FISH PASSAGE CENTER

1827 NE 44th Ave., Suite 240, Portland, OR 97213
Phone: (503) 230-4099 Fax: (503) 230-7559
http://www.fpc.org/
e-mail us at fpcstaff@fpc.org

MEMORANDUM

TO: Rick Kruger, ODFW

FROM: Michele DeHart

DATE: October 5, 2012

RE: Evaluation of proposal entitled, "Provide access to Columbia River water when flows exceed the Biological Opinion (Bi-OP) flows for fish"

In response to your request, the Fish Passage Center reviewed one of the options prepared by the Columbia River-Umatilla Solutions Task Force, entitled, "Provide access to Columbia River water when flows exceed the Biological Opinion (Bi-OP) flows for fish" (Proposal). The Proposal would allow additional water withdrawals from the Columbia River when river flows are above the established BiOp flow targets at McNary Dam. The Proposal focuses on water withdrawals from the McNary Dam to John Day Dam river reach. We understand that the intent of the proposal is to allow additional water withdrawals for agricultural use from the Columbia River while supporting the regional objective of rebuilding of Endangered Species Act threatened and endangered salmon and steelhead. We focused our review on spring migrants and spring migration flows, since the Bi-Op minimum flow targets identified in the proposal are rarely met in the summer period. We reviewed the Proposal in this context while relying on the decades of existing fish migration and survival data existing for the Columbia Basin. Our review focused upon the appropriate flow level for fish migration and on the historical water record to identify the historical occurrence of those flows. We also reviewed the historical water record to access the frequency that Bi-OP minimum flow targets are met. We used existing data, analysis, fish survival and water travel time relationships, and water travel time and smolt-to-adult return (SAR) relationships to identify a springtime flow level, above which water withdrawals could occur without adversely impacting the rebuilding of listed salmon and steelhead. Consistent with the Proposal our evaluation focused on Columbia River flows that would be considered the minimum necessary to achieve sustainable SARs and assure rebuilding populations of Snake River fish passing through the Columbia hydrosystem.

The following bullets summarize our findings:

- The Bi-Op minimum flow targets are established by NOAA as a minimum below which significant adverse impact on survival of listed species will occur. Salmon and steelhead survival flow relationships indicate that survival increases at flow levels above the Bi-Op minimums. The available data and analyses do not indicate that the Bi-Op minimums are the target flow for rebuilding ESA listed salmon and steelhead.
- The flow metric should be defined in terms of fish migration. Seasonal and monthly average flow targets are not appropriate because they do not accurately capture fish migration affects. The fish flow metric should be defined in terms of weekly average flows.
- The Bi-Op minimum flows are rarely met in the summer migration period, and they are often not met in the spring period.
- When spill is assumed constant at 40%, which is typical under current hydro-system operations and controlled spills at dams, the Water Transit Time (WTT) between the Lower Granite tailrace and Bonneville Dam necessary for spring/summer Chinook and steelhead to approach 4% SARs would be less than 4 days. A flow of 1000 Kcfs would be needed in the Columbia River (McNary Dam) to achieve a 4-day WTT.
- When spill percentages were allowed to increase when flows were above project hydraulic capacity and current Columbia and Snake River spill levels, the target WTT needed to achieve 4% SAR for steelhead was 6.5 days or approximately 600 Kcfs at McNary Dam. Similarly, for spring/summer Chinook, WTT needed to achieve a 4% SAR was about 7.5 days or roughly 530 Kcfs at McNary Dam.
- Over the April 10-August 31 period over the years 1990-2012 at McNary Dam, a weekly flow average never equaled or exceeded 1000 Kcfs and only slightly exceeded 530 Kcfs as a weekly flow average during one week in 1997 when weekly average flows were 543 Kcfs. The 1997 runoff volume in the Columbia River (The Dalles Dam, January-July period) was the highest over the available historical record between the years 1929-2012.

Migration flow metric

In order for a migration flow metric to be meaningful in terms of fish migration and flow management, it should be defined in terms that actually reflect the effect on migrating fish. Definition of the migration flow metric in terms of seasonal averages or monthly averages are misleading to managers. Figure 1 - is provided as an example. In 2010 spring Bi-OP seasonal average flow objective at McNary Dam was 220 kcfs. A series of late spring rain events lead to unusually high flows during late May and June. Due to these rain driven flows the spring seasonal average flow was 225 kcfs indicating that the Bi-Op seasonal average was met in 2010. However, approximately 82% of the steelhead and 66% of the yearling Chinook experienced migration flow conditions that were below the Bi-OP target minimum flow during the 2010 spring migration. Migration flows did not reach the Bi-OP minimum target until most of the

spring migration period was over. The fish passage metric should be defined in terms of weekly average flow.

In considering the Proposal, it is important to note the historical flow record. Although the Bi-Op minimum flows are considered a floor below which significant impact to survival of listed species occur, these minimums are rarely met in the summer migration period and are not met a significant portion of the time in the spring migration period at McNary Dam.

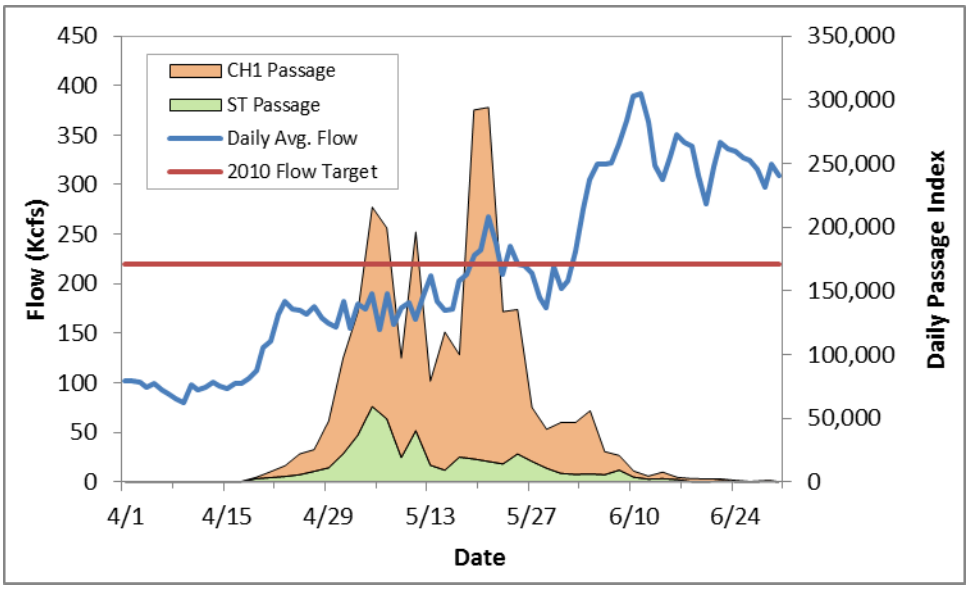

Figure 1. Daily average flow at and passage of yearling Chinook and steelhead at McNary Dam in 2010. 2010 Flow target is provided for reference.

Evaluating required flow level with constant fixed spill

Our evaluation of the Proposal utilized recently published relationships between river conditions during the juvenile fish outmigration and subsequent adult return rates to set flow levels that would be considered the minimum necessary to achieve sustainable SARs for Snake River fish passing through the reservoirs between the Lower Granite Dam tailwater and Bonneville Dam (Haeseker et. al. 2012). The authors of this study analyzed the relationship between conditions in the hydro-system from Lower Granite Dam tailwater to Bonneville Dam tailwater (LGR to BON) during the juvenile salmon outmigration, and subsequent adult return rates (SAR). Based on their analysis, equations were derived to predict SARs from the in-river variables Water Transit Time (WTT) and average spill percentage (Tables 1 and 2). Haeseker et. al (2012) showed that for the cohorts of PIT-tagged fish they analyzed, average spill percentages in the hydro-system had reached a maximum around 45% in the years 1998 to 2006. In addition, water transit times reached a minimum (which corresponds to highest flows) of around 10 days for the reach during those same years.

Table 1. Predicted Smolt-to-Adult Return percentages (SARs) for Snake River spring/summer Chinook, based a model of water transit time (WTT) and spill percentage encountered during juvenile outmigration in the reach Lower Granite Dam tailwater to Bonneville Dam tailwater. Table from Haeseker et. al. 2012.

	Average spill percentage						
WTT (d)	**30**	**35**	**40**	**45**	**50**	**55**	**60**
14	0.3%	0.5%	0.9%	1.5%	2.6%	4.4%	7.2%
12	0.3%	0.5%	0.9%	1.6%	2.7%	4.5%	7.4%
10	0.3%	0.6%	0.9%	1.6%	2.7%	4.6%	7.6%
8	0.3%	0.6%	1.0%	1.7%	2.8%	4.8%	7.8%
6	0.3%	0.6%	1.0%	1.7%	2.9%	4.9%	8.0%
4	0.4%	0.6%	1.0%	1.8%	3.0%	5.0%	8.2%

Table 2. Predicted Smolt-to-Adult Return percentages (SARs) for Snake River steelhead, based a model of water transit time (WTT) and spill percentage encountered during juvenile outmigration in the reach Lower Granite Dam tailwater to Bonneville Dam tailwater. Table from Haeseker et. al. 2012.

	Average spill percentage						
WTT (d)	**30**	**35**	**40**	**45**	**50**	**55**	**60**
14	0.4%	0.6%	0.9%	1.4%	2.3%	3.5%	5.4%
12	0.4%	0.6%	1.0%	1.5%	2.4%	3.7%	5.7%
10	0.4%	0.7%	1.0%	1.6%	2.6%	3.9%	6.1%
8	0.4%	0.7%	1.1%	1.7%	2.7%	4.2%	6.4%
6	0.5%	0.7%	1.2%	1.8%	2.9%	4.4%	6.8%
4	0.5%	0.8%	1.3%	2.0%	3.1%	4.7%	7.2%

According to the Northwest Power and Conservation Council (NWPCC), SARs averaging 4% (ranging from 2% to 6%) are necessary in order to achieve recovery of endangered salmon stocks in the Columbia River Basin. Based on those SAR targets we estimated flow levels that would need to be achieved at McNary Dam prior to recommending that additional water withdrawals be allowed from the Columbia River.

The Reservoir Storage Replacement Method was used to calculate Water Transit Times from Columbia River flows that would be necessary to achieve an average SAR of 4%. The formula for the calculation is as follows:

$$\text{Water Transit Time (WTT) (s)} = \text{Reservoir Volume } (ft^3) / \text{Flow } (ft^3/s)$$

The storage replacement method is relatively simple if the following are known: flow rate exiting the pool, pool elevation, and pool storage/elevation rating curve. This methodology has been suggested for by personnel from the US Army Corps of Engineers and has been validated by the modeling program HEC-2.

Under current hydro-system operations and controlled spills at dams, typical spill percentages have averaged about 40% in the reach LGR to BON. According to Tables 1 and 2, and assuming that spill percentages in the hydro-system were 40%, it is clear that a 4% SAR could not be reached for either spring/summer Chinook or steelhead at any level of WTT. From these tables, SARs above the 4% level would not be predicted unless WTT was well below 4 days.

Although SARs of 4% under average spill levels of 40% would require a WTT of much less than 4 days, it was of value to determine what Columbia and Snake River flow levels would lead to a WTT of 4-days. It should be reiterated that the flow levels equating to a 4-day WTT are an underestimate of the actual flows needed to achieve SARs of 4% at spill levels of 40%.

The Reservoir Storage Replacement Method was used determine what flow levels would be needed to achieve a 4-day WTT between the Lower Granite Tailrace and Bonneville Dam. For this exercise, we assumed flows in the Columbia were on average 2.6 times those in the Snake River based on the ratio of maximum spring Biological Opinion Flow Targets at McNary Dam (260 Kcfs) and Lower Granite Dam (100 Kcfs). Under these assumptions, it was determined that a flow of 1000 Kcfs would be needed in the Columbia River (McNary Dam) and 385 Kcfs would be needed in the Snake River (Lower Granite Dam)[1] to achieve a 4 day WTT. Because the water withdrawal is proposed in the Columbia River, weekly flow averages were calculated over each week between April 10 and August 31st over the period between 1990 and 2012 at McNary Dam. Over this period, weekly average flows never equaled or exceeded 1000 Kcfs. The highest weekly flow average over the mentioned period occurred between June 12-18, 1997 and was 543 Kcfs. It should be pointed out that the1997 runoff volume in the Columbia River (The Dalles Dam, January-July Period) was the highest over the available historical record between 1929-2012. Furthermore, the COE informational webpage concerning McNary Dam[2] lists the maximum historical peak discharge at McNary Dam under regulated conditions as 668 Kcfs, occurring in 1894.

Evaluating flow level with increasing spill

The last portion of this evaluation considered an alternate modeling approach in which spill percentages were allowed to increase when flows were above project hydraulic capacity and current Columbia and Snake River spill levels. In the most recent Water Years of 2011 and 2012 flow conditions were such that projects were often at hydraulic capacities and spill levels

[1] For WTT calculations, the Snake River reservoirs were held at Minimum Operating Pool plus 1 foot (MOP+1), John Day Dam was held at Minimum Irrigation Pool (MIP), and McNary Dam, the Dalles Dam and Bonneville Dam were all held at Normal Full Pool.

[2] http://www.nwd-wc.usace.army.mil/report/mcn.htm.

exceeded that called for under BiOp conditions. Over the period of April 10 to August 31 in 2011 and 2012, weekly spill percentages and WTT were calculated at each project in the reach between the Lower Granite tailrace and Bonneville Dam. Individual project weekly average spill percentages were then averaged over each project in the river reach between the Lower Granite tailrace and Bonneville Dam, resulting in weekly average spill percentages over the entire river reach of interest (LGR tailrace- BON Dam). Similarly, individual project weekly WTT was calculated and then summed over each project in the river reach between the Lower Granite tailrace and Bonneville Dam, resulting in a weekly WTT over the entire river reach of interest (LGR tailrace- BON Dam). Using this information, the relationship between weekly WTT and weekly average spill percentage over the hydro-system between the Lower Granite tailrace and Bonneville Dam was determined. The relationship in Figure 1 below, shows that average per dam spill increased to above 40% at a WTT near 13 days, and reached 50% when WTT was below 10 days. Using this relationship from observed operations in 2011 and 2012, and Tables 1 and 2 above, the WTT/spill combination that would be needed to achieve an average SAR of 4% for Chinook and steelhead was estimated.

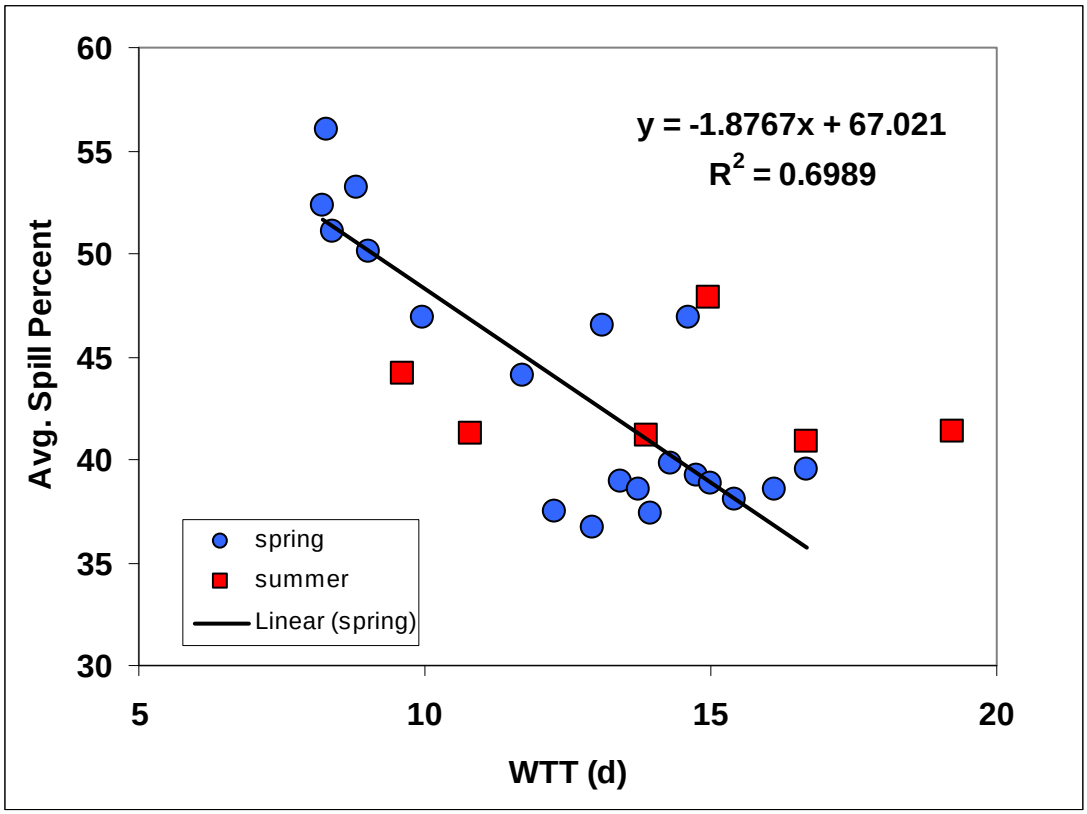

Figure 2. Observed relationship between water transit time and average spill percentage in the LGR to BON reach (excluding LGR dam) during weekly time periods in the spring and summer of 2011 and 2012.

Using the relationship in Figure 2, as spill percentage was allowed to increase as flows increased above hydraulic capacity (and conversely WTT decreased), the target WTT needed to achieve 4% SAR for steelhead was 6.5 days or approximately 600 Kcfs at McNary Dam.

Similarly, for spring/summer Chinook, WTT needed to achieve a 4% SAR was about 7.5 days or roughly 530 Kcfs at McNary Dam. Based on the weekly flow average dataset discussed previously that encompassed the period between April 10 and August 31st over the years between 1990 and 2012 at McNary Dam, only one weekly average flow at McNary Dam exceeded 530 Kcfs over this period. This one weekly flow average was the highest weekly flow average over the mentioned period and occurred between June 12 and 18, 1997 and was 543 Kcfs. Again, the1997 runoff volume in the Columbia River (The Dalles Dam, January-July Period) was the highest over the available historical record between 1929 and 2012.

In summary, our evaluation of the Proposal provided by Oregon Department of Fish and Wildlife focused on Columbia River flows that would be considered the minimum necessary to achieve sustainable SARs for Snake River fish passing through the Columbia hydrosystem. The results of our analysis indicate that when spill is assumed constant at 40%, which is typical under current hydro-system operations and controlled spills at dams, the Water Transit Time (WTT) between the Lower Granite tailrace and Bonneville Dam for yearling spring/summer Chinook and steelhead would need to be less than 4 days to approach 4% SARs. Under these assumptions, it was determined that a flow of 1000 Kcfs would be needed in the Columbia River (McNary Dam) to achieve a 4-day WTT. When an alternate modeling approach was utilized in which spill percentages were allowed to increase when flows were above project hydraulic capacity and current Columbia and Snake River spill levels, the target WTT needed to achieve 4% SAR for steelhead was 6.5 days or approximately 600 Kcfs at McNary Dam. Similarly, for spring/summer Chinook, the WTT needed to achieve a 4% SAR was about 7.5 days or roughly 530 Kcfs at McNary Dam. Over the April 10-August 31 period over the years 1990-2012 at McNary Dam, a weekly flow average never equaled or exceeded 1000 Kcfs and only slightly exceeded 530 Kcfs as a weekly flow average during one week in 1997 when weekly average flows were 543 Kcfs. It should be pointed out that the1997 Runoff Volume in the Columbia River (The Dalles Dam, January-July Period) was the highest over the available historical record between 1929-2012.

References

Haeseker, S.L., J.A. McCann, J. Tuomikoski and B. Chockley (2012). Assessing freshwater and marine environmental influences on life-stage-specific survival rates of Snake River spring–summer Chinook salmon and steelhead, Transactions of the American Fisheries Society, 141:1, 121-138