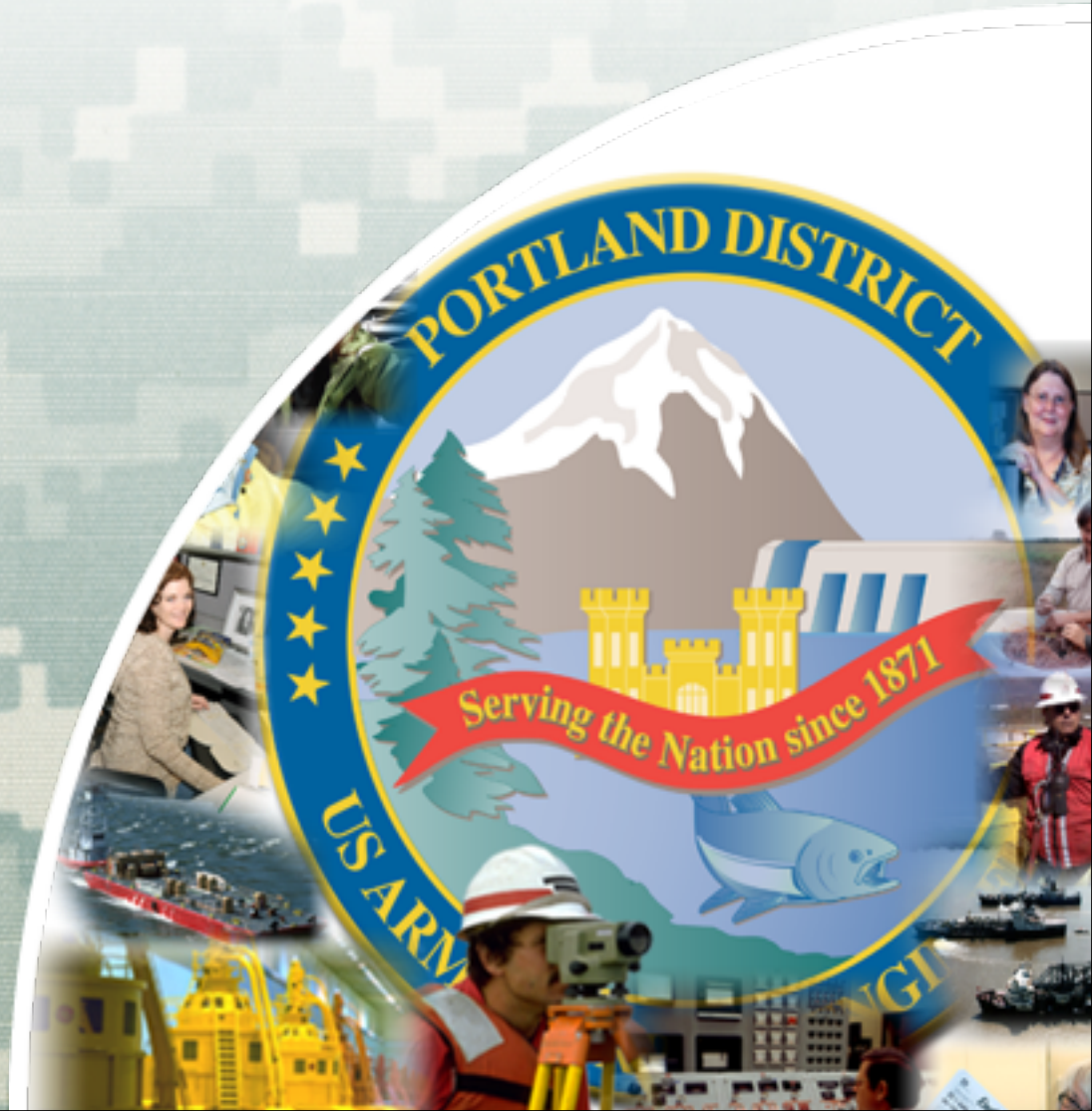
Adult Fish Passage Facilities on the Columbia and Snake Rivers

Mike Langeslay

Supervisory Fish Biologist

Portland District, Corps of Engineers

March 19, 2014



US Army Corps of Engineers
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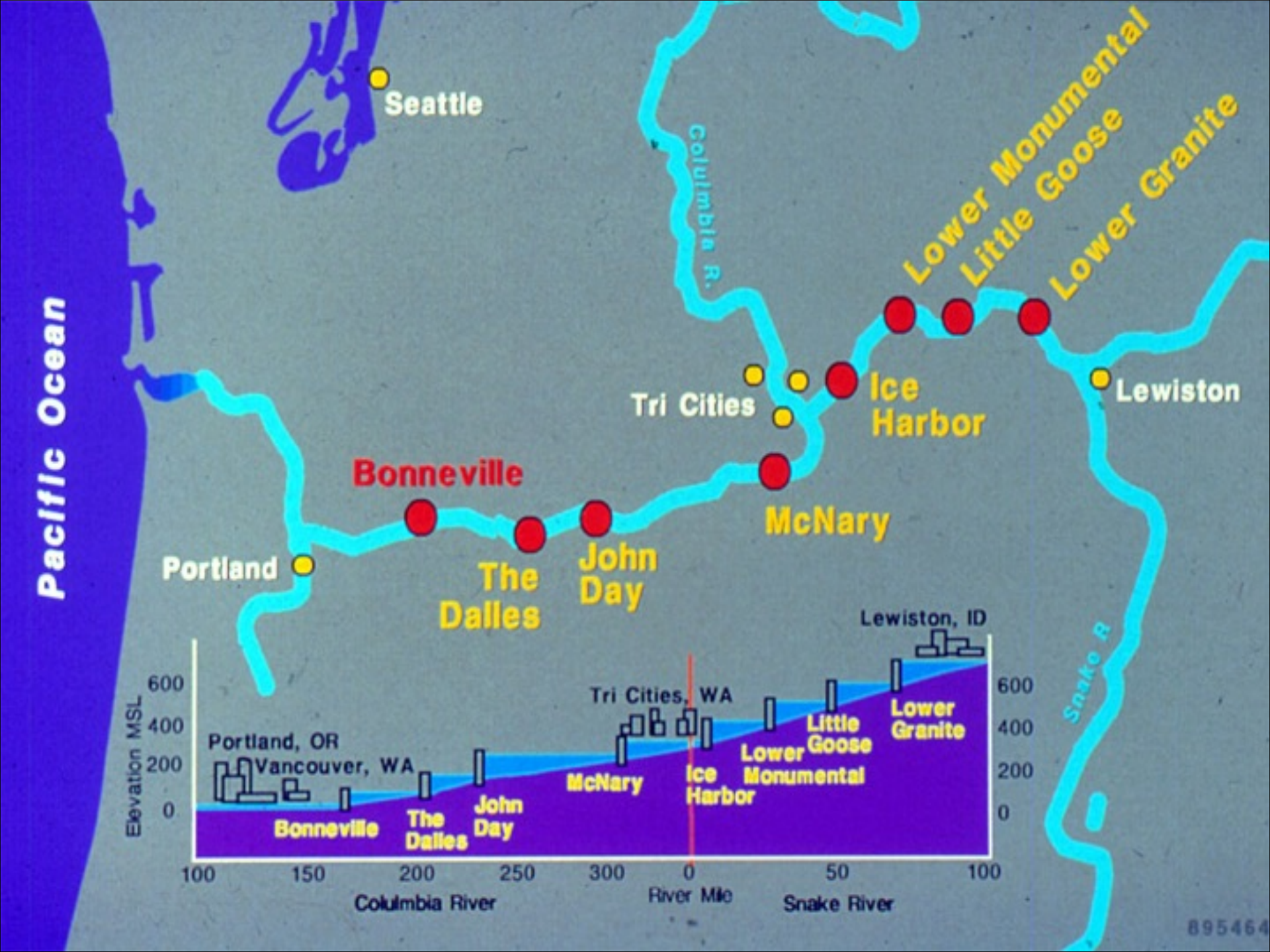

Pacific Ocean
Seattle
Columbia R.
Lower Monumental
Little Goose
Lower Granite
Tri Cities
Ice Harbor
Lewiston
Bonneville
McNary
Portland
The Dalles
John Day
Lewiston, ID
Snake R
Elevation MSL
600
400
200
0
Portland, OR
Vancouver, WA
Bonneville
The Dalles
John Day
McNary
Tri Cities, WA
Ice Harbor
Lower Monumental
Little Goose
Lower Granite
100
150
200
250
300
0
50
100
Columbia River
River Mile
Snake River
895464

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

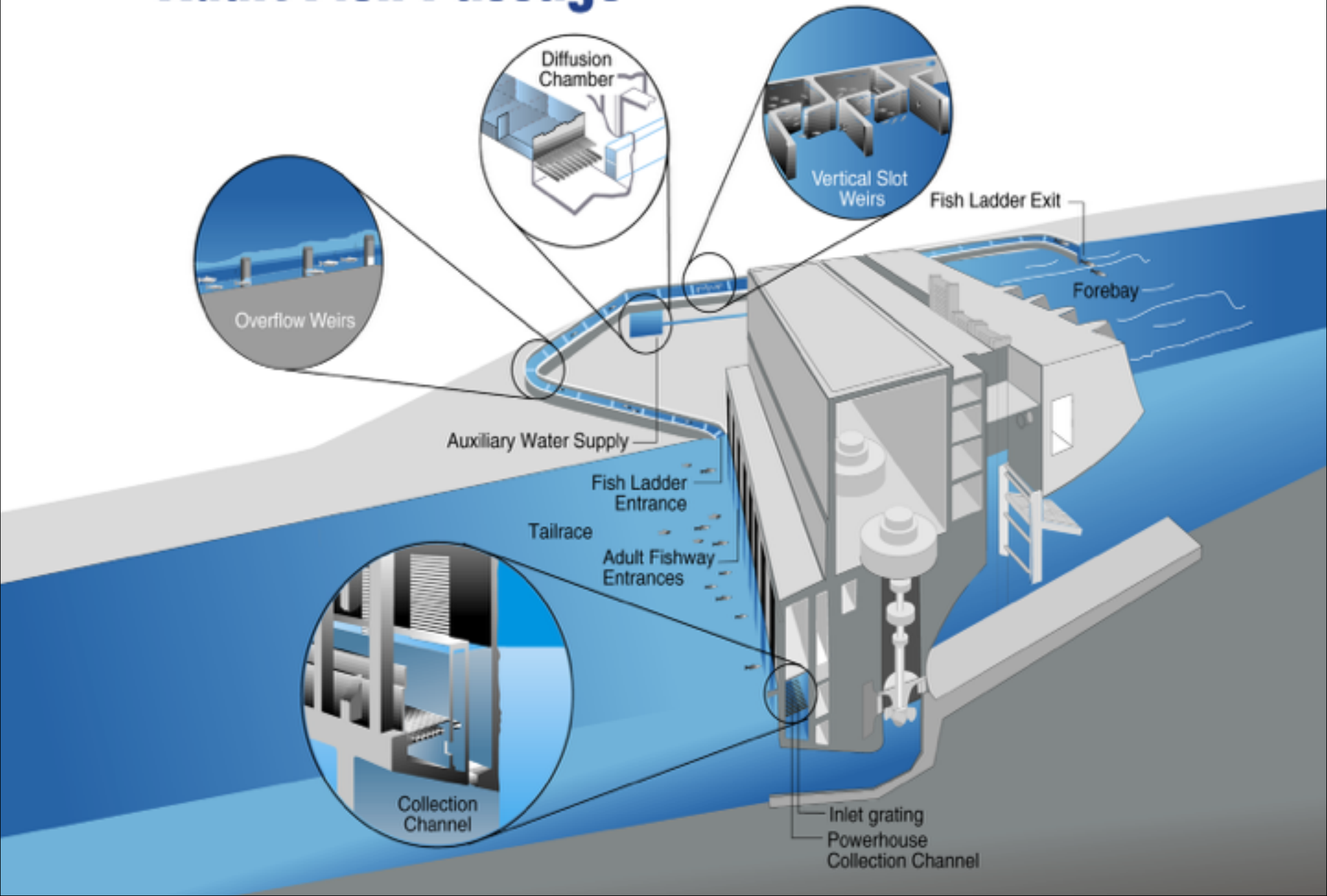
FISHERIES ENGINEERING RESEARCH PROGRAM

NORTH PACIFIC DIVISION
CORPS OF ENGINEERS, U. S. ARMY

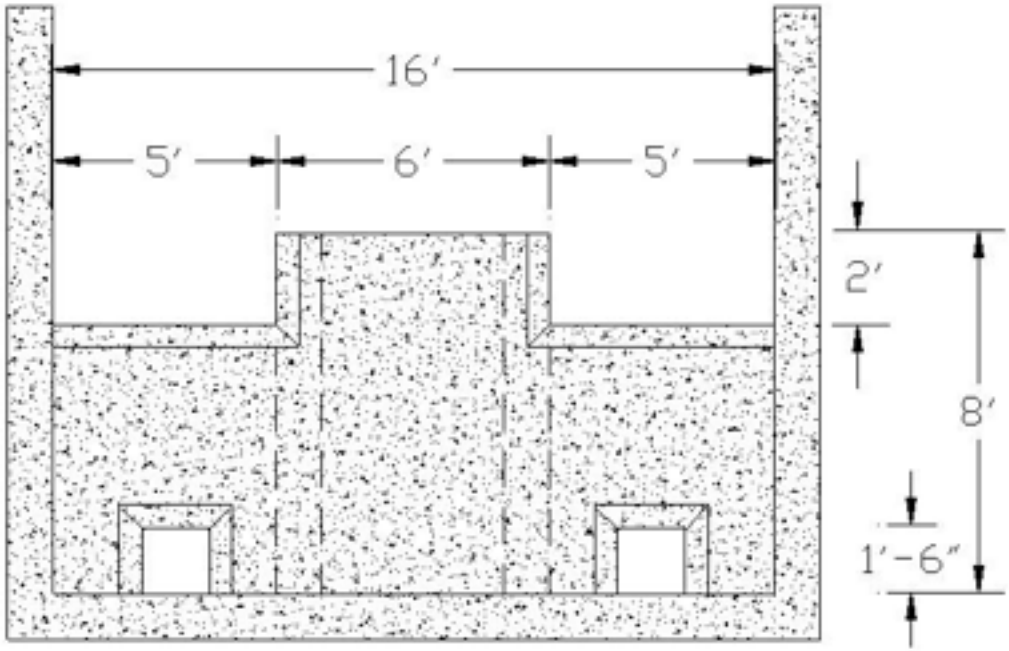
NOVEMBER 1956

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



U.S.ARMY



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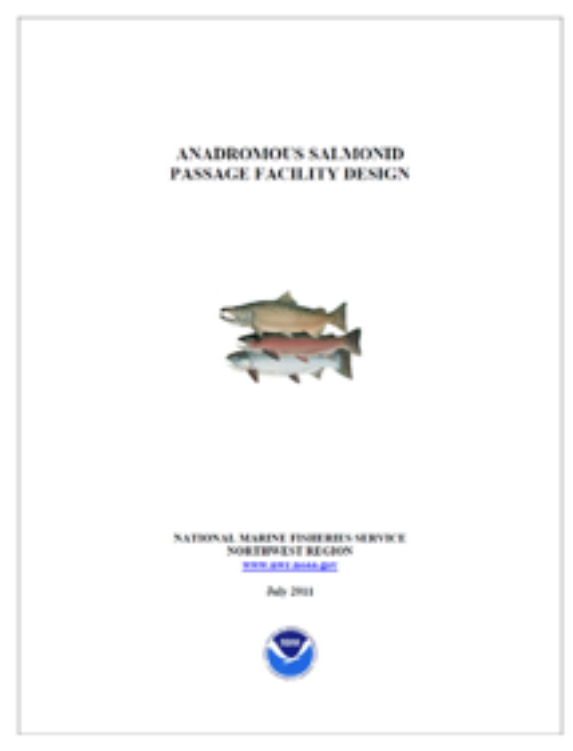
Design Considerations

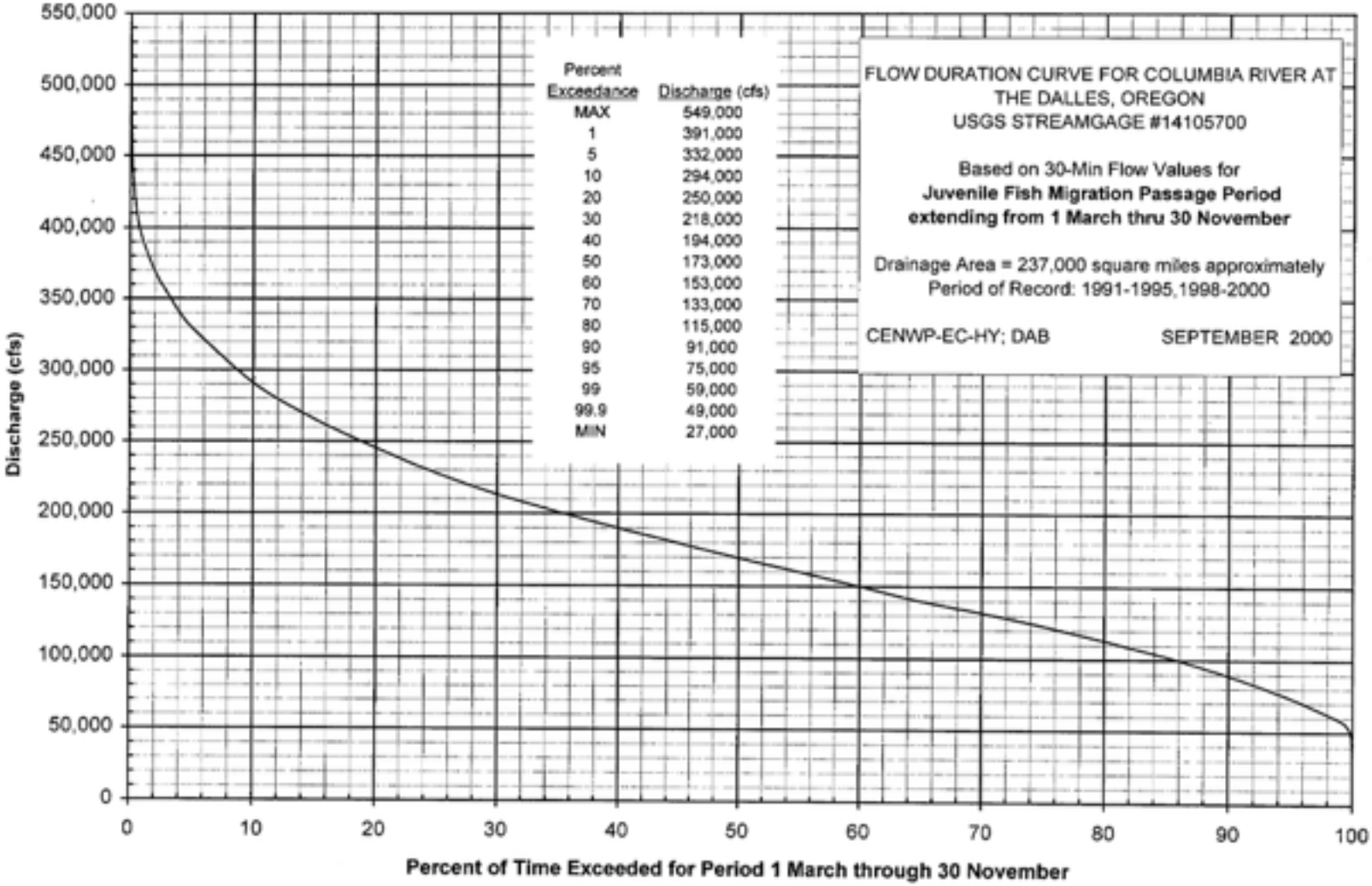
- Biological Info
  - Species
  - Swimming performance
  - Behavior
  - Size
  - Run timing
- Design Flow
- Forebay / Tailwater Stage
- Dam configuration and operation

- http://www.habitat.noaa.gov/pdf/salmon_passage_facility_design.pdf


ANADROMOUS SALMONID
PASSAGE FACILITY DESIGN

NATIONAL MARINE FISHERIES SERVICE
NORTHWEST REGION

July 2011


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
Period of Record: 1991-1995,1998-2000
CENWP-EC-HY; DAB
SEPTEMBER 2000
Percent Exceedance
Discharge (cfs)
MAX 549,000
1 391,000
5 332,000
10 294,000
20 250,000
30 218,000
40 194,000
50 173,000
60 153,000
70 133,000
80 115,000
90 91,000
95 75,000
99 59,000
99.9 49,000
MIN 27,000
Discharge (cfs)
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
0
10
20
30
40
50
60
70
80
90
100
Percent of Time Exceeded for Period 1 March through 30 November

Operation Criteria

- Fish Passage Plan
  - http://www.nwd-wc.usace.army.mil/tmt/documents/fpp/2013
- Powerhouse and spillway operation
- Entrance head and depth
- Transport channel velocity
- Drop between pools and depth over weirs
- Monitoring and inspection

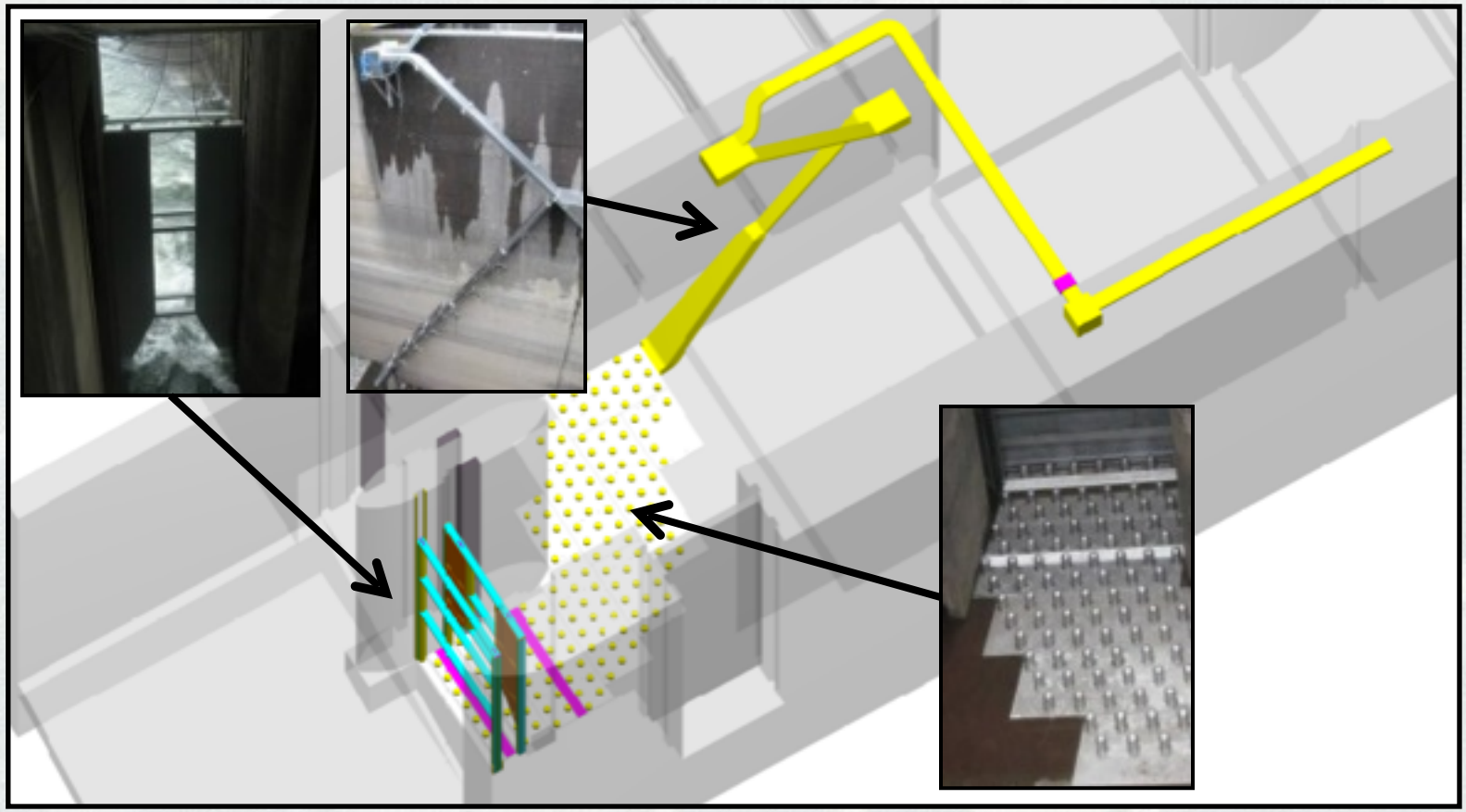
Ladder Design: Lessons Learned

- 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

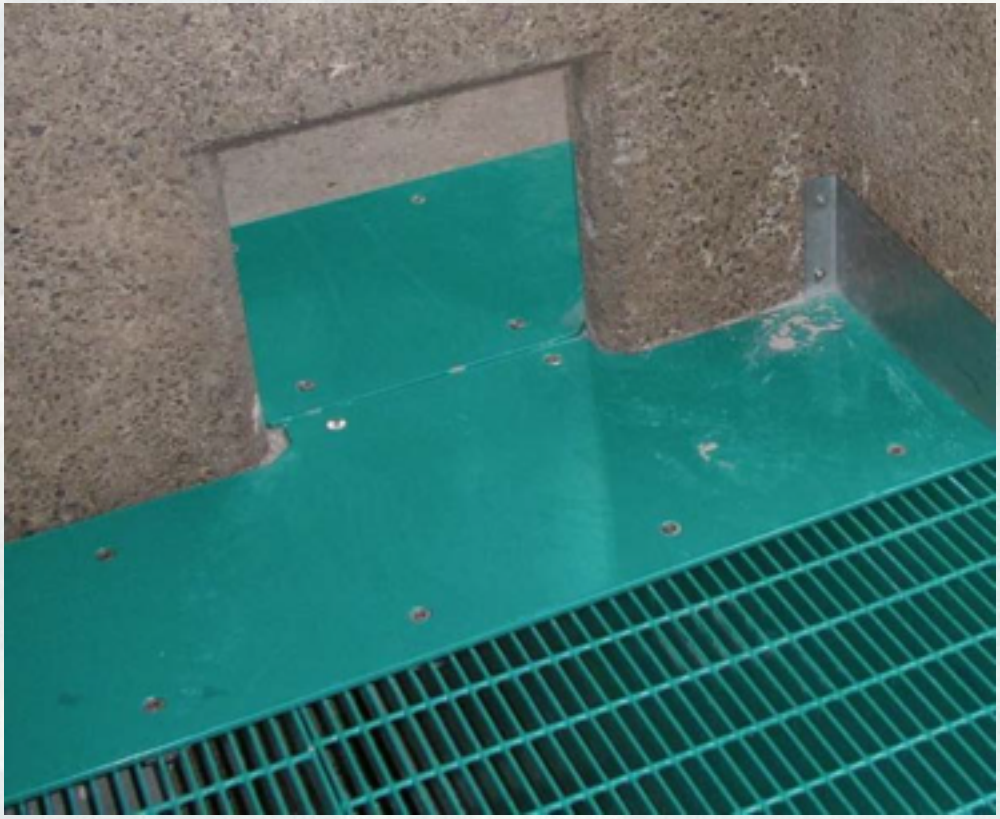
- Four inches minimum radius rounding on all outside corners (>180 degree in change in bearing in any surface) of indented fish passage openings, wherever weir opening is not flush with sidewall or orifice opening is not flush with floor.

- 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 Mwhr = $29

Resources

- University of Idaho – more than 2 decades of radio telemetry studies
  - http://www.webpages.uidaho.edu/uiferl/Reports.htm
- Fish Passage Plan
  - http://www.nwd-wc.usace.army.mil/tmt/documents/fpp/2013/
- NOAA Fish Facility Design Guidelines
  - http://www.habitat.noaa.gov/pdf/salmon_passage_facility_design.pdf
- Corps Library http://www.nwp.usace.army.mil/References.aspx
- DVD