URCHIN FISHERY IN BARBADOS

L.A. VERMEER, W. HUNTE AND H.A. OXENFORD
Marine Resource and Environmental Management Program (MAREMP)
University of the West Indies
P.O. Box 64
Bridgetown, Barbados

ABSTRACT

The potential for community-level management of the sea urchin fishery in Barbados was investigated by interviewing 35 sea urchin fishermen to obtain information on the characteristics of the fishery and fishing community, and on the fishermen's responses to management. There are about 220 fishermen in the fishery, approximately 6 million sea urchins are harvested annually during the legal harvest season, and most fishermen (91%) consider revenue from the fishery to be an important part of their annual income. Although most fishermen (88%) claimed that over-harvesting was not a major cause of decreased sea urchin abundance, most (74%) felt that the fishery should be managed. Management measures most favoured by fishermen included gear restrictions, seasonal closure and habitat preservation. Measures least favoured were licensing and allocation of exclusive fishing rights to community groups. Fishermen perceived sea urchin fishing areas to differ in quality, which would create equity problems for allocation of property rights between communities. Moreover, most fishermen (76%) did not object to persons from outside their community sharing their fishing area, and felt that it would be difficult to prevent this. Less than half of the fishermen (48-49%) felt that community management groups could be formed, or that a community leader could encourage greater cooperation amongst sea urchin fishermen within the community. Based on these results, it seems unlikely that an area-specific community-level management approach, such as that used in St. Lucia, would be effective for the Barbados sea urchin fishery. An alternative co-management approach, which uses a system of flexible closed seasons implemented by Government but determined annually by fishermen monitoring sea urchin abundance, is described and recommended.

INTRODUCTION

The sea urchin *Tripneustes ventricosus* is widely distributed throughout the Caribbean, ranging from Bermuda and Florida in the north and west, to the east coast of Mexico, Central America and Brazil. It also occurs at Ascension Island and

along the west coast of Africa (Mortensen 1943; Mayr 1954; Lewis 1958). *T. ventricosus* typically inhabits beds of *Thalassia testudinum*, and areas of coral rubble and rock flats which support heavy algal growths, particularly of *Dictyota* and *Padina* spp. (Clark 1919; Lewis 1958; McPherson 1965). It seldom occurs on living coral reefs or on sand substrate, and is typically limited to depths not exceeding 30 ft. (Lewis 1958).

In the eastern Caribbean, populations of *T. ventricosus* are harvested in several countries including Barbados, Grenada, St. Lucia, St. Vincent and the Grenadines and Martinique. In Barbados, the urchins have supported an important fishery for over a century, their gonads being considered a traditional local delicacy (Scheibling and Mladenov 1987). As early as the 1870's, complaints by fishermen about a reduction in the distribution and abundance of urchins prompted the implementation of the Sea Egg Preservation Act (1879) which prohibited the harvest of the urchins between May and August, during what was believed to be the reproductive season (Bair 1962). In 1904, the Fisheries Regulation Act was enacted and was the first comprehensive law pertaining to fisheries regulation in Barbados. This legislation was prompted, not only by the continued decline of sea urchins, but also by reduced abundance of turtles, marine crabs, lobsters and reef fish, and by the persistence of dynamiting on reefs (Bair 1962). With respect to sea urchins, it mandated that the annual closed season would be as published in the official gazette, and the official closed season continued to be May-August each year. However, seasonal closure has never been effectively enforced and remains generally unheeded, and harvesting typically occurs well before the legal start date of September 1st every season.

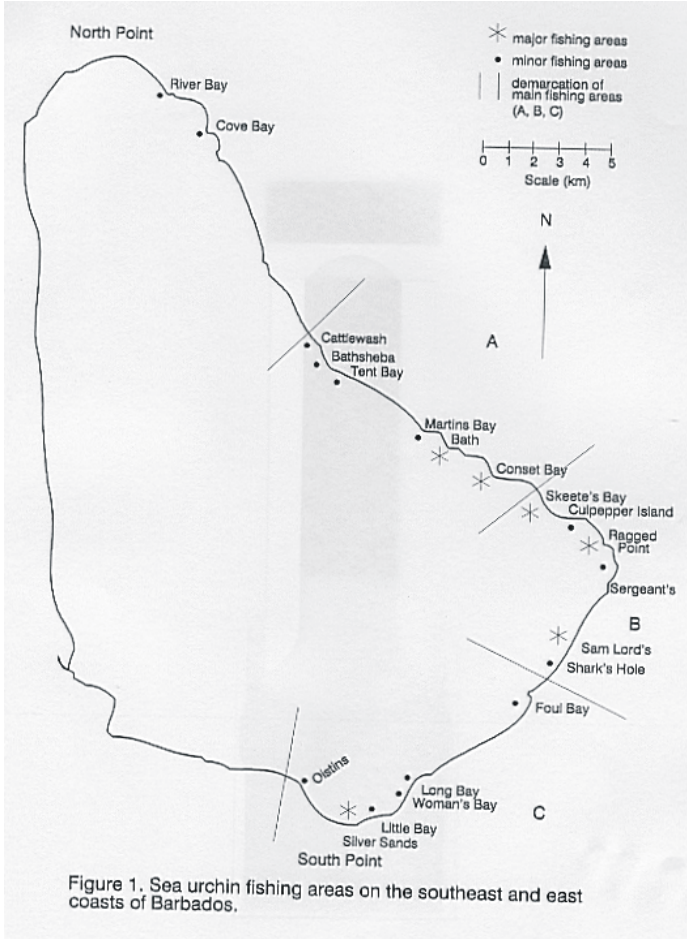

Figure 1. Sea urchin fishing areas on the southeast and east coasts of Barbados.

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In the mid-1980's, the abundance of *T. ventricosus* in Barbados was so low that fishermen did not consider harvesting to be worthwhile. In 1986, Bellairs Research Institute (BRI), the University of the West Indies (UWI) and the Barbados Fisheries Division (BFD), with sponsorship from the International Development

Research Center (Canada), initiated a program to rehabilitate the sea urchin fishery and to make recommendations for future management of sea urchins in Barbados. Resulting from this, the Government of Barbados imposed a moratorium on sea urchin harvesting for two seasons, i.e. for September 1987 to August 1989 (Hunte, 1987a). A monitoring program indicated a fairly rapid increase in sea urchin abundance during the moratorium, and the moratorium was lifted in September 1989 as scheduled. The sea urchin fishery was re-opened as a free-access commercial fishery. However, the fishing season was reduced by Gazette from the traditional 8-month period (September to April) to the 4-month period September to December. The rationale was that this may be the best compromise between allowing urchins the opportunity for some breeding prior to harvest onset, thereby allowing some production of next season?s harvestable population, and the need of fishermen to harvest before the end of the breeding season when most urchins would be devoid of roe (Hunte et al. 1993a). This conflict is somewhat relieved by the fact that the gonads contain nutritive cells which are only slowly re-absorbed following seasonal spawning. Although the gonads are smaller at this time than at peak spawning, they are firmer and the firmer texture is preferred by Barbadian consumers (Hunte et al. 1993b). Additional recommendations made by the BRI/UWI/BFD Project were that urchins in patches should be sub-sampled for ripeness prior to harvesting the patch, since individual spawning cycles tend to be synchronized in patches and the ripeness stage of sub-sampled individuals therefore predicts the ripeness stage of the patch; and that SCUBA gear should not be used to harvest urchins, since this encouraged the removal of whole patches with "ripeness testing" only occurring later at time of "processing" (Hunte et al. 1993a).

These recommendations were never implemented as management measures. In particular, there was no serious cooperation with, or enforcement of, the 8-month closed season, and substantial harvesting continued to begin before September 1st. Population levels of *T. ventricosus* declined rapidly, and were again so low by 1991 that harvesting in both 1991 and 1992 was negligible (Hunte et al. 1993b). Monitoring conducted in 1993 and 1994 again suggests a quite rapid recovery of the urchin populations following 2 years of negligible harvesting.

Community-based management of natural resources has frequently been advocated as a solution to the "commons problem" created by the open access fisheries of the Lesser Antilles (Berkes 1987; Chakalall 1991; Renard 1991; Smith and Berkes 1991). The "tragedy of the commons", as proposed by Hardin (1968), maintains that commonly owned scarce natural resources are inherently prone to over-exploitation. Conventional approaches to solving the commons problem are either the privatization of the resource or centralized government control, the latter

being the more common. Privatization of resources is more feasible for readily appropriated resources, less so for most marine resources. However, the assignation of exclusive and transferrable harvest rights to individuals (i.e. individual transferrable quotas or "ITQs") is a commonly employed mechanism through which marine resources can be privately allocated.

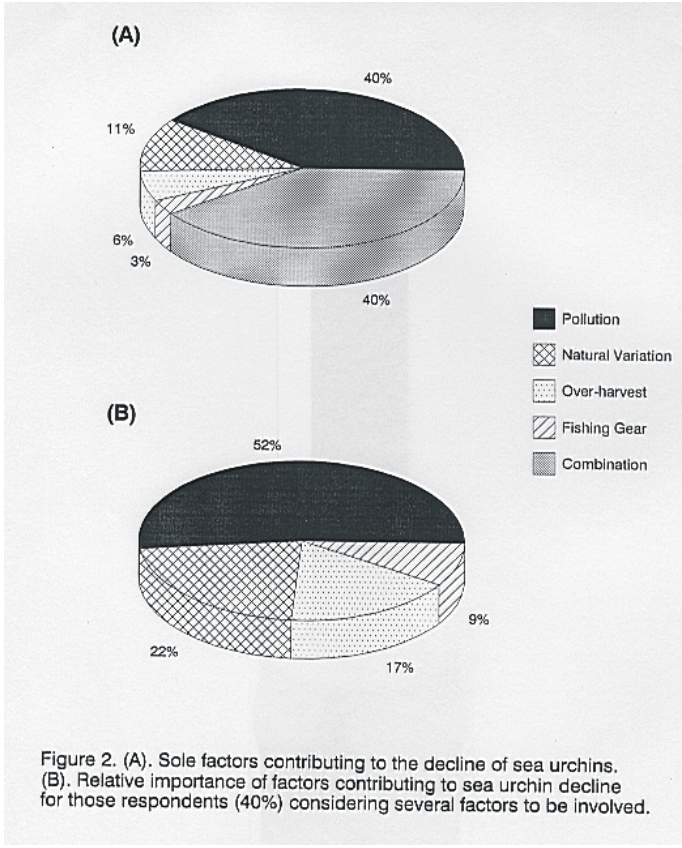

Figure 2. (A). Sole factors contributing to the decline of sea urchins. (B). Relative importance of factors contributing to sea urchin decline for those respondents (40%) considering several factors to be involved.

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Community-based management can be perceived as the assignation of exclusive harvest rights to groups of individuals (communities), who have responsibility for management of that portion of the resource over which they have harvest rights. Preliminary results from the sea urchin fishery in St. Lucia suggest that this area-specific community-based management may prove to be an effective solution to the commons problem for scarce natural resources in the eastern Caribbean (Smith and Walters 1991; Smith and Berkes 1991; George and Joseph in press).

The feasibility of community-based management of the Barbados sea urchin fishery should be assessed by considering the general criteria necessary for the success of community-based management against the background of the traditional and current nature of the fishery in Barbados, and by comparing the characteristics of the Barbados fishery with the sea urchin fishery in St. Lucia, where initial results suggest that community-based management may have been successful.

A number of factors can be considered pertinent to the success of community-based management. The first is that the resource must be divisible, and preferably readily allocated among different communities. Allocation among communities is feasible if the communities can be readily defined and are relatively discrete. This is facilitated by spatial separation of communities. Second, the biology of the resource must be such that the resource can respond to spatially local management efforts. This requires that the resource be self-recruiting, i.e. local populations are functionally discrete, or that recruits are attracted to areas of greater adult abundance. It is not yet possible to state with confidence whether either of these characteristics are exhibited by *T. ventricosus* (but see Hunte et al. 1993a). Harvestable individuals should be constrained in their movement, tending to remain in the same general locations. Third, members of the fishing group or community must share a common interest and goal, the interest being the shared resource and the goal being sustainable harvest of the resource. Finally, community members must be able to enforce agreed management measures among themselves and on individuals from outside the community. In this study, sea urchin fishermen from the southeast and east coasts of Barbados, where most sea urchin fishing occurs, were interviewed to obtain information on (1) characteristics of the sea urchin fishery, (2) characteristics of the sea urchin fishing community, and (3) the fishing community?s responses to possible management measures for the sea urchin fishery. The primary objective was to use the data collected from the interviews to assess the feasibility of developing a community-based approach to management of the Barbados sea urchin fishery.

METHODS

A total of 35 sea urchin fishermen were interviewed by questionnaire between March and April 1993 in Oistins, Silver Sands, Sam Lords, Ragged Point, Marley Vale, Skeete?s Bay, Conset Bay, Bath and Tent Bay along the southeast and east coasts of Barbados, where most sea urchin fishing occurs (Figure 1). Most of the respondents lived in the parishes of St. Philip (38%) and St. John (27%), while some lived in Christ Church (18%) and St. Joseph (14%). Only one lived on the west coast of Barbados (St. James). This distribution of respondents by parish reasonably approximates the distribution of sea urchin fishermen by parish, since most sea urchin fishermen live in parishes adjoining the coasts where sea urchin fishing is heaviest (Figure 1). The questionnaire was divided into 3 components: (1) characteristics of the sea urchin fishery, (2) characteristics of the sea urchin fishing community, and (3) responses to management of the sea urchin fishery. Throughout the results section, the number of respondents (N) to a question is provided in parentheses, since all 35 respondents did not provide answers to each question.

Table 1. Ranges of the number of sea urchin fishermen in Barbados, as indicated by the individuals interviewed in the survey (N=33 respondents).

Number of Sea urchin Fishermen (Range)	% Interviewees Indicating the Specified Range
1 - 50	18.2
51 - 100	15.2
101 - 500	21.2
> 500	15.2
uncertain	30.2

Table 2. Ranges of the number of sea urchin harvested by day by urchin fishermen

(N=33 respondents). Crude estimated mean = 220

Sea urchin Harvested (Range)	% Fishermen Harvesting this Range
0 - 100	27.3
101 - 300	24.2
301 - 500	24.2
501 - 1000	6.1
>1000	12.1
uncertain	6.1

RESULTS

Characteristics of the Sea Urchin Fishery

Fishing Area

The survey results confirmed that sea urchins are distributed all around Barbados, but occur in greatest densities on the southeast and east coasts, primarily between South Point and Bath (Figure 1). Respondents were equally divided as regards the spatial continuity of sea urchin fishing areas, 50% (N=34), perceiving the areas as continuous and 50% perceiving them as well separated. However, all respondents (N=35) claimed that certain areas were better than others for harvesting sea urchins, because of greater densities (40%), better quality of sea urchins (29%), or a combination of density and quality (31%). In particular, respondents interviewed between Ragged Point and Skeete?s Bay (N=12) were adamant that the sea urchins in their area were better tasting than anywhere else on the island. Variation in quality of fishing areas, whether real or perceived, creates difficulties for allocating fishermen to specific fishing areas.

Fishing Gear

Few fishermen interviewed used SCUBA to harvest sea urchins (11%; N=35). Most objected to its use (59%; N=35), claiming that it resulted in over-harvest of urchins. These figures may underestimate use and approval of SCUBA in the fishery, since the fishermen interviewed were the more established, regular and traditional harvesters. The fishermen who use SCUBA tend to be opportunistic, less regular harvesters. The respondents typically harvested the urchins by diving with mask, snorkel and fins. Most fishermen either swam out from shore (43%; N=35)

or went out by the traditional Barbadian "day boat" (7-12 m launch with inboard motor) (40%). However, some (14%) went out by "moses" (small open row boat with or without outboard motor) and a few (3%) by "ice boat" (12-18 m launch with inboard motor).

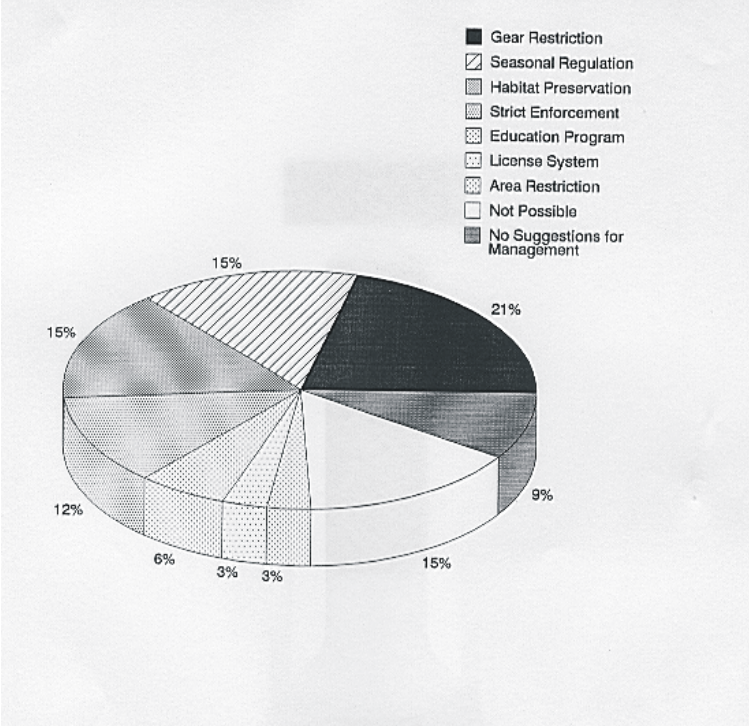

Figure 3. Measures identified by respondents as being of primary importance for the management of the sea urchin fishery.

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Those who swam often carried a floating log (e.g. a "maypole") from which sacks to hold the urchins were suspended. Some fishermen who had boats claimed that they rarely used them since the presence of boats attracted other fishermen. In all cases, the urchins are removed from the substrate, by hand or with a metal rod, and collected in a net bag called a "screeler".

Fishing Practices

Almost all respondents (94%; N=35) sub-sampled a few urchins from each urchin patch encountered to check for ripeness of the gonads before harvesting the patch. This figure probably overestimates the practice since most respondents were regular fishermen using traditional practices and no SCUBA. The basis for determining ripeness was primarily direct assessment of the condition of the roe (79%; N=34). However, 9% of respondents claimed to ascertain ripeness by either the time of the year or by the thickness of the urchin shell. The plausibility of assessing ripeness by shell thickness is questionable. Most fishermen (60%; N=35) claimed that the ideal sea urchin harvest season was between September and December. However, 31% felt that August to October were the best months to harvest, and 9% contended that harvest was similar year-round.

Fishing Effort and Catch

The number of sea urchin fishermen estimated to be in Barbados by respondents varied considerably (Table 1). This may be partly due to differences between respondents in what constitutes a "sea urchin fisherman", e.g. someone who regularly harvests sea urchins throughout the season or someone who harvests infrequently and/or opportunistically. A crude mean number of fishermen estimated from these data is 220. During the peak fishing season (considered by fishermen to be September to November), 71% of respondents (N=35) fished daily; 23% fished 4 to 5 times per week, and 6% fished 2 to 3 times per week. The estimated number of sea urchins collected per fisherman per fishing trip varied between respondents (Table 2). Most fishermen (76%; N=33) typically harvested less than 500 urchins per trip, but the number estimated ranged between 30 and 3000. A crude mean estimated from these data is 350 urchins harvested per fisherman per trip. Based on this figure, on the estimated number of fishermen, and on the estimated frequency of harvesting in peak season (September to November), approximately half a million sea urchins would be harvested per week, giving a total of 6 million urchins harvested in peak season alone.

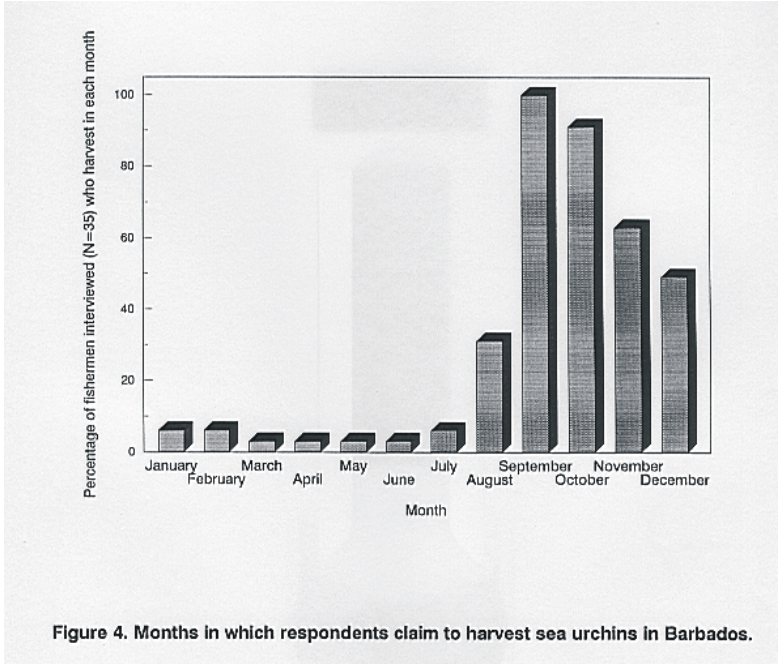

Figure 4. Months in which respondents claim to harvest sea urchins in Barbados

Characteristics of the Sea Urchin Fishing Community

Importance of the Fishery

Most individuals interviewed (59%; N=35) were full-time fishermen who focused their effort on the offshore pelagic fishery between December and June, and switched to the sea urchin fishery during the pelagic off-season (July-November).

Most respondents (91%; N=35) claimed that revenue generated by the urchin fishery was an important part of their annual income. Fishermen quoted the sales price of roe as $20 US per liter container, and estimated that it takes about 150 urchins to provide a liter of roe. Based on the estimated catch rates, an urchin fisherman could earn more than $300 US per week if fishing daily, and therefore

about $4000 US during the 3-month peak fishing. Most respondents (91%, N=35) also claimed that sea urchins were an important part of their diet and the diet of their families. Moreover, 94% of respondents (N=35) felt that the consumption of sea urchins was an important part of the tradition and culture of Barbadians.

Social Practices in the Fishery

Sea urchin harvesters typically fish with other urchin fishermen (89%; N=35), usually with the same individuals each time (88%; N=32), and most often in groups of 5 people or less (90%; N=29). The crude mean fishing group size estimated from the data was 4. There are typically between 5 and 10 groups from a community fishing in the same basic area. Of particular interest in the context of this study, few fishermen (11%; N=35) objected to other groups from within the community fishing in the same area as their group. Moreover, most respondents (76%; N=33) did not object to outsiders coming into areas near to their community to fish; the remaining 24% were undecided. "Outside fishermen" are a common occurrence, the mean number of "outsiders" fishing in an area near to a community being estimated at about 50. Moreover, "outsiders" tend to fish within "community areas" every season for most of the season (assertion made by 63% of N=35 respondents; 13% of the respondents were uncertain). Consistent with the tendency for most fishermen not to object to "outsiders", only a few fishermen (20%; N=35) perceived the area within which they generally harvest as belonging to their group and to other groups within their community.

Processing and Sale

Eighty percent of respondents (N=35) cleaned their own urchins, prepared them for sale, and sold the urchins themselves. Fifty-one percent of respondents (N=35) sold their urchins exclusively to locals, and 49% sold them to a combination of locals and restaurants/hotels.

Responses to Management of the Sea Urchin Fishery

Factors Decreasing Urchin Abundance

Forty percent of the respondents (N=35) claimed that pollution was the sole factor causing decline of urchin abundance around Barbados (Figure 2a). Eleven percent (N=35) attributed the decline exclusively to natural inter-annual variation in abundance, 6% attributed it exclusively to over-harvesting, and only 3% placed sole blame on inappropriate harvesting techniques such as the use of SCUBA (Figure 2a). The latter statistic is interesting, given the 59% who objected to the use of SCUBA. It may imply that a strong reason for objecting to SCUBA is

that non-users feel disadvantaged, rather than the claimed reason that the use of SCUBA leads to stock collapse.

Forty percent of respondents (N=35) would not identify a sole cause of sea urchin decline, but attributed it to a combination of factors (Figure 2a). Of these respondents, 52% suggested that pollution was the most important factor, 27% suggested natural variation in abundance, 17% suggested over-harvesting and 9% suggested inappropriate fishing gear, i.e. SCUBA (Figure 2b).

Management Measures

Most respondents (74%; N=35) expressed a need for management of the urchin fishery. The discrepancy between this figure and the 46% acknowledging that over-fishing may be contributing to urchin decline is interesting. Twenty percent (N=35) of respondents claimed that there was no need to manage the fishery and 6% were undecided. Those expressing a need for management priorised the possible management measures (Figure 3). Twenty-one percent (N=33) claimed that gear restriction (i.e. ban of SCUBA) was the most important management measure, 15% considered it to be seasonal regulation, 15% favored habitat rehabilitation and preservation, 12% identified stricter enforcement of current legislation and increased policing, 6% identified increased public education and information about the fishery, 3% favored a licensing and individual quota system, and only 3% wanted fishing areas to be restricted to community members. Nine percent had no suggestions for management and 15% did not feel that management was possible. The identification of SCUBA control as the major management measure, when SCUBA was not considered an important cause of stock decline, may again indicate unstated motives for desiring SCUBA control. The fact that only 3% of respondents wanted use of fishing areas to be restricted to community members is particularly important in the context of this study.

Sixty-nine percent of the respondents (N=35) approved of the recommended 4-month fishing season (September-December), and most harvesting does presently occur between September and November (Figure 4). The remaining 31% felt that the 4-month season was too short. However, although only 31% claimed that the season was too short, 55% (N=35) expressed a desire to start harvesting before September. Most respondents (64%; N=34) did not object to ending the harvest in December. Despite the 69% who expressed approval of the 4-month September to December season, 82% of respondents (N=34) admitted to beginning harvesting before September in each season, and 79% (N=35) admitted to harvesting after December. The discrepancy may indicate that fishermen are aware that the 4-month season is appropriate, but choose to, or are forced to, fish outside of it, i.e.

fishermen might stay within the 4-month season if others did, but fish outside of it because others do. More illegal fishing currently occurs before the start of the legal fishing season than after it (compare August and January, Figure 4).

Most respondents fished in areas removed from their own community both prior to the legal start of the season (90%; N=31), and after the legal end (93%; N=29). Many respondents (46%; N=28) were unsure as to whether individuals from outside a community fished illegally in "community areas" more often than fishermen from within the community. Of the 54% who expressed an opinion, 73% (N=15) claimed that outsiders did not fish illegally more often than fishermen from within the community.

Most respondents (86%; N=35) claimed to have either been warned for illegal harvesting or to know of fishermen within their community who had been warned. Based on the responses (N=33), government authorities had arrested 65% of fishermen caught harvesting outside of the legal season. Of this 65%, 86% had gone to court and had paid fines of up to $75. Fishermen may inflate these figures to create an image of harassment. However, if accurate, they suggest that attempts at enforcement are more active than typically believed.

Most respondents (57%; N=35) approved of the 2-year moratorium on harvesting implemented in 1987 to 1989. Thirty-one percent (N=35) claimed that populations had recovered because of the ban, 26% noticed little change, 23% reported an initial improvement followed by a decline, 14% contended that abundance had been depleted further, and 6% were uncertain of the moratorium?s effect.

Slightly less than half of the respondents (49%; N=35) believed that the formation of management groups for particular sea urchin fishing areas was possible; 51% believed that it was not. Similarly, less than half of the respondents (48%; N=31) believed that a community leader could encourage cooperation among urchin fishermen within the community. Sixty-eight percent of the respondents (N=34) were not in favor of the allocation of exclusive sea urchin fishing rights. Moreover, 59% of respondents (N=25) did not believe that outsiders could be prevented from harvesting in certain areas. These responses are not encouraging in the context of developing an area-specific community-based management system for the sea urchin fishery in Barbados.

Only 35% (N=31) of respondents were in favor of licensing fishermen/vendors. The same 35% considered that it should be unlawful for fishermen/vendors to sell urchins without a license. However, 64% of respondents (N=21) considered that it should be illegal for consumers to buy from unlicenced fishermen/vendors.

The respondents were asked to prioritize the criteria that should be used for licensing sea urchin fishermen/vendors, if licensing were implemented. Twenty-nine percent of all respondents (N=24) felt that seniority as a sea urchin fishermen was the most important licensing criterion, 21% identified being a traditional harvester as most important, 21% identified knowing the correct harvesting techniques as being most important, 17% chose being a licensed boat owner and 8% chose being a licensed food handler (Figure 5). Four percent of respondents did not specify any licensing criterion.

DISCUSSION

Characteristics of the Sea Urchin Fishery: Implications for Management

The results of the survey indicated that about 6 million sea urchins may be harvested annually over the 3-month (September-November) peak fishing season. Moreover, since fishing does occur in the other legal fishing month (December), and since approximately 80% of the urchin fishermen interviewed admitted to harvesting outside of the legal season, it is evident that the total number of urchins harvested annually in Barbados is high. Moreover, most illegal fishing occurs in the month prior to the legal start of harvest, ensuring that a substantial amount of harvesting occurs quite early in the annual spawning cycle. The suggestion that over-harvesting is the principal cause of urchin decline in Barbados is supported by the observed rapid recovery of urchins following a 2-year fishing moratorium. Further circumstantial evidence indicating that heavy harvesting can lead to stock decline is provided by the fact that only countries harvesting urchins in the eastern Caribbean (e.g. Barbados, St. Lucia) have reported substantial abundance declines (see also Hunte 1987b). The fact that abundance can substantially decline in some countries while remaining high in others is also circumstantial evidence indicating that island populations are functionally discrete, and hence, that national, rather than regional approaches to management, are appropriate (Hunte et al. 1993a).

Despite the above observations and the high urchin catches estimated in this study, only 6% of the fishermen interviewed stated that over-harvesting was the sole cause of decline in sea urchin abundance in Barbados; and of those considering that the decline was due to a combination of factors, only 17% identified over-harvesting as the primary cause. Most fishermen claimed that pollution was the principal cause of urchin decline. Other factors identified were natural variation in abundance and inappropriate fishing practices, specifically the use of SCUBA and its intendant practice of harvesting entire urchin “patches” without prior sampling for ripeness.

Coastal pollution, arising primarily from increased sewage inputs and

agricultural run-off, has occurred in Barbados, but is more evident on the highly developed west and south coasts than on the lightly developed southeast and east coasts where *T. ventricosus* has historically been common. The decline in the urchin populations has therefore occurred on coasts where pollution is least severe (Scheibling and Mladenov 1987). The fact that urchin populations could recover rapidly during a 2-year fishing moratorium is not consistent with the suggestion that their decline is primarily caused by coastal pollution (see also Hunte et al. 1993a,b).

Some component of inter-annual variation in urchin abundance is likely to be generated by environmentally-driven variation in recruitment strength, i.e. by "natural variation". However, environmentally-driven variation in recruitment strength alone is unlikely to be strong enough to result in stock collapse, as witnessed by the prior observation that unharvested stocks of *T. ventricosus* in the eastern Caribbean have not declined in abundance. However, if breeding stocks have been harvested to critically low levels, a poor recruitment year, in the context of environmentally-driven variation in recruitment strength, could quite likely lead to stock collapse.

Inappropriate harvesting practices, encouraged by SCUBA use, could be contributing to urchin decline. Ninety-four percent of the respondents in this study claim to sub-sample urchins from each "urchin patch" to check for gonad ripeness before harvesting the patch. Urchins typically spawn in aggregates (patches) to facilitate fertilization, and the state of gonad ripeness is synchronized within patches (Hunte et al. 1993b). This is the biological basis for the traditional fishing practice of sub-sampling urchins from each patch. Many respondents claimed that the disuse of this technique by non-traditional fishermen using SCUBA ("tank men") was a contributing factor to urchin decline. Tank men typically harvest entire patches, and later break the urchins to obtain roe.

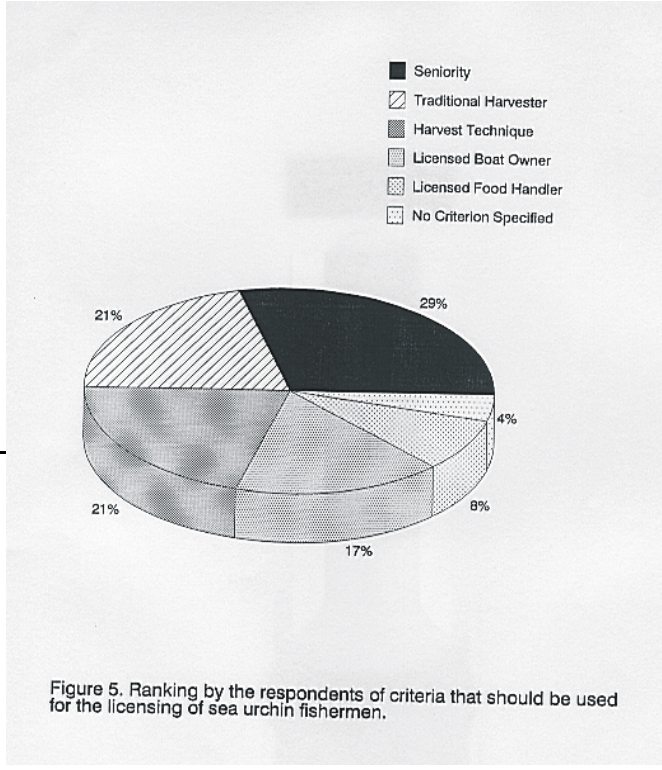

Figure 5. Ranking by the respondents of criteria that should be used for the licensing of sea urchin fishermen.

This results in the harvest of immature and spent urchins which provide negligible roe to the harvester but which are likely to have contributed later in the season to population reproduction, since individual urchins spawn several times per season. Traditional fishermen also restrict their harvesting to urchins near the periphery of a patch, since they claim that adults occur towards the periphery, and immature towards the center of the patch.

Characteristics of Sea Urchin Fishing Communities: Implications for Management

Most sea urchin fishermen in Barbados fish in small groups, and group members often assist each other in the preparation of urchins for sale. Several fishermen indicated that they periodically survey fishing areas to determine the distribution and abundance of urchins prior to the harvest season, and that they often share this information with other fishermen. Urchin fishermen in Barbados therefore do have a basically cooperative approach to harvesting, an approach that would be required for successful implementation of community management. However, most urchin fishermen fish in areas quite distant from their own communities, and do not object to "outsiders" fishing in areas near to their own communities. They do not perceive urchins near to their communities as property of their communities, and were therefore not in favor of the allocation of exclusive community rights for the harvest of sea urchins. They further stated that restricted access to fishing areas would lead to confrontations among urchin fishermen and promote aggression between communities. These perspectives make it most unlikely that area-specific community management, such as being attempted in St. Lucia (Smith and Berkes 1991; Smith and Walters 1991; George and Joseph in press) would be successful in Barbados.

The sea urchin fishing communities in St. Lucia differ in several ways from the fishing communities in Barbados. The St. Lucia fishing communities, located along the southeast and southwest coasts, tend to be geographically discrete. Inter-community movement is somewhat constrained by topography and infrastructure. Moreover, the coastline is characterized by discrete, separate bays, and fishing areas can therefore be readily identified with particular communities. Fishing communities in Barbados are less topographically and infra structurally isolated, and the high coastal population density ensures that population distribution is quite continuous. Fishing communities are not therefore as readily demarcated as in St. Lucia, and Barbadian urchin fishermen were divided as to whether the fishing areas themselves were separate or continuous.

The consequence of these country-specific characteristics is that fishing communities, particularly in the south of St. Lucia, have a strong community perspective, and because they perceive fishing areas as well separated, they consider the traditional fishing grounds in their areas as community property. Conversely, the greater continuity of fishing communities in Barbados causes fishermen to relate less strongly to specific communities. Consequently, they do not perceive nearby fishing grounds as community property, but rather consider fishing grounds to belong to all nationals. It should also be noted that, in at least one village (Laborie) in St. Lucia, the community has apparently had a long history of sustainable sea urchin harvesting through what was essentially a community-based

management system for that fishery. A similar situation has never existed in Barbados; there has never been a community-based management system upon which one could now build.

Recommendations for Management of the Barbados Sea Urchin Fishery

Seventy-four percent of the respondents in this study stated that the Barbados sea urchin fishery was in need of management. Most identified gear restriction (i.e. a SCUBA ban) as being of primary importance, although very few had identified this as a primary or sole cause of stock collapse. Fishermen also place high priority on the need for measures to control coastal pollution. Interestingly, several considered that the traditional management measure of closed seasons was the most appropriate management tool.

The characteristics of the sea urchin fishery in Barbados ensure that few management tools are likely to be appropriate. A TAC (total allowable catch) system requires regular monitoring of catch. This would necessitate considerable manpower in the context of the sea urchin fishery in Barbados, given its non-centralized and diffuse nature. This characteristic would also make regulation of effort (as number of fishermen) particularly difficult. Regulation of fishermen would require a system of licensing, perhaps with individual transferrable quotas (ITQs). However, the urchin fishermen were generally not in favor of licensing. Even with licensing, control of effort would be difficult, since it would require considerable manpower to monitor and detect unlicenced harvesters.

Seasonal limitations on harvest, i.e. closed seasons, have an advantage over effort control through licensing since, with a closed season, individuals fishing illegally can simply be detected by time of year. In the case of the urchin fishery in Barbados, a closed season has the additional advantage of being the traditional management tool. However, a closed season is only an effective tool if it is adhered to, and this has typically not been the case in Barbados. Better adherence to the closed season will require greater cooperation from fishermen and an improved national effort with respect to surveillance and enforcement. Better surveillance and enforcement will depend on involvement by all Barbadians in reporting illegal harvesting by fishermen, and will require a much more purposeful approach to enforcement by regulatory authorities and the judiciary. The results of this study suggest that about two-thirds of illegal urchin harvesters in Barbados have been apprehended and fined. This indicates that apprehension of illegal harvesters may often be active enough, but that fines for illegal harvesting may have to be increased, since current penalties are not effective as deterrents.

Perhaps more important than improved surveillance and enforcement is

improved cooperation from fishermen. A strategy for improving fishermen cooperation, which depends on a flexible closed season and the involvement of fishermen in determining closed season duration, is described below. Most illegal urchin fishing in Barbados occurs because fishermen do not wait until the legal September 1st start of the fishing season. Much fewer fishermen harvest after the December close, since the gonads are usually spent by this time and most fishermen have switched to the offshore pelagic fishery. Depending on levels of urchin abundance in any given year, the start of the harvest season could begin earlier than or after September 1st. This approach would require an assessment of sea urchin abundance quite early in the year, e.g. between March and May. Such assessments could be conducted, on several fishing areas, by the urchin fishermen themselves, since they are familiar with the fishing areas and are already in the habit of conducting such surveys. The fishermen could then share this information with the Government Fisheries Division, and participate with them in determining the most appropriate onset date and duration for the coming fishing season. For example, the surveys could categorize urchin abundance as being very high, high, average, low and very low. Onset harvest dates could be August 15, September 1, September 15, October 1 and a moratorium, for each of these abundance estimates respectively.

A major advantage of the proposed strategy is that participation in the monitoring actively involves urchin fishermen in the management of their resource and allows them to contribute to the annual decisions on fishing activities. Fishermen are more inclined to adhere to regulations if they are part of the process of imposing them (see also Moore 1988). The proposed approach would therefore be incorporating one of the greatest strengths of community-based management into the management strategy for the urchin fishery in Barbados, i.e. allowing fishermen to be a more active part of the management process. This flexible closed season approach to management, based on information supplied by the fishermen themselves, could be augmented by a ban on the use of SCUBA, and the education of all harvesters on the most appropriate harvest techniques, such as the practice of sub-sampling urchins to check for ripeness before harvesting a patch.

The approach recommended here for managing the sea urchin fishery in Barbados differs from that being attempted in St. Lucia, but appears to be better suited to the Barbadian geographical, social, and traditional harvesting contexts. It is a form of community co- management, but is not community area-specific. This has the added advantage of not requiring that the biological characteristics of the resource are such that area-specific community management is feasible. The necessary biological characteristics are either that local populations are self-recruiting or that recruits are of mixed origins but are attracted to areas of high

adult abundance. Neither of these characteristics has been definitively shown to be true for *T. ventricosus* (but note that the black sea urchin, *D. antillarum*, does preferentially settle in areas of high adult abundance; Hunte and Younglao 1988). Communities will clearly be less likely to cooperate with management constraints on fishing effort if they are unable to detect an obvious relationship between the degree of effort constraint in a particular resource area and future abundance levels in that same area. It is of interest in the above context that populations of *T. ventricosus* in St. Lucia, which are under area-specific community management, have apparently declined dramatically in abundance over the past 2 years. The precise cause of this recent decline has not yet been identified and documented.

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