Freshwater ecosystems: From models to applications

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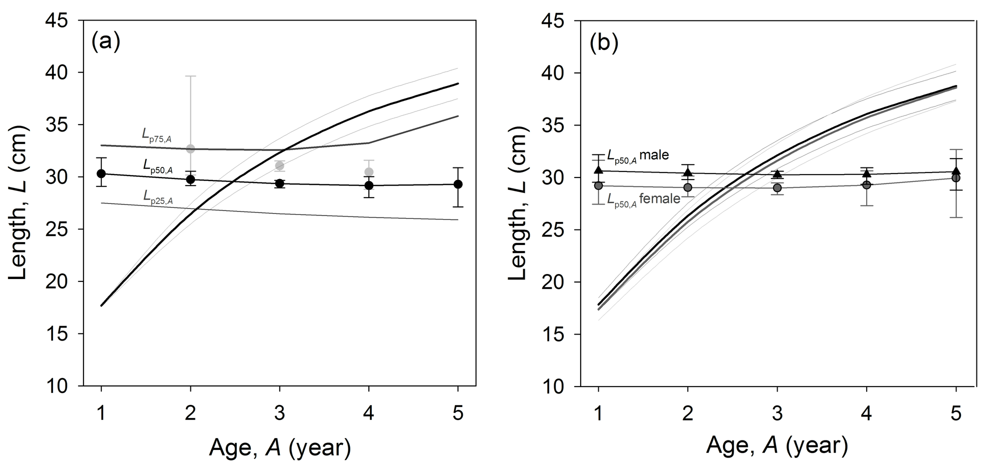
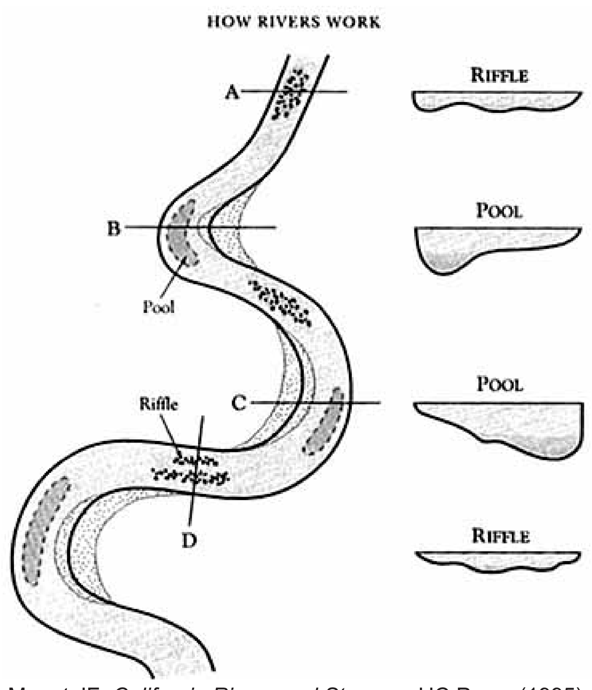
Freshwater ecosystems

Lakes and streams are being endangered by agricultural, urban, and industrial pollution, hydraulic engineering, and overexploitation, which threaten their capacity to provide important services (recreation and supply of food and clean water, among others). Ecological modelling may be employed to estimate impacts and analyze mitigation strategies. Toy models are easy to construct, but applying them to real-world problems is often challenging. Here, we present two case studies that make the connection from model to application. The first study analyzes whether and how the impact of climatic change on a mostly recreational fishery in an Alpine lake can be mitigated, while the second looks at the diversity of aquatic insects in a Korean river system, which play an essential functional role in aquatic food-webs and are very sensitive to water quality. These studies highlight the ability of process-based eco-evolutionary models to generate testable hypotheses and contribute solutions to real-world problems.

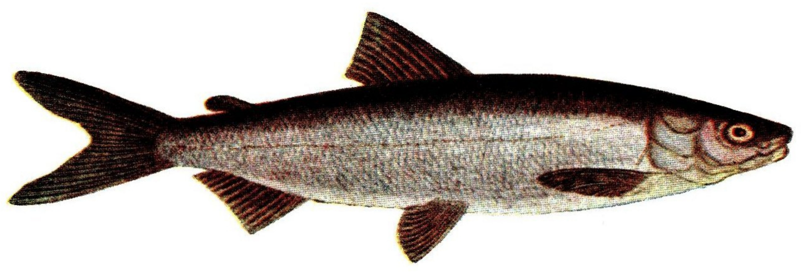
Lake Irrsee, Austria



Growth and maturation



Mount JF. *California Rivers and Streams.* UC Press (1995)



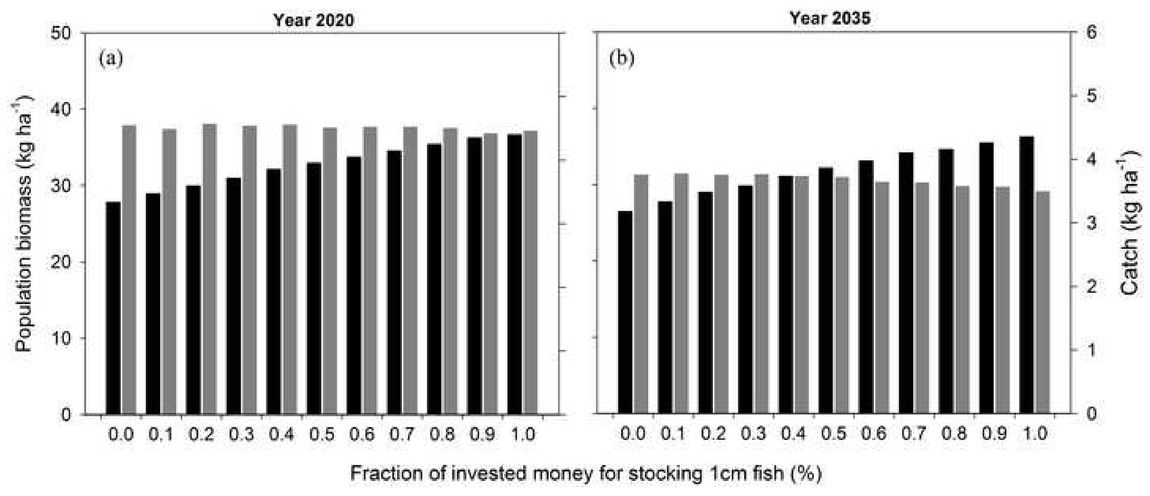
Coregonus lavaretus (L.)

Whitefish in an Alpine lake

Cold-water fish stocks are affected by increasing water temperatures. This effect manifests mainly via their influence on growth and hence the age of maturation. The question arises whether stock management can be adapted to mitigate the consequences of this climatic change.

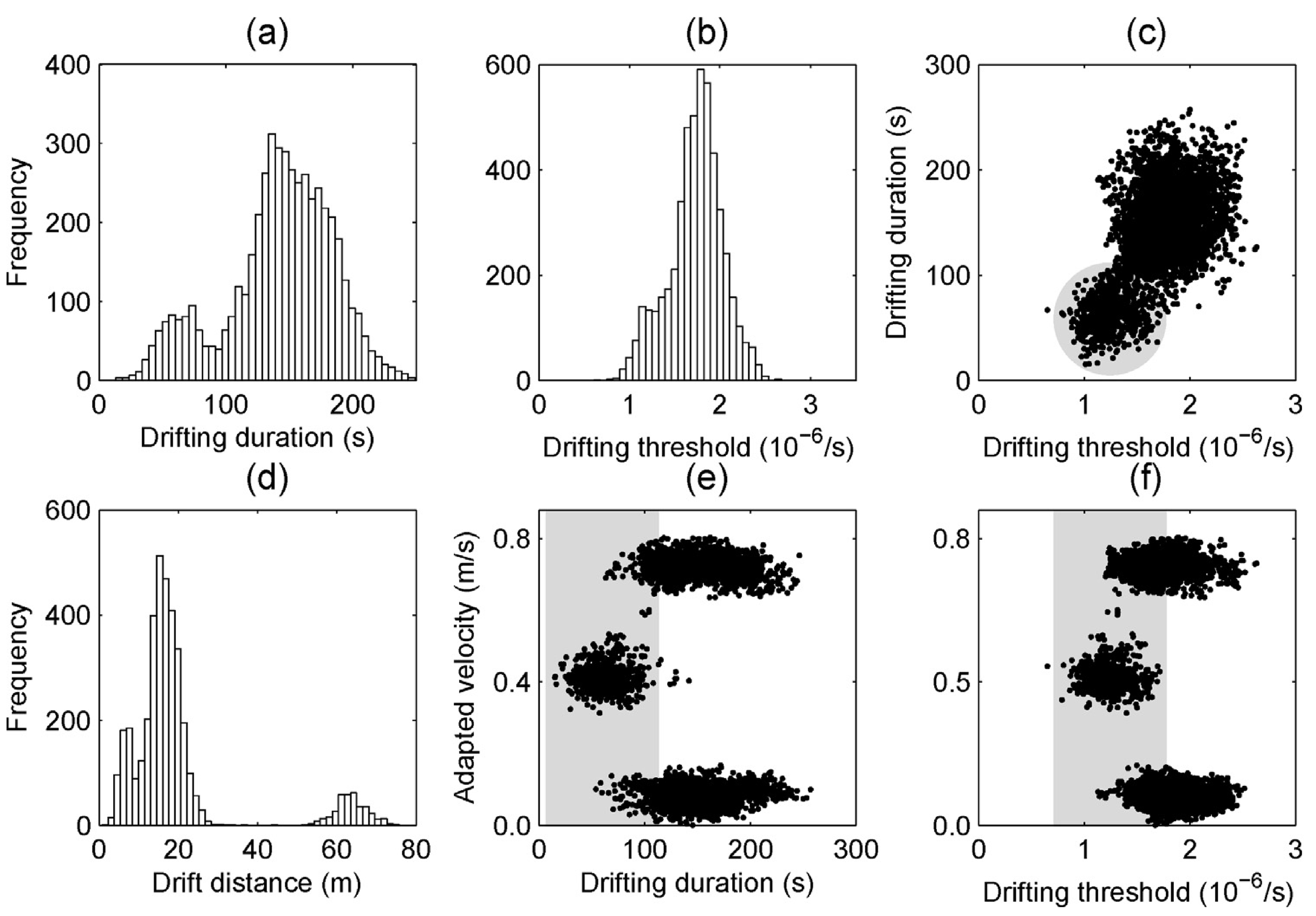
We estimate the effects of increasing water temperatures on fisheries yield and population dynamics of a typical cold-water fish species. Using a process-based population model calibrated on an empirical long-term data set for the whitefish population (*Coregonus lavaretus* (L.) species complex) of the pre-alpine lake Irrsee, Austria, we project population growth and compare established stocking strategies to alternative stocking strategies under the aspect of cost neutrality.

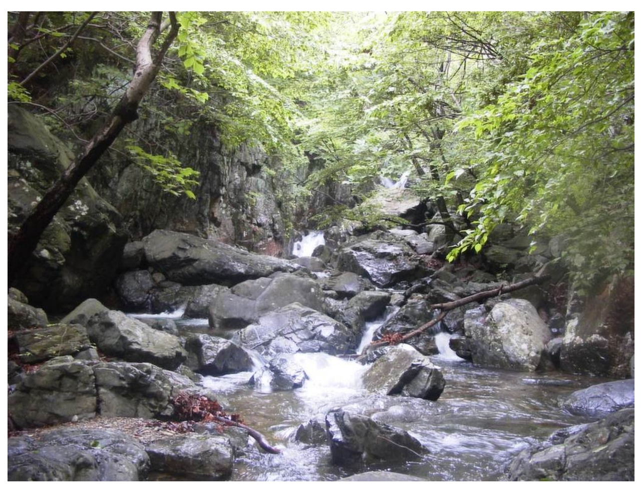
We find that with increasing temperatures, stocking one-summer-old fish may be considered more advantageous for the angling fishery, as it maximizes catch. Adaptation to climate change by changing stocking strategies cannot, however, prevent an overall reduction in catch and population size.

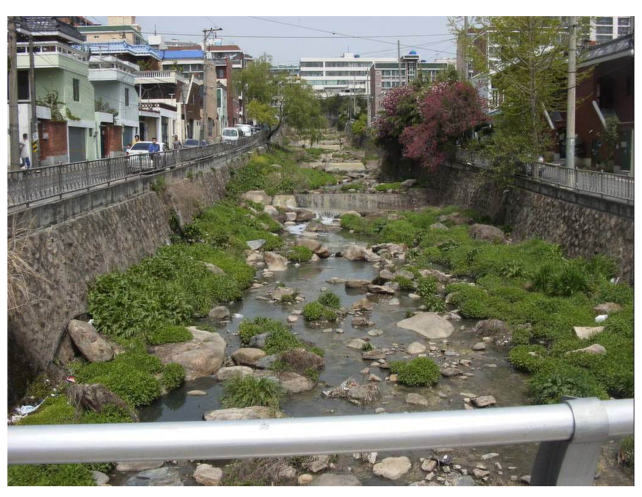


Aquatic insects in Korean streams

Water velocity is one of the most important abiotic factors influencing the survival of aquatic insects in rivers and streams. The unidirectional water flow shaping their habitat and characteristically dividing it into alternating zones of high and low water velocity (riffles and pools) also imposes on them the special necessity to adapt to continual downstream drift. Analyzing an individual-based eco-evolutionary model parameterized with field data, we show how species adapted to riffles and pools, respectively, emerge, and how evolutionary branching in velocity adaptation is accompanied by an differentiation of drifting behavior. Generally, individuals drift either frequently and for only a short duration, or infrequently and for a longer duration. While riffle and pool species each exhibit both drifting strategies, a third species that can stably establish at intermediate water velocities (runs) exhibits exclusively the former.







A clean stream and a polluted stream

References

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