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## Session B4: New Insights into Schooling Behavior in Response to Flow

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# Schooling behaviour in response to flow

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International Centre for Ecohydraulics Research



# Outline

- Background
- Research question
- Methods
- Results
- Conclusions

# Functions of grouping

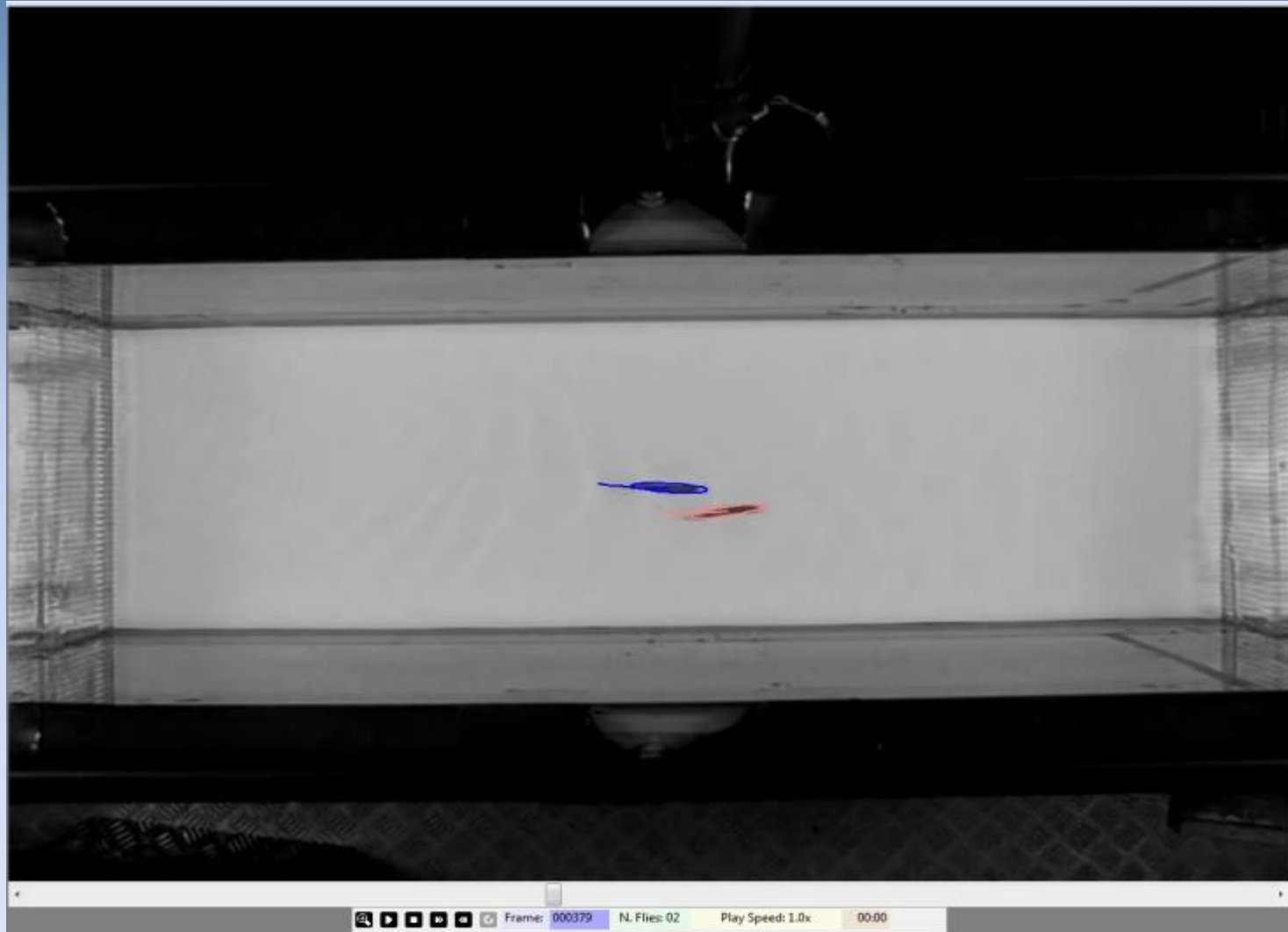
- Anti predator
- Foraging
- Hydrodynamic efficiency
- Migration
  - For upstream migrants, essential, whereas downstream behavioural traits while
  - Variety of barriers along
  - Local changes in hydraulic conditions
    - Acceleration of flow / increased turbulence
    - Cause of delay



# Research question

- How do hydrodynamics affect school cohesion and behaviour?
  - Focus on flow velocity and drag
  - Energy savings
- ‘Back to basics’ approach
  - Proxy for migrating fish species
  - Controlled environment

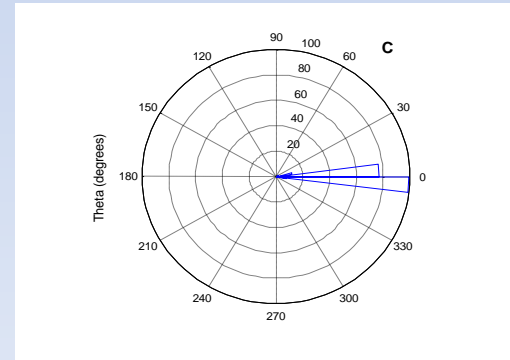
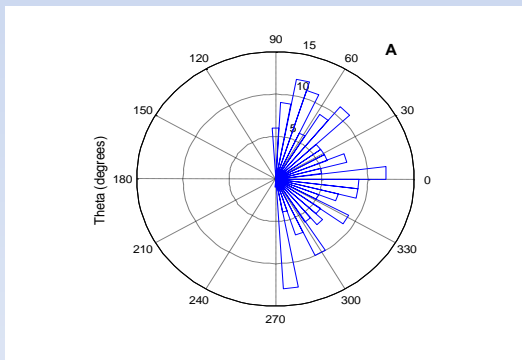
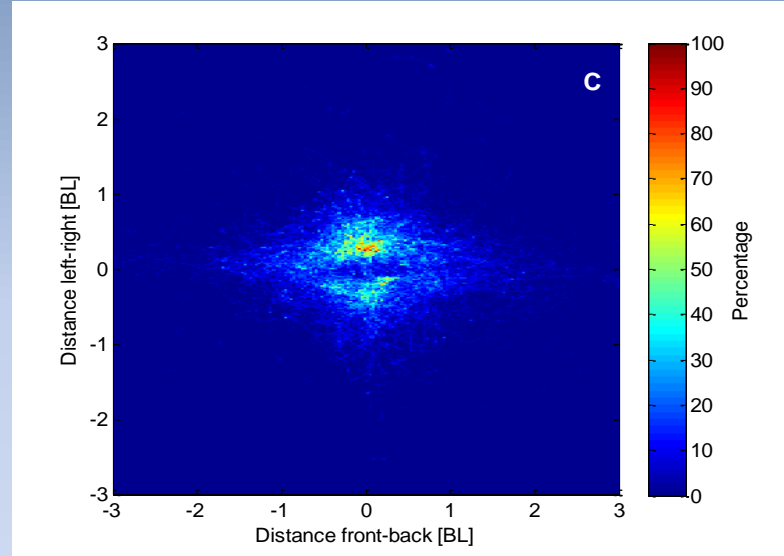
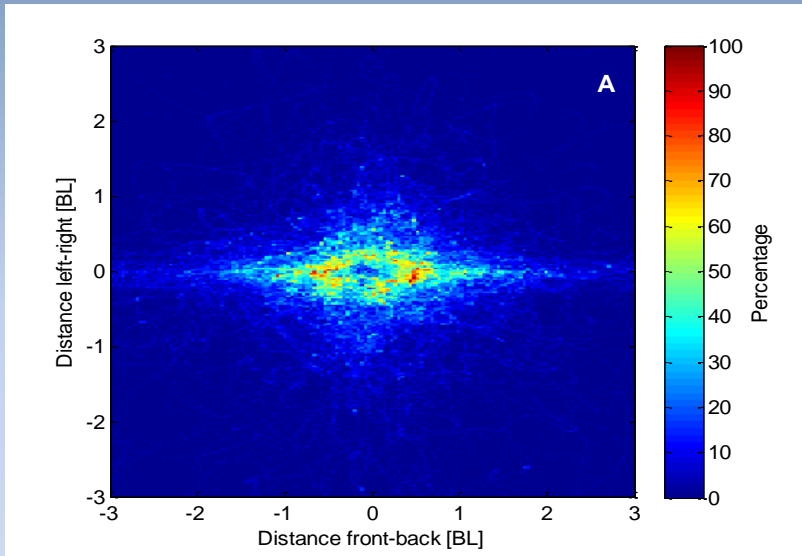
# Methodology



# Results

- Increase in schooling time

Kruskal-Wallis:  $H = 8.689$ ,  $p = 0.013$  ; Jonckheere-Terpstra:  $z = 2.890$ ,  $p = 0.004$



Standing water

High flow

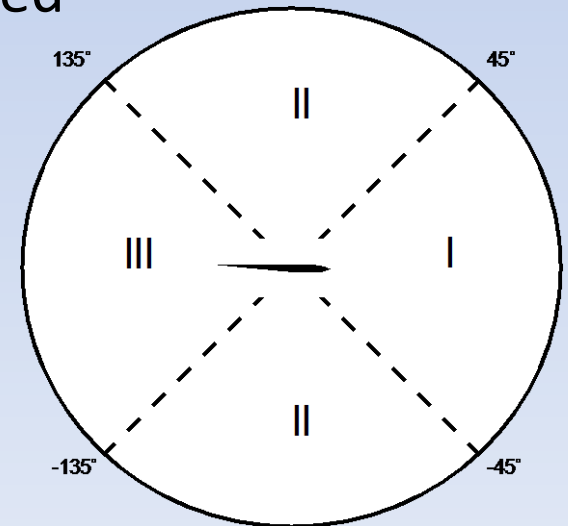
# Conclusions (1)

- Flow drives fish together in a school
- Side-by-side configuration facing the flow
  - No wake exploiting
  - Novel finding that persists in bigger schools
- Why:
  - Saving energy possible?<sup>1</sup>
  - Disturbance of lateral line limiting information transfer?<sup>2</sup>



# Results

1. Model drag coefficients in ANSYS Fluent®
  - As distance between fish decreases, drag increases and is higher than that of single fish
2. Investigate speeding ( $V_x$ ) and turning ( $V_y$ ) velocity correlations
  - Faster response time to change in speed
  - Higher turning correlation



# Conclusions (2)

- Fish aim to maximise information transfer in flowing environment
  - Role of lateral line/vision changes in noisy environment
  - Neighbour along side preferred
  - Optimal navigation
- Fish sacrifice possible energy savings in the process

# Thank you

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**KATZ, Y., TUNSTROM, K., IOANNOU, C. C., HUEPE, C. & COUZIN, I. D. 2011.** Inferring the structure and dynamics of interactions in schooling fish. *Proceedings of the National Academy of Sciences of the United States of America*, 108, 18720-18725.

**CHICOLI, A., BUTAIL, S., LUN, Y., BAK-COLEMAN, J., COOMBS, S. & PALEY, D. A. 2014.** The effects of flow on schooling *Devario aequipinnatus*: school structure, startle response and information transmission. *Journal of Fish Biology*, 84, 1401-1421.