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Lees Ferry, Arizona.

Artificial Floods from Glen Canyon Dam Benefit the Tailwater Rainbow Trout Population Due to Changes in the Invertebrate Prey Base (A443)

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Adult rainbow trout (*Oncorhynchus mykiss*).

1. Introduction

- Closure of Glen Canyon Dam on the Colorado River (Arizona, USA) and subsequent hydropeaking operations have led to changes in the geomorphology of the downstream ecosystem, particularly reductions in sandbars.
- Three artificial floods (1996, 2004, and 2008) have been released from Glen Canyon Dam to restore sandbar building processes and potentially benefit the downstream ecosystem, including fish populations.
- The effects of the March 2008 artificial flood on food availability for the rainbow trout population below Glen Canyon Dam were evaluated using invertebrate production, invertebrate drift, and diets of trout 2 years before and 1 year after the flood (Figure 1).

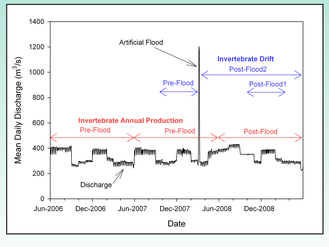


Figure 1. Line graph depicting the experimental hydrograph and time periods of different data collections. The black line represents mean daily discharge; the artificial flood occurred in March 2008 and had a duration of 60 hours. The red arrows depict the time periods of invertebrate secondary production measurements while the blue arrows depict the time periods of invertebrate drift measurements.

2. Findings

- The flood strongly reduced total invertebrate production (Figure 2) but production of two less-common taxa increased (chironomidae and simuliidae; see Figure 3).
- In contrast, invertebrate drift concentrations increased by more than 2X after the flood (Figure 4).

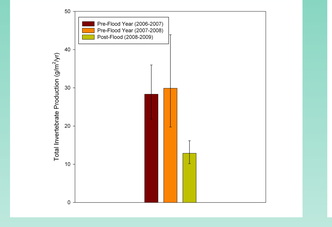


Figure 2. Bar graph showing the significant reduction in total invertebrate production that occurred after the artificial flood. Errors bars represent 95 percent confidence intervals around the mean.

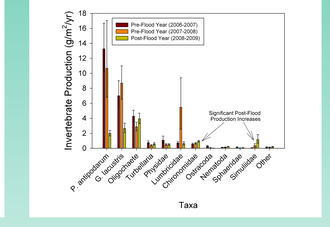


Figure 3. Bar graph showing invertebrate production by species. Species are arranged left to right from highest to lowest production during year 1 of the study. The large reduction in total production in year 3 was because of large reductions in the production of the two dominant species: *P. antipodarum* (New Zealand mudsnails) and *G. lacustris* (amphipod crustaceans). In year 3 two species—Chironomidae (midges) and Simuliidae (black flies)—actually had significantly higher production than in pre-flood years. Error bars represent 95 percent confidence intervals.

- This increase in drift was driven by substantial increases in concentrations of chironomidae and simuliidae in the drift (4–8X increase, depending on taxa; see Figure 5).
- Proportionately more chironomidae and simuliidae production was present in drift relative to other taxa (10–15% vs. <1–3%; see Figure 6).
- Trout are primarily drift feeders and their consumption of invertebrates closely tracks invertebrate availability in drift (Figure 7).

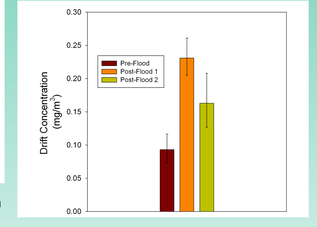


Figure 4. Bar graph showing the significant increase in total invertebrate drift that occurred after the artificial flood. Error bars represent 95 percent confidence intervals.

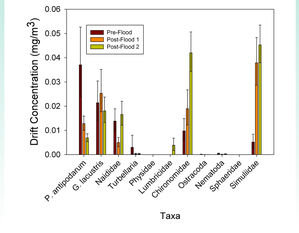


Figure 5. Bar graph showing invertebrate drift by species. Species are arranged in the same order as for figure 3 based on their rank production during year 1. The significant increase in total invertebrate drift was because of significant increases in concentrations of midges and black flies in drift.

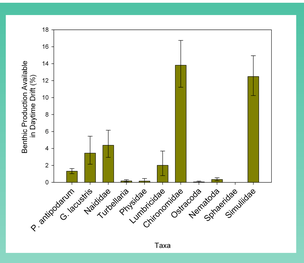


Figure 6. Bar graph showing the percentage of total production that occurred over the 25 km-long study reach that was observed in daytime drift measurements at the downstream end of the study reach. Note that a much higher percentage of Chironomidae and Simuliidae production was observed in the drift relative to other species (12–14% vs. 0–5%). This finding is consistent with a review (Rader, 1997) that found these two species are prone to drifting and therefore readily consumed by salmonids.

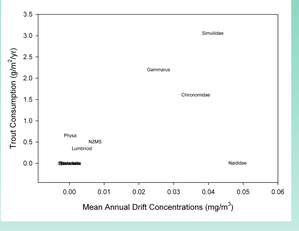


Figure 7. Scatterplot showing the total consumption of different invertebrates by trout (g/m²/yr) plotted against the mean annual drift concentrations (mg/m³). At the origin is a cluster of species that are not present in the drift and are not consumed by trout (Physa, Turbelaria, Ostracoda, Nematoda, and Spaeridae). With the exception of Naididae (worms), trout consumption of prey items is proportionate to their availability in the drift.

3. Conclusions

- Studies in other systems have documented natural and artificial floods benefit salmonid populations because of improvements in spawning gravels (Ortlepp and Mürle, 2003).
- This study indicates artificial floods can also benefit salmonid populations because of improvements in the invertebrate prey base.

References:

Ortlepp, J., and Mürle, U., 2003, Effects of experimental flooding on brown trout (*Salmo trutta fario* L.)—the River Spöl, Swiss National Park: Aquatic Sciences, v. 65, p. 222–238.

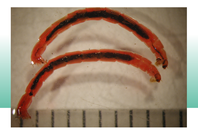
Radar, R.B., 1997, A functional classification of the drift—Traits that influence invertebrate availability to salmonids: Canadian Journal of Fisheries and Aquatic Sciences, v. 54, no. 6, p. 1211–1234.

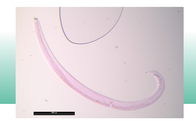
Invertebrates pictured below appear in the order they are presented in Figures 3, 5, and 6 (left to right): *Potamopyrgus antipodarum* (New Zealand mudsnail); *Gammarus lacustris* (scuds, sideswimmers); Naididae (sludge worms); Turbellaria (flatworms); Physidae (bladder snails); Lumbricidae (earthworms); Chironomidae (midges); Ostracoda (seed shrimp); Nematoda (round worms); Sphaeridae (fingernail clams); Simuliidae (black flies)









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