Dec 11th, 1:30 PM - 3:10 PM

Ultrasound to guide American shad toward a spillway

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Caumartin, Jean; Lafleur, François; and Desrochers, Denis, "Ultrasound to guide American shad toward a spillway" (2018). International Conference on Engineering and Ecohydrology for Fish Passage. 11.
https://scholarworks.umass.edu/fishpassage_conference/2018/December11/11
Ultrasound to guide American shad toward a spillway

Jean Caumartin, Hydro-Québec – Environment
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François Lafleur, IREQ
American shad (*Alosa sapidissima*)

- Anadromous fish, found all along the East Coast of North America
- Reproduce between 1 and 7 times depending on latitude
- The St-Lawrence population:
  - Feeds in North Atlantic
  - Spends the winter in Bay of Fundy (NB)
  - In spring, (mid April) starts its spawning migration toward fresh water and the Montreal area
In May, shad arrive in the Montreal region migrating toward the Carillon GS to spawn.
From the end of May to late June, adults migrate back to the Atlantic ocean.
A sizable portion will enter the des Prairies River and encounter the GS or the spillway.
Other issues
Other issues

- Largest Lake sturgeon spawning ground in Quebec’s St-Lawrence River system
  - Spilled water is managed for lake sturgeon protection
  - Possibility to flush L. sturgeon larvae if hydraulic downstream of the GS is modified
- The arrival of post spawned downstream migrating A. shad conflicts with L. sturgeon protection
Solution – until 2005

- Spent adults detected by sonars
- Units shutdown and opening up spillway 1 h/d
Problem / Solution

- How to protect A. shad before dates set by Ministry of Environment for L. sturgeon (no gates maneuvers)?
- How to protect A. shad between the maneuvers (1 hr/d)?
- Is it possible to hold back A. shad during week-ends?
- Is it possible to keep some units in operation if enough flow?

Solution:
- Develop a procedure to evaluate the date at which L. sturgeon larvae are off the substrate
- Develop a sound guidance system (ultrasound)
  - Shad reacts to these frequencies
  - Similar to the «clicks» made by hunting marine mammals
  - Possibility to keep turbines in no-charge state during the maneuvers or to keep some turbine on-line
Guidance system 2006 - 2010

200 kHz transducers
10 m
4° beam
129 m
Powerhouse

125 kHz transducers
10 m
7° beam
75 m
Powerhouse

125 kHz transducer
200 kHz transducer
Guidance system 2006 - 2010

90° configuration

Dove tail configuration

7° 17° 30° 45° 62° 79° 97°
Conclusion:

- Frequency = 125 kHz
- Pulse width = 3.8 ms
- Duty cycle = 8% (21 clicks/s)
- Amplifier produces ± 220 dB, ref. 1μPa at 1 m of the transducers
Guidance system 2009 - now

- Joined with Hydro-Quebec’s Research Institute (IREQ) in 2009

- Objective:
  - Built a system to prevent shad to enter the des Prairies River (based on ultrasound)

- 2010 to 2016: improvements on the GS system made toward developing an autonomous shad guidance system:
  - Simulation and back calculation → threshold at which shad are reacting: 168 dB (ref. 1 µPa @ 1 m)
  - Re-designed amplifiers
  - Customized transducers
  - Only 2 poles in the water instead of 6: Easier debris clean-up operation at the GS
Guidance system at the GS
**Guidance system at the GS**

- Two ultrasound stations
  - Effective and reliable systems
  - Powerful: $\pm 238 \text{ dB, ref. } 1 \mu \text{Pa @ 1 m}$
  - $168 \text{ dB threshold at } 600 \text{ m and more}$
  - Ok with GS operations
  - Two configurations:
2016: The lowest mortalities observed since 2000
- 23 dead shads collected
- Only one was injured
Prevent shad in the River: Bizard Island

- Autonomous sound generators

  - Monitoring shad’s guidance system with:
    - Sonars
    - Gill net fishing
    - Sonars at the GS

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**Prevent shad in the River: Bizard Island**

- Solar panel ± 50 W (± 300 W at GS)
  - At GS, 109 emission parameters tested
- Buoys stable in lake and in river
  - Onboard communication card, pitch and roll sensor, GPS
  - Operation parameters remotely controlled
- Biology: no real guidance yet!
  - Geographic positioning tests (in or out river)
  - Gill net fishing: Mooneyes (*Hiodontidae tergisus*)
  - Down migration timing better known (3h-11h)
Questions?
Guidance system 2006 - 2010

System OFF at 10:42

System ON at 11:12

System OFF at 10:42

System ON at 11:12

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