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Dec 12th, 1:30 PM - 3:10 PM

Sensing what fish feel about passage through three different low-head hydropower turbines

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Presenter Information
Craig Boys, Brett Pflugrath, Melanie Mueller, Joachim Pander, Zhiqun Daniel Deng, and Juergen Geist

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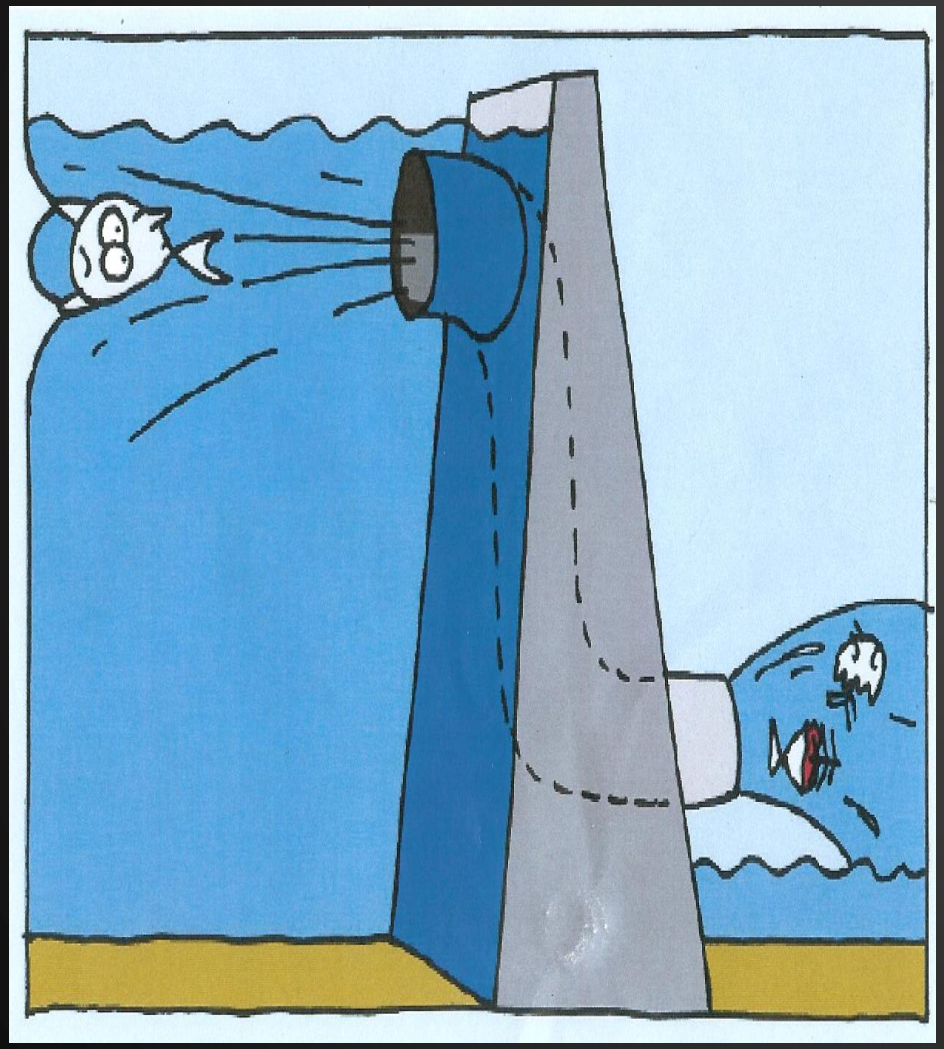
Sensing what fish feel about passage through three different low-head hydropower turbines.

Craig Boys[1], Brett Pflugrath[1,3], Melanie Mueller[2], Joachim Pander[2], Zhiqun Daniel Deng[3] and Juergen Geist[2]

1. New South Wales Department of Primary Industries.
2. Technical University of Munich
3. Pacific Northwest National Laboratory

Big dam hydro can be bad news for downstream migrating fish

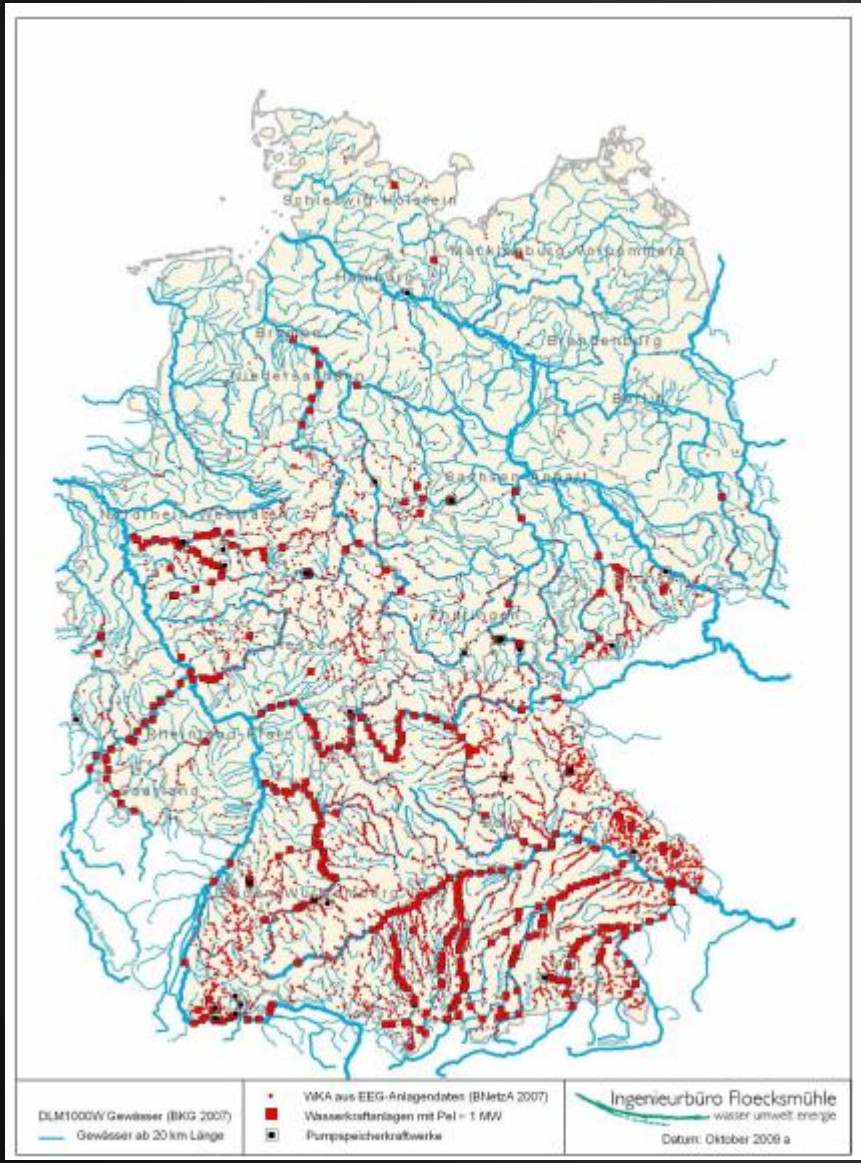


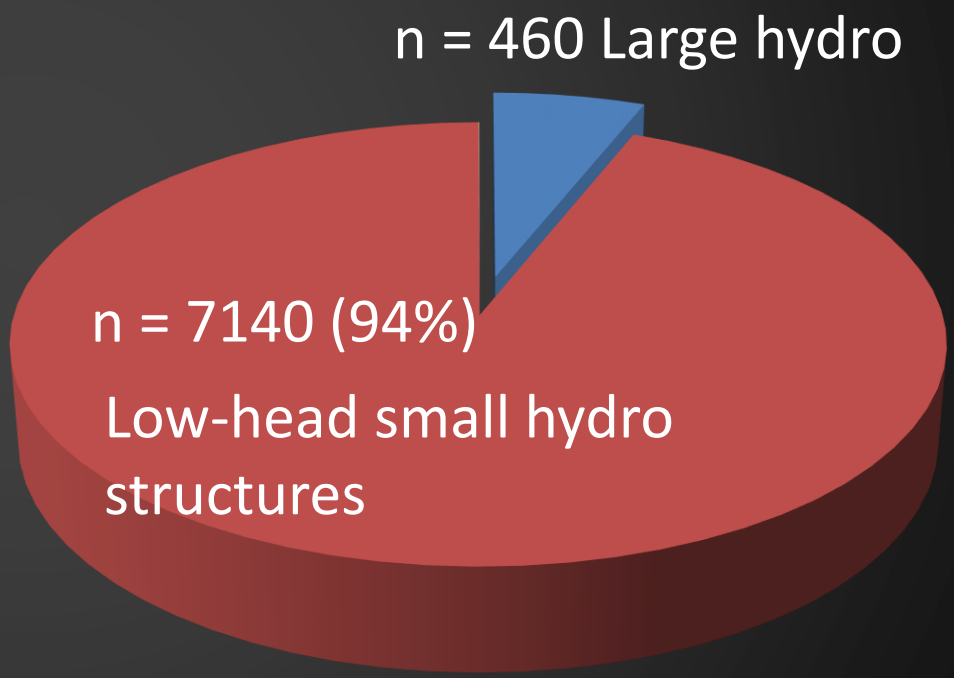
Mortal injuries caused by:

- Rapid decompression
- Shear forces
- Strike

In-field and laboratory mortality studies, hydraulic investigations

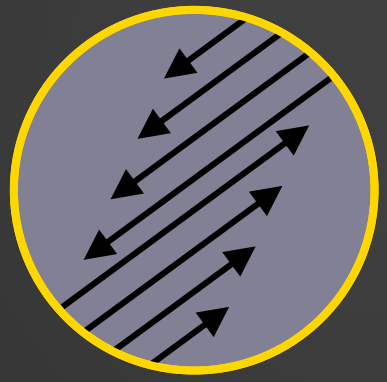
But can good things come in smaller packages?





What stressors do fish face at low-head hydro?

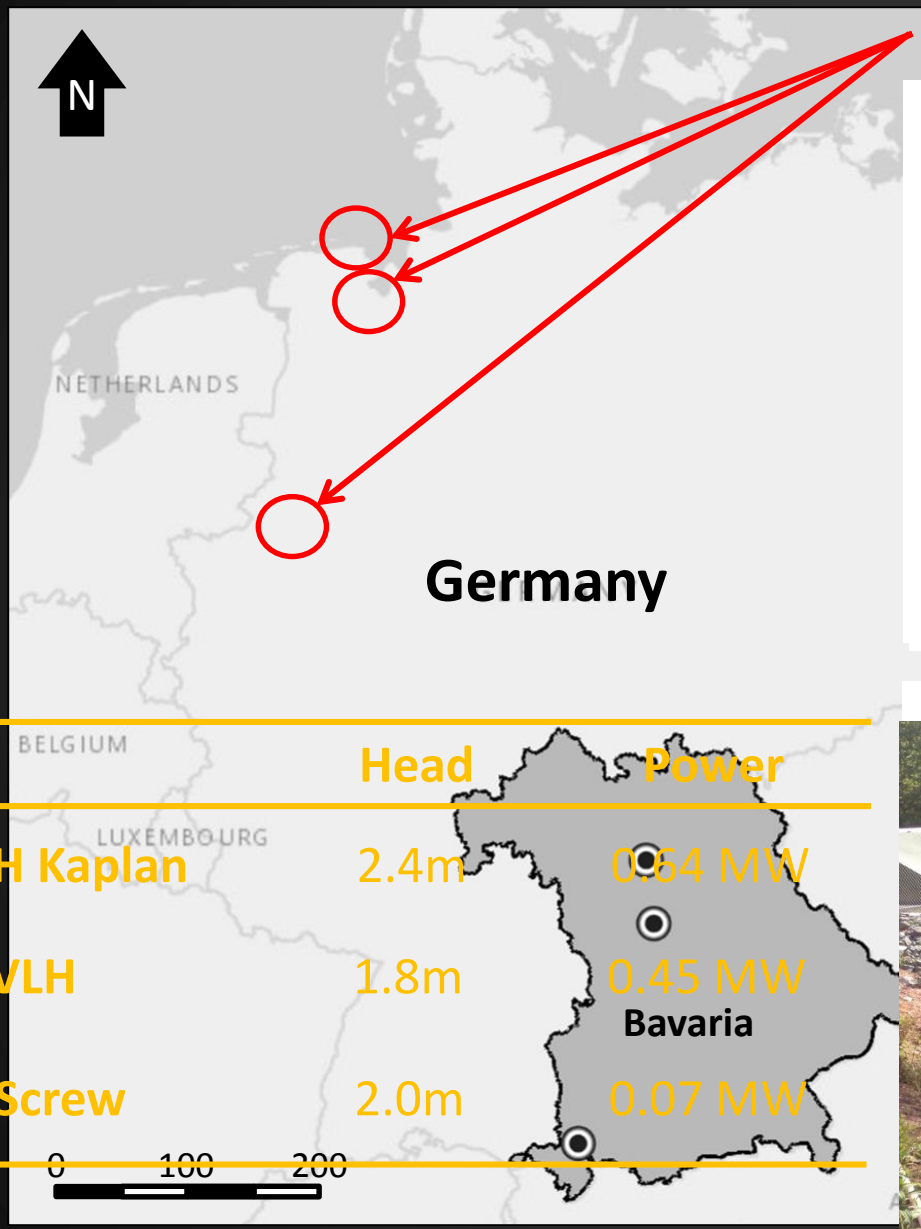
Pressure?

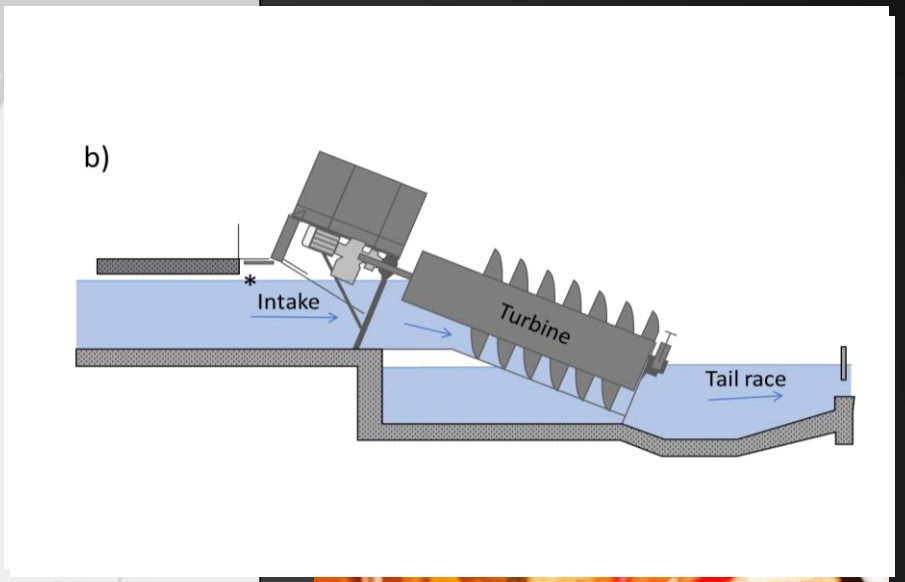


Shear?

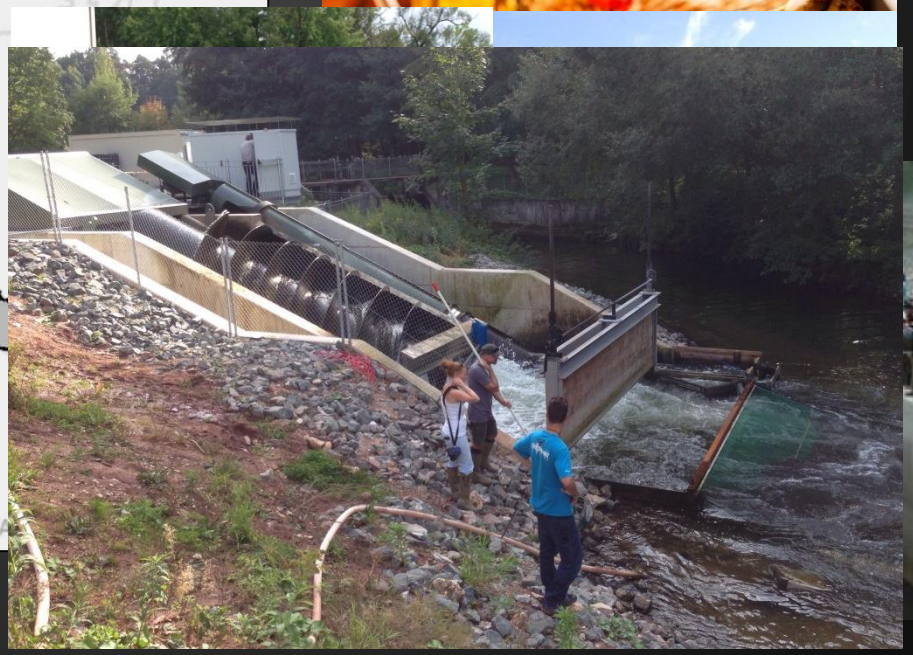
Strike?

Horizontal Kaplan turbine
VLH Turbine
Archimedes Screw





	Head	Power
H Kaplan	2.4m	0.64 MW
VLH	1.8m	0.45 MW
Screw	2.0m	0.07 MW

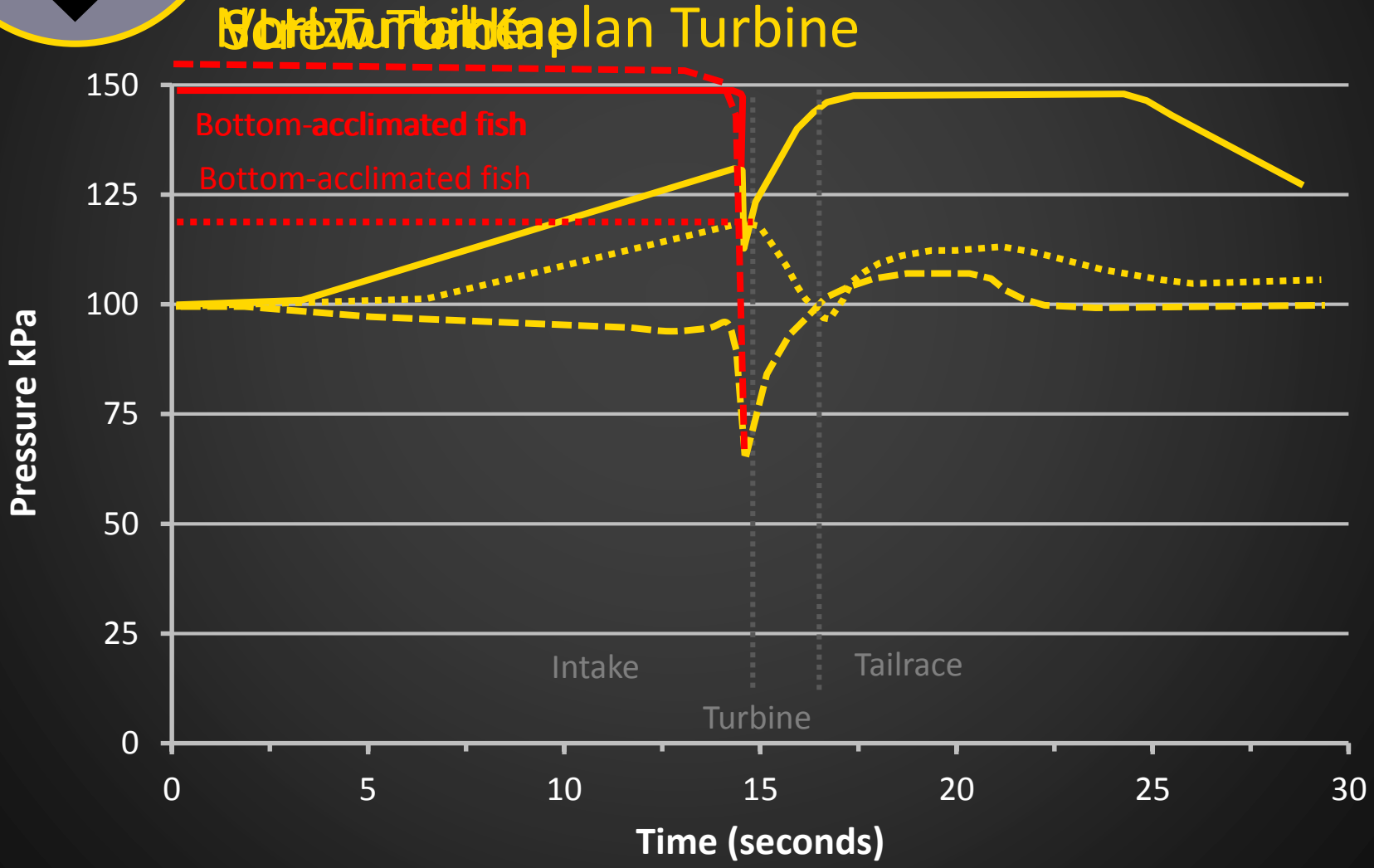


Sensor Fish

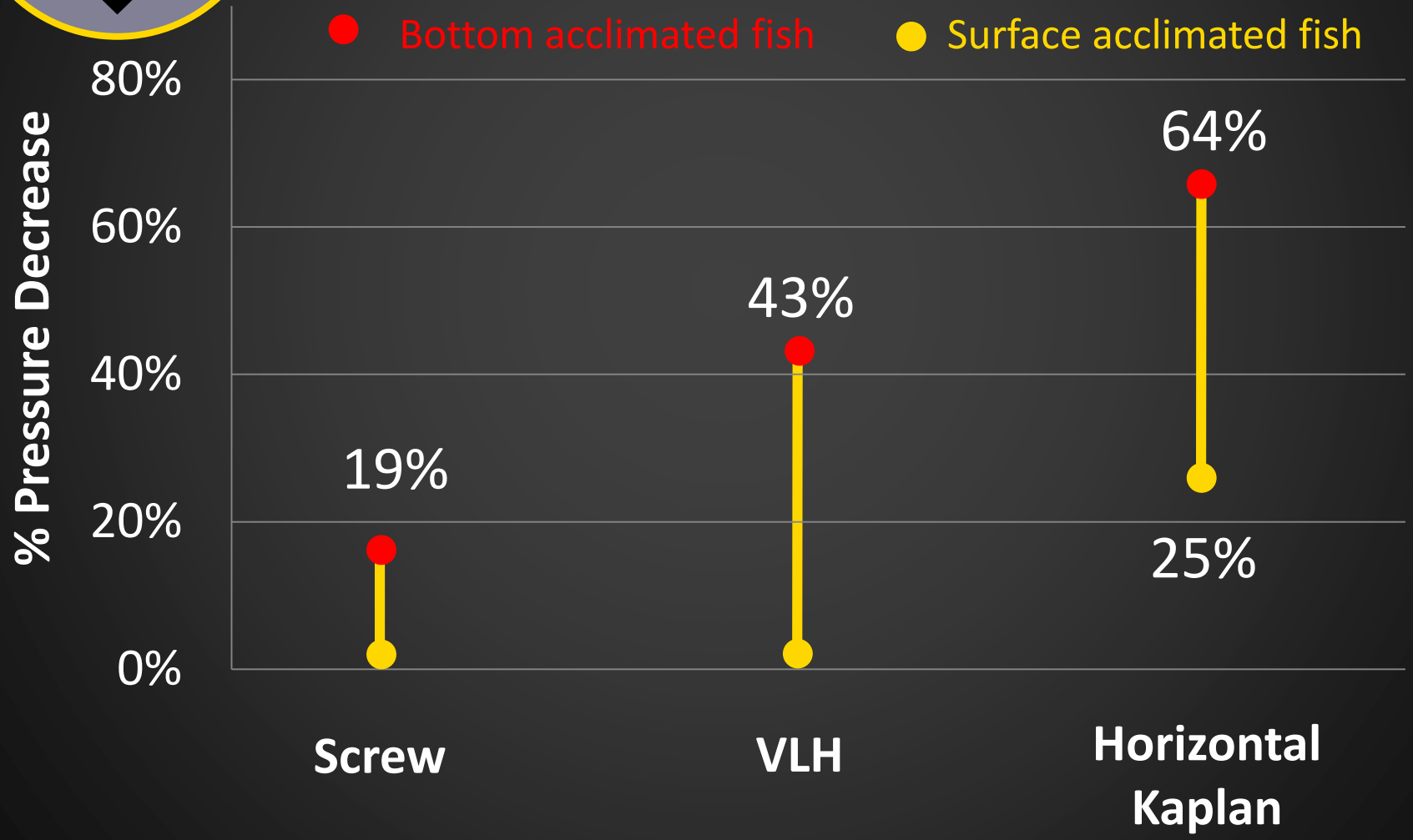
4 separate releases

82 retrieved with data

Pressure

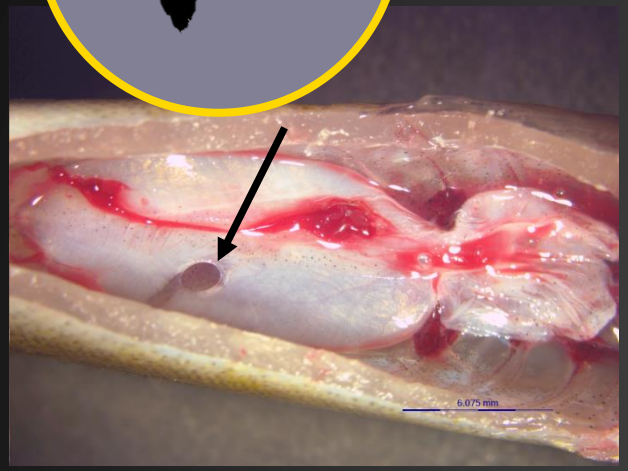

Kaplan Turbine
Bottom-acclimated fish
Bottom-acclimated fish
Pressure kPa
150
125
100
75
50
25
0
Intake
Turbine
Tailrace
0
5
10
15
20
25
30
Time (seconds)

Pressure (based on worst case nadir)

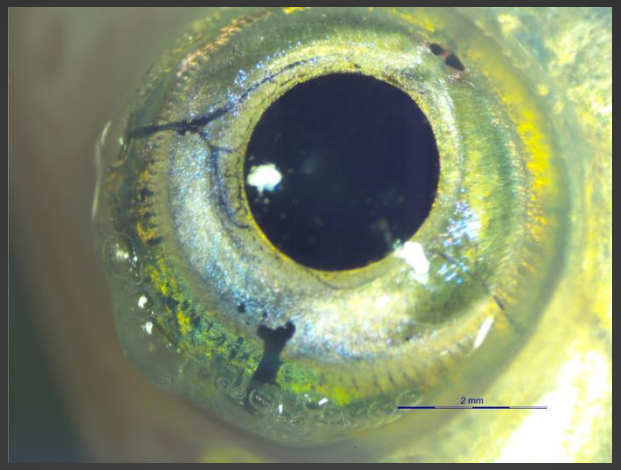


Injury Estimates

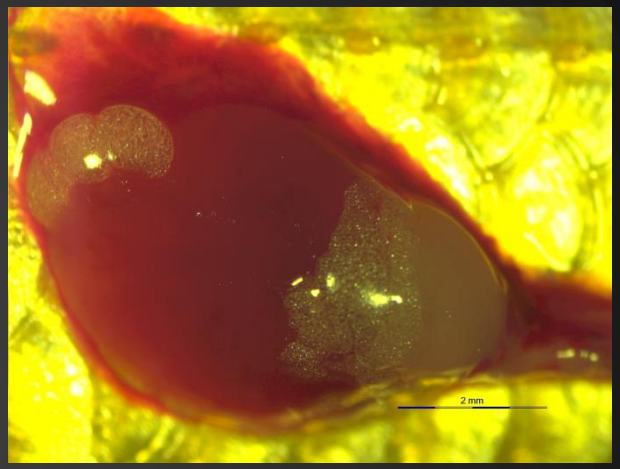
Barotrauma



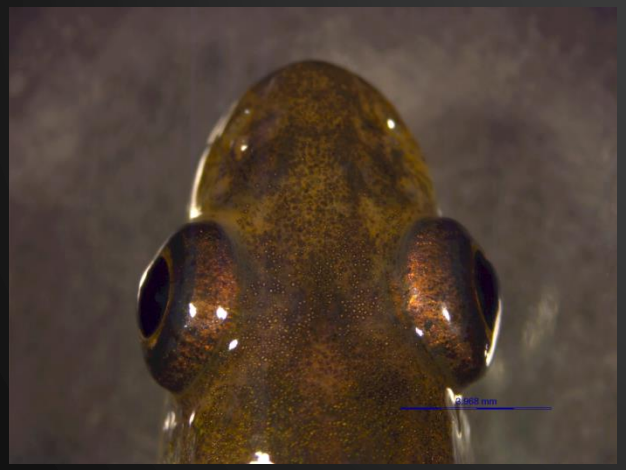
Swim bladder rupture



Eye haemorrhage & emphysema

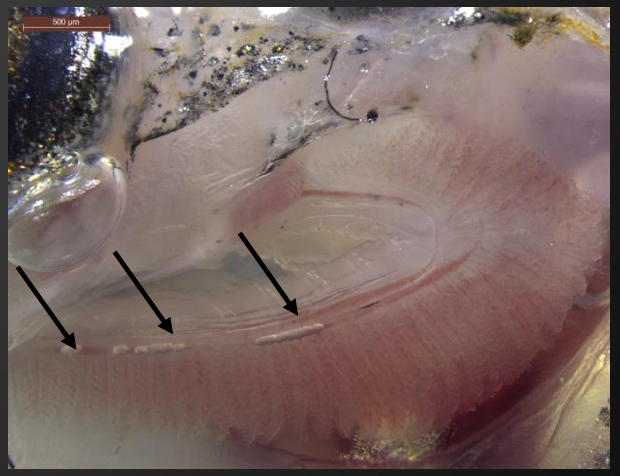


Heart haemor & emphysema



Exophthalmia

Fin haemorrhage & emphysema



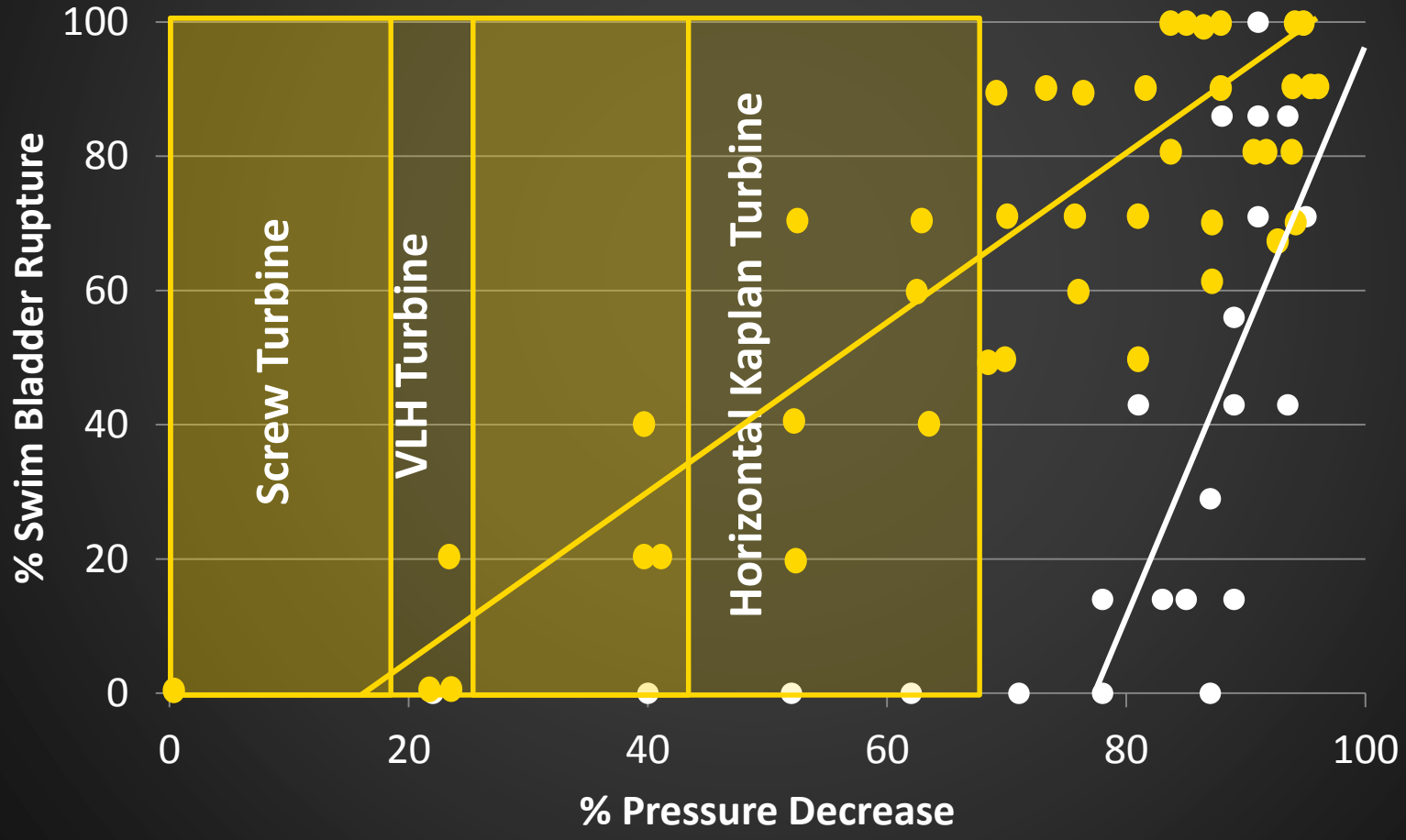
Gill haemor & emphysema

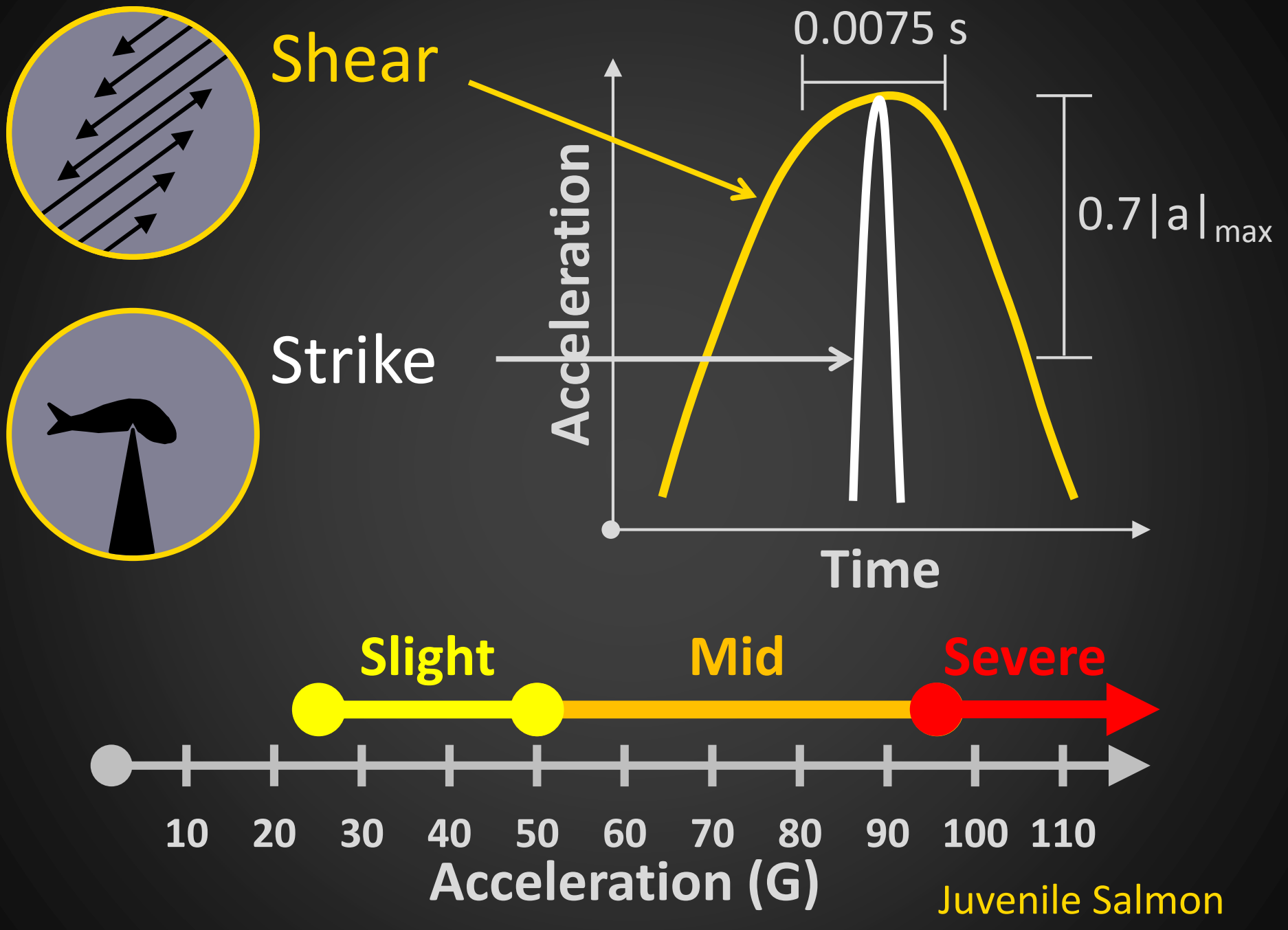
Injury Estimates

Barotrauma

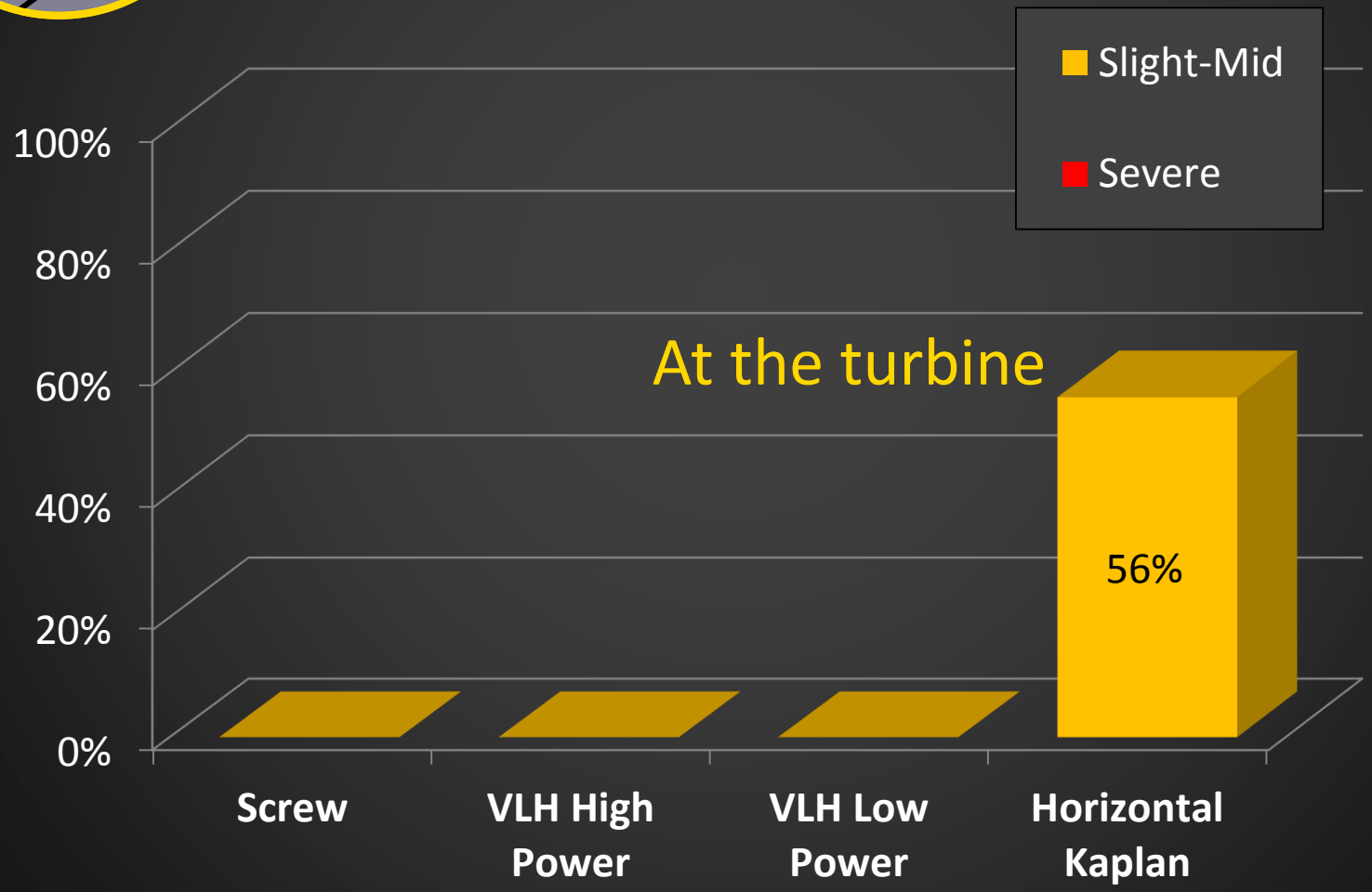
Juvenile Murray Cod

Juvenile Silver Perch



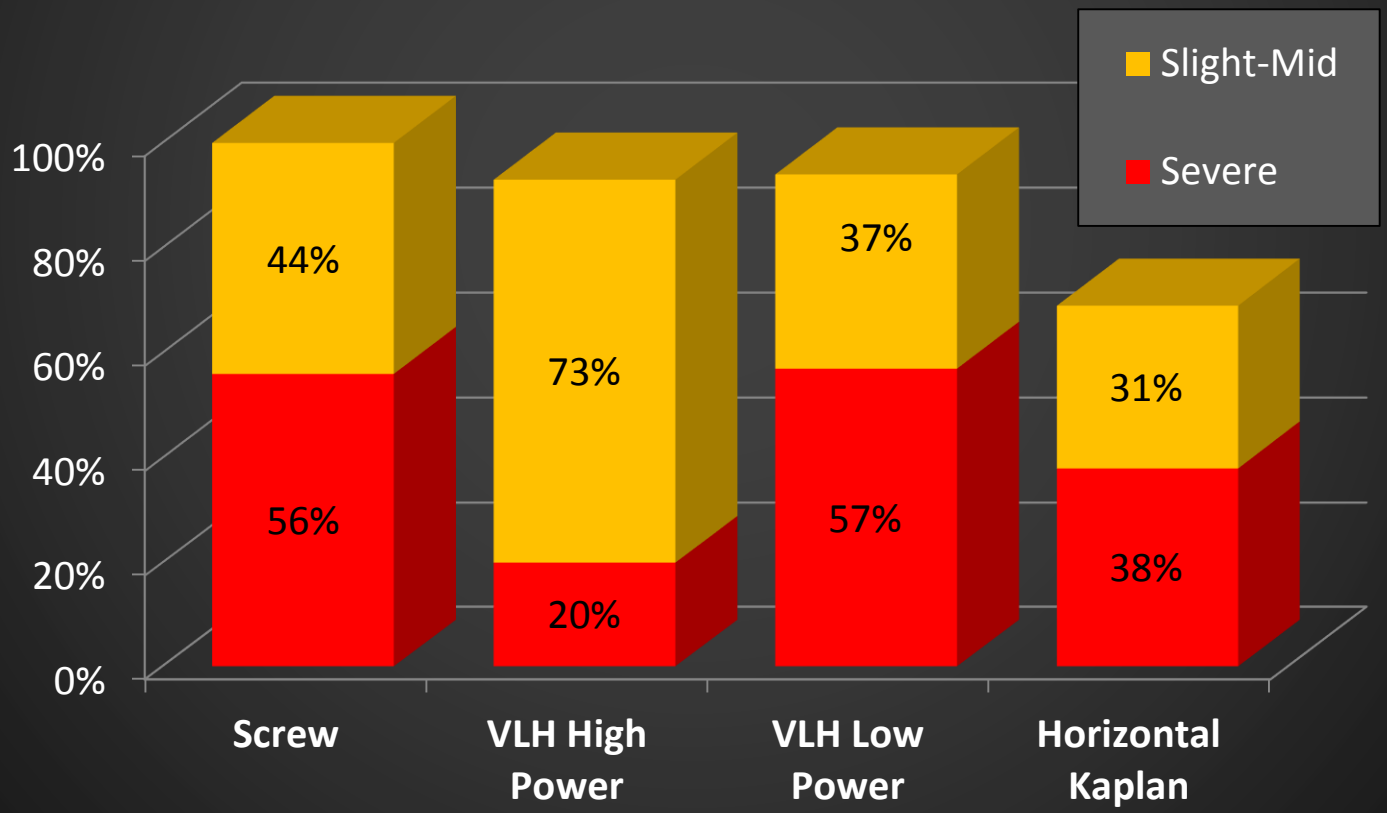

Shear
Strike
0.0075 s
0.7|a|max
Acceleration
Time
Slight
Mid
Severe
10
20
30
40
50
60
70
80
90
100
110
Acceleration (G)
Juvenile Salmon

Shear


Slight-Mid
Severe
100%
80%
60%
40%
20%
0%
At the turbine
56%
Screw
VLH High Power
VLH Low Power
Horizontal Kaplan

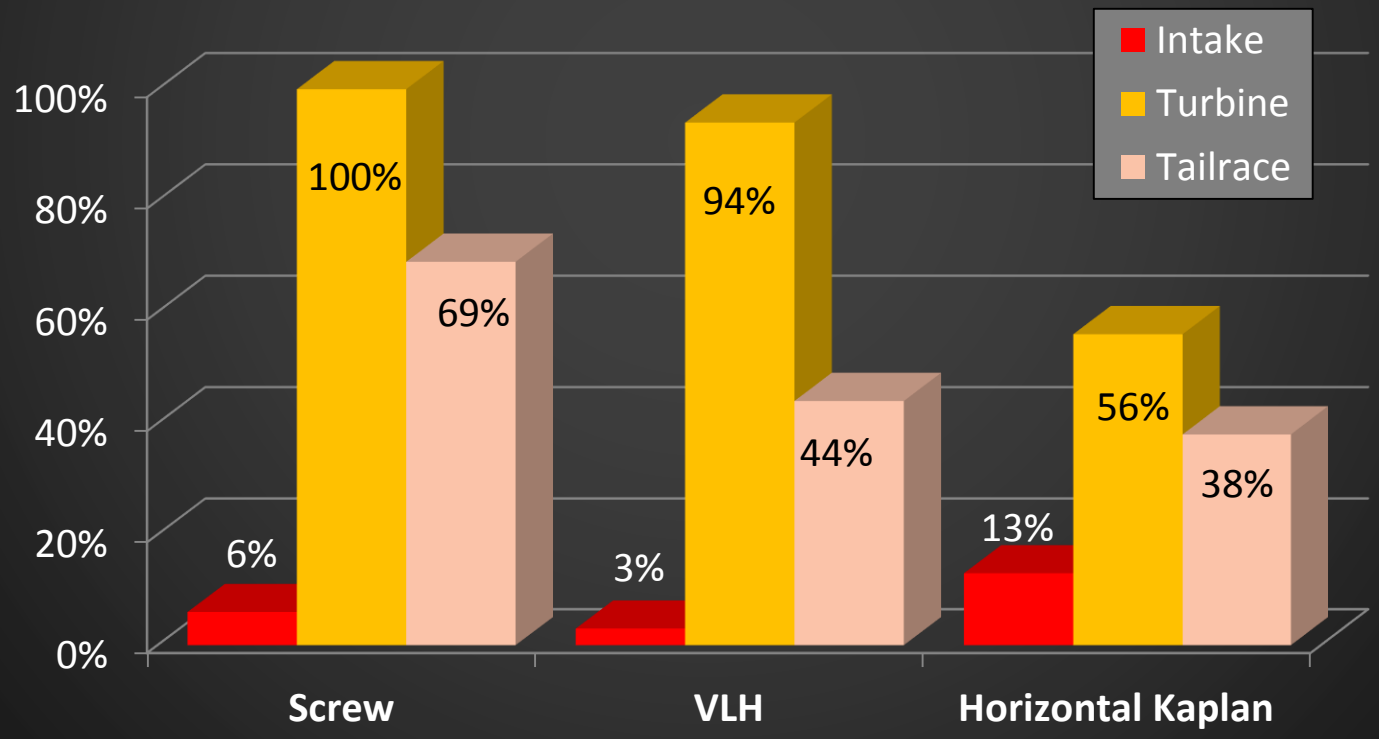
Strike

(% fish passes experiencing strike)



Strike

(% fish passes experiencing strike by location)

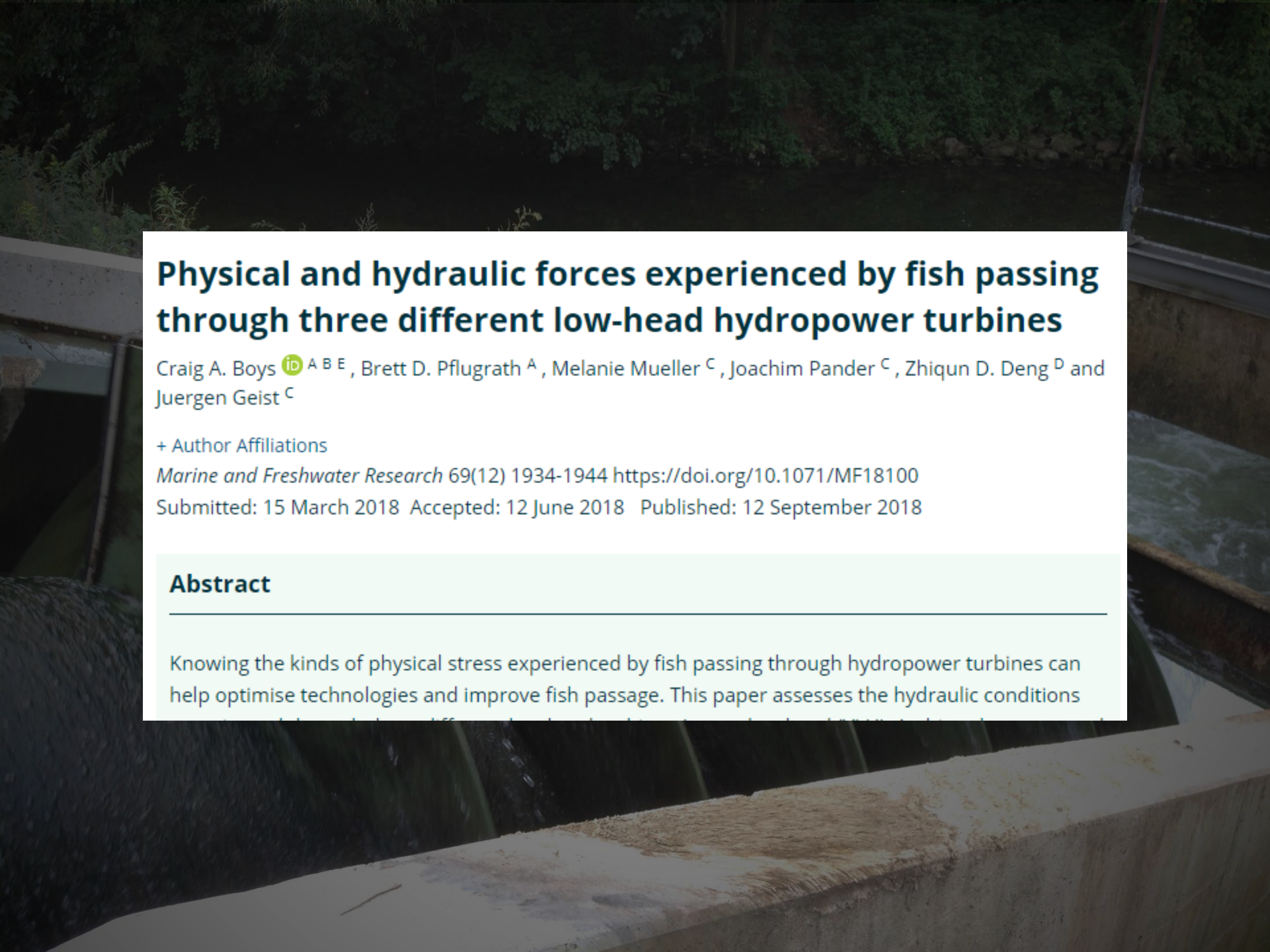


Discussion

- Low-head hydro not without its risks
- Type of turbine and how its operated can influence stressors faced by fish
- Decompression of the degree to cause significant barotrauma more likely at HK
- Shear can also occur at HK at blades (albeit slight to mild)
- Strike was common at all turbines, most frequent and severe at turbine followed by tailrace
    - Lower power VLH can result in worse strike

More work is underway or planned

- Sensor Fish at additional novel small hydro turbines
- Live fish mortality trials have been completed
- Associate hydraulic data with mortality estimates
- Determine critical thresholds for European species in the laboratory



Physical and hydraulic forces experienced by fish passing through three different low-head hydropower turbines

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Abstract

Knowing the kinds of physical stress experienced by fish passing through hydropower turbines can help optimise technologies and improve fish passage. This paper assesses the hydraulic conditions

Next Generation Sensor Fish Mini

1st Generation Sensor Frog

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