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Consider the bigger picture: The effect of multimodal sensory integration on fish passage efficiency

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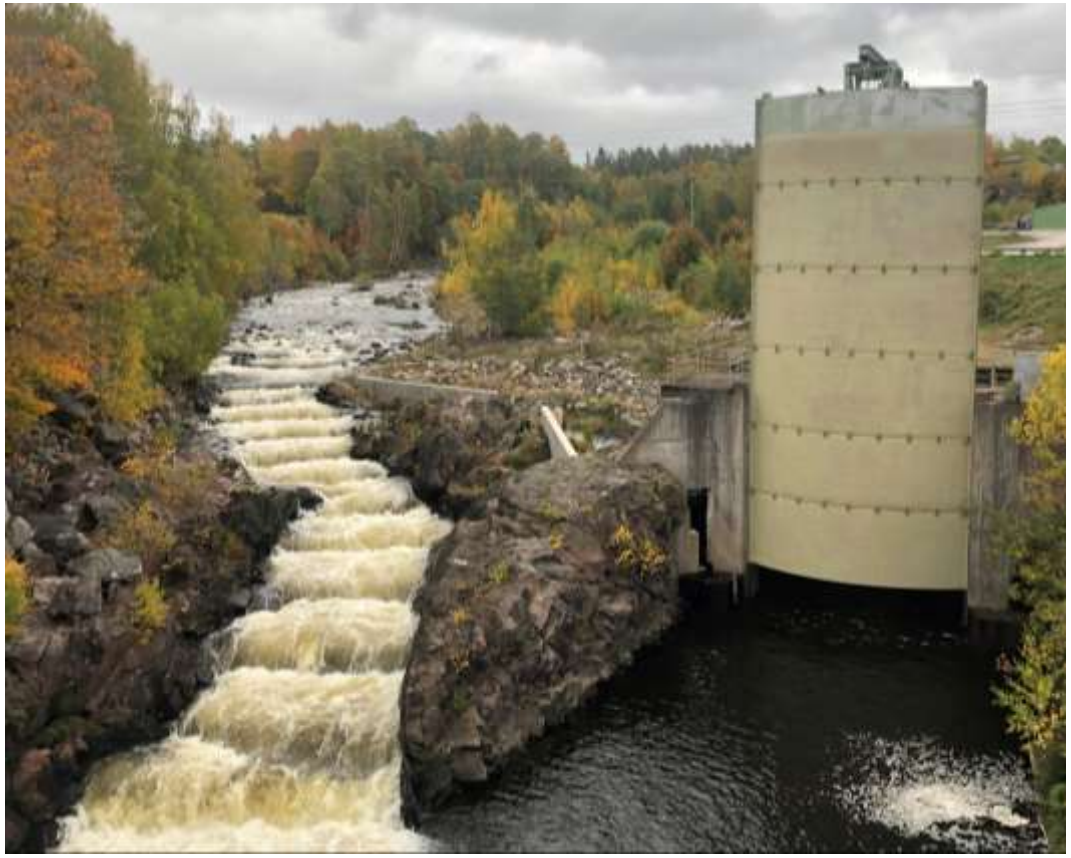
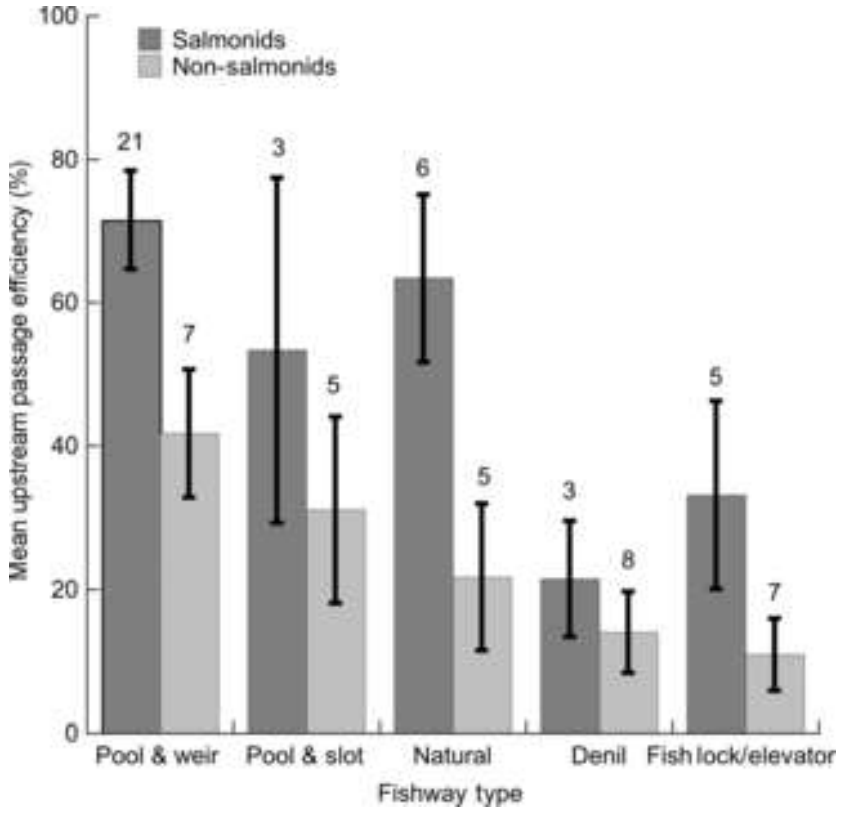
Infrastructure impacts waterways

- Ecological impacts
  - Habitat fragmentation
  - Migration disruption
  - Entrainment and impingement
- Importance of freshwater fish
  - > 18,000 species of freshwater fish
  - Main protein source for ~200 million people
  - Main income source for 60 million people

Fish behaviour influences passage efficiency

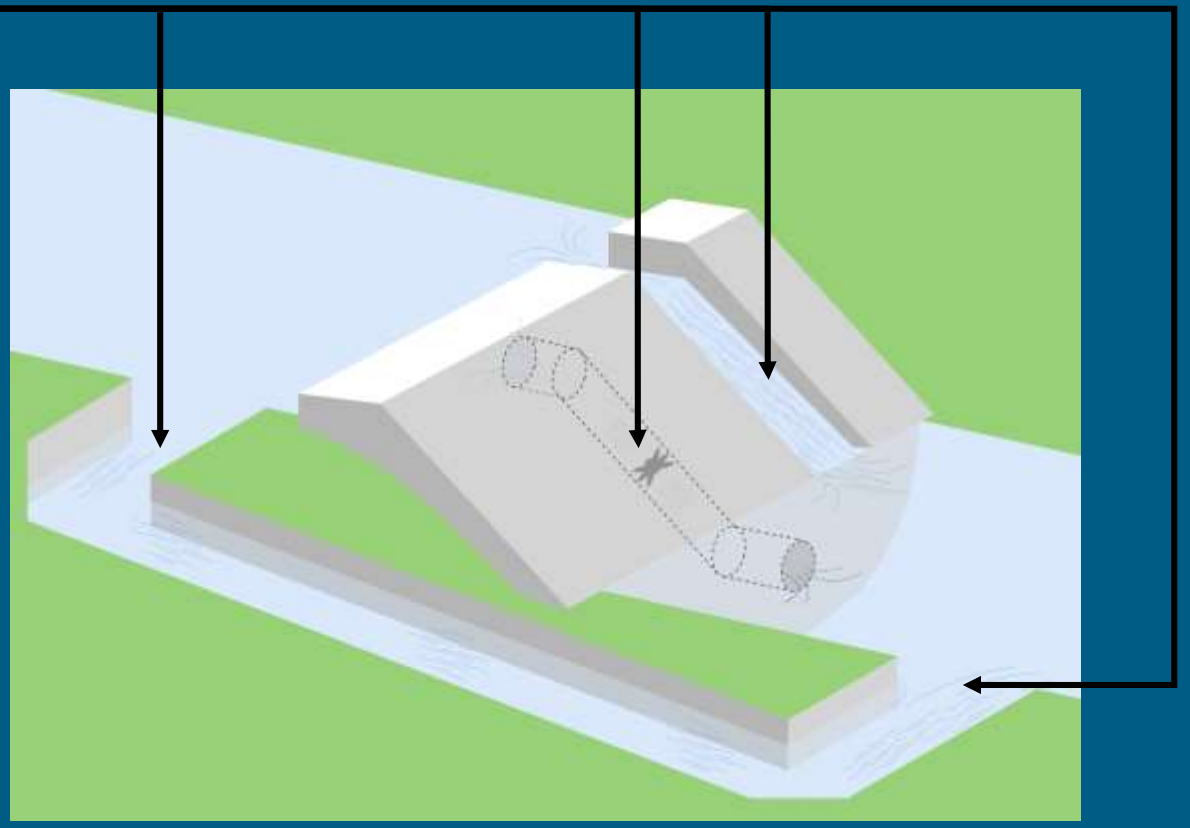




Noonan MJ, Grant JWA, Jackson CD (2012). A quantitative assessment of fish passage efficiency: effectiveness of fish passage facilities. Fish Fisher 13:450–464.

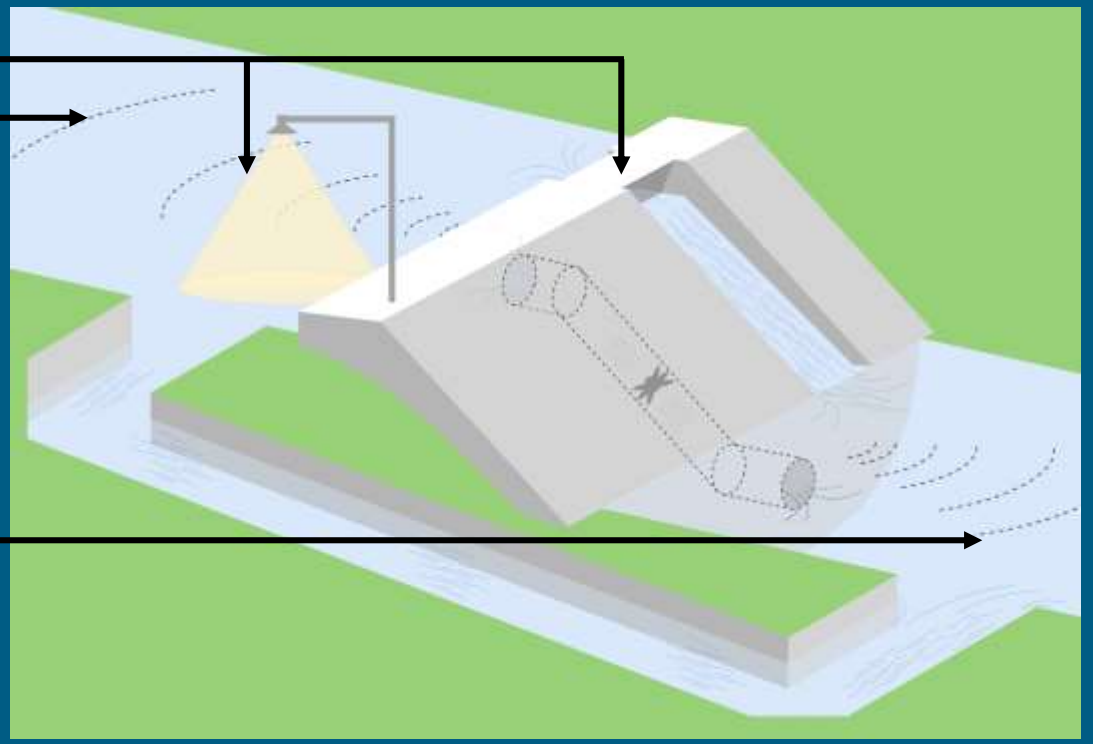
Sensory stimuli influence behaviour

- Hydrodynamic stimuli
  - Flow velocity, velocity gradients, & turbulence
  - Attractance and avoidance behaviours
  - Masking effects



Sensory stimuli influence behaviour

- Hydrodynamic stimuli
  - Flow velocity, velocity gradients, & turbulence
  - Attractive and repulsive behaviours
  - Masking effects
- Visual stimuli
  - Addition of artificial light loss, of natural light
  - Attractive and repulsive behaviours
- Acoustic stimuli
  - Infrastructure operation, road noise, etc.
  - Repulsive behaviours
  - Masking and distraction effects



Multiple sensory inputs influence behaviour

- Multimodal integration: Stimuli detected across multiple sensory channels inform behavioural expression
- Peripheral sensory information can influence behaviour expressed towards a given stimulus
- Multimodal integration influences passage-related behaviours

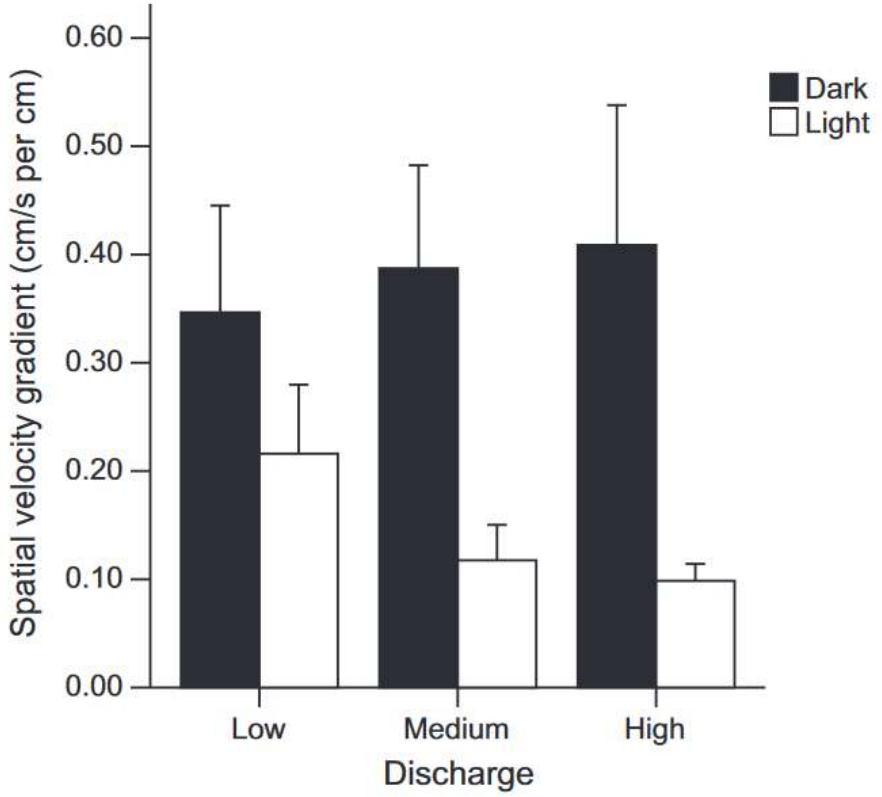
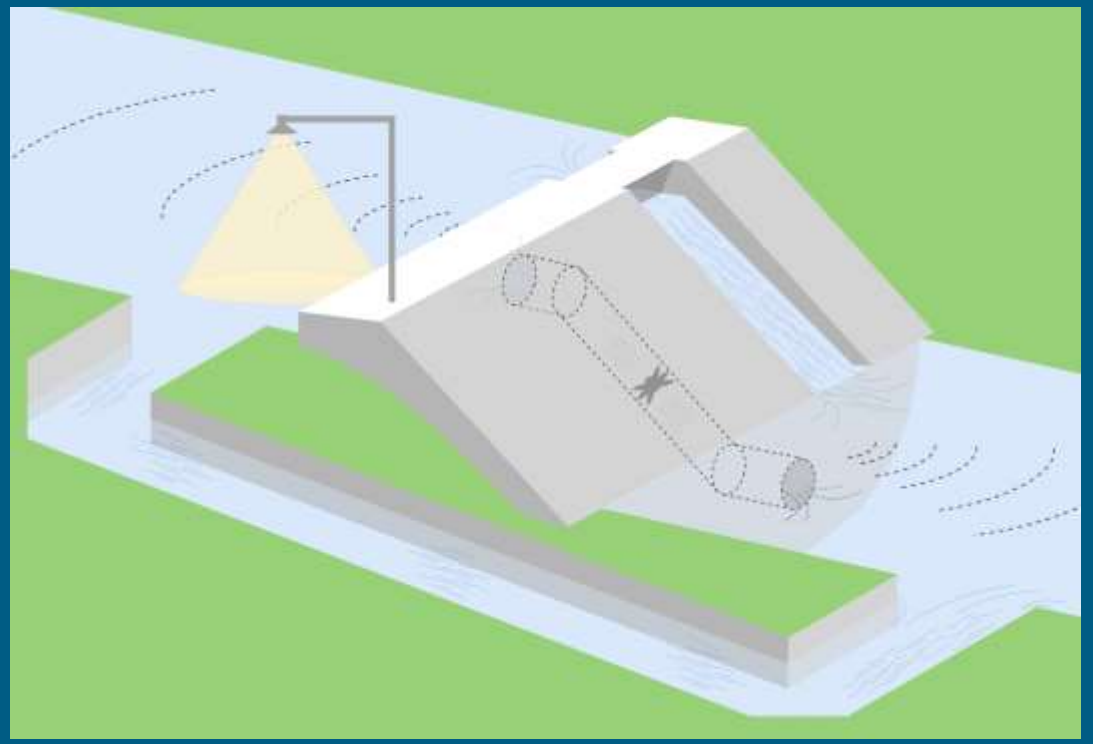


Fig. 5. Spatial velocity gradient ($cm\ s^{-1}\ cm^{-1}$) along the body length of brown trout when initial responses were expressed. Error bars depict + 1 SE of the mean.

Vowles, A. S., & Kemp, P. S. (2012). Effects of light on the behaviour of brown trout (Salmo trutta) encountering accelerating flow: Application to downstream fish passage. *Ecological Engineering*, *47*, 247–253

Multimodal integration & passage performance

- How does multimodal integration impact fish passage behaviour?
  - What stimuli are fish exposed to?
  - Do fine scale responses reflect large scale patterns?
  - How common are synergistic and antagonistic effects on behaviour?
  - Are outcomes species-specific?
- Application towards behavioural guidance system design?



Consider the bigger picture

Behaviour plays an important role in determining passage efficacy

Multiple sensory dimensions influence fish behaviour.

Accounting for this influence supports more holistic approaches to improving habitat connectivity

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Thanks for listening

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