Fisheries Research, 13 (1992) 353–367
Elsevier Science Publishers B.V., Amsterdam

Impact of the use of trammelnets on a tropical reef resource

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(Accepted 21 October 1991)

ABSTRACT

Gobert, B., 1992. Impact of the use of trammelnets on a tropical reef resource. *Fish. Res.*, 13: 353–367.

Trammelnets are sometimes considered as harmful gears for coastal reef resources and their banning has been recommended in the Caribbean. In the present state of the fishing technologies and strategies used in Martinique, trammels are more species selective than Antillean wire traps because they target mainly spiny lobsters and their fishing time is shorter. Furthermore, the trammels catch finfish at a much larger size than traps of the most common mesh sizes, including the mesh sizes recommended as optimal; however, no obvious differences were found between traps and trammels in their selectivity for lobsters. Therefore, the trammels are not more destructive than the widely accepted wire traps, at least as long as the reef fishery targets medium-sized fish at the expense of the larger species. The main drawback of trammels is the waste of spoiled fish. An optimal use of this gear could be fishing for lobsters with a net of low height and possibly larger mesh size.

INTRODUCTION

Coastal resources of tropical oceanic islands are often unsuitable for industrial harvesting because of narrow shelves, oligotrophic waters and hard bottoms. Therefore, they are exploited by artisanal, small-scale fleets using a wide variety of fishing techniques and strategies which reflect both the knowledge fishermen have of the diversity of the resource, and the action of external factors such as market opportunities and the price or availability of fishing gears. Managing such heterogeneous fishery systems often implies dealing with conflicts between resource users, particularly between fishermen using different gears, and assessing the impact of each of the main components of the fishery on the long-term conservation of the resource.

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010001148

O.R.S.T.O.M. Fonds Documentaire
14 FEV. 1996 N° : 43023
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Martinique (14°N, 61°W, in the Lesser Antilles, Fig. 1) is a good example of the general case presented above: its shelf is narrow and generally consists of rocky or coral substrates, especially on the east coast where it is widest. The coastal fisheries, which landed about 3300 t in 1987, use a wide array of techniques classified into 11 broad categories, which could themselves be further divided according to differences involving the gear itself or its use (Guillou et al., 1988; Gobert, 1989a).

As a consequence of the considerable economic and social evolution of the

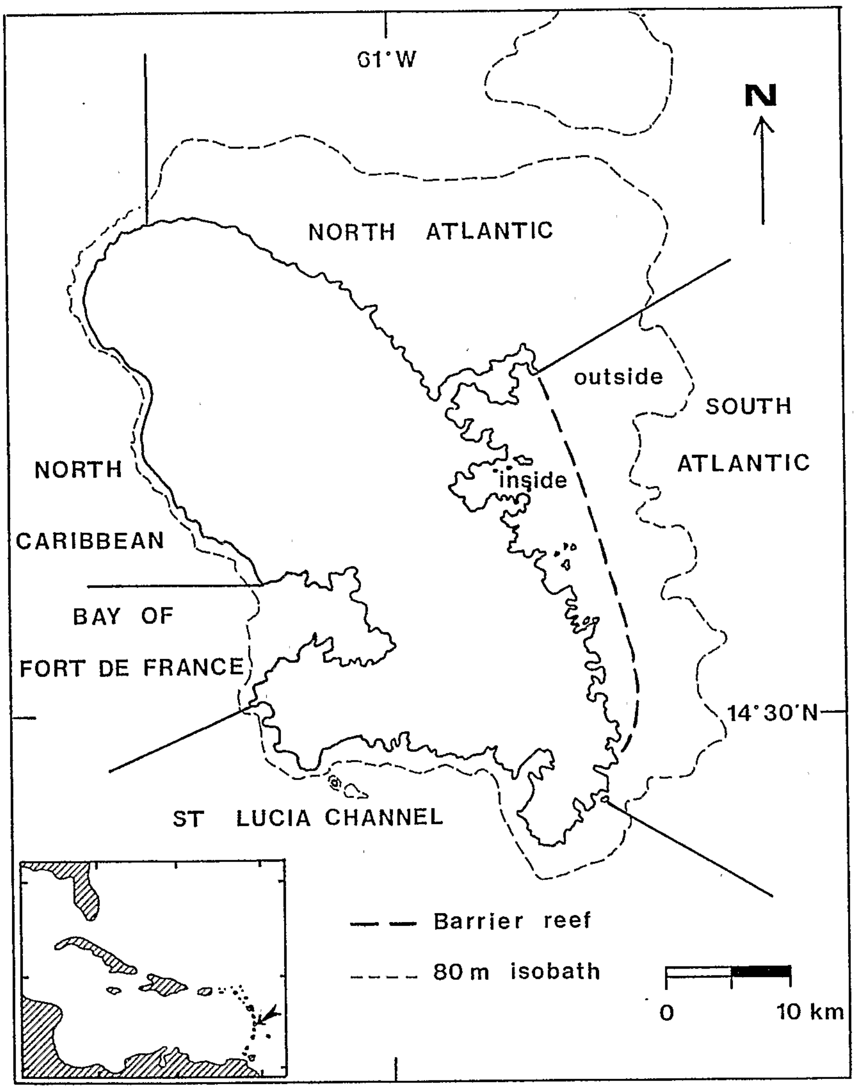

Fig. 1. Map of Martinique showing the main sectors of the shelf.

island during the last few decades, the fishery experienced increases in fishing effort and production costs, while the individual yields diminished, leading to generally high levels of exploitation (Gobert, 1991a), low levels of net income (De Miras, 1989), and a steady reduction and ageing of the officially registered fisherman population (Pary, 1989).

In this general feeling of crisis, scapegoats are sometimes pointed at, either outside the fishery (pollution, incompetence of the administration), or within it, such as the use of some gear(s) supposedly destructive or harmful to the resource. In this respect, beach seines (a traditional fishing gear in most Antillean islands) and trammels (introduced only 25 years ago in Martinique) have been incriminated. The beach seines, operated on the west coast of the island, target schooling pelagic species and catch many juveniles of demersal species, but their numbers have been decreasing since 1960 (the rate increasing for the last 10 years (Taconet, 1986)) and their potential threat seems low on the scale of the whole island. Trammelnets could be a more serious problem inasmuch as their fishery has grown at an increasing rate since its beginning in the mid-1960s (Fig. 2), and seems more and more to attract the younger fishermen less interested in the traditional trap fishery (Pary, 1989).

More generally, the use of trammels is widely considered as harmful in the Caribbean: several Lesser Antilles countries have forbidden its use in their waters (Chakalall, 1988), and recent recommendations issued by a regional working party on fishery management in the Lesser Antilles (Mahon, 1990) proposed that trammelnets should be banned (as well as tangle-nets and dynamite) as 'destructive fishing practices' which 'fish indiscriminately'.

This paper is a contribution to an objective analysis of the impact of trammels in the Caribbean context, based on the knowledge of the Martinican fishery.

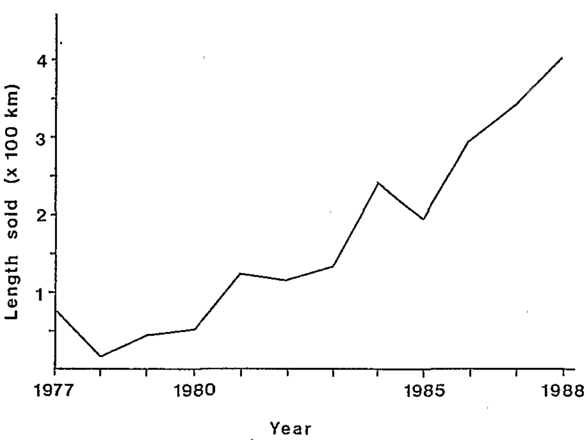

Fig. 2. Length of trammels sold yearly by the Fisheries Cooperative since 1977 (from Pary, 1989).

METHODOLOGY

Data collection

Within a multidisciplinary programme addressing the whole fishery sector, intensive sampling was conducted from February 1987 to January 1988, using principles proposed by Gobert (1988) and Chevaillier (1990).

In a first level of sampling, the numbers of trips by gear and trip characteristics (fishing effort, depth and location, catch by species groups) were recorded by field agents in the 25 most important sites ('main sites'), whereas only daily trip numbers were recorded in the 106 remaining sites ('secondary sites'). During the whole sampling period, 1925 and 3253 trips were recorded in the main and secondary sites, respectively. A total of 7093 trips were sampled for characteristics, among which 2171 used traps and 324 used trammels.

A second level of sampling dealt with length–frequency data and the species composition of catches within a subsample of the catches observed at the first level. A rigorous protocol was followed to optimize the field time and to serve as a practical guide in situations where very little time (sometimes less than 1 min) was available to measure fish before the sale began or the fisherman took the catch away. In most cases, the qualitative list of species present in the catch was recorded. In 1986, some length–frequency sampling took place, but was less rigorously organized; these data are used when possible. The numbers of samples and fish measured during the 2 years are indicated in Table 1. Species names follow Randall (1968). Lengths measured were total lengths (TL) for fishes and cephalothoracic lengths (CL) for lobsters.

Data processing

Trip numbers, trip characteristics and length frequencies were sampled according to different sampling plans, and the estimators corresponding to each plan were used (Chevaillier and Gobert, 1988; Chevaillier, 1990). Measure-

TABLE 1

Characteristics of length–frequency sampling

		1986	1987
Number of samples	Traps	1711	3214
	Trammels	271	780
	Total	3384	6805
Number of fish measured	Traps	9815	16766
	Trammels	2863	4038
	Total	34932	43441

TABLE 2

Length/height ($H=a+bTL$) and length/perimeter ($P=c+dTL$) relationships (N is the sample size)

Species	N	a	b	R^2	c	d	R^2
A. bahianus	143	11.456	3.251	0.90	22.698	7.318	0.94
H. plumieri	84	1.159	3.075	0.96	5.547	7.126	0.97
Sparisoma spp.	217	1.216	3.152	0.89	1.367	7.634	0.91

ment errors associated with cost-effective methods at the first sampling level were estimated and, when necessary, a correction model was applied (Gobert, 1989b, c). The size, and sometimes the absence, of the samples in many strata led to the pooling of strata into superstrata (for catches by group) or to ignoring them (for length frequencies) when estimating averages or totals for the whole catch. Catches by species group were obtained in a straightforward way by multiplying the average catch per trip by the number of trips with the considered gear in each superstratum. Species groups were generally identical to families, with the exception of Lutjanidae, Haemulidae and Sparidae, which were lumped together to avoid group misidentification by recorders for species of similar general appearance. Proportions of species within groups were calculated from samples where all the fish belonging to the group had been measured, using published or unpublished length–weight relationships to estimate sample weights. The species composition of groups of minor interest could not be calculated, but a rough estimate of species proportions within the group was obtained from the frequencies of occurrence in catches where the entire species list had been recorded. Relative proportions of length classes were calculated using the ratio estimator: number of fish kg^{-1} of the group (Cochran, 1977). For the fish species, lengths were converted into maximum heights (H) and maximum perimeters (P) using unpublished data collected in 1984 by P. Chevaillier (Table 2). The relationship obtained for all species of *Sparisoma* was applied for *Sparisoma rubripinne* because of the great morphological homogeneity within this genus (except for *Sparisoma radians*, which was absent from the samples). Average selection lengths (L_{50}) were estimated by Chevaillier (1990) for the main trap meshes used in Martinique, i.e. 25 mm, 31 mm and 41 mm, corresponding to maximum apertures of 32.3 mm, 44.6 mm and 54.7 mm, respectively.

RESULTS

Trammelnet catches were estimated at 104 t in 1987 (7.5% of the demersal landings) and mainly came from the 0–30 m depth zone of the eastern shelf. The nets, ranging in length from 0.3 to 1 km, are usually set to fish at night for 12–14 h and rarely during daytime. The fishery is quite homogeneous as far as mesh sizes are concerned since nearly all the fishermen use stretched mesh of 80 mm (59.6%) or 90 mm (35.1%). Besides the considerable increase of fishing effort,the fishing strategy has evolved through a slight increase of mesh sizes and a reduction of the height of the nets: half of the nets were more than 2 m high in 1979, but 54% are now less than 1 m, corresponding to more targetting of lobsters.

The traps used in Martinique, whose catches are compared to those of trammels, have various dimensions and mesh sizes (see below), but are usually Z-type (with two entrances) built from hexagonal chicken wire on a wooden frame (Munro, 1974). Most of them are hauled once a week (but the soak time ranges from a few days to 2 weeks) and are unbaited or baited with non-animal baits such as breadfruit and bread (Gobert, 1989a).

Species selectivity

Together with traps and gillnets, trammels catch a wide range of species (Table 3). The most important species is the lobster *Panulirus guttatus* (19.7%), with the other lobster species (*Panulirus argus*) ranking fifth (4.6%). This confirms the targetting strategy of the trammel fishery, as opposed to the trap fishery where globally no species contributes to more than 7.5% of the catch, lobsters ranking only second (*Panulirus argus*, 6.2%) and thirty-first (*Panulirus guttatus*, 0.7%). Among major demersal fish species caught in the trammels are the yellowtail parrotfish *S. rubripinne* (5.6%), the shark *Mustelus canis* (5.2%), the white grunt *Haemulon plumieri* (3.5%), the stoplight parrotfish *Sparisoma viride* (2.9%) and the bigeye *Priacanthus cruentatus* (2.8%).

Besides the lobsters, only four fish families in all sectors of the Atlantic

TABLE 3

Number of species caught by the demersal gears (TR, trammels; TP, traps; GN, gillnets; HL, handlines; TL, 'Tombé-levé' (small baited traps); LL, longlines; SD, skin diving). The number of species caught by traps might have been underestimated because some non-commercial species are probably discarded at sea, whereas all the fish caught in a net are removed on the shore and thus can be seen by the sampler

	All gears	TR	TP	GN	HL	TL	LL	SD
Total number of identified species	182	107	127	118	40	19	35	41
Number of species amounting to 50% of the catch	16	8	12	8	2	2	2	2
Number of species amounting to 75% of the catch	32	21	24	25	10	3	5	4

shelf are more than negligible in the night-fishing trammel catches (Fig. 3): grunts (Haemulidae), parrotfishes (Scaridae), groupers (Serranidae) and, to a lesser extent, bigeyes (Priacanthidae). The catch is somewhat more evenly distributed among families for traps than for trammels (suggesting more species selectivity for the latter gear), although a possible underestimation of 'others' in trap catches could have contributed in part to this difference.

Overall species compositions were computed for four of the main families (Fig. 4). A variety of differences can occur between catches of trammels and traps, from the completely opposite compositions (lobsters) to differences involving mostly secondary species (haemulids), but the specificity of gears versus the multispecific resource, through differences in catchability for each species, appears clearly.

Within the fishery as it operates presently in Martinique (i.e. given the technical development of the fishermen, their knowledge of the resource, their fishing strategies) and in the present state of the stock (i.e. the respective abundance of each species), there is no sound argument to blame the tram-

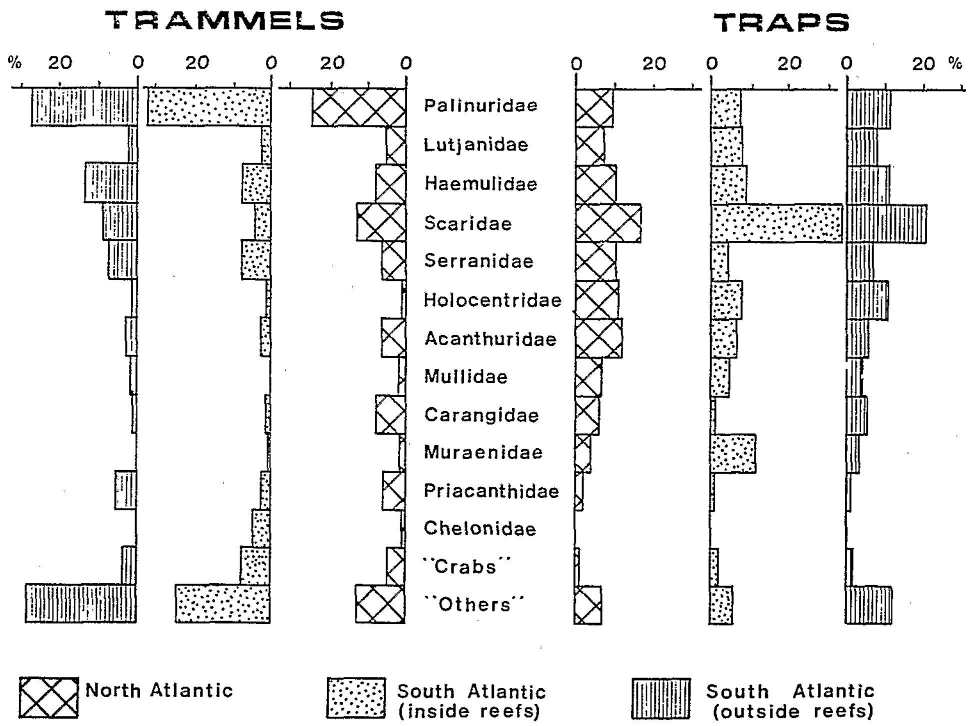

Fig. 3. Composition of the catches by trammels and traps in the three sectors of the Atlantic shelf of Martinique, by family.

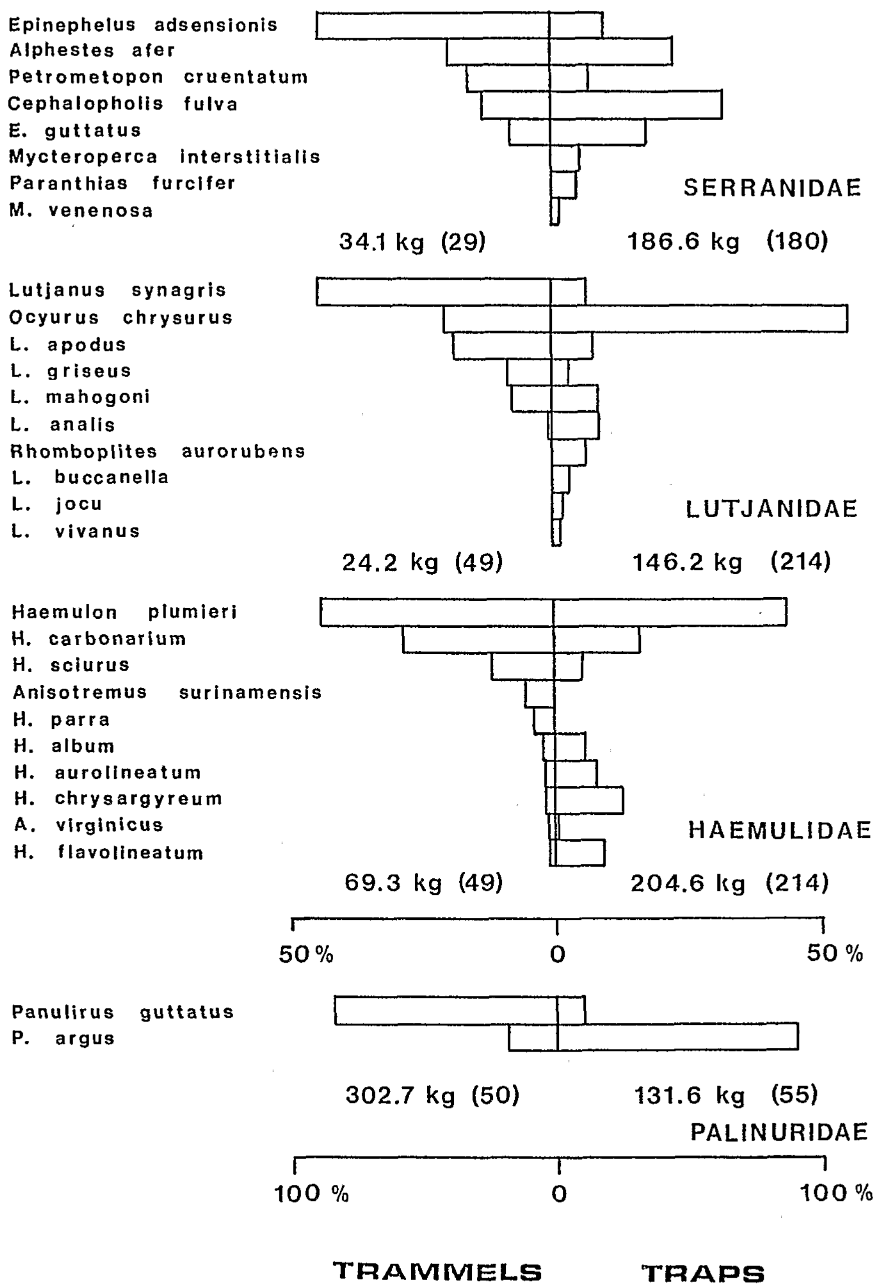

Fig. 4. Overall species composition of catches by trammels and traps for the families Serranidae, Lutjanidae, Haemulidae and Palinuridae. Numbers show the total weight of samples and, in parentheses, the number of trips sampled.

melnet for being species unselective or, at least, for being more species unselective than the traps which are the main gear used in Martinique and throughout the Caribbean.

Size selectivity

The theoretical selectivity curve of a trammelnet is the result of two components: the first, bell-shaped, corresponds to the gillnet-type action of its central panel where fish are caught in the meshes by the gills, head or body (Hamley, 1975); the second, corresponding to the enmeshment of larger fish in the loose central panel without being gilled, results in higher values of probabilities of selection in the right-hand part of the gillnet-type curve. These values are positively correlated to the slackness of the central panel (Koike and Matuda, 1988). Therefore, for a given species of fish, the minimum size retained is a function of the mesh size of the central net and of the height and transverse shape of its body.

Given the limits of the data, analysis of length–frequency distributions was possible only for the surgeon *Acanthurus bahianus* (Fig. 5), the white grunt *H. plumieri* (Fig. 6), the yellowtail parrotfish *S. rubripinne* (Fig. 7) and the lobster *Panulirus argus* (Fig. 8). For the first two species, the length–frequency of trammel catches is strongly unimodal and was very similar in 1986

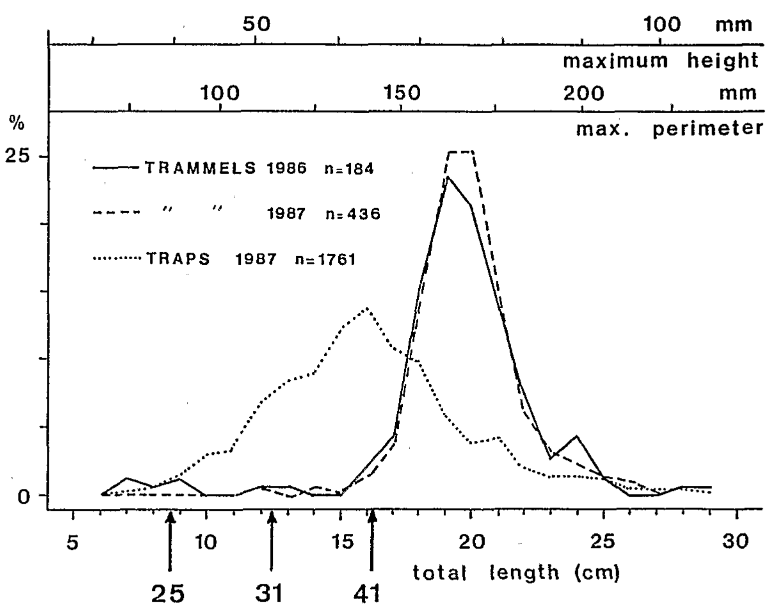

Fig. 5. Length–frequency structure of catches of *A. bahianus* in trammels (1986 and 1987) and in traps (1987). Arrows point to the average selection length (L_{50}) of traps of mesh sizes indicated by bold numbers (see the text).

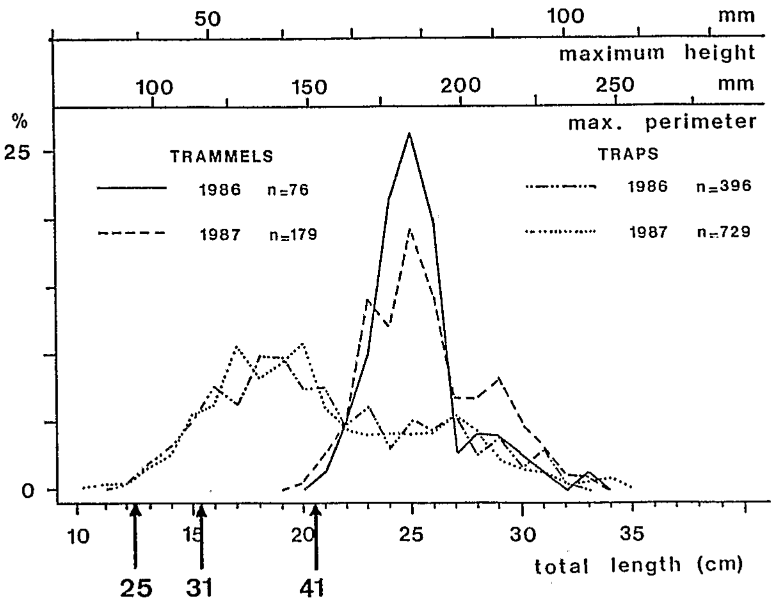

Fig. 6. Length–frequency structure of catches of *H. plumieri* in trammels and traps in 1986 and 1987. Arrows are as in Fig. 5.

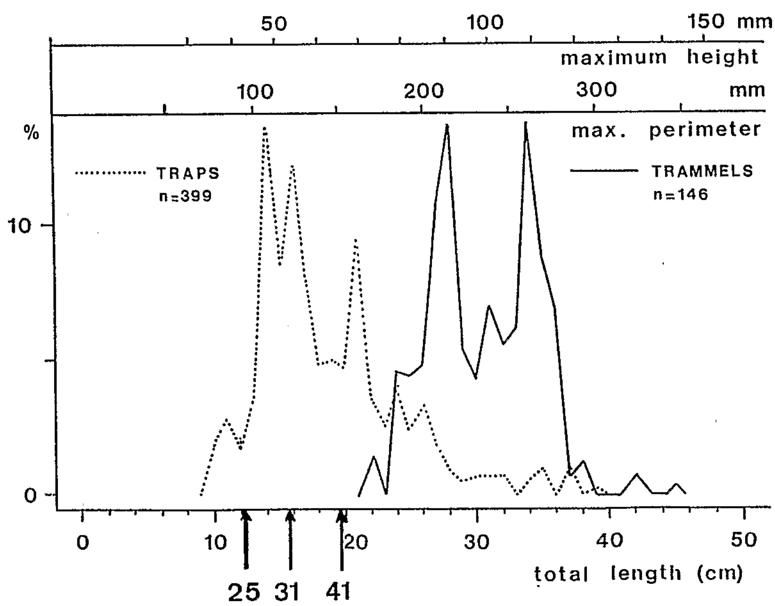

Fig. 7. Length–frequency structure of catches of *S. rubripinne* in trammels and traps in 1987. Arrows are as in Fig. 5.

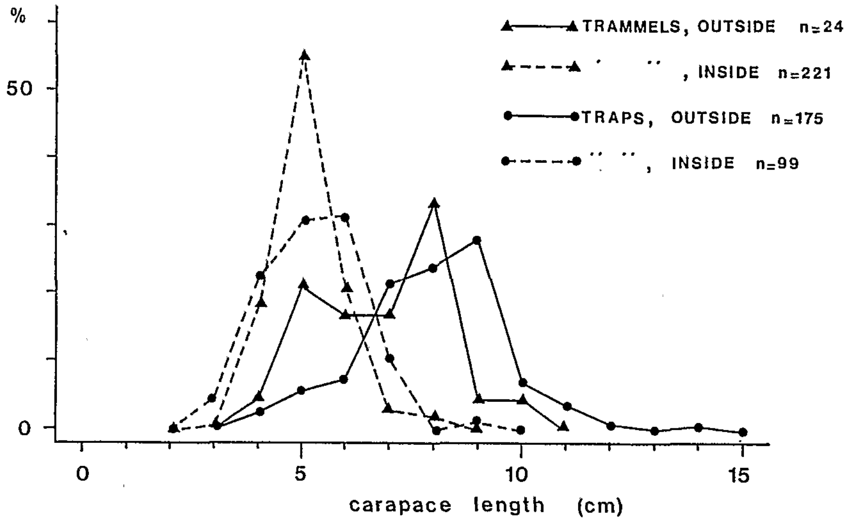

Fig. 8. Length–frequency structure of catches of *Panulirus argus* in trammels and traps in 1987.

and 1987. The gillnet-type selection predominates with little catchability for the larger fish, shown by the sharp decrease of trammel frequencies as opposed to the steady decrease of traps, indicating that larger fish are present in the population. This enmeshment effect is hardly noticeable for *A. bahianus*, but is more apparent for *H. plumieri*. The low catchability of larger fish is probably due to a low slackness of the inner panel (Koike and Matuda, 1988), either because of the small height of the whole net or because of the respective hanging ratios of its inner and outer panels (which are in the proportions 1.2:1.0 horizontally and 1.6:1.0 vertically; A. Guillou, personal communication, 1991). For *S. rubripinne* (Fig. 7), the selection process of the trammel is less clear, probably because of the small size of the sample. For both *A. bahianus* and *H. plumieri*, the peak frequency of trammel catches occurs for heights between 70 and 80 mm, and for perimeters lower or higher than, but close to, 175 mm. In all three fish species, the selection by trammels operates at lengths much larger than those of the traps. Fish are caught in traps at heights ranging from 40 to 60 mm, as compared with the range 50–90 mm for trammels.

The samples of the lobster *Panulirus argus* (Fig. 8) were processed separately, depending on whether they came from inside or outside the reefs in the South Atlantic sector, since the size distribution of the population is dependent on depth and distance from the shore. As opposed to fish, there is no clear difference between the length structures of trap and trammel catches, the sector effect being predominant over the gear/mesh effect. Owing to their numerous appendices and spines, lobsters do not follow the selection model described above: they enter the catches at smaller sizes than their perimeter would indicate (as might be the case for traps) and show little or no decrease in catchability with increasing size.

Fish discards

One of the main drawbacks of the use of gillnets and trammels in tropical waters is the spoiling of fish caught early and remaining dead for several hours in the warm water. In Martinique, the problem was stated earlier by Farrugio and Saint-Félix (1975) whose 35 trammel stations all produced some unmarketable catch (Fig. 9). According to their raw data, 32.3% of the weight for which the condition ('good' or 'spoiled') was explicitly recorded was spoiled. If this proportion was applicable to the present fishery, about 25 t of finfish would have been wasted.

In 1987, only qualitative data were recorded on the trammel discards (whether or not some discard had taken place). Globally, for 76.8% of the 237 trammel trips surveyed in the Atlantic sectors, the fisherman declared that he did not discard any fish. This high proportion may seem surprising in comparison with the results mentioned above. The obvious uncertainty about the subjective appreciation of the quality of a fish for consumption, the possible misreporting by fishermen and the reduction of the height of trammels make a comparison with the quantitative data of Farrugio and Saint-Félix (1975) difficult. It is, therefore, impossible to estimate the amount of finfish presently wasted by the use of trammels; it is probably much less than 30%.

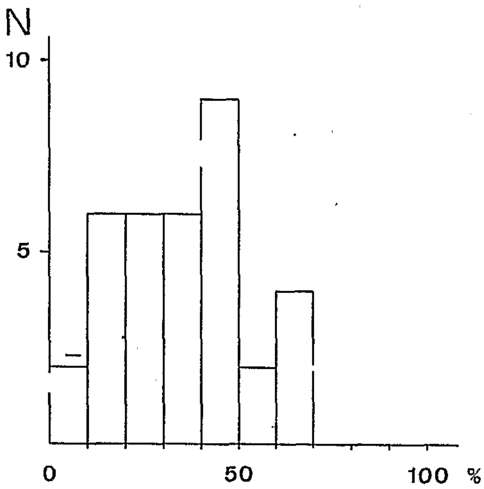

Fig. 9. Frequency distribution of the trammel catches of Farrugio and Saint-Félix (1975) according to the proportion (%) of spoiled fish.

DISCUSSION AND CONCLUSIONS

As opposed to traps, no specific studies have so far been conducted on the performance of trammelnets in the Caribbean (Mahon et al., 1986). The present work is, rather, an analysis of the impact of their use in the actual case considered, within a given context of technology, fishermens' skills and habits, and environmental and resource conditions.

The fishing time of trammels is short enough to allow some targetting of species according to their diurnal (e.g. parrotfish) or nocturnal (e.g. lobsters) feeding habits, whereas traps are usually soaked for several days and fish by day and by night. Different trap-fishing strategies have been described in Martinique (Chevaillier and Lagin, 1985; Pary, 1989), but they do not appear clearly in the data collected during the survey. Even if some targetting is possible at the level of individual traps, this fishery as a whole is not more species selective than the trammel fishery. Although some species or groups of species are equally important in both, the compositions of trap and trammel catches are, to a large extent, complementary.

The length-selectivity pattern of trammels for finfish depends on the mesh size and the slackness of its inner panel. Trammels catch fish quite selectively, possibly as much as gillnets when there is little slackness, and most often much more so than traps whose catchability is usually considered as constant above the size at first capture with a sigmoid selection curve (Pope et al., 1975). Thus, catching juveniles is related only to the size of the mesh and not to the principle of the trammel itself. For lobsters, the selection process is more complicated and apparently much less size dependent.

In Martinique, fish are retained in traps at small sizes because of the use of small mesh netting: 31 mm meshes are the legal minimum, but in some sectors 25 mm and even 18 mm meshes are still used. The high level of exploitation found in most finfish species of the shelf is, therefore, not attributable to trammels, for which the sizes of first capture are much larger than those for traps, even considering the larger mesh sizes usually recommended for the management of trap fisheries (Mahon, 1990). As far as lobsters are concerned, it appears that *Panulirus argus* is obviously overfished and that the smaller *Panulirus guttatus* could probably sustain a higher level of effort (Gobert, 1991a). Given the strong gear specificity of these two species (Fig. 4), it is very unlikely that the growth of the trammel fishery could be blamed for the poor status of the stock of *Panulirus argus*.

The use of trammels raises other problems less directly related to the exploitation of the resource. Spoiling fish is hardly justifiable when the demand for fish largely exceeds the supply, even when it provides 'bait' for lobsters. The filling in of the net by floating algae, and the frequency of damage when it is used on rocky or coral grounds, entail hours of work between trips. Other poorly known problems related to fishing rough grounds are the catching power of lost ('ghost') nets and the destructive impact on the habitat when the entangled net is mechanically pulled free of the coral heads. The progressive reduction of the height of the trammels and the increase in mesh sizes probably reduced the spoiling of fish and the filling in of the net. Fishing smoother grounds could modify the catch composition, but would prevent too much damage of both the nets and the reefs.

As far as management is concerned in Martinique, there is presently no sound reason to ban the use of trammelnets if the fishery is intended to keep exploiting the medium-sized species and if the impact on the reef habitat is proved to be negligible. In many Caribbean islands, the traditional inshore fisheries have eliminated or brought to very low levels of abundance the largest-growing species (Koslow et al., 1988; Gobert, 1991b; Sadovy, 1991). In this general context, the trammels do not seem more harmful than the widely accepted traps. A promising research and management option could be to promote the use of trammels as a very selective gear targetting lobsters only, with a height as small as possible (to avoid algal retention and limit the finfish catch, and thereby spoiling) and an inner mesh size as large as is compatible with the selection mechanism of lobsters. This would further improve the complementarity shown between the different gears used on these shallow reef resources and thus contribute to their more efficient use.

ACKNOWLEDGEMENTS

Field data were collected under the responsibility of Pierre Chevaillier and the author, with the technical coordination of Marc Picheral and Hughues Francil, and the direct participation of many other people, Pierre Fréon and two anonymous reviewers helped with useful comments on the manuscript.

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