

- ❖ Scaling up restoration: a metapopulation approach to designing a network of oyster sanctuaries  
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A key to scaling up habitat restoration is to design restoration projects in an interdependent, rather than independent manner. An example relevant to oyster restoration is the design of a network of broodstock sanctuaries protected from harvest and connected by larval dispersal. The metapopulation concept, a population of populations, is a central tenet in the assessment and design of sanctuary networks. Effective application of this concept, however, is often limited by a lack of data on spatiotemporally explicit demographic rates and connectivity among populations. In this study, we integrated empirically-based demographic rates within ten oyster sanctuaries constructed by the NCDMF and regional hydrodynamic-based larval connectivity estimates among sanctuaries in Pamlico Sound, North Carolina to (1) assess the self-sustainability (i.e., interdependence) of the sanctuary network, (2) evaluate the efficacy of stock enhancement to improve network sustainability, and (3) determine whether a Few Large or Several Small sanctuaries, a modification of the Single Large or Several Small (SLOSS) debate, promoted greater network connectivity. Oyster sanctuary metapopulation abundance was projected to decline an order of magnitude over a 5 year period, due primarily to limited larval connectivity among sanctuaries. Stock enhancement was unable to augment the metapopulation decline. Increasing the number of existing sanctuaries tended to promote greater metapopulation retention of sanctuary-spawned larvae than increasing the size of existing sanctuaries. As the number or area of sanctuaries in the network increased, however, larval connectivity was equivalent between both designs, suggesting that Few Large and Several Small sanctuaries (FLASS) may be the optimal network design. Sanctuaries can be an effective restoration tool for improving oyster demographic rates and size-structure, but designation of multiple sanctuaries does not guarantee a self-sustaining network. Consideration of metapopulation dynamics is a useful framework for scaling up sanctuary-based restoration efforts in an interdependent manner to promote long-term benefits.