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PARTICIPATORY MONITORING OF SHALLOW TROPICAL MARINE FISHERIES BY ARTISANAL FISHERS IN DIANI, KENYA

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ABSTRACT

Artisanal fishermen possess a wealth of knowledge about their environment and the dynamics of fish populations. This study uses an eco-anthropological approach to document and map the resource and spatial knowledge of coral reef fishermen in the Diani region of Kenya. The objective of the study is to document fishermen's knowledge, and to assess the nature and utility of information used by fishermen as a basis for resource management. As the foundation of their livelihoods, fishermen possess mental 'monitoring mechanisms' for assessing trends in the fishery and show a high awareness of the issues involved in mapping, recording catch data, and analysis of the information. This paper presents an overview of a participatory monitoring study with artisanal fishermen, to try and adapt their existing assessment mechanisms to paper and computing. Data collection focussed on variables important to fishermen in their daily activities, i.e., the captain and crew, gear used, sites selected for fishing, the total weight of catch and the types of fish caught. This paper focuses on some of the issues raised by the process of participatory monitoring.

Artisanal fishing is one of the most intensive uses of shallow tropical marine environments, particularly coral reefs (Salvat, 1987; Dahl, 1988), and a major cause of overexploitation of reef resources and long term degradation (Ginsburg et al., 1994; McClanahan and Obura, 1994). Typical of many subsistence and traditional forms of renewable resource use, overexploitation results in direct and seldom reversible economic, social and cultural harm to the very people causing the destruction.

Fisheries management on coral reefs faces two major obstacles. First, is the ecological complexity of reef communities, and the non-applicability of temperate-based single- or low-species-number fisheries models (Bohnsack, 1996; Pauly and Murphy, 1982; Roberts and Polunin, 1993; Polunin and Roberts, 1996). Historically, fisheries management developed in cold temperate waters, to manage fisheries on single target species that occurred in high-biomass aggregations. Thus controls on fishing could be highly specific to the behavior, feedings habits, seasonal cycles and migrations of the target species. These controls required large volumes of research, information and conventional wisdom on the target species. The ecological complexity of coral reefs presents to the fisherman and manager a multi-species fishery with no single target species, most of which are at low individual biomass compared to temperate waters. Additionally, while there is abundant indigenous knowledge on fish species behavior and population dynamics (Johannes 1987, 1981), it is not constructed in a way compatible with modern resource management or analytical systems. As a result, fisheries science from cold temperate waters offers little to tropical reef fisheries management, and alternatives need to be developed.

The second major obstacle is that identified above, that is, the extreme cultural, educational and perceptual differences between the principal resource users and resource managers. There are two approaches to dealing with this problem: to educate users in the language and knowledge system of the managers, or to educate the managers in the language and knowledge system of the users. The former is the common practice, while the latter is only recently being tried. Ideally, a mix of the two would provide a dynamic system that incorporates and innovates the best practices from the world of fisheries science and management, while being soundly based in local fishermen's culture and practices, with both users and managers playing cooperative roles. In the last decade there has been a strong growth in efforts incorporating traditional knowledge and forms of management into fisheries management (Ruddle, 1996).

This paper describes an effort to reduce the second obstacle by exploring the notion of coral reef fisheries management from within the cultural framework of fishing communities. The project's approach is that active monitoring of resources and the environment by a user community (PLA Notes, 1997, 1998) should: (1) generate greater awareness of resource dynamics by establishing a permanent record of their existing knowledge, (2) encourage a rapprochement between management and user communities by making the former view resources from the latter's framework, and (3) encourage independent proactive evaluation of resource trends by the user community.

Thus, a system for fisheries catch monitoring, implemented by fishermen, was initiated within a small community, starting with establishing reliable data collection procedures. Participatory catch monitoring has several aspects that are different from formal monitoring. First, data collection is done by members of the fishing community, not by government agents or researchers with a different educational and cultural background from the communities. Second, recording is conducted in a local language instead of English, in this case Swahili, which is the second language of the Digo people in the area. Third, the units of monitoring were derived from the fishermen's knowledge system, not an externally imposed one.

Methods

This study was conducted in the Diani-Chale coral reef area, located about 20 km south of Mombasa (Fig. 1). The area supports local indigenous fishing populations, mainly concentrated in the southern half, as well as an active tourism industry, mainly located in the north (Rubens, 1996; McClanahan et al., 1997). Conflict among the different resource users has been severe, focussed in 1994 by attempts to implement a newly gazetted marine by the Kenya Wildlife Service. Since 1994, no further attempts to establish MPA management have been made in the area.

Fishing activity is controlled mainly by roughness of the sea and monsoon wind conditions, with stronger winds during the southeast monsoon (May–October) reducing the number of safe days for fishers to cross the reef lagoon and fish inside and outside the reef. The seasons and weather also affect fish migration, changing the behavior of fishermen with respect to target species and methods of fishing.

Three fishing methods are considered here, though several others are practiced at the sites by fewer fishers, and/or less regularly. Basket traps are a traditional gear, constructed of wood and reed strips interwoven in hexagonal patterns. These are left overnight with mixed bait (algae, crushed sea urchins and mollusks), checked on a daily basis, the catch removed, and the trap usually reset in the same place or nearby. Hook and line fishing is also a traditional gear, now using steel hooks and nylon monofilament. The third method considered here is more modern, using spearguns made of wood with rubber-tire strips to power a metal spear. Metal tubes are increasingly being used instead of wood to increase the strength and power of homemade spearguns, copying commercial sport models.

Basket traps and line fishing are operated from dugout canoes powered by poles and sometimes paddles. They are the more traditional methods, and are generally used by older fishers. Using basket traps also requires a greater amount of off-water work to build and maintain traps. Speargun fishers swim from the beach and do not use boats. Younger fishers tend to start fishing with spearguns

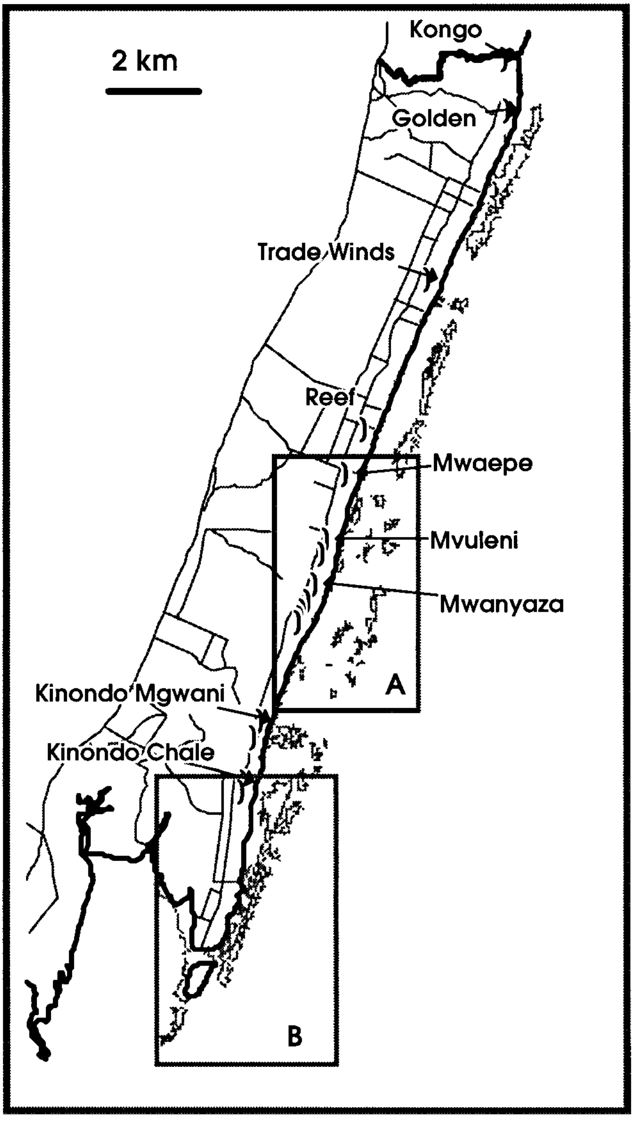

Figure 1. Map of the Diani-Chale area, south of Mombasa, Kenya. Fishing sites referred to in this study are in box A. Fishery landing sites in boxes A and B retain the local names, while sites in the tourist area north of box A have taken on the adjacent hotel names.

as they are relatively simple to make, involve little off-water work (hence enabling them to do other occupations, such as act as 'beach boys' to earn money from tourism), require less learned skill, and appeal to their male pride.

A system for data collection was developed over a period of 3–4 mo in conjunction with the fishermen. Initially, site use mapping was conducted as an ice-breaking exercise, during which discussions on any aspects of fishing were conducted. Gradually, units for measurement were identified that were consistent with the fishermen's knowledge and practices, and with the needs of a catch monitoring system. The following units were identified (Table 1): name of the captain, number of additional crew, fishing gear used, fishing sites visited and catch. The total catch was weighed

Table 1. Sample data sheet.

Captain	Number of crew	Fishing gear used	Fishing sites visited	Catch - fish species, (number of fish)	Catch - total (kg)
Mwanza	3	Nyavu (net)	Ligangana	Tafi (20)	10
Juma Mwarupia	1	Mshipi(hook/line)	Makonde	Changu (5)	5
Issa	3	Nyavu (net)	Chale	Tafi (15)	7.5
Suleiman Hamad	0	Bunduki (gun)	Makonde	Pono (19)	10

in kilograms, but information on composition of the catch was done through estimation of the number of fish, as weighing each type of fish would have interfered too much with the buying and selling of fish at the beach, and activities of individual fishermen. All data units were recorded using local names, i.e., for gear, sites and fish. A potential problem for conversion to scientific analysis, fish 'species' or classes assigned local names do not map directly onto biological taxonomic classes. Thus some names correspond to scientific species, while others correspond to higher taxonomic levels, such as families, and others to a range of polyphyletic species. The term fish 'taxon' is used here to refer to those identified by fishermen. The tabular form for data collection (Table 1) was only developed after 2–3 mo of initial free form, cursive data writing to enable innovation by fishers. Data collectors were selected by the fisher groups and were required to be active fishermen and literate. Beyond initial development of the data form, the only instructions given were that sampling should be of at least 10–15 different fishermen and crews each day, about twice per week.

Statistical analysis was conducted using JMP 3.0 statistical package (Sall and Lehman, 1996), on daily catch records in kilograms per unit effort, where the unit of effort is variously taken as a fishing crew, or as a single fisher. Statistical tests (correlation, ANOVA) were conducted on the raw numbers as the sample sizes were relatively large (approx. 540 catch records in total). A cluster analysis of fish taxon composition in the catch was conducted on catch frequency data, using an average distance clustering method (Sall and Lehman, 1996).

Results

At Mwaepe, on average 7–10 fishing crews were sampled each day, with the frequency of sampling varying from 3 to 11 times per month (Fig. 2). Fishing crews varied in size with season, tending to be larger and more variable during the rough season (May to August) than at other times. Differences in fishing crew size result in differences between Catch per Unit Effort (CPUE) statistics based on number of crews versus number of fishers (Fig. 3). Both measures of fishing success increase in the change of season from the rougher southeast monsoon (ending in September) to the calmer northeast monsoon. Differences in catch per fisher by season are significant (ANOVA: $r^2 = 0.212$, $F = 144.3$, $P < 0.001$).

Fishing crew size at Mwaepe never exceeded two for the gears recorded here, with many fishermen operating alone. Speargun fishers essentially operate alone, though they may swim together. Crew size for trap fishermen was independent of season, but increased for line fishermen in the rough season (Table 2). Catch per fisher declined significantly when fishers teamed together, especially during the calm season (Fig. 4). Differences in fishing crew size depend partially on the type of gear used (e.g., Table 1), and these have different catch characteristics.

All gears recorded had lower catches during the rough season for both catch per crew and catch per fisher (Table 2, Fig. 5). During the calm season, catch per crew is highest for basket traps and hook and line fishing. Catch per fisher is higher for spearguns compared to basket and line fishing during the rough season, but not during the calm season, where

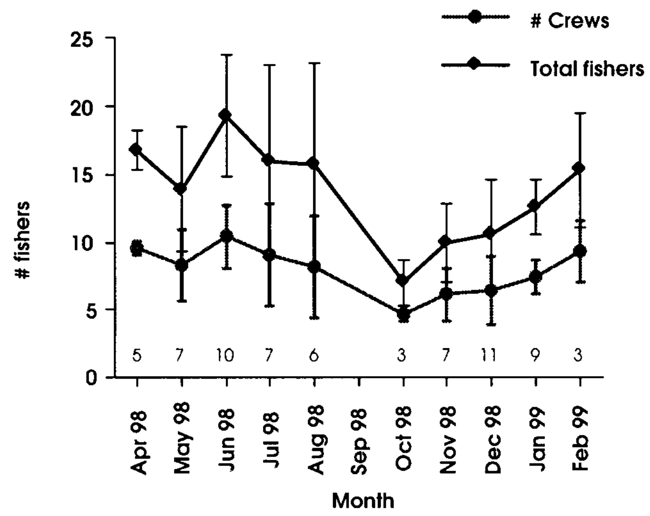

Figure 2. Number of fishing crews and total fishermen sampled each day at Mwaepe. Numbers above the x axis indicate number of days sampled per month.

line fishing can record higher catches. Basket traps persistently have the lowest catch for individual fishermen throughout the year.

Fishers show strong site preferences, with certain sites attracting more fishers on a daily basis than others (Fig. 6). During the rough season, the preferred sites are those that are close to the landing beach and well protected. Fishing effort during the calm season was more dispersed, though numbers were not very different from during the rough season. The three catch statistics at each of the sites (Fig. 6) are significantly correlated for

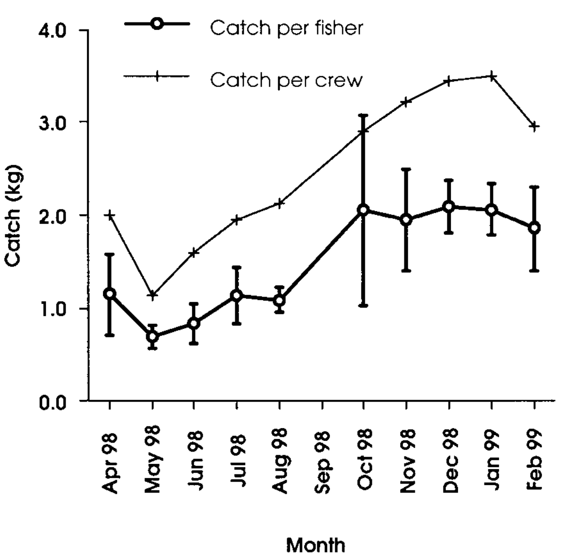

Figure 3. Catch per unit effort at Mwaepe: per crew (mean), and per fisher (mean and SD).

Table 2. Crew size and total catch recorded for calm and rough seasons. Catch per fisher is calculated as mean catch divided by mean crew size.

		Crew size (# fishers)			Catch (kg)		Catch per fisher (kg)
		n	mean	SD	mean	SD	
Traps	Calm	52	1.71	0.46	3.58	1.48	2.09
	Rough	93	1.72	0.45	1.72	1.31	1.00
Hook/line	Calm	96	1.40	0.49	3.65	1.32	2.62
	Rough	130	1.70	0.46	1.75	0.88	1.03
Spearguns	Calm	70	1.00	0.00	2.87	0.85	2.87
	Rough	95	1.00	0.00	1.63	0.72	1.63

calm and rough seasons (Table 3). The lack of negative correlations between seasons indicates there is not a complete change of site use caused by season. The most-visited, or preferred, sites at the top of Figure 6 have the highest total catches per day with significant positive correlations between catch per day and the number of fishers using the sites per day (Table 3, bottom). However catch per fisher is inversely correlated with the number of fishers at a site (though not significantly, Table 3) during both seasons, indicating decreasing individual returns at preferred sites, and over-exploitation of fish. Interestingly, catch per fisher is inversely correlated with catch per day during the rough season, while the relation is positive during the calm season (again, not significantly, Table 3). This suggests that during the calm season, increasing effort does not suppress individual returns, potentially because more sites are accessible to fishermen and the site-specific over-exploitation that occurs during the rough season does not occur.

Different fishing gears target different taxa of fish as they take advantage of specific fish behaviors to attract and trap fish. Local fishers are well aware of these characteristics

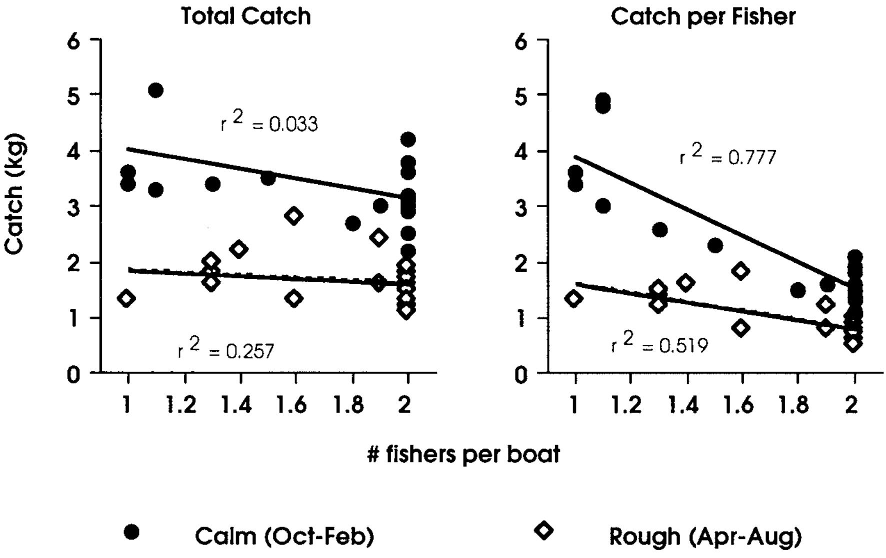

Figure 4. Daily catch versus mean daily crew size, Mwaepe. Left – catch per crew (total catch) by number of fishers in a crew; right – catch per fisher by number of fishers per crew. The light black regression line (right) excludes the high outlying points of 5 kg catch for 1 fisher, based on 2 records out of a dataset of 541.

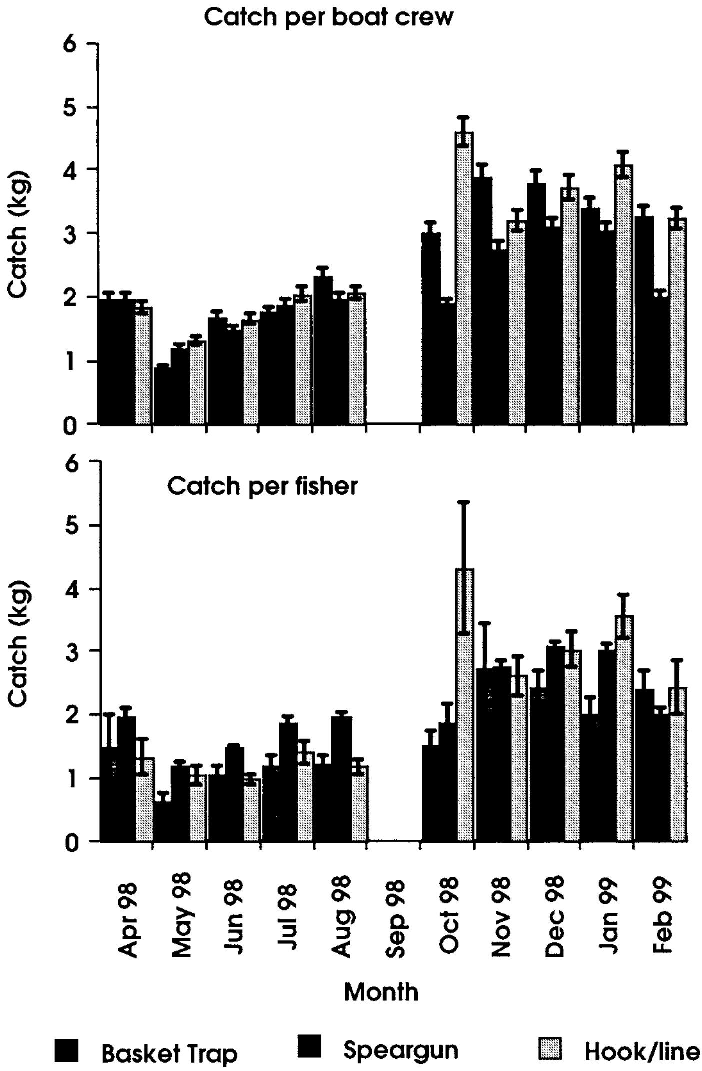

Figure 5. Catch per fisher for basket traps, spearguns and hook/line fishing. Above – catch per fishing crew; below – catch per fisher.

and take advantage of them by honing successful techniques for particular fish taxa. As a result, locally identified taxa reflect the fishes' importance to fishers. Thus local fish names can be highly specific with reference to important or noticeable fish, but very general for unutilized and unimportant fish. For example, *chengo*, *dizi*, *mchakufa* and *tawa* are names for various species and groups of species of snappers, *raa* refers to all types of rays, and *tafi* is used to refer to the preferred rabbitfish species, *Siganus annulatus*, but could also be used more generally for congenerics.

Speargans and hook-and-line fishing capture a similar diversity of local fish taxa on a day to day basis (approx. 3.2 taxa per day, Table 4), compared to the more passive basket traps (2.9 taxa per day). This difference is significant over the 10 mo of data reported here

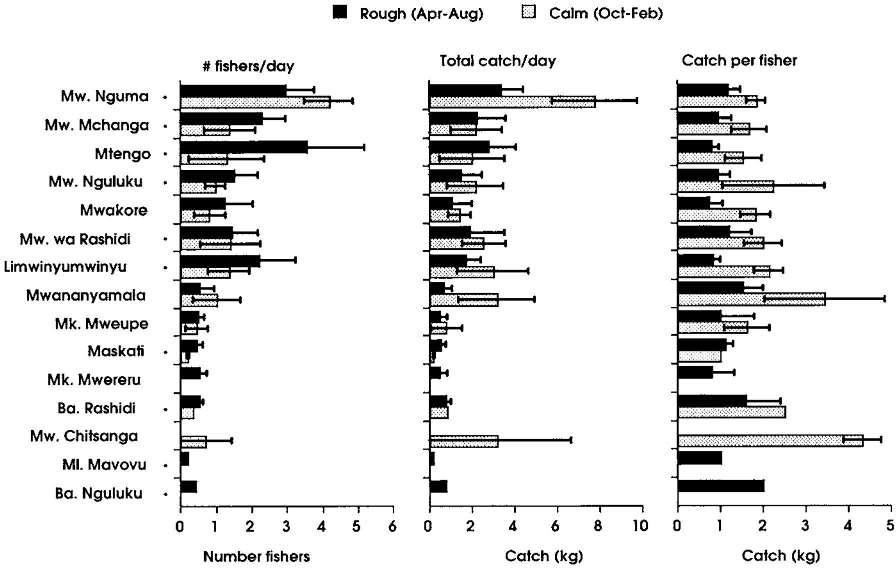

Figure 6. Site preferences shown by fishers. Sites are ordered by decreasing preference (number of fishers/day for rough and calm seasons). The bar graphs show mean and standard deviations of: left - number of fishers per day, middle – total catch per day (kg), and right – catch per fisher. Abbreviations: Mw. = Mwamba (reef); Mk. = Mkono (channel. Lit. 'hand'); Ba. = Bara (sand shallows/bar); Ml. = Mlango (reef pass. Lit. 'door').

(Kruskal Wallis ANOVA, χ^2= 17.68, df = 3, P = 0.0005), resulting in total numbers of local fish taxa caught by the three gears of 31, 26 and 19 (spearguns and hook-and-line, and basket traps, respectively).

Cluster analysis of the frequency with which each fish taxon is caught by each gear during the two seasons shows associations among the fish species (Fig. 7). The groups labeled in the cluster analysis correspond to the following patterns. Group B is a large mix of infrequently caught fish in variable site and season combinations. Groups A and C contain fish caught mainly by speargun and hook-and-line gears, in rough season more than the calm season, with Group A occurring more frequently in the catch. Group D includes fish caught primarily by traps and hook and line, during both seasons. Fish in group D represent the principal resource species, especially for the more traditional fish-

Table 3. Fishing site and season use from figure 5. Pairwise Pearson correlation coefficients comparing numbers of fishers per day, daily catch, and catch per fisher at each site on a seasonal basis. Top: between-season correlations; bottom: between variable. Significance levels: ns not significant; + P < 0.10; * P < 0.05; ** P < 0.01; *** P < 0.001.

Season comparisons - rough vs calm					
Fishers/day	0.663 (*)	Catch/day	0.738 (**)	Catch/fisher	0.590 (+)
Variable comparisons					
	Rough season			**Calm season**	
	Fishers/day	Catch/fisher		Fishers/day	Catch/fisher
Catch/day	0.948 (***)	−0.227 (ns)	Catch/day	0.939 (***)	0.230 (ns)
Catch/fisher	−0.416 (ns)		Catch/fisher	−0.103 (ns)	

Table 4. Catch diversity by gear type, in number of local fish taxa recorded by fishers.

Gear type	Diversity of fish catch		
	Daily		Total
	m	s	
Basket traps	2.9	0.86	19
Spearguns	3.2	0.63	31
Hook/line	3.2	0.65	26

ers using basket traps and hook and line. In particular, 'tafi' (rabbitfish – Siganidae) are the favored food fish and mainly targeted by trap fishermen, 'pono' (parrotfish – Scaridae) are common in all catches, and 'tengo' (snappers – Lutjanidae) of various sizes are caught by most gear types. Groups A and C represent seasonal variation in fish availability in reef lagoons, as sampled by the active fishing methods, hook and line, and spearguns.

Mwaepe is adjacent to one of the most overfished and degraded reefs on the Kenya coast (McClanahan and Muthiga, 1988; McClanahan et al., 1997), and as shown here, catch size is extremely small, dropping to <1 kg per fisher per day during the rough season. Figure 8 compares the situation at Mwaepe to two other landing sites immediately south (Fig. 1), Mvuleni (approx. 1 km) and Mwanyaza (3 km), for a broader range of catch and gear type data. All three landing sites have the same community 'catchment' of villages and inter-related families. Overall, catch per fisher at Mwaepe is very low, and much less variable than at either Mvuleni or Mwanyaza (Fig. 8). Equally, catch per fisher can be very different between gear types, and from one month to another, illustrated most clearly at Mvuleni. Further, Mvuleni and Mwanyaza follow different rough-calm season variations in total fish catch to that found at Mwaepe. Mvuleni shows some increase in basket trap, hook and line, and speargun fishing during the calm season similar to Mwaepe, though the difference is less pronounced. Net fishing appears to decline drastically during part of the northeast monsoon (November – January). Mwanyaza has a completely opposite pattern, with higher catches during the southeast monsoon.

Discussion

Data collected by the fishers included information on the fisher himself and his crew, gear used, sites visited, and catch composition and size. This paper illustrates the various relationships among these data items from just one site out of four in the area. With appropriate data collection controls and management, this type of participatory monitoring can contribute important information to formal fisheries assessment and management programs. A further, and perhaps more important advantage, is the opportunity afforded by participatory monitoring to evaluate and influence the decision making process of resource users themselves, particularly in the context reported here of severe overfishing, resource and environmental degradation, and economic hardship.

The principal feature of the fishery reported here is it's small catches. Total and per fisher catch sizes in the area covered by this study are extremely low, varying from 4–6 kg per fisher at the most productive site and season (Mwanyaza, southeast monsoon), down to less than 1 kg per fisher at the least productive site and season (Mwaepe, southeast monsoon). As the principal cash and protein source for families headed by a fisher, these catch levels illustrate the low incomes and standard of living experienced by fishing fami-

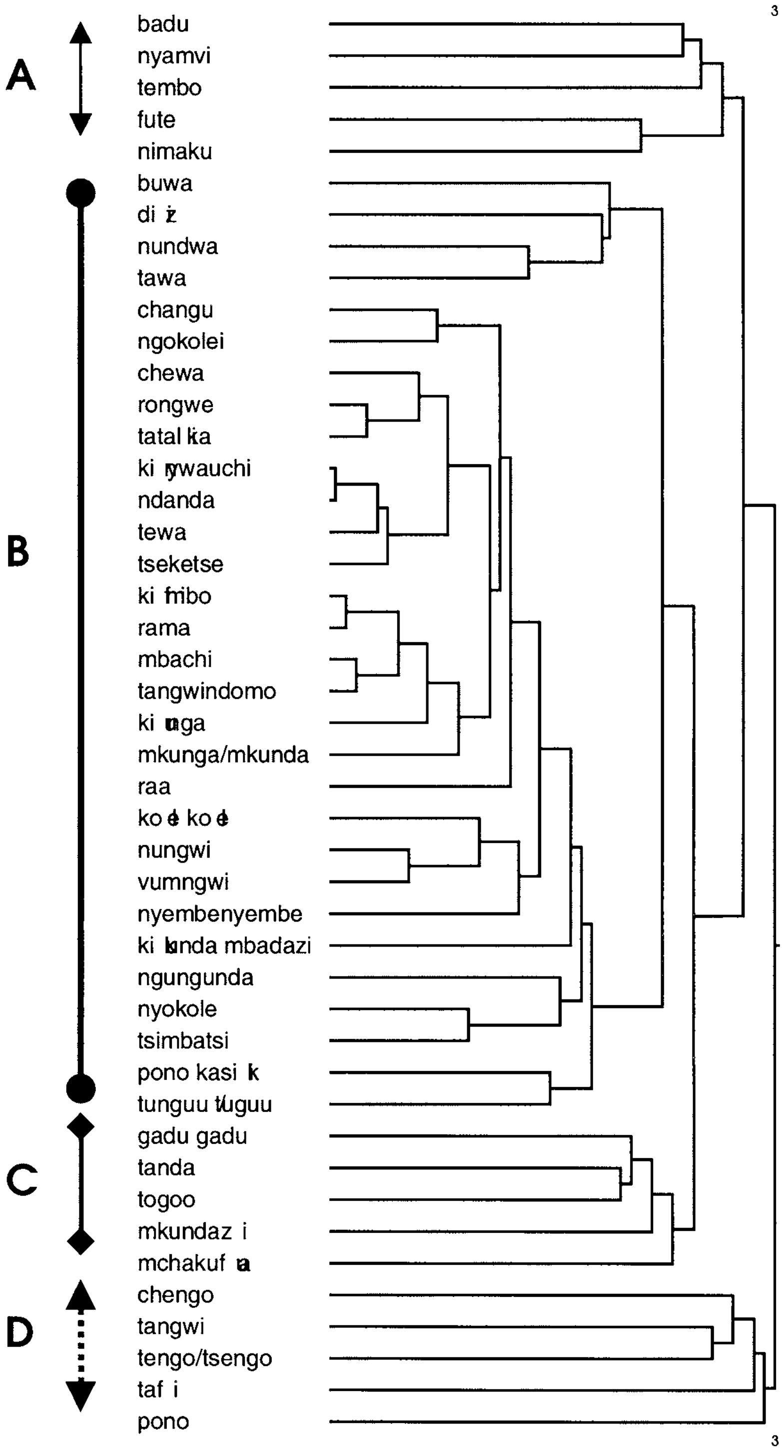

Figure 7. Cluster analysis of fish by gear and season.

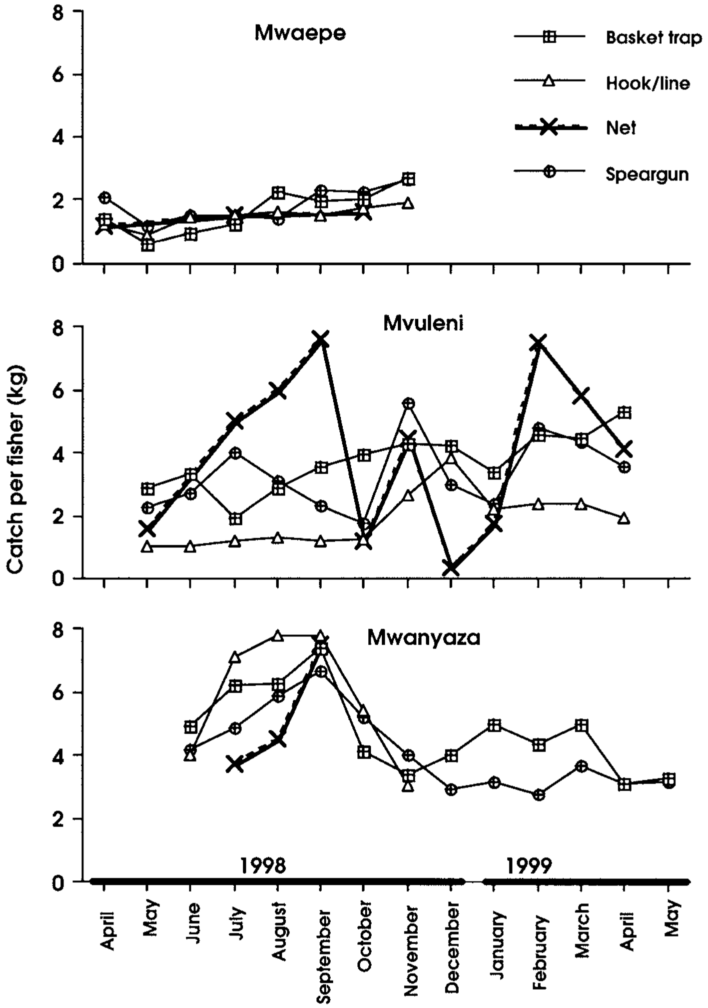

Figure 8. Catch per fisher for landing sites in Kinondo location by gear type – Mwaepe, Mvuleni and Mwanyaza.

lies. The fishery is highly seasonal, dominated by accessibility of fishing sites controlled by monsoon winds, though the reefs never become completely inaccessible except during brief storms. The intensity of fishing site use varies by season, with catch rates showing lower individual fisher success during the rough season when activity is more concentrated on accessible sites (Table 3).

The multi-species nature of the fishery is apparent from the high diversity of fish taxa caught (Fig. 7), which would be much larger if scientific species names were recorded. Fishers do show strong preferences for certain fish, in particular rabbitfish (tafi) and snappers (tengo). An interesting question is to determine whether their preferred gear evolved to catch their preferred fish, or fish preferences followed the catch behavior of gear that evolved around other constraints such as materials. Very few fish are actually discarded as inedible, whether by reason of size or identity. An important gear issue in all the traditional fishing areas in East Africa currently centers around the use of small-mesh beach seines that are dragged along the bottom and catch small and juvenile fish. They catch a higher diversity of fish than the methods recorded here (Rubens, 1996), and reduce fish diversity and size in the catch of other gears, and in the water (McClanahan et al., 1997). The destructive effects of these nets on fish abundance and diversity in the water and in catches is explicitly recognized by fishermen at the fishing sites studied here (A. King, unpubl. data).

A combination of factors probably contributes to the extreme resource-poor case of Mwaepe, including: the reef and lagoon are narrow and shallow compared to the other sites, a higher density of human population and fishing utilization of the site, and better road access and proximity to fish markets (including local markets, tourist hotels and cottages, and middle class community). The coral reefs in Diani from Mwaepe northwards are perhaps the most heavily utilized and impacted reefs in Kenya from fishing (McClanahan and Muthiga, 1988) and tourism. Overfishing has resulted in significant ecological degradation of reefs in the area, pushing them towards a state of dominance by fleshy algae and sea urchins as the major primary producers and consumers. Southwards from Mwaepe, poorer roads and a slower pace of commercial development have resulted in a lower demand for fish, and coupled with the greater width and depth of reef lagoons, a lesser degree of overfishing.

This study is being undertaken not only to document fish catch, which is ongoing through the national Fisheries Department and other studies (McClanahan et al., 1997). The principal reason for the study, and the selection of study sites, was to explore the possibilities of participatory monitoring in raising resource use and environmental degradation issues in the dialogue between managers and potentially conflictual user groups. A dominant factor for site selection was the importance of subsistence resource use in a degrading environment and the influence of poverty on human-environment interactions.

An important issue in participatory monitoring where poverty is a significant factor is the provision of short term incentives, and not only long term goals, to undertake monitoring. Artisanal fishers live from day to day on the protein they take home as food, and the cash earned from sales, averaging perhaps US \$0.20–1.00 d^{-1}. Thus payment of data collectors for their time, contributions in cash or kind to the community and other forms of assistance are necessary to induce, at least initially, fishers to contribute their valuable time to monitoring.

While elder fishers tend to hold community authority and are most knowledgeable about fish and the environment (Johannes 1987), numeracy and literacy skills are necessary for data collection. All fishers were highly numerate, being fast and perceptive fish-accountants by trade. Kenya has a high school-leaving rate and a high unemployment rate. Thus many of the young fishers have received several years of schooling, and in the absence of other employment opportunities, turn to fishing which is traditionally open to all. These school leavers have the skills to conduct data recording, and often also of constructing monthly accounts of fishing activity.

Data collected by members of the fishing communities have a number of characteristics that are different from those collected by researchers or fisheries officers. Fishers will respond more often to expediency (financial need, social pressures, etc.) through the absence of a formal background in sampling or analysis, potentially resulting in major and arbitrary changes in recording patterns (e.g., halt in records on net fishing in Mwanyaza in September 1998, Fig. 7). Additionally, severe barriers to initiate participation in catch monitoring had to be overcome, with one landing site only becoming cooperative after 2 yrs. Social pressures on the data collectors have been frequent and significant in altering sampling effort, for example certain gear users refusing to be sampled (e.g., beach seiners). On the positive side, the volume of data that can be collected is vastly increased, as fishers are already on-site, and their intimate knowledge of the subject introduces new features unknown to outside researchers and which may otherwise remain hidden. Participatory fisher monitoring of this nature requires shifting the principal effort of the researcher from the activity of data collection to managing the data collecting process to ensure consistency of sampling.

One of the objectives in participatory monitoring is to present in a more explicit fashion, i.e., on paper, patterns in fishing behavior that may already be known to the fishermen. This can be illustrated in two areas by the data presented here. First, the differences in catch between Mwaepe and the other two productive sites (Fig. 8), and in catch efficiency of gear types (Fig. 5), are clear. This type of information should already be known to the fishermen as they observe and communicate with each other. The interesting question from a fisheries assessment and management perspective, is how do fishers use the information they have to make decisions? From a 'modern' fisheries perspective, this translates into the question 'why do fishers make decisions that afford them such low catches, where higher catches can be seen in other fishers using a different gear type, or fishing from a nearby site?'

A similar decision-making paradox is apparent in the effect of increased crew size resulting, on average, in lower individual returns. Fishermen must be aware of this through the amount of food and cash they take home each day, and discussing the results of the monitoring data only reemphasizes the point. Reasons for forming larger crews may depend on other considerations, some of which may be explicitly stated by fishermen, others not:

- Social factors tend to promote kinship, group and community practices over individual endeavors, such as fishing with an extended family group.
- Economic poverty forces fishers without their own gear to 'work' for others or for a gear-owner. This may occur as fish catch declines, and large, small-mesh seine nets become the preferred gear as they catch smaller fish and outcompete traditional gear types (McClanahan et al., 1997). In this case, declining income from decreasing fish resources and individual poverty reinforce each other.
- Gear types require different amounts of labor (e.g., nets require two or more fishers, traps and hook and lines can be operated by one), and historical preference for a gear type may outweigh considerations of gear efficiency.
- Unpredictable or short term appearance of certain fish (e.g., sardines) results in fishers joining together to catch them, in general with nets. When successful, this can offer returns many times higher than normal, but can also result in very poor catches on unsuccessful outings.

The data presented here has been collected in a context of severe conflict of interests between fishing and tourism/conservation interests in the area. Tension was brought to a focus in 1994 by efforts to establish a marine protected area (MPA) extending across the whole reef area from north to south (Fig. 1). The class of MPA selected, a Marine National Reserve, is specifically legislated to allow traditional resource extraction but prevent more intensive utilization. Technically, this should enhance and protect fishing communities' rights and resources however, the fishing communities responded principally to the fear that MPA management under a government agency (Kenya Wildlife Service) would eventually restrict and end their rights and access to the reefs (A. King unpubl. data; Obura et al., 2000).

While the MPA initiative has been dormant for 5 yrs, it will be rekindled as growing conflict in resource use among stakeholders will increasingly require resolution. It is hoped that the active participation of fishers in monitoring and evaluation in this project, and their ownership of data documenting their resource use practices, will enable more focussed and reasonable negotiation of rights and responsibilities with other stakeholders at a future date. The fishers' participation and involvement in discussions may perhaps even make the MPA initiative specifically structured around artisanal resource use and community rights. Successful co-management with formal government agencies will provide the safest means to ensure rights of access and use by fishermen as well as protecting resource stocks and environmental health.

Improvements in the data collection system are continually being added. Areas in need of improvement include the rigorousness of sampling each day to cover all gear types being used, improving the skills of data collectors to calculate monthly summaries of their data and discuss these with other fishers, ongoing awareness building among other fishers of the work and its objectives, and building links with the Fisheries Department to formalize the involvement of fishermen in catch monitoring and assessment. Implementation of the system is being trialled in other parts of East Africa, leading to local innovations and improvements in the system. Finally, a large area that needs additional work is expansion of the monitoring system to incorporate indigenous knowledge and aspects of their activities that fishers deem to be important.

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