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Overview of options for management of eastern Caribbean flyingfish fisheries

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INTRODUCTION

Flyingfish (*Hirundichthys affinis*) are a very important component of the fisheries for pelagic species in the eastern Caribbean, yet the resource remains unmanaged. Total annual catch by all islands was estimated to be around 3,500 metric tons in the early 1990s, with a landed value of about US$ 5.5 million (Oxenford 2007, Chapter 8). Barbados, the major participant in this fishery, expanded its fleet in the period 1978-1990, about doubling its catch. Other islands are developing their fisheries for pelagics, including flyingfish. The rapid and successful expansion of the flyingfish fleet in Barbados, and the stated aim of other Lesser Antillean islands to expand their flyingfish fisheries, suggests that overcapitalization and overexploitation of this resource may occur if fishing effort is not controlled in the future. Therefore, the extent to which the flyingfish stock in the eastern Caribbean can sustain increased exploitation is a matter of concern for all islands participating in the fishery, particularly given the indication that recruitment may be low in years following low spawning stock sizes.

The biological information gathered during the Eastern Caribbean Flyingfish Project indicates that this species is annual, and that both recruitment and catches are highly variable among years. The variability is probably caused by environmental variability, although no key environmental factors driving the recruitment variability have yet been identified. This variability results in uncertainty regarding the point at which low spawning stock size will reduce recruitment and lead to stock collapse.

The "Management Plan for Flyingfish" contained in "Fishery management options for Lesser Antilles countries" (Mahon 1990), was used as the basis for the present plan. The conclusions and recommendations contained in that document are reviewed in the light of the new information available through the ECFFP. The revised plan is presented below.

MANAGEMENT OBJECTIVES

The primary management objectives should be to maximise long-term catches of flyingfish, with consideration to safety margins which may be required to ensure sustainability, while minimising economic uncertainty for the harvesters, and variability in supply to consumers, by adopting measures which will stabilise catches between years.

Management measures should also consider the possible impact of reduced flyingfish stock sizes on abundance of pelagic predators, e.g. dolphinfish, which are also commercially exploited. Furthermore, the interactions of the flyingfish fishery with fishing for other pelagic species which is frequently carried out the same trips should be considered, particularly where flyingfish are frequently used as bait for those species.

Management unit

The minimum management unit for flyingfish should be the combined EEZs of Dominica, Martinique, St. Lucia, Barbados, St. Vincent and the Grenadines, Grenada and Trinidad and Tobago. This area would have to be expanded if the stock were found to be more widely distributed. This is based on the ECFFP finding that flyingfish appear to move freely among the islands of the eastern Caribbean. However, under the guidelines set out by UNCLOS individual countries may choose to develop management scenarios on the assumption that there are unit stocks of flyingfish within their EEZs, or that the extent of mixing is sufficiently low that it can be ignored for management purposes, until conclusive evidence to the contrary is found.

MANAGEMENT OPTIONS, TOOLS AND IMPLICATIONS

Management options for flyingfish could initially be considered in the context of two scenarios: (1) that the method of harvest remains dependent on the aggregation

of spawning adults; and (2) that harvest methods are developed which allow immature fish to be targeted. The latter scenario is considered to be unlikely, partly because of processing and marketing constraints imposed by the small size of the fish. However, these constraints might be alleviated if the primary reason for harvesting flyingfish was for bait for large pelagics. Management should discourage the harvesting of immature flyingfish for food or bait since recruitment overfishing is highly probable if immature fish are targeted. Management options for harvesting immature fish will therefore not be considered further in this document.

Increased fishing effort is likely to result in recruitment overfishing prior to the point at which yield-per-recruit (Y/R) is maximised (Oxenford *et al.* 2007, Chapter 24). Y/R recruit is therefore unlikely to be a useful management reference criterion for flyingfish. Recruitment overfishing will produce significant resource fluctuations, and periods during which fishing is not commercially viable. Management measures for flyingfish will therefore need to be aimed at protecting the spawning stock. This can be achieved by the use of management tools such as closed seasons and closed areas which protect fish during spawning, or by gear regulations, a total allowable catch (TAC) or limited effort which attempt to control the overall fishing mortality to a level which ensures an adequate spawning stock biomass.

Closed season or area

Since the fishery must take place during the spawning season, the spawning stock could be protected by closing the fishery during a part of the season. A major consideration would then be the timing of the closure. Spawning of flyingfish extends over 6-8 months, from November through June, and individual fish may spawn several times. There appear to be two peaks of spawning activity; a minor one around November-December, and a major one in April-May. The bimodality in spawning activity may indicate that there are two distinct groups of flyingfish each with its own spawning period. Alternatively, and more likely, since the mean size of flyingfish increases steadily from November to April, it may be due to environmental influences on a single extended spawning period.

If there are two distinct spawning groups, both must be protected, otherwise, one or other may collapse. Therefore, a closed period approach would have to ensure that there was at least one closed period for each spawning group. In either case, in an intensive fishery, taking the majority of the catch from one part of the season would shift the timing at which most spawning occurred. Instead of being distributed over the entire season, it would become concentrated in the closed period. This could have a number of undesirable effects which cannot be easily predicted at this time because they will depend on a number of characteristics which are presently unknown. These are primarily the frequency and duration of spawning of individual fish relative to the entire spawning season, but also include the extent to which the environmental characteristics which are favourable for survival of young flyingfish vary over the spawning season.

It would probably be inappropriate to implement management which would affect the timing of the spawning season, until the likely effects can be better evaluated. However, if a closed season is considered to be the most logistically feasible method of protecting the spawning potential of flyingfish, one approach could be to have several closed seasons over the spawning period. Another would be to shift the closed season within the spawning season from year to year.

Socioeconomic implications of a closed season approach will include the effects of closure on the economics of fishing operations, and on supply of fish to processors and consumers. These effects will be aggravated if more than one closed period is used per fishing season.

Present data suggest that flyingfish spawn throughout the eastern Caribbean, but may spawn more prolifically in some areas than in others. However, further information is required to accurately identify preferred spawning locations, before considering the use of closed areas as a management tool.

Gear regulations

It should be noted that there is little or no potential to influence the size of fish caught, or to affect the timing of capture of the fish by regulating the mesh size of the gillnets used to capture the fish (Mahon *et al.* 2000). Flyingfish appear to grow very little after they mature. Therefore, they vary little in size throughout the spawning season. Any change in gillnet mesh size has been observed to result in markedly lower catch rates for flyingfish, rather than a shift in the mean size of fish caught.

The practice of using tethered FADs to attract spawning adults may have management implications for recruitment. These FADs often become covered with eggs, and are brought back to shore by fishermen. If, as research results suggest, floating spawning substrate is scarce, the eggs removed from the stock in this way may

be a significant component of reproductive output. It may therefore be advantageous to require that fishermen set their FADs adrift at the end of each fishing trip.

TAC or limited effort

If a closed season is not used because it is desirable that fishing take place throughout the season, approaches which limit the proportion of spawning adults that are taken at all times throughout the spawning season should be considered. This can be achieved either by allocating the fishery a total allowable catch (TAC), or by limiting the fishing capacity of the fleet (limited effort) to a size which corresponds to an appropriate long-term average catch. The use off these approaches depends on the availability of information on which to base an appropriate TAC or maximum fleet size. However, since current catch and fleet size do not appear to be affecting flyingfish abundance, they can be used as a basis for management until better information becomes available.

A TAC approach can be implemented in various ways. The simplest approach is an open TAC for each fishing season. However, in this situation, competition between fishing units for the TAC would probably result in the development of excess fishing capacity (overcapitalisation). This might decrease the proportion of spawning occurring early in the season, with the longer-term risk of decreasing the availability of fish early in the season, and hence reducing the duration of the fishing season. Another approach is to implement a TAC either by setting quotas for periods within the spawning season (e.g. monthly TACs) which would reduce competition between fishing units, or by allocating quotas to individual fishing units, or enterprises which would prevent competition between them. The former situation would ensure a more even distribution of catch over the fishing season. In the latter situation, units would harvest their quotas on a schedule which would optimise their economic returns. This would probably result in a relatively even distribution of effort over the fishing season.

Despite the potential benefit of a TAC approach in protecting spawning stock biomass, it has considerable ongoing research and monitoring implications. The fishery managers must have the capability to monitor current cumulative catch and to close the fishery, or fishing operations of a unit, when the TAC or unit quota has been reached. This requires a considerable commitment of management resources, and will be particularly difficult under a regional management regime. A potential advantage of the TAC approach is that the TAC can be changed from year to year in response to the abundance of fish. However, to realise this advantage, the fishery manager must be able to predict the abundance in the coming season, and there must be the fishing capacity to take advantage of extra TAC in years of high abundance. The information required to accurately predict flyingfish abundance in the coming season is not yet available, and will be difficult to obtain.

The approach of limiting the fishing capacity of the fleet to a size which corresponds to an appropriate long-term average catch is less flexible than a TAC approach, but will probably be the more practical since it requires less intensive management and monitoring. On the basis of an agreed estimate of an average annual catch that is sustainable in the long-term, the appropriate fishing effort can be expressed in terms of the number of fishing units with the lowest fishing power (e.g. canoes). These units of fishing effort could then be allocated among participants. Inter-calibration of the various vessels fishing flyingfish may be required to allow the conversion of the effort allocation to the number of vessels of the type to be used by that participant.

MULTISPECIES CONSIDERATIONS

The multispecies nature of the pelagic fishery, which includes the flyingfish fishery, has important implications for both a closed season and a limited effort approach to management. Not only are flyingfish taken on the same trips as the large pelagics, and may constitute a significant proportion of the daily pelagic catch (particularly in Barbados), but they are also used as bait for the large pelagics. If a closed season were implemented, it would be necessary to permit the taking of flyingfish for bait, and its sale as bait, but not as food, during the closed season. It would also be necessary to evaluate the economic impact which the closed season may have on the operation of a pelagic fishing unit. If the flyingfish component of the catch is prohibited, fishing for the large pelagics alone may not be economical, and the closed season may reduce landings of species which are not the target of the regulations.

The multispecies nature of the fishery will make estimation of the fishing effort which corresponds to estimated sustainable annual catch, imprecise. Depending on the availability of, and preference for other species, the total effort directed at flyingfish in any year could vary considerably among years. A level of effort which would exert the appropriate fishing mortality on flyingfish in a year with average abundance of large pelagics, would overexploit flyingfish in a year when the abundance of large pelagics was low. This could increase the

probability of stock depletion and collapse. A further problem is that the optimal effort required to harvest flyingfish may differ from that required for the other species. Under these circumstances, some boats would have to be licensed to fish only large pelagics, and the potential problem that fishing large pelagics alone may not be economical would have to be considered again.

REGIONAL CONSIDERATIONS

The principle issues that must be considered if a regional approach to management is adopted are:

- Agreement on an appropriate regional yield for the resource.
- Fishing access by participating countries to the resource within the regional management area.
- Allocation of the appropriate yield between the participating countries.
- The appropriate management tools for achieving target allocations.
- Mechanisms for verifying adherence to allocations.

Approaches that can be used to estimate an appropriate regional yield for the resource are discussed by Oxenford *et al.* (2007, Chapter 24).

Fishing access to the resource could be based on the principle that each participant takes its allocation of the resource in its own EEZ, or on the principle of a common fishing zone within which participants fish wherever it is economically most appropriate. Factors that might influence this decision include, *inter alia*, economic efficiency of fishing which would be influenced by proximity to areas of high flyingfish abundance, control of access to resources other than flyingfish when fishing within the EEZs of other countries, national security, and narcotics and other goods surveillance and control.

In the context of allocation, criteria that could be considered include relative sizes of EEZs, relative flyingfish stock abundance or productivity within EEZs, the location of critical areas (such as preferred spawning areas), and historical rights. These issues are more fully discussed by Gulland (1980) and Caddy (1982).

Possible management tools for achieving target allocations include national TACs or effort quotas (numbers of fishing vessels). A TAC approach to allocation will require more intensive monitoring and more management infrastructure, and will therefore be more costly than an allocation approach based on effort quotas (see sub-section "TAC and limited effort"). Effort quotas may therefore be the more appropriate tool for managing target allocations at the present time. In the case of an effort quota approach in a common fishing zone, allocation will require that differences in the fishing power (catching capacity) of the various types of vessels harvesting flyingfish in the participating countries must be considered. Fishing power conversion factors between vessel types should be based on the average catch rates of the various vessel types when fishing in areas of equivalent flyingfish abundance.

Given likely geographical variation in flyingfish abundance, catch rates by national vessel types fishing within their own EEZs (domestic catch rates), should ideally not be used in calculating fishing power conversion factors, since it can not be assumed that flyingfish abundance is equivalent between EEZs. The data necessary to calculate fishing power conversions is not currently available. One approach would be to use domestic catch rates initially for effort allocations, and then to monitor fishing success as vessels move around within the common fishing zone, and use these data to calculate the fishing power conversion factors and revise effort quotas accordingly. Alternatively, a specific activity could be implemented before effort allocation, to obtain the necessary data for calculating fishing power conversions.

In the context of verifying adherence to effort allocations, a system of monitoring fleet size, and documenting fishing vessel upgrades and consequent increased catch rates, will be necessary to ensure that participating countries remain within their effort quotas, and to allow modification of national effort quotas as appropriate.

Finally, it should be noted that under a regional management plan, a country need not take its full share of the resource, but may sell or trade its rights to foreign (extra- or intra-regional) fleets. If an effort quota system were in place, the fishing power of the foreign vessels permitted to fish would need to be assessed, if not already known.

ENVIRONMENTAL CONSIDERATIONS

There are no well documented habitat conservation considerations for these species. However, recent indications of possible offshore dumping of toxic wastes in the Caribbean give cause for concern and vigilance.

Deforestation in the basins of major rivers of northern South America may influence the availability of flotsam on which flyingfish are reported to spawn.

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