Hydrodynamic abilities of riverine fish: a functional link between morphology and velocity use

To better understand the effects of perturbations (e.g. global change) or habitat restorations on fish population dynamics, it is crucial to improve the knowledge about strategies of habitat use (especially in terms of velocity use) by fish. Many recent studies accurately describe kinematics or energetic budgets of swimming activities, which are often species-specific and hardly transferable to other species. The main goal of the present study was to revive more general ecomorphological relationships between body shape and strategies of velocity use by highlighting a functional aspect of fish morphology: the hydrodynamic potential. For this purpose, potential relationships between minimum drag coefficients (Cdmin, constant at high Reynolds numbers), velocity use, fish morphology and drag in given flow conditions were investigated. To assess these relationships, dead drag values (i.e. drag values measured on dead, straight individuals) of 27 riverine species (108 individuals in total) common in France were experimentally measured under various flow conditions. These values served to estimate the Cdmin of fish. For pelagic species, Cdmin values were related to both preferred and near-maximum flow velocity used by the fish in nature. Explaining 61% of its variability, Cdmin was described using six morphological variables, which demonstrates the functional link between fish morphology and velocity use. For all studied species, a model explained 94% of drag variability using the Reynolds number of fish and three morphological variables. The link between morphology and drag force at given velocity conditions provides simple elements for modelling fish energetics in the context of physical habitat use. Moreover, the relationships between fish velocity use and their Cdmin open many applied perspectives, such as assessing the species abilities to withstand discharge modulations.

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