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Aboiteaux Fish Passage Gate

Client: Nova Scotia Department of Agriculture
Agriculture and Food Operations Branch
Land Protection & Field Services

Project Focus

- Over 260 aboiteaux structures are used across Nova Scotia to protect agricultural land from saltwater inundation.
- Current aboiteaux structures are not fish friendly and block up stream habitats.
- Goal is to select a new aboiteaux gate design that better allows fish passage, while still protecting agricultural land from flooding.

Site Information

- Site: McClure's Brook
- Location: 4.7 km West of Truro, Nova Scotia
- Aboiteau: 2 structures with 1.8 m x 1.8 m steel gates

Requirements

- Gate must cover a 1.5 m round culvert
- Outflows at gate < 4.2 m/s
- Flow within culvert < 1.2 m/s

Design Process

Research → Design Alternatives → Prototyping → Testing & Validation

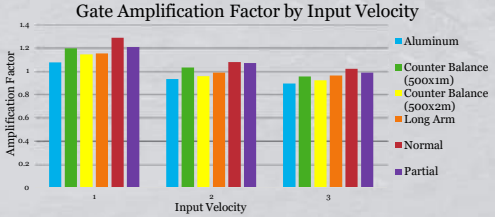
Designs

1. Current Gate
   - 1.8 m square, 940 kg
2. Aluminum Gate
   - Same gate design but aluminum for lighter weight
3. Counter Balanced Gate
   - Attach a counter balance to reduce the force required to open the gate.
4. Longer arm
   - Increase the length of the hinges to increase the moment caused by the flow on the gate.
5. Partial Gate
   - Remove the bottom 30% of current gate design
6. Side Hinged Gate
   - Mount hinges on the side of the culvert

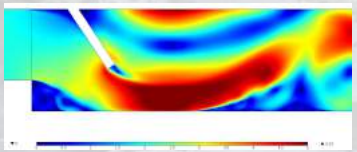
Computational Fluid Dynamics (CFD) Testing

Testing was done using 2D modelling with variable input velocity and Fluid Structure Interaction.

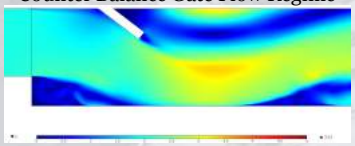
Gate Amplification Factor by Input Velocity



Current Gate Flow Regime



Counter Balance Gate Flow Regime



Recommendations

- Construct the physical model for further testing of designs.
- Collect flow data to define a more narrow range of parameters for testing.
- Best solution is to add counter weights for a customizable integration and easy retrofit.

Acknowledgements

- Chris Ross & Carl Esau, Nova Scotia Department of Agriculture
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- Addison Rayner, Dalhousie University

References

- All images taken by the group unless noted otherwise (2018, 2019)
- Dhiman, A. (2018, February 5). Pump Ass'y. Retrieved March 24, 2019, from https://grabcad.com/library/pump-ass-y-dc24v-1
- Icely, S. S. (2012, October 4). Liquid Funnel. Retrieved March 23, 2019, from https://grabcad.com/library/liquid-funnel
- Cardinal Caster. (n.d.). Retrieved March 25, 2019, from https://www.mcmaster.com/2426t72

Scale Model

- Allows multiple different gate designs to be tested individually. Angle of opening, duration open and average velocities can be recorded.
- Culvert and gate dimensions at a 1:24 scale.
- One reservoir represents fresh upstream water, one reservoir represents tidal basin. Bottom reservoir adds system capacitance.
- Flow to each reservoir is controlled by its own pump, throttling valve and flow meter to achieve desired conditions.
- Tidal basin reservoir has a drain to enable falling tide simulation, equipped with a throttling valve and flow meter to achieve desired conditions.
- Constant inflow (modeling river flow) set to 25 L/min.
- Reservoir size allows for one complete tidal cycle to occur over approximately 10 minutes, to achieve approximate steady state response.
- Flow through culvert desired to be approximately 0.5 m/s at low tide.
- Sluice gate placed at upstream end of culvert to control water level through culvert at low tide. Can be removed during high tide.

Sluice gate