Adult Fish Passage Facilities on the Columbia and Snake Rivers

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The Early Years

- **Rivers and Harbors Act 1888**
  - Identified a need for fishways when obstruction are built.

- **Federal Power Act 1920**
  - Required fishways at private hydropower dams.

- **Fish & Wildlife Coordination Act 1934**
  - Fed operating agencies and Fed fish & wildlife agencies must work together for fish passage.

- **Bonneville Dam Fishways Built 1938**
  - 3 ladders, 2 lifts, $3M passage facility, “most complex and largest.”

- **Fisheries Engineering Research Program 1951.**
Fisheries-Engineering Research Lab: 1955-1980

- Test facility included an Experimental Fish Flume to study and understand the:
  - Rate at which fish ascend fishways.
  - Appropriate water velocities, gradient, and length of fishways to maximize fish passage.
  - Effect of lighting on fish.

- Beginning of regional collaboration on studies of fish passage behavior.
U.S. ARMY CORPS OF ENGINEERS
NORTH PACIFIC DIVISION
FISHERIES-ENGINEERING RESEARCH PROGRAM
4TH ANNUAL PROGRESS REPORT
1976

PROGRESS REPORT
ON
FISHERIES ENGINEERING
RESEARCH PROGRAM
NORTH PACIFIC DIVISION
CORPS OF ENGINEERS; U.S. ARMY

NOVEMBER 1956

Participating Organizations:
North Pacific Division, Corps of Engineers, U.S. Army
U.S. Fish and Wildlife Service
University of Washington, School of Fisheries
Oregon State Game Commission
State of Washington, Department of Fisheries
Fish Commission of the State of Oregon
State of Idaho, Department of Fish and Game
State of Washington, Department of Game
Portland District, Corps of Engineers, U.S. Army
Walla Walla District, Corps of Engineers, U.S. Army
Seattle District, Corps of Engineers, U.S. Army
Adult Fish Passage

- Diffusion Chamber
- Vertical Slot Weirs
- Fish Ladder Exit
- Forebay
- Auxiliary Water Supply
- Fish Ladder Entrance
- Tailrace
- Adult Fishway Entrances
- Collection Channel
- Inlet grating
- Powerhouse Collection Channel
- Overflow Weirs
Design Considerations

- Biological Info
  - Species
  - Swimming performance
  - Behavior
  - Size
  - Run timing
- Design Flow
- Forebay / Tailwater Stage
- Dam configuration and operation

http://www.habitat.noaa.gov/pdf/salmon_passage_facility_design.pdf
FLOW DURATION CURVE FOR COLUMBIA RIVER AT THE DALLES, OREGON
USGS STREAMGAGE #14105700

Based on 30-Min Flow Values for Juvenile Fish Migration Passage Period extending from 1 March thru 30 November

Drainage Area = 237,000 square miles approximately

CENWP-EC-HY; DAB
SEPTEMBER 2000
Operation Criteria

- Fish Passage Plan
- Powerhouse and spillway operation
- Entrance head and depth
- Transport channel velocity
- Drop between pools and depth over weirs
- Monitoring and inspection
Ladder Design: Lessons Learned

- Exit sections
  - Not upstream of spillways or on islands
  - Not serpentine
Ladder Design: Lessons Learned

- Avoid ledges: floor passage in vertical slots and/or orifices
- Entrances and Collection Channels
  - Powerhouse orifices – mixed results
  - Fixed weirs when possible to minimize O&M
- Gravity fed auxiliary water supply
  - Consider temperature when placing intakes
  - Include redundancy if not gravity fed
Bonneville Dam
Cascades Island Fish Ladder Entrance
Lamprey Criteria

- Four inches minimum radius rounding on all outside corners (>180 degree in change in bearing in any surface) of indented fish passage openings, wherever weir opening is not flush with sidewall or orifice opening is not flush with floor.

- Ramping to raised orifices or along sidewall to indented weirs to assure lamprey passage.
Lamprey Criteria

- Diffuser gratings with maximum 0.75-inch openings to prevent lamprey infiltration.

- At least one seamless floor connection without steps or abrupt corners between weir pools (usually orifice) and through counting slot and picket leads in count station.
Cost

- Construction examples
  - Exit section rebuild ~ $1-4 million
  - JDA N Ladder renovation ~ $30 million
  - Bonneville OR shore expressway ~ $60 million
- Maintenance – Bonneville annual (OR shore full + WA shore partial) ~$800,000
Cost

- **Water**
  - Grand Coulee – 0.018-0.025 Mw per cfs
  - Lower Columbia River ladder section
    - 75-120 cfs
    - 1.4-2.5 Mw
  - AWS
    - 2000 – 4000 cfs total
    - 36-100 Mw

- 2014 annual average replacement cost per Mw/hr = $29
Resources

- University of Idaho – more than 2 decades of radio telemetry studies
  - http://www.webpages.uidaho.edu/uiferl/Reports.htm
- Fish Passage Plan
- NOAA Fish Facility Design Guidelines
- DVD