Artisanal Coastal Net Fisheries' Impact on Biodiversity and Protected Species in Guadeloupe and Martinique, FWI, 2009

LAURENT LOUIS-JEAN[1,2], PHILIPPE LENFANT[2], RENÉ GALZIN[2], ERIC DELCROIX[3], and JEAN-PHILIPPE MARECHAL[1]

[1] *Observatoire du Milieu Marin Martiniquais, 3 avenue Condorcet, 97200 Fort-de-France, Martinique*
[2] *UMR 5244 CNRS – EPHE, Université de Perpignan, 52 avenue Paul Alduy, 66860 Perpignan, France*
[3] *ONCFS, Basse Terre, 97100 Basse-Terre, Guadeloupe*

ABSTRACT

Guadeloupe and Martinique fisheries are strictly small scale fisheries exploiting pelagic and coastal resources. In the French West Indies coastal areas, the marine resources decline is shown through the low catches and fishermen sayings. One of the major reasons is the impact of non-selective fishing techniques. Among these, the net fisheries cause a lot of waste of non commercial species, mostly fish, lobster and conch bottom nets fisheries. For a sustainable fishery objective, this coastal fishery has been studied. The gill net, trammel net and "folle" net are tested and compared. The trammel net, with 62% of non commercial species captured, appears as a non selective gear. The "folle" net, used for the conch fisheries in Guadeloupe, would be most selective. The gill net would permit more selective and productive fisheries. Particular attention has been brought to the marine turtle bycacth, as marine turtles are fully protected in FWI: trammel and "folle" nets cause more mortality than the gill net. New legislation for bottom net techniques' regulation is required to develop more sustainable fisheries.

KEY WORDS: small scale fisheries, French West Indies, bottom nets, sustainable fisheries, marine turtles

Pesquerias Costeras de Redes Artesanales su Impacto en Biodiversidad y en Species Protegidas en Guadalupe y Martinica, FWI, 2009

Las industrias pesqueras de Guadalupe y de Martinica son terminantemente industrias pesqueras de la escala pequeña que explotan recursos pelágicos y costeros. En las áreas costeras del oeste francesas de Indias, la declinación marina de los recursos se demuestra con los retenes y los refranes bajos de los pescadores. Una de las razones principales es el impacto de las técnicas no selectivas de la pesca. Entre éstos, las industrias pesqueras de la red causan muchos de pérdida de industrias pesqueras inferiores no comerciales de las redes de la especie, sobre todo de los pescados, de la langosta y de la concha. Para un objetivo sostenible de la industria pesquera, se ha estudiado esta industria pesquera costera. Se prueban y se comparan el gillnet, la red de trasmallo y la red del "folle". La red de trasmallo, con el 62% de especie no comercial capturada, aparece como engranaje no selectivo. La red del "folle", usada para las industrias pesqueras de la concha en Guadalupe, sería la más selectiva. El gillnet permitiría industrias pesqueras más selectivas y más productivas. La atención particular se ha traído al bycacth marina de la tortuga, pues las tortugas marinas se protegen completamente en FWI: las redes del trasmallo y del "folle" causan más mortalidad que el gillnet. La nueva legislación para regulación de las técnicas netas inferiores' se requiere para desarrollar industrias pesqueras más sostenibles

PALABRAS CLAVES: Serranidae, los abastos reproductivo, especie protegidas, manejo de áreas protegidas marinas

La Pêche Nette Côtière d'Artisanal' Effectue sur la Biodiversité et les Espèces Protégées en Guadeloupe et Martinique, FWI, 2009

En Guadeloupe et Martinique s'exerce une pêche strictement artisanale. Divers engins et techniques de pêche sont utilisés, aussi bien de façon côtière que pélagique. Les Antilles françaises sont victimes d'une croissante raréfaction de la ressource halieutique côtière, à laquelle s'ajoute une pêche peu sélective. La pêche au filet occasionne de nombreux rejets d'espèces non commerciales, principalement la pêche au filet de fond à poissons, langoustes et lambis. Avec un objectif de pêche durable, cette pêche côtière au filet a été étudiée. Les filets droits, trémails et « folles » sont testés et comparés. Le Trémail, avec 62% de captures d'espèces non commerciales, apparait comme un engin peu sélectif. La « folle », utilisée en Guadeloupe pour la pêche au lambis, serait plus sélective. Le filet droit permettrait une pêche plus sélective et productive. Une attention a été portée sur les captures de tortues marines, espèce protégée aux Antilles françaises : le trémail et la folle occasionneraient d'avantage mortalités que le filet droit. Des nouvelles réglementions sur ces techniques de pêche au filet de fond permettraient d'aboutir à une pêche plus durable.

MOTS-CLÉS : Pêche artisanale, Antilles françaises, filets de fond, pêche durable, tortues marines

INTRODUCTION

In Martinique and Guadeloupe, both pelagic and coastal fisheries are artisanal. Fishermen mainly use 6 - 8 m boats fitted with powerful outboard motors. Coastal fisheries represent about 60% of the total fishery. The continental shelf is overexploited (Antillean traps and nets) and marine resources are decreasing (Aiken 2000, Hawkins 2004, Hardt 2008). The use of fishing nets accounts for 20% of the total fishing gear used (DRAM 2005). They target fish, lobsters and queen conch resources. These gear are known to affect marine resources through massive fish captures (Gobert 1992, Acosta *et al*. 1995), especially the trammel net (Chakalall *et al*. 1997). The most impacting technique is the use of bottom nets, one reason being the long soak times. As a consequence, non commercial and protected species like marine turtles, are caught (Pandav *et*

al. 1997, Gearhart *et al.* 2003, Carreras *et al.* 2004, Brown et al. 2005, Bell *et al*. 2006, Koch *et al.* 2006, Louis-Jean 2006, Aucoin *et al*. 2007, Gearhart *et al*. 2007). Thus, the gill, trammel and "folle" (net used before for marine turtle fishing) nets are tested.

The fishing fleets of the south Atlantic and the north Caribbean account respectively for 29% and 20% of the Martinique fleet. This first one is the most productive fleet for lobster and the second an important area for fish (DRAM 2004, SIH IFREMER Unpublished data). As these two areas are also associated with turtles, our effort sampling has been focused over these sites.

The aim of this work is to integrate research results in policy development to contribute to the reduction of by-catches of non commercial and protected species. Experiments have been conducted to (i) evaluate the catches dynamics function of the gear used, (ii) highlight the non-selectivity of these nets and (iii) compare them.

MATERIAL & METHODS

Experimental fishing area location

The fishing sites for these experiments were localized using the local fishery data (DRAM 2005, IFREMER) and GIS to produce maps of potential areas (Figures 1, 2) and crossing fisheries' data with turtles' data. As a result, experimental fishing areas where located as shown on Figure 1. Two experimental sites where chosen, namely fish area (S1) and lobster area (S2).

The queen conch fishing is more common in Guadeloupe, in South Basse-Terre, so this site (S3) was chosen to conduct the queen conch surveys (Figure 2).

Experimental fishing gears and methods

Professional nets were chosen as control nets and compared to pilot ones.

The experiment targeting finfishes consist of comparing gill (one tight meshing size layer) and trammel (a tight meshing size layer surrounded by two loose meshing size (200 mm) layers) nets. The nets have a principal mesh size of 45 mm and floats every 1 m ensuring a vertical setting. The control net is a 3.40 m gill net. Several parameters were modified and combined to design pilot nets: the height (low profile: 1.60 m / high profile: 3.40 m) and the number of layer (1 for the gill net (G) / 3 for the trammel net (T)). Four different nets were designed for the surveys: low and high profile trammel nets (T2 and T4) and gill net (G2 and G4) (Tab.1).

Gill and Trammel nets were also compared for lobster fisheries. The lobster nets are 50 mm meshing size with floats. The control net is a 1.40 m (high profile / low profile is 1 m) trammel net. Thus, low and high profiles gill and trammel nets (G0, G1, T0 and T1) were designed (Tab.2).

Both trammel and "folle" (F: one loose meshing size (100 mm) layer) nets were tested for queen conch fishing, although conch resources are targeted with the "folle" technique. The control net was a 1.50 m "folle" net (high profile / low profile is 0.80 m). The incline of the net (with or without floats (f)) were tested too. Thus, 8 different conch nets were designed for the surveys: T150f, T150,

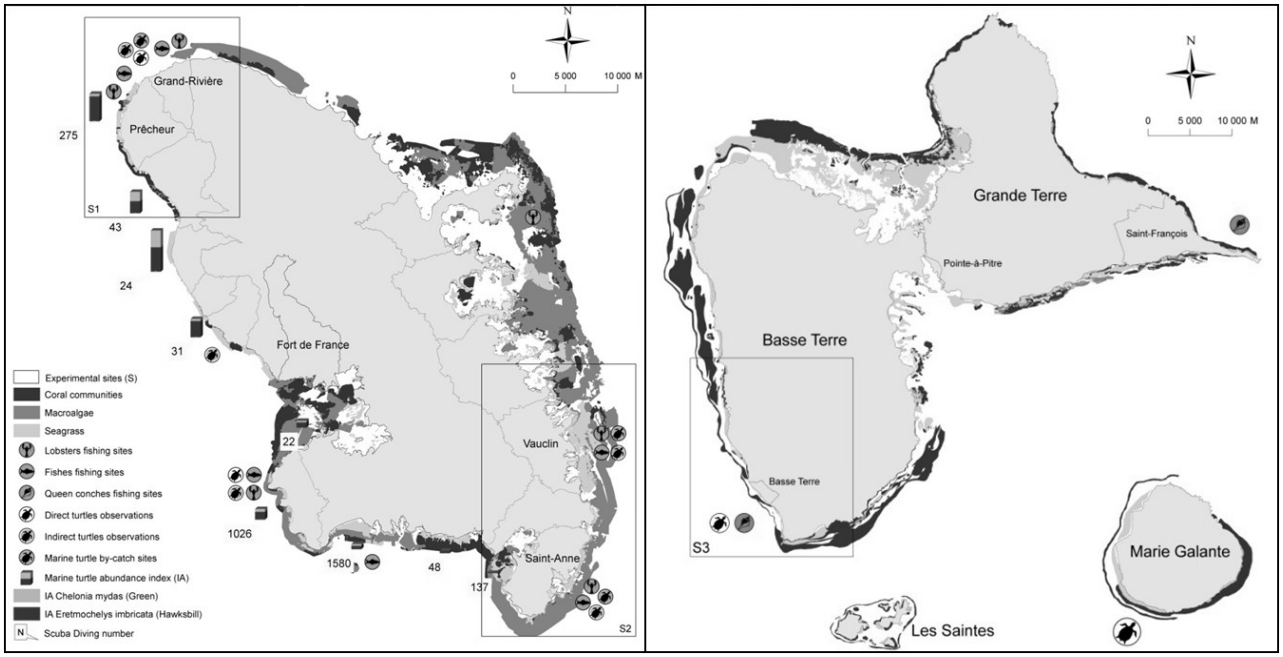

Figure 1. Experimental sites for the fish (S1), lobster (S2) and conch (S3) campaigns (data IFREMER, Louis-Jean, OMMM, Marine Turtle Networks). This map gives the localization of the main marine ecosystems, the most important fisheries, and the data on marine turtle observation for the Martinique and Guadeloupe Islands.

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**	200 / 45 / 200
T2	300	Vertical	**3.40**	**Trammel net (T) 3 layer**	200 / 45 / 200

Table 2. Features of the experimental and control bottom nets for the small scale lobster fishery.

Net	Length (m)	Angle	Height (m)	Number of layer	Mesh width (mm)
G0	300	Vertical	**1.00**	**Gill net (G) 1 layer**	50
G1	300	Vertical	**1.40**	**Gill net (G) 1 layer**	50
T0	300	Vertical	**1.00**	**Trammel net (T) 3 layer**	200 / 50 / 200
T1 Control	300	Vertical	**1.40**	**Trammel net (T) 3 layer**	200 / 50 / 200

T80f, T80, F150f, F150, F80f, F80 (Tab.3).

A total of 30 trials have been performed for fish (3 to 7 hours soak), 9 for lobsters (1 night soak) and 18 for conch (1 day soak).

Experimental and control nets were set at the same time, for the same duration, with the help of professional fishermen at the selected sites.

The total non exploitable (non commercial species) and exploitable (commercial species) biomasses were recorded for all nets, as well as marine turtle captures.

The sampling strategy has been developed to test the efficacy of the nets regarding both productivity and bycatch data and by comparing the control net data with those from the experimental nets. The intra-nets and inter-nets variability is evaluated using non-parametric statistics methods (Mann-Whitney test).

RESULTS

The preliminary results (57 trials) illustrate trends in catches.

Fish Fisheries

A total of 1296 individuals were captured, including 1155 fishes (1052 finfishes, 75 rays, 25 soles and 3 eels), 101 shellfish (65 lobsters and 36 crabs), 14 echinoderms (10 sea urchins and 4 sea cucumbers), 5 gastropods (4 conchs and 1 octopus) and 21 turtles. These organisms belong to 72 species, of which 49 commercial species, including 40 fishes and 2 lobsters. Two marine turtle species, *Eretmochelys imbricata* and *Chelonia mydas*, were captured, respectively 16 and 5 individuals.

The results are not statistically significant but show trends.

Particular attention has been given to commercial species to assess the net selectivity. The gill nets (G2; G4) showed higher catches of commercial species (64%), as opposed as the trammel nets (T2; T4) (41% of commercial species) (Figure 2).

The gill nets (G2; G4) CPUE (Catch Per Unit Effort in $g.m^2.h^{-1}$) accounted for 56% of the total biomass of the commercial species. The gill nets (G2 with 18.24 $g.m^2.h$ and G4 with 15.93 $g.m^2.h$) and the short trammel net (T2 with 18.16 $g.m^2.h$) have a higher productivity than the tall trammel nets (T4 with 8.4 $g.m^2.h$) (Figure 3).

Twenty one marine turtles were caught, 13 in the trammel nets (10 in the T4 and 3 in the T2) and 8 in the gill nets (5 in the G4 and 3 in the G2). The high profile nets (T4 and G4) captured 15 turtles among the 21. 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 gill nets. Nine turtles were dead of which 6 in the trammel nets.

Lobster Fisheries

A total of 580 individuals were captured, including half of shellfish. These organisms belong to 43 species, of

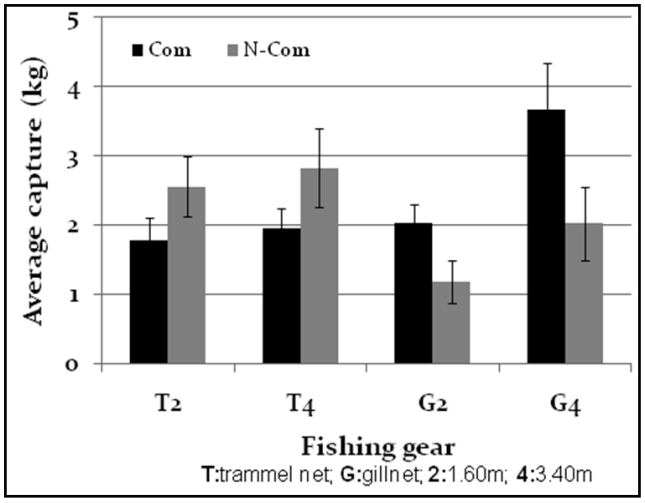

Figure 2: Average biomass (in kg) of commercial (Com) and non-commercial (N-Com) species for each fish gear.

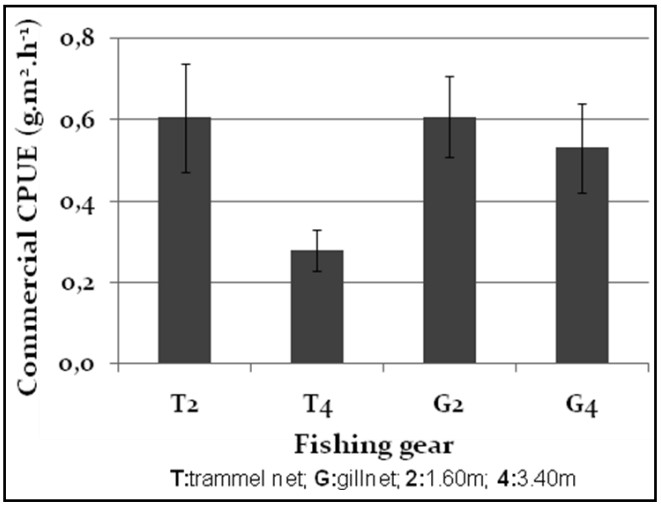

Figure 3: Average CPUE of commercial species (in $g.m^2.h^{-1}$) for each fish gear.

which 32 commercial species. Commercial species represented 91% (i.e. 499) of the total individuals captured (Fig.4).

Concerning the total biomass, the trammel nets (T0 with 160 kg; T1 with 238 kg) showed a higher potentiality to catch more individuals (79% of the total biomass) than the gill nets (G0 with 54 kg; G1 with 52 kg) (Fig.4). More commercial organisms are caught in the nets (Mann-Whitney test, p-value<0.05) (Fig.4).

The CPUE values for the trammel nets (3.79 $g.m^2.h$ for T0 and 3.95 $g.m^2.h$ for T1) were higher than those of the gill nets (1.3 $g.m^2.h$ for G0 and 0.77 $g.m^2.h$ for G1). Statistically the low profiles have equivalent productivity to the tall ones (Fig.5). We obtained many rays and a shark in the trammel nets, contrary to the gill nets were have just been found few rays.

Two marine turtles were caught during the trials, both of these were dead, one in the short trammel net (T0) and the other in the tall gill net (G1).

Queen Conch fisheries

A total of 949 individuals were captured (in the 8 nets), including 619 fishes (555 finfishes, 52 rays, 11 soles and 1 eel), 138 shellfish (118 lobsters and 11 crabs), 177 gastropods (134 queen conches) and 9 turtles. These organisms belong to 65 species, of which 43 commercial

Table 3. Features of the experimental and control bottom nets for the small scale conch fishery.

Net	Length (m)	Angle	Height (m)	Number of layer	Mesh width (mm)
T150f	200	**Vertical** with floats (f)	**1.50**	**Trammel net (T)** 3 layer	**200 / 50 / 200**
T150 Control	200	**0° / 45°** no floats	**1.50**	**Trammel net (T)** 3 layer	**200 / 50 / 200**
T80f	200	**Vertical** with floats (f)	**0.80**	**Trammel net (T)** 3 layer	**200 / 50 / 200**
T80	200	**0° / 45°** no floats	**0.80**	**Trammel net (T)** 3 layer	**200 / 50 / 200**
F150f Control	200	**Vertical** with floats (f)	**1.50**	**Folle net (F)** 1 layer	**100**
F150	200	**0° / 45°** no floats	**1.50**	**Folle net (F)** 1 layer	**100**
F80f	200	**Vertical** with floats (f)	**0.80**	**Folle net (F)** 1 layer	**100**
F80	200	**0° / 45°** no floats	**0.80**	**Folle net (F)** 1 layer	**100**

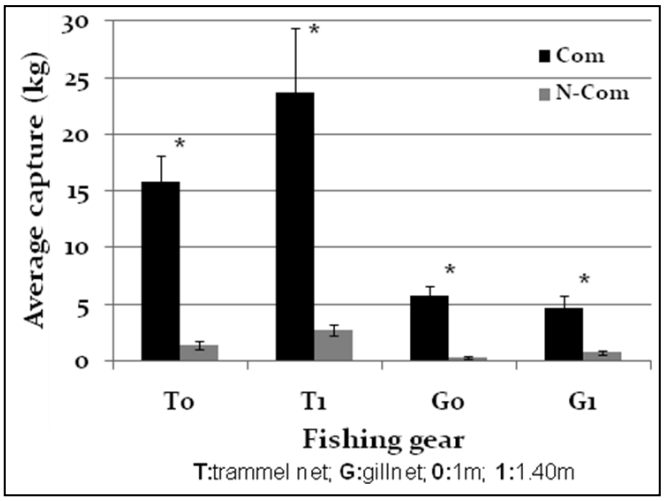

Figure 4. Average biomass (in kg) of commercial (Com) and non-commercial (N-Com) species for each lobster gear (*:Com captures different to N-Com captures, Mann-Whitney test, p-value < 0.05).

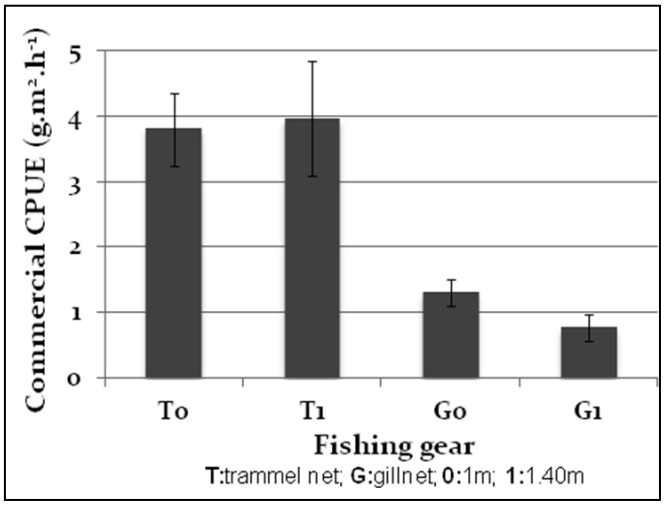

Figure 5. Average CPUE of commercial species (in g/m²/hour) for each lobster gear.

species.

Among the 949 individuals, 180 (19%) have been caught by the "folle" nets (F) and 769 (81%) by the trammel nets (T), with 83% (144/180) and 75% (575/769) of commercial individuals respectively in the "folle" and trammel nets.

The tall "folles" captured 62% of the total "folles" captures and the tall trammel nets captured 58% of the total trammel nets captures (Figure 6).

The 134 queen conches accounted for 14% of the total captures (949), 102 conches and 32 being captured respectively in the "folle" and the trammel nets. These conches counted respectively for 57% of the "folle" total captures and 4% of the trammel total captures.

Mature queen conch accounted for 95% in the "folles" and 44% in the trammel net. The later captured more juveniles and small individuals. The tall nets and the no floats nets captured respectively 56% (61/108) and 61% (66/108) of the mature conches (Fig.7).

Nine marine turtles were caught during this experiment among which 8 were dead (89%). Seven were captured in the "folle" nets (F) and 2 in the trammel nets (T), and 6 were in the tall nets with floats (F150f; T150f).

CONCLUSIONS

While more trials have still to be carried out trends can be drawn from our results. Gill, trammel or "folle" nets productivities depend on the targeted species. Gill net seems to be more appropriate for finfishes, whereas trammel net and "folle" net are more suited respectively for lobster and queen conch. Nevertheless, we can observe that trammel nets are less selective than the other gears. More species, especially non commercial ones, are captured and die in these three layer nets what has an effect on reef biodiversity.

Furthermore, the trammel nets seemed to capture a

Table 4. Fish gears data.

		Gill net		Trammel net		
		G2	**G4**	**T2**	**T4**	**Total**
All Species	Total catches / *Com. Individuals*	252 / *166*	414 / *282*	278 / *113*	352 / *172*	1296 / *733*
Com. Species	CPUE ($g.m^2.h^{-1}$)	18.24	15.93	18.16	8.4	60.73
Turtles		3	5	3	10	21

Table 5. Lobster gears data.

		Gill net		Trammel net		
		G0	**G1**	**T0**	**T1**	**Total**
All Species	Total catches / *Com. Individuals*	91 / *83*	91 / *78*	182 / *160*	216 / *176*	580 / *497*
Com. Species	CPUE ($g.m^2.h^{-1}$)	1,3	0,77	3,79	3,95	9,81
Turtles		0	1	1	0	2

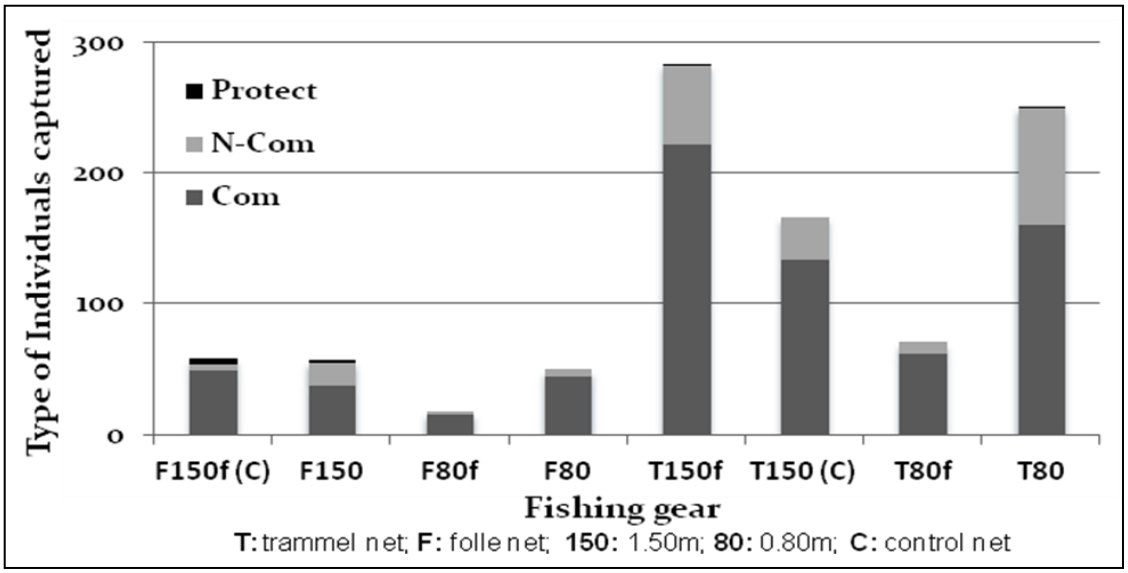

Figure 6. Number of individuals captured for each conch gear.

larger range of size, more small individuals like juvenile conches but also bigger organisms like rays and marine turtles (Carreras *et al*. 2004). We can note that the tall profile nets caught more turtles.

The three layers with loose meshing size of the trammel net cause serious sustainability problems. Nets are generally non selective and capture many marine turtles (Brown 2005, Eckert 2005, Gearhart 2003, 2007, Pandav 1997, Louis-Jean 2009). The long soak times associated to these techniques induce turtles' death by drowning. Mortality is rather due to the large meshes causing entanglement (Acosta 1995, Louis Jean 2009), especially at the neck of these pulmonary breathing marine animals. It is an important consideration as they are endangered and protected species over the world.

This study highlights the complexity of the small scale fisheries. It confirms that the trammel net is a non selective gear because of the biomass values of spoiled fish and the wide range of catches of non commercial species (Gobert 1992, Louis-Jean 2009). The low profile nets could be an interesting alternative to non selectivity impact (Gobert 1992, Brown 2005, Gearhart 2003, 2007, Louis Jean 2009), with an acceptable productivity compared to the classic nets and a reduction of bycatch, among which marine turtles.

Various techniques and gear are used with limited regulation and rules. Regulation for the soak time duration and fishing closure areas could be a solution to overfished marine resources. Antillean traps already used and known as non selective techniques (Gobert 1992) are not a sustainable solution and lines do not offer equivalent catches of coastal species of commercial interest.

A reinforcement of the exchanges between the professionals, scientific and administrative institutions as well as the improvement of marine resources management through marine reserves is necessary to reach sustainable fishery objectives in the French West Indies.

Table 6. Conch gears data.

			Folle net				**Trammel net**				
			F-150-f	**F-150**	**F-80-f**	**F-80**	**T-150-f**	**T-150**	**T-80-f**	**T80**	**Total**
All catches	Total catches / *Com. Ind.*		180 / *144*				769 / *575*				949 / *719*
	Total catches per net height		112		68		446		323		949
	Total / *Mature*		102 / *94*				32 / *14*				140 / *108*
Queen conch	Among Mature	Short (80 cm)			*6*	*31*			*1*	*9*	*47*
		Tall (150 cm)	*32*	*25*			*3*	*1*			*61*
		Floats (f)	*32*		*6*		*3*		*1*		*42*
		No Floats		*25*		*31*		*1*		*9*	*66*
Turtles			4	2	0	0	2	0	0	1	9

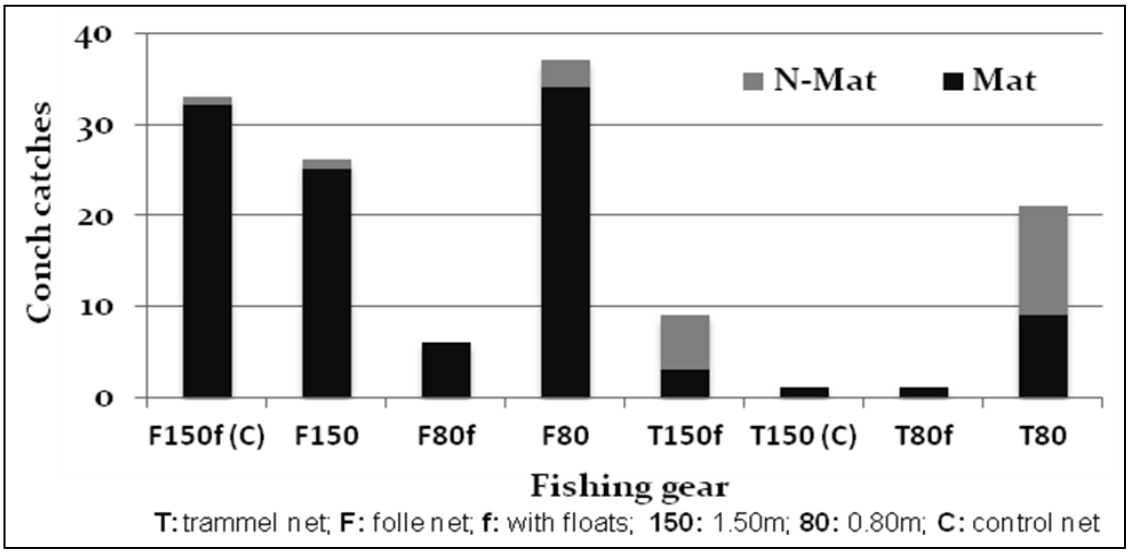

Figure 7. Number of mature (Mat) and non mature (N-Mat) conch captured for each conch gear.

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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.

Aiken, K. and G. A. Kong. 2000. The marine fisheries of Jamaica. *Naga, The ICLARM Quarterly* (Vol. 23, No. 1) January-March 2000

Aucoin, S. and Y.M. Leon. 2007. 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, Silver Spring, Maryland USA 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.

Eckert, S. and K. Eckert. 2005. Strategic plan for eliminating the incidental capture and mortality of leatherback turtles in the coastal gillnet fisheries of Trinidad and Tobago: Proceedings of a National Consultation. Port of Spain, 16-18 February 2005. *Widecast Technical Report* No.5. Beaufort, N. Carolina. 30 pp. + appendices.

Gearhart, J. and B. Price. 2003. Documentation and reduction of bycatch in North Carolina fisheries. NOAA, Silver Spring, Maryland USA 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. *WIDECAST 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.

Hardt, M. J. 2008. Lessons from the past: the collapse of Jamaican coral reefs. *Fish and Fisheries* **10**:1–16.

Hawkins, J. P., C. M. Roberts. 2004. Effect of artisanal fishing on Carribbean coral reefs. *Conservation Biology*, Vol.18, No.1: 215-226.

Koch, V., W. J. Nichols, H. Peckham, and V. De laToba. 2006. Estimates of sea turtle mortality from poaching and bycatch in Bahı´a 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.

Louis-Jean, L., P. Lenfant, R. Galzin, J.-P. Maréchal. 2009. Crossing fishery statistics with marine turtle bycatch data and habitat mapping in martinique, FWI. *Proceedings of the Gulf and Caribbean Fisheries Institute* **61**:375-379.

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.