

**Evaluation and comparison of the fish  
friendliness of two fish friendly axial flow  
pumps: Pentair Nijhuis pump vs. the newly  
developed Van Hooste pump**

**Stijn Bruneel, Sarah Broos, Kaat Thienpont, Ine  
Pauwels, Lore Vandamme, Jeroen Van Wichelen,  
Pieterjan Verhelst, Johan Coeck, Gert Toming,  
Jeffrey Tuhtan, David Buysse**

**[stijn.bruneel@inbo.be](mailto:stijn.bruneel@inbo.be)**

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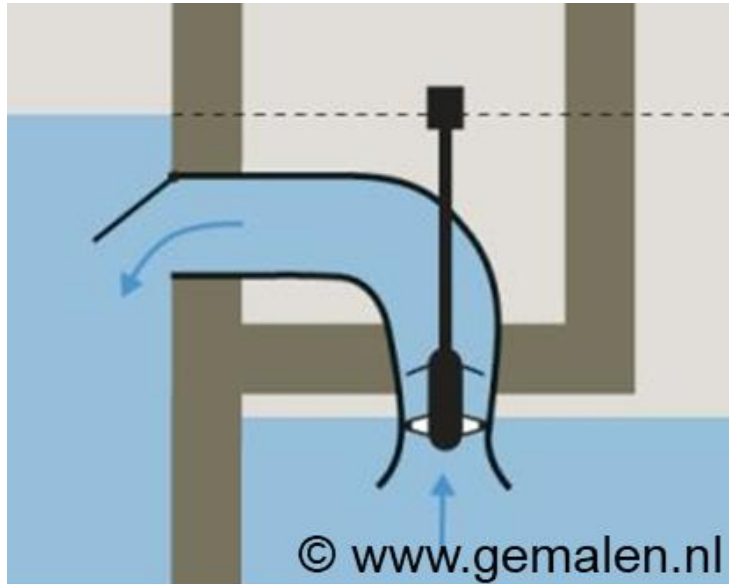
**TAL  
TECH**

Veendam, 12/2/2025

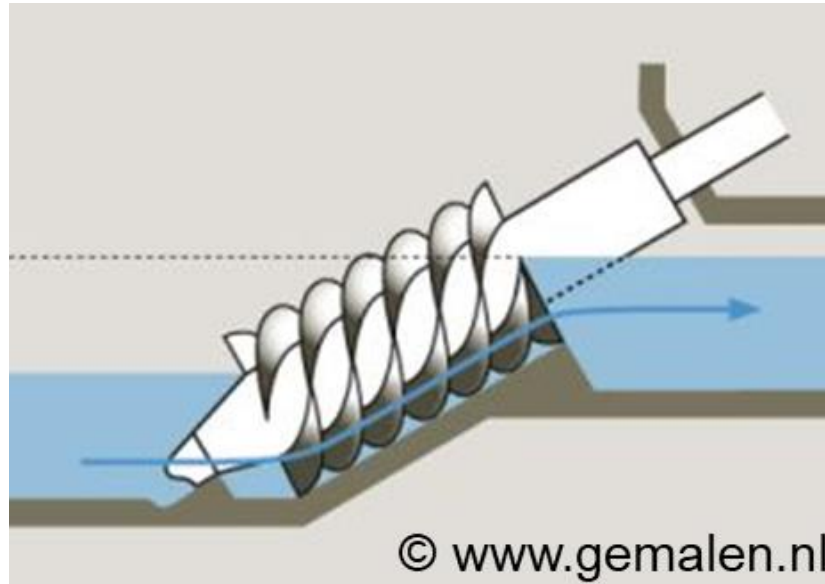


# Pumps aim to quickly move water against gravity

Axial flow pump



Archimedean screw pump



Centrifugal pump



Agriculture



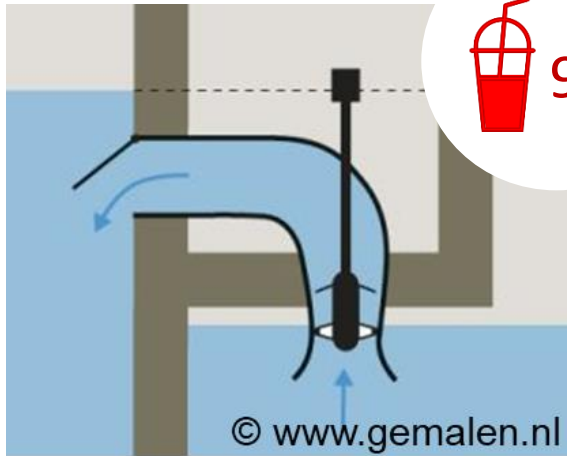
Waste & drink water



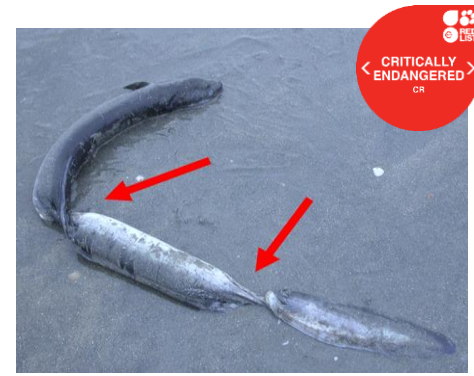
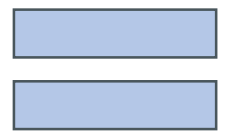
Water level control



# Pumps are fish mixers



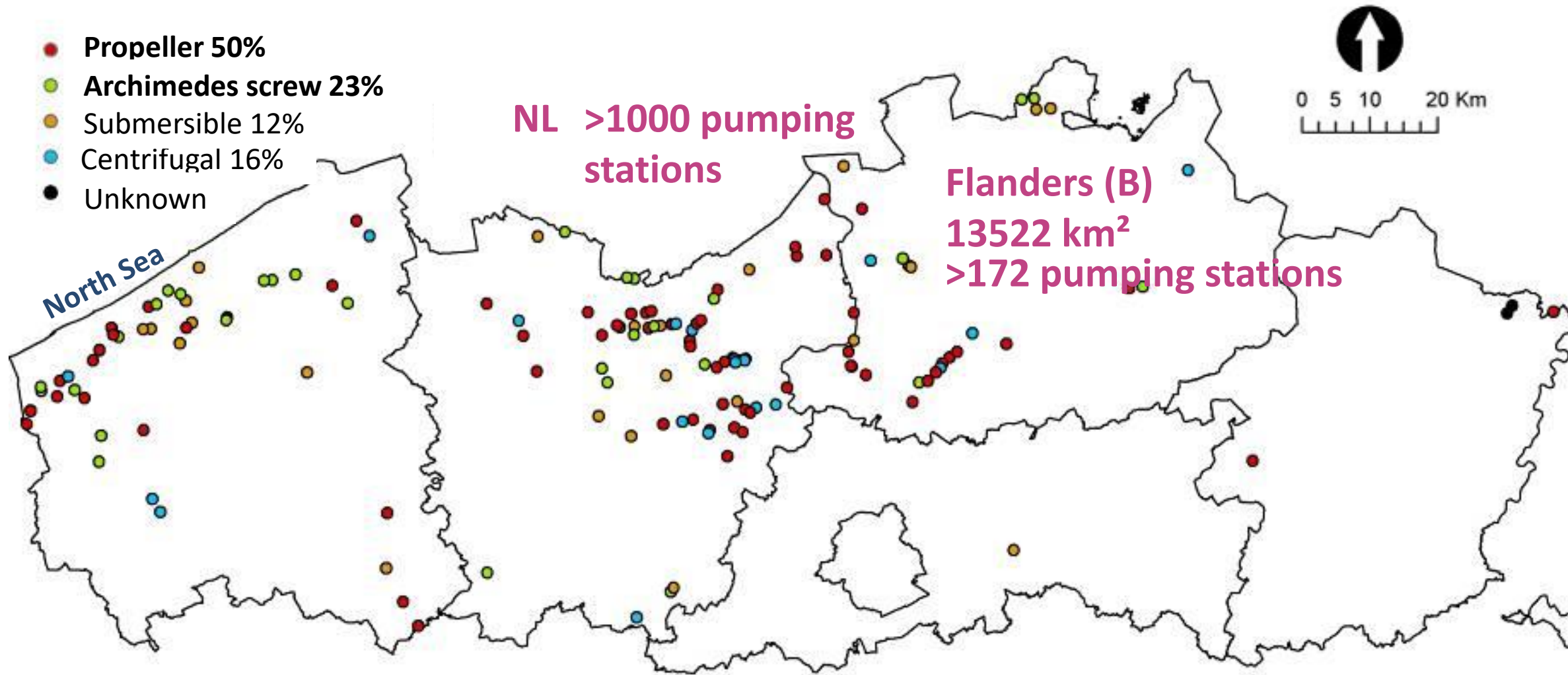
 97%



Buysse et al. 2014

Bruneel et al. 2024

# Pumping stations in Flanders (Belgium)



# Increase in pump use due to climate change

## Rising sea levels

- Challenge: Gravity-driven drainage is becoming less effective.
  - Increased reliance on pumps to move water and prevent flooding.

## Intensified rainfall & flooding

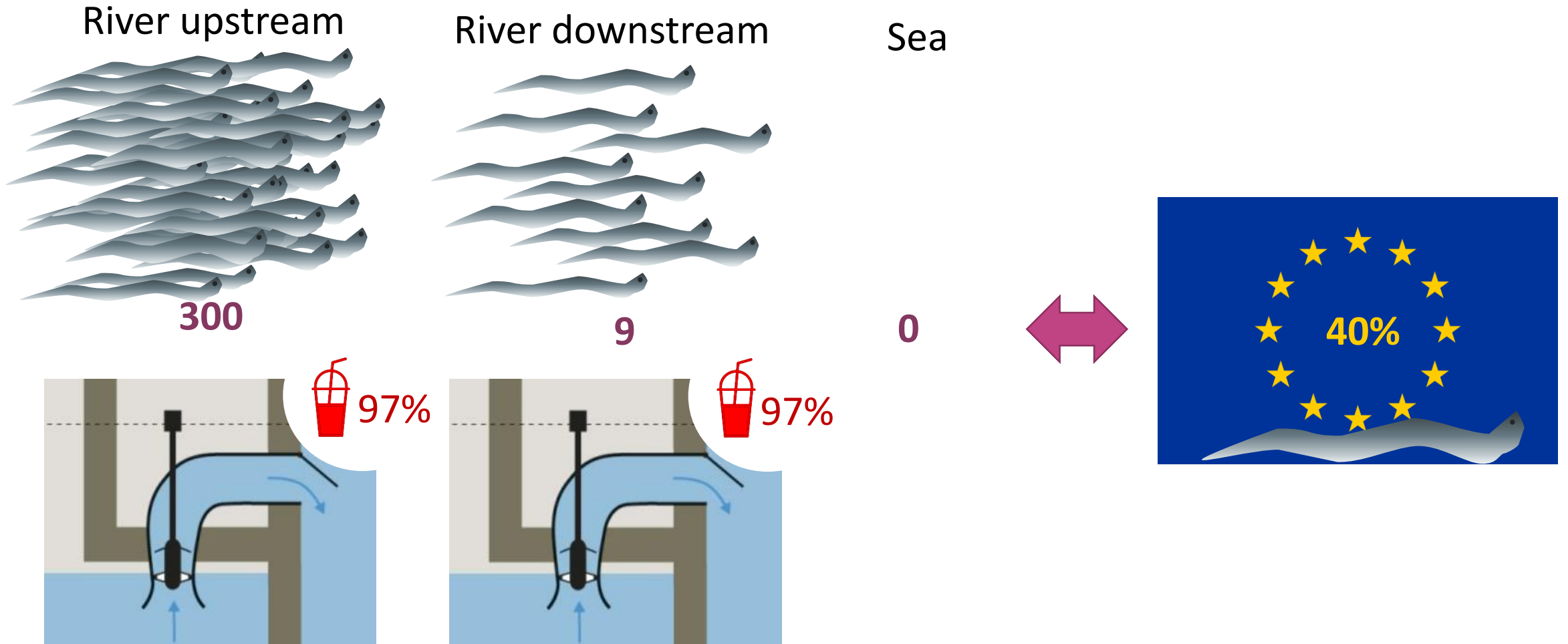
- Challenge: Heavy rainfall events overwhelm drainage systems.
  - Rapid water evacuation using high-capacity pumps.

## Severe drought & water scarcity

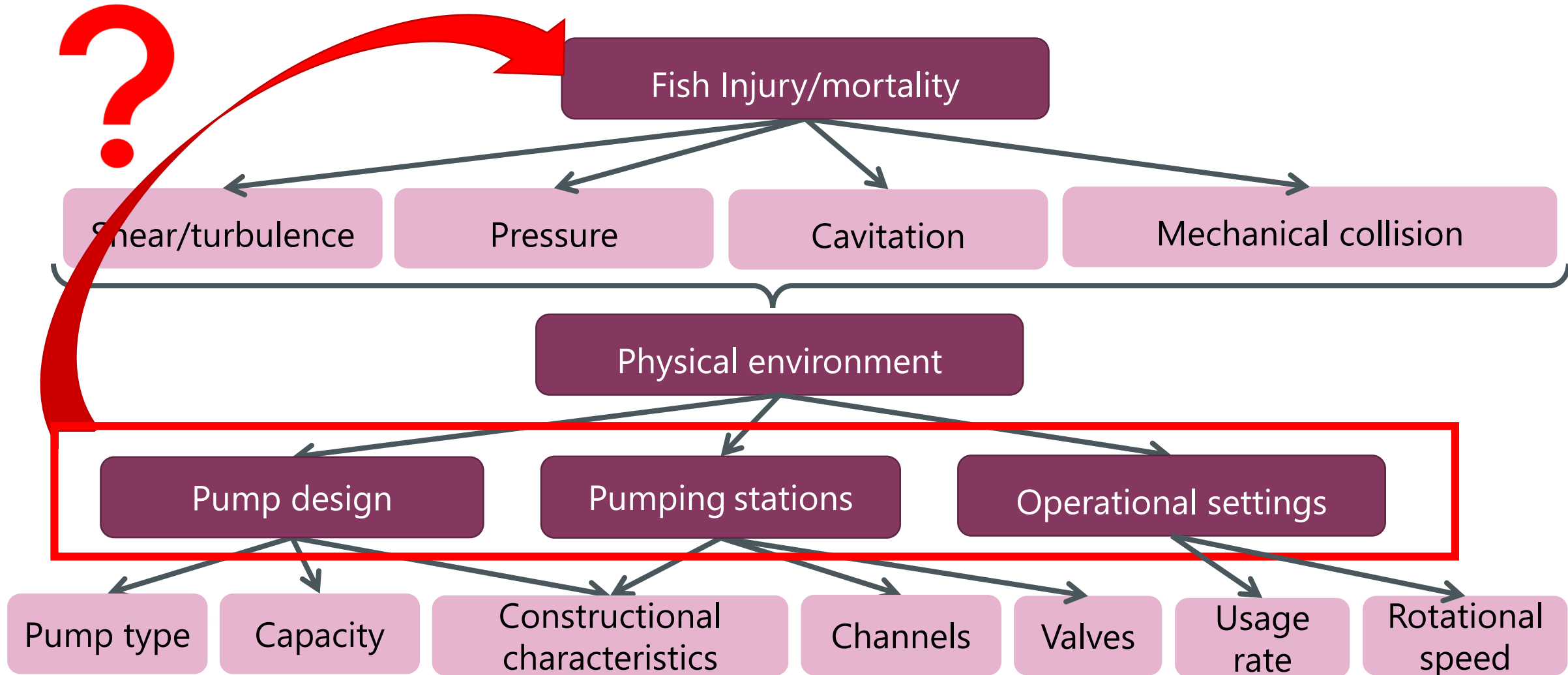
- Challenge: Lower river levels impact navigation and water availability.
  - Pumping systems at locks and reservoirs to manage water distribution.



# Fish mixers vs EU eel regulation



# Factors that influence the fish safety



# Methodology

## Live fish tests

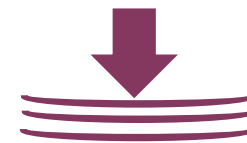


- At least 100 individuals per scenario
- Control: at least 50 fish per scenario
- Forced passages
- Adapted from Dutch standard (NEN)

## Passive sensors (BDS)



- Measures physical environment



Pressure



Acceleration



Rotation

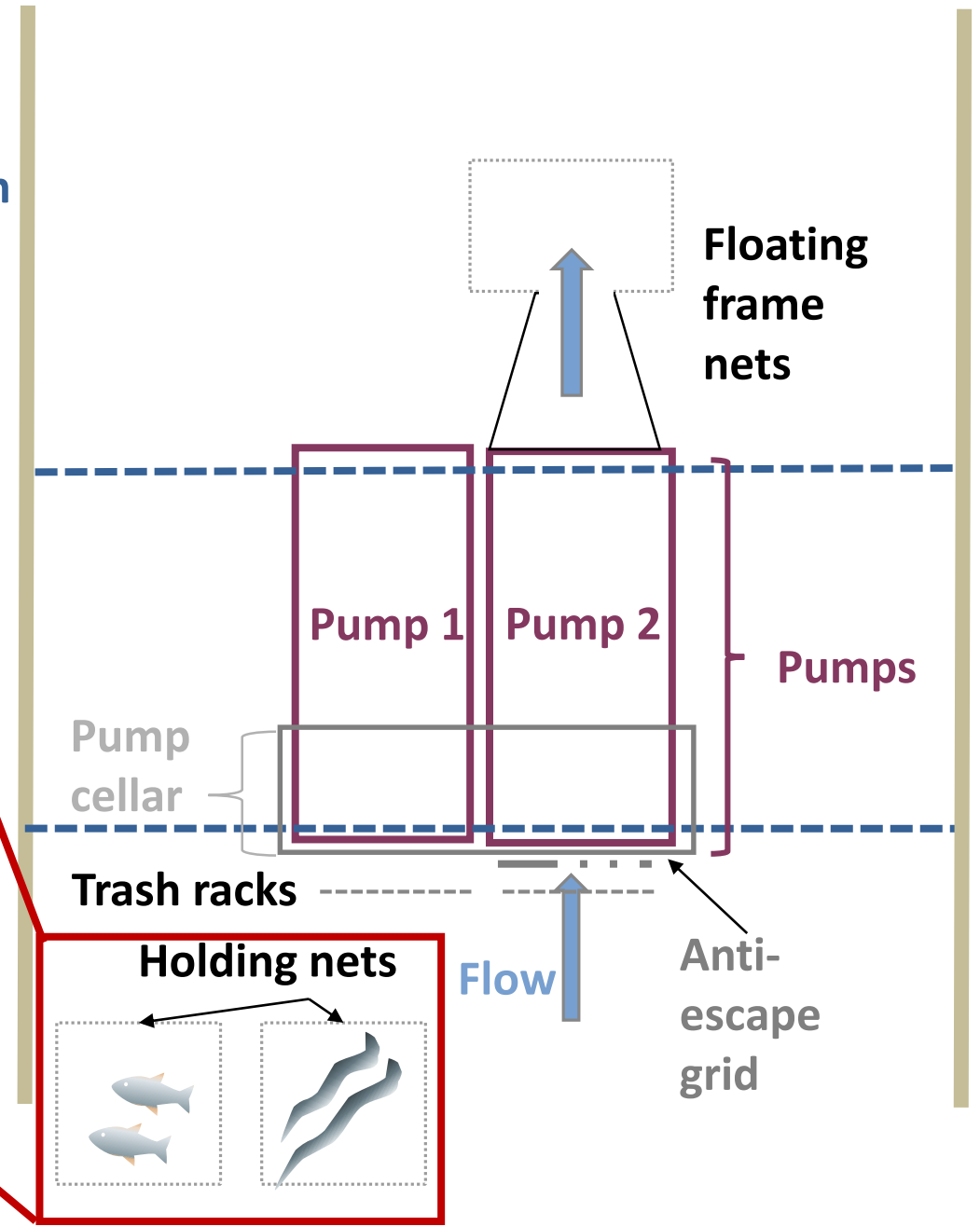


# Experimental setup: Acclimatization



Downstream

Upstream

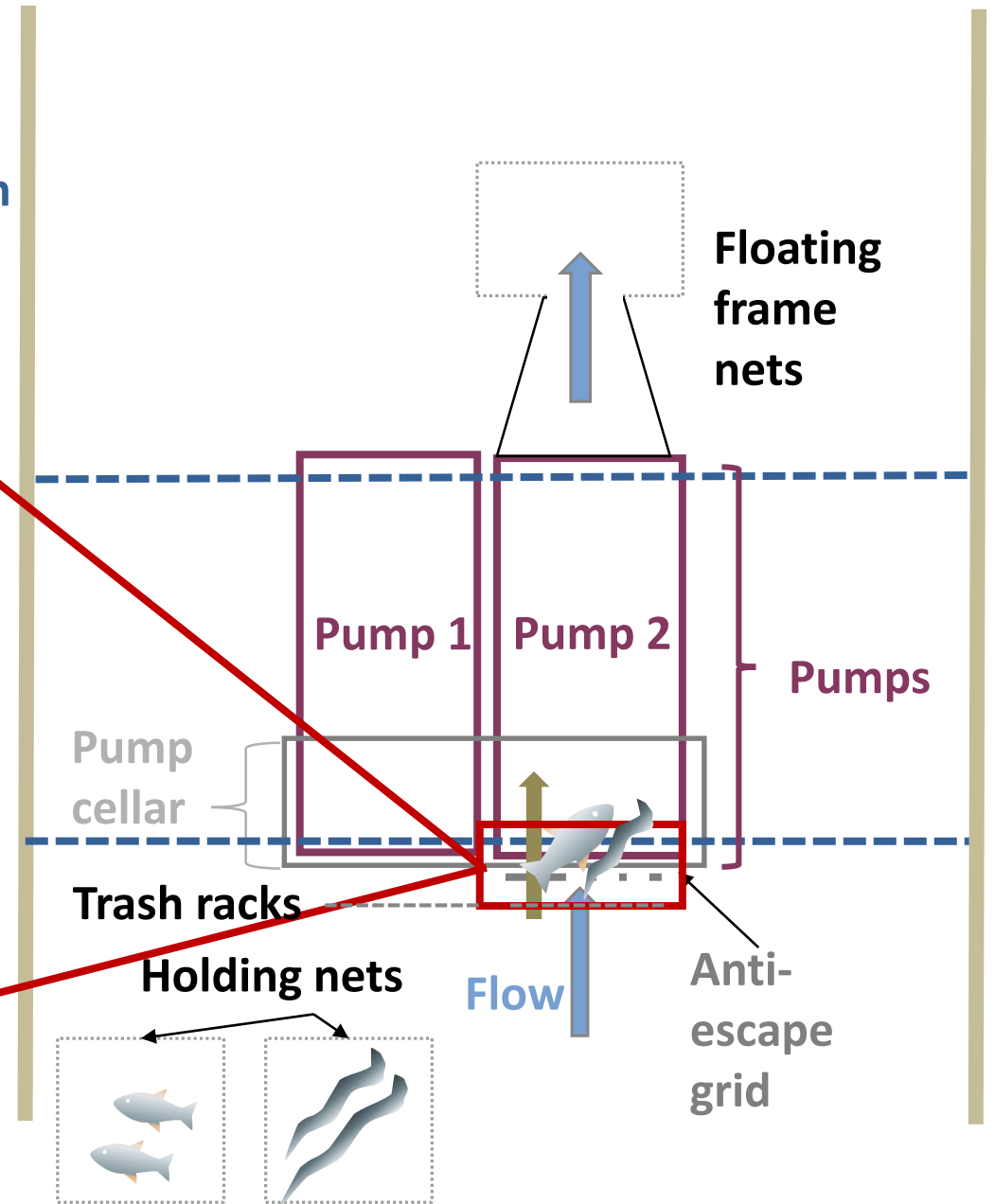
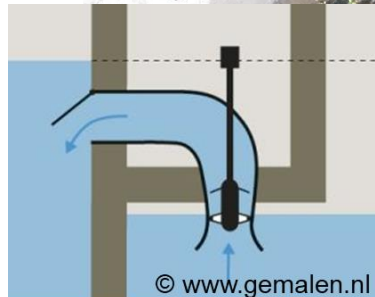


# Experimental setup: Input: pump passage



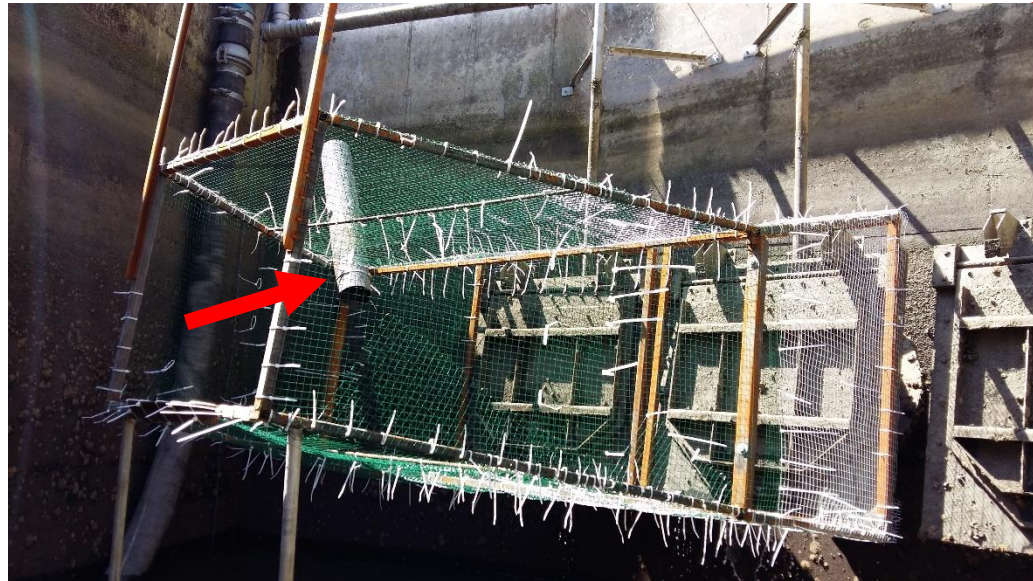
Downstream

Upstream



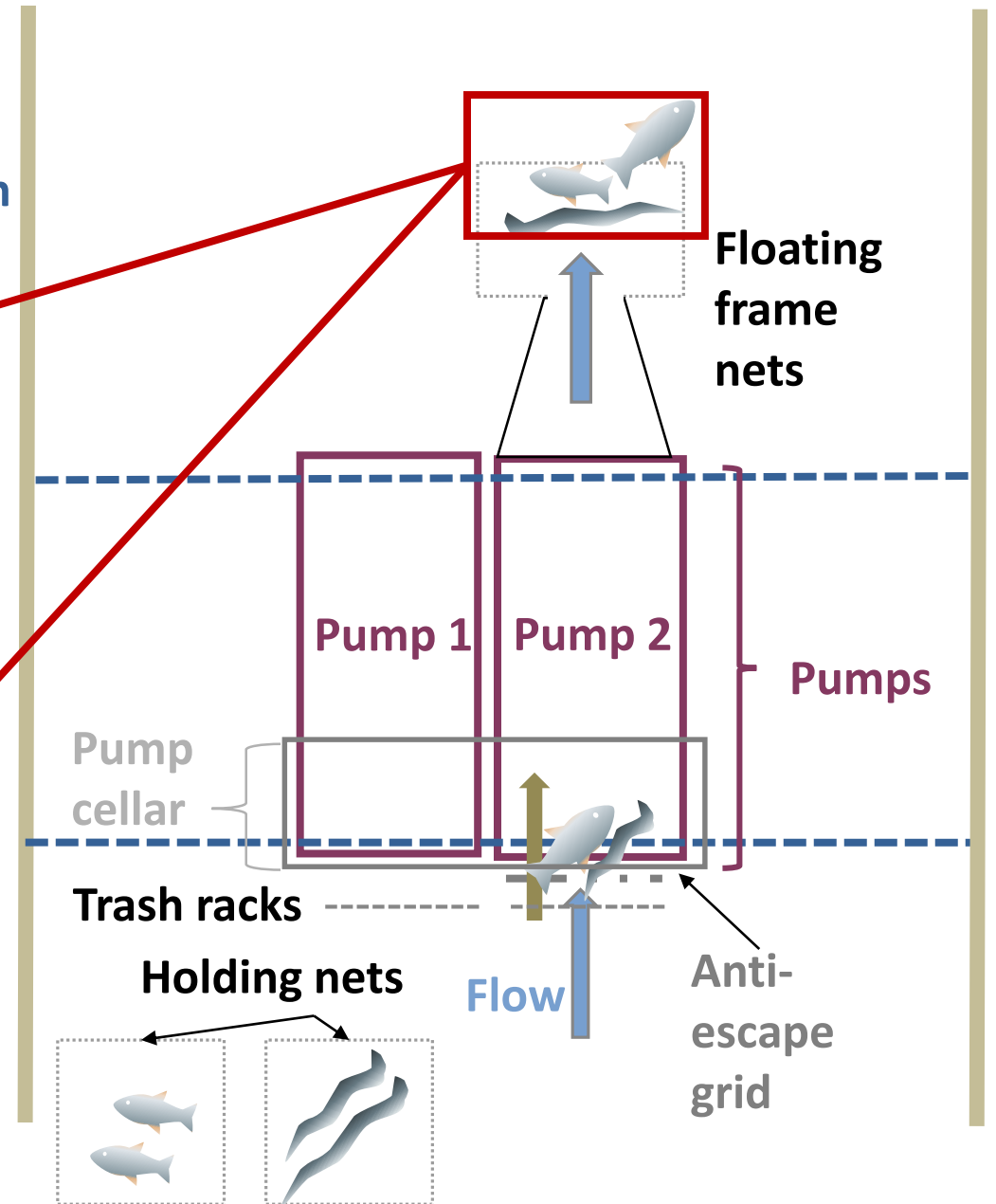
# Experimental setup:

## Input: control



Downstream

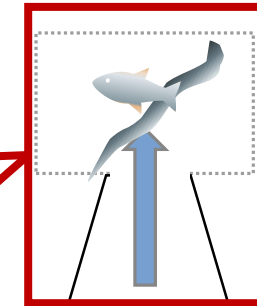
Upstream



# Experimental setup: Output: pump passage



Downstream



Floating  
frame  
nets

Pump 1

Pump 2

Pumps

Pump  
cellar

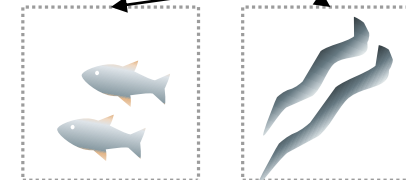
Trash racks

Holding nets

Flow

Anti-  
escape  
grid

Upstream



# 2 fish-friendly axial flow pumping stations

Pentair Fairbanks Nijhuis



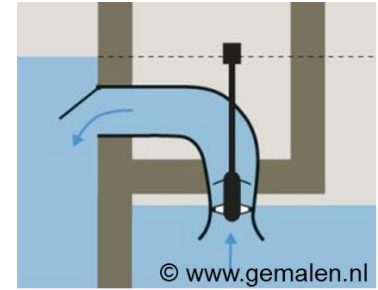
Van Hooste



## A fish-friendly axial flow pump turns out to be eel safe, roach unfriendly and bream unsafe

[Stijn Bruneel](#) , [Ine S. Pauwels](#), [Sarah Broos](#), [Lore Vandamme](#), [Jeroen Van Wichelen](#), [Johan Coeck](#), [Gert Toming](#), [Jeffrey A. Tuhtan](#) & [David Buysse](#)

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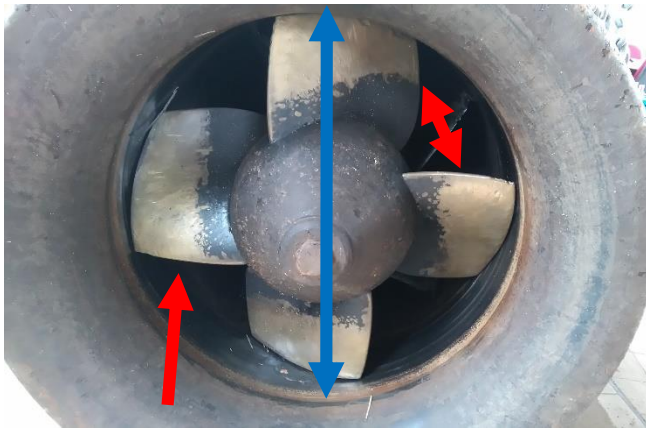


# Fish-friendly axial flow pumps?

## Devils Hole



## Classic axial flow pump



- Fixed speed
- 4 blades = less spaces
- Same diameter

## Pentair Fairbanks Nijhuis pump



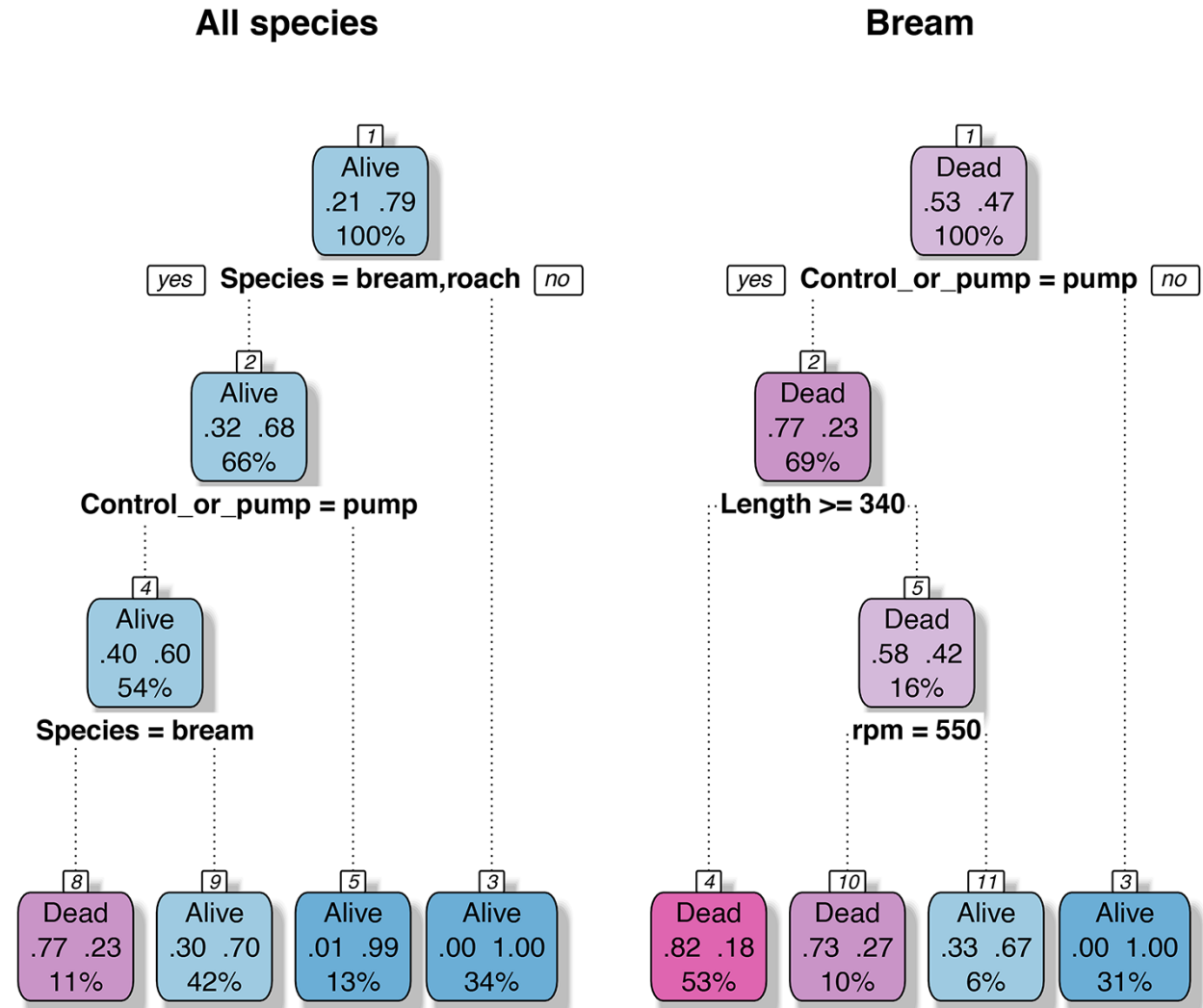
- Variable rotation speed
- Rounded blades
- 2 blades = more spaces
- Same diameter

Blade strike reduction?

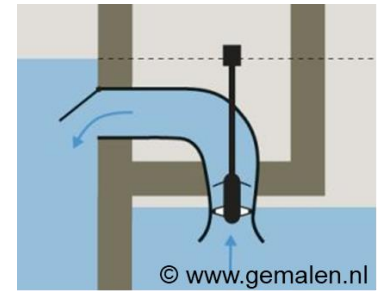
# Fish-friendly axial flow pumps?

## Passage through a fish-friendly Pentair Fairbanks Nijhuis pump

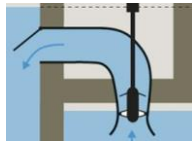
- If you are an eel or if you can avoid the pump itself, you are fine
- If you are a roach there is a decent change you won't survive and it becomes more dangerous at higher rpm and if you are quite large
- If you are a bream you will most likely die, especially if you are large and pass through at high rpm



# Eel safe axial flow pumps?



Pump type    rpm    control    (re)captured    mean length    mortality



97%



**Van Hooste Pump**

250

51

151

662

0 %



**Pentair Fairbanks**

468

50

256

633

0%

**Nijhuis pump**

550

50

267

631

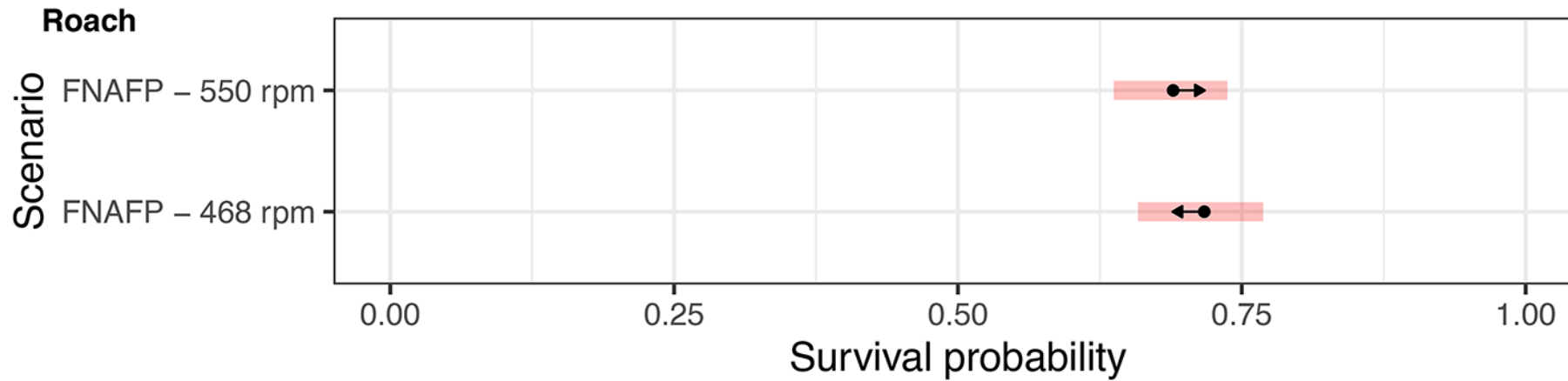
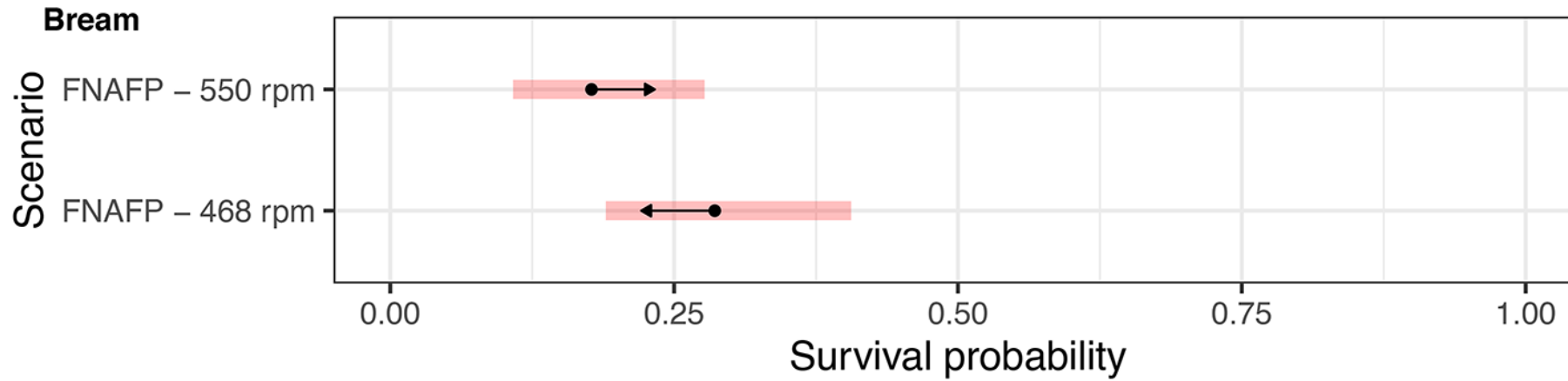
0%



**Pentair Fairbanks Nijhuis and Van Hooste pumps = eel safe**



# Fish-friendly axial flow pumps?

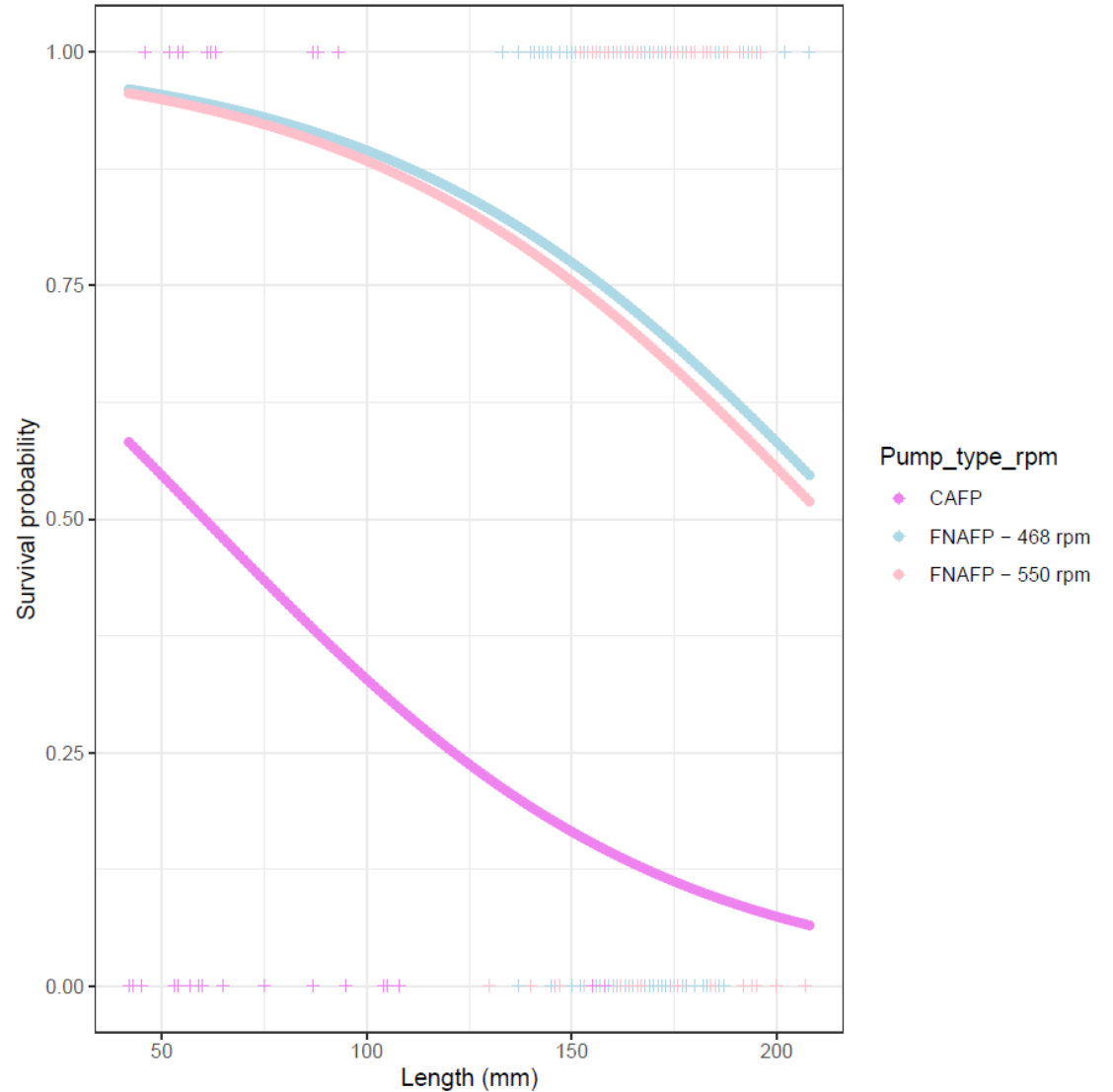


RPM is important

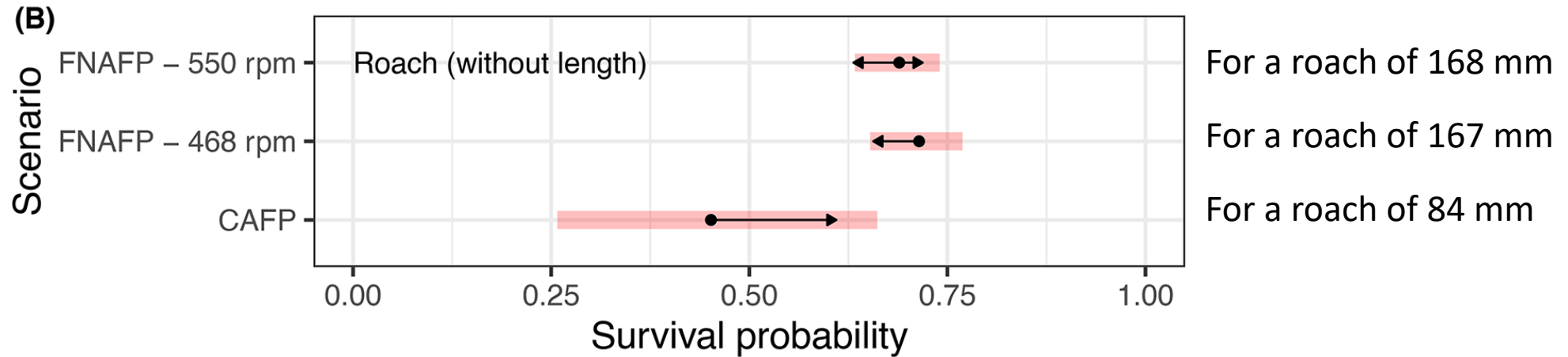
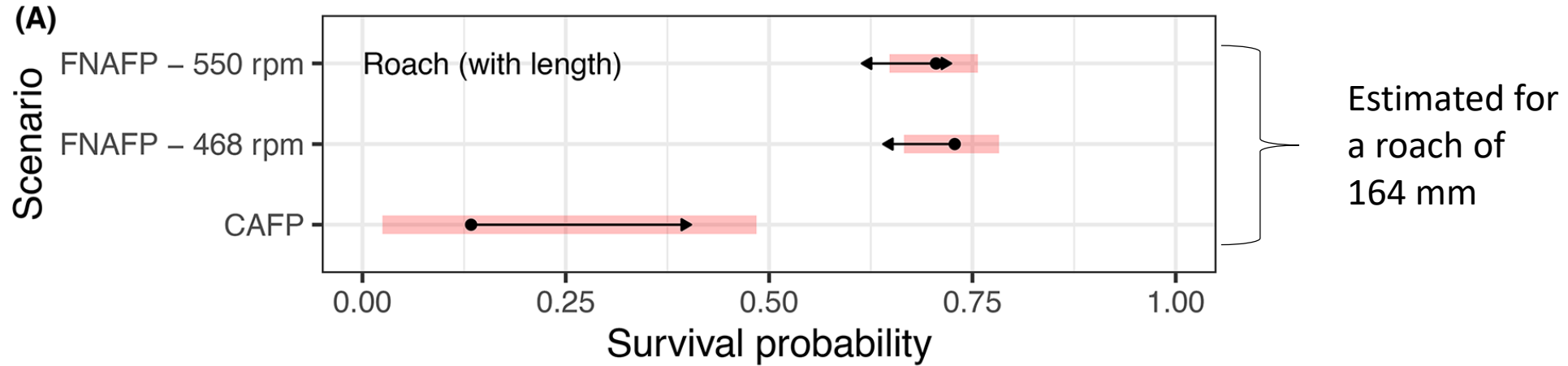
# Fish-friendly axial flow pumps?

Mortality of roach in function of fish length

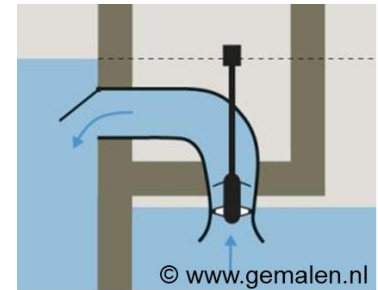
Larger fish -> higher mortality



# Fish-friendly axial flow pumps?



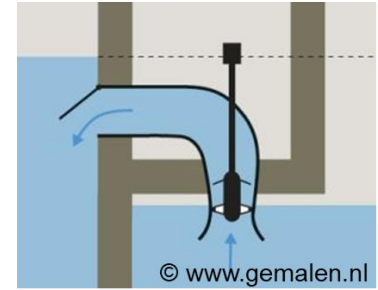
# Roach safe axial flow pumps?

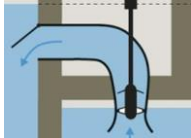







Pump type	rpm	Control	(re)captured	mean length (mm)	mortality
Traditional axial flow pump	585	/	33	84	<b>55%</b> (87% estimated if 164 mm)
Pentair Fairbanks	468	97	343	167	<b>28%</b>
Nijhuis pump	550	82	428	168	<b>30%</b>

**Pentair Fairbanks Nijhuis = roach unfriendly**

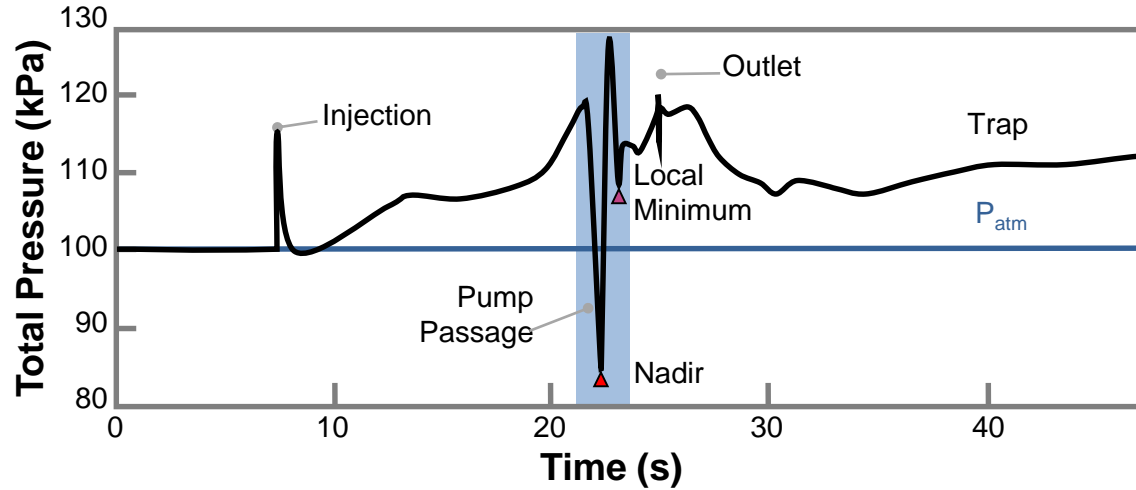
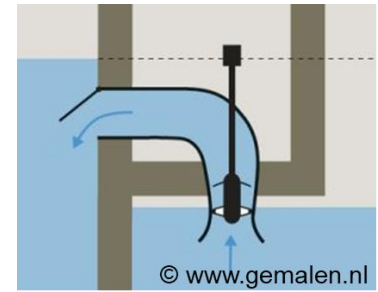
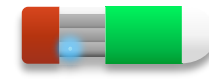
# Bream safe axial flow pumps?



Pump type	rpm	Control	(re)captured	mean length (mm)	mortality
					
<b>Pentair Fairbanks</b>	468	50	97	380	<b>73%</b>
<b>Nijhuis pump</b>	550	44	109	369	<b>85%</b>

**Pentair Fairbanks Nijhuis pump = bream unsafe**

# Fish friendly axial flow pumps?



Barotrauma risk high if:

Pressure



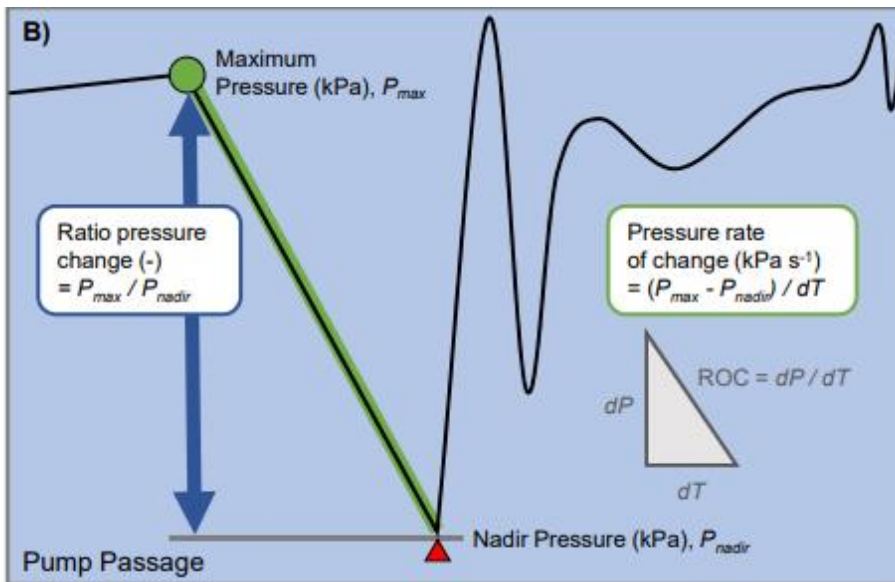
Nadir = low



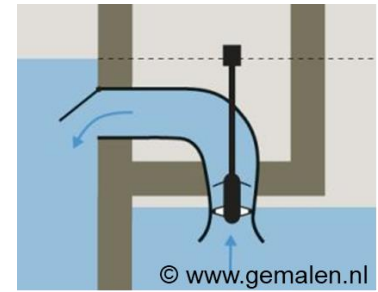
Log Ratio = high



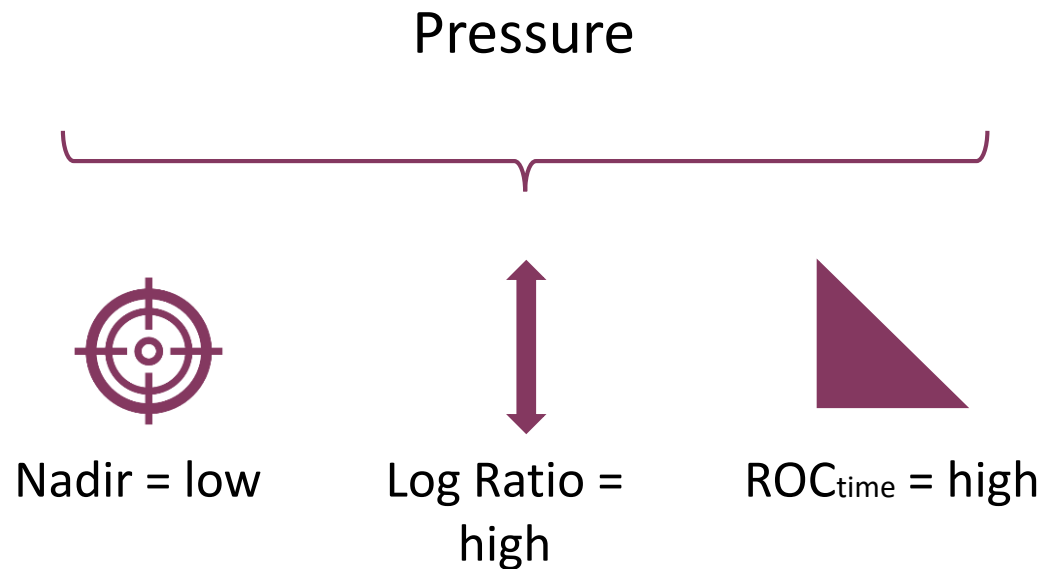
ROC<sub>time</sub> = high



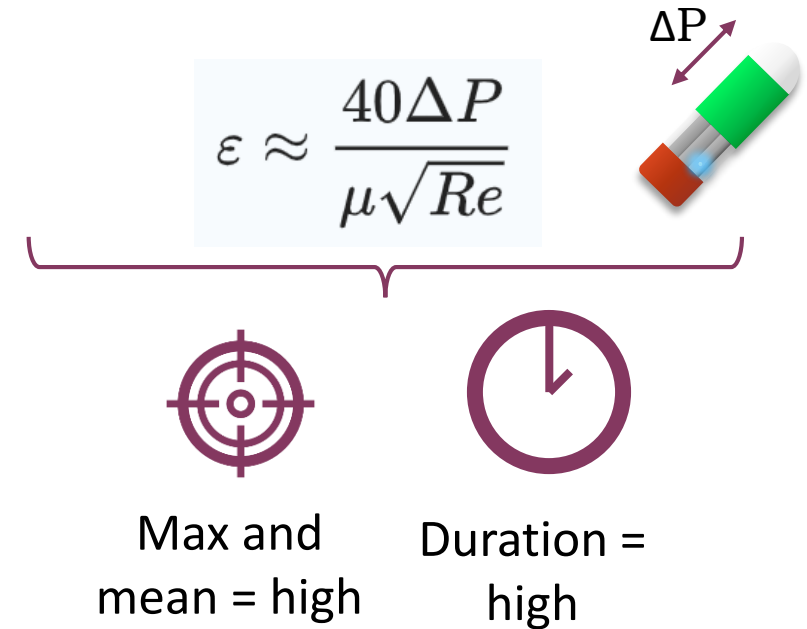
# Fish friendly axial flow pumps?



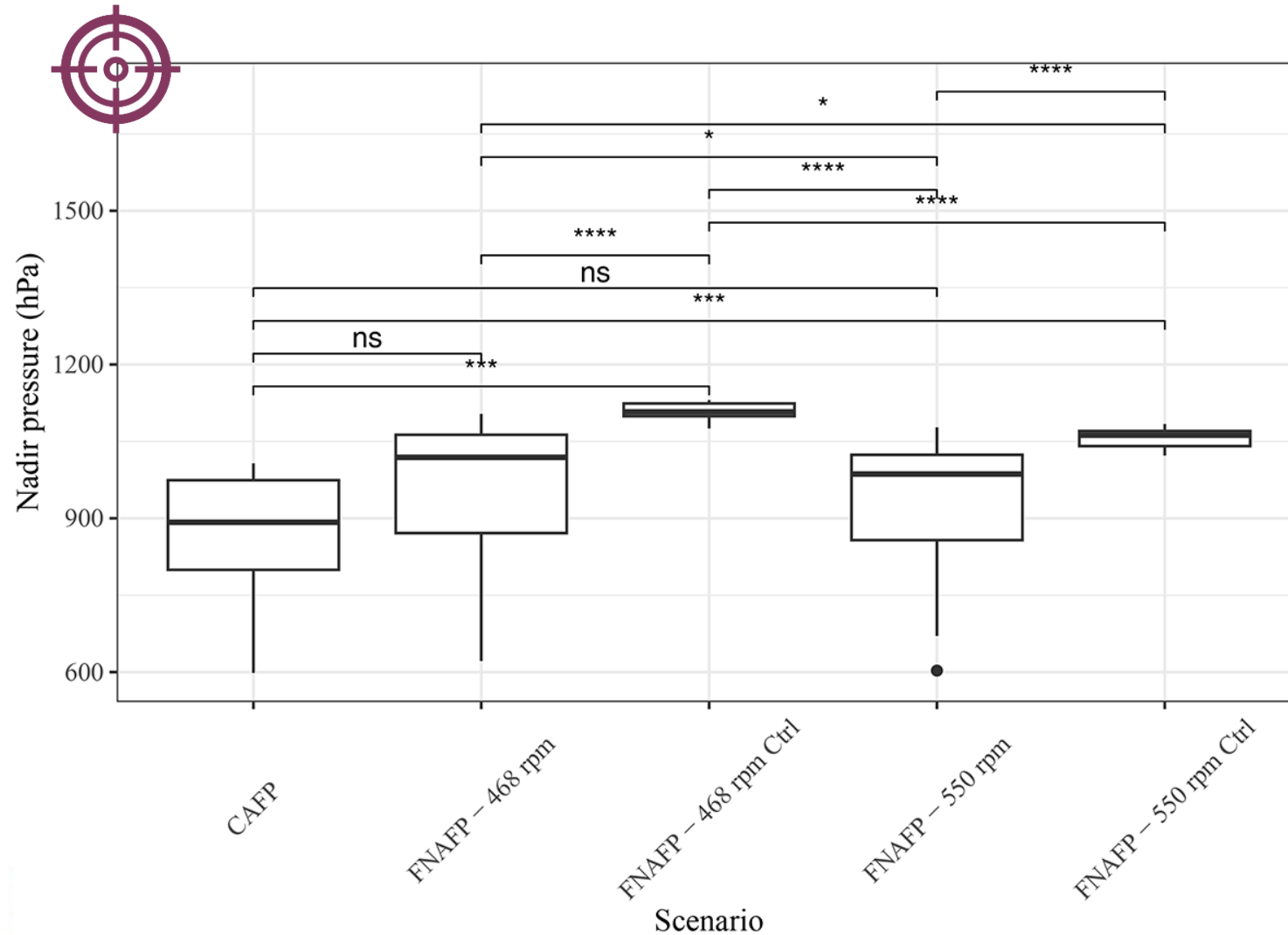
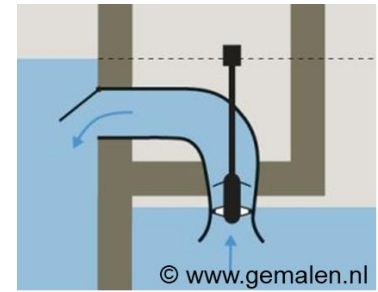
Barotrauma risk high if:



Shear stress high if:



# Fish friendly axial flow pumps?

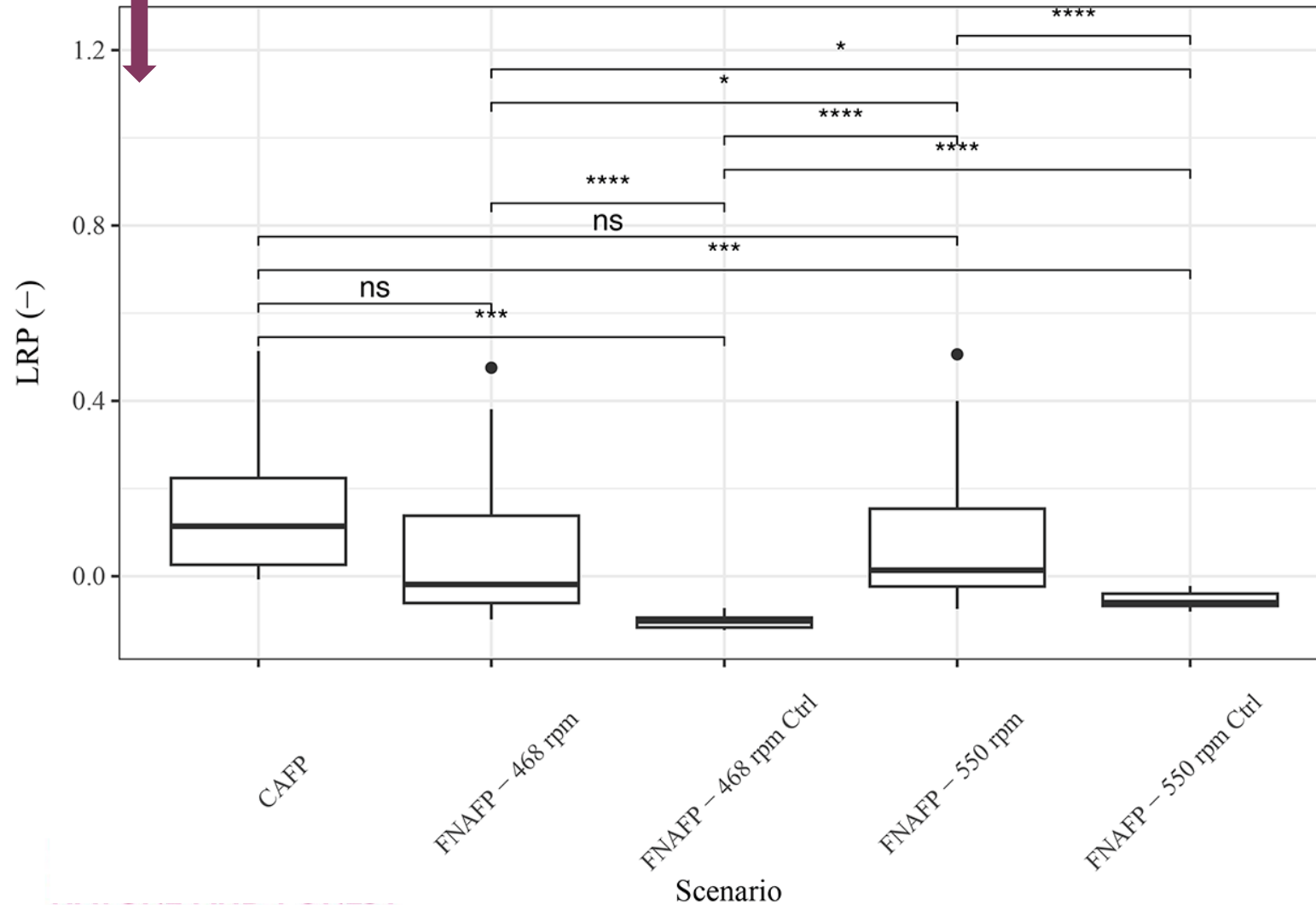
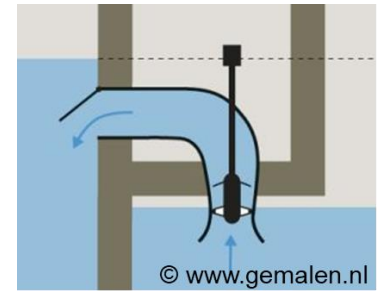


Barotrauma risk decreases from:

- CAFP
- FNAFP – 550 RPM
- FNAFP – 468 RPM
- Control



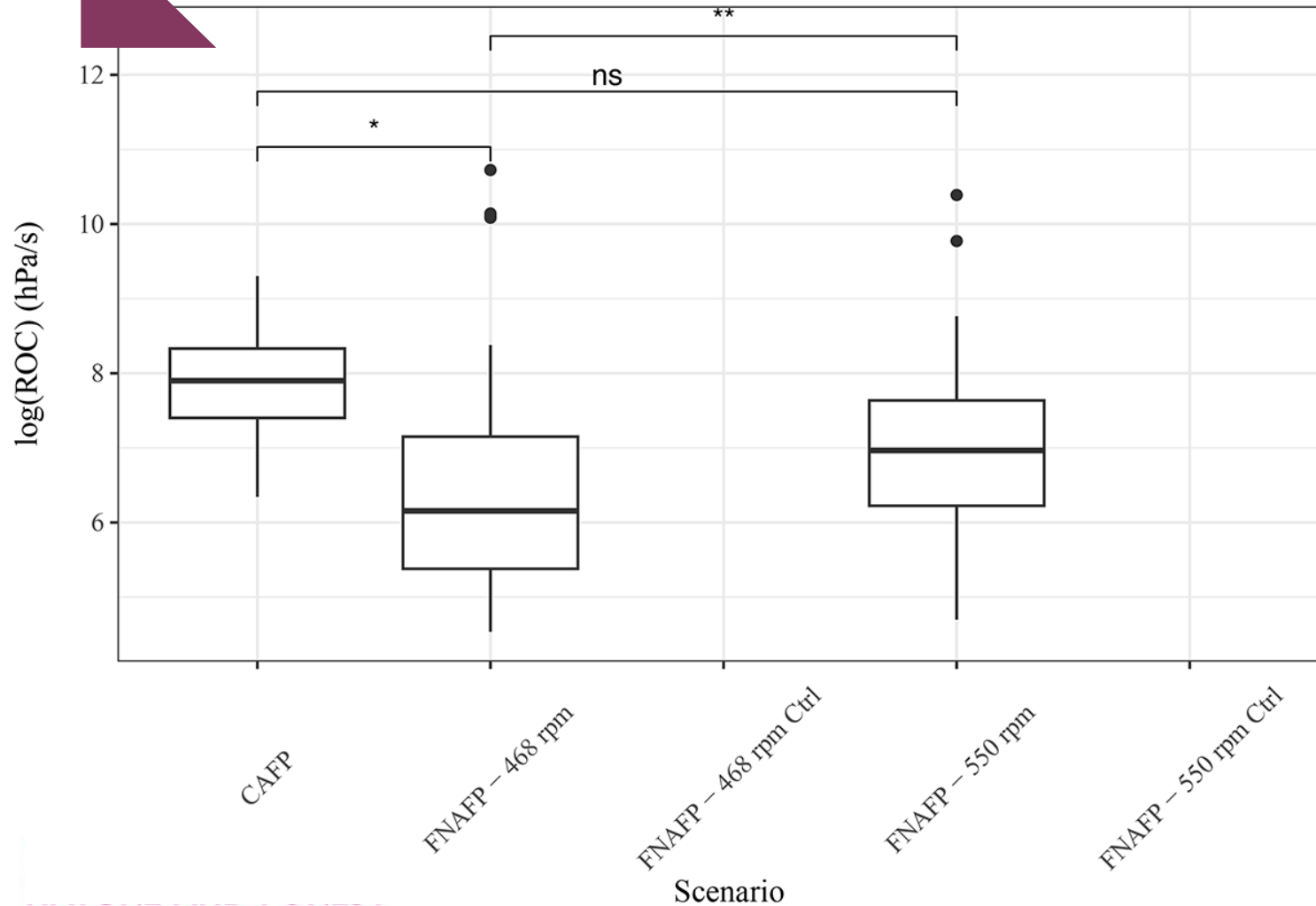
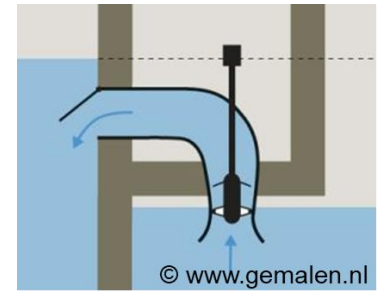
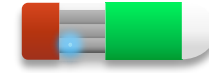
# Fish friendly axial flow pumps?



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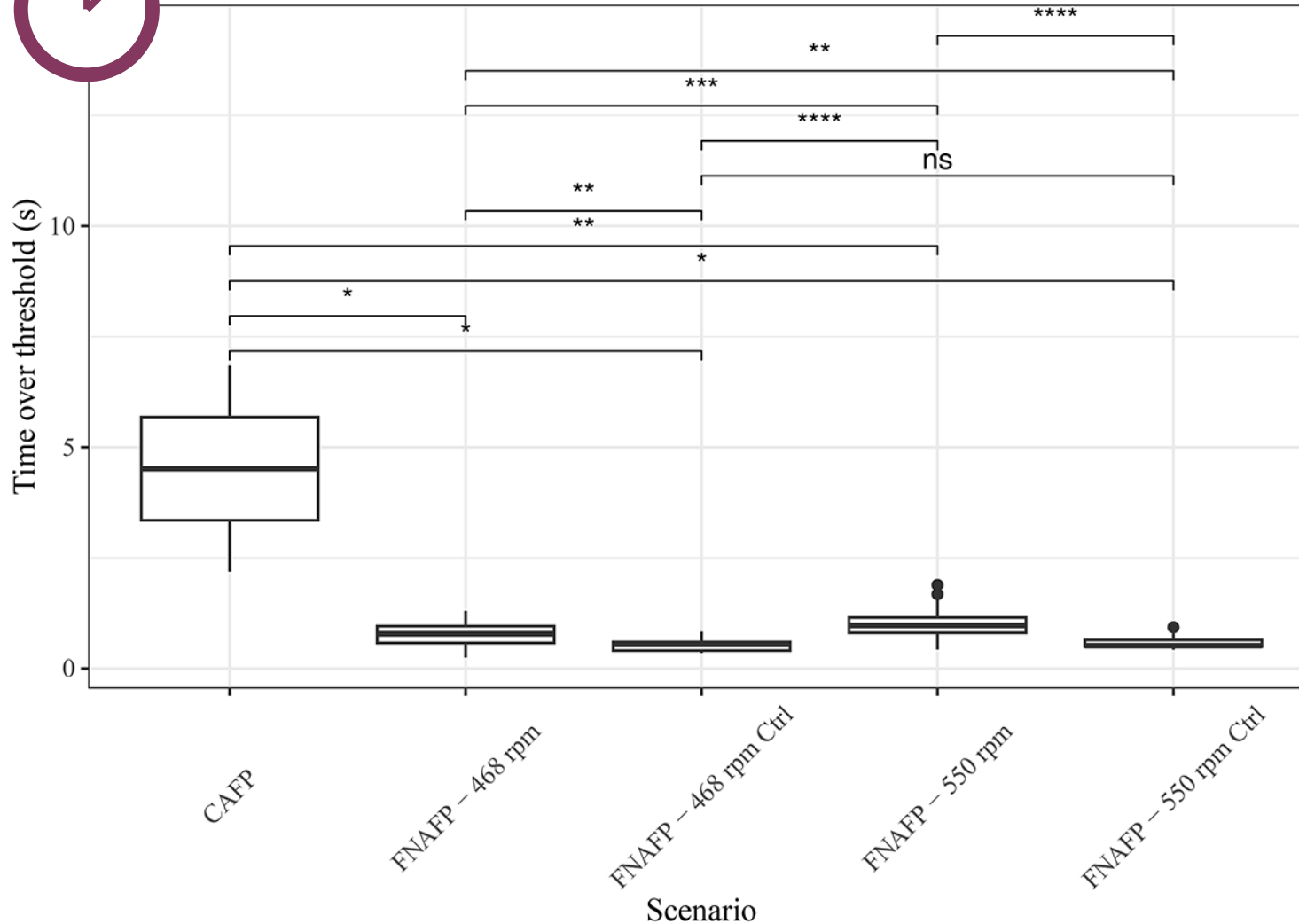
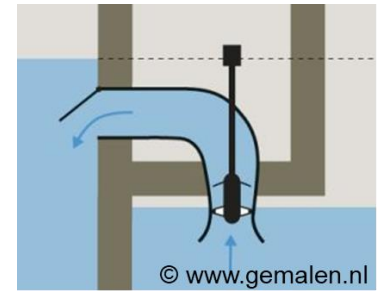
# Fish friendly axial flow pumps?



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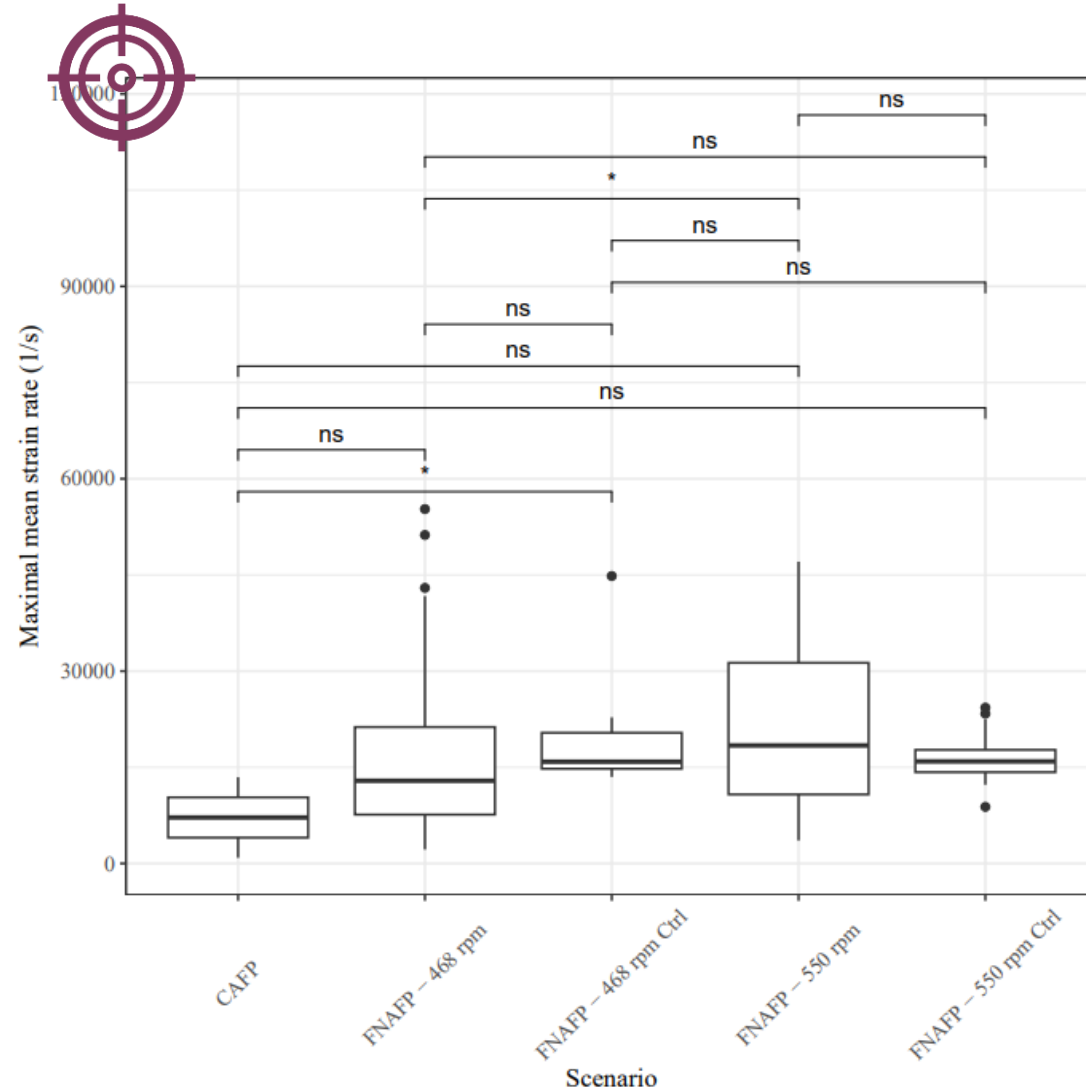
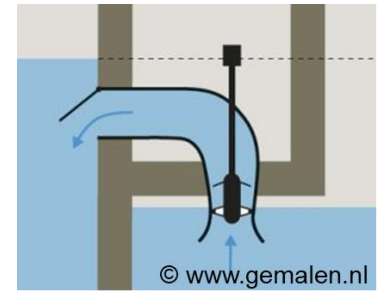
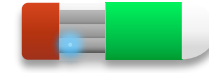
# Fish friendly axial flow pumps?



Shear stress risk decreases from:

- CAFP
- FNAFP – 550 RPM
- FNAFP – 468 RPM
- Control

# Fish friendly axial flow pumps?



Shear stress risk decreases from:

- FNAFP – 550 RPM
- Control
- FNAFP – 468 RPM
- CAFP

# What is the most likely source of injury?

- Barotrauma?
  - Magnitude needs to be larger
  - Not size-dependent
- Shear stress?
  - No conclusive results
  - More harmful for smaller fish
  - Would have led to a higher variety of injuries
- Collisions and blade strikes?
  - In accordance with observed injuries
  - Smoothed edges of the impeller and large center opening of the FNAFP -> fewer incidents of strike and collision

# Conclusion

- Pentair Fairbanks Nijhuis pump and Van Hooste pump similar performance for eel
- Pentair Fairbanks Nijhuis pump performs much better than conventional axial flow pumps, but is still far from safe for many fish
- Though the conditions of baseline studies with a sound design on pump fish-friendliness, are unlikely to be a perfect match to any real life situation water managers are faced with, they can still inform on what might be extrapolated but also caution against what cannot and underline the need for additional testing when in doubt.