

Science for Environment Policy

Benefits of marine reserves revealed for wider range of fish species

Mathematical models created to help design marine reserves have tended to focus on fish species where larvae are highly mobile but adults occupy relatively small areas. However, new research has extended these models to include fish species with different life histories, such as groupers and flounders, showing that they also benefit substantially from reserve protection.

Marine reserves have been shown to benefit fish populations and maintain catches for the fishing fleets that depend on them. In designing these reserves, mathematical models are often used; however, these tend to focus on fish species where the adults are largely sedentary and only the larval stage moves any distance. This is a pattern commonly seen amongst fish living on rocky and coral reefs and in kelp forests. However, many economically important fish species do not follow that pattern of life history. Instead, the juveniles will spend time in a particular habitat before migrating as adults to habitats elsewhere.

To understand how marine reserves, and particularly 'no-take' reserves where fishing is banned, affect such species, the author of the study modelled a system containing two pairs of adult and juvenile habitats. In the model, juveniles could move from juvenile to adult habitats, and adults could move between adult habitats. Larvae also moved from adult habitats to juvenile habitats. The degree of connectivity between the habitats could also be varied.

To test the benefits of marine reserves, three different fishing scenarios were tested. The first included fishing in the juvenile habitat only, and the second included fishing only in the adult habitat. The final fishing scenario included fishing in both adult and juvenile habitats.

For all three scenarios, the model was run with fishing in both pairs of habitats e.g. both juvenile habitats, both adult habitats or both juvenile and adult habitats, as well as in just one of each pair — representing the presence of a no-take marine reserve in the unfished habitat.

The results showed that reserves buffered the fishery against overexploitation. Protecting one of the adult habitats with a marine reserve when fishing was concentrated in adult habitats prevented population collapse as long as connectivity between the adult habitats was poor, limiting adult movement between the habitats. In contrast, protecting one of the juvenile habitats with a marine reserve when fishing was focused in these habitats sustained populations regardless of the degree of connectivity between habitats.

When fishing occurred in both adult and juvenile habitats, marine reserves were only effective if they protected a connected pair of adult and juvenile habitats.

To apply these results in the design of marine reserves, policymakers would need to understand how adult populations are connected. The models also assumes little or no movement of juveniles between juvenile habitats, and it would be important to confirm this assumption in any species to which no-take reserves were being applied.



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