HYDROACOUSTIC EVALUATION OF JUVENILE SALMONID PASSAGE AND DISTRIBUTION AT FOSTER DAM, 2013-2014

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The goal of this 14-month study (April 2013 through May 2014) was to provide baseline data on juvenile salmonid passage at Foster Dam (Foster) to support decisions on long-term measures and operations to improve passage conditions. The objectives of the evaluation of juvenile-size target[1,2] passage and distribution at Foster were as follows: 1) estimate passage rates, run timing, horizontal and diel distributions, and passage proportion at the following routes: turbines, spillway, and fish weir; 2) estimate passage proportions for the spillway and weir during concurrent operations; 3) determine if operating the fish weir decreases turbine passage; 4) analyze relationships between downstream fish passage and environmental variables; 5) estimate vertical distribution in the forebay near the upstream face of the dam. An additional objective was to estimate passage rates, run timing, and distributions for adult-size[3] targets (steelhead kelts) during spring 2013 and spring 2014.

We instituted the fixed-location hydroacoustic technique to accomplish the objectives of this study. Transducers (420 kHz) were deployed in each of the two turbine penstock intakes, at Spill Bays 2 and 3, at the fish weir in Spill Bay 4, and on the dam face. A total of nine transducers (one single-beam and eight split-beams) were sampled 24 hr/d, 7d/wk. We interpreted the hydroacoustic data using species composition data from a screw trap in the tailrace operated by the Oregon Department of Fish and Wildlife. To determine if operating the fish weir during summer months when the reservoir was full (El. 635 ft) decreases turbine passage rates, a passage test with a treatment block design was conducted for the summer passage season (June 3 - September 26, 2013). Four-day treatment blocks consisted of two days of turbine only operation (T) followed by two days of turbine + weir operation (T+W). The response variable in the test was turbine passage.

We present results for five seasonal periods based on distinct patterns in pool elevation and migrational periods: spring 2013 (April 1–May 31); summer (June 1 – September 30); fall (October 1–November 30); winter (December 1–February 28, 2014); and spring 2014 (March 1–May 31). Key findings included:

- Turbine passage rates for juvenile-size targets were highest during spring 2013, fall, winter, and spring 2014 (low pool periods). Turbine passage was lowest during summer months (full pool).

[1] While we can discriminate between size classes of fish, we cannot discriminate with hydroacoustic data between salmonid species and non-salmonid species of the same size and having swim bladders.
[2] For the purpose of analysis in this study, juvenile-size targets were defined as fork length ~70 mm ≤ FL < ~300 mm. The lengths are approximations based on acoustic target strength.
[3] For the purpose of analysis in this study, adult-size targets were defined as fork length ~300 mm ≤ FL ≤ ~800 mm. The lengths are approximations based on acoustic target strength.

- Horizontal distribution for hours when both turbine units were operated simultaneously indicated Unit 1 passed the vast majority of fish when compared to Unit 2.
- When the turbines and spillway (either Spill Bay 2 or Spill Bay 3 or both) were operated simultaneously in fall 2013 (95 h) and winter 2013−2014 (536 h), spillway passage proportion[4] ranged from 0.15 to 0.38 and effectiveness[5] from 0.36 to 0.53.
- When the turbines, spillway (either Spill Bay 2 or Spill Bay 3 or both), and fish weir were operated simultaneously in fall 2013 (503 h), spillway passage proportion was 0.29 and effectiveness was 0.85. For the weir, passage proportion was 0.02 and effectiveness was 0.47.
- When Spill Bays 2 and 3 were operated simultaneously, horizontal distribution data indicated twice the number of juvenile-sized targets passed via Spill Bay 2 than Spill Bay 3.
- Through multiple regression analysis, the following environmental variables were included in the model of fish passage: total project discharge, water temperature, and season.
- Passage rates during the T+W treatment (summer 2013; full pool), when both the turbines and fish weir were operated, indicated 84% of all juvenile-size targets passing under these conditions did so via the fish weir; 571 ± 48 (95% CI) fish at the turbines vs 2,869 ± 49 (95% CI) fish at the weir. Under the T+W treatment, differences in turbine and weir passage rates were statistically significant ($P < 0.001$). However, there was no difference ($P = 0.93$) in total turbine passage rates between the weir open and closed treatments. These findings imply fish did not sound to pass into the turbines when the weir was closed, but when the weir was open, they passed over it.
- An estimated 233 ± 96 (95% CI) kelt-size acoustic targets passed Foster Dam in spring 2013 with the majority passing via the weir when at the low pool (616 ft) elevation (126 ± 50 [95% CI]) and at the high pool (635 ft) elevation (18 ± 6 [95% CI]). Similarly in spring 2014, 195 ± 57 (95% CI) passed with 174 ± 46 (95% CI) passing via the weir at the 616 ft elevation.

We reached the following conclusions based on the evaluation of juvenile and adult salmonid passage and distribution at Foster Dam from April 2013 through May 2014: the timing of peaks in passage at Turbine Unit 1 corresponded reasonably well to peaks in fish passage observed in the direct-capture data from the tailrace screw trap; yellow perch biased the hydroacoustic estimates of fish passage upward when perch were prevalent in fall 2013, winter 2013−2014, and spring 2014; the fish weir and the spillway both passed juvenile-size targets, although neither route was very efficient because Turbine Unit 1 passed the majority of the juvenile-size fish moving downstream through the dam; and estimates of kelt-size targets passing Foster Dam indicate the fish weir is the primary route for passage during the spring.

[4] Spillway and weir passage proportion is estimated as spillway or weir passage divided by total project passage.

[5] Spillway/weir effectiveness is estimated by the fish:flow ratio—proportion fish passage at a route (e.g., spillway/weir) divided by proportion of water through that route out of the total project.