



## Natural Solutions

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Greetings:

Natural Solutions' Project 35034 is intended to provide a field examination of induced turbulent flow in quiescent water bodies. Specifically, the project would test the zone of influence, magnitude of influence, and the response of juvenile fish (smolts) to artificial current created by our innovative flow device. Successful implementation of the flow device can have far reaching effects on the ability to guide salmon to a safe passage area without spill, or with reduced spill, thus directly or indirectly addressing various recommended actions of the Reasonable and Prudent Alternative in the NOAA Fisheries 2000 Biological Opinion. A brief review of these affected Actions follows our budget revisions and the Independent Scientific Advisory Board ("ISAB") report.

Natural Solutions wishes to thank the Northwest Power and Conservation Council and the Columbia Basin Fish and Wildlife Authority for this opportunity to present revisions to the budget we proposed in Project 35034. Since submitting our original funding request, we have proceeded to build and test eductors, and solicit advice from biologists, hydrologists, and others in the field. We appreciate this opportunity to strengthen our original proposal.

### **Budget revision — Reduced by \$28,106**

The fiscal year 2003 budget reduction was possible because we have already conducted some of the tests we originally proposed. The completion of a 16 inch eductor and our decision to rent a work platform in lieu of purchase netted a savings of \$19,300. Additional savings were achieved through continuing research and a flow test project organized for August 2003 at Mayfield Dam. Natural Solutions will map flow profiles for an 8 inch and a 16 inch eductor through the collaborative efforts of Natural Solutions, USGS, and Tacoma Power.

*The decision to rent, however, did increase the 2004 and 2005 budgets by \$6,700, respectively.*

### **In-kind contribution — Increased by \$25,636**

Natural Solutions' in-kind contribution increased due to construction of a 16 inch eductor, the test at Mayfield Dam, and 3 successful juvenile salmonid mortality tests. These tests were performed to answer questions raised by the Independent Scientific Review Panel ("ISRP") in their review of our project. The first test was with 4 inch cutthroat trout; the second, 4 inch coho salmon; and the third, 6 inch chinook smolt. The fish were purposely entrained through a 6 inch eductor. [... no physical harm has occurred to the fish and ... no short or medium-term mortalities have resulted from their entrainment.] *Tod Jones, CEDC Fisheries Project [emphasis added] [See attached]*

**The ISAB report 2003-1 "A Review of Flow Augmentation,"** suggests that alternative measures to flow augmentation be reviewed and/or tested. The following excerpts are from that report:

"When smolts migrate downstream using various behavioral cues to distinguish direction, as is generally believed, the cues may diminish or disappear as flows are progressively more impounded

near dams. The riverine turbulence and velocity cues may diminish to the point where the fish loses its orientation, stops migration, swims back upstream in an attempt to relocate the flow, or follows the reverse flow induced by a seiche. This is the migration pattern observed in telemetry studies of yearling chinook and steelhead and underyearling chinook, although the mechanism is not established. Further study of reservoir hydraulics at different flows and fish migration mechanisms are needed.”

“Management approaches to providing more migration cues in reservoirs without augmenting flows might include artificial induction of turbulence and/or velocity and drawing reservoirs to lower levels to extend the riverine reaches closer to the dam. It is clear that different species and life stages of migrants behave somewhat differently and will require somewhat different solutions. Detailed travel time and survival relationships differed among yearling chinook salmon and steelhead, and underyearling chinook salmon. It is possible that the relationships also will be different for other stages of the life cycle and other anadromous species such as coho, sockeye, and lamprey.”

**Project 35034** directly addresses those suggestions. The ability to guide migrating juvenile salmonids to safe passage routes without the need to spill water as an attractant flow could have far reaching affects on the operation of the Federal Columbia River Power System (“FCRPS”).

**The 2000 FCRPS Biological Opinion, dated Dec. 21, 2000, Chapter 9, “Reasonable and Prudent Alternative,”** directs action to recover anadromous fish listed under the Endangered Species Act (“ESA”). A major component of salmon recovery efforts in the Columbia Basin relies on improving the survival of downstream migrating juvenile salmonids. Researchers have strived to find solutions to high smolt mortality caused by delayed migration, increased water temperatures, and reduced water velocities. In turn, some of the solutions have created problems of their own. Increased spill produces high levels of Total Dissolved Gasses (“TDG”) while decreasing water available for power production. Flow augmentation affects the hydro system as far upstream as headwater storage reservoirs, causing impacts to resident fish and adding to the complexity of hydro operations. Most of these problems result from flow augmentation and spill to benefit downstream migrating smolts. Implementation of a behavioral guidance system would affect recovery of listed fish species. Following a thorough review of Chapter 9, we concluded that several recommended actions can be affected, either directly or indirectly, by the innovative device proposed for funding in Project 35034.

Those recommended actions can be found in subchapters

- 9.6.1.2 Water Management
- 9.6.1.3 Juvenile Fish Transportation
- 9.6.1.4 Juvenile Fish Passage
- 9.6.1.5 Reservoir Passage
- 9.6.1.6 Adult Passage and Research
- 9.6.1.7 Water Quality

For your convenience, we then list the section and include the relevant recommended Actions that we believe relate to Project 35034, and our rationale for the claim.

## **Related Recommended Actions**

### **9.6.1.2 — WATER MANAGEMENT**

*Action 14 makes it clear that a prime purpose of this Section is to manage water “for the benefit of migrating juvenile salmon.” The Flow Velocity Enhancement System (“FVES”) in Project 35034 will provide guidance*

*for migrating smolt in the quiescent forebays where most delays occur, without the need for spill. This would significantly reduce the need for water used in flow augmentation and for spill used as attractant flow. This water could be stored to provide summer flows and manage the rivers in a more natural manner.*

**Action 14 [direct]:** The Action Agencies shall operate FCRPS dams and reservoirs with the intent of meeting the flow objectives (Table 9.6-1) on both a seasonal and weekly average basis for the benefit of migrating juvenile salmon. [Pg 9-55]

**Action 24 [direct]:** BPA and the Corps shall continue to request and negotiate agreements to annually provide 1 Maf of Treaty storage from January through April 15, release the water during the migration season, and seek additional storage amounts. [Pg 9-67]

**Action 25 [direct]:** BPA and the Corps shall continue to request, and negotiate with BC Hydro for storage of water in non-Treaty storage space during the spring for subsequent release in July and August for flow enhancement, as long as operations forecasts indicate that water stored in the spring can be released in July and August. [Pg 9-67]

### **9.6.1.3 — JUVENILE FISH TRANSPORTATION**

**9.6.1.3.1 . . .** Spill is to be provided in accordance with Section 9.6.1.4.4 to provide the highest survival passage route for inriver migrants during the spring months and to provide for research in summer. Except as specifically provided for research, however, all collected fish are to be transported. [Pg 9-75]

*The ability to guide migrating smolt to safe passage routes for inriver migration would reduce or eliminate the need for juvenile fish transportation. Reducing the need for transportation would have an affect on this entire Section and directly address the following Actions:*

**Action 40 [direct]:** The Corps shall continue to transport all non-research juvenile salmonids collected at the Snake River collector projects. The Corps and BPA shall continue to implement voluntary spill at all three Snake River collector projects when seasonal average flows are projected to meet or exceed 85 kcfs. [Pg 9-76]

**Action 41 [direct]:** The Corps and BPA shall continue (pending results of the McNary Transport Evaluation) to bypass juvenile spring migrants collected at McNary Dam and shall provide the spring spill levels described for that project. [Pg 9-76]

**Action 51 [direct]:** If results of Snake River studies indicate that survival of juvenile salmon and steelhead collected and transported during any segment of the juvenile migration (i.e., before May 1) is no better than the survival of juvenile salmon that migrate inriver, the Corps and BPA, in coordination with NMFS through the annual planning process, shall identify and implement appropriate measures to optimize inriver passage at the collector dams during those periods. [Pg 9-81]

**Action 53 [direct]:** The Corps shall evaluate and implement structural and operational alternatives to improve juvenile transportation at the collector dams. [Pg 9-81]

### **9.6.1.4 — JUVENILE FISH PASSAGE**

**9.6.1.4.1 Juvenile Fish Passage Strategy.** A primary objective of the biological opinion is to

increase survival of juvenile outmigrants through the Federal hydrosystem. This objective should be accomplished consistent with two biological principles: 1) protecting biodiversity and 2) favoring fish passage solutions that best fit the natural behavior patterns and river processes (ISAB, 1999). This applies to fish passage through the eight FCRPS hydroelectric projects and their associated reservoirs. The purpose of this fish passage strategy statement is to provide general guidance on dam passage priorities for future annual implementation planning. [Pg 9-82]

**Spillway Passage.** Spillway passage is the preferred passage method for juvenile salmonids that are not collected and transported. . . . Therefore, measures that increase juvenile fish passage over FCRPS project spillways are the highest priority unless it can be shown that alternative passage improvements would provide comparable survival. [Pg 9-82]

**Surface Bypass Passage.** Surface bypass is defined as a surface-oriented route that provides an appreciable **attraction flow-field** and discharges juvenile fish directly to the project tailrace. Continued development and testing of surface bypass prototypes at mainstem FCRPS projects should be a high priority. [Pg 9-82] *[emphasis added]*

*Project 35034 generates an attraction flow field and induces turbulence without spill. Both of these are migrational cues for migrating smolts. This guidance system would direct fish to the desired bypass routes at each dam and thereby increase fish passage efficiency. Project 35034 addresses or affects most of the Actions in this Section. In particular:*

**Action 54 [direct]:** The Corps and BPA shall implement an annual spill program, consistent with the spill volumes and TDG limits identified in Table 9.6-3, at all mainstem Snake and Columbia River FCRPS projects as part of the annual planning effort to achieve the juvenile salmon and steelhead performance standards. [Pg 9-88]

**Action 75 [direct]:** The Corps shall investigate a surface bypass RSW at McNary Dam, based on prototype results at other locations, and shall install the unit in multiple spillway bays, as warranted. Pg 9-99]

**Action 77 [direct]:** The Corps shall investigate surface bypass (e.g., RSW) at Lower Monumental Dam, based on prototype results at other locations, and install in multiple spillway bays, as warranted. [Pg 9-99]

**Action 80 [direct]:** The Corps shall continue the design development, fabrication-deployment, and testing of a prototype RSW at Lower Granite, in conjunction with the existing prototype powerhouse occlusion devices, including the forebay behavioral guidance structure (BGS) and upper turbine intake occlusion devices. As warranted by prototype test results, the Corps shall install one or more permanent RSWs and occlusion devices at appropriate lower Snake hydro projects, in coordination with the annual planning process. [Pg 9-100]

**Action 83 [direct]:** The Action Agencies, in coordination with NMFS through the annual planning process, shall evaluate the effect of spill duration and volume on spillway effectiveness (percent of total project passage via spill), spill efficiency (fish per unit flow), forebay residence time, and total project and system survival of juvenile steelhead and salmon passing FCRPS dams. Studies shall include both collector and non-collector projects. Adult passage considerations and potential adult fallback shall also be considered in study designs. Little Goose and Lower Granite dams shall be specifically considered for daytime spill studies. An overall phased study approach for spill evaluations will be determined in the 1- and 5-year implementation plans. [Pg 9-101]

### **9.6.1.5 — RESERVOIR PASSAGE**

In general, juvenile mortality in reservoirs typically is associated with predation. While predation may be the primary cause of mortality, many factors contribute to vulnerability to predation, including water temperature, delay of passage or migration, TDG supersaturation, fish condition, disease, turbidity, lack of cover, etc. Various ongoing measures that directly reduce predation of juvenile outmigrants (e.g., Northern Pikeminnow Management Program) or may indirectly affect potential predation (water management, including releases of cool water, 24-hour spill, spill patterns, avian lines, water cannons, etc.) should continue. **The Action Agencies should also develop other approaches that may contribute to reducing reservoir mortality.** [Pg 9-106]

*The ability of the FVES to provide quick and efficient guidance to safe passage routes without the need for spill would significantly reduce or eliminate the many factors that contribute to vulnerability to predation - in particular, migration delays, water temperature, TDG super saturation and fish conditions.*

### **9.6.1.6 — ADULT PASSAGE AND RESEARCH**

*Though the focus of Project 35034 and the FVEC is to provide guidance through a generated current and induced turbulence for migrating juveniles, there may also be application affecting adult passage. This system could be used to provide additional attraction flows at the foot of fish ladders and reduce the need for additional flow from the reservoir and down the fish ladder.*

### **9.6.1.7 — WATER QUALITY**

Currently, voluntary spill for fish passage occurs at dams up to the TDG level of 120% in the project tailrace, or 115% TDG in the next downstream project forebays, as allowed by special variances to state and Tribal water quality standards. However, spill for fish passage that results in exceedances of the 110% gas standards is considered an interim strategy in the sense that the long-term goal is to keep TDG levels within water quality standards. [Pg 9-120]

**Without physical modifications to the dams beyond those that are presently under way, the long-term TDG goal cannot be attained between April and August at and between the eight mainstem FCRPS dams.** [Pg 9-121]

*The ability of Project 35034 to guide fish to a safe passage reduces voluntary spill to an amount needed as a passage route, such as a single RSW, and not as an attraction flow. This would seriously reduce spill except as needed for hydro operations. Reduced spill means reduced TDG levels at each dam and a reduced cumulative effect. OR: reduced spill = reduced TDG = higher water quality = water for power generation. Project 35034 directly addresses:*

**Action 134 [direct]:** The Corps shall continue the spillway deflector optimization program at each FCRPS project and implement it, as warranted. The Corps and BPA shall conduct physical and biological evaluations to ensure optimum gas abatement and fish passage conditions. Implementation decisions will be based on the effect of spill duration and volume on TDG, spillway effectiveness, spill efficiency, forebay residence time, and total project and system survival of juvenile salmon and steelhead passing FCRPS dams. [Pg 9-124]

**Action 138 [direct]:** The Corps shall continue to investigate RSWs, in conjunction with extended

spillway deflectors, as a means of optimizing safe spillway passage of adult steelhead kelts and juvenile migrants. [Pg 9-125]

*In Summary:*

*The development of a system to guide migrating smolt in quiescent waters affects many areas of the RPA. It could:*

- (1) Simplify hydro operations where they relate to juvenile migration;*
- (2) Reduce the need for and allow for greater flexibility in flow augmentation;*
- (3) Reduce the need for spill and thereby reduce TDG levels;*
- (4) Reduced spill provides more water for increased power generation.*
- (5) Reduced spill would provide a friendlier environment in the stilling basin.*
- (6) Efficient guidance to safe passage reduces migrational delays and the associated predation and mortality.*
- (7) Efficient guidance to safe passage reduces the need for transportation.*
- (8) Efficient guidance would decrease migration times and mitigate the effect and mortality associated with increased water temperature.*
- (9) The savings accrued through operational changes and the increased revenue from power generation could be invested in habitat restoration.*

