

Crossing Fishery Statistics with Marine Turtle Bycatch Data and Habitat Mapping in Martinique, FWI

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ABSTRACT

Small scale fisheries in Martinique concern 1,300 fishermen for about 1,275 boats (6 - 8 m) and concentrate on the continental shelf where numerous commercial species are catchable. Among the gears used locally, bottom trammel nets and gillnets targeting fishes, queen conches and spiny lobsters are responsible for significant marine turtle catches. Bottom nets account for 20% of the total fishing gears with gillnets more used than trammel nets. The south Atlantic fleet and the north Caribbean fleet, where turtles' bycatch is the most important, account respectively for 29% and 20% of the total fleet. The combination of the CPUE data with those of marine turtle abundance and marine habitat mapping has led 1) to the identification of experimental fishing areas to test new equipment targeting demersal reef resources, 2) to new orientation for policy development based on turtle ecology knowledge and 3) to a reflection on fisheries regulation to preserve marine turtles and marine resources.

KEY WORDS: Bottom nets, by-catch, marine turtles, Martinique, small scale fisheries

Estadísticas de Pesca en Relación con los Datos de Capturas Accidentales de Tortugas Marinas y la Cartografía de los Hábitats Marinos de Martinica

Las pesquerías en pequeña escala en Martinica se refieren a 1.300 pescadores por alrededor de 1275 barcos (6-8m de longitud) y se concentran en la plataforma continental donde muchas especies comerciales están presentes. Entre las artes de pesca utilizadas localmente, el trasmallo y la red simple de fondo que apuntan peces, lambi y langostas están implicados en numerosas capturas de tortugas de manera significativa. Las redes de fondo representan 20% de las artes de pesca totales y las redes simples de fondo son más utilizadas que los trasmallos. La flotilla atlántica del sur y la flotilla del Caribe del norte representan respectivamente 29% y 20% de la flotilla total. La combinación de los datos de CPUE con los de la abundancia de tortugas marinas y de la cartografía de los hábitats marinos ha permitido la identificación de zonas de pesca experimentales para probar un nuevo equipo apuntando recursos de arrecife demersales, una nueva orientación para el desarrollo de una política basada sobre el conocimiento de la ecología de la tortuga y una reflexión en la adaptación de las pesquerías para proteger las tortugas marinas.

PALABRAS CLAVES: Pesquerías en pequeña escala, captura involuntaria, pesca experimental, tortugas marinas, Martinica

Croisement des Statistiques de Pêche en Relation avec les Données sur les Captures Accidentelles de Tortues et al Cartographie des Habitats Marins de Martinique, FWI

La pêche artisanale en Martinique concerne 1300 marins pêcheurs pour 1275 bateaux de 6-8m et se concentre sur le plateau continental où se trouvent diverses espèces d'intérêt commercial. Parmi les engins utilisés localement, les trémails et filets droits de fond ciblant les poissons, le lambi et les langoustes sont responsables de nombreuses captures accidentelles de tortues marines. Les filets de fond représentent 20% du total des engins de pêche et le filet droit est plus utilisé que le trémail. Les flottes sud atlantique et nord caraïbe représentent respectivement 29% et 20% de la flotte totale. La combinaison des données de CPUE avec celles d'abondance de tortues marines couplé à la cartographie des habitats marins a permis d'identifier des aires de pêche expérimentales pour tester de nouveaux équipements ciblant les ressources coralliennes démersales. Ces tests permettent également d'envisager de nouvelles orientations de la réglementation basées sur les connaissances de l'écologie des tortues et d'engager une réflexion sur l'adaptation des méthodes de pêche pour la préservation des tortues et des ressources marines.

MOTS-CLÉS: Pêche artisanale, captures accidentelles, filets de fond, tortues marines, Martinique

INTRODUCTION

In Martinique, small scale fisheries concern 1.300 fishermen and 1.200 boats (6 - 8 m) fitted with outboard engines. It represents a very important economic and social sector. The fishing activity is concentrated on the continental shelf where numerous commercial species are catchable. Nets account for 20% of the total fishing gears used in Martinique (DRAM 2005). Gill nets and trammel nets are known to affect marine resources through benthic degradation, massive fish captures (Acosta *et al.* 1995,

Gobert 1992) and bycatch (Aucoin *et al.* 2007, Bell *et al.* 2006, Brown *et al.* 2005, Carreras *et al.* 2004, Gearhart *et al.* 2003, 2007, Koch *et al.* 2006, Pandav *et al.* 1997). The gill net is composed of one layer net with tight meshing size. The trammel net consists of a three layers net with a tight meshing size layer surrounded by two loose meshing size layers. Trammel nets are the most problematic gears for marine resources and sea turtles in Martinique. It has been banned in surrounding countries (Dominica, St-Lucia) for many years (Chakalall *et al.* 1997) because of its

impacts on marine resources.

Since the 1990s, marine turtle populations have decreased to a critical level in Martinique. A local total protection has been approved in 1993 and a marine turtle recovery plan (Chevalier 2003) has been implemented in 2006. Bottom nets are the most destructive gears involved in marine turtle bycatch, killing hundreds of individuals every year (Louis-Jean 2006). Among the gears used locally, bottom trammel nets and gillnets targeting fishes, spiny lobsters and queen conch (*Strombus gigas*) are first concerned.

The aim of this study is to:

- i) Analyze the local artisanal fishery and collect experimental data using these problematic fishing techniques, and
- ii) To precisely determine the impact on marine turtles.

It will help to improve marine coastal resources management in Martinique through the adaptation of fishermen practices and to significantly reduce bycatch. This first part of the study concerns the bottom nets targeting fishes.

Experimental Fishing Area Location

The INA-Scuba protocol (protocol of Abundance INdex) gives a marine turtle abundance index for each site along the coast (Figure 1). Data on marine turtles observed are collected by scuba diving centers. For each dive, divers record the presence or absence of sea turtles, the species, the site and the date. The major marine turtle sites are located in the south and the north Caribbean coast (Réseau Tortues Marines Martinique 2006) (Figure 1).

The principal fishing sites have been localized using the local fishery data (IFREMER Pers. comm.) (Figure 1). The main fish bottom net fishery sites are located at the center and the south Atlantic coast and along the south and the north Caribbean coast (Louis-Jean 2006). The fishing fleets of the south Atlantic and the north Caribbean account respectively for 29% and 20% of the total fishing fleet (DRAM 2004).

A marine habitat mapping project has been conducted by the Martinique Marine Environment Observatory between 2006 and 2008 (Figure 1). Maps of benthic communities were produced for the whole island between the surface and 50 m depth.

These data were transferred into a GIS (Geographic Information System) to add up marine communities, turtles and fishery data to identify experimental fishing areas for the new gears to be tested (Figure 1).

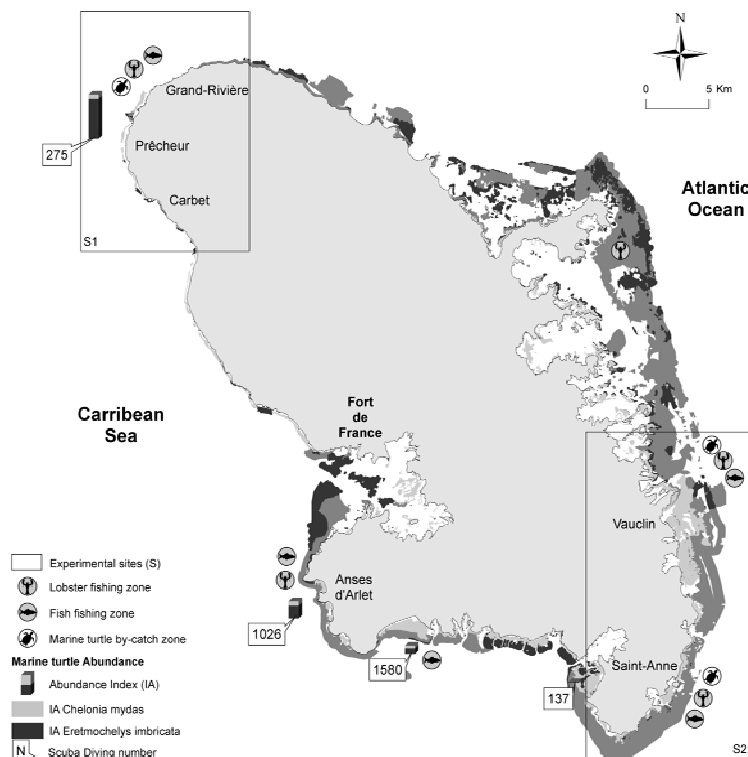


Figure 1. Experimental site for the fish campaign (S1) (data IFREMER, Louis-Jean, OMMM, Réseau tortues marines). This map gives the localization of the main marine ecosystems, the most important fisheries in the area, and the data on marine turtle observation (2007 INA-Scuba protocol) for the Martinique Island.

Experimental Fishing Gears and Methods

The principal net used by professional fishermen was chosen as control net (gill net of 3 to 4 m high). Our control net was a 3.40 m gill net. Other parameters were modified and combined to create pilot nets, according to their impact on turtle: the height (1.60 m / 3.40 m) and the number of layer (one for the gillnet (G) / three for the trammel net (T)) (Table 1).

All the nets in this study were 300 m long with a principal mesh size of 45 mm and floats ensuring a vertical setting. The external layers of the trammel net had a mesh size of 200 mm (same as professional fish nets in Martinique). Four different nets were designed for the surveys : 1.60 m trammel net (T2), 1.60 m gill net (G2), 3.40 m trammel net (T4) and 3.40 m gill net (G4) (Table 1).

Experimental fishing was conducted during both the dry season (January to June) and the wet season (July to December). A campaign of 18 fishing trips was conducted during the wet season (Figure 1). The four nets were used at the same time, for the same duration (between 3 and 7 hours), with the help of professional fishermen and over professional fishing sites located in the experimental fishing areas.

For each net, biomass and exploitable biomass (commercial species), marine turtle bycatch, and catch dynamics were calculated. The marine turtles captured were identified (species, size, sex, condition...), tagged if alive, and a tissue sample was taken for genetic studies before releasing the animal.

The sampling strategy has been developed to test the efficacy of the nets, regarding both productivity and bycatch data and comparing the control net data with those from our experimental nets. The inter-net variability (nets of the same type), the control and experimental nets differences in catches, the seasonal factor and the annual variability over the two years of the study were evaluated (Figure 2).

The same protocol will be used for all the experiments in the study to obtain statistically robust and comparable results.

The preliminary results presented in this paper are from the first campaign and correspond to 18 fishing trips (2 trips had been cancelled because of meteorological conditions).

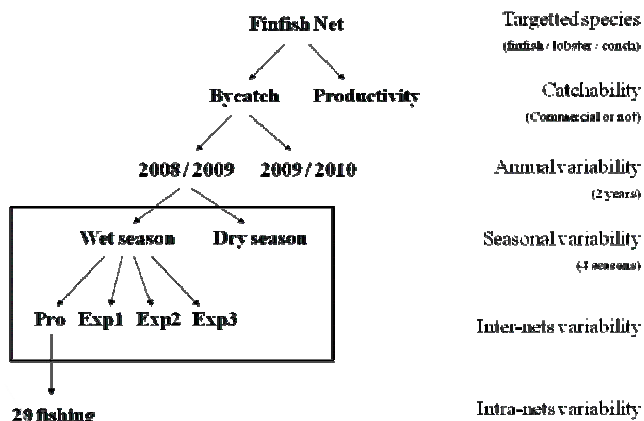


Figure 2. Sampling strategy. This strategy assesses both productivity and bycatch of each net for each season over two years with a total of 80 fishing trips. The comparison of the values of each net shows the intra-nets, inter-nets, and seasonal and annual variations.

RESULTS

Eighteen experimental fishing trips were performed in site S1 in the north Caribbean (Figure 1). A total of 806 individuals were captured, including 748 fishes (674 finfishes, 62 rays, 11 soles and 1 eel), 43 shellfish (28 lobsters and 15 crabs), 5 echinoderms (urchins), 3 gastropods (conchs), and 7 turtles. These organisms belong to 72 species, of which 49 commercial species including 40 fishes, 2 lobsters, and the 2 marine turtle species *Eretmochelys imbricata* and *Chelonia mydas*.

Among the 806 individuals, 180 were captured with the 1.60 m trammel net (T2), 203 in the 3.40 m trammel net (T4), 167 in the 1.60 m gillnet (G2) and 256 in the 3.40 m gillnet (G4).

The higher biomass value was obtained with the tall nets – 3.40 m trammel and gillnets (T4; G4). The net with the highest total capture was the control net (G4 - 3.40 m gillnet), with a total biomass of 117.725 g and an average biomass of 6.540 g (Figure3).

Particular attention was paid to commercial species to assess the net selectivity. The gill nets (G2; G4) showed a higher potentiality to catch more commercial species. An opposing trend was observed for the trammel nets (T2; T4). The gill nets (G) captured 64% of commercial species

Table 1. Features of the experimental and control bottom nets for the small scale fish fishery.

Net	Length (m)	Angle	Height (m)	Number of layer	Mesh width (mm)
G2	300	Vertical	1.60	Gill net (G) 1 layer	45
G4 Control	300	Vertical	3.40	Gill net (G) 1 layer	45
T2	300	Vertical	1.60	Trammel net (T) 3 layer	45 / 200
T2	300	Vertical	3.40	Trammel net (T) 3 layer	45 / 200

against 36% of non-commercial species, and the trammel nets (T) caught 38% of commercial species against 62% of non commercial species (Figure 4).

The CPUE (Catch Per Unit Effort in $\text{g}/\text{m}^2/\text{hour}$) values for the gillnets were higher than those of the other gears. Both the short (G2) and the tall (G4) gillnets had a higher CPUE (12.2 g and 11.7 g) than the two trammel net, T2 and T4 (10.3 g and 6.16 g) (Figure 5). Among the four nets tested, the gillnets (G2; G4) captured 60% of the total biomass of the commercial species.

Seven marine turtles were caught during this experiment. Four were captured in the trammel nets (T) and three in the gillnets (G). The tall nets (T4; G4) captured five turtles against two in the short ones (T2; G2). The turtles were tangled up at many parts of their body and carapace in the trammel nets, even at the neck. The turtles were not tangled as much in the gillnets. Four turtles were dead of which three in the trammel nets and three were alive of which two in the gillnets.

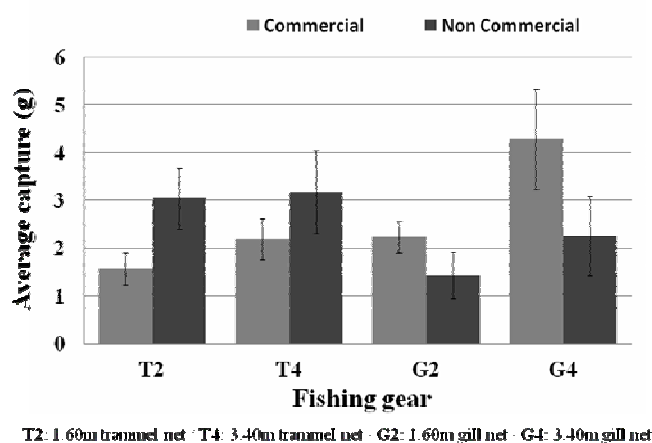


Figure 4. Average biomass (in kg) of commercial and non-commercial species for each gear.

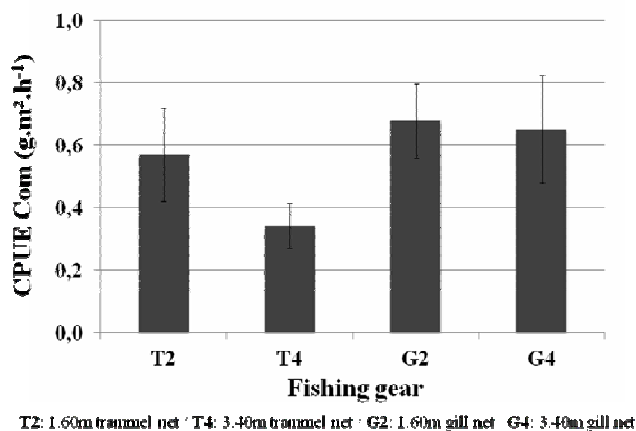


Figure 5. Average CPUE of commercial species (in $\text{g}/\text{m}^2/\text{hour}$) for each gear tested.

DISCUSSION

Although the results are not significantly different, some trends seem to be highlighted. The trends in the preliminary results for the first fish experimental fishing campaign show that trammel nets are less selective than gillnets. The gillnet seems to give a better productivity for commercial species. As Gobert (1992) noticed in Martinique, the main negative aspect of trammel net is the waste of spoiled fish. These nets are generally non selective gears, but among those used in the Lesser Antilles, the trammel net is the most problematic with a wide range of catches of non commercial species and a huge impact on marine biodiversity in reef ecosystems. Among the non-commercial species, protected species like sea turtles are at risk. The death of the marine turtles in the trammel nets is probably due to strangulation and drowning comparatively to the gill nets where the turtle death is rather due to drowning. Acosta (1995) draw the same conclusion concerning the trammel net particularity influenced by the entanglement. The large meshes catch more large individuals like sharks, rays, and turtles. The threat of trammel net to turtle populations has been highlighted in Balearic Islands too (Carreras *et al.* 2004).

However, our results are based only on 18 experimental fishing trips and need to be confirmed.

The use of bottom nets increases the degradation of benthic marine ecosystems of Martinique and marine turtle bycatches. This paper relates the first experimental fishing campaign results. Other seasons and complementary experiments are under course. Nets used for lobster (trammel and gill nets) and queen conch (trammel net and “folle”, a loose meshing gill net) fisheries will also be tested against experimental nets developed for this study. A total of 240 experimental fishing trips is planned in this research program over two years for the three types of net (80 experimental fishing / gear). The height and the number of layers of the nets are two of the features that will be tested, but the angle (horizontally to vertically) will also be investigated for the nets used for the conch fishery. The height is an important parameter to modify. An optimal use of these gears could be fishing with nets low height as Gobert B. (1992) thought. Studies have already shown it. The low profile net designed in North Carolina (Brown 2005, Gearhart 2007) is a viable deep water fishing gear that significantly reduces the incidence of sea turtle entanglements, while maintaining an acceptable level of targeted catch and reducing unwanted bycatch of lower value finfish species.

Each gear will be tested over two years and during the dry and wet seasons. We expect to obtain significant differences between the nets tested, inter-nets variability, mostly between the control and the experimental nets (Figure 2). As marine turtles are migratory species, we expect to see a seasonal variability (Figure 2) according to the nesting season (April to September), when reproductive individuals come to Martinique or leave the island.

Bycatch in coastal waters adjacent to sea-turtle nesting beaches are first concerned in order to ensure the sea turtle's long-term survival (Pandav *et al* 1997). This study will clarify our view of the net fisheries along the coast of Martinique and its impact on marine resources and marine turtles.

Gearhart (2003) published an example of bycatch study related gillnet closure in North Carolina. A major conclusion was that above all, fishermen, turtle management groups and other stakeholders have to work together to develop mitigation methods and respond to fisher feedback, conclusion also presented in the study on leatherback turtles bycatches in nets in Trinidad (Gearhart 2007). The fishery may impede the local population recovery like in the Cayman Islands (Bell *et al.* 2006) and in Mexico (Koch *et al.* 2006). The results from our work will be used to change the local fishery legislation and to adapt fishermen practices for more sustainable small scale fisheries.

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LITERATURE CITED

- Acosta, A. and R. Appeldoorn. 1995. Catching efficiency and selectivity of gillnets and trammel-nets in coral-reefs from Southwestern Puerto-Rico. *Fisheries Research* **22**:175-196.
- Aucoin, S. and Y.M. Leon. 2008. Preliminary data on hawksbill turtle (*Eretmochelys imbricata*) bycatch in an artisanal gillnet used near Jaragua National Park, Dominican Republic. *Proceedings of the Gulf and Caribbean Fisheries Institute* **60**:169-172.
- Bell, C.D., J.M. Blumenthal, T.J. Austin, J.L. Solomon, G. Ebanks-Petrie, A.C. Broderick, and B.J. Godley. 2006. Traditional Caymanian fishery may impede local marine turtle population recovery. *Endangered Species Research* **2**: 63-69.
- Brown, K. and B. Price. 2005. Documentation and reduction of bycatch in North Carolina fisheries. NOAA. 24 pp.
- Carreras, C., L. Cardona, and A. Aguilar. 2004. Incidental catch of the loggerhead turtle *Caretta caretta* off the Balearic Islands (western Mediterranean). *Biological Conservation* **117**(3):321-329.
- Chakalall, B. and U. Tietze. 1997. The status of marine fishery resources and fisheries management in the Lesser Antilles. *Fisheries Report* **549**:71-93.
- Chevalier, J. 2003. Plan de Restauration des Tortues marines aux Antilles Françaises. Sept. 2003.
- DRAM (Direction Régionale et Départementale des Affaires Maritimes de la Martinique). 2005. Monographie des pêches maritimes et des élevages marins à la Martinique. 60 pp.
- Gearhart, J. and B. Price. 2003. Documentation and reduction of bycatch in North Carolina fisheries. NOAA. 20 pp.
- Gearhart, J. and S. Eckert. 2007. Field tests to evaluate the target catch and bycatch reduction effectiveness of surface and mid-water drift gillnets in Trinidad. *WIDECASST Information Document 2007-01*. Beaufort, North Carolina. 21 pp.
- Gobert, B. 1992. Impact of the use of trammel-nets on a tropical reef resource. *Fisheries Research* **13**(4):353-367.
- Koch, V., W. J. Nichols, H. Peckham, and V. De la Toba. 2006. Estimates of sea turtle mortality from poaching and bycatch in Bahía Magdalena, Baja California Sur, Mexico. *Biological Conservation* **128**:327-334.
- Louis-Jean, L. 2006. La conservation de la tortue marine face au secteur clé de la pêche maritime en Martinique. EMTS Master II Thesis, Muséum national d'Histoire Naturelle, Paris, France. 83 pp.
- Pandav, B., B.C. Choudhury, and C.S. Kar. 1997. Mortality of olive ridley turtles *Lepidochelys olivacea* due to incidental capture in fishing nets along the Orissa coast, India. *Oryx* **31**(1):32-36.
- Réseau Tortues Marines Martinique. 2006. Bilan d'activités réseau tortues marines, année 2006. 50 pp.