Missouri River Master Water Control Manual
Review and Update Study

Spring Rise Alternative Analyses

Introduction

The U.S. Fish and Wildlife Service (USFWS) provided the U.S. Army Corps of Engineers (Corps) a Biological Opinion (BiOp) in 2003 that required that the Corps develop a plan for spring rises in 2005. This plan would then be followed in 2006 as the Corps complied with the 2003 BiOp. If the Corps were unsuccessful in developing a plan for spring rises by 2006, much of the criteria for a prescribed spring rise were provided in the 2003 BiOp.

To provide a process for input to the formulation process for a spring rise, the Corps and other Federal agencies enlisted the services of the U.S. Institute for Environmental Conflict Resolution to facilitate the involvement of these stakeholders in a consensus process to provide a recommendation to the Corps and USFWS for a spring rise plan. In turn, the Institute contracted with CDR Associates to conduct the facilitation. At the request of the Plenary Group that was formed to make the recommendation, a the hydrologic work group met and agreed upon a set of criteria to incorporate into an array of alternatives for the Corps to model and evaluate. This report summarizes the set of criteria and resulting set of alternatives. It also presents some of the results of the evaluation of alternatives to help the technical work group to understand the effects of the various criteria on potential impacts that the Plenary Group would like to minimize or eliminate as it arrives at its recommendation to the Corps and USFWS for a spring rise plan.

Criteria for Alternative Formulation and List of Alternatives Developed

At the meeting with the Plenary Group in St. Joseph, Missouri on June 1 and 2, the Corps gave a PowerPoint presentation that concluded with a slide that identified the various criteria on which the Corps needed feedback in order to develop alternatives. This same presentation was given to two work groups (hydrologic and fish and wildlife work groups) when it met in Minneapolis, Minnesota on June 8 and 9. At the latter meeting, potential values for the various criteria were discussed by the hydrologic work group, and the list of criteria and the value or range of values to be modeled are listed in Table 1. Using this list of criteria and their values, the Corps was to develop a set of alternatives that would allow an analysis of impacts that basin stakeholders might want to be minimized. The resulting set of alternatives along with several specific alternatives requested for analysis by the technical work group are listed in Table 2 with the specific criteria highlighted for each alternative. There is no key to the alternative file name listed in Table 2 other than the name has to be six characters long. Some of the key hydrologic files for these alternatives are listed on the Master Manual website (http://www.nwd-mr.usace.army.mil/mmanual/rdeis-files.html) that the Corps maintains as part of the Northwestern Division website.

Table 1. Criteria Provide by the technical work group for alternative formulation.			
Criteria	**Values to be Modeled**		
1st Rise	No rise	Nav. +5 for 1 wk	--
Drop between rises	Min. Service	PPT Guide Curve	MM Guide Curve
2nd Rise – Max.	16 kcfs for 2 wks	--	--
2nd Rise – FC Constraints	Plus 16 to MM	Min change from MM	--
Max or Prorate During Drought	Maximum with preclude	Prorate with Preclude	--

Table 2. Alternatives Formulated from Table 1 Requirements

Alternative Name	First Rise		Drop Between Rises			Max Rise	FC Constraints		Max or Prorate during drought	
	None	Nav +5 1 Wk	Min Serv	New GC	Current GC	16 kcfs 2 wk pk	Plus 16	Min. Raise	Max w/ Precl.	Prorate w/ Precl.
Existing runs										
MR16FS									46 MAF	
F2 and F2 lie between										
MR16F3									46 MAF	
MR16MN									46 MAF	
M1 and M2 lie between										
MR16M3									46 MAF	
M16F50									50 MAF	
M16F40									40 MAF	
M16F31									31 MAF	
MRBIO3		31 kcfs							46 MAF	
MRBIO4		31 kcfs								31 MAF
MRBIO5										31 MAF
N at end indicates no first rise										
MBIO53										31 MAF
Special Criteria Identified by the Hydrologic Work Group										
MRBP52 - MRBIO5 w/ shorter 2nd Rise						16 kcfs w/ < 2 wk peak				31 MAF
BIO521 - MRBP52 with 21 kcfs max						21 kcfs w/ < 2wk peak				31 MAF
BIO518 - MRBIO5 with 18 kcfs April			< MS							31 MAF

Analysis of the Impacts of the Alternatives

All of the alternatives listed in Table 2 were analyzed to identify hydrologic, economic use, and environmental resource impacts. This section of the report summarizes the results of the analyses in the order listed above. In some cases, the results will be presented in tables and others will be presented in figures, with the form of presentation based on which form best depicts the impacts. For example, the basic average annual economic use and environmental resource will be presented in tabular form; whereas, the impacts relating to pallid sturgeon spawning cue will be done in a figure form.

Hydrologic Impacts

The hydrologic impact analyses focused on changes and total system storage, which is a primary upper basin concern regarding the spring rise, and on increases in Lower River flows, which is a primary lower basin concern regarding the spring rise. The effects of the first spring rise, the releases between the two rises, and the drought criteria (preclude and type of cutbacks down to the preclude) will be variables against which system storage will be shown. Similarly, the releases between the two rises and the amount of flood control constraint increases will be variables used to demonstrate their effects on downstream flow increases, which are related to the potential for crop damage risk increases.

System Storage. System storage during droughts is reduced below those under the current water control plan by any factor that increases releases from Gavins Point Dam during droughts. The first rise, the higher the service level between the rises, the deeper into a drought the second rise is precluded (shut off), and the higher the flood control constraints are set on the lower river will all increase the Gavins Point releases during droughts, and, therefore, decrease system storage during droughts.

Figure 1 shows the effect of adding the first rise to a plan that does not have the first rise on total system storage. A first rise of an additional 5 thousand cubic feet per second (kcfs) over the service level specified for this period for the new current Water Control Plan (CWCP) by the current Master Manual criteria decreased the storage level in three droughts by amounts from 0.3 to 0.5 million acre-feet (MAF) (An N in the alternative name indicates no first rise in the run.), which translate to a foot or less in the upper three, larger reservoirs. In the fourth drought (1954-1961), the first rise actually increased minimum system storage by 0.2 or 0.7 MAF, or by less than 1 foot to about 2 feet in the three larger reservoirs. In general, common sense indicates that the first rise would more likely decrease system storage, as it did in the other three droughts.

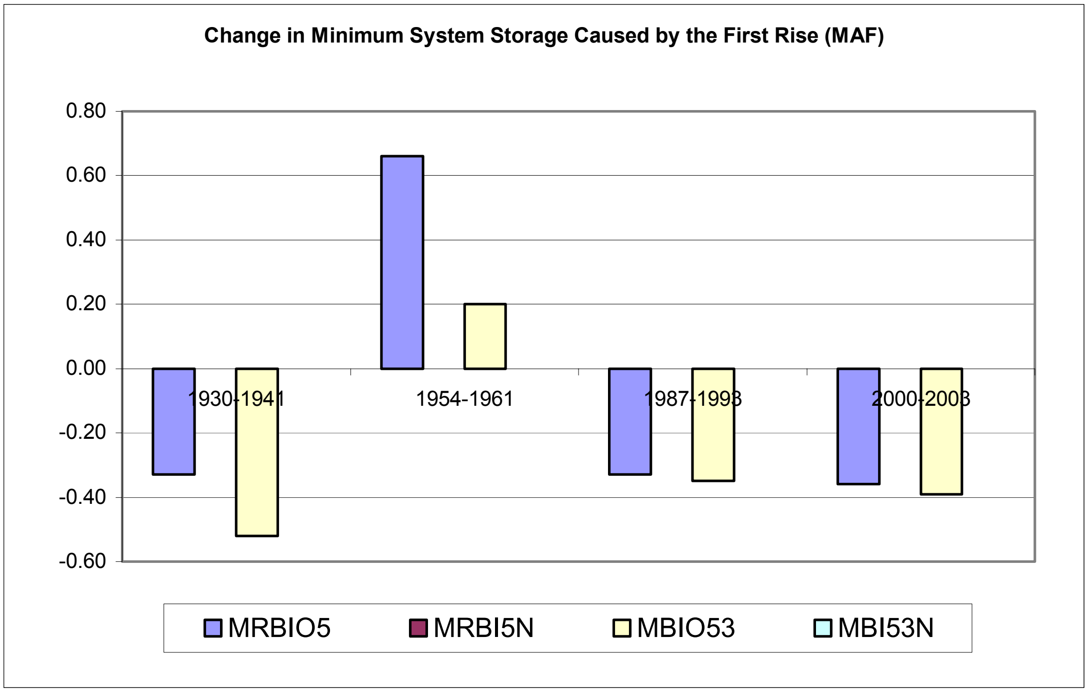

Figure 1. Changes in minimum system storage caused by the first rise of the spring rise in MAF.

Figure 2 shows the effect of three service levels during the period between the two rises. Three levels of service were examined. The first was to have minimum service during this period in all years but flood storage evacuation years, the second was to follow a new service level guide curve for this period that went to minimum service quicker than under the current Master Manual guide curve for this period, and the third was to follow the current Master Manual guide curve for this period. This figure shows that going to minimum service (MR16M3) results in the lowest decrease in system storage from current water control plan levels for two of the droughts (1930-1941 and 1987-1993), but the new guide curve guide curve (MBIO53) decreased the drawdown in the other two droughts. The current guide curve plan (MR16F3) had the greatest drawdown of the three options for the releases between the two rises. One would expect the minimum service plan to result in the least drawdown; however, this was not always the case. The minimum and full service plans had a full second rise in it down to 46 MAF of storage; whereas, the new guide curve plan had a prorated rise down to 31 MAF. In other words, these plans had a second variable that could explain some of the surprise in the results. In two of the droughts, the minimum system storage would actually increase for two of the runs (minimum service in the 1930-1941 drought and new guide curve in the 2000-2003 drought, which is still not over)

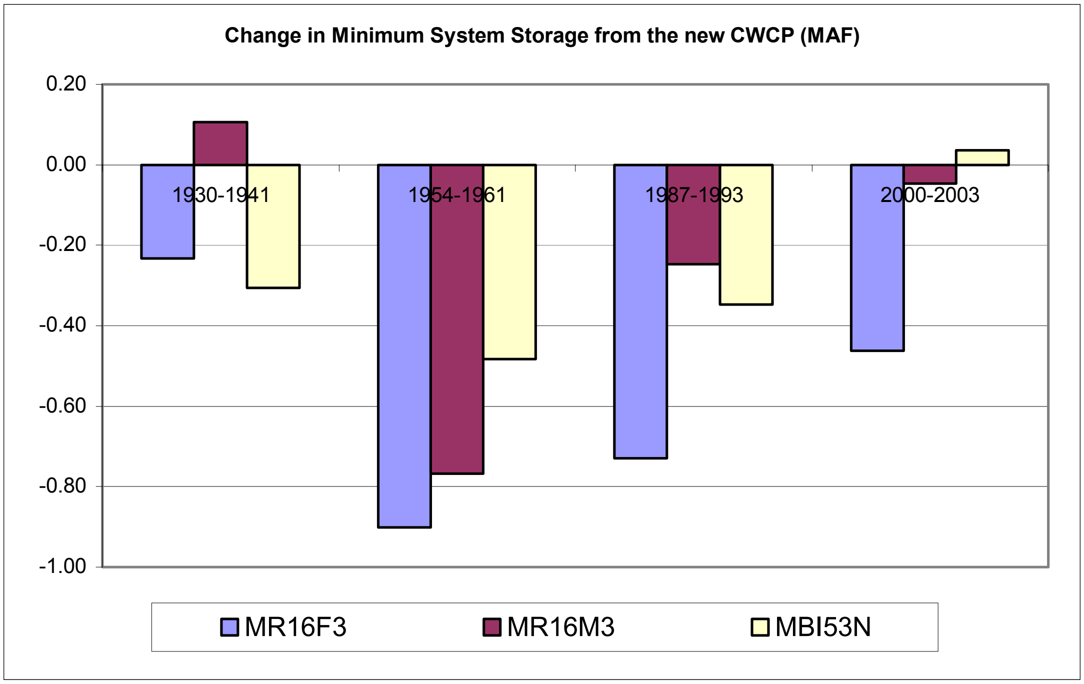

Figure 2. Changes in minimum system storage caused by the releases between the two rises of the spring rise in MAF.

Figure 3 shows the effect of the increase in flood control constraints. Historically, the Corps has completed simulations of the alternatives with models that raised the flood control constraints by the amount of the spring rise. In other words, for a spring rise of 16 kcfs, the flood control constraints were raised 16 kcfs. More recently modeling was completed for lower increases in flood control constraints. This figure shows the full range of the 16-kcfs increase down to a minimal increase in the constraints. This minimal increase results in some constraints being increased to some actually being decreased, as shown in Table 3. The changes range from an increase of 8 kcfs for the Omaha target that call for a reduction to full service releases to a decrease of 8 kcfs for the Kansas City target that call for a reduction to minimum service releases. Two intermediate sets of flood control constraints (MR16M1 and MR16M2) are also shown on the figure. The effect of using the lower increases in the flood control constraints during the second rise was to progressively reduce the system storage drawdown in all four droughts. The amount of the drawdowns compared to those under the current water control plan range from a +0.1 to a –1.1 MAF. These all translate to a slight increase to a reduction of over 2 feet in reservoir level for all three of the larger reservoirs. In general as the data shows, as flood control constraints are increased, the amount of drawdown of system storage in a drought increases.

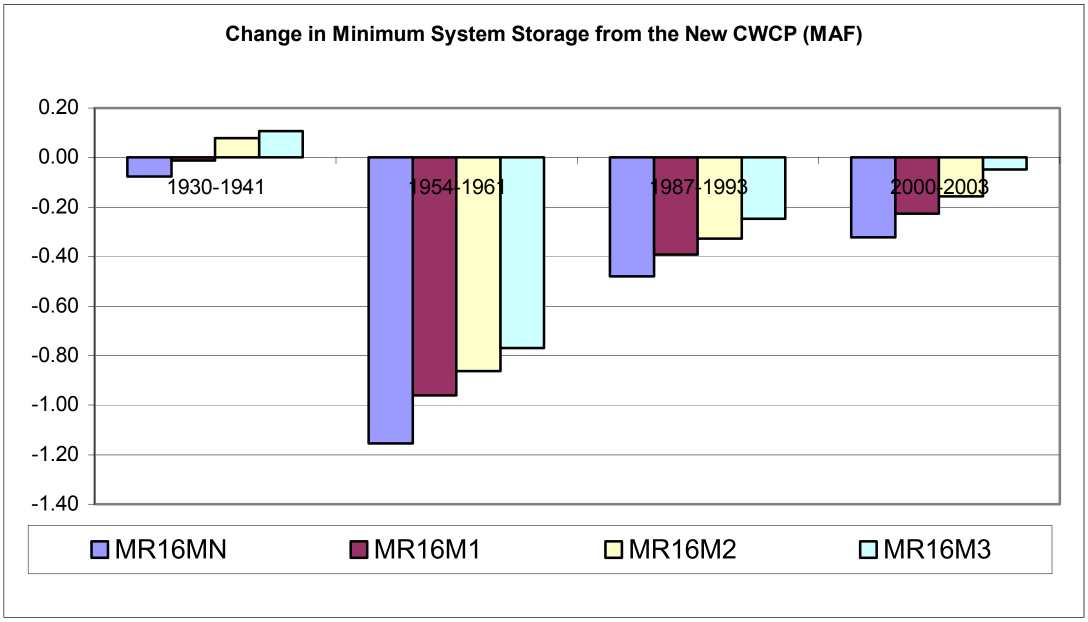

Figure 3. Changes in minimum system storage caused by decreasing flood control constraints during the second rise of the spring rise in MAF.

Table 3. Current flood control constraint flow values in kcfs and low-increase option for constraints.

	Flow Target for Service Level of 35 (Full Service)	Current Flood Control Target (Reduce to Full Service)	Current Flood Control Target (Reduce to Min. Service)	Low Increase for Spring Rise FC Target (Reduce to Full Service)	Low Increase for Spring Rise FC Target (Reduce to Min. Service)
Sioux City	31				
Omaha	31	41	46	49	50
Nebraska City	37	47	57	55	57
Kansas City	41	71	101	75	93

Figure 4 shows the effect of lowering the system storage (based on March 15 value) at which the second rise is precluded, or stopped. As the drought preclude for the second rise is lowered toward 40 MAF of storage on March 15, the amount of water in system storage is reduced. At 40 MAF and lower, the effect is the same in three of the droughts (through 2003 in the current drought); whereas, there are differences in the 1931-1942 drought, where the system storage goes down below 31 MAF. All of the alternatives had a full rise programmed for each year the preclude would allow the rise in each of the four droughts. As expected, the lower the preclude the lower the system storage. The only time this was not the case was during the 1930-1941 drought, where an additional non-navigation year had to be added to account for the increased drawdown through that drought that was allowed by the 31-MAF preclude. For the 40-MAF preclude, the order of the non-navigation years was changed, which accounts for the unexpected increase in minimum system storage shown in Figure 4.

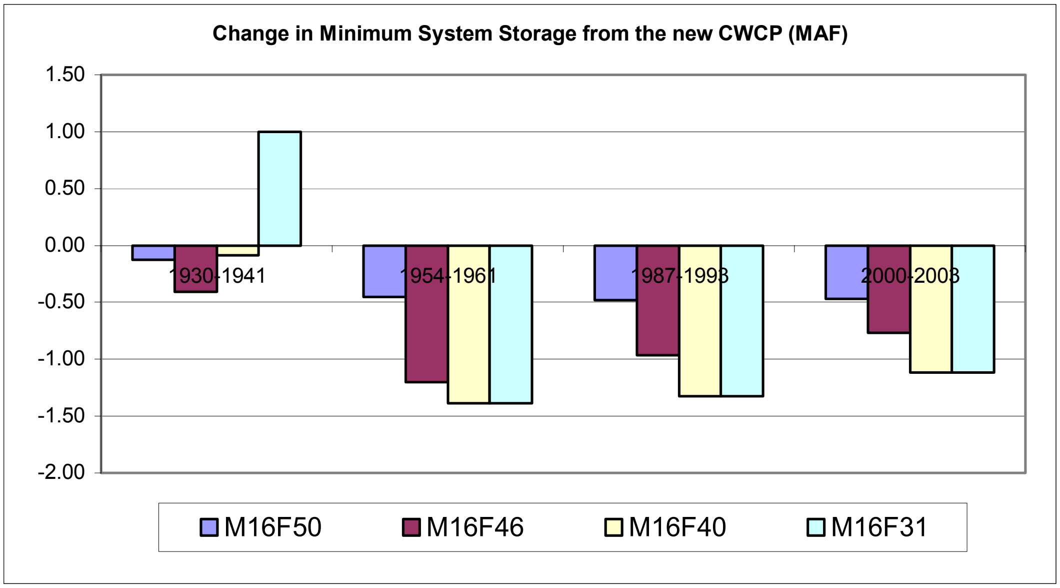

Figure 4. Changes in minimum system storage caused by reducing the drought precluded for the second rise of the spring rise in MAF.

Lower River Flows. Releases from Gavins Point Dam are increased or decreased for some of the criteria studied for the releases between the two rises and for the second rise. This section of the report will look at the service criteria for the service level between the two rises and the flood control constraints for the second rise. An indicator for increased lower river flows will be the changes in the number of days that flows exceed 55 kcfs at Nebraska City during the months of May and June of the simulation of inflows into the system during the 1898-1997, 100-year period of analysis used for the Master Manual EIS's. This is a good indicator because this is the flow at which the river begins to back up against the flood drainage structures draining the farm fields in that reach of the river. A duration plot will be used to depict the changes in the number of years.

Figure 5 shows the changes in the number of days flows would exceed 55 kcfs at Nebraska City for the three options for the service level between the two rises. These three options are for the current Master Manual guide curve for this period (MR16FS), minimum service in all years except flood storage evacuation years (MR16MN), and a new guide curve that goes to minimum service quicker than under the current Master Manual guide curve (MRBIO5). The new CWCP is also shown on the figure to identify the changes from current operation effects. All three spring rise alternatives raise the number of days that 55 kcfs is exceeded; however, the minimum service and the new guide curve alternatives result in a lower increase than the current guide curve does. In some cases, the new guide curve results in even fewer days than the minimum service alternative. In the case of service level during this period, the minimum service alternative would appear to be the best without data; however, the data shows that the new guide curve would be as good or even better than the minimum service in some years.

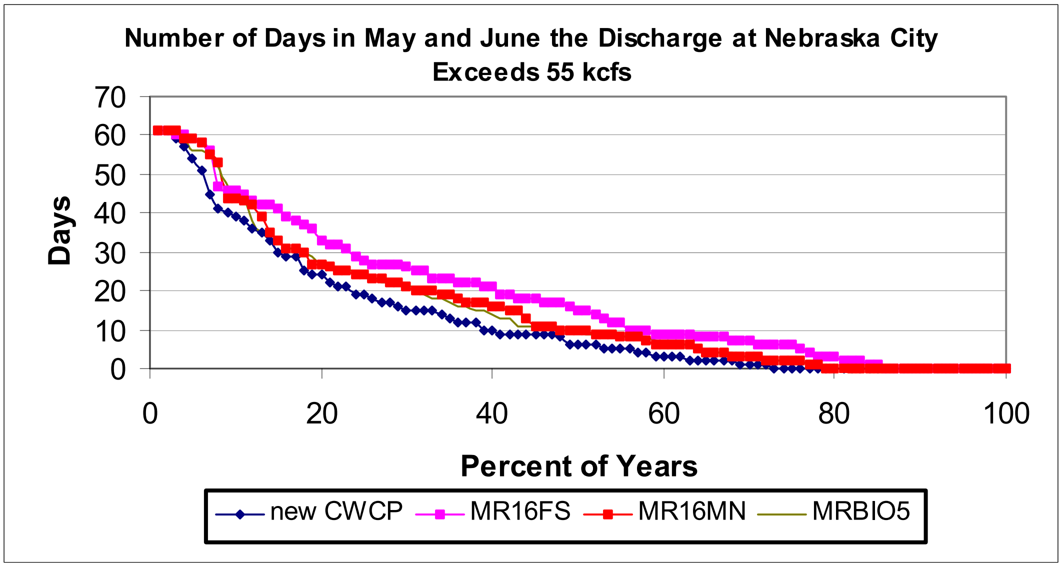

Figure 5. Changes in the number of days in May and June that the flow at Nebraska City exceeds 55 kcfs for changes in the service level criteria between the spring rises with a full 16 kcfs in flood control constraint increases.

Figure 6 shows the effects of reducing the flood control constraints from the full 16 kcfs increase shown in Figure 5 to a slight increase above the current values. Having the minimal flood control constraint increases (see Table 3) reduces the differences from the new CWCP values. To show the differences between number of days with the new guide curve for the service level between the two rises with the minimal flood control constraint changes and the number of days under the new CWCP in the current Master Manual, Figure 7 is shown. It demonstrates that the differences can be relatively minimal with the right combination of criteria for these two sets of criteria. The changes range from no increase in days to less than 5 additional days between the two curves in the figure.

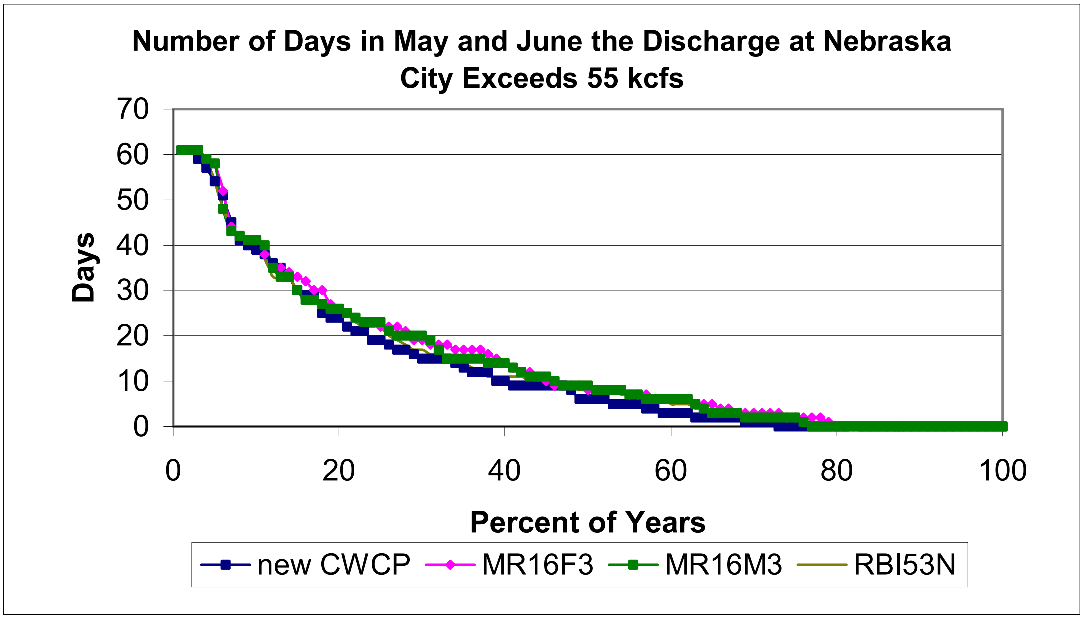

Figure 6. Changes in the number of days in May and June that the flow at Nebraska City exceeds 55 kcfs for changes in the service level criteria changes between the rises for the spring rise with the minimal flood control constraint changes.

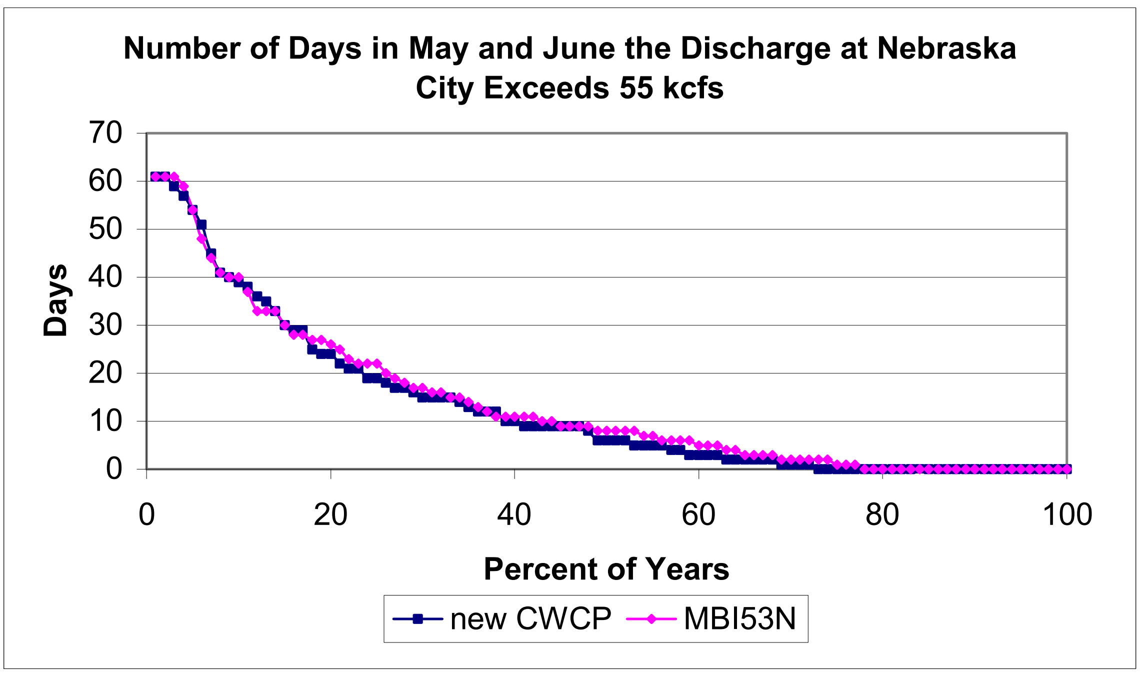

Figure 7. Changes in the number of days in May and June that the flow at Nebraska City exceeds 55 kcfs for the new guide curve for service level between the rises for the spring rise with the minimal flood control constraint changes.

Average Annual Economic Use and Environmental Resource Values

Table 4 presents the average annual economic use benefits and the average annual environmental resource values for the various categories presented in the Final Environmental Impact Statement for the Master Manual Review and Update. A short version of the use or resource name is used in the table to limit the size of the table, and the full names follow. Economic uses, in order, are flood control, navigation, hydropower, water supply, recreation, and total National Economic Development benefits, which is a summary of the previously listed uses. Environmental resources are young-of year fish production in the reservoirs (an index), coldwater fish habitat in the four larger reservoirs (MAF), cold river fish habitat downstream from Fort Peck and Garrison Dams (miles), warm river fish habitat downstream from the same two dams (miles), physical habitat for native river fish in all of the river reaches from Fort Peck to the mouth of the Missouri River (an index), tern and plover habitat on the river reaches from Fort Peck Dam to Sioux City (acres), wetland habitat and riparian habitat at selected sites between the upper reaches of Fort Peck Lake to the mouth of the Missouri River (1,000 acres), and historic properties (includes cultural and prehistoric sites) on the upper reservoirs (an index).

This table has some information that needs some clarification. First, the file name shown in the second column is the file name created for the 100-year (1898-1997) data file from the hydrologic modeling. The impacts models have some limits, one of which is that the data file cannot be longer than 100 years. So that the reader can relate these file names to the files put on the Corps website, the first column includes the file name for the hydrologic run with either 106 years (1898-2003) or 107 years (1898-2004) of data. The most recent runs have data sets through 2004; whereas, the runs made through December 2004, have data sets through 2003. This factor provides some insight as to when the Corps was analyzing these spring rise alternatives. Finally, there are some lines or cells with file names that are shaded in yellow if printed in color or looked at on the computer screen. These lines are marked to indicate that these are data for the same run; however, the same run can be used to look at two different criteria. In the case of the second set of data, they represent a drought preclude for the spring rise of 46 MAF; therefore they are included in the subset of data that is focused on the drought preclude (runs of 50, 46, 40, and 31 MAF).

Examination of the data in the lower part of Table 4 (data on percent change from the new CWCP) shows that the percent changes are relatively constant. The two categories with some notable variability are the navigation and the riverine tern and plover habitat value. The hydrologic model has been providing flawed navigation data for the spring rise runs, and time constraints have not allowed the required hand changes to the raw data files from the hydrologic model. The tern and plover data for the river reaches are also suspect because the model is based on habitat that was available in the early 1990s. This habitat has changed dramatically and new habitat has recently been constructed and will continue to be constructed by the Corps.

Table 4. Economic use and environmental resource impacts of the spring rise alternatives.

Impacts 1898-1997

File Name 1898-2003		FLD CON	NAVIG	HYDRO	WTR SUP	RECR	TOT NED	YOY	CLD RES	COLD RIV	WRM RIV	PHY HAB	T&P HAB Riv	WET HAB	RIP HAB	HIS PROP
NWCP00	MCP300	410.2	9.35	674.3	611.3	87.4	1792.5	2.13	10.3	185.9	50.4	81.4	304.9	157.6	107.8	4905
MRBIO3	MRBIOX	407.6	7.18	673.7	607.7	86.6	1782.8	2.15	10.1	185.8	48.6	82.1	283.9	157.0	106.3	4958
MR16FS	MR160S	408.1	8.47	672.0	607.6	86.4	1782.4	2.13	10.0	185.0	48.8	82.6	298.7	155.7	105.6	5025
MR16F1	MR1601	407.9	8.54	672.3	607.7	86.5	1783.0	2.13	10.0	184.7	49.3	82.5	287.2	154.4	105.9	5017
MR16F2	MR1602	408.1	8.54	672.6	611.2	86.4	1786.8	2.13	10.0	184.7	48.8	82.4	265.6	154.4	106.1	5014
MR16F3	MR1603	407.9	8.55	673.0	607.9	86.4	1783.7	2.13	10.0	184.9	49.3	82.3	251.9	153.1	106.9	5003
M16F50	M16050	408.1	8.25	672.6	607.8	86.6	1783.4	2.13	10.0	184.8	49.2	82.5	295.6	155.9	105.6	5006
M16F46	MR160S	408.1	8.47	672.0	607.6	86.4	1782.4	2.13	10.0	185.0	48.8	82.6	298.7	155.7	105.6	5025
M16F40	M16040	408.1	8.72	671.6	610.9	86.6	1785.9	2.12	9.9	184.4	49.3	82.7	299.8	157.2	105.4	5045
M16F31	M16031	408.1	8.80	671.8	610.6	87.1	1786.3	2.13	10.0	184.7	48.9	82.6	316.5	156.8	105.0	5043
MR16MN	MR16IN	407.6	8.37	674.2	608.0	86.9	1785.1	2.14	10.1	186.9	48.4	82.0	277.6	156.4	107.6	4933
NR16M1	MR16I1	407.6	8.37	674.5	611.4	86.8	1788.7	2.15	10.2	187.8	47.0	81.9	280.6	154.4	108.1	4927
NR16M2	MR16I2	407.5	8.33	674.8	611.4	86.9	1788.9	2.16	10.2	187.5	47.8	81.9	272.0	153.8	108.6	4921
NR16M3	MR16I3	407.5	8.35	674.9	611.7	86.9	1789.4	2.16	10.3	187.3	48.3	81.8	277.6	155.1	107.5	4897
1898-2004																
MRBIO4	MJBIO4	407.3	9.5	673.6	607.3	86.3	1784.0	2.16	10.2	186.9	47.8	82.1	293.9	157.3	106.3	4941
MRBIO5	MJBIO5	405.9	10.3	673.1	607.3	86.2	1782.8	2.15	10.1	186.0	48.4	82.1	281.8	158.3	107.0	4964
MBIO53	MJIO53	407.3	10.3	673.9	607.4	86.8	1785.7	2.17	10.2	186.9	48.2	81.9	284.7	154.9	107.9	4933
MRBP52	MJBP52	407.2	9.8	673.4	607.2	86.3	1784.0	2.15	10.1	186.4	48.8	82.1	305.3	157.9	107.0	4962
BIO521	BJO521	407.5	9.5	672.8	610.8	87.5	1788.2	2.15	10.1	185.1	48.7	82.2	297.6	157.5	106.4	5021
MRBI5N	MJBI5N	405.7	10.3	673.9	607.4	86.8	1784.0	2.16	10.2	186.4	48.7	82.0	305.4	158.1	106.6	4924
MBI53N	MJI53N	405.5	9.7	674.7	611.4	87.0	1788.4	2.17	10.3	186.7	47.6	81.8	310.7	154.5	107.4	4897

Percent Change From the Value for the NWCP (MCP300 Run)

	FLD CON	NAVIG	HYDRO	WTR SUP	RECR	TOT NED	YOY	CLD RES	COLD RIV	WRM RIV	PHY HAB	T&P HAB Riv	WET HAB	RIP HAB	HIS PROP
MRBIOX	-1	-23	0	-1	-1	-1	1	-1	0	-4	1	-7	0	-1	1
MR160S	-1	-9	0	-1	-1	-1	0	-3	0	-3	1	-2	-1	-2	2
MR1601	-1	-9	0	-1	-1	-1	0	-3	-1	-2	1	-6	-2	-2	2
MR1602	-1	-9	0	0	-1	0	0	-3	-1	-3	1	-13	-2	-2	2
MR1603	-1	-9	0	-1	-1	0	0	-2	-1	-2	1	-17	-3	-1	2
M16050	0	-12	0	-1	-1	-1	0	-2	-1	-3	1	-3	-1	-2	2
MR160S	-1	-9	0	-1	-1	-1	0	-3	0	-3	1	-2	-1	-2	2
M16040	-1	-7	0	0	-1	0	-1	-3	-1	-2	2	-2	0	-2	3
M16031	-1	-6	0	0	0	0	0	-3	-1	-3	2	4	-1	-3	3
MR16IN	-1	-10	0	-1	-1	0	0	-1	1	-4	1	-9	-1	0	1
MR16I1	-1	-11	0	0	-1	0	1	-1	1	-7	1	-8	-2	0	0
MR16I2	-1	-11	0	0	0	0	1	-1	1	-5	1	-11	-2	1	0
MR16I3	-1	-11	0	0	0	0	1	0	1	-4	0	-9	-2	0	0
MJBIO4	-1	1	0	-1	-1	0	1	-1	1	-5	1	-4	0	-1	1
MJBIO5	-1	10	0	-1	-1	-1	1	-2	0	-4	1	-8	0	-1	1
MJIO53	-1	10	0	-1	-1	0	2	-1	1	-4	1	-7	-2	0	1
MJBP52	-1	5	0	-1	-1	0	1	-2	0	-3	1	0	0	-1	1
BJO521	-1	2	0	0	0	0	1	-2	0	-3	1	-2	0	-1	2
MJBI5N	-1	10	0	-1	-1	0	1	-1	0	-3	1	0	0	-1	0
MJI53N	-1	4	0	0	0	0	2	0	0	-6	0	2	-2	0	0

Spawning Cue Effects

Measurement of the potential for a successful spawn has been limited in the Master Manual Review and Update studies to determining the number of days a specified increase in flow is maintained. The count starts on May 1 after going out 10 days in advance to determine the 10-day running average as the basis for comparison of later increases in flow. This running average is recomputed for each day the model goes after May 1. A percent increase is specified to determine if the flow for that day has reached that level. Once the specified percent increase is attained, the number of days that this flow is maintained or exceeded is counted. Once the flow drops off to less than the increased amount, the count of days is stopped, but the 10-day running average is restarted at that point. It is, therefore, possible to have multiple rises that meet the specified criteria as this process is conducted for the complete May and June period. This process is followed for each year of the period of record, with the maximum number of years being 100. If the file is longer than 100 years, years must be deleted from either end of the file to have a 100-year file. In the case of this current effort, the period of 1898-1997 was used for this analysis.

The effects of several variables were examined, and the pertinent ones are shown in this section of the report. An analysis was recently conducted to determine if the 20 percent increase used in the Final EIS for the Master Manual Review and Update Study was appropriate. Figures 8 and 9 show the results of this analysis. The new CWCP, MR16MN (16-kcfs second rise with minimum service preceding it in all years down to a drought preclude of 46 MAF on March 15), and MR16M3 (same as MN only the flood control constraints were minimally increased) alternative was used for the analysis. Increases of flow of 20, 30, and 40 percent were used as meeting the "spawning cue" requirement. Durations of 7 and 14 days were included in the analysis. Figure 8 shows the results for the Gavins Point, Nebraska City, and Boonville reaches for the 7-day duration for the MR16MN and MR16M3 alternatives. Examination of the figure shows a similar pattern for each percent increase at the three locations evaluated. Figure 9 also looks very similar to Figure 8. Basically, as the percent increase for the cue increases, the number of years meeting that requirement diminishes. Similarly, as the number of days for the cue duration increases, the number of years meeting that requirement also diminishes. The important change to note, however, is the consistent change between the two alternatives shown on each figure. This analysis points out that decisions made on changes in spawning cue among alternatives can be conducted for any percent increase in flow or any duration of the rise. The data used in the remainder of the spawning cue discussion will be based on the 20-percent increase in flow for a 14-day duration.

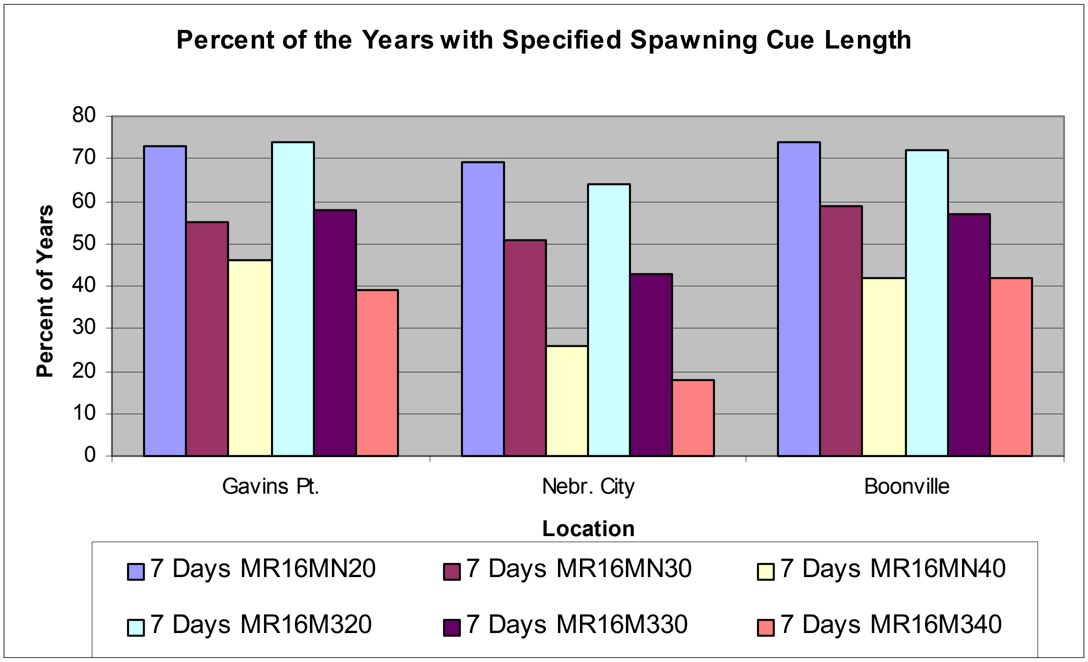

Figure 8. Change in the number of years of a rise of 20, 30, and 40 percent for a rise duration of 7 days to represent a potential spawning cue.

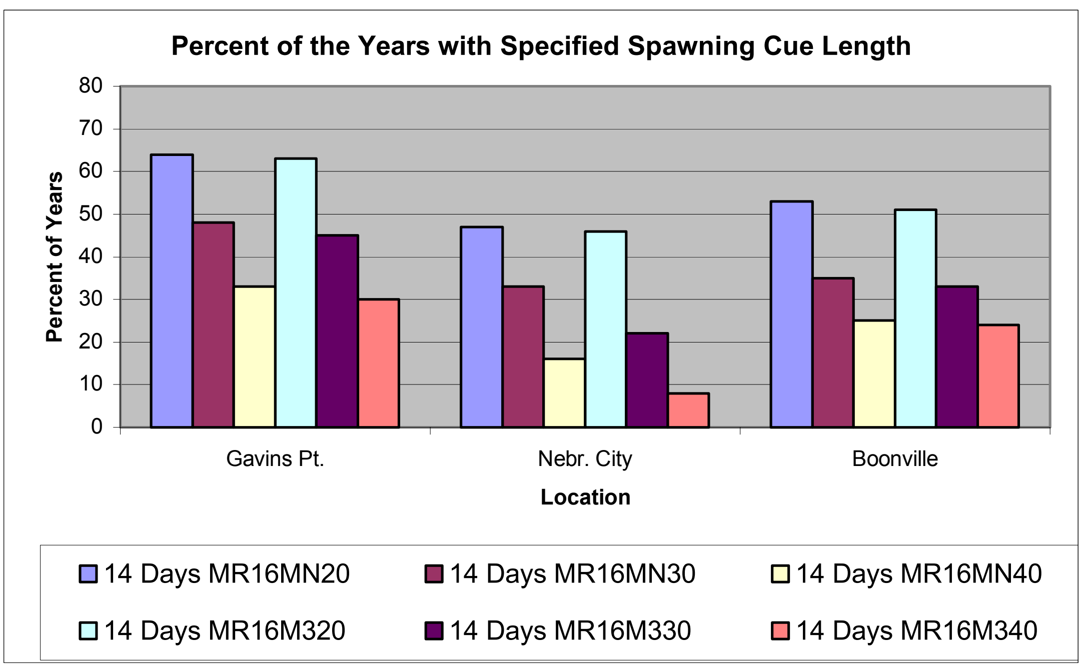

Figure 9. Change in the number of years of a rise of 20, 30, and 40 percent for a rise duration of 14 days to represent a potential spawning cue.

Figure 10 compares the spawning cue data for the three options for the Gavins Point Dam releases between the two rises. The FS option is based on the current Master Manual guide curve for service level in the April through June period. The MS option provides minimum service in all years except the non-navigation years and the flood storage evacuation years. Finally, the BI5N option provides service based on a new guide curve that would go to minimum service at higher storage levels than the current guide curve would require. The figure shows that there is relatively little difference in the number of years this spawning cue criteria would be met. This difference is generally 5 years or less among the three options, and the values are all between 40 and 70 percent for the three options. This analysis indicates that the number of spring rises should not be a factor when selecting the release criteria for the period between the two rises.

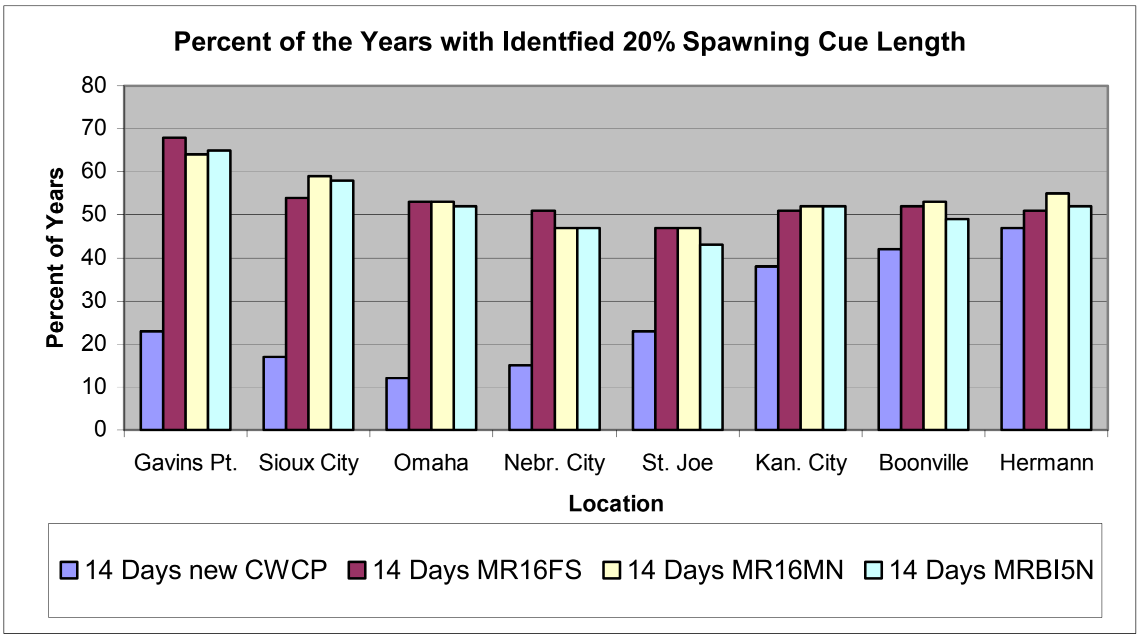

Figure 10. Change in the number of years of a 20-percent, 14-day spawning cue for three Gavins Point Dam release options between the two rises of the spring rise.

Figure 11 shows similar data for the flood control constraint options. The 16-kcfs increase in the flood control constraints is represented by MR16FS, and the other three alternatives represent progressively diminishing increases with the MR16F3 option having minimal changes in the flood control constraints to accommodate the spring rises. The pattern seen in this figure would also be seen if the base alternative were MR16MN or MRBIO5. The number of years with the specified spawning cue diminishes as the flood control constraints are not raised as much, and the changes in the various river reaches range from 2 years up to a maximum difference of 10 years among the three options. The values all lie between 35 and 70 years, with the lower values being in the St. Joseph reach. The choice among the flood control constraint changes has a higher effect on the number of spring rises than the release criteria for the period between the two rises.

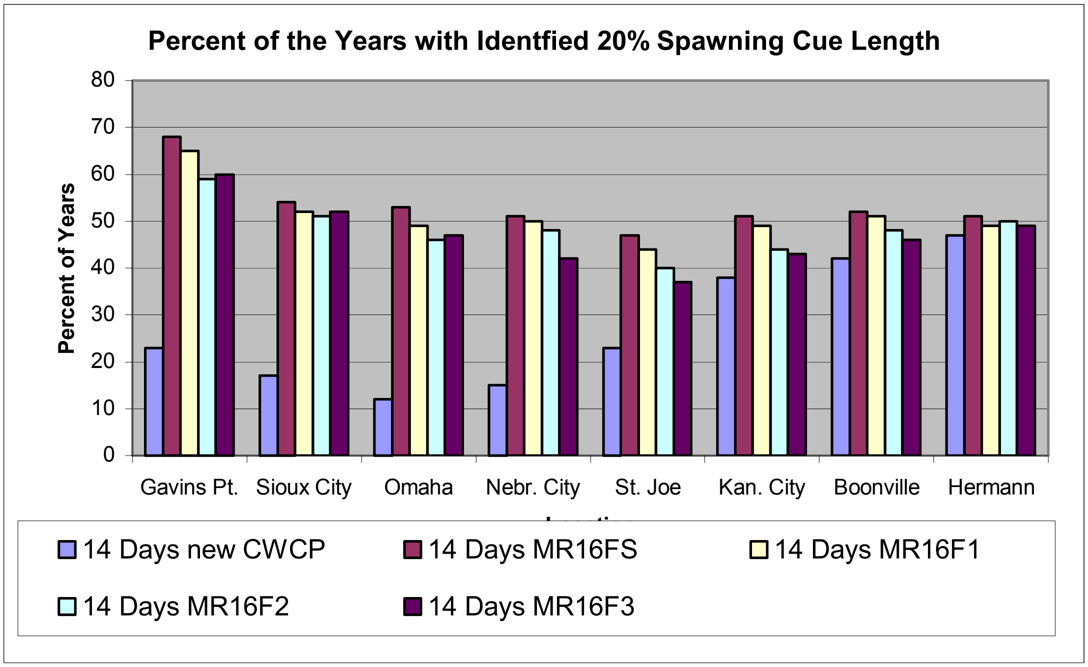

Figure 11. Change in the number of years of a 20-percent, 14-day spawning cue for four flood control constraint options for the second rise of the spring rise.

Figure 12 presents the spawning cue data for the drought preclude options ranging from having no rises if the system storage drops below 50 MAF down to a drop to 31 MAF, which corresponds to the drought preclude for the suspension of navigation service. This figure shows that the number of years there would be a spawning cue (of a 20-percent increase in flow for at least 14 days) increases as the drought preclude for the spring rise is reduced. The maximum difference across the range analyzed is 11 years. The values range between 35 and 80 percent, with the lowest values being in the St. Joseph reach.

To better visualize the range of differences, the values for two alternatives to the new CWCP are shown in Figure 13. These are the M16F31 and the MBIO53 options, and the new CWCP data are shown to provide additional perspective. Generally, the differences between the two options range from 2 years (Hermann reach) up to 17 years (St. Joseph reach). The number of rises in the St. Joseph reach are about 32 percent higher than under the new CWCP for the MBIO53 option. With the additional rises of the M16F31 option, the percent increase would rise to about 53 percent. Overall, there would be an spring rise in over 35 percent of the time with the MBIO53 option, and this would rise to just over 45 percent with the M16F31 option for the St. Joseph reach.

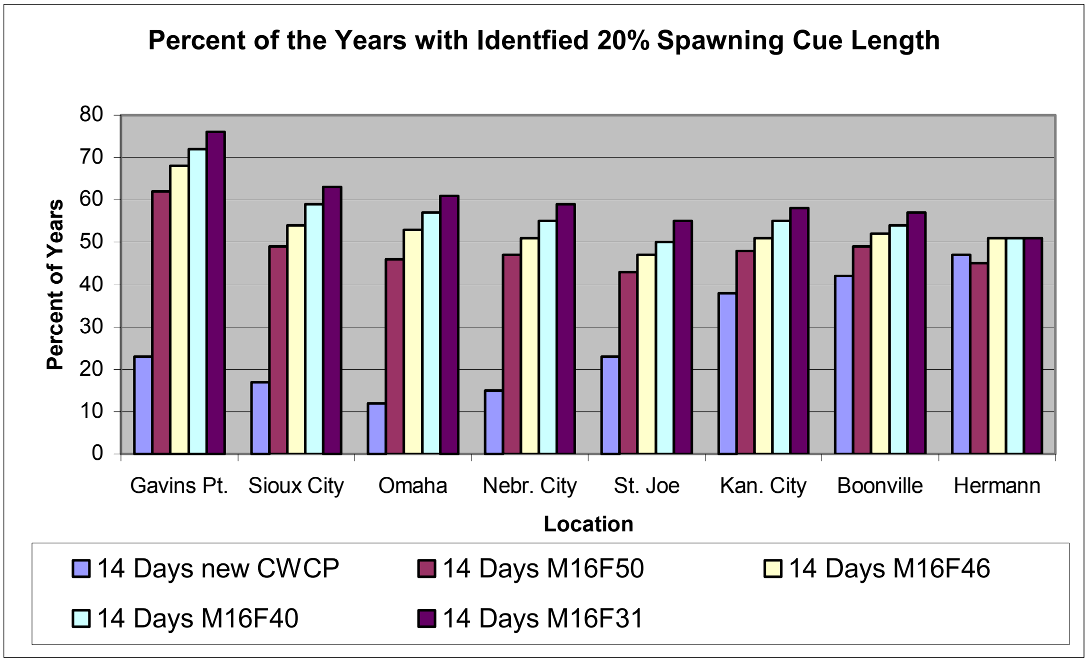

Figure 12. Change in the number of years of a 20-percent, 14-day spawning cue for drought preclude options for the second rise of the spring rise.

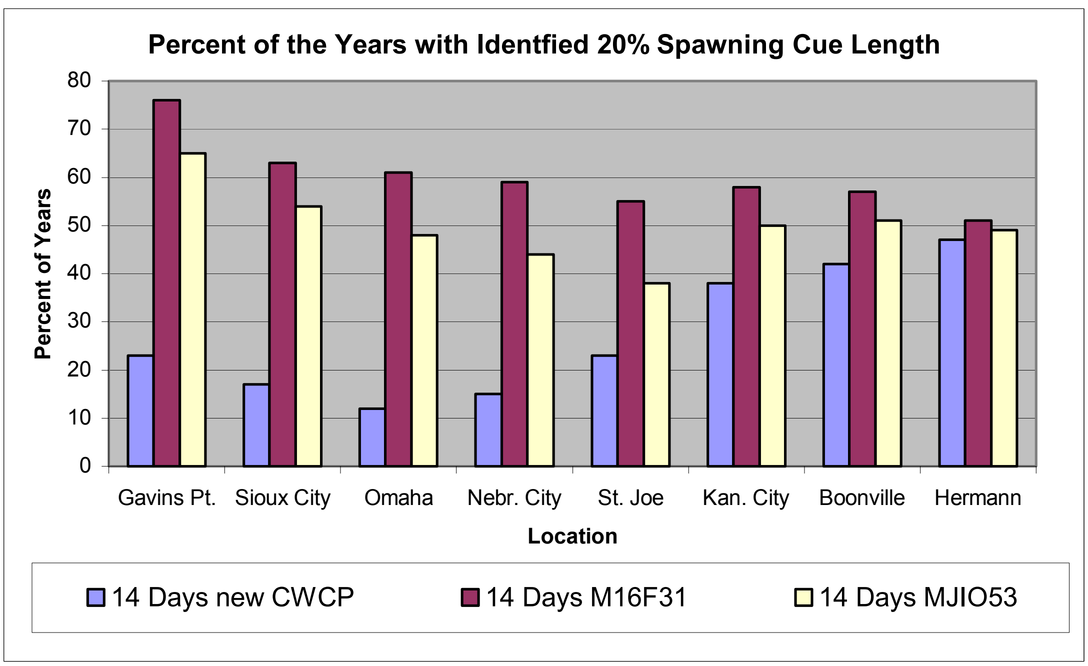

Figure 13. Change in the number of years of a 20-percent, 14-day spawning cue for two alternatives representing the maximum difference for number of years for the spawning cue.

Summary

This section of the report will provide a summary of the results of the various analyses conducted on the spring rise alternatives analyzed to date. This summary will be based on the assumptions that basin stakeholders would want to minimize adverse impacts while supporting a relatively large increase in the number of spring rises, represented by a 20 percent rise in flows for at least 14 days.

Examination of the data for the first rise (Figure 1) shows that the first rise adversely affects minimum system storage during three of the four major droughts since 1898. The reduction in system storage was a maximum of 0.5 MAF (1930-1942 drought), and the reductions were generally about 0.4 MAF, or about 1 foot in the upper three, larger reservoirs. This could be reduced somewhat if a drought preclude higher than 31 MAF, which was in the modeling of this option) were included in the recommended plan for this option. Because the navigation guide curve is not a continuous curve, this guide curve does not change season length enough to offset all of the increase in system drawdown, thus the extra loss in system storage.

For the releases between the rises, three options were evaluated. Generally, the higher the release rate, the higher one can expect the system drawdown to be. The season length guide curve somewhat corrects for the reduction in storage; however, it does not complete correct for it for the reason stated above. Even though the new guide curve (when compared to the current Master Manual service level guide curve for this period) provides for some full service years during this period, it drops back to minimum service enough that it actually results in a higher minimum storage level in two of the three lesser droughts.

The less the flood control constraints are increased to allow more spring rises, the less system storage is reduced during droughts and the lower the increase in the number of days the drainage structures would be. This increase is lowest for the minimal increase in the flood control constraints, and it is hardly noticeable for the MBIO53 alternative (Figure 7).

When economic use and environmental resource values on an average annual basis are considered, there is not enough difference among the alternatives to make this a factor in the development of a recommended plan for a spring rise. This is demonstrated in Table 4 and in the data presented in Chapter 7 of the Final EIS for the Master Manual Review and Update.

When all is considered regarding the spring rise and the adverse effects to system storage and the potential for increased crop damage along the Lower River, one alternative appears to minimize these factors while having all of the components of the spring rise (first rise and second rise). That is the MBIO53 alternative. This alternative includes a 5-kcfs increase in releases for the first week when releases are at the level to meet required service level requirements in navigation years. This rise is followed by service levels meeting the requirements of a revised service level guide curve for the period following this rise to the beginning of the second rise (and actually through the rise as the second rise magnitude is based on a 16-kcfs release above the service level specified during the rise). This revised guide curve drops the service level to minimum service at a March 15 storage level of 58,5 MAF. The second rise is then set at 16 kcfs over this service level. A 7-day ramp up would be followed by a 2-week peak, which would be followed by a 7-day ramp down to the summer service, which would be based on the anticipated maximum release requirement for the subsequent period through about the end of August (service level based on current Master Manual July 1 service guide curve). Three sets of criteria would reduce the magnitude and duration of this second rise. First, flood control constraints could result in a reduction or even elimination of the second rise if downstream flooding were likely to occur (may not be very responsive to sudden storms in some of the tributaries or near the mouth of major tributaries). Second, a new guide curve for the magnitude of the spring rise during droughts would reduce system releases as the drought worsened (in terms of system storage). Third, the drought preclude would eliminate the rise if system storage were to drop below the specified level, which is 31 MAF in the MBIO53 alternative. Figures 14 through 17 show the effects of this alternative on the minimum system storage, the number of days flows would exceed 55 kcfs at Nebraska City, Nebraska, and the number of years with a spawning cue of 20 percent increase in flow for at least 14 days, respectively. The basis for comparison will be the new CWCP.

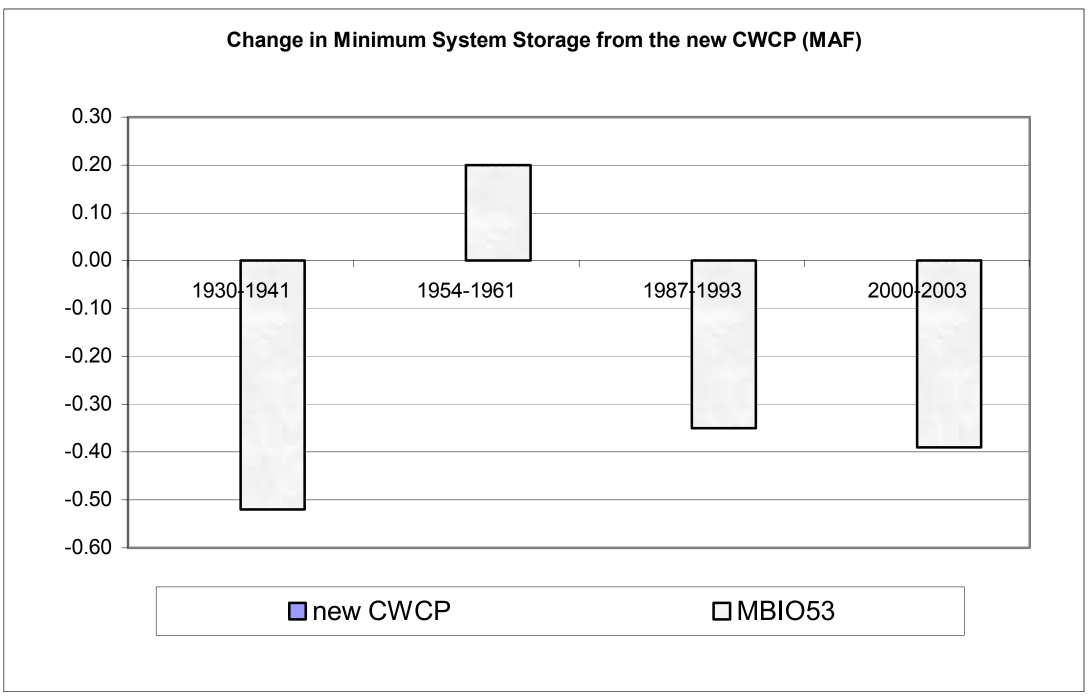

Figure 14. Change in minimum system storage for between the MBIO53 alternative and the new CWCP.

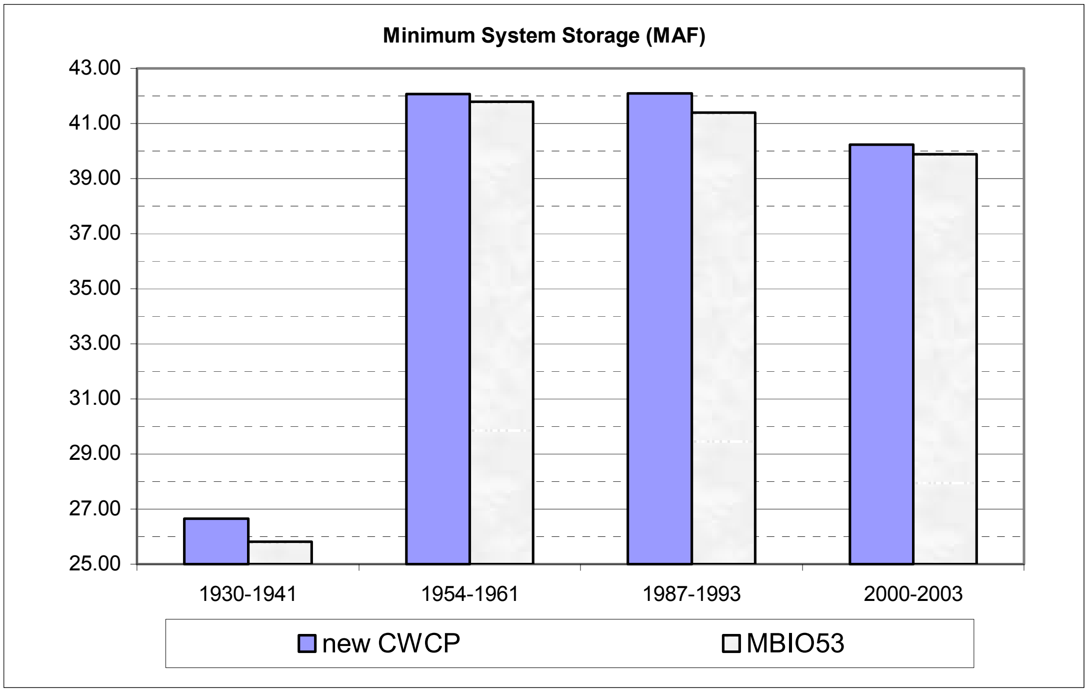

Figure 15. System Storage for the new CWCP and the MBIO53 alternative.

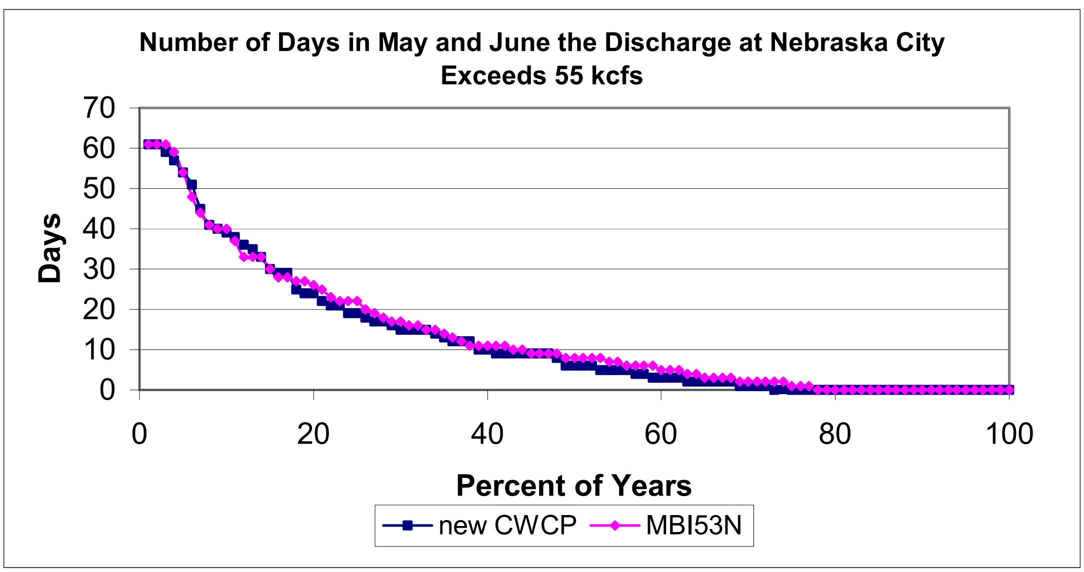

Figure 16. Number of days in May and June the Nebraska City flow exceeds 55 kcfs for the new CWCP and the MBIO53 alternative.

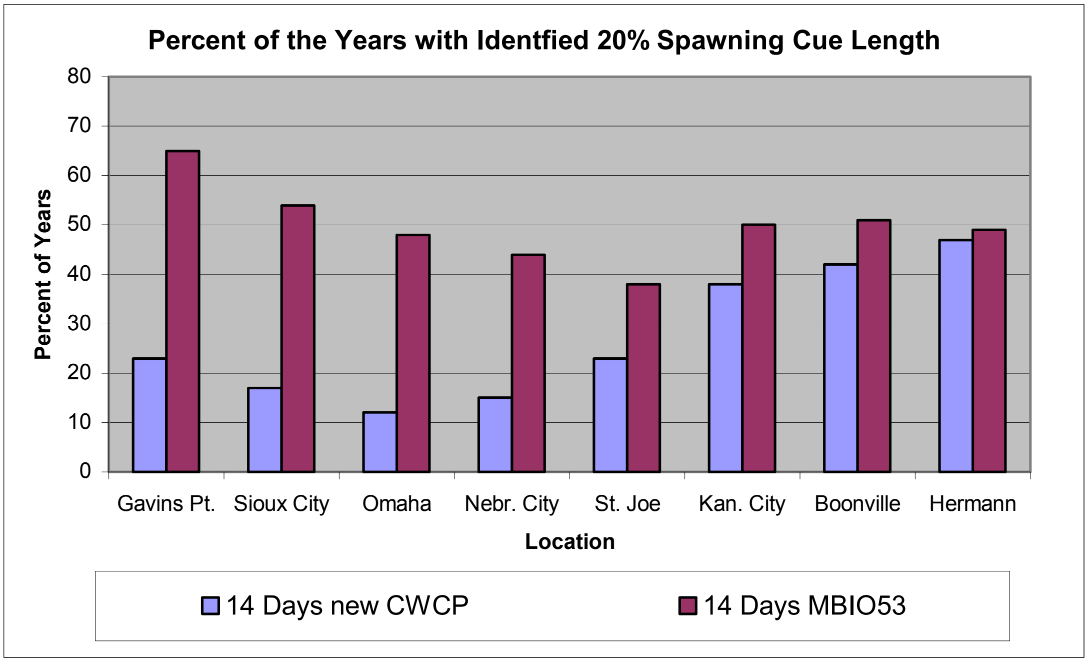

Figure 17. Percent of years with a spawning cue represented by a 20 percent increases in flow for at lease 14 days in May and June for thee new CWCP and the MBIO53 alternative.

Supplemental Information Special Runs Requested by the Hydrology and Water Quality Technical Working Group

The Hydrology and Water Quality Technical Working Group requested that several additional alternatives be evaluated that did not fit into the general formulation criteria of minimally meeting authorized project purposes or having a different shape to the second rise in terms of duration and/or magnitude. To date, two of the alternatives have not been modeled due to modeling constraints that have not been resolved. These are the runs with an 18-kcfs release between the two rises and with winter releases up to May 1 with no first rise. These two would be generally categorized as not minimally meeting navigation service levels through the spring months. The other two alternatives, MRBP52 and BIO521, were successfully modeled. The first alternative had a reduced duration from the 2-week peak of the other alternatives modeled to date for the second rise. Its peak release was still 16 kcfs above the service level provided by the new guide curve for the period between the two rises. The BIO521 alternative was the same except if had a 21-kcfs-peak increase for the reduced duration time. For both runs, the peak release period modeled was 9 days, which is the minimum the model would accommodate. These two runs were made off of the MRBIO5 run, which had a drought preclude of 31 kcfs with the prorated reduction in the maximum increase for the second spring rise. They both had the 5-kcfs increase when releases were up to the service level specified by the current Master Manual for April 1. The results of these two runs are added to Figures 15 through 17 to result in Figures 18 through 20 to provide some insight on how they might perform.

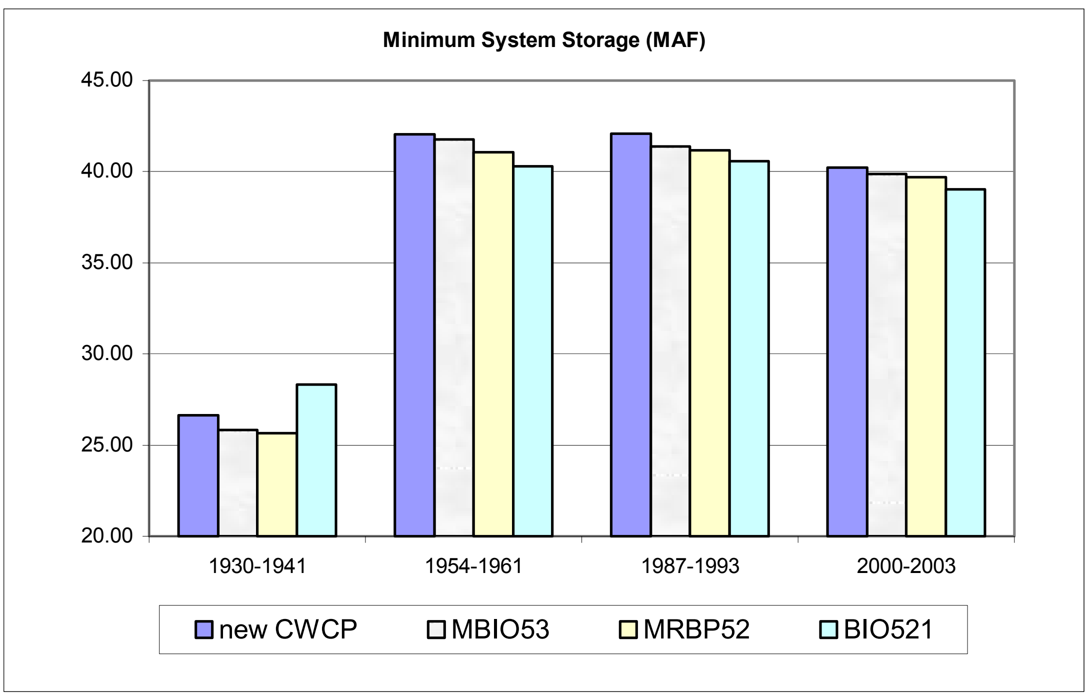

Figure 18. Minimum system storage for four alternatives, including two specially requested alternatives.

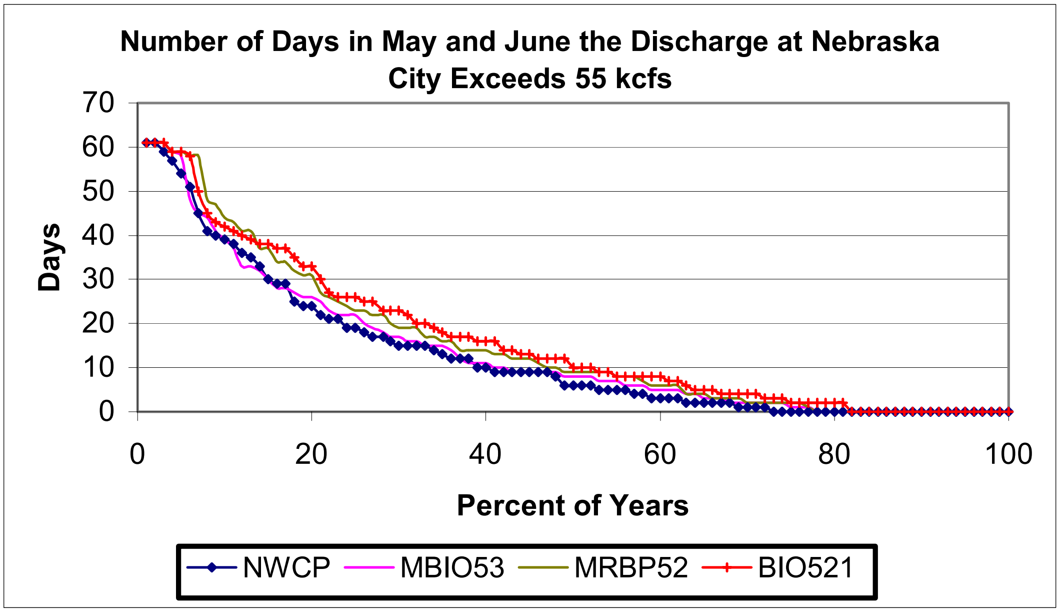

Figure 19. The number of days the flows at Nebraska City exceed 55 kcfs in May and June for four alternatives, including two specially requested alternatives.

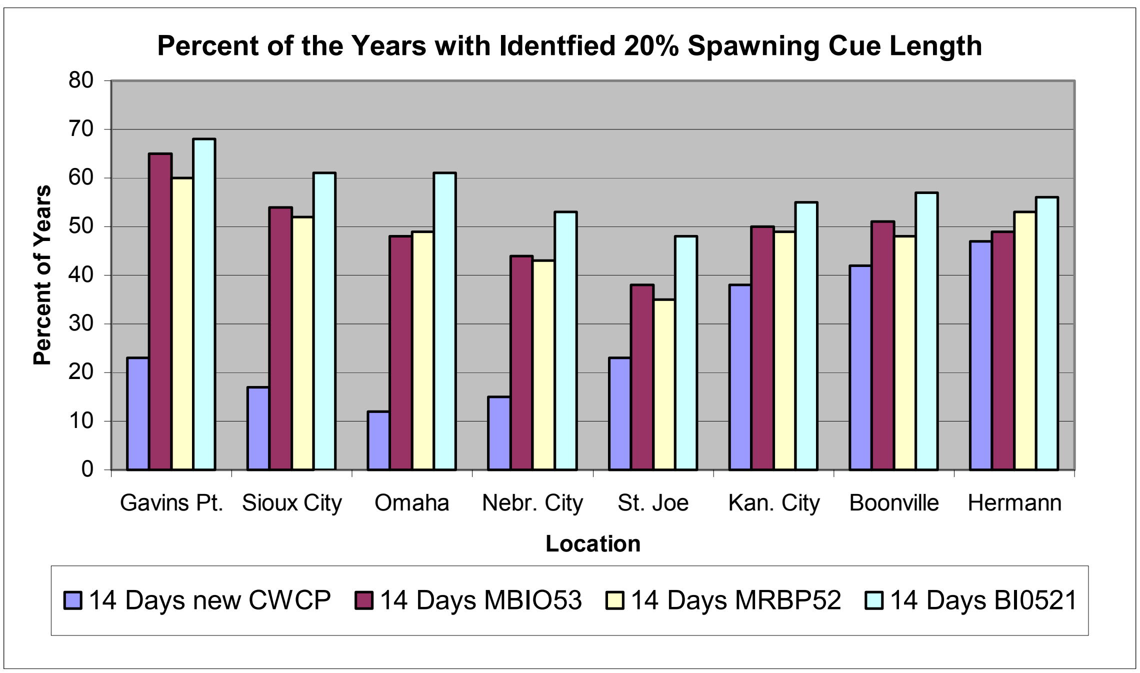

Figure 20. The number of years the spawning cue of a 20 percent increase in flow for a minimum of 14 days for four alternatives, including two specially requested alternatives.