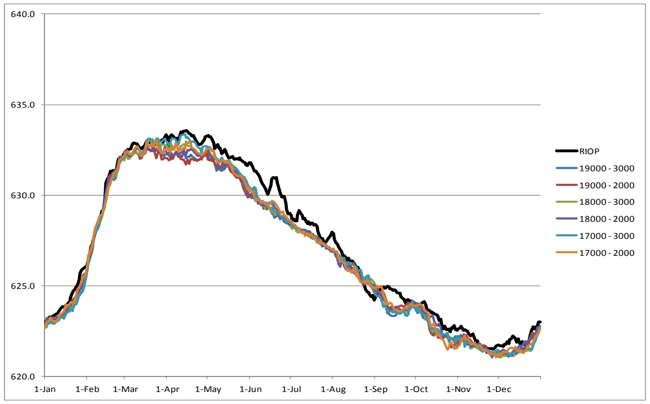

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Figure 8 - 71. 90% EXCEEDED ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AND VARYING AUGMENTATION

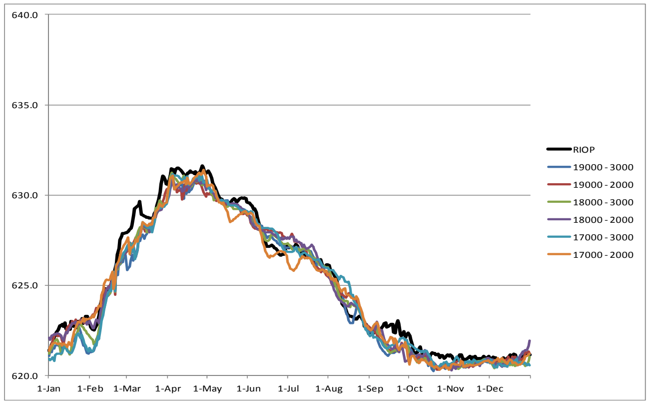

Figure 8 - 72. MINIMUM ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AND VARYING AUGMENTATION

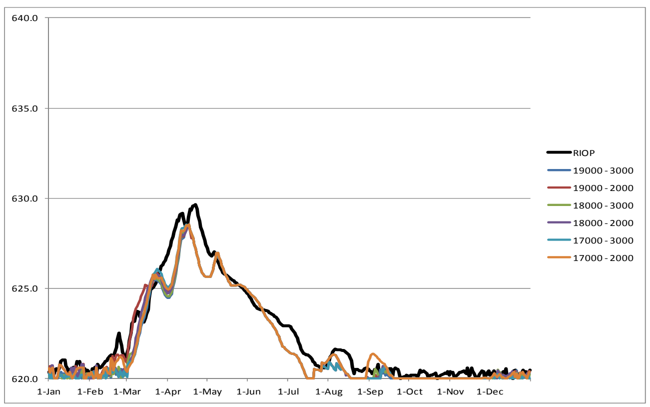

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Figure 8 - 73. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (1970) AND VARYING AUGMENTATION

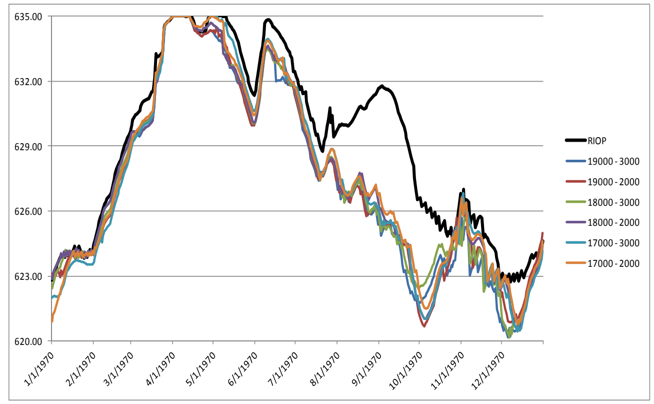

Figure 8 - 74. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (1977) AND VARYING AUGMENTATION

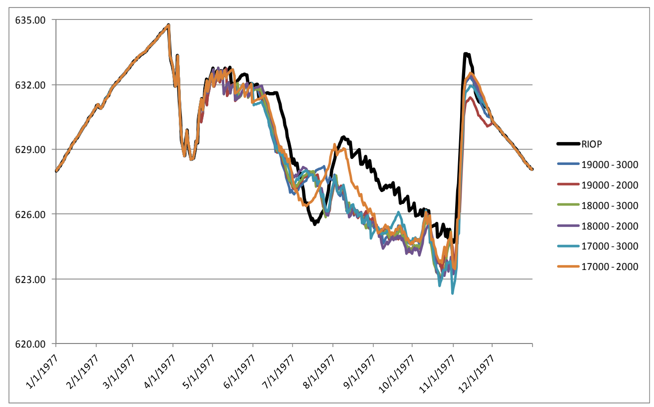

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Figure 8 - 75. ANNUAL TIME SERIES OF A LOW FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (1981) AND VARYING AUGMENTATION

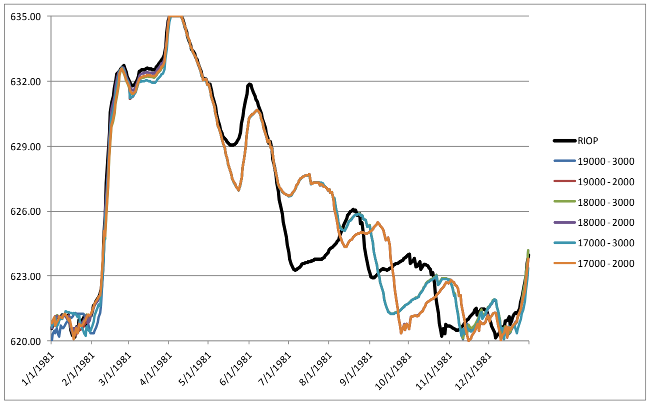

Figure 8 - 76. ANNUAL TIME SERIES OF A LOW FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (1988) AND VARYING AUGMENTATION

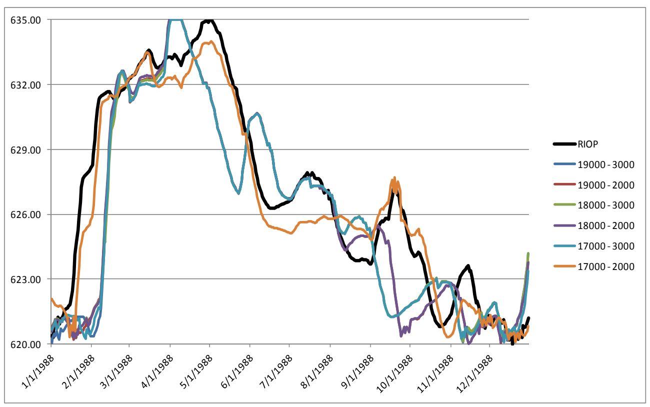

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Figure 8 - 77. ANNUAL TIME SERIES OF AN EXTREME LOW FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (2002) AND VARYING AUGMENTATION

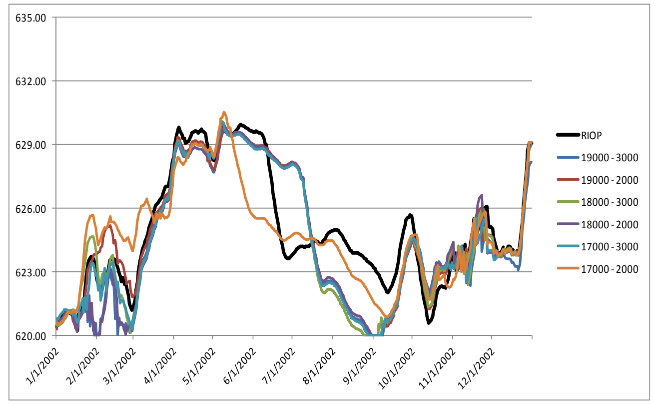
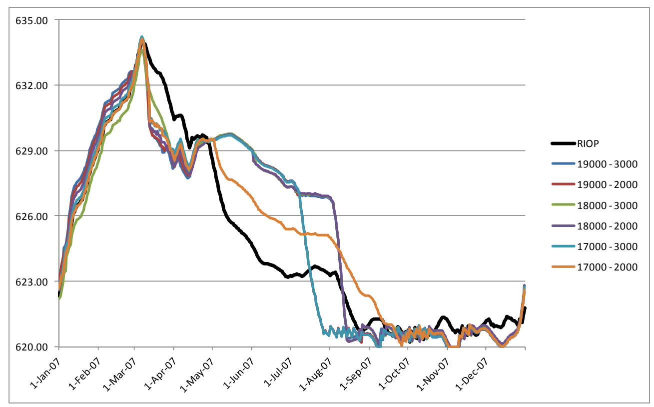


Figure 8 - 78. ANNUAL TIME SERIES OF AN EXTREME LOW FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (2007) AND VARYING AUGMENTATION



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W.F. GEORGE

Figures 8-79, 8-80, 8-81 and 8-82 how the period of record data for elevations at W.F. George and figures 8-83, 8-84, 8-85, 8-86, 8-87 and 8-88 show the annual time series data for elevations at W.F. George.

The period of record figures show that elevations at W.F. George are sensitive to changes in the flow needed to provide the navigation channel and level of augmentation in the median elevation figures, but not so much in the 75% exceeded, 90% exceeded and minimum elevation figures. In the period of record figure for median elevation (figure 8-79) the average annual elevation under the RIOP was 187.8. In the sensitivity analyses the median average annual elevation ranged from 187.07 for a 19,000 cfs release to provide the 9-foot channel with an augmentation limit of 3,000 cfs to 187.38 for the 17,000 cfs release to provide a 9-foot channel with an augmentation limit of 2,000 cfs augmentation limit. In the period of record figure for 75% exceeded elevation (figure 8-80) the average annual elevation under the RIOP was 186.37. In the sensitivity analyses the 75% exceeded elevations average annual elevation ranged from 186.21 for a 17,000 cfs release to provide the 9-foot channel with an augmentation limit of 2,000 cfs to 186.29 for the 17,000 cfs release to provide a 9-foot channel with an augmentation limit of 3,000 cfs augmentation limit. In the sensitivity analyses the 90% exceeded elevations average annual elevation ranged from 185.54 for a 19,000 cfs release to provide the 9-foot channel with an augmentation limit of 3,000 cfs to 185.65 for the 19,000 cfs release to provide a 9-foot channel with an augmentation limit of 2,000 cfs augmentation limit. For the 90% exceeded elevations the average annual elevation under the RIOP was 625.18. For minimum elevations the average annual elevation under the RIOP was 184.46. In the sensitivity analyses the minimum elevations average annual elevation ranged from 184.44 for a 19,000 cfs release to provide the 9-foot channel with an augmentation limit of 3,000 cfs to 184.49 for the 17,000 cfs release to provide a 9-foot channel with an augmentation limit of 2,000 cfs augmentation limit.

The annual time series figures show in certain years that there is a sensitivity of elevations at W.F. George to a change in the flow needed to provide the 9-foot channel and changes in the level of augmentation.

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Figure 8 - 79. MEDIAN ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AND VARYING AUGMENTATION

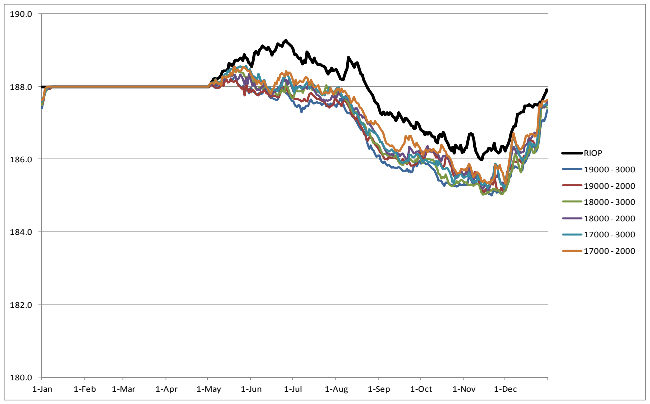

Figure 8 - 80. 75% EXCEEDED ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AND VARYING AUGMENTATION

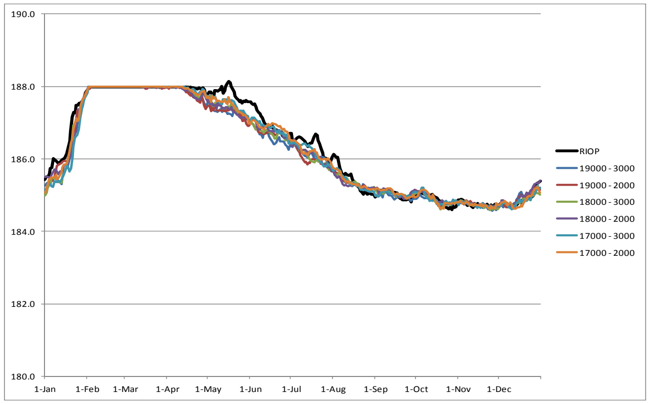

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Figure 8 - 81. 90% EXCEEDED ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AND VARYING AUGMENTATION

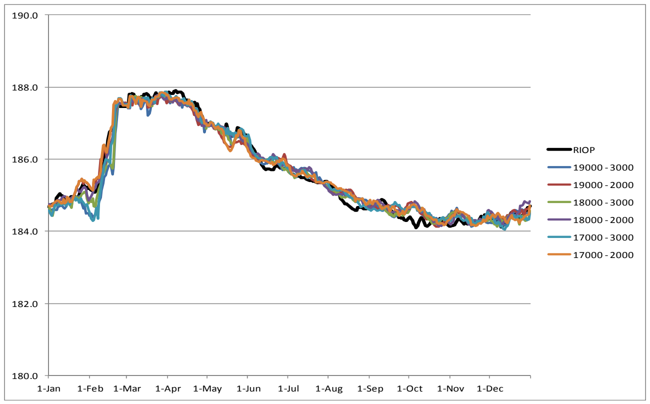

Figure 8 - 82. MINIMUM ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL AND VARYING AUGMENTATION

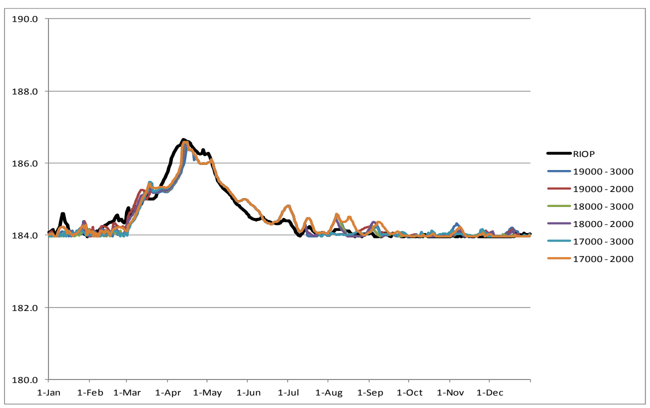

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Figure 8 - 83. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (1970) AND VARYING AUGMENTATION

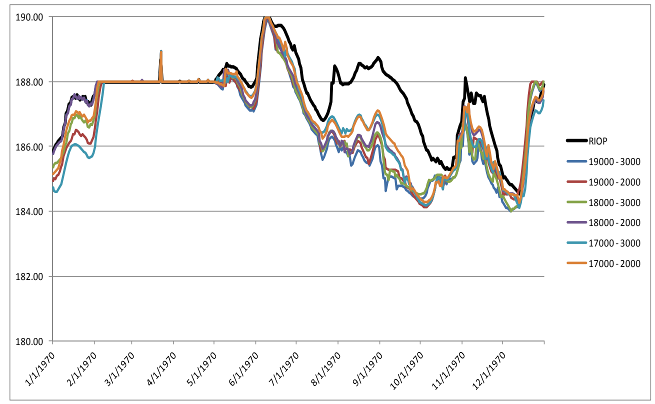

Figure 8 - 84. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (1977) AND VARYING AUGMENTATION

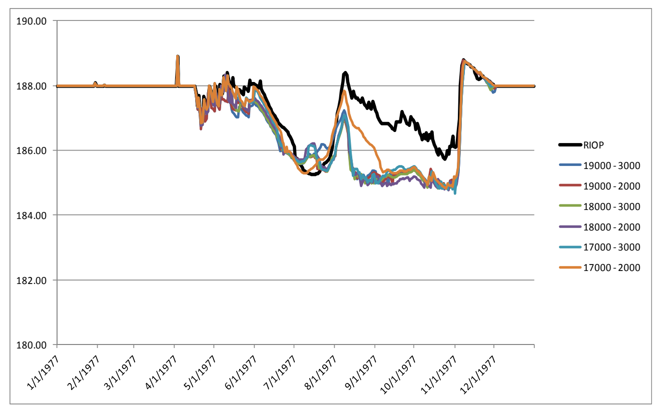

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Figure 8 - 85. ANNUAL TIME SERIES OF A LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (1981) AND VARYING AUGMENTATION

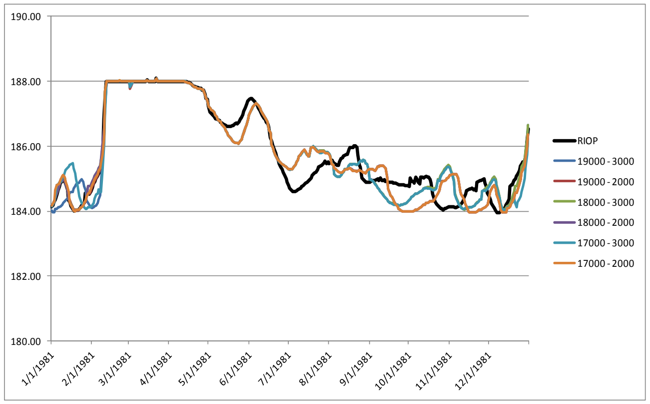

Figure 8 - 86. ANNUAL TIME SERIES OF A LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (1988) AND VARYING AUGMENTATION

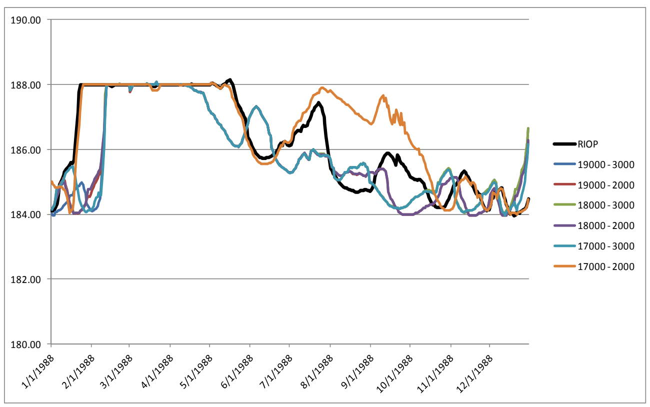

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Figure 8 - 87. ANNUAL TIME SERIES OF AN EXTREME LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (2002) AND VARYING AUGMENTATION

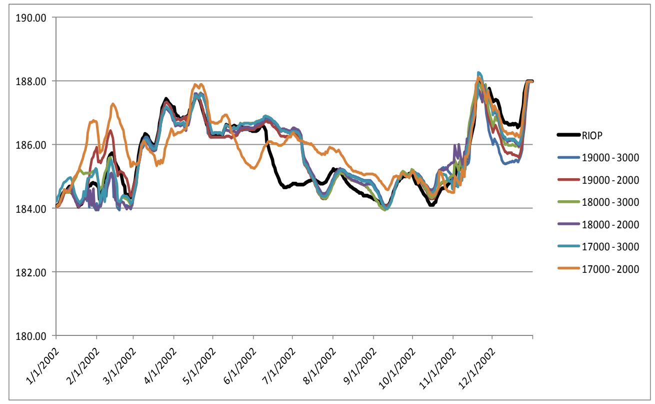
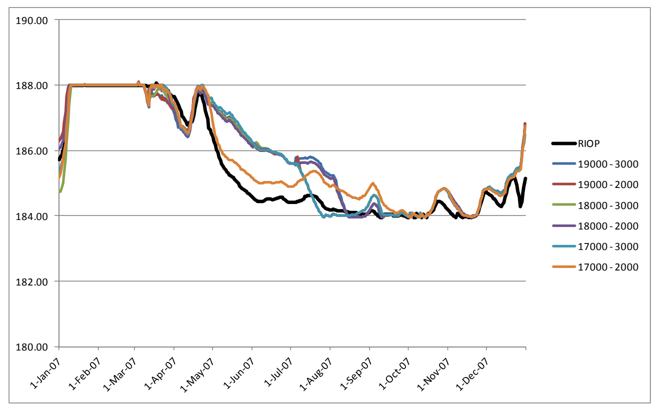


Figure 8 - 88. ANNUAL TIME SERIES OF AN EXTREME LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF FLOW NEEDED TO PROVIDE A NINE-FOOT NAVIGATION CHANNEL (2007)



CHATTAHOOCHEE RIVER MINIMUM FLOW PERFORMANCE MEASURES

In Chapter 6 it was noted that there were minimum flow criteria for the Chattahoochee River for Peachtree Creek, Columbus and the Farley nuclear plant (Andrews outflow). The daily minimum flow value for Peachtree Creek is 750 cfs, for Columbus 1,850 cfs and for the Farley

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plant 2,000 cfs. As was explained in Chapter 6, in the first series of sensitivity analyses the minimum flow requirements for Columbus and Farley plant will be considered as "passive targets", that is, the reservoirs will not be required in the model to meet the target but an evaluation of how well they met the target incidentally will be done. If there are a significant number of violations of the target, the model logic will be modified to require releases to meet the target. Table 8-2 show the number of times each of these three targets were not met in the 80 year model run period. From this table it can be seen that flow is below the minimum values for Columbus and the Farley Plant far too frequently in all of the examples.

In reviewing the output for table 8-2 it can be seen that minimum flow targets for Columbus and Andrews, are not met with some regularity and that the number of violations increase as the navigation releases and as augmentation limits increase. In the next chapter this will be examined in more detail. These failures could either be due the fact that the minimum flow requirements are not fixed targets, but are passive targets or that there is inadequate water at either West Point or George reservoirs so that the release to meet the target could not be made. This issue will be examined in Chapter 9.

Table 8 - 2. PERCENT OF TIME THAT FLOW IS BELOW THE MINIMUM VALUE FOR THE PERFORMANCE MEASURES FOR PEACHTREE CREEK, COLUMBUS AND FARLEY PLANT

AUGMENTATION LIMIT	COLUMBUS	ANDREWS	PEACHTREE CREEK
RIOP	0.30%	3.25%	0.00%
19000 - 3000	0.47%	4.10%	0.00%
19000 - 2000	0.42%	3.76%	0.00%
18000 - 3000	0.38%	3.89%	0.00%
18000 - 2000	0.30%	3.62%	0.00%
17000 - 3000	0.37%	3.83%	0.00%
17000 - 2000	0.33%	3.66%	0.00%

SUMMARY OF FINDINGS FOR CHANGING THE FLOWS AT WHICH THE 9-FOOT CHANNEL IS PROVIDED

In reviewing model output from having the navigation releases set at 17,000, 18,000 and 19,000 cfs with augmentation limits set at 2,000 and 3,000 cfs it was found that there are significant improvements over the RIOP release rules (RIOP evaluated at providing the channel at 19,000 cfs) and that as the level of augmentation increases and the flow needed to provide the 9-foot and 7-foot channel decreases the level of availability of the 9-foot and 7-foot channel increases.

In reviewing outflow at Jim Woodruff Dam it was found that there were minimal differences for median flows in whether 17,000 cfs, 18,000 or 19,000 cfs is released to provide the 9-foot channel and whether the augmentation limit is set at 2,000 or 3,000 cfs.

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The extent of floodplain inundation is highly sensitive to flow release and amount of flow augmentation provided from the reservoirs for both the 15,000 cfs and 17,000 cfs thresholds so long as the release necessary to provide a 9-foot channel is greater than the flow threshold whose exceedance is being evaluated. For these two figures, the closer the flow needed to provide the 9-foot channel is to the desired threshold and the greater the amount of augmentation provided the federal reservoirs, the greater the amount of time the threshold is exceeded. Therefore, in Figure 8-56 the line which shows the greatest amount of time that the 15,000 cfs threshold is met or exceeded is when the 9-foot channel is provided at a 17,000 /3,000 cfs augmentation flow and for the 17,000 cfs threshold the greatest amount of time is for the 18,000/3,000 cfs threshold. The 29,000 cfs threshold showed little sensitivity to alternate flows needed to provide the 9-foot channel since they were all below the threshold level. The period of record figures also show that at median elevations at Lake Lanier in the fall of the year the differences can be over two feet between the RIOP operations and operations which provide the navigation channel. Sensitivity to changes in flow to provide the navigation channel and in level of augmentation is more evident in the 75% exceeded, 90% exceeded and minimum elevations. In examining the differences in the annual time series data it can be seen that reservoir elevations at Lanier showed little sensitivity to changes in the individual years except for during the 2002 and 2007 drought years. The period of record figures show that West Point reservoir shows limited sensitivity to the changes in flow needed to provide a 9-foot channel in the 17,000 cfs to 19,000 cfs range and changes in augmentation from 2,000 cfs to 3,000 cfs. Median and 75% exceeded elevations are in general less than elevations under the RIOP, although at the 75% exceeded level the differences are relatively minor. The annual time series figures show little variation with the changes in flow needed to provide the 9-foot channel and changes in augmentation level in the more normal flow years (1970 and 1977), but a greater range of variability in the low flow and extreme low flow years.

The period of record figures show that elevations at W.F. George are sensitive to changes in the flow needed to provide the navigation channel and level of augmentation in the median elevation figures, but not so much in the 75% exceeded, 90% exceeded and minimum elevation figures. The annual time series figures show in certain years that there is a sensitivity of elevations at W.F. George to a change in the flow needed to provide the 9-foot channel and changes in the level of augmentation.

CONCLUSIONS FOR CHANGING THE FLOWS AT WHICH THE 9-FOOT CHANNEL IS PROVIDED

In this chapter the effects of changing the volume of flow needed to provide a 9-foot channel and the conclusions found from sensitivity analyses in this regard were:

- With regard to the availability of the federal navigation channel the greater the amount of dredging (and hence the lower the flow needed to provide a 9-foot channel) the greater the availability of the federal navigation channel. In all instances including navigation releases in the operations increased the availability of the navigation channel relative to the RIOP.
- So long as flow exceeds critical threshold elevations for inundating the floodplain, the lesser the flow needed to provide a 9-foot channel the greater the duration of

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floodplain inundation. In all instances, once the threshold is exceeded the duration of floodplain inundation is greater than under the RIOP.

- Elevations at Lake Lanier are lower than they would be under the RIOP and the largest effect is at median elevations. As the release needed to provide the 9-foot channel and the level of the augmentation limit increases, elevations at Lake Lanier are lowered.
- Elevations at West Point Lake are lower than under the RIOP and the largest effects are at median elevations. Differences at the 75% exceed, 90% exceeded and minimum elevations show much less sensitivity to changing the releases needed to provide a 9-foot channel than at Lake Lanier.
- Elevations at W.F. George are lower than under the RIOP and the largest effects are at median elevations. Differences at the 75% exceed, 90% exceeded and minimum elevations show much less sensitivity to changing the releases needed to provide a 9-foot channel than at Lake Lanier.

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CHAPTER 9 – SENSITIVITY ANALYSIS OF MAKING THE CHATTACHOOCHEE RIVER MINIMUM FLOW TARGETS ACTIVE TARGETS

INTRODUCTION

In Chapters 7 and 8 an analysis was provided which documented that minimum flow targets in the Chattahoochee River at Columbus and Plant Farley (Andrews Outflow) were not met far too frequently when these targets were set as passive targets within the models. By the term "passive" it is meant that the flows needed for Columbus and Plant Farley were met conjunctively with other releases in the model runs. Specific releases were not made with the intent of keeping flow above the desired minimum levels. In this chapter an evaluation of what would have to be done from a reservoir management perspective to actively meet the flow targets for Columbus (1,350 cfs, 7-day flow) and Plant Farley (2,000 cfs).

The approach taken to meet this requirement was first to include for West Point and W.F. George a release rule which would include meeting the specific minimum flow requirements. Since both West Point and W.F. George reservoirs can be drawn down in a severe drought so that there is not adequate storage to support the minimum release requirement an additional provision had to be included in which Lake Lanier would provide a supplemental release to support West Point to ensure that the Columbus and Farley minimum flow requirements would be met. The approach taken in our model coding is that once West Point is drawn down below a specified threshold, Lake Lanier would make supplemental releases to support West Point reservoir's storage pool. Therefore, there are two variables for which sensitivity analyses were done in defining this supplemental release: 1) the elevation at West Point at which supplemental releases start and stop, and 2) the volume of the supplemental release. The values for these two variables that were ultimately settled on were to begin and end the supplemental releases at an elevation of 622 NGVD at West Point and for the supplemental release to be 300 cfs.

Table 9-1 shows how often the Chattahoochee River minimum flow requirements were met based on the above modifications to reservoir operating rules and from this table it can be seen that there were no violations for the Columbus and Peachtree Creek minimums and very minor violations of the Plant Farley minimum and none of the violations were of a duration of more than one day and consequently could be eliminated by reservoir operator discretion in the real world.

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Table 9 - 1. FREQUENCY OF MEETING CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS WITH MODIFIED RESERVOIR RELEASE RULES

AUGMENTATION LIMIT	COLUMBUS	ANDREWS	PEACHTREE CREEK
RIOP	1.74%	4.91%	0.00%
17,000 - 2,000	0.00%	0.06%	0.00%
17,000 - 3,000	0.00%	0.04%	0.00%
16,000 - 2,000	0.00%	0.05%	0.00%
16,000 - 3000	0.00%	0.03%	0.00%

For the balance of this chapter the effects of these alterations to reservoir release rules will be evaluated first relative to not having these releases and then for alternative release levels to provide a 9-foot channel and to alternative levels of flow augmentation based on the findings of Chapters 7 and 8.

COMPARISON OF ACTIVE AND PASSIVE RESERVOIR RELEASES TO SUPPORT CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS

NAVIGATION PERFORMANCE MEASURES

Figure 9-1 shows the availability of the 9-foot navigation channel both with active and passive releases to provide the minimum flow targets. Figure 9-2 shows the availability of a 7-foot channel.

From these figures it can be seen that it can be seen that including supplemental releases to insure that Chattahoochee River minimum flow targets are met does not have a major effect on the availability of the 9-foot or 7-foot channel.

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Figure 9 - 1. AVAILABILITY OF A NINE-FOOT CHANNEL WITH ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS

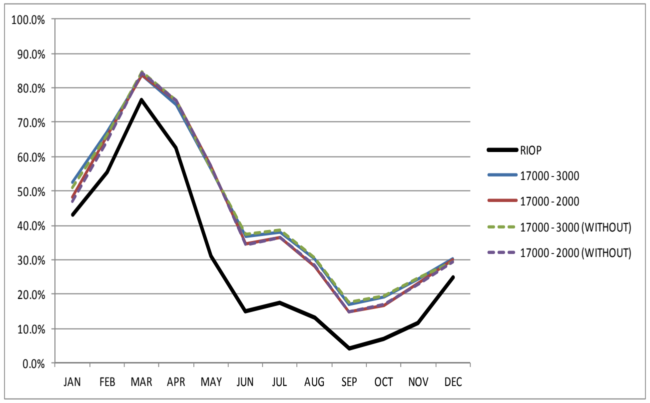

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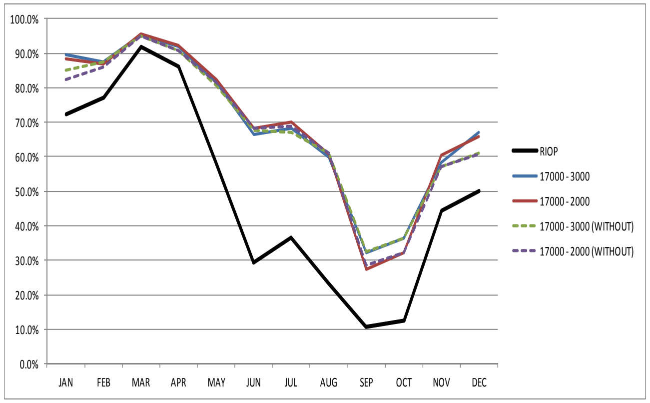
Figure 9 - 2. AVAILABILITY OF A SEVEN-FOOT CHANNEL WITH ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS



ENVIRONMENTAL PERFORMANCE MEASURES

Figures 9-3, 9-4 and 9-5 show the comparisons of median, 75% exceeded flows and 90% exceeded flows for model runs relative to the RIOP for the entire model run period (1939 – 2008) and figures 9-6, 9-7, 9-8, 9-9, 9-10 and 9-11 show the same data for individual years chosen to represent normal flows, low flows and extreme low flows. In the annual time series data the flow values shown were truncated to the 0 to 30,000 cfs range to better display differences between model runs.

Figures 9-3, 9-4, and 9-5 show that for the period of record median, 75% exceeded and 90% exceeded flows are not affected to a major extent whether active or passive release rules are used to meet the Chattahoochee River minimum flow requirements. Figures 9-6 to 9-11 show that in the annual time series figures some differences in flow can be seen when the Chattahoochee minimum targets are met passively or actively. Some of these differences are phase changes where the timing of a flow event is shifted and some are differences in the flow.

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Figure 9 - 3. MEDIAN FLOWS FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS FOR THE PERIOD OF RECORD (1939 – 2008)

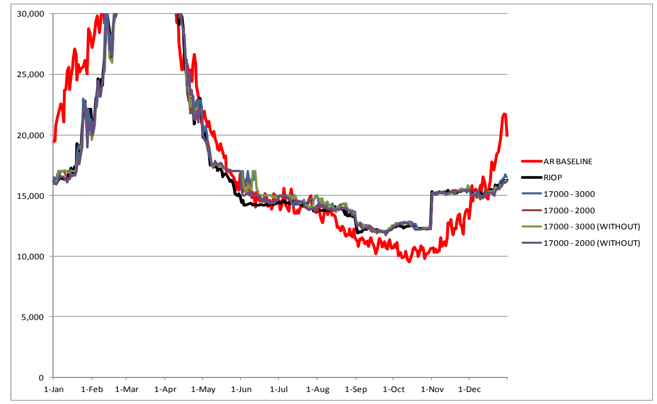

Figure 9 - 4. 75% EXCEEDED FLOWS FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS FOR THE PERIOD OF RECORD (1939 – 2008)

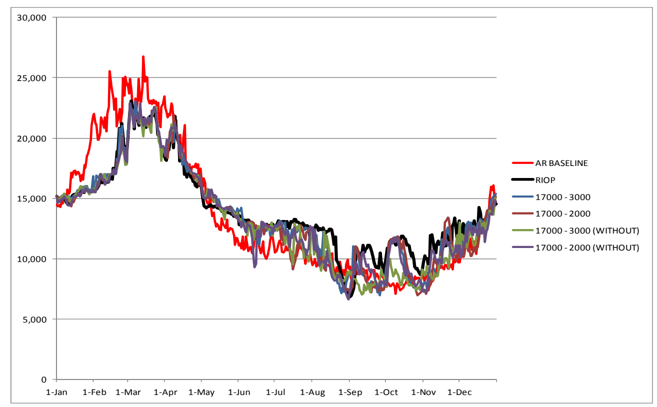

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Figure 9 - 5. 90% EXCEEDED FLOWS FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS FOR THE PERIOD OF RECORD (1939 – 2008)

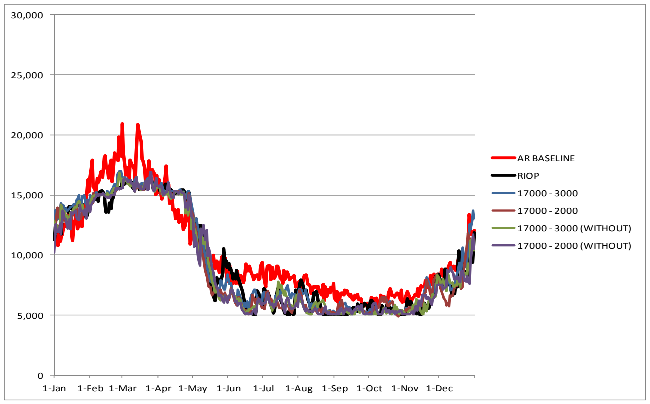

Figure 9 - 6. ANNUAL TIME SERIES FOR NORMAL FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (1970)

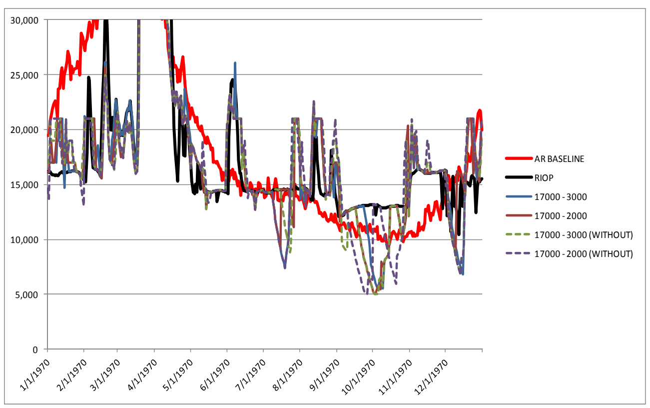

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Figure 9 - 7. ANNUAL TIME SERIES FOR NORMAL FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (1977)

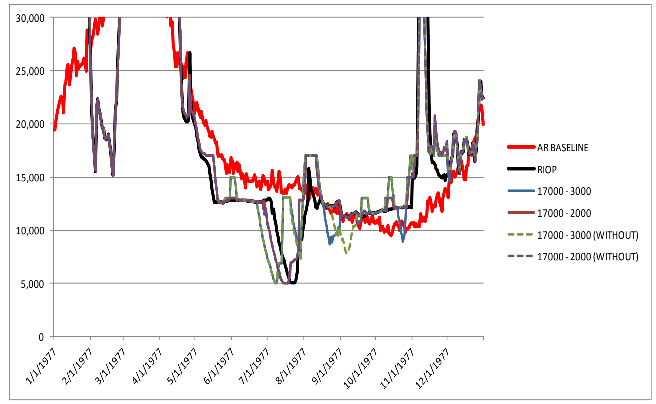

Figure 9 - 8. ANNUAL TIME SERIES FOR LOW FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (1981)

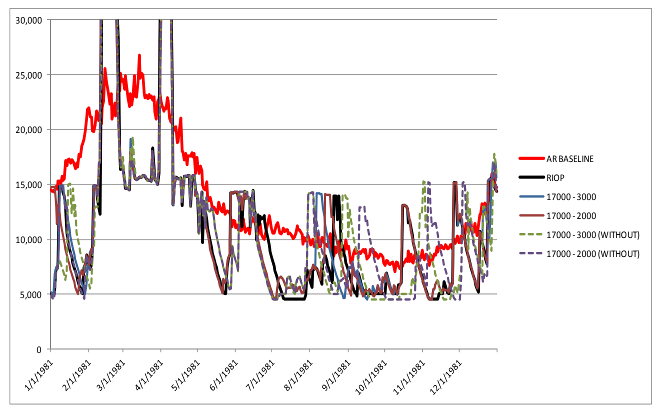

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Figure 9 - 9. ANNUAL TIME SERIES FOR LOW FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (1988)

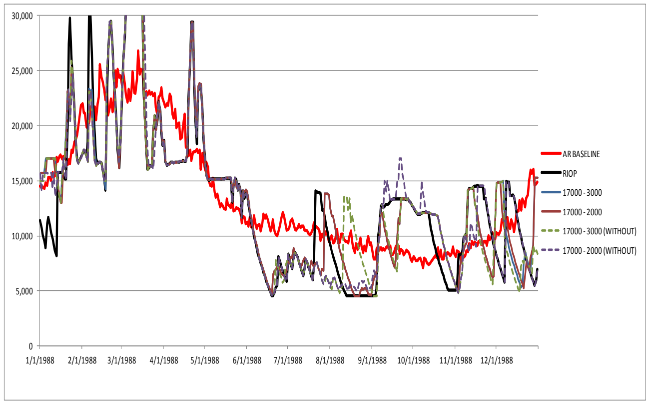

Figure 9 - 10. ANNUAL TIME SERIES FOR EXTREME LOW FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (2002)

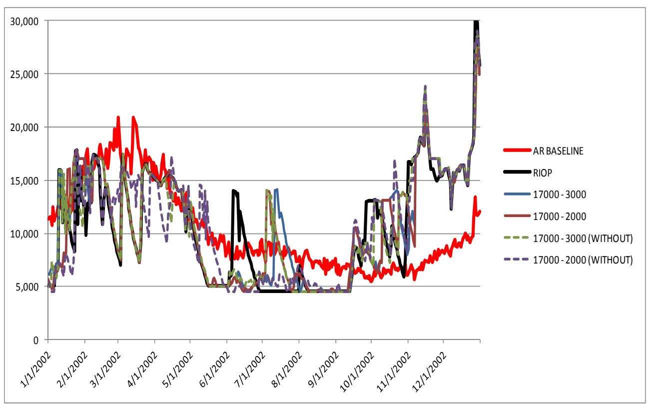

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Figure 9 - 11. ANNUAL TIME SERIES FOR EXTREME LOW FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (2007)

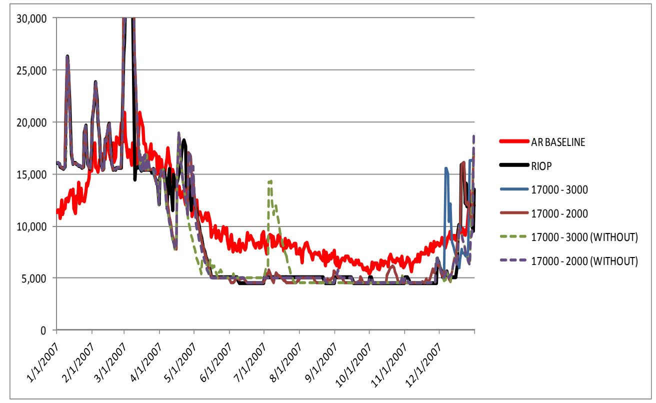

Figure 9-12 shows the amount of time 15,000 cfs was exceeded; figure 9-13 the amount of time 17,000 cfs was exceeded and figure 9-14 the amount of time 29,000 cfs was exceeded to evaluate the floodplain inundation thresholds discussed earlier. From these figures it can be seen that the extent of floodplain inundation is not affected by the differences in whether the Chattahoochee River minimum flow requirements are met passively or actively.

Figure 9 - 12. PERCENT OF TIME 15,000 cfs WAS EXCEEDED FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS

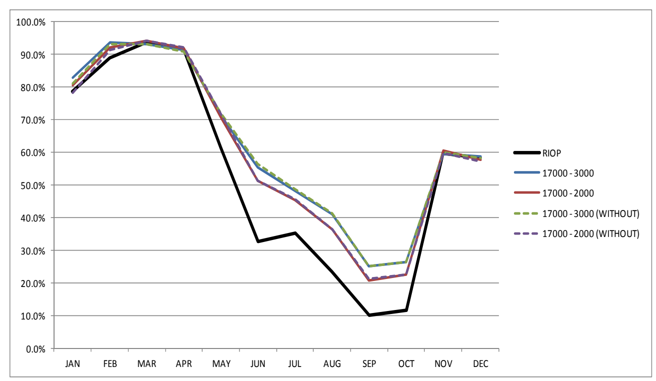

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Figure 9 - 13. PERCENT OF TIME 17,000 cfs WAS EXCEEDED FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS

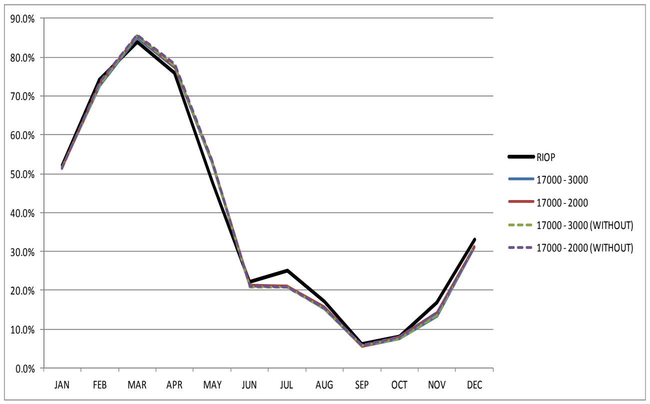
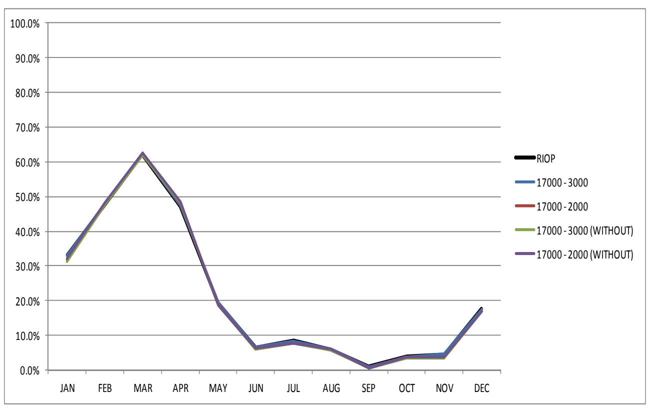


Figure 9 - 14. PERCENT OF TIME 29,000 cfs WAS EXCEEDED FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS



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RESERVOIR ELEVATION PERFORMANCE MEASURES

LAKE LANIER

Figures 9-15, 9-16, 9-17 and 9-18 show the elevations at Lake Lanier for the period of record and figures 9-19, 9-20, 9-21, 9-22, 9-23, and 9-24 show annual time series charts comparing the elevation at Lake Lanier for various levels of augmentation.

The period of record figures show minor differences in the median elevations but much greater differences in the 75% exceeded, 90% exceeded and minimum elevation figures which was expected since the condition at which Lanier augments West Point storage was during period of lower flows. The annual time series figures show this same trend where elevations are comparable during normal flow years but where larger differences are evident in low flow years such as 2002.

Figure 9 - 15. MEDIAN ELEVATIONS AT LAKE LANIER FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS

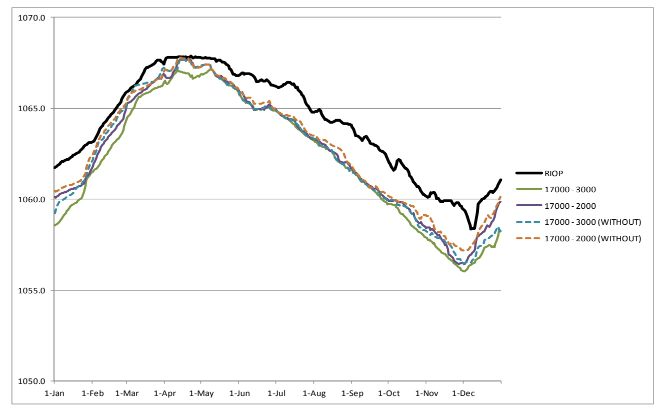

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Figure 9 - 16. 75% EXCEEDED ELEVATIONS AT LAKE LANIER FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS

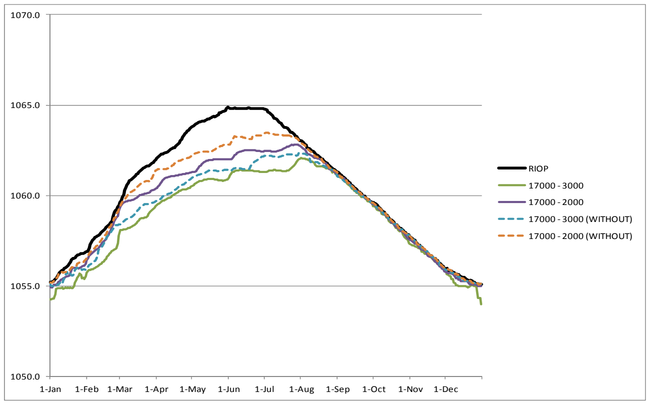

Figure 9 - 17. 90% EXCEEDED ELEVATIONS AT LAKE LANIER FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS

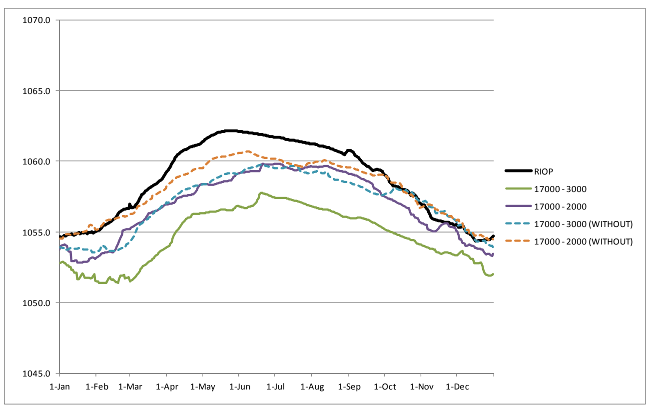

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Figure 9 - 18. MINIMUM ELEVATIONS AT LAKE LANIER FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS

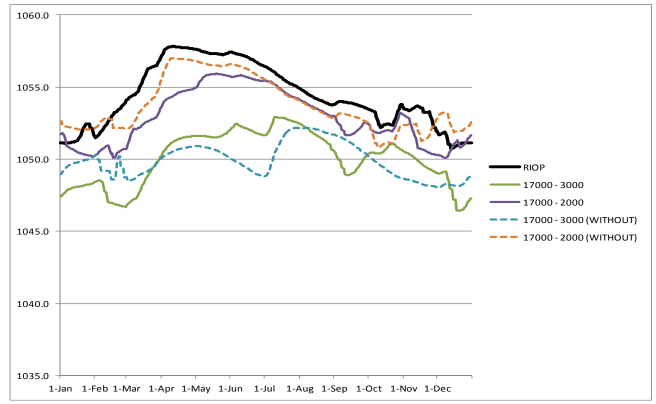

Figure 9 - 19. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT LAKE LANIER FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (1970)

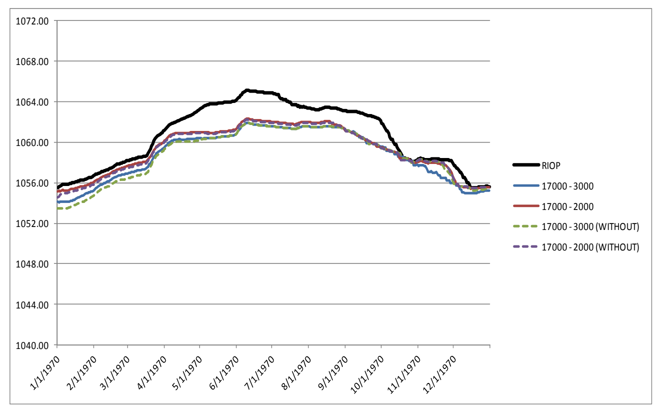

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Figure 9 - 20. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT LAKE LANIER FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (1977)

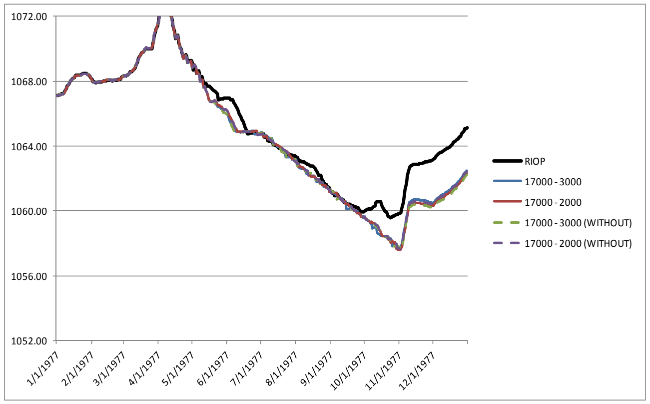

Figure 9 - 21. ANNUAL TIME SERIES OF LOW FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (1981)

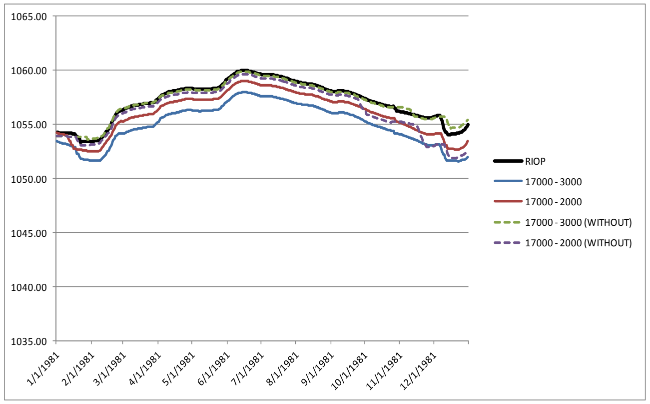

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Figure 9 - 22. ANNUAL TIME SERIES OF LOW FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (1988)

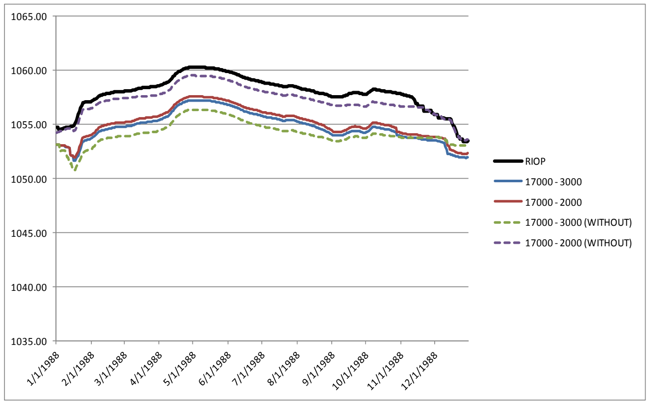

Figure 9 - 23. ANNUAL TIME SERIES OF EXTREME LOW FLOW YEAR ELEVATIONS AT LAKE LANIER FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (2002)

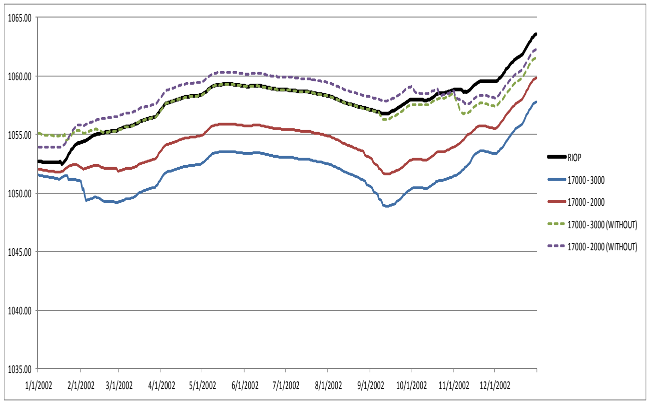

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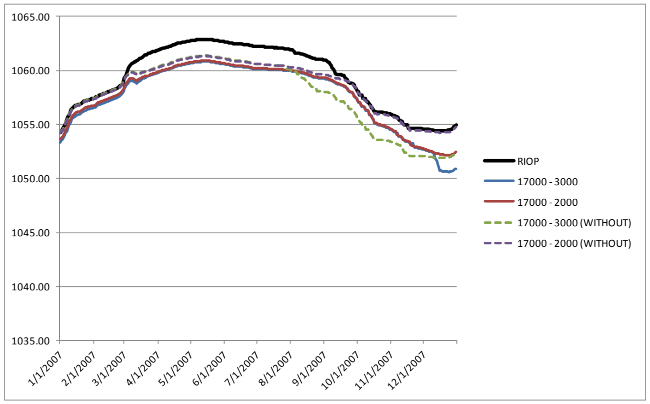
Figure 9 - 24. ANNUAL TIME SERIES OF EXTREME LOW FLOW YEAR ELEVATIONS AT LAKE LANIER FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (2007)



WEST POINT

Figures 9-25, 9-26, 9-27 and 9-28 show the period of record data for West Point elevations and Figures 9-29, 9-30, 9-31, 9-32, 9-33 and 9-34 show the annual time series data for selected years for elevations at West Point reservoir.

For the period of record figures the greatest sensitivity is at the minimum elevations and minimal differences are evident in the median and 75% exceeded elevation figures. In the daily time series figures for West Point more differences are evident in the low flow and extreme low flow years.

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Figure 9 - 25. MEDIAN ELEVATIONS AT WEST POINT LAKE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS

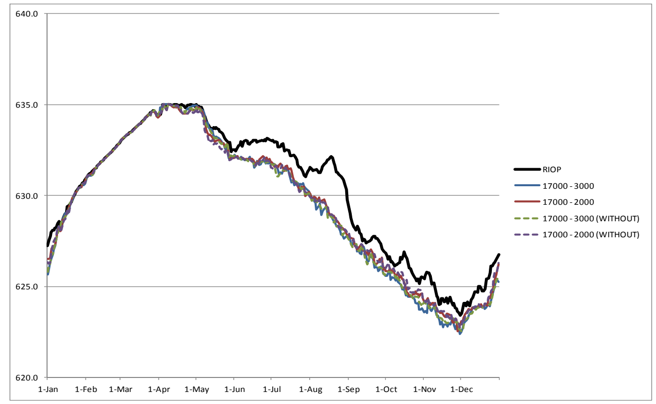

Figure 9 - 26. 75% EXCEEDED ELEVATIONS AT WEST POINT LAKE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS

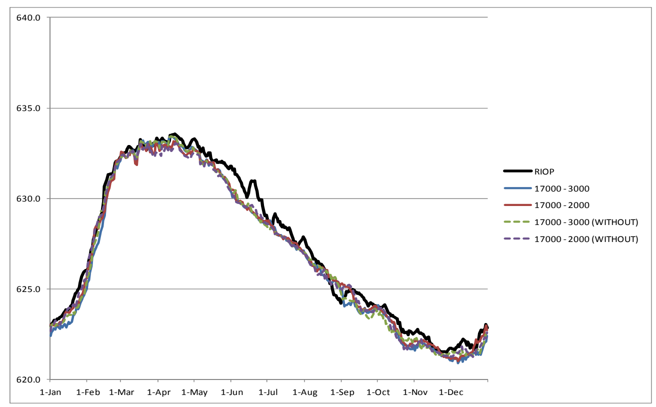

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Figure 9 - 27. 90% EXCEEDED ELEVATIONS AT WEST POINT LAKE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS

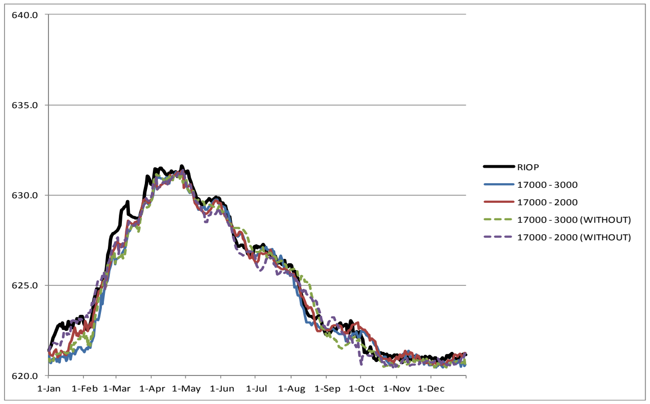

Figure 9 - 28. MINIMUM ELEVATIONS AT WEST POINT LAKE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS

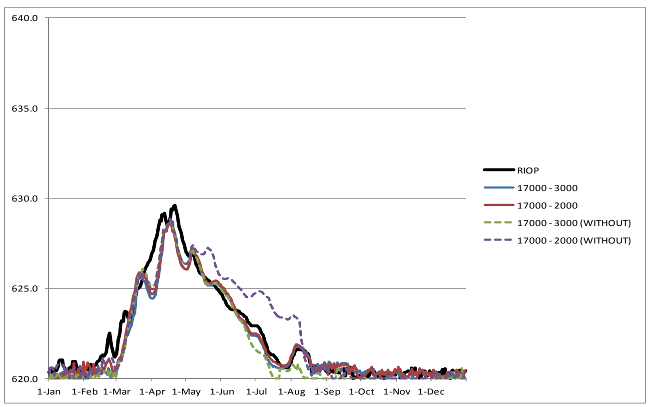

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Figure 9 - 29. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (1970)

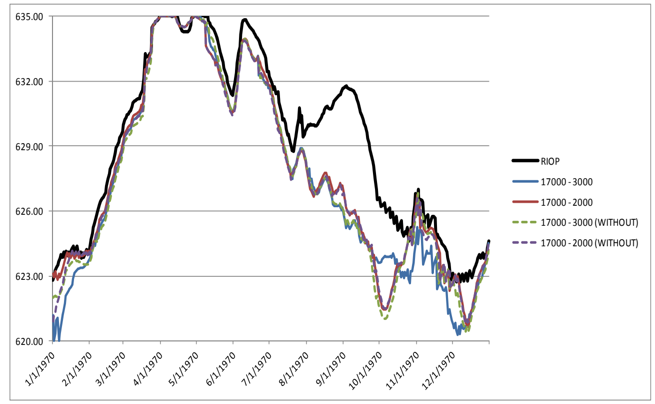

Figure 9 - 30. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (1977)

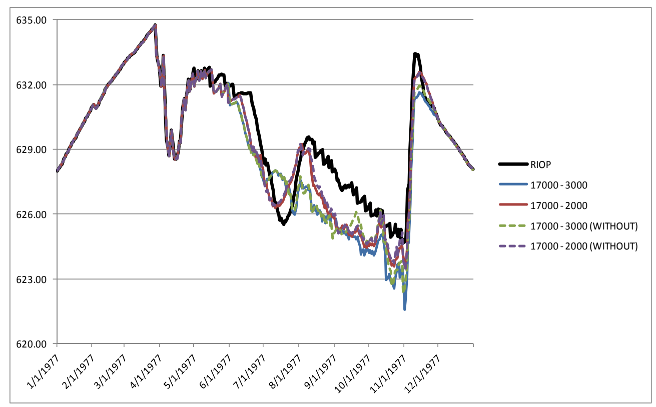

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Figure 9 - 31. ANNUAL TIME SERIES OF A LOW FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (1981)

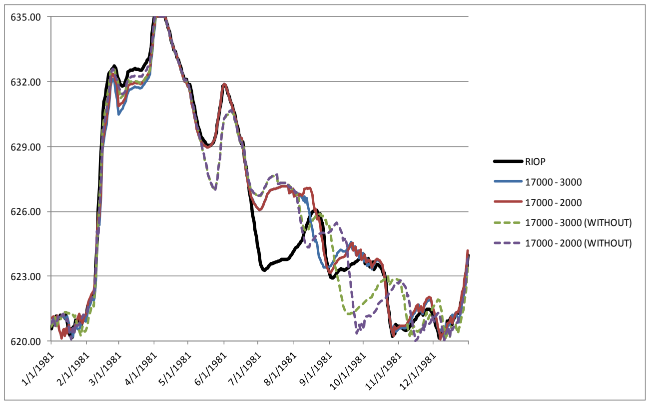

Figure 9 - 32. ANNUAL TIME SERIES OF A LOW FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (1988)

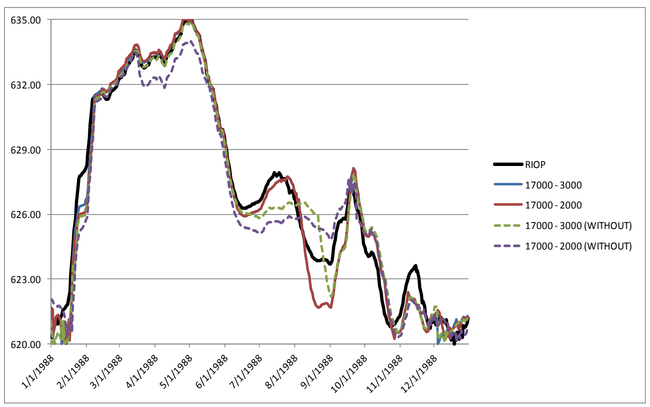

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Figure 9 - 33. ANNUAL TIME SERIES OF AN EXTREME LOW FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (2002)

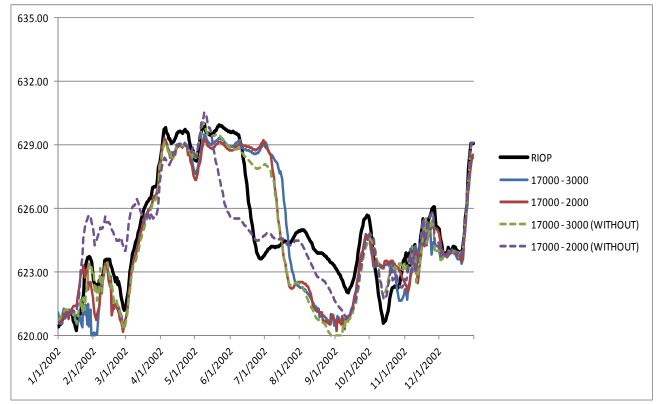
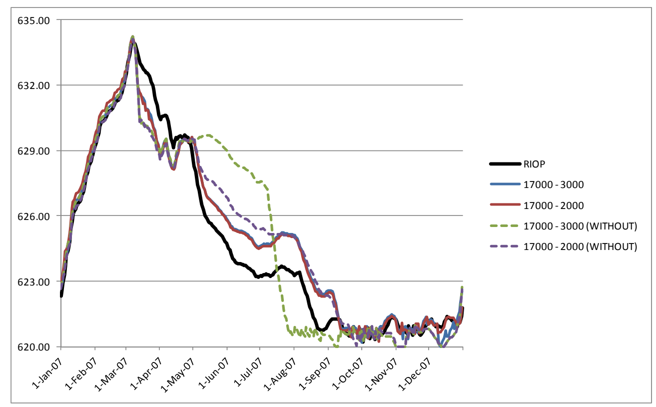


Figure 9 - 34. ANNUAL TIME SERIES OF AN EXTREME LOW FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (2007)



W.F. GEORGE

Figures 9-35, 9-36, 9-37 and 9-38 show the period of record data for elevations at W.F. George and figures 9-39, 9-40, 9-41, 9-42, 9-43 and 9-44 show the annual time series data for elevations at W.F. George.

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For the period of record figures minimal differences are noted between having passive or active releases to support the Chattahoochee River minimum flow requirements. For the annual time series figures there was more variation in elevations in low flow years.

Figure 9 - 35. MEDIAN ELEVATIONS AT W.F. GEORGE LAKE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS

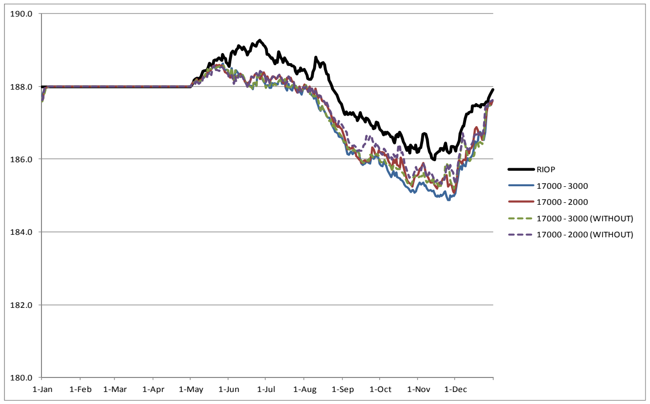

Figure 9 - 36. 75% EXCEEDED ELEVATIONS AT W.F. GEORGE LAKE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS

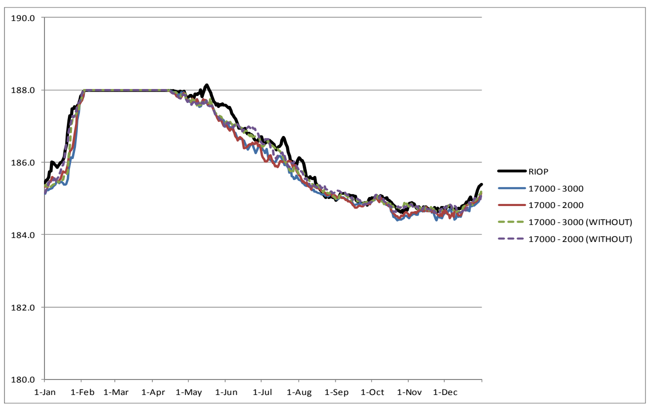

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Figure 9 - 37. 90% EXCEEDED ELEVATIONS AT W.F. GEORGE LAKE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS

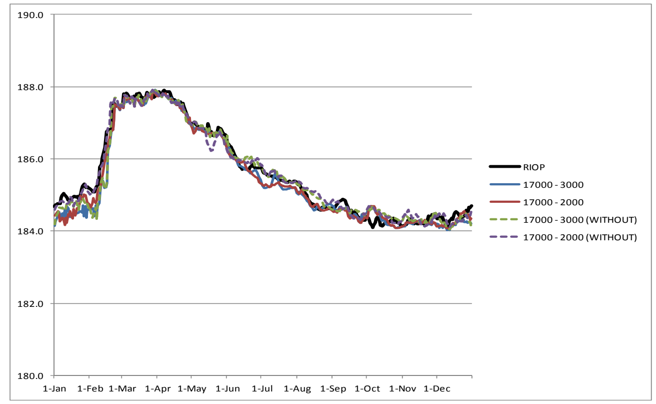

Figure 9 - 38. MINIMUM ELEVATIONS AT W.F. GEORGE LAKE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS

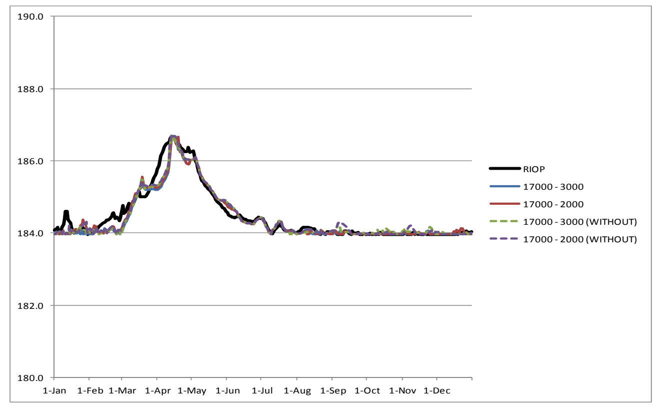

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Figure 9 - 39. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (1970)

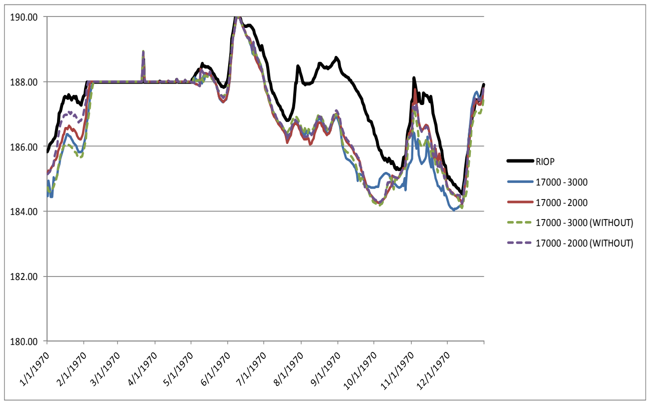

Figure 9 - 40. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (1977)

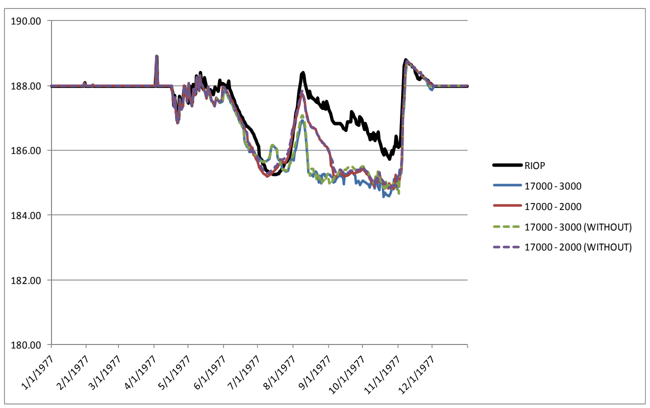

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Figure 9 - 41. ANNUAL TIME SERIES OF A LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (1981)

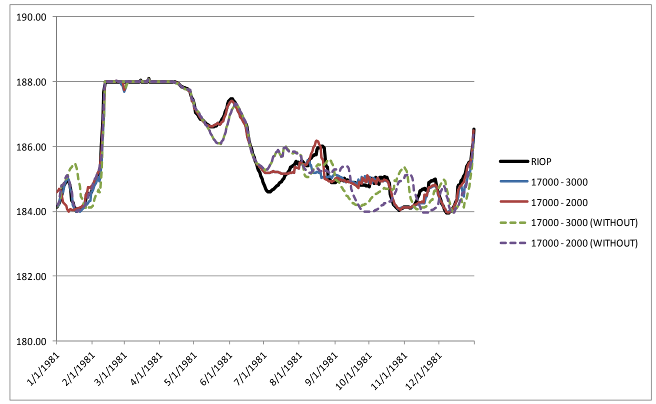

Figure 9 - 42. ANNUAL TIME SERIES OF A LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (1988)

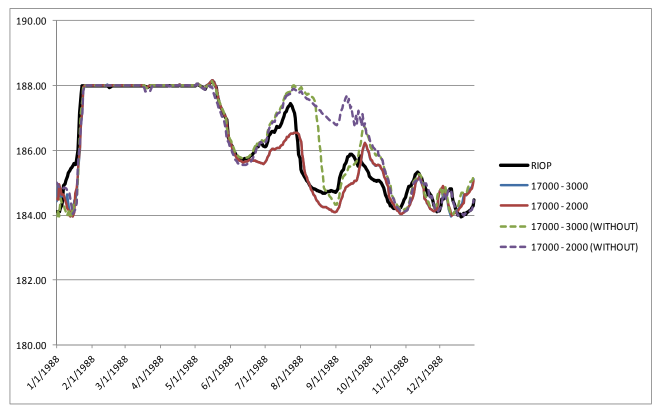

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Figure 9 - 43. ANNUAL TIME SERIES OF AN EXTREME LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (2002)

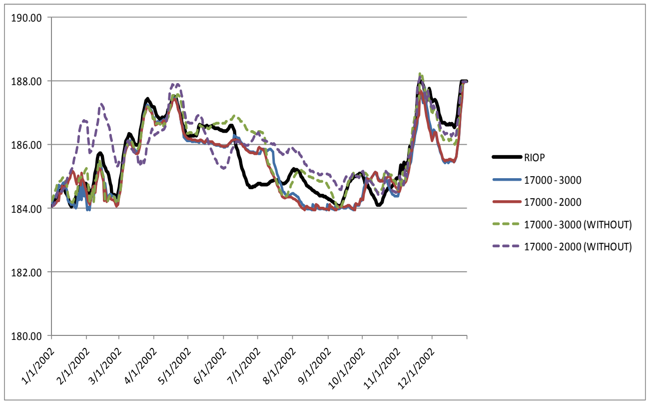
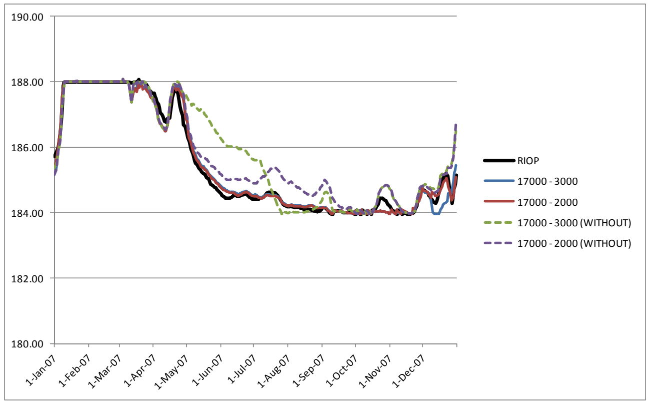


Figure 9 - 44. ANNUAL TIME SERIES OF AN EXTREME LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR ACTIVE AND PASSIVE MEETING OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS (2007)



SUMMARY OF FINDINGS FOR HAVING CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS ACTIVE TARGETS

It was shown that with providing active releases from Lanier and W.F. George to meet the minimum flow targets for Columbus and Plant Farley and a supplemental release of 300 cfs

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from Lake Lanier whenever the elevation at West Point is below 622 NGVD that these minimum requirements could be met more than 99.9% of the time over 70 year model run period. Comparisons were made with identical model runs which did not provide these supplemental releases. These supplemental releases did not have a major effect on the availability of the 9-foot or 7-foot channel. Likewise, these changes had little effect on flow at the Chattahoochee gage on the Apalachicola River or the extent of inundation of the Apalachicola River's floodplain.

For elevations at Lake Lanier the period of record figures show minor differences in the median elevations but much greater differences in the 75% exceeded, 90% exceeded and minimum elevation figures. This was expected since the condition at which Lanier augments West Point storage was during period of lower flows. The annual time series figures show this same trend where elevations are comparable during normal flow years but where larger differences are evident in low flow years such as 2002.

For West Point and W.F. George elevations the period of record figures show the greatest sensitivity at the minimum elevations and minimal differences are evident in the median and 75% exceeded elevation figures. In the daily time series figures for West Point more differences are evident in the low flow and extreme low flow years.

For the period of record figures minimal differences are noted between having passive or active releases to support the Chattahoochee River minimum flow requirements. For the annual time series figures there was more variation in elevations in low flow years.

COMPARISON OF DIFFERENT NAVIGATION FLOW RELEASE REQUIREMENTS AND FLOW AUGMENTATION THRESHOLDS WITH ACTIVE RESERVOIR RELEASES TO SUPPORT CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS

NAVIGATION PERFORMANCE MEASURES

Figures 9-45 and 9-46 show the availability of the 9-foot and 7-foot navigation channel for different navigation releases and augmentations releases and an active requirement to meet the Chattahoochee River minimum flow requirements.

These figures document what has already been shown in Chapters 7 and 8: that the extent of availability of the 7-foot and 9-foot navigation channel is dependent on the flow needed to provide the channel and the limit of augmentation provided from the federal reservoir system. The lower the flow needed to provide the navigation channel the greater the availability of use; the higher the level of augmentation the greater the availability of the channel.

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Figure 9 - 45. AVAILABILITY OF A NINE-FOOT CHANNEL WITH VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS

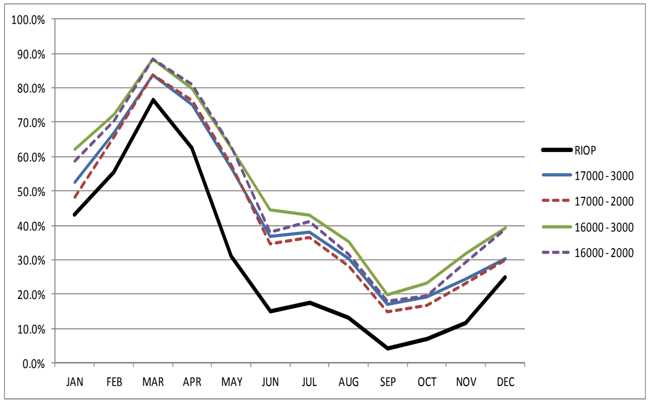
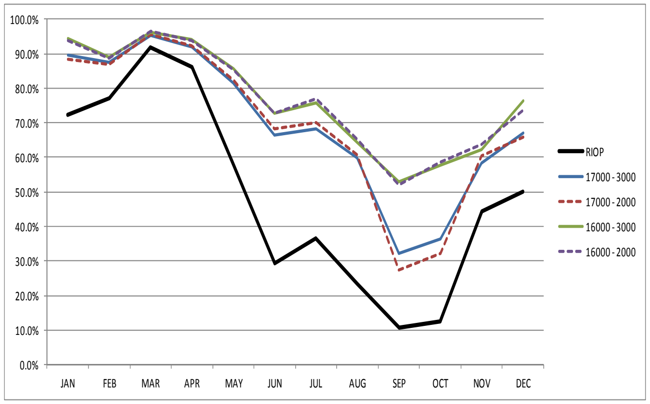


Figure 9 - 46. AVAILABILITY OF A SEVEN-FOOT CHANNEL WITH VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS



ENVIRONMENTAL PERFORMANCE MEASURES

Figures 9-47, 9-48 and 9-49 show the comparisons of median, 75% exceeded flows and 90% exceeded flows for model runs relative to the RIOP for the entire model run period (1939 – 2008) and figures 9-50 to 9-55 show the same data for individual years chosen to represent

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normal flows, low flows and extreme low flows. In the annual time series data the flow values shown were truncated to the 0 to 30,000 cfs range to better display differences between model runs.

From the period of record figures minimal differences are evident in terms of flow. For the annual time series figures there are differences in some of the years.

Figure 9 - 47. MEDIAN FLOWS FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS

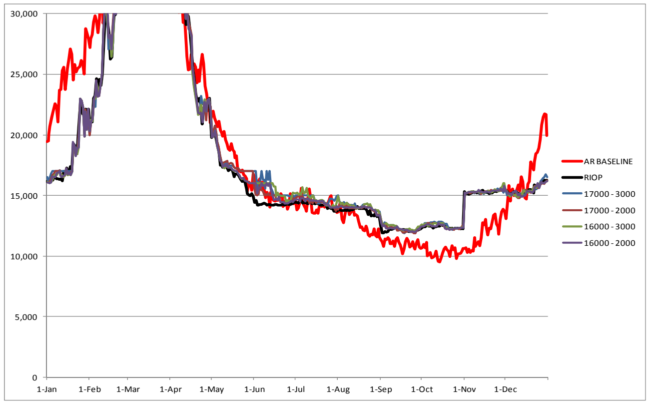

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Figure 9 - 48. 75% EXCEEDED FLOWS FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS

Figure 9 - 49. 90% EXCEEDED FLOWS FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS

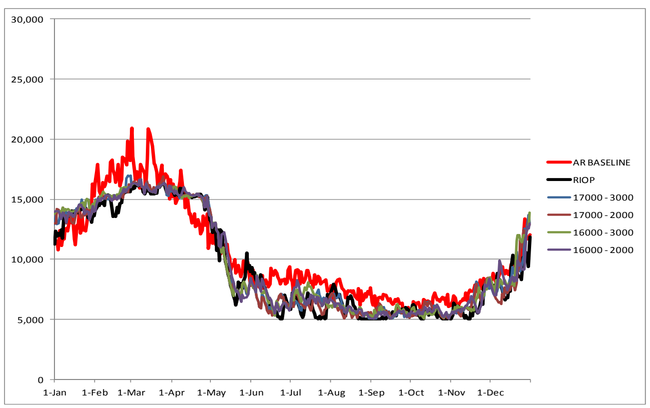

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Figure 9 - 50. ANNUAL TIME SERIES FOR NORMAL FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (1970)

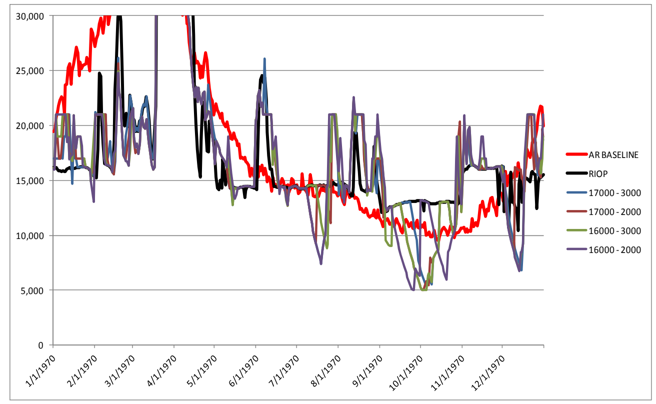

Figure 9 - 51. ANNUAL TIME SERIES FOR NORMAL FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (1977)

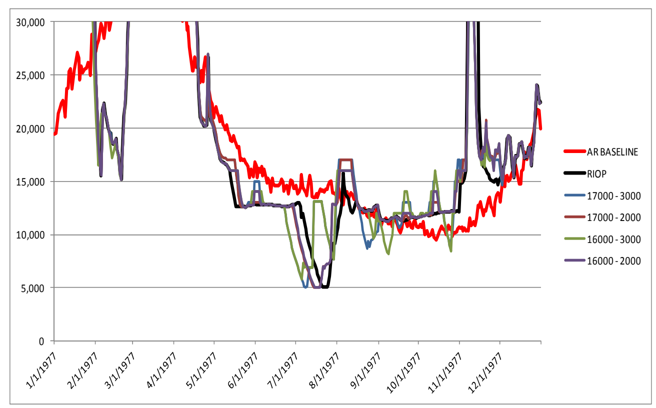

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Figure 9 - 52. ANNUAL TIME SERIES FOR LOW FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (1981)

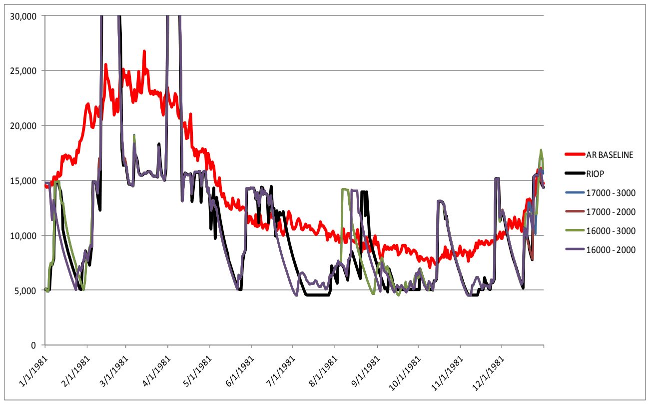

Figure 9 - 53. ANNUAL TIME SERIES FOR LOW FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (1988)

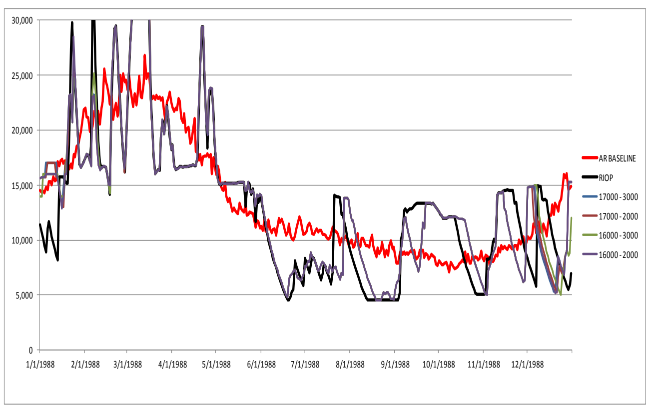

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Figure 9 - 54. ANNUAL TIME SERIES FOR EXTREME LOW FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (2002)

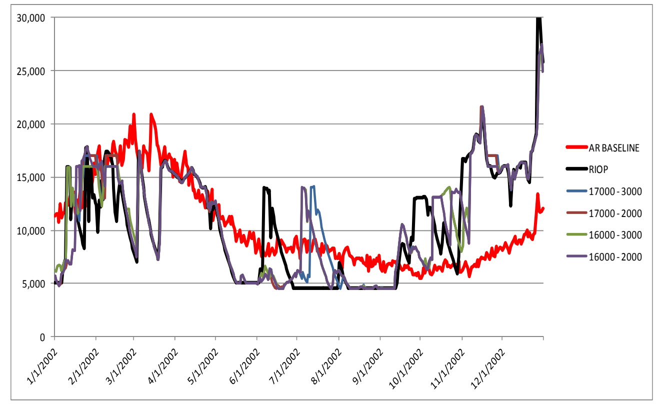

Figure 9 - 55. ANNUAL TIME SERIES FOR EXTREME LOW FLOW YEAR FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (2007)

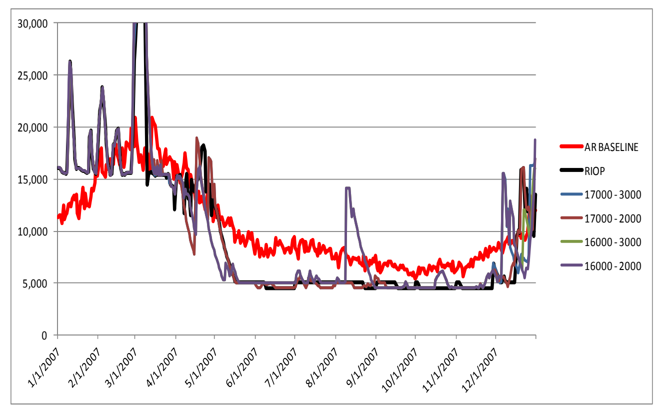

Figure 9-56 shows the amount of time 15,000 cfs was exceeded; figure 9-57 the amount of time 17,000 cfs was exceeded and figure 9-58 the amount of time 29,000 cfs was exceeded.

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From figure 9-56 it can be seen that for the 15,000 cfs threshold the greater the release needed to provide the navigation channel and the greater the amount of the augmentation threshold the greater the frequency of floodplain inundation. Figure 9-57 shows that there are limited differences between the RIOP and the flows in table 9-1. This is because 16,000 cfs is a critical flow threshold in the RIOP as well as in the model runs. The 29,000 cfs threshold showed little sensitivity.

Figure 9 - 56. PERCENT OF TIME 15,000 CFS WAS EXCEEDED FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS

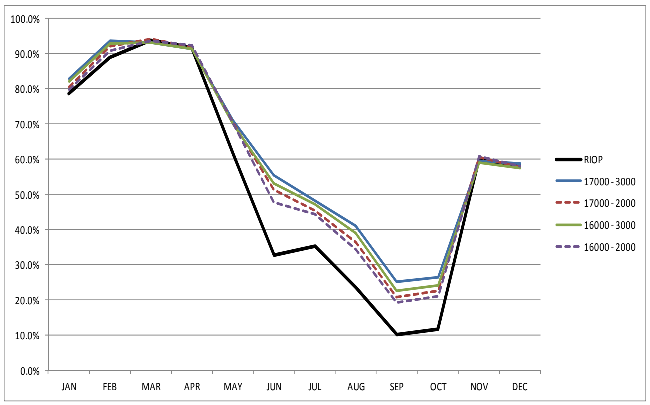

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Figure 9 - 57. PERCENT OF TIME 17,000 CFS WAS EXCEEDED FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS

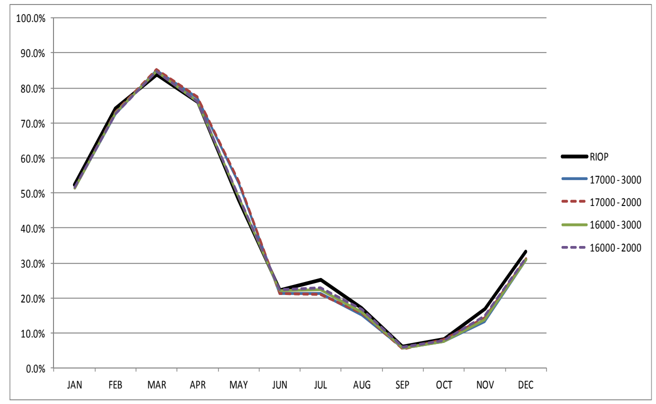
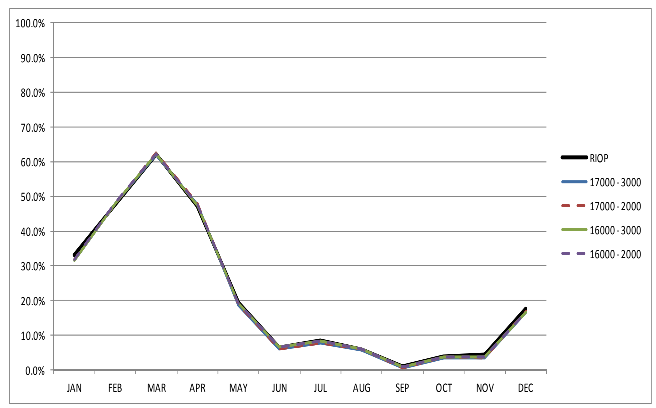


Figure 9 - 58. PERCENT OF TIME 29,000 cfs WAS EXCEEDED FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS



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RESERVOIR ELEVATION PERFORMANCE MEASURES

The next set of performance measures to be considered is the effects on reservoir elevations. Background on these performance measures can be found in Chapter 5.

LAKE LANIER

Figures 9-59, 9-60, 9-61 and 9-62 show the elevations at Lake Lanier for the period of record and figures 9-63 to 9-68 show annual time series charts comparing the elevations at Lake Lanier for various levels of augmentation.

The period of record figures show that for Lake Lanier there were minimal differences at median elevations, but much greater differences in the 75% exceeded, 90% exceeded and minimum elevation figures. It can be seen that the greater the flow needed to provide the 9-foot channel, the higher the elevation at Lake Lanier, but greater the amount of augmentation, the lower the elevation at Lake Lanier. This can be explained by the fact that the higher the amount of flow release required to provide the 9-foot channel, the less frequent the release will be made. The annual time series figures showed little differences in the average flow years, but substantial differences in one of the extreme low flow years (2002).

Figure 9 - 59. MEDIAN ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS

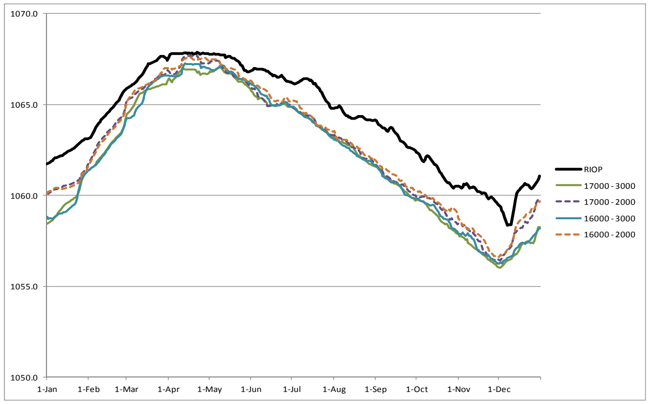

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Figure 9 - 60. 75% EXCEEDED ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS

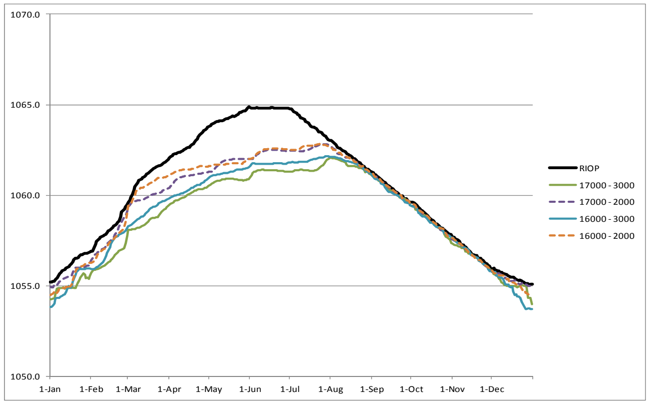

Figure 9 - 61. 90% EXCEEDED ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS

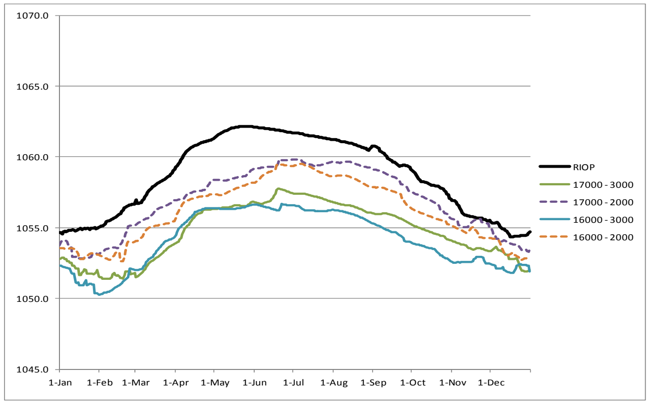

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Figure 9 - 62. MINIMUM ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS

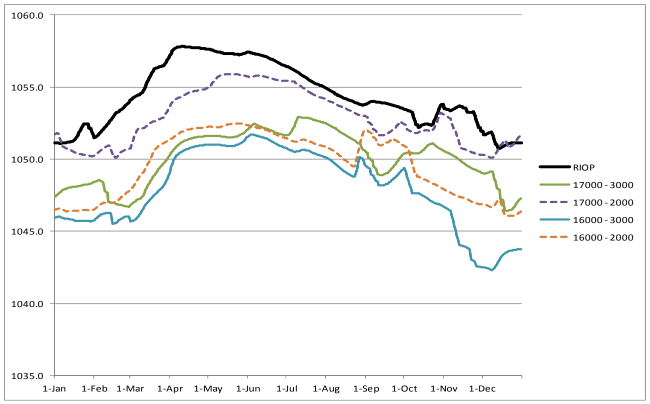

Figure 9 - 63. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (1970)

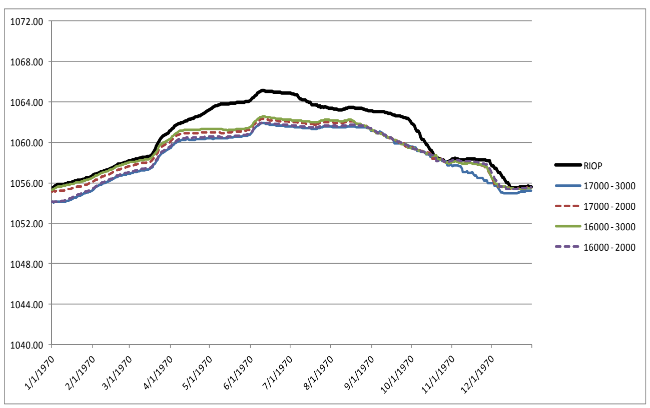

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Figure 9 - 64. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (1977)

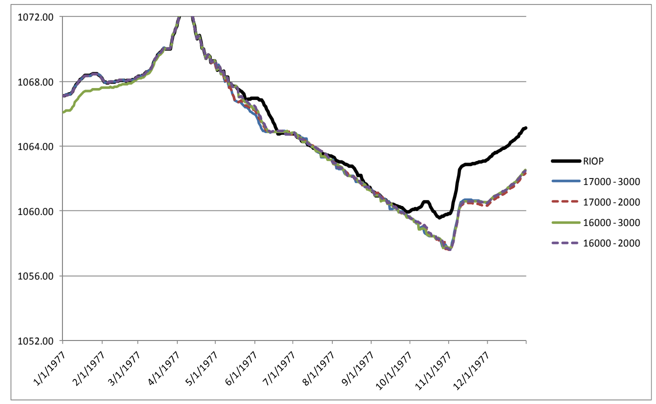

Figure 9 - 65. ANNUAL TIME SERIES OF LOW FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (1981)

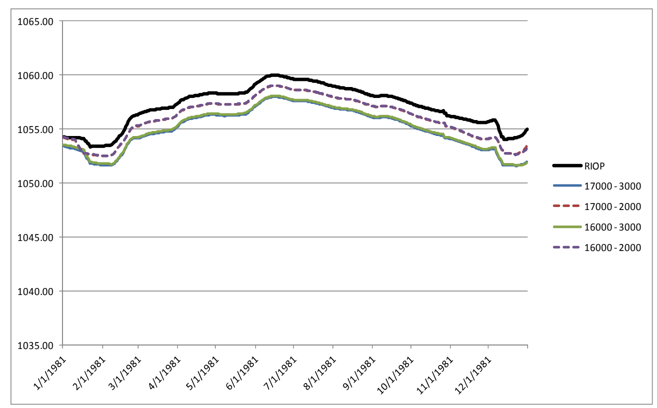

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Figure 9 - 66. ANNUAL TIME SERIES OF LOW FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (1988)

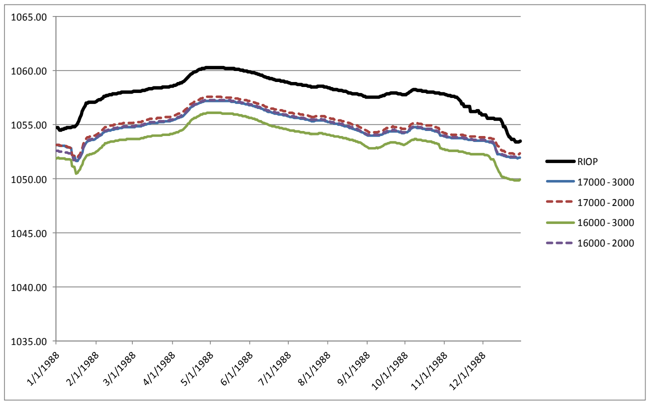

Figure 9 - 67. ANNUAL TIME SERIES OF EXTREME LOW FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (2002)

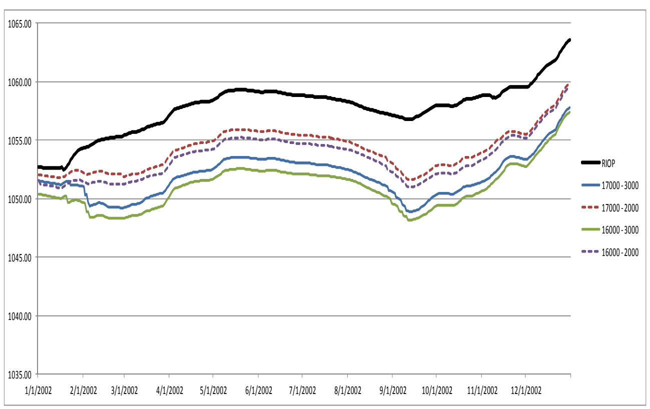

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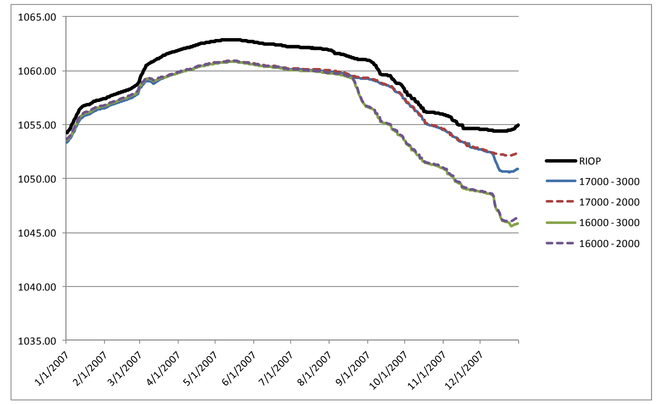
Figure 9 - 68. ANNUAL TIME SERIES OF EXTREME LOW FLOW YEAR ELEVATIONS AT LAKE LANIER FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (2007)



WEST POINT

Figures 9-69, 9-70, 9-71 and 9-72 show the period of record data for West Point elevations and Figures 9-73 to 9-78 show the annual time series data for selected years for elevations at West Point reservoir.

The period of record figures show minimal differences for all of the charts and the daily time series figures show variations among the level of flow needed to provide the 9-foot channel in some years and little difference in other years. The year that showed the greatest variation was one the average flow years, 1977.

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Figure 9 - 69. MEDIAN ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS

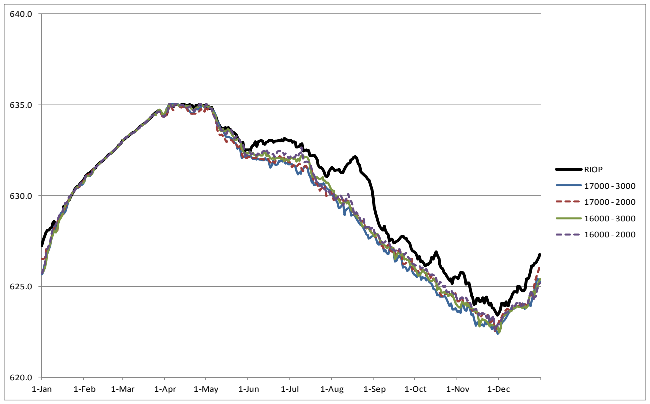

Figure 9 - 70. 75% EXCEEDED ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS

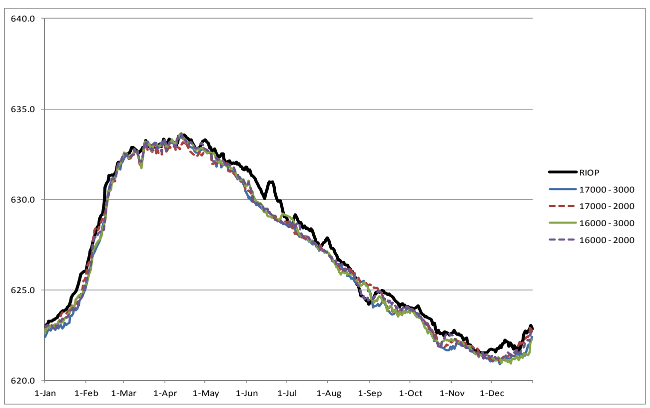

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Figure 9 - 71. 90% EXCEEDED ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS

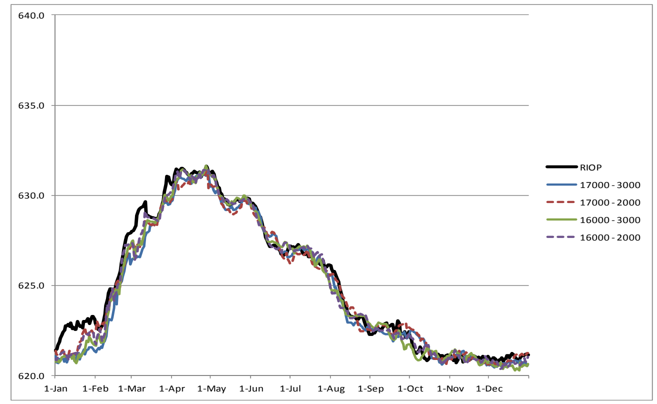

Figure 9 - 72. MINIMUM ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS

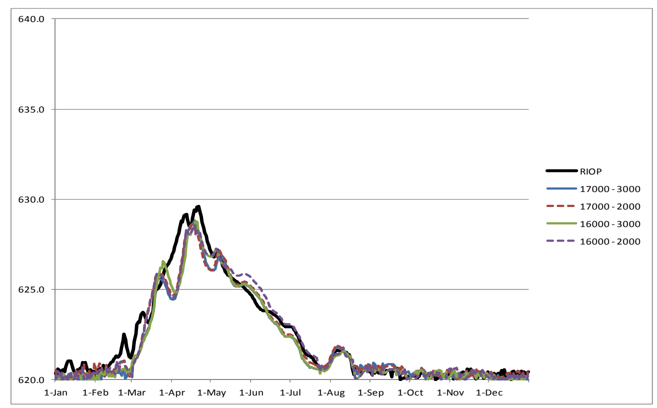

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Figure 9 - 73. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (1970)

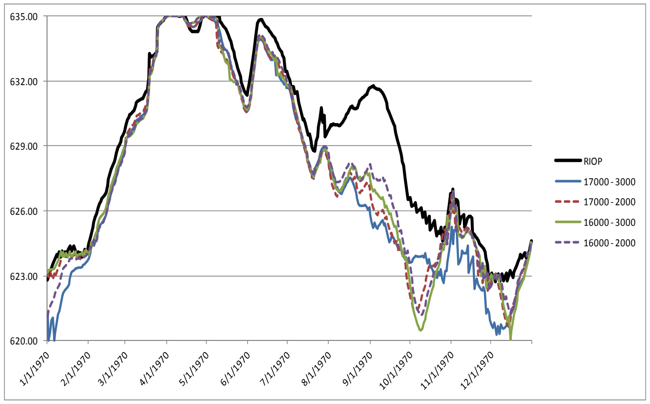

Figure 9 - 74. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (1977)

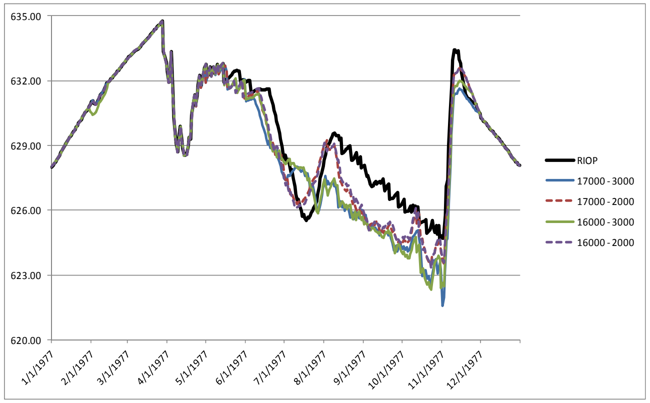

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Figure 9 - 75. ANNUAL TIME SERIES OF A LOW FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (1981)

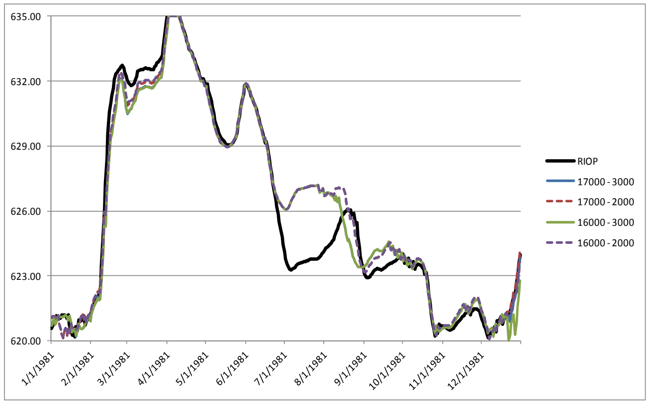

Figure 9 - 76. ANNUAL TIME SERIES OF A LOW FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (1988)

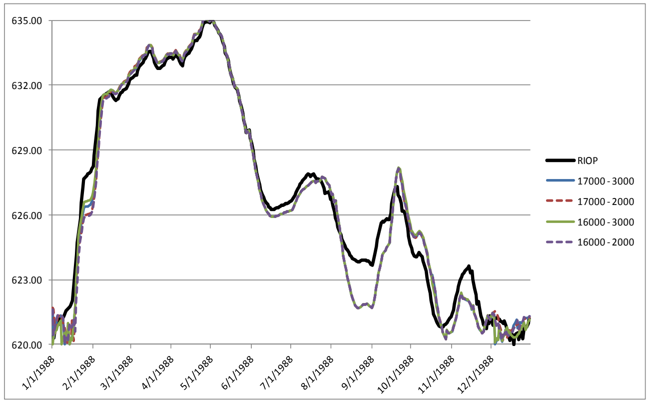

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Figure 9 - 77. ANNUAL TIME SERIES OF AN EXTREME LOW FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (2002)

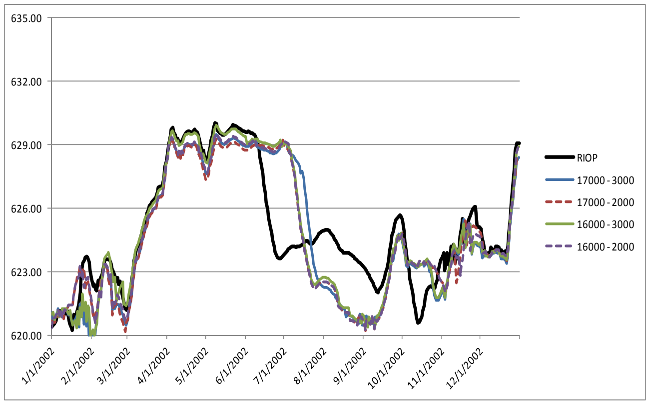
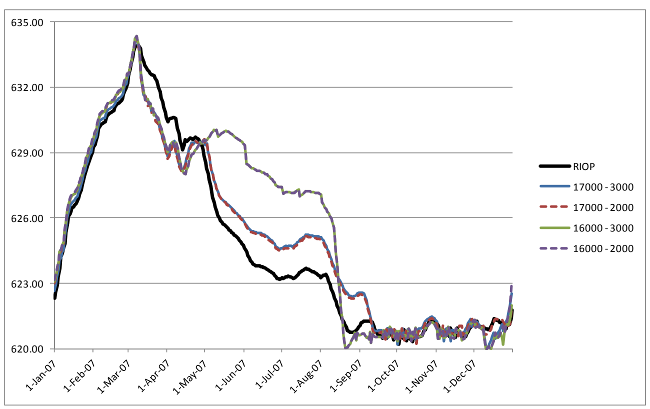


Figure 9 - 78. ANNUAL TIME SERIES OF AN EXTREME LOW FLOW YEAR ELEVATIONS AT WEST POINT LAKE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (2007)



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W.F. GEORGE

Figures 9-79, 9-80, 9-81 and 9-82 show the period of record data for elevations at W.F. George and figures 9-83 to 9-88 show the annual time series data for elevations at W.F. George.

For W.F. George, the period of record figures show the most variation occurring in median level with limited variations in the 75% exceeded, 90% exceeded and minimum elevations. The model runs with the lesser augmentation limit result in the higher elevations at W.F. George. For the annual time series figures the greatest amount of variation was seen in the average flow years.

Figure 9 - 79. MEDIAN ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS

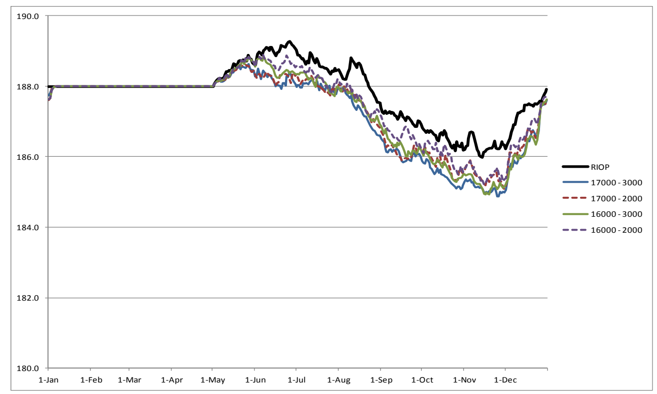

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Figure 9 - 80. 75% EXCEEDED ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS

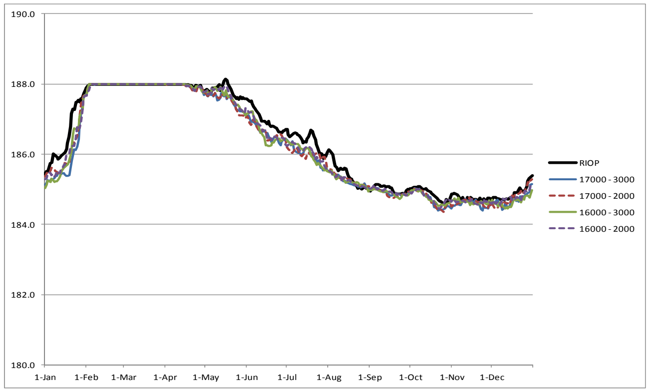

Figure 9 - 81. 90% EXCEEDED ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS

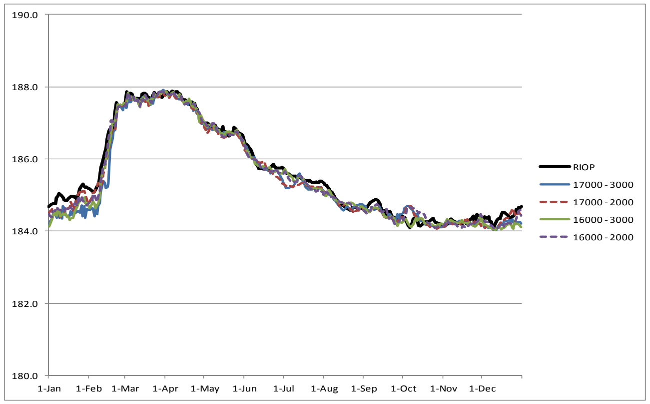

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Figure 9 - 82. MINIMUM ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS

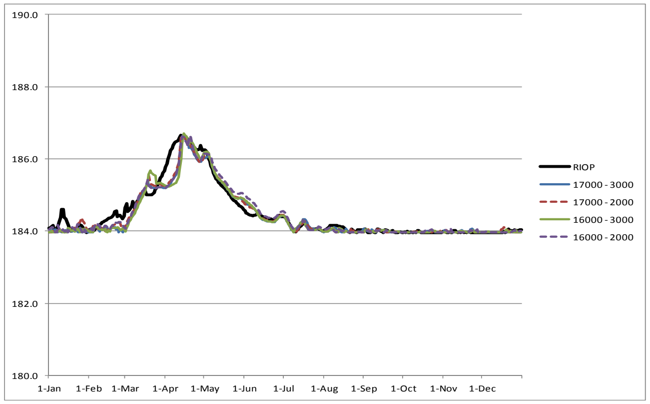

Figure 9 - 83. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (1970)

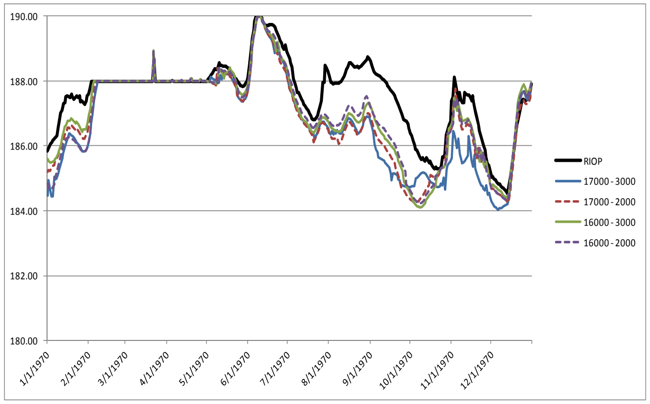

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Figure 9 - 84. ANNUAL TIME SERIES OF NORMAL FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (1977)

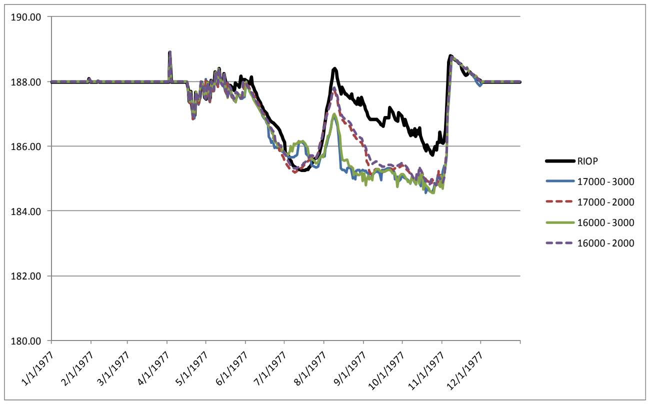

Figure 9 - 85. ANNUAL TIME SERIES OF A LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (1981)

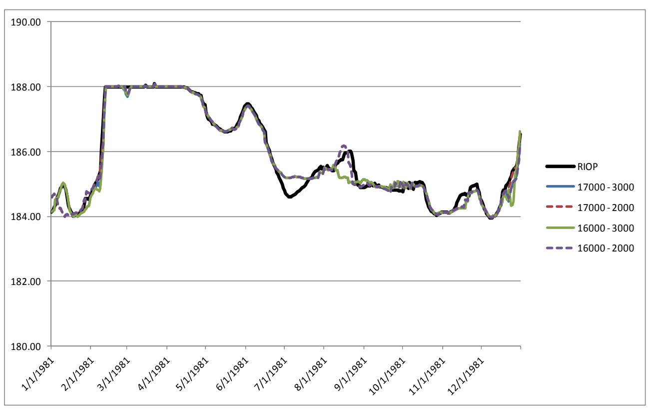

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Figure 9 - 86. ANNUAL TIME SERIES OF A LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (1988)

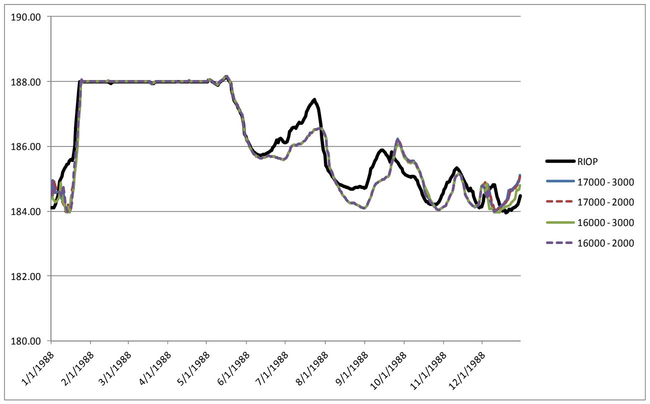

Figure 9 - 87. ANNUAL TIME SERIES OF AN EXTREME LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (2002)

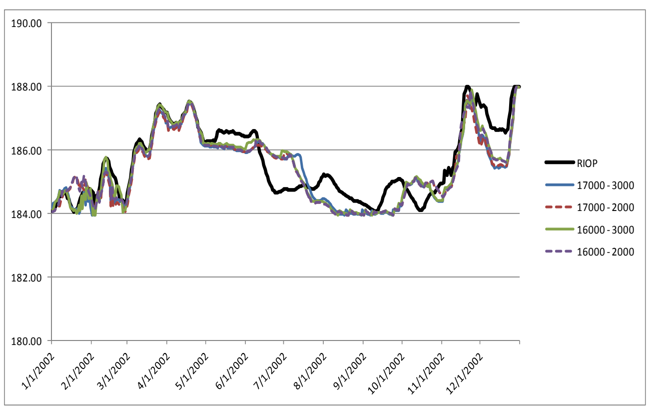

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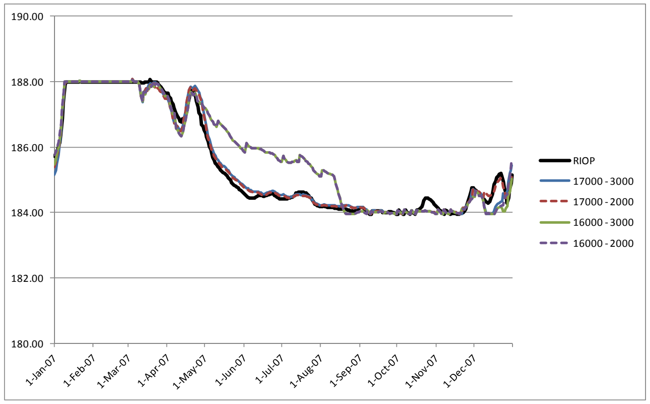
Figure 9 - 88. ANNUAL TIME SERIES OF AN EXTREME LOW FLOW YEAR ELEVATIONS AT W.F. GEORGE LAKE FOR VARYING LEVELS OF DREDGING AND AUGMENTATION AND ACTIVE RELEASES TO MEET CHATTAHOOCHEE RIVER MINIMUM FLOW REQUIREMENTS (2007)



SUMMARY OF FINDINGS FOR SENSITIVITY ANALYSES FOR HAVING ACTIVE MINIMUM FLOW TARGETS IN THE MIDDLE CHATTAHOOCHEE WITH VARIABLE FLOWS NEEDED TO PROVIDE THE 9-FOOT NAVIGATION CHANNEL AND VARIABLE AUGMENTATION THRESHOLDS

In this portion of Chapter 9 comparisons are made between having different levels of releases to provide the navigation channel (16,000 and 17,000 cfs) and different levels of augmentation releases (2,000 and 3,000 cfs). These figures document what has already been shown in Chapters 7 and 8: that the extent of availability of the 7-foot and 9-foot navigation channel is dependent on the flow needed to provide the channel and the limit of augmentation provided from the federal reservoir system. The lower the flow needed to provide the navigation channel the greater the availability of use; the higher the level of augmentation, the greater the availability of the channel.

Analysis of flows for the Apalachicola River at Chattahoochee showed that for the period of record figures it can be seen that minimal differences are evident in terms of flow. For the annual time series figures there are differences in some of the years. In regard to floodplain inundation it was found that for the 15,000 cfs threshold the greater the release needed to provide the navigation channel and the greater the amount of the augmentation threshold the greater the frequency of floodplain inundation. There were limited differences between the RIOP and the percent of time the 17,000 cfs threshold was exceeded and this is because 16,000 cfs is a critical flow threshold in the RIOP as well as in the model runs. The 29,000 cfs threshold showed little sensitivity.

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For Lake Lanier the period of record figures show that there were minimal differences at median elevations, but much greater differences in the 75% exceeded, 90% exceeded and minimum elevation figures. It can be seen that operating for the minimum flow targets results in a lower the elevation at Lake Lanier. The annual time series figures showed little differences in the average flow years, but substantial differences in one of the extreme low flow years (2002).

For West Point Lake, the period of record figures show minimal differences for all of the charts and the daily time series figures show variations among the level of flow needed to provide the 9-foot channel in some years and little difference in other years. The year that showed the greatest variation was one the average flow years, 1977.

For W.F. George, the period of record figures show the most variation occurring in median level with limited variations in the 75% exceeded, 90% exceeded and minimum elevations. The model runs with the lesser augmentation limit result in the higher elevations at W.F. George. For the annual time series figures the greatest amount of variation was seen in the average flow years.

CONCLUSIONS FOR EVALUATION OF CHATTAHOOCHEE RIVER MINIMUM FLOW TARGETS

In reviewing the effects on the system from actively meeting minimum flow requirements in the Chattahoochee River by making releases from the storage reservoirs to support these instream flow targets it was found that:

1. With providing active releases from Lanier and W.F. George to meet the minimum flow targets for Columbus and Plant Farley and a supplemental release of 300 cfs from Lake Lanier whenever the elevation at West Point is below 622 NGVD that these minimum requirements could be met more than 99.9% of the time over 70 year model run period.
2. These supplemental releases did not have a major effect on the availability of the 9-foot or 7-foot channel. Likewise, these changes had little effect on flow at the Chattahoochee gage on the Apalachicola River or the extent of inundation of the Apalachicola River's floodplain.
3. Elevations at Lake Lanier the period of record figures show minor differences in the median elevations but much greater differences in the 75% exceeded, 90% exceeded and minimum elevation figures.
4. West Point and W.F. George elevation the period of record figures the greatest sensitivity is at the minimum elevations.

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CHAPTER 10 – SENSITIVITY ANALYSIS OF INCREASING CONSUMPTIVE DEMANDS

INTRODUCTION

In the previous three chapters analyses have been done on the sensitivity of performance measures for navigation, environmental flows and reservoir elevations to the volume of flow needed to provide the 9-foot navigation channel, to the limits of augmentation allowed from the federal storage reservoirs, and to whether in-stream flow targets are met actively or passively. In this chapter the final set of sensitivity analyses is conducted:

The sensitivity of one of the reservoir management options to increasing consumptive demands.

The management option used in this sensitivity analysis is a 17,000 cfs release to provide the 9-foot navigation channel, an augmentation limit of 3,000 cfs and with the Chattahoochee River minimum flow targets being met actively.

The approach taken to test the sensitivity to consumptive demands was to uniformly increase all of the demands above Jim Woodruff Dam by increments of 10% until the demands were increased by 50%. It is recognized that in the real world future increases in consumptive demands will not be distributed equally across the basin, but to conduct sensitivity analyses of all possible increases in consumptive demands is beyond the funding and scope of this project.

COMPARISON OF INCREASES TO CONSUMPTIVE DEMAND INCREASES

NAVIGATION PERFORMANCE MEASURES

Figure 10-1 shows the availability of the 9-foot navigation channel both with consumptive demands. Figure 10-2 shows the availability of a 7-foot channel.

From these figures it can be seen that increasing consumptive demands has a limited effect on the availability of the availability of the 7-foot and 9-foot navigation channel. The maximum difference between the availability in any month was about 5% of the time when consumptive losses were increased by 50%. Average annual availability of the 9-foot channel ranged from 48.3% with a 50% increase in 2007 consumptive demands to 50.4% with 2007 demands. Average annual availability of the 7-foot channel ranged from 73.9% with a 50% increase in 2007 consumptive demands to 76.9% with 2007 demands.

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Figure 10 - 1. AVAILABILITY OF A NINE-FOOT CHANNEL WITH INCREASED CONSUMPTIVE DEMANDS AND 17,000 CFS TO PROVIDE A NINE-FOOT CHANNEL AND A 3,000 CFS AUGMENTATION LIMIT

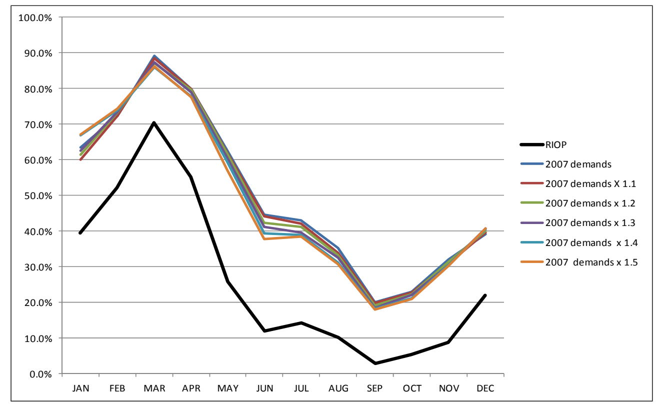

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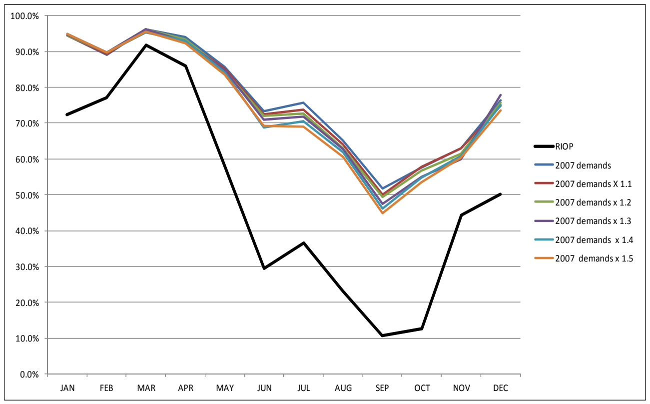
Figure 10 - 2. AVAILABILITY OF A SEVEN-FOOT CHANNEL WITH INCREASED CONSUMPTIVE DEMANDS AND 17,000 CFS TO PROVIDE A NINE-FOOT CHANNEL AND A 3,000 CFS AUGMENTATION LIMIT



ENVIRONMENTAL PERFORMANCE MEASURES

Figures 10-3, 10-4 and 10-5 show the comparisons of median, 75% exceeded flows and 90% exceeded flows for model runs relative to the RIOP for the entire model run period (1939 – 2008) and figures 10-6, 10-7, 10-8, 10-9, 10-10 and 10-11 show the same data for individual years chosen to represent normal flows, low flows and extreme low flows. In the annual time series data the flow values shown were truncated to the 0 to 30,000 cfs range to better display differences between model runs.

Figures 10-3, 10-4, and 10-5 show that for the period of record median flows increasing demands does not change flows to any major extent. However, the 75% exceeded and 90% exceeded flows show more sensitivity to increasing the volume of consumptive demands in the latter half of the year when flows are of a lesser magnitude. At median flow, average annual flow for the Jim Woodruff outflow declined by 282 cfs when demands were increased 50% (a 1.5% decrease in flow). At the 75% exceeded level, average annual flow for the Jim Woodruff outflow declined by 662 cfs (a 5.1% decline) and at the 90% exceeded flows, average annual flows declined by about 315 cfs (a 3.35% decrease in flow) Figures 10-6 to 10-11 show that in the annual time series figures some differences in flow can be seen when the level of consumptive withdrawals are increased. Some of these differences are phase changes where the timing of a flow event is shifted and some are differences in the flow.

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Figure 10 - 3. MEDIAN FLOWS FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR INCREASED CONSUMTIVE WITHDRAWALS AND 17,000 CFS TO PROVIDE A NINE-FOOT CHANNEL AND A 3,000 CFS AUGMENTATION LIMIT FOR THE PERIOD OF RECORD (1939 – 2008)

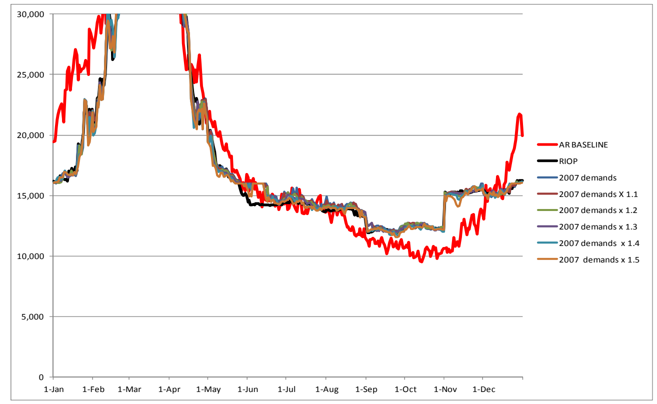
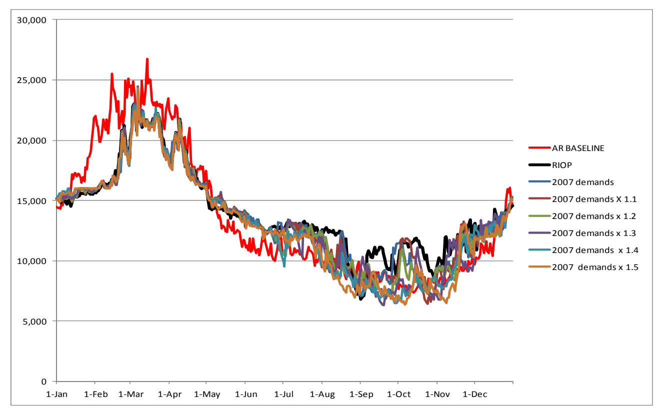


Figure 10 - 4. 75% EXCEEDED FLOWS FOR THE APALACHICOLA RIVER AT CHATTAHOOCHEE FOR INCREASED CONSUMTIVE WITHDRAWALS AND 17,000 CFS TO PROVIDE A NINE-FOOT CHANNEL AND A 3,000 CFS AUGMENTATION LIMIT FOR THE PERIOD OF RECORD (1939 – 2008)



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