FISH MOVEMENT NEAR INFRASTRUCTURE EMERGES FROM NATURAL RIVER ARCHITECTURE

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Abstract: Decades of empirical studies have identified many factors that affect the relationship between fish movement and water flow. How water flow pattern shapes the movement trajectories of fish near infrastructure remains unknown, however, and this knowledge gap impacts the success of existing and near-future engineered structures that are meant to improve the long-term health of fish populations. We present field evidence and an analysis of a hypothesis that describes fish movement near infrastructure in terms of naturally evolved behavior in free-flowing rivers for navigating heterogeneity arising from river architecture, where river architecture is defined as the geometric sum of contributions from the riverbed and embedded objects. The hypothesis assumes that fish modulate experienced changes in water acceleration (exchanges of force with the flow field) as the fish transits heterogeneity in the river. The acceleration-duration phenomenon that we identify as important in fish movement behavior has analogies to the acceleration-duration phenomena that have been implicated in sediment motion. Thus, it may be possible to interpret the hydraulic navigation of fish in rivers using phenomena involved also in the evolution of river architecture. We discuss numerical results from the application of the hypothesis to 47 flow fields at seven sites (dams) across 14 years when fish movement was monitored. Our hypothesis suggests that with a limited evolutionary history for navigating engineered structures, fish behavior reflects their naturally evolved response in free-flowing rivers. As such, we surmise that our hypothesis is applicable to fish outside the context of dams, in natural settings and near other forms of infrastructure such as fish diversion devices (booms and non-physical barriers), marine and hydrokinetic turbines, and also has implications for habitat design.