Seasonality in the Commercial Marine Fisheries of Barbados

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RESUMEN

La pesca de agua salada de Barbados es anotada en cuatro grupos principales: le pelágica, de profundidad, de red y de nasas. Estas comprenden el 84.8, 7.4, 7.0 y 0.8% respectivamente, del total de la producción de peces de escama. El pez volador y el dorado constituyen el 53.2 y 34.1% respectivamente de las capturas de pelágicos y son las especies que más nos conciernen. Por más de cino años, ha existido una marcada y consistente estacionalidad en la pesca de las dos. El auge de la estación es de marzo a junio, con prácticamente ninguna pesca en agosto y octubre. El pináculo de la pesca coincide con la parte principal del período de desove de ambas especies. Las posibilidades de crecimiento de estas pesquerías debe incluir el averiguar dónde se encuentran las especies fuera de la temporada. La evidenica y teorías relativas a la caraterística estacional ha de requieir una evalución en lo que atañe al tamaño y estructura poblacional; factor importante en la determinación de cómo han de responder y si el manejo debiera comenzar en escala local o regional. Se considera el potencial de crecimiento de las pesquerías actuales de redes, trampas y de aguas profundas.

INTRODUCTION

The considerable annual variation in the harvest of most fishes exploited around Barbados undoubtedly has a primary influence on the social and economic structure of the fisheries. Nevertheless, the timing and magnitude of the variation has not been defined formally. In this study, we define the marine fisheries of Barbados, describe and discuss their seasonality, and consider the implications of the seasonality for the development and management of the fisheries.

THE FISHERIES

Since 1957 the Department of Fisheries, Barbados, has kept daily records of the weights of various groups of fishes landed at three major markets (Fig. 1), and of the number of launches landing fishes each day. Four major groups, or fisheries, are considered.

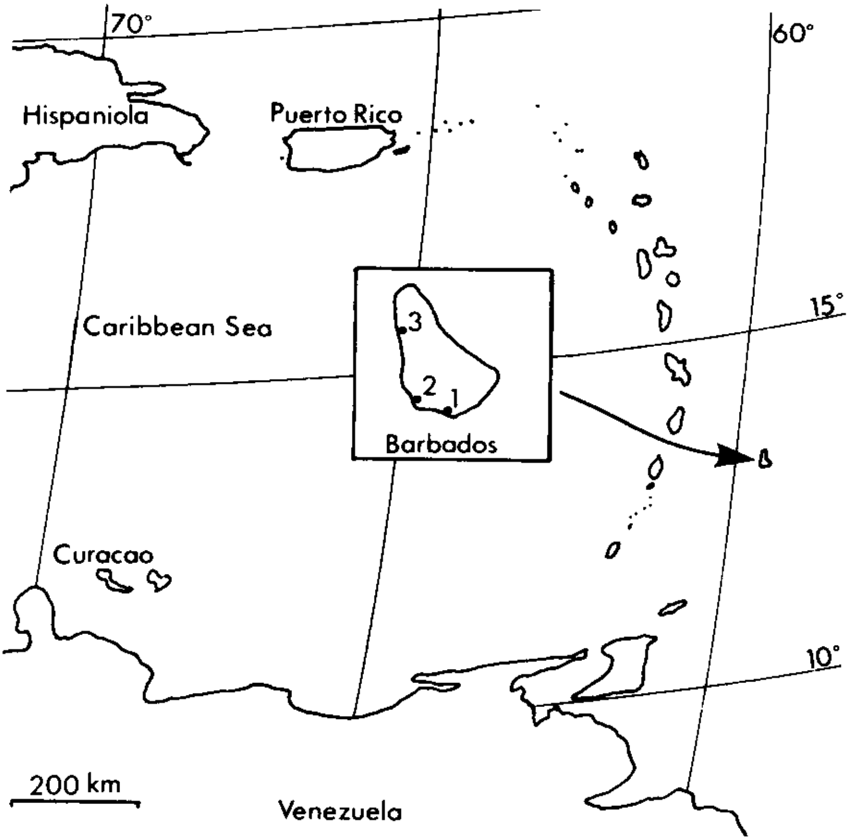

Figure 1. Barbados, and the location of the markets (1) Oistins, (2) Bay St., and (3) Speightstown.

Pelagic Fishery

Flying Fish.—primarily *Hirundichthys affinis* (common flying fish), occasionally *Cypselurus cyanopterus* (margined flying fish). These are taken about 15–40 km offshore on all coasts of the island, primarily by surface set gill nets. Short lines with baited hooks are also used, and in the peak of the season when large schools are at the surface, dip nets. In each case baskets of rotting fish are used to attract the fish.

Dolphin.—*Coryphaena hippurus* (dolphin), very seldom *C. equisetis* (pompano dolphin). Taken mainly by trolling around flotsam, but also in the open ocean travelling to and from flying fishing. In the latter case about 40 m of line is used; when flotsam is encountered several short lines are trolled back and forth around the object. At such times one or two hooked, living dolphins are left overboard to attract others. Flying fish are used for bait. Dolphin are also hooked from a drifting boat and by suspending baited hooks from a raft attached to the boat by a line.

Kingfish.—primarily *Acanthocybium solanderi* (wahoo), occasionally *Scomberomorus* spp. and other fishes of similar appearance. These are taken by trolling as described above, with variations in technique and bait.

Shark.—includes all sharks and rays. Many species are taken, among these the most common appear to be *Carcharinus maou* (oceanic whitetip shark), *Prionace glauca* (blue shark), and *Isurus oxyrinchus* (shortfin mako shark).

Billfish.—*Istiophorus albicans* (Atlantic sailfish) and *Makaira nigricans* (blue marlin). Taken by trolling in the open ocean.

Albacore.—primarily *Thunnus albacares* (yellowfin tuna) and *T. atlanticus* (blackfin tuna), some *Katsuwonus pelamis* (skipjack tuna), rarely *Thunnus alalunga* (albacore).

Flying fish and all large pelagic fishes are fished from the same launches on the same trips.

Deep Sea Fishery

The most common species are *Etelis oculatus* (queen snapper), *Lutjanus vivanus* (silk snapper), *Caranx lugubris* (black jack), *Seriola dumerili* (greater amberjack). Less common are *Rhomboplites aurorubens* (vermilion snapper), *Anisotremus surinamensis* (black margate), *Epinephelus mystacinus* (misty grouper), *Priacanthus cruentatus* (glasseye), *Selar crumenopthalmus* (bigeye scad), and *Hemipteronotus martinicensis* (straighttail razorfish). These are taken at depths of 100 m or greater; mostly on hand lines and occasionally in traps.

Seine Fishery

A beach seine, set from a small boat, is used to capture carangids and other fishes which school inshore. Detailed composition of the catch is not known.

Trap Fishery

Traps, referred to locally as pots, are set on or near reefs and seagrass beds. The most common species taken are: *Holocentrus rufus* (squirrel fish), *Cephalopholis fulva* (coney), *Epinephelus adscensionis* (rock hind), *E. guttatus* (red hind), *Haemulon chrysargyreum* (smallmouth grunt) and *Sparisoma viride* (stoplight parrotfish). Less common are: *Myripristis jacobus* (blackbar soldierfish), *Malacanthus plumieri* (sand tilefish), *Haemulon flavolineatum* (french grunt), *Bodianus rufus* (Spanish hogfish), *Halichoeres radiatus* (puddingwife wrasse) and *Scarus taeniopterus* (princess parrotfish). Numerous other species are occasionally taken.

The lists of species and fishing methods given above are not exhaustive; they are given with the intention of characterizing the fisheries rather than describing them completely. The four groups represent distinct fishery ventures as they employ different gear in different habitats.

SEASONALITY AND RELATIVE ABUNDANCE

The mean landings per month per market are shown in Figure 2 for flying fish, large pelagic fishes and for deep sea, seine, and trap fishes together. There is a distinct cycle in landings of pelagic species such that it is more appropriate to consider their season as extending from the beginning of October to the end of the following September, rather than according to the calendar year. Fishing effort (Fig. 3) varies seasonally in phase with the landings of pelagic species, almost certainly in response to their availability.

The landings of fishes of the other three groups are out of phase with the seasonality of the pelagic fishery and they will be referred to as the "alternative fisheries." These alternative fisheries contribute from about 8-20% of the total landings at the three markets (Table 1). These figures may underes-

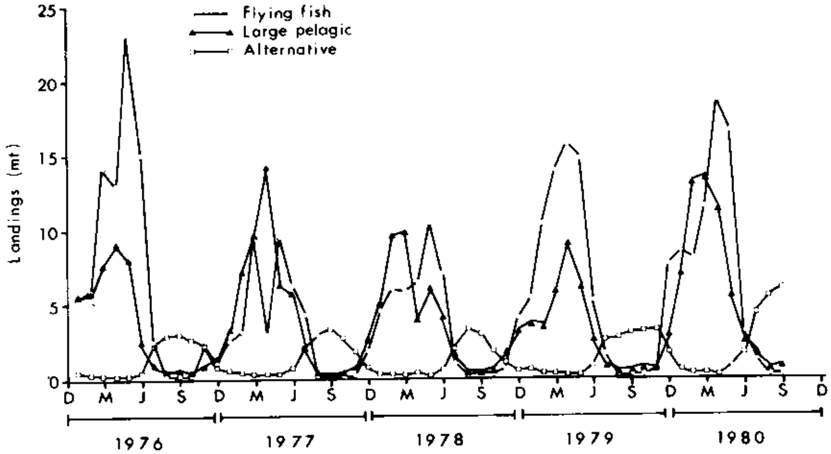

Figure 2. The average monthly landings (mt) per market for flying fish, large pelagic fishes and the alternative fisheries.

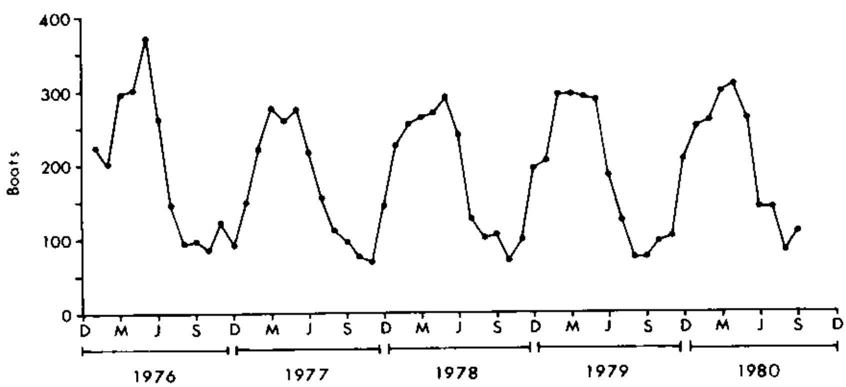

Figure 3. The average number of boats per market landing fish each month.

Table 1. The percentage composition of the catch landed at the three markets during the 1977-1978, 1978-1979, and 1979-1980 fishing seasons

Fishery	Oistins	Bay Street	Speightstown
Pelagic			
Flying fish	27.2	62.7	70.3
Dolphin	41.2	16.2	12.1
Other	12.9	12.7	4.5
Total	81.3	91.6	86.9
Seine	8.6	2.3	7.5
Deep sea	9.8	5.4	3.9
Trap	0.3	0.7	1.7
Total	18.7	8.4	3.1

timate the islandwide importance of the alternative fisheries which are more likely to be pursued part time, and the fishes consumed locally.

Dolphin are clearly the most important large pelagic species in each market (Table 1). Surprisingly, the proportions of flying fish, dolphin and other large pelagic species vary considerably among the markets (Table 2),

Table 2. The mean catch per launch per day (kg) in each market during the peak season for pelagic fishes (January-June inclusive)

Species	Season	Market		
		Oistins	Bay St.	Speightstown
Flying fish	1975-76	29.6	44.8	88.4
	1976-77	17.3	25.3	41.9
	1977-78	15.7	26.3	48.2
	1978-79	33.3	39.3	80.5
	1979-80	17.4	33.5	84.9
Dolphin	1975-76	37.4	8.6	10.6
	1976-77	42.2	10.4	16.7
	1977-78	32.4	8.4	13.1
	1978-79	26.7	5.1	7.1
	197 -80	49.0	8.8	11.2

considering that Speightstown and Oistins are only 30 km apart. The mean catch of flying fish per launch per day is consistently about four times higher in the Speightstown region than in the Oistins region. For dolphin, the mean catch per launch per day is highest in the Oistins region but similar at the other two markets.

DISCUSSION

In most Caribbean territories, coral reef fishes dominate the harvest (Munro, 1973). Of the exceptions mentioned by Munro, Barbados is perhaps unique in the extent to which pelagic fishes, especially flying fish (Hess, 1961), comprise the harvest. In the Caribbean, flying fish are exploited primarily by a few islands in the southeast, and are not even considered by Klima (1976) in his review of the fishery resources of the western central Atlantic. Dolphin, on the other hand, are widely utilized throughout the Caribbean (Beardsley, 1967) and up the east coast of the United States, where they support a seasonal sport fishery (Rose and Hasler, 1974).

The biology of the flying fish is poorly known and we are ill-equipped to explain the annual variation in its abundance. The period of peak abundance coincides with the peak spawning period (Lewis et al., 1962). However, whether the variations result from an onshore-offshore type of movement such as postulated by Hall (1955) or a contranatant-denatant migratory pattern, is not known. An onshore spawning movement can be advantageous since, owing to the "island mass effect", plankton productivity is usually higher in the vicinity of Barbados than in the neighboring open ocean (Sander and Steven, 1973), thus providing abundant food for larvae and juveniles. Furthermore, eddies, such as described by Emery (1972), could serve to reduce dispersal of offspring from the vicinity of the island until they were capable of actively swimming against the current. A case for the role of eddies and gyres in minimizing the dispersal of the young of neritic species from oceanic islands has been presented by Johannes (1978).

The sequence of peaks in abundance of dolphin at various points in the west central Atlantic indicates a generalized north-south movement, but there is insufficient evidence to distinguish its pattern or extent. According to Gibbs and Collette (1959) the period of maximum abundance in the Gulf Stream coincides with the period of minimum abundance in the Caribbean region. Within the Caribbean, the peak at Barbados (Fig. 2) occurs a month or two after the peak at Puerto Rico (Erdman, 1962) and a month or two before the peak at Curacao (Zanefield, 1962). Similar north-south movements of dolphin have been observed off the east coasts of Africa (Williams and Newell, 1957) and China (Kojima, 1955). Although in both cases the details of these movements are also unclear, they appear to be correlated with surface salinity and temperature. The period of minimum abundance of dolphin around Barbados coincides with the annual minimum surface salinity of waters entering the Caribbean near Barbados (Borstad, in press) and is just before the annual maximum in surface water temperature (Sander and Steven, 1973). Off China, low catches also coincide with a period of high salinity (Kojima, 1955). In contrast, off Africa, high catches of dolphin coincide with low salinity and high temperature (Williams and Newell, 1957).

The pattern of seasonal abundance of dolphin around Barbados may be further complicated by an onshore-offshore movement as observed by Williams (1953) for dolphin off the east coast of Africa, and by Kojima (1955) for those in the Japan Sea. Williams suggests that the dolphin move inshore to spawn. The patterns of movement of dolphin in the Caribbean and the factors affecting these movements require closer examination. We are of the opinion that, in the absence of funds for extensive tagging studies, data on seasonal abundance of dolphin in various Caribbean territories will play an important role in evaluating these patterns.

The differences in relative abundance of flying fish and dolphin among the three markets are striking. However, although the island is small, sea conditions on the Atlantic and Caribbean coasts are very different. Dolphin are commonly associated with floating objects (Kojima, 1956; Beardsley, 1967), and since Barbados is downstream of northeast South America, flotsam approaches the island from the southeast. Consequently, these objects are first encountered by launches from the Oistins market (Fig. 1) and are likely "fished out" by the time they reach the west of the island. Nevetheless, if the hypothesis that flying fish move inshore to spawn for the reasons outlined above is correct, then they should be most abundant on the western, downstream side of the island, where the area of increased productivity is largest (Sander and Steven, 1973). This is the area fished by the Speightstown market fleet for which flying fish catches are highest. Since both dolphin and flying fish are taken on the same trips, a negative association between the catches of these two species, similar to that described for cod and haddock by Dickie (1965), is to be expected. Nevertheless, as dolphin are fished in preference to flying fish the differences in catch per unit effort for dolphin among markets are probably an accurate reflection of their relative abundance in the areas fished. On the other hand, preferential fishing for dolphin in Oistins may result in low catches of flying fish which bear no relationship to their abundance. As pointed out by Dickie (1965), it will be necessary to determine the amount of effort expended on each species, or to conduct independent surveys of abundance, before the differences among markets can be satisfactorily evaluated.

The practical implications of the observed seasonality pertain to both development and management. Marked seasonality of the two major species indicates that they may be available for exploitation at other times of the year. Evaluation of this possibility requires determination of the location of the fishes in off season. If they migrate out of the region, as dolphin may, or disperse widely offshore, as flying fish may, expansion of the fishery will be impractical, or at least expensive. However, if only a change in depth distribution of the fishes is involved, as in the case of flying fish in the Red Sea (Messieh, pers. comm.), then an alternative strategy for exploitation in the off season may be possible.

Management implications of the observed seasonality concern the size and extent of the stocks of flying fish and dolphin which are being exploited. In both cases, the alternative of wide ranging migration suggests that the stocks will be large and that the fisheries of the eastern Caribbean islands are unlikely to be appreciably affecting them at present. However, under these circumstances regional management programs will be needed as exploitation intensifies. In contrast, local stocks, associated with each island, could be managed independently but are more likely to have been affected by present levels of exploitation.

Among the alternative fisheries, the deep sea fishery probably has the most potential for expansion into a year round venture. To determine the feasibility of this it will be necessary to assess the size of the resource. The species presently harvested are fished extensively in many other Caribbean territories and Kawaguchi (1974) has estimated that annual production in most of these fisheries could be increased by two to four times. Expansion of the seine fishery will most probably be limited by the availability of suitable beaches, most of which are already fished. Although there is no documentation, the inshore resource, harvested by the trap fishery, appears to have been severely overexploited. Increased production in this fishery would require rehabilitation of the resource by closure and gear regulation. The feasibility of this approach requires an assessment of the potential of the resource, perhaps by comparison with the productivity of other similar areas in the Caribbean as given by Munro (1976). The costs and benefits of rehabilitation could then be compared.

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