Controllability of a Competitive Diffusive Lotka–Volterra System

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Abstract

We investigate the controllability of a generalized diffusive Lotka-Volterra competition model for two species, incorporating boundary controls and an interior multiplicative control. Considering a smooth, bounded N-dimensional domain, we analyze ecologically pertinent scenarios characterized by constraints on both the controls and system states. Our results demonstrate how integrated control strategies can effectively overcome the limitations identified in previous studies. We prove two main results: (1) asymptotic controllability to single-species survival steady states under arbitrary system parameters, ensured by a combination of boundary and interior controls which act jointly to stabilize the system; and (2) finite-time controllability to a specific heterogeneous coexistence steady state via a two-phase strategy - first steering the system near the target with boundary control, then activating an interior multiplicative control in a localized region. The strong synergy between the two control mechanisms is crucial in both cases.

References

[1] Barreira, J. C.; Sonego, M.; Zuazua, E. Boundary and Interior Control in a Diffusive Lotka-Volterra Model. Journal of Differential Equations, v. 466, p. 114257, 2026. https://doi.org/10.1016/j.jde.2026.114257