
Multiple states in river and lake ecosystems

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Nonlinear models of ecosystem dynamics that incorporate positive feedbacks and multiple, internally reinforced states have considerable explanatory power. However, linear models may be adequate, particularly if ecosystem behaviour is primarily controlled by external processes. In lake ecosystems, internal (mainly biotic) processes are thought to have major impacts on system behaviour, whereas in rivers, external (mainly physical) factors have traditionally been emphasized. We consider the hypothesis that models that exhibit multiple states are useful for understanding the behaviour of lake ecosystems, but not as useful for understanding stream ecosystems. Some of the best-known examples of multiple states come from lake ecosystems. We review some of these examples, and we also describe examples of multiple states in rivers. We conclude that the hypothesis is an oversimplification; the importance of physical forcing in rivers does not eliminate the possibility of internal feedbacks that create multiple states, although in rivers these feedbacks are likely to include physical as well as biotic processes. Nonlinear behaviour in aquatic ecosystems may be more common than current theory indicates.

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