Biological Assessment for Effects of Federal Columbia River Power System and Mainstem Effects of Other Tributary Actions on Anadromous Salmonid Species Listed Under the Endangered Species Act

U.S. Army Corps of Engineers
Bonneville Power Administration
U.S. Bureau of Reclamation

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2.1.2.2 Hydrosystem Performance

The primary benchmark for assessing progress of FCRPS actions for conservation of ESA-listed fish is adult and juvenile survival through the hydrosystem. The Action Agencies have the greatest influence on this outcome, and it is less confounded by actions of others. Hydrosystem performance will be tracked and evaluated through adult reach survival and juvenile dam survival performance standards, and through a juvenile system survival performance target.

Adult Survival Standards

For adult fish, the Action Agencies have largely achieved or exceeded the performance standards identified in the 2000 BiOp (Ruff 2004). Because the Action Agencies do not expect the Proposed RPA to reduce adult upstream passage survival, they will continue that operation and monitor adult passage. The intent of this standard is to demonstrate that current high levels of adult survival are being maintained.

The performance standard for Snake River Chinook salmon ESUs (including Spring/Summer and Fall), will be based on PIT-tag detections at Bonneville and Lower Granite dams. Past estimates have yielded an upstream survival estimate of 90 percent for Snake River Spring Chinook salmon, 94 percent for Snake River Summer Chinook salmon and 92 percent for Snake River Fall Chinook salmon. The Action Agencies propose to use these as estimates as the standard. For the Upper Columbia Chinook salmon ESU, the standard would be measured from Bonneville Dam to McNary Dam and would be 92 percent. Adult performance standards are summarized by ESU in Table 2-1. A more detailed discussion and the methods for calculating adult performance are located in Attachment B.2.6-2.

Table 2-1. Adult Performance Standards

ESU	Adult Standard	Reach	Rationale
Snake River Spring Chinook Salmon	90%	Bonn. to Lower Granite	Longest migratory route
Snake River Summer Chinook Salmon	94%	Bonn. to Lower Granite	Longest migratory route
Upper Columbia Spring Chinook Salmon	92%	Bonn. to McNary	Longest migratory route
Snake River Fall Chinook Salmon	92%	Bonn. to Lower Granite	Longest migratory route
Willamette River Chinook Salmon	None	None	Low Encounter Rate
Lower Columbia River Chinook Salmon	None	None	Surrogate of upriver ESU
Snake River Steelhead	N/A	Bonn. to Lower Granite	Unaccounted harvest leads to uncertainty in calculations
Upper Columbia River Steelhead	N/A	Bonn. to McNary	Unaccounted harvest leads to uncertainty in calculations
Mid-Columbia River Steelhead	N/A	Variable	Unaccounted harvest leads to uncertainty in calculations
Lower Columbia River Steelhead	None	None	Upriver Steelhead ESU surrogate
Willamette River Steelhead	None	None	Low Encounter Rate
Snake River Sockeye Salmon	None	None	Uncertainty in data
Lower Columbia River Coho Salmon	None	None	Upriver Chinook ESU surrogate
Columbia River Chum Salmon	None	None	Low Encounter Rate

Juvenile Dam Passage Survival Standards

The Action Agencies propose specific performance standards of 96 percent average relative dam survival for spring migrating fish and 93 percent average relative dam survival for summer migrating fish, with averaging/tradeoffs allowed between dams. Any survival averaging or tradeoffs between dams may occur among the Snake River dams or among the lower Columbia River dams, but not between Snake and Columbia River dams. Definitions and methods for calculating juvenile performance are located in Attachment B.2.6-2.

One mechanism for adaptive management to improve performance, when necessary, will be the Configuration and Operation Plans (COP) that the Corps prepares to evaluate and develop hydrosystem project improvements. The Corps has prepared COPs to lead to improvements including surface passage (e.g., RSWs) and other dam passage improvements at each of the lower Columbia River and Snake River projects. A COP is being/has been developed for each dam in close coordination with the Region at the technical level. Each COP will recommend the ultimate configuration and operation for that project.

The COP considers alternatives and performance standards, and several other components as described in the *Draft Snake and Columbia River Surface Passage Strategy* prepared by the Corps in July 2005. Following installation of dam passage improvements, an evaluation will be conducted to determine the success of the action in meeting the performance standard. If the standard is not met, the Corps will update the COP coordinated through the Regional Forum to determine additional potential actions.

Juvenile System Survival Targets

In the biological analyses, the Action Agencies have assessed the expected juvenile system survival to the Bonneville tailrace under current conditions (2006 hydrosystem configuration and the operation plan that were identified in the 2004 BiOp) and under the prospective conditions of our proposed hydrosystem actions through 2017. The Action Agencies propose to use the relative improvement in direct system survival from the 2004 base level conditions to the 2017 Proposed RPA conditions, as the system survival performance targets. Further explanation is provided in Appendix B.2.6-2 and tables in Appendix B of the Comprehensive Analysis.

Achievement of Performance Standards

Once the Action Agencies meet adult survival and juvenile dam survival performance standards, they will move from detailed actions to maintenance of the performance standard, subject to regular monitoring to ensure continued performance. The choice of tools needed to maintain performance will be at the discretion of the Action Agencies. The juvenile system survival target is a longer-term goal that will be used to inform broader lifecycle improvement assessments

2.1.2.3 Predation Management Performance

Management of piscivorous and avian predation of juvenile salmonids is an effective means of increasing juvenile fish survival (Beamesderfer et al. 1996, Roby et al. 1998, NMFS 2000, Good et al. 2004). The Action Agencies will pursue focused measures that reduce predation mortality in the near and long term. These measures will be monitored annually for programmatic-level standards.

For both piscivorous and avian predation, estimates of juvenile fish survival improvements associated with the 2007 to 2017 Actions (3.1 percent for Chinook salmon, 4.4 percent for steelhead, and 1.7 percent for fall Chinook salmon) will serve as long-term performance targets. Additional performance metrics that will be reported and included into modeling assessments will include monitoring results on predator exploitation rates and changes in estimated annual predation rates. As described above for juvenile system survival measures, comprehensive evaluations using modeling will take into account any improvements in predation management over the 2004 BiOp baseline condition (i.e., current survival benefits associated with ongoing predation control).

1.2.3.2 Regulating Flow to Assist Juvenile Salmon Migration

Managing water in the Columbia River system for its many purposes is particularly challenging given the relatively small portion of the annual runoff volume that can actually be stored in reservoirs. The runoff produces an annual average of about 200 MAF of water, but only about 20 percent of it can be impounded in storage reservoirs and regulated for useful purposes. By contrast, the Colorado River system can store about three times as much runoff as it normally receives in a given year. The Missouri River system has about two times more useable storage than average annual runoff.

The notably larger storage capacities of the Colorado and Missouri River systems present much different management considerations than the Columbia River system. These systems have the capacity to store water for subsequent years' use, whereas the Columbia River system, with its large annual volume to usable storage ratio, has to evacuate on a yearly basis to accommodate water supply conditions in the Columbia River Basin. This means that operators cannot use stored water to transform a dry year's water supply into an average flow year. Operators of the hydropower system must deal with the variability in annual rain and snowpack, relying on professional judgment.

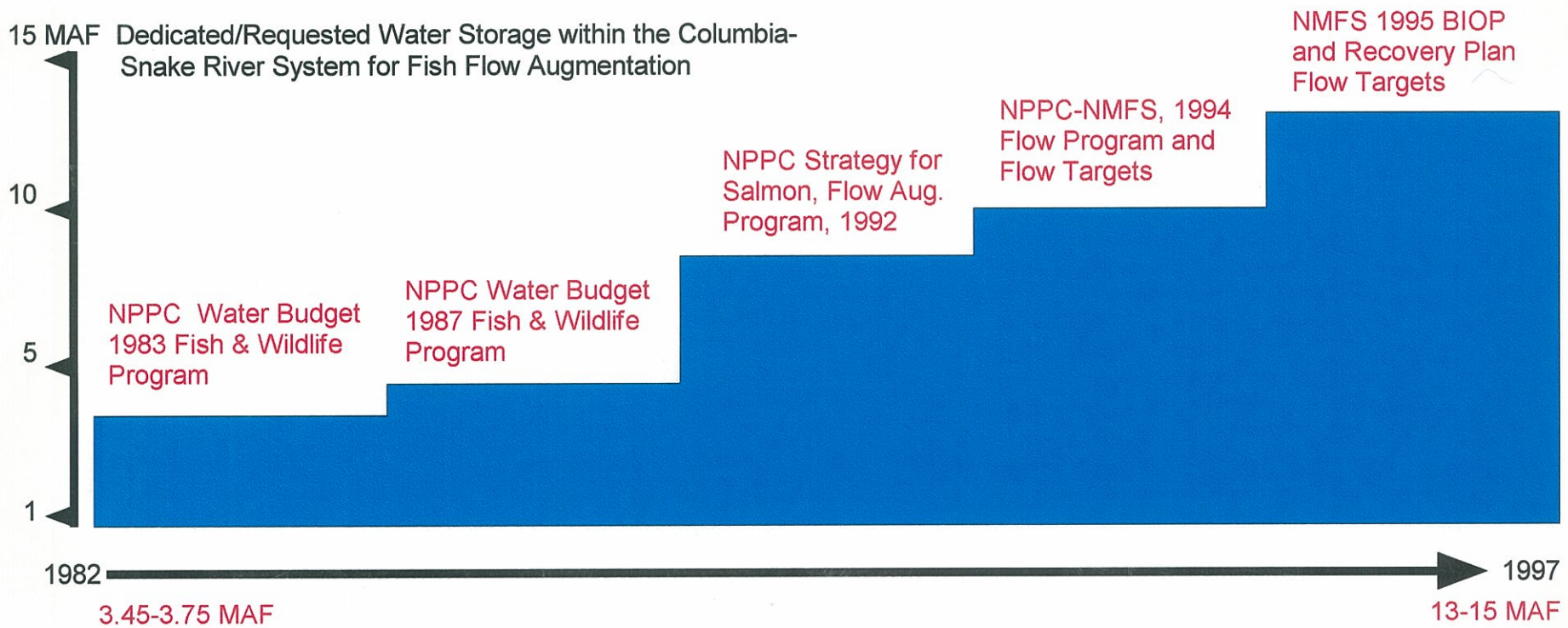
Providing flows for fish is an important component of water management in the Columbia River Basin. Fish operations draw on up to 5 MAF of stored water annually—about one-sixth of the 32 MAF of storage in U.S. reservoirs in the FCRPS and Treaty storage in Canadian reservoirs. Because much of the available storage is in Treaty projects in Canada, its use downstream is governed by the Columbia River Treaty. Use of Treaty storage for fishery purposes is contingent on development of mutually beneficial agreements between the United States and Canada. Use of space in Canadian reservoirs not included in the Treaty, referred to as non-Treaty storage, requires negotiating additional agreements.

In recent Treaty agreements, Canada has allowed storage of flow augmentation water (1 MAF) for U.S. fishery benefits in exchange for flow shaping to meet fishery objectives in Canada. The 1 MAF is released within the May through July period to assist juvenile migration in the United States. If this flow augmentation water is released across one month, it equates to an additional flow of 16,000 thousand cubic feet per second (kcfs) for that month, equal to about 6 percent of spring flow objective, or about 8 percent of the summer flow objective of 200 kcfs at McNary Dam.

With the issuance of the 1995 BiOp, the RPA "substantially alters the operation of the reservoirs in the FCRPS compared to the 1993 and 1994 BiOps" (1995 BiOp, p. 96). The Action Agencies were to henceforth operate the FCRPS during fall and winter months at high confidence levels that refill would be accomplished by April 20. Flows were to be released in the spring while ensuring sufficient storage of water to be available by June 30 to provide for summer flow augmentation.

An objective of fish operations today is to provide flows in a more natural pattern or hydrograph, to the extent that the design of the system, to meet multiple purpose responsibilities, will allow. Figure 1-6 illustrates how flows are shaped to more closely approximate a natural, unregulated river to assist fish migration. This figure compares the "regulated" flow in October 2005 to September 2006 (the 2006 water year) to what would have been a natural flow, absent the hydrosystem, in that same water year. In this year, precipitation was measured at about 100 percent of the 71-year average.

Figure 1. Milestones of the Flow Augmentation/Targets Program Columbia-Snake River System



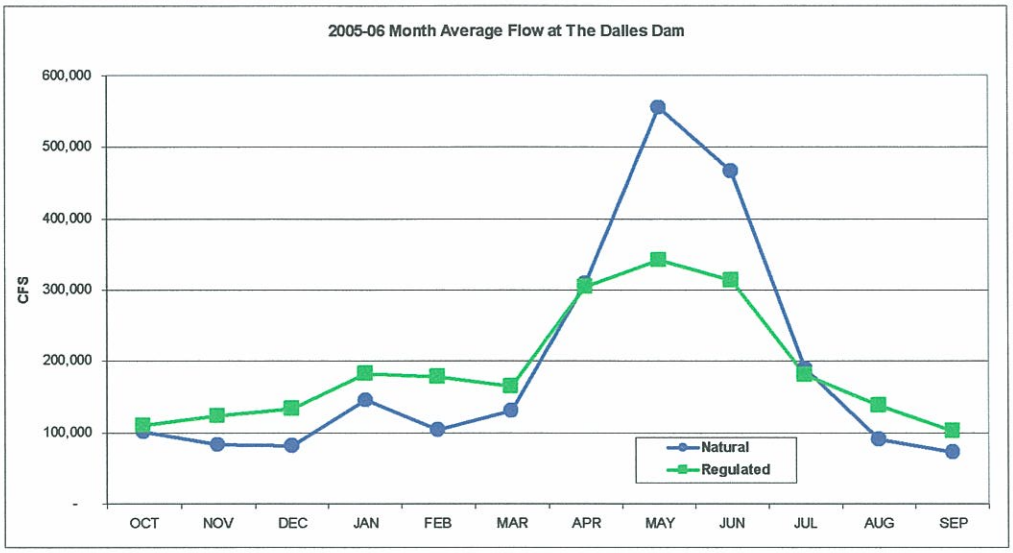


Figure 1-6. Natural and Regulated Monthly Average Flow at The Dalles Dam for the 2006 Water Year

Another way of looking at the available flow due to changes in reservoir operations to benefit fish, is noting the millions of acre-feet of water passing The Dalles Dam. Figure 1-7 shows the additional flow at The Dalles during the juvenile migration period (April through August) as a result of reservoir operations for fish (60-year average) under the 2004 BiOp. Operations for fish flows shape 8.3 MAF on average — 4.6 to 13.2 MAF, depending on annual precipitation.

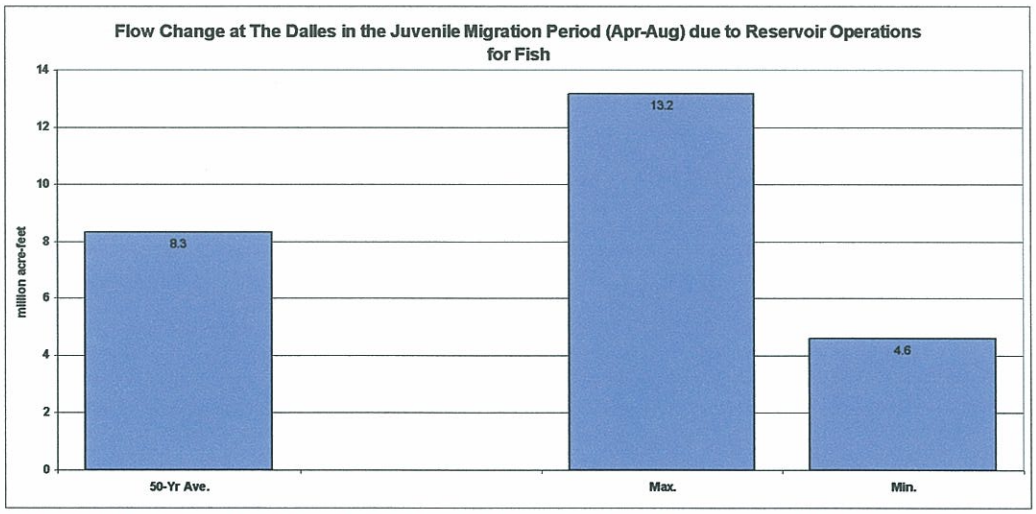


Figure 1-7. Flow Change at The Dalles Dam during the Juvenile Migration Period (April through August) Due to Reservoir Operations for Fish (60-year average)

Table 1. Columbia-Snake River Flow Augmentation Program 1994-1996

Flow Augmentation	Estimated 1994	Estimated 1995	Estimated 1996
Spring Period:			
Snake River (MAF)			
Dworshak	0.87	0.83	0.27
Brownlee and Above	0.33	0.35	0.41
Total Snake R.	*1.20*	*1.18*	*0.68*
Columbia R. (MAF)			
Arrow (Canada)	------	(1.47)	(0.14)
Libby/Hungry H.	------	1.60	0.36
Grand Coulee	------	3.70	(0.07)
Total Columbia R.	*6.60*	*3.83*	*0.15*
Total Flow Aug.	*7.80*	*5.01*	*0.83*
Summer Period:			
Snake River (MAF)			
Dworshak	1.02	0.92	0.95
Brownlee and Above	0.46	0.26	0.35
Total Snake R.	*1.47*	*1.18*	*1.30*
Columbia R. (MAF)			
Arrow (Canada)	0.20	1.60	1.33
Libby/Hungry H.	0.00	(0.43)	0.35
Grand Coulee	1.13	0.94	1.09
Total Columbia R.	*1.33*	*2.11*	*2.77*
Total Flow Aug.	*2.80*	*3.29*	*4.07*
Spr-Sum Total Flow Aug.	*10.60*	*8.30*	*4.90*

Data Source: Bonneville Power Administration, Dittmer Control Center, Portland, Oregon August-December 1997. Estimates are based on net with/without fish operations impacts to the hydro system.

As mentioned above, the volume of water in the river each year is as variable as the weather. Figure 1-8 depicts a 60-year average regulated flow at The Dalles Dam, with and without fish operations. Given the limited storage available in the hydro system and other constraints to provide for multiple uses, these operations represent a substantial improvement in providing flows for fish within the design capabilities of the system.

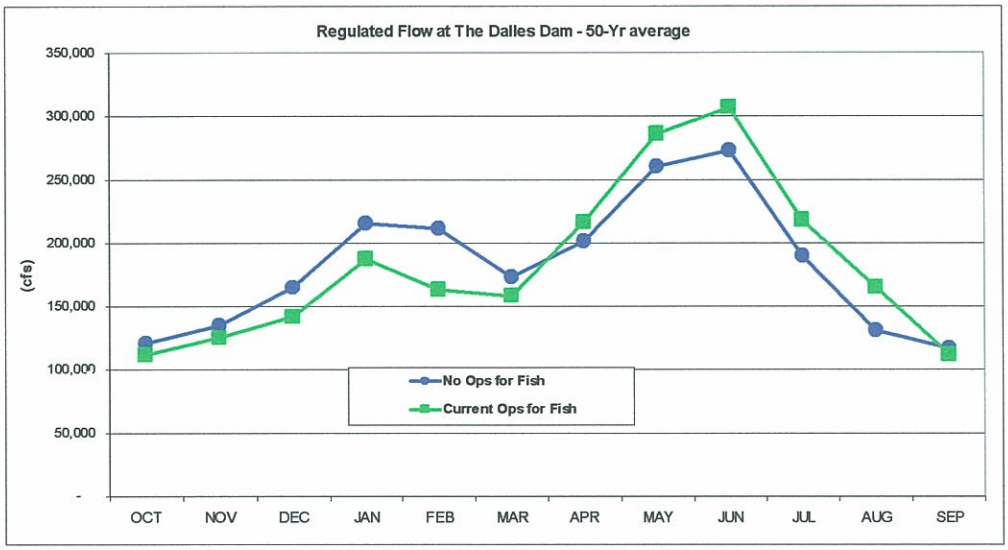


Figure 1-8. Sixty-Year Average Regulated Flow at The Dalles Dam, With and Without Fish Operations

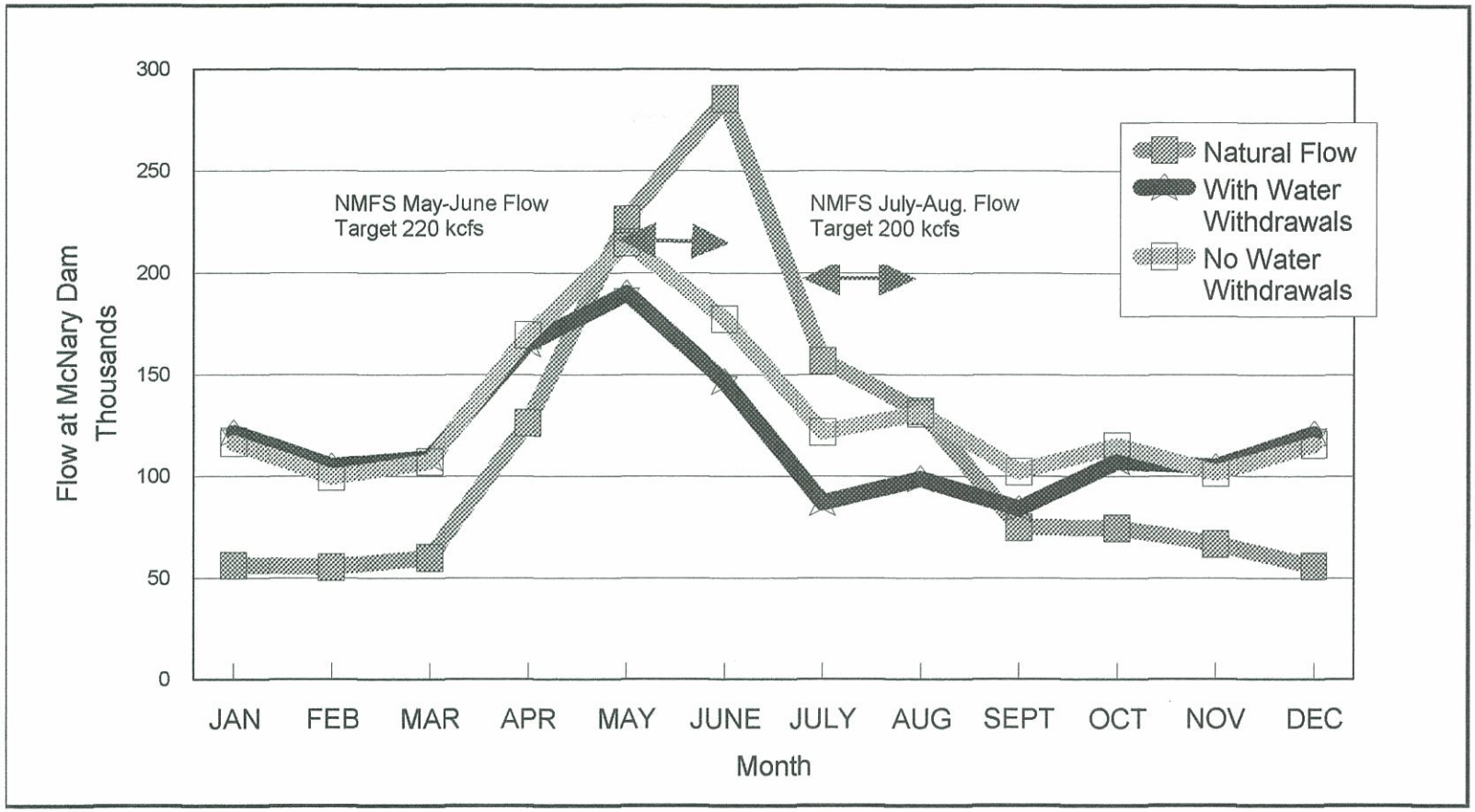
Flood control procedures have been closely evaluated and modified to the extent possible. At storage reservoirs behind Libby and Hungry Horse dams, operators adopted new flood control procedures with the objective of having more water available for spring flow augmentation, while maintaining flood control objectives. This new flood control criteria is called VARQ (variable outflow). It entails a new set of storage reservation diagrams (SRD) and upper rule curves (URC) for both Libby and Hungry Horse dams, which allows for higher water levels in the reservoirs from January through April when the runoff is forecasted to be about average or less. As the reservoir pools may be higher in spring than previously, releases must be increased during the refill period (April, May, and June). By this means, operators can provide the same level of flood protection, while ensuring that more water is available for adult Kootenai River white sturgeon and juvenile salmon and steelhead migration in spring and summer.

The summer flow management objective is to draft reservoirs within specific limits in attempt to meet flow targets and to manage water temperatures to benefit migrating juvenile salmon. Cooler water is also thought to assist adult migration.

The eight Federal dams on the mainstem lower Columbia and Snake rivers are "run of the river" dams, that is, low head dams that have little or no storage capacity and essentially pass inflows[6]. Nevertheless, these reservoirs impede flow and affect the progress of juvenile salmon through the system in several ways: slowing travel, increasing exposure to warmer water temperature, and increasing exposure to predators among them. In 1995, the Corps began operating the lower Snake reservoirs within 1 foot of minimum operating pool (MOP), the level required to provide safe navigation, operate fish facilities within design criteria, and operate turbines. The 1995 BiOp also called for John Day pool to be operated

[6] John Day Dam has approximately 500 thousand acre-feet of flood control storage.

NMFS (NOAA Fisheries) Flow Targets
Low-Water Condition, Average Monthly Flows at McNary Dam



The above graph depicts river flows at the McNary Dam with low water-year conditions (such as 2001). Under the NMFS Biological Opinion, the NMFS "target flows" cannot be met, either with or without existing water withdrawals from the Greater Columbia River Basin region. Nor can the target flows be met under "natural flow" conditions, where river system dams and water storage reservoirs would be eliminated. The flows cannot be met, because the flows exceed the physical hydrological capability/conditions of the river basin.

The flow targets were developed in 1994-95 largely based on the CBFWA 1991 "flow Proposal," based on data and analyses prepared by Sims and Ossiander (1981)--no longer considered by NOAA Fisheries to be appropriately applied to current water management regimes. New data and analyses are significantly improved, with different water management implications.

within 1.5 feet of MOP from April 20 through the summer. These drawdowns reduce the width or the cross-section of the reservoir, thereby increasing water velocity.

Finally, the water managers strive to provide flow conditions for mainstem habitat suitable for spawning chum and fall Chinook salmon. They maintain sufficient flow below Bonneville Dam to keep spawning redds submerged until juvenile fish hatch in the spring.

1.2.3.3 Spill Operations to Assist Juvenile Fish Passage

Spill operations are a method of guiding juvenile salmon and steelhead through spillways rather than through turbines. The objective of the spill program is to achieve maximum passage survival, along with other passage routes, at each dam. Survival is measured by detecting the PIT-tagged fish as they pass from the forebay above the dam to the tailwater below the dam.

Prior to the 1995 BiOp, the operators' objective was to attain a fish passage efficiency[7] (FPE) of 70 percent for spring migrants and 50 percent for summer migrants. To accomplish this, spill was provided at three dams. The other dams met this goal without spill. In the longer term, the plan was to complete structural bypass systems at the four lower Snake River and four lower Columbia River dams to boost in-river survival.

In the 1995 BiOp, the objective was raised to achieve 80 percent FPE at all eight projects by spilling water through the spring months at each project. Timing and volume of spill at each project was designed to achieve biological benefits with a cap to avoid harmful levels of TDG. Limited spill was to be provided in summer months, primarily at Ice Harbor on the lower Snake River and the three lower Columbia dams.

With the 2000 BiOp, the focus was shifted to dam survival estimates instead of FPE due to advancements in radio and acoustic tracking technologies. This has allowed for better assessment of passage improvements at mainstem dams. For instance, bypass facilities of various types have been added to dams with survival of juvenile fish increasing to 90 to 95 percent at each dam. As discussed earlier, surface passage modifications such as RSWs and the Bonneville Dam Corner Collector can achieve higher survival rates (97 percent or higher with RSWs, and 100 percent with the Corner Collector), while spilling less water.

The various routes of juvenile passage notwithstanding, most juvenile fish in the river find their way through juvenile bypass facilities, spillways, and surface bypass facilities. The 2000 BiOp based annual spill programs on "the best available monitoring and evaluation data concerning project passage, spill, and system survival research" (2000 BiOp, pp. 9-88). This principle was extended to the 2004 BiOp, further increasing the reliance on biological performance to set spill levels at each project.

In 2004, emphasis turned to 24-hour surface spill through RSWs and the Corner Collector at Bonneville Dam. The Court Order in 2005 required summer spill at Lower Granite, Little Goose, and Lower Monumental dams on the Snake River, and at McNary Dam on the Columbia River, which was continued in 2006 and 2007. Monitoring in 2005 and 2006 showed nearly all of the Snake River fall Chinook salmon (both hatchery and wild) passed Little Goose and Lower Monumental dams by late July or early August.

[7] Fish Passage Efficiency (FPE) is a measure of percent of juvenile fish that are diverted away from turbine passage, either via spill or through the juvenile bypass facilities.

1.2.3.4 Transportation of Juvenile Fish

Research on the most effective ways to transport juvenile fish began in 1968. Today, millions of juvenile fish are collected and transported each year from facilities located at Lower Granite, Little Goose, Lower Monumental, and McNary dams. Utilizing transportation is a component of the "spread the risk" strategy, given the uncertainties surrounding both in-river migration and transportation.

Operations since 1995 dictate transport during summer flow and other low-flow periods, when juveniles face the highest risk if left in the river to migrate. Ninety-eight percent of transported fish survive to be released in the river below Bonneville Dam. While researchers have collected substantial data on the risks of leaving juvenile fish in the river to migrate, they have not been able to quantify any latent or delayed mortality that might occur among transported fish.

The returns of adult fish are an indicator of the success of transportation. During the drought of 2000-2001, virtually all spring and summer migrants in the Snake River were transported. When those fish returned as adults to Ice Harbor Dam as adults in 2003 and 2004, their numbers were among the highest of record (University of Washington Data Access in Real Time [DART] Program). Transportation, along with other mitigating measures, helped ensure that a large number of healthy juvenile fish entered the Pacific Ocean to benefit from favorable ocean conditions. Since 1995, two additional large transport barges went into service, bringing the total to eight.

1.2.3.5 Predation Management

Federal and State agencies are cooperating in efforts to reduce predation on juvenile listed species. Programs to redistribute Caspian terns in the estuary, drive away and block sea lions from the Bonneville Dam fish ladders, and reduce the northern pikeminnow population by a sport-reward program have been successful in reducing loss to predation. The Federal agencies are now preparing to address growing populations of double-crested cormorants nesting in the estuary and Caspian terns and double crested Cormorants in the Mid-Columbia River that also prey on juvenile salmonids.

1.2.3.6 Hatcheries

With the exception of Lower Columbia River Chum Salmon ESU and the Mid-Columbia River Steelhead and Upper Willamette River Steelhead DPSs, 50 percent or more of the anadromous salmonids in the basin today originate in hatcheries. In the Snake River Basin, 60 to 85 percent of steelhead and salmon begin their lives in hatcheries (NMFS 2005). BPA funds, in whole or in part, 75 anadromous fish propagation programs out of a total of 189 programs in the Columbia River Basin. The remaining facilities are supported by other State and Federal funding. Since the first ESA listing of Columbia River salmon in 1991, BPA has increasingly reoriented programs toward recovery of weak natural stocks.

BPA began funding the development of over 200 Hatchery and Genetic Management Plans (HGMPs) in 2000, continued funding this action under the 2004 UPA, and recently completed the project in 2006. The HGMPs facilitate the application of hatchery reforms to specific artificial production programs, thus providing a standardized approach and consistent body of relevant information about hatchery programs. According to the 2000 BiOp, the HGMP would comprehensively address facility and operational details relevant to reform measures and the menu of potential hatchery reform actions.

Work continues on establishing the optimal mix of hatchery and natural stocks. The Action Agencies have funded and completed HGMPs for all basin hatcheries to address the number of hatchery fish and balance the ratio of wild-to-hatchery stocks over time.