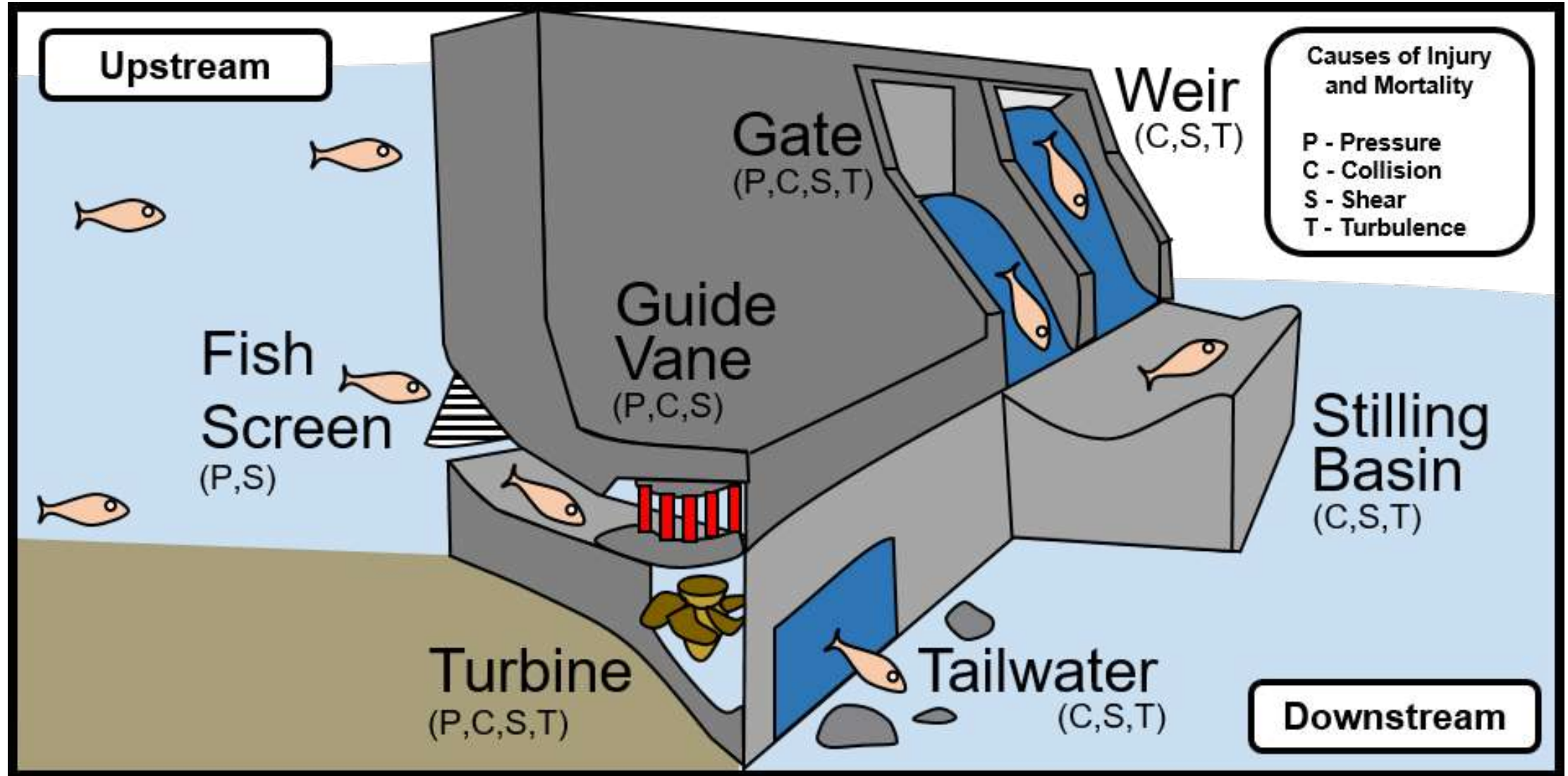


# **HOW TO COMPARE PASSIVE SENSOR DATA WITH LIVE FISH OUTFITTED WITH ARCHIVAL BIOLOGGERS TO ASSESS THE RISK OF INJURY AND MORTALITY**

Assoc. Prof. Dr.-Eng. Jeffrey A. Tuhtan  
School of Information Technology / Dept. of Computer Systems  
Tallinn University of Technology, Estonia

# Turbine Entrainment Injury and Mortality

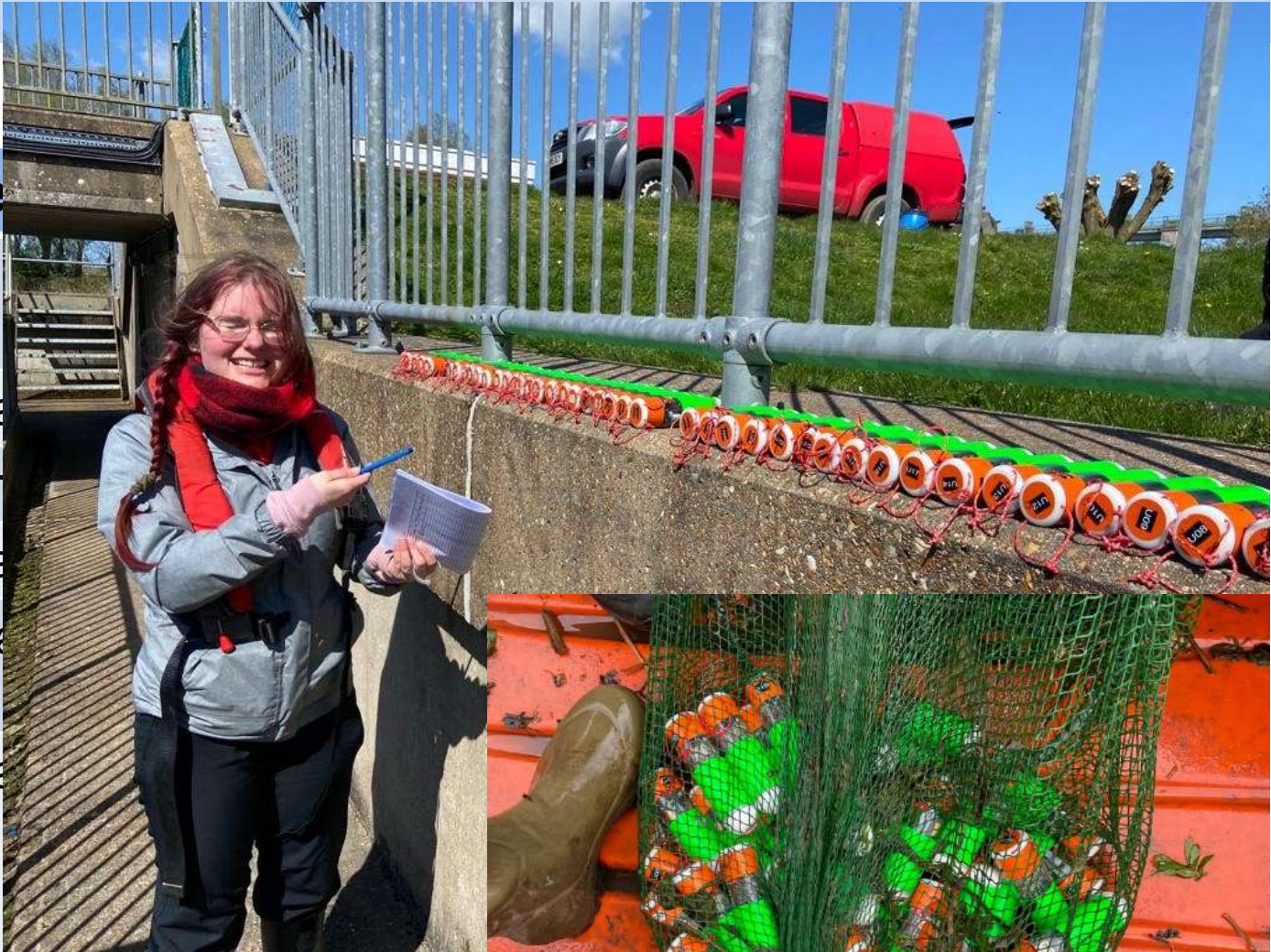




# Passive Sensors

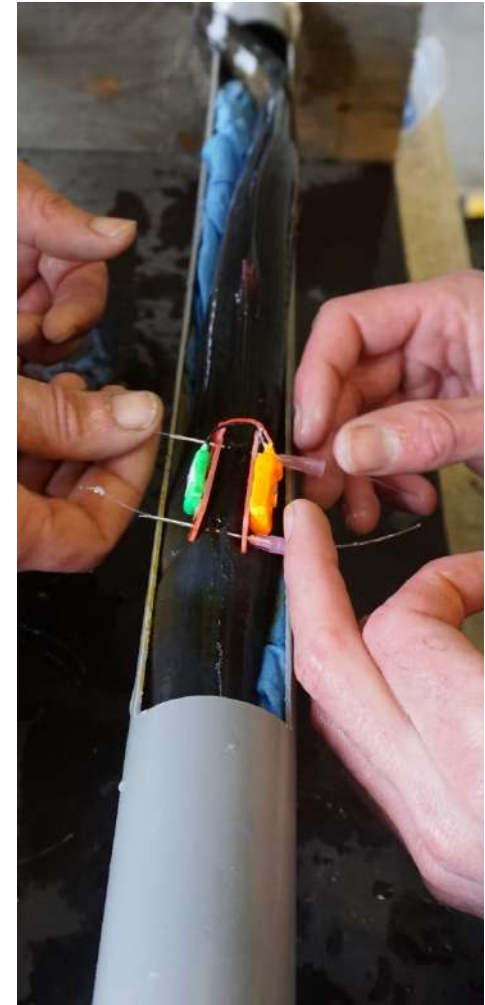


re  
y ra  
tur  
bra  
Dia  
ma

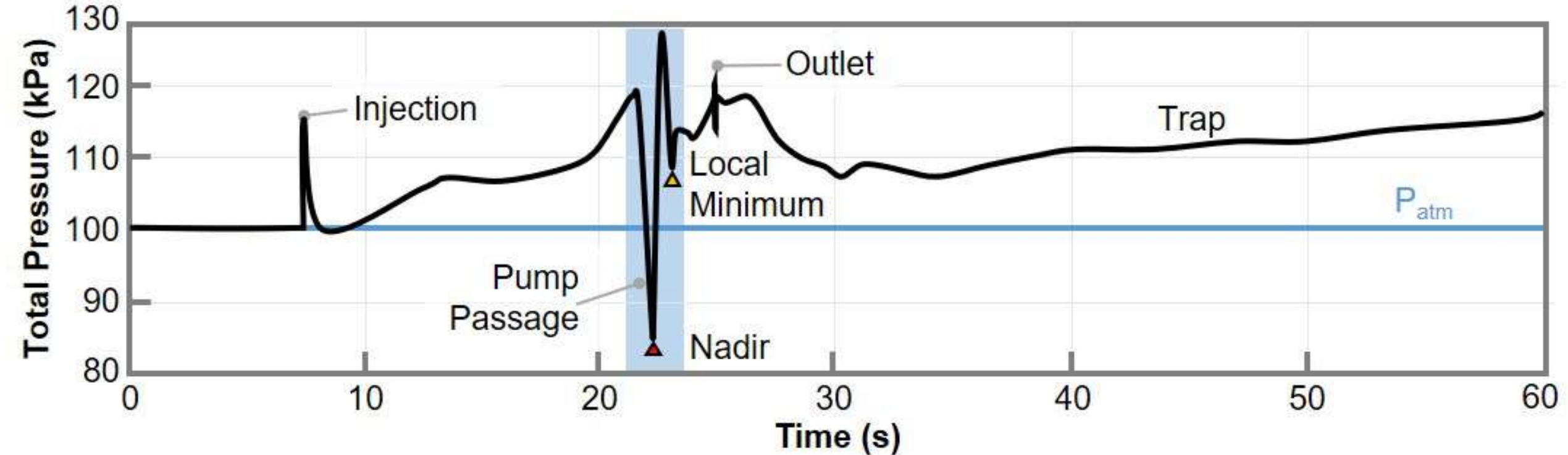




# Fish Backpacks

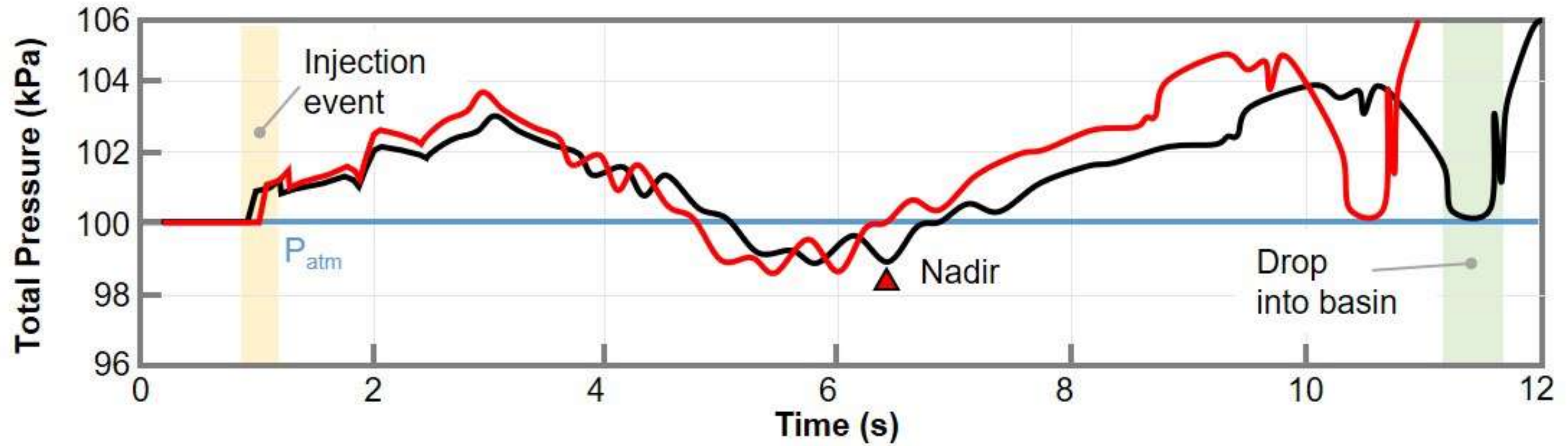


# Entrainment Pressure Time Series



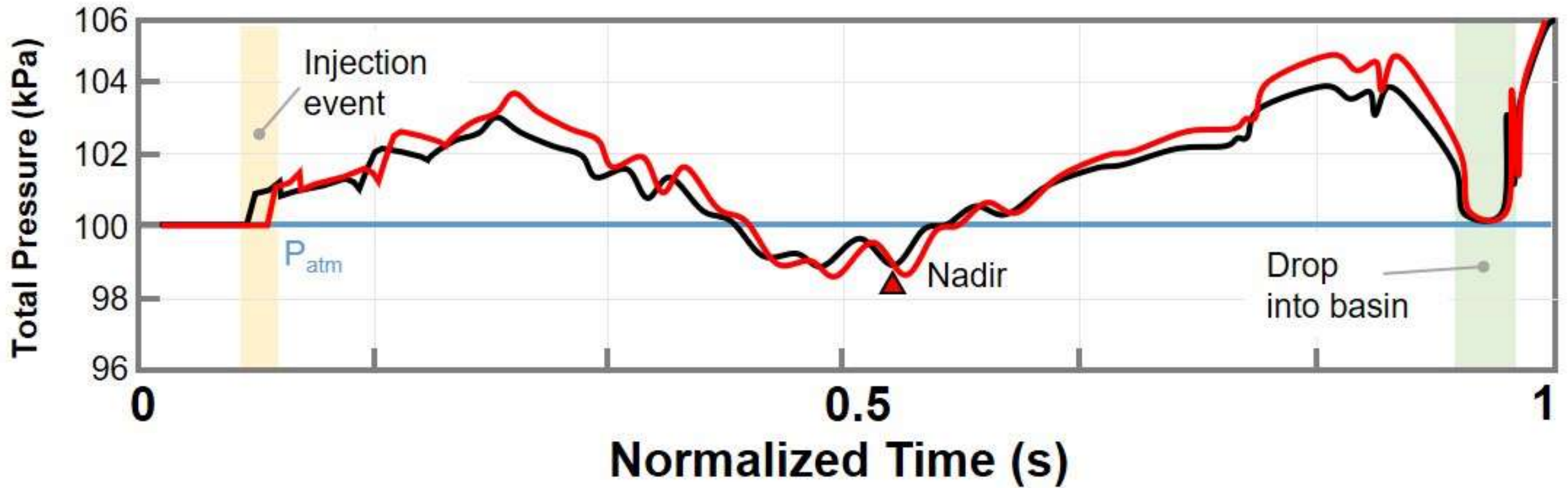
Fish-Friendly Pump

# Pressure Time Series During Entrainment



Large Archimedian Screw

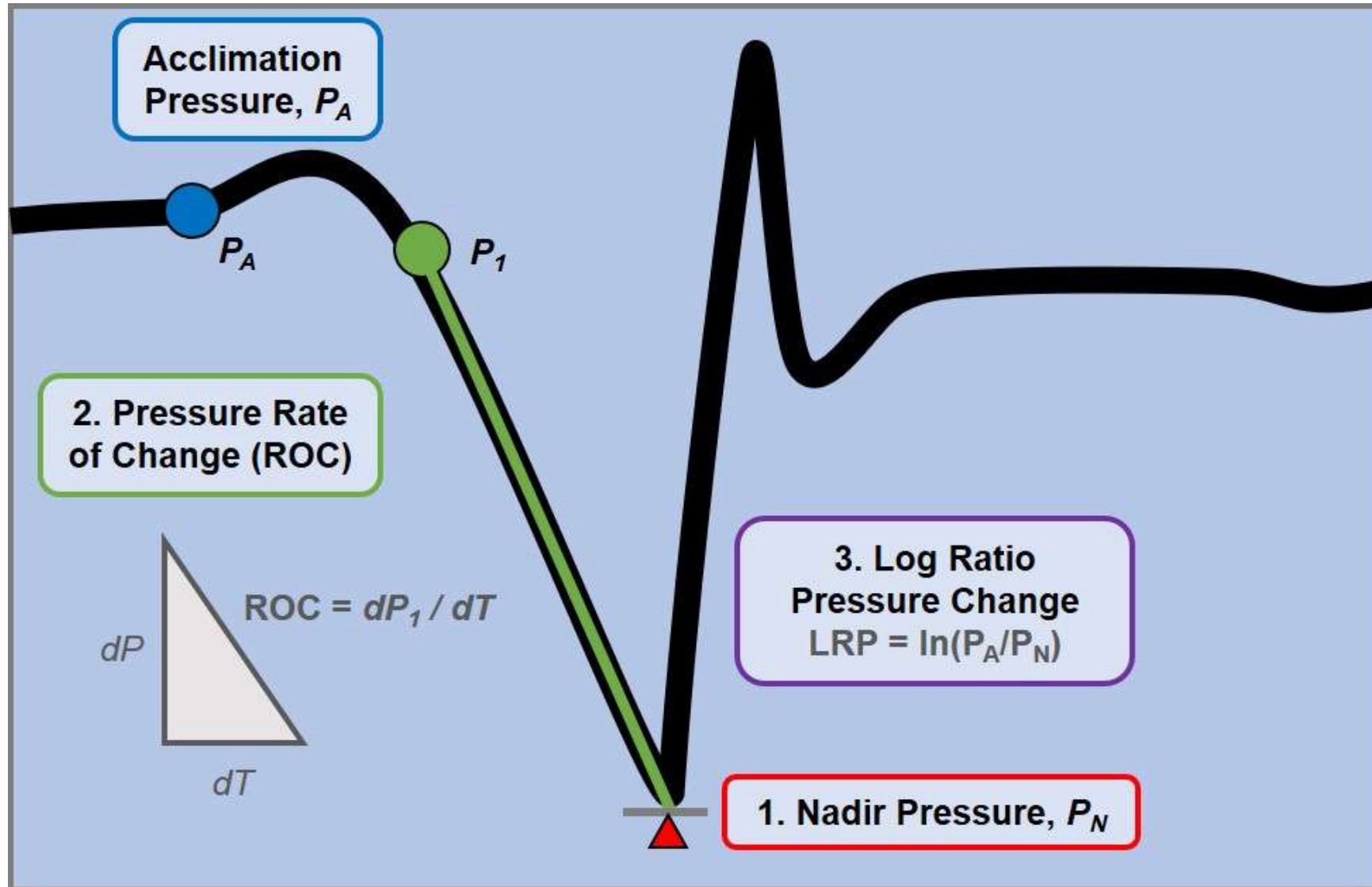
# Temporal Alignment



Normalization = time is rescaled from 0 to 1

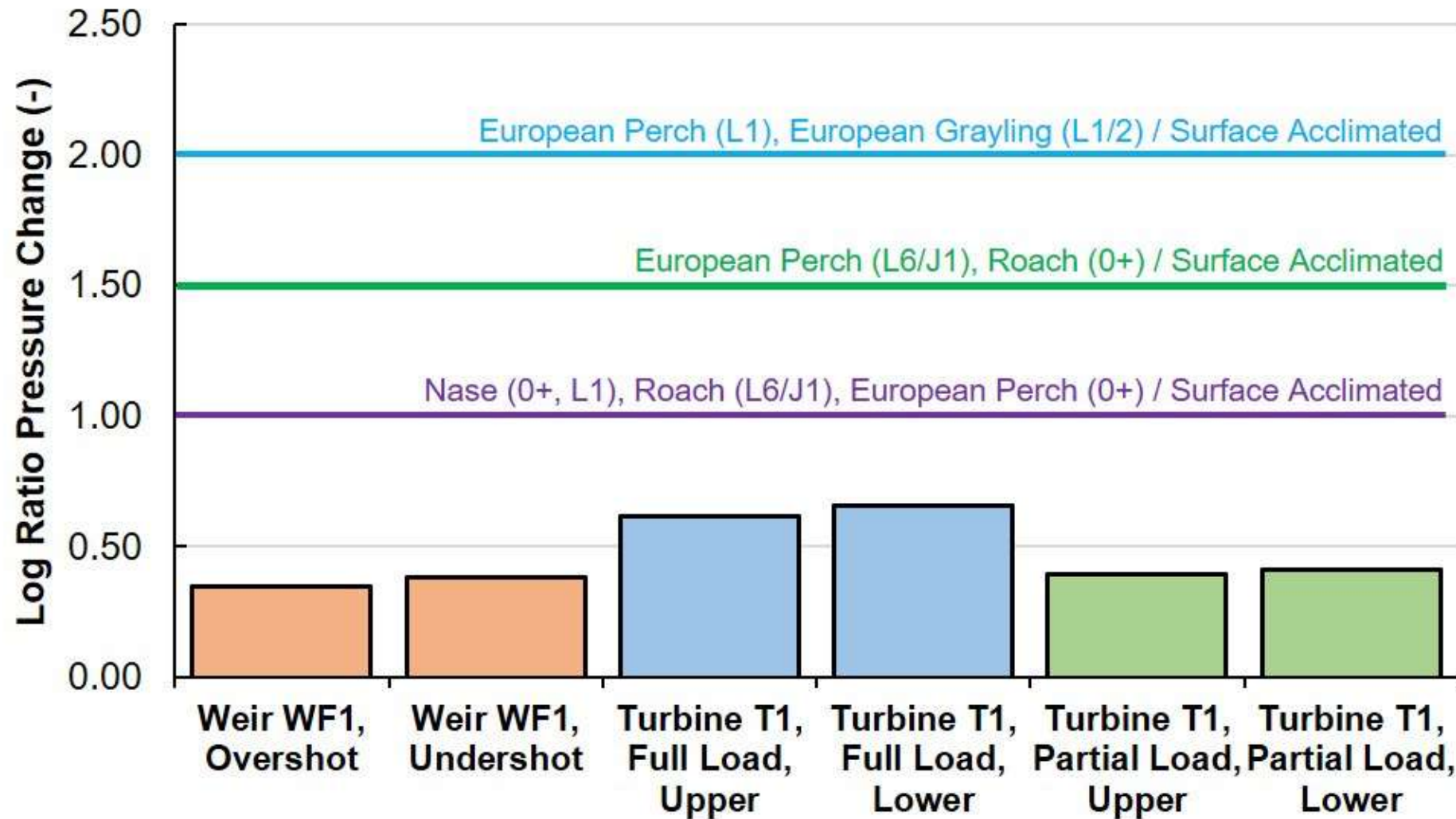


# Pressure Criteria for Injury and Mortality

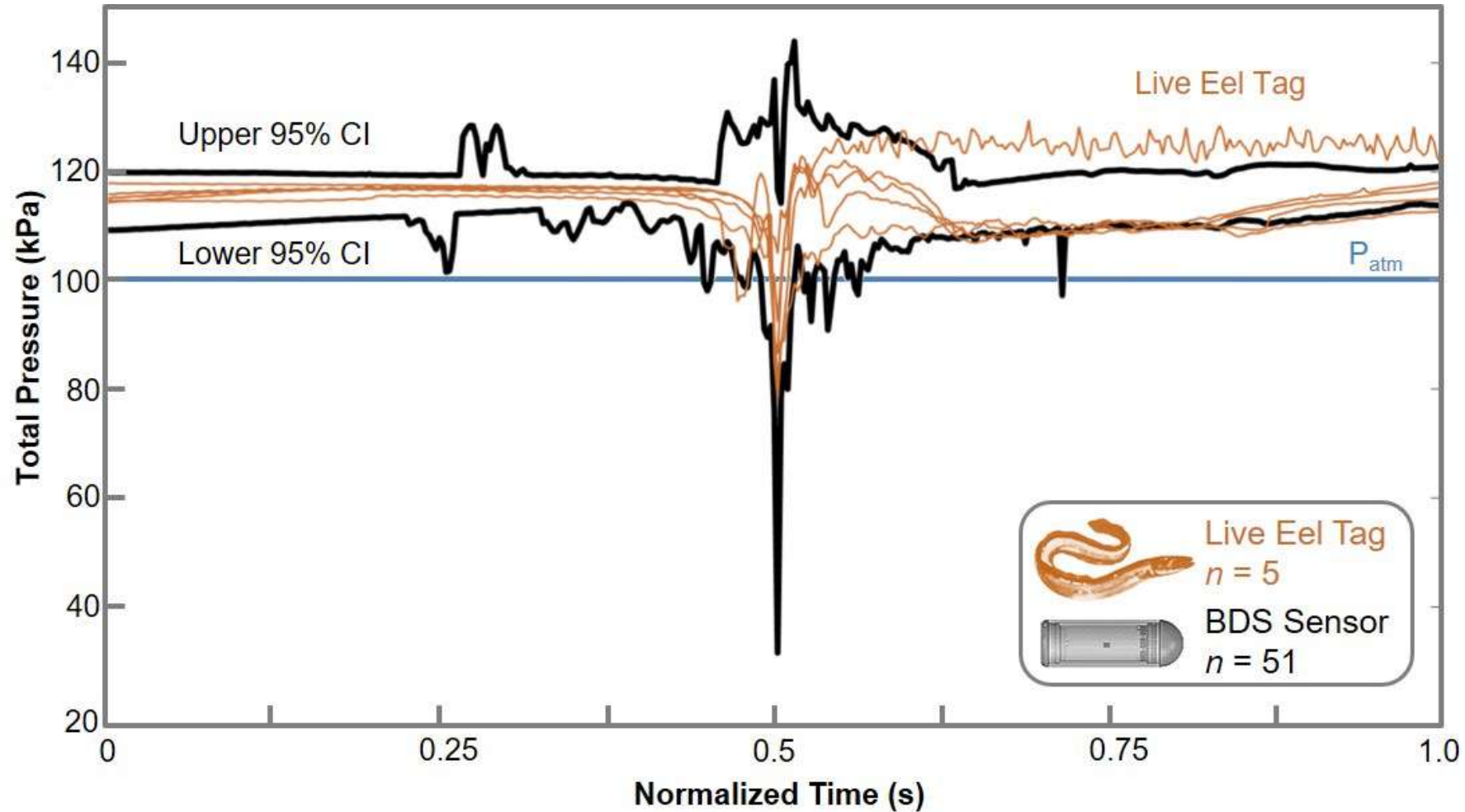




# Assessing Pressure-Related Risk



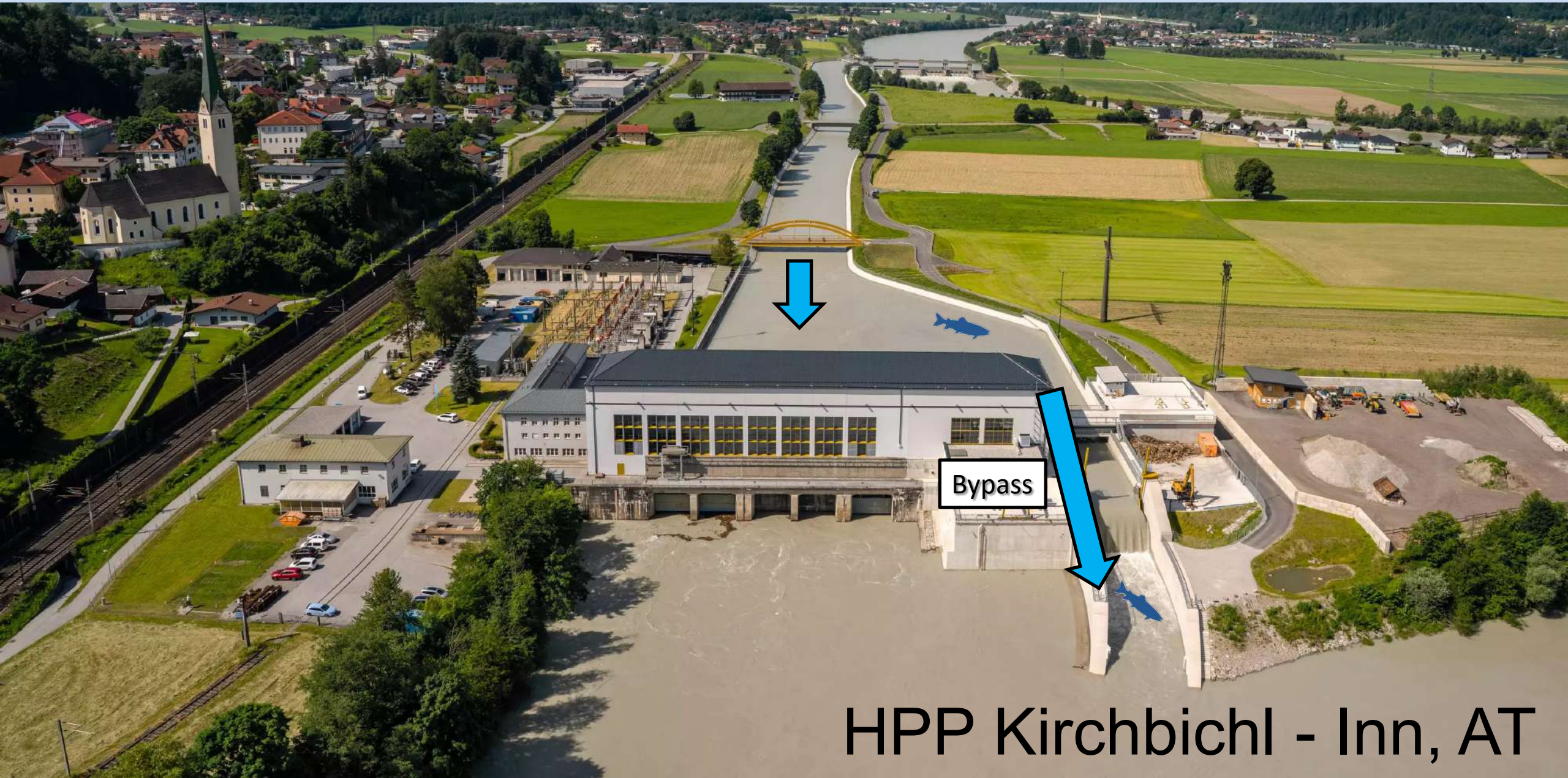
# What about swimming activity?



Sensor and Silver Eel Pump Passage

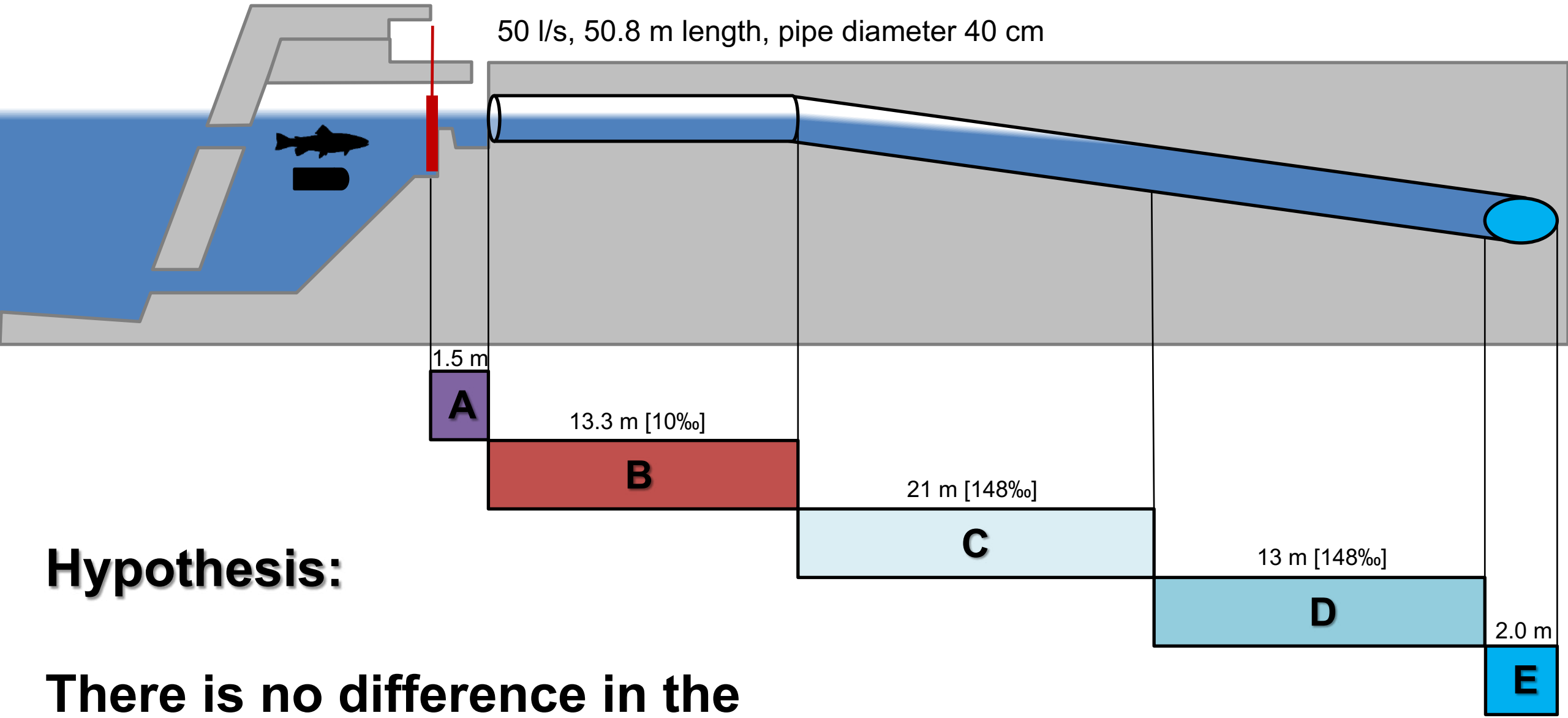


# BMBF Project: RETERO



HPP Kirchbichl - Inn, AT





**Hypothesis:**

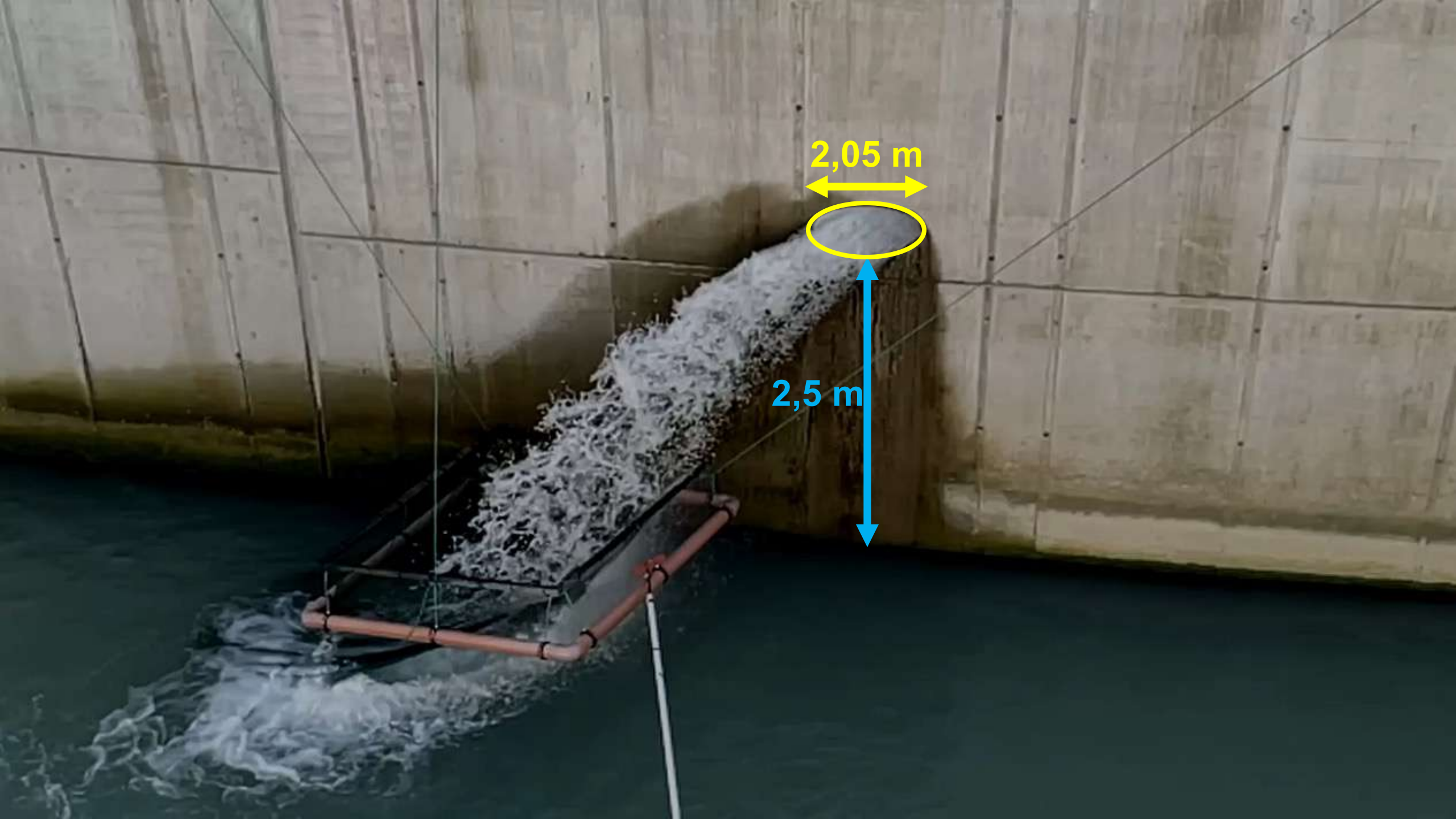
**There is no difference in the entrainment durations**







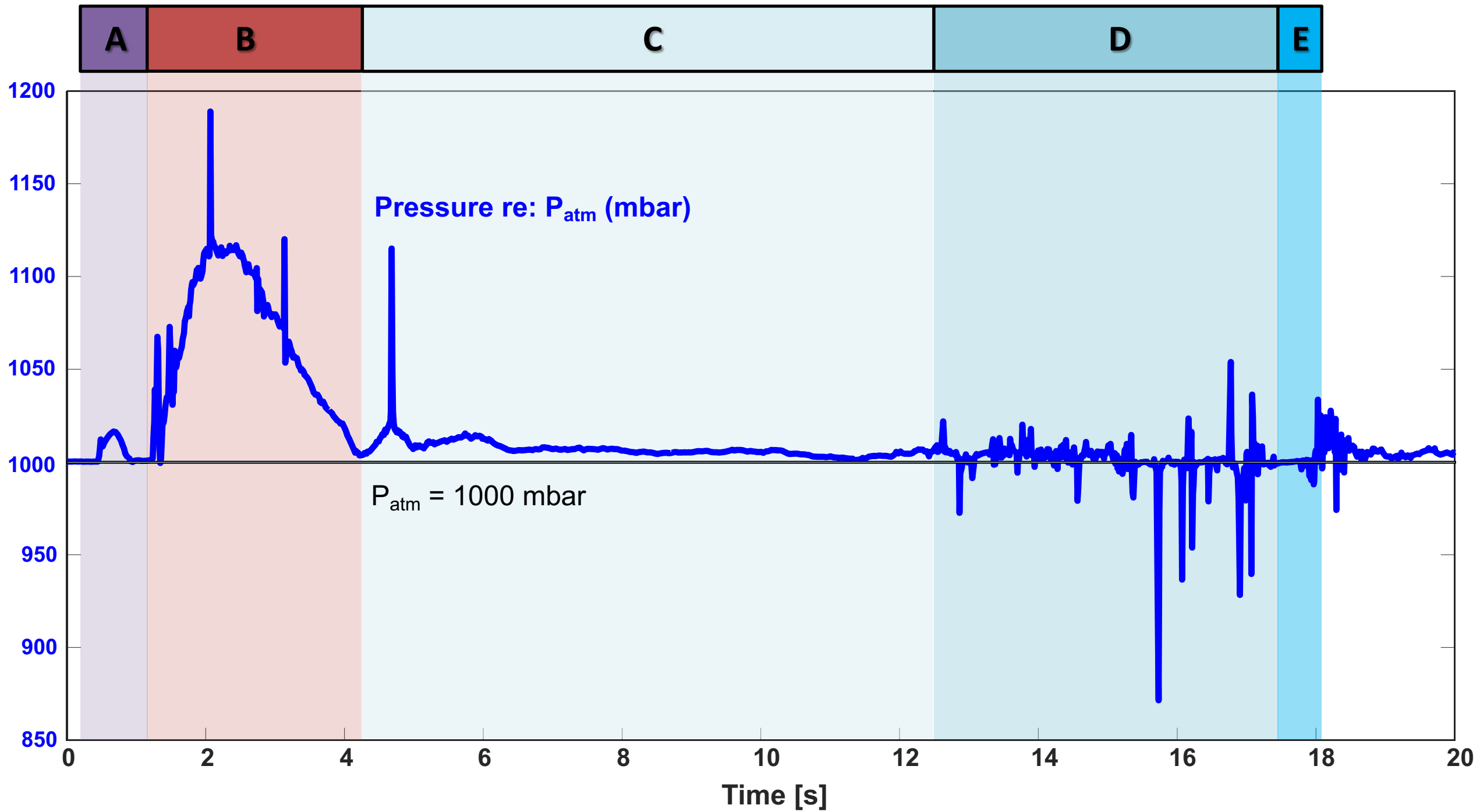




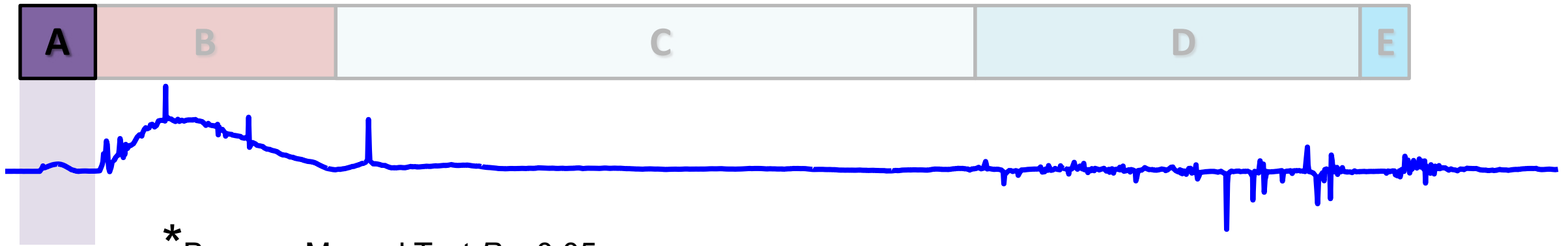
2,05 m

2,5 m

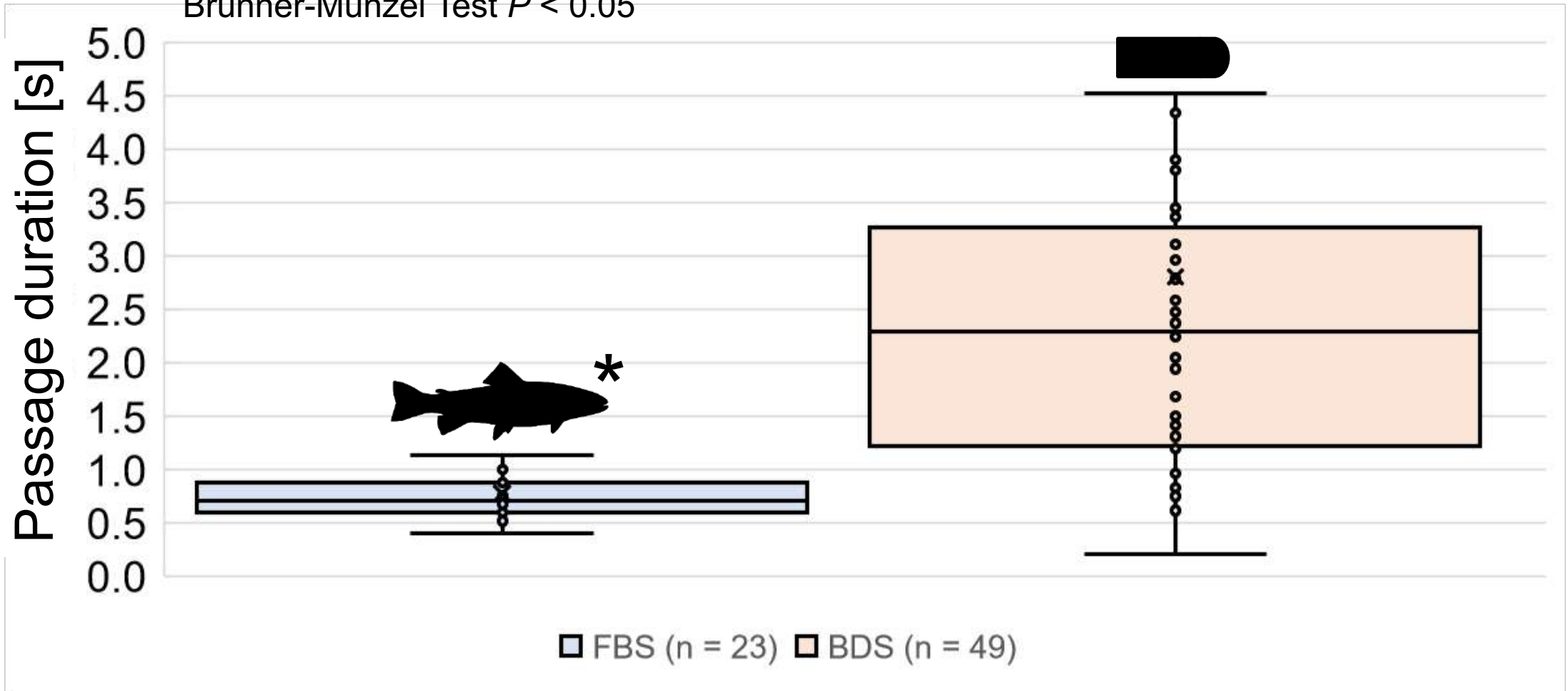


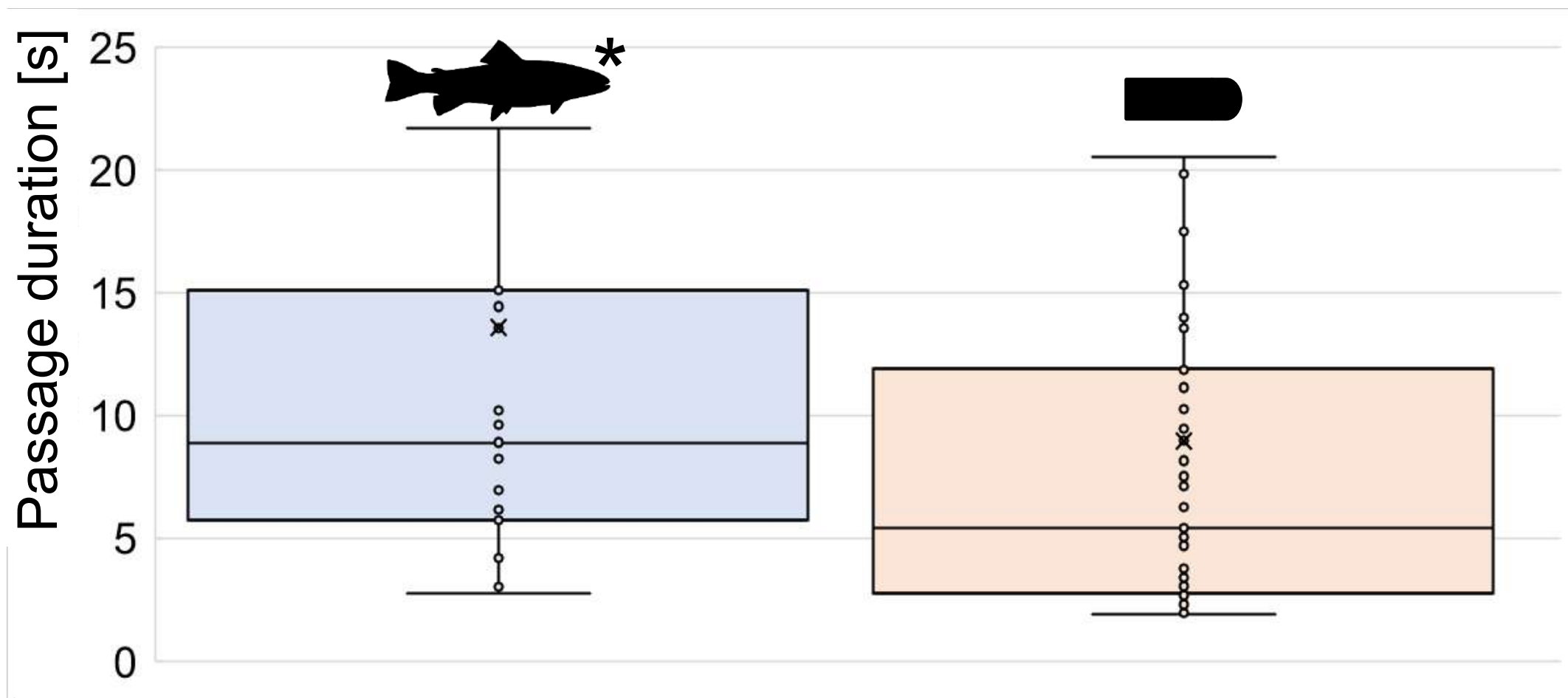
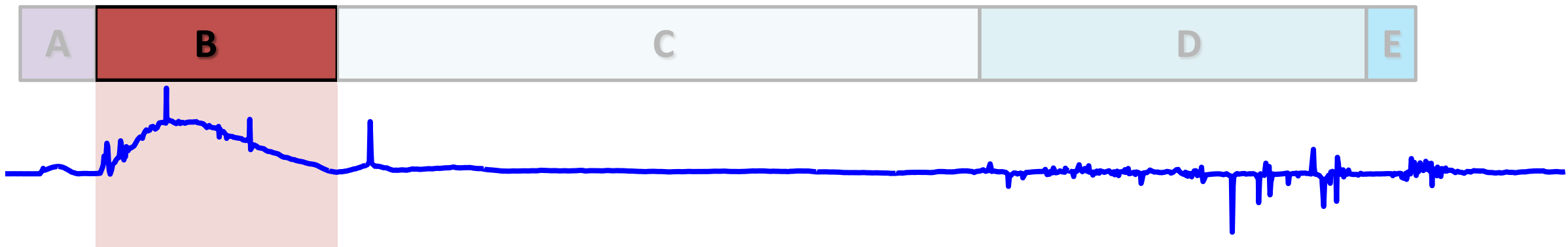


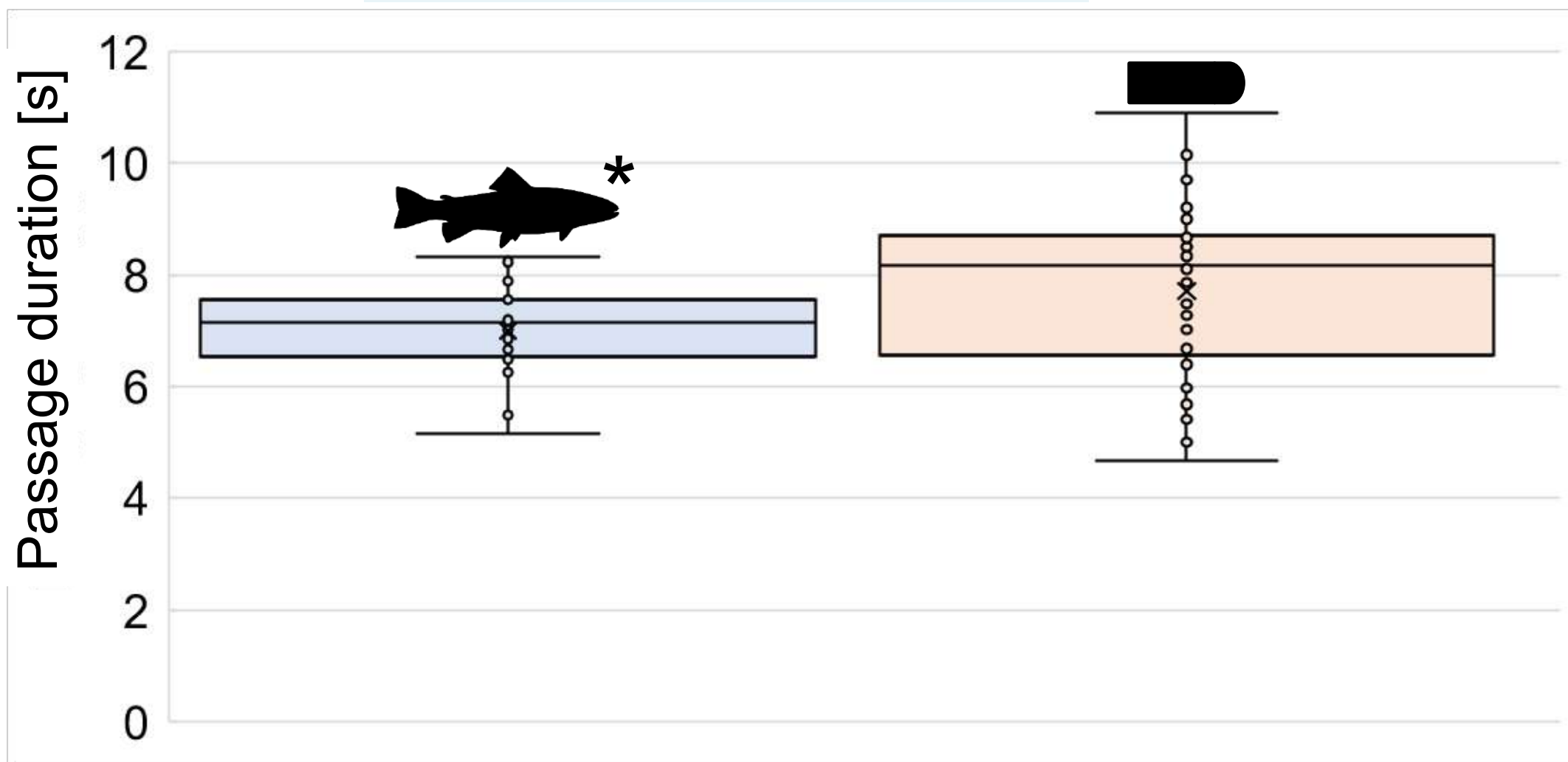
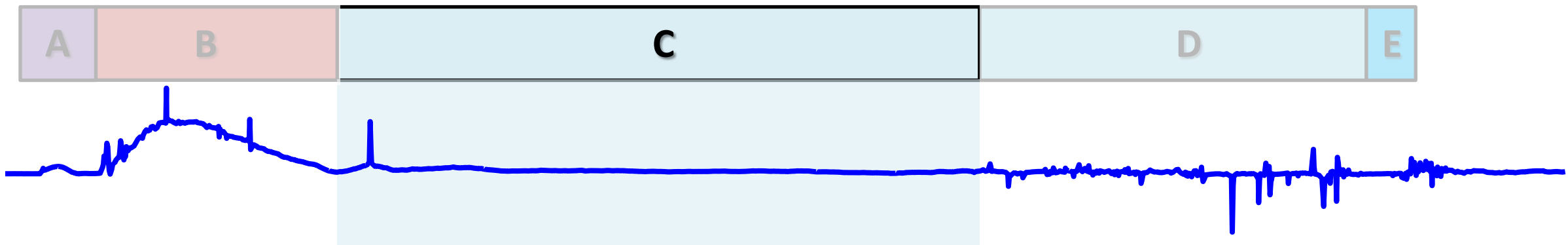




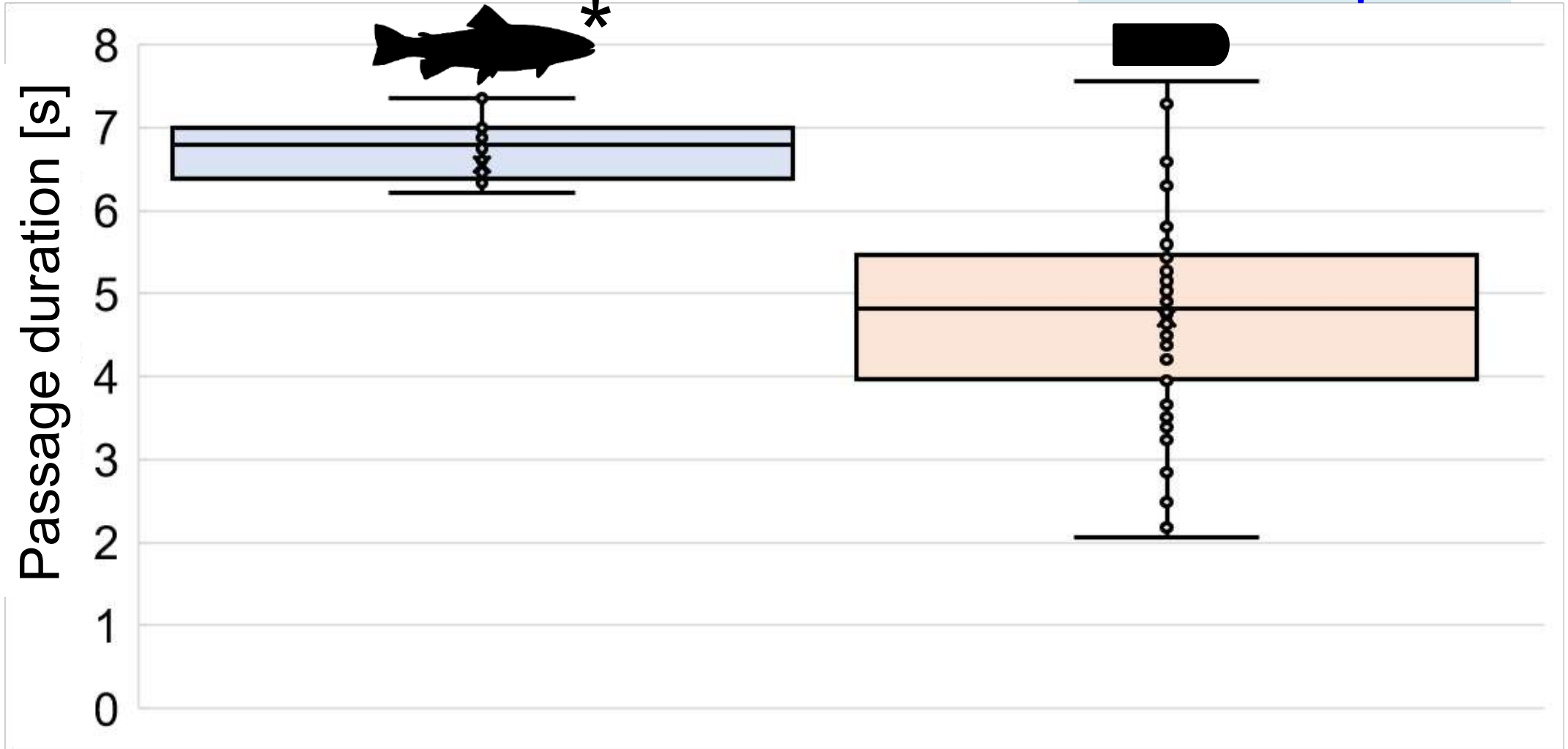
\* Brunner-Munzel Test  $P < 0.05$

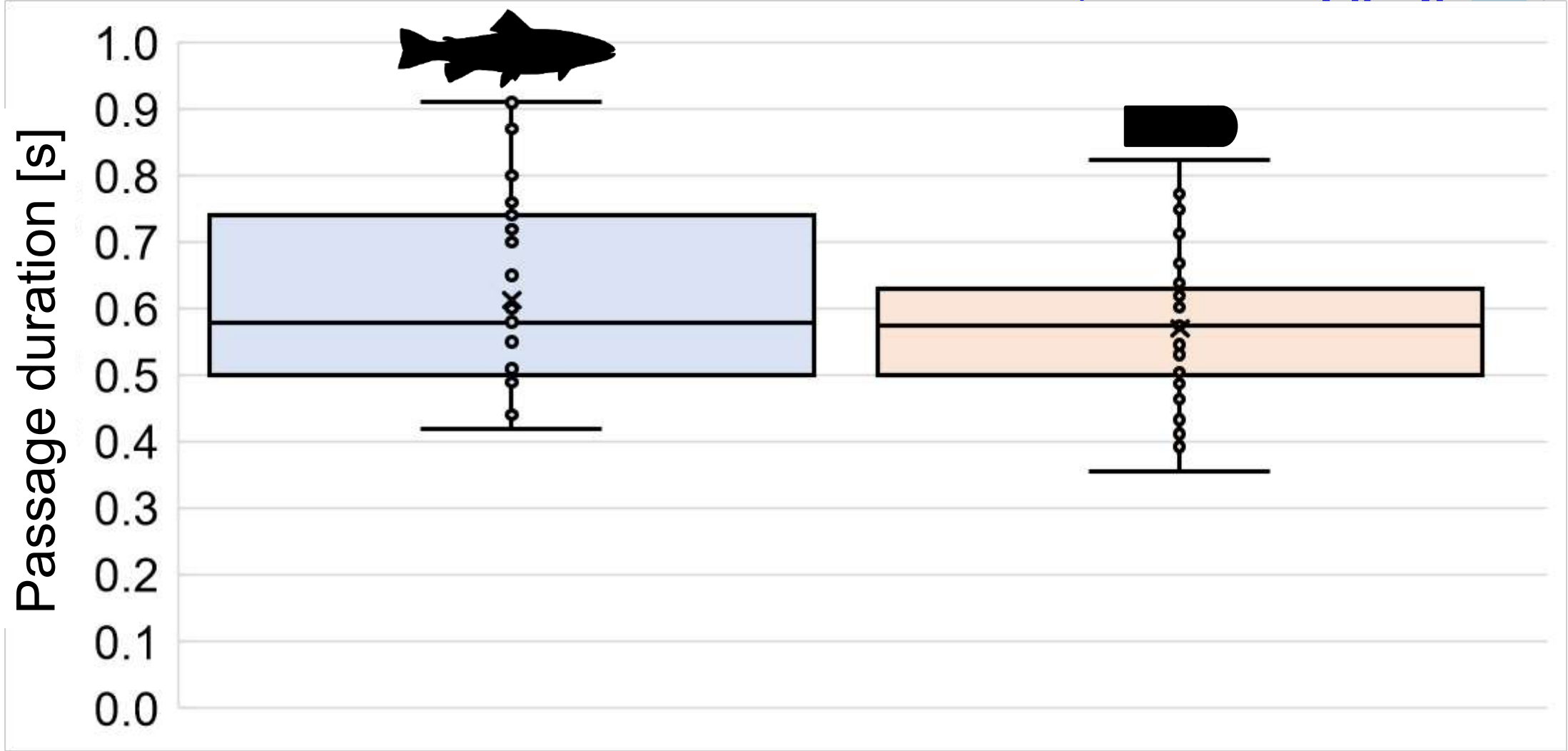
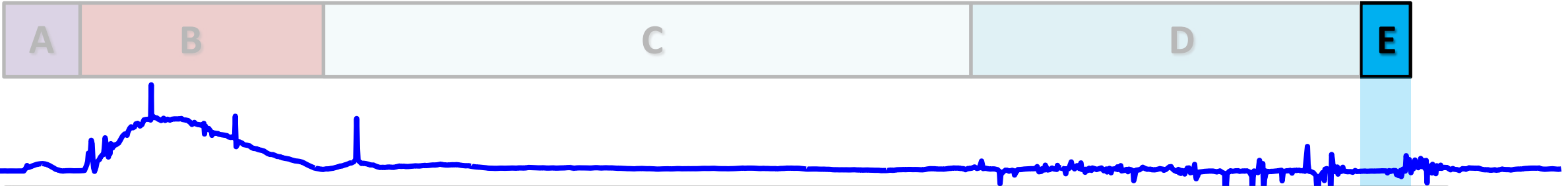




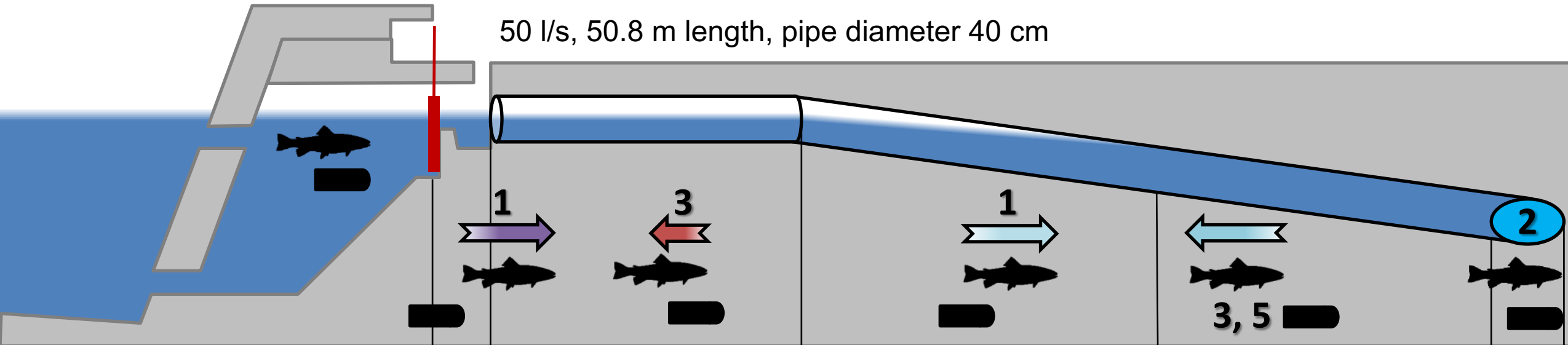








50 l/s, 50.8 m length, pipe diameter 40 cm



1.5 m

**A**

13.3 m [10‰]

**B**

21 m [148‰]

**C**

13 m [148‰]

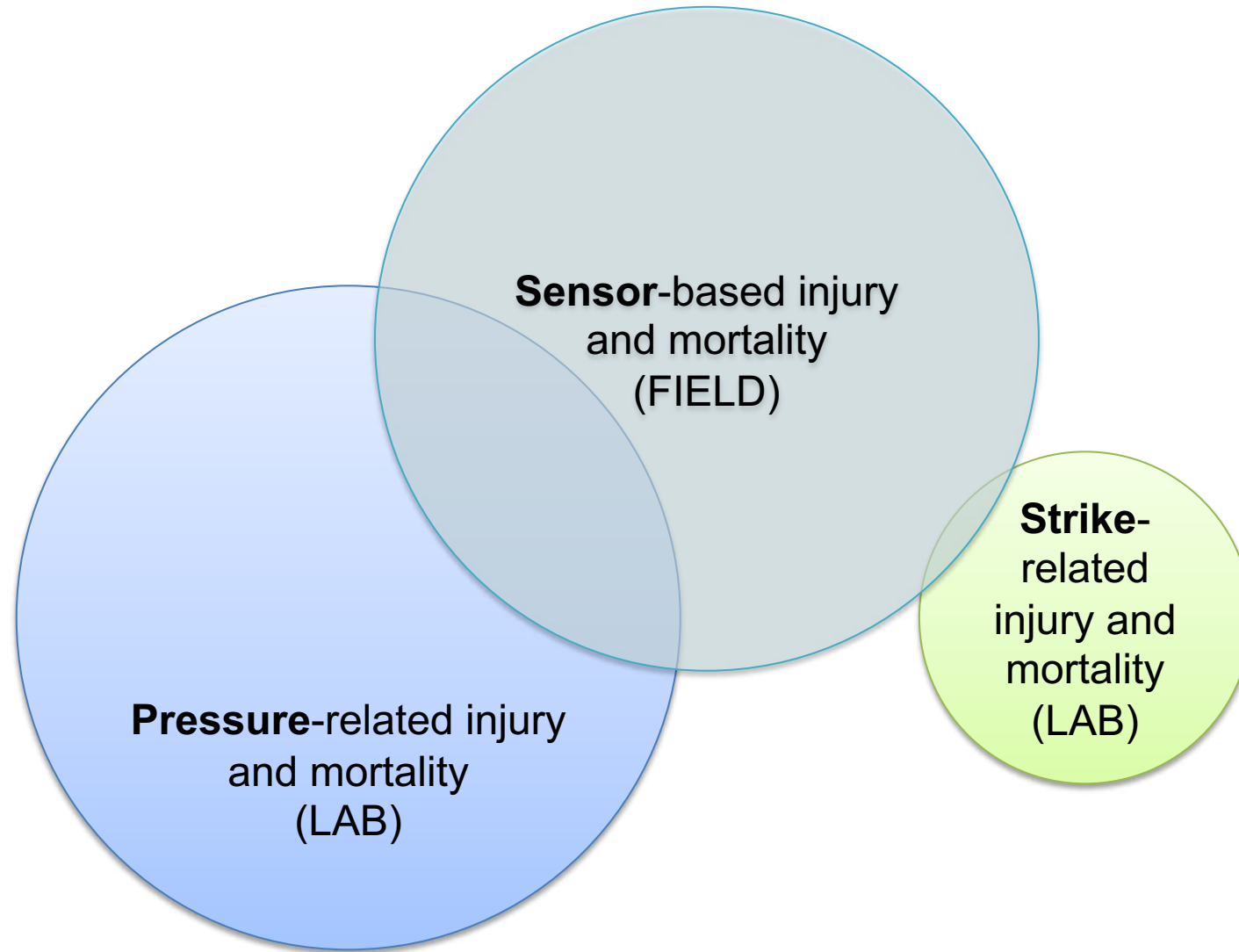
**D**

2.0 m

**E**

No.	Movement Mode	Velocities	Categories (after Pavlov et al. 2011)
1	Downstream active		Negative active
2	Drift uncontrolled		Negative passive
3	Drift controlled		Negative active-passive
4	Stationary		Neutral
5	Upstream		Positive

# Where we are...

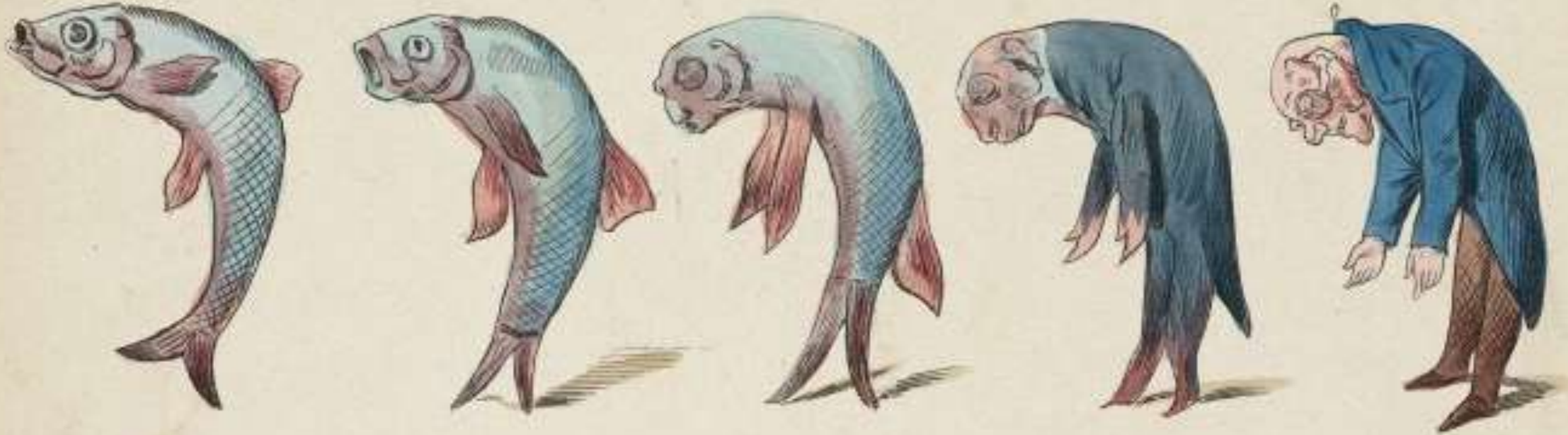




# Conclusions

1. Passive sensors = passage *without* activity
2. Fish backpacks = passage *with* activity
3. Must *normalize time* to compare PS vs. FB
4. Fish activity *can be considered* in the assessment of entrainment injury and mortality

# Thank You!



Special thanks to: Gert Toming, Andres Ernits, Ine Pauwels, David Buysee, Martin Schletterer, Falko Wagner, Oliver Evans, Jon Bolland and Katha Reimann

[jeffrey.tuhtan@taltech.ee](mailto:jeffrey.tuhtan@taltech.ee)