

Benthic Macroinvertebrates of Hells Canyon (E.3.1-8)

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I. Introduction

“This report deals specifically with the effects of the reservoirs, dams and tailwaters on benthic macroinvertebrates. It incorporates the methods, results, and conclusions of separate components to the study of benthic macroinvertebrates associated with the Hells Canyon Complex. These studies were approached from the standpoint of benthic macroinvertebrate persistence in the system and their roles in ecosystem dynamics.

“This report deals specifically with the effects of dams, reservoirs and tailwaters on macroinvertebrates. It incorporates the methods, results, and conclusions of separate components to the study of benthic macroinvertebrates associated with the HCC. These studies were approached from the standpoint of benthic macroinvertebrate persistence in the system and their role in ecosystem dynamics. IPC did not study the determination and rectification of measured impairment or significant limitation caused by project construction and operation: it is not possible to elucidate the original workings of the ecosystem since we know very little about the physical, chemical and biological interactions in this river segment prior to the complex. In addition, FERC requires that only current and existing conditions be studied since ‘no one can guess at what pre-project conditions on a river might have been like and then try to recreate them’ (FERC 1990)” (Page 2, Paragraph 2)

II. Conclusions

1. “The Snake River above the inflow to Brownlee Reservoir (the upstream reach) supports a benthic macroinvertebrate community dominated by a few species of mayflies, worms and leaches. Based on results of research, we believe that this community is shaped by an environment reflecting the effects of regulation, agricultural effluent, and livestock practices. The environment is further affected by the input of five major tributaries to the Snake River, three of which flow through urban areas and agricultural land.” (Page 24, Paragraph 3)

Response: The BLM agrees with this conclusion. The Snake River and its tributaries above Brownlee Reservoir are documented to have a serious pollution problem. The only organisms that can survive or thrive are those that are adapted to the types of pollutants in the system. The Applicant reported that no salmonid species were found in the free-flowing river above Brownlee Reservoir, which may be a reflection of the pollution problems.

2. *“The macroinvertebrate community of Brownlee Reservoir appears to be highly tolerant of nutrient and sediment.” [Brownlee Reservoir receives, processes, and retains agricultural runoff and eroded soil. It has high levels of organic matter and suspended sediment.] “This productive system probably maintains the bulk of its macroinvertebrate biomass as zooplankton, which serves as food for many fish communities in the reservoir.” (Page 24, Paragraph 4)*

Response: The BLM agrees that the macroinvertebrate community of Brownlee Reservoir is highly tolerant of nutrient and sediment. The lack of species diversity is symptomatic of a highly polluted system. The population of zooplankton provides an abundant food base for fish, but at times the pollution levels that create this food base depletes oxygen levels and cause fish mortality.

3. *“The Macro- or microinvertebrate community probably bears little resemblance to the community that existed in the river before Brownlee Reservoir was formed.”(Page 24, Paragraph 4)*

Response: The BLM agrees with this conclusion. Invertebrate communities are highly responsive to the habitat type provided. The benthic communities that inhabited a clean, free-flowing Snake River would have been much more diverse than the ones now found in Brownlee Reservoir.

4. *“The macroinvertebrates in Oxbow and Hells Canyon reservoirs belong to a transitional community with characteristics between the communities of the Brownlee and Hells Canyon tailwaters. In fact, for most of the metrics used in this study—richness, index of biotic integrity, and percentage of dominance—these communities fall in the middle range. Because the individuals are a mix of riverine and lake/reservoir species, the aquatic macroinvertebrates reflect the HCC reaches, which are geographically and ecologically mixed between reservoir and riverine.” (Page 25, Paragraph 1)*

Response: The BLM agrees with this conclusion. The conclusion correlates well with the habitat type that is created by Oxbow and Hells Canyon reservoirs.

5. *“The macroinvertebrate community below Hells Canyon Dam (the downstream reach) is resilient and persistent. When applied, the biometrics described a structure in the downstream reach that indicated a more diverse habitat template, with more niches and probably better habitat conditions for benthic macroinvertebrates than conditions in and upstream of the reservoirs. The community is not characteristic of communities associated with an undisturbed or unimpounded river: many of the organisms are robust and able to deal with a dynamic ecosystem, as is true of communities in the reaches above the HCC.” (Page 25, Paragraph 2)*

Response: The BLM agrees with the statement that the communities are resilient and persistent but not characteristic of communities associated with an undisturbed or unimpounded river. However, to say the population is resilient and persistent is somewhat misleading. Aquatic organisms will inhabit any body of water that is not

completely toxic. There is a greater diversity of species below the dams because it has cleaner water and is a free-flowing river with fewer pollutants than above Hells Canyon Dam.

To state that many of the organisms are robust and able to deal with a dynamic ecosystem is another euphemism for saying that only those communities that can tolerate existing impaired water quality and unnatural fluctuations created by the Hells Canyon Complex are doing well. They represent only a small spectrum of the species diversity and abundance that probably existed prior to dam closure.

6. *“The fluctuation zones produced the highest taxa richness. Those zones, coupled with daily fluctuations, may allow a wider variety of habitats to be used. In addition, various species may benefit from the increased light in the wet or damp areas and stranded pockets of water. As discussed in Cazier 1998, inhabitation of these areas probably depends on the consistency and duration of dewatering, not on whether the areas are actually dewatered.” (Page 25, Paragraph 3)*

Response: There may be more taxa but that does not necessarily mean there would be an abundance of the organisms. It is important to note that the productivity of the fluctuation zone is dependent on the duration of de-watering. If ramping does not occur at regular intervals many of the macroinvertebrates may die of desiccation and colonization would have to begin anew when the water again rises.

7. *“Daily, the macroinvertebrate community experiences fluctuating water levels and changes in velocities. The inhabitants move downstream, upstream, and probably from side to side within the river, again on a daily basis. In one year of collecting up and down these reaches, we found that macroinvertebrate communities persisted in richness and density with little change in the structure of each community. Functioning at these levels of efficiency enabled the invertebrates to fill the niches and occupy the habitats accessible to them. Therefore, their mass in the biological component of the system and their availability in the trophic hierarchy are not likely to be limiting to the ecosystem.” (Page 25, Paragraph 3)*

Response: The conclusion that macroinvertebrates can move upstream, downstream, and side to side within the river on a daily basis is not documented in this study. It is clear from sampling that the organisms persist in available habitat, but it is speculation to say that “their mass in the biological component of the system and their availability in the trophic hierarchy are not likely to be limiting to the ecosystem.” It has been stated previously by the author that there is no pre-impoundment data with which to compare the existing population.

The condition of fish living in the system would indicate that there are no food deficiencies. Due to the opportunistic feeding of fish, it is probable that they are able to adjust to changes in the invertebrate food supply.

8. *“The benthic community represents an important group of organisms in the studied reaches of the Snake River. Although their environment is one of a large regulated river—interrupted linearly by dams and reservoirs and linked by intermittent, complex free-flowing reaches—they persist in communities of great diversity. The dams and reservoirs of the HCC represent additional features or conditions in the ecosystem, and each different condition provides opportunities for macroinvertebrates to maximize.”* (Page 25, Paragraph 4)

Response: The BLM agrees with this statement. The macroinvertebrates present have probably changed from their original diversity and abundance but are able to adjust and utilize the habitat available. However, the species diversity and abundance are not the same as prior to dam construction.

9. *“Analyses of the relationships between the physical environment and the macroinvertebrate species collected during this study did indicate significant relationships. Whether these relationships diminished the integrity of benthic macroinvertebrates in the free-flowing reaches or the reservoirs is difficult to say without understanding preimpoundment conditions.”* (Page 25, Paragraph 4)

“The NMS analysis revealed significant relationships between the benthic community structure and several physical and chemical variables, in particular dissolved oxygen, temperature, and aquatic habitat for Plecoptera, Bivalves, Turbellaria, and Trichoptera. These same relationships are found in rivers worldwide and considered resident, ‘normal’ relationships. It may be that dissolved oxygen, temperature, and volume of water are the important drivers in the downstream reach for species distribution, diversity, and abundance. However, these same variables in any aquatic system vary widely according to season.” (Page 25, Paragraph 4)

Response: The BLM agrees with this statement. However, the sampling results indicate that the population in the tailrace and tailwaters below Hells Canyon Dam, a distance of 17.6 miles, has a much lower abundance of macroinvertebrates (Figure 14) than further down river. There is a high probability that the depressed population is caused by the poor water quality associated with the HCC. There is an oxygen deficiency during late summer that may affect benthic populations.

Although IPC indicates there is no pre-impoundment data, it did not try to compare the Salmon River invertebrate population with that of the Snake River. The Salmon River is free-flowing and could serve as a template for the diversity and abundance found in a relatively large river with no impoundments.

10. *“Spatial relationships over the entire study reach—specifically the patterns in tolerant to intolerant or intolerant to tolerant species, as measured by taxa richness and other metrics—were apparent. But those relationships were probably complicated by distance and other river dynamics, such as velocity, gradient, and water volume, and were not only related to impoundment of the river.”* (Page 26, Paragraph 1)

Response: The BLM agrees with this statement.

11. "Because the increasing taxa richness and decreasing percentage of worms did show recognizable patterns below Hells Canyon Dam (Table 6), dissolved oxygen could be an important determinant of the Snake River benthic community in the tailrace of Hells Canyon Dam. The NMS analysis also indicated that dissolved oxygen, temperature, and aquatic habitat were the highest contributors to axes explanation of species ordination in space. Since dissolved oxygen levels, together with nutrients and sediment, are affected as water passes through reservoirs and dams, the benthic community is probably affected indirectly by the projects, especially in the tailrace of Hells Canyon Dam. The additional factors of linear distances and dilution may have complicated results in these analyses. In any case, organisms that tolerate and are supported well by these conditions have colonized the system (including the tailrace and tailwaters) and appear to be stable." (Page 26, Paragraph 1)

Response: The BLM agrees with this statement. However, it should be noted that only those organisms that are tolerant of the perturbation caused by the HCC and upriver pollution dominate these communities that remain in the system. It was stated in the *Tributary Pollutant Sources to Hells Canyon Complex* study that large amounts of ammonia are being generated in the deep water areas of Brownlee Reservoir. The release of ammonia if in sufficient concentration in the threshold range of 0.53 to 22.8 mg/L can be lethal to aquatic organisms including fish. Toxic levels are both pH and temperature dependent. Levels were recorded as high as 0.34 mg/L below Hells Canyon Dam on December 9, 1997. The State of Illinois has proposed a chronic exposure limit for non-ionized ammonia of 0.025 mg/L during the winter and 0.057 during the summer (Illinois Serracclub.org, 2002). These levels are exceeded much of the time below Hells Canyon Dam (*Tributary Pollutant Sources to Hells Canyon Complex*, Page 91).

12. "However, the presence of the New Zealand mudsnail or a subsequent population increase of mudsnail will probably affect the aquatic ecosystem of the HCC." (Page 26, Paragraph 1)

Response: The BLM agrees with this statement. Monitoring of this species should be included in the terms and conditions unless it can be shown that the HCC has no effect on the mudsnail distribution or reproduction.

III. Study Adequacy

The BLM should accept the study as adequate. However, the conclusions reached by the Applicant are couched in language that puts the best light on the results. The study covers a large area from Swan Falls to the Salmon River and a number of tributaries. The number of samples collected and the techniques for analysis appear to be adequate to provide an overview of species abundance and distribution. However, it is likely that the results of the study cannot be considered statistically significant in all aspects due to the large area covered. There are too many variables that must be considered in such a long distance.

IV. BLM Conclusions and Recommendations

Conclusions

1. The tailrace and tailwaters below Hells Canyon Dam have a macroinvertebrate population that is depressed for 17 miles. This is likely caused by low oxygen levels and temperature. Ammonia production from the reservoirs is another factor that may contribute to this low population.
2. The macroinvertebrate populations in the river above Brownlee Reservoir are heavily influenced by pollution from urban and agricultural practices.
3. Brownlee Reservoir acts as a trap for sediment and chemical pollution. These pollutants create a nutrient rich area that produces high densities of zooplankton and have reduced the diversity of taxa.
4. The Oxbow and Hells Canyon reservoirs have a mix of both riverine and lake/reservoir taxa. This is probably due to increased flow through the reservoir and less pollution.
5. The Hells Canyon Reach has a richer mix of taxa, but it does not resemble that of a natural, unregulated river.
6. The study provides documentation of a depressed macroinvertebrate population below Hells Canyon Dam that is most likely related to dissolved oxygen, pollutants, temperature or a combination of these factors. This information will be useful in requesting modification of the dam to improve oxygen levels that are important to fish as well as macroinvertebrates.

Recommendations

1. The BLM should support recommendations in the new license to improve oxygen, TDG, temperature, and ammonia levels below Hells Canyon Dam.
2. The BLM should request that the Applicant provide analysis of the impact of ammonia being produced in Brownlee Reservoir on aquatic communities including fish below Hells Canyon Dam.
3. The BLM should request that the Applicant conduct research to determine the potential impact of the expanding mudsnail population in the Snake River aquatic community.
4. The BLM should request that the Applicant provide further analysis of the causes of the reduced population of invertebrates in the 17.6 miles below the Hells Canyon Dam.
5. The BLM should request that the Applicant conduct a comparative invertebrate study of the Salmon and Snake rivers to determine how a regionally similar unimpounded river invertebrate population compares with that of the Snake River.