Design and Construction of a Recirculating Flume for Lumpfish Adhesion Strength Testing

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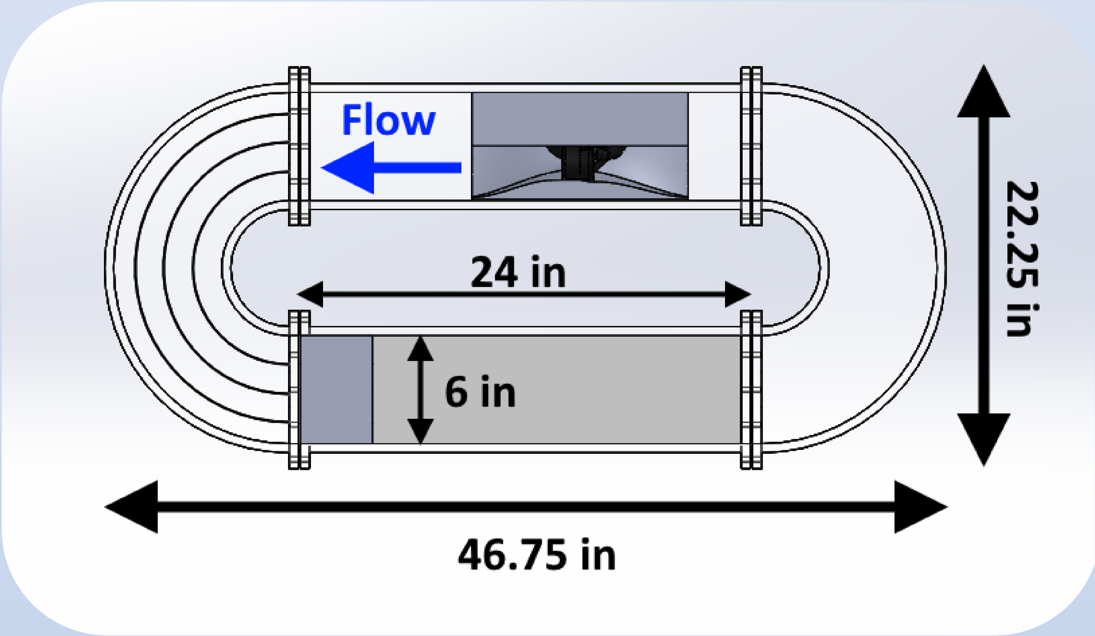
Objective

The goal of this project was to design and build a variable flow swim chamber to test the adhesion strength of 25-75g juvenile lumpfish. The design requirements were as follows:

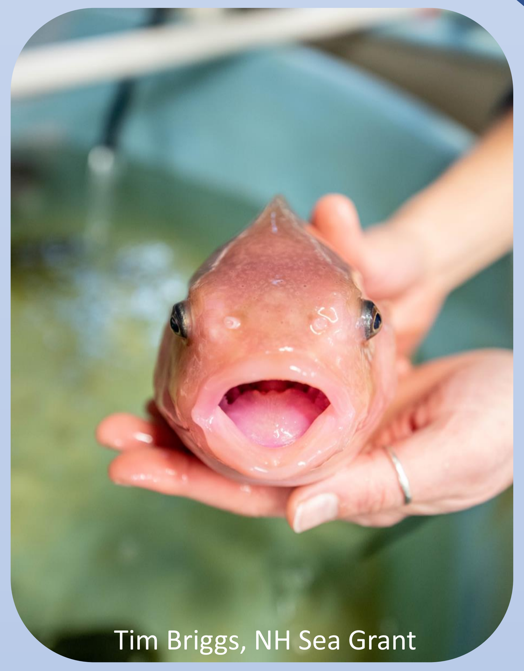
- Achieve water velocities ranging from 4-60 cm/s
- Produce gradual acceleration and steady flow
- Test section viewable by camera
- Compact form factor



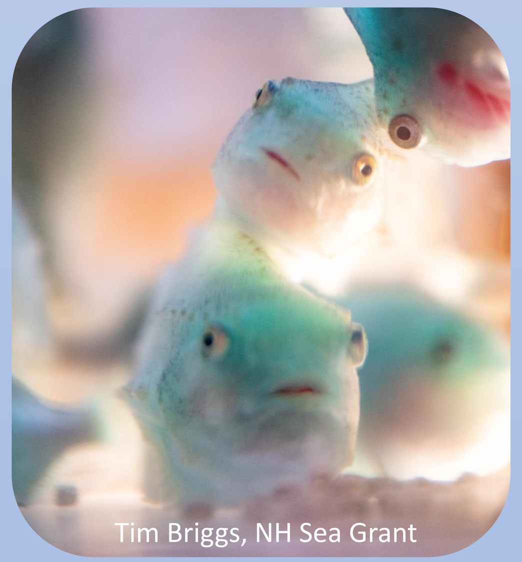
Top View of Flume Layout

Background

Lumpfish *(Cyclopterus lumpus)* are an effective treatment for sea lice infestations in open ocean salmon farming systems. When inactive, they adhere to surfaces using a modified pelvic fin. Salmon cages experience more volatile currents and wave activity than lumpfish are adapted to in their benthic environments, therefore it is necessary to test their adhesion strength to determine their viability as pest control in salmon aquaculture. We designed a variable speed flume capable of reaching a maximum flow velocity of 60 cm/s to simulate storm conditions commonly experienced in Gulf of Maine salmon farms.



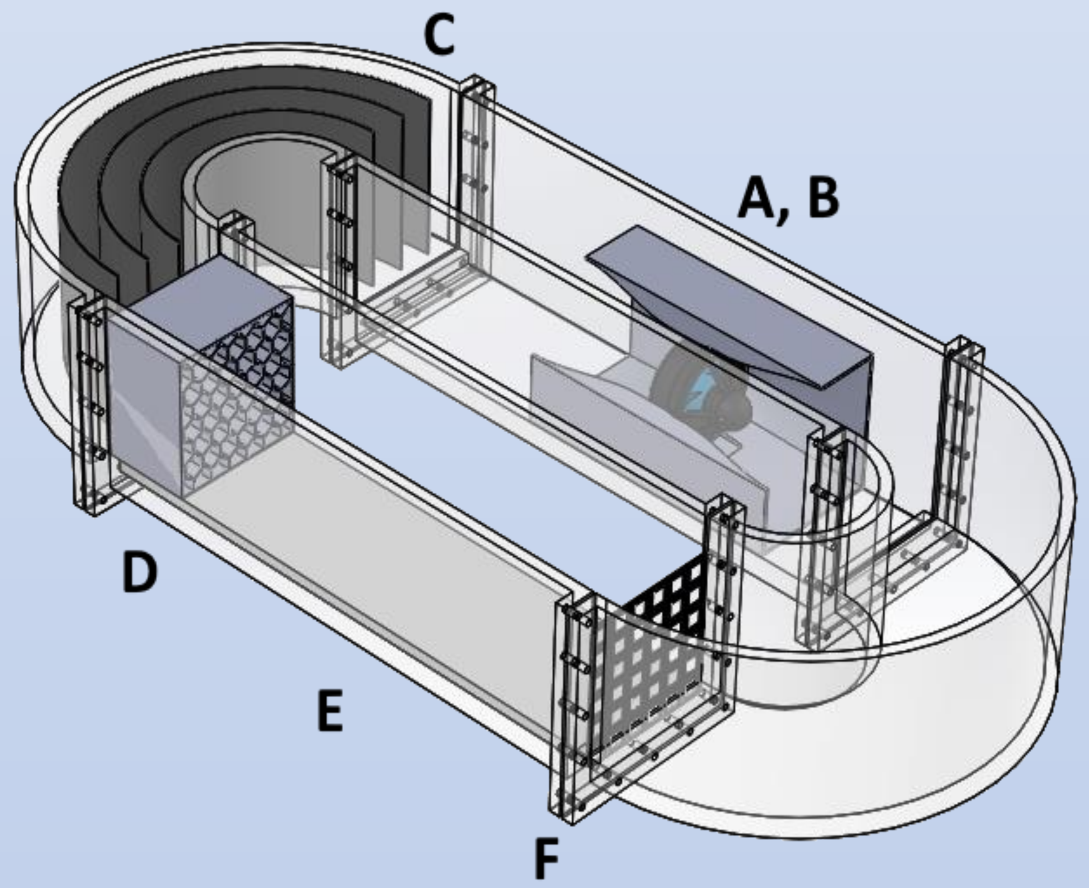
Adult Male Lumpfish



Juvenile Lumpfish

Flume Design

A racetrack style flume was selected for this project. The closed-loop racetrack style most closely mimics benthic environments and allows well developed flows to be achieved in a small footprint. Water is accelerated through a flow duct (A) via a thruster (B.) The flow is conditioned through the first bend with flow veins (C) and honeycomb (D.) A false bottom (E) is included to allow various adhesion materials to be tested. At the end of the test section there is a safety mesh (F) to prevent fish from being harmed by the thruster setup. All bio-safe materials were used.



A - Flow Duct
B - Thruster
C - Flow Veins
D - Honeycomb
E - False Bottom
F - Safety Mesh

3D Guide of the Flume

Bending Plexiglass

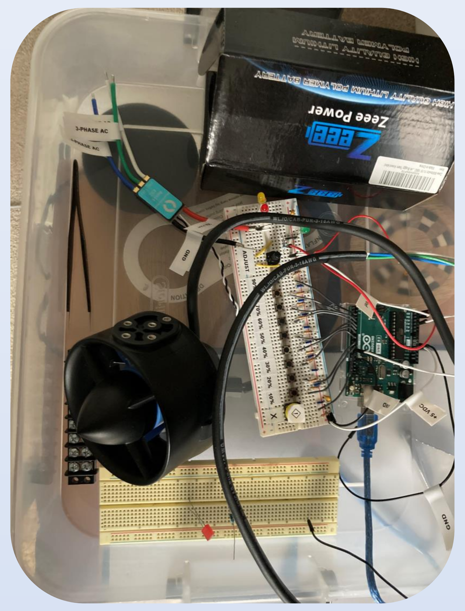
All acrylic used was sustainably salvaged from past projects. Pieces were cut and heated to 165°C before being shaped using plywood and 3D printed molds to form curved side sections.

Plexiglass Bending Tests

Matthias and Marco Bending

Assembly

The body of the racetrack was constructed from plexiglass salvaged from old flumes. All pieces were cut to size and squared. The flange faces were laser cut to achieve high precision and repeatability. The gaskets were cut from a silicone sheet. The bends were heated in a sediment drying oven, bent into molds, and then trimmed to size. All plexiglass pieces were glued together using acrylic glue. The flume was assembled then all seams were sealed with silicone caulking.



Thruster and Electronics

Construction Guide

Initial Testing

The tank was filled with water. The flow duct and thruster setup were inserted into the tank and tested. The thruster assembly worked well and was able to drive the flow even at very low power. The duct worked but needs to be redesigned to prevent cavitation.

Flume Filled with Water for Testing

Future Research

Further flow testing is recommended to assess thruster capabilities within the tunnel. The flume's modular design allows for researchers to easily install additional sensor probes. The setup is compatible with nearly any small fish species and may be used to assess swimming performance under a variety of conditions. Different shapes of test section could easily be installed if necessary.