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The effect of homing fidelity on the persistence of migratory fish population

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The question of population persistence is of great interest in theoretical and conservation ecology. In many cases, this question has been approached through the use of matrix models. However, most matrix models do not consider spatial factors that affect population dynamics by assuming a population without dispersal or migration. Using a spatially explicit matrix model, we investigated the dependence of the overall population persistence on the strength of connectivity among subpopulations distributed at different locations and connected by migration. In particular, we studied the question of population persistence for a native, threatened, migratory fish species in North America, bull trout (Salvelinus confluentus), and examined the effect of the migration behavior of subpopulations on the persistence of overall population based on a four-patch matrix model. Here a classical persistence parameter, net reproductive rate, R0, was calculated by a new graph reduction method. The analysis of the rate of change of R0 with respect to the strength of connectivity indicates that the overall population has a high net reproductive rate when most subpopulations show strong homing fidelity while few stray. By way of contrast, we also introduced a new measure of population persistence, R1, the average number of offspring produced by the worst possible distribution of individuals amongst classes. Hence, R1 is a quantity that can be used to assess potential losses in the number of individuals incurred over a single generation. We then applied the R1 theory to the four-patch model. The relationship between R1 and the connectivity strength shows the opposite result to R0: homing fidelity can reduce R1, increasing the intergenerational population losses of migratory population. These results are applicable to other single-species migratory population where the life cycle of the subpopulations can be described explicitly in terms of ages or stages. The spatially structured population theory developed here introduces a new tool for the management and conservation of migratory species.

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