DIEL VARIATION IN SALMON SMOLT PASSAGE AT BONNEVILLE DAM SPILLWAY IN TWO YEARS WITH DIFFERENT SPILLWAY OPERATIONS

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EXTENDED ABSTRACT ONLY – DO NOT CITE

Introduction

Spillway discharge is determined by factors including the need to spill for smolt passage without either raising total dissolved gas (TDG) to physiologically harmful levels or causing fallback of up migrating adult salmon (National Marine Fisheries Service 2000). Spill discharge is usually high at night, often up to the set TDG maximum "gas cap". Since adult salmon move mostly during daylight hours, spillway discharge is usually set lower then to reduce fallback. The effects on passage of diel differences in fish behavior and distribution are confounded with the effects of spillway operations, with higher spill discharge and passage at night and lower spill discharge and passage during the day.

At Bonneville Dam on the lower Columbia River we conducted full project hydroacoustic sampling in both 2000 (Ploskey et al. 2002) and 2001 (Ploskey et al. In preparation). The year 2000 was a fairly typical water year in the Pacific Northwest but in 2001 there was a combination of very low water and high energy demand. Relatively little water was allocated to spill and so spill discharge levels were lower and the spill season was shorter than usual. In 2000 there was more spill at night than during daytime, but in 2001 the rate of spill was almost constant day and night. This provided an opportunity to separate the

effects of fish distribution and behavior from spillway operations and may provide insights for more strategic use of spill for passage in low water years.

Methods

In both passage years individual spill bays were sampled 24 hours/day by down-looking transducers mounted on the upstream faces of the spill bay gates. Of the 18 spill bays the two at the ends were opened only slightly to provide adult attraction flow and were not sampled. We sampled 11 of the remaining 16 spill bays in 2000. In 2001 only eight interior spill bays operated and we sampled six of those. Samples were processed by autotracking software and resulting counts were spatially and temporally expanded to provide fish passage estimates.

Results

In 2000, when the hourly proportion of spill discharge was higher at night than during daytime, the hourly proportion of estimated fish passage was also higher at night (Figure 1).

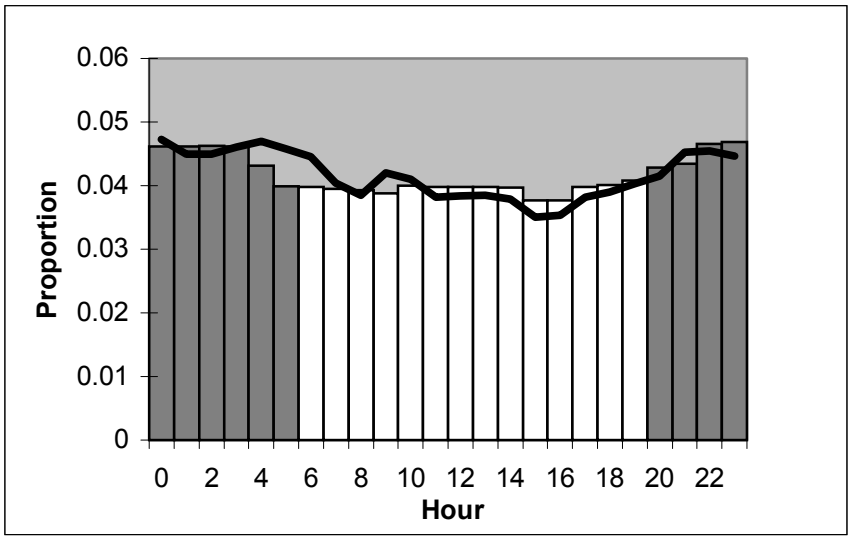

Figure 1. Hourly proportion of total spillway discharge and estimated fish passage at Bonneville Dam in 2000. Vertical bars indicate hourly proportion of total spillway discharge in 80 days of sampled spill during both spring and summer. Dark and light bars indicate approximate hours of darkness and light respectively. The black line indicates the hourly proportion of total estimated fish passage at the spillway.

In the drought year of 2001 there was an even greater diel change in hourly proportion of estimated fish passage although it was not associated with a change in hourly proportion of spillway discharge (Figure 2).

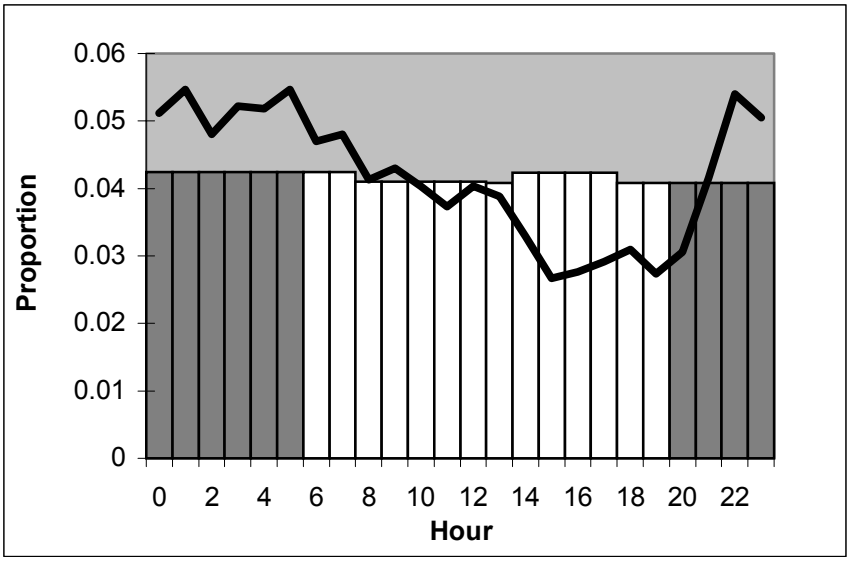

Figure 2. Hourly proportion of total spillway discharge and estimated fish passage at Bonneville Dam in 2001. Vertical bars indicate hourly proportion of total spillway discharge in 30 days of sampled spill during both spring and summer. Dark and light bars indicate approximate hours of darkness and light respectively. The black line indicates the hourly proportion of total estimated fish passage at the spillway.

The absolute values of both spillway discharge and estimated fish passage were much higher in 2000 than in 2001. In the sampling and spilling days represented here (83 days in 2000 compared to only 30 days in 2001) the Bonneville Dam spillway passed about 4.8 times more water and an estimated 17.6 times more fish in 2000 than in 2001. Normalized for number of days of sampled spill the Bonneville Dam spillway passed about 1.7 times more water and an estimated 6.4 times more fish per day in 2000 than in 2001.

Discussion

Spillway and turbine passage at Pacific Northwest dams are thought to be primarily nocturnal (Thorne and Johnson 1993) and spillway operations in normal water years usually reflect that assumption with higher spill at night. Often managers set nighttime spill to the "gas cap" for night and set lower spill levels for daytime to reduce the likelihood of adult salmon fallback. In the 2001 drought year, however, the spillway operations schedule at Bonneville Dam was very nearly constant throughout the diel cycle. In spite of that the diurnal variation in proportion of total estimated fish passage at the spillway was much greater than in a more typical spillway operations season (Compare Figures 1 and 2). This evident uncoupling of diel spillway operations and estimated fish passage suggests that, at least at low spill levels, there is a strong diel behavioral component to spillway passage, which is below the spill gates. Diel vertical migration is a common characteristic of many fishes (Helfman 1993) and of at least some juvenile salmonids (Levy 1990).

There may be fish-related reasons to spill water in a drought besides providing fish passage including the maintenance of water quality above or below the spillway, attraction of up migrating adults to fishways, maintenance of current for juvenile attraction to the spillway, and spillway tailrace egress. But if juvenile fish passage is the reason for spill in a low water year it might be well for project managers to conserve water during daytime for higher nighttime spillway discharge or to extend the spilling season.

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Acknowledgements

This work was sponsored by Portland District of the U.S. Army Corps of Engineers. The hydroacoustic data collection and processing was carried out by all of the Fisheries Engineering Team, which is made up representatives of Waterway Experiment Station, Battelle's Pacific Northwest National Laboratory, DynTel, and MEVATEC Corporation. Ms. Jina Kim of MEVATEC Corporation and Ms. Deborah Patterson of DynTel provided invaluable assistance in the preparation of this manuscript. The Bonneville Project provided physical support and operations data. At the publication of this report Dr. James R. Houston was the director of the U.S. Army Research and Development Center and Col. John W. Morris III was commander and executive director.