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By

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1-1-1-1-1 Bottom trawls

1-1-1-1-1-1 Shrimp trawls

The shrimp fishery is the most important fishing activity along the coasts of the Guiana-Brazil shelf. In general, the shrimp trawlers are of the industrial Florida type, made of steel, of a total length varying between 15 and 25 m, and operating with double outrigger otter trawl nets plus one stern try net, but trawlers with one stern otter trawl net operate in Trinidad and Tobago, and in Guyana, all shrimp trawlers use four smaller outrigger otter trawl nets (twin-trawling). Except for three shrimp trawlers in French Guiana which target orange shrimp *Solenocera acuminata* and Scarlet *Plesiopenaeus edwardsianus* on the continental slope at depth ranging from 300 to 900 m, shrimp trawlers operate on the continental shelf. The shrimp trawlers which target various penaeid shrimp species *Penaeus sp.* operate at depth of 18 to 90 m, while trawlers targeting shrimp sea bob *Xiphopenaeus kroyeri* fish in shallow waters (10-20m). Trawl or haul duration is high in shrimp trawl activities and varies with target species, fishing depth, time of day and season. In general, penaeid haul duration is greater during the night and ranges between 4 to 6 hours, while it varies from 3 to 4 hours during the day. Sea Bob haul duration ranges from 2 to 4 hours during the day or night. Fleet size and other characteristics of the penaeid and sea bob shrimp fishery are presented in table 1.

1-1-1-1-1-2 Finfish trawls

Shrimp trawl activities induce finfish bycatch which is usually sold as sea products (Table 1). However, some trawlers only target finfish :*Macrodon ancylodon*, *Micopogionias furnieri*, *Nebris microps*, *Arius sp*., *Cynoscion sp.*, *Lutjanus synagris*, notably in Suriname (Table 1).

1-1-1-1-1-3 TEDs

The specifications of TEDs as requested by national legislation are presented in table 2. The size of escape opening of TED mandated in countries of the Guiana-Brazil shelf doesn't allow the leatherback *Dermochelys coriacea* to escape from the shrimp trawl net.

Country	Fleet size in 1999	Countries of exportation of shrimps	Shrimp trawl regulations	Fish bycatch products

	penaeid	sea bob	finfish		TED	closing season	fishing depth	closing areas	
Guyana	51	55	nil	USA, Canada, Caribbean	yes 1994	no	no	no	yes
Suriname	109	21	12	Japan, France, USA, Holland, Caribbean islands	yes 1992	no	>15 F.[1]	yes[2]	yes
French Guiana	60	nil	nil	European Union	no	no	>line[3]	no	no
Trinidad & Tobago	28[4]	nil	nil	USA, others?	yes 1994	no[5]	>10 F.[5]	yes[5]	yes
Venezuela[6]	66[6]	?	?	?	yes 1994	?	?	?	yes
Brazil[7]	158[7]	?	?	?	yes	yes 12 to 1	?	?	?
total	472	76	12						
total trawlers		560							

Table 1. Fleet size and other characteristics of the bottom trawl fisheries on the Guiana-Brazil shelf

[1] 1fathom = 1.8 meters

[2] the marine area in front of Galibi reserve, 15 km west and 15 km north, is closed for all trawl and gillnet fishery activities

[3] trawl is allowed outside a geographical line defined by the following points A, B et C : A (06°01'N ; 53°51'W), B (05°43,5'N ; 52°59'W) et C (04°54'N ; 51°52'W). This line is on the side of the 50 bathymetric line

[4] only type III and IV trawlers

[5] trawling is allowed beyond two nautical miles from each of the north and south coasts of Trinidad. Trawling is prohibited on the East Coast of Trinidad and within twelve nautical miles off Tobago. In the Gulf of Paria trawling is allowed beyond one nautical mile from the coastline for the artisanal (Type I and Type II) trawlers; six fathom contour for the semi-industrial (Type III) trawlers, and ten fathom contour for the industrial (Type IV) trawlers. The amendment permits trawling on the North Coast only in the area west of Saut D'eau and during the period November 15 to January 15 and trawling is prohibited at night (Soomai, *pers. comm.*).
Trawling occurs all year round in the Gulf of Paria and in the Columbus Channel off the south coast.

[6] Atlantic coasts

[7] Amapa and Para states

Country	Type	Size of Grid	Size of escape opening
Guyana	Hard Grid Super Shooter	51 x 42 in.[1]	horizontal taut length : 35 in.

Suriname	Hard Grid Super Shooter	?	?
Trinidad & Tobago	Hard Grid Super Shooter	horizontal and vertical measurement of at least 30 in.	horizontal taut length : 35 in., and simultaneously a vertical taut height : 12 in.

Table 2. Specifications of TED

[1] in. = inch = 2.54 cm

Photo 1*: Super shooter TEDs on a Sea Bob trawler (Paramaribo, Suriname), by Luc Laurent*

1-1-1-1-2 Mutifilament polyethylene drift gillnets

Mutifilament polyethylene drift gillnet called “Guyana seine” is the most widely used net in Guyana and Suriname. The mutifilament polyethylene drift gillnet fishery accounts for approximately 60% of the artisanal landings in Guyana (WECAFC *in press*). This is a multifilament polyethylene gill net with a stretched mesh size of 7 inch (17.7 cm) or 8 inch (20.3 cm) equivalent to 8.8 and 10 cm in bar length. The length of net ranges from 2 to 4 km and the height varies from 5 to 8 meters. Multifilament polyethylene gillnets are generally held on the bottom, drifting freely, with one end attached to the boat, the led line touching the bottom and the length of float lines being adjusting according to the depth and to requested webbing hanging. Target species are grey snapper *Cynoscion acoupa*, sea trout *Cynoscion virescens*, gillbacker *Arius parkieri*, blackstip shark *Carcharhinus limbatus*, Caribbean sharpnose shark *Rhiziopriodon porosus*, Spanisk mackerel *Scomberomorus brasiliensis*, Cuffum *Megalops atlanticus*, etc. Boats involved in this gillnet fishery are “Guyana-type” boats. These are either decked “Guyana boats” with inboard engine or open

"Guyana boats" with outboard engine, both being 15 m in length. Mutifilament polyethylene drift gillnet fisheries is particularly developed in Guyana and Suriname, but totally absent in Trinidad &Tobago. In French Guiana, Korean boat operating under the Venezuelan flag, operated multifilament polyethylene gillnets to catch sharks in 1983 (Bellail & Achoun 1984). European Regulations still allow foreign boats to use this fishing gear in French Guiana waters (EC Regulation 324/1999), but number of permits issued in 1998 and 1998 is unknown. No data is available for Brazil and Venezuela concerning. The number of vessels involved in gillnet fishery in 1999 is 368 in Guyana (60 decked and 308 open Guyana boats) and 360 in Suriname (60 decked and 300 open Guyana boats), making to a total of **728** vessels.

Photo 2: *Multifilament polyethylene drift gillnets with floats and floatlines (Guyana), by Luc Laurent*

1-1-1-1-3 Multifilament bottom set gillnets

This gillnet is used in Guyana, Suriname, French Guiana, and probably in Venezuela and Brazil, but rarely in Trinidad & Tobago. This is a multifilament braided nylon gillnet with a stretched mesh size ranging from 3.7 to 4.5 inch, sometimes 7 to 8 inch. The length varies from 300 to 1 000 m. These gillnets are set and anchored on the bottom or drift in shallow waters in contact with the bottom, notably in French Guiana, where it is called "follettes". The number of boats using this fishing gear in Guyana is estimated to 442, while the fleet is estimated at 50 in Suriname. No data is available for Brazil and Venezuela. In French Guiana, the official number of boats using this fishing gear is 44, but such boats are involved in other coastal fisheries, notably monofilament bottom set gillnets.

1-1-1-1-4 Monofilament bottom set gillnets

The monofilament gillnet, also called “transpearing net”, is particularly used in Trinidad & Tobago and to some extent in French Guiana. No data is available for Brazil and Venezuela. The stretched mesh size ranges from 3.7 to 4.5 inch (9.5 to 11.4 cm) and length of nets varies from 450 to 1098 m in length (Henry & Martin 1992). Monofilament gillnets in Trinidad and Tobago are usually set and anchored on the bottom (Hodgkinson-Clarke 1994). The target species of this fishery is the Spanish mackerel or Carite *Scomberomorus brasiliensis* (Hodgkinson-Clarke 1994). Cavalli *Caranx crysos* and Bigbelly shark *Carcharinus limbatus* are then the most important species caught. The demersal *Cynoscion jamaicensis*, *Diapterus shombeus*, *Micropogonias furnieri*, *Lutjanus sp.* and *Orthopristis sp.* are also important in monofilament catches (Hodgkinson-Clarke 1994). The use of monofilament gillnets will be banned on 17 March 2000 [The Fisheries (Amendment) Regulations, 1998, The fisheries Act, section 4, 17 March 1998], except for the catching of flyingfish in Tobago (Kuruvilla *pers. comm*.).

1-1-1-1-5 Snapper liners and pots

Fishing boats known as handliners, measuring up 18m in length, fishing at depths between 120 m and the edge of the continental shelf, target snapper *Lutjanus sp.* and grouper *Serranidae*. Simultaneously local fishermen adopted the use of traps (Pots) to target snapper. The size of fleets was estimated in 1999 at 38 in Guyana, 126 in Suriname, 27 in French Guiana, and at 60 in Trinidad & Tobago in 1991 (Fabres & Kuruvilla 1992). Most of these vessels flew Venezuelan flag. No data is available in Brazil and Venezuela.

1-1-1-1-6 Other gear

Numerous other bottom-fishing gears are used by coastal fisheries, such as Pin seine, Chinese seine, and bottom longlines.

1-1-1-2 Pelagic fisheries

1-1-1-2-1 Multifilament drift gillnets

This is the main fishing gear used in coastal fishery in Trinidad & Tobago (Henry & Martin 1992 ; Hodgkinson-Clarke 1994). This is a multifilament braided polyamide (nylon) net (green net). The stretched mesh size ranges from 3.7 to 4.5 inch (9.5 to 11.4 cm) and the length varies from 732 to 1190 m (Henry & Martin 1992). The net is set as traditional surface drift gillnets (set generally at night), with the headline floating at the surface and the webbing hanging vertically in the water (Hodgkinson-Clarke 1994). The target species is the Spanish mackerel or Carite *Scomberomorus brasiliensis* (Hodgkinson-Clarke 1994). King mackerel *Scomberomorus cavalla* and Zapate *Oligoptiles saurus* are then the most important species caught. Other species are : Cavalli *Caranx crysos*, *Pomatomus saltator*, *Trachinotus goodei*, *T. caronilus*, *Carcharinus limbatus*, *Rhizoprionodon lalandii, Lutjanus sp.* The demersal species listed and others such as *Cynoscion*,

Rachycentron, and *Mugil curema* are landed only rarely, and then mainly when the nets fish in shallow water (Hodgkinson-Clarke 1994). The number of boats involved in this fishery in Trinidad & Tobago was estimated to 393 vessels in 1991 (Fabres & Kuruvilla 1992). This fishing gear is not used in Guyana, Suriname and French Guiana. No data is available for Venezuela and Brazil.

1-1-1-2-2 Monofilament flyingfish gillnets

This fishery occurs as part of a coastal drift fishery in Tobago during the months November to June (Kuruvilla, *pers. comm*.). The flyingfish gillnet is a monofilament surface drift gillnet which target flyingfish *Hirundichthys affinis*. Associated species of this fishery are dolphinfish *Coryphaena hippurus*, kingfish *Scomberomorus cavalla* sailfish *Istiophorus albicans* and sharks *Carcharinus sp.* (Fabres & Kuruvilla1992). The number of boats using this fishing gear in Tobago was estimated at 39 in 1991 (Fabres & Kuruvilla1992).

1-1-1-2-3 Hooks and lines

Surface hand-line fishing such as live-bait fishing “A la vive” and trolling, are fishing methods employed in Trinidad and Tobago to catch pelagic species, mainly Kingfish *Scomberomorus cavalla* and Carite *Scomberomorus brasiliensis* (Henry & Martin 1992). Number of boats involved in this fishery in Trinidad and Tobago was estimated at 621 in 1991 (Fabres and Kuruvilla 1992).

Photo 3: *Pirogues equipped with multifilament and monofilament gillnets (Sea lots, Trinidad), by Luc Laurent*

1-1-2 High sea fisheries

1-1-2-3 Driftnets

Drifnets are gillnets which are left to drift in oceanic areas. Guyana, Suriname, French Guiana, Trinidad & Tobago and Brazil have no driftnet fishery targeting tuna species (ICCAT 1998 ; Weidner *et al.* 1999 ; Weidner & Arocha 1999). A large fleet operates from Venezuela and involves 220 boats (Weidner *et al.* 1999).

1-1-2-2 Drifting longlines

Guyana, Suriname and French Guiana have no drifting longline fishery targeting tuna species (*Thunnus sp*., Swordfish *Xiphias gladius*, billfishes *Istiophoridae* and other big *Scombridae*). Five boats are involved in this fishery in Trinidad and Tobago (Kuruvilla *pers. comm*.). The main target species is the Yellowfin tuna *Thunnus albacares*, Swordfish and Bigeye tuna *Thunnus obesus*. The fishing area is off the Guyanas up to 40° W. Venezuela and Brazil have drifting longline fleets working in west tropical Atlantic and their size are estimated at 294 and 73 boats respectively (Weidner & Arocha 1999 ; Weidner *et al.* 1999 ; ICCAT 1999).

1-1-2-3 Pure seines

Except Venezuela that operates the second largest Latin American tuna purse seine fishery with a purse seine fleet totalling 34 vessels (Weidner *et al.* 1999), other countries of the Guiana-Brazil shelf have no purse seine fisheries.

Photo 4: *Green turtle and hawksbill carapace in sale in Manzilla, Trinidad, by Luc Laurent*

1-2 MARINE TURTLE BYCATCH AND FISHERY-RELATED MORTALITY IN WEST ATLANTIC

1-2-1 Coastal fisheries on the Guiana-Brazil shelf

1-2-1-1 Shrimp trawls

Reported trawler captures of tagged turtles showed for the first time that olive ridley and green turtles interact with shrimp trawl fisheries on the Guiana-shelf (Pritchard 1991). At the time data based on interviews with trawlermen suggested that total catch of marine turtles in shrimp trawlers in Guyana and Suriname is very high (Tambiah 1994). The leatherback, green, and olive ridley turtle were reported to be caught and total captures on the basis of interviews were estimated at 1 300 and 3 200 turtles/year in 1991 in Guyana and Suriname respectively (Tambiah 1994). In French Guiana, analysis of scientific trawl campaigns and logbook program demonstrated that shrimp trawlers induce olive ridley captures (Moguedet *et al.* 1994). A total of 6 captures were recorded leading to a direct mortality rate[1] of 16.6% (Moguedet *et al.* 1994). The authors suggested that marine turtle catch rate[2] in the French Guiana shrimp fishery would be higher than in trawl shrimp fisheries in United-States (Hendwood & Stunz 1987), and that total catch would be around 1 000 olive ridley turtles per year (Moguedet *et al.* 1994). No data is available concerning leatherback. In Trinidad & Tobago in 1991, a logbook program was implemented to collect catch/effort data from the semi-industrial (8 trawlers) and industrial (20 trawlers) fleets including a

[1] proportion of individuals found dead in trawl nets due to drowning or severe trauma
[2] number of turtles per trawling unit effort, *i.e.* turtles/headrope length in meters x hour fished

logbook form focused on marine turtle bycatch (WECAFC *in press*). The program was not very successful and collapsed by May 1992 (WECAFC *in press*), and no data was collected concerning marine turtles (Kuruvilla *pers. comm.*). Finally, except the statement of Pritchard (1984) in (Fournillier & Eckert 1997) saying that "a fair proportion" of adult olive ridleys tagged while nesting in Suriname in the late 1960's and early 1970's were subsequently ensnared by trawls "in Trinidad and western Venezuela", we can consider that marine turtle bycatch in shrimp trawl activities, in terms of species caught, catch rates and mortality, was not investigated at all in Trinidad waters (prior or after the implementation of TEDs). In Venezuela, an onboard observer program was implemented in the shrimp trawl fleet in the north-eastern region from February 91 to December 93 (Marcano & Alio *in press*). In total, 48 turtle captures were recorded : 11 hawksbill *Eretmochelys imbricata* captures[3] (23 %), 16 green *Chelonia mydas* captures (33%), 15 loggerhead *Caretta caretta* captures (31%) and 6 leatherbacks captures (13%) during 13 600 trawls (35 118 trawl net hours), leading to an estimated turtle catch rate of 1.4 turtle captures/1 000 trawl net hours and a leatherback catch rate of 0.17 leatherback captures/1 000 trawl net hours (Marcano *et al. in press*). Direct mortality rate, estimated from those turtles that could not be reanimated on board, reached 19% (Marcano *et al. in press*). No data is available concerning Brazil shrimp trawl activities.

1-2-1-2 Multifilament polyethylene drift gillnets

Data based on interviews with fishermen in Guyana and Suriname (Pritchard 1991 ; Tambiah 1994 ; interviews with fishermen made for the preparation of the present report), and on direct observation of 8 dead individuals in a piece of multifilament polyethylene drift gillnets found at sea in French Guiana in May 99 (Chevalier *pers. comm.*), indicate that marine turtles interact with multifilament polyethylene drift gillnet fisheries.

1-2-1-3 Other gillnets and entangling nets

Leatherback is known to be caught in gillnets in Trinidad (Chu Cheong 1984). Interview data source clearly indicates that bycatch of Leatherbacks in gillnets multifilament and monofilament drift and set gillnets fisheries in the north-eastern coats of Trinidad is very high during the nesting season (Fournillier & Eckert 1997). For example, 200 leatherbacks were captured in the Balandra Bay area each year (Fournillier & Eckert 1997). Fishermen operating out of the Salybia Fishing Depot reported that three Leatherbacks were caught in their nets each day, for a total of 450 turtles over the 150 day peak nesting season (March-July) (Fournillier & Eckert 1997). Eckert (1999) states that "In 1997, it was estimated that between 200-450 leatherbacks were captured in gillnets between Balandra bay and Salybia on the east coasts of Trinidad and it was suggested that the leatherback take off Tocco point is so high that the total for the northeast region probably exceeds 1000 leatherbacks annually". Eckert (1999) conclude that "such data is indicative of the very high

[3] concern the number of captures, since same individuals may have become caught more than once

incidental capture rate of leatherbacks along the north and east coast. It can be inferred that a large portion of all leatherbacks nesting in Trinidad are captured at least once during the nesting season!". Concerning mortality rate, interviews with fishermen from Manzanilla (3 boats) reported catching 1 leatherback per day (5 days each weak) from January-April with 50% mortality (Eckert 1999).

In French Guiana, Trammel nets used during leatherback nesting season (May to August) in the Maroni mouth and in front of the nesting beach "les Hattes", induce high leatherback bycatch, damaging nets (Bellail & Dintheer 1992).

1-2-2 Coastal fisheries in west Atlantic

Marine turtles, notably leatherbacks, interact with shrimp trawl fisheries in other part of Atlantic, notably in United-States. In this country, based on onboard observer program catch rates were estimated to 48.4 turtle captures/1 000 trawl net hours and to 0.4 leatherback + hawksbill captures/1000 trawl net hours in the Southern North Atlantic (9,943 trawl net hours observed) , and to 3.1 turtle captures/1 000 trawl net hours and 0.12 leatherback + hawksbill captures/1 000 trawl net hours in Gulf of Mexico (16,771 trawl net hours observed) (Henwood & Stuntz 1987).

Other coastal fisheries such as nets and lines are known to induce marine turtle bycatch in the west Atlantic. For example, 14 incidental catches of leatherbacks were recorded in various inshore fishing gear during the period 1976-85 in Newfoundland Canada with a direct mortality rate estimated at 28.5% (Goff & Lien 1988).

1-2-3 High-seas fisheries

1-2-3-1 Driftnets

In the United-States, an onboard observer program was initiated from 1989 to 1994 to monitor bycatch in drift gillnet fisheries along the eastern coasts (Gerrior 1997). In total, 533 sets were monitored and 62 marine turtles were recorded (loggerhead and leatherback) leading to catch rates ranging from 0.04 to 0.21 turtle capture per set and a direct mortality rate estimated at 8% (Gerrior 1997). The French albacore tuna driftnet fisheries was surveyed in eastern Atlantic during campaigns in 1992 and 1993 (Goujon *et al.* 1993). 29 leatherbacks and five loggerheads were reported, all were alive. Total marine turtle catch for the fisheries was estimated to 30 in 1992 and 100 in 1993 (Goujon *et al.* 1993). According to authors, direct mortality is low in these fisheries. In western Mediterranean, the Spanish multifilament polyamide driftnet fishery targeting swordfish *Xiphias gladius* was monitored by onboard observers over 94 sets conducted in July and August 1992 to 1994 (Silvani *et al.* 1999). 32 marine turtle captures were recorded (30 loggerhead and 2 leatherbacks) given a catch rate estimated at 0.02 leatherback captures per set with a direct mortality rate of zero, the only turtle found dead being a loggerhead (Silvani *et al.* 1999).

1-2-3-2 Drifting longlines

Marine turtle and drifting longline fishery interactions were monitored in numerous Atlantic fisheries using reliable methods such as onboard observer programs. In the United-States, the study carried out from onboard observers and a logbook program by Japanese fisheries working in American waters over the period 1978-81 allowed to estimate the catch rate to 0.0005 leatherback captures/1 000 hooks along the Atlantic coast and at 0.0072 leatherback captures/1 000 hooks in the Gulf of Mexico for a direct mortality rate estimated at 7.14% (n=14) (Witzelll 1984). The onboard observation program over 54 trips by the American drifting longlines fisheries along the North Eastern coasts (Gerrior 1996), totalled 485 sets and 333 849 hooks over the period 1991-93 reported 56 leatherback captures, 15 loggerhead captures, 10 green turtles captures, one hawksbill turtle and 3 unidentified turtles amounting to an estimated catch rate of 0.12 leatherback captures/set and 0.167/1 000 hooks. The direct mortality rate was 2.35% (all species together) (Gerrior 1996). The onboard observer program conducted on American drifting longliners fishing in the North West Atlantic zone extending from May 1992 to December 1994 over 174 trips (1 066 sets) reported 59 leatherbacks captures, 20 loggerhead captures, 2 green turtles and one non identified (Lee *et al.* 1995). The catch rate was 0.093 leatherback captures/1 000 hooks and direct mortality rate for this species was 1.69% (n=59) (Lee *et al*. 1995). Very recently, the analysis of incidental captures noted in logbooks by the fishermen gave an overall view of marine turtles interaction and American longline fishery interactions in the North West Atlantic, US boats fishing from South America up to Newfoundland via the Caribbean and the Gulf of Mexico (Witzell 1999). During the period 1992-95, 1 337 loggerhead captures and 1 264 leatherback captures[4] were recorded and catch rates for the leatherback was sometimes very high, ranging from 0 to 0.77 captures/1 000 hooks according to the fishing areas and the types of longline used (Witzell 1999). The mortality rate remains unknown. Fortunately, leatherbacks tend to become entangled in branch lines rather than hooked (Witzell 1999).

In Mexico, an onboard observer program in Mexican fisheries working in the Gulf of Mexico from 1994 to 1995 reported 21 turtle captures (leatherback, hawksbills, loggerheads) over 16 trips, leatherback accounting for 85.7% of the captures (Ramirez & Gonzalez Ania *in press*).

In Brazil, observers onboard a Brazilian longliner monitored from 13 March to 12 April 1998 9 sets made in international waters and in the Brazilian (ZEE) (200 nautical miles) (Weidner & Arocha 1999). Only loggerheads were reported. Catch rate was very high, estimated at 11.61 loggerhead captures/1 000 hooks with a direct mortality rate of 15.3% (Weidner & Arocha 1999).

In Uruguay, the data collected in 1994-95 by observers onboard foreign vessels (Spanish and American) fishing in the Uruguay ZEE and in international waters show that both loggerheads and leatherbacks interact with drifting longline fisheries in these marine areas (Weidner *et al.* 1999 ; Achaval *et al. in press*), along which these species do not reproduce. The catch rate for leatherback

[4] concern the number of captures, since same individuals may have become caught more than once

is very high, varying between 0 and 0.85 leatherback captures/1 000 hooks according to the type of longlines, the zone and the fishing season (Weidner *et al*. 1999 ; Achaval *et al. in press*). The direct mortality rate for both species was estimated at 2%, but the turtles are released with a hook in the digestive tract. Two dead leatherback were seen and some observers suspect they had become entangled in the lines and had not been able to surface (Weidner *et al*. 1999 ; Achaval *et al in press*).

1-2-3-3 Purse seines

An onboard observer program conducted in the French and Spanish tuna seine fisheries fishing in tropical Atlantic recorded 21 marine turtle captures, of which six were leatherbacks, over 360 observed sets, leading to a catch rate of 0.016 leatherback captures per set (Stretta *et al.* 1993). The captured turtles were released alive (Stretta *et al.* 1993).

1-3 THE ATLANTIC FISHERIES AND THE CONSERVATION OF MARINE TURTLE NESTING POPULATIONS OF GUIANA-BRAZIL SHELF : A PRELIMINARY ANALYSIS

1-3-1 Concepts

The overall objective of this analysis is to identify priority actions (recommendations), in terms of research activities, on an Atlantic scale. This analysis is based on two approaches. First, a population dynamics (modelling) approach which demonstrated that survival in adult and immature stages is the major demographic parameters to be taken into consideration for marine turtle conservation. In other words, conservation efforts which aim at increasing natural survivorship of eggs and hatchlings, and more generally at protecting nesting beaches, are therefore inevitably bound to fail without the concomitant reduction of adult and immature mortality in fisheries. Second, a global fishery approach aimed at assessing the potential impact of fisheries according to their census on an Atlantic scale (Chapter 1-1), in terms of gear and size fleet, and their interactions with marine turtles (Chapter 1-2), in terms of catch and direct mortality rates.

1-3-2 Coastal fisheries

1-3-2-1 Coastal fisheries on Guiana-Brazil shelf

1-3-2-1-1 Shrimp trawls

Recapture data of tagging turtles reported by shrimp trawlers (Pritchard 1991), logbook data collected in French Guiana shrimp fishery (Moguedet *et al.* 1994), data based on interviews with trawlermen conducted in Guyana (Tambiah 1994) and observer data recorded in Venezuela (Marcano & Alio *in press*), clearly indicate that both olive ridley and leatherback interact with shrimp trawl fisheries along the coasts of the Guiana-Brazil shelf. Since, leatherback and olive ridley turtles occurs in high densities along these coasts due to high nesting activities and may be also feeding grounds for olive ridley turtle, catch rates for this two species is likely significant. Therefore,

because shrimp trawl fishing effort is very high, in terms of number of operational shrimp trawlers estimated to 548 on the Guiana-Brazil shelf (Table 1) and shrimp trawl activities operating all year round, total catch at a regional scale is large, probably greater than thousands per year (Chapter 1-2). As legislation mandate the use of standard TEDs in five countries (Table 1), direct and delayed mortality rates is probably reduced for olive ridley turtle and other *Cheloniidae* species in these fisheries. However, TEDs is not implemented in French Guiana and the size of escape opening of standard TED mandated in other countries doesn't allow leatherback to escape from trawl nets. That means that a large proportion of leatherbacks caught in Guiana-Brazil shelf shrimp fisheries and of olive ridley turtle caught in French Guiana fishery, drown each year. For instance, when the US shrimp trawl fishery was not equipped of TEDs, direct mortality rate for marine turtles, mainly loggerhead, was estimated at 21 and 29% for the Atlantic and Gulf of Mexico, respectively (Henwood & Stunz 1987).

In conclusion, reduction of bycatch and mortality in shrimp trawl activities operating along the Guiana-Brazil shelf is one of the most relevant issues for the long term conservation of marine turtle nesting populations of Guyanas.

Photo 5: *Shrimp trawlers equipped with TEDs (Paramaribo, Suriname), by Luc Laurent*

1-3-2-1-2 Multifilament polyethylene drift gillnets

In Guyana and Suriname the fishing effort of this gillnet fishery, in terms of length of gillnets ranging from 2 to 4 km, number of "Guyana-type" boats estimated at 728 boats (Chapter 1-1) and activities year round, is particularly huge. Such drift gillnet efforts likely induce very high marine turtle bycatch and mortality along the coasts of the Guiana-Brazil shelf. At present time no monitoring program has been conducted to estimate interaction parameters, enabling total catch and mortality to be assessed. However, many authors had already highlighted the importance of this assessment (Pritchard 1991 ; Reichart & Fretey 1993 ; Tambiah 1994).

1-3-2-1-3 Other gillnets and entangling nets

As multifilament polyethylene drift gillnet fisheries which set all year round wall of nets along the coasts of Guiana-Brazil shelf, multifilament and monofilament bottom and drift gillnet fisheries develop also a large fishing efforts, in terms of length of nets and size fleet, notably in fishing areas in front of nesting beaches, but at present time no monitoring program has been conducted to precisely assess the significance of this issue.

The flyingfish gillnet is a surface drift monofilament gillnet used in Tobago during the months of November to June (Kuruvilla, *pers. comm*.). At present time nothing is known regarding interaction with marine turtles, but bycatch probably occurs with a probable substantial catch rate (per net or boat), since this fishery works in coastal waters where locally leatherback occurs in high densities. As fleet size of the flyingfish gillnet fishery was estimated to be 29 vessels in 1991

(Fabres & Kuruvilla 1992) total catch per year might be large. In contrast, direct mortality might be low, since flyingfish gillnets drift at the surface and height of net is probably small, permitting entangled turtles to breath. However, as monofilament nets are suspected to entirely foul turtles (Eckert 1999), individuals may be killed to simplify their release from the net.

1-3-3 High-seas fisheries

Three high-seas fisheries were recorded in Atlantic as inducing marine turtle bycatch (Chapter 1-2).

Purse seine fisheries are poorly monitored in Atlantic and bycatch data is scarce. However, by contrast with cetaceans, marine turtles appear to slightly interact with these fisheries which usually induce very low catch rate, and direct mortality may be null. Moreover, fishing effort is low in the Atlantic.

Pacific drifnet fishery is known to induce large leatherback catch rates and high mortality rates according to the type of gillnets and methods of boarding and releasing turtles (Balazs 1982 ;Frazier & Montero 1990 ;Wetherall *et al.* 1993). Marine turtle bycatch in this fishery is poorly documented in the Atlantic. This is probably due to the small size of this fishery in comparison with the Pacific one. Indeed, in contrast to the Pacific, no Asian countries use driftnets to target tunas in the Atlantic (ICCAT 1998). Moreover, fishing effort conducted by Atlantic countries which have such a fishery : United-States, Morocco, Ireland and France, appear to be relatively small (ICCAT 1998). As regards direct mortality the situation is contrasted. Based on observer data the direct mortality rate was estimated at 8% (n=62 turtles loggerhead and leatherback together) in US driftnet fishery (Gerrior 1997), while it was equal to zero in French albacore *Thunnus alalunga* fishery (n=29 leatherbacks and 5 loggerheads) (Goujon *et al.* 1993), and for leatherback in Spanish swordfish multifilament polyamide diftnet fishery (n=30 loggerheads and 2 leatherbacks), the only turtle found dead being a loggerhead (Silvani *et al.* 1999).

The drifting longlines that target swordfish, *Scombridae* and other large pelagic species interact with leatherback populations, notably in the Pacific (Skillman & Kleiber 1998). Catch rates may be relatively high and show large variations in space and time. Differing from loggerheads which remain hooked once they have swallowed the bait, leatherbacks more often become entangled in the lines (Witzell 1984 ; Skillman & Kleiber 1998 ; Witzell 1999) or are hooked on an outside part of the body (Skillman & Kleiber 1998) ; some authors however, have reported cases of leatherback which had swallowed the hook (Skillman & Balazs 1992 ; Price 1995 ; Skillman & Kleiber 1998). In the Atlantic, direct mortality rate for leatherbacks is generally low, estimated at 7.14% (n=14) in Japanese tuna fisheries (Witzell 1984) and 1.69% (n=59) in US longliners (Lee *et al.* 1995), but delayed mortality[5] remains unknown.

[5] subsequent death of individuals released in a weak or comatose condition, or injured

This comprehensive review indicates that catch rate for olive ridley turtle appears to be non significant in these three fisheries. As regards leatherbacks : (1) in driftnet fisheries catch rate is low, but direct mortality rate might be in some cases significant in connection with type of nets. The total fishing effort in Atlantic appears to be small, leading to a probable low total catch and mortality at the Atlantic scale. However, no data is available concerning catch rate and direct mortality in Venezuelan driftnet fishery, involving 220 boats (Weidner *et al.* 1999) and operating in the western Atlantic, where leatherback occurs in high densities (in contrast to the central or eastern Atlantic). (2) In drifting longline fisheries, catch rate is low, as direct and delayed mortality rate, since leatherbacks more often become entangled in the lines, whereas fishing effort is relatively high, notably in the western Atlantic. (3) In purse seine fisheries, catch rate is very low with a direct mortality rate close to zero, and as total fishing efforts in Atlantic appear not to be developed, total catch and total mortality are probably insignificant. In conclusion, except Venezuelan drifnet fishery that should be monitored for bycatch and mortality, Atlantic high-seas fisheries are not priority conservation issues for marine turtle nesting populations of Guiana-Brazil shelf.

2 RECOMMENDATIONS ON A REGIONAL SCALE

Estimate catch and direct mortality rates of marine turtles in the French Guiana shrimp trawl fishery within the framework of a stratified random sampling using onboard observers as data source

Relevance of the action :

(1) to estimate the total catch and mortality in these fisheries on the basis of a statistical sampling design

(2) to assess the impact of this fishery in terms of total catch and mortality on nesting populations

(3) to discuss with fishery managers and facilitate the implementation of TEDs in French Guiana fishery on sound and incontestable basis

(4) to identify areas where catch rate are high along the French Guiana coasts in relation to the definition of closed areas (marine reserve)

(5) to provide reference data for the other Guiana-Brazil shelf shrimp trawl fisheries concerning leatherback bycatch and mortality

(6) to discuss and facilitate the modification of TEDs to allow leatherback to escape from nets, which entails the enlargement of the standard escape opening.

Estimate catch and direct mortality rates of marine turtles in the Suriname and Guyana multifilament polyethylene drift gillnets within the framework of a stratified random sampling using onboard observers as data source

Relevance of the action :

(1) to estimate the total catch and mortality in these fisheries on the basis of a statistical sampling design

(2) to assess the impact of this fishery in terms of total catch and mortality on nesting populations, and the level of priorities

(3) to identify possible mitigation measures.

Investigate bycatch and mortality in Venezuelan driftnet fishery using interviews with fishermen as exploratory data source

Relevance of the action :

(1) to asses the level of leatherback catch rate and mortality

(2) to evaluate the need to set up other data collection program within a statistical sampling design

Estimate leatherback stock composition in Trinidad fishery bycatch with molecular markers

Relevance of the action :

(1) to identify and record new sources of mortality for the French Guiana and Suriname leatherback nesting populations in their spatial distribution

(2) to focus attention on large marine turtle bycatch and mortality in Trinidad and Tobago gillnet fisheries

(3) to help the identification, the development and the implementation in Trinidad and Tobago of mitigation measures for gillnet fisheries, such as the reduction of fishing effort, the shift of fishing effort from one fishing gear to another one, etc.

Investigate leatherback bycatch and mortality in flyingfish gillnets in Tobago using interviews with fishermen as exploratory data source

Relevance of the action :

(3) to asses the level of leatherback catch rate and mortality

(4) to evaluate the need to set up other data collection program within a statistical sampling design

Put marks to physically delimit the closed fishing areas in front of Galibi reserve (Suriname)

Relevance of the action :

(1) to facilitate the identification of marine reserve by fishermen

(2) to increase the implementation of regulation for all fisheries

Develop new tools (adult survival rate, recruitment rate in annual nesting female population, yearly proportion of nesting experienced females) for monitoring populations on nesting beaches within the framework of standardised and comparative approaches on Guiana-Brazil shelf

Relevance of the action :

(1) to understand the relations between adult stock and nesting activity

(2) to detect population trends more easily

(3) to measure the efficiency of conservation actions implemented in fisheries

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