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A new free boundary problem

I will present a novel free boundary problem to model the movement of single species with a range boundary. The change of a free boundary is assumed to be influenced by the weighted total population inside the range boundary, which is described by an integro-differential equation. Our free boundary equation is a generalization of the classical Stefan condition that allows for nonlocal influences on the boundary movement. We prove that the new model is well posed and possesses steady state. The spreading speed of the model is smaller than that for the equivalent problem with a Stefan condition. While the classical Stefan condition categorizes asymptotic behavior via a spreading-vanishing dichotomy, the new model extends this dichotomy to a spreading-balancing-vanishing trichotomy. Our model allows both expansion and shrinking of the range boundary. When the model is extended to have two free boundaries, we observe asymmetric shifts, as well as steady state within synchronous moving boundaries. These are newly discovered phenomena in free boundary problems of animal movement.

*This is a joint work with Mark Lewis, Chuncheng Wang, and Chunxi Feng.