White Paper on the Power System Value of Conserved Irrigation Diversions

The Northwest Power and Conservation Council
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Contents

Executive Summary

This paper provides an estimate of the power-system value of water that remains in the river from conserved irrigation diversions, both in terms of energy gained and increased revenues, at various locations in the Columbia River Basin. For certain watersheds in the region, conserved irrigation water may more likely be utilized by other water users and, therefore, not remain in the hydroelectric system. For these areas, there is no additional energy generated or increased revenue and thus no power-system benefit. The monetary benefit of conserved irrigation diversions for these areas must be assessed differently – a topic that is beyond the scope of this paper.

In general, the more upstream a diversion is taken, the greater the power-system value of conserving water from that diversion because it passes through more hydroelectric facilities. For example, averaged over the irrigation season, each thousand acre-feet of water that passes through Grand Coulee and all downstream dams generates 1,026 megawatt-hours of energy. The same volume of water generates 216, 147 and 46 megawatt-hours, if left in the system in the upper Salmon, the Walla Walla, and the Deschutes areas, respectively. Revenue gained from conserved irrigation diversions is estimated below based on an average electricity price of $55 per megawatt-hour.[1]

- $56.60 per acre-foot at Grand Coulee,
- $12.00 per acre-foot in the upper Salmon,
- $8.16 per acre-foot in the Walla Walla area, and
- $2.53 per acre-foot in the Deschutes area.

Several key factors are required to assess the value of conserving irrigation diversions; 1) site at which the diversion is taken, 2) site at which the return flow (unused portion of the diversion) reenters the river, 3) percentage of the diversion that reenters the river, 4) monthly power factors for all downstream hydroelectric facilities and 5) monthly market price of electricity. First, the amount of energy gained by leaving one thousand acre-feet (Kaf) of conserved irrigation water in the hydroelectric system is calculated. Second, a reduction is made to account for energy that would have been produced by return flows had this diverted water not been conserved. Finally, the net energy gain is priced at the bulk electricity market value to assess gained revenue.

As noted, this analysis only provides a rough estimate of the power-system value of conserved irrigation diversions because many simplifying assumptions are made. One assumption is that any water conserved through irrigation efficiency measures that remains in the river passes through all downstream hydroelectric facilities, subject to non-power constraints. Another component of the benefits calculation is the amount of energy saved by not pumping conserved irrigation water. However, because pumping loads are assumed to be relatively small, these savings are not added in. The only exception is at Grand Coulee where the saved pumping energy is significant. Furthermore, return flow percentages are approximated based on the general area of withdrawals. All return flows are assumed to reenter the system in the same month as the withdrawals are taken – no adjustment is made for lag time. This assumption is reasonable for surface water but for ground water, reentry may be months later. All return flow assumptions (locations and percentages) are based on the Bonneville Power

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[1] The Seventh Northwest Conservation and Electric Power Plan, February 2016, Chapter 8: Electricity and Fuel Price Forecasts.

Administration's 2000 Level Modified Streamflow[2] report. A more current report is available[3] but extracting and processing return flow data is complicated and time-consuming. For this assessment, return flow percentages and locations are not updated because those changes are assumed to be small relative to updated hydroelectric power factors, which account for current biological opinion operations, and updated electricity market prices.

The Regional Technical Forum (a Council advisory committee established to develop standards to verify and evaluate energy efficiency savings) has developed savings estimates for measures to reduce electricity usage due to reduced water usage for irrigation (e.g. efficient sprinkler systems). The concept is to set up utility programs that provide monetary incentives to irrigators or other water users to convert to more efficient means of using water. The added power system value of water that stays in the system could be used by the RTF and others to more fully capture the benefits of these conservation measures.

Introduction

This paper estimates the power-system value of water that remains in the river from conserved irrigation diversions, both in terms of energy gained and increased revenues, at various locations in the Columbia River Basin.[4] Based on data prepared by federal agencies in the Pacific Northwest,[2] irrigation withdrawals result in a net annual reduction in streamflow volume of about 14.4 million acre-feet (Maf) at McNary of which about 8.4 Maf is due to withdrawals in the Snake River Basin. Total irrigation withdrawals are somewhat greater than the net values because the net values are offset by return flows (the portion of irrigation withdrawals that is not consumed and returned to the river). The annual average streamflow volumes (net of irrigation withdrawals) are about 135 MAF for the Columbia River and about 37 MAF for the Snake River.[5]

Background Information on Irrigation

Since about 1900, irrigated land in the Columbia River Basin has grown substantially, increasing from about half a million acres in that year to over 8 million acres today. Figure 1 shows the amount of irrigated land in the basin for various years from 1900 through 2013. Since 1980 there has been a slight decrease in irrigated land, dropping from a high of 9.2 million acres in 1980 to 8.4 million in 1990 and to 8.6 in 2013.

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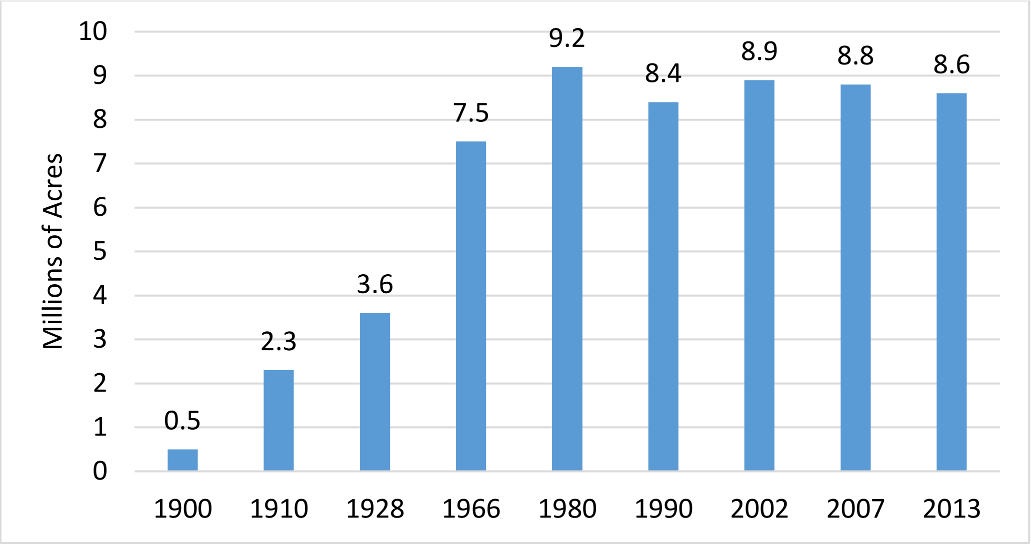
[2] 2000 Level Modified Streamflow, 1928-1998, Bonneville Power Administration.

[3] 2010 Level Modified Streamflow, 1928-2008, DOE/BP-4352, August 2011, Bonneville Power Administration.

[4] The amount of water that remains in the river system from conserved irrigation varies by watershed. In Washington, RCW 90.90 requires a third of saved water shall be used to augment instream flows.

[5] The Columbia River System: The Inside Story, September 1991, Bonneville Power Administration, et. al.

Figure 1 – Irrigated Land in the Pacific Northwest



Of the 1990 value[6], 2.2 million irrigated acres are in the upper Columbia River Basin above the mouth of the Snake River, including Canada. In the Snake River Basin, about 4 million acres were irrigated. In the lower Columbia River between Ice Harbor and Bonneville dams, about three-quarters of a million acres were irrigated and 1.3 million acres were irrigated in the Willamette and other lower Columbia River tributaries. Figure 2 illustrates the breakdown of irrigated land by region and by state.

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[6] We are describing the 1990 level of irrigation as background material only. The analysis for this paper includes current irrigation flow data.

Figure 2 – Irrigated Land by Region and State

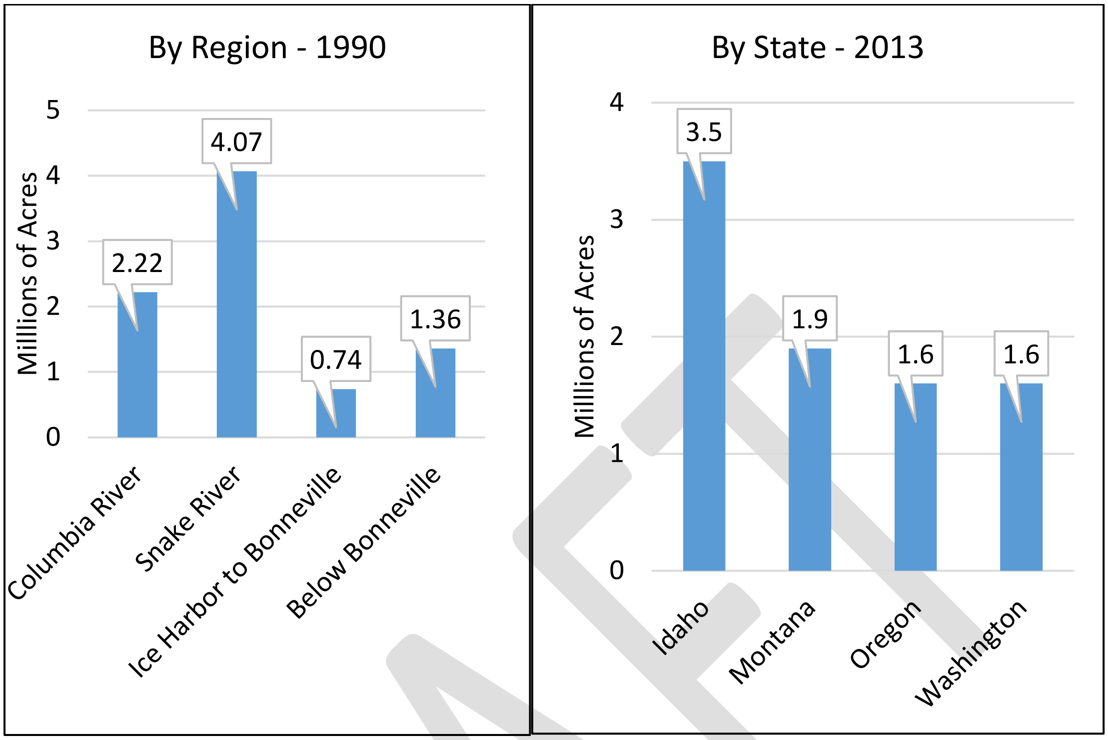
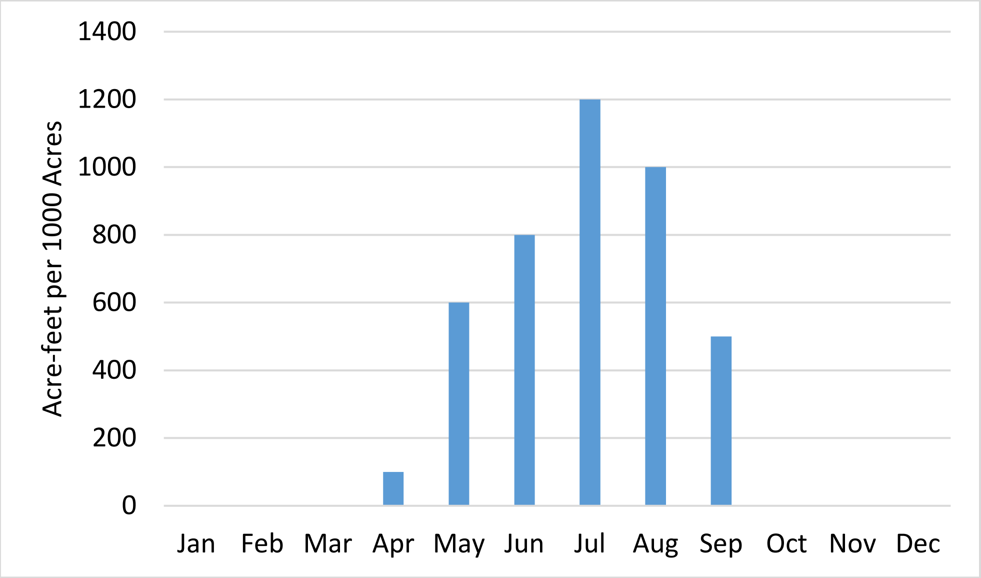


Figure 3 summarizes the timing and amount of irrigation diversions for the entire basin per 1000 acres of irrigated land, which shows that irrigation generally begins in late April and ends in September. Diversions steadily increase each month from April through July (the peak irrigation month) and then decrease through September. The pattern for return flow also peaks in July, which can be interpreted to mean that most of diverted water returns within the same month.

Figure 3 – Timing and Amount of Irrigation Diversions per 1000 Acres



More specifically, Figure 4 shows the average monthly streamflows at McNary, with and without irrigation diversions. Figure 5 highlights the irrigation diversion flows (e.g. flows without diversions minus flows with diversions). Irrigation diversion flows include the effects of return flows. Figure 6 shows the monthly average irrigation diversion volumes, with an average of 3.9, 3.1 and 2.4 Maf withdrawn in May, Jun and July, respectively. Figures 7-9 show the corresponding data for Lower Granite, where the same pattern is seen. Figure 9 shows the monthly average irrigation diversion volumes at Lower Granite, with an average of 2.5, 2.4 and 1.3 Maf withdrawn in May, June and July, respectively.

Figure 4 – Average Streamflows at McNary Dam (with and without irrigation diversions)

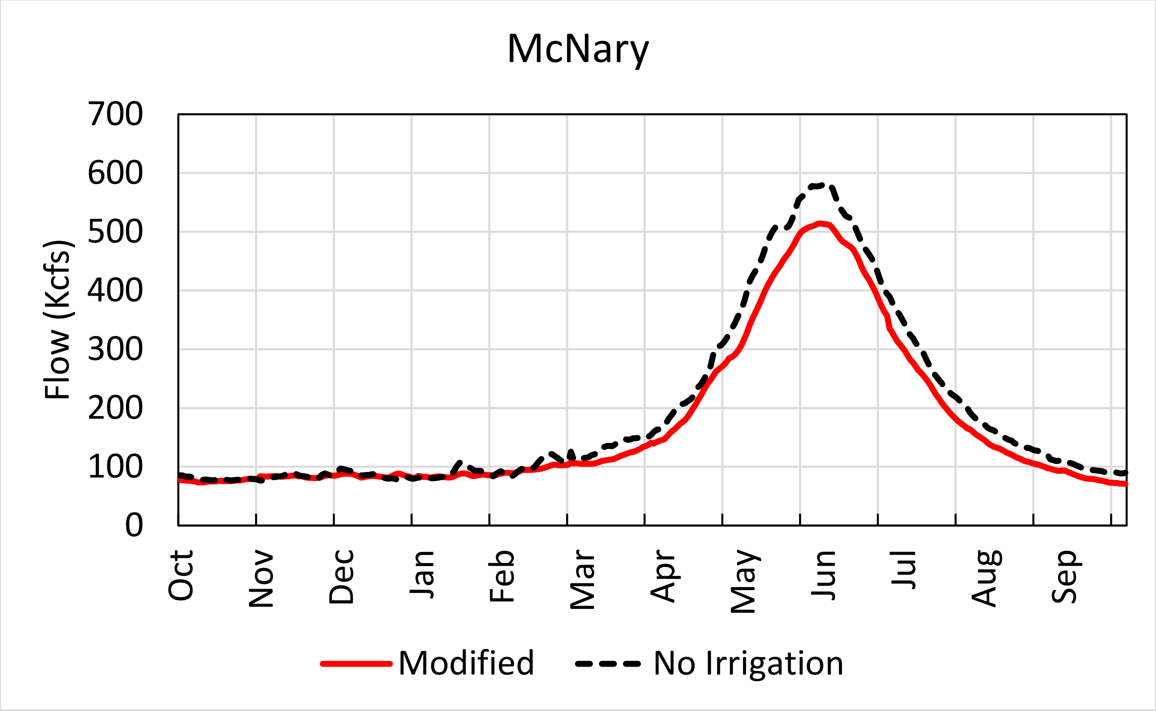


Figure 5- Average Irrigation Diversion Flows at McNary Dam

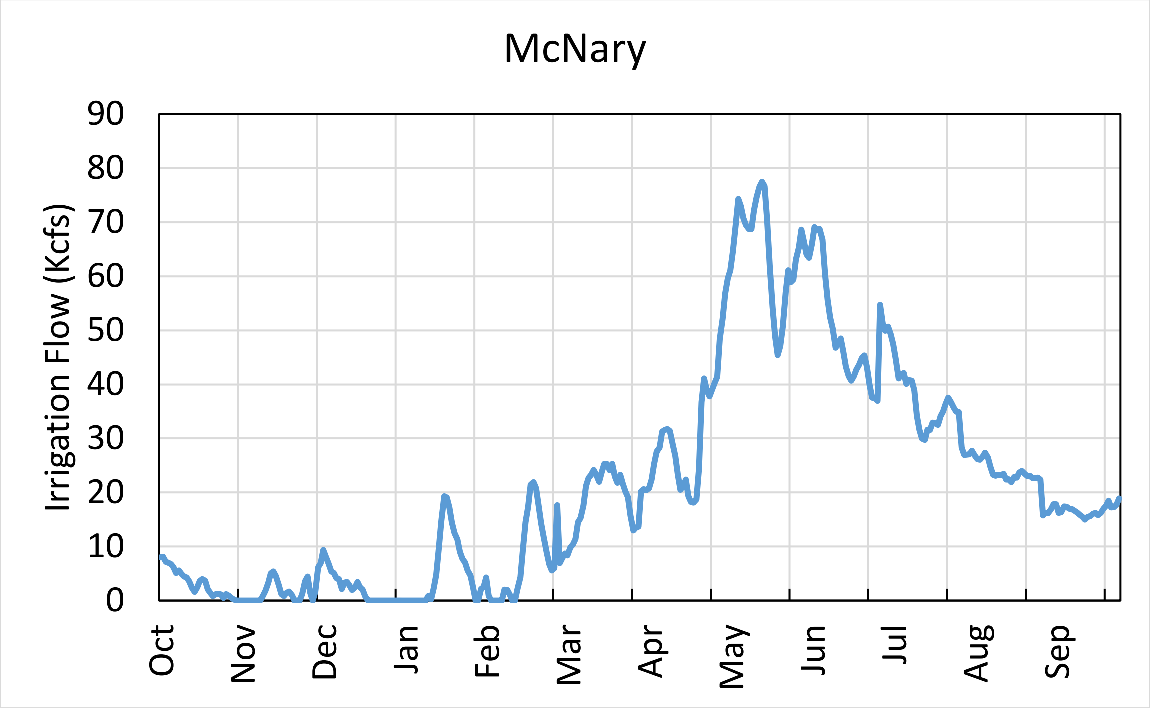


Figure 6 – Average Irrigation Diversion Volumes at McNary

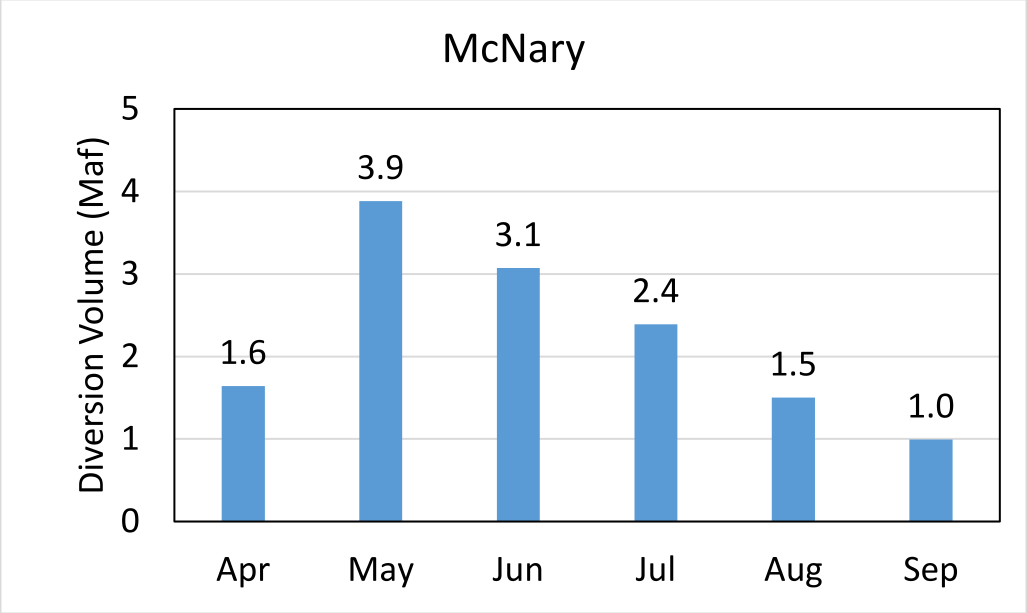


Figure 7 – Average Streamflows at Lower Granite Dam (with and without irrigation diversions)

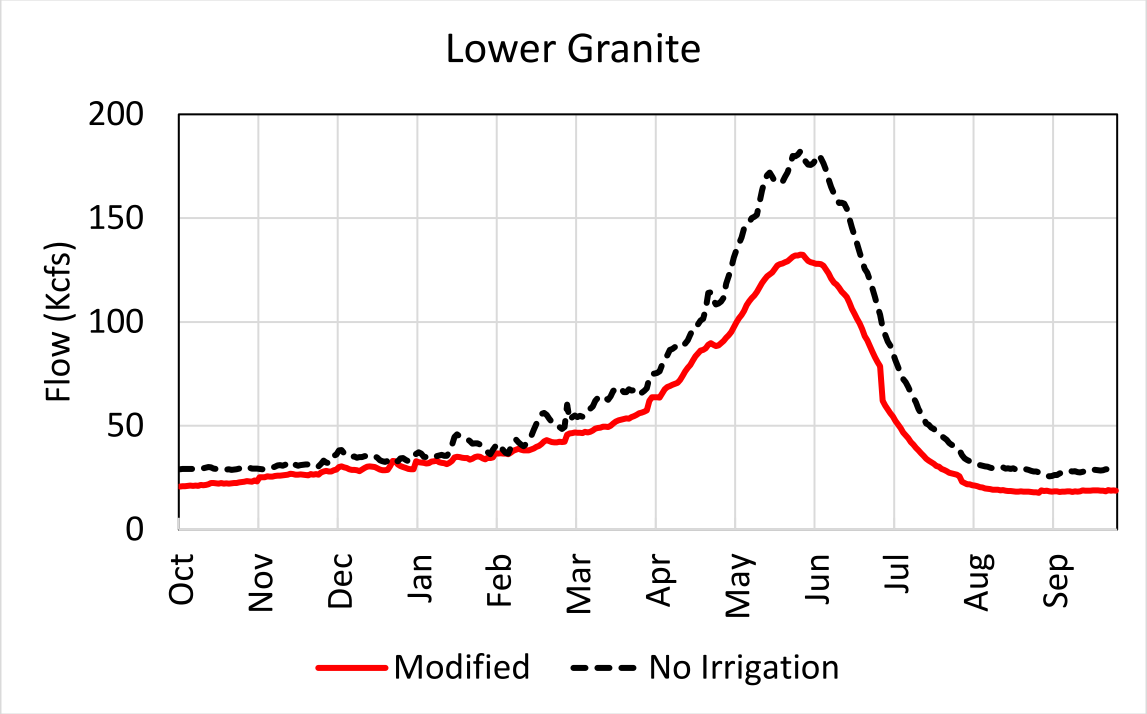


Figure 8 – Average Irrigation Diversion Flows at Lower Granite Dam

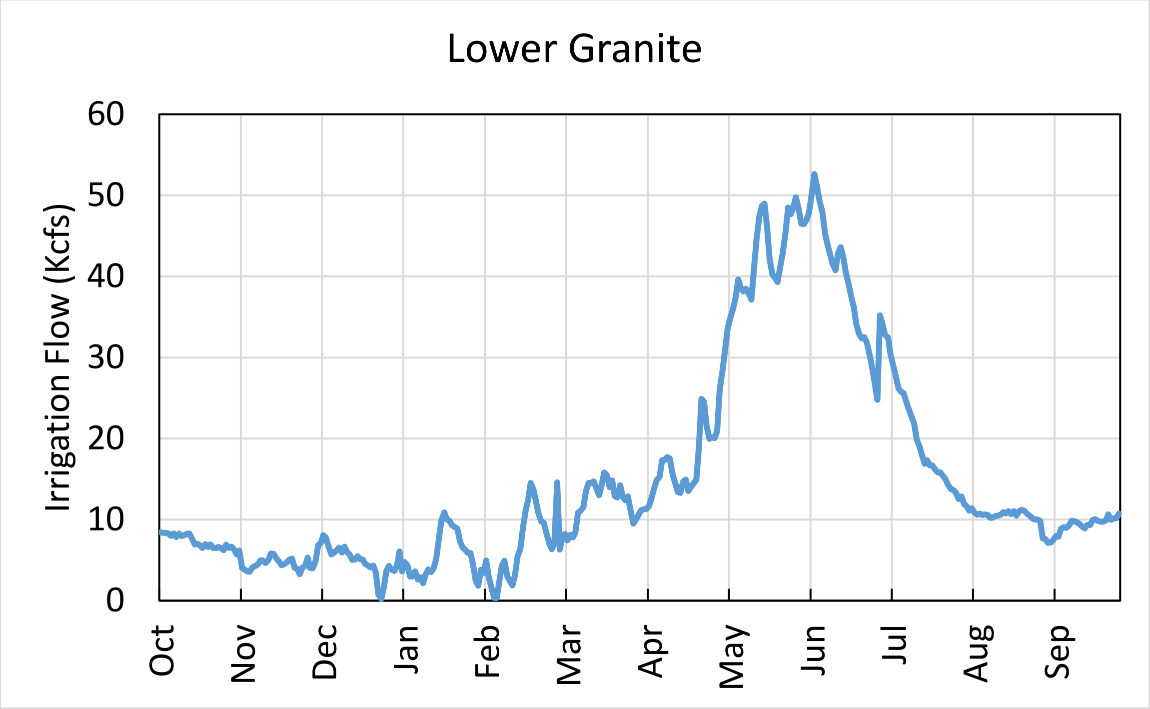
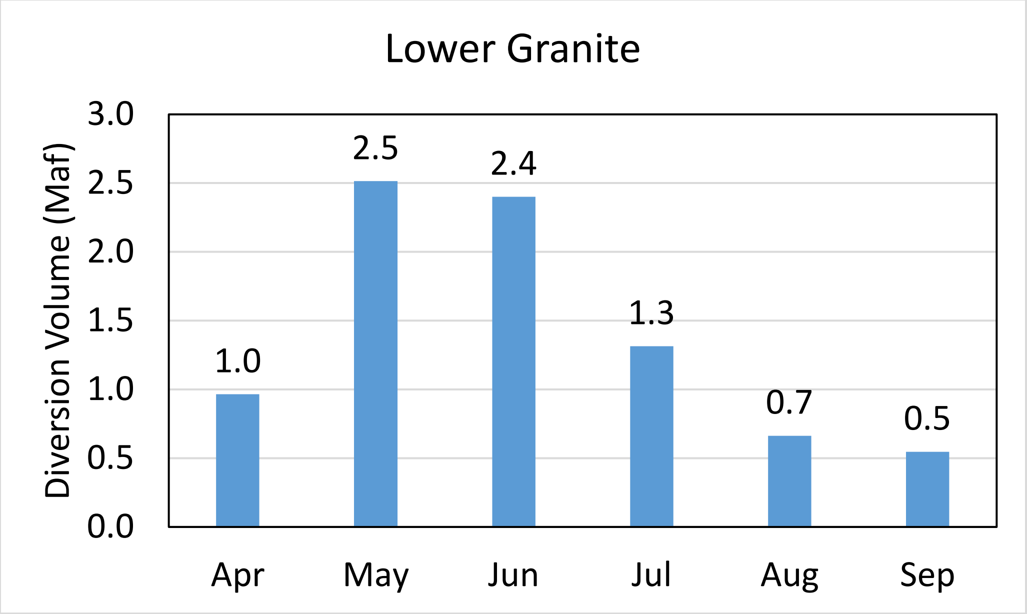


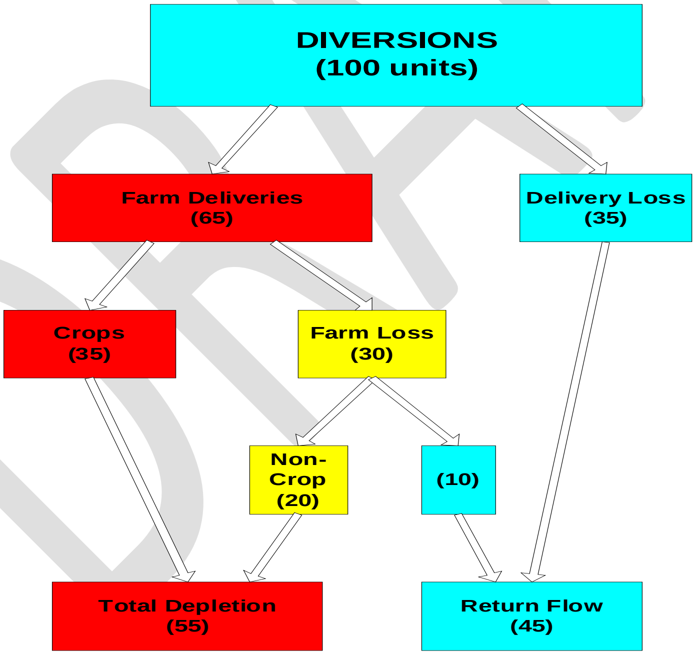
Figure 9 – Average Irrigation Diversion Volumes at Lower Granite



Not all diverted water is lost to the river system. As one might expect, water that is not consumed or evaporated eventually returns to the river, sometimes much further downstream from where it was diverted. The amount of return flow depends on many parameters, including the location and the type of crop, the method of irrigation, and the number of acres irrigated. Return flow can re-enter the river directly through waste ditches and channels or indirectly through groundwater movement. Return flow can re-enter the river relatively soon after it is diverted, or it could re-enter many months later depending on whether it takes a direct or indirect route back. Figure 10 illustrates potential paths for a water diversion. It should be noted that while the values in Figure 10 are typical, they are not necessarily representative for any given location.

Rough estimates indicate that only about 65 percent of diverted water is delivered to farm lands. The remaining 35 percent returns to the river directly. Of the water that is delivered to farms, a little more than half of it gets to the crops. Farm losses account for 30 percent of the total diversion. Of that amount, 10 percent eventually finds its way back to the river and the other 20 percent is lost in non-beneficial consumptive use (non-crop vegetation) and ground water buildup. Of the 35 percent that gets to the crops, only 2 percent is consumed by plants. The rest is lost to evapotranspiration. Thus, for each unit volume of diverted water, about 45 percent eventually returns to the river.

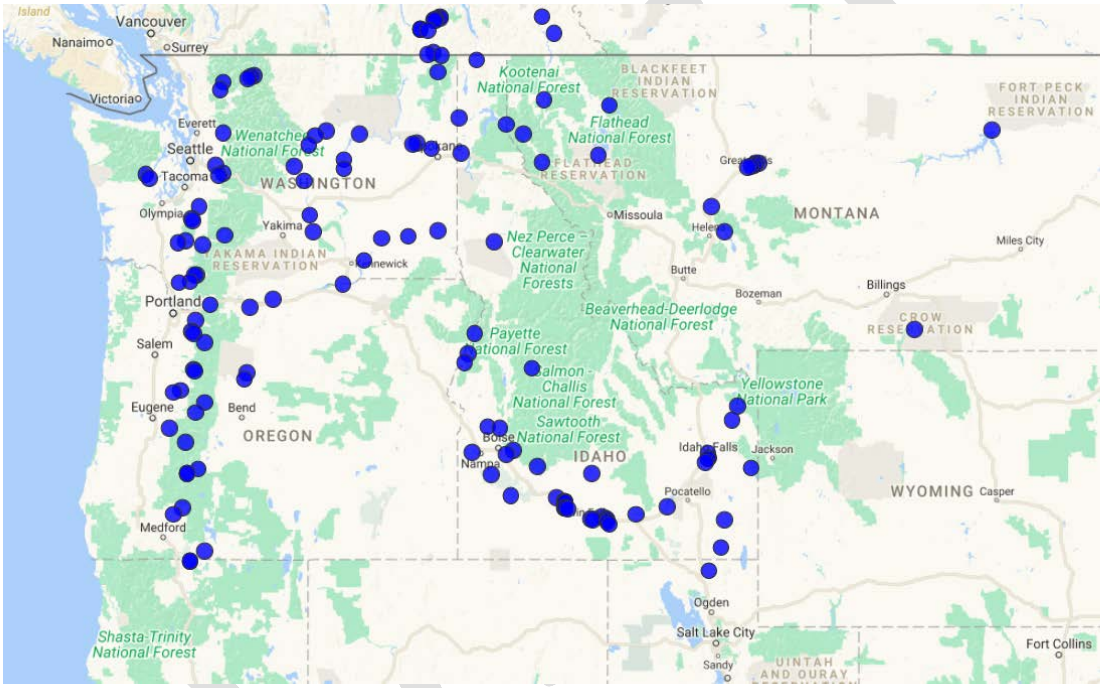
Figure 10 – Sample Paths for Diverted Irrigation Water



The Hydroelectric System

The Columbia River Hydroelectric System consists of over 250 dams, which produce electricity, provide flood control protection and facilitate recreation and navigation. The Columbia River also provides water for irrigation and industrial use. Federal agencies have built 30 major dams on the river and its tributaries. Of those, 14 are deemed large enough to explicitly simulate their operation in regional computer planning models. For purposes of this paper, only 8 of the major Federal dams and 2 non-Federal dams will be examined. Figure 11 provides a map that shows the location of the larger hydroelectric projects in the basin. The schematic in Figure 12 shows the relative location and river flow path of the projects highlighted in this paper, starting with Grand Coulee on the upper Columbia River and Dworshak and Brownlee on the Snake River down to Bonneville Dam on the lower Columbia.

Figure 11 – Hydroelectric Facilities in the Pacific Northwest



Calculating the Value of Conserved Water Diversions

If all diverted water were consumed (i.e. no return flow) then calculating energy gains of reducing diversions would be simple. But this is not the case. To properly assess the value of conserved diverted water, return flows must be incorporated into the calculation. Unfortunately, the amount and timing of return flows varies with location. Figure 13 highlights four[7] major diversions: 1) the Columbia River Basin Project above Grand Coulee with more than one and a half million acre-feet of water diverted, 2) the Upper Salmon area with about 350,000 acre-feet of diverted water, 3) the Walla Walla area with 230,000 acre-feet of diversion and 4) the Deschutes area with about 460,000 acre-feet of diversion. These sites were chosen to represent the upper Columbia, the lower Snake, the mid-Columbia, and the lower Columbia regions, respectively. While these sites are more-or-less typical, they may not necessarily accurately reflect the characteristics for all the diversions in their respective areas. That is, even within a small area, the amount and timing of return flow can vary depending on the land, crop, and irrigation method.

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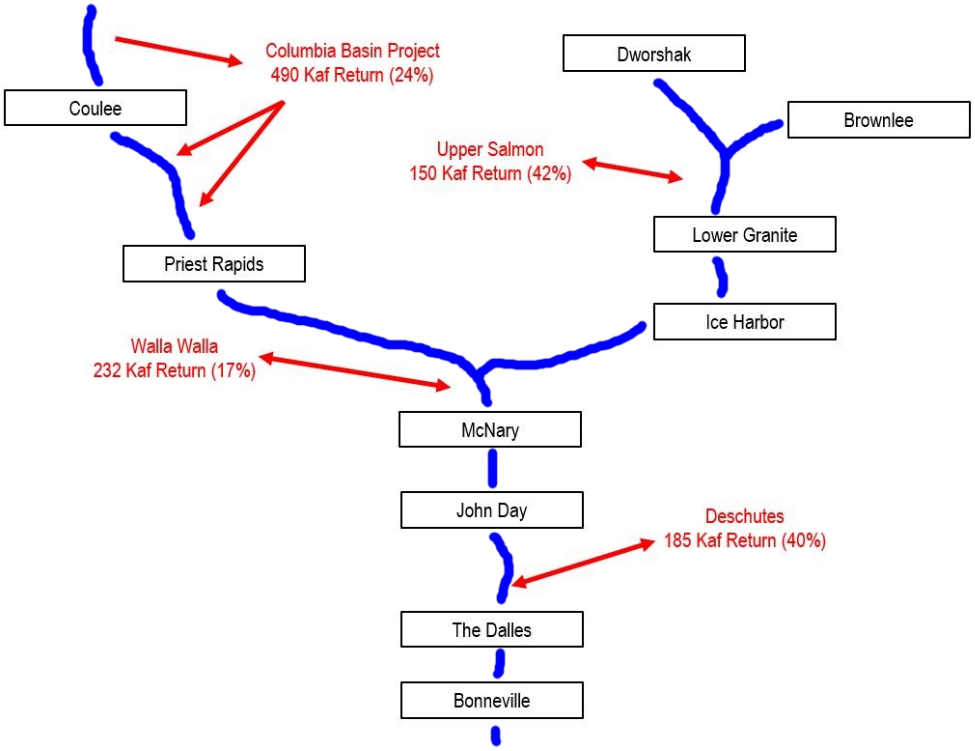
[7] Water use and laws in the upper Snake area are very complex. In this region water use is managed in a holistic manner that includes, for example, considerations to maintain aquafers at acceptable levels. Conserved irrigation water is added to a water bank account and can subsequently be rented by other users. It is unlikely this conserved water will be returned to the river. Therefore, for the upper Snake region a better estimate of the benefit of conserving irrigation water should be based on the water bank rental rates and consequently we assume that there would not be any power system benefits.

Figure 12 – Return Flow Percentages at Various Diversion Sites



For the four selected sites in Figure 13, the return flow is 24 percent of the withdrawal at the Columbia Basin Project, 42 percent at the Upper Salmon site, 17 percent at Walla Walla, and 40 percent at the Deschutes site. In all but the Columbia Basin Project, it is assumed that return flow re-enters the river without bypassing any major downstream dams. For the water pumped out of Grand Coulee, return flows re-enter the river at various locations downstream. Most of the return flow bypasses Chief Joseph, Wells, Rocky Reach, and Rock Island dams (not shown in Figure 13). Some of the return flow re-enters above Wanapum, some above Priest Rapids, and some above McNary dam. For this analysis, all return flow for the Columbia Basin Project diversion is assumed to return above the Priest Rapids Dam.

Power Factors at Hydroelectric Dams

The power factor at each hydroelectric dam is used to estimate the rate at which energy can be produced at that project and at all downstream projects for a specified amount of turbine flow. It is measured in units of megawatts per thousand cubic feet per second of turbine flow (MW/Kcfs). By multiplying the turbine flow at a specified project by its power factor, the total system rate of energy production is calculated (e.g. sum of the power capability from the specified site and all downstream projects). For example, on average, each thousand cubic feet per second of flow through Grand Coulee's turbines and all downstream turbines generates about 69 megawatts of power. It should be noted that power (in units of megawatts) is a rate of energy production. To calculate the amount of energy produced, the power (or rate) must be multiplied by an amount of time (usually hours). So, for the Grand Coulee example, every hour in which one Kcfs of water passes through Grand Coulee and all other downstream dams will produce 69 megawatt-hours of energy.

The power factor is a function of reservoir elevation (both at site and downstream), flow (which can affect turbine efficiency) and fish-bypass spill (both at site and downstream). It will vary from month-to-month and from year-to-year depending on these three parameters. Table 1 shows the monthly average power factors for selected sites. The decrease in the spring and summer power factors is primarily due to fish-bypass spill requirements.

To estimate the energy gained by leaving one thousand acre-feet (1 Kaf) of conserved diversion water in the river;

1. Calculate the average flow for each 1 Kaf of water, if it were released evenly over a 30-day period (the number of days will cancel out later). Using that assumption yields a flow of 16.7 cubic feet per second (cfs) or 0.0167 thousand cubic feet per second (Kcfs).
2. Calculate the rate of energy production (i.e. power) in megawatts by multiplying 0.0167 Kcfs by the power factor (MW/Kcfs) at the dam above which the water would have been diverted. This is the rate of energy production for 1 Kaf of water passing through all the hydroelectric projects downstream of the diversion site.
3. Calculate the gross energy gain (megawatt-hours) by multiplying the power (MW) by 720 hours (the number of hours in 30 days – this is where the number of days cancels out).
4. Calculate the return flow energy using steps 1 through 3 but using the percentage of unit flow (0.0167 Kcfs) that is returned to the river and using the power factor for the hydroelectric project just below the return location.
5. Calculate the net energy gain by subtracting the return flow energy from the gross energy gain.

Table 1: Monthly Average Power Factors (MW/KCFS)[8]

Period	**Grand Coulee**	**Priest Rapids**	**Lower Granite**	**McNary**	**The Dalles**
April 16-30	57.2	15.7	28.3	13.4	5.9
May	49.9	13.4	27.4	11.9	5.7
June	43.7	12.8	24.9	11.5	5.0
July	58.1	17.0	28.7	15.2	6.3
August 1-15	64.7	17.4	24.2	15.0	5.8
August 16-31	69.8	17.1	31.8	13.2	4.7
September	83.4	27.7	51.6	22.7	10.8
Average	61.0	17.3	31.0	14.7	6.3

At the Upper Salmon site, for example, each thousand acre-feet of conserved diversion water kept in the river produces energy at an average rate of 0.52 megawatts (a flow rate of 0.0167 Kcfs times the annual average power factor of 31 MW/Kcfs). Multiplying the power by 720 hours yields the amount of gross energy gained, in this case 373 megawatt-hours. The return flow is 42 percent of the diversion volume and reenters the river above the same hydroelectric project (e.g. does not bypass any dams). In this case, the return flow energy is 0.0167 Kcfs times 0.42 times 31 MW/Kcfs or about 157 megawatt-hours. Thus, the net energy gain by keeping 1 Kaf of conserved diversion water in the river at the Upper Salmon site is about 216 megawatt-hours.

When return flow bypasses one or more power-producing dams, the calculation is the same except that the power factor used for the return flow energy comes from the downstream facility above which the return flow reenters the river.

For the Columbia Basin Project, the average gross energy gain for each 1 Kaf of diverted water kept in the river is 736 megawatt-hours. The return flow energy (assuming return flow re-enters above Priest Rapids Dam) is 50 megawatt-hours. This yields a net average energy gain of 686 megawatt-hours for each 1 Kaf of conserved diversion water that is kept in the river above Grand Coulee Dam.

Without considering energy savings from reduced pumping demands, the average net energy gains at the selected sites are 686 megawatt-hours for the Columbia Basin Project, 216 megawatt-hours for the upper Salmon, 147 megawatt-hours for Walla Walla, and 46 megawatt-hours in the Deschutes area. The value of conserved irrigation water above Grand Coulee is much higher than at other selected sites because of two reasons. First, Grand Coulee is at a higher elevation and there are more downstream dams for the water to pass through. Second, the diversions have a low return percentage (24 percent)

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[8] These values are based on the current biological opinion (BPA rate case hydro regulation for the 2022 operating year).

and re-enter the river far downstream, bypassing several power-producing dams (the irrigation season average power factor drops from 61 at Grand Coulee to 17.3 at Priest Rapids dam).

The energy gains for conserved diversions calculated above are reasonable approximations and can be done in a relatively short time. It should be noted, however, that many simplifying assumptions are made. First, it is assumed that all return flows re-enter the river system in the same month. Return flows for all sites except Grand Coulee are also assumed to not bypass any major downstream dams. Energy savings (pumping loads) of not delivering conserved irrigation water to crops are not included in the energy gain calculation, except for diversions at Grand Coulee.

Pumping Loads

Grand Coulee's pumping loads for diverting water into Bank's Lake[9] are provided in Table 2 below. The monthly pattern of pumping demand depends on reservoir elevation, that is, the higher water is pumped, the higher the pumping load. Pumping loads from Table 2 are added to the energy gain for the Grand Coulee area calculated above. So, on average, the total energy gain of not diverting a thousand acre-feet of water from Grand Coulee's reservoir into Bank's Lake is 683 plus 340 or 1,026 megawatt-hours.

Pumping loads at other sites are more difficult to acquire but are generally assumed to be smaller than those at Grand Coulee. Unfortunately, no quantitative data was available as of this date. Because pumping loads can vary dramatically and because we do not have detailed information for all the sites that were examined in this analysis, only the pumping loads at Grand Coulee have been included. Thus, it should be noted that the total energy gains at the other sites are understated and would be higher if pumping loads were to be added to the savings.

Table 2 - Grand Coulee Pumping Loads (MW-hours per Kaf)

Period	**Demand per Kaf**
April 16-30	460
May	400
June	340
July	340
August 1-15	340
August 16-31	340
September	295
Average	**354**

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[9] Bank's Lake is used as a holding reservoir for irrigation water. Water is pumped from the Grand Coulee reservoir into Bank's Lake for later withdrawal to irrigation sites.

Results

The examples of energy gains calculated above are based on annual average power factors. A more precise estimate of energy gains uses monthly power factors (Table 1) and only calculates energy gains for months when irrigation occurs. Tables 3 through 5 below show the results of this analysis. Table 3 summarizes the net energy gained from keeping 1 Kaf of water in the river system at the specified sites. As mentioned previously, energy gains for the Columbia Basin (i.e. Grand Coulee area) include pumping load savings. Table 4 summarizes the bulk electricity market prices used to assess gained revenue. These prices are from the Northwest Power and Conservation Council's Seventh Power Plan. These prices are based on the regional equilibrium market price, and thus are not differentiated by irrigation location. Finally, Table 5 summarizes the revenue gained (in dollars per acre-foot of water) by month and location.

Table 3 – Net Energy Gain (MW-hours) for each 1,000 Acre-feet of Conserved Irrigation Water

Period	**Col Basin**	**Up Salmon**	**Walla Walla**	**Deschutes**
April 16-30	1102	198	134	42
May	961	191	119	41
June	828	174	115	36
July	989	200	151	46
August 1-15	1068	169	149	42
August 16-31	1129	222	132	34
September	1218	360	227	78
Average	**1026**	**216**	**147**	**46**

Table 4 – Average Electricity Market Prices ($/MW-hour)

Period	**Col Basin**	**Up Salmon**	**Walla Walla**	**Deschutes**
April 16-30	52	52	52	52
May	52	52	52	52
June	53	53	53	53
July	55	55	55	55
August 1-15	59	59	59	59
August 16-31	59	59	59	59
September	58	58	58	58
Average	**55**	**55**	**55**	**55**

Table 5 – Monthly Average Revenue Gain ($ per acre-foot) of Conserved Diversion Water

Period	**Col Basin**	**Up Salmon**	**Walla Walla**	**Deschutes**
April 16-30	$ 57.10	$ 10.23	$ 6.94	$ 2.19
May	$ 50.00	$ 9.92	$ 6.20	$ 2.15
June	$ 43.73	$ 9.18	$ 6.08	$ 1.92
July	$ 53.92	$ 10.91	$ 8.25	$ 2.49
August 1-15	$ 62.74	$ 9.91	$ 8.78	$ 2.47
August 16-31	$ 66.34	$ 13.01	$ 7.75	$ 1.98
September	$ 70.59	$ 20.84	$ 13.15	$ 4.52
Average	**$ 56.61**	**$ 12.24**	**$ 8.24**	**$ 2.61**

Appendix

This appendix provides additional background information about irrigation diversions at each of the five sites examined in this paper. It is only intended to provide general information regarding the types of irrigation methods and expected water uses at these sites. Since a major portion of this information is taken from the federal agencies 2000 Level Modified Streamflow report, some of the data may be out of date. For more current information, please refer to the more current report referenced earlier.

Upper Salmon Diversion

Total irrigated land (1990 level) is 104,800 acres of which 22,700 acres (22 %) are irrigated via sprinkler systems and the other 82,100 acres (78 %) are irrigated via gravity systems. For each thousand acres of land, the sprinkler system diverts 2,677 acre-feet of water, of which 776 acre-feet return to the river (29 %). The gravity system diverts 3,588 acre-feet per thousand acres of which 1,614 acre-feet return (45 %). The pro-rated return percentage for the entire area is about 42 percent. Table A1 below provides the monthly distribution of water diversion per thousand acres for both the sprinkler and gravity systems.

Table A1 - Monthly Distribution of Diverted and Returned Water at Upper Salmon Diversion

Month	**Diversion (%)**	**Return (%)**
April	1	8
May	15	9
June	26	11
July	33	12
August	25	13
September	1	12
October	0	9
November	0	6
December	0	6
January	0	5
February	0	5
March	0	4
Acre-feet of diversion per 1,000 acres of irrigated land		
Sprinkler	2,677	776
Gravity	3,588	1,614

Columbia Basin Project

Total irrigated land (1990 level) is 552,500 acres of which 420,500 acres (76 %) are irrigated via sprinkler systems and the other 132,000 acres (24 %) are irrigated via gravity systems. Using the area west of Bank's Lake as a reference for each thousand acres of land, the sprinkler system diverts 2,663 acre-feet of water, of which 399 acre-feet return to the river (15 %). The gravity system diverts 4,793 acre-feet per thousand acres of which 2,397 acre-feet return (50 %). The pro-rated return percentage for the entire area is about 24 percent. Table A2 below provides the monthly distribution of water diversion per thousand acres for both the sprinkler and gravity systems.

Table A2 - Monthly Distribution of Diverted and Returned Water West of Bank's Lake

Month	**Diversion (%)**	**Return (%)**
April	2	4
May	17	11
June	28	14
July	31	15
August	17	14
September	4	12
October	1	9
November	0	5
December	0	5
January	0	4
February	0	4
March	0	3
Acre-feet of diversion per 1,000 acres of irrigated land		
Sprinkler	2,663	399
Gravity	4,793	2,397

Walla Walla Diversion

Total irrigated land (1990 level) is 91,700 acres of which 88,600 acres (97 %) are irrigated via sprinkler systems and the other 3,100 acres (3 %) are irrigated via gravity systems. For each thousand acres of land, the sprinkler system diverts 2,481 acre-feet of water, of which 397 acre-feet return to the river (16 %). The gravity system diverts 3,969 acre-feet per thousand acres of which 1,786 acre-feet return (45 %). The pro-rated return percentage for the entire area is about 17 percent. Table A3 below provides the monthly distribution of water diversion per thousand acres for both the sprinkler and gravity systems.

Table A3 - Monthly Distribution of Diverted and Returned Water at Walla Walla

Month	**Diversion (%)**	**Return (%)**
April	11	7
May	28	9
June	28	11
July	15	11
August	10	11
September	6	11
October	2	8
November	0	7
December	0	7
January	0	7
February	0	6
March	0	5
Acre-feet of diversion per 1,000 acres of irrigated land		
Sprinkler	2,481	397
Gravity	3,969	1,786

Deschutes Diversion

Total irrigated land (1990 level) is 13,800 acres of which 13,100 acres (95 %) are irrigated via sprinkler systems and the other 700 acres (5 %) are irrigated via gravity systems. For each thousand acres of land, the combined sprinkler-gravity system diverts 2,516 acre-feet of water, of which 1,006 acre-feet return to the river (40 %). Table A4 below provides the monthly distribution of water diversion per thousand acres for both the sprinkler and gravity systems.

Table A4 - Monthly Distribution of Diverted and Returned Water at Deschutes

Month	Diversion (%)	Return (%)
April	0	3
May	12	9
June	28	12
July	40	12
August	20	15
September	0	13
October	0	12
November	0	9
December	0	6
January	0	3
February	0	3
March	0	3
Acre-feet of diversion per 1,000 acres of irrigated land		
Combined Sprinkler and Gravity	2,516	1,006
