Jun 21st, 1:15 PM - 1:30 PM

Case Studies II: Downstream Fish Passage at High Head Dams

Fenton Khan
U.S. Army Corps of Engineers

Follow this and additional works at: https://scholarworks.umass.edu/fishpassage_conference

Khan, Fenton, "Case Studies II: Downstream Fish Passage at High Head Dams" (2016). International Conference on Engineering and Ecohydrology for Fish Passage. 5.
https://scholarworks.umass.edu/fishpassage_conference/2016/June21/5

This Event is brought to you for free and open access by the Fish Passage Community at UMass Amherst at ScholarWorks@UMass Amherst. It has been accepted for inclusion in International Conference on Engineering and Ecohydrology for Fish Passage by an authorized administrator of ScholarWorks@UMass Amherst. For more information, please contact scholarworks@library.umass.edu.
Downstream Fish Passage at High Head Dams

Fenton Khan
U.S Army Corps of Engineers, Portland District

Fish Passage 2016
University of Massachusetts, Amherst, MA
June 20 – 22, 2016
Presentation Outline

- Background information on High Head Dams
- Challenges for volitional fish passage
- Examples of historical bypass systems
- Summary of a passage test at a bypass system
Background

- Most hydropower dams are constructed with considerations for upstream fish passage (e.g. ladders)
- Downstream passage generally occur via turbines, bypass, or surface outlets (e.g. spillways, sluiceways)
- High-head dams present greater challenges for downstream passage because of the height of the dams:
  - The vast difference between the forebay and tailrace elevations and the fluctuating reservoir elevations are two major challenges
  - Volitional passage occur via turbines and spillway or outlets
Run of River Dams

Photos courtesy of USACE

McNary Dam

Ice Harbor Dam

The Dalles Dam

Bonneville Dam
High-Head Dams

- Detroit Dam
- Cougar Dam
- Lookout Point Dam
- Upper Baker Dam
- Green Peter Dam
- Shasta Dam

Photos courtesy of USACE, USBOR, and PSE
Reservoir Elevation

Lookout Point Dam - Reservoir
- Normal full pool: 926 ft.
- Min. pool for flood control: 825 ft.

Detroit Dam - Reservoir
- Normal full pool: 1563 ft.
- Min. pool for flood control: 1450 ft.

Data source: USACE Water mgt.
Volitional Passage Routes

- Turbines
- Spillway
- Regulating Outlets
Challenges

- High Structures
- Large forebay elevation fluctuations
- Outlets positioned low on dam

- Typical TW Elev. – 1235 ft
- Height of dam > 300 ft
- Detroit Dam (453 ft tall)
- Flow
- Regulating outlet – 1340 ft
- Penstock – 1403 ft
- Min. Pool – 1450 ft
- Spillway – 1541 ft
- Max. Pool – 1563 ft
Examples of Historical Bypass

- Cougar and Fall Creek dams (Willamette Valley, Oregon)
- Fish horns passed fish from forebay into pipes though the dam
- Outlets positioned low on dam
- Abandoned because of high injury and mortality

Reservoir
Max. Pool – 1690 ft

Flow
Min. Pool – 1532 ft

Section through dam (Cougar Dam)
Height of dam > 500 ft
Green Peter Dam – Bypass System

- El. 1,015 Max. Pool
- El. 1,000
- Highest Fishing Position of Horn
- Rubber Hose
- Gate
- El. 985
- El. 960
- El. 935
- Lowest Position of Horn
- El. 910
- Pump Intake
- Pump Discharge El. 850
- Penstock El. 810
- Gate Guides
- 24" Diameter Transportation Pipe
- Discharge to Tailrace
Fish Injury and Survival Study
Green Peter Dam Bypass

- Study conducted with juvenile salmon and steelhead - 2015
- Tested the two lowest bypass pipes
  - Hydrostatic heads; ~25 ft. (935 pipe) and ~50 ft. (910 pipe)
  - 4 gate valve openings; full flow, 75%, 50%, 25% open

- Study conducted in 2016
- Tested the two lowest bypass pipes
  - Hydrostatic heads; ~55 ft. (935 pipe) and ~80 ft. (910 pipe)
  - Released tagged fish into river for delayed mortality
Fish Injury and Survival Study Results - 2015

- Survival was high; 99% salmon and 100% steelhead
- Injury was low; 6% salmon and 3% steelhead
  - Injuries were mainly bruises and scale loss; few hemorrhaged eyes – valve opening at 50%
- Lowest survival and highest injuries occurred at the deepest pipe with valve 25% open

Injuries at the 50% valve opening
Downstream Fish Passage at High Head Dams

- Background information
- Challenges for volitional passage
- Examples of historical bypass systems
- Summary of a passage test at a bypass system
Acknowledgements / Questions

- Normandeau Associates, Inc.
- Pacific Northwest National Laboratory