University of Basel

D|U|W Departement Umweltwissenschaften

mgu

Swimming competition!

Who beats the flow in a hydraulic barrier for invasive fish?

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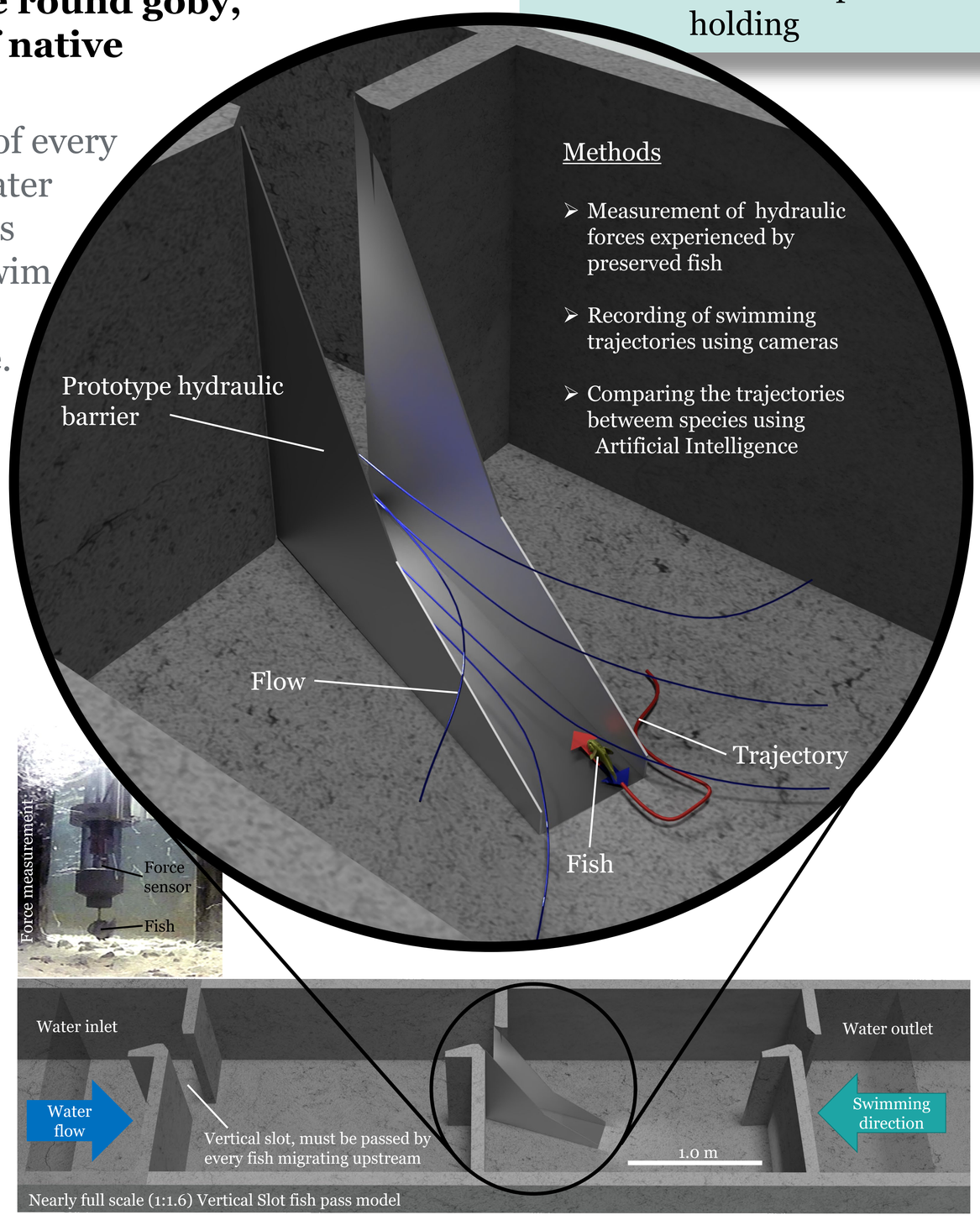
Round goby is an invasive species, which out-competes native species and represents a major threat for invaded ecosystems. Fish passes are bottlenecks that must be passed by every fish migrating upstream. The proposed hydraulic barrier is designed to create hydraulic conditions that impede passage of the round goby, whilst allowing passage of native species.

To test the barrier, ca. 43 fish of every species were released at the water outlet of a vertical slot fish pass model. The fish were free to swim upstream for two hours, unaffected by human presence. The species were tested separately.

The prototype hydraulic barrier

- ✓ Stainless steel plate (3 mm) of 1m length to extend the jet stream and exceed the swimming capacity of the round goby
- ✓ Diagonal side walls to affect the flow predominantly at the bottom
- ✓ Smooth surface to prevent the round goby from substrate holding



Round goby

(*Neogobius melanostomus* Pallas, 1814) is native in the Black and Caspian Sea. Round goby arrived in the river Rhine near Basel (Switzerland) in 2012, outcompete native species, and continue dispersal upstream.

Gudgeon

(*Gobio gobio* L.) is a poweful, semi-pelagic swimmer with similar ecological niche as round goby and bullhead.

Bullhead

(*Cottus gobio L.*) looks similar to the round goby, inhabits small tributaries, and has a burst -and-hold swimming style.

Gudgeon experienced significantly smaller hydraulic forces on the barrier than the other species.

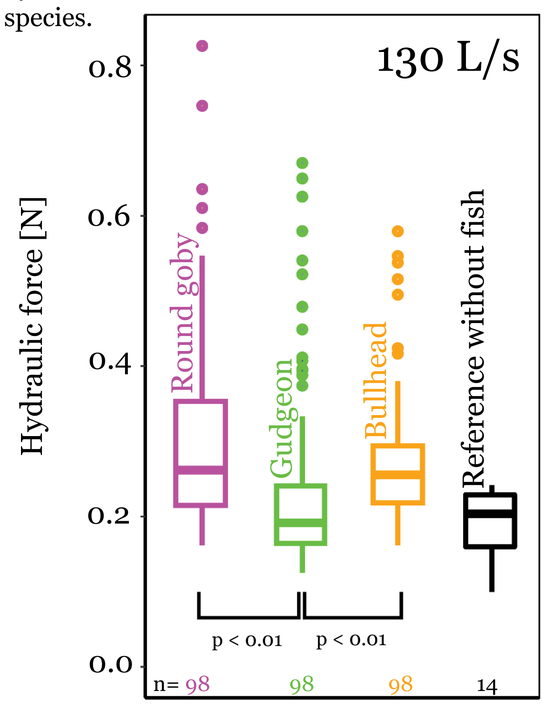


Figure1: **Hydraulic forces** experienced by 7 preserved fish per species over the barrier at 14 measurement points.

80L/s

Predominantly round goby but no gudgeon passed the barrier.

105 L/s

Round goby and gudgeon passed the barrier.

130 L/s

No round goby but six gudgeon passed the barrier. Three bullhead passed and immediately returned.

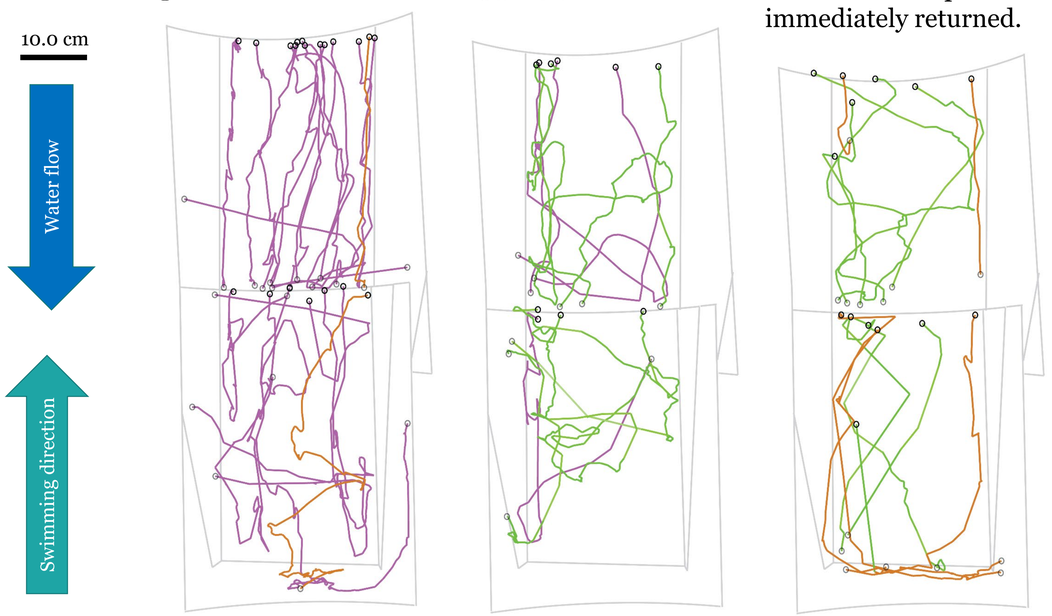


Figure. 2: The **swimming trajectories** of the three species on the barrier were extracted from the video footage of all three tested water discharges by hand. The 130 L/s water discharge is representative for real fish passes. The gray lines represent barrier contours.

Artificial Intelligence

Random Forest models revealed distinct swimming behaviour between species as they were able to predict the species of round goby and gudgeon on the swimming trajectories with high F1 scores.

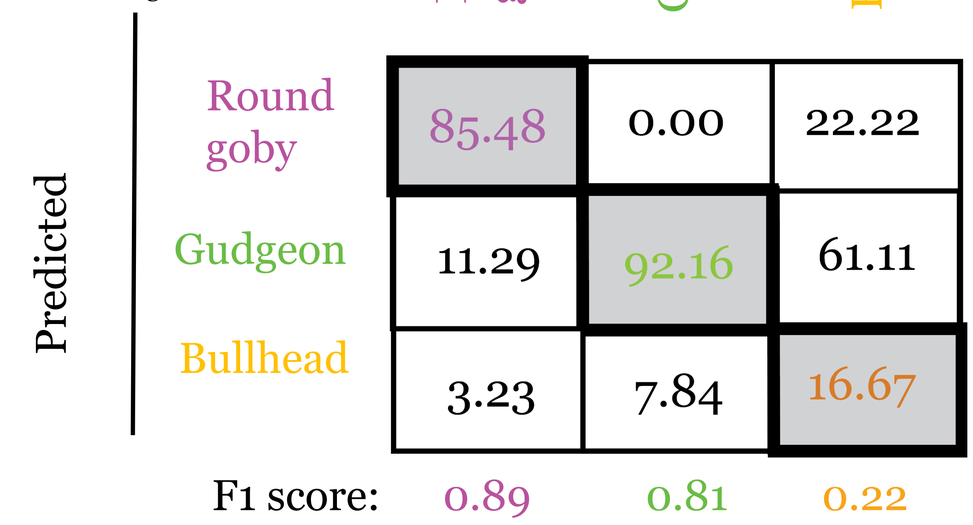


Figure. 3: Crossvalidation of the **Random Forest model**, which was trained to predict the species on the swimming trajectories of Fig. 2. The confusion matrix displays prediction proportions [%] for the different species with correct prediction in the gray areas. A perfect model has an F1 score of 1.

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