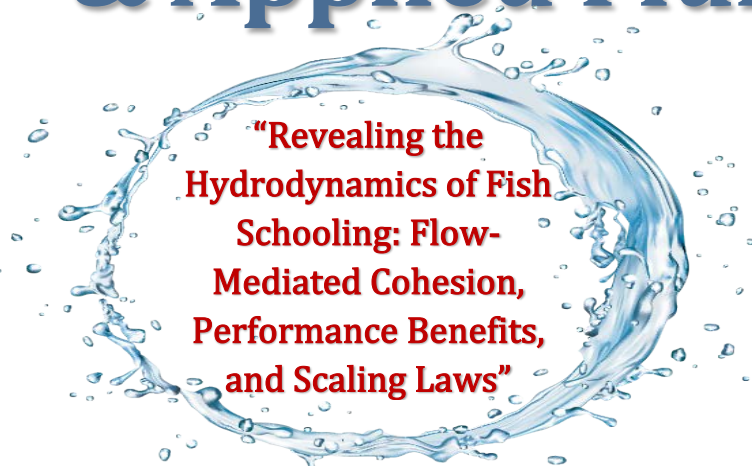


Center for Environmental & Applied Fluid Mechanics



**“Revealing the
Hydrodynamics of Fish
Schooling: Flow-
Mediated Cohesion,
Performance Benefits,
and Scaling Laws”**

Prof. Keith Moored
Lehigh University
Mechanical Engineering
and Mechanics

Fish schools are fascinating examples of self-organization in nature. They serve many purposes from enhanced foraging, and protection against predators to improved socialization and migration. Beyond the implications for biology, engineers can take inspiration from the hydrodynamic benefits of schooling to apply to the design of schools of next-generation bio-robotic vehicles. This new class of schooling unmanned underwater vehicles would enable unprecedented efficiency, maneuverability, agility and stealth; as well as unlock novel missions that require distributed tasks or swarming. However, our understanding of the hydrodynamic interactions in schools is primitive. Importantly, the links from the organization, synchronization, and kinematics of individuals to the performance and stability of a school has yet to be established.



In this talk I will present recent work examining the influence of school organization and synchronization on the locomotion performance and stability of simple interacting pitching hydrofoils. Experiments and potential flow simulations will detail the flow interactions that occur among pitching hydrofoils with varying synchronization. Significant thrust and efficiency benefits for the whole school are revealed, and the hydrodynamic mechanisms of drafting, body-to-body interactions, and vortex-body interactions that give rise to these benefits will be examined. It is further discovered that schooling interactions can generate cohesive forces between foils and, specifically, that there are two-dimensionally stable equilibrium arrangements that arise. Focusing in on the side-by-side organization, the origin of the forces that produce an equilibrium arrangement are discovered. New physics-based scaling laws are developed for hydrofoils' equilibrium arrangement, thrust generation, and power consumption, which are found to be in good agreement with inviscid simulations and viscous experiments. Stable arrangements for larger schools of foils and in bio-robots will also be discussed.

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October 13, 2023 ✦ 3:00 PM ✦ Hodson Hall 210