Fish swimming performance: effect of flume length and different fatigue definitions

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Fish swimming performance is a key to understanding behavioral strategies that affect fish migration, habitat selection, reproduction, predator-prey interaction, etc. Quantification of fish swimming performance through either step-increase (Ucrit) or fixed velocity testing is influenced by channel geometry size and length. Since time to fatigue, the swimming time after which a fish is no longer able to swim against a given flow condition is the prime yardstick to evaluate swimming performance, lacking a common time to fatigue definition could potentially lead to a specious assessment of the fish swimming performance.

Systematic experiments on the juvenile (5cm) Vairone (Telestes muticellus), a fish species endemic to the Italian Po river basin, were carried out to elucidate the effect of flume length on their swimming performance. Three different flume lengths of 15, 30, and 100 cm, corresponding to 3, 6, and 12 body lengths (BL) were tested against two different flow velocities, 35 and 45 cm/s (i.e. 7 and 9 BL/s). In particular, the effect of two different criteria for determining times-to-fatigue was studied: (1) physiological fatigue, i.e. fish was declared fatigued when resting on the rear grid with its tail for ≥ 3 seconds for 3 different times in a row despite tapping it, and (2) behavioral fatigue, i.e. defined as fish resting on the rear grid for ≥ 5 seconds for the first time. The experiments were conducted using a fixed velocity testing protocol in a portable open channel flume with a 30 cm by 30 cm cross-sectional area under controlled water temperature (12.5±1 °C).

Differences in swimming performance of juvenile vairone were statistically significant between two treatment velocities i.e. 7 and 9 BL/s. Flume length affected swimming performance based on behavioral but not on physiological fatigue. It is concluded that the quantification of swimming performance is sensitive to the criteria used for fatigue. This needs to be taken into account in order to increase the relevance of laboratory experiments to fish swimming performance in rivers and fish passages.