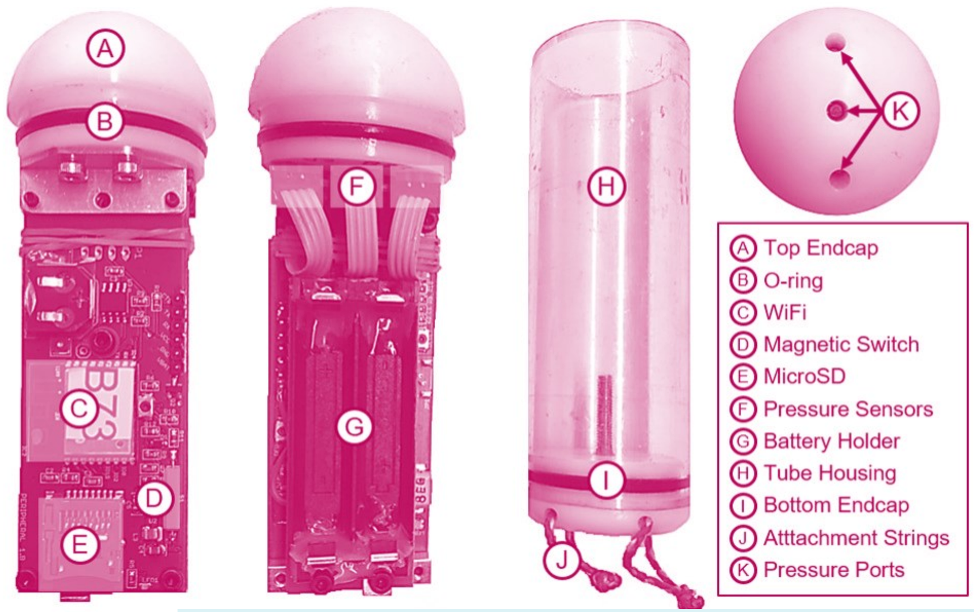
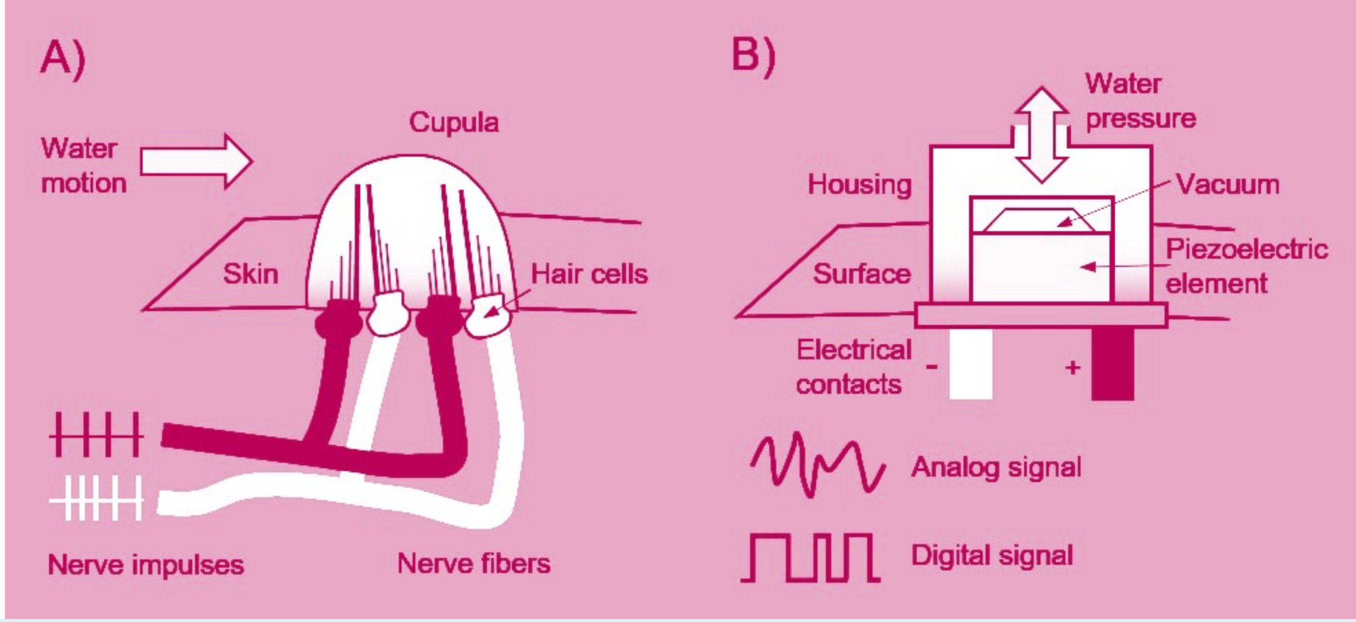




FIGURES
What and Where

Assoc. Prof. Dr.-Eng. Jeffrey A. Tuhtan
Tallinn University of Technology
Centre for Environmental Sensing and Intelligence
Email: jeffrey.tuhtan@taltech.ee

31.10.2022

WHAT ARE FIGURES GOOD FOR?

- Illustrating places, things and methods difficult to describe in words
- Presenting and comparing results
- Conceptual summaries of classes, ideas, methods, results, possibilities and visions

THINGS

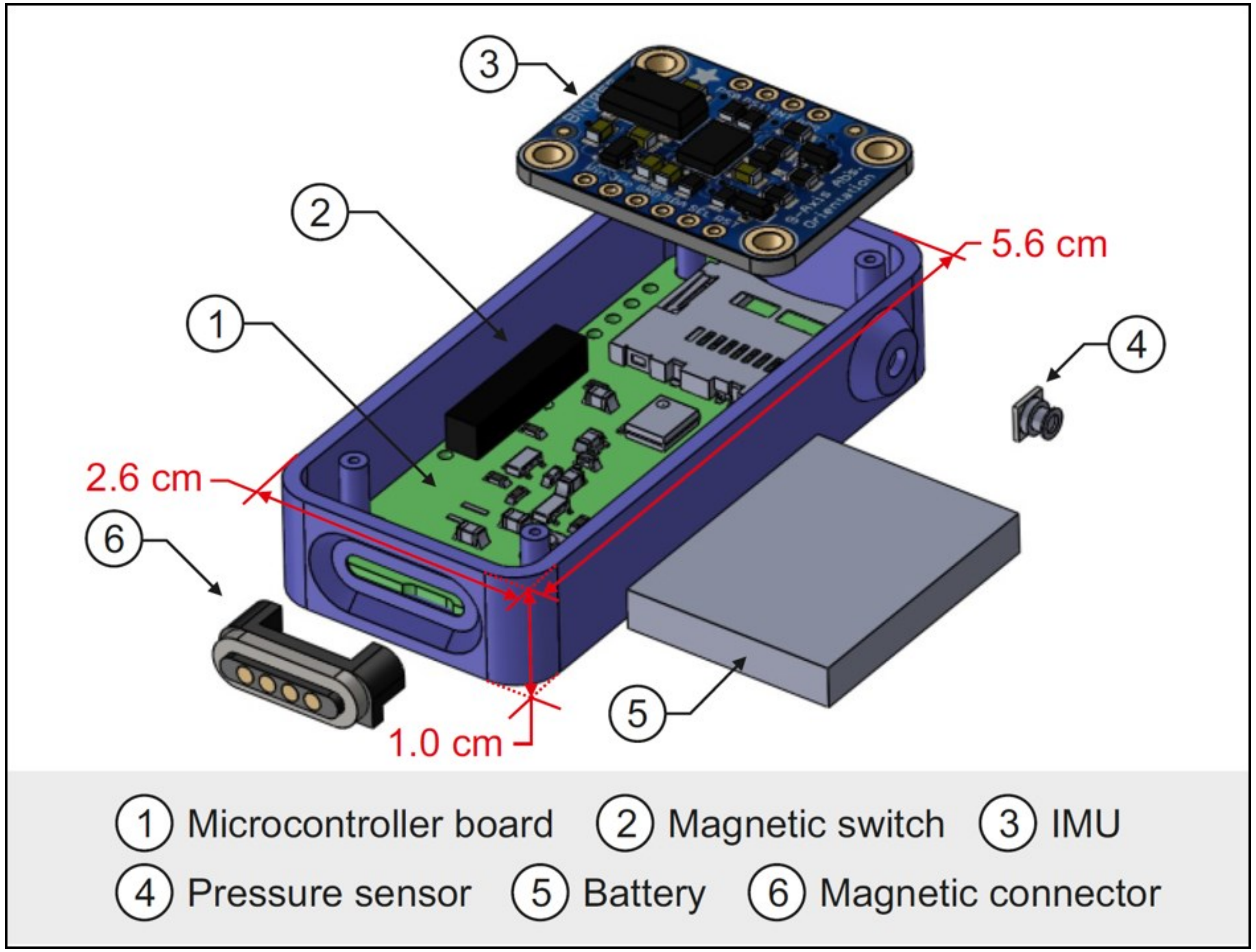


Fig. 2) Breakdown of the wearable IMU logger applied in this work to estimate the knee angle during the walking gait on land and underwater.

Monoli C., Fuentez-Pérez J.F., Cau N., Capodaglio P., Galli M. & Tuhtan J.A. (2021). Land and underwater gait analysis using wearable IMU. IEEE Sensors Journal 21 (9), 11192-11202

THINGS

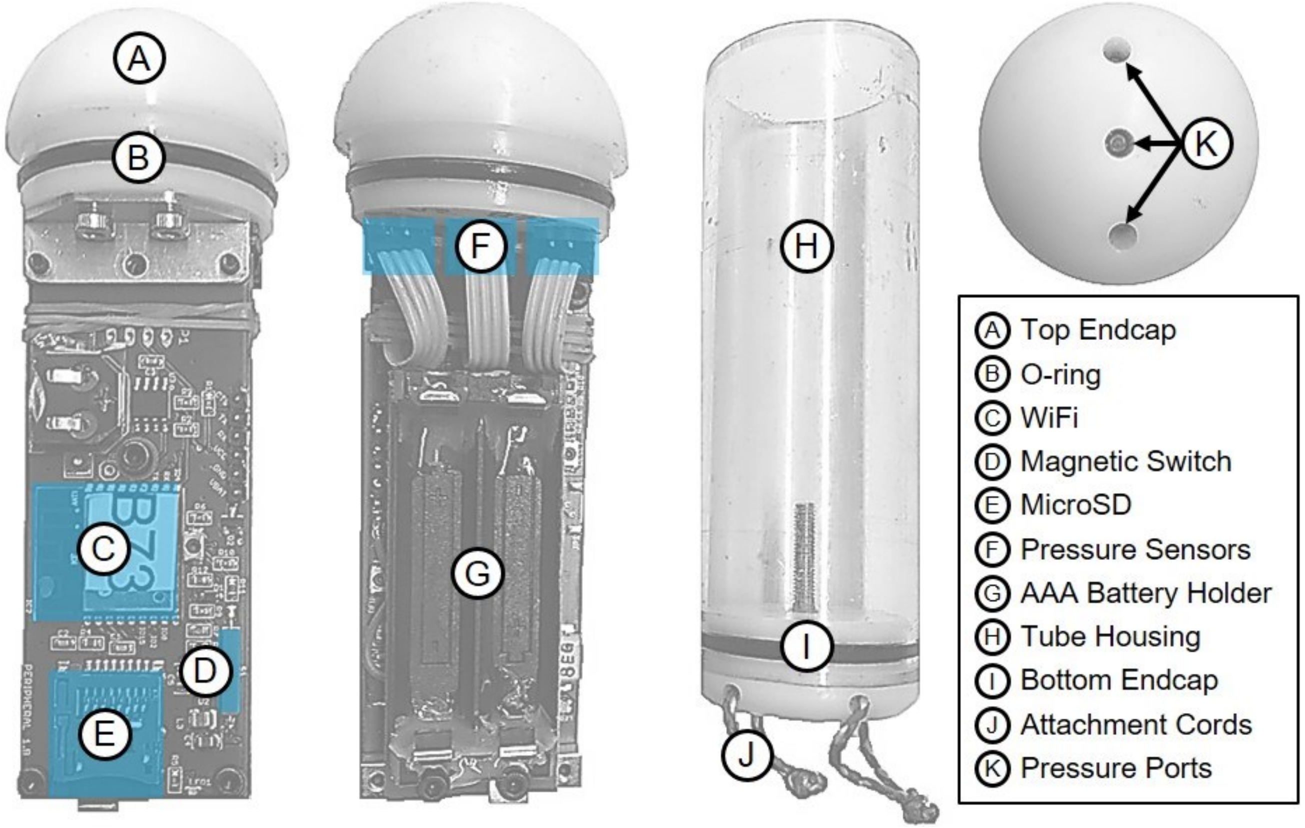


Figure 3) Overview of the BDS sensors. The top endcap (A,B) contains three pressure transducers (F,K). Below there are two electronics boards containing the WiFi module (C), magnetic switch (D), microSD storage (E), and AAA battery holder (G). The sensor and electronics payload (A–G) is screwed by hand onto the bottom endcap (I), which also includes two rugged nylon attachment strings (J) for the balloon tags to bring the neutrally buoyant sensor back to the water surface.

Pauwels, I. S., Baeyens, R., Toming, G., Schneider, M., Buysse, D., Coeck, J., & Tuhtan, J. A. (2020). Multi-species assessment of injury, mortality, and physical conditions during downstream passage through a large archimedes hydrodynamic screw (Albert canal, Belgium). Sustainability, 12(20), 8722.

THINGS

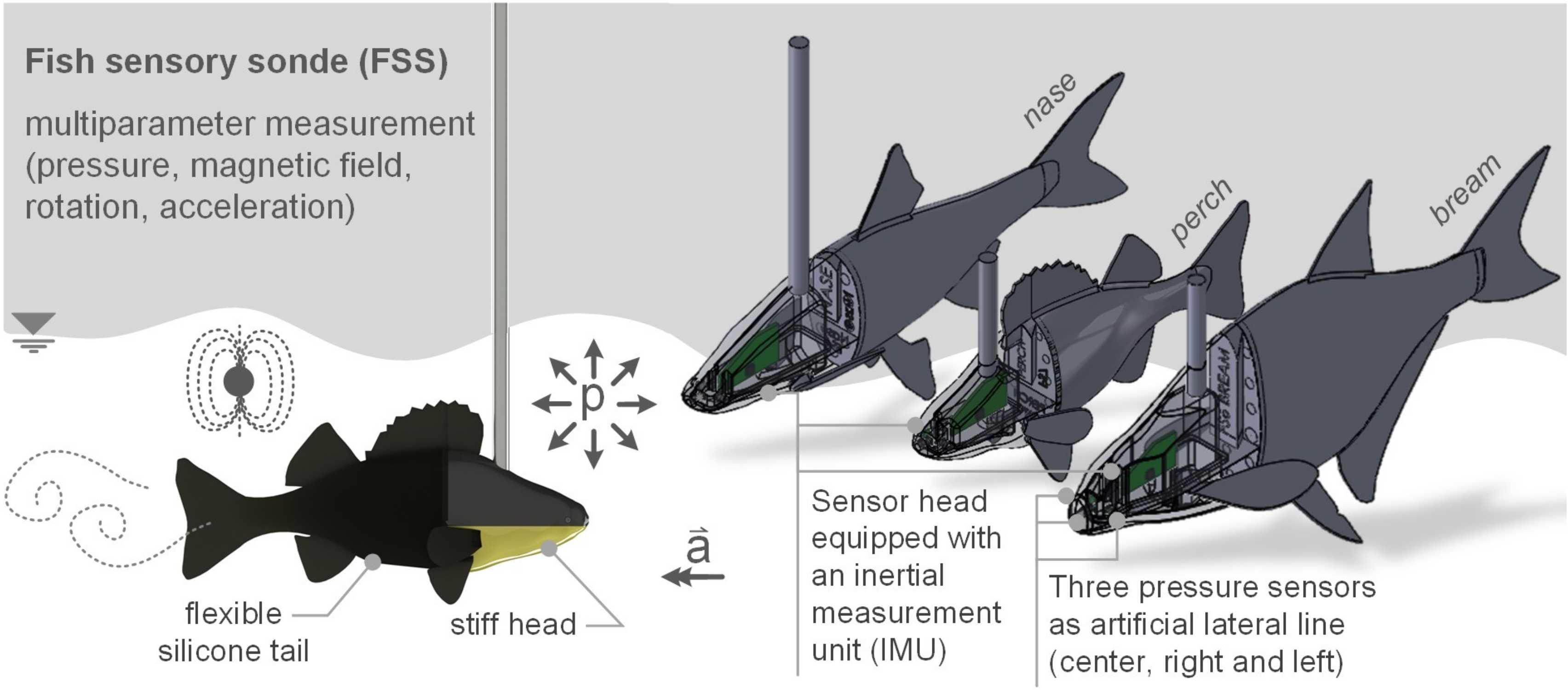


Fig. 4.3) Principle of fish sensory sondes (FSS): recording the total body motion (proprioception) and fluid-body interaction (flow sensing). The FSS with their fish-like geometries can provide more detailed information about how fish's bodies interact with the flow field in both laboratory and field investigations.

Lehmann B., Bensing K., Adam B., Schwevers U. & Tuhtan J.A. (2022). Ethohydraulics: A Method for Nature-Compatible Hydraulic Engineering. Springer Nature.

THINGS INSIDE OF THINGS

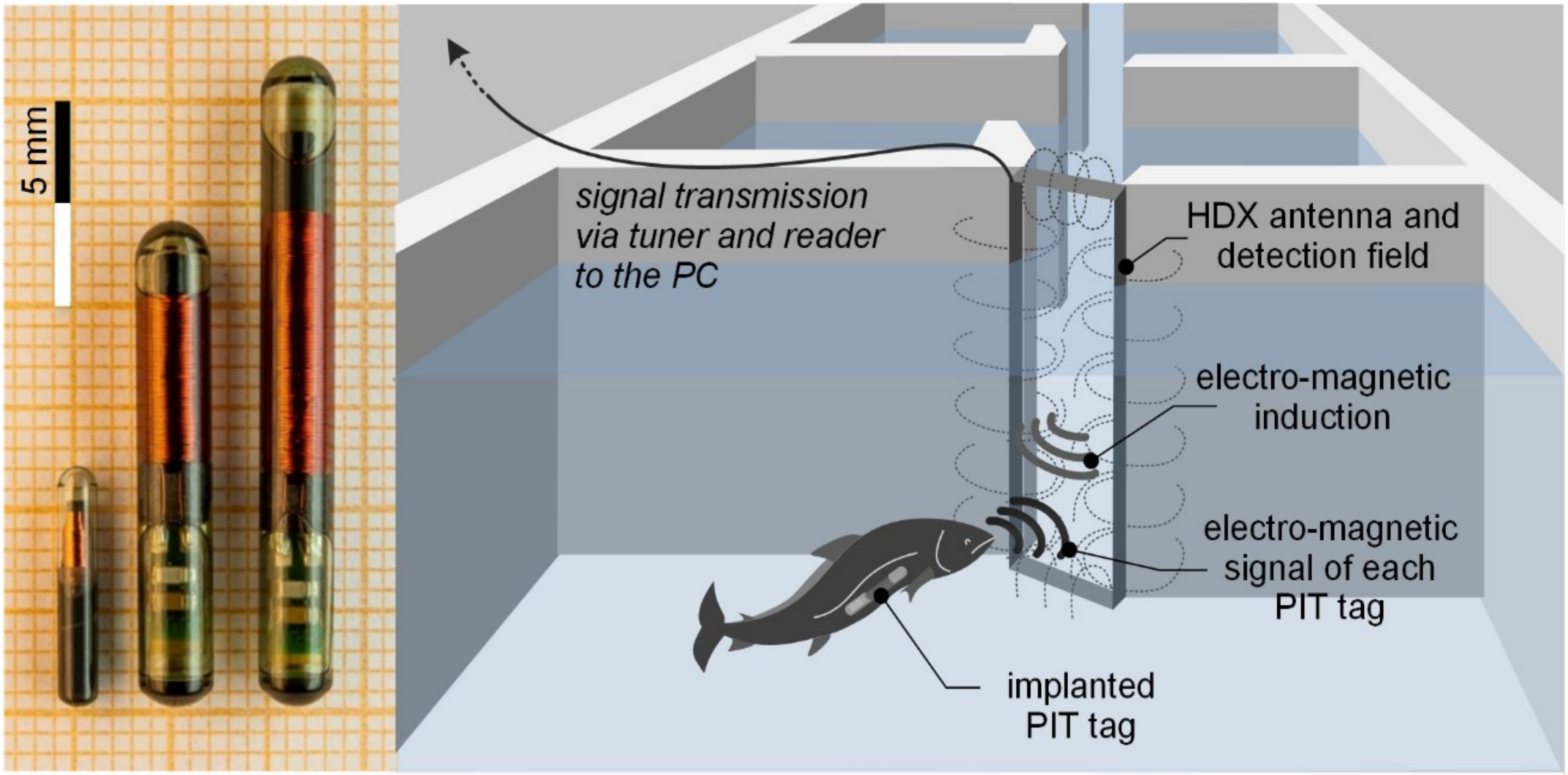


Fig. 4.5) PIT tags of different sizes (left) and sketch showing the operation of a frame antenna at the slots of a fishway (right).

Lehmann B., Bensing K., Adam B., Schwevers U. & Tuhtan J.A. (2022). Ethohydraulics: A Method for Nature-Compatible Hydraulic Engineering. Springer Nature.

THINGS AND METHODS

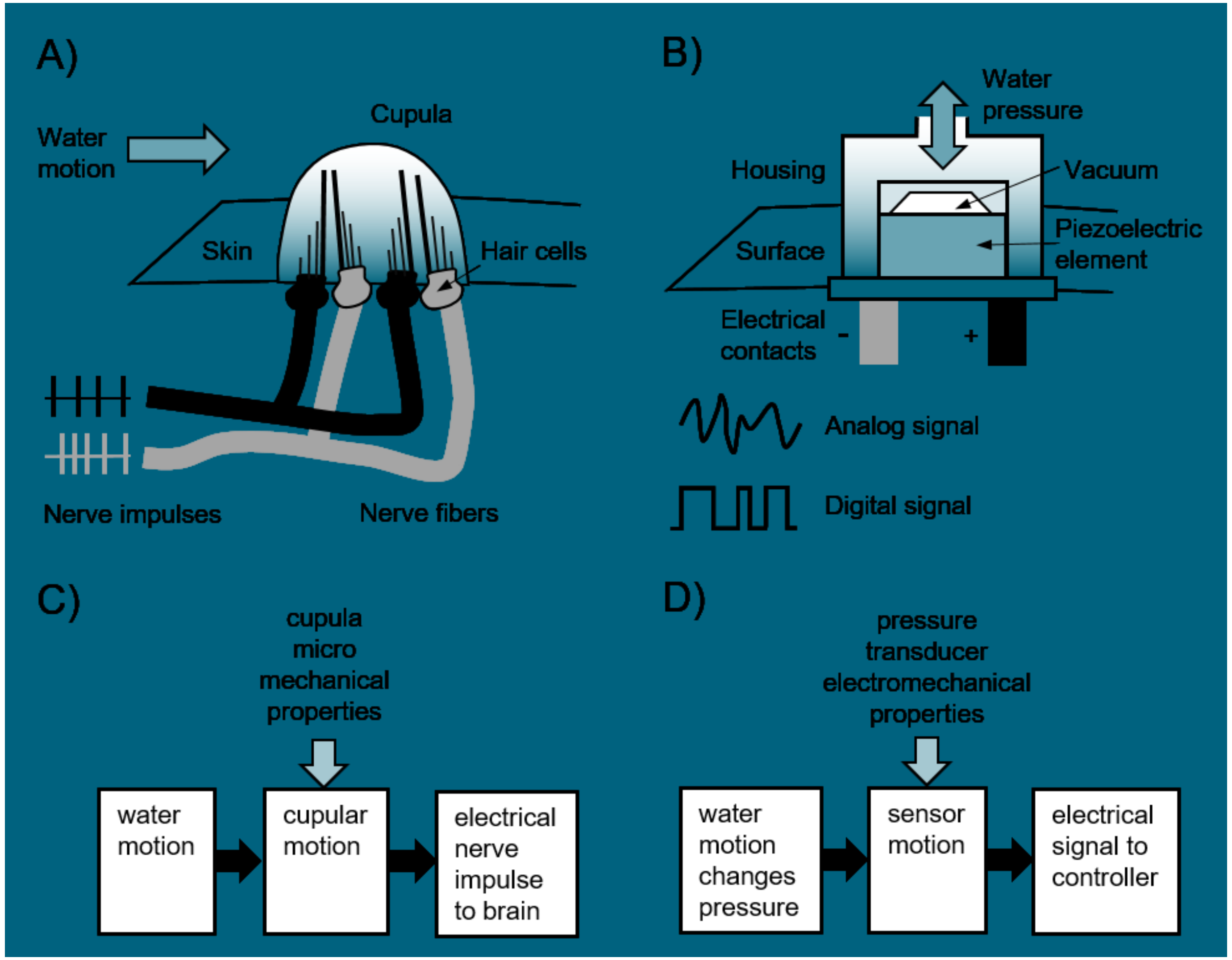
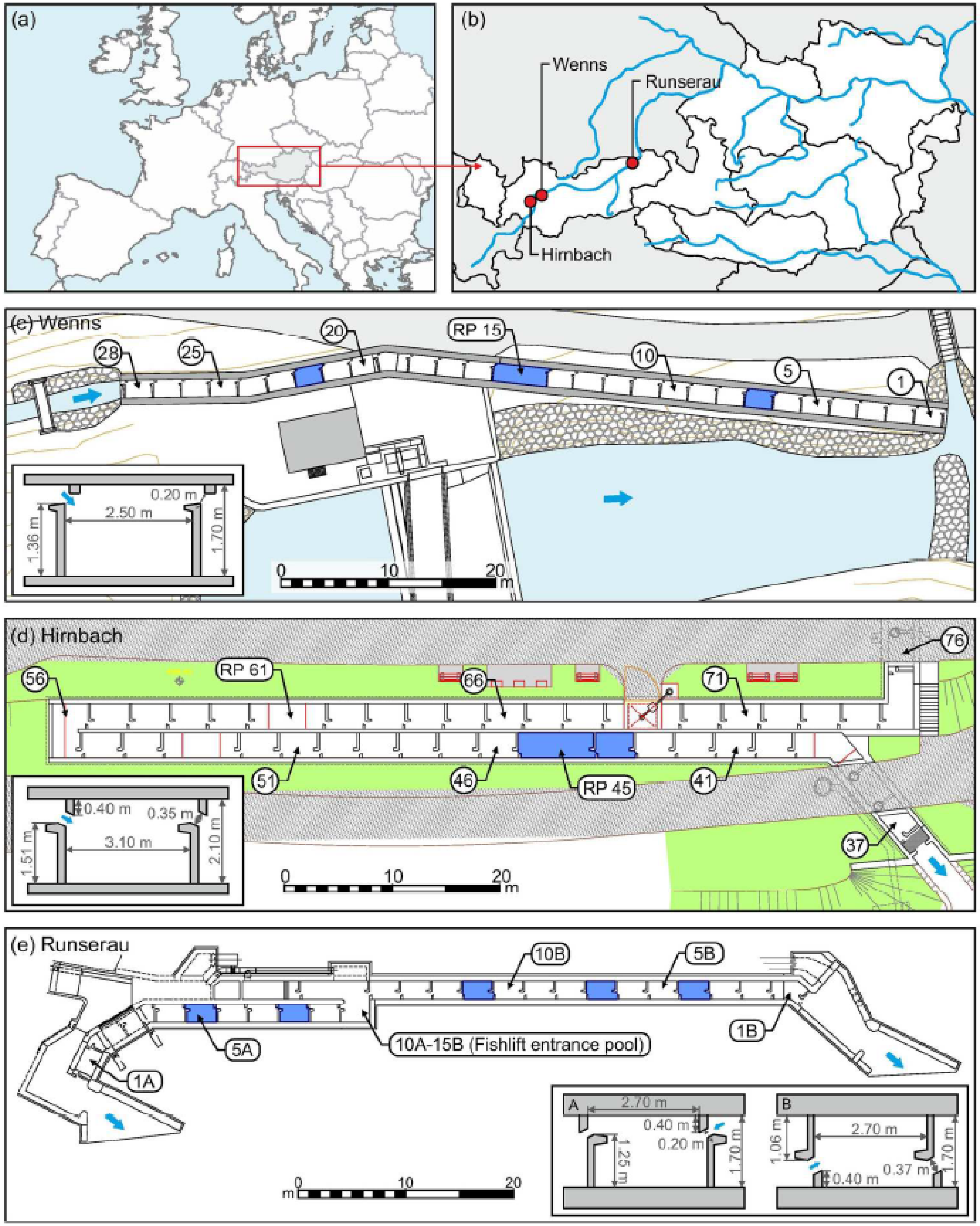


Figure 5) Example of the “flow as information” concept following the fish’s lateral line sensory system. A) In a biological system, water motion bends the cupula, causing polarized hair cells to send a spike train of nerve impulses to the fish’s brain. B) In our electromechanical proxy, we can use tiny sensors which react to changes in the magnitude of near-body pressure fluctuations. C) The cupulae are mechanically tuned to a range of flow stimuli, depending on their location on the fish’s body, and the life stage and species. D) We can tune our artificial neuromasts in a similar way using mechanical filters (e.g. restrict pressure sensor tube diameter) and our choice of the pressure transducer type and material (e.g. silicon vs. steel diaphragm).

Tuhtan, J. A., Nag, S. & Kruusmaa, M. (2020). Underwater bioinspired sensing: New opportunities to improve environmental monitoring. IEEE Instrumentation & Measurement Magazine, 23(2), 30-36.

PLACES

Figure 6) (a, b) Case study locations in Austria. Slots measurements were made throughout, pools where pool measurements were made are highlighted in blue. Scaled elevation views of the Wenns (c), Hirnbach (d) and Runserau (e) vertical slot fishways. The bulk flow direction is indicated by the blue arrow.



THINGS, PLACES AND RESULTS

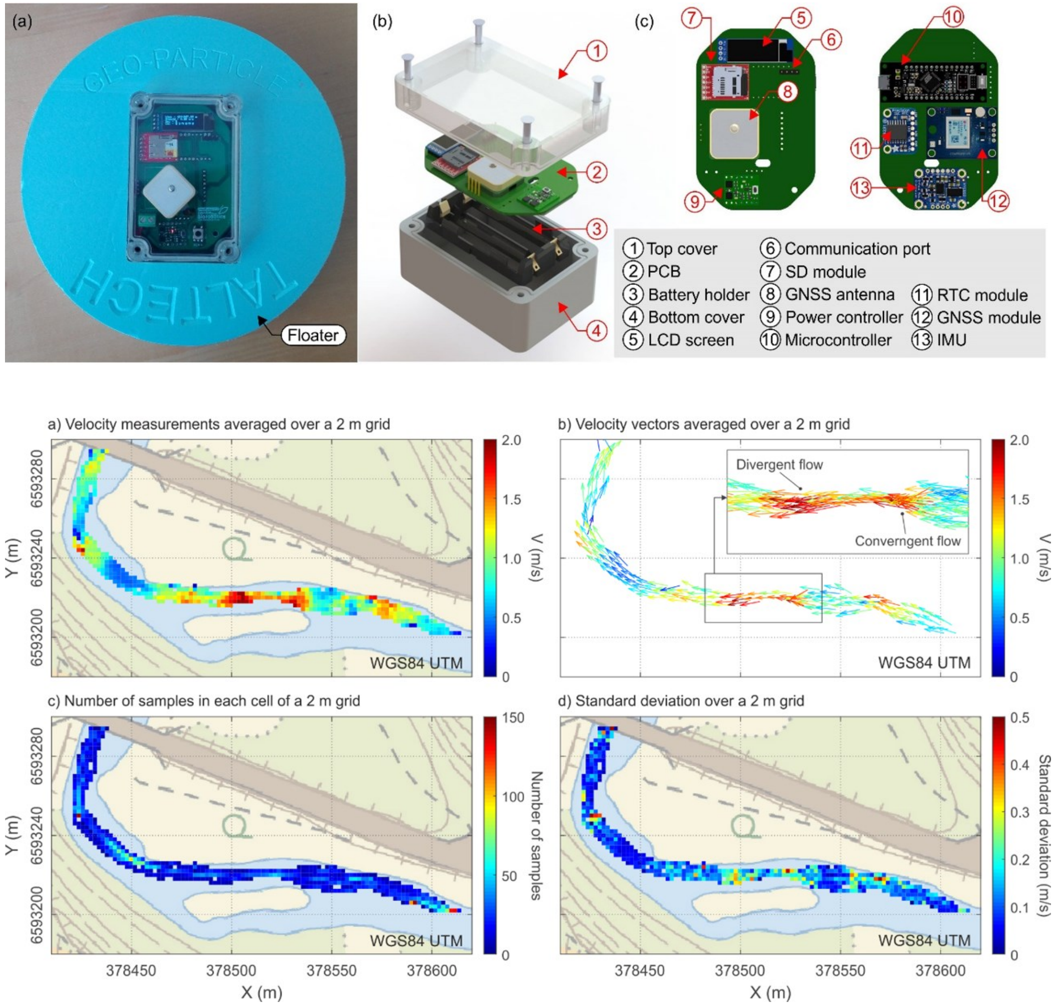


Figure 7) Top Left: Floating multimodal drifter used for large-scale surface flow mapping. Top Right: The custom electronics include a satellite positioning receiver, wireless communications module and inertial measurement unit. Bottom: Multiscale flow maps can be made in real-time by averaging the drifter data in grids of different sizes, and visualization can be done in both scalar (e.g. pressure) and vector (e.g. velocity, acceleration, and magnetic field intensity) quantities. When repeated using a swarm of sensors, maps of spatially-distributed measurement uncertainty can be created and provide field studies with a rapid and effective way to optimize the quality of data collected by focusing on reducing measurement uncertainty while still in the field.

Tuhtan, J.A., Kruusmaa M., Alexander A. & Fuentes-Perez J.F. (2020). Multiscale change detection in a supraglacial stream using surface drifters. River Flow 2020, 1483-1490

THINGS, PLACES AND RESULTS

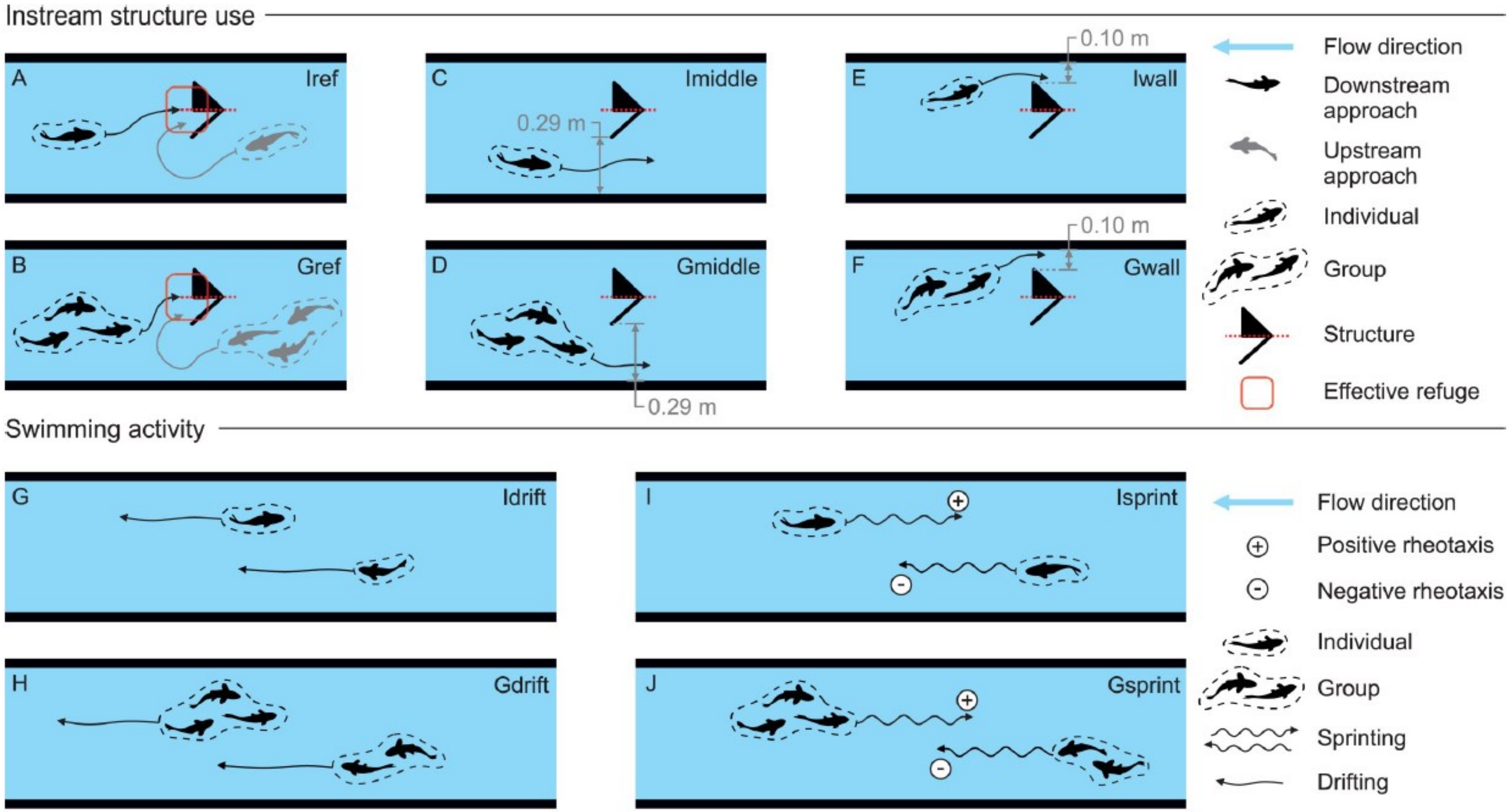


Fig 2. Classification of the behaviour metrics. (A and B)—Individual (Iref) and group (Gref) structure use; (C and D)–Individual (Imiddle) and group (Gmiddle) passage by the structures using longest distance between the structure and the flume wall; (E and F)–Individual (Iwall) and group (Gwall) passage by the structures using the shortest distance between the wall and the structure. (G and H) Individual (Idrift) and group (Gdrift) drifts. (I and J) Individual (Isprint) and group (Gsprint) sprints. Plus (+) and minus (-) signs represent the swimming direction of *L. bocagei*, as positive and negative rheotaxis respectively. These metrics were used for all configurations.

Costa, M. J., Fuentes-Pérez, J. F., Boavida, I., Tuhtan, J. A., & Pinheiro, A. N. (2019). Fish under pressure: Examining behavioural responses of Iberian barbel under simulated hydropeaking with instream structures. PloS one, 14(1), e0211115.

PLACES, THINGS, METHODS AND RESULTS

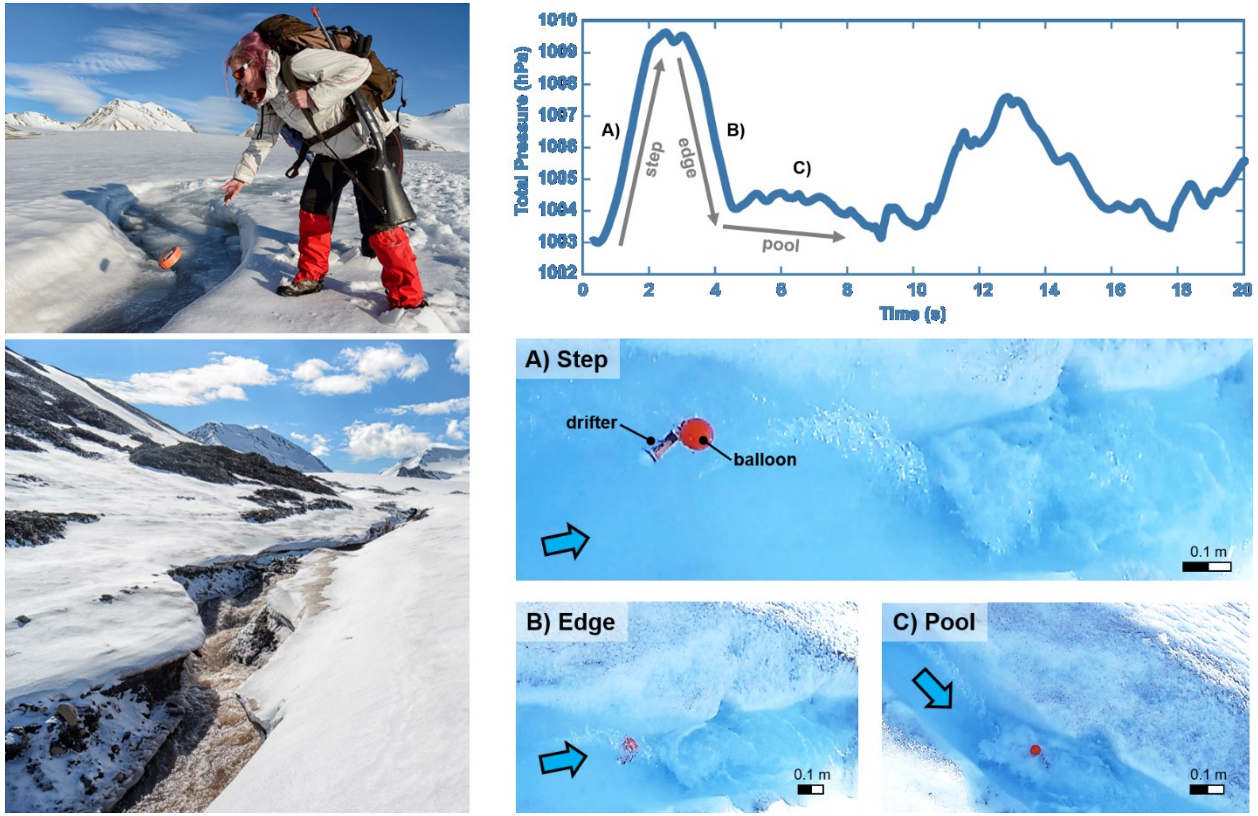
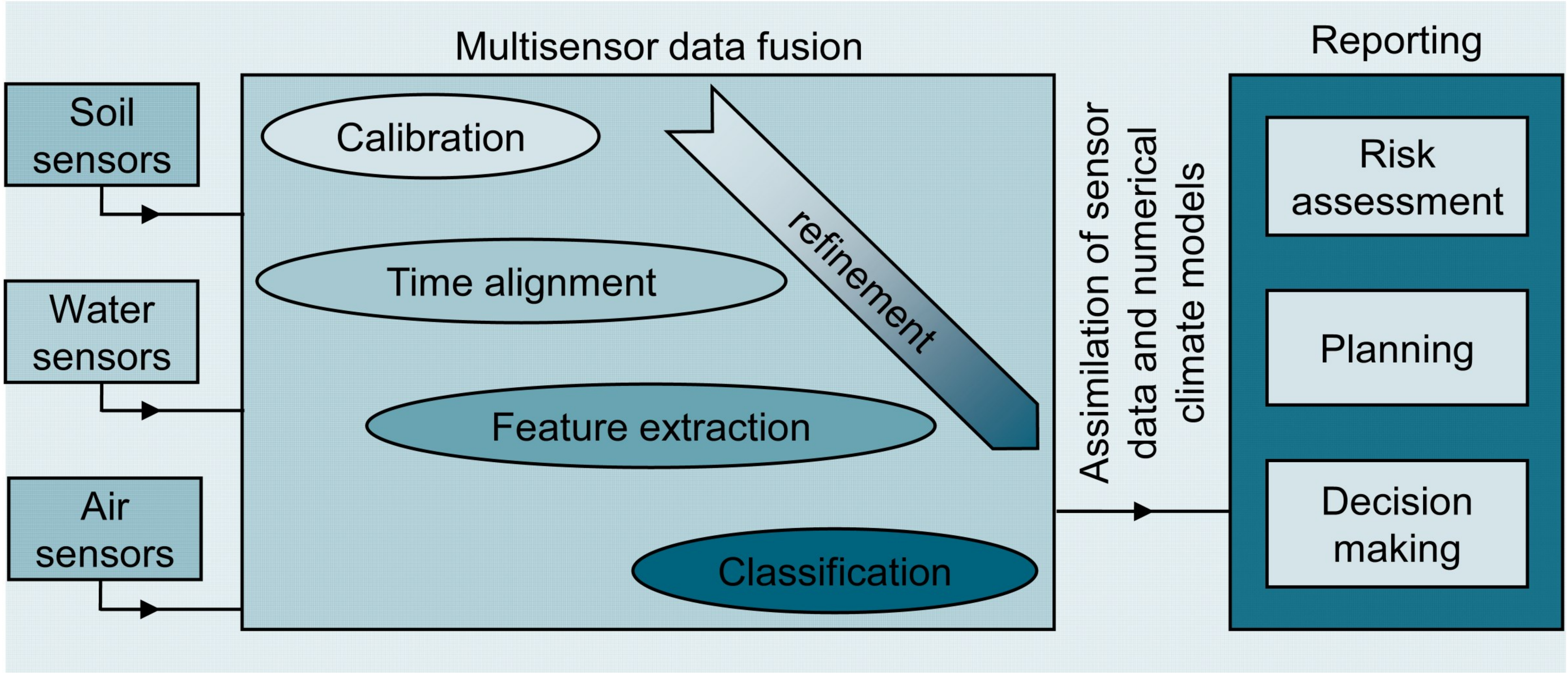


Figure 4) Top Left: Deployment of our multimodal sensors is often very easy, getting there is the hardest and most expensive part. Bottom Left: Surface channels on glaciers are constantly changing over an hourly basis, making fixed measurements both difficult and dangerous. Top Right: The pressure changes experienced by a submersible drifter can be excellent indicators of stream channel geometry. Bottom Right: The drifters can be affixed with balloons to quickly make both underwater and surface drifter measurements of the A) channel steps, B) bend edges and C) pools. The time scales of this method range from the 100 Hz sampling rate to the 1-5 s duration of a geometric feature expressed in the sensor data. The spatial scales investigated range from the 1 cm sensor pressure spacing to the 1 m channel width to the 1.2 km long channel investigated.

Alexander, A., Kruusmaa, M., Tuhtan, J. A., Hodson, A. J., Schuler, T. V. & Kääb, A. (2020). Pressure and inertia sensing drifters for glacial hydrology flow path measurements. The Cryosphere, 14(3), 1009-1023.

METHODS



Tuhtan, J. A., Nag, S., & Kruusmaa, M. (2020). Underwater bioinspired sensing: New opportunities to improve environmental monitoring. IEEE Instrumentation & Measurement Magazine, 23(2), 30-36.

METHODS

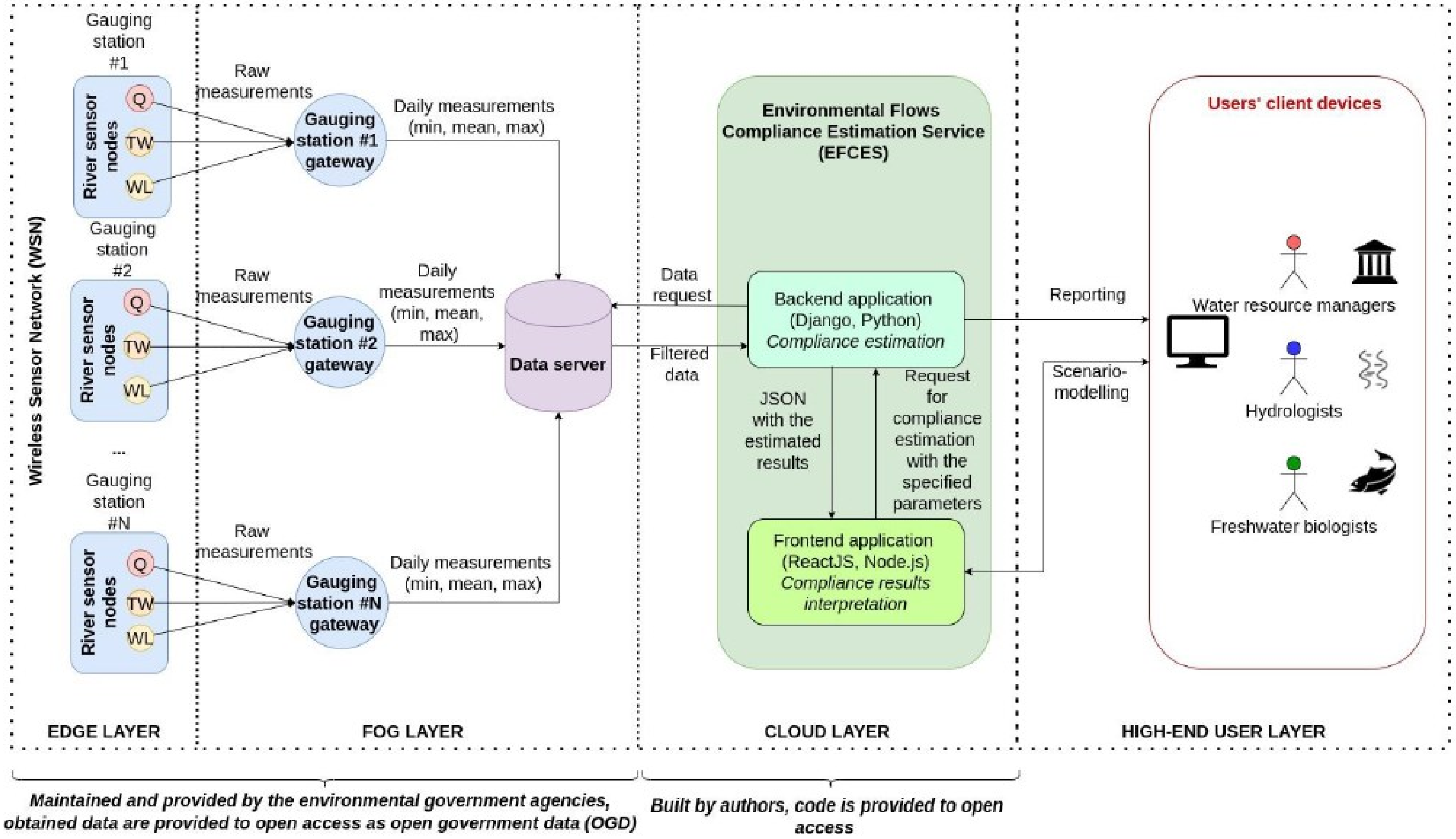
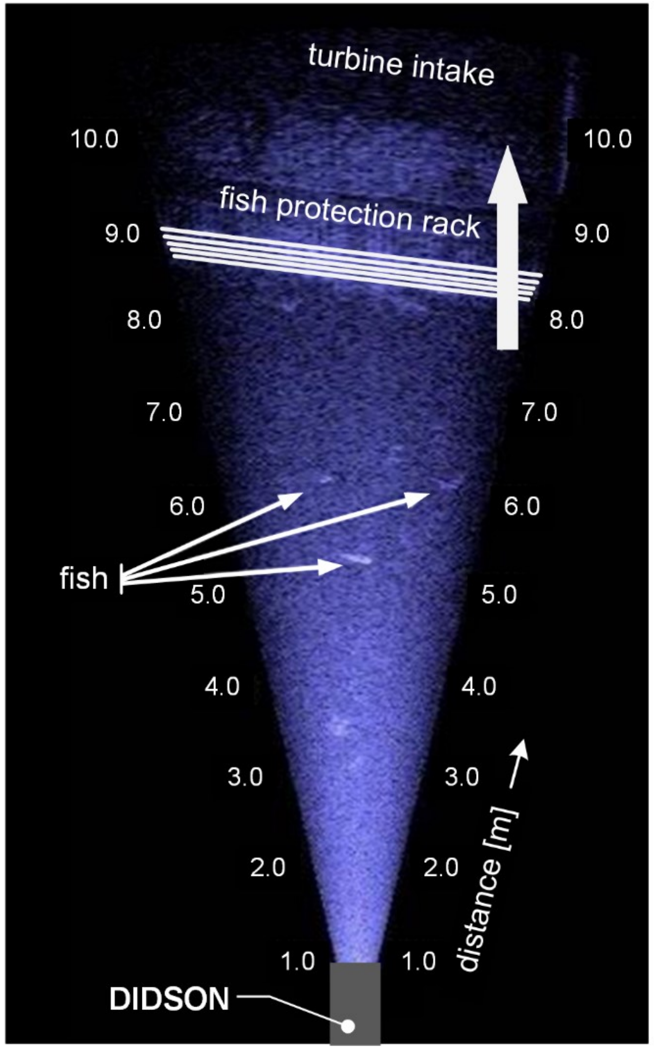


Fig. 3) Architecture of the proposed IoOGDT real-time environmental flows (eflows) compliance monitoring system. The edge layer consists of the river sensor nodes which measure the flow rate (Q), water temperature (TW) and water level (WL). The raw measurements undergo data quality control and post-processing, the statistical results are pushed to the data server. The compliance estimation service runs at the cloud layer, which is accessed by high-end users.

Miasayedava, L., McBride, K., & Tuhtan, J. A. (2022). Automated environmental compliance monitoring of rivers with IoT and open government data. Journal of Environmental Management, 303, 114283.

RESULTS TWO WAYS



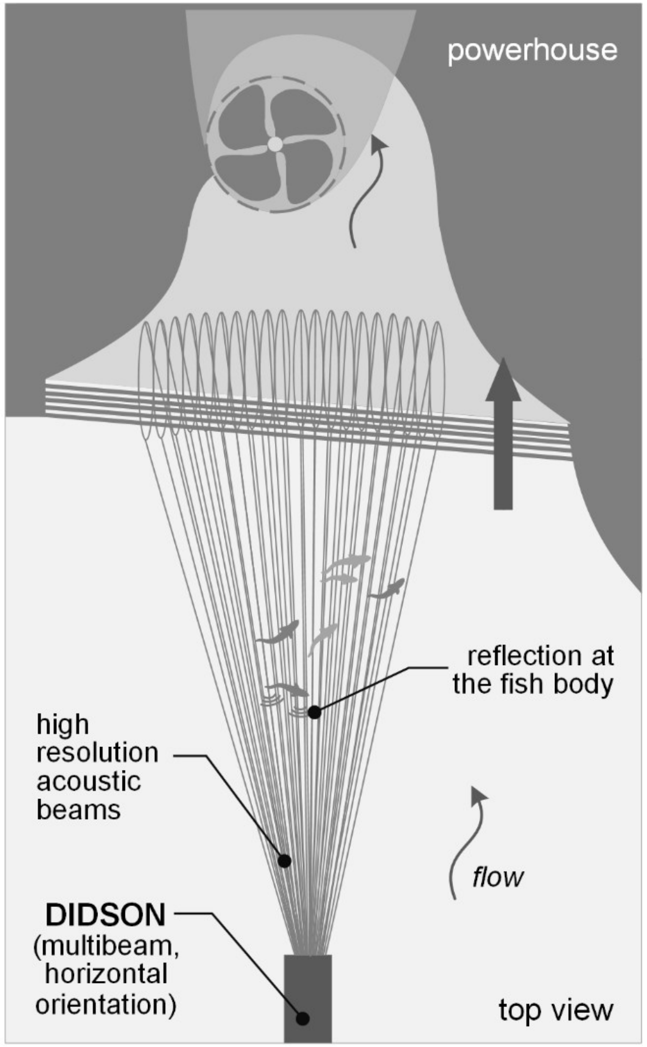
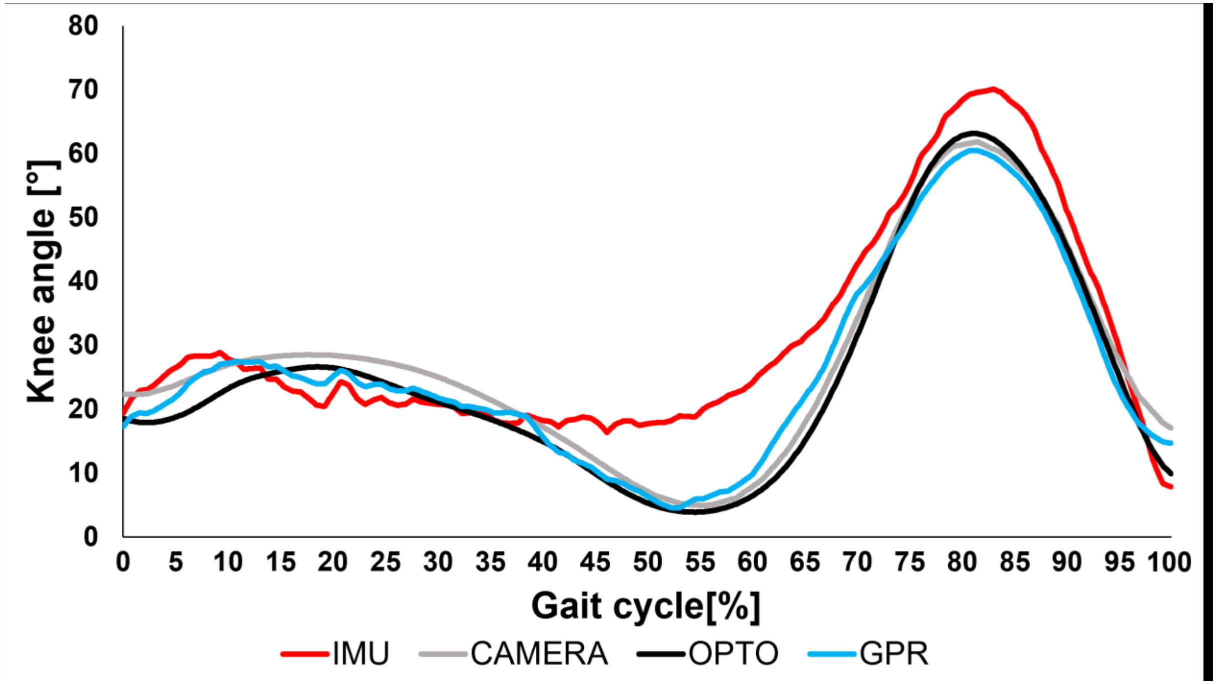
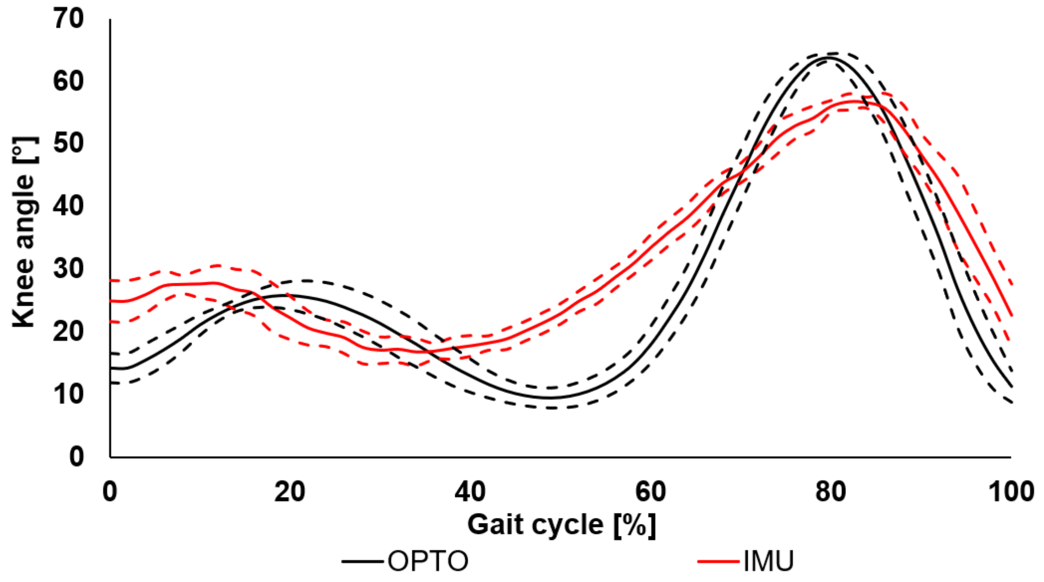


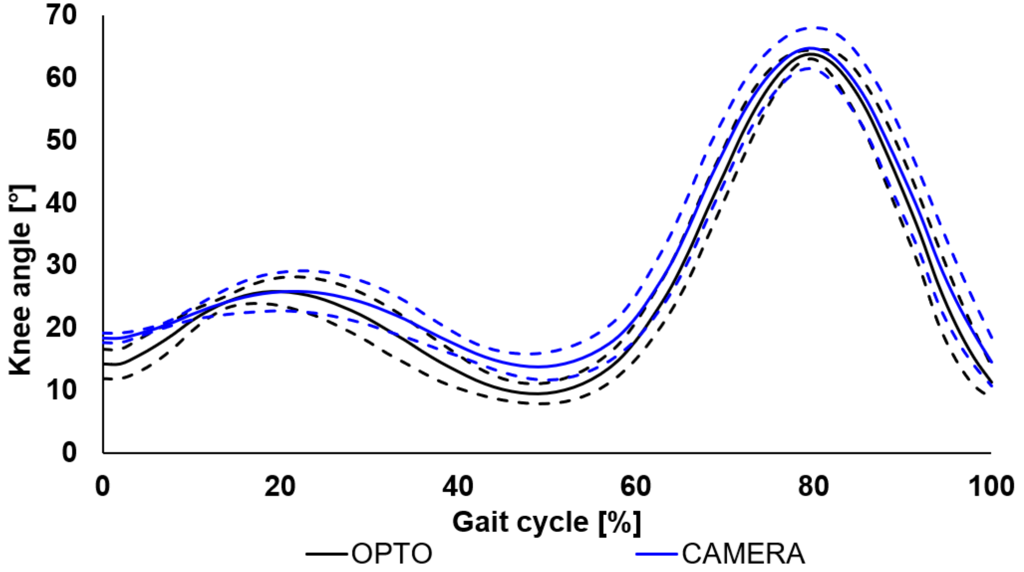
Fig. 4.7) DIDSON image of various fish of a length between 5 and 45 cm (left) and schematic representation of a DIDSON (right) setup for ethohydraulic investigation.

Lehmann B., Bensing K., Adam B., Schwevers U. & Tuhtan J.A. (2022). Ethohydraulics: A Method for Nature-Compatible Hydraulic Engineering. Springer Nature.

COMPARING RESULTS: MULTIPLE LINES

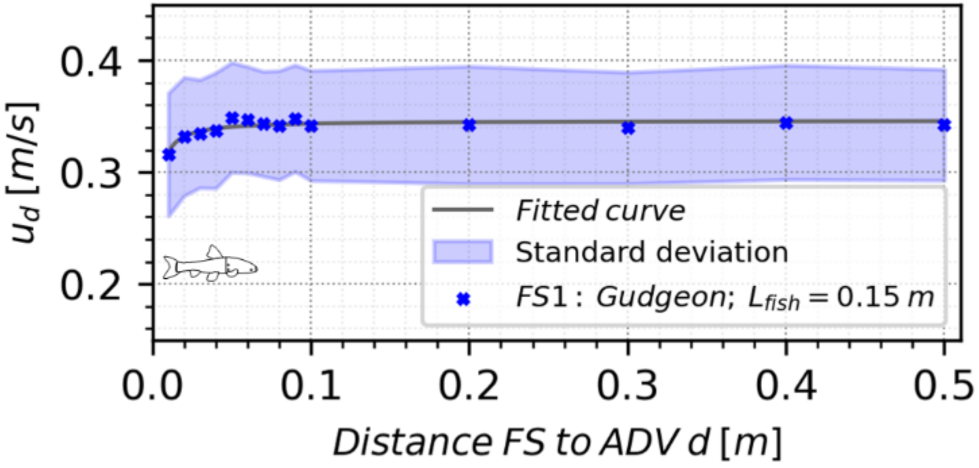


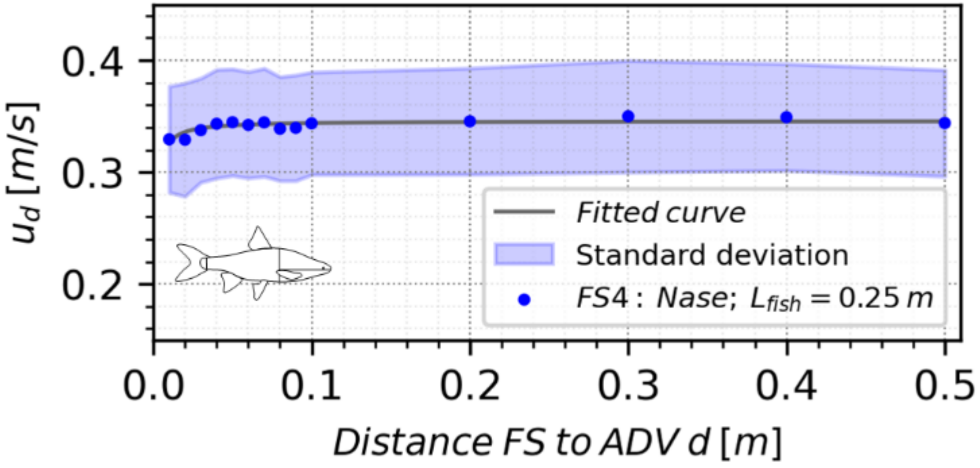


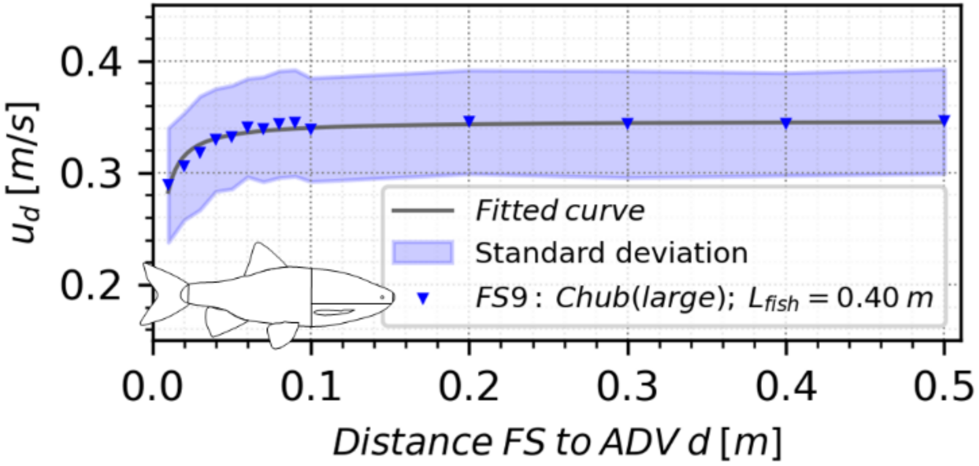


Monoli C., Fuentez-Pérez J.F., Cau N., Capodaglio P., Galli M. & Tuhtan J.A. (2021). Land and underwater gait analysis using wearable IMU. IEEE Sensors Journal 21 (9), 11192-11202

COMPARING RESULTS: MULTIPLE LINE, SCATTER







Fitted curves – u_∞ ≈ 0.35 m/s

FS1 - Gudgeon: $u_d = 0.3463 - 0.00029/d$; $R^2 = 0.79$
FS4 - Nase: $u_d = 0.3459 - 0.00020/d$; $R^2 = 0.70$
FS9 - Chub (large): $u_d = 0.3465 - 0.00064/d$; $R^2 = 0.93$

Bensing K., Tuhtan J.A., Toming G., Khan A.H. & Lehmann B. (2022). Fish body geometry reduces the upstream velocity profile in subcritical flowing waters. Aquatic Sciences 84 (3), 1-14

COMPARING RESULTS: MULTIPLE LINE, SCATTER

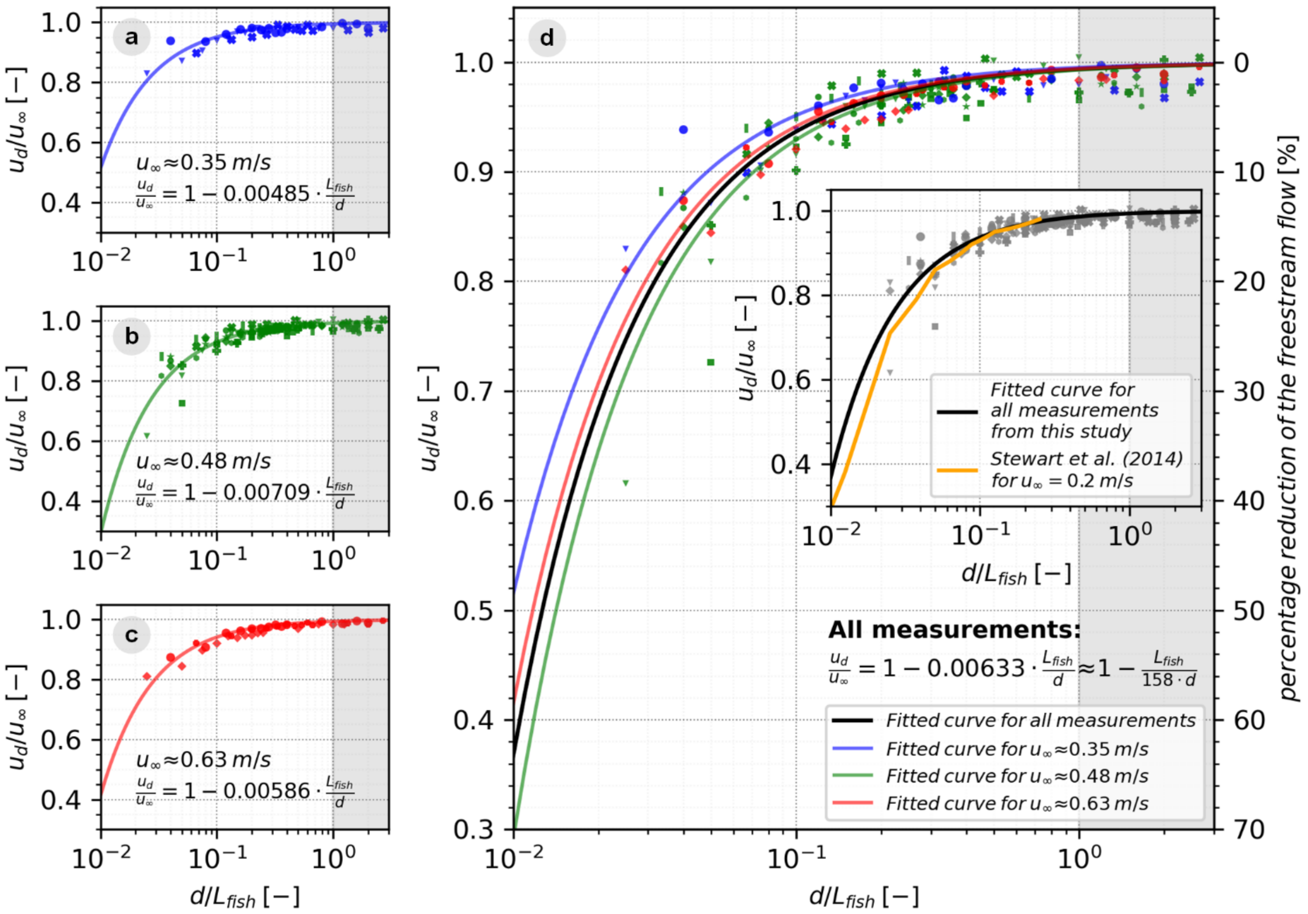
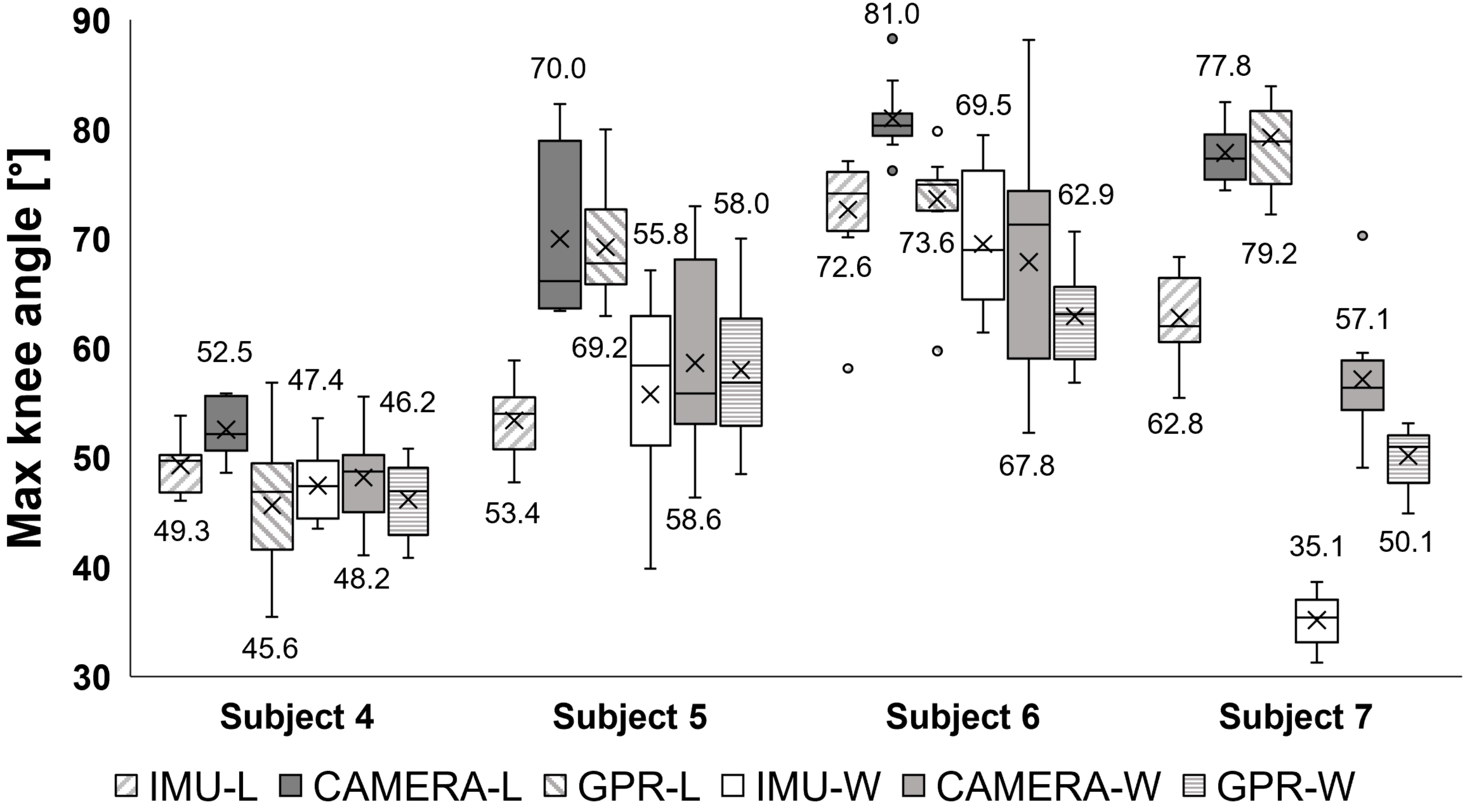


Fig. 4) Upstream velocity profile plots and fit curves for all setups and fish-shaped bodies. The normalized streamwise velocity ud/u∞ is plotted against the dimensionless length scale d/L using a logarithmic scaling of the horizontal axis. a) The upstream profile for a freestream velocity, u∞ of 0.35 m/s (FS 1, 4 and 9); b) Upstream profile for 0.48 m/s (all FS); c) Upstream profile for 0.63 m/s (FS 1, 4 and 9); d) Measurements from all experiments summarized as a single plot, the insert figure compares the results of this study with a replotting of the results found in Stewart et al. (2014). In the tests of Stewart et al. (2014), the fish was propelled (0.2 m/s shown) through still water. The right axis of (d) indicates the percentage reduction of the freestream flow velocity.

Bensing K., Tuhtan J.A., Toming G., Khan A.H. & Lehmann B. (2022). Fish body geometry reduces the upstream velocity profile in subcritical flowing waters. Aquatic Sciences 84 (3), 1-14

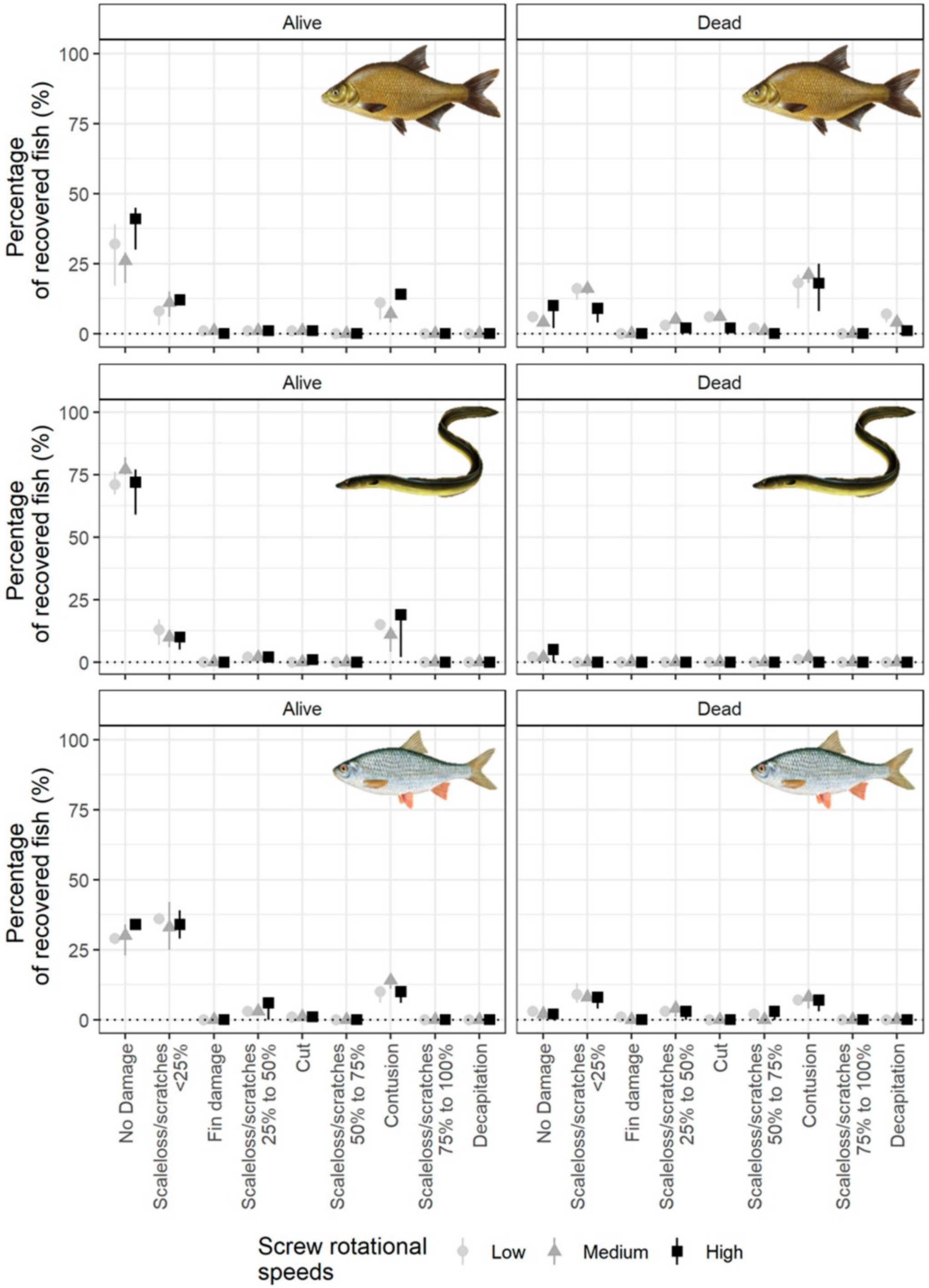
COMPARING RESULTS: BOX PLOT



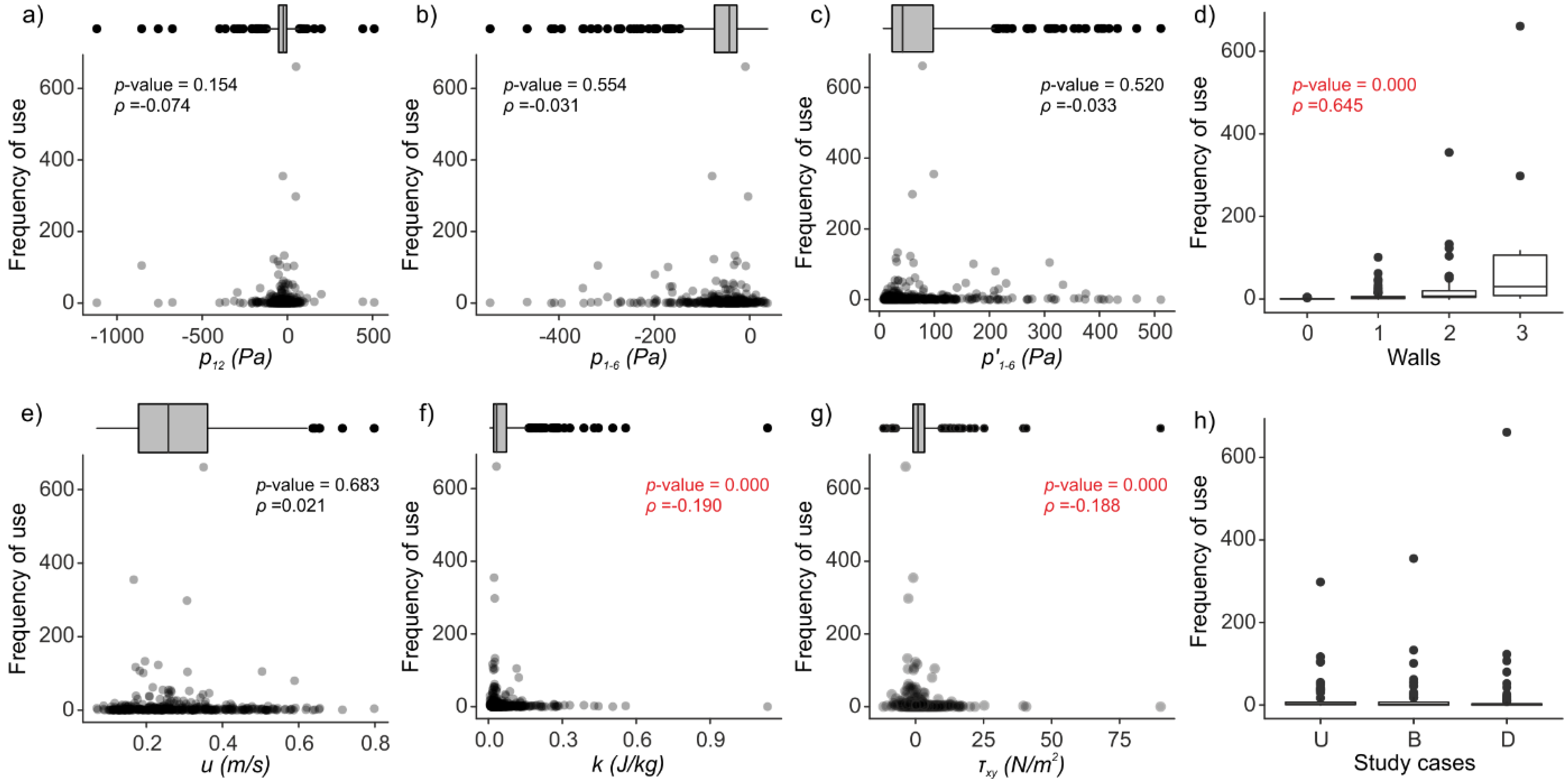
Monoli C., Fuentez-Pérez J.F., Cau N., Capodaglio P., Galli M. & Tuhtan J.A. (2021). Land and underwater gait analysis using wearable IMU. IEEE Sensors Journal 21 (9), 11192-11202

RESULTS: MULTIPLE BOX PLOTS

Figure 6) Proportions of recovered bream (Abramis brama, top), eel (Anguilla anguilla, middle), and roach (Rutilus rutilus, bottom), indicating the injury type and the state as either alive (**left**) or dead (**right**) for each of the three rotational speeds (legend). Marks indicate the average proportion over three repeated tests. Vertical lines indicate the observed range from the three replicates. Scale loss applies to bream and roach, whereas scratches apply to eel.

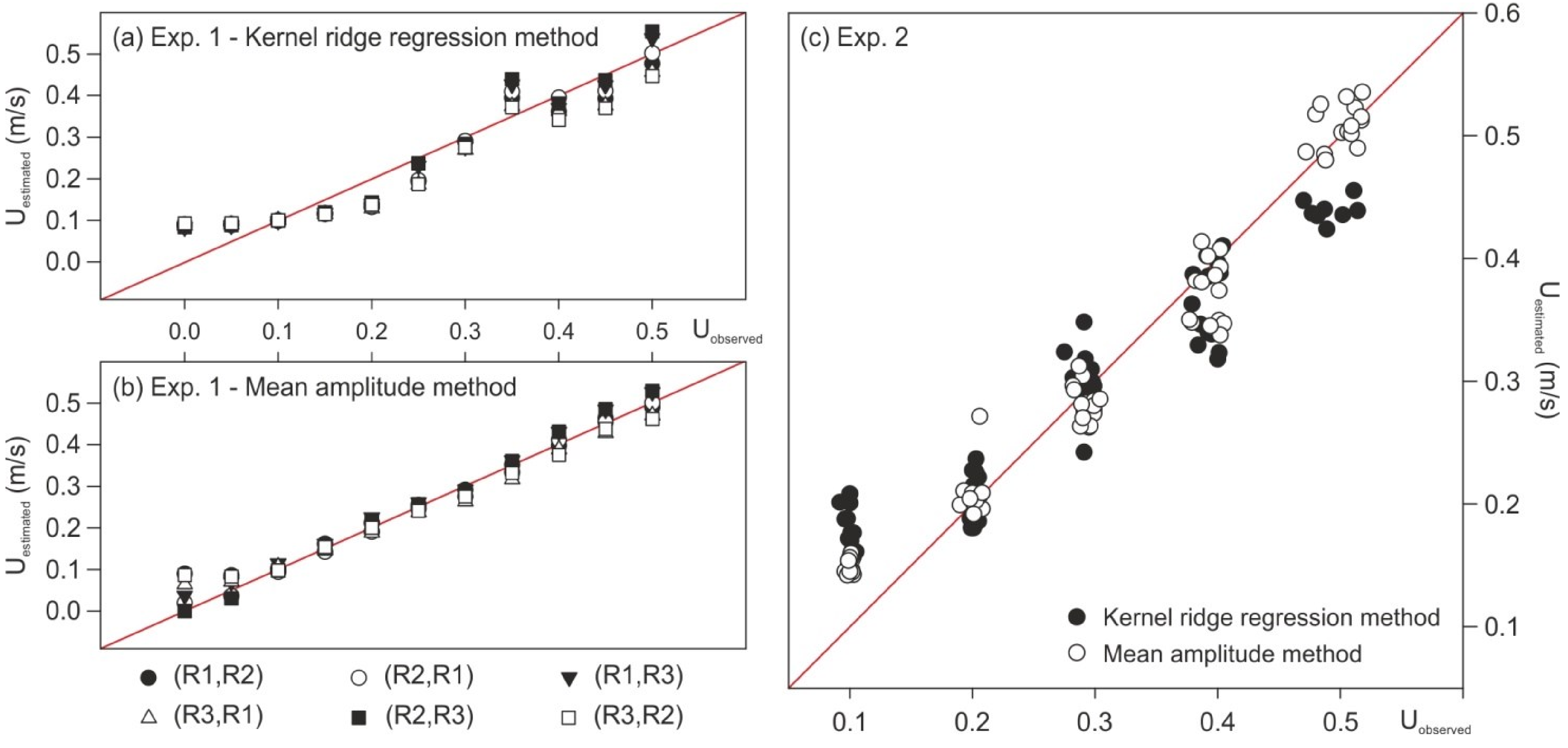


COMPARING RESULTS: SCATTER AND BOX PLOT



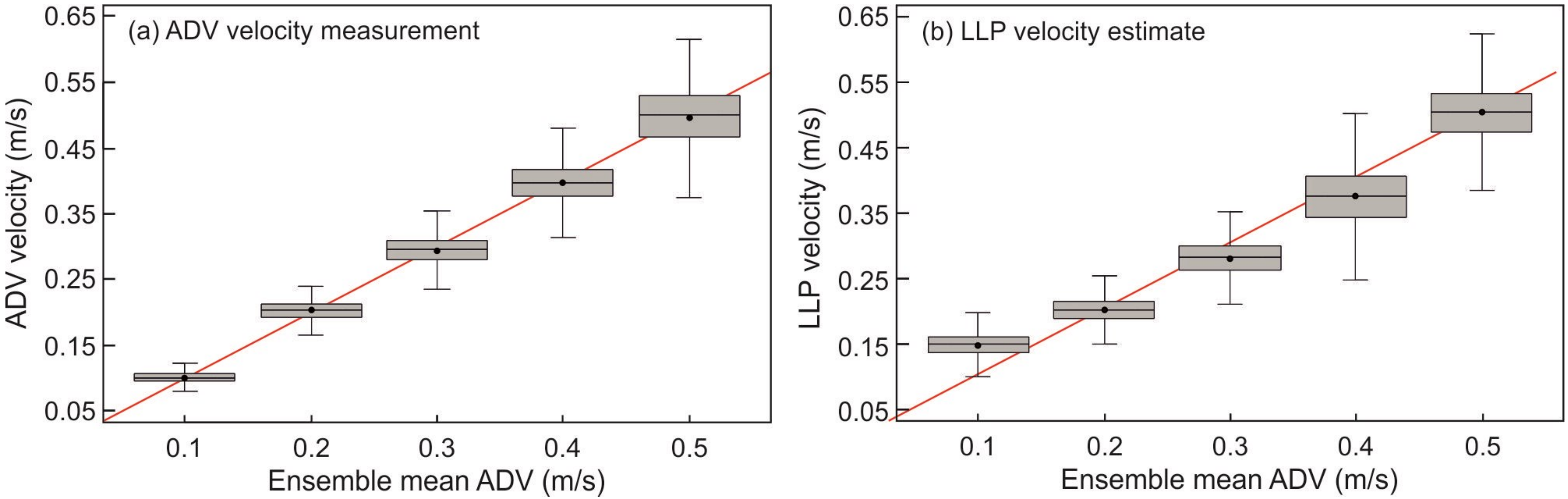
Fuentes-Pérez J.F., Eckert M., Tuhtan J.A., Ferreira M.T., Kruusmaa M. & Branco P. (2018). Spatial preferences of Iberian barbel in a vertical slot fishway under variable hydrodynamic scenarios. Ecological Engineering 125, 131-142

COMPARING RESULTS: MULTIPLE SCATTER PLOTS



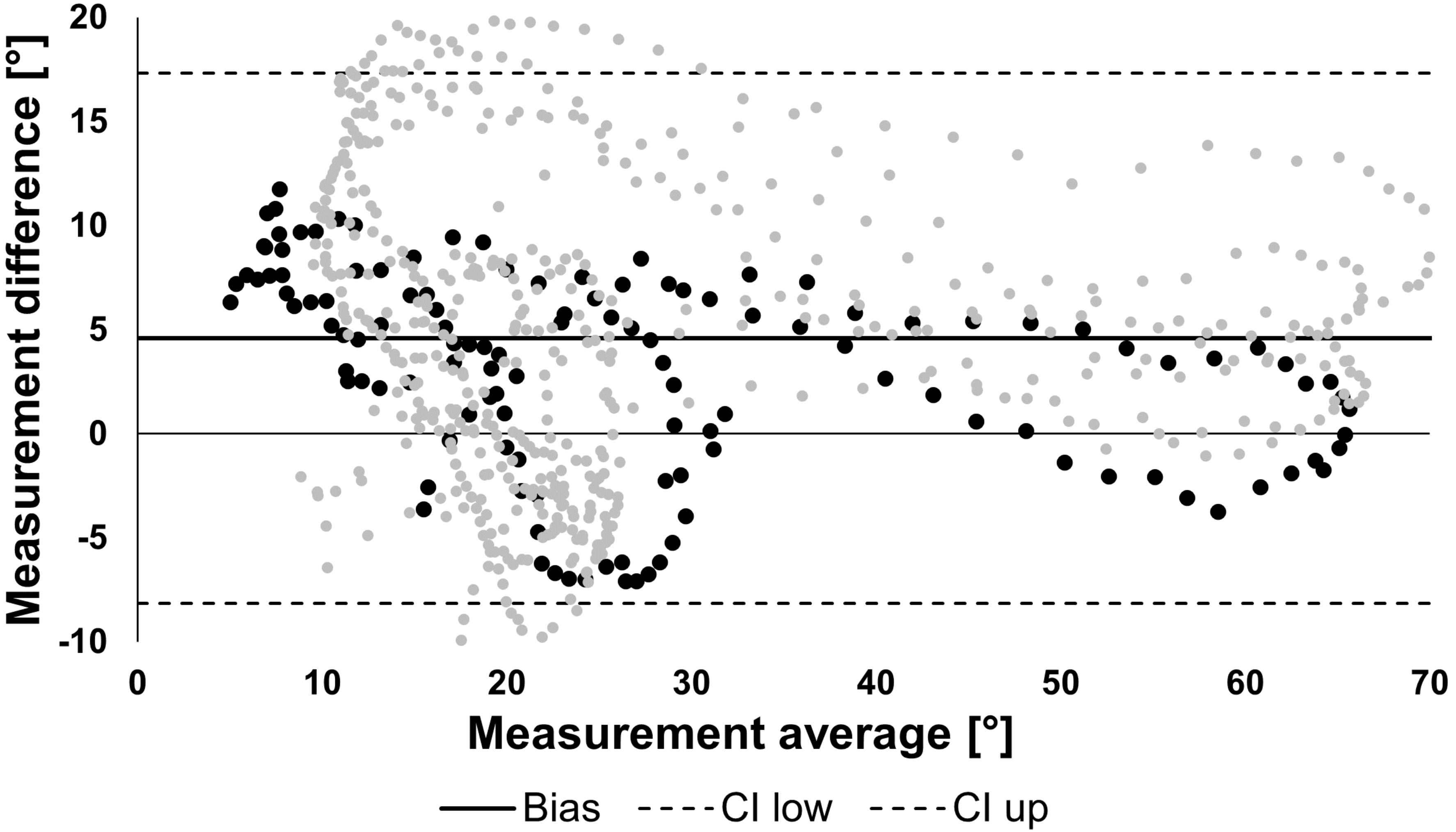
Tuhtan J.A., Fuentes-Pérez J.F., Strokina N., Toming G. Musall M., Noack M., Kämäräinen J.K. & Kruusmaa M. (2017). Design and application of a fish-shaped lateral line probe for flow measurement. Review of Scientific Instruments 87 (4), 045110

COMPARING RESULTS: MULTIPLE BOX PLOTS



Tuhtan J.A., Fuentes-Pérez J.F., Strokina N., Toming G. Musall M., Noack M., Kämäräinen J.K. & Kruusmaa M. (2017). Design and application of a fish-shaped lateral line probe for flow measurement. Review of Scientific Instruments 87 (4), 045110

COMPARING RESULTS: BLAND-ALTMAN PLOT



Monoli C., Fuentez-Pérez J.F., Cau N., Capodaglio P., Galli M. & Tuhtan J.A. (2021). Land and underwater gait analysis using wearable IMU. IEEE Sensors Journal 21 (9), 11192-11202

COMPARING RESULTS: BAR PLOTS

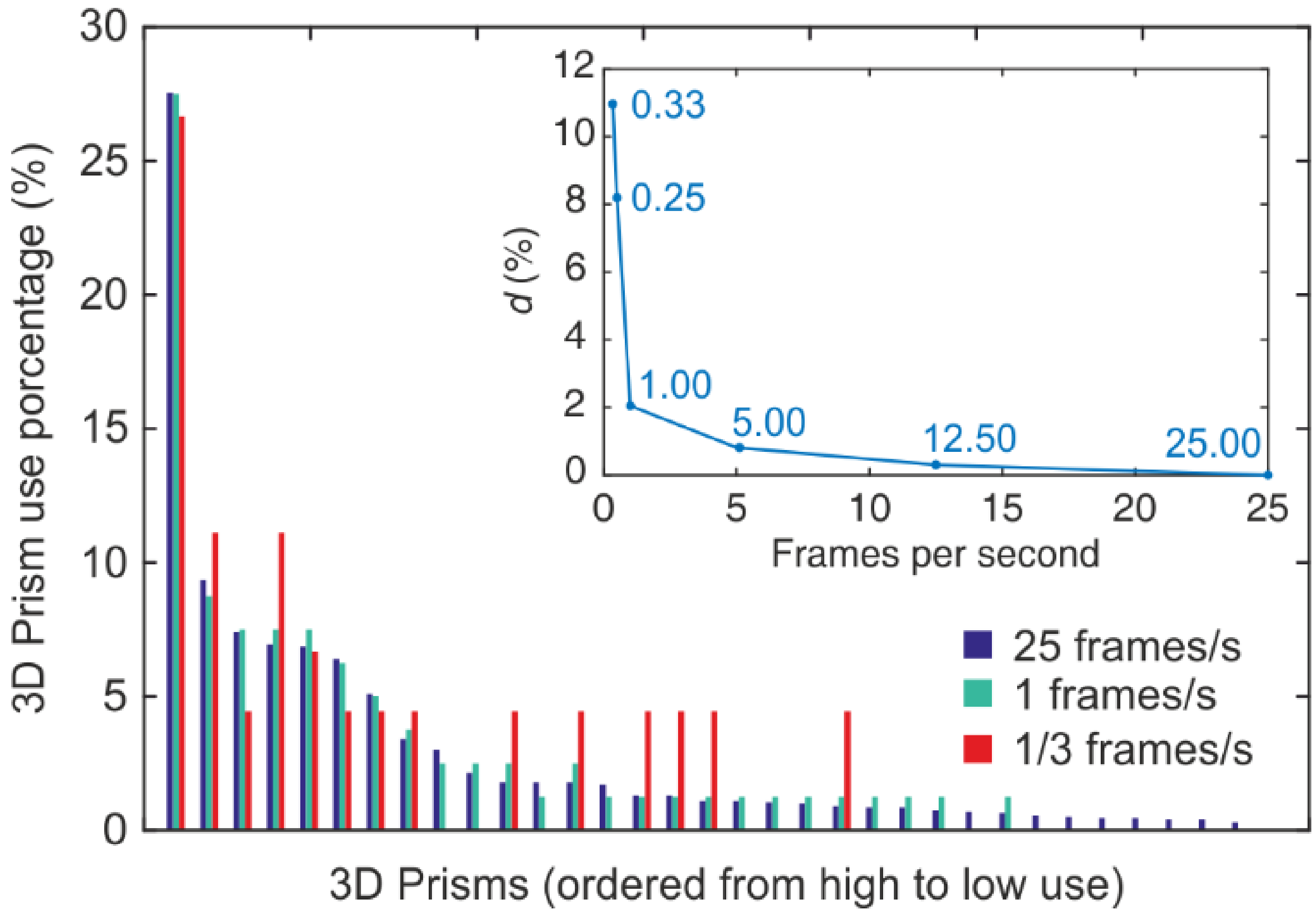
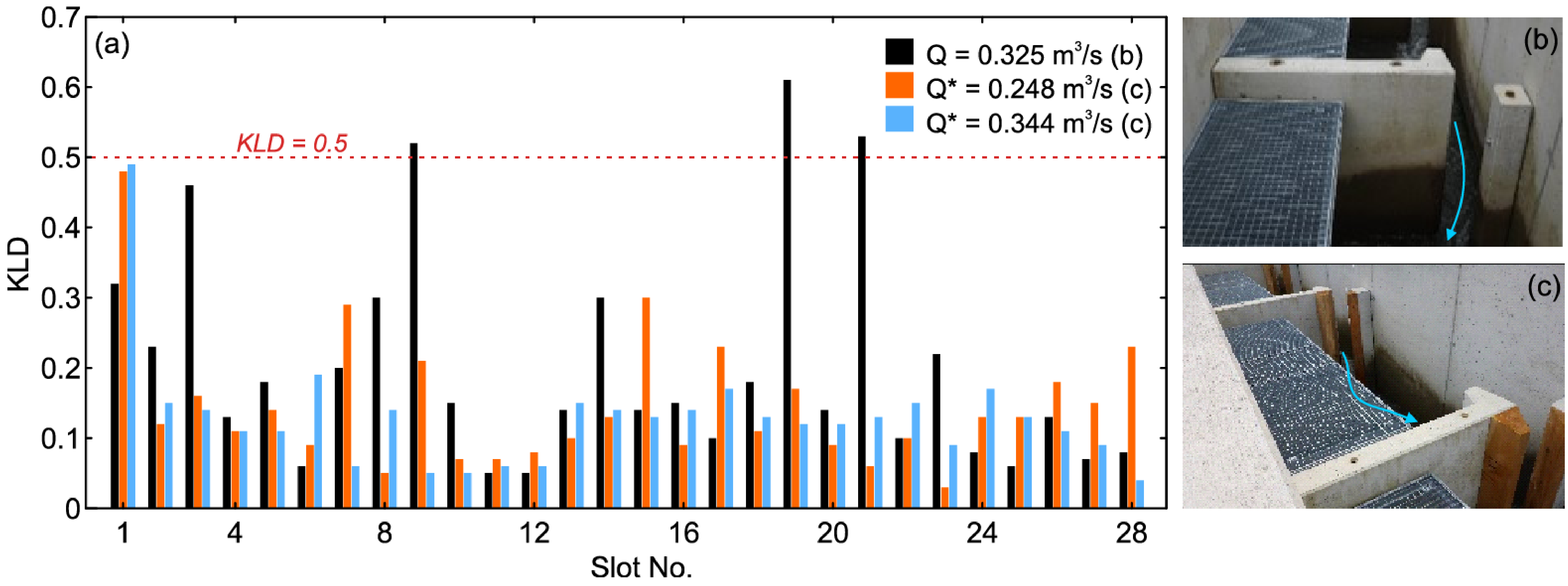


Fig. 4) Usage frequency distribution according to different frame per second for a sample of 2000 frames (first replicate of the backwater profile). *d* is the Euclidean distance travelled between 25 frames/s histogram and the target in each case.

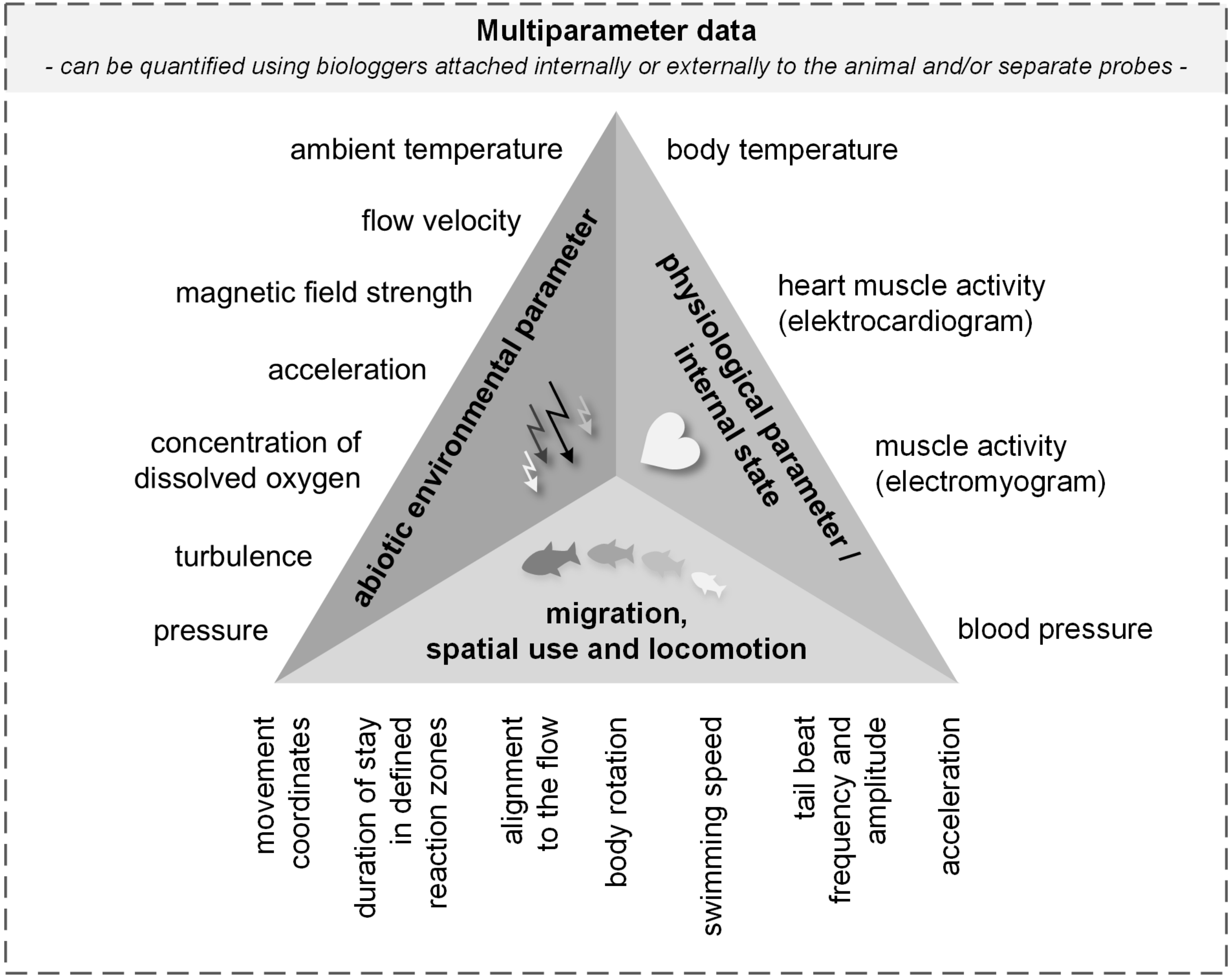
Fuentes-Pérez J.F., Eckert M., Tuhtan J.A., Ferreira M.T., Kruusmaa M. & Branco P. (2018). Spatial preferences of Iberian barbel in a vertical slot fishway under variable hydrodynamic scenarios. Ecological Engineering 125, 131-142

COMPARING RESULTS: MULTIPLE BAR PLOTS

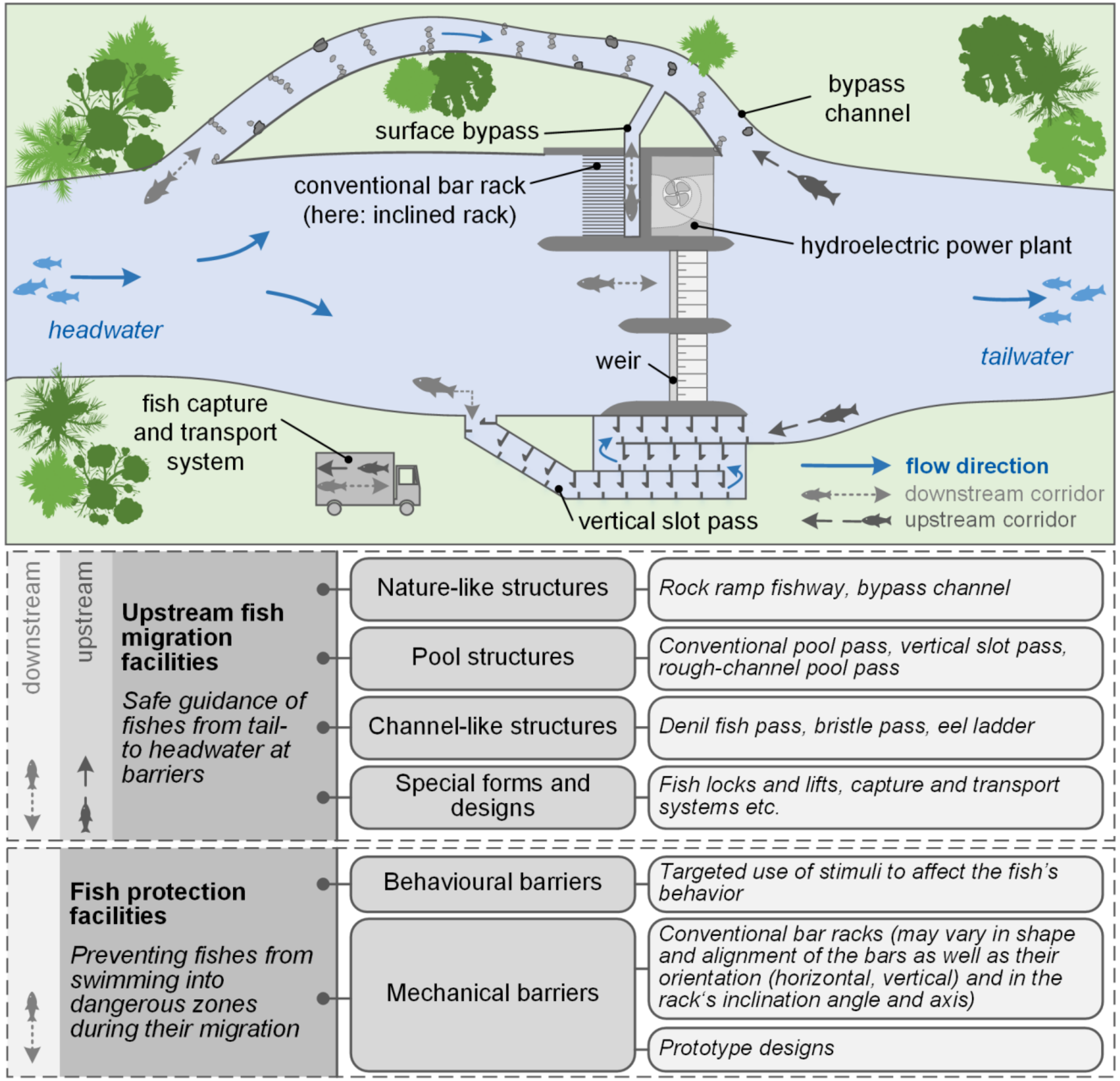


Tuhtan, J. A., Fuentes-Perez, J. F., Toming, G., Schneider, M., Schwarzenberger, R., Schletterer, M., & Kruusmaa, M. (2018). Man-made flows from a fish's perspective: autonomous classification of turbulent fishway flows with field data collected using an artificial lateral line. Bioinspiration & biomimetics, 13(4), 046006.

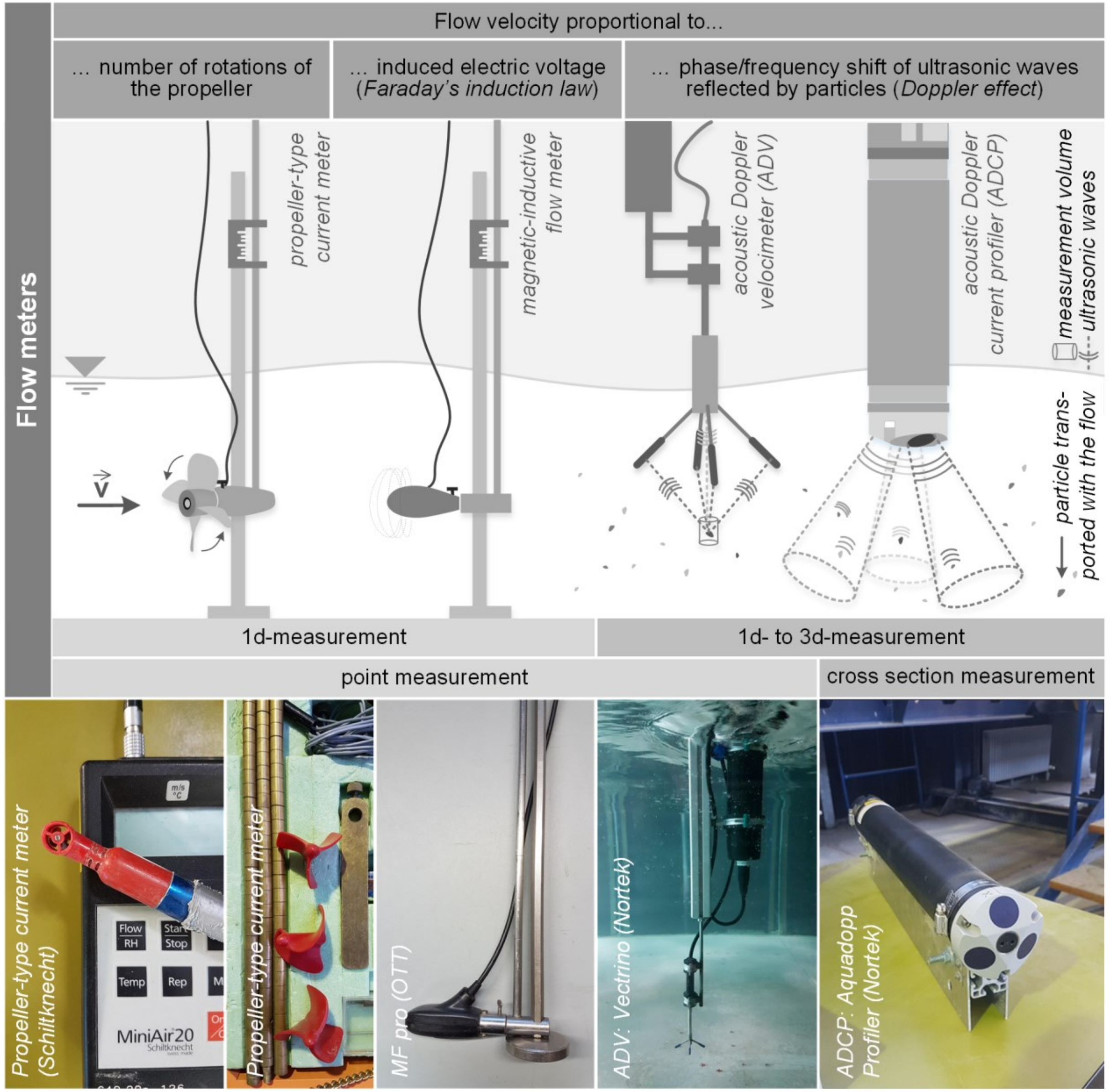
CONCEPTUAL: MULTIPLE CATEGORIES



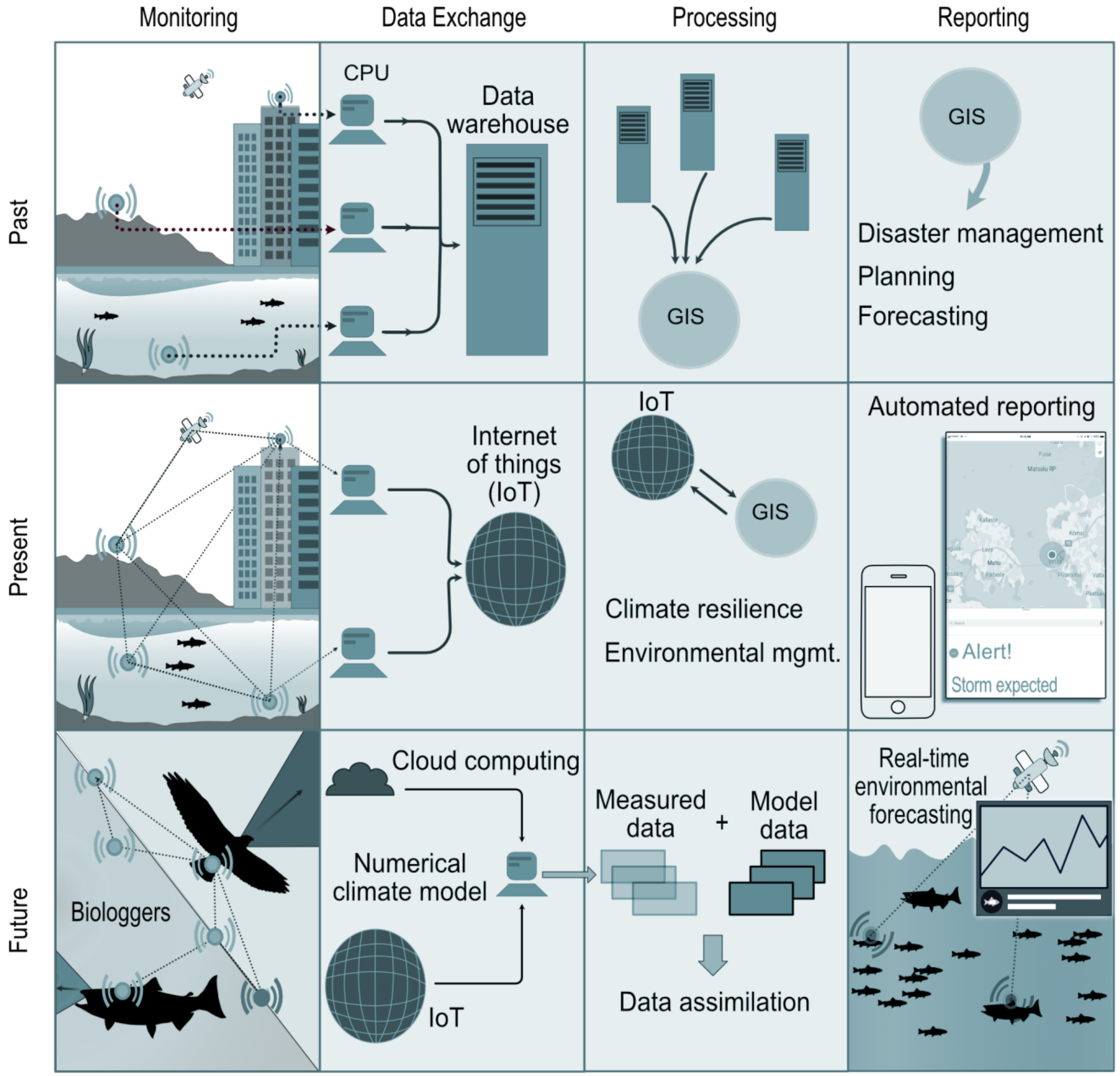
CONCEPTUAL: PLACES AND PROCESSES



CONCEPTUAL: MULTIPLE METHODS

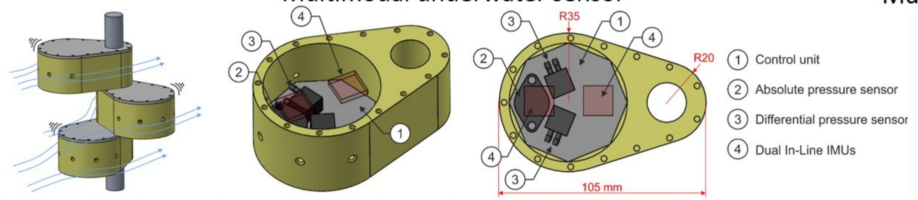


CONCEPTUAL: VISION OF THE FUTURE

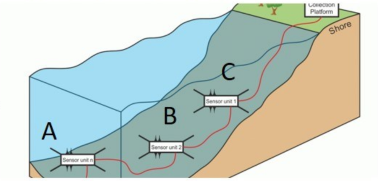


HIGH-LEVEL CONCEPTS: SKETCH IT OUT

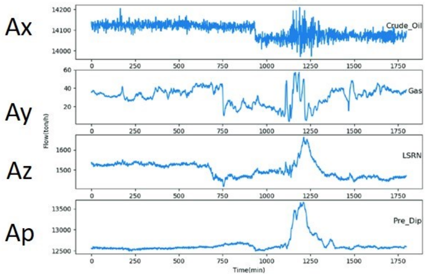
Multimodal underwater sensor



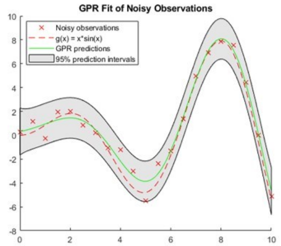
Multimodal underwater sensor network

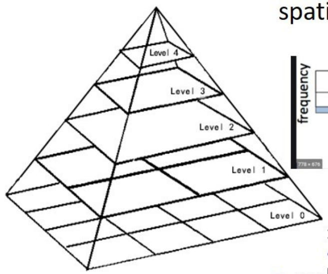


Multivariate time series, each sensor

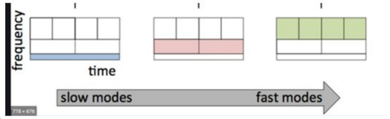


Filling gaps and uncertainty estimation

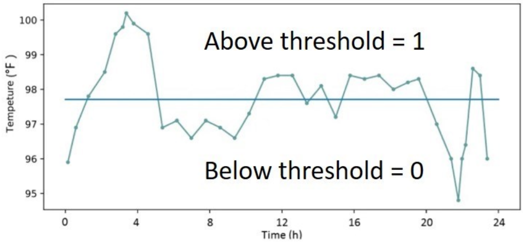


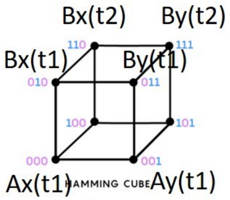


Choose thresholds based on spatial and / or temporal scale

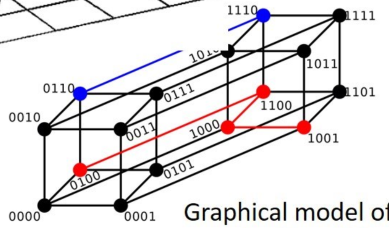


Binarization of time series data



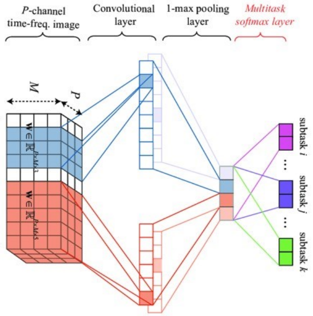


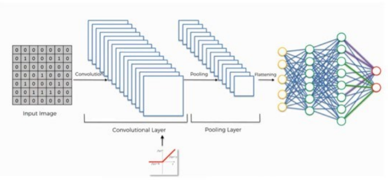
Convert sensor data to Hamming Cube with different thresholds t1, t2



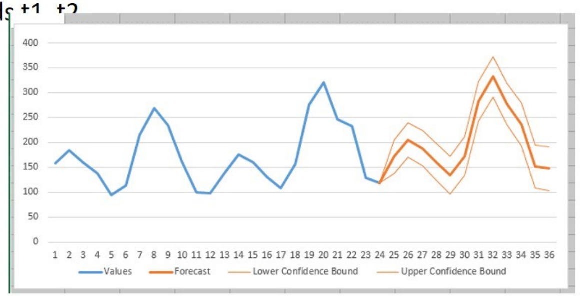
Graphical model of sensor network as collection of Hamming Cubes

Multiscale feature exraction of Hamming Cube features at multiple resolutions in time and in space





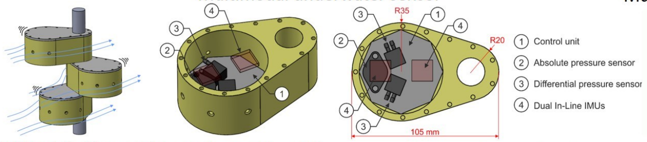
Convolutional Neural Network With Hamming Cube features for Multiresolution, multiscale forecasting



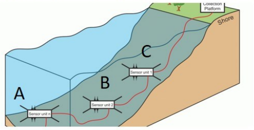
Time series forecasting with uncertainty bounds depending on spatial and temporal thresholding

REVISE, REVISE, REVISE…

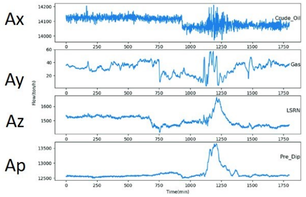
Multimodal underwater sensor



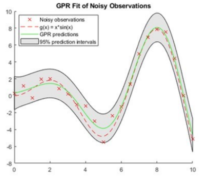
Multimodal underwater sensor network

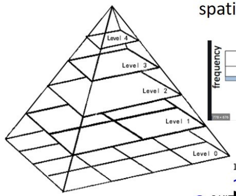


Multivariate time series, each sensor

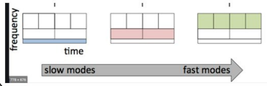


Filling gaps and uncertainty estimation

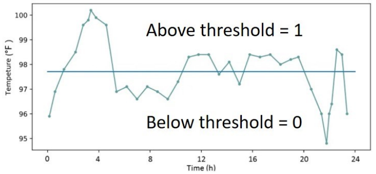


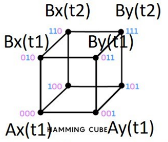


Choose thresholds based on spatial and / or temporal scale

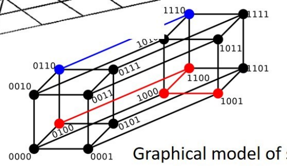


Binarization of time series data

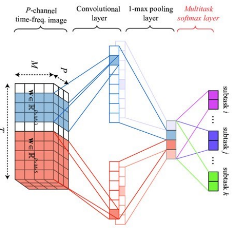




Convert sensor data to Hamming Cube with different thresholds t1, t2



Graphical model of sensor network as collection of Hamming Cubes



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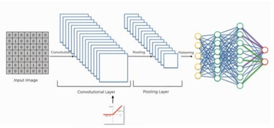
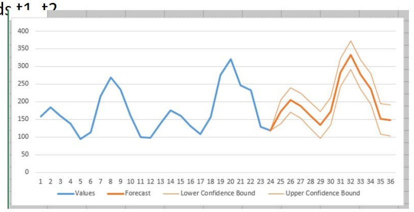
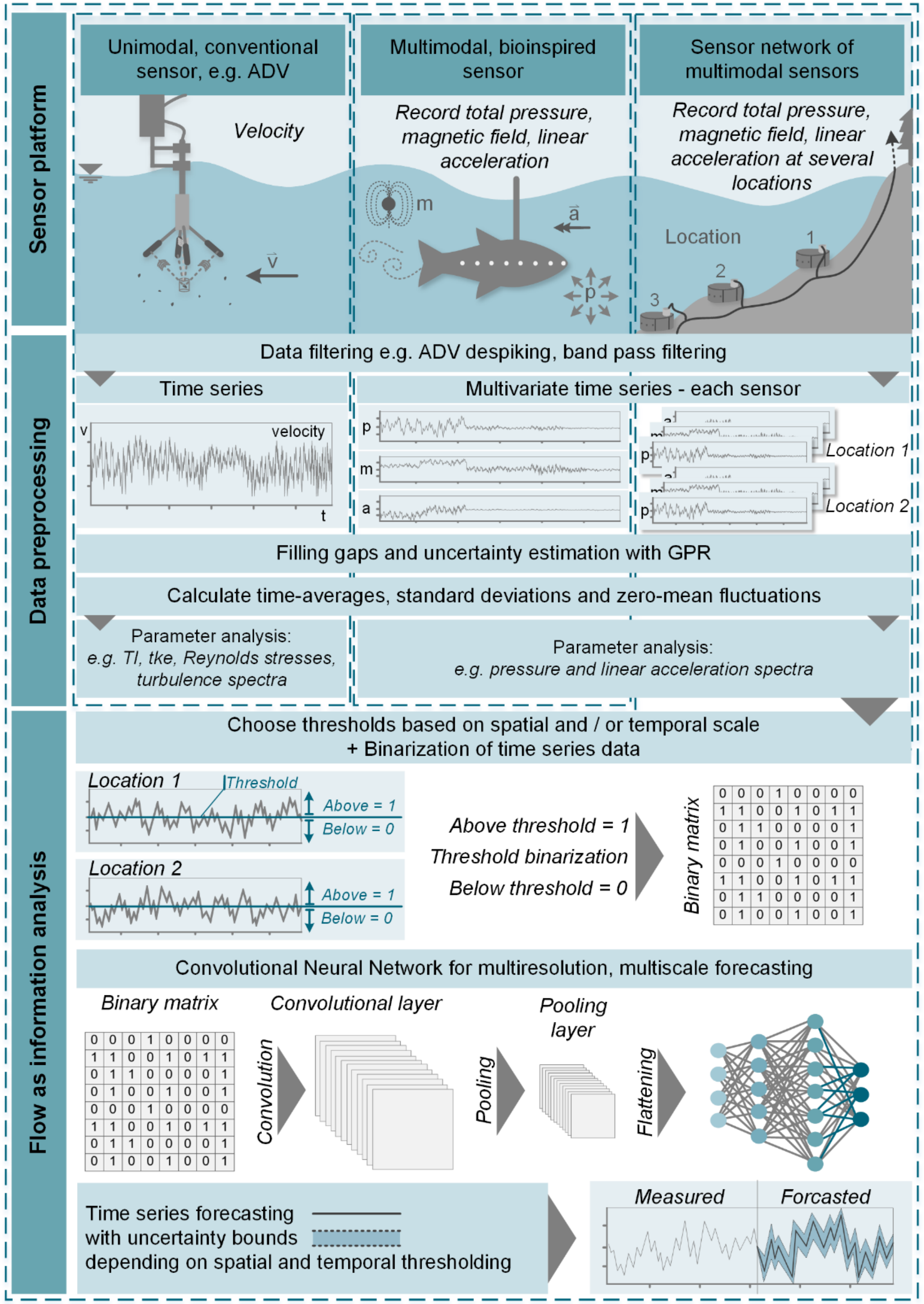


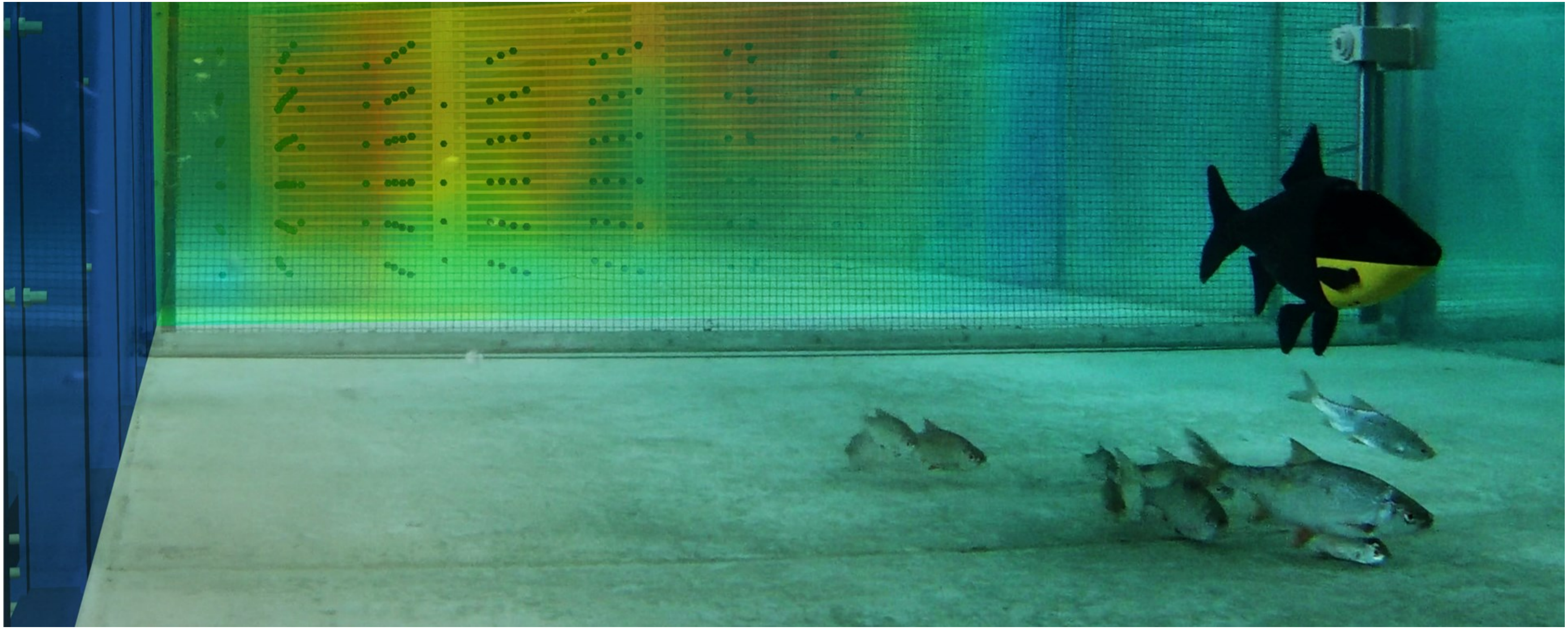
Convolutional Neural Network With Hamming Cube features for Multiresolution, multiscale forecasting



Time series forecasting with uncertainty bounds depending on spatial and temporal thresholding



CONCEPTUAL: SYNTHESIS



WHERE TO PUT MY FIGURES?

1) Go to your target journal
2) Download the „guide to authors“
3) Read the requirements and suggestions for figures
4) Find at least 5 papers with quality figures similar to those in your paper

MAKING YOUR FIGURES FIT

1) Where in the text are the figures typically located?
2) What sizes are the figures? What fonts and colors do they have?
3) How long are the figure captions, and how are figures referred to in the body text?
4) Add placeholder figures as good examples in your draft manuscript so the co-authors can comment.

ASSIGNMENT

1) Find 3 "good" and 3 "bad" figure examples by scoping your target journal(s).
2) Explain in 2-3 sentences what you would recommend fixing, and why, for each of the "bad" figures.
3) Explain in 2-3 sentences why you chose each of the "good" figures.
4) Submit the 6 figures and explanations including DOI for each figure as a PDF file.
5) Make sure your name and date is on the top of the first page.