Are Caribbean Fisheries Sustainable? Conservation and Exploitation Strategies Should be Compatible

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ABSTRACT

Most fisheries in the Caribbean are in decline. Regional governments have implemented fisheries management strategies with varying degrees of success. Although there are few examples of sustained fisheries in the Caribbean, there is evidence that damaged fisheries can recover and that some fisheries are sustainable. Recent research has documented that reef fish abundance can increase in closed areas and marine reserves. Investigations in the Virgin Islands have documented that species composition may be maintained at relatively low fishing effort. Fisheries landings may be sustained at higher fishing effort, but the species composition may change with increased yields of fecund, fast-growing species (e.g., surgeonfishes and parrotfishes) and depressed yields of long-lived, slow growing species (e.g., groupers and snappers). Sound management strategies are dependent on reliable fisheries data collection and efficient assessment methods, however, many conventional approaches are not effective for most tropical reef fisheries and ignore changes in fish assemblage structure. Assessments which use information on species composition may prove beneficial for management in tropical reef fisheries. The greatest challenge will be to derive fisheries strategies which will sustain fisheries, with intact assemblage structure, over decades.

KEY WORDS: Fisheries management, fisheries assessment, tropical reef fisheries

EFFECTS OF FISHING ON TROPICAL REEF FISH ASSEMBLAGES

Although numerous publications have discussed sustainable yield in tropical reef fisheries, few have discussed yield in terms of fishing effect on community structure, specifically species composition (reviewed by Russ, 1991; Medley *et al.*, 1993). There are several ecosystem models for fisheries, as well as a few attempts at development of ecosystem management plans. However, these have been of limited value for management of sustained yields within tropical reef

fisheries. Although examples of apparent sustained and underexploited tropical reef fisheries exist, these usually ignore fish assemblage structure.

Numerous investigations have shown the impact of fishing on species composition in tropical reef fisheries (reviewed by Russ, 1991; Medley *et al.*, 1993). One of the most complete studies for the Caribbean region was conducted on Pedro Bank and the Port Royal Cays off Jamaica (Koslow *et al.*, 1988). In this investigation, changes in fisheries effort over two decades were shown to have resulted in dramatic changes inspecies composition. Species composition on the eastern and western portions of Pedro Bank also was significantly different, apparently due to large differences in fishing effort. As in similar investigations elsewhere, large, slow-growing piscivorous species (e.g., groupers, snappers) significantly declined in catches in areas of high fishing pressure, whereas smaller, rapidly-growing species increased proportionally in catches.

Much of the decline in the larger piscivorous species is due to overfishing of spawning aggregations. Many of the species in this trophic group (primarily large groupers and snappers) are hermaphroditic and spawn at specific sites once per year. Although this practice has been widely recognized as destructive (Johannes, 1978; Olsen and LaPlace, 1979; Bohnsack, 1989; Beets and Friedlander, 1992), protection of spawning aggregations is still uncommon throughout the Caribbean. Intensive fishing of spawning aggregations can greatly affect the species composition of a fishery within a few years (Olsen and LaPlace, 1979).

Several important questions arise from the recognition of changes in species composition. One of the most important questions is how the biomass decline of species, and within trophic groups, affects the fish assemblage structure and the entire ecosystem. Few experiments have been conducted on these effects, although a few investigations have suggested potential ecosystem shifts (reviewed by Medley *et al.*, 1993; Hughes, 1994).

Another major question is whether overfished spawning aggregations can recover or re-establish. We have little data suggesting the level of fishing pressure which an aggregation can sustain. We have no data on recovery of an overfished aggregation. Although we have information on spawning behavior and social structure of a few species, little information exists on migration distance to aggregation sites, aggregation fidelity, social dynamics within and among aggregations, sex determination, etc. Also critical for biology and management is an understanding of the genetic structure among aggregations and a better understanding of what constitutes a stock or management unit. An

understanding of the relative contribution of retention and drift of larvae among aggregations is important.

Finally, how long does it take for an overfished area (or spawning aggregation) to recover? Levels of recovery have been observed in tropical reef fisheries following the establishment of various management strategies, especially in small areas (such as marine reserves; reviewed in Medley *et al.*, 1993). However, data are needed for large fisheries units, especially those under continuous fishing pressure, since that is a more realistic scenario for most nations. Many of these conditions may be similar among locations, although it is important to realize the variability among locations (e.g., assemblage structure, recruitment variability, etc.). There are large differences in species richness within trophic groups among regions. For example, numerous species of large herbivores are present in the Indo-pacific region (acanthurids, scarids, siganids), whereas the Caribbean region is relatively depauperate. Documentation of relative resilience is important. At the 8th International Coral Reef Symposium, Dr. Joe Connell presented information on the relatively slow recovery of Caribbean coral communities compared to other regions. This is probably true for reef fish assemblages as well, although the documentation is lacking.

EVALUATION OF REEF FISHERIES

Conventional reef fisheries assessment approaches have long been recognized as difficult for complex, multispecies reef fisheries. Although a few intensive, single-species assessments have been conducted, most assessments have been conducted using conventional models on the entire fish complex, e.g., surplus production models (reviewed in Medley *et al.*, 1993; Koslow *et al.*, 1994). Such models may demonstrate sustained or overexploited fisheries, but they do not include changes in species composition. Such evaluations are conducted separately, or, more commonly, not at all.

It has been suggested that fisheries assessments may be more useful, and certainly more practical, using species composition indices and/or other techniques (Koslow *et al.*, 1988). This approach could be accomplished with considerably less effort and could provide easy evaluation of improvements or declines in regional and local fisheries. This techniques should not be replace efforts of conventional methods, especially for important target species, but supplement existing efforts.

Data needed for development of a species composition index or evaluation would include: 1) abundance and biomass measurements of all species landed

within a fishery for the year (season), 2) measurement or estimate of effort, and 3) estimate of yield per area. Data could be derived from a fisheries-dependent project or supplemented with fisheries-independent sampling. Regardless, continuous sampling would not be critical for such an evaluation, although for comparison, consistent sampling would be necessary (same season, gear type, sampling method).

For example, data collected during recent studies in the US Virgin Islands showed that locations on the insular shelf with different fishing effort had significantly different fish species composition (Beets, in press). As observed on Pedro Bank (Koslow *et al.*, 1988), large piscovous fishes had declined in proportion to catches, whereas herbivorous fishes had increased. Using data collected on species abundance and biomass in catches, along with landings and effort data, estimates of yield per unit area were calculated. Estimated yield per unit area for the location with lower fishing effort and relatively intact species composition was 125 kg/km^2/year, whereas the estimated yield per unit area in the location with significantly different species composition and approximately three times the fishing effort was 352 kg/km^2. It would appear that for this shelf area in the Virgin Islands, a level of fishing effort and yield falling between these estimates would allow for maintenence of the assemblage structure. Sampling of effort would readily allow for this type of evaluation on a regular basis.

MANAGEMENT CONSIDERATIONS

Sound and successful management should use assessments which provide information for frequent evaluation. Conventional assessments (e.g., surplus production, yield per recruit models, etc.) are not only difficult or impossible to conduct in many tropical reef fisheries, but they are usually not conducted regularly, making evaluation of management strategies impossible. Changes in fish assemblage structure are frequently not evaluated during conventional fisheries assessments, therefore, ignoring potentially important shifts in fish species composition even if sustained yield is suggested.

Collection of data which allows for evaluation of species composition should be a priority in tropical reef fisheries. Significant changes in species composition should indicate the need for changes in or implementation of management strategies. The data from the Virgin Islands suggest that conservation and fisheries exploitation may be compatible if goals are defined and evaluations are conducted regularly. Management may allow for different goals and purposes in different locations, but resources should not be allowed to

decline to the level of ecosystem instability. A few management strategies should be adopted regardless of approach. Spawning aggregation protection should be implemented for maintenence of local population abundance and avoidance of severe changes in species composition. Marine fisheries reserves not only allow for recovery of fish assemblages in overharvested locations, but also allow for collection of comparative data useful for sound assessment.

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