Linking ecological and social elements to sustain coral reef fisheries: A case of groupers [Epinephelidae] in Mafia Island, Tanzania

Koblinger mellom økologiske og sosiale dimensjoner i sikring av bærekraftig korallrevfiskerier – Et case-studium av groupers [Epinephelidae] i Mafia Island, Tanzania

Philosophiae Doctor (PhD) Thesis

Lydia Gaspare Kanyairita

Department of International Environment and Development Studies, Noragric
Faculty of Social Sciences
Norwegian University of Life Sciences (NMBU)

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Abstract

The study of the dynamic nature of interactions within and between social and ecological aspects of reef fisheries is increasing, in order to promote understanding and to mitigate complex changes from global pressure and local threats that undermine sustainable coastal fisheries. In Tanzania, a trial fisheries policy allowing the export of grouper/rock cod, among other fishes, was endorsed in the year 2002. The policy goals were to improve the livelihoods of coastal communities and increase fish product exports. However, studies of the sustainability of commercially targeted fish species in Tanzania are inadequate; no information is available on the ecology and biology of groupers in Tanzanian marine waters that would ensure the sustainability of the fishery. There is a paucity of empirical evidence on impacts of management practices on ecological and social aspects of grouper fisheries. In particular, there is little documentation on the perceptions of small-scale fishers of changes related to Marine Protected Areas (MPAs) as a fisheries management tool.

This study investigates linkages between ecology and social elements for sustainability of targeted finfish *Epinephelinae* (groupers) fisheries in Mafia Island, Tanzania. In particular, this study draws on insights from different knowledge sources to investigate ecological trends of groupers in a Marine Protected Area (MPA), and the biological traits of frequently caught grouper species. The aim is to gain scientific evidence to support sustainable grouper harvesting. Groupers are ecologically important as top-level predators and play a major role in structuring coral reef ecosystems. Being highly priced fish, groupers are heavily exploited for commercial purposes and for local consumption worldwide, hence they are susceptible to overfishing. This vulnerability to overfishing is exacerbated by the life history characteristics of groupers, such as longevity, late maturation and spawning aggregation behaviour.

Using histological analysis, the sexual maturity of *Epinephelus malabaricus* was examined and the relationship between fish size, gear used, and depth of capture was evaluated. Underwater visual census (UVC) results were used to assess changes in ecological traits (body size, biomass and abundance) of groupers with reference to the establishment of the Mafia Island Marine Park (MIMP), and results were compared with fishers' perceptions. Semi-structured interviews, key informants interviews, focus group discussions, direct observation and informal discussions

were used to generate information from fishers' knowledge and perceptions about the ecology and biology of groupers and management outcomes. Factors influencing fishers' perceptions of MPA input and outcomes were also documented.

Analysis of *E. malabaricus* specimens, a large grouper species frequently caught by small-scale fishers, showed that all specimens above 90 cm in size were male. Low numbers of large groupers were landed, mostly during the northeast monsoon, a period coinciding with the spawning season (September to February). Interviews with fishers and observations made indicated no sign that small-scale fishers were targeting spawning aggregation areas.

Fishers had mixed perceptions concerning changes in size of groupers in the MPA; their perceptions were inconsistent with results from the UVCs which show no changes in size. Perceptions related to changes in abundance of groupers were consistent with data from the UVCs, both indicating a decrease. This observation encourages reconciling information from resource users with conventional scientific data to support effective management. A decrease in abundance of groupers in both no-take zones (NTZs) and specified-use zones (SUZs) was observed. This difference could be explained, among other reasons, as a detrimental effect of fishing.

The study also found that fishers' ecological knowledge and conventional scientific knowledge (CSK) complement one another. Fishers provided information on the dynamics and patterns of grouper utilization in Mafia, habitat preferences, and feeding habits. This information coincides with data from conventional knowledge. Fishers also provided information which is new to CSK, including fishing locations and environmental threats facing groupers in the wild. An area where fishers' knowledge and CSK did not coincide relates to spawning aggregations. The disagreement may be because both fishers and scientists have limited knowledge of deeper areas of Mafia where groupers are likely to spawn. Besides, fishers lack knowledge of spawning seasons and sex differentiation of groupers. The findings suggest that further collaborative research between fishers and scientists would enhance mutual learning.

Fishers' area of residence and fishing gear operated were found to influence their perceptions of MPA outcomes. Juani fishers felt more impacted by the MIMP than those from Kiegeani, due to the restriction of pull-net fishing which is an important type of gear for Juani fishers. Fishers' involvement in MPA planning and implementation increased the likelihood of perceiving positive effects of the MPA on fishers' own fishing activities. However, their involvement in enforcement and local level awareness of MPA regulations did not enhance acceptance of the MPA in the two communities assessed. Lack of access and user rights to productive fishing grounds and gear restrictions are factors responsible for the ongoing conflict between the MIMP and fishers.

The results of the study indicate that linking ecological and social aspects of commercially targeted fish resources would contribute to the successful implementation of the ecosystem approach to fisheries at local level. The study shows that reconciling information from different sources enhances the sustainable utilization of fisheries resources. The most important contributions of this thesis include the evidence about size at first maturity of *E. malabaricus*, the complementarity of fishers' ecological knowledge and CSK on the ecology and biology of groupers, and the value of fishers' perceptions on the outcomes of changes in management practices. The study recommends that integration of fishers' knowledge and conventional knowledge would improve the participation of local communities in the management of reef fisheries resources. The sharing of information and understanding different viewpoints of fishers and western trained managers and scientists, would result in a common forum for discussing problems related to fisheries and the management of MPAs.