FISH PASSAGE CENTER

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MEMORANDUM

TO: Michele DeHart

FROM: David A. Benner

DATE: December 9, 2002

RE: NWPPC Mainstem Amendment Analysis Review

At your request, I have reviewed the draft Northwest Power Planning Council Fish and Wildlife Program Amendment Analysis. As a part of this review, I have compared the NWPPC analysis to a similar analysis conducted by the Bonneville Power Administration (BPA). In addition, I have utilized the flow travel time relationships developed from monitoring programs and research studies.

The Main Points of this investigation are as follows:

Lower Granite

- During an average water year, the NWPPC amendment would result in lower flows at Lower Granite from April 16 to August 15. During July, flows are continuously expected to be 1,528 cfs lower relative to 2000 Biological Opinion operations, a total loss of water of 93.8 Kaf.
- In low water years, the NWPPC Plan would result in continuously decreased discharges of 7,213 cfs in July, a total loss of water of 442.7 Kaf. During WY 2000 (relatively low water year during period of BiOp implementation), discharges in July averaged 37,800 cfs; if the NWPPC Plan had been in effect, flows would have been 30,587 cfs, a 19% decrease. This flow decrease would result in an estimated average increase of approximately 14% in subyearling chinook travel times between Lower Granite Dam and McNary.
- During average, median, and low water years at Lower Granite, the NWPPC Plan would shift 113.6, 177.0, and 473.1 Kaf of water out of the time period between July 1 and August 15 (according to NWPPC results).
- According to BPA modeling results, during low water years at Lower Granite the month of May could expect a drop in monthly average discharge of 1,600 cfs if the NWPPC plan were instituted, a volume loss of 98.2 Kaf. Additionally, BPA results indicate that

during average water years, monthly discharges could be expected to drop between 300 and 900 cfs between April 16th and the end of June.

McNary

- During an average water year, the NWPPC amendment would result in lower flows at McNary from April 16 to August 31. During the first half of August, flows are expected to be 16,468 cfs lower at McNary, relative to operations resulting from the 2000 Biological Opinion, a total loss of water of 489.1 Kaf. During the summer of 2002, an approximately average water year, discharges averaged 156,600 cfs at McNary between August 1-15; if the NWPPC Plan would have been in effect, flows would have been 140,132 cfs, an 11% decrease. This flow decrease would result in an estimated average increase of approximately 13% in subyearling chinook travel times between McNary and John Day Dam.
- In low water years, the NWPPC Plan would result in decreased discharges of 22,618 cfs in the second half of April and 17,431 cfs in July. During WY 2000 (relatively low water year during period of BiOp implementation) discharges averaged 297,500 cfs in the second half of April and 166,700 cfs in July; if the NWPPC Plan had been in effect, flows would have been 274,882 cfs in the second half of April and 149,269 cfs in July, decreases of 7.6% and 10.5%, respectively. In the second half of April, this flow decrease would result in steelhead and chinook travel time increases between McNary and Bonneville of approximately 7%. In July, the flow decrease would lead to an estimated average increase of 10% in subyearling chinook travel times between McNary and John Day Dam.
- During average, and low water years at McNary Dam, the NWPPC Plan would shift 392.4 and 936.5 Kaf of water out of the time period between April 16 and June 30th (according to NWPPC results). Additionally, during average, median, and low water years at McNary, the NWPPC Plan would shift 712.2, 1094.9, and 1468.6 Kaf of water out of the time period between July 1 and August 15. Overall, between April 16 and August 15, 1104.6 Kaf of water would be lost during average water years and 2405.1 Kaf would be lost during low water years, relative to the Biological Opinion. The original Fish and Wildlife Water Budget contained 3500 Kaf for flow augmentation; therefore, during low water years nearly 70% (2405.1Kaf/3500Kaf) of the original water budget volume of water would be transferred out of the period between April 16 to August 15.
- During average, median, and low water years between April 16-30 discharges would decrease between 9,376 and 3,144 cfs relative to the pre-water budget period at McNary. This suggests that the NWPPC Plan would lead to a decay in April 16-30 flows, beyond that of the pre-water budget years.
- According to BPA model results at McNary, during low water years the second one-half of April could experience discharges 63,500 cfs less if the NWPPC Plan were implemented as compared to the BiOp, a total loss of 1886.0 Kaf of water. Also, during low water years, discharges are predicted by BPA to be between 4,500 and 12,900 cfs less between May and July if the NWPPC plan is instituted. Additionally, BPA results indicate that during average water years monthly discharges could be expected to drop

between 2,900 and 24,300 cfs between April 16th and the end of July, again with the most significant drop in discharge in the second half of April.

- Both the NWPPC and the BPA models agree that severe decreases in discharges can be expected at McNary Dam if the NWPPC Mainstem Amendment is implemented.

The NWPPC used data from water years 1929 to 1978 to model the impact of the "Council Preferred Alternative" on spring/summer flows and refill probabilities relative to that of the current NMFS 2000 Biological Opinion and that of the pre-water budget years. According to John Fazio, the NWPPC constrained the analysis to the mentioned water years due to a lack of system data from BPA, from whom the NWPPC gets data. Consequently, the NWPPC could not use COE data that uses observed runoff to calculate flood control elevations, as compared to BPA, which uses water supply forecasts to evaluate flood control points. Because the NWPPC agrees with BPA in terms of determining flood control based upon water supply forecasts, the NWPPC elected to use only the data that BPA had readily available.

More than the last twenty water years have been excluded from the NWPPC council analysis. The 20%, 50%, and 80% exceedence January-July runoff volumes at Lower Granite and The Dalles were calculated over the span of years between 1929-1978 and over 1929-2001; in effort to evaluate how the selection of limited water years may influence the magnitude of exceedence runoff volumes (Table 1).

Table 1. The 80%, 50%, and 20% exceedence runoff volumes (January-July) at Lower Granite and The Dalles between 1929-1978 and 1929-2001.

	LGR (Jan-July, Maf)		TDA (Jan-July, Maf)	
	1929-1978	1929-2001	1929-1978	1929-2001
80% Exceedence	20.4	19.9	83.0	82.1
50% Exceedence	28.5	26.7	106.8	104.5
20% Exceedence	35.5	36.8	119.5	122.6

From Table 1, both the 80% and 50% exceedence runoff volumes (lower water years) at The Dalles and Lower Granite decreased when the entire record (1929-2001) was used as compared to the record used by the NWPPC (1929-1978). Alternatively, the 20% Exceedence runoff volumes (higher water years) increased when the entire record (1929-2001) was used as compared to the record used by the NWPPC (1929-1978). It appears that the years between 1979 and 2001 contain relatively extreme water years, which tend to extend both the lower and upper exceedence runoff volumes.

The following sections will focus on evaluating the spring and summer month-to-month differences in discharge at both Lower Granite and McNary that could occur as a result implementing the NWPPC's Preferred Alternative. The NWPPC modeled monthly discharges at LGR and McNary under three scenarios 1) The current Biological Opinion 2) The NWPPC Preferred Alternative 3) The operation in effect before the Water Budget. All subsequent

analyses by FPC used the model results provided in the original NWPPC Draft Amendment spreadsheet, which can be found at *http://www.nwcouncil.org/library/2002/2002-16/modeling.htm*. Additionally, NWPPC month-to-month results were compared to similar analyses conducted by BPA.

Monthly differences in discharge were quantified in two ways 1) the difference in discharge that would occur if the NWPPC Amendment were adopted, relative to the operation called for in the Biological Opinion and 2) the difference in discharge that would occur if the NWPPC Plan were adopted, relative to the hydrosystem operation in effect before the water budget. All differences in monthly discharges were calculated for the average, median, 20% exceedence, and 80% exceedence runoff volumes for the water years comprising the data set from 1929 to 1978. Again, all numbers were taken directly from the NWPPC Draft Amendment Analyses.

Table 2 and Figure 1 display the month-to-month differences in discharge at Lower Granite that could be expected during varying water years if the NWPPC Plan were implemented, relative to the operation of the Columbia hydrosystem under the Biological Opinion operations. During an average water year, the NWPPC amendment would result in lower flows at Lower Granite from April 16 to August 15. During July, flows are expected to be 1,528 cfs lower at Lower Granite, relative to operations resulting from the 2000 Biological Opinion. During the summer of 2002, an approximately average water year, discharges averaged 38,300 cfs at Lower Granite; if the NWPPC Plan would have been in effect, flows would have been 36,772 cfs, a 4% decrease.

In low water years (80% Exceedence), the NWPPC Plan would result in discharges decreased 7,213 cfs in July. From Table 1, an 80% Exceedence water year between 1928 and 2001 had a January-July runoff volume of 19.9 Maf at Lower Granite. Water year 2000 contained a runoff volume of 24.6 Maf at Lower Granite, which was the closest volume to the historical 80% Exceedence runoff volume during the period of Biological Opinion implementation. During WY 2000 discharges in July averaged 37,800 cfs; if the NWPPC Plan had been in effect, flows would have been 30,587 cfs, a 19% decrease. The following multiple regression equation was developed ($p<0.001$, $R^2 = 0.59$) using information from Table 32 (Page 74) of the 2001 Annual Report of the Fish Passage Center:

Subyearling Chinook Travel Time from Lower Granite to McNary
= 21.693 – 0.295 (Date) + 484.186/Flow

Where,

Date = day subsequent to June 1
Flow = Discharge, kcfs

Using this equation, it was estimated that the NWPPC Plan would lead, on average, to an approximate 14% increase in subyearling chinook travel time from Lower Granite to McNary if average monthly July flows decreased from 37,800 cfs to 30,587 cfs.

Overall, the NWPPC plan would have the largest impact upon Lower Granite discharges during July and early August.

Table 2. Monthly and bi-monthly differences in discharge at Lower Granite that could be expected for varying water years if the NWPPC preferred alternative were implemented, differences are relative to the current Biological Opinion operations.

Date	Average WY Discharge (cfs)	Median WY Discharge (cfs)	80% Exceedence (Low WY) Discharge (cfs)	20% Exceedence (High WY) Discharge (cfs)
April 16-30	-316	-72	0	0
May	-205	0	0	0
June	-199	0	0	0
July	-1528	-2657	-7213	4700
Aug 1-15	-666	-469	-1021	-394
Aug 16-31	2185	-201	6594	-570

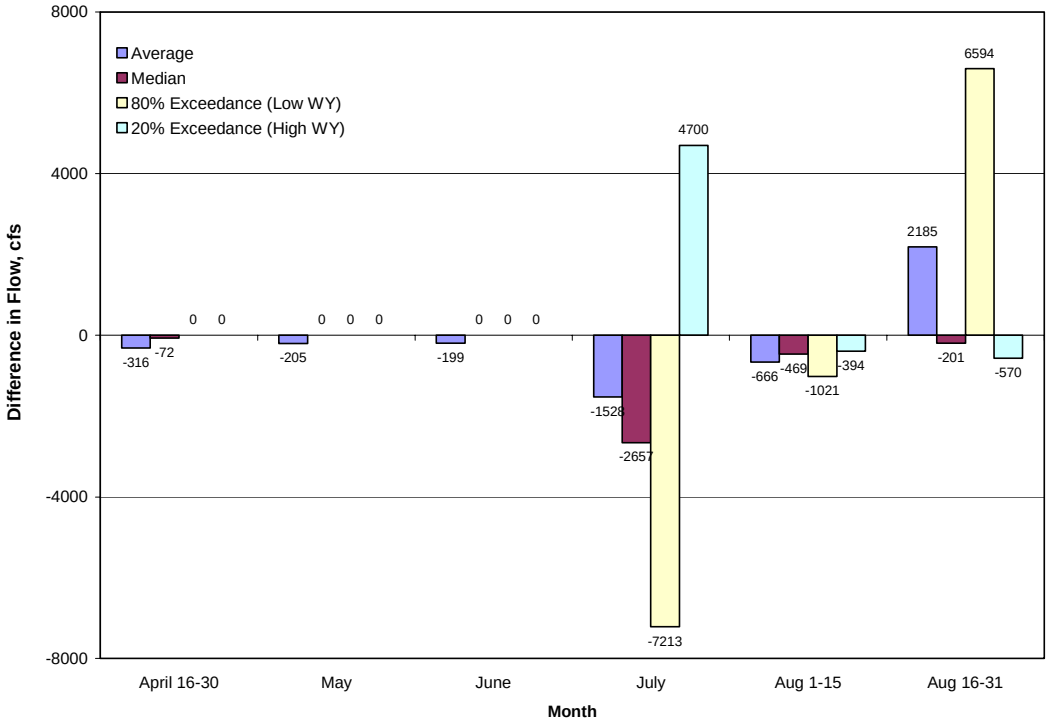

Figure 1. Monthly and bi-monthly differences in discharge at Lower Granite that could be expected for varying water years if the NWPPC preferred alternative were implemented, differences are relative to the current Biological Opinion operations. Negative values indicate less discharge would occur under the NWPPC Plan, positive values indicate greater discharge would occur under the NWPPC Plan, and zero values indicate no change in discharge would be expected.

Table 3 and Figure 2 display the month-to-month differences in discharge at Lower Granite that could be expected during varying water years if the NWPPC Plan were implemented, relative to pre-water budget operations. As would be expected, month-to-month discharges at Lower Granite resulting from the NWPPC Plan would be increased over all periods between April 16 and August 31, relative to pre-water budget operations.

Table 3. Monthly and bi-monthly differences in discharge at Lower Granite that could be expected for varying water years if the NWPPC preferred alternative were implemented, differences are relative to the current pre-water budget operations.

Date	Average WY Discharge (cfs)	Median WY Discharge (cfs)	80% Exceedence (Low WY) Discharge (cfs)	20% Exceedence (High WY) Discharge (cfs)
April 16-30	5258	8235	4026	4213
May	3644	1516	5278	2935
June	1692	2992	2770	255
July	11613	11535	11011	12666
Aug 1-15	12429	13228	11992	12171
Aug 16-31	13494	12970	13669	14434

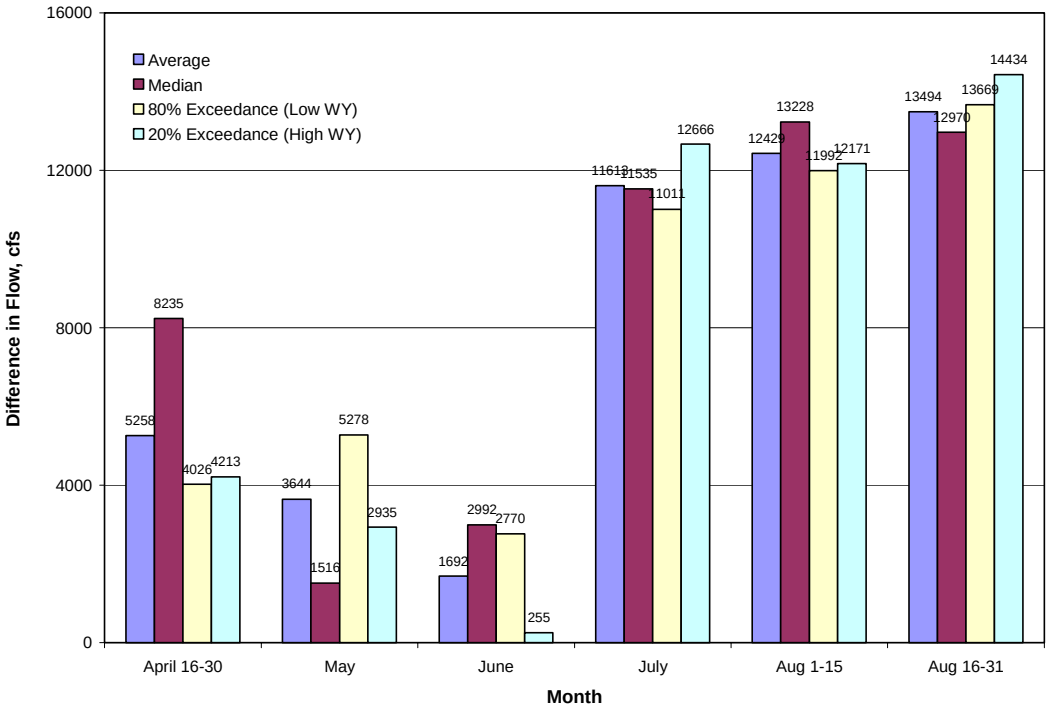

Figure 2. Monthly and bi-monthly differences in discharge at Lower Granite that could be expected for varying water years if the NWPPC preferred alternative were implemented, differences are relative to the current pre-water budget operations. Negative values indicate less discharge would occur under the NWPPC Plan, positive values indicate greater discharge would occur under the NWPPC Plan, and zero values indicate no change in discharge would be expected.

The BPA conducted separate modeling which was useful in comparing the differences in monthly discharge that could be expected if the NWPPC Plan were implemented as compared to the operation of the hydrosystem under the BiOp. BPA modeled monthly flows at Lower Granite and McNary under the following scenarios:

1) **2000 Biological Opinion**: Base Case; Target chum flows from November 1-14 (125 kcfs), November 15-December 31 9145 kcfs); operate reservoirs to respective confidence levels of being at URC on April 10 then refill by June 30, meet summer flow targets with reservoir drafts limited per the BiOp
2) **Alternative 1**: 95% confidence of refill by June 30th is the primary operational objective. Target chum flows November 1-Decembber 31 (125 kcfs); operate reservoirs no lower than the 95% confidence criteria allows; meet summer flow targets with reservoir drafts limited per the BiOp
3) **Alternative 2**: 95% confidence of refill by June 30th is the primary operational objective. Target chum flows November 1-Decembber 31 (125 kcfs); January 1-March 31 meet a minimum flow of 125 kcfs for chum but operate reservoirs no lower

than the 95% confidence criteria allows; meet summer flow targets with reservoir drafts limited per the BiOp

According to the Summary of Modeling Assumptions for Mainstem Hydro Operations found at http://www.nwcouncil.org/library/2002/2002-16/modeling.htm, which compares Biological Opinion operations to the NWPPC proposed alternative operations, the BPA Alternative #1 was selected to best represent the NWPPC plan. The output for BPA modeling contained monthly flow differences between the operations of the BiOp and Alternative 1 (NWPPC Plan) for each water year between 1929 and 1978 (same data set used by the NWPPC). Table 1 was utilized to determine the 20%, 80%, and median exceedence runoff volumes between 1929 and 1978. The complete dataset of runoff volumes (Jan-July) throughout the period between 1929-1978 was used to identify water years with similar runoff volume as each of the exceedence runoff values. Table 4 displays the month-to-month differences in discharge at Lower Granite that could be expected during varying water years if the NWPPC Plan were implemented, relative to the operation of the Columbia hydrosystem under the Biological Opinion operations, as presented by BPA. The BPA predicted that discharges would not be influenced largely at Lower Granite as a result of the implementation of the NWPPC operational plan. According to BPA modeling results, during low water years the month of May could expect a drop in monthly average discharge of 1,600 cfs if the NWPPC plan were instituted. Additionally, BPA results indicate that during average water years, monthly discharges could be expected to drop between 300 and 900 cfs between April 16th and the end of June.

Table 4. Monthly and bi-monthly differences in discharge at Lower Granite that could be expected for varying water years if the NWPPC preferred alternative were implemented, differences are relative to the hydrosystem under Biological Opinion operations. Analyses presented by the Bonneville Power Administration.

Date	Average WY Discharge (cfs)	Median WY, 1953 Discharge (cfs)	80% Exceedence (Low WY, 1945) Discharge (cfs)	20% Exceedence (High WY, 1959) Discharge (cfs)
April 16-30	-900	-600	200	0
May	-300	0	-1600	0
June	-300	0	0	0
July	100	0	400	0
Aug 1-15	0	0	0	0
Aug 16-31	-100	0	0	0

Table 5 and Figure 3 display the month-to-month differences in discharge at McNary that would be expected during varying water years if the NWPPC Plan were implemented, relative to Biological Opinion operations. During an average water year, the NWPPC amendment would result in lower flows at McNary from April 16 to August 31. During the first half of August, flows are expected to be 16,468 cfs lower at McNary, relative to operations resulting from the 2000 Biological Opinion. During the summer of 2002, an approximately average water year, discharges averaged 156,600 cfs at McNary between August 1-15; if the NWPPC Plan would

have been in effect, flows would have been 140,132 cfs, an 11% decrease. The following multiple regression equation was presented in Berggren and Filardo (1993) ($p<0.001$, $R^2 = 0.65$):

Subyearling Chinook Travel Time from McNary to John Day
= -42.364 + 0.165 (Date) + 0.133(DFlow) + 3016.061(1/Flow)

Where,

Date = Day subsequent to January 1
DFlow = Absolute change in daily average flow (kcfs) over travel time days
Flow = Discharge, kcfs

Using this equation, it was estimated that the NWPPC Plan would lead, on average, to an approximate 13% increase in subyearling chinook travel time from McNary to John Day if flows between August 1-15 decreased from 156,600 cfs to 140,132 cfs.

In low water years (80% Exceedence), the NWPPC Plan would result in decreased discharges of 22,618 cfs in the second half of April and 17,431 cfs in July. From Table 1, an 80% Exceedence water year between 1928 and 2001 had a January-July runoff volume of 82.1 Maf at The Dalles. Water year 2000 contained a runoff volume of 98 Maf at Lower Granite, which was the closest volume to the historical 80% Exceedence during the period of Biological Opinion implementation. During WY 2000 discharges averaged 297,500 cfs in the second half of April and 166,700cfs in July; if the NWPPC Plan had been in effect, flows would have been 274,882 cfs in the second half of April and 149,269 cfs in July, decreases of 7.6% and 10.5%, respectively.

Using 1999-2002 springtime yearling chinook and steelhead travel time and discharge data, the following relationships were calculated:

Yearling chinook travel time between McNary and Bonneville =
579.06 * (Flow)^-0.818

Yearling steelhead travel time between McNary and Bonneville =
874.54 * (Flow)^-0.907

Where:

Flow = the average discharge at McNary, The Dalles, and John Day over the travel time period, kcfs

Assuming that the discharges at McNary that would result from the NWPPC plan and the BiOp would be approximately equal to the average discharge across McNary, The Dalles, and John Day over the same period, it was estimated that the NWPPC Plan would lead, on average, to approximately 7% increases in yearling chinook and steelhead travel times between McNary and Bonneville if average flows in second half of April decreased from 297,500 cfs to 274,882 cfs.

Additionally, the following multiple regression equation, presented in Berggren and Filardo (1993) ($p<0.001$, $R^2 = 0.65$), was utilized to determine the increase in travel times associated with decreasing July flows from 166,700 cfs to 149,269 cfs during relatively low water years:

Subyearling Chinook Travel Time from McNary to John Day
= -42.364 + 0.165 (Date) + 0.133(DFlow) + 3016.061(1/Flow)

Where,

Date = Day subsequent to January 1
DFlow = Absolute change in daily average flow (kcfs) over travel time days
Flow = Discharge, kcfs

Using this equation, it was estimated that the NWPPC Plan would lead, on average, to an approximate 10% increase in subyearling chinook travel time from McNary to John Day if average monthly July flows decreased from 166,700 cfs to 149,269 cfs.

Overall, the NWPPC plan would lessen flows (relative to the BiOp) at McNary continuously from April 16 to August 31 during average water years with the largest impact during the first part of August. During low water years, discharges would decrease significantly more than 10,000 cfs for two months (April 16-30, July, and Aug 1-15).

Table 5. Monthly and bi-monthly differences in discharge at McNary that could be expected for varying water years if the NWPPC preferred alternative were implemented, differences are relative to the current Biological Opinion operations.

Date	Average WY Discharge (cfs)	Median WY Discharge (cfs)	80% Exceedence (Low WY) Discharge (cfs)	20% Exceedence (High WY) Discharge (cfs)
April 16-30	-5174	0	-22618	0
May	-2835	1	-1578	0
June	-1089	0	-2827	-3998
July	-3635	-4670	-17341	9966
Aug 1-15	-16468	-27213	-13610	-9903
Aug 16-31	-2092	2419	6740	-24269

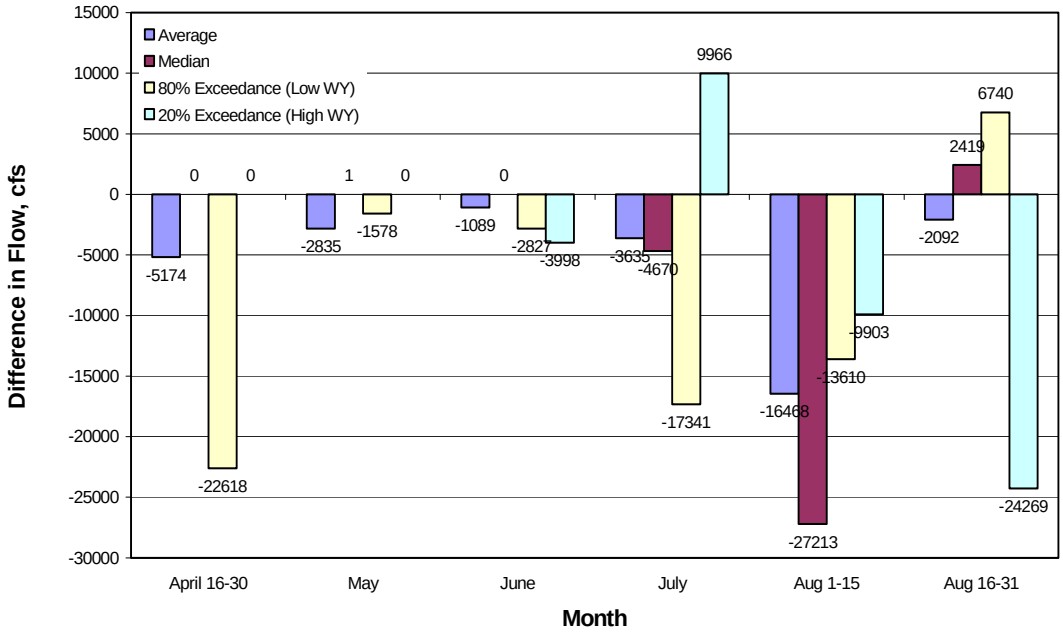

Figure 3. Monthly and bi-monthly differences in discharge at McNary that could be expected for varying water years if the NWPPC preferred alternative were implemented, differences are relative to the current Biological Opinion operations. Negative values indicate less discharge would occur under the NWPPC Plan, positive values indicate greater discharge would occur under the NWPPC Plan, and zero values indicate no change in discharge would be expected.

Table 6 and Figure 4 display the month-to-month differences in discharge at McNary that could be expected during varying water years if the NWPPC Plan were implemented, relative to pre-water budget operations. Month-to-month discharges at McNary resulting from the NWPPC Plan would be increased over all periods *except* from April 16-30, relative to pre-water budget operations. During the average, median, and low water years discharges would decrease between 9,376 and 3,144 cfs relative to the pre-water budget period. This suggests that the NWPPC Plan would lead to a decay in April 16-30 flows, beyond that of the pre-water budget years.

Table 6. Monthly and bi-monthly differences in discharge at McNary that could be expected for varying water years if the NWPPC preferred alternative were implemented, differences are relative to the current pre-water budget operations.

Date	Average WY Discharge (cfs)	Median WY Discharge (cfs)	80% Exceedence (Low WY) Discharge (cfs)	20% Exceedence (High WY) Discharge (cfs)
April 16-30	-9030	-9376	-3144	401
May	15097	33594	47759	-8933
June	13618	4168	47744	-1846
July	32872	47662	14906	54829
Aug 1-15	20358	17495	18539	18216
Aug 16-31	31013	26775	36163	28819

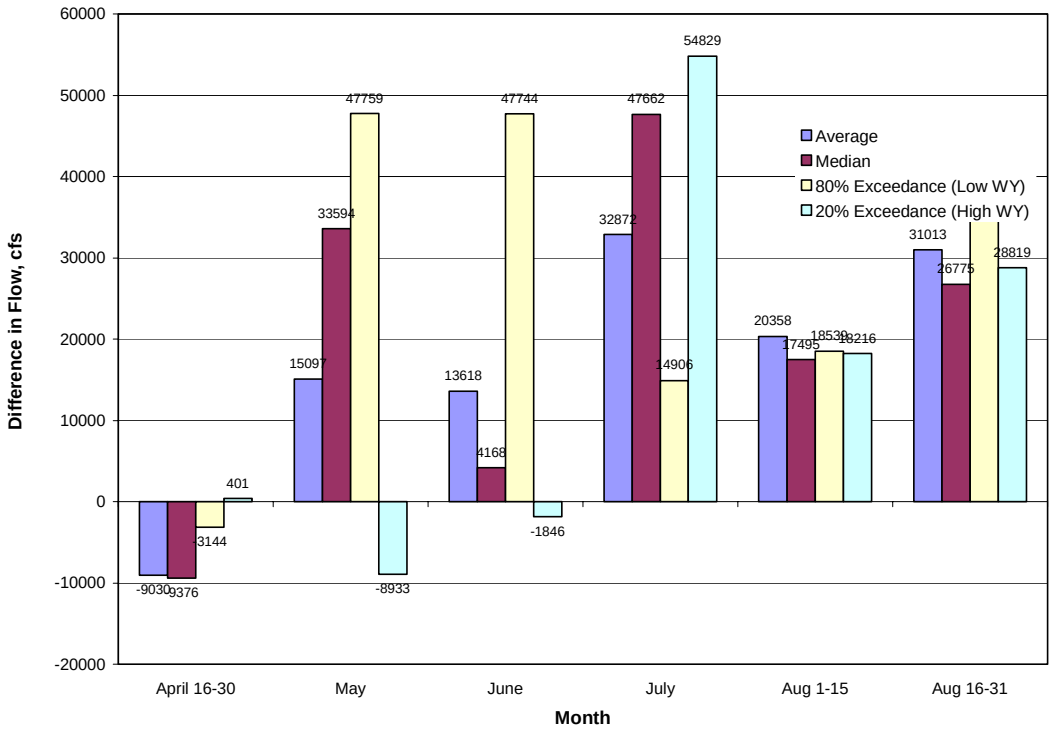

Figure 4. Monthly and bi-monthly differences in discharge at Lower Granite that could be expected for varying water years if the NWPPC preferred alternative were implemented, differences are relative to the current pre-water budget operations. Negative values indicate less discharge would occur under the NWPPC Plan, positive values indicate greater discharge would occur under the NWPPC Plan, and zero values indicate no change in discharge would be expected.

Table 7 displays the month-to-month differences in discharge at McNary that could be expected during varying water years if the NWPPC Plan were implemented, relative to the operation of the Columbia hydrosystem under the Biological Opinion operations, as presented by BPA. BPA modeling predicted that discharges would be influenced largely at McNary as a result of the implementation of the NWPPC operational plan. According to BPA model results, during low water years the second one-half of April could experience discharges 63,500 cfs less if the NWPPC Plan were implemented as compared to the BiOp. Also, during low water years, discharges are predicted by BPA to be between 4,500 and 12,900 cfs less between May and July if the NWPPC plan is instituted. Additionally, BPA results indicate that during average water years monthly discharges could be expected to drop between 2,900 and 24,300 cfs between April 16th and the end of July, again with the most significant drop in discharge in the second half of April.

In contrast to NWPPC models, BPA results indicate that discharges in the second one-half of April and the entire month of May will suffer the most severely. The NWPPC models predicted the largest drop in discharges in July and August. Both models agree that severe decreases in discharges can be expected at McNary Dam if the NWPPC Mainstem Amendment is implemented.

Table 7. Monthly and bi-monthly differences in discharge at McNary that could be expected for varying water years if the NWPPC preferred alternative were implemented, differences are relative to the hydrosystem under Biological Opinion operations. Analyses presented by the Bonneville Power Administration.

Date	Average WY Discharge (cfs)	Median WY, 1967 (The Dalles) Discharge (cfs)	80% Exceedence (Low WY, 1939 The Dalles) Discharge (cfs)	20% Exceedence (High WY, 1957 The Dalles) Discharge (cfs)
April 16-30	-24300	-8800	-63500	-62800
May	-5200	-100	-12900	-3400
June	-2900	2500	-4500	-8500
July	-5500	-2800	-9700	-10900
Aug 1-15	2100	1600	9900	0
Aug 16-31	2200	13500	1500	700

Additional calculations were performed which converted the differences in instantaneous discharge between the NWPPC Plan and the Biological Opinion to volumes over the respective month or bi-month periods. For example, during an average water year from April 16-30 at Lower Granite the difference in instantaneous discharge was calculated to be –316 cfs (Table 2), which multiplied by 86400 seconds in a day and 15 days (between April 16-30), is equivalent to 409,536,000 cubic feet or 9.4 Kaf. Therefore, it could be assumed that if the NWPPC Plan were instituted, 9.4 Kaf less water (relative to the BiOp) would be available over the second part of April. Table 8 summarizes monthly volumes of water lost or gained as a result of the NWPPC Plan, relative to the BiOp.

Table 8. Monthly and bi-monthly volumes of water lost or gained at Lower Granite as a result of implementation of the NWPPC preferred alternative, differences are relative to the 2000 Biological Opinion operations. Negative values indicate a loss of water, positive values a gain of water.

Date	Average WY Volume (Kaf)	Median WY Volume (Kaf)	80% Exceedence (Low WY) Volume (Kaf)	20% Exceedence (High WY) Volume (Kaf)
April 16-30	-9.4	-2.1	0.0	0.0
May	-12.6	0.0.	0.0	0.0
June	-11.8	0.0	0.0	0.0
July	-93.8	-163.1	-442.7	288.5
Aug 1-15	-19.8	-13.9	-30.3	-11.7
Aug 16-31	69.2	-6.4	208.9	-18.1
Volume Lost/Gained				
April 16 to June 30	-33.8	-2.1	0.0	0.0
July 1 to Aug 15	-113.6	-177.0	-473.1	276.8
April 16 to Aug 31	-78.1	-185.5	-264.2	258.7

From Table 8, during average, median, and low water years at LGR, the NWPPC Plan would shift 113.6, 177.0, and 473.1 Kaf of water out of the time period between July 1 and August 15 (according to NWPPC results).

Table 9. Monthly and bi-monthly volumes of water lost or gained at McNary as a result of implementation of the NWPPC preferred alternative, differences are relative to the 2000 Biological Opinion operations. Negative values indicate a loss of water, positive values a gain of water

Date	Average WY Volume (Kaf)	Median WY Volume (Kaf)	80% Exceedence (Low WY) Volume (Kaf)	20% Exceedence (High WY) Volume (Kaf)
April 16-30	-153.7	0.0	-671.8	0.0
May	-174.0	0.1	-96.9	0.0
June	-64.7	0.0	-167.9	-237.5
July	-223.1	-286.6	-1064.4	611.7
Aug 1-15	-489.1	-808.2	-404.2	-294.1
Aug 16-31	-66.3	76.6	213.5	-768.8
Volume Lost/Gained				
April 16 to June 30	-392.4	0.1	-936.5	-237.5
July 1 to Aug 15	-712.2	-1094.9	-1468.6	317.6
April 16 to Aug 31	-1170.9	1018.2	-2191.6	-688.7

From Table 9, during average, and low water years at McNary Dam, the NWPPC Plan would shift 392.4 and 936.5 Kaf of water out of the time period between April 16 and June 30th (according to NWPPC results). Additionally, during average, median, and low water years at McNary, the NWPPC Plan would shift 712.2, 1094.9, and 1468.6 Kaf of water out of the time period between July 1 and August 15. Overall, between April 16 and August 15, 1104.6 Kaf of water would be lost during average water years and 2405.1 Kaf would be lost during low water years.