The Quality and Availability of Fall Chinook Salmon Spawning and Incubation Habitat Downstream of the Hells Canyon Complex (E.3.1-3, Chapter 3 and Figures 1-20)

John W. Anderson
AFS Certified Fisheries Scientist
Cold Stream Consulting, P.O. Box 575 Baker City, OR 97814
Contracted by the
Oregon and Idaho Bureau of Land Management
November 4, 2002

I. Introduction

In 1991 IPC began a program to provide stable habitat for fall chinook salmon that spawn in the Snake River downstream of the Hells Canyon Dam. At the inception of this flow stabilization program, little was known about the availability of spawning habitat for fall chinook salmon downstream of Hells Canyon Dam. Because of ESA listing, it was essential for IPC to know whether critical habitat was being protected and whether an acceptable quantity was being provided. The quantity of habitat would have to allow for the population to grow to the point that the species might ultimately be removed from the list of threatened fish. To accomplish these goals, IPC cooperated with the USFWS in a project to model the relationship of habitat availability to river discharge and provide a geographic information system (GIS) database of potential spawning gravels within the Snake River downstream of Hells Canyon Dam. Study objectives included the following:

- Identifying areas within the Snake River that are used by spawning fall chinook salmon;
- Developing habitat suitability criteria for use in site-specific hydraulic and habitat models;
- Choosing specific spawning sites from which to collect PHABSIM-type instream flow data for modeling purposes;
- Using the calibrated models to evaluate the efficacy of IPC's protective flow program;
- Estimating redd capacity within the free-flowing section of the Snake River downstream of Hells Canyon Dam;
- Describing the relative quality of spawning substrates with respect to incubation success;
- Objectively identify, survey, and catalogue (within a GIS database) all areas within the study area that contain potential spawning habitat, based on substrate characteristics.

II. Conclusions

1. "The hydraulic models developed to assess habitat availability and quantity appeared to function without problems and provided reasonable results…Below we summarize our

conclusions concerning the availability, quantity, and quality of spawning habitat of fall chinook salmon within the Snake River downstream of the HCD:

1. *Our hydraulic and habitat models (RHABSIM) indicate that habitat availability increases moderately as discharge from the HCD increases from 8,000 to 13,000 cfs, remains stable from 13,000 to 15,000 cfs, and decreases rapidly at discharges greater than 15,000 cfs.*

2. *An evaluation of measured and predicted stage changes at discharges from the HCD ranging from 8,000 to 15,000 cfs indicates that habitat throughout the Snake River would not be appreciably altered by discharge levels varying within this range. Within this range, the stage elevation changes by only about 0.9 m[eters], and less than 9% of all measured redds have been observed at that depth. Therefore, slight modifications of discharge during the spawning period of fall chinook might be attainable without significantly interfering with the spawning process. This possibility will have to be further evaluated, considering that fall chinook are protected under ESA.*

3. *We produced a reasonable estimate of the area required for a female fall chinook to successfully construct a redd (45.8 m^2) and used that estimate to calculate redd capacity within the Snake River.*

4. *The redd capacity estimates that we developed predict that the quantity of habitat within the Snake River downstream of the HCD is relatively stable across a wide range of discharge levels.*

5. *Within a discharge range of 8,000 to 13,000 cfs, we predict the redd capacity of the Snake River downstream of the HCD to be between approximately 3,450 and 3,750 redds ($\pm$1,217). Recovery goals for Snake River fall chinook salmon require that sufficient suitable habitat be available upstream of Lower Granite Reservoir to support a minimum of 1,250 redds.*

6. *The quality of the incubation environment within the Snake River varies between sites located upstream and downstream of the Salmon River confluence.*

7. *Hyporheic dissolved oxygen levels, measured in late September at the Hells Canyon sites in the upper section of the canyon (that is, Wild Sheep, Suicide Point, and Robinson Gulch), generally exceeded the levels necessary to incubate salmon embryos (approximately 5 mg/L), while at the RM 152 site, these levels averaged only 1.5 mg/L. However, these measurements were obtained not from actual redds, which would likely be significantly higher, but from undisturbed, ambient gravel.*

8. *The velocity of subsurface water has been shown to correlate positively with the embryonic STE [survival to emergence] and growth of salmonids. Values of subsurface water velocity (v) calculated for this study indicate that, within the*

upper Hells Canyon Reach, the STE would be at least 22%; within the lower Hells Canyon Reach, the STE would be very low (approximately 1%); within the Hanford Reach spawning area, over 4%; and within the Hanford Reach nonspawning area, over 2%. We emphasize that these survival estimates are based on relationships determined from data collected in functional redds. Because our data are from undisturbed, ambient gravel, our estimates should serve only as an index. The process of creating a redd probably increases the permeability of the sediment, so actual survival at our study sites would be significantly higher than our estimates.

9. *In general, the technique of using freeze-core sampling worked well for collecting substrate samples within the Hells Canyon Reach. At three of the sample sites in the Hells Canyon Reach, we exceeded nominal criteria used to evaluate how well this methodology performed (collecting a total sample weight of 100 kg at each site). At the remaining site (Wild Sheep), we exceeded 80 kg of sample. We would have had better results if we had performed the coring in cooler water temperatures.*

10. *The general results of our analysis of grain size distribution—based on our sampling in the Hells Canyon Reach using freeze-core and Wolman surface-substrate methods—in combination with results from the Hanford Reach, substantiate the conclusion that the grain-size distribution of the spawning sediment of the Hells Canyon Reach should not limit fall chinook redd construction.*

11. *The percentage of fines(<1mm) at the lower Hells Canyon Reach site was approximately 11%, compared with approximately 3 to 8% at the three upper Hells Canyon Reach sites. For comparison, the percentage of fines within spawning and nonspawning areas of fall chinook salmon in the Hanford Reach were higher, averaging 15 and 19% respectively.*

12. *Permeability values (for example, hydraulic conductivity) were lowest at RM 152 (0.009 cm/s), with the highest values occurring at the site further upstream. Compared with the Hanford Reach of the Columbia River, the sediments from sites in the upper section of the Hells Canyon Reach were more permeable. Hanford Reach sediments, collected in both spawning and nonspawning locations, were generally less permeable than sediments in all of the Snake River sites. Results from all sites fell within the normal range of values determined for alluvium and are typical for fluvial sediments comprising a riverbed.*

13. *No general agreement on a numerical target for defining a habitat criterion for fine sediment has been reached in the scientific literature, although several values have been suggested and are in common use as default criteria. Our results on the percentage of fines (<1 mm) indicate that the upper Hells Canyon Reach sites would have an STE of 46.5%, and the lower canyon would have an STE of 26%. Data for the Hanford Reach predict an STE of at least 8.6% in spawning areas*

and less than 8% in nonspawning areas. We view these results with caution because using fin-sediment content as a criterion for determining STE is complicated, given the difficulties in quantifying its effect on salmonids.

14. *To avoid the difficulties of using percentage of fines to calculate incubation and emergence success, various unifying statistics, such as the geometric mean particle size ($d_{g)}$, degree of sorting ($_{Sg}$), and Fredle index (F_i), have been proposed to calculate STE. Data from the Hells Canyon sites translate into an STE of 61 to 90% at sites in the upper canyon and 58 to 87% in the lower canyon. Samples collected from the Hanford Reach predict an STE of at least 56% in spawning areas and 31% in nonspawning areas. Using the calculated Fredle indices, the STE would be at least 46.5% in the Hells Canyon Reach, 54% in Hanford Reach spawning areas, and 20% in Hanford Reach nonspawning areas.*

15. *The average of all sediment evaluation methods (% fines<1 mm, d_g, F_i, and v) suggested that the most suitable area (in terms of quality of available habitat) for spawning and incubation was the upper Hells Canyon Reach, followed by the Hanford Reach and Lower Hells Canyon Reach site, and lastly the Hanford Reach nonspawning sites." (Page27-28, Paragraphs 3-15)*

Response: The BLM agrees with the findings #1-15.

[IPC Figures 1-20, provide a GIS plan view of modeled Snake River fall chinook salmon spawning sites by number showing flow direction, location of hydraulic and habitat cross sections, individual redd locations, and WUA values for selected evaluation flows.] [Summary of figures 1-20]

Response: Figure 1-20 show the location of fall chinook spawning areas and compliment the information provided by this report.

III. Study Adequacy

The study meets the stated goals and is adequate.

IV. BLM Conclusions and Recommendations

Conclusions

The study is adequate for modeling potential fall chinook salmon spawning area quality and quantity in the Snake River below Hells Canyon Dam. The study shows that there is more than enough spawning area below the HCD to meet the redd target set by the ESA. The quality of the gravel is actually better than that found in the Hanford Reach of the Columbia River, which is known for its production of fall chinook salmon. The study adequately models optimum spawning flows for the Snake River below Hells Canyon Dam. Figures 1-20 illustrate the data recorded in the GIS database.

Recommendations

The study is adequate to answer the questions concerning spawning and incubation flow requirements and the quantity and quality of fall chinook salmon spawning area in the Snake River below Hells Canyon Dam. How ever if it does not address the area below the mouth of the Salmon to Captain John Creek, this needs to be done.