Landscape Ecology of Mississippi River Mussels: Multiple Scale Metapopulation Perspective in Unionid Population Biology

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Goals and Objectives:

- To determine whether unionid populations in the Upper Mississippi River function as metapopulations.
- To determine whether fish host populations in the Upper Mississippi River function as metapopulations.
- To determine whether one species of fish host could contribute to population connectivity of unionid species or if multiple species are necessary to provide connectivity of populations.

Progress:
Daelyn Woolnough successfully defended her dissertation, "The importance of host fish in long range transport of unionids in large rivers" in June 2006 and obtained a Ph.D., majoring in Ecology and Evolutionary Biology. She is currently employed at Trent University in the Biology Department as a post-doctoral researcher (Peterborough Ontario, Canada).

Conclusions and Recommendations:
Ecological processes are influenced by spatial patterns of biota and the ways in which these patterns are connected. Freshwater mussel larvae are parasites on the gills and fins of fishes, and thus, the spatial distribution of these species are interrelated. We investigated the spatial distribution of this host-parasite relation over a 38 km reach of the Mississippi River using three spatial analysis tools (grid, spatial gradient, and Ripley's point pattern). We used a grid analysis to show that while both mussels and host fish are found along the entire reach of the river, <13% of the area had >2 species of mussels (out of a possible 36), but >18% of the area had >13 species of host fish (out of a possible 37). We identified areas which contained high mussel and host fish communities. Our spatial gradient analysis showed that 59% of all mussel communities were located within 100 m of host fish and there was a maximum of 21 mussel species (58% of all species). The maximum number of mussel species in communities did not increase from 100 m to 400 m from the host fish locations. We used Ripley's point pattern analysis to estimate the degree to which the mussel and host fish data were clustered, and found that both mussel and host fish species were statistically clustered over all spatial scales examined (0 to 1000 m) even after accounting for landscape complexity (i.e., islands and shoreline).

We demonstrate how the spatial patterns of freshwater mussel communities and the host fish for their larval stages were used to quantify the connectivity that host fish provide mussel communities. We considered 15 mussel species and their 35 species of host fish in a 38 km reach of the Upper Mississippi River. Connections were measured with two methods—direct connectivity and functional connectivity. Direct connectivity is that connectivity provided when a given mussel community is contained within the home range of its host fish; our results show that nine mussel species had large direct connectivity (>90% of communities contained within home range of hosts). Functional connectivity is a measure of the potential connection among and between mussel communities. We found that mussel communities with greater functional connectivity provided by hosts had a better condition (i.e., high species richness, high abundance, large site size, and variety of age distribution). The variation in this functional connectivity-condition relation can be partially explained by the subfamilies of mussel species. These analyses account for heterogeneity within river reaches of required resources and these methods may be used to predict the success of communities in fragmented environments.

There are five suggestions for future research that can expand on this research. First, a genetic analysis of mussel communities that either differ in functional connectivity or community condition could verify the results of this study. Second, would be to use the concepts presented to calculate host fish connectivity in an extremely fragmented or genetically understood population of mussels. Third, would be to test this methodology in small rivers that have less open water areas. The fourth empirical test would be to test these methods in lentic systems. Host fish are likely distributed differently in lentic systems and the lentic systems have less landscape complexity. Finally, the concept of