Tools for Evaluating the Importance of Habitat Patches in Hydrothermal Vent Metapopulations

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The transient, fragmented nature of hydrothermal vent habitats makes them well-suited for metapopulation models. Periodic disturbances such as vent eruptions mean each vent species exists as a network of local populations connected by dispersal—a metapopulation. The habitat topology of a vent metapopulation – e.g., the size, arrangement, and duration of habitat patches and dispersal corridors – can have a profound effect on population distribution and persistence. However, it is unclear exactly how these aspects of vent topology interact to determine persistence. Previous researchers have developed metrics rank the importance of habitat patches within a network in terms of their contribution to metapopulation persistence. Such metrics can quantify the effects of habitat topology. However, the effect of periodic changes in habitat suitability on these metrics has not been addressed. We develop and analyze a novel metapopulation model that explicitly incorporates the ephemeral nature of vent habitats. Our model quantifies the contribution of each habitat patch to vent metapopulation functioning and then relates those quantities to habitat topology. We determine the properties of a habitat patch that make it especially important for metapopulation functioning, with potential applications for deep-sea conservation.