Stability and dispersal delays in predator–prey metapopulation models

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In metapopulation models, dispersal between habitat patches is usually assumed to occur instantaneously. In reality, organisms take a finite amount of time to move from patch to patch. This "travel time" can be incorporated into metapopulation models via a delay in the interpatch migration term. Recently, Neubert et al. [1] examined the effect of including such a term in the Lotka–Volterra predator–prey model. They formulated integrodifferential equation models where one species (the predator or the prey) disperses. They showed that a dispersal delay almost always stabilizes the positive equilibrium of the system.

The Lotka–Volterra model however, is structurally unstable. It is therefore hard to say how strong this stabilizing effect is. To find out, we incorporated dispersal delays in a Lotka–Volterra metapopulation model that also included a Type II functional response. Type II responses are known to be destabilizing. We can therefore balance the stabilizing effects of dispersal delays against the destabilizing effects of the functional response to measure the "strength" of the stabilizing effects.

In this poster, we will show how to formulate metapopulation models that include time delays. We will illustrate this using two different forms of dispersal delays as our examples. Discrete delays assume that all the individuals take the same amount of time to perform the migration. Another possibility, more often observed in nature, is that the durations of trips of the individuals are distributed around some mean value (distributed delay). We will demonstrate that both forms of dispersal delays are strong enough to overcome the destabilizing effects of the Type II functional response. This is observed as one or more "islands" of stability in the time delay–emigration rate parameter space.

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References

[1] Neubert, M. G., Klepac, P., & van den Driessche, P., 2002, Stabilizing dispersal delays in predator–prey metapopulation models, *Theor. Popul. Biol.* 61, 339–347.