Habitat degradation and the future of fish assemblages on temperate and tropical reefs

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Background

Human impacts on temperate kelp forests and tropical coral reefs continue to cause dramatic changes to the biotic structure of these habitats (e.g., McClanahan and Muthiga 1988, Jones et al., 1993, Hughes 1994, Steneck and Carlton 2001). However, few have examined the consequences of declining kelp and coral cover for the biodiversity of mobile organisms using these habitats.

Aim

In this paper, reef-associated fishes are used as an indicator of the ecological price that the habitat-user pays for habitat degradation. While there are some fishes that play key "top-down" roles in both kelp forest and coral reef habitats, by far the greatest biodiversity of fish species are likely to be influenced from the "bottom-up".

Results

There are striking parallels between temperate and tropical reefs in fish-habitat interactions. In both kelp forest and coral reef systems, different biotic habitats are always associated with recognizably different fish communities. In both systems, greater fish biodiversity is always associated with habitats of greater complexity. Habitat degradation results in deterministic changes to the structure of fish communities, regardless of whether they are caused by global warming, pollution, or the exploitation or introduction of keystone predators, grazers (urchins, crown-of-thorns) or habitat-forming organisms (kelp, corals). Moderate disturbance to habitats is likely to be an important process that maintains fish species diversity, because it creates patchiness and promotes spatial heterogeneity. However, chronic or severe disturbance establishes homogeneous habitats that are the end point of a phase shift from one habitat type to another. Inevitably, this results in a decline in fish biodiversity through local extinction.

Unless these shallow water ecosystems are effectively managed, the following predictions can be made. Local extinctions will progress through regional extinction to global extinctions as the scale of human disturbance increases. The fish species most threatened are those with specialized habitat requirements and those with small geographic ranges. It is estimated that the extirpation of corals in tropical Australia would result in the regional extinction of obligate coral specialists (10-15% of reef fish species). However, most tropical fishes have some resilience to global extinction because of their large geographic ranges. A lower proportion of fishes in temperate Australian kelp-forests are likely to be affected by loss of kelp, as there are relatively few kelp specialists (<5% of species). However, specialists on temperate reefs are at a greater risk of global extinction because of their relatively small geographic ranges.

Conclusions

Clearly, human impacts on habitat-forming organisms (kelp, corals) and key habitat-drivers (urchins, starfish) must be ameliorated if fish biodiversity is to be maintained. Marine reserves have proven to be an effective tool in re-establishing natural habitat dynamics, where exploitation has proven to be the key human impact. However, marine reserves alone do not work when habitat changes are driven extrinsic processes that do not recognize reserve boundaries. No reef fish has or is likely to be exploited to extinction. Global warming represents the greatest threat to reef fishes, because it is the most efficient at destroying habitat-forming organisms (e.g., coral bleaching, kelp disease) and can modify the aquatic environment over large spatial scales.

References

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