8. SELECTION OF THE PREFERRED ALTERNATIVE AND DESCRIPTION OF ITS EFFECTS

8.1 INTRODUCTION

Selection of a Water Control Plan for the Mainstem Reservoir System has been a complex process due to the diversity of interests and resources affected by Missouri River Mainstem Reservoir System operations. The Corps has attempted to involve all of these diverse interests in shaping a preferred alternative (PA) since it released the Revised Draft EIS (RDEIS) in August 2001, which included an evaluation of six alternatives (see Chapter 7): the current Water Control Plan (CWCP), Modified Conservation Plan (MCP), and four Gavins Point (GP) options. Considerable input from the basin's stakeholders, as well as interests outside of the basin, was received during the numerous public hearings and workshops and from those submitting comments to the Corps during the 6-month RDEIS review and comment period. This input represents the diverse views of the many basin and non-basin interests that have participated in the EIS process since the Study was initiated in November 1989.

The Corps developed a set of four objectives that a Water Control Plan should attain. These objectives were to identify a Water Control Plan that: 1) serves the contemporary needs of the Missouri River basin and the Nation; 2) complies with environmental laws, including the Endangered Species Act (ESA); 3) serves Congressionally authorized project purposes; and 4) fulfills the Corps' responsibilities to Federally recognized Tribes.

Based on a thorough consideration of all the comments received and careful review using the best engineering and biological science available, the Corps has identified a PA. The PA includes more stringent drought conservation measures, a more defined methodology for unbalancing the upper three lakes, higher non-navigation season flows, and a planned re-evaluation in 3 years.

In selecting the PA, the Corps considered additional information obtained subsequent to the RDEIS. In January 2002, the National Academy of Sciences' (NAS) National Research Council (NRC) published a report entitled *The Missouri River: Exploring the Prospects of Recovery*, which underscores the importance of restoring river form and function and highlights adoption of an adaptive management approach that includes broad stakeholder participation. The NRC report also noted that there is scientific uncertainty regarding the lifecycle requirements of the pallid sturgeon and a lack of understanding of the factors that are limiting spawning and recruitment.

In its November 2000 Biological Opinion (BiOp), the USFWS recommended release modifications at Fort Peck and Gavins Point Dams. The four GP options evaluated in Chapter 7 of the RDEIS and this FEIS cover a range of these recommended release modifications. Since the RDEIS, the Corps conducted several engineering analyses of the Gavins Point Dam release recommendations. Engineering studies show that the recommended spring rise releases would not be effective in building and maintaining additional habitat for terns and plovers or reconnecting the river with the floodplain. With respect to the low summer releases, engineering studies show that the recommended releases below minimum service levels would not be an effective means of attaining significant amounts of additional shallow water habitat. The Corps concluded that recovery of Missouri River listed species would require a broader array of measures to ensure that the physical attributes and biological effects necessary to increase the likelihood of the continued existence of the threatened and endangered species are achieved.

In light of this new information, the designation of piping plover critical habitat, and the scientific uncertainties regarding the flow requirements of the listed pallid sturgeon, the Corps reinitiated Endangered Species Act (ESA) consultation with the USFWS. On November 3, 2003 the Corps provided the USFWS with a Biological Assessment (BA) that identified the Corps' proposed action for operation of the Mainstem Reservoir System, the Missouri River Bank Stabilization and Navigation Project, and the Kansas River Reservoir System. The Corps' proposed action includes the operational changes identified in the PA. On December 16, 2003, the USFWS provided the Corps an amendment to its November 2000 BiOp on the Operation of the Missouri River Mainstem Reservoir System, Missouri River Bank Stabilization and Navigation Project, and Kansas River Reservoir System. The amended BiOp and comments received in response to this FEIS will be considered in the Corps' decision regarding a selected plan, which will be announced in the Corps' Record of Decision (ROD) following the FEIS comment period.

In its November 2003 BA, the Corps proposed the PA in combination with a comprehensive approach, the Missouri River Recovery Implementation Program (MRRIP), which includes multiple measures intended to benefit the species. The BA is included as Appendix C to this FEIS. The Corps believes that this course of action offers the basin a real opportunity to move forward with a sound, comprehensive approach to recover the listed species and restore their ecosystem. While MRRIP is not a feature of the Water Control Plan (and, therefore, the PA), it is important to understand the relationship of the PA to MRRIP. A brief description of MRRIP follows.

MRRIP is a comprehensive and integrated set of measures to be undertaken by the Corps in collaboration with the USFWS, working with the States, Tribes, and other stakeholders in the basin. It will include recovery measures on the mainstem of the Missouri River from Three Forks, Montana to St. Louis, Missouri and on selected tributaries of the Missouri River, including the Kansas River, while taking into consideration other Congressionally authorized and traditional uses of the river. The objective of measures undertaken for MRRIP by the Corps, USFWS, and others is to develop appropriate conditions and habitat to avoid the likelihood of jeopardizing the continued existence of the three listed species (piping plover, least tern, and pallid sturgeon) and the adverse modification of designated critical habitat.

The basic measures in MRRIP include:

- **Habitat creation, enhancement, and maintenance for pallid sturgeon, piping plover, and least tern.** Under this measure, the Corps' existing efforts to build shallow water habitat for the pallid sturgeon and emergent sandbar habitat for the least tern and piping plover will continue, and for shallow water habitat, be accelerated. Additional habitat enhancement efforts will be undertaken to provide even more and potentially better habitat for all three species.
- **Hatchery support, including facility improvements, accelerated brood stock collection, and accelerated stocking for the pallid sturgeon**. The Corps is enhancing pallid sturgeon propagation activities at six rearing facilities to assist in achieving annual stocking goals. The facilities have been able to upgrade water systems, fish transport units, holding and rearing capabilities, and a variety of miscellaneous items. The continuation and enhancement of these activities as part of MRRIP will enable propagation and augmentation efforts to be maintained and expanded. Successful collection, spawning, rearing, and stocking will help ensure that the genetic stocks are carried into the future.
- **Population assessments of the pallid sturgeon, piping plover, and least tern**. The

Corps has implemented a comprehensive least tern and piping plover monitoring program, which has provided state-of-the-art information on the birds and their habitat. With this measure, the Corps will continue this successful assessment program and seek ways to improve and modernize the monitoring and evaluation techniques and data delivery and communication tools. Sampling efforts for the pallid sturgeon population assessment have been initiated and will continue to expand. Crews will conduct standardized assessments of all of the high-priority river segments.

- **Intense research, monitoring, and evaluation of all three species**. The Corps recognizes that a complete monitoring and evaluation program should be a central and operational component of all management activities. As a focal point of this measure, the Corps will incorporate a monitoring and evaluation program that provides data to further understanding and resolve uncertainties.
- **Flow tests as part of an adaptive management strategy.** Flow tests to create and condition emergent sandbar habitat are included in MRRIP. Due to their experimental nature, any future flow tests will be addressed in an adaptive management strategy.
- **Implementation of the revised Water Control Plan.**

MRRIP actions will be reviewed, modified, and implemented within an adaptive management framework. As part of the framework, the Corps will establish a Missouri River Recovery Implementation Committee (MRRIC), which will include broad and diverse stakeholder representation to ensure that public values are incorporated into recovery implementation. MRRIC will provide recommendations to the Federal agencies regarding recovery implementation measures and will be developed cooperatively with entities having an interest in recovery of listed species and their habitat. Representation on MRRIC will include the full spectrum of basin interests. Committee membership will comprise representatives of Tribal and State governments and of other governmental and non-governmental organizations that have an interest in the management of the river and the recovery of the listed species and their habitat. The Corps plans to revisit the scientific findings of the robust research, monitoring, and evaluation program; the progress and success of accelerated habitat development; and other actions in 3 years. This is consistent with the adaptive management approach recommended in the NRC report. In its November 2003 BA, the Corps concluded that it believes the PA, in combination with the other measures of MRRIP, is not likely to jeopardize the continued existence of Missouri River listed species or adversely modify their critical habitat.

In light of the continuation (fourth year) of the second major drought since the Mainstem Reservoir System became fully operational in 1967, there has been wide spread basin interest to implement a revised Water Control Plan in the 2004 operating year. While the development of a proposed action by the Corps consisting of numerous measures to protect and conserve the three listed species was a prominent requirement, the Corps also worked toward identification of modified drought conservation measures for use in a revised Water Control Plan.

All of the alternatives to the CWCP evaluated in detail in Chapter 7 of the RDEIS, and two of the alternatives submitted by the USFWS for consideration and evaluated in Chapter 5 of the RDEIS, contained the drought conservation measures of the MCP. Many lower basin stakeholders and other stakeholders along the Mississippi River expressed concern over the more stringent drought conservation measures of the MCP in lower runoff years. These more stringent drought conservation measures provided for reduced navigation service and shortened navigation seasons in 40 of the 100 years modeled for the Study. This increased the risk that low flows on the Missouri River could coincide with low flows in the Upper Mississippi River. If they were to coincide, Mississippi River navigation could be adversely affected. This concern has been expressed by the State of Missouri and other Mississippi River basin states before and during the comment period on the RDEIS.

Since the RDEIS, the Corps developed several variations to the MCP in collaboration with the basin states to address these concerns. The variations to the MCP were based on changing the drought conservation criteria from a “trigger” set of criteria to a “guide curve” set of criteria. Studies were performed comparing how well the CWCP, MCP, and the new variations of the MCP met the four Study objectives stated above. In general, the MCP met the objectives better than the CWCP; however, the new variations performed similarly to the MCP in meeting most of the listed objectives.

Noting that the new variations addressed the concerns of the downstream states better than the MCP, the Corps identified one of these new variations as the PA. The Corps believes that this plan has the greatest degree of acceptance among all eight of the basin states.

In selecting the PA, the Corps considered its responsibility to comply with all laws, regulations, and executive orders enacted or promulgated to protect or conserve environmental resources. These laws, regulations, and executive orders include but are not limited to the ESA, Clean Water Act, Clean Air Act, National Historic Preservation Act, Native American Graves Protection and Repatriation Act, and Migratory Bird Treaty Act.

The Corps coordinated with the American Indian Tribes in the basin to fulfill its Tribal trust responsibilities, including Government-to-Government consultation and the protection of cultural resources. Many Tribes provided substantive comments throughout the process, and consultation with the Tribes will continue into the future.

The rationale for selecting the PA is a composite of analyses, information briefings, technical expertise, and comments concerning the resources evaluated as part of the Study. The Corps believes that the PA, when combined with the other measures under MRRIP, conserves more water in the upper three lakes during extended droughts, meets the needs of ESA-listed fish and wildlife species, is consistent with the Corps' responsibilities under environmental laws and Tribal trust responsibilities, and provides for the Congressionally authorized uses of the System.

8.2 DESCRIPTION OF THE PA

The PA has three basic flow features that are changed from the CWCP. First, more stringent drought conservation measures, which retain more water in the upper three lakes, are included. Second, a more defined methodology for intrasystem unbalancing is included. Third, the summer (May through August) non-navigation service level is increased. All three features will be included in the PA; however, the Water Control Plan revisions made at this time will be re-evaluated for inclusion of other features in 3 years.

8.2.1 Drought Conservation Measures

During extended drought periods, or those lasting more than 1 year, navigation service would be curtailed more under the PA than it is under the CWCP. This would allow more water to be stored in the upper three lakes through the drought than would be conserved by the CWCP. During the more severe droughts, such as the 1930 to 1941 drought, releases for navigation would be curtailed at a higher total Mainstem Reservoir System storage level than under the CWCP.

The drought conservation criteria included in the PA consist of “guide curves” for the determination of flow support for navigation and other downstream purposes and navigation season length. Under the PA, the navigation service level and season length would be reduced such that the amount of water in Mainstem Reservoir System storage would not decline as far as it would under the CWCP. The March 15 System storage level at which navigation would not be served for that year was raised from 21 million acre-feet (MAF) under the CWCP to 31 MAF. Figures 8.2-1 through 8.2-3 compare the drought storage levels and the corresponding navigation service levels and season lengths of the CWCP and PA.

The PA calls for suspension of navigation service if Mainstem Reservoir System water-in-storage (storage) is at or below 31 MAF on March 15 of any year. It should be noted that the occurrence of Mainstem Reservoir System storage at or below 31 MAF would most likely coincide with a national drought emergency. If any of the reservoir regulation studies performed for the development of the Annual Operating Plan (AOP) indicate that storage will be at or below 31 MAF by the upcoming March 15, the Corps will notify the Secretary of the Army. Approval from the Secretary of the Army will be required prior to implementation of back-to-back non-navigation years. The Corps will ensure that basin stakeholders are promptly informed of the notification to the Secretary of the Army and of the Secretary's decision regarding suspension of navigation.

8.2.2 Unbalancing of the Upper Three Lakes

The Corps has the authority under the existing Master Manual to implement (and does currently implement) intrasystem unbalancing under the CWCP. Unbalancing of the lakes was also included as a feature of the 2000 BiOp RPA. Unbalancing under the PA consists of a set pattern of purposefully lowering one of the upper three lakes approximately 3 feet to allow vegetation to grow around the rim, and then refilling the lake to inundate the vegetation. The unbalancing would rotate among the three lakes on a 3-year cycle. Movement of water among the lakes as they are lowered and refilled provides benefits to fish and birds in both the intervening river reaches and the lakes. Higher spring releases would fill the downstream lake and provide a rising lake level for game and forage fish spawning. The subsequent 2 years of lower flows would expose sandbar habitat for use by the protected birds. Unbalancing would also provide more bare sandbar habitat around the perimeter of the lakes for the birds. In subsequent years, the inundated vegetation around the perimeter would be used by adult fish for spawning and by young lake fish hiding from predators.

Intrasystem unbalancing would be implemented in those years when there is not an excessive amount of flood control storage utilized or significant drawdown of the lakes due to severe drought conditions. To the extent possible, based on hydrologic conditions, a 3-year cycle would be followed for lowering the water level about 3 feet below normal the first year, followed by a refill of the lake to about 3 feet above normal the second year and declining lake levels (a “float” year) the third year. This 3-year cycle would be rotated among the upper three lakes on an annual basis so that each year one lake is high, one is low, and the third is floating. Table 8.2-1 describes the 3-year cycle of lake unbalancing.

During the low year at a lake, the goal of the Corps would be to begin the runoff season on March 1 with a low lake elevation with respect to the other two upper lakes. Ideally, the lake would rise during

Table 8.2-1. Unbalancing schedule for upper three lakes.

	Fort Peck		Garrison		Oahe	
	March 1	**Rest of Year**	**March 1**	**Rest of Year**	**March 1**	**Rest of Year**
Year 1	High	Float	Low	Hold Peak	Raise and hold during spawn	Float
Year 2	Raise and hold during spawn	Float	High	Float	Low	Hold Peak
Year 3	Low	Hold Peak	Raise and hold during spawn	Float	High	Float

the lake fish spawn and then hold the peak lake level for the remainder of the year. The following year, the high year, the lake would begin the runoff season high with respect to the other lakes, rise during the fish spawn, and then float downward during the remainder of the year. The float year, or third year, the lake would rise during the fish spawn and then drift downward for the remainder of the year so that it is in position to be at a low elevation the following year as the cycle repeats.

8.2.3 Summer Non-Navigation Service Level

Several reaches of the Missouri River currently have thermal powerplants that rely on the river or lake for cooling water. Concerns regarding adequate cooling capability in terms of water temperature surfaced in the early years of the Study. For that reason, a higher summer service level was included in almost all of the alternatives developed since the Draft EIS was released in 1994. All of the alternatives to the CWCP developed for the preliminary RDEIS, RDEIS, and this FEIS had a summer non-navigation service level of 18 kcfs. This service level is based on water supply targets of 18 kcfs at Sioux City, Omaha, and Kansas City. This feature rarely gets used because the number of non-navigation service years rarely exceeded 5 years in the alternatives evaluated since 1994. All of the non-navigation years occurred in the 1930 to 1941 drought. Future depletions of water from the Mainstem Reservoir System were analyzed for the DEIS, RDEIS, and the FEIS, and the non-navigation years increased with the amount of additional depletion being analyzed. Above varying levels, depending on the alternative being evaluated, the non-navigation years occurred in the other two major droughts in the 100-year period modeled.

8.2.4 Three-Year Re-Evaluation

Consistent with the adaptive management approach under MRRIP, the Corps proposes that the decision on the PA be reviewed along with the status of the species; the scientific findings of the proposed robust research, monitoring, and evaluation program; the progress and success of other implemented measures to date; and other relevant new information be re-evaluated within 3 years following the implementation of the PA. This re-evaluation would inform decisions concerning implementation of additional measures or modification of existing measures and strategies, including potential flow releases out of Gavins Point Dam. The “3-year check-in” would include input from MRRIC to promote conservation of listed species and the broader ecosystem values of the Missouri River.

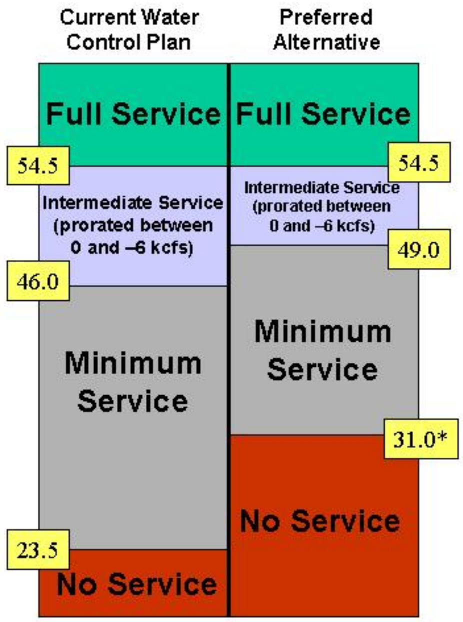

Figure 8.2-1. Comparison of drought conservation measures between the CWCP and the System operations under the PA based on the March 15 Mainstem Reservoir System storage check for service level.

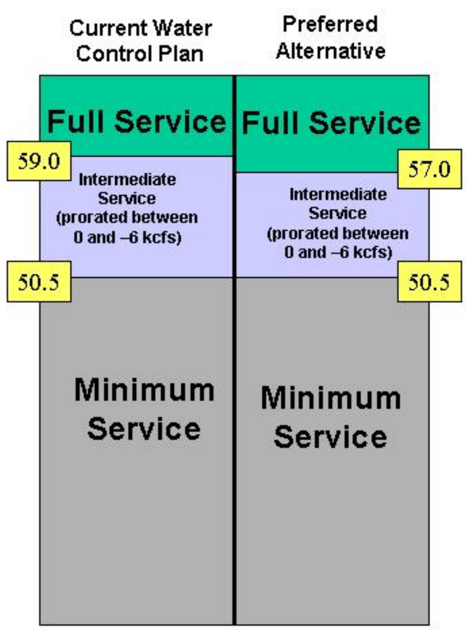

Figure 8.2-2. Comparison of drought conservation measures between the CWCP and the System operations under the PA based on the July 1 Mainstem Reservoir System storage check for service level.

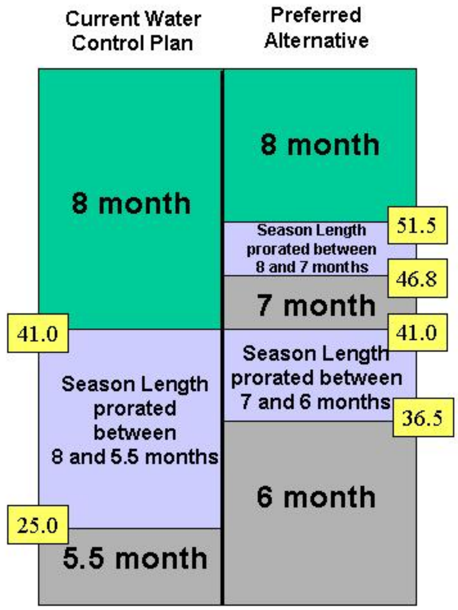

Figure 8.2-3. Comparison of drought conservation measures between the CWCP and the System operations under the PA based on the July 1 Mainstem Reservoir System storage check for season length.

8.3 EFFECTS OF THE PA

Many of the effects of the PA are very similar to those of the MCP that were identified in detail in Chapter 7. The PA responds to droughts in a prorated response versus the triggered response of the MCP. This results in essentially very little response during single-year droughts under the PA; whereas, the MCP reacted more dramatically in almost every drought year. This slight difference in drought conservation, especially in the initial year or two of an extended drought, resulted in some differences in Mainstem Reservoir System operations that could lead to slight differences in effects on an annual basis. When the entire period of analysis is considered, however, the differences for most categories of effects are the same or very close to being the same. In other words, the "relative differences" are essentially the same in almost every category. This section of Chapter 8 provides details on the differences in the effects between the CWCP and PA, with an initial comparison of the MCP and PA effects.

8.3.1 Comparison of Average Annual Effects of the MCP and PA

The average annual values for many of the economic use and environmental resource categories analyzed in Chapter 7 for the MCP are presented for the MCP and the PA in Table 8.3-1. Also presented are the percent changes for each category for the change from the MCP to the PA. In general, the economic use categories have changes between these two alternatives of 1 percent or less; whereas, the environmental resource differences ranged from no difference to as much as about 19 percent difference.

All of the differences between the MCP and PA for the economic use categories are minor. Four of these categories show increased benefits to the Nation under the PA compared to those provided by the MCP. These increases range from 0.1 percent for water supply to 1.0 percent for navigation. Only recreation benefits, which represent recreational use benefits in the upper and lower basin, were reduced, with this decrease being 0.6 percent. Overall, total economic use benefits increased by $4.1 million under the PA when compared to those of the MCP. Finally, Mississippi River lost navigation efficiency costs would go up according to the figures in Table 8.3-1; however, when considered from the viewpoint of Mississippi River navigation benefits, there is virtually no change between the two alternatives.

Table 8.3-1. Average annual use and resource values for the MCP and PA with relative differences.

Use/Resource Category	MCP	PA	Percent Difference
Flood Control ($millions)	408.0	410.2	0.5
Navigation ($millions)	9.3	9.4	1.0
Hydropower ($millions)	672.8	674.3	0.2
Water Supply ($millions)	610.4	611.3	0.1
Recreation ($millions)	87.9	87.4	-0.6
Coldwater Fish Habitat in Lakes (MAF)	186.7	185.9	-0.5
Coldwater Fish Habitat in River (miles)	10.2	10.3	1.1
Warmwater Fish Habitat in River (miles)	48.8	50.4	3.2
Physical Habitat for Native Fishes (index)	81.6	81.4	-0.3
Young-of-Year Fish Production (index)	2.0	2.1	4.7
Tern and Plover Habitat (River) (acres)	315.6	304.9	-3.4
Tern and Plover Habitat (Lake) (acres)	3,167.8	3,762.0	18.8
Wetland Habitat (thousands of acres)	155.0	157.6	1.6
Riparian Habitat (thousands of acres)	108.1	107.8	-0.3
Historic Properties (index)	4,875.9	4,905.4	0.6
Mississippi River Navigation ($ millions)[1/]	44.0	41.7	0.0

1/ Mississippi River values are costs instead of benefits. Benefits are in the billions of dollars, and relative difference is essentially zero, when benefits are compared.

Environmental resource values increase for six resource categories and decrease for four of the categories when the PA values were compared to those of the MCP. The increases range from a low of 0.6 percent for the historic properties index to 18.8 percent for the lake tern and plover habitat. Other increases were for the coldwater lake fish habitat (+1.1 percent), wetland habitat (+1.6 percent), coldwater river fish habitat (+3.2 percent), and young-of-year lake fish production (+4.7 percent). The decreases range from –0.3 percent for warmwater river fish habitat and riparian habitat to –3.4 percent for river tern and plover habitat. Coldwater habitat for lake fish also decreases (-0.5 percent).

The data presented in Table 8.3-1 indicate that the differences between the effects of the MCP and PA are relatively minor in all but four categories presented in the table. For those who are familiar with the relative differences presented in Chapter 7 between the CWCP and MCP for these categories, the effects of the PA will be very similar. Greater attention will need to be given to the four environmental resource categories with the larger differences. These are warmwater river fish habitat, young-of-year fish production for the lakes, and tern and plover habitat for both the river and lake reaches.

8.3.2 Comparison of CWCP and PA Effects

A change from the CWCP to the PA will result in the alteration of some economic use benefits and environmental resource values. This section of Chapter 8 provides a quick summary of these effects and the relative differences between the two alternative Water Control Plans. Discussion will focus on the average annual values and the annual values as they vary from year to year. In some of the effects categories, the reason for the differences, whether average annual or annual values, will be readily apparent, and in other categories they will not be as apparent. For those that are apparent, the likely cause of the change will be identified.

Mainstem Reservoir System Hydrology

Various aspects of the Mainstem Reservoir System hydrology will be affected by the changes from the CWCP to the PA. Changes for total Mainstem Reservoir System storage, minimum lake levels for the upper three lakes, and flows at Bismarck, North Dakota and Nebraska City, Nebraska will be presented.

Total storage in the Mainstem Reservoir System varies between the CWCP and the PA, as shown in Figures 8.3-1 through 8.3-3. Because the major differences between the two alternatives occur during the droughts, the values for the end of June in the years during and following the three major droughts are presented. The greatest differences occur during and following the 1930 to 1941 drought. Much smaller differences occur during the 1954 to 1961 and 1987 to 1993 droughts.

Minimum Mainstem Reservoir System storage and lake levels are two sets of data that are important to the upper basin states of Montana, North Dakota, and South Dakota, the states where the three largest dams are located. Table 8.3-2 contains these data for the three droughts. In all three droughts, the total water in storage and lake levels are higher for the PA, as indicated in Figures 8.3-1 though 8.3-3. There is approximately an 8 MAF increase in

Table 8.3-2. Minimum Mainstem Reservoir System storage (MAF) and lake levels for the upper three lakes (feet).

	System Storage		Fort Peck Lake		Lake Sakakawea		Lake Oahe	
Alternative	**Date**	**MAF**	**Date**	**Level (feet)**	**Date**	**Level (feet)**	**Date**	**Level (feet)**
1930-1941 Drought								
CWCP	9/6/41	18.7	6/3/41	2,157	2/27/37	1,773	5/22/41	1,537
PA	2/28/37	26.6	3/2/37	2,180	2/27/37	1,792	2/23/37	1,558
1954-1961 Drought								
CWCP	12/29/61	40.1	3/18/62	2,206	2/1/62	1,813	8/28/61	1,586
PA	12/29/61	42.1	3/14/62	2,209	2/1/62	1,817	8/24/59	1,588
1987-1993 Drought								
CWCP	1/7/93	40.2	4/13/91	2,206	3/3/93	1,813	8/22/90	1,585
PA	1/8/91	42.1	3/9/91	2,208	2/1/91	1,817	8/18/90	1,587

storage in the 1930 to 1941 drought and approximately a 2 MAF increases during the 1954 to 1961 and 1987 to 1993 droughts for the PA.

Flows at two locations, one within the Mainstem Reservoir System and one on the Lower River, were plotted and evaluated to determine the differences between the CWCP and the PA. Bismarck, North Dakota and Nebraska City, Nebraska were the two locations selected. The results of the comparisons are shown on Figures 8.3-4 through 8.3-7. Average monthly flows are shown on Figures 8.3-4 and 8.3-5 for Bismarck and Nebraska City, respectively. The Bismarck figure shows more variability between the two alternatives than the Nebraska City figure shows. The Bismarck differences are likely due to both the drought conservation and the intrasystem unbalancing changes in the PA; whereas, the Nebraska City changes are due just to the drought conservation measures. Because the drought conservation affects a relatively small part of the 100-year period, that factor is likely a relatively small factor, as indicated by the relatively small differences in the Nebraska City monthly values. Figures 8.3-6 and 8.3-7 present the differences in the annual maximum flows at the same two locations. These plots look different than one would normally expect because the CWCP values are sorted from maximum to minimum. The corresponding annual value for the PA is plotted on the same x-axis location as the sorted annual value for the CWCP is plotted. This allows one to more easily see the differences between the two sets of values. Generally, there is more variability and the magnitude of this variability is greater for the Bismarck figure. This is most likely due to the intrasystem unbalancing component included in the PA. The relatively small differences at Nebraska City are as expected because the drought conservation measures are the only factor affecting flow differences.

Sedimentation, Erosion, and Ice Processes and Water Quality

Impacts in these categories for the PA would be very similar to those described for the MCP in Chapter 7. The only differences relate to a spring rise from Fort Peck Dam, which is not a plan component for the PA. Refer to Sections 7.3 and 7.4 for details on potential impacts in these categories of changing from the CWCP to the PA. In general, no changes are expected for the sedimentation, erosion, and ice processes for a change to the PA, and water quality impacts will be reduced in the upper three lakes for coldwater habitat and eutrophication due to the higher lake levels during the droughts.

Wetland and Riparian Habitat

Changes in these two types of vegetation classifications will occur for the change to the PA. Tables 8.3-3 and 8.3-4 and Figures 8.3-8 and 8.3-9 present the average annual and annual values, respectively for the CWCP and PA.

Total average annual wetland habitat, shown in Table 8.3-3, increases 0.9 percent for a change to the PA; however, this change is not indicative of what is happening in the upper basin reaches. Lake delta wetland habitat is diminishing by 4.9 percent while upper river habitat is increasing 8.4 percent. The cause of these more dramatic differences is not readily apparent just looking at the average annual differences.

Figure 8.3-8 presents the annual values for the total and the Lower River wetland habitat. Examination of this figure shows that the amount of wetland habitat on the Lower River reaches has a similar pattern to the amount of wetland habitat on the total annual plot. The reduction in flows during the droughts to the Lower River appear to result in wetland habitat losses on the Lower River, which are reflective of the total habitat losses. The

Table 8.3-3. Average annual wetland habitat (thousands of acres).

Alternative	Total	Lake Delta	Upper River	Lower River
CWCP	**156.1**	35.1	44.2	76.8
PA	**157.6**	33.4	47.9	76.3

Table 8.3-4. Average annual riparian habitat (thousands of acres).

Alternative	Total	Lake Delta	Upper River	Lower River
CWCP	**108.1**	12.0	41.9	54.1
PA	**107.8**	11.9	40.7	55.2

differences between the two plans are a result primarily of the considerable variability from year to year on the upper river and delta reaches. This difference is likely due to the intrasystem unbalancing, with the delta reaches diminishing habitat and the upper river reaches increasing habitat (can also be readily seen on the annual plots not presented).

Total average annual riparian habitat, shown in Table 8.3-4, is essentially the same for the CWCP and PA. This habitat type changes by 0.3 percent for the change to the PA. Riparian habitat at the Lower River sites increases by 2.0 percent on an average annual basis, and the lake delta and upper river habitat decrease by 1.3 and 3.0 percent, respectively.

Figure 8.3-9 presents the annual values for the total and the Lower River riparian habitat. The year-by-year pattern for riparian habitat on the Lower River is essentially the same as the annual total riparian habitat values. Relatively small differences occur between the two sets of values for the Lower River and total value, and these differences are due to the differences between the upper basin values, which tend to vary for the upper river sites only. The differences for a change to the PA for the lake delta sites are generally negative and the differences for the upper river sites vary between negative and positive. The overall effect of the upper river sites tend to be slightly negative, as shown by the differences between the two sets of lines in the figure (and overall negative change in the average annual values for the upper basin sites).

Wildlife Resources (Tern and Plover Habitat)

Tables 8.3-5 and 8.3-6 and Figures 8.3-10 and 8.3-11 present the average annual and annual riverine and lake tern and plover habitat data, respectively, for the CWCP and PA. Table 8.3-5 and Figure 8.3-10 are for the riverine habitat, and Table 8.3-6 and Figure 8.3-11 present the data for the lake habitat.

Riverine habitat occurs on four river reaches downstream from Fort Peck, Garrison, Fort Randall, and Gavins Point Dams. Table 8.3-5 presents the average annual values for each of these reaches and the total for all four reaches. The overall acreage increases by 38.3 percent. The larger increases in the individual reaches occur downstream from Garrison and Fort Peck Dams (68.8 and 24.9 percent, respectively). Smaller increases occur downstream from Fort Randall and Gavins Point Dams (2.4 and 9.7 percent, respectively). Because the greatest increases are downstream from the upper two dams, it can be concluded that the intrasystem unbalancing is the primary cause of the increase in riverine tern and plover habitat.

As shown in Figure 8.3-10, the total riverine tern and plover habitat is highly variable, ranging from a low of no habitat in several years to more than 1,200 acres in 2 years. Drought conservation measures are a factor in the three droughts; habitat is greater for the PA than the CWCP in some of the drought years, when the amount of water stored in the upper three lakes is balanced. Intrasystem unbalancing also appears to be a factor because there are increased levels of riverine habitat in non-drought periods. High flows would scour the vegetation in some years, which would be followed by lower flows that would exposed the bare sandbar and island habitat. This could occur as part of the unbalancing, but it could also occur in the Fort Randall and Gavins Point reaches following high flows on the Lower River, such as the high flows in 1952.

Table 8.3.5. Riverine tern and plover habitat (acres).

Alternative	Total	Fort Peck	Garrison	Fort Randall	Gavins Point
CWCP	**220.5**	50.3	97.9	32.7	39.5
PA	**304.9**	62.9	165.2	33.5	43.4

Table 8.3-6. Average annual lake tern and plover habitat (acres).

Alternative	Total	Lake Oahe	Lake Sakakawea
CWCP	**3,035**	1,228	1,807
PA	**3,762**	1,272	2,490

Lake tern and plover habitat values are derived based on an analysis estimating the available appropriate habitat for the terns and plovers around 25 percent of Lakes Sakakawea and Oahe. The total lake habitat increases by 23.9 percent. The greater share of this increase is due to the 37.8 percent increase in habitat on Lake Sakakawea, which has about two-thirds of the lake habitat for the PA. Lake tern and plover habitat increase only 44 acres, or 3.6 percent, on Lake Oahe for the change to the PA.

Annual total lake tern and plover habitat values fluctuate considerably for both the CWCP and PA, as shown on Figure 8.3-11. The CWCP has several years where the lake habitat is, or approaches, zero following the first year of computations in 1902. (Note that the value is zero in 1898 through 2001 because the model does not compute its first value until the fifth year because one computation input requires 4 years of data to "kick in" the fifth year.).

Under the PA, there are no zero habitat years in the 96 years with computed values. In fact, the habitat drops to less than 1,000 acres in only 3 years. This last factor indicates that intrasystem unbalancing is beneficial for the production of lake tern and plover habitat. There are also some noticeable increases in some years during the three droughts when the upper three lakes are balanced, indicating that increased conservation is also beneficial. Overall, the PA has higher lake habitat acreages in 77 of the 96 years modeled.

Young Fish Production in the Mainstem Lakes

The young fish production average annual and annual values are presented in Table 8.3-7 and Figure 8.3-12, respectively. Values in these two displays are relative index values, which were computed for each of the six mainstem lakes and summed to get the total value.

The average annual young fish production value for the PA is 6.7 percent higher than the total index value is for the CWCP. Values increase for five of the six mainstem lakes, with Fort Peck Lake being the exception (has no change). Lewis and Clark Lake has the greatest increase at 33.8 percent; however, its influence (+0.05 units) on the total value is diminished because the index value is related to size (volume of water in) of the lakes (Lewis and Clark Lake is the smallest lake). The other four lakes have values that increase by 1.2 to 9.4 percent.

Annual values are highly variable, as shown in Figure 8.3-12. Because most of the equations on which the index values are computed for each lake include at least one variable related to flow through the lake during some period of the year, the annual values were plotted versus annual runoff at Sioux City, Iowa, which is just downstream from the Mainstem Reservoir System. The data were sorted and a linear regression analysis was conducted for the resulting data sets, as shown in Figure 8.3-13. The resulting regressions have fairly similar slopes to the regression line, and the correlation coefficients are both about 0.80, which indicates a relatively good correlation. Because the annual runoff is highly variable and the total index is closely related to runoff, the total index is going to be highly variable. The values are more likely related to the runoff in that year than to other variables. Unbalancing of the upper three lakes likely has some effect that is causing the increased total annual value for the PA.

Coldwater Fish Habitat in the Mainstem Lakes

Table 8.3-8 and Figure 8.3-14 present the average annual and annual values, respectively, for the total volume of coldwater fish habitat in Fort Peck Lake, Lake Sakakawea, and Lake Oahe. This habitat is a requirement for differing fish species in these three lakes.

Table 8.3-7. Average annual young fish production in the mainstem lakes (relative index).

Alternative	Total	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Lake Sharpe	Lake Francis Case	Lewis and Clark Lake
CWCP	**2.00**	0.55	0.46	0.40	0.23	0.20	0.16
PA	**2.13**	0.55	0.50	0.41	0.24	0.22	0.21

Table 8.3-8. Average annual coldwater fish habitat in the mainstem lakes (MAF).

Alternative	Total	Fort Peck Lake	Lake Sakakawea	Lake Oahe
CWCP	**9.88**	3.59	2.81	3.47
PA	**10.30**	3.79	2.93	3.58

The average annual volume of coldwater habitat in the three lakes totals about 10 MAF, with the PA having 4.2 percent more habitat. The differences for the individual lakes are similar, ranging from 3.2 to 5.4 percent more.

The annual plots of the individual lakes show about the same annual changes as the plot of the total annual values, with one important difference being shown on the plot for Lake Sakakawea. This plot has the same pattern; however, it has generally lower values in the three droughts. The minimum value for Lake Sakakawea drops to less than 1 MAF of coldwater habitat in the two minor droughts. All three drop to, or near, zero in the 1930 to 1941 drought under both the CWCP and PA (Lake Oahe never reaches zero). The total annual plot, Figure 8.3-14, shows that the PA retains a very minor amount of coldwater habitat through the 1930 to 1941 drought; however, it is very small at about 1.25 MAF, compared to a "normal" value of 10 MAF. The minimum value for the CWCP is 0.16 MAF. The differences during the 1930 to 1941 drought account for the greatest amount of the differences in the average annual values for all three lakes, which means that the increased drought conservation measures account for most of the difference between the total average annual amounts of coldwater fish habitat in the lakes.

Coldwater Fish Habitat in the River Reaches

Coldwater habitat for river fish occurs downstream from Fort Peck and Garrison Dams. The average annual values for this habitat for the CWCP and PA are shown in Table 8.3-9, and the annual values are shown in Figure 8.3-15.

Total miles of riverine coldwater habitat are about the same for both the CWCP and PA. The PA has only 1.3 percent more of this habitat, and the two reaches comprising the total increase 1.1 and 1.6 percent. These small differences indicate that there is very little difference between the alternatives.

Figure 8.3-15 shows that there are notable differences between the CWCP and PA. The year-to-year variation is highly variable, with the lowest amount of coldwater fish habitat in the river reaches occurring during the three droughts. Comparison of the values through the droughts indicates that there are some differences between the CWCP and PA that could indicate that the change in the drought conservation measures is a factor for the differences. Because some of the greater differences between the CWCP and PA occur in the non-drought periods, the addition of intrasystem unbalancing to the PA is also a likely cause of the differences between the CWCP and PA.

Warmwater Fish Habitat in the River Reaches

Warmwater fish habitat was computed on an annual basis for the river reaches downstream from Fort Peck, Garrison, and Fort Randall Dams. The resulting average annual values for the three reaches and the sum total are presented in Table 8.3-10. The annual total values are shown in Figure 8.3-16.

Table 8.3-9. Average annual coldwater fish habitat in the river reaches (miles).

Alternative	Total	Fort Peck	Garrison
CWCP	**183.6**	140.2	43.4
PA	**185.9**	141.8	44.1

Table 8.3-10. Average annual warmwater fish habitat in the river reaches (miles).

Alternative	Total	Fort Peck	Garrison	Fort Randall
CWCP	**52.9**	32.8	6.1	13.9
PA	**50.4**	30.0	6.9	13.5

As expected (because average annual miles of coldwater fish habitat increased), the average annual miles of warmwater fish habitat decreased for a change to the PA. The amount of habitat decreased by 4.6 percent. This trend, however, did not occur in all three reaches. The value increased in the Garrison reach (12.9 percent) and decreased in the Fort Peck and Fort Randall reaches (8.5 and 3.3 percent, respectively). Considering only the average annual values provides no insight as to the cause of the increases and decreases.

Figure 8.3-16 includes data for the total and the Fort Peck reach annual values for the CWCP and PA. Comparison of the four sets of data shows that the total value has essentially the same year-to-year pattern as the Fort Peck reach, which has values most affected by the drought conservation measures. The other two reaches cause some variation in the total values from the general pattern of the Fort Peck reach. These variations are the result of drought conservation differences for the Fort Randall reach (reach not affected by intrasystem unbalancing) and the addition of intrasystem unbalancing to the PA for the Garrison reach.

Physical Habitat for Native River Fish

Indices indicating how close operations under the CWCP and PA compared to historic operations before the construction of the projects on the Missouri River (Mainstem Reservoir System and the Bank Stabilization and Navigation Project on the Lower River) comprise the physical habitat for native river fish values presented in Table 8.3-11 and Figure 8.3-17. The table includes the average annual values for the 100 years evaluated, and the figure presents the annual values for the CWCP and PA.

The average annual values presented in Table 8.3-11 show that the changes on a total and individual reach basis change very little. The changes are all less than 1 percent, with many being near zero. The most notable trend for the change to the PA is that the three Upper River sites increase in value and the Lower River sites decrease in value.

The annual values for the three sets of data for the total, Upper River, and Lower River are shown in Figure 8.3-17. This figure shows that the overall pattern for the total values is very similar to the Lower River values. This is likely the case because there are six reaches in the Lower River and there are only three in the Upper River. The year-to-year differences on the annual plots are so small that it is hard to discern any reason for the differences.

Shallow Water Habitat, Spawning Cue, and Connectivity to the Low-Lying Lands along the Lower River

The model runs identified that there was essentially no change in the performance of the PA in providing for these three attributes for the pallid sturgeon and other native river fish. This was expected for two reasons. First of all, these individual models basically capture attributes that are considered necessary for the native river fish that are captured in the single model for physical habitat for native river fish, which showed essentially no change on the Lower River. Second, the PA has no general change in the springtime and the summer flows on the Lower River between the CWCP and PA (see Figures 8.3-5 and 8.3-7 for Nebraska City); therefore, no change in the performance of the PA compared to the CWCP was expected in the values for these three attributes.

Flood Control

Flood control benefits were computed for all of the river reaches from Fort Peck Dam to the mouth and the four largest lakes of the Mainstem Reservoir System. Average annual benefits for each of these reaches and their sum total are presented in Table 8.3-12. Annual values for the sum total of the benefits are presented in Figure 8.3-18.

Table 8.3-11. Average annual physical habitat for native river fish in nine river reaches (relative index).

Alternative	Total	Fort Peck	Garrison	Fort Randall	Gavins Point	Sioux City	Nebraska City	St. Joseph	Kansas City	Boonville
CWCP	**81.46**	9.03	7.86	8.56	9.30	10.22	7.98	7.93	10.03	10.55
PA	**81.41**	9.10	7.88	8.56	9.30	10.18	7.95	7.89	10.01	10.53

Table 8.3-12. Average annual flood control benefits ($millions).

Reach	CWCP	PA
Fort Peck Lake	-0.07	-0.07
Fort Peck Dam downstream	2.96	2.92
Lake Sakakawea	-0.07	-0.10
Garrison Dam downstream	72.41	72.39
Lake Oahe	-0.28	-0.32
Oahe Dam downstream	14.75	14.75
Lake Francis Case	-0.17	-0.14
Fort Randall Dam downstream	0.70	0.71
Gavins Point Dam downstream	15.94	15.97
Sioux City	112.51	112.71
Omaha	49.30	49.28
Nebraska City	41.66	41.45
St Joseph	36.71	36.67
Kansas City	37.73	37.57
Boonville	9.29	9.31
Hermann	16.93	17.07
Total	**410.30**	**410.17**

The average annual flood control benefits, as shown in Table 8.3-12, are very similar for the CWCP and PA. There is no difference in the total benefits; however, there are some very small differences, in terms of dollar value, on some of the individual reaches. The greatest differences occur for the Nebraska City ($204,000 per year less for the PA) and Kansas City reaches ($160,000 per year less for the PA). A detailed analysis of the causes of the differences looked at flow data in individual years at the two sites next to the release data for Gavins Point Dam. In only 2 years, 1944 and 1945, was the cause of the difference related to the drought conservation criteria change for the PA.

In those 2 years, the service level for the PA was slightly higher (0.85 and 2.78 kcfs, respectively) because the PA recovered from the 1930 to 1941 drought slightly faster than the CWCP. All of the other notable differences in flood control benefits for these two reaches are due to very slight differences in the modeling. In reality, these other differences (March release rate, change in summer spiking flows, and change in evacuation rates) would not occur under real-time operations for either the CWCP or PA.

The annual total flood benefits (see Figure 8.3-18) look identical on an annual basis. To see the differences, the flood control benefits of the CWCP were subtracted from those of the PA. Figure 8.3-19 shows the results. Differences greater than $5 million occurred in only 7 years (3 positive and 4 negative). All but one of these differences occurred in years that the drought conservation criteria were not a factor. In 1935, which was a non-navigation season under the PA, the flood benefits were greater (some major increases in flood damages were prevented under the PA in one or more Lower River reaches other than Nebraska City and Kansas City) because of the resulting lower PA releases from Gavins Point Dam in that year..

Interior Drainage and Groundwater

Interior drainage impacts for the CWCP were determined by calculating the crop damages resulting from water ponding at the drainage outlets through the levees to the river. The analysis was conducted for a 45-year period, from 1950 through 1994, using current-day economic values. Ponding of water at drainage structures for six representative leveed areas along the Lower River was studied. Crop production through the season for an equal distribution of corn and soybeans was tracked to compute the costs of interior drainage ponding on the crops.

Total average annual interior drainage costs (negative impact) in millions of dollars per year were computed for the six sites. Damages are $1.34 million per year for the CWCP. Analysis of the Nebraska City flows for the PA indicates that interior drainage costs would be expected to be comparable to or less than the CWCP.

Groundwater impacts for the CWCP were determined by calculating the crop damages resulting from high groundwater levels. High groundwater levels limit crop planting and production, and the resulting increased costs of putting in the crop or harvesting a lower yield were computed as damages. The analysis was conducted for the 10-year period of 1970 through 1979 using current-day economic values. Three leveed areas and one unleveed area along the Lower River were studied to determine the impact to drainage and recharge of the water table resulting from flow differences among the alternatives.

Groundwater damage impacts are $4.52 million annually for the CWCP. Analysis of the Nebraska City flows for the PA indicates that groundwater damages would be expected to be comparable to or less than the CWCP.

Figures 8.3-20 and 8.3-21 present average monthly flows at Nebraska City for the CWCP and PA. These two figures, one for each period of analysis, show that the average monthly flows on the Lower River are, generally, slightly less during the crop planting and growing season of April through September. These results support the assumption that interior drainage and groundwater effects on crop damages would be comparable or slightly less for the PA.

Flow data for individual years at Nebraska City were also examined, and the results are presented in Table 8.3-13. The table shows that the number of years with PA equal or lower average monthly flows for both the 45-year period of the interior drainage analysis and the 10-year period of the groundwater analysis are greater than the number of years the PA flows were higher. This is dramatically true for the 10-year period of the groundwater analysis. This analysis indicates that the risk of interior drainage and groundwater damages should be lower for the PA than for the CWCP.

Because interior drainage can be a problem if the flows exceed a certain value adjacent to the outlet structures for relatively few days, another analysis was conducted of the daily flow data at Nebraska City. Figure 8.3-22 shows that the number of days the flow at Nebraska City exceeds 50 kcfs from April 1 to September 30 in the period from 1950 to 1994 is less for the PA than the CWCP. This flow was selected for the analysis because interior drainage problems start when the flows approach 55 kcfs in the Nebraska City reach. Over the entire 45-year period during those months of the year, the PA had 102 fewer days that exceeded 50 kcfs when compared to the CWCP. This further indicates that the risk of interior drainage damages should be lower for the PA than for the CWCP.

Water Supply

Water supply benefits for the CWCP and PA are presented in Table 8.3-14 and on Figure 8.3-23. These benefits occur in all of the river and lake reaches from Fort Peck Dam to the mouth. Included in the benefits are those to the project purposes of water supply, irrigation, and water quality (thermal heat discharge).

Average annual benefits for each reach are included in Table 8.3-14. In general, all of the differences between the CWCP and PA are very small. In some cases, the percent change can be as high as 4.5 percent for Lake Sakakawea; however, the differences in the benefits between the two Water Control Plans for the total value and for most of the reaches are near zero.

Table 8.3-13. Comparison of the CWCP and PA monthly average flows (years).

	Interior Drainage Study Period - 1950-1995 (46 years)						
	April	**May**	**June**	**July**	**August**	**September**	**October**
PA Higher	5	11	21	19	21	21	21
Both the Same	9	11	1	7	12	8	1
PA Lower	31	23	23	19	12	16	23
	Groundwater Study Period - 1970-1979 (10 years)						
	April	**May**	**June**	**July**	**August**	**September**	**October**
PA Higher	1	1	3	2	2	2	3
Both the Same	1	2	2	1	2	3	1
PA Lower	8	7	5	7	6	5	6

Table 8.3-14. Average annual water supply benefits ($millions).

Lake/Reach	CWCP	PA
Fort Peck Lake	0.6	0.6
Lake Sakakawea	6.3	6.6
Lake Oahe	6.0	6.0
Lake Sharpe	4.7	4.7
Lake Francis Case	2.3	2.3
Lewis and Clark Lake	0.7	0.7
Lake Subtotal	**20.6**	**20.8**
Fort Peck	1.4	1.4
Garrison	92.4	94.3
Fort Randall	0.0	0.0
Upper River Subtotal	**93.8**	**95.7**
Gavins Point	1.5	1.5
Sioux City	32.2	32.1
Omaha	198.8	198.0
Nebraska City	145.4	145.2
St. Joseph	24.3	24.2
Kansas City	49.2	49.2
Boonville	0.6	0.6
Hermann	43.8	43.8
Lower River Subtotal	**495.8**	**494.8**
Total	**610.1**	**611.3**

Total annual benefits were plotted to see when the differences were occurring during the 100-year period of analysis, and the most notable differences occurred during the droughts. The most significant of these differences occur during a drought like the 1930 to 1941 drought. Total water supply benefits during the period from 1930 to 1946 are plotted in Figure 8.3-23 to show the changes during this major drought and the subsequent recovery period. Because the minimum values occurred in non-navigation years, the Lower River annual values were added to the figure. This combination of plots demonstrates that the differences in the total benefits are directly related to those on the Lower River. These impacts are most likely the result of cutbacks required for thermal waste discharge at the Lower River powerplants because of the magnitude of the changes ($50 million to $100 million) in the non-navigation years (1937 for the CWCP and 1935, 1937, 1938, and 1941 for the PA) for the two Water Control Plans.

Hydropower

Hydropower is generated at all six mainstem dams. Table 8.3-15 and Figure 8.3-24 show the hydropower benefits for the Mainstem Reservoir System.

The CWCP and PA provide essentially the same total average annual hydropower benefits, as shown in Table 8.3-15, with the PA providing 0.9 percent more than the CWCP. Hydropower generated at Fort Peck, Garrison, and Oahe Dams account for the greatest share of the increased benefits, with the increases ranging from 1.0 to 2.1 percent more for the PA. This is likely due to increased drought conservation measures included in the PA.

Figure 8.3-24 verifies that the increased hydropower benefits are in response to the drought conservation measures, particularly their effects during the 1930 to 1941 drought and subsequent recovery period. The minimum hydropower benefits occur in the non-navigation years for the two alternatives. This results because hydropower benefits are the result of the head on the generators (lake elevation) and the volume of water released through the generators. The lakes are generally near the lowest levels in the non-navigation years, and releases are generally at their lowest in these same years. This combination results in the lowest

Table 8.3-15. Average annual hydropower benefits ($millions).

Alternative	Total	Fort Peck	Garrison	Oahe	Big Bend	Fort Randall	Gavins Point
CWCP	**668.00**	63.62	139.67	197.60	115.14	111.98	40.00
PA	**674.32**	64.24	142.64	199.77	115.08	112.42	40.17

annual hydropower benefits. The CWCP has its lowest benefits in 1937 (non-navigation year) and 1941 (lowest Mainstem Reservoir System storage or combined lake elevation year), and the PA benefits are lowest in its four non-navigation years (1935, 1937, 1938, and 1941).

Due to the scale required to present the annual hydropower benefits, the variation in the benefits in the other two major droughts and the non-drought periods are not distinguishable on Figure 8.3-24. For this reason, Figure 8.3-25 was prepared to show the differences between the CWCP and PA. This figure shows that there is considerable variation from year to year; however, these differences are generally less than plus or minus $20 million in the years outside of the 1930 to 1941 drought and its recovery period, with two exceptions. These variations could be due to the intrasystem unbalancing.

Because the annual generation pattern was being affected enough to raise concerns over hydropower revenues (different than hydropower benefits in this EIS), the Western Area Power Administration (WAPA) worked as a cooperating agency on this EIS to assist with the identification of potential hydropower revenues differences among the alternatives. Under the PA, average monthly power generation on a month-by-month basis is redistributed slightly from that for the CWCP (see Table 8.3-16). This redistribution results in a slight reduction in the amount of revenues potentially resulting from operations under the PA. This analysis showed an estimate of $1.3 million per year of reduced revenues for the change from the CWCP to the PA.

Available generating capacity has also been an issue for the power consumer groups throughout the Study; however, concern on this issue heightened when alternatives with lower summer flows were potential preferred alternatives. Concerns included not only the hydropower capacity but also the thermal generating capacity on the river reaches where lower summer flows could limit the discharge of the waste heat. Figure 8.3-26 presents the annual values for the average monthly generation capability at the Mainstem Reservoir System for the CWCP and PA. This plot looks similar to the hydropower benefits plots, with the lowest values occurring during the 1930 to 1941 drought. This figure shows that the generating capability could drop from a non-drought average of about 2,400 MW to about 1,800 MW for the PA and 1,500 MW for the CWCP. The PA provides from about 150 to about 300 MW of additional generation capability on an average monthly basis during July in the depths, and early recovery years, of the 1930 to 1941 drought. This compares to lost generating capability on an average monthly basis of up to about 900 MW for the CWCP.

The hydropower generation capability losses pale compared to potential thermal generation losses. Losses under the PA would be similar to those under the MCP reported on in Section 7.10 of Chapter 7. Estimated losses, assuming that they would occur simultaneously on all of the Lower River reaches in mid-July to mid-August, could be

Table 8.3-16. Monthly average hydropower capacity and energy generated by the Mainstem Reservoir System.

	Capacity (MW)											
Alternative	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
CWCP	2,146	2,148	2,053	2,009	2,130	2,244	2,270	2,255	2,089	2,071	2,150	2,141
PA	2,177	2,181	2,081	2,032	2,157	2,274	2,302	2,288	2,120	2,100	2,180	2,172
	Energy (GWh)											
Alternative	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
CWCP	729	637	554	711	928	912	1,023	1,053	973	928	857	722
PA	744	613	596	748	925	883	1,010	1,043	989	942	843	743

as high as about 9,000 MW (1937) for the CWCP and over 4,000 MW (1937 and 1940) for the PA. These figures are based on the assumptions used by the Corps to complete the water supply benefits analysis, which included the water quality limitations potentially place on thermal power generation. The very high capability loss during 1937, which is a non-navigation year, occurred as a result of the lower summer non-navigation service releases of 9 kcfs (versus 18 kcfs for the PA).

Recreation

Recreation benefits were computed for all reaches of the Missouri River from Fort Peck Lake to the mouth. These benefits are summarized in Table 8.3-17 and Figure 8.3-27.

The average annual benefits for recreation in each individual reach; the subtotal for the lakes, Upper River reaches, and Lower River; and the sum total are presented in Table 8.3-17. Overall, the PA provides 3.2 percent more recreation benefits than the CWCP provides. Reach benefits increase for the four largest lakes, with the range of improvement being 1.7 percent for Lake Francis Case to 11.5 percent for Fort Peck Lake. The improvements at the other two larger lakes are each about 8 percent. While benefits increase by 1.3 percent downstream from Fort Peck Dam, recreation benefits generally decrease for the other river reaches. The most likely reason for the increases at the lakes and the decreases on the river reaches are the increased drought conservation measures.

Figure 8.3-27 verifies that increased drought conservation measures are the factor responsible for increased recreation benefits. This figure shows that the benefits drop dramatically during the 1930 to 1941 drought and to a much lesser degree during the other two major droughts. It also shows that the major differences between the two Water Control Plans occurs during this greatest drought during the period modeled. Finally, the benefits for the upper three lakes are included in Figure 8.3-27. Comparison of the two sets of plots for the lakes and total benefits shows almost a direct correlation between these two sets of benefits for both plans. It also shows that these three lakes are the greatest

Table 8.3-17. Average annual recreation benefits ($millions).

Lake/River Reach	CWCP	PA
Mainstem Lakes		
Fort Peck Lake	2.92	3.25
Lake Sakakawea	13.81	14.85
Lake Oahe	14.90	16.11
Lake Sharpe	7.97	7.97
Lake Francis Case	10.58	10.76
Lewis and Clark Lake	10.20	10.20
Lake Subtotal	**60.38**	**63.15**
Upper River		
Fort Peck	0.35	0.36
Garrison	3.24	3.19
Fort Randall	0.99	0.99
Upper River Subtotal	**4.58**	**4.54**
Lower River		
Gavins Point	5.10	5.08
Sioux City	11.45	11.42
St. Joseph	0.61	0.61
Kansas City	0.90	0.90
Boonville	0.71	0.71
Herman	0.96	0.96
Lower River Subtotal	**19.73**	**19.68**
Total	**84.70**	**87.37**

benefactors of the increased drought conservation measures of the PA, as indicated also with the average annual values in Table 8.3-17.

Subtracting the annual benefits for the CWCP from those of the PA for the upper three lakes provides insight on the annual change in recreation benefits the PA provides to these lakes. This plot reinforces what was said in the previous paragraph regarding the PA. The greatest positive benefits are definitely provided during the 1930 to 1941 drought and subsequent recovery period. Benefits provided during the period of 1930 to 1947 for recreation on these three lakes total $259 million, or an average of $14.4 million per year during this 18-year period. Positive benefits are also provided during the 1954 to 1961 drought and subsequent short recovery period, and the 1987 to 1993 drought (recovered totally in second half of 1993). The negative benefits provided by the PA, relative to those of the CWCP, likely occur in years with higher lake levels, which also reduces recreation benefits by increasing costs to repair or move facilities due to high lake levels. This could be partially due to the unbalancing change for the three lakes included in the PA.

Another analysis was conducted of the recreation benefits data. This analysis focused on the reduction of benefits provided by the CWCP compared to those that appear to be the benefits at "normal" times. Figure 8.3-27 shows that the recreation benefits on the upper three lakes approximate $40 million per year in these normal years. Using this value and the average annual benefits provided by the CWCP and PA for these three lakes, the average annual loss of benefits during the 100-year period equates to $40 million minus $31.6 million for the CWCP and $40 million minus $34.2 million for the PA. The reduced benefits on an average annual basis from the normal level are, therefore, $8.4 million under the CWCP and $5.8 million under the PA.

Missouri River Navigation

Navigation occurs on the Missouri River from Sioux City to the mouth. The average annual navigation benefits over the 100-year period of analysis are shown in Table 8.3-18 on a total and reach basis. Table 8.3-19 presents the navigation service level and season length data for the CWCP and PA. Figure 8.2-29 presents the total benefits on an annual basis over the 100 years.

Missouri River navigation is the economic use with the lowest total average annual benefits, at $8.8 million per year. A change to the PA increases these benefits by 6.2 percent. The absolute benefits for each reach change about the same, ranging from $0.12 million to $0.17 million; however, the percent increases range from 2.8 percent for the reach with the greatest absolute increase in benefits (Kansas City) to 23.2 percent for the Nebraska City reach. The percent increases for the other two reaches lie near the middle of this range.

Annual navigation benefits are shown on Figure 8.3-29. These benefits vary considerably from either year to year or from period to period throughout the 100-year period of analysis. The range is from about $16 million for an extended navigation season to a low of about -$3 million in several years of the 1930 to 1941 drought. The reductions from about $15 million are due to either reduced service in drought years or extended droughts, or periodic navigation suspension in years with flood flows on the Lower River during which navigation may be suspended on the Missouri River to limit damage to levees due to wakes emanating from the navigation tows and their barges. Benefits drop to below zero because of the operation and maintenance costs (negative benefits) that are included in the analysis of navigation benefits to the Nation.

Figure 8.3-30 presents the relative differences in the annual navigation benefits for the PA and CWCP on an absolute basis. Increases in 6 years of the 1930 to 1941 drought and subsequent recovery period (to 1947) are relatively high when compared

Table 8.3-18. Average annual Missouri River navigation benefits ($millions).

Alternative	Total	Sioux City	Omaha	Nebraska City	Kansas City
CWCP	**8.80**	1.20	0.91	0.66	6.03
PA	**9.35**	1.33	1.01	0.81	6.20

Table 8.3-19. Summary of navigation service level and season length data (years).

1898 to 1997		
March 15 Check		
Service Level	**CWCP**	**PA**
Full	56	58
Intermediate	24	18
Minimum	19	20
No Service	1	4
July 1 Checks		
Service Level		
Full	59	67
Intermediate	16	14
Minimum	24	15
No Service	1	4
No Service Years (19__)	37	35, 37, 38, 41
Season Length		
5.5 to < 6 months	5	0
6.0 to < 6.5 months	2	3
6.5 to < 7.0 months	1	1
7.0 to < 7.5 months	0	9
7.5 to < 8.0 months	0	5
8 months	45	31
8.33 months	46	47

to average annual benefits of about $9 million. In these 6 years, the increases in benefits are in the $4 million to $7 million range.

The navigation service level and season length data are summarized in Table 8.3-19. This table shows that the number of years at full service will be higher for the PA based on both the March 15 and July 1 service level checks. The number of minimum service years increases for the PA by only one for the March 15 check; however it decreases by 9 years for the July 1 check. The primary factors conserving more water in the lakes during droughts are shorter navigation seasons and more non-navigation years. The number of 8-month and longer seasons over the 100-year period modeled is reduced from 91 for the CWCP to 78 for the PA. The number of non-navigation seasons is increased from one for the CWCP to four for the PA.

Another analysis was conducted of the navigation benefits data. This analysis focused on the reduction of benefits provided by the CWCP compared to those that appear to be the benefits at "normal" times. Figure 8.3-29 shows that the recreation benefits on the upper three lakes approximate $15 million per year in these normal years (actually are $15.3 million for an 8-month normal season). Using the $15.3 million value and the average annual benefits provided by the CWCP and PA for navigation, the average annual loss of benefits during the 100-year period equates to $15.3 million minus $8.8 million for the CWCP and $15.3 million minus $9.3 million for the PA. The reduced benefits on an average annual basis from the normal level are, therefore, $6.5 million under the CWCP and $6.0 million under the PA.

Historic Properties

The historic properties analysis focused on the potential erosion of known cultural, prehistoric, and historic sites located along the upper three lakes and Lake Sharpe. Average annual effects of the CWCP and PA on these sites over the 100-year period of analysis are listed in Table 8.3-20, and annual relative index value for each year is shown in Figure 8.3-31. An index value was selected as the basis for presenting this effect versus presenting the number of "hits" to the known sites. The model first computes the number of times the known sites are subject to erosion each month for the 12 months of the year. This value is then subtracted from a constant that was selected for each lake based on a number approximately twice the number of average sites eroded. This allowed the percentage difference between alternatives to be maintained

Table 8.3-20. Average annual historic properties values for the upper three lakes and Lake Sharpe (relative index).

Alternative	Total	Fort Peck Lake	Lake Sakakawea	Lake Oahe	Lake Sharpe
CWCP	**5,015**	143	2,658	2,011	204
PA	**4,905**	143	2,570	1,988	204

close to that of the comparison of the number of hits. This index value was selected as the final number to be computed by the model because it ensures that the higher the output number, the better the effects number is for known sites on a total basis. It becomes a "benefit" to have a higher number, which is consistent with the chosen method for presenting effects of the alternatives. Historic properties effects are more generally effects to Tribal resources because the majority of sites are Tribal cultural sites.

Table 8.3-20 presents the average annual index values on a total basis and for each of the four lakes. The total value drops by 2.2 percent for a change to the PA. This adverse effect is completely due to the adverse effects on the sites on Lakes Sakakawea and Oahe, which have index values that drop by 3.3 and 1.1 percent, respectively.

Annual index values are presented in Figure 8.3-31, which shows that the index value increases noticeably during the three droughts. This is an indication that the known sites are in the upper levels of each lake. Unfortunately, this analysis does not account for the erosional effects to sites that are noticeably being eroded as the lakes drop below the levels where sites have been identified. Figure 8.3-31 looks like an upside-down version of the lake level plots. Where the lake levels drop during lake unbalancing periods or during droughts, the index values increases. The increases are highest during the three major droughts and range from about 3,700 up to about 7,500 for the greater 1930 to 1941 drought and up to about 7,000 for the other two droughts. Again, this result does not mean that impacts to cultural and historic sites are reduced during the droughts; it means that erosional impacts to known sites are reduced during the droughts.

To provide some more perspective on the differences for a change to the PA, Figure 8.3-32 was prepared. This figure shows how much the index value changed. A negative value is bad, and a review of this figure shows why the average annual index value declines, as there are more negative values and many are much larger than the positive differences. The greatest differences occur in the recovery period for the 1930 to 1941 drought (1943 to 1947) when the lakes filled up earlier under the PA. This earlier refill caused the lake levels to return earlier to the levels in the lakes where the known sites are located.

To provide further perspective on the differences for a change to the PA, a breakdown in the annual and average annual differences was conducted. The index value represents the effects of erosional "hits" for all 12 months of the year. An average annual difference of 110, using the total numbers from Table 8.3-20, means that an average of 110/12, or an average about 10 sites a month would be adversely affected for a change to the PA. The greatest negative impact shown in Figure 8.2-32 is about 1,800 "hits" in 1944. This equates to an average monthly impact to 1,800/12, or 150 sites. To put these numbers into perspective, a total of 2,516 sites are located on Lakes Sakakawea and Oahe, the two lakes with the greatest share of the adverse impacts (only 158 sites were identified in a partial survey of Fort Peck Lake). A figure of 150 sites being more adversely affected by a change to the PA (increased drought conservation) is 6.0 percent of the known sites in a period when the lakes are rapidly recovering into the levels where the known sites are located. There are many years where the index number differences are less than 500, which equates to about 40 sites being more adversely affected in those years for a change to the PA. The Corps fully understands that an adverse effect to even one site is an impact that should be avoided, if possible.

Mississippi River Navigation

Effects of the alternatives on Mississippi River navigation are not computed in terms of benefits like all of the effects presented on uses and resources in this chapter. These effects are computed in terms of costs associated with lost navigation efficiency when river stages are low on the Mississippi River, whether in the Middle (computed based on St. Louis stage) or Lower (computed based on Cairo stage) Mississippi River reaches. Although not broken down in the data presented in this chapter, the costs include those for shallow draft in the two reaches as well as the effects of longer delays in the shallow-draft commodity movements in the two reaches on deep-draft (to and from the Gulf of Mexico) movements on the Lower Mississippi River. The bottom-line average annual effects are presented in Table 8.3-21, and the annual effects are shown in Figure 8.3-33.

Total average annual lost navigation efficiency costs decrease for a change from the CWCP to the PA. These costs decrease by 7.9 percent, and the costs for the two reaches decrease by about the same percentage. This indicates that the change to the PA has the same relative effect on both reaches as it does overall.

Because of the extremely high costs on the Mississippi River in the winter of 1939 and 1940 (model puts total costs of a continuous low-flow event into the year it started), Figure 8.3-33, showing the annual costs, may not accurately portray the potential for high lost efficiency costs on the Mississippi River. In this case, costs less than $50 million do not show up as being very significant on this figure. In reality, these are very high costs. Finally, it is very difficult to discern differences between the CWCP and PA on this figure.

To address problems with seeing the differences between the CWCP and PA in Figure 8.3-33, a second figure was prepared. It shows the differences based on subtracting the PA costs from the CWCP costs. This makes positive numbers in Figure 8.3-34 to be "good" or beneficial values, which is consistent with all of the difference plots presented in this chapter. A quick glance at this second Mississippi River navigation effects figure shows that a summation of the positives is greater than the negatives, meaning the PA is better by 7.9 percent on an average annual basis, as discussed above. Again, the scale of the figure, to account for the large cost reductions in 1939, makes some of the "smaller" changes look insignificant. In reality, there are 5 years in which the PA provides $10 million of reduced costs (increased benefits or positive on the figure) and 5 more years with reduced costs in the $5 million to $10 million range (total of 10 years with over $5 million of reduced costs under the PA).

The drought conservation measures are the reason for the differences in most years. Exceptions include the increased no-navigation service level in the summer months of May through August and some minor modeling differences. The service level difference caused a reduction in Lower River flows in 1937, when the summer release from Gavins Point Dam was based on meeting 9-kcfs water supply targets on the Lower River under the CWCP compared to 18-kcfs targets under the PA. The difference in 1976 resulted from a difference in the fall evacuation rate from the Mainstem Reservoir System. This resulted from a modeling difference in March 1975 when the release dropped to 9 kcfs (spring non-navigation service level). This retained more water in storage, which became a problem later in 1975 when the high runoff that year forced high evacuation rates. The model did not get rid of enough water in the fall of 1975 due to evacuation limits; therefore, the extra water was carried over to 1976, when it was evacuated in the fall. This higher fall evacuation rate under the PA in 1976 resulted in an extra $16.7 million of "benefits" for the PA (positive number on the figure). These reduced costs, hypothetically, should not have been included in the modeling results. If they had not been included, the difference between the CWCP and PA would have been reduced by $0.25 million on an average annual basis. This would have reduced the percent reduction in the average annual costs from 7.9 percent to 7.3 percent, which does not affect the relative, e.g., large, medium, or small, difference for a change to the PA for Mississippi River lost navigation efficiency costs.

Summary of Impacts of the PA to American Indian Tribes

The individual sections of this chapter discuss the impacts to the various resources and uses analyzed

Table 8.3-21. Mississippi River lost navigation efficiency average annual costs ($millions).

Alternative	Total	St. Louis	Cairo
CWCP	**45.27**	26.50	18.77
PA	**41.71**	24.59	17.13

for the Study on a total basis, with some discussion on a reach basis when it provided additional insight on the total impacts. In all of the effects sections readers were encouraged to consider the relative effects among the alternatives, not the absolute values presented for the various resources or uses. This section of Chapter 8 summarizes the impacts into 12 tables, one for each Reservation except for Iowa and the Sac and Fox Reservations, for which impacts are addressed on a single table. (Individual tables would be identical for each Reservation).

Tables 8.3-22 to 8.3-33 present the summary of impacts for the 13 Tribes. The numbering of the tables corresponds with the order of the Reservation locations going from upstream to downstream. The order of the listing of the resources and uses corresponds with the order they are presented in this chapter to make it easier to refer back to the individual sections for more information on an individual resource or use.

Table 8.3-22. Fort Peck Reservation impacts summary.

	Percent Change from CWCP
Wetland Habitat	-14
Riparian Habitat	0
Riverine Tern and Plover Habitat	25
Lake Tern and Plover Habitat	--
Lake Young Fish Production	--
Lake Coldwater Fish Habitat	--
River Coldwater Fish Habitat	1
River Warmwater Fish Habitat	-8
Native River Fish Physical Habitat	1
Flood Control	-1
Water Supply	2
Hydropower	--
Recreation	1
Navigation	--
Historic Properties	--

Light gray shading denotes a beneficial impact greater than 1 when compared to the CWCP.
Black shading denotes an adverse impact greater than -1 when compared to the CWCP.
-- denotes not available or not applicable

Table 8.3-23. Fort Berthold Reservation impacts summary.

	Percent Change from CWCP
Wetland Habitat	--
Riparian Habitat	--
Riverine Tern and Plover Habitat	--
Lake Tern and Plover Habitat	38
Lake Young Fish Production	10
Lake Coldwater Fish Habitat	4
River Coldwater Fish Habitat	--
River Warmwater Fish Habitat	--
Native River Fish Physical Habitat	--
Flood Control	-47
Water Supply	6
Hydropower	--
Recreation	8
Navigation	--
Historic Properties	-3

Light gray shading denotes a beneficial impact greater than 1 when compared to the CWCP.
Black shading denotes an adverse impact greater than -1 when compared to the CWCP.
-- denotes not available or not applicable

Table 8.3-24. Standing Rock Reservation impacts summary.

	Percent Change from CWCP
Wetland Habitat	-62
Riparian Habitat	4
Riverine Tern and Plover Habitat	--
Lake Tern and Plover Habitat	4
Lake Young Fish Production	1
Lake Coldwater Fish Habitat	3
River Coldwater Fish Habitat	--
River Warmwater Fish Habitat	--
Native River Fish Physical Habitat	--
Flood Control	-5
Water Supply	15
Hydropower	--
Recreation	7
Navigation	--
Historic Properties	-1

Light gray shading denotes a beneficial impact greater than 1 when compared to the CWCP.
Black shading denotes an adverse impact greater than -1 when compared to the CWCP.
-- denotes not available or not applicable

Table 8.3-25. Cheyenne River Reservation impacts summary.

	Percent Change from CWCP
Wetland Habitat	-9
Riparian Habitat	-33
Riverine Tern and Plover Habitat	--
Lake Tern and Plover Habitat	4
Lake Young Fish Production	1
Lake Coldwater Fish Habitat	3
River Coldwater Fish Habitat	--
River Warmwater Fish Habitat	--
Native River Fish Physical Habitat	--
Flood Control	-17
Water Supply	-4
Hydropower	--
Recreation	0
Navigation	--
Historic Properties	-1

Light gray shading denotes a beneficial impact greater than 1 when compared to the CWCP.
Black shading denotes an adverse impact greater than -1 when compared to the CWCP.
-- denotes not available or not applicable

Table 8.3-26. Lower Brule Reservation impacts summary.

	Percent Change from CWCP
Wetland Habitat	--
Riparian Habitat	--
Riverine Tern and Plover Habitat	--
Lake Tern and Plover Habitat	--
Lake Young Fish Production	7
Lake Coldwater Fish Habitat	--
River Coldwater Fish Habitat	--
River Warmwater Fish Habitat	--
Native River Fish Physical Habitat	--
Flood Control	31
Water Supply	0
Hydropower	--
Recreation	0
Navigation	--
Historic Properties	0

Light gray shading denotes a beneficial impact greater than 1 when compared to the CWCP.
Black shading denotes an adverse impact greater than -1 when compared to the CWCP.
-- denotes not available or not applicable

Table 8.3-27. Crow Creek Reservation impacts summary.

	Percent Change from CWCP
Wetland Habitat	--
Riparian Habitat	--
Riverine Tern and Plover Habitat	--
Lake Tern and Plover Habitat	--
Lake Young Fish Production	7
Lake Coldwater Fish Habitat	--
River Coldwater Fish Habitat	--
River Warmwater Fish Habitat	--
Native River Fish Physical Habitat	--
Flood Control	38
Water Supply	0
Hydropower	--
Recreation	0
Navigation	--
Historic Properties	0

Light gray shading denotes a beneficial impact greater than 1 when compared to the CWCP.
Black shading denotes an adverse impact greater than -1 when compared to the CWCP.
-- denotes not available or not applicable

Table 8.3-28. Yankton Reservation impacts summary.

	Percent Change from CWCP
Wetland Habitat	5
Riparian Habitat	-4
Riverine Tern and Plover Habitat	2
Lake Tern and Plover Habitat	--
Lake Young Fish Production	8
Lake Coldwater Fish Habitat	--
River Coldwater Fish Habitat	--
River Warmwater Fish Habitat	-3
Native River Fish Physical Habitat	0
Flood Control	0
Water Supply	0
Hydropower	--
Recreation	0
Navigation	--
Historic Properties	--

Light gray shading denotes a beneficial impact greater than 1 when compared to the CWCP.
Black shading denotes an adverse impact greater than -1 when compared to the CWCP.
-- denotes not available or not applicable

Table 8.3-29. Ponca Tribal Lands impacts summary.

	Percent Change from CWCP
Wetland Habitat	0
Riparian Habitat	-2
Riverine Tern and Plover Habitat	2
Lake Tern and Plover Habitat	--
Lake Young Fish Production	--
Lake Coldwater Fish Habitat	--
River Coldwater Fish Habitat	--
River Warmwater Fish Habitat	-3
Native River Fish Physical Habitat	0
Flood Control	0
Water Supply	--
Hydropower	--
Recreation	0
Navigation	--
Historic Properties	--

Light gray shading denotes a beneficial impact greater than 1 when compared to the CWCP.
Black shading denotes an adverse impact greater than -1 when compared to the CWCP.
-- denotes not available or not applicable

Table 8.3-30. Santee Reservation impacts summary.

	Percent Change from CWCP
Wetland Habitat	0
Riparian Habitat	-2
Riverine Tern and Plover Habitat	2
Lake Tern and Plover Habitat	--
Lake Young Fish Production	33
Lake Coldwater Fish Habitat	--
River Coldwater Fish Habitat	--
River Warmwater Fish Habitat	--
Native River Fish Physical Habitat	--
Flood Control	0
Water Supply	2
Hydropower	--
Recreation	2
Navigation	--
Historic Properties	--

Light gray shading denotes a beneficial impact greater than 1 when compared to the CWCP.
Black shading denotes an adverse impact greater than -1 when compared to the CWCP.
-- denotes not available or not applicable

Table 8.3-31. Winnebago Reservation impacts summary.

	Percent Change from CWCP
Wetland Habitat	-2
Riparian Habitat	-2
Riverine Tern and Plover Habitat	--
Lake Tern and Plover Habitat	--
Lake Young Fish Production	--
Lake Coldwater Fish Habitat	--
River Coldwater Fish Habitat	--
River Warmwater Fish Habitat	--
Native River Fish Physical Habitat	0
Flood Control	0
Water Supply	-11
Hydropower	--
Recreation	0
Navigation	--
Historic Properties	--

Light gray shading denotes a beneficial impact greater than 1 when compared to the CWCP.
Black shading denotes an adverse impact greater than -1 when compared to the CWCP.
-- denotes not available or not applicable

Table 8.3-32. Omaha Reservation impacts summary.

	Percent Change from CWCP
Wetland Habitat	-2
Riparian Habitat	-2
Lake Tern and Plover Habitat	--
Lake Young Fish Production	--
Lake Young Fish Production	--
Reservoir Coldwater Fish Habitat	--
River Coldwater Fish Habitat	--
River Warmwater Fish Habitat	--
Native River Fish Physical Habitat	0
Flood Control	0
Water Supply	-11
Hydropower	--
Recreation	0
Navigation	--
Historic Properties	--

Light gray shading denotes a beneficial impact greater than 1 when compared to the CWCP.
Black shading denotes an adverse impact greater than -1 when compared to the CWCP.
-- denotes not available or not applicable

Table 8.3-33. Iowa and Sac and Fox Reservations impacts summary.

	Percent Change from CWCP
Wetland Habitat	7
Riparian Habitat	-4
Lake Tern and Plover Habitat	--
Lake Young Fish Production	--
Lake Young Fish Production	--
Reservoir Coldwater Fish Habitat	--
River Coldwater Fish Habitat	--
River Warmwater Fish Habitat	--
Native River Fish Physical Habitat	-1
Flood Control	0
Water Supply	--
Hydropower	--
Recreation	0
Navigation	--
Historic Properties	--

Light gray shading denotes a beneficial impact greater than 1 when compared to the CWCP.
Black shading denotes an adverse impact greater than -1 when compared to the CWCP.
-- denotes not available or not applicable

Individual numbers for each use/resource in the tables are computed by taking the value for the PA, subtracting the CWCP value for that specific use or resource for that Reservation from it, dividing the difference by the CWCP value, and then multiplying by 100 to get the percent change from the CWCP value. If the PA increases the value from the CWCP, the percent change presented in the table is positive. If the value decreases relative to the CWCP, the percent change is negative. The reader is asked to focus attention on the "significant" changes. Significant positive changes are those greater than a +1 percent and are shaded a light gray. Significant negative changes are greater than -1 percent and are shaded black with white lettering. A change of +1 represents changes up to 1.49 percent more than, or 101.49 percent of, the CWCP value due to rounding. Similarly, a -1 represents a change up to 1.49 percent less than, or 98.51 percent of, the CWCP value.

Caution must be used when focusing on the shaded percent changes because a resource may have a special meaning to those on one or more of the Reservations, and an "insignificant" change (+1, 0, or -1 in the tables) may be an important change to those on that Reservation. If one of the resources or uses falls into that category for those associated with that Reservation, those individuals are encouraged to note whether the change is slightly positive (+1), no change (0), or slightly negative (-1). A double dash (--) indicates data were not available for that resource or use for that Reservation or that resource or use is not applicable to the reach in which the Reservation is located. Readers are encouraged to review the table/s of interest and to make their own "value" judgements.

Summary of Impacts of the PA

The individual sections of this chapter discuss the impacts to the various resources and uses analyzed for the Study. Readers of this EIS are encouraged to consider the relative differences in impacts among the alternatives, not the absolute values presented for the various resources or uses. This section of Chapter 8 summarizes the impacts into a single table.

Table 8.3-34 presents the summary of impacts for the PA. The order of the listing of the resources and uses corresponds with the order they are presented in this chapter to make it easier to refer back to the individual sections for more information on an individual resource or use. Individual numbers for each use/resource in the tables are computed by taking the average annual value of the

Table 8.3-34. Impacts Summary for the PA.

	Percent Change From CWCP
Missouri River	
Wetland Habitat	1
Riparian Habitat	0
Riverine Tern and Plover Habitat	38
Lake Tern and Plover Habitat	24
Lake Young Fish Production	7
Lake Coldwater Fish Habitat	4
River Coldwater Fish Habitat	1
River Warmwater Fish Habitat	-5
Native River Fish Physical Habitat	0
Flood Control	0
Water Supply	0
Hydropower	1
Recreation	3
Missouri River Navigation	6
Historic Properties	-2
Mississippi River	
Lost Navigation Efficiency	0

Light gray shading denotes a beneficial impact greater than 1 when compared to the CWCP.
Black shading denotes an adverse impact greater than -1 when compared to the CWCP.

PA, subtracting the CWCP value for that specific use or resource from it, and dividing the difference by the CWCP value and then multiplying by 100 to get the percent change from the CWCP value. If the PA increases the value from the CWCP, the percent change presented in the table is positive. If the value decreases relative to the CWCP, the percent change is negative. The reader is asked to focus attention on the "significant" changes of greater than a plus or minus 1 percent. Positive changes greater than 1 are shaded a light gray. Negative changes greater than -1 are shaded black with white lettering. (Note: A change of +1 represents changes up to 1.49 percent more than, or 101.49 percent of, the CWCP value due to rounding. Similarly, a -1 represents a change up to 1.49 percent less than, or 98.51 percent of, the value for the CWCP.)

Caution must be used when focusing on the shaded percent changes because a resource may have a special meaning to an individual, and an "insignificant" change (+1, 0, or -1 in the tables) may be an important change to that person. Those individuals that situation applies to are encouraged to note whether the change is slightly positive (+1), no change (0), or slightly negative (-1). Readers are encouraged to review the table and to make their own "value" judgements.

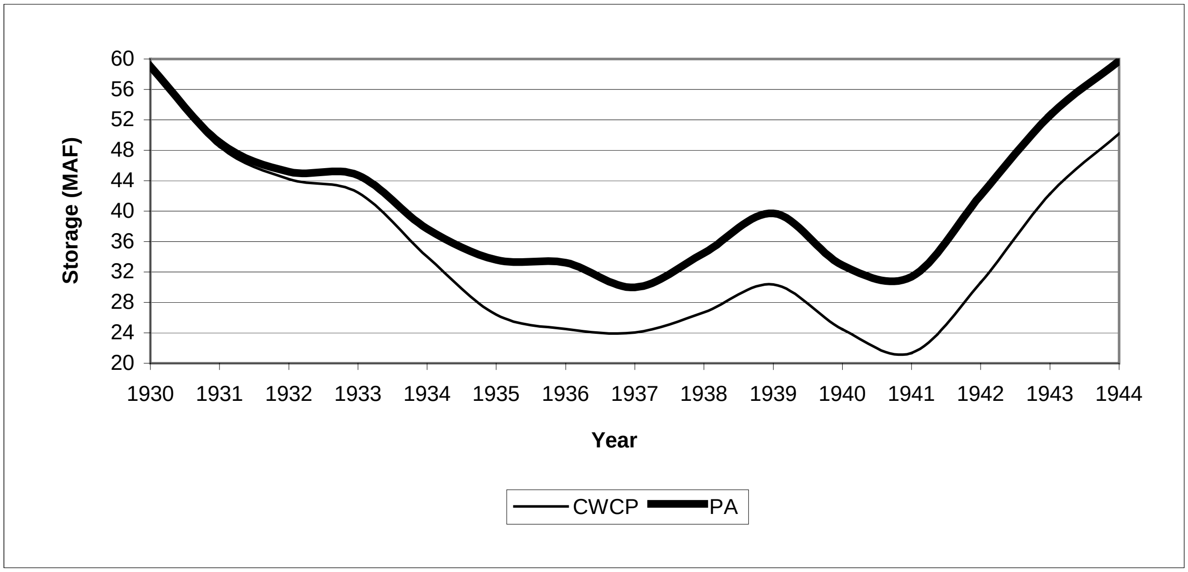

Figure 8.3-1. End-of-June Mainstem Reservoir System storage, 1931 to 1941 drought.

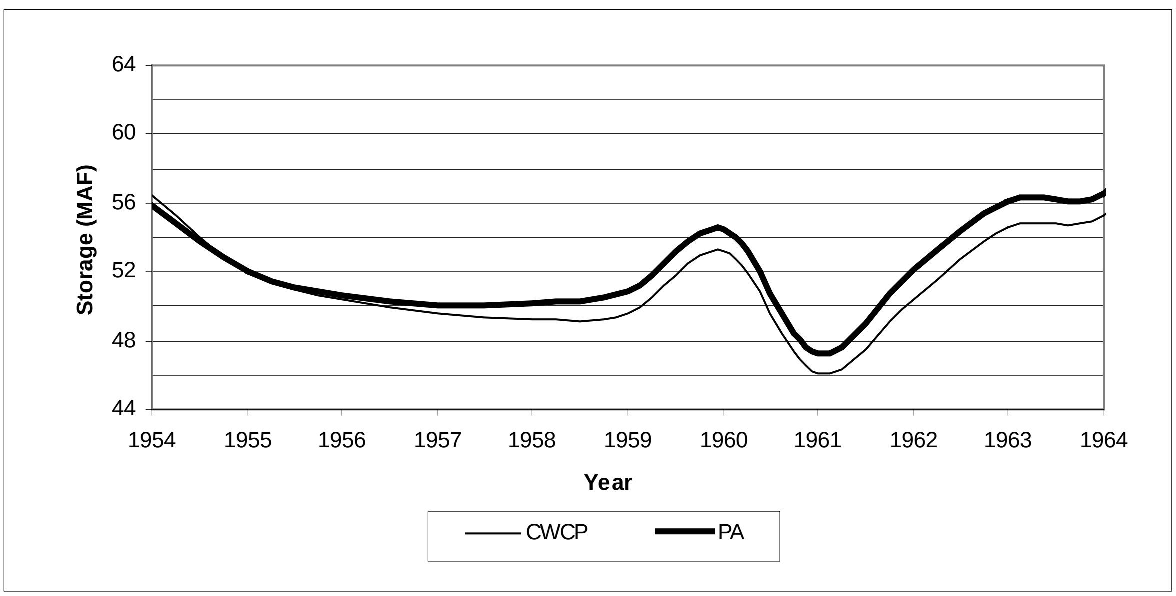

Figure 8.3-2. End-of-June Mainstem Reservoir System storage, 1954 to 1961 drought.

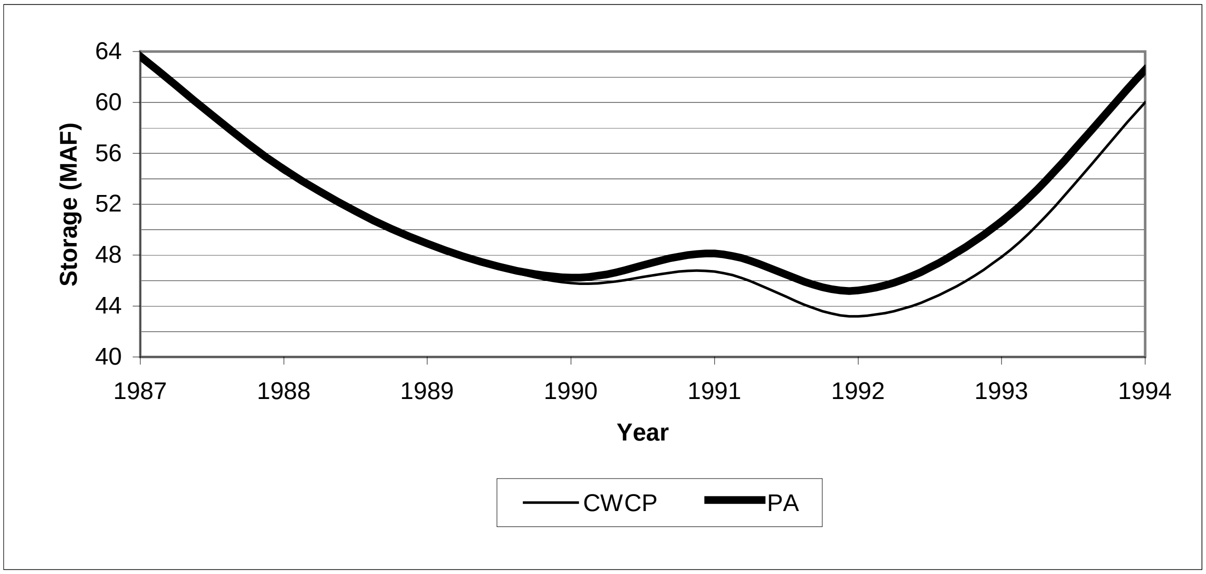

Figure 8.3-3. End-of-June Mainstem Reservoir System storage, 1987 to 1993 drought.

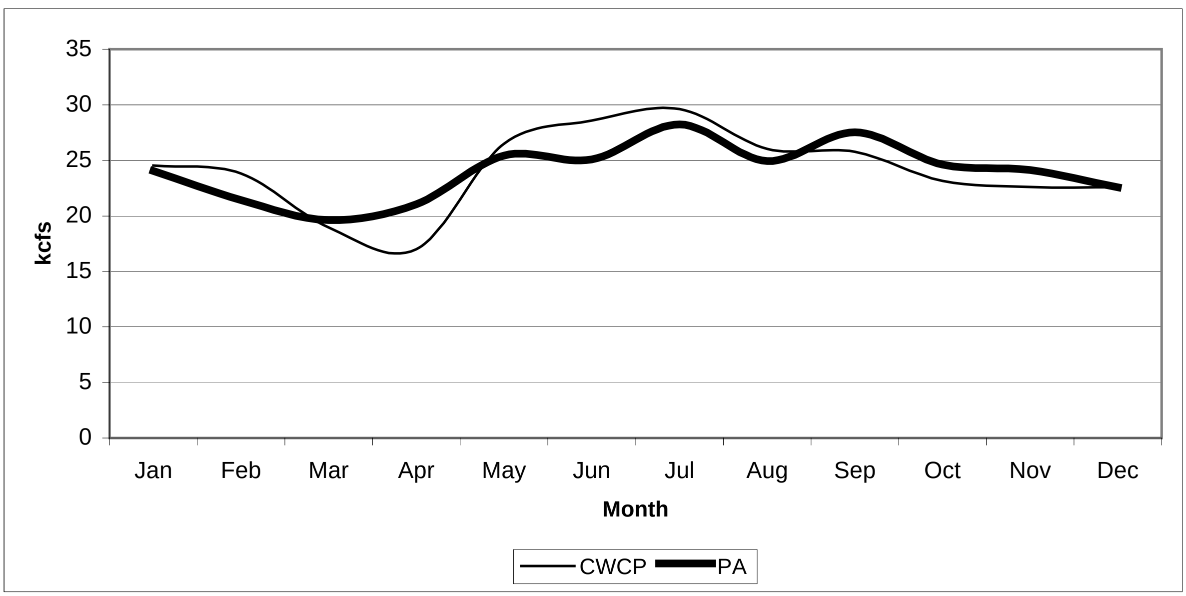

Figure 8.3-4. Comparison of the average monthly flows at Bismarck, North Dakota.

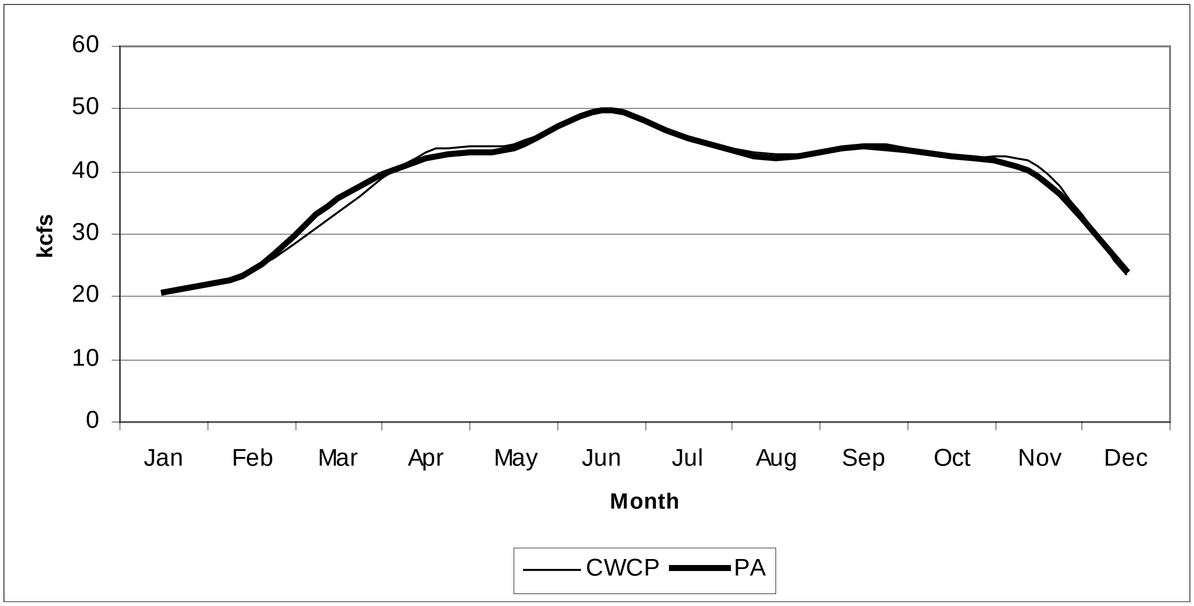

Figure 8.3-5. Comparison of average monthly flows at Nebraska City, Nebraska.

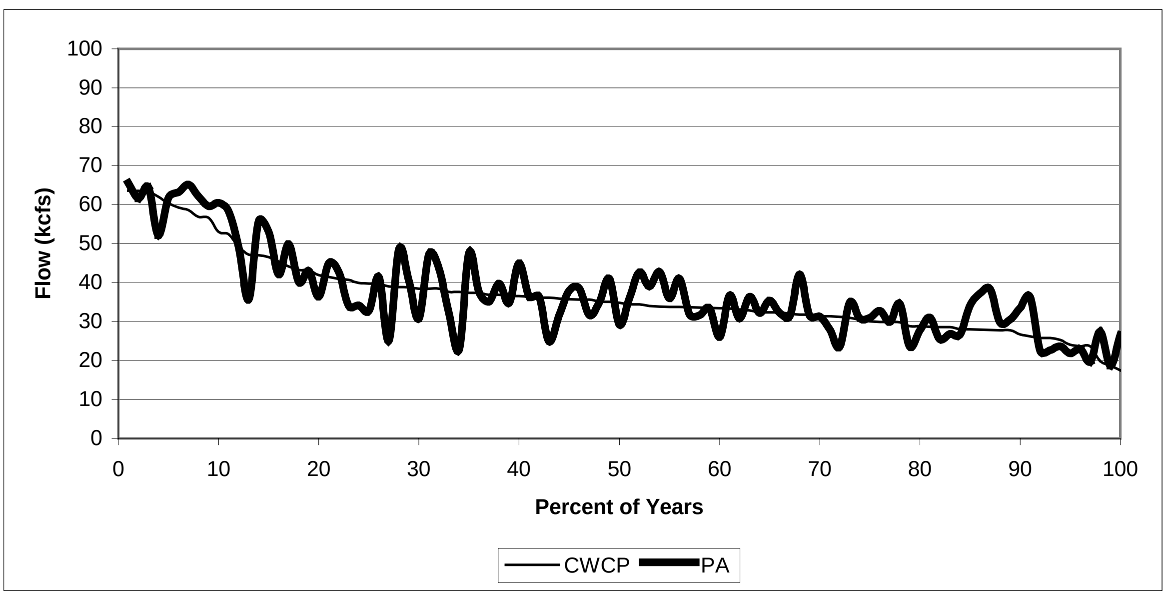

Figure 8.3-6. Comparison of annual maximum flows at Bismarck, North Dakota.

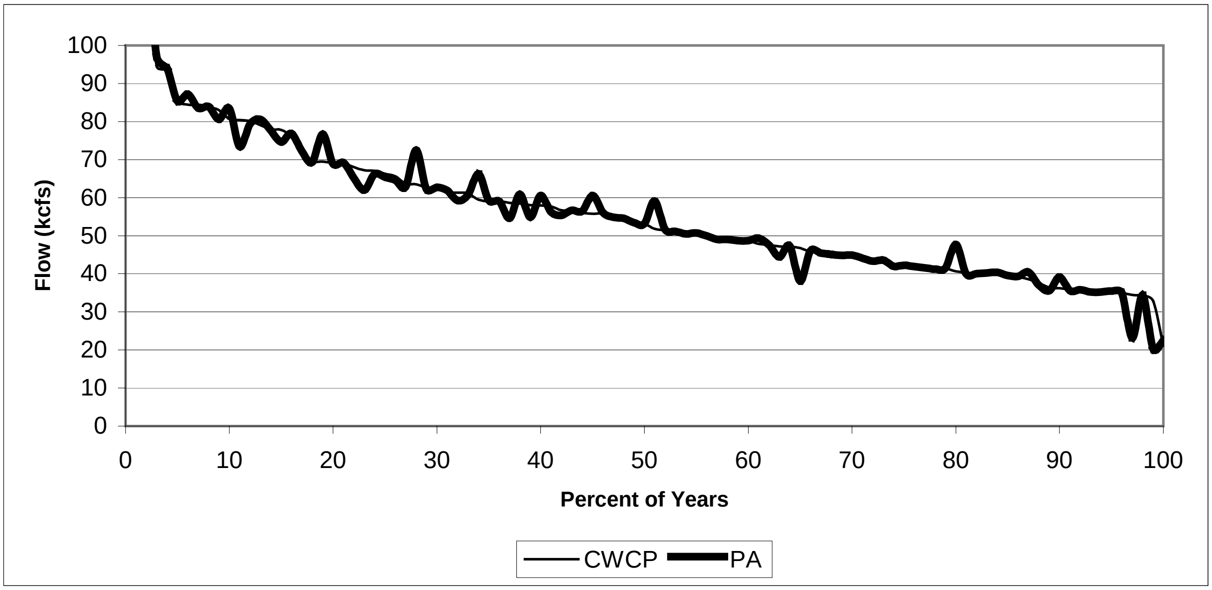

Figure 8.3-7. Comparison of annual maximum flows at Nebraska City, Nebraska.

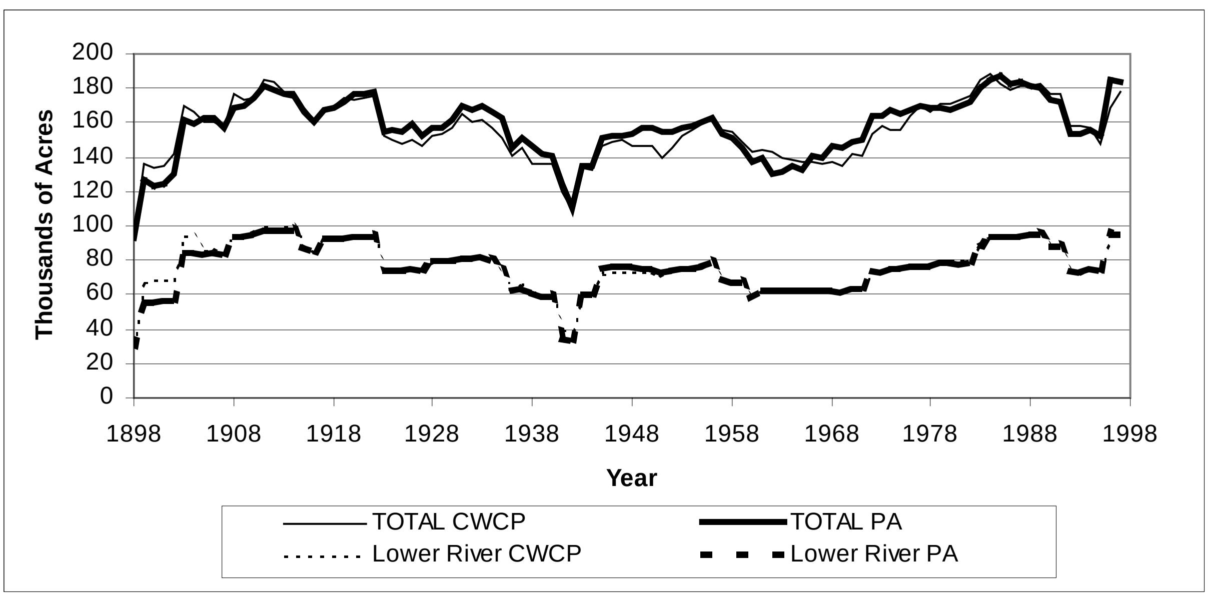

Figure 8.3-8. Annual wetland habitat acreages for all of the sites and only the Lower River sites (thousands of acres).

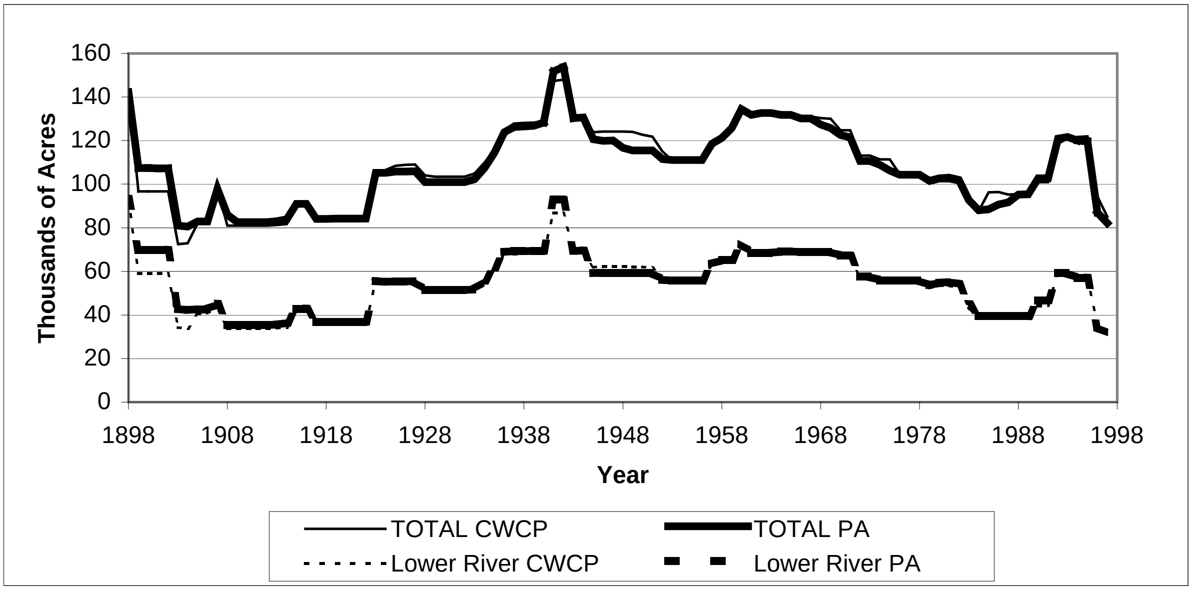

Figure 8.3-9. Annual riparian habitat acreages for all of the sites and only the Lower River sites (thousands of acres).

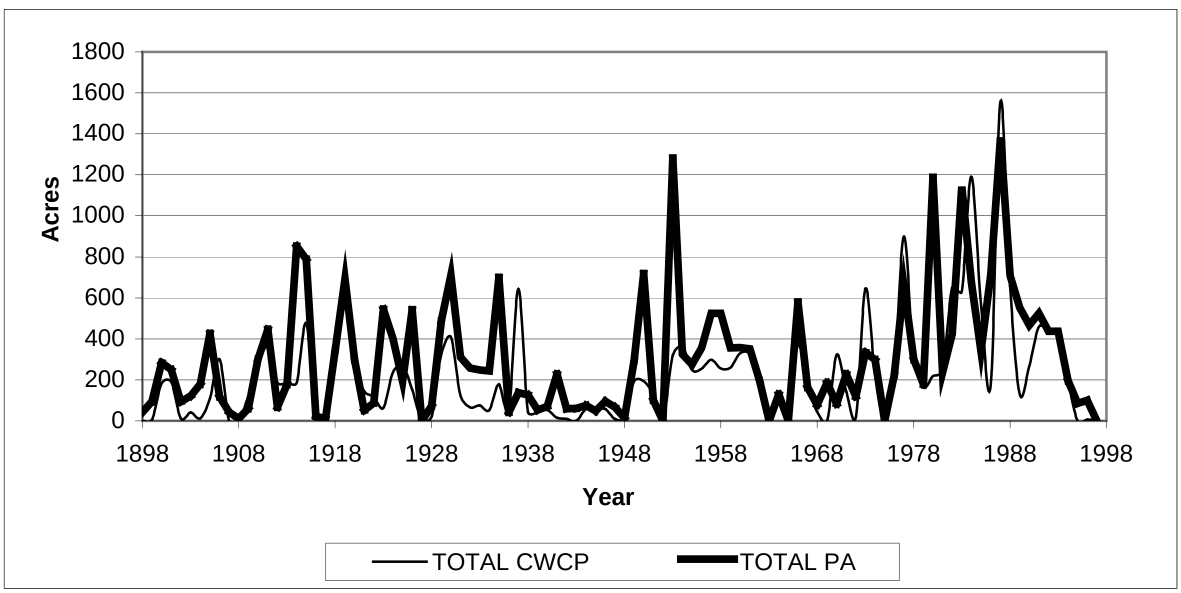

Figure 8.3-10. Annual total riverine tern and plover habitat (acres).

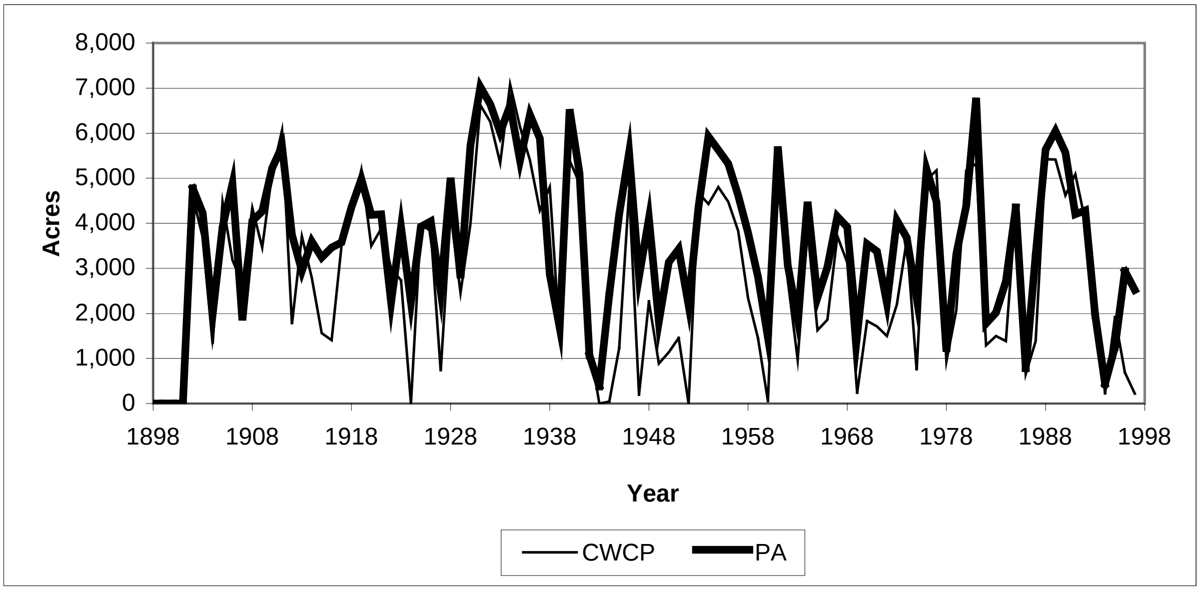

Figure 8.3-11. Annual lake tern and plover habitat (acres).

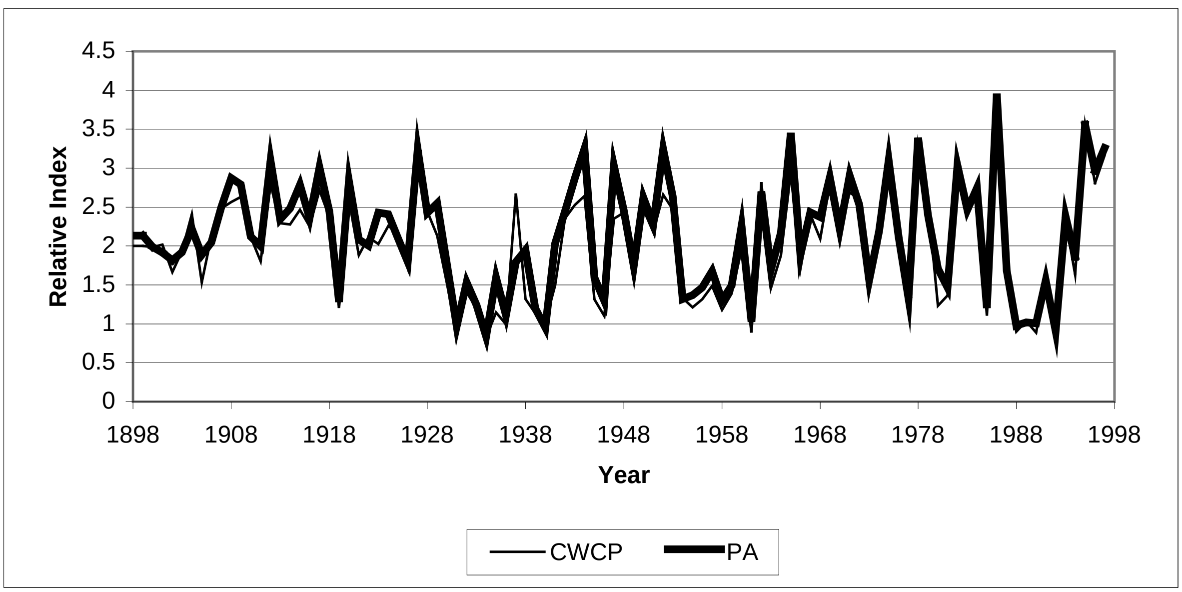

Figure 8.3-12. Annual total young fish production in the lakes (index).

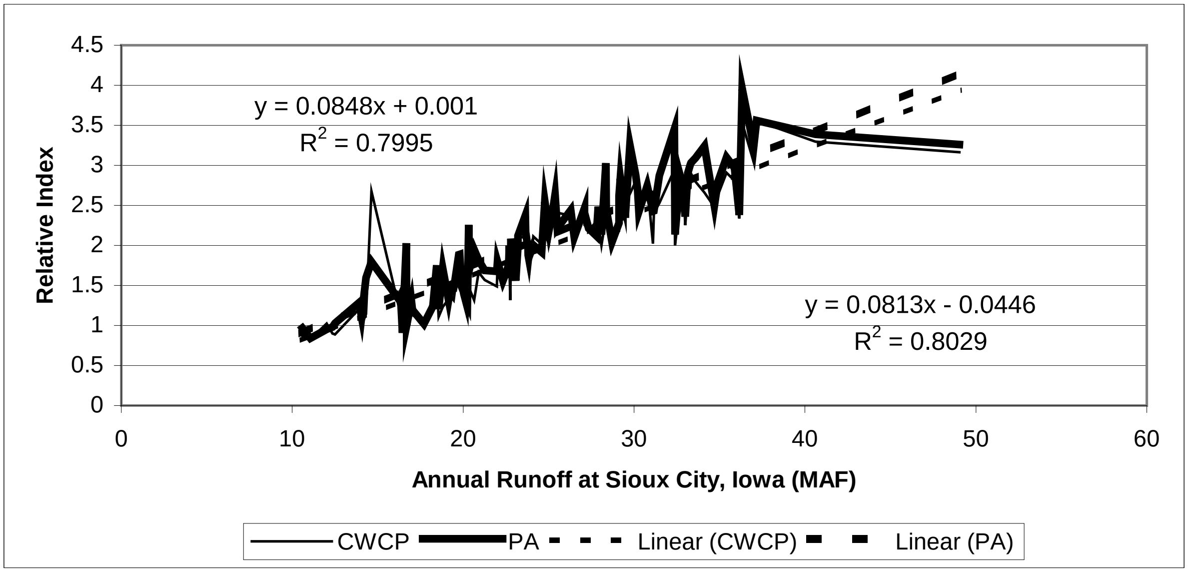

Figure 8.3-13. Correlation plot of the young fish production index value versus annual runoff.

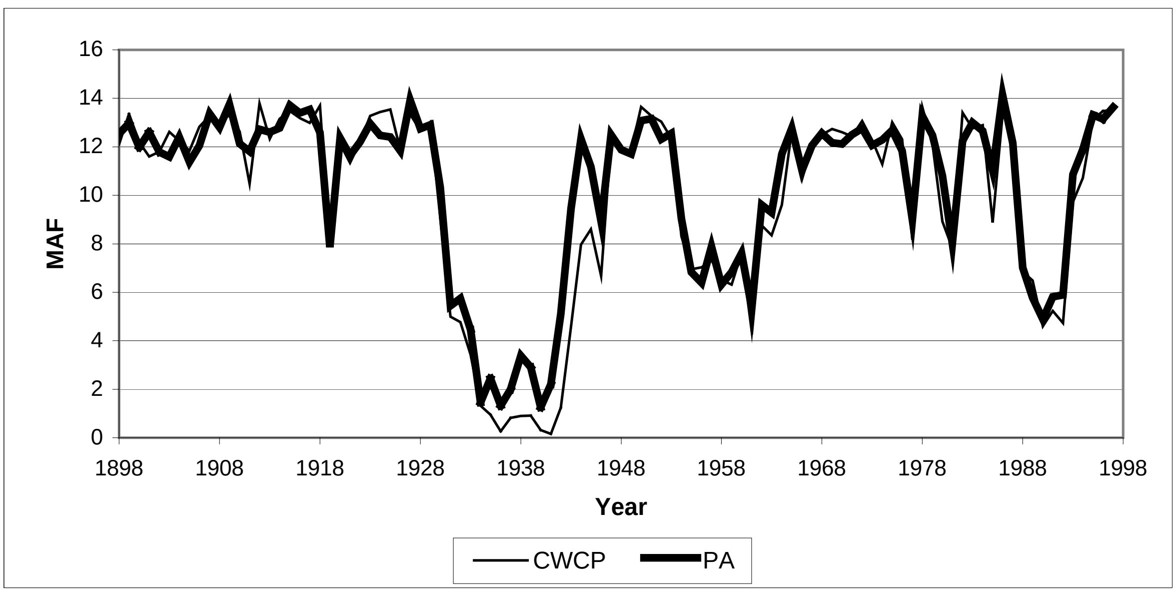

Figure 8.3-14. Annual total coldwater fish habitat in the lakes (MAF).

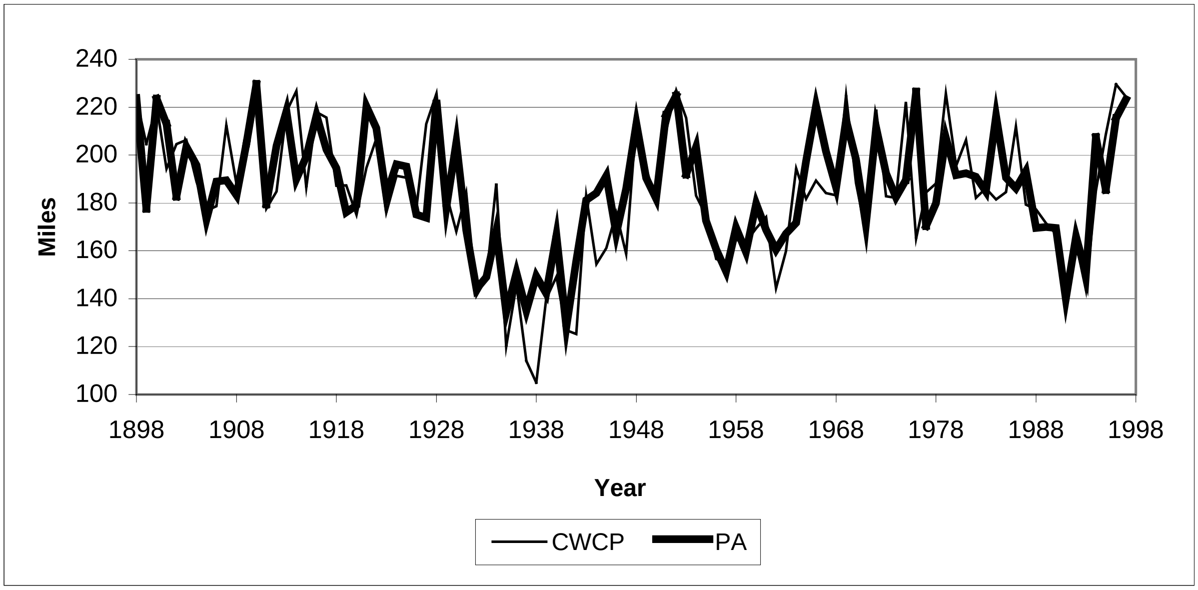

Figure 8.3-15. Annual total coldwater fish habitat in the river reaches (miles).

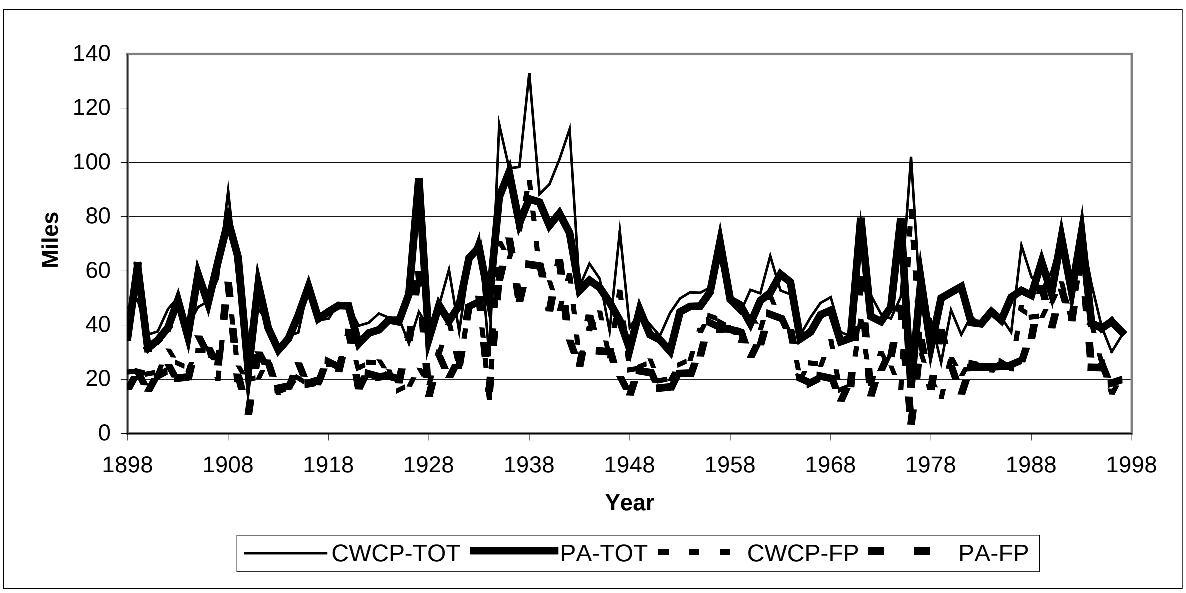

Figure 8.3-16. Annual total and Fort Peck reach warmwater fish habitat in the river reaches (miles).

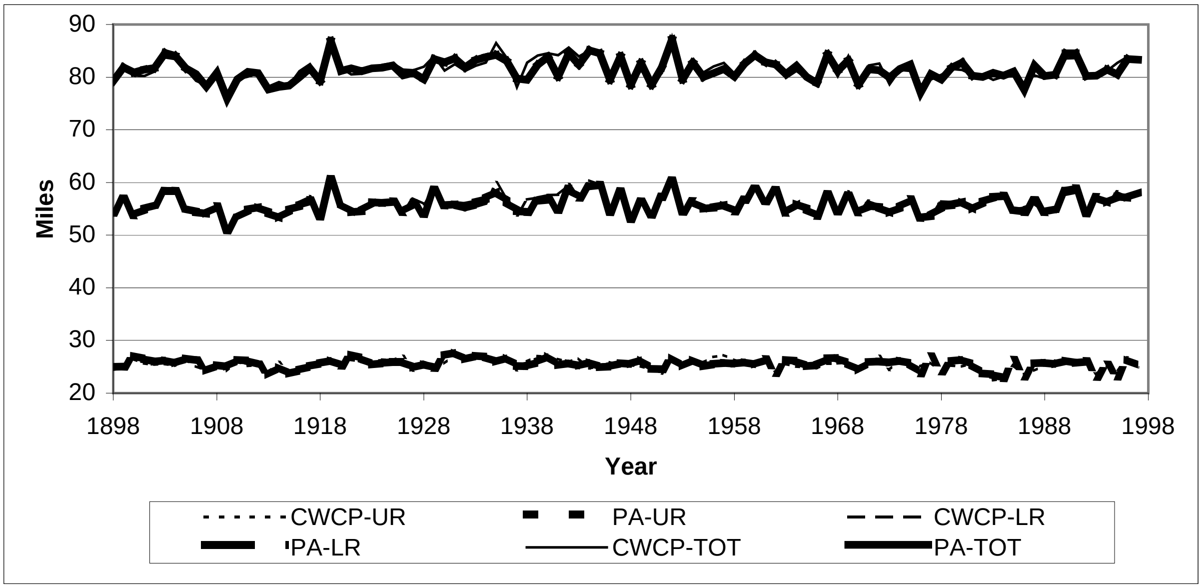

Figure 8.3-17. Annual physical habitat index values for all reaches, the three Upper River reaches, and the six Lower River reaches (miles).

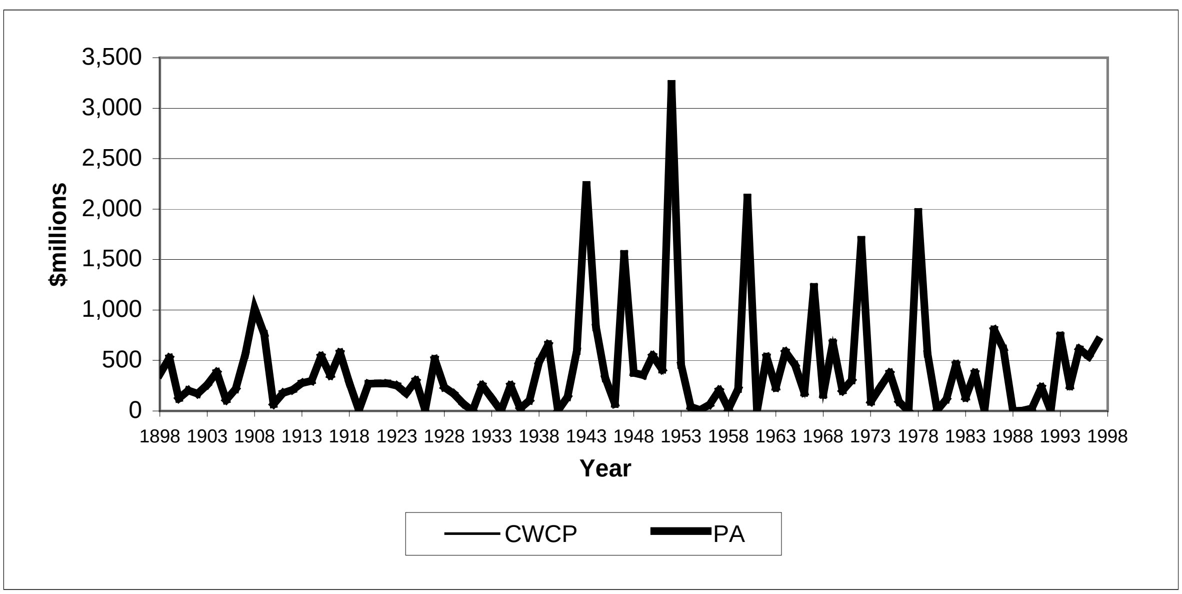

Figure 8.3-18. Annual flood control benefits ($millions).

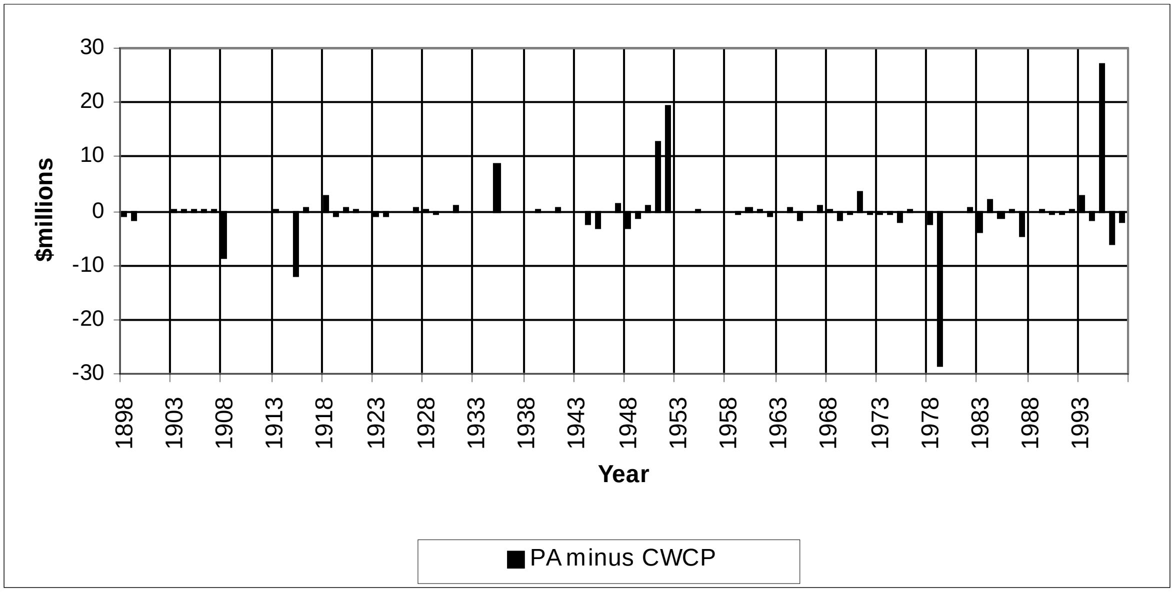

Figure 8.3-19. Differences in the annual flood control benefits between the PA and CWCP ($millions).

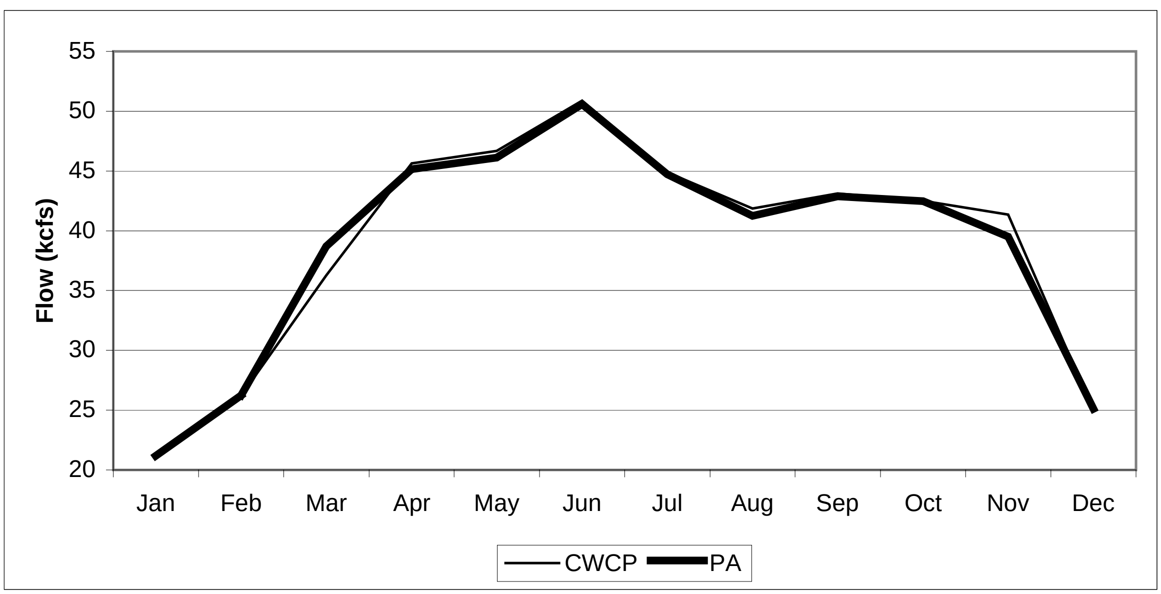

Figure 8.3-20. Average monthly flow at Nebraska City, Nebraska for the interior drainage modeling period of 1950 to 1994.

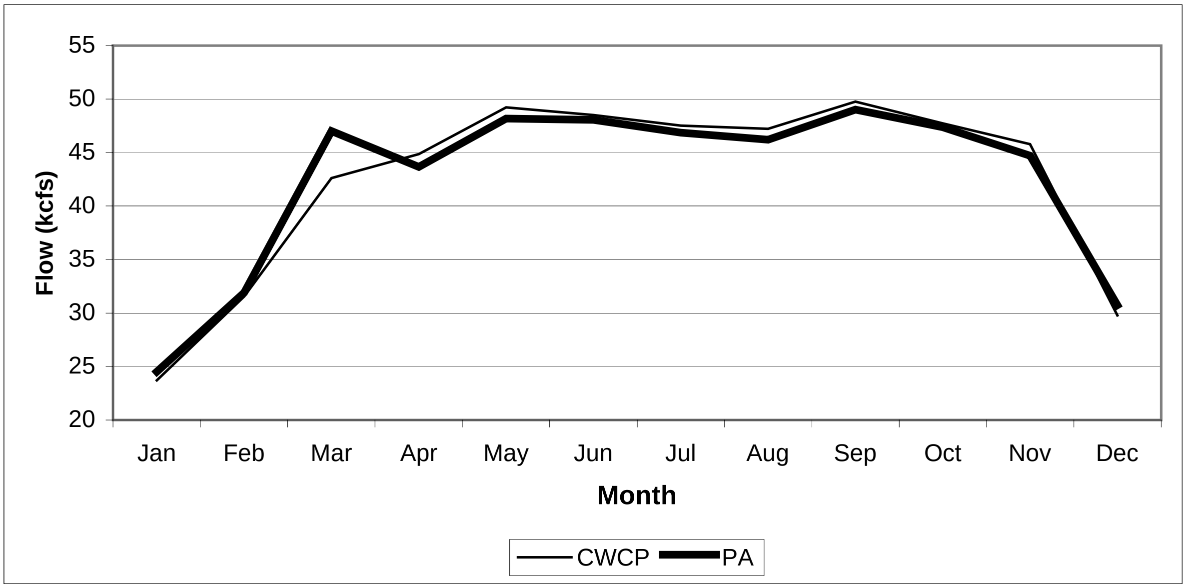

Figure 8.3-21. Average monthly flow at Nebraska City, Nebraska for the groundwater modeling period of 1970 to 1979.

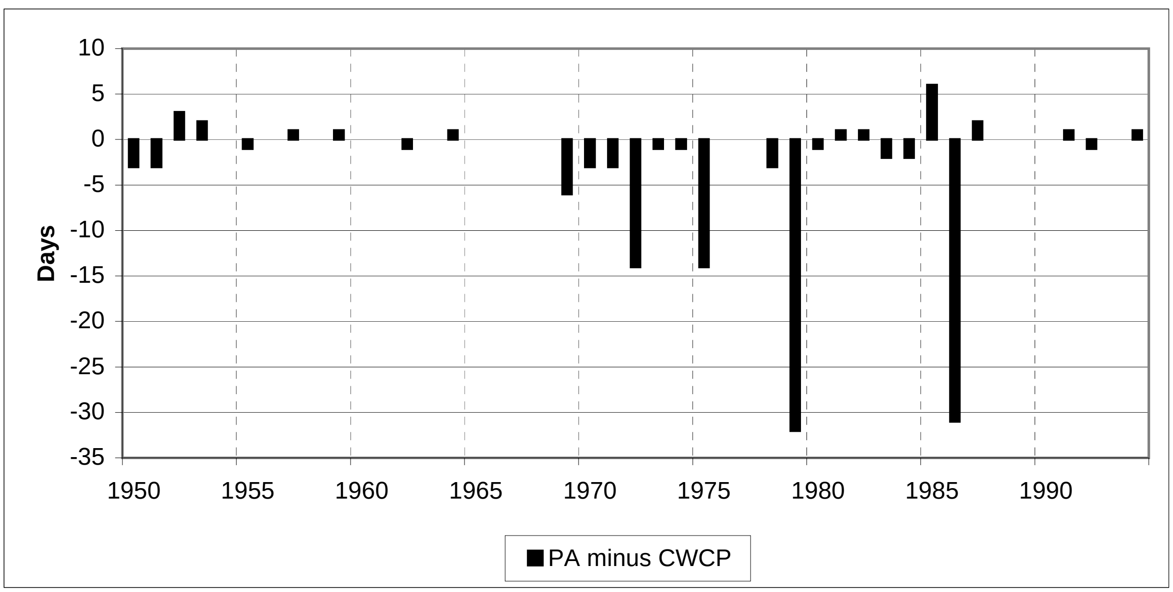

Figure 8.3-22. Difference in the number of days between the PA and CWCP that the flow at Nebraska City exceeds 50 kcfs for the 45-year interior drainage modeling period (1950-1994).

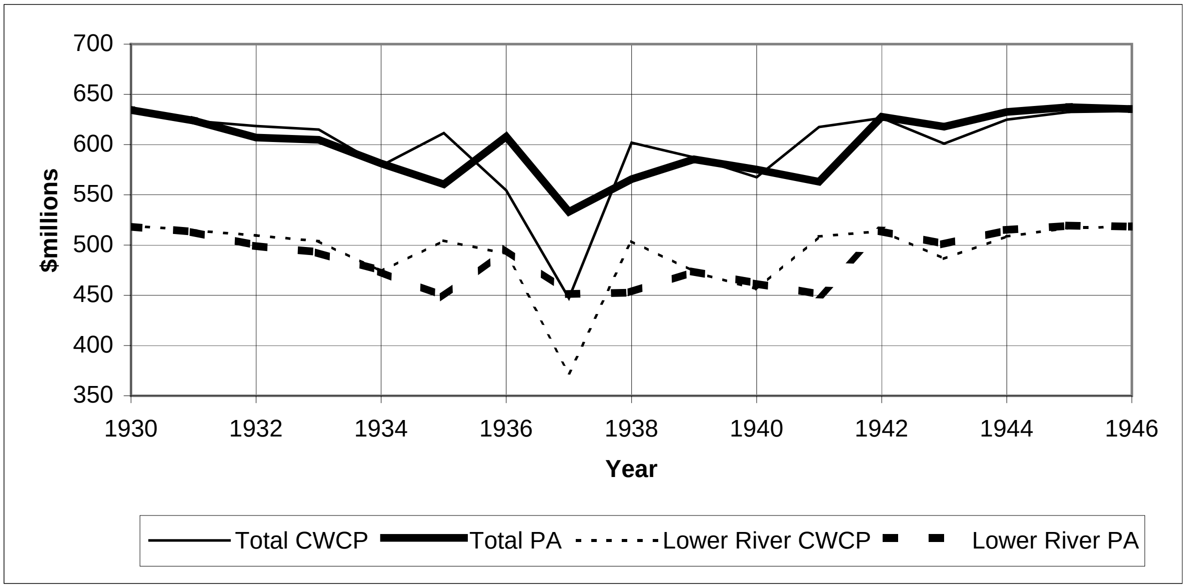

Figure 8.3-23. Annual water supply benefits (1930-1946) ($millions).

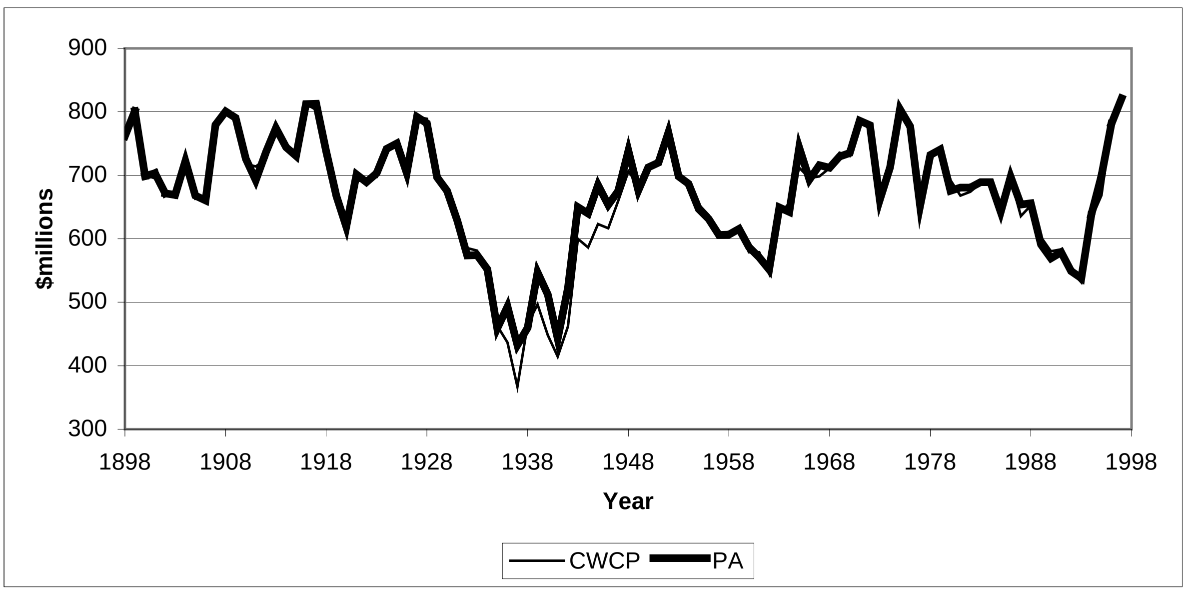

Figure 8.3-24. Annual hydropower benefits ($millions).

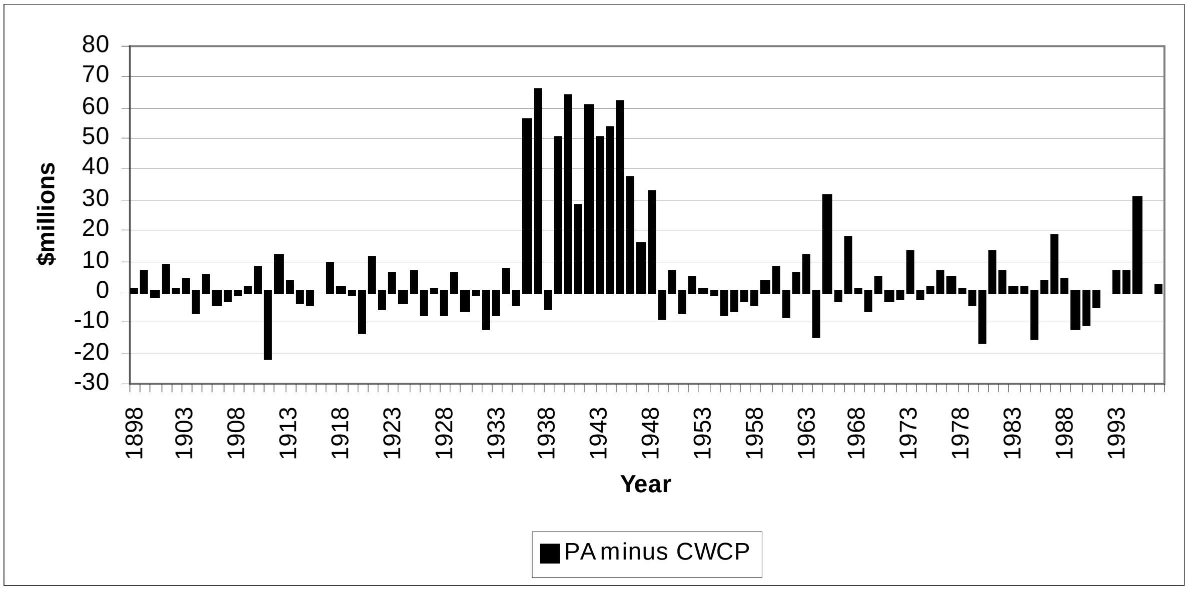

Figure 8.3-25. Difference in the annual hydropower benefits between the PA and CWCP ($millions).

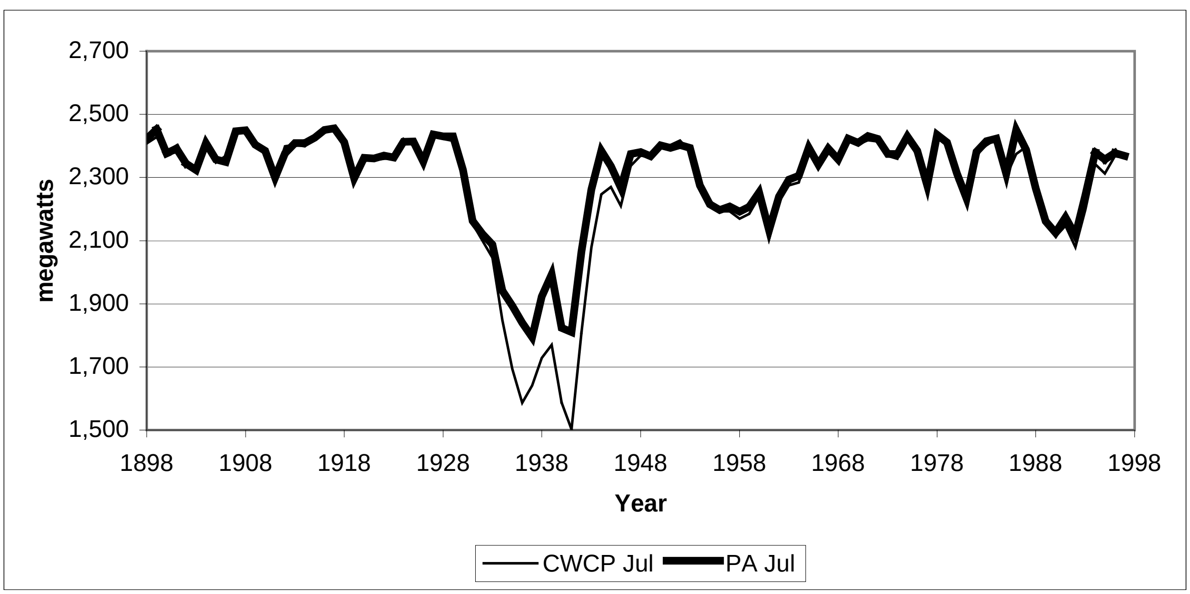

Figure 8.3-26. Annual average monthly July hydropower capacity.

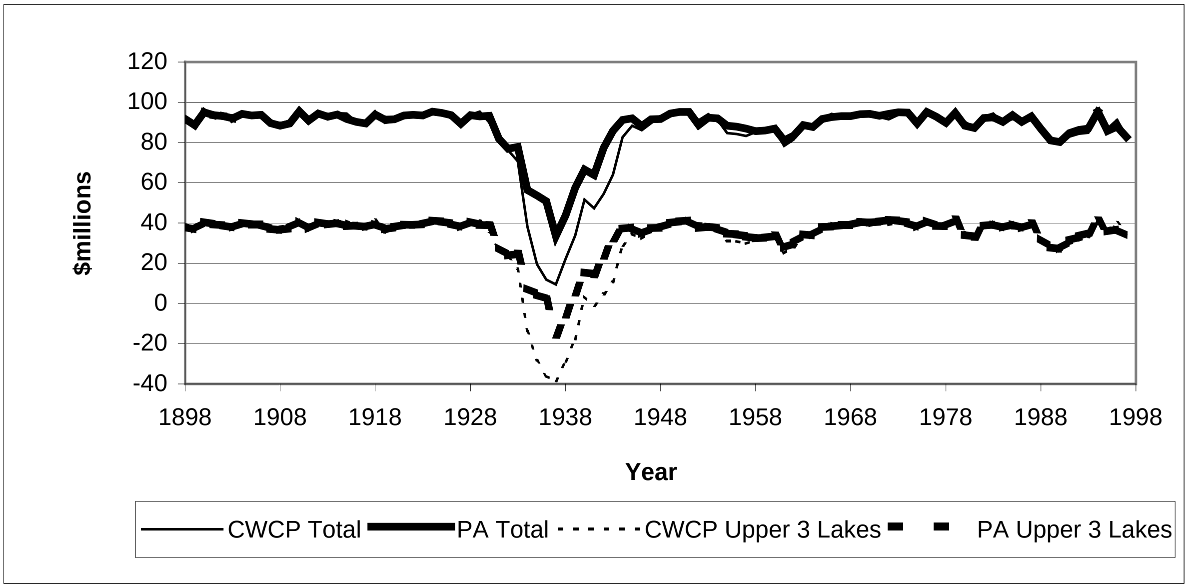

Figure 8.3-27. Annual total and upper three lakes recreation benefits ($millions).

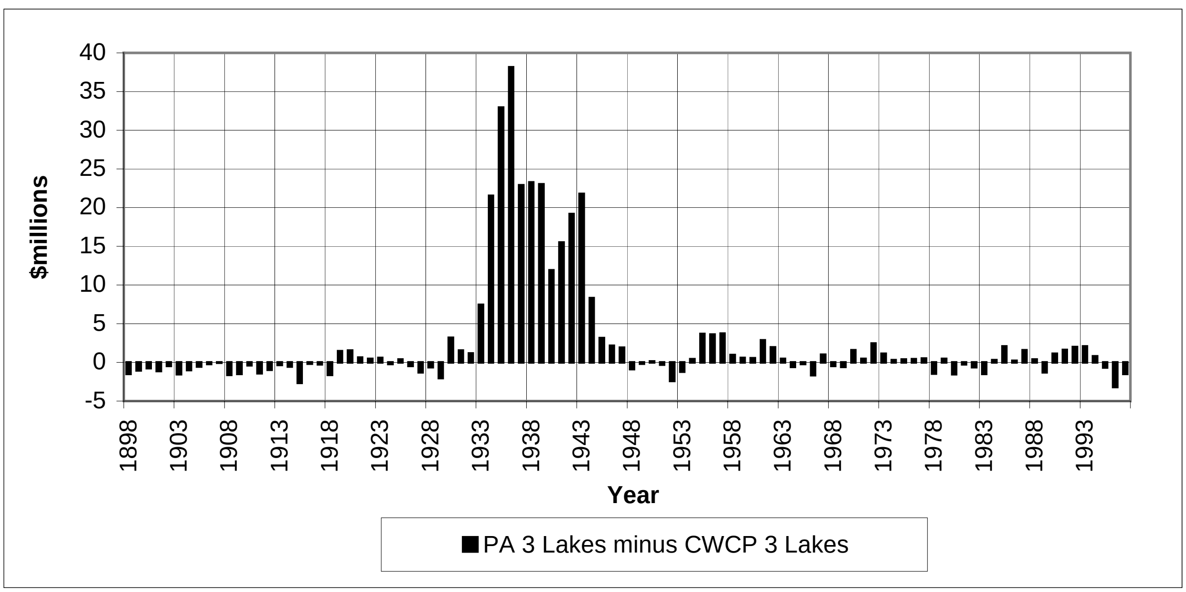

Figure 8.3-28. Annual recreation benefit changes provided by the PA to the upper three lake, as compared to the benefits of the CWCP ($millions).

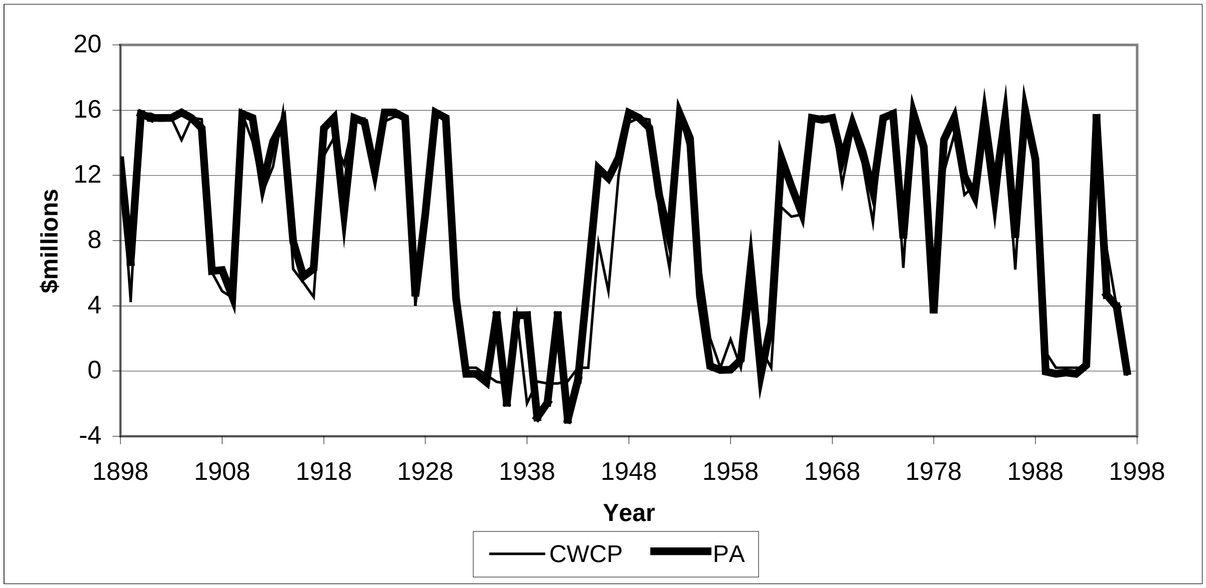

Figure 8.3-29. Annual Missouri River navigation benefits ($millions).

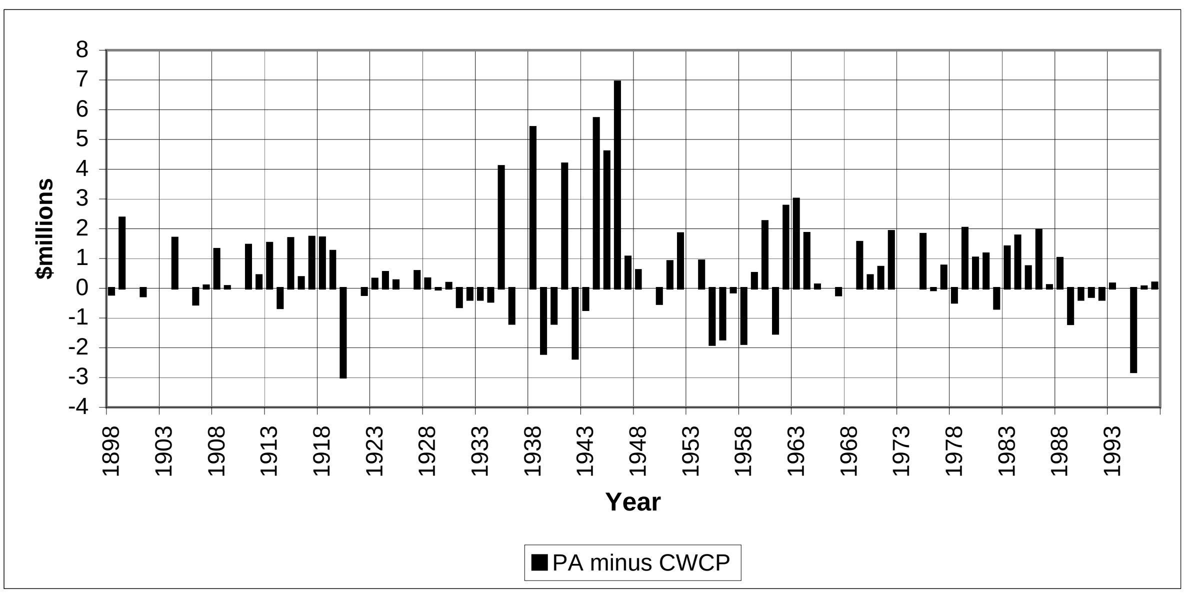

Figure 8.3-30. Change in navigation benefits provided by the PA compared to the CWCP ($millions).

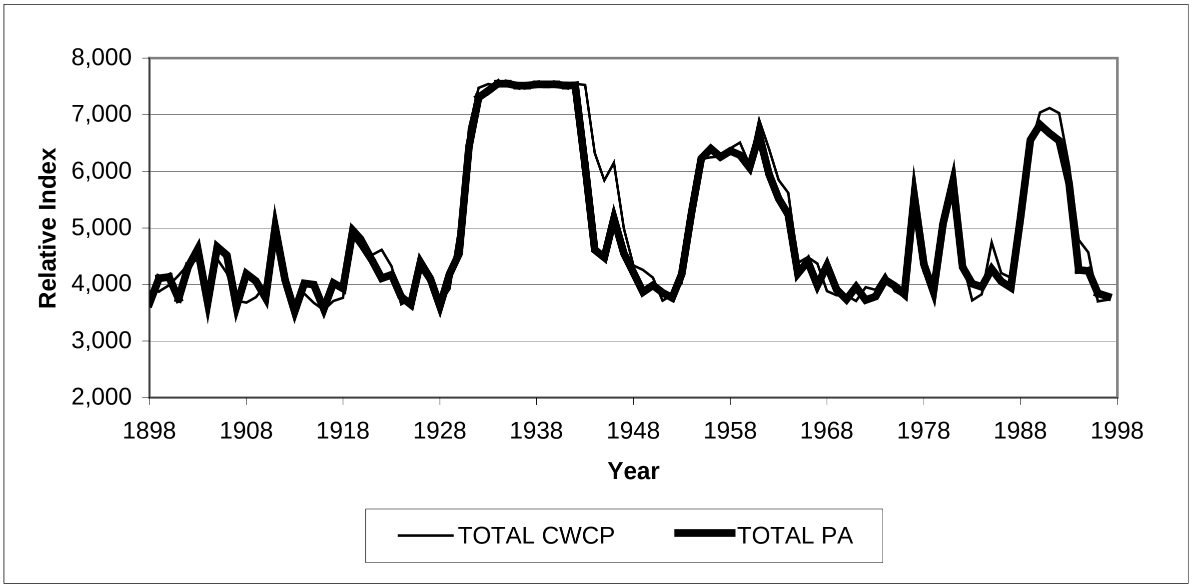

Figure 8.3-31. Average annual index values for historic properties.

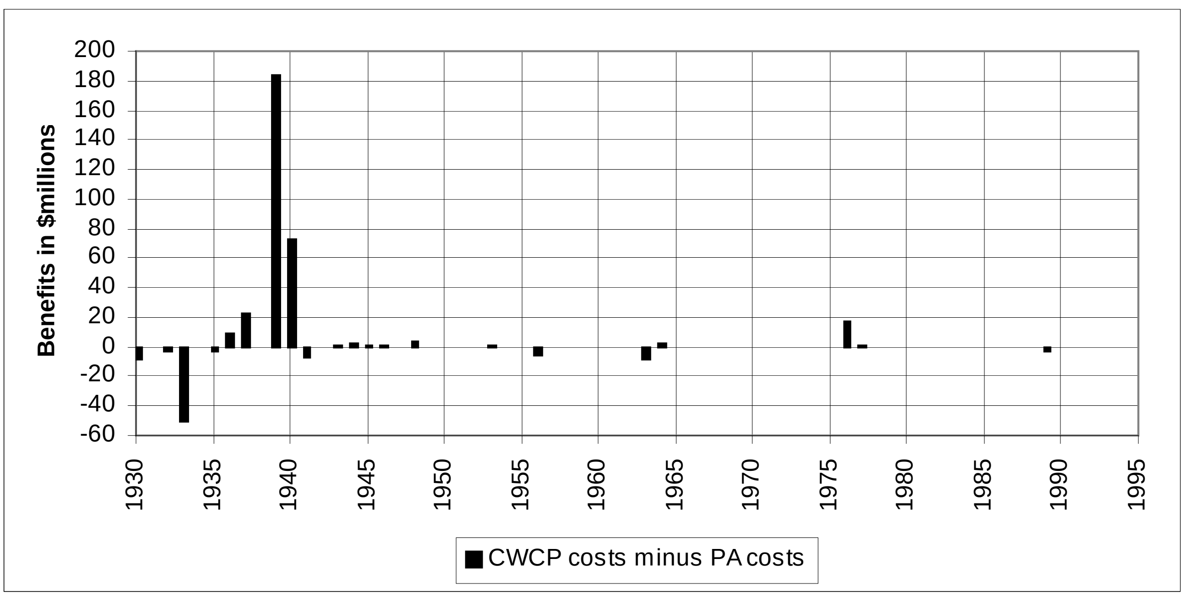

Figure 8.3-32. Relative difference between the PA and the CWCP historic properties index values.

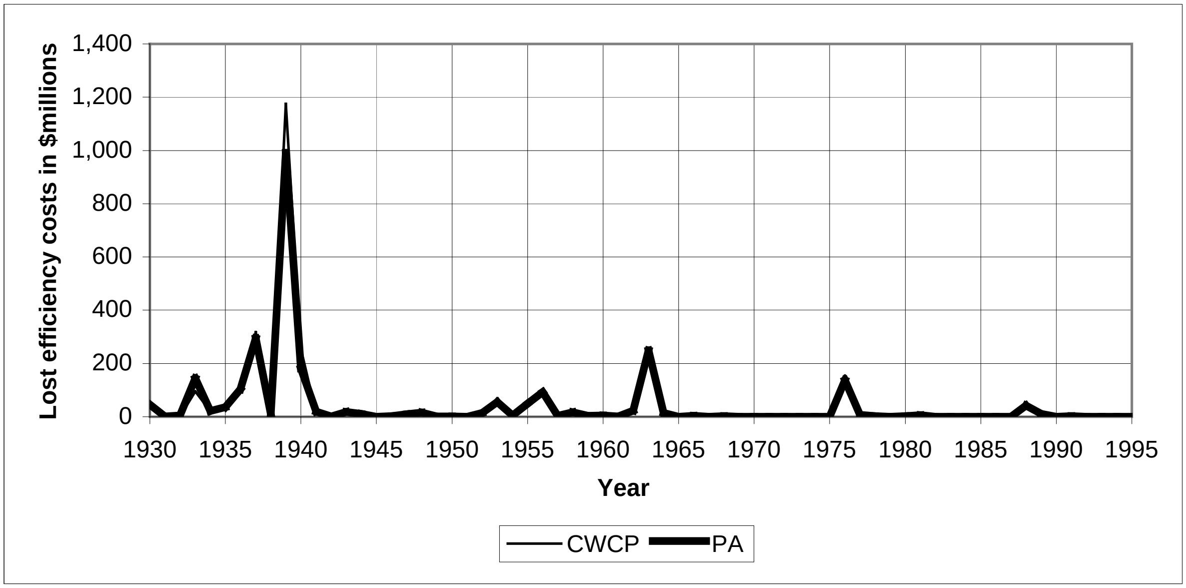

Figure 8.3-33. Annual Mississippi River lost navigation inefficiency costs ($millions).

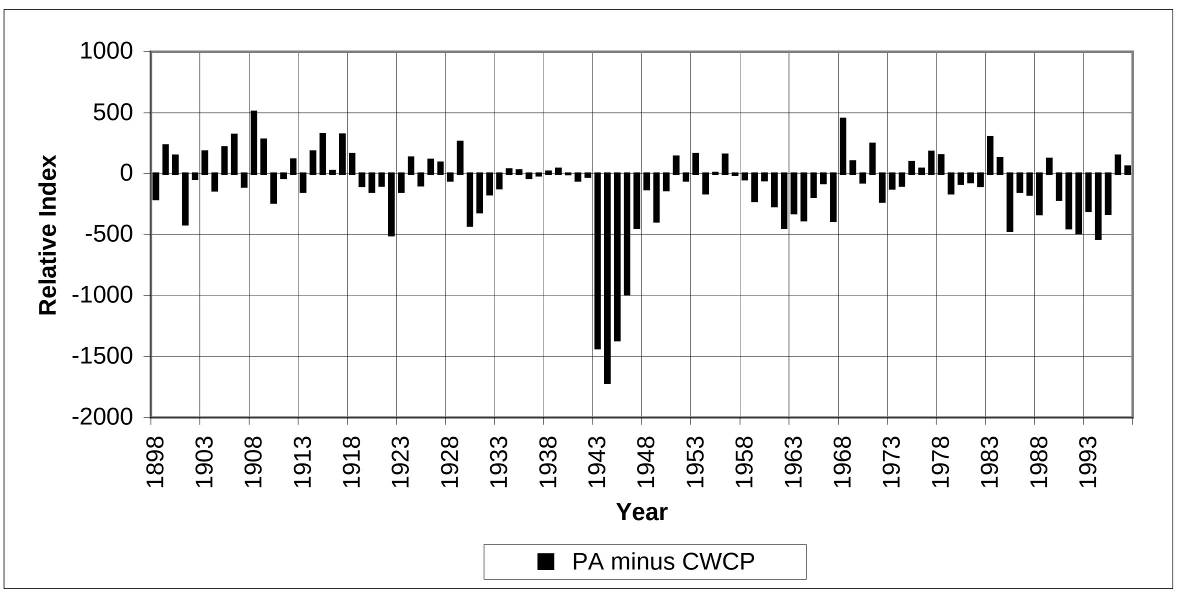

Figure 8.3-34. Mississippi River navigation benefits provided by the change from the CWCP to the PA ($millions).

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8.4 FUTURE DEPLETIONS ANALYSIS

Model simulations using the output files from the DRM were run through the economic use or environmental resource models to determine the average annual benefits or values provided for each use or resource category. These data were then plotted using the Excel spreadsheet program, which has the capability to draw regression lines through the plotted data. The Excel program also computes the equation of the line, which provides the slope of the line, and the R-squared value, which is a correlation index, for the line through the data. The closer the correlation index is to 1.0, the better the correlation.

The slope of the linear correlation line (change per MAF of depletion) and the R-squared values are listed in Table 8.4-1 for all of the use or resource categories on which data are provided in Chapter 8. Data with very poor correlation coefficients (i.e., R-squared values less than 0.4) are marked with gray shading. For these resources, increasing levels of depletion have unknown effects on use or resource values.

The remaining slope values were then compared for each use or resource category to determine which of the two alternatives (CWCP or PA) had the greatest change per unit of depletion; these values are highlighted as white text on a black background.

Because sensitivity assessments are based on a comparison of values, only those resources for which both alternatives have good correlation coefficients are included in this analysis. This allows a quick scan of the table to see which of the two alternatives is most sensitive to future depletions and which alternative is least sensitive.

It is readily apparent that the CWCP is by far the more sensitive to future depletions. It has the greatest change (steepest positive or negative slope on the depletion plot) in 12 of the 16 categories. Correlation coefficients were not high enough to allow the comparison of the slopes of the plots for three categories. Only Mississippi River lost navigation efficiency is affected more by depletions under the PA.

Table 8.4-1. Comparison of the depletion effects to the uses or resources.

		CWCP		PA	
Resource/Use	**Units**	**Chg/MAF**	**R squared**	**Chg/MAF**	**R squared**
Flood Control	$millions	1.74	0.753	1.39	0.951
Missouri River Navigation	$millions	-0.45	0.915	-0.23	0.964
Hydropower	$millions	-15.63	0.999	-13.85	0.998
Water Supply	$millions	-3.29	0.991	-2.51	0.986
Recreation	$millions	-1.64	0.772	-0.74	0.826
Total NED Economics	$millions	-19.27	0.996	-15.94	1.000
Lake Young Fish Production	Index	-0.003	0.024	-0.016	0.796
Lake Coldwater Habitat	MAF	-0.66	0.976	-0.50	0.992
River Coldwater Habitat	miles	-4.07	0.991	-1.65	0.948
River Warmwater Habitat	miles	1.93	0.799	1.01	0.831
River Fish Physical Habitat	Index	-0.11	0.613	0.03	0.165
Riverine Tern and Plover Habitat	acres	28.8	0.795	8.52	0.206
Wetland Habitat	1000 acres	-2.03	0.902	-1.66	0.803
Riparian Habitat	1000 acres	4.24	0.969	3.06	0.997
Historic Properties	Index	236	0.992	186	0.998
Mississippi River Navigation	$millions	-3.78	0.765	-7.72	0.969

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8.5 MITIGATION AND MONITORING

Mitigation is required for environmental resources that are adversely affected in a significant way by the changes being proposed, in this case, a change in the Water Control Plan. An example of such mitigation is currently being constructed for the Missouri River Bank Stabilization and Navigation Project. The Corps will also continue to conduct monitoring of the Mainstem Reservoir System and Lower River to better understand the impacts of the projects it has constructed, and the Corps will conduct monitoring of any changes to operations, whether due to inflow changes or a change in the Water Control Plan.

Throughout the development and evaluation of alternatives for the RDEIS and the continuation of looking at additional alternatives leading to the identification of a preferred alternative for this FEIS, the Corps has also communicated continually with the USFWS on the actions that the Corps must take to ensure that the species listed under the ESA are not likely to be jeopardized. The USFWS' November 2000 BiOp identified measures that should be incorporated into any action proposed by the Corps to preclude jeopardy to the listed species, in particular, the least tern, piping plover, and pallid sturgeon. Even though the November 2000 BiOp prescribed changes to the Water Control Plan, the PA in this FEIS does not include those recommended for spring releases from Fort Peck Dam and spring and summer releases from Gavins Point Dam. Other measures beyond those specified in the November 2000 BiOp, however, have been incorporated into the Corps' proposed action at this time. Because the Corps' proposed action would address negative effects of Mainstem Reservoir System operations, all of the measures included in this proposed action must be considered along with potential mitigation to address the adverse environmental effects for the change from the CWCP to the PA and monitoring of the effects of the change to the PA as it is implemented.

8.5.1 Mitigation

The potential for mitigation for any of the alternatives discussed in this chapter can be evaluated by examining the relative differences in the various environmental resource values presented in Table 8.3-34, Impacts Summary for the PA. This table shows that many of the resources are positively affected by the change to the PA; however, two resources would be adversely affected by the change to the PA: warmwater fish habitat in the river and historic properties.

The first resource, warmwater fish habitat, is adversely affected, according to the modeling results present earlier in this chapter, for two of the three reaches modeled. These are the reaches downstream from Fort Peck and Fort Randall Dams. Responses to these negative effects are very different.

Part of the Corps' proposed action for the listed species, in response to the requirements of ESA, is to test the effects of warmer water releases over the spillway at Fort Peck Dam. A mini-test and a full test in a subsequent year would be conducted, and monitoring and evaluation of that data would be conducted. Depending on the evaluation of the effects of these two tests, changes may be made in the future. Any decision to make a permanent change to the Water Control Plan for Fort Peck operations would be made as part of the adaptive management to be conducted under MRRIP.

The Corps' response to the potential loss of riverine warmwater habitat downstream from Fort Randall Dam is more complex. The amount of warmwater habitat provided under the CWCP and PA were compared for this reach, and the resulting plot of the differences are presented in Figure 8.5-1. This identifies the years in which differences occur, and it indicates that the negatives outweigh the positives, as the average annual value difference indicates. The greatest negative differences occur in 3 of the 4 non-navigation years of the PA, with the fourth year (1937) being a common non-navigation year for both the CWCP and PA. Sorting of the data in Figure 8.5-1 results in Figure 8.5-2. This figure is enlightening in that it shows that the PA is better than the CWCP in terms of the amount of warmwater fish habitat in the Fort Randall reach. This is the case in 58 of the 100 years modeled. The primary factor leading to the net average annual difference between the CWCP and PA is that the PA improves this habitat by more than 5 miles in only 3 years; whereas, the CWCP has more than 5 miles of this habitat in 9 years, a difference of 6 years. The warmwater habitat value for this reach also varies considerably from year to year no matter which alternative is followed to operate the Mainstem Reservoir System. Because of this variability, the PA being better in more years, and the relative low loss of miles, no mitigation is planned for the potential reduction on an average annual basis for the change to the PA.

Known historic properties, which include but are not limited to prehistoric sites, Tribal cultural resources, and historic sites, are adversely affected by a change from the CWCP to the PA. Increased conservation during droughts is likely the primary factor leading to this result. Because the Corps has existing programs to address the protection of sites or their documentation if protection cannot be accomplished, new efforts to mitigate the effects of the operation of the Mainstem Reservoir System on known sites are not required. Continued efforts to protect the sites are necessary to limit the adverse effects of the exposure or loss of the known sites.

8.5.2 Monitoring

The change to the PA will be extensively monitored as the Corps implements the action it proposed to the USFWS to preclude jeopardy of the listed species, which includes the change to the PA. To comply with the December 2003 Amended BiOp, monitoring of many aspects of various habitats, whether for the two bird species or the pallid sturgeon, must be established. The resulting data will provide a basis on which to evaluate the effects of operations, differing flow and related conditions, and annual changes in the factors affecting the three species. Monitoring can be performed to establish a baseline against which to measure the effects of changes. It can also be performed to identify the effects of changes in the annual Mainstem Reservoir System operations and changes in variability provided by the range of inflows into the Mainstem Reservoir System, weather air conditions, and other physical changes, whether constructed or naturally occurring.

As changes in operations and ambient conditions occur, the monitoring data can be analyzed to determine the beneficial and adverse effects that may be occurring to the species and other river resources and uses. If the analyses of the various data provide some insight into the need for a modification of operations, the existing data becomes the baseline for future monitoring.

The BA submitted to the USFWS in November 2003 provides some insight into what is to be monitored (see Appendix C). The Corps has increased monitoring efforts in recent years as it has developed this Study and made steps in preparation to implement USFWS recommendations for the endangered species in the November 2000 BiOp. For example, a significant baseline monitoring effort was established and conducted beginning in 2001 for the mini- and full tests of spillway releases at Fort Peck Dam. Monitoring will be increasing dramatically to better understand the requirements of the endangered species and any effect the operation of the Mainstem Reservoir System may have on them.

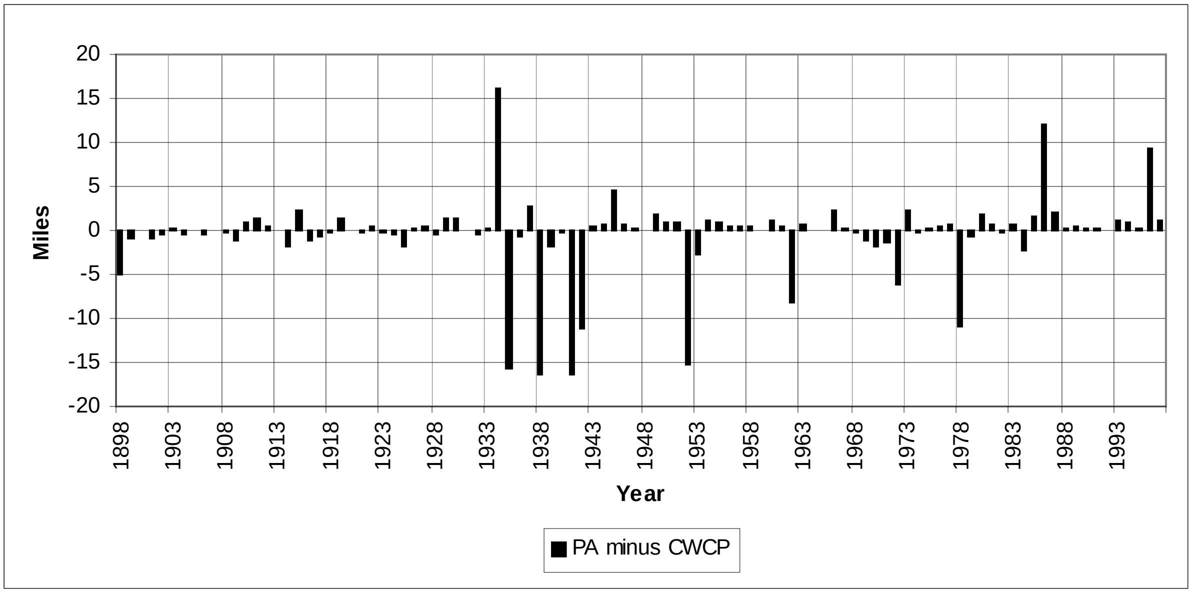

Figure 8.5-1. Change in the warmwater fish habitat in the Fort Randall reach for a change from the CWCP to the PA (miles).

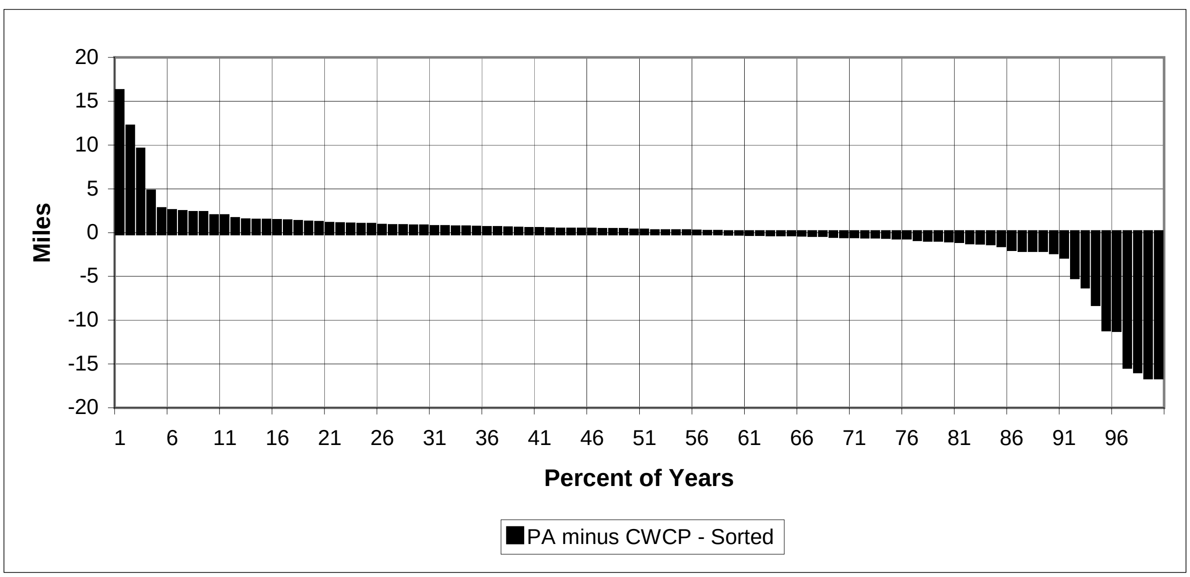

Figure 8.5-2. Sorted change in the warmwater fish habitat in the Fort Randall reach for a change from the CWCP to the PA (miles).

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