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April 3, 2002

MEMORANDUM

TO: Council Members
FROM: John Fazio
SUBJECT: Analysis of Recommendations to Amend the Fish and Wildlife Program Relating to Mainstem Hydroelectric Operations

Some of the recommendations[1] that were submitted to the Council to amend its Fish and Wildlife Program propose to change the operation of the hydroelectric system. This paper summarizes the physical and economic impacts of those recommendations. In general, physical impacts include river flows, reservoir elevations and power generation. Economic impacts estimated in this analysis reflect only the cost to the power system, evaluated in a market condition.[2] All costs and impacts are assessed relative to the National Marine Fisheries Service's (NMFS) 2000 Biological Opinion.

Every effort was made to properly reflect the intent of each recommendation, however, translating written words into data for analysis can be difficult. In many cases, a subjective interpretation was required to "fill in the gaps" for those recommendations that were not sufficiently specific. Whenever necessary, agencies providing the recommendations were contacted for clarification. The results provided in this paper represent the staff's best estimates of the anticipated impacts for the submitted recommendations.

Recommended actions to alter mainstem hydroelectric operations range widely, both in scope and magnitude. Generally, they fall into three groups; 1) those that back away from current fish and wildlife constraints, 2) those that propose significant changes, including dam breaching and 3) those that propose less significant changes to current operations. Since this analysis focuses only on the short term, only those recommended actions that could be implemented within the next five years were examined. Dam breaching, which is proposed by several agencies, is a longer-term action that will require more research and regional debate. While none of the scenarios reviewed in this paper include dam breaching, the Council has examined the impacts of such actions in prior analyses. See the Council's 1994 Fish and Wildlife program for more information.

The Columbia and Snake River Irrigators Association (Irrigators), whose recommendations fall into the first category, would reduce flow augmentation and use the savings to fund non-mainstem recovery activities. The Columbia River Intertribal Fish Commission (CRITFC), whose

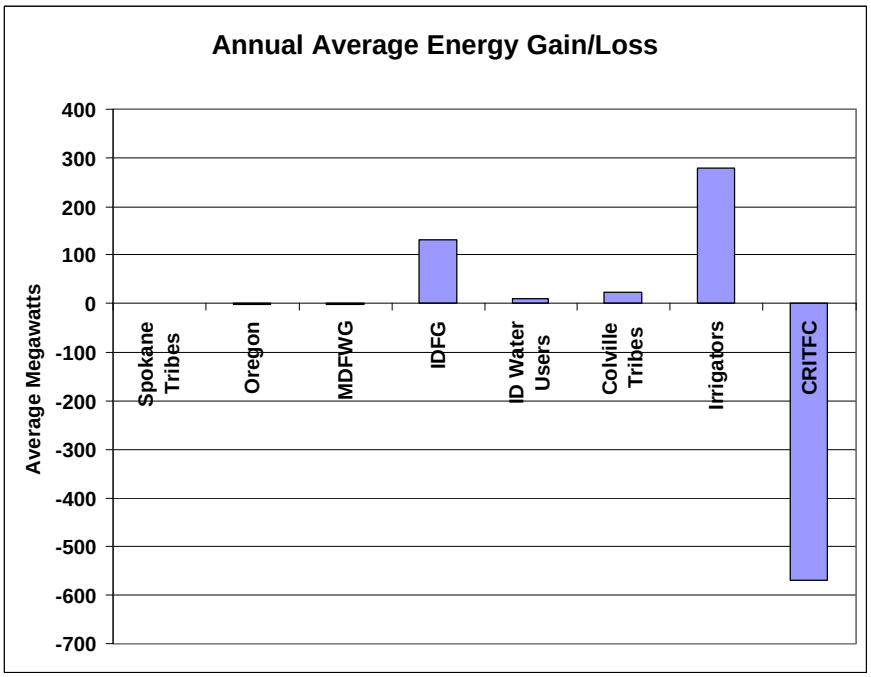
[1] All recommendations received can be found in Council document number 2001-16, entitled "Recommendations to Amend the Columbia River Basin Fish and Wildlife Program - Mainstem Plan (2001)," Volumes 1-2.
[2] In months when generation is less than that under current operations, the deficit is made up with purchases valued at the average monthly price. In months when generation exceeds that in the base case, the surplus is sold. The annual cost is the sum of the costs and revenues for each month.

recommendations fall into the second group, would change flood control (to store more water for flow augmentation), increase spring and summer flow objectives and, in the long term, breach dams. The remaining contributors, who fall into the third category, include the Bonneville Power Administration (BPA), the National Marine Fisheries Service (NMFS), the Montana Department of Fish, Wildlife and Parks (MDFWP), the Oregon Department of Fish and Wildlife (ODFW), the Idaho Water Users, Idaho Fish and Game (IDFG), and the Colville and Spokane tribes. A more detailed description of each recommendation is provided in the section entitled "Summary of Recommendations."

Energy and Cost Impacts

Figure 1 illustrates the average loss or gain in regional annual energy production for each recommendation, relative to the 2000 biological opinion (current operations). All results are summarized in Tables 1a and 1b. The average loss or gain in annual generation includes both firm energy and non-firm energy changes.[3] The CRITFC scenario shows a net loss of nearly 600 average megawatts (aMW). For perspective, the entire Northwest hydroelectric system produces about 15,800 aMW of energy per year, under average runoff volume conditions.[4] The Irrigator's recommendations save the region about 300 aMW/year primarily because of reduced flow augmentation and greater use of stored water for power needs in the winter and because they recommend leaving the bypass spill at the lower 1998 biological opinion levels. The IDFG's recommendations save about 130 aMW/year partially because Libby, Hungry Horse and Dworshak reservoirs are higher at the end of summer, leaving more water for power generation during the winter months. The IDFG recommendation also produces more energy during July and August because it effectively reduces summer bypass spill until tests can be done to determine if overall survival can be improved. Once the spill tests are completed, some amount of bypass spill is likely to be recommended, thus reducing the energy gains shown in this analysis.

Figure 1



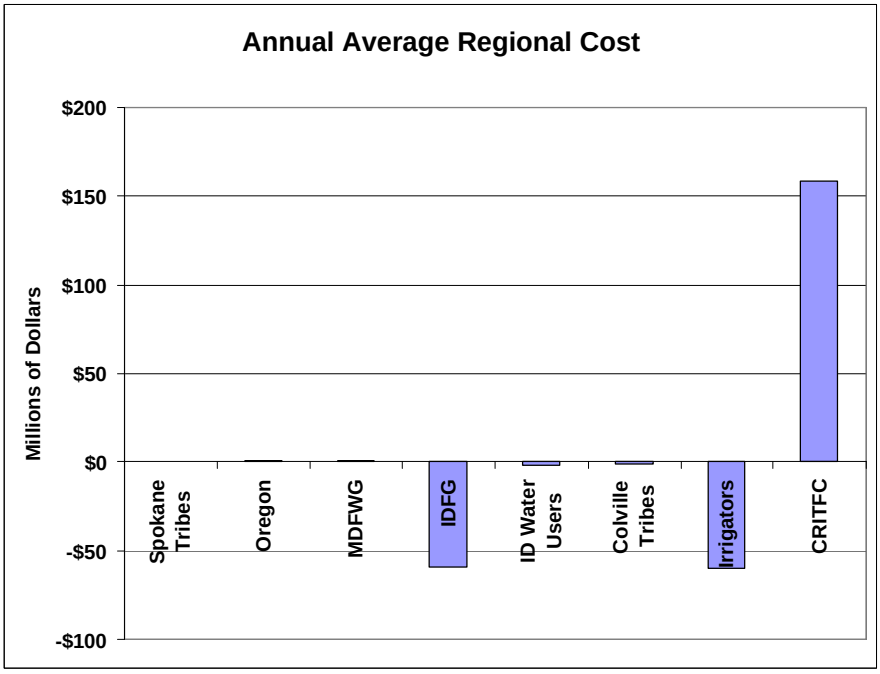
[3] For example, the 1995 biological opinion operation shows a regional firm energy loss of about 1,250 average megawatts (aMW) and a non-firm energy gain of about 350 aMW to yield a net average energy loss of about 900 aMW.
[4] In the driest years, energy production is about 11,800 aMW and in the wettest years it is about 20,000 aMW.

Other scenarios show little or no annual average generation difference. That does not mean, however, that there are no energy impacts. In most cases, the recommendations will shift hydro generation from one season to another. Shifting hydro generation from a high demand (high price) season to a low demand season will reduce revenues or force the purchase of non-hydro resources to replace the shifted generation.

Figure 2 shows the average annual cost to the regional power system for each scenario.[5] It is very nearly the inverse of the graph in Figure 1. In most cases, scenarios that reduce annual energy production will show a net cost while those that increase annual generation yield a net benefit. These annual costs take the monthly shift in hydro generation into account. For each month, the difference in generation (from the base case) is valued using that month's average mid-Columbia wholesale electricity price. In months when the energy production is less than that in the base case, the deficit is made up with purchases. In months when the energy production is greater, the surplus is sold on the market. The net annual cost is the sum of all the month's costs and revenues.

The CRITFC scenario would cost about $160 million/year, on average. The only other operations that significantly impact regional costs are the Irrigator's and IDFG's recommendations. Each shows about a $60 million/year benefit. For perspective, BPA's annual net revenue requirement is on the order of $2.6 billion, which includes a debt repayment of about $700 million to the Treasury and about a $650 million repayment for the WPPSS (now called the Columbia Generating Station) nuclear plants.

Figure 2



[5] Costs are based on average monthly prices for wholesale electricity at the mid-Columbia hub. These forecasted prices were derived for the Council's reliability study (March 2000) using the AURORA model. These prices are currently being revised.

Impacts to River Flows

Figures 3 and 4 illustrate the expected change in river flows at McNary and Lower Granite dams for spring and summer periods. Spring flows are averaged over the period from April 15th to June 30th and summer flows are averaged between July 1st and August 31st. Under CRITFC's recommendations, all efforts would be made to recreate the natural runoff peak in June. These actions would increase average spring flows (Figure 3) by over 17,500 cubic feet per second (cfs) at McNary Dam and by nearly 3,400 cfs at Lower Granite Dam. The average regulated flow at McNary Dam for that period under current operations is about 275,000 cfs.

The Irrigator's recommendations begin with a "power optimized" operation and add some summer flow augmentation and bypass spill. The power-optimized operation includes no fish and wildlife actions and reflects how the system was operated prior to the creation of the Council. Under the Irrigator's recommendations, average spring flows would decrease by about 2,400 cfs in the Snake and by about 11,000 cfs in the lower Columbia. Other recommendations have little affect on spring flows.

Summer flows (Figure 4) are more sensitive to operational changes because natural flows are much lower. The average regulated flow for that period at McNary Dam is about 180,000 cfs under current operations. The ODFW operation shows the greatest increase in summer flows -- over 11,000 cfs at McNary. This is because water is stored in Canadian reservoirs during the fall and winter months specifically for flow augmentation in July and August. CRITFC's operation increases the average flows at McNary Dam by about 4,000 cfs while they decrease the flows at Lower Granite by nearly 2,000 cfs.

In the Irrigator's recommended operation, McNary flows are about 23,400 cfs less and Lower Granite flows are about 8,700 cfs less, on average. MDFWP, Idaho Water Users, IDFG, and the Colville tribes all made recommendations that would tend to decrease summer flows, especially at McNary. Each of these scenarios incorporates some actions to keep federal reservoirs higher through the summer.

Figure 3

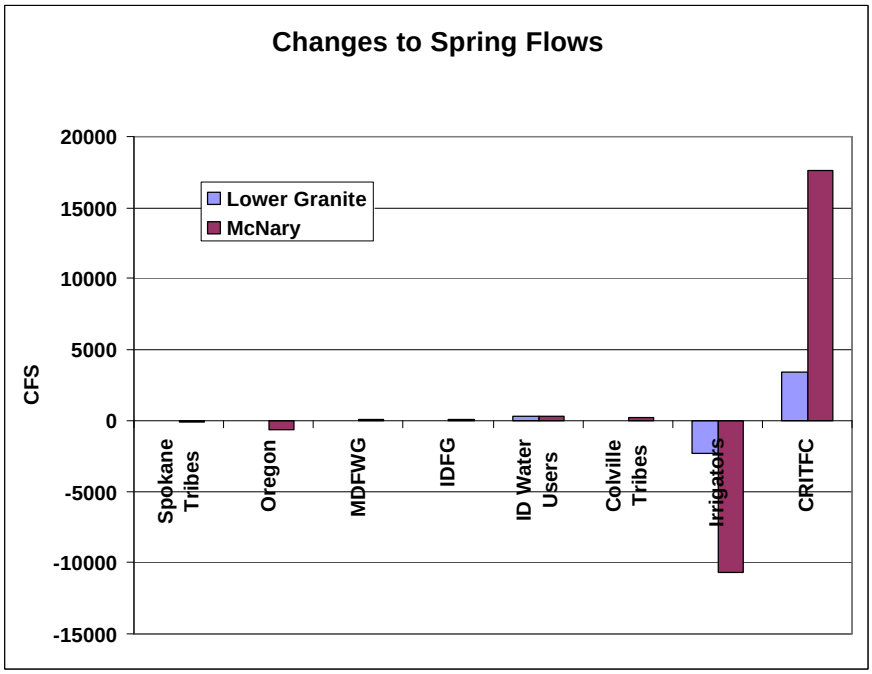
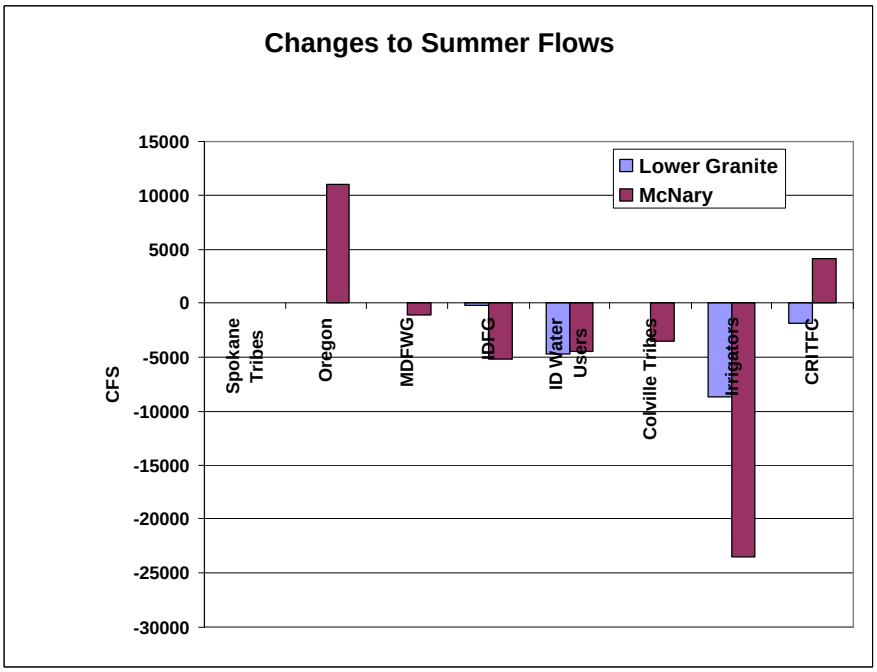


Figure 4



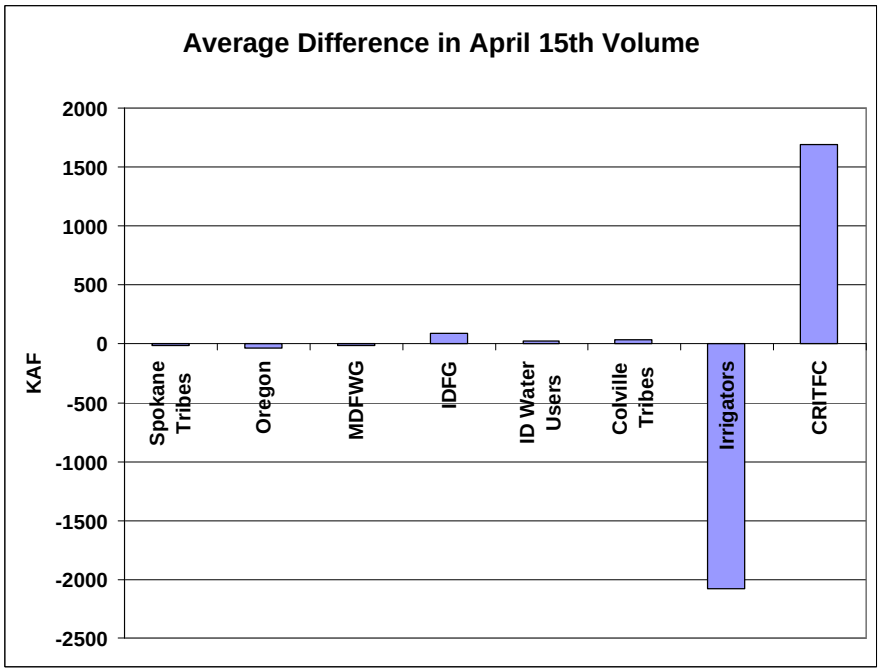
Impacts to Reservoir Elevations

Another parameter that is often used to highlight impacts to the hydro system is reservoir elevation or content. Figures 5-7 show the average difference (from current operations) in reservoir content at Federal dams[6] on April 15th, June 30th and August 31st.

Only two scenarios show significant changes in April 15th reservoir content. The Irrigator's scenario results in federal reservoirs having about 2,100 kaf less water, on average. CRITFC's operation leaves the federal reservoirs with almost 1,700 kaf more water entering into the migration season.

In Figure 6, which shows the end-of-June federal content, the Irrigator's operation continues to have lower than base case storage -- about 1,000 kaf less. ODFW and IDFG leave the reservoirs slightly higher -- about 100 kaf. CRITFC uses as much of stored water as possible to attempt to recreate the very high natural streamflows in June. Consequently, federal reservoirs in this operation are left about 1,000 kaf lower going into summer.

Figure 5



[6] The Federal dams are Libby, Hungry Horse, Grand Coulee and Dworshak.

Figure 6

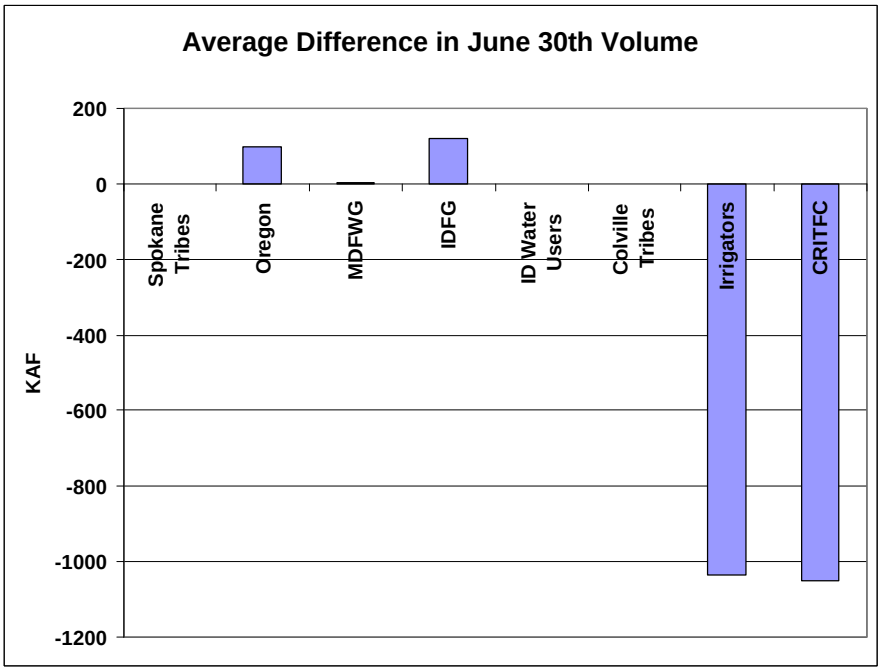
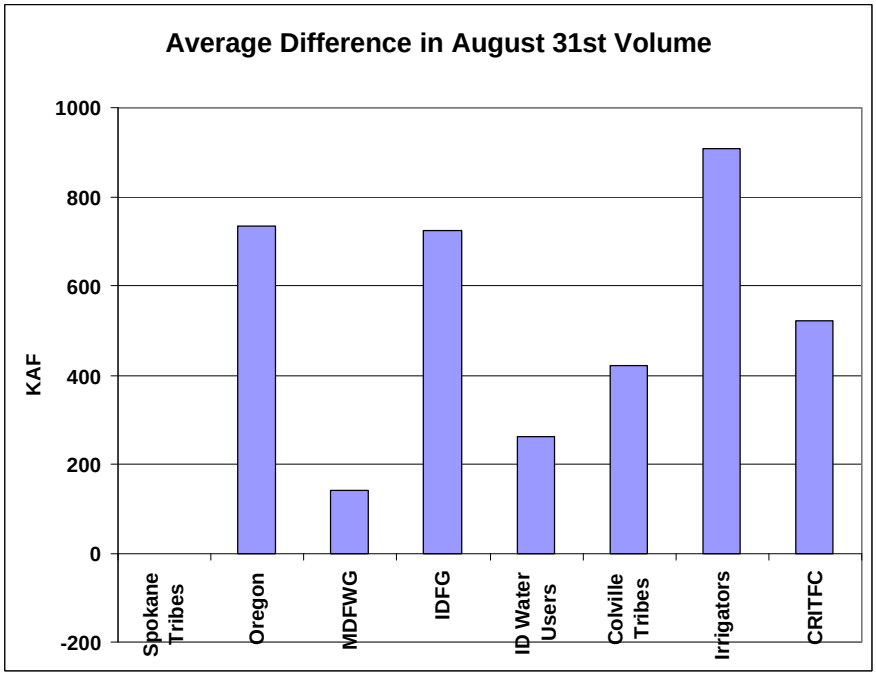


Figure 7



All of the recommended operations, except the Spokane tribes' scenario, leave the federal reservoirs with more water in storage at the end of summer. Under current operations, Grand Coulee would be at 1,280 feet or 1,278 feet (10 or 12 feet down from full) depending of runoff volume, Libby would be at 2,439 feet (20 feet down), Hungry Horse would be at 3,540 feet (20 feet down) and Dworshak would be at 1,520 feet (80 feet down).

The Irrigator's recommendation would leave Grand Coulee and Libby reservoirs about three feet higher, Hungry Horse about eight feet higher and Dworshak about 19 feet higher than current

operations. In all, the federal reservoirs would have about 900 kaf more water by August 31st. ODFW and IDFG's operations also both leave the system higher -- about 700 kaf. ODFW's operation has Libby 12 feet higher and Hungry Horse 9 feet higher while Coulee and Dworshak remain at the biological opinion elevations. IDFG's operation has Libby 12 feet higher, Hungry Horse 8 feet higher and Dworshak about 2 feet higher while Coulee remains at biological opinion elevations.

The CRITFC recommendation shows Grand Coulee a little more than two feet higher, Libby about four feet higher and Dworshak about 19 feet higher than the base case. The August 31st elevation at Hungry Horse remains about the same. Overall, CRITFC's operation leaves the system about 500 kaf higher than the biological opinion.

It may seem odd that in this scenario, CRITFC ends up with higher reservoir elevations in August (Figure 7) and yet provides greater flows during spring and summer (Figures 3 and 4). The answer can be found by observing the operation of Canada's Arrow and Mica reservoirs. Releases from the Arrow Dam flow directly into the U.S. system. One of CRITFC's recommendations calls for Arrow to fill as much as possible by the end of June and then use this water for flow augmentation in July and August. CRITFC also calls for the release of up to 1 million acre-feet of water from Mica's non-treaty storage for flow augmentation. The net result of these combined actions is observed in Figures 8 and 9, which show the change in Arrow's outflow for spring and summer. Arrow's outflow is reduced by an average of over 3,000 cfs during spring (while it is filling) and is increased by over 12,000 cfs in summer. This allows CRITFC to keep Dworshak higher, so that it can provide water for temperature control and flow augmentation in September.

The Irrigator's scenario begins with a power-optimized operation both for the US and Canadian reservoirs. Thus, in Figure 8, this scenario shows less outflow from Arrow in the spring. The ODFW scenario calls for Arrow to store water in the fall and winter for summer flow augmentation. That operation adds over 15,000 cfs to McNary flows, on average, for summer months.

More specific information regarding all the recommendations is found in the following section. Tables 1a and 1b provides a summary of the key results. Tables 2a, 2b and 2c offer a more detailed description of the 1998 and 2000 biological opinions compared to the Council's 1994 Fish and Wildlife Program. For more information please refer to the Council publication, "Recommendations to Amend the Columbia River Basin Fish and Wildlife Program -- Mainstem Plan (2001)" (document number 2001-16). More extensive information on the analysis is available upon request.[7]

It should be noted that current operations (2000 biological opinion) provide more water for flow augmentation and higher levels of spill than the Council's 1994 Fish and Wildlife program. The 1994 program was not analyzed in this report but based on previous studies, it is estimated to result in about a 300 aMW per year average savings over current operations. This translates into approximately $73 million in annual savings. (See tables 2a, 2b and 2c for more details).

[7] For more information contact the Council and ask for the F&W_analysis_2002.xls spreadsheet.

Figure 8

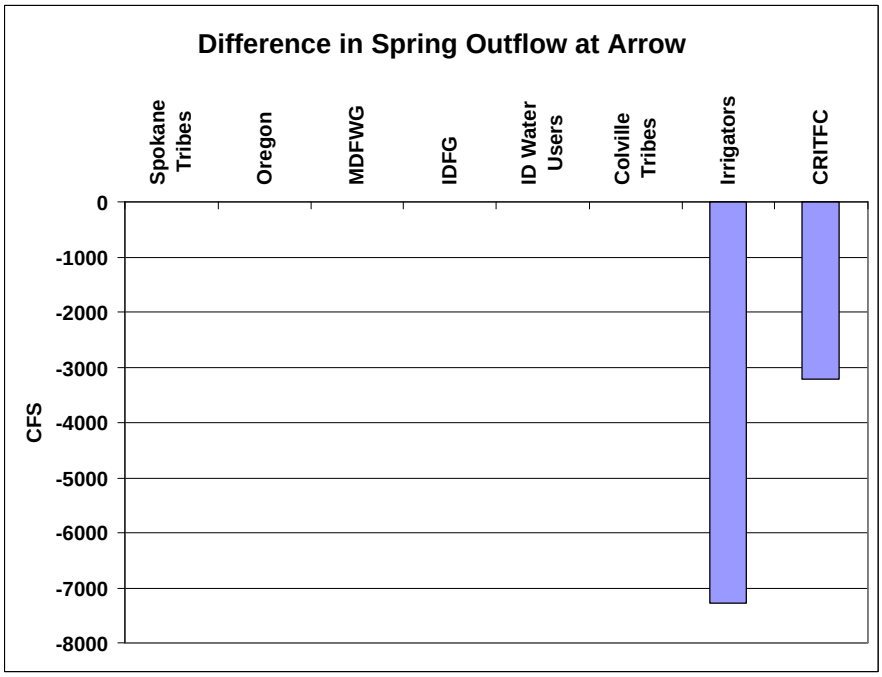
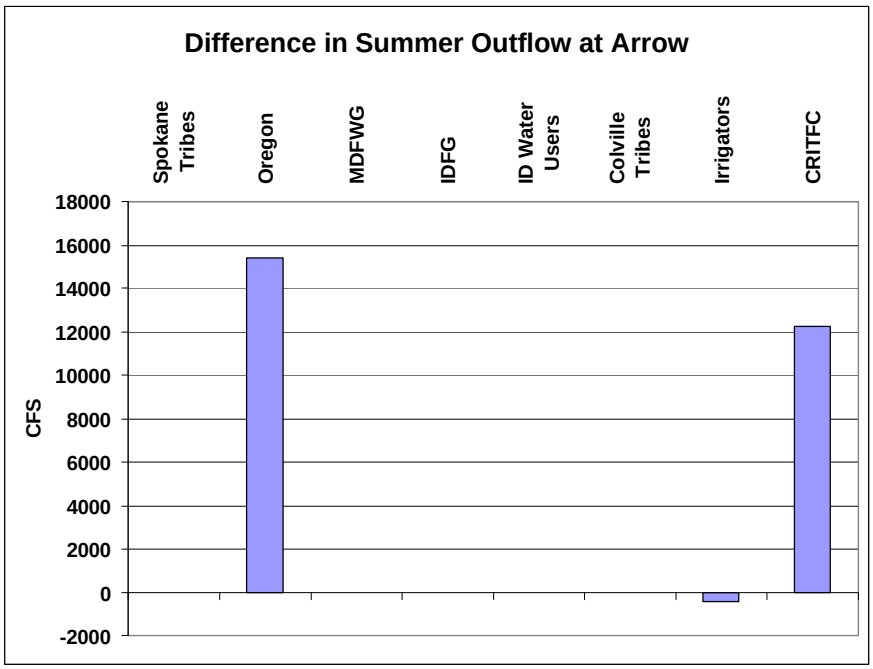


Figure 9



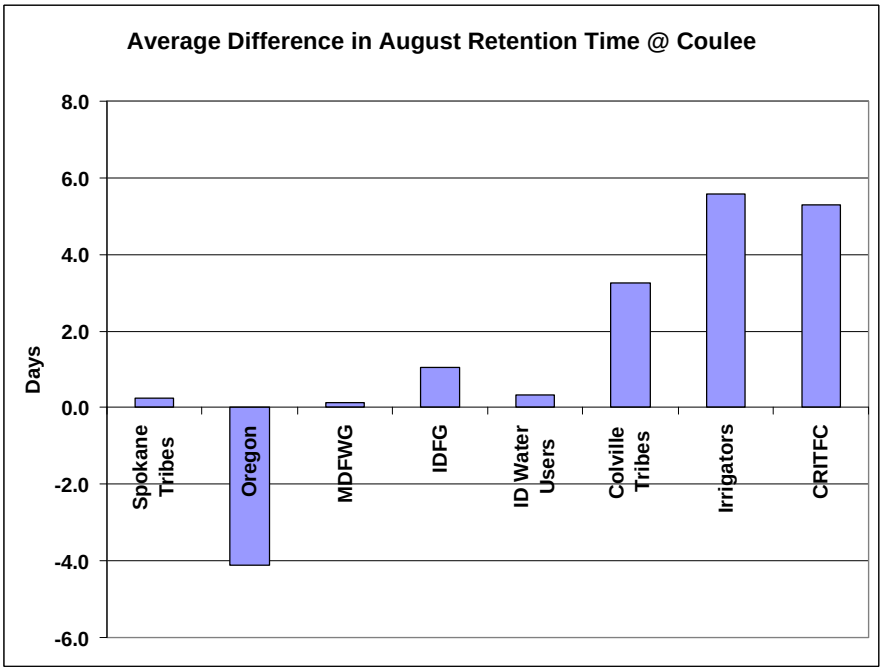
Nutrient Retention at Grand Coulee

Figure 10 provides an example of another parameter that can be affected by different hydro operations. In that figure, the average water retention time at the Grand Coulee reservoir is shown for the last half of August. Water retention time is a surrogate for nutrient retention time, i.e. the amount of time it takes for nutrients to be evacuated from a reservoir. This parameter is important for resident fish. If flows are too high or if the reservoir is too low, nutrients can escape fast enough to limit the availability of food for resident fish. This can impact the populations and size of fish.

It is particularly hard to control retention time in spring because of high flows. The recommended target for May is 35 days, yet under current operations, the average achieved is only 21.5 days. None of the recommendations received raise this average to 35 days. The CRITFC scenario goes the furthest in bringing the average up to 27.5 days, an increase of 6 days. The only other scenario that increases this average by over a day is the Irrigator's recommended operation, which raises the average to 22.6 days.

August is another key month for resident fish. The recommended minimum target is 40 to 45 days. Under current operations, the average retention time for the second half of August is 43.1 days, within the recommended range. Of all the recommendations received, the ODFW scenario is the only one that reduces the August retention time. In that case, the average drops to 38.9 days, a change of over 4 days. All of the other recommendations tend to raise the average, with the most significant changes reported for the Colville, Irrigator's and CRITFC operations, which raise the average by 3.3, 5.6 and 5.3 days respectively. Figure 10 illustrates the change in the average August retention time for each scenario.

Figure 10



Summary of Recommendations

This section provides a brief summary of each recommendation that would affect mainstem hydro operations. Only those actions within each recommendation that affect mainstem operations are summarized. In some cases, more than one agency or organization provided similar recommendations to the Council. In those situations, only one set of recommendations was analyzed.

Idaho Water Users (Volume 2, page 728)

- Eliminate all flow augmentation from the Upper Snake River Basin.
- Abolish flow targets at Lower Granite Dam.

Implementing this recommendation would save the region about 10 average megawatts (aMW) of energy and $2 million per year. River flows at Lower Granite and McNary remain about the same in spring months. During summer, flows at Lower Granite would decrease by an average of about 4,700 cfs, dropping the current average of 45.2 kcfs to 40.5 kcfs. Summer flows at McNary are reduced by about the same amount, dropping the average from 184 kcfs to 179.5 kcfs. The federal reservoirs would have about 260 kaf more water in storage by the end of summer. The additional storage is all at Dworshak, which would be about 21 feet higher, on average. This recommendation does not affect the retention time at Grand Coulee.

Idaho Fish and Game (Volume 2, page 641)

- Change the flow objective to 100 kcfs at Lower Granite Dam during the spring.
- Use Brownlee and Dworshak water in late summer for temperature control.
- Refill Brownlee and Dworshak by June 30th.
- Maximize spillway passage at all dams for all spring migrants (except in dry years).
- Implement Integrated Rule Curves (IRC) at all federal reservoirs.
- Test bypass spill for summer migrants

This recommendation saves the region about 130 average megawatts and $60 million per year. Average flows remain mostly unchanged except at McNary in the summer when they decrease by over 5,000 cfs, dropping the current average from 184 kcfs to 179 kcfs. Federal reservoirs would be higher at the end of summer, with over 700 kaf more water in storage. On average, Libby would be nearly 12 feet higher and Hungry Horse would be about 8 feet higher than under current operations. Coulee's end-of-summer elevation remains unchanged and Dworshak would be about 2 feet higher. This operation slightly improves the nutrient retention time at Coulee in the summer.

Columbia-Snake River Irrigators Association

- Eliminate winter storage for flow augmentation at federal reservoirs.
- Eliminate all spring flow augmentation for both the Snake and Columbia rivers.
- Provide up to 500 kaf of water from Brownlee and the upper Snake for summer flow augmentation.
- Provide up to 900 kaf of water from Dworshak for summer flow augmentation or for temperature control.
- Provide up to 3.0 maf of water from federal reservoirs on the Columbia River for summer flow augmentation.

- Limit spill to the levels provided in the 1998 biological opinion for non-collector dams.
- Eliminate bypass spill at collector dams.

This recommendation will save the region about 280 aMW and $60 million per year. Spring flows at Lower Granite are reduced by about 2,300 cfs, which represents only a 2 percent change. Summer flows are reduced by 8.7 kcfs, dropping the current average of 45.2 kcfs to 36.5 kcfs. At McNary, spring flows are reduced by 10.7 kcfs, bringing the average from 275.3 kcfs to 264.6 kcfs. The summer flows drop by 23.5 kcfs, which reduce the average from 184 kcfs to 160.5 kcfs. This recommendation leaves the federal reservoirs higher at the end of summer, with about 900 kaf more water than the base case. Libby is about 9 feet higher, Grand Coulee is 5.1 feet higher and Dworshak is about 19 feet higher, on average. Hungry Horse is actually about 10 feet lower in this operation. It is drafted more heavily during the winter months for power needs and cannot recover to current biological opinion elevations. Summer retention time at Grand Coulee increases by nearly six days, bringing the average up from 43 to 48.6 days (the recommended minimum value ranges between 40 and 45 days).

Oregon Department of Fish and Wildlife (Volume 2, page 500)

- Place restrictions on the VARQ flood control to eliminate reduction in spawning flows for chum and Chinook below Bonneville Dam.
- Reserve an additional 1 maf of water in Canadian reservoirs for flow augmentation.
- Lower the end-of-summer draft limit at Libby by 10 feet to elevation 2,530 feet.
- Lower the end-of-summer draft limit at Dworshak by 20 feet to elevation 1,500 feet.
- Lower the end-of-summer draft limit at Coulee by 10 feet to elevation 1,270 feet.
- Lower the draft limit at Albeni Falls by 3 feet to elevation 2059.5 feet.
- Increase the spring flow objective to 100 kcfs at Lower Granite for those years whose runoff volume (at Lower Granite) is greater than 16 maf.
- Increase the summer flow objective at Lower Granite to a range from 50 to 100 kcfs for those years whose runoff volume ranges from 16 to 28 maf.
- Increase the summer flow objective at Lower Granite to 100 kcfs for those years whose runoff volume is greater than 28 maf.
- Increase the flow objectives at Bonneville Dam from 125 kcfs through winter to a range between 140 and 160 kcfs for Chum.
- Increase the spring flow objective at McNary Dam to a range from 220 to 260 kcfs for those years whose runoff volume (at The Dalles) is between 80 and 92 maf.
- Increase the spring flow objective at McNary Dam to 260 kcfs for those years whose runoff volume is greater than 92 maf.
- Give summer flow augmentation a priority over spring flows (i.e. attempt to fill federal reservoirs by the end of June).
- Maximize spill, up to the gas super saturation limit.

The ODFW operation shows virtually no annual change in energy or cost. Flows are generally not affected except during summer months at McNary. Average summer flows at McNary increase from 184 kcfs to 195 kcfs, a change of 11,000 cfs. Most of this increase arises from water stored in the Arrow reservoir during winter months, which is then released during the summer. The federal reservoirs end up with more water in storage by August 31st (about 730 kaf more) due to the implementation of IRCs at Libby and Hungry Horse. Libby is 12 feet higher and Hungry Horse is about 9 feet higher, while Coulee and Dworshak remain at the same average elevations. Coulee retention time drops over 4 days due to the increase in summer flows.

Montana Department of Fish, Wildlife and Parks (Volume 2, page 605)

- Operate dams to provide reservoir operations consistent with VARQ flood control and Integrated Rule Curve concepts.
- Reduce the frequency of refill failure (to within 5 feet of full) at Hungry Horse and Libby reservoirs.

This recommendation adds the integrated rule curve operation to the 2000 biological opinion. It shows essentially no energy or cost impacts. Whenever possible, Libby and Hungry Horse reservoirs will be held no lower than their IRC limits. During the summer, the IRC elevations will be maintained unless river flows fall below the biological opinion target levels. This operation has no effect on Snake River flows. At McNary, average spring flows remain about the same. Summer flows are reduced by a little over 1,000 cfs. On average, the composite storage at Grand Coulee, Libby, Hungry Horse and Dworshak reservoirs is only about 140 kaf higher by the end of summer. All of the additional water is at Hungry Horse, whose elevation is about six feet higher than in the base case. August 31st elevations at Libby, Coulee and Dworshak are not affected. The IRCs don't have a large impact because they are given second priority to the biological opinion flow objectives. This operation has little impact to retention times at Coulee.

The Confederated Tribes of the Colville Reservation (Volume 2, page 586)

- Current mainstem program activities should be retained. Staff interpreted this to mean that current biological opinion operations should continue but that the operation at Grand Coulee to increase nutrient retention time (from the Council's 1994 Fish and Wildlife program, outlined below) should also be implemented.

Period	Elevation	Target Retention Time
January-April	at flood control elevation	35 day minimum
May	1,265 feet	35 day minimum
June-July	1,290 feet	45 to 60 days
August	1,280 minimum	45 day minimum
Sep-Dec	1,285 to 1,290	45 to 60 days or greater

The Colville Tribes' proposal adds elevation and outflow limitations at Grand Coulee Dam in an attempt to achieve the target retention times shown in the table above. This operation saves the region about 25 aMW per year but only increases revenues by about $1 million annually. Snake River flows are not affected. On average, spring flows at McNary are unchanged but summer flows decrease by about 3,500 cfs. Grand Coulee reservoir is 5.5 feet higher, on average, by August 31st. These actions increase the average August retention time from 43 days to 46.3 days. Libby, Hungry Horse and Dworshak summer elevations are not affected.

Bonneville Power Administration (Volume 2, page 478) and
National Marine Fisheries Service (Volume 2, page 576) and
The Corps of Engineers (Volume 2, page 828)

- Implement the NMFS' 2000 Biological Opinion.

Compared to a pre-Council (power optimized) operation, the 2000 biological opinion reduces annual energy production by about 1,200 aMW and costs the region $260 per year. At Lower Granite, average spring flows are increased from 97.5 kcfs to 101 kcfs and summer flows are increased from 32.4 kcfs to 45.2 kcfs. At McNary, average spring flows increase from 264.5 kcfs to 275.3 kcfs and summer flows increase from 146.9 kcfs to 184 kcfs. The biological opinion also calls for bypass spill (diverting water around the turbines) to increase smolt survival during the migration period. So, even though flows are increased during the summer months, when electricity prices are high, generation is only slightly increased due to the required spill. The bulk of the cost for this operation is due to the bypass spill. The remainder of the cost comes from holding back water in federal reservoirs during winter months (when northwest demands are highest) and not using it for power generation (so other, more costly resources are dispatched). On average, approximately 8 to 9 maf of water is allocated for flow augmentation. The total useable storage for US reservoirs is about 21 maf[8] and the average January-through-July runoff volume as measured at The Dalles is 106 maf.

Federal reservoirs are emptier by end of summer, nearly 2 maf less water than the pre-Council operation. On average, Coulee and Libby are about 10 feet lower and Dworshak is 52 feet lower. Hungry Horse is actually higher under the biological opinion probably because it is held higher through the winter months. In a pre-Council operation, Hungry Horse is drafted for power during winter months because is has a very high power factor.[9] The inflows are so low into its reservoir that quite often it cannot refill by the end of summer.

Retention times at Grand Coulee are much higher in the pre-Council operation. Average retention time in July is about 46 days, 10 days longer that in the biological opinion. In August, retention time is 47 days in the first half of August and 59 days in the second half -- 10 and 16 days longer than the base case.

Columbia River Inter-Tribal Fish Commission (Volume 1)

The CRITFC recommendations are very detailed and comprehensive. In this summary, only the major actions that affect mainstem hydro operations are summarized.

- Operate John Day reservoir at minimum-operating-pool elevation year round
- Reduce flood control space at federal dams beyond the VARQ limits. (This is done without compensating actions and could increase the risk of flooding).
- Use 1 maf of Canadian non-treaty water for flow augmentation.
- Refill the Arrow reservoir (Canadian) by the end of June. Use the additionally stored water for summer flow augmentation.
- Pass inflow at all federal dams in June.
- Use 500 kaf of Banks Lake water for flow augmentation.

[8] Canadian reservoirs can store about 21 maf also but they cannot be used specifically for flow augmentation in the US.
[9] Each unit of water passed through Hungry Horse generates about twice the energy that it would at Grand Coulee.

- Implement IRCs at Libby and Hungry Horse reservoirs.
- Attempt to replicate the natural hydrograph by implementing the flow objectives outlined below.
- Adjust drafting limits at federal dams to aid in flow augmentation releases.

Project	Month	Range of Flow Objectives
Lower Granite	May	86,250 to 149,500 cfs
Lower Granite	June	75,000 to 130,000 cfs
Lower Granite	July	47,250 to 81,900 cfs
Lower Granite	August	30,000 to 59,800 cfs
Lower Granite	September	28,875 to 50050 cfs
The Dalles	April	168,000 to 288,000 cfs
The Dalles	May	320,000 to 480,000 cfs
The Dalles	June	360,000 to 540,000 cfs
The Dalles	July	240,000 to 360,000 cfs
The Dalles	August	112,000 to 240,000 cfs
The Dalles	September	100,000 to 150,000 cfs
The Dalles	October	80,000 to 120,000 cfs
The Dalles	November	69,600 to 104,400 cfs

This proposal alters the use of federal and Canadian reservoirs in an attempt to reshape river flows to match the natural hydrograph (June peak flows). Flood control elevations are relaxed beyond the VARQ levels, which results in a higher risk of flooding. This recommendation reduces annual energy production by about 570 aMW and costs the region $160 million per year. On average, flows at Lower Granite Dam increase by 3,400 cfs in the spring but are reduced by a little over 1,800 cfs in the summer. At McNary Dam, spring flows increase by an average of 17,600 cfs and summer flows increase by 4,150 cfs.

Federal storage projects hold about 1.7 maf more water by April 15th, on average, than in the base case. At the end of summer, federal reservoirs have about 500 kaf more water in storage. Some of this water is used for flow augmentation or for temperature control in the early fall. By the end of August, Libby and Hungry Horse elevations are about what they are for the biological opinion operation. Grand Coulee is about 3.1 feet higher and Dworshak is 19 feet higher. The August retention time at Grand Coulee is improved somewhat due to its higher elevation.

The Spokane Tribes (Volume 2, page 618)

- Change the draft limits at Grand Coulee reservoir to the values provided below.
- Provide maximum flow limits at Grand Coulee to attempt to achieve the nutrient retention times outlined below but give first priority to the biological opinion flow augmentation operation.

Period	Elevation	Target Retention Time
January	1,270 feet	45 days
February	1,260 feet	40 days
March-April 15	1,250 feet	30 days
April 16-30	1,255 feet	30 days
May	1,265 feet	35 days
June-December	1,288 feet	40 to 60 days

Similar to the Colville Tribe's recommendation, the Upper Columbia United Tribe's proposal adds elevation and outflow limitations at Grand Coulee Dam to attempt to achieve the target retention times shown in the table above. These constraints take second priority to flow-augmentation actions and thus do not come into play very often. The scenario shows virtually no change to annual generation or cost. The gain in average summer retention time at Grand Coulee is less than one day, because this operation is given second priority to anadromous fish flow objectives. On average, Snake and Columbia River flows are not affected, and the elevation at federal projects, including Grand Coulee, is relatively unchanged. In order to make this a more effective operation, higher priority must be given to the target elevations and outflows at Grand Coulee.

Table 1a
Summary of Impacts (Relative to the 2000 Biological Opinion)

				Spring Flows			Summer Flows	
	Energy	**Cost**		**L Granite**	**McNary**		**L Granite**	**McNary**
	(aMW)	**(millions)**		**(cfs)**	**(cfs)**		**(cfs)**	**(cfs)**
Pre-Council	1202	- $ 257		-3416	-10843		-12865	-37051
Spokane	0	$ 0		0	-84		0	17
Oregon	-1	$ 1		0	-668		20	11075
MDFWG	-1	$ 1		0	41		0	-1132
IDFG	131	- $ 59		0	43		-208	-5163
ID Water	10	- $ 2		316	316		-4683	-4416
Colville	25	- $ 1		0	195		0	-3490
Irrigators	278	- $ 60		-2355	-10699		-8699	-23472
CRITFC	-570	$ 158		3392	17580		-1826	4150
	Difference in Volume (kaf)				**Water Retention Time at Coulee (days)**			
	April 15th	**June 30th**	**August 31st**		**October**	**February**	**June**	**Aug16-31**
Pre-Council	-2179	-771	1960		6.3	0.4	2.9	16.0
Spokane	-13	0	-2		0.3	0.0	0.0	0.3
Oregon	-37	98	736		7.0	1.6	0.1	-4.1
MDFWG	-15	1	141		2.7	-0.1	0.1	0.1
IDFG	87	119	726		2.4	-0.1	0.1	1.0
ID Water	23	0	260		0.1	0.0	0.0	0.3
Colville	31	0	422		2.0	0.3	0.0	3.3
Irrigators	-2074	-1034	908		6.3	0.1	1.9	5.6
CRITFC	1693	-1050	522		-0.3	17.0	-6.1	5.3

Table 1b
50-Year Average Reservoir Elevations (Feet)

	April 15th				June 30th			
	Libby	**Horse**	**Coulee**	**Dworshak**	**Libby**	**Horse**	**Coulee**	**Dworshak**
2000 Biop	2377.1	3503.1	1250.1	1511.0	2450.7	3556.8	1287.0	1598.2
Pre-Council	2335.9	3467.7	1245.0	1485.6	2444.2	3536.9	1286.9	1593.0
Spokane	2377.1	3503.1	1249.9	1511.0	2450.7	3556.8	1287.0	1598.2
Oregon	2377.3	3507.5	1248.3	1511.0	2452.5	3557.8	1287.0	1598.2
MDFWG	2377.1	3501.9	1250.3	1511.0	2450.7	3556.8	1287.0	1598.2
IDFG	2377.3	3507.4	1250.1	1511.0	2452.9	3557.8	1287.0	1598.2
ID Water	2377.1	3503.1	1250.1	1512.5	2450.7	3556.8	1287.0	1598.2
Colville	2377.1	3503.1	1250.5	1511.0	2450.7	3556.8	1287.0	1598.2
Irrigators	2345.0	3462.1	1244.3	1485.8	2441.1	3533.4	1286.5	1591.3
CRITFC	2377.0	3501.0	1270.6	1542.8	2446.5	3544.2	1279.7	1597.9
	August 31st				**Full Reservoir Elevation**			
	Libby	**Horse**	**Coulee**	**Dworshak**	**Libby**	**Horse**	**Coulee**	**Dworshak**
2000 Biop	2441.6	3542.5	1279.5	1534.9	2459	3560	1290	1600
Pre-Council	2451.5	3534.8	1289.5	1586.3				
Spokane	2441.6	3542.5	1279.5	1534.9				
Oregon	2453.5	3551.3	1279.7	1534.7				
MDFWG	2441.6	3548.7	1279.5	1534.9				
IDFG	2453.3	3550.6	1279.5	1536.7				
ID Water	2440.9	3542.5	1279.5	1555.8				
Colville	2441.4	3542.4	1285.0	1534.9				
Irrigators	2450.6	3532.9	1284.6	1553.8				
CRITFC	2441.8	3543.0	1282.6	1553.9				

Table 2a
Summary of Modeling Assumptions for Mainstem Hydro Operations
Snake River

Project	Council's 1994 F&W Program	NMFS' 1998 Biological Opinion	NMFS' 2000 Biological Opinion
Upper Snake	527 kaf	427 kaf	**427 kaf plus**
Brownlee	Apr16-30: 110 kaf May: 110 kaf (2069') Jun: pass inflow Jul: 137 kaf (2067') Aug: pass inflow Sep: 100 kaf (2059')	Dec-Apr: min flow = Nov max May: 2069' Jun: refill Jul: 2067' Aug: 2059' Nov: max outflow 9 Kcfs	Under FERC consultation
Dworshak	Sep-Apr15: min flow Apr15-Jun: 1 maf Jul: draft limit 1520' Aug: refill Sep: 200 kaf	Sep-Apr15: min flow Apr16-Aug: 14 Kcfs max flow Aug: draft limit 1520'	Sep-Apr15: min flow Apr16-Aug: 14 Kcfs max flow Aug: draft limit 1520' **Evaluate 1500' for adults**
Lower Granite	Apr16-Jun15: near spillway Jun16-Aug: near MOP Flow target Apr16-Jun: 85-140 Kcfs Jul: 50 Kcfs Spill: to achieve 80% FPE 40 to 50% Cap: 120% gas	Apr16-Aug: near MOP Flow targets Apr3-Jun20: 85-100 Kcfs Jun21-Aug: 50-55 Kcfs Spill: 60 Kcfs 12 hours/day Cap: 60 Kcfs	Apr16-Aug: near MOP Flow targets Apr3-Jun20: 85-100 Kcfs Jun21-Aug: 50-55 Kcfs Spill: 60 Kcfs 12 hours/day Cap: 60 Kcfs
Little Goose	Apr16-Jun15: near spillway Jun16-Aug: near MOP Spill: to achieve 80% FPE 40 to 50% Cap: 120% gas	Apr16-Aug: near MOP Spill: 45 Kcfs 12 hours/day Cap: 45 Kcfs	Apr16-Aug: near MOP Spill: 45 Kcfs 12 hours/day Cap: 45 Kcfs
Lower Monumental	Apr16-Aug: near MOP Spill: none	Apr16-Aug: near MOP Spill: 37 Kcfs 12 hours/day Cap: 37 Kcfs	Apr16-Aug: near MOP **Spill: 70 Kcfs 24 hours/day** **Cap: 70 Kcfs**
Ice Harbor	Apr16-Aug: near MOP Spill: to achieve 80% FPE 27 to 70% Cap: 120% gas	Apr16-Aug: near MOP Spill: 45 Kcfs day 105 Kcfs night Cap: 105 Kcfs	Apr16-Aug: near MOP Spill: 45 Kcfs day 105 Kcfs night Cap: 105 Kcfs

Table 2b
Summary of Modeling Assumptions for Mainstem Hydro Operations
Upper Columbia River

Project	Council's 1994 F&W Program	NMFS' 1998 Biological Opinion	NMFS' 2000 Biological Opinion
Mica	Explore the use of non-treaty Canadian water for flow augmentation		**Negotiate with BC Hydro to release non-treaty water in July and August**
Arrow	Jan-Apr15: store "operational" volume (total of 4 maf in US and BC)	Store up to 1 maf in treaty space in low water years for release to enhance migration flows for juveniles.	Store up to 1 maf in treaty space in low water years for release to enhance migration flows for juveniles.
Libby	Jan-Apr15: Store "operational" volume IRC draft limits year round	Jan-Apr15: min flow May-Jul: sturgeon & bull trout Aug: draft limit 2439'	**VARQ flood control** Jan-Apr15: min flow May-Jul: sturgeon & bull trout Aug: draft limit 2439'
Hungry Horse	IRC draft limits year round	Jan-Apr15: fish curves Jun: refill Aug: draft limit 3540'	**VARQ flood control** Jan-Apr15: fish curves Jun: refill Aug: draft limit 3540' **dry years 480 kaf or 3530'**
Albeni Falls	No lower than 2056'	Oct-Apr: 2051'	**Oct-Apr: alternate between 2051' and 2056' for 6 years**
Grand Coulee	Jan-Apr15: store "operational" volume Retention time constraints Aug: draft limit 1283' to 1288'	Jan-Apr15: fish curves Jun: refill Aug: draft limit 1280' Nov-May: Vernita Bar flows	**VARQ flood control** Jan-Apr15: fish curves Jun: refill **Aug: 130 kaf (Banks Lake)** Aug: draft limit 1280' **dry years 1278'** **Nov-Apr: Chum flows** Nov-May: Vernita Bar flows

Table 2c
Summary of Modeling Assumptions for Mainstem Hydro Operations
Lower Columbia River

Project	Council's 1994 F&W Program	NMFS' 1998 Biological Opinion	NMFS' 2000 Biological Opinion
Priest Rapids		Flow targets Apr10-Jun: 135 Kcfs	Flow targets Apr10-Jun: 135 Kcfs
John Day	Near MOP year round Spill: to achieve 80% FPE 30 to 40% Cap: 120% gas	Apr16-Sep: elevation 262.5' Oct-Apr15: elevation 265' Spill: 22 to 30% Cap: 58 to 80 Kcfs	Apr16-Sep: elevation 262.5' Oct-Apr15: elevation 265' **Spill: alternate 0 & 30% day** **60% night** **Cap: 160 Kcfs**
McNary	 Spill: to achieve 80% FPE 24 to 45% Cap: 120% gas	Flow targets Apr20-Jun: 220-260 Kcfs Jul-Aug: 200 Kcfs Spill: 136 Kcfs 12 hours/day Cap: 136 Kcfs	Flow targets **Apr10**-Jun: 220-260 Kcfs Jul-Aug: 200 Kcfs Spill: 136 Kcfs 12 hours/day Cap: 136 Kcfs
The Dalles	Flow targets Apr16-Apr30: 170 Kcfs May-Jun: 180-300 Kcfs Jul: 200 Kcfs Aug: 160 Kcfs Spill: to achieve 80% FPE 40% 24 hours/day Cap: 120% gas	 Spill: 64% 24 hours/day Cap: 230 Kcfs	 **Spill: 40% 24 hours/day** Cap: 230 Kcfs
Bonneville	 Spill: to achieve 80% FPE 68 to 77% Cap: 120% gas	 Spill: 75 Kcfs day, 120 night Cap: 75 Kcfs day, 120 night	Chum flows Nov1-Nov15: 125 Kcfs Nov16-Apr: 145 Kcfs **Spill: 175 Kcfs 24 hours/day** **Cap: 175 Kcfs**