ENHANCED MONITORING OF LARGE PELAGIC FISHES CAUGHT BY THE VENEZUELAN ARTISANAL OFF-SHORE FLEET TARGETING TUNA AND TUNA-LIKE SPECIES IN THE CARIBBEAN SEA AND ADJACENT NORTHWESTERN ATLANTIC WATERS: FINAL ANALYSIS

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SUMMARY

A three year project funded by the Japanese Data & Management Improvement Program (JDMIP) to monitor the Venezuelan artisanal off-shore (VAOS) fleet targeting tuna and tuna-like species using pelagic longline gear was successfully completed. At-sea sampling consisted of 92 observed trips by 7 trained Captains. The total number of sets observed for all trips covered was 977 in which the number of sets per trip varied between 3 and 18 sets, and number of hooks per trip varied between 2340 and 18720. The overall main target species reported and validated from at-sea sampling included 19285 dolphinfish, 5649 sailfish, and 611 white marlin, 46 longbill spearfish, 37 roundscale spearfish and 36 blue marlin measured and sexed. Secondary target species included catches of 306 silky sharks (FAL) which consisted mostly of small individuals and 78 scalloped hammerhead sharks, both species were the most common sharks caught. The tuna sample was mostly formed by 765 BLF, 56 YFT, and 29 ALB. Port activities recorded landings from 92 vessels during the overall sampling period, all billfish and shark species were identified and length measures were recorded, all shark specimens were sexed. In addition, port sampling activities in Juangriego (Margarita Island) in 2013-2014 were complemented with interviews of Captains and crews from 52 of the 55 vessels of the active fleet in Juangriego.

RÉSUMÉ

Le projet sur trois ans financé par le Projet d'amélioration des données et de la gestion du Japon (JDMIP) afin d'effectuer un suivi de la flottille artisanale vénézuélienne (VAOS) ciblant en haute mer les thonidés et les espèces apparentées à la palangre pélagique a été couronné de succès. L'échantillonnage en mer a consisté en 92 sorties avec observateur réalisées par sept capitaines formés. Le nombre total d'opérations observées pour toutes les sorties couvertes s'est chiffré à 977. Au cours de chaque sortie, entre trois et 18 opérations étaient réalisées et le nombre d'hameçons par sortie a varié entre 2.340 et 18.720 hameçons. Les principales espèces cibles déclarées et validées de l'échantillonnage en mer incluaient 19.285 coryphènes communes, 5.649 voiliers, 611 makaires blancs, 46 makaires bécunes, 37 makaires épées et 36 makaires bleus mesurés et dont on a déterminé le sexe. Les espèces cibles secondaires comprenaient les prises de 306 requins soyeux (FAL) qui étaient principalement constitués de petits spécimens et de 78 requins-marteaux halicornes, ces deux espèces étant les requins les plus communément capturés. L'échantillon des thonidés a été essentiellement constitué de 765 thons à nageoires noires, de 56 albacores et de 29 germons. Les activités au port ont consisté à consigner les débarquements de 92 navires pendant toute la période d'échantillonnage ; toutes les espèces d'istiophoridés et de requins ont été identifiées et les longueurs ont été enregistrées ; l'on a déterminé le sexe de tous les spécimens de requins. En outre, les activités d'échantillonnage au port à Juangriego (île Margarita) en 2013-2014 ont été complétées par des entretiens avec les capitaines et les membres d'équipage de 52 navires sur les 55 embarcations qui composaient la flottille active à Juangriego.

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RESUMEN

Se llevó a cabo con éxito un proyecto de tres años financiado por el Programa de Japón para la mejora de la ordenación y los datos (JDMIP) para hacer un seguimiento de la flota artesanal de alta mar de Venezuela (VAOS) dirigida a los túnidos y especies afines utilizando el palangre pelágico. El muestreo en el mar consistió en 92 mareas observadas por siete patrones formados. El número total de lances observados en todas las mareas cubiertas fue de 977, en los que el número de lances por marea variaba entre 3 y 18 lances, y el número de anzuelos por marea variaba entre 2.340 y 18.720. Las principales especies objetivo comunicadas y validadas en el muestreo en el mar incluían 19285 dorados, 5649 peces vela, 611 agujas blancas, 46 agujas picudas, 37 marlines peto y 36 agujas azules medidas y a de las que se determinó el sexo. Las especies objetivo secundarias incluían capturas de 306 tiburones jaquetones (FAL), compuestas sobre todo por ejemplares pequeños y por 78 cornudas comunes que fueron las especies más comunes de tiburones capturadas. Los túnidos muestreados fueron sobre todo 765 BLF, 56 YFT y 29 ALB. En el marco de las actividades de muestreo en puerto se muestrearon los desembarques de 92 buques durante el periodo de muestreo total, se identificaron todas las especies de tiburones e istiofóridos, se consignaron todas las mediciones de talla y se determinó el sexo de todos los ejemplares de tiburones. Además, las actividades de muestreo en puerto en Juangriego (isla Margarita) en 2013-2014 fueron complementadas con entrevistas a patrones y tripulaciones de 52 de los 55 buques de la flota activa en Juangriego.

KEYWORDS

Artisanal fishery, Pelagic longline, Caribbean Sea, Venezuela, Billfish, Sharks, Tunas

Introduction

The Venezuelan small scale artisanal fleet that targets tuna and tuna-like species known as 'Flota Artesanal Costa-Afuera' (i.e., Artisanal Off-shore fleet, VAOS fleet), is a medium and long range fishery that operates within the Venezuelan EEZ and that of neighboring Caribbean island States and along the Guiana's shelf from Venezuela to French Guiana. As shown by Arocha *et al.* (2013) the VAOS fleet deploying pelagic longline gear is formed by vessels in the range of 11-18 m in length, mainly targeting dolphinfish (DOL) and billfishes (BIL), and tunas and sharks as secondary targets; in which the pelagic longline fishing operations of the fleet consists of fishing between 400 and 1040 hooks per set, normally using live sardine (Sardinella aurita) as bait. The dynamics of this fleet has made difficult a constant monitoring program, and the few studies available are from the mid 1990s (Marcano *et al.*, 1995), which point out that most of the catch is landed without species identification, with the exception of the fishery directed at *Scomberomorus sp* (KGM/BRS) that is one of the oldest fisheries in Venezuela (Marcano *et al.*, 1998).

Considering that the JDMIP is for data improvement to be submitted to ICCAT, a three-year project was developed to help Venezuela's Fishery Agency to fulfill the new ICCAT RECs that calls for CPCs to develop alternative scientific monitoring approach in fleets with vessels around 15 m, by implementing a reliable monitoring system for the VAOS fleet targeting tuna and tuna-like species that would be undertaken by the National Fishery Agency (INSOPESCA) once completed. The present document reports on the activities conducted during the entire period of the project that was completed in March 2014.

Methods

The procedure developed to collect, process, and store the data from the VAOS fleet were detailed in Arocha *et al.* (2013) and consisted in at-sea and port sampling activities in two key communities where most of the vessels of this fleet targeting tuna and tuna-like species are based, Morro de Puerto Santo-Sucre in the mainland and JuanGriego, in Margarita Island (**Figure 1**).

The at-sea sampling activity continued to be self reporting by the same the trained Captains operating during the first year of the project. The validating procedure continued to be similar to the one implemented during the first year of the project, which consisted of debriefing the Captain upon arrival of the vessel to port, review the information recorded in the data forms, and confirm species identification with images provided by the Captain. Fishing effort in number of hooks per 1000 and catch rates (CPUE) based on the number of fish per 1000 hooks were examined spatially for every important group of species and presented in 1° square bins over the bathymetry of the fishing area.

Port sampling activities in Morro Pto. Santo continued to be dependent on vessel availability to be sampled by project port samplers as described in earlier documents (Arocha *et al*. 2013 and Arocha *et al*. 2014). However, port sampling activities in the community of Juangriego (Margarita Island) were reevaluated at the end of the YEAR 2 and the procedure was changed for Year 3, due to the changing dynamic of the fleet's landing sites which were spread-out in different ports in the northeastern coast of Venezuela and neighboring Island States, making it difficult to sample the landed catch. Noting that all vessels based at Juangriego return to the base port to land all or the remaining portion of the catch and load provisions for the next trip, a procedure was established to interview the captains and crews and revise the landing slips provided to the local offices of INSOPESCA-Margarita Island. The information recorded for Year 3 during the period from January 2013 to March 2014 resulted in the interview of Captains and crews of 52 vessels which consisted of almost the entire fleet (55 active vessels in 2013).

The complete data information from the At-sea and Port sampling activities of the JDMIP Venezuela Project are in the ICCAT Secretariat. Tissue samples collected from istiophorid and shark species for genetic ID are in the analysis process by collaborative ICCAT scientists.

Results and Discussion

1. At-sea sampling

At-sea sampling activities consisted of 92 observed trips that were conducted from June 2011 through March 2014. The majority of the trips (91) were trained Captain observed trips, and only 1 was scientific observer-based. The reason for having the majority of the observed trips as "*self reporting*" was the impossibility of placing observers on board due to limited space, relaxed safety on board, and no strong ties with crew members, as detailed in Arocha *et al.* (2013). The spatial distribution of the observed sets during the study period is represented in **Figure 2**; 2012 and 2013 were the years in which the highest coverage of observed sets occurred, in contrast with the first and last year of the study during which the observed set coverage was less than expected. There are several reasons for it; among them are administrative and logistics. From the logistics point of view, a monitoring project of artisanal fisheries with complex operations, like varying landing sites based on opportunity value, it will usually take a year to tune-in the at-sea sampling activites. From the administrative point of view, an independent contractor would be in a better position to expedite the logistics, a more efficient flow and exchange of information, and more on site (community level) interaction with artisanal fishers, because it would not be subject to administrative delays of the institutions involved.

The spatial distribution of observed sets by fleets within each community during the study period was analyzed in an effort to determine potential differences in fishing grounds. The overall spatial distribution of observed sets by fleets indicates a couple of contrasting patterns between the two fleets. 1, the fleet from Morro Pto. Santo (Sucre, in the mainland) appear to fish at the furthermost end of the southeastern Caribbean Sea, and in the Atlantic side off the Orinoco river delta and with some operations off Suriname (**Figure 2**, bottom map); and 2, the fleet from JuanGriego (Margarita Island) fishes further west into the Caribbean Sea and around the Venezuelan off-shore islands, in the Atlantic side the fleet fishes further off-shore than the fleet from Morro Pto. Santo. Aside from the unbalanced number of sets observed favoring those from the fleet in JuanGriego, this pattern is rooted more on traditional fishing operation from each community. Fisher-folk from Morro Pto. Santo have been traditional fishers for king mackerel (*Scomberomorus cavalla*), that they dedicate 3-6 months of the year to target king mackerel, in contrast to fisher-folk from JuanGriego which had a tradition to target snapper – grouper off Surinam in the early 1980's and after the decline of the stocks shifted target to billfish and dolphinfish in the late 1980's. Fishing grounds for king mackerel have always been located at the furthermost end of the southeastern Caribbean Sea where both fleets coincide, and southeast of Trinidad. Fishing grounds for billfish were initially off central Venezuela between the off-shore Islands and the mainland (Arocha *et al.*, 2015), and after 2000 operations shifted seasonally to the Atlantic side based on what fishers call migration patterns of billfish and dolphinfish in the fishing grounds.

A total of 977 sets have been observed and the data recorded, in which a total of 747620 hooks/set were fished during the 92 trips (**Table 1**). During these trips, a total of 25 species were identified, in which length measurements and sex identification were recorded. The largest proportion of the total landed catch of all observed trips was represented by dolphinfish (DOL, 71%), followed by sailfish (SAI, 20.8%), and the remaining 8.2% was mainly represented by blackfin tuna (BLF, 2.8%), white marlin (WHM, 2.2%) and sliky sharks (FAL, 1.1%).

1.1 Species composition

The landed catch from this fleet has been normally separated and reported as four gross commercial species groups which correspond to dolphinfish (mainly *Coryphaena hippurus*), billfishes (five species), tunas (five species), and sharks (5-9 species). However, there are some commercial variations in the reported catch in billfish, in which the reported catch is further separated into 'palagar' (group four species) and 'aguja' (=BUM & WHM, when large). Tunas and sharks can also be further separated, in tunas the separation can be between 'albacora' (=BLF), 'atún' (=YFT) and 'atún ojo gordo u ojote' (BET=), and an occasional 'barrilote' (=ALB) and/or 'listado' (=SJK), all landed tunas can be identified to species with little problem because there are landed in low numbers. In sharks, the catch is mostly landed as 'cazón' (for all shark species), and occasionally 'tiburón' (when is for large oceanic sharks like SMA, BSH or OCS). The information recorded from the 977 pelagic longline sets contributed to separate the catch composition from the commercial species groups into the catch composition by species of the most complex groups, *i.e.*, billfish and sharks. The resulting proportions for the billfish species (**Table 2**) were transformed into weight propotions from average dressed weights recorded from the artisanal billfish fishery off central Venezuela in the community of Playa Verde (**Table 3**). The estimated proportions for billfish species in the present document were recently used to disaggregate a portion of the billfish unclassified catch from the VAOS pelagic longline fishery for the period 1986-2013 (Arocha *et al*., 2015).

The estimated annual proportions to disaggregate the shark unclassified catch were combined into an average proportion due to the low number of samples (**Table 4**). Three species, smooth-hound, pelagic stingray, and great hammerhead shark (DUS, PLS, SPZ) were excluded from the estimated proportions because Captains and crews considered those species uncommon in the catch of the VAOS fleet. The other species considered that showed low numbers in the VAOS landed catch like blue (BSH), oceanic whitetip (OCS), shortfin mako (SMA), tiger (TIG) and spiner sharks (CCB) were considered to be commomly caught by the fishery but in low numbers, 1 or 2 specimens on a given trip. Proportions in numbers of sharks were converted into weight by using estimated weights provided by trained Captains during the 92 observed trips of the study period.

1.1.1 Spatial distribution of fishing effort and major commercial species

The spatial distribution of the fishing effort, expressed as total number of hooks, is presented in 1° square bins over the bathymetry of the fishing area (**Figure 3**). The results indicate that overall fishing effort was mostly concentrated in areas where the shelf break is more prominent, like in the Caribbean Sea around the 65°W line, and in the Atlantic around the shelf break off the Orinoco river delta (9°N, 59°W), but in general fishing effort was distributed throughout the fishing area. However, the spatial fishing effort varied seasonally, during the 1st quarter the fishing effort was concentrated off the Orinoco river delta in the Atlantic and SW of the Grenadine islands in the Caribbean Sea. In the 2nd quarter, the overall fishing effort was reduced but was concentrated off the Orinoco river delta in the Atlantic, and in the Caribbean the area between some Venezuela off-shore islands (65°-66°W). In the 3rd quarter, most of the fishing effort was concentrated in the Atlantic side, in particular off the Orinoco river delta and E of Trinidad. In the Caribbean Sea, the fishing effort mostly concentrated between 66°-64°W, and was absent further east. Finally, during the 4th quarter the fishing effort increased across the Caribbean Sea and diminished off the Orinoco river delta in the Atlantic.

The spatial distribution of catch rates (CPUE) of the most commonly caught species of the VAOS fishery is presented in **Figure 4**. Dolphinfish (DOL), one of the main target species, as well as the billfishes (mainly the most relevant billfish species in the catches) were spatially distributed in a similar way throughout the study period. The largest concentration of captured fish were off the the Orinoco river delta, off the Venezuelan off-shore islands (64°-67°W), and SW of the Grenadine islands. However, off the Surinam plataform dolphinfish cath rates decreased while sailfish (SAI) seemed to encrease. In the case of the billfish species, sailfish was the dominant species in the catches throughout the area followed by white marlin (WHM) in much smaller numbers, and was mostly present where the highest numbers of fish were caught, in the Caribbean Sea. Blue marlin (BUM) were also present, but in smaller numbers and most of them were caught in the Atlantic side along the shelf break off the Orinoco river delta.

The spatial distribution of the shark catch rates was mostly concentrated in the Atlantic side and at the entrance of the Caribbean. Silky shark (FAL), the most common shark species, was mostly caught off the influence the river deltas (Esequibo-GUY and Orinoco-VEN) in the Atlantic side; in the Caribbean Sea shark catch reates were present but at lower levels. Spatial differences were observed between species, the smooth hammerhead shark (SPL) was more abundant at the entrance to the Caribbean Sea (south of the Grenadines I.) and east of Trinidad, it also showed important levels of CPUE off the river deltas but less than the levels observed in the Caribbean Sea. The other two species, the dusky shark (DUS) and the blue shark (BSH) had a limited presence, although the blue shark appeared distributed throughout the area, it was in small numbers and in areas associated to open ocean waters. Dusky shark catches were limited to the area south of the Grenadines I.

In tunas, the catch rate distribution was marked by the predominance of blackfin tuna (BLF) in the Caribbean Sea, concentrated NE Margarita Island and further east but in lower levels. The other tuna species, like bigeye tuna (BET) was mostly caught in the Atlantic side, off the Surinam plataform; while important catch rates of albacore (ALB) were present off the central coast of the Caribbean Sea where the shelf is very narrow; and the few yellowfin tuna (YFT) caught were from the Caribbean side, with occasional catches rates from the Atlantic side.

1.2 Size distribution of the sampled catch

The analysis of sailfish (SAI) size data during the study period showed that averaged sizes remain similar across years, regardless of the unbalanced size data (**Figure 5**), but with small fish (<120 cm LFJL) present only in 2012. Sailfish size comparison between fishing areas and fleets, showed similar average size in the catch but the smallest fish (<100 cm LJFL) appeared to be caught in the Atlantic side by the fleet from Morro Pto. Santo. For white marlin (WHM), the size data showed that average size was similar across years except for 2014, when it was smaller, but the data represents the first quarter of the year 2014. However, some differences in white marlin average sizes were observed between areas and fleets, white marlin caught in the Atlantic side showed smaller average size; likely fish caught by the Morro Pto. Santo fleet showed smaller average sizes than the ones caught by the Juangriego fleet. The largest white marlin caught, were from the Atlanic side caught by the Morro Pto. Santo fleet.

The analysis of dolphinfish (DOL) size data showed that average sizes varied across years, showing an increasing trend over the years (**Figure 6**). The average size of dolphinfish was larger in the Atlantic side, and the fleet from Morro Pto. Santo caught larger average size fish than the Juangriego fleet. Size data analysis for blackfin tuna (BLF), showed no marked variation in average size fish across years, areas or fleets. In silky sharks (FAL), size data indicated that most of the catch consisted of small fish, only in 2012 the catch included larger fish (>120 cm FL). Average size fish were slightly smaller in the Atlantic side, and the average size fish caught by the fleet from Morro Pto Santo were also smaller. However, in both areas and catches by both fleets included lager inividuals (>120 cm FL).

The analysis of size data of the most important species in the catch appear to show some variations in the average size between areas and/or between fleets in several of the species, that may be attributed, initially to fleet operations, but it warrants further thorough analysis when standardized catch rates for this fishery are developed. The fishery operation appears to be similar in both fleets, but in the gear deployment they differ. The fleet from Juangriego set their hooks shallower than the fleet from Morro Pto. Santo, hooks are set at a mean approximated depth of 10.82±2.35 m and of 24.68±7.36 m. Therefore, the depth of hooks and area may be factors to be considered when standardizing the catch rates of sharks or billfish from the VAOS pelagic LL fishery in the future.

2. Port sampling

A total of 92 vessels fishing that at least made 1 set with longline gear indicated that they were targeting either dolphinfish (54%), billfish (18%), tunas (6%), or king mackarel (6%). The average number of fishing days per trip varied between 11.5 and 16.4 during the 3 year period that lasted the study. It went from as low as 3 to as long as 22 days; while the average number of longline sets deployed during the study period varied between 8.2 and 11.0 sets (**Table 6**). The very low number of sets deployed occurred when the target was KGM, and skippers shifted to longline gear at the end of the trip when 1-4 longline sets were deployed before reaching port. The species specific catch of the sampled trips indicated that the largest proportion (~50%) of the catch was dolphinfish (DOL), followed by sailfish (~25%), a pattern that was seen during the years of the study period. Similar to what it was observed by community for all years combined, however, some differences arises in the

reaming 25% catch. In Morro Pto. Santo the catches of blue and white marlin are much less than those of Margarita Island, in contrast with spearfish where is more common in the fleet from Morro Pto. Santo. Similarly, in the landed catch of SHK2 (which is likely SPL), the fleet from Morro Pto. Santo caught more than Margarita Island's fleet. It appears that this pattern is mostly due to the preference of Margarita Island fishers for the Caribbean Sea as well as the Atlantic, unlike some of the fleet from Morro Pto. Santo appear to fish more in the Atlantic and towards the most eastern part of the Caribbean Sea.

2.1 Species composition

A total of 2410 specimens were identified to species, measured, and sexed in the case of shark species during port sampling activities in Morro de Pto. Santo and Margarita Island (**Table 7**). Most of the sampled species were gutted and headed (BIL and most SHK), others were only gutted (TUN, DOL). In the case of billfishes (SAI, WHM, BUM, SPF, SPG), measurements were based on pectoral fin – fork length (PFL) measurements and convert them later to LJFL (see ICCAT Manual); however, for *T. pfluegieri* (SPF) and *T. georgii* (SPG), length conversions are not available. In the case if some shark species (FAL, SVD, SPL), those that were headed and gutted, the only measurement possible was the dorsal trunk (TR), measured as the length from origin of the anterior part of first dorsal fin to the origin of the anterior part of second dorsal fin. The species sampled (measured) during port activities included, in order of magnitude, SAI (1693), BLF (347), FAL (102), and SPL (72). The SFD for the most common species in the sampled catch (SAI, BLF, FAL and SPL) were compared after conversion to LJFL in sailfish and FL in sharks. However, trunk length-fork-length relationships in sharks were not estimated due to the small sample size, so a proportion of Trunk to FL was estimated from the measurements taken by the at-sea sampling program resulting in 0.42 for FAL and 0.53 for SPL, and were used to estimate shark FLe. Results show that sizes sampled from port sampling activities are comparable to at-sea sampling size data, and that large as well as small sailfish (<120 cm LJFL) are landed. Shark species consisted of mostly juveniles and/or sub adult specimens with an occasional adult specimen (**Figure 7**).

2.2 Fishing areas

The majority of the trips recorded fished in section 6 (49%) located in the Atlantic side, followed by sections 2 (25%), 7 (10%), and 1 (7%), two of which are located in the Caribbean Sea and 1 in the Atlantic side (**Figure 8**). The fishing areas preferred by the Juangriego VAOS LL fleet is a corner between zones 2 and 6 which was termed Trin (2-6) in **Figure 8**, located southeast of Trinidad. Almost 75% of the trips were in that area and confirmed by the locations of sets of the observed trips in **Figure 1**. The next area in importance was zone 6 (Guy). The zones within the Caribbean Sea were relatively poorly visited during 2013; it may be due to a marketing advantage offered by landing part of the catch in Trinidad in recent times. Comparing the fishing area information between the two methods based on port sampling activities, it became evident that fishing area information reported in 5°x5° grid is too gross for artisanal fisheries, although reducing the grid to 1°x1° is ideal, fishers in personal interviews indicate land reference points, bearing, and distance; therefore it is the interviewer that can record the information on to a map with a lower grid. However, this information is based on trust and confidence that the interviewer has to obtain from fishers, and it only became available in the last year of the Project, once trust and confidence was gained by project personel. A suggestion was passed to INSOPESCA personnel to collect detailed fishing areas in future data collection schemes, particularly from Margarita Island fleets.

2.3 Margarita Island 2013-2014 data

In Margarita Island, the newly defined port sampling resulted in a total of 200 trips recorded from the interview process, indicating that the average number of sets/trip was 8.2, the average number of hooks/set was 715.2 and the average total number of hooks/trip was 5892.5 (**Table 8**).

The landed catch reported by Captains and crews in the interviews recorded in Margarita Island was represented by several species and species groups, those that needed partitioning were billfishes (BIL) and sharks (SHK). The total reported landed billfish catch from interviews crews was 113473 kg, and 9093 kg of unclassified sharks which were disaggregated into species according to the information given in **Tables 2** and **4**. In the case of separating the billfishes, the proportions estimated for 2013 were used, but in the case of the sharks, the average proportions were used because annual proportions were considered unrepresentative. The resulting separation is presented in **Table 9**. The rest of the landed catch was formed by dolphinfish (DOL), blackfin tuna (BLF) and wahoo (WAH). Other fish species caught with pelagic longline were albacore tuna (ALB), yellowfin tuna (YFT), swordfish (SWO), and a few number of vessels separated the landed white marlin (WHM) from the billfish catch, but that was only during the last quarter of 2013. It became evident from the data recorded from

Juangriego that a seasonality of the species and/or species/groups landed exists. The data showed that during the period of interviews (Jan 2013-Mar 2014), the first quarter of the year was the most productive, and the third was the least productive for all mayor species/groups landed (**Figure 9**), a pattern that is common for this fleet. During the months of low large pelagic catch, Captains tend to fish with bottom longline gear alternating with pelagic logline and hand lines.

Concluding remarks

The information presented contributes with new high resolution data as well as new knowledge on the operations, detailed effort, and species specific catch of probably one of the most important artisanal fleets in the Caribbean Sea and adjacent Atlantic waters that target species under the ICCAT Convention, as it was intended in the objectives of the 3 year JDMIP project. The data presented in this document has been submitted to the ICCAT Secretariat.

Several information segments have been improved with the updated information, among them are: **1**. The spatial distribution of the fishing areas of the VAOS fleet using longline gear; as the spatial data increases it seems clear that the fleet operates in four clearly defined areas, two in the Caribbean Sea and two in the Atlantic side. **2**. The species composition of the reported catch for all observed trips through March 2014, annually as well as seasonally, was an important step to separate the reported landed catch by commercial species groups into species specific catch which enabled scientists to produce annual proportions of species to disaggregate unclassified billfish and shark catch from the VAOS fleet deploying longline gear. **3**. The spatial and temporal distribution of the fishing effort as well as the spatial and temporal distribution of catch rates for each of the most important ICCAT interested species caught by the fleet contributed in the understanding of the fleet interaction with its target species in the area over space and time. **4**. The size structure of the catch of the most relevant species was increased, and offered information on the size groups that are more vulnerable to the fleet's operations. It is likely that the size structure of the captured species may change in time, area, and fleets as it has been observed in the Venezuelan industrial pelagic longline fleet (Arocha & Marcano, 2008; Arocha *et al.*, 2012) as well as in the VAOS fleets, but the available data preclude an in-depth analysis until more data is collected. Nevertheless, these considerations need to be accounted for in future standardization of catch rates from this fishery.

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Table 1. Total number of trips, sets and hooks fished by sampling year, and number of fish by species sampled in observed at-sea sampling activities in the Venezuelan Artisanal Off-Shore (VAOS) fleet from July 2011 through March 2014. Species codes follow those of ICCAT.

Year	# Trips	# Sets	# Hooks	ALB	BET	BLF	BON	BSH	BUM	CCB	DOL	DUS	FAL	KGM	OCS	PLS	SAI	SKJ	SMA	SPF	SPG	SPL	SPM	SPZ	TIG	WAH	WHM	YFT
2011	4	48	34220		10	54		1	2		525	10	2			6	164	1				7		1	1	1	39	28
2012	48	525	395288	27	26	631		9	13	3	10599		283	1	6		3351	1	1	24	27	24	1		1	97	387	25
2013	31	307	243608	2	1	60	33		7	1	6912		18				1472	4		4	10	10			2	51	89	
2014	9	97	74504			20			14		1249		3				662			18		37				8	96	3
TOTAL	92	977	747620	29	37	765	33	10	36	4	19285	10	306	1	6	6	5649	6	1	46	37	78	1	1	4	157	611	56

Table 2. Numbers of fish and proportion (in wt.) of billfish species in the observed catch of the 92 trips of the Venezuelan artisanal off-shore (VAOS) pelagic longline fishery.

	BUM	SAI	WHM	SPF	SPG	Total	BUM wt	SAI wt	WHM wt	SPF wt	SPG wt	Total wt	BUM Prop	SAI prop	WHM prop	SPF prop	SPG prop
2011	2	164	39	-	-	205	147	2768	765	-	-	3680	0.040	0.752	0.208	-	-
2012	13	3351	387	24	27	3802	953	56555	7592	360	459	65919	0.014	0.858	0.115	0.005	0.007
2013	7	1472	89	4	10	1582	513	24843	1746	60	170	27332	0.019	0.909	0.064	0.002	0.006
2014	14	610	95	18	-	737	1027	10295	1864	270	-	13455	0.076	0.765	0.139	0.020	-
									2011-2014 mean proportions in weight				**0.037**	**0.821**	**0.131**	**0.009**	**0.007**

Table 3. Metrics for billfish species caught by the artisanal fishery off '*El Placer de La Guaira*' the billfish hotspot off central Venezuela in 2013.

PlyVrd	**WHM**		**BUM**		**SAI**	
2013	LJFL	DWT	LJFL	DWT	LJFL	DWT
Mean size	156.6	19.6	206.3	73.3	161.6	16.8
Min. size	61	10	50	1	150	10
Max. size	200	45	357	398	220	39
n	609		804		4608	

Table 4. Numbers of fish and proportion (in wt.) of shark species in the observed catch of the 92 trips of the Venezuelan artisanal off-shore (VAOS) pelagic longline fishery.

Year	BSH	CCB	DUS	FAL	OCS	PLS	SMA	SPL	SPM	SPZ	TIG	TOTAL
2011	1		10	2		6		7		1	1	28
2012	9	3		283	6		1	24	1		1	328
2013		1		18				10			2	31
2014				3				37				40
TOTAL	10	4	10	306	6	6	1	78	1	1	4	427
Capt. Estimated wt.	274	55		1352	32		45	813	20		45	2636
Proportion (wt)	**0.104**	**0.021**		**0.513**	**0.012**		**0.017**	**0.308**	**0.008**		**0.017**	

Table 5. Size (cm) of target species in at-sea sampling activities in the observed 92 trips of the Venezuelan Artisanal Off-Shore (VAOS) fleet from July 2011 to March 2013.

		SPECIES	min. Size	mean size	max. size	numbers	Measurement type
TRAGET		DOL	42	93.5	152	1039	FL
	BILLFISH	BUM	123	164.2	291	33	LJFL
		SAI	80	160.1	198	5498	LJFL
		SPF	126	152.1	179	41	LJFL
		SPG	123	140.3	170	35	LJFL
		WHM	106	149.9	223	605	LJFL
SECONDARY TARGET	TUNAS	ALB	79	101.6	110	28	FL
		BET	53	81.7	134	31	FL
		BLF	22	60.4	158	530	FL
		SKJ	57	62.5	68	4	FL
		YFT	78	99.9	131	60	FL
	SHARKS	BSH	160	188.3	220	10	FL
		CCB	102	122.0	130	4	FL
		DUS	10	61.5	94	10	FL
		FAL	25	71.1	190	276	FL
		OCS	60	80.3	118	6	FL
		PLS	51	58.7	68	27	DW
		SMA	183	183.0	183	1	FL
		SPL	20	99.8	175	80	FL
		SPM	128	132.9	150	7	FL
		SPZ	106	106.0	106	1	FL
		TIG	135	141.0	146	3	FL

Table 6. Recorded landed catch (kg) by species in port sampling activities in Morro Pto. Santo (Morro) and Margarita Island (Marg) by the Venezuelan Artisanal Off-Shore (VAOS) during the years of port sampling activities in both sampling locations, and by community (FLEETS).

	Mean No. fishing days/trip	Mean No. sets/trip	Trips sampled	SAI	WHM	BUM	SPF	FAL	SPL	KGM	BLF	DOL	Total
2011	13.8	9.7	32	15521	600	174	38	835	94	11696	2424	39355	55489
2012	11.5	8.2	36	15728	190	1794	152	3218	1710	1306	6318	28948	73679
2013	16.4	11.0	24	8669	22	58	39,5	233	617	0	3568	12298	27775
FLEETS													
Marg	13.5	9.0	35	19951	726	1968	23	3562	547	0	5773	52304	70581
Morro	13.6	9.7	57	19967	86	58	207	724	1874	13002	6537	28297	86362

Table 7. Species metrics (mean length, size range, and number of samples) from port sampling activities in Morro Pto. Santo (MORR) and Margarita Island (MARG) by the Venezuelan Artisanal Off-Shore (VAOS) fleet from July 2011 to March 2014 when operating at least 1 pelagic longline set and/or declaring targeting tuna and tuna-like species. Billfish species length measurements are pectoral-fork length (PFL), estimated LJFL are in parenthesis; tuna species is FL, and SHK species is *TR (dorsal trunk, distance from anterior insertion of first dorsal fin to anterior insertion of second dorsal fin).

Species	Min. (cm)	mean (cm)	Max. (cm)	Numbers
BUM	116 (153.9)	155.4 (203.6)	214 (277.5)	28
SAI	70 (105.2)	123.3 (162.9)	177 (221.1)	1693
WHM	94 (130.3)	117.58 (159.6)	124 (167.5)	36
SPF	52	83.7	122	11
SPG	86	111.8	129	5
BLF	28	57.71	102	347
YFT	36	82.92	110	70
ALB	91	98.96	106	30
SKJ	58	60.0	62	2
FAL*	36	38.3	53	104
SPL*	47	50.62	44	72
BSH*	33	50.33	66	3
CCL*	26	38.0	79	9

Table 8. Effort information obtained from the VAOS fleet fishing with pelagic longline based in Juangriego (Margarita Island) during interviews with Captains and crew after completion of a fishing trip during the period of January 2013 to March 2014.

	min	mean	max
# Sets	2	8.2	14
# hooks/set	500	715.6	800
# hooks/trip	1400	5892.5	11200

Table 9. Total reported landed billfish and shark catch (kg) in 2013 as reported by Captains and crews from the Margarita Island longline artisanal fleet separated into species based on proportions reported in this document (see text).

Billfish	*Catch (kg)*	*Sharks*	*Catch (kg)*
BUM	2156	BSH	946
SAI	103147	CCB	191
WHM	7262	FAL	4665
SPF	227	OCS	109
SPG	681	SMA	155
		SPL	2801
		SPM	73
		TIG	155
Total	**113473**		**9093**

Figure 1. Typical vessel of the VAOS pelagic longline fleet; map showing sampling locations (Morro de Puerto Santo in the mainland, and JuanGriego in Margarita Island), and the location of the Instituto Oceanográfico de Venezuela-Universidad de Oriente (blue star).

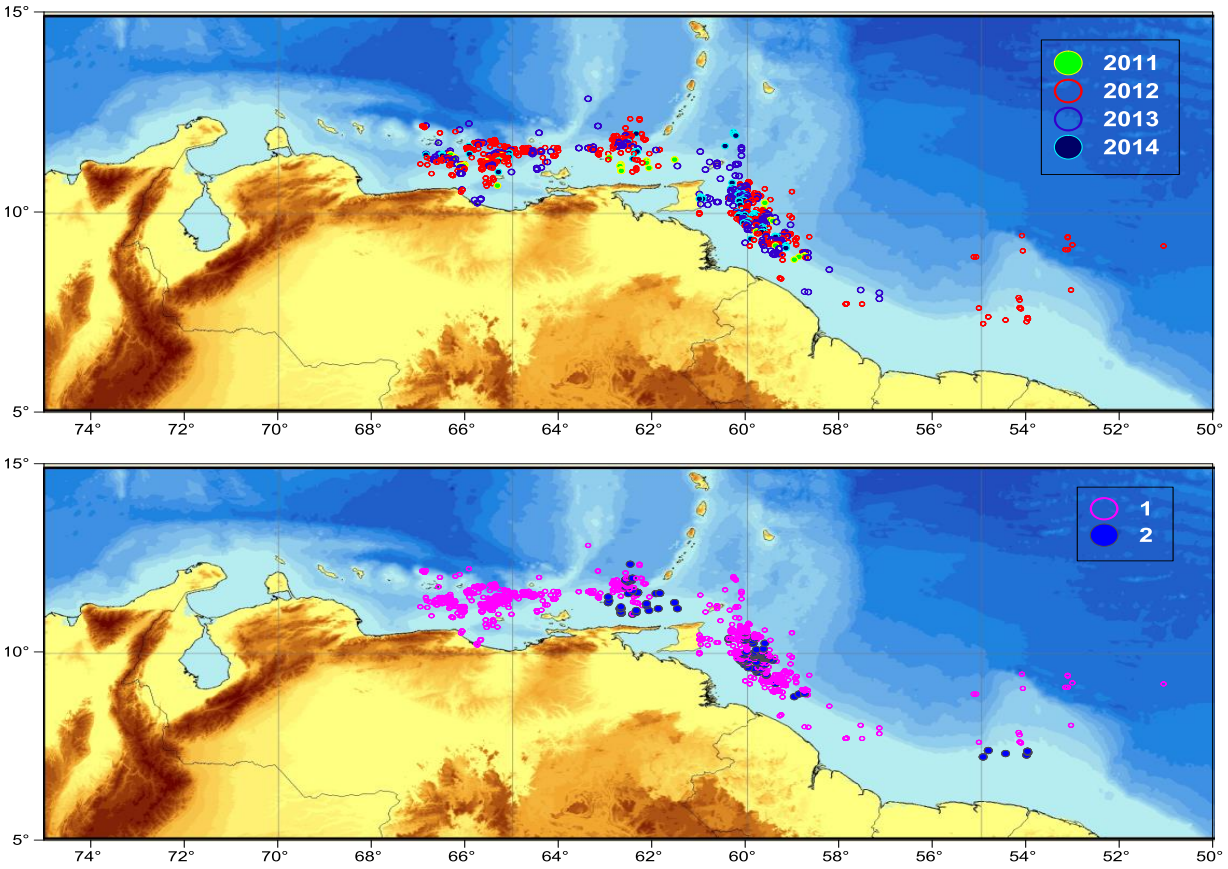


Figure 2. Spatial distribution of longline sets deployed by the 92 observed trips by year of sample (top) and by fleets based at the 2 communities' monitored (bottom). 1=JuanGriego, Margarita Island fleet; 2=Morro Pto. Santo, Sucre fleet.

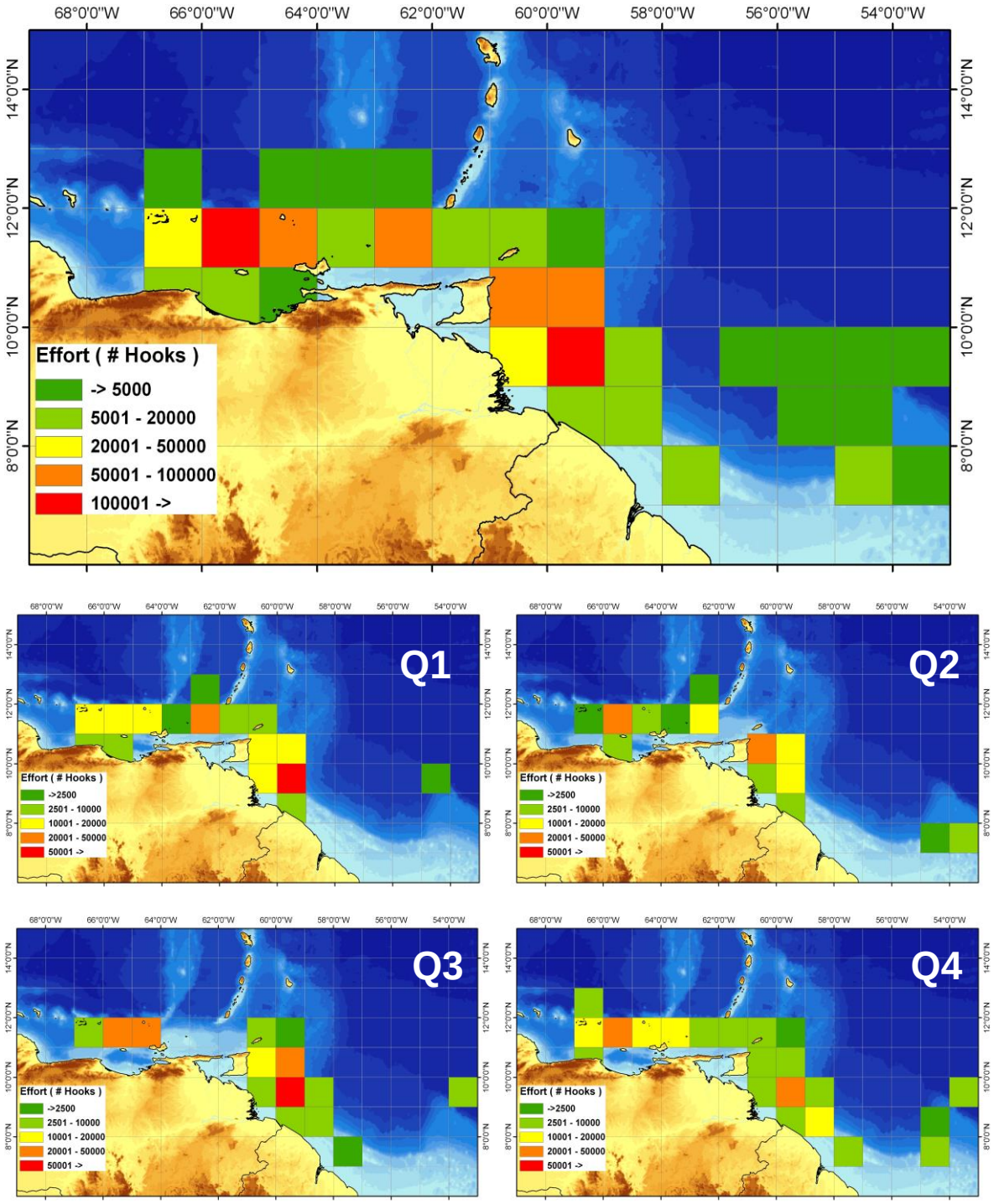


Figure 3. Overall spatial distribution in 1°x1° of the total fishing effort (number of hooks) deployed by the VAOS fleet from July 2011 to March 2014; and seasonal (by quarters) fishing effort spatial distribution (bottom maps).

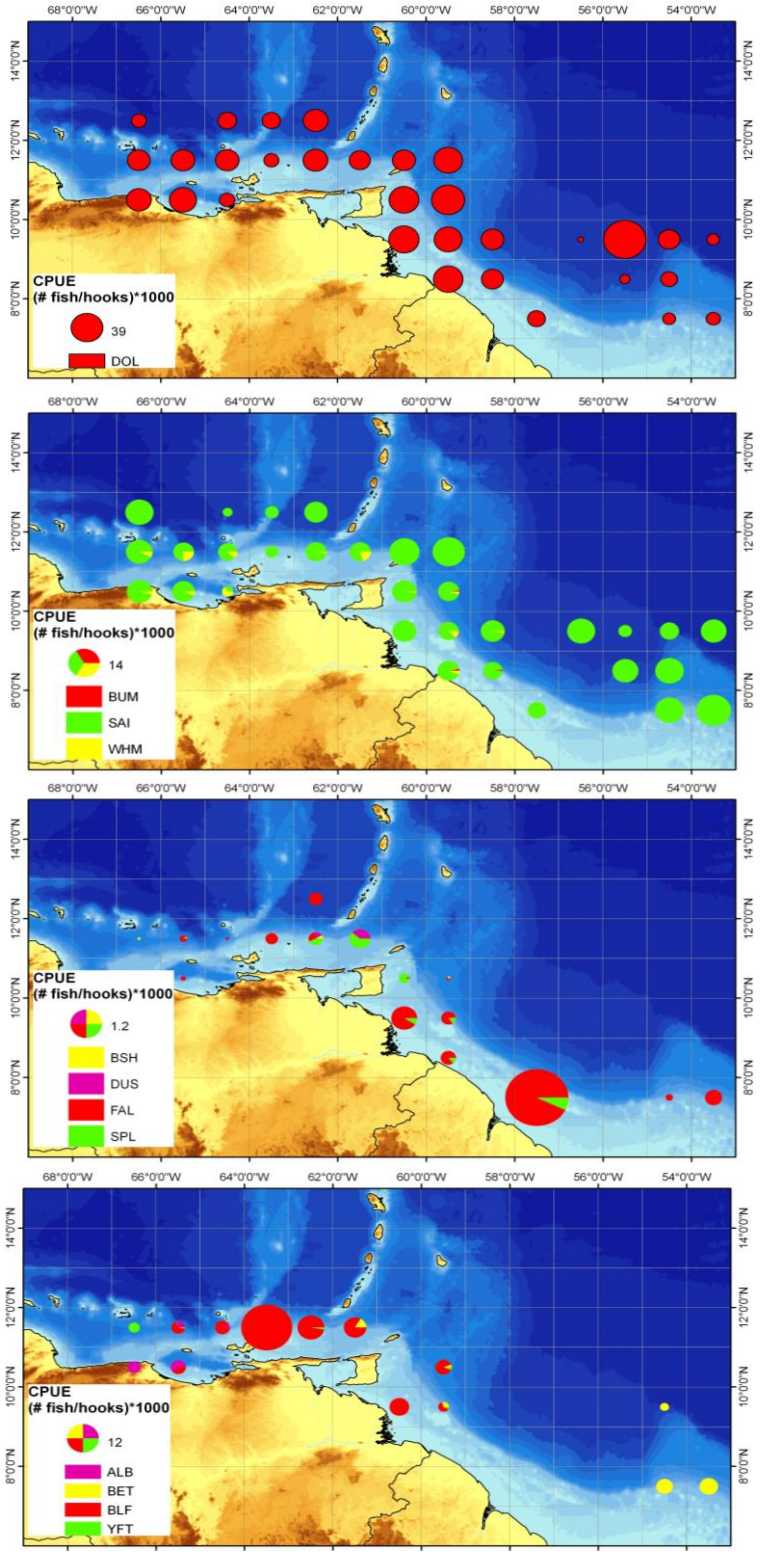


Figure 4. Overall spatial distribution of mean observed catch rates (in numbers of fish/hooks ×1000) of dolphinfish (top), the most common billfish (center-top), sharks (center-bottom), and tunas (bottom) in the at-sea sampling of the catch of the VAOS fleet from July 2011 to March 2014. Size of pies are proportional to the CPUE in 1° square bin.

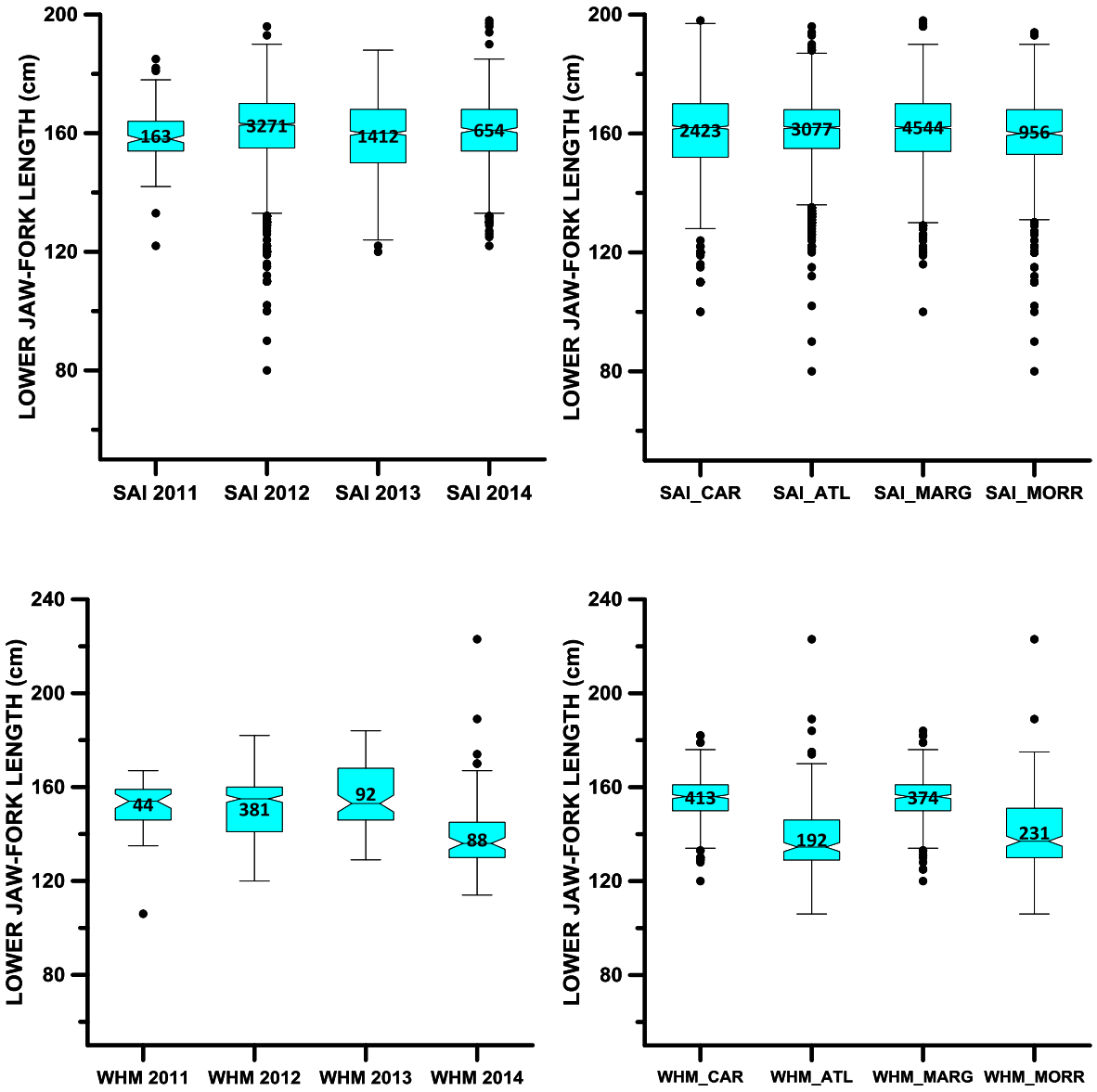


Figure 5. Box-plots of size distributions of the most frequent billfish species (sailfish, SAI; white marlin, WHM) caught by the VAOS fleet from July 2011 to March 2014 (left pannel). Box-plots of size distribution of the same species (right pannel) grouped by area (_CAR=Caribbean; _ATL=Atlantic) and fleets (_MARG=Margarita; _MORR=Morro Pto Santo) for all years combined.

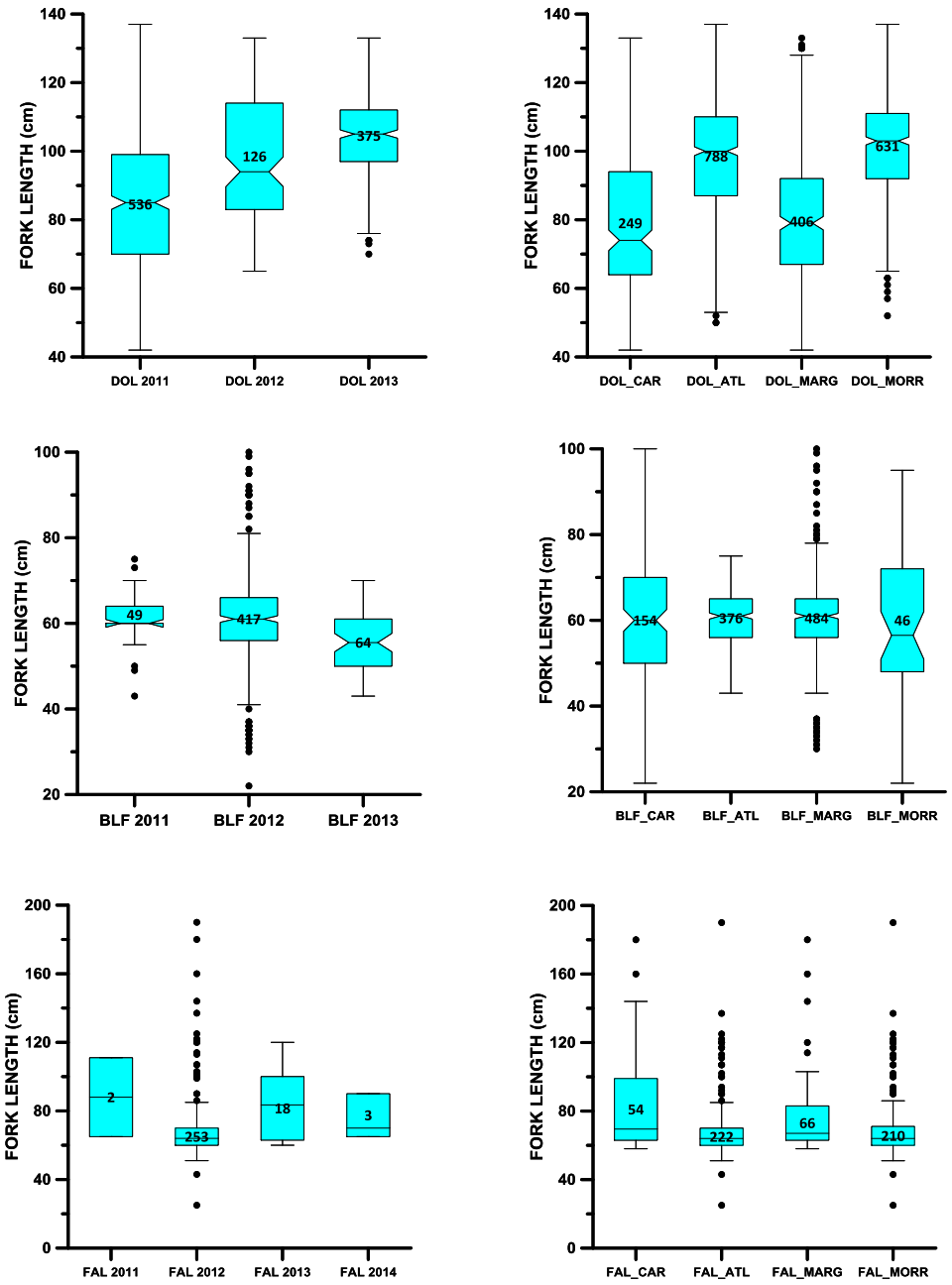


Figure 6. Box-plots of size distributions of one of the main target species (dolphinfish, DOL), the most frequent species of tunas (blackfin tuna, BLF), and sharks (silky shark, FAL) caught by the VAOS fleet from July 2011 to March 2014 (left pannel). Box-plots of size distributions of the same species (right pannel) grouped by area (_CAR=Caribbean; _ATL=Atlantic) and fleets (_MARG=Margarita; _MORR=Morro Pto Santo) for all years combined.

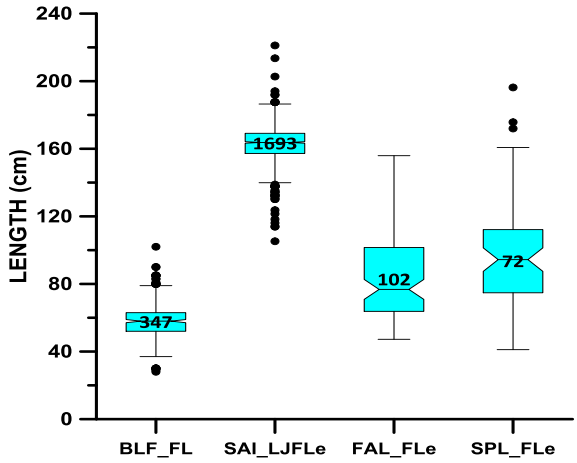
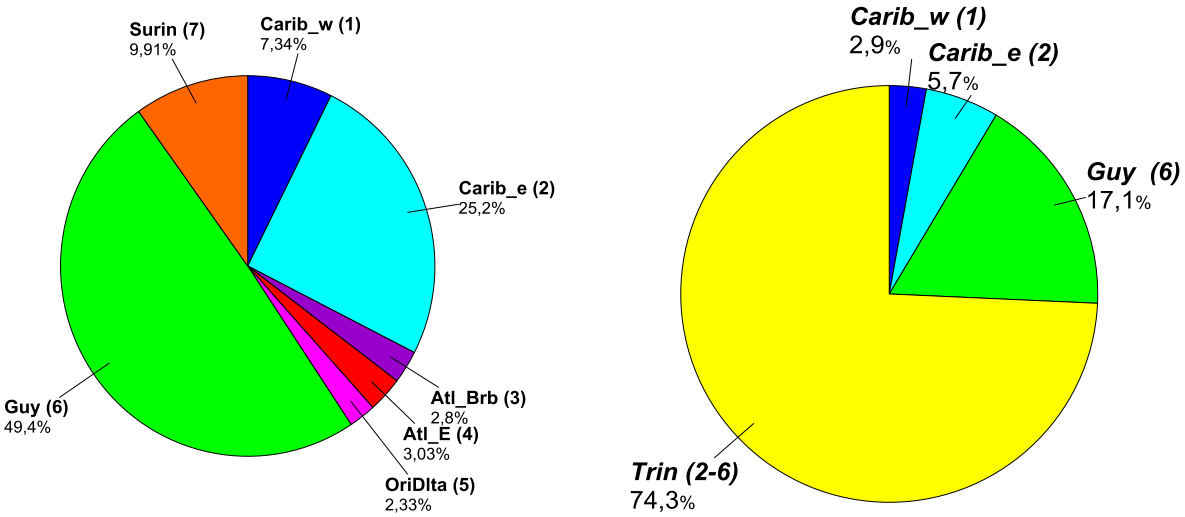


Figure 7**.** Box-plot of size distributions of the most frequent species landed by the VAOS pelagic longline fleet during port sampling in both communities (Morro Pto Santo and Margarita Island) from July 2011 to December 2013. LJFLe measurements from SAI were converted from PFL for sexes combined (see ICCAT Manual), shark FLe measurements were converted from an average Trunk to Fork-length proportion (see text).



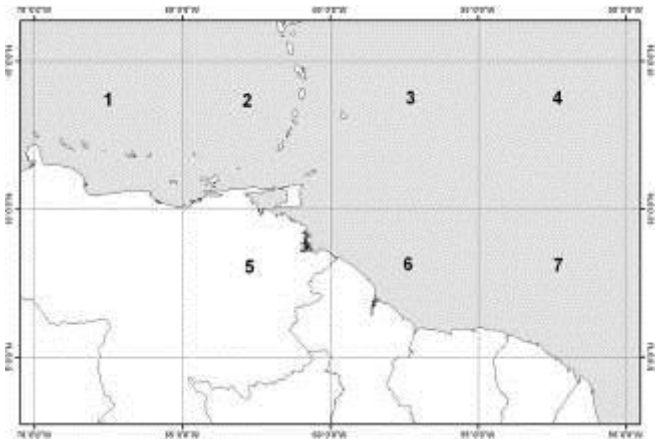


Figure 8. Preferred fishing areas of the VAOS LL fleet during the study period, Jul2011-Mar2014, as reported during port sampling activities (left). Preferred fishing areas reported by interviewed Captains and crews from Juangriego (Margarita I.) during the period of January 2013 to march 2014 (right). Map of fishing areas (bottom) defined for the port sampling activities forms of the VAOS fleet in Morro Pto. Santo and Margarita Island from July 2011 to December 2012.

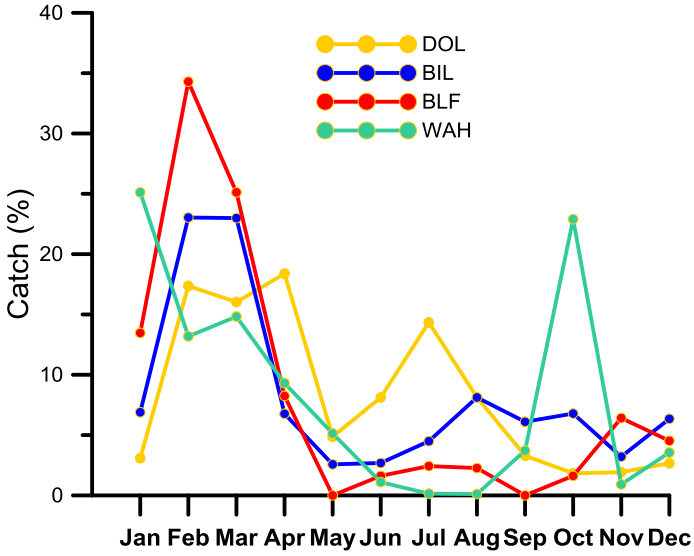


Figure 9. Total catch (kg) by species and species groups of interviewed Captains and crews of vessels based in Juangriego (Margarita Island) during January-May 2013.