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## Relationship between the wreck of small-scale fishing equipment and ghost fishing in Guadeloupe (French West Indies) with palliative proposals for a better long-lasting management of biodiversity

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### Introduction

Ghost fishing and its consequences are little known in the French West Indies. In Guadeloupe, no allegation concerning ghost fishing was made public to date. In the absence of objective studies about this phenomenon, it is impossible to quantify the impact of these lost gears on the resource (Chaves et al. 2006). However, the characteristics of small-scale fishing existing in this area let think that it happens indeed that fishing machines are lost:

- weather constraints, sometimes of catastrophic type (storms, hurricanes). The fishermen fix less racks (traps) during the period preceding the hurricane season in preparation for possible loss (Komla-Soukha and Bouchereau 2007). Of the 40 000 Caribbean traps around Guadeloupe, about 20 000 are lost each year during hurricane season, but continue to catch fish for many months (Burke and Maidens 2004);
  - accidents (most common causes after the literature) occurring during a fishing operation are events already well orally brought back (Macfayden et al. 2009);
  - the voluntary abandonment at sea of material by the fisherman for convenience reasons;
  - the consequences of conflicts of use (thefts, destruction of fishing gears, boardings of ships).
- It is the case in the Caribbean area in connection with the interactions related to the stake on resources exploitation (Blanchet et al. 2002).

Ghost fishing and its consequences are little known in the French West Indies. In Guadeloupe, no allegation concerning ghost fishing was made public to date. This study aims to diagnose the responsible elements and the environmental and economic consequences for ghost fishing in the area, and to put forward measures to reduce its effects and to improve durable management of biodiversity in Guadeloupe.

### Material and Methods

#### Investigations near fishermen

In order to proof that ghost fishing exists in Guadeloupe, we questioned the fishermen sailor under cover of anonymity, either directly by oral examination on the spot of unloading (Komla-Soukha and Bouchereau 2007), or indirectly by means of a simple and short questionnaire (Table 1) on which they could answer in writing.

Table 1 Questionnaire submitted to fishermen.

<i>Questions</i>	<i>Answers</i>
During your activity, did you already lose fishing tackle?	Yes <input type="checkbox"/> , No <input type="checkbox"/>
<i>If so, continue after</i>	
During your activity, how much fishing machines were lost?	< 10 <input type="checkbox"/> ; 11 <input type="checkbox"/> 20 <input type="checkbox"/> ; > 20 <input type="checkbox"/>
Are the lost fishing machines of which type?	cage <input type="checkbox"/> , gill net <input type="checkbox"/> , drifting net <input type="checkbox"/> , trawl <input type="checkbox"/>

With which depth, these fishing machine were lost? < 5m □ ; 6 □10m □ ; > 10m □

### Field sampling

The exposure to the winds, accessibility, variety of substrates along the coast, reduced human activity and weak frequentation were the principal criteria in the choice of a coastal sector of the Guadeloupe for searching and collecting for mislaid fishing tackle. The North-eastern sector of Grande-Terre and a zone with mangrove in the Grand Cul-de-Sac Marin lagoon (Figure 1) were retained.

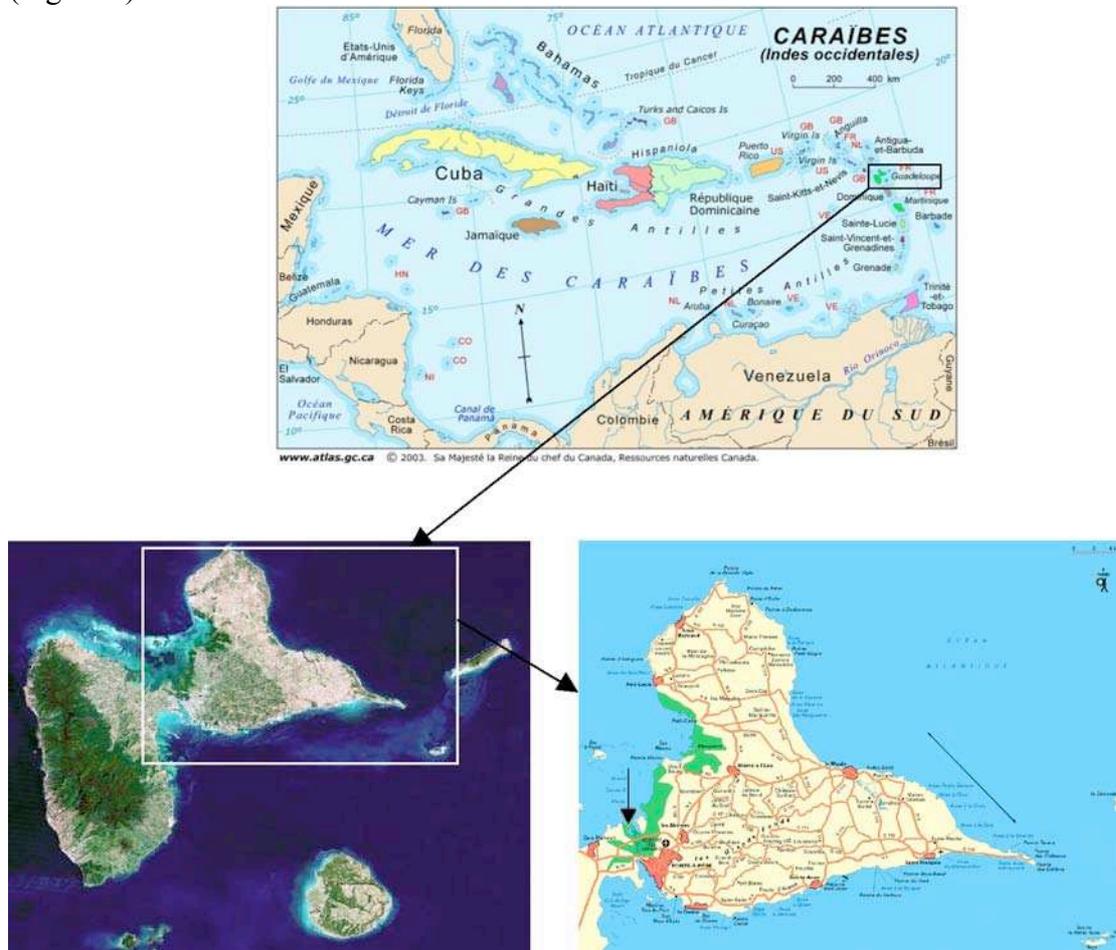


Figure 1 Geographical position of the Guadeloupe Archipelago and localization of field samplings in mangrove (vertical arrow) and along the coast (milked arrow) between Le Moule and Pointe des Châteaux.

The three following methods were adopted to inventory the fishing tackle mislaid with collecting or harvesting samples of parts of fishing machines become stray, for examination and measurements at the laboratory (Figure 1; Table 2):

- deep-sea diving of exploration in edge of coast, until 5m depth;
- walking along five portions of coasts in the intertidal zone and the supralittoral between Le Moule City and the Pointe des Châteaux;
- inspection in boat of the edges of mangrove of the Manche-à-Eau lagoon.

Table 2 Sites, types of substrates present and dates of visits from West to East on the North-eastern sector of *Grande Terre*, and in the *Grand-Cul de Sac Marin* lagoon; n = number collected parts of fishing machines.

Locality	Anse à la Gourde	Anse à l'Eau	Porte d'Enfer	Anse Salabouelle	Anse Salmon	Manche-à-Eau lagoon
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Substrat	Sand	Sand / Reef	Shingle / Reef	Sand / Reef	Sand	Mangrove
Date	21/02/2010	28/02/2010	14/03/2010	11/03/2010	07/03/2010	25/03/2010
n	76	58	41	171	377	1

### Treatment at laboratory

The objects brought back to the laboratory were indexed and counted, and the nature of material constituting the parts, identified (wood, metal, plastic, mono or multi-filament ropes). Dimensions of racks, buoys, floats, lengths of mesh (mesh side, stretched mesh) of the nets, and ropes diameters were measured to the inferior mm with a slide calliper. Statistical calculations (mean, standard deviation) of dimensions were carried out for better identifying the types of fishing and the targeted groups of species.

### Results

#### Investigations near fishermen

The direct consultations near fishermen at the landing places of fishing ports of *Saint François, Le Moule, Port-Louis, Petit-Canal* and *Pointe-à-Pitre* made it possible to confirm that they had lost fishing machines consecutively with an operation, bad weather episode, theft, or that they had given up damaged material.

The returns of investigation remain still weak to date to draw some consistent results from the statistical point of view, also we still prefer to await other hoped answers. Nevertheless, the answers confirm losses of fishing machines at sea by specifying that they are cages and/or nets.

#### Inventory and characterization of wrecks of fishing gears collected

The two adjacent localities *Anse Salmon* and *Anse Salabouelle* are richest (Table 2) in various wrecks of fishing devices. It was observed 724 different parts coming from fishing gears on the sampled beaches (Table 2) and 698 of them could be brought back to the laboratory for analysis (Table 3).

Table 3 Schedule of the sampling effort of wrecks of fishing gears found on the field and characteristic of the sampled parts;

∅ : diameter in mm; Ms: mesh side in mm; Sm: stretched mesh in mm; th: thickness; No: number of observations; Nm: number of measurements; σ: standard deviation.

Fishing gears	Piece of net without full mesh		Piece of net with full mesh			Ropes ∅(mm)	Floats (cL)	Buoys (L)	Traps Ms x Sm x th	Trawl net ∅xMsxSm	Total
	∅	Ms	∅	Ms	Sm						
No	74		146			431	13	17	14	3	698
%	10.6		20.9			61.8	1.9	2.4	2.0	0.4	100
Nm	73	53	146	146	146	431	14	28	20	3	1040
mean	3.40	56.50	3.48	50.16	93.6	6.47	(2-80)	(2)	5-43x18-46x3-6	6x20x37	-
σ	0.93	10.98	1.28	14.8	29.3	7.59					-



A

Figure 2 Wrecks of gill net stranded, A in the roots of mangrove (Manche-Éau), B seine on the rocks (Porte d'Enfer) and buoys C on the shore (Porte d'Enfer).



B



C

These parts correspond to remains (Figure 2) of ropes (61.8%), pieces of nets (Figure 2A,B) of various sizes (31.5%), floats and buoys (Figure 2C) of fishing gear positioning (4.3%), metal or plastic racks (2.0%) and parts of trawl net (0.4%). The species targeted by the racks are benthic fish and shellfish (lobsters, cicadas, crabs).

The majority (84.4%) of ropes remains has a diameter ranging between 2 and 8mm, which corresponds to material pertaining to gill nets (multifilament out of synthetic fibre). Diameter class of 1 mm represents gill nets (Figure 3) out of nylon (0.2%), that of 15 to 100 mm corresponds to rope of mooring (3.0%) of machine or boat.

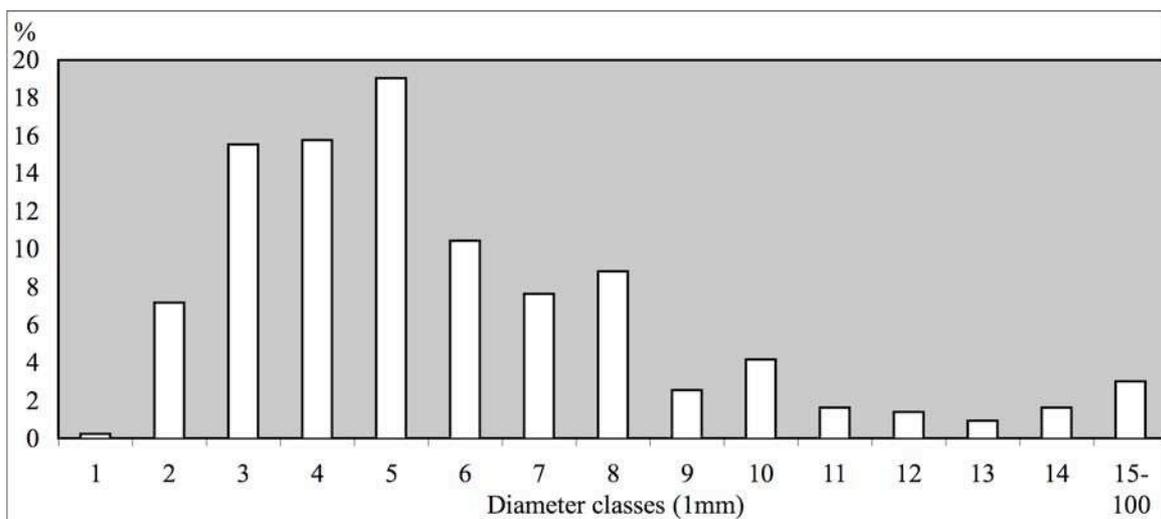


Figure 3 Ropes diameter (class size 1mm) occurrence frequency (%) in the samples analyzed.

The principal characteristics of the gill nets (mm) are: diameter 3.5, mesh side 50.2, stretched mesh 93.6. They are nets placed at the bottom, from 100 to 250m of length, 12 m in height provided with a sliding rope, with two sizes of stretched mesh (Sm): from the small ones ( $75 < Sm < 95$ ) toward the ends and from the largest ( $95 < Sm < 125$ ) in the middle (Figure 4).

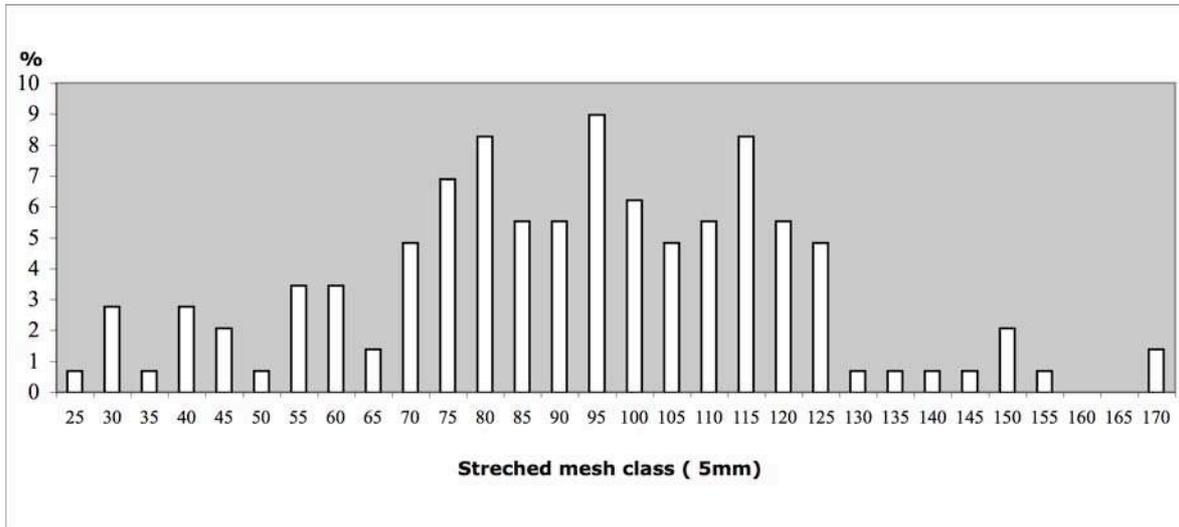


Figure 4 Relative frequencies (%) of stretched mesh class (5mm) from parts of nets collected.

Two boats are necessary to direct this type of seine. Species targeted by these fishing gears are shellfish and benthic and demersal fish (Figure 5).



Figure 5 Fishermen ordering on board a type of net often used for fishing.

The remains of cages belong to the least frequent observations because they do not float as much as the nets and are less mobile. The relative frequency of the plastic cages is higher (85.7%) than that of the metal cages (14.3%). Parts of trawl net were also found. The floats and buoys were often observed associated with cages or parts of nets, other times separated on the strand.

In sea diving, with a visibility going until 12m depth, we observed, in September-October 2009, according to the locality, between 4 and 11 lobster cages with reinforcement out of wooden (Figure 6A), and none out of plastic with metal reinforcement (Figure 6B).



Figure 6 Lobsters and fish traps, with reinforcement out of A wood with wire-netting envelope, B metal with plastic envelope.

According to the Guadeloupe fishermen converted to the use of racks into plastic metal envelope framework, those have the advantage of being easy of maintenance and repair of tears. From an economic point of view, this type of rack has a great longevity, 8 years, versus 8 months for the fitted latticework on rack with reinforcement out of wooden (Figure 6B) for a fast return of investment.

#### Discussion

##### Obviousness of ghost fishing

Investigation near the fishermen and the numerous objects observed along the shore belonging to various fishing tackles confirm well the loss or otherwise discarded fishing gear and that those are potentially likely to continue to passively fish in absence of human control. Characteristics of these wrecks show that they are engines generally used by small-scale fisheries (SSF), and more rarely for the high-sea fishing too. Thus their origin is multiple: SSF and deep-sea fishing. Observations in diving of abandoned and empty racks (not fitted out with cord and marking buoy) were evidence of loss, but also showed the limit of ghost fishing action even if it is likely to continue to fish a little once material is abandoned.



Figure 7 Fisherman fixing his racks.

The racks with reinforcement out of wooden and wire-netting (Figure 7) are more fragile when they are fixed for fishing, and, once given up, those do not fish a long time alone. They need more attention by the fishermen and are of more expensive maintenance than the racks with metal reinforcement and plastic envelope. This latter is more easily repairable and its cost price is weaker than the wire-netting envelope one. When lost such a rack with plastic envelope will open more quickly than netting and reduce the ghost fishing effect. Moreover, in the event of loss, the plastic envelope more easily takes a part in artificial reef than the fitted latticework on cage, while becoming overcast of fouling, once the envelope tear.

The nets given up by SSF are made with synthetic more or less thick multifilament fibre ropes. The majority of them fall on the bottom when lost and are then taken along in various directions, of which coasts, to the liking from the tide or marine currents. Under these conditions, nets are very quickly out of state to fish because they end up being rolled up around stones or themselves to form a cluster, of ropes in the shape of roll, which one often collected on the shores.

Whatever the type of fishing gear found on the shore, it is difficult to evaluate the share of ghost fishing, when there is one. Causes can be the lack of knowledge about conditions under which it can happen, and its duration of action according to the state of capacity of whole the fishing gear or the abandoned part of it.

#### Proposals suggested

Measures to reduce socio-economic and biological consequences of ghost fishing and to improve durable management of the biodiversity in Guadeloupe and Caribbean countries also users of similar small-scale fishing gears.

(i) to make the fishermen to be aware

Whole of managers in charge of fishing should work near the fishermen to make known by education, the consequences of abandonment of fishing machines on their own income and the biodiversity.

(ii) to regulate manufacture of a fishing machine

States should cooperate to develop and apply technologies, materials and operational methods that minimize the loss of fishing gear and the ghost fishing effects of lost or abandoned fishing gear (FAO, 1995).

It would be interesting to consider, during the manufacture of any fishing device, to secure it with points of weakness so that it neutralized itself quickly once given up in water.

(iii) to register the fishing machines with recording of its owner

Marking the fishing machine by a registration referred at the fishermen's co-operative (conciliation board or local maritime administration) presents two advantages: to avoid or reduce the poaching and the theft of gears, and to involve fishermen's responsibility with two aims. To prevent them from throwing at sea (a fishing tackle become unusable in their eyes), but to ground once returned with at the port; to recover their lost material, under penalty of entry of charge if it is found.

(iv) to remove wrecks of fishing machines from sea-beds and shore

It is suggested to seek and to withdraw the wrecks of fishing machine in spaces going from the fishing zone to the shore, whatever the depth of fishing; finally to charge the owners of these abandoned fishing machines.

(v) to practise preventive withdrawal of fishing machines before an announced hurricane

Fishing with passive machines should be prohibited during the period preceding and that lasting the passage by a hurricane. A fast information network should be set up to sufficiently early inform the fishermen in advance with the confirmed approach of a hurricane, to withdraw the fishing machines fixed in order to avoid their loss.

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