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ILVO MEDEDELING 113

Bio-Environmental
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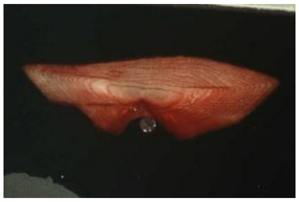

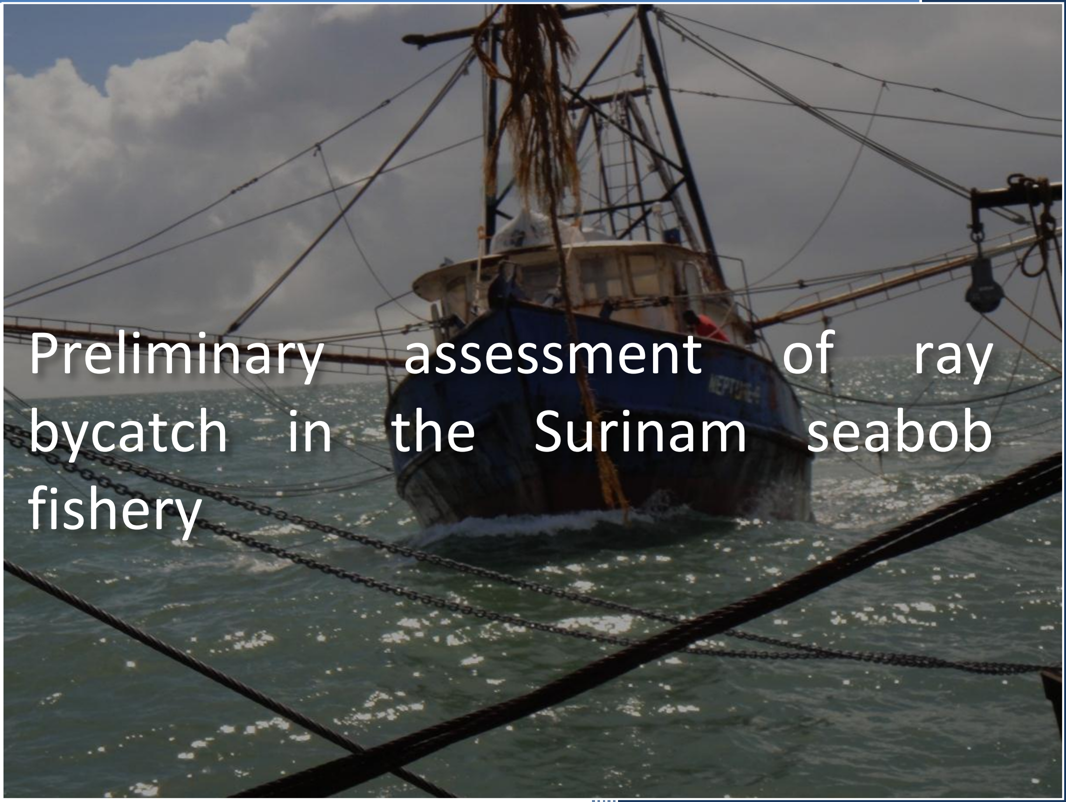

Preliminary assessment of ray bycatch in the Surinam seabob fishery

Hostens Kris, Willems Tomas

June 2012

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Aansprakelijkheidsbeperking

Contents

1 Summary

This pilot study was carried out to to fulfil one of the requirements of the Marine Stewardship Council (MSC) Sustainable Fisheries Certificate that was granted to the Heyploeg group for the seabob fishery in Surinam waters. The main objectives were: (1) to assess the effectiveness of Turtle Escape Devices (TEDs) and Bycatch Reductions Devices (BRDs) in reducing bycatch of highly vulnerable rays, and (2) to provide a preliminary assessment of the ray populations in the seabob fishing zone.

For this pilot study, ten hauls of approximately 1¼ hour were taken on 21th February 2012 with the Neptune 6, a typical Florida twinrig trawler (4 nets, mesh size 45 mm in the codend), with at one side both TEDs and BRDs in place and at the other side closed selectivity devices.

No Endangered, Threatened or Protected (ETP) species were caught. In total 673 individuals of five ray species were caught in all hauls from both sides, most of which were dead already or in rather poor condition when the nets were emptied. Smooth butterfly ray *Gymnura micrura* (58%), longnose stingray *Dasyatis guttata* (18%) and smalleyed round stingray *Urotrygon microphthalmum* (18%) were the most common species. Sharpsnout stingray *Dasyatis geijskesi* and Brazilian electric ray *Narcine brasiliensis* made up 2 and 4% of the ray bycatch during these experimental hauls.

Overall, 30% less rays were caught in the nets with TEDs and BRDs installed (on average 29 vs. 39 individuals per haul). However, this reduction was not unequivocal for all hauls, size classes and ray species. The different size classes that were caught reflected a relatively normal population structure for the five ray species, but the bycatch of many small individuals might partly be attributed to the survey period. Overall, not so many large individuals were caught, but a significant reduction was noted in the nets with TEDs for the largest size classes of at least 2 ray species *G. micrura* and *D. geijskesi*. The selectivity devices seem to be helpful to reduce bycatch of (large) rays to a certain amount, but based on this pilot study it can be stated that TEDs and BRDs are not effective enough to reduce the ray bycatch to negligible levels.

For a better assessment of the state of the different ray populations in relation to bycatch in the seabob fishery, more research in time and space is needed. More data are already available from a second survey but were not processed yet, but preferably more surveys should be planned to perform statistically and ecologically sound analyses. An upscaling of the derived values from the different experimental surveys to the whole seabob fishing fleet should be performed. The assessment of the ray populations in Surinam waters might benefit from a structural compilation of the Local Ecological Knowledge (LEK) of the captains and fishermen.

2 Introduction

The fishery for seabob *Xiphopenaeus kroyeri* in Surinam started in 1995 with 5 licences and is now stabilized at 20 licences since 2010, with total landings of ca. 10,000 tonnes of seabobs per annum (Southall et al. 2011). The Atlantic seabob fishery is restricted to Surinamese waters (FAO Statistical area 31) in a designated trawling zone between the 10 and 15 fathom depth contours (~ 18-27 metres depth), at a distance varying between 15 and 35 km offshore (Anon. 2010).

Seabobs are harvested with 'Florida' twin rig demersal shrimp trawlers (20 m, 500 hp), equipped with 4 nets (mesh size: 57 mm in the body and wings, 45 mm in the codend). The nets are normally fitted with Turtle Excluder Devices (TED) and Bycatch Reduction Devices (BRD).

Through an extensive Seabob Management Plan, a Code of Practice and significant efforts already made by the Heyploeg Group (and all stakeholders involved in this fishery), the Suriname Atlantic seabob fishery has been certified according to the Marine Stewardship Council Principles and Criteria for Sustainable Fisheries (MSC) in November 2011[1].

Although, significant efforts have been made to reduce bycatch, e.g. through the use of BRDs (allowing smaller fish to escape from the net) and TEDs (to prevent sea turtles and larger fish from entering the net), still a wide range of non-target organisms are captured along with seabob. The total bulk catch on average comprises 69% seabob, 19% fish species for local consumption and 12% discarded 'trash' fish. As many as 40 different species of organism have been recorded from a single haul in the seabob fishery. It is stated that the BRD and TED reduce the bycatch with 33%. Still, discarded bycatch typically comprises 60-70% demersal roundfish, 16% pelagic species, 5% brackish water finfish and 3% sharks and rays (Southall et al. 2011).

Rays are considered to be the most vulnerable species among the discarded species. TEDs might reduce the bycatch of large rays, but it is questioned how effective the TEDs and BRDs are to reduce the bycatch of different ray species. Also, the current population status of the different ray species in (and out) the seabob fishing zone remains unclear. If large rays are not caught by the seabob fishery, it is not clear whether these large individuals are still there (good status) but not caught due to the TEDs or whether they are absent, which reflects an unhealthy population structure and requires further management actions in addition to the TEDs. Therefore, a proper assessment of the ray populations in Surinam waters is needed.

A pilot research project was set up to compare the bycatch of rays in a limited number of side-by-side trawls in the seabob fishing zone. At one side the nets have both TEDs and BRDs fixed and the other side has neither of the selectivity measures.

[1] http://www.msc.org/newsroom/news/suriname-atlantic-seabob-worlds-first-tropical-shrimp-fishery-to-be-awarded-the-msc-ecolabel?set_language=en.

This small scale project might serve as the basis for a broader research project. The main objectives of the pilot project are:

- to assess the effectiveness of the TEDs in reducing bycatch of rays (and other large ETP fish)
- to provide a preliminary assessment of the ray populations in the seabob fishing zone.

The study is carried out by the Institute for Agricultural and Fisheries Research (ILVO-Oostende), in the framework of a VLIR-VLADOC PhD study, supported by Guiana Seafood company (Heyploeg Suriname) and commanded by Heyploeg Group (N.V. Morubel) to fulfil one of the MSC requirements, namely condition 2 “To ensure main bycatch species are within biologically based limits”. The pilot study largely followed the proposal made by Medley (2010). Please see Southall et al. (2011) for more detailed information on the Suriname seabob fishery, the Seabob Management Plan, Code of Practice and the MSC assessment.

3 Materials and Methods

The sampling for this pilot project on ray bycatch in the Surinam seabob fishery has been carried out during a first survey in the framework of a larger research project on the role of seabob in Surinam waters (VLIR-VLADOC PhD study Tomas Willems).

Sampling was done from the fishing vessel Neptune 6, a typical 'Florida' twinrig outrigger trawler, operated by Guyana Seafoods (Heyploeg Suriname). The nets have a low opening (less than 2 meters) with the wings attached to the upper and lower edge of wooden otter boards and mesh sizes ranging from 57 mm in the body and wings to 45mm at the codend (Figure 1). As the seabob fishing ground exists of a flat and smooth bottom substrate, no rock-hopper bobbins are required.

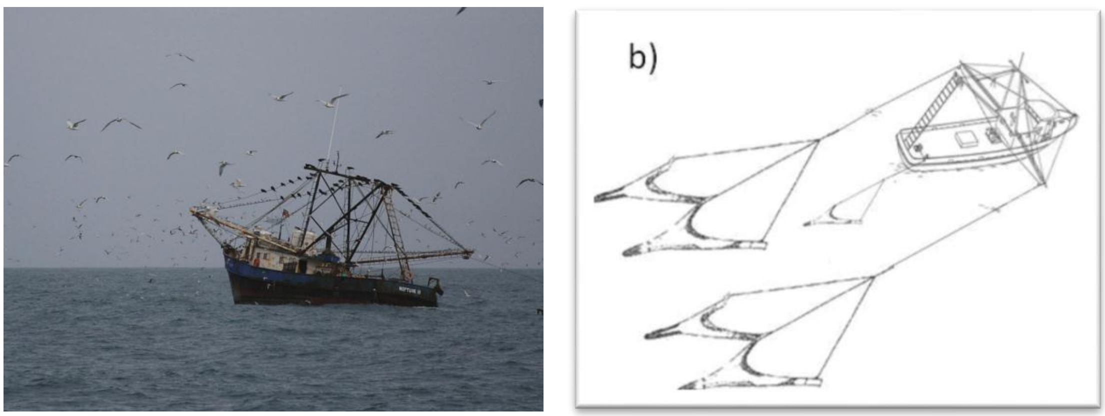

Figure 1. Typical Surinam seabob twinrig trawler (© Tomas Willems, ILVO), showing the configuration of gear and 'try' net (image adapted from FAO Gear-type Factsheet by Southall et al. 2011).

In normal (commercial) fishing circumstances, one haul lasts 3 to 4 hours with 4 outrigger nets with Turtle excluder Devices (TEDs) and Bycatch Reduction Devices (BRDs) in place (Figure 2). For this test, the net at starboard was normally equipped with the selectivity devices, while in the net at larboard the TED and BRD were closed off.

On 21 February 2012, ten experimental tracks were taken in the seabob fishing zone, all situated on an on/offshore line around 55°45'W (Figure 3). The hauls were shorter than normal and limited to 1¼ hour, to reduce the risk of bycatch of Endangered, Threatened and Protected (ETP) species (i.e. six turtle species from the CITES Appendix-II list and a number of fish species from the IUCN endangered species list). The exact begin and end coordinates of each haul are given in (Table 1). Sampling started around 7h45 and lasted till 23h00.

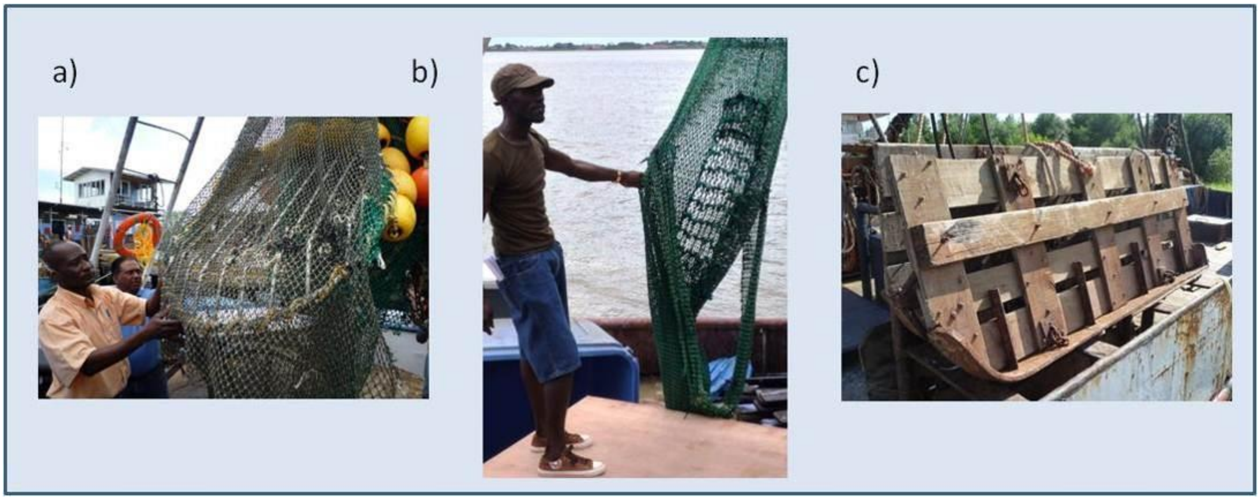

Figure 2. a) Turtle Excluder Device, b) Bycatch Reduction Device & c) a typical trawl door (Southall et al. 2011).

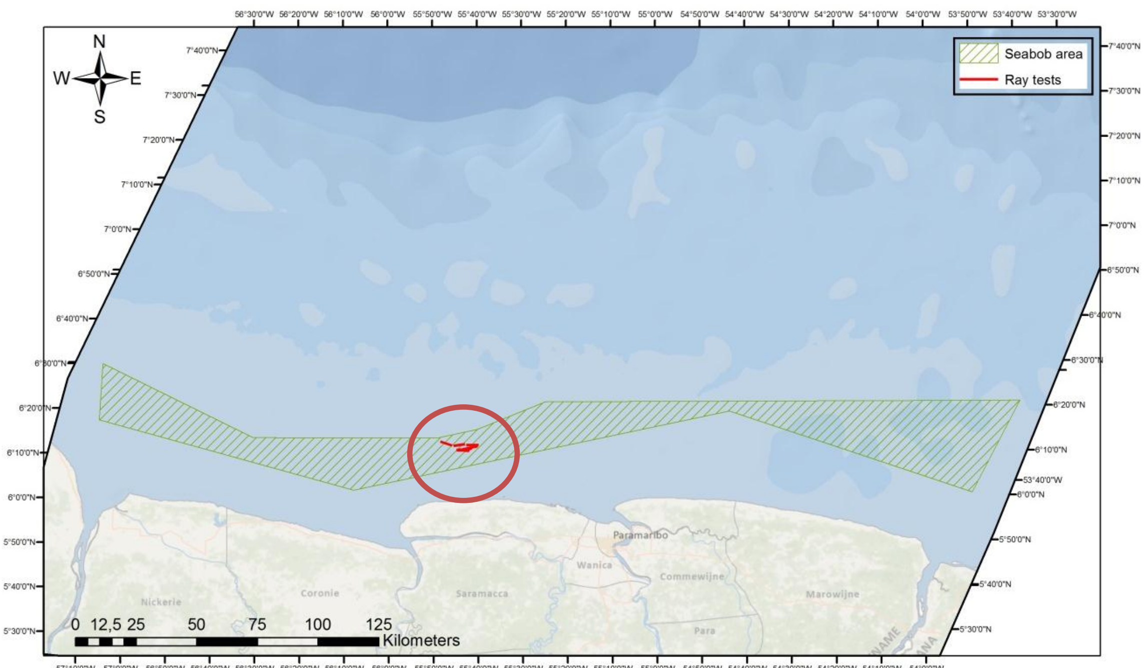

Figure 3. a) Map showing VMS tracks of the 10 experimental hauls (red circle) taken on 21th February 2012 with Neptune 6 (VMS data from LVV).

Table 1. Coordinates (start and end) of the 10 experimental trawls taken on 21th February 2012, in UTM (Easting/Northing) and DMS (degrees, minutes, decimal seconds) North and West, al in WGS84 projection.

Haul		Easting	Northing	D	M	S		D	M	S		Time (start)
1	start	632045.324	686143.344	6	12	22.196	N	55	48	23.320	W	07h46
	end	636942.364	684610.139	6	11	31.911	N	55	45	44.115	W	
2	start	637441.075	684417.378	6	11	25.597	N	55	45	27.905	W	09h10
	end	642116.921	685047.326	6	11	45.745	N	55	42	55.737	W	
3	start	642644.891	684688.513	6	11	34.021	N	55	42	38.589	W	10h15
	end	647857.997	684646.483	6	11	32.233	N	55	39	48.998	W	
4	start	647345.207	684095.739	6	11	14.344	N	55	40	5.725	W	11h40
	end	641241.021	683020.328	6	10	39.818	N	55	43	24.391	W	
5	start	640192.957	682626.836	6	10	27.088	N	55	43	58.517	W	13h06
	end	642743.14	682631.729	6	10	27.048	N	55	42	35.555	W	
6	start	641167.421	682614.205	6	10	26.601	N	55	43	26.817	W	14h45
	end	642258.771	682915.032	6	10	36.310	N	55	42	51.290	W	
7	start	643900.929	682725.951	6	10	30.024	N	55	41	57.883	W	16h10
	end	640972.171	682547.364	6	10	24.440	N	55	43	33.174	W	
8	start	641868.106	682902.357	6	10	35.928	N	55	43	4.000	W	17h35
	end	639168.555	682739.554	6	10	30.837	N	55	44	31.834	W	
9	start	638614.79	682622.98	6	10	27.084	N	55	44	49.858	W	19h10
	end	643996.695	682331.045	6	10	17.159	N	55	41	54.799	W	
10	start	643760.845	682929.153	6	10	36.651	N	55	42	2.424	W	20h50
	end	645000.587	683283.81	6	10	48.099	N	55	41	22.065	W	

On completion of each trawl, the twin nets from both sides were emptied on deck and kept separate (Figure 4). For every haul and side (with/without TED), all rays and sharks were identified, sexed, and measured to width (cm, length for sharks). Also the condition per individual was noted (good, poor, dead). Due to time and handling constraints, no length or weight per individual could be recorded, so only the width of the rays was measured. Except for sharks, no other large animals were noted or measured. No ETP species were caught during this pilot study.

Basic analyses were carried out at ILVO. Differences in number of species, presence, density, size and sex of the different ray species are presented and briefly discussed. Several non-parametric Wicoxon matched pair tests for dependent variables were performed, using the Statistica 10 package (StatSoft 2011).

Figure 4. emptying the nets on board the Neptune 6 and bycatch of different ray species (and many small and large roundfish species).

4 Results

4.1 Species diversity

No ETP species were caught in either net configuration. Next to a number of ray species, 12 smalleyed smooth-hound *Mustelus higmani* were caught in 7 hauls, 6 in the nets with TEDs and BRDs and 6 in the nets without selectivity devices. Most of these were small individuals around 20 to 25 cm in length. They were released in poor to good condition. In several hauls one or more serpenton *Ophichthus cylindroideus* and/or conger *Cynoponticus savanna* were caught (most of them >80 cm) but these were not counted as they were quite aggressive and vivid, and rapidly released by the fishermen. The rest of the bycatch has not been processed as this is was not part of this study, but according to Southall et al. (2011), bangamary *Macrodon ancylodon*, trout *Cynoscion virescens*, rockhead *Larimus breviceps* and catfish *Bagre bagre* are amongst the most common bycaught (sized) and discarded (undersized) fish species.

Five common ray species were caught and all species were found in both nets with and without devices (Table 2, Figure 5). In February 2012, no chola guitarfish *Rhinobatos percellens* were caught, but the species is surely present in Surinam waters. Also, it seems a bit strange that no *Dasyatis americana* was caught in either net configuration.

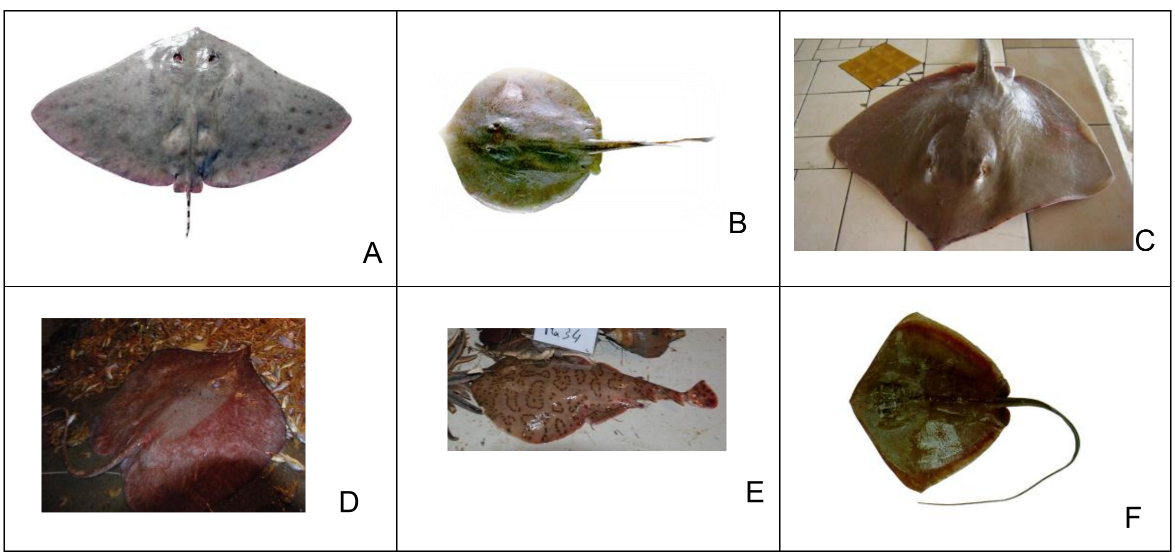

Figure 5. The main ray species in the bycatch of seabob fishing, from A to F: *Gymnura micrura*, *Urotrygon microphthalmum, Dasyatis guttata, Dasyatis geijskesi, Narcine brasiliensis, Dasyatis americana (the latter* was not found in the nets in February 2012). Pictures A, B, C and F taken from Delbare (2011), see references therein for copyrights; .Pictures D & E © Tomas Willems, ILVO).

Table 2. The main ray species in seabob bycatch.

Scientific name	common name
Gymnura micrura	smooth butterfly ray
Urotrygon microphthalmum	smalleyed round stingray
Dasyatis guttata	longnose stingray
Dasyatis geijskesi	sharpsnout stingray
Narcine brasiliensis	brazilian electric ray

In total 673 ray individuals were caught in the four nets over 10 hauls of approximately 1¼ hour each (Table 3). Smooth butterfly ray *Gymnura micrura* was the most caught ray species and accounted for 58% of all rays in both nets; Longnose stingray *Dasyatis guttata* and smalleyed round stingray *Urotrygon microphthalmum* amounted on average to 18% each; sharpsnout stingray *Dasyatis geijskesi* and Brazilian electric ray *Narcine brasiliensis* completed with 2 to 4% of ray bycatch (Figure 6).

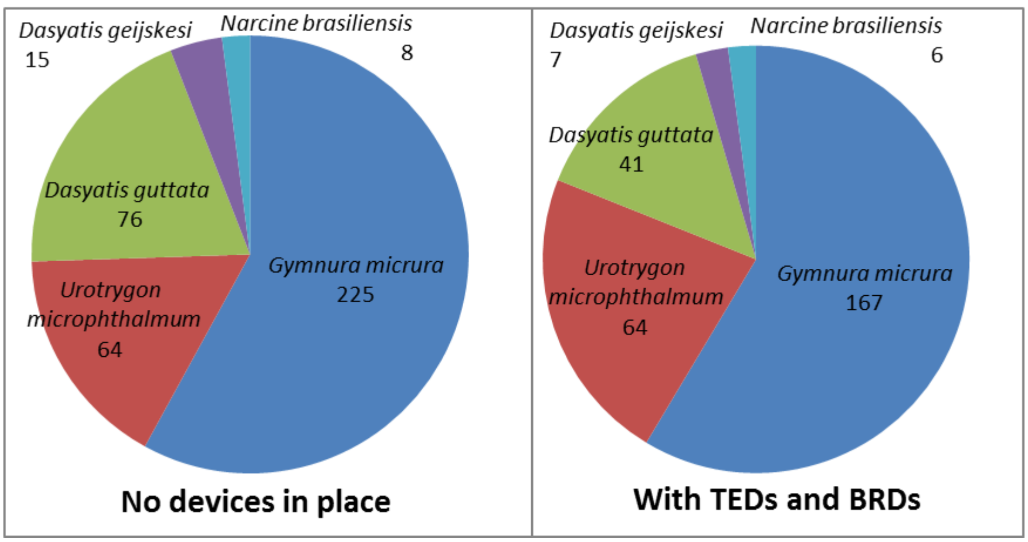

Figure 6. Relative contribution of the main ray species in the bycatch of seabob fishing for nets with and without selectivity devices (values represent total numbers caught in 10 hauls).

4.2 Density related differences

In total 30% less rays were caught in the nets with TEDs and BRDs installed. On average 39 (± 8 SE) ray individuals were caught per haul in the nets without devices vs. 29 (± 5) individuals in the nets with devices in place.

For **smooth butterfly ray** an average reduction of 25% was noted in the net with TEDs and BRDs in 9 of the 10 locations (Figure 7). In total a 46% reduction for

longnose stingray (42 vs. 76 individuals) was calculated for the nets with devices, but this was not an unequivocal signal: the reduction was mainly seen in 4 hauls were >75% less longnose stingray were caught in the nets with devices, but in the other hauls the difference was much lower or neglectible.

Table 3. number of rays caught in 10 experimental hauls in nets with and without selectivity devices in February 2012.

No devices					**Haul**						**Total**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
Gymnura micrura	13	3	4	30	53	26	13	22	19	42	**225**
Urotrygon microphthalmum	17	2	2	1	8	9	3	3	13	6	**64**
Dasyatis guttata	13	1		12	24	4	2	4	6	10	**76**
Dasyatis geijskesi	2			2	3		1	2	4	1	**15**
Narcine brasiliensis		1	1		2	2		1	1		**8**
Total count	**45**	**7**	**7**	**45**	**90**	**41**	**19**	**32**	**43**	**59**	**388**
with TEDs/BRDs					**Haul**						**Total**
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
Gymnura micrura	12	1	3	19	37	19	16	21	13	26	**167**
Urotrygon microphthalmum	22	2	1	2	10	7	3	11	2	4	**64**
Dasyatis guttata	3		1	9	5	4	3	6	1	9	**41**
Dasyatis geijskesi	1				1		1	1	1	2	**7**
Narcine brasiliensis		1	1				2			2	**6**
Total count	**38**	**4**	**6**	**30**	**53**	**30**	**25**	**39**	**17**	**43**	**285**

Only few **sharpsnout stingray** individuals were caught at both sides, but a total reduction of 53% (7 vs. 15 individuals over 10 tracks in total) was seen at 5 out of 7 hauls in the nets with TEDs and BRDs (no sharpsnout stingray were caught in the 3 other hauls).

In some hauls a little bit less **smalleyed round stingray** were caught in the nets with devices, and vice versa in 4 other hauls, but overall the same number of this ray species were caught in the nets with and without devices (in total 64 individuals at each side).

When all 5 ray species are taken into account, a reduction was noted in 8 of the 10 hauls in the nets with selectivity devices installed. It is not clear for the 2 other hauls (haul 7 and 8) if this could be related to time of sampling.

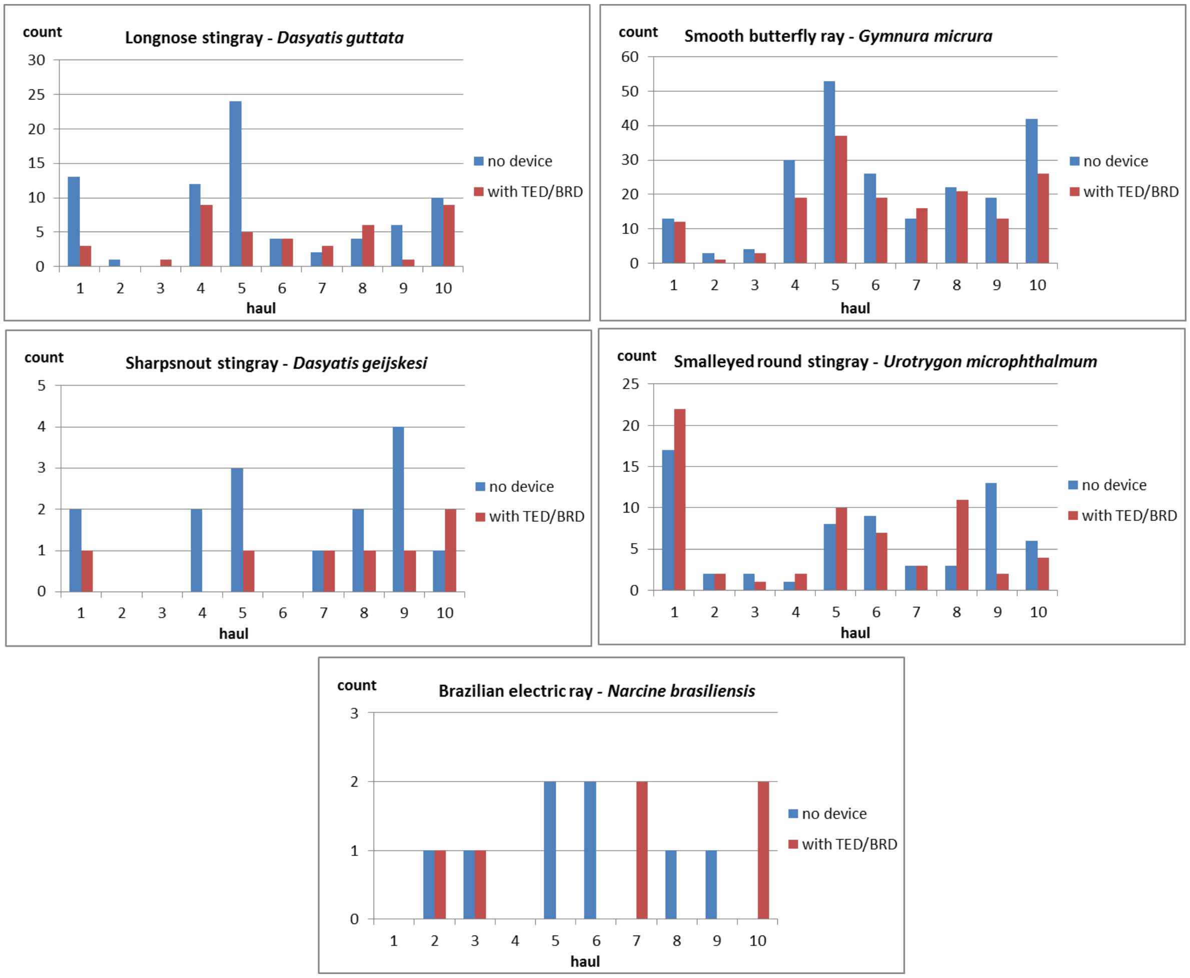

Figure 7. Numbers caught for 5 ray species in 10 experimental hauls (Feb. 2012) in the nets with TEDs and BRDs installed vs. devices closed off.

4.3 Size related differences

The most caught size class (maximum wing width) of **smooth butterfly ray** was 15 to 34 cm. Only 6 smaller individuals were caught all together in only 3 of the 10 hauls. On average 2 resp. 3 individuals of the size classes 35-44 and 45-60 cm were caught in each haul (both sides together). For all size classes (except the smallest) less individuals were caught in the nets with TEDs and BRDs installed. The most abundant classes were caught in almost every haul in both nets, while the larger individuals were only caught in 6 hauls with devices vs. 8 hauls without devices. Overall, the same number of males and females were caught per size class, except for the largest size class which were almost exclusively females. Per size class 30 to 50% less females and 10 to 50% less males were caught in the nets with devices.

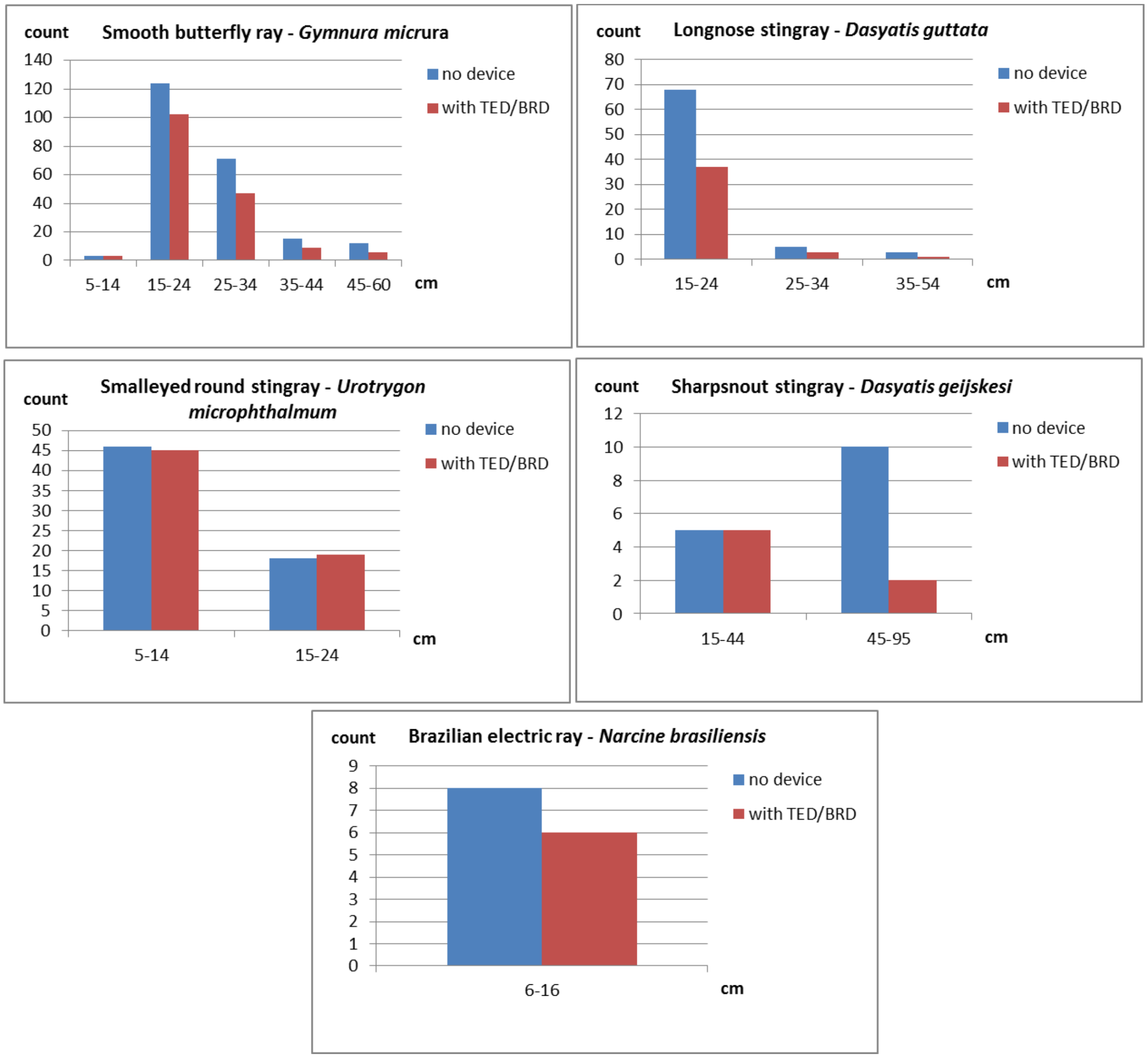

Figure 8. Numbers caught for 5 ray species per size class (max. wing width), total over 10 experimental hauls in the nets with TEDs and BRDs installed vs. devices closed off.

Smalleyed round stingray is a rather small species with the most caught size class 5-14 cm (width). On average 2 males and 2 females of this size class were caught per haul at either side (with/without device). The larger individuals (15-24 cm width) were almost exclusively females, on average also 2 individuals per haul at either side.

Most **longnose stingray** that were caught are found in the 15-24 cm size (width) class, with on average 3 females and 4 males per haul in the nets without selectivity devices and only 2 individuals of every sexe in the nets with TEDs and BRDs. Few larger individuals of longnose stingray were caught, in total 12 in only 4 hauls (size range 25-54 cm), equally divided in males and females, and in almost all cases less larger individuals in the nets with devices.

Sharpsnout stingray is the biggest ray species and was only caught in very low numbers in 7 out of 10 hauls. The size class 15-44 cm (width) was equally present in both net types, with on average 0.5 individuals per haul and a little bit more males in the nets with devices. The larger individuals (class 45-95 cm width, both sexes) were caught with on average 1 individual per haul in the nets without devices, and only 0.2 individuals with devices.

The few **Brazilian electric rays** that were caught in 6 out of 10 hauls were all small individuals (6-16 cm width), on average 0.7 individuals per haul, with mainly males in the nets without devices and mainly females in the nets with TEDs and BRDs.

4.4 Statistical comparison

Wilcoxon matched pairs tests are used to investigate whether the observed differences between nets with TEDs and BRDs vs. nets without selectivity devices could be statistically validated. The data were grouped to the level of numbers caught per size class (max. wing width), sexe, species and haul.

When taking into account all five ray species and without dividing into size classes, a statistically difference could only be shown for the 5th and 9th haul (Table 4). When looking at the species level per size class, 3 tests were significant: large smooth butterfly ray (45-60 cm), large sharpsnout stingray (45-94 cm) and the most common size class (15-24 cm) of longnose stingray (Table 5). All other tests were not significant.

Table 4. Results of the Wilcoxon matched pairs tests. Marked tests show significant differences between nets with TEDs and BRDs vs. nets without selectivity devices at the 0.05 level.

Haul	Valid	T	Z	p-value
1	11	18.0	1.33	0.182
2	8	12.0	0.84	0.401
3	7	12.5	0.25	0.800
4	11	12.0	1.87	0.062
5	17	31.5	2.13	0.033
6	10	12.0	1.58	0.114
7	12	27.5	0.90	0.367
8	13	38.0	0.52	0.600
9	14	4.0	3.04	0.002
10	16	54.5	0.70	0.485

Table 5. Results of the Wilcoxon matched pairs tests. Marked tests show significant differences between nets with TEDs and BRDs vs. nets without selectivity devices at the 0.05 level.

Scientific_name	size class (max. width in cm)	Valid	T	Z	p-value
Gymnura micrura	**5-14**	2	1.5	0.00	1.000
	15-24	16	42.0	1.34	0.179
	25-34	14	24.0	1.79	0.074
	35-44	9	16.5	0.71	0.477
	45-60	5	0.0	2.02	0.043
Urotrygon microphthalmum	**5-14**	17	60.5	0.76	0.449
	15-24	8	17.0	0.14	0.889
Dasyatis guttata	**15-24**	14	21.0	1.98	0.048
	25-34	4	2.5	0.91	0.361
	35-44	2	1.5	0.00	1.000
	45-94	2	0.0	1.34	0.180
Dasyatis geijskesi	**15-44**	7	12.0	0.34	0.735
	45-94	7	0.0	2.37	0.018
Narcine brasiliensis	**5-14**	10	25.0	0.25	0.799

5 Discussion

For this pilot study the hauls were kept relatively short, i.e. 1¼ hour. No ETP species were caught, not in the nets with TEDs and BRDs in place, nor in the nets without selectivity devices. The sampling took place on 21th February when the turtle season was not very intensive yet, although green turtles *Chelonia midas* already started laying eggs on the Surinam beaches.

When nets were emptied on deck, most ray species and individuals were already dead or in poor condition, even as the experimental hauls only lasted for approximately one hour. This suggests that in a normal fishing regime of 3 to 4 hours per haul, most probably none of the rays in the bycatch survive. It remains unclear what happens to ray individuals that eventually hit the selectivity devices but are not caught in the nets. It might be interesting to investigate whether these individuals get damaged and/or successively die as well.

As many as 40 different organisms have been recorded from a single haul in the seabob fishery. The most vulnerable among the discarded species are considered to be longnose stingray *Dasyatis guttata* and smooth butterfly ray *Gymnura micrura* (Southall et al. 2011). This is confirmed by this pilot study, but also smalleyed round stingray *Urotrygon microphthalmum* was caught in relatively high numbers in February 2012. The latter seems to be much less abundant in the experimental hauls of the 2nd survey in May 2012 (unpubl. data, not processed yet). It remains unclear why no *Dasyatis americana* was caught, as this species is thought to be relatively common in Surinam coastal waters (Delbare 2011, Southall et al. 2011).

Although 30% less rays were caught in the nets with TEDs and BRDs installed, the proportional presence of the 5 species was comparable to the nets without selectivity devices. Also, the reduction in the nets with devices installed was not unequivocal for all species nor for all 10 experimental hauls, which makes it difficult to come up with firm conclusions on the effectiveness of selectivity devices for ray species.

Selectivity is affected by many factors besides the gear configuration, such as the fishing location and time of the year. In February 2012 (and May 2012) the 10 hauls were taken in close vicinity of each other (6°10.17' to 6*11.45' Northern latitude and 55°39.49' to 55°45.44' Eastern length), as it was found to be a good fishing ground for seabob (and not necessarily for the bycatch of rays). As such, no correlation between ray bycatch and fishing location, i.e. in relation to depth or relative distance to the shore within the seabob fishing zone, could yet be shown.

In the proposal for this preliminary assessment it was suggested that ideally 50 or more rays should have been caught after 1 hour of fishing. This threshold was not reached, as on average only 39 (resp. 29) individuals were caught per haul in the nets without (resp. with) selectivity devices installed. As it is nowhere registered were many rays are bycaught throughout the year, this information is dependent on the captains knowledge and willingness to go fishing in a zone where many rays are known to be present. A thorough study to compile this so-called *local ecological knowledge* (LEK) might reveal a lot of information that is up till now unavailable to carry out a proper assessment.

Also other periods and locations should be investigated in a similar way as this pilot study. In May and June 2012 already two other surveys are carried out/planned. Hopefully some more surveys will be carried out in the period September-December.

Still, an overall reduction for one or more ray species was noted in the nets with TEDs and BRDs in 8 of the 10 hauls, which suggests that the selectivity devices do work to a certain extent for ray species. The overall figures indeed suggest a reduction in bycatch of four ray species (not for smalleyed round stingray). However, this could not really be proven by statistical analyses, as the reduced bycatch in the nets with TEDs and BRDs seems to be significant only for 2 hauls. As the variables are dependent (with vs. without device per haul) and the assumptions for the parametric T-test were not met in most cases, a Wilcoxon matched pairs test is the proper statistical test to be carried out in such situations (StatSoft 2011). By taking into account more hauls, periods and locations in the follow-up report, the significance levels of the statistical results might be strengthened and improved.

For all ray species, the smaller size classes were most common in both nets. For relatively small species like smalleyed round stingray and Brazilian electric ray this seems obvious. For mid-sized species like smooth butterfly ray and longnose stingray, this might be partly related to time of the year. Again, although several figures show a reduction per species and size class in the nets with TEDs and BRDs, this could not be proven statistically, except for the larger size classes of sharpsnout stingray and smooth butterfly ray and the common smaller size class of longnose stingray. BRDs are designed for small (round)fish to escape, while TEDs are developed to avoid that big turtles are caught in the nets. The typical rhomboid shape of most rays probably makes the small and mid-sized size classes more vulnerable to be caught in a fishing net with mesh sizes 57 to 45 mm, even with the BRDs installed. On the other hand, the fact that the biggest size classes of 3 ray species were significantly (at least for 2 species) less caught in the nets with selectivity devices installed, might prove that the TEDs do selectively deter large rays to a certain extent.

No data were available to indicate the state of affected populations of bycatch species, nor hard data on the ray species that should be expected in the seabob fishing zone. The fact that all size classes are present with both males and females and that several larger individuals were caught, might point towards a relatively healthy population status of at least the five different ray species. Of course, the number of larger individuals caught is relatively low, even in the nets with the TEDs and BRDs closed off. Due to the limited amount of data it cannot be stated (yet) if the reduced bycatch of large individuals is sufficient to keep the different ray populations in good condition. Moreover, fishing trips typically comprise around 40 hauls and some 20 vessels fish almost year round for seabob. For sure, an upscaling to normal hauls (3 to 4 hours), trip and complete seabob fishing fleet per year needs to be performed to get a better idea of the impact at population level for the different ray species in Surinam waters.

6 Conclusion

As this was a pilot project, the results are rather indicative than conclusive. It can be argued that the duration of the hauls (ca. 1 hour) is sufficiently short as no ETP species were caught. However, this can also be related to the time of sampling in February. On the other hand, almost all caught ray species and individuals were dead or in poor condition already after 1 hour of trawling, which shows that rays indeed are highly vulnerable to the Surinam seabob fishery.

Five ray species were caught in this pilot project, with longnose stingray *Dasyatis guttata,* smooth butterfly ray *Gymnura micrura* and smalleyed round stingray *Urotrygon microphthalmum* as the most common species. Overall, 30% less rays were caught in the nets with TEDs and BRDs installed, although this reduction was not unequivocal for all hauls, size classes and ray species.

For the five ray species different size classes were caught, reflecting a 'normal' population structure. The fact that many small individuals were caught might also be related to the period of the survey. Although not so many large individuals were caught, a significant reduction in the bycatch of the largest size classes in the nets with selectivity devices installed was noted for at least 2 ray species *G. micrura* and sharpsnout stingray *Dasyatis geijskesi*. As such, TEDs seems to be useful to reduce bycatch of large rays. Still, many rays are bycaught in the nets with TEDs and BRDs, which indicates that nor the TEDs or BRDs are effective enough to reduce the bycatch of rays to negligible levels. More research is needed, both in time and space to investigate whether the ray populations are in good condition and whether a relation between (reduced) bycatch and time or depth/location in the seabob fishing zone can be found. Already 2 more surveys (May and June 2012) are carried out or planned. Hopefully, also other months will be sampled at a larger spatial scale, to build a firm dataset and to perform sound analyses.

This pilot project is partly based on the Local Ecological Knowledge (LEK) of the captain and fishermen. A thorough assessment of the ray bycatch in Surinam waters might benefit if this highly relevant information is compiled in a structural way. Also, an upscaling to the whole seabob fishing fleet will be necessary to evaluate realistic values of ray bycatch in the Surinam seabob fishery.

7 References

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