

## Water Conditions Triggers

The Environmental Flows Project for the Cypress Basin has developed the first steps for an SB3 type of the flow reservation. These initial recommendations provide the critical flow components for the flow regime including natural variation. This variation is captured by including the full flow regime with associated seasonal variability and by recognizing the need for intra-annual variability to account for dry, average or wet water conditions. One of the challenges to the implementation of these recommendations is the need identify the current water condition (i.e. dry, average or wet) and develop triggers to ensure that flow recommendations associated with the water conditions are met at desired frequencies. The question of desired frequency was introduced and briefly discussed in the water availability paper. This paper addresses the issue of implementing a desired frequency on a regulated system, in this case on Big Cypress. Assuming that desired frequency can be determined by the scientists/experts, this paper presents some first steps and ideas that will need to be considered in order to implement a management approach to achieve the goals initial recommendations. Accompanying this paper is a spreadsheet model that will be used to explain and examine some of the issues discussed below. Please note that this is a highly idealized exercise, intended to stimulate discussion and is not meant to serve as the basis for a final recommendation or as a replacement for a more detailed and thorough analysis.

*What parameter will be used to determine whether the conditions are Dry, Average or Wet?*

One of the first issues that will need to be address is the selection of an appropriate parameter or parameters that could be used to define dry, average or wet conditions. At least three candidates seem worth consideration. These are meteorology (temperature, precipitation or some combination), flow and reservoir storage. From an ecological perspective, natural inflow to Lake O 'the Pines would be an ideal choice however since there are reservoirs and diversions upstream, estimating naturalized inflows may prove difficult. Theoretically inflows could be adjusted to account for diversions and evaporations and remove return flows upstream; other alternatives might include rainfall or a rainfall-runoff model. From a reservoir operations perspective the simplest trigger would be to use reservoir levels, though these have problems if for instance reservoirs are lowered in the future to supply demands out of basin but in reality flow conditions in the basin are about are average, we might end up managing for dry conditions when we are actually in an average period. Ultimately the choice of an indicator is perhaps less important than that the indicator can be used to set triggers which maintain the ecological objectives defined in the building blocks. (- the important thing is that if we decide we need dry conditions exceeded 80 % of the time then a trigger level that occurs about 80 percent of the time should be selected. This could be accomplished with reservoir levels or flows. To the extent that this trigger is an actual indicator of dry, average and wet would be best because it would keep flow more in synch the system i.e. long term cycles etc.) It is likely that a balance between both reservoir elevations and inflows will guide this decision. For the purposes of developing a simple example, we choose the flow at the nearby, less impacted gauge on Black Cypress as a surrogate for water conditions in Big Cypress.

*What time frame will be used to determine the current water conditions?*

The next important question that needs to be addressed is temporal window that will be used to define the conditions. Again there are three main possibilities. These are past, current or future (forecasted) conditions. With perfect knowledge forecasted approach would be ideal though in the real world may not be feasible. Current conditions may also be difficult to implement in that it might result in constantly switching from dry, average and wet one daily basis. We used the cumulative inflow for the previous three months to determine whether we are in a dry, average or wet period. The pervious three month inflow for each month was calculated for the Black Cypress gauge for the period of record. This data is used to select trigger flows corresponding to the frequency at which the various water conditions should be met.

*At what frequencies should the various water conditions targets be met?*

As discussed in the Water Availability paper, selection of these frequencies requires some additional consideration by the scientist/experts. For this example, the hydrograph was divided into three equal parts, with wet being those times when upstream inflows flows were greater than the 33<sup>rd</sup> percentile flow,

average when greater than the 66<sup>th</sup> percentile flows and dry the rest of the time. Since flows show a strong seasonal components these percentiles were calculated on a monthly basis. Table 1 shows the 33<sup>rd</sup> and 66<sup>th</sup> percentile three month antecedent flows for Black Cypress Bayou at Jefferson gauge records.

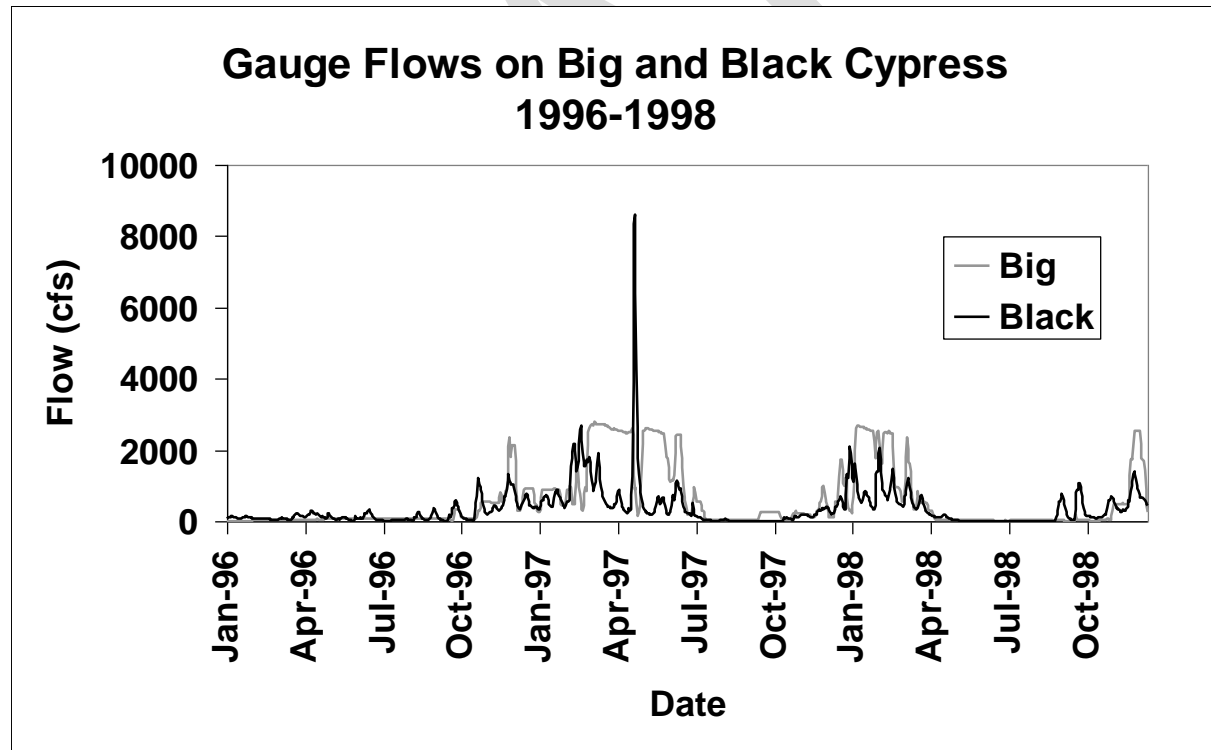
**Table 1 Black Cypress Bayou at Jefferson 33rd and 66th percentile three month antecedent flows (ACFT/3 Months)**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.33	23,063	47,528	73,835	84,525	80,629	69,311	46,943	34,319	10,609	4,067	1,792	5,474
0.66	57,828	89,388	124,636	133,535	117,334	114,681	92,753	63,791	31,518	12,307	10,748	27,168

The approach proposed in this example is that on the first day of each month the cumulative inflow for the pervious three months is calculated. If the value is less than the 33<sup>rd</sup> percentile flow the dry targets should be in force for the month. If the value is between the 33<sup>rd</sup> and 66<sup>th</sup> percentile flows the average should be in force and when the flows are greater than the 66<sup>th</sup> percentile flows the wet targets should be in force.

*How does this help to develop an implementation strategy?*

Evaluation of this approach will require analysis of impacts on reservoir storage of meeting constant base flow targets and on the potential to utilize flood storage to capture and redistribute high flows as prescribed in the flow recommendations. This detailed analysis has not yet been performed; however as a preliminary analysis, historic flow records were reviewed. The example considers potential releases from Lake O' the Pines (LOP) for 1996-1998. Based on annual flows 1996 was a dry year, 1997 was wet and 1998 was average. Figure 1 shows flows at Big and Black Cypress gauges.



**Figure 1**

Based on the 3 month antecedent flow the water conditions for each month is designated. Figure 2 shows the gauge flows (now just Black Cypress) on the left side y-axis and a code for water condition (dry=-1, average = 0 and wet = 1) on the right side axis.

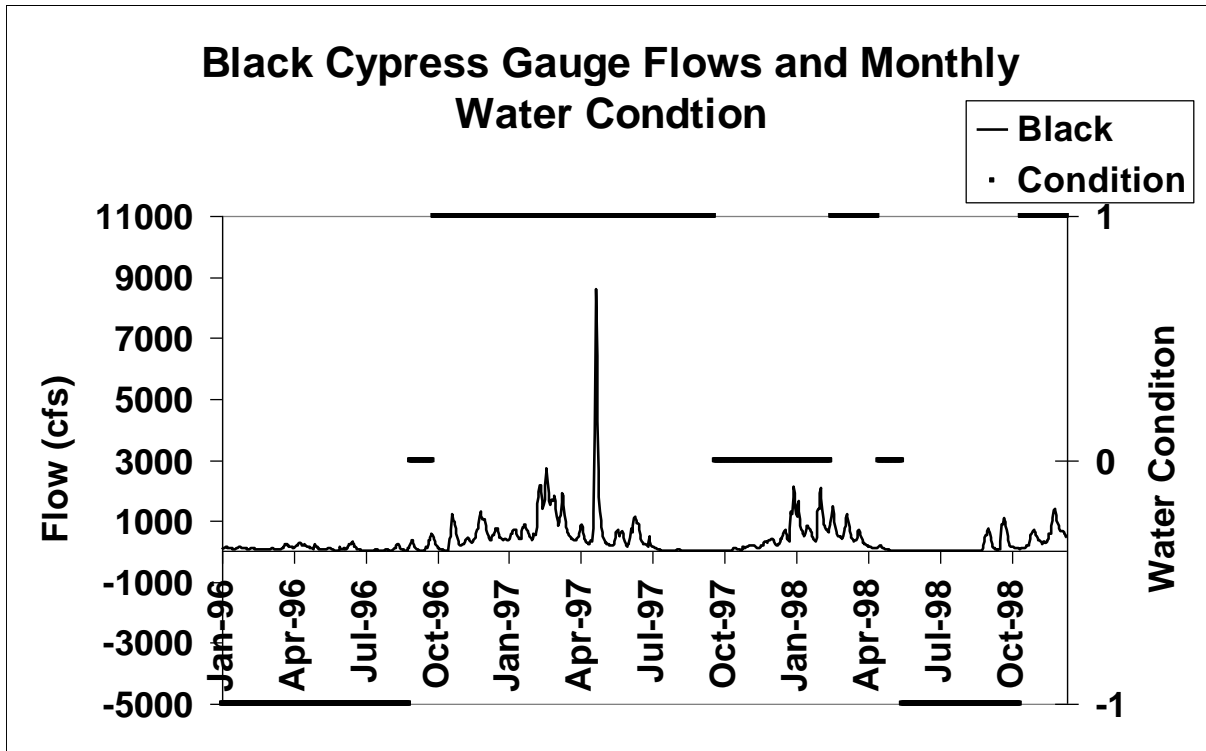


Figure 2

Conditions were dry for most of 1996, wet for 1997 and variable in 1998. Based on the water conditions the desired base flow targets can be set for Big Cypress. Figure 3 shows the base flow targets as well as the Big Cypress historical gauge flows (what was actually released from LOP)

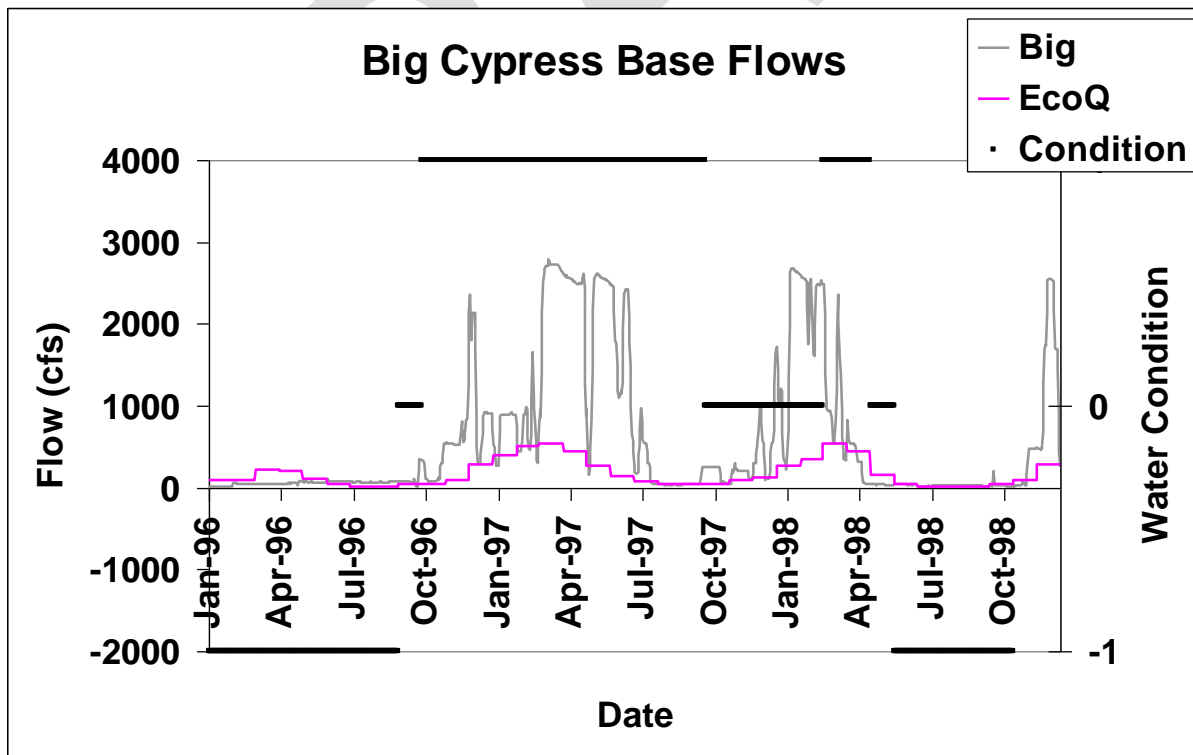


Figure 3

Figure 4 shows the same information as Figure 3 but focuses on the low flow (<500 cfs) part of the hydrograph.

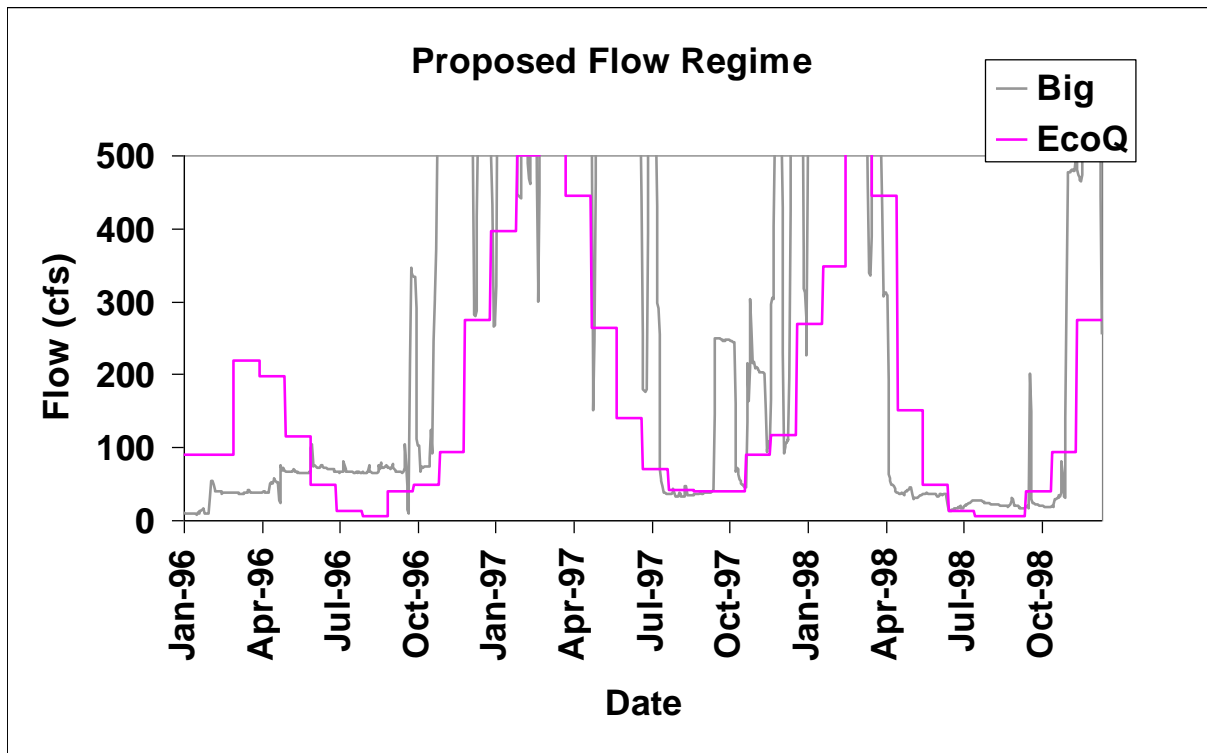


Figure 4

From Figure 4 we see that during the dry 1996 year, the base flow prescriptions recommend flows that are higher than what was historically released. During the wet 1997 year, even the wet period targets were generally exceeded. Finally in 1998 targets flows are reasonable close to what was released.

The next step is to include some of the high flow recommendations. Since current constraints on releases limit the maximum flow to 3,000 cfs, we modified, for this exercise only, the building blocks recommendations. For this exercise, average conditions will include 4 high flow pulses of 1,500 cfs and wet conditions will include 3 high flow pulses of 1,500 cfs and one of 3,000 cfs. We also include the concept of an amount of storage that could be used to satisfy the flow prescriptions. We have assumed that 40,000 ACFT could be available for meet the targets on the first day of the exercise (January 1, 1996). This value will go up or down based on the difference between the prescribed release and the actual historical release but will never exceed 40,000 ACFT.

Based on the designated water condition and the seasonal timing for high flows the first time that a high flow release would be required would be in December 1997. December is designated wet based on antecedent flow so on a 3,000 cfs release would be initiated. In a similar manor 3 additional high flow pulses would be made in the spring of 1997 based on water condition and the availability of storage. In December 1997 water conditions are designated as average therefore only the 1,500 cfs release is prescribed. By February 1998 conditions are wet and a 3,000 cfs is made. Figure 5 show the results of this exercise in terms of a prescribed release pattern (EcoQ).

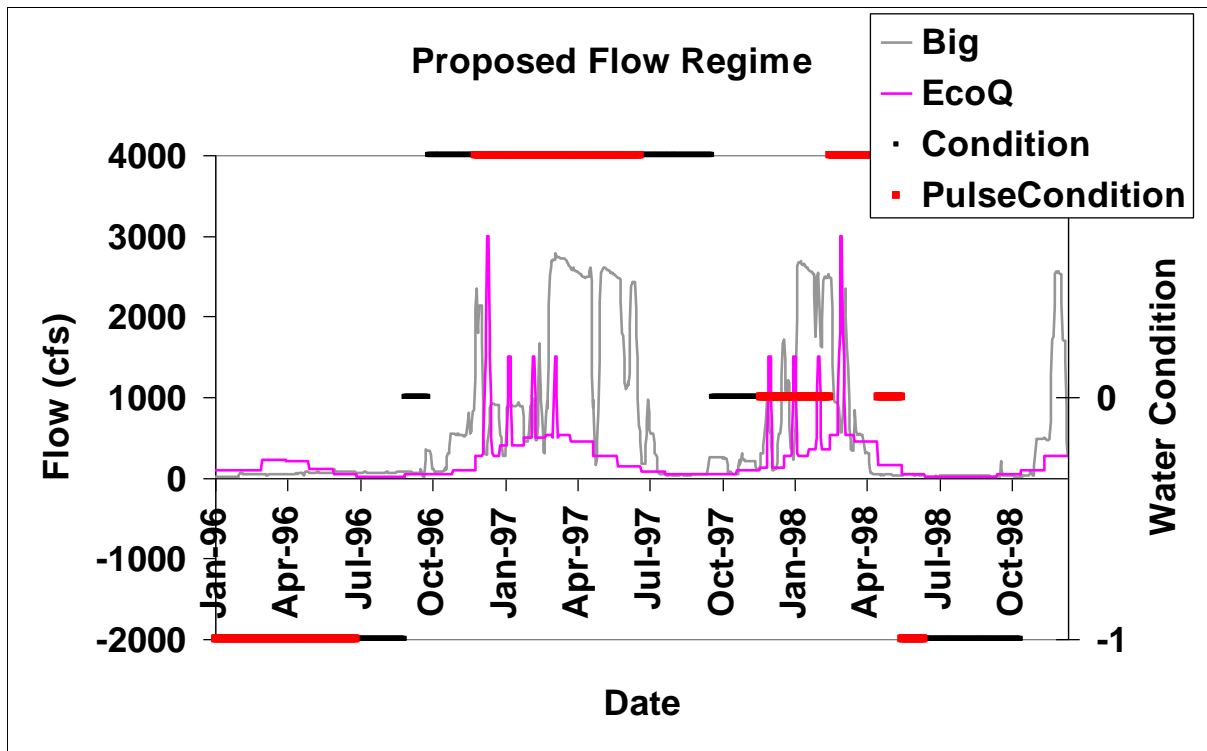


Figure 5

At the completion of this exercise the simulated 40,000 of storage would have fallen to its minimum of 9,350 ACFT on May 31, 1996, suggesting storage of closer to 30,000 ACFT would satisfy most of the prescribed release requirements during low flow periods. For most of the time, less water would have been prescribed than was historically released. Clearly the flood events in the spring 1997 would need to be evacuated from the flood pool and maintenance of the recommended environmental flows would be a secondary concern during this period. Storage of 30,000-40,000 that may be necessary to maintain flows during dry periods represents about 2 feet at LOP at top of conservation pool.