Towards reducing biodiversity loss in fragmented habitats

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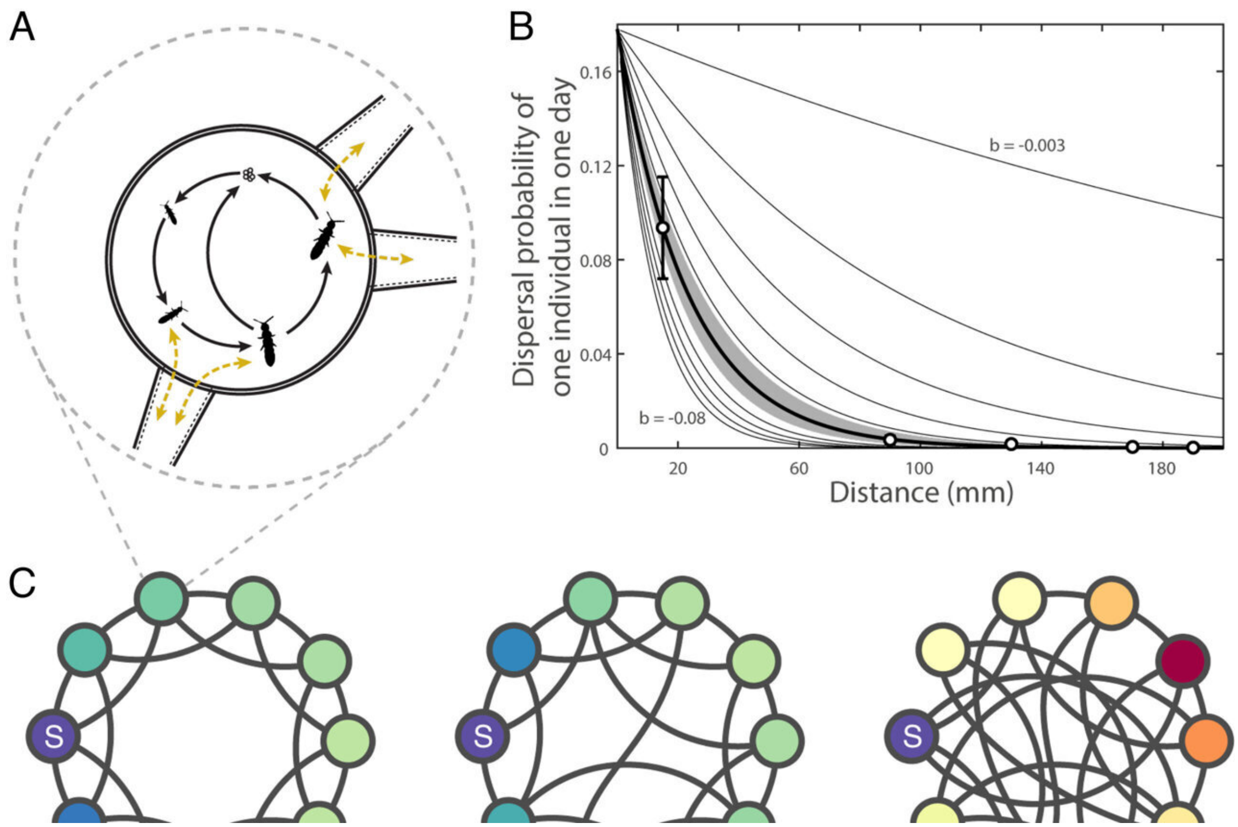

Habitat network configurations and demographic characteristics of the model system. (*A*) Depiction of *Folsomia candida*'s life cycle, size stages, reproduction, and dispersal. (*B*) Dispersal kernel. Open black circles show dispersal probabilities of *F. candida* estimated experimentally. The thick black line shows the negative exponential function fitted to these experimental data points; the gray shaded area shows the 95% CI of this fitted function. Thin black lines show alternative dispersal kernels used in the model. (*C* and *D*) Representative replicates of each of the three habitat configurations used in this study. From left to right: lattice, partially rewired, and random. (*C*) Network structure. Circles are nodes (habitat patches), and black lines are links (movement corridors). The diameter of nodes and lengths of links are shown to scale. "*S*" indicates the location of the source node—the initial location of the individuals added to the network at the start of the experiment. (*D*) Node population size over the course of the experiment; each line represents a single node. Vertical dashed lines indicate the number of days to full network occupancy. Color of circles (*C*) and lines (*D*) indicates the number of days it took for that node to be colonized. Credit: *Proceedings of the National Academy of Sciences* (2023). DOI: 10.1073/pnas.2201553120

When natural habitats are cleared to make way for cities, roads and agriculture, this often leaves behind "islands" of fragmented habitat that can place species at risk of extinction. Species are at risk when they find it hard to move among habitat patches to find resources and reproduce.

By combining lab experiments and mathematical modeling, researchers at McGill University and the Swiss Federal Institute of Aquatic Science and Technology have found a way to predict the movement of species that could guide conservation efforts to reconnect fragmented habitats.

The researchers determined that the survival of species lies in the interplay between their patterns of movement, such as how far they will travel to move between habitat fragments, and the way the corridors that link habitat patches are oriented.

They also found that the same landscape can promote the spread of certain species and impede the spread of others, depending on how far they will travel.

"We found that to predict the spread of species, we need to combine knowledge of their behavior and about the network of potential corridors that link the habitat patches," said McGill University Biology Professor Andrew Gonzalez, the lead author on a new study published in *PNAS*.

Lab experiments and mathematical modeling

The researchers reached this conclusion by combining a laboratory experiment with theory.

They first built patchy habitat networks in which to study the movement behavior and population growth of a model species, the tiny, insect-like springtail Folsomia candida.

Then, they used a mathematical model to explore other scenarios not addressed by the experiment, such as networks containing many more habitat patches than in the experiments. Gonzalez and his team found that the time taken for a population to colonize a network of habitat fragments can be predicted by the distances between habitat fragments and how easily organisms move between fragments.

Informing conservation efforts

Conservation efforts in patchy landscapes are geared toward reconnecting isolated habitat fragments with corridors to help organisms find the resources they need to avoid extinction in the long run.

"We wanted to give conservation actors a way to quantify and predict the connectivity of patchy landscapes," said Gonzalez.

"This knowledge is valuable for conservation NGOs because it could guide conservation action to reconnect patchy landscapes and ensure the long-term spread and persistence of threatened species." said Bronwyn Rayfield, the researcher who collected the experimental data.

The researchers also believe the results can be used to assist with habitat corridor restoration efforts that are already underway in many parts of the world.

The Canadian federal government is currently preparing a strategy for the conservation of habitat connectivity and investing in protecting and restoring habitat corridors. The Global Biodiversity Framework agreed upon at the COP15 Convention on Biological Diversity also places a great emphasis on restoring habitat connectivity worldwide.

"We believe our results provide new knowledge to guide action by nations looking to achieve the 2030 target for habitat connectivity in the coming decade," said Gonzalez, who is the founding director of the Quebec Centre for Biodiversity Science.

More information: Bronwyn Rayfield et al, Spread of networked populations is determined by the interplay between dispersal behavior and habitat configuration, *Proceedings of the National Academy of Sciences* (2023). DOI: 10.1073/pnas.2201553120

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