BRIEF UPDATE ON SIZE DISTRIBUTION OF BLUE SHARK (*PRIONACE GLAUCA*) IN THE CARIBBEAN SEA AND ADJACENT WATERS OF THE NORTH ATLANTIC OCEAN CAUGHT BY VENEZUELAN FISHERIES

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SUMMARY

In this document, statistical data from past ICCAT sponsored monitoring programs for data improvement in Venezuela and available information from the National Observer Program were used to update specific blue shark information for the period of 2013-2018 caught by the industrial longline fishery and from the artisanal drift-gillnet fishery for the period 2013-2022. Information on size and sex of blue shark from the Venezuelan pelagic longline fishery and catch & effort, and size information from the artisanal drift-gillnet fishery is updated for the period 2013-2018 (LL) and through 2022 (artisanal, GN). The document reviews the size distribution of 622 blue sharks from both fisheries.

RÉSUMÉ

Dans ce document, les données statistiques des programmes de suivi antérieurs parrainés par l'ICCAT pour l'amélioration des données au Venezuela et les informations disponibles du Programme national d'observateurs ont été utilisées pour actualiser l'information spécifique sur le requin peau bleue pour la période 2013-2018, capturé par la pêcherie palangrière industrielle et par la pêcherie artisanale de filets maillants dérivants pour la période 2013-2022. Les informations sur la taille et le sexe du requin peau bleue provenant de la pêcherie palangrière pélagique vénézuélienne et les informations sur la prise, l'effort et la taille provenant de la pêcherie artisanale de filets maillants dérivants sont mises à jour pour la période 2013-2018 (LL) et jusqu'en 2022 compris (artisanale, GN). Le document examine la distribution des tailles de 622 requins peau bleue provenant des deux pêcheries.

RESUMEN

En este documento, se han utilizado los datos estadísticos de anteriores programas de seguimiento patrocinados por ICCAT para la mejora de datos en Venezuela y la información disponible del Programa Nacional de Observadores para actualizar la información específica sobre tiburón azul para el periodo 2013-2018 capturado por la pesquería de palangre industrial y la pesquería artesanal de redes de enmalle a la deriva para el periodo 2013-2022. Se ha actualizado la información sobre talla y sexo del tiburón azul procedente de la pesquería de palangre pelágico de Venezuela y la información sobre captura y esfuerzo, y talla de la pesquería artesanal de redes de enmalle a la deriva para el periodo 2013-2018 (LL) y hasta 2022 (artesanal, GN). En el documento se examina también la distribución por tallas de 622 tiburones azules de ambas pesquerías.

KEYWORDS

Blue shark, artisanal catch,
size distribution, Venezuela, Caribbean Sea, Longline fishing

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Introduction

The present document offers an update since Arocha et al. (2016), on the composition of size and the spatial distribution by sex of blue sharks caught by the Venezuelan large pelagic fisheries. Detailed information on blue shark catch estimates since the initial period when catches of sharks started to be reported and recorded by species was presented in that document (Arocha et al., *op.cit.*). Since then, the sampling abilities available in the past are not present anymore. Therefore, most of the information presented in the current document comes from data recovered recently that had not been previously reported. Nonetheless, blue shark (*Prionace glauca*) continues to be a key component of the shark landings in Venezuela coming from the large pelagic fisheries operating in the Caribbean Sea and adjacent waters of the North Atlantic (Arocha et al., 2002). As documented in the past, in this part of the southwestern North Atlantic, Venezuelan fisheries targeting tropical tunas have had an important retention of sharks in which blue sharks represented about 35% of the shark species caught by the pelagic longline fleet (Tavares and Arocha, 2008). Blue shark continues to be caught and landed by Venezuelan artisanal fisheries targeting billfishes at the Billfish hotspot of *El Placer de La Guaira* (Marcano et al.,2014). Recurring observations made on landing sites for the longline fleet consists of blue shark finned trunks (gutted and beheaded); the fins are removed at port; while the trunk is sold in the local market and the fins are traded in the international market. Similarly, in the artisanal drift-gillnet fishery, the sharks are landed whole, then beheaded, gutted and finned on site.

Material and Methods

Data sources

Presently, the national agency responsible for collecting fishery statistical data in Venezuela is the Instituto Socialista de la Pesca y Acuicultura (INSOPESCA) and manages the National Observer Program (PNOB) for large pelagic fisheries from 2012 through 2018 when it was stopped due to lack of funds and qualified personnel. An additional source is the port sampling at the community of Playa Verde (in central Venezuela) where an artisanal drift-gillnet fishery targeting billfishes operates and has been monitored since 1991 by the former ICCAT's-EPBR in Venezuela. The sponsored program ended in 2014. However, trained personnel continued to record (in paper) catch, effort, size and sex information for all major large pelagic species caught by the fishery. Through a grant obtained from The Billfish Foundation the update of catch and effort information for all billfish species including other major large pelagics (*i.e.*, major sharks and major tunas) from 2014 to 2022 was digitized and made available to the authors.

Collection of size samples by sex

Size data updates of blue shark from the period of 2013 to 2018 came from the Venezuelan National Observer Program (PNOB) and from 2009 to 2014 from the artisanal drift-gillnet fishery. All blue shark specimens captured were sexed and the fork length (FL) and/or total length (TL) were measured to the nearest cm, TL were converted to FL using Kohler et al. (1995) length conversion factors. Considering that all specimens in the present study came from tropical waters of the western North Atlantic, the separation of immature sharks from mature specimens were the median sizes-at-maturity defined according to the ICCAT-Sharks Working Group report (ICCAT, 2014), for male mature sharks: ≥ 197.0 cm FL, and for female mature specimens: ≥ 182.1 cm FL. Recorded specimens that only had dressed weight or dressed size measurements were excluded from the analyses.

Results and Discussion

Blue shark catch estimates

Catch estimates for the pelagic longline fishery are updated in ICCAT Task 1 through 2021; however, 2022 official estimate is of 8.99 t, which will be reported to the ICCAT Secretariat by the statistical correspondent in time.

Catch estimates for the artisanal drift-gillnet fishery were updated from 2014 through 2022 (**Table 1**). The complete catch and effort series from that fishery are presented in **Figure 1**. The blue shark catch is a bycatch product of this fishery which its main target are billfishes followed by major tunas. Catch information from 1991 through 2010 was estimated as indicated in Arocha et al. (2016), thereafter all shark catches were recorded as species specific, including blue shark. The blue shark catch from that fishery varies around 1 and 2 tons, with three periods of high catches being the largest between 2013 and 2017 regardless of the effort variability in those years. In recent years (2020-2022), catches are noticeable low likely due to the drop in effort caused by the COVID pandemic and economical constraints in the fishery (fuel availability).

Size distribution

An additional 622 blue sharks were added to the overall size frequency distribution of blue sharks caught by the Venezuelan large pelagic fisheries sampled; however, a total of 96 samples had to be excluded from the analyses because there is no dress weight (DW) to length conversions available for the fishing area sampled. The remaining 526 blue shark sampled consisted of 334 females and 179 males, the rest (13) did not have sex recorded.

The overall blue shark size distribution (1994-2018) show evidence of bimodal distribution (**Figure 2**), whereas the size distribution from the artisanal drift-gillnet fishery is unimodal, slightly skewed towards large individuals. Mean size of the 526 blue sharks from the current update is 206.2 ± 30.85 cm FL with a size range from 104-440 cm FL (2 specimens of: 400 and 440 cm FL were reported). Mean sizes of blue shark by fleets were the same for both fleet, 206.2 ± cm FL. By sex for both fleets combined were for the 334 females 201.6 ± 25.28 cm FL (104-440 cm FL) and for the 179 males 215.2 ± 34.95 cm FL (104-350 cm FL).

Overall (1994-2022), there is no apparent pattern in the size of blue shark caught by year for either sex; nevertheless, year to year variation is quite clear (**Figure 3**). However, during most of the annual time series the median of female blue shark was above the size-at-maturity, including the recent years (2013-2018), while the median in males remained above their size-at-maturity during the updated period with some periodical variation in earlier time.

Spatial size distribution and sex ratios

The overall spatial distribution of blue shark reported by the national observer program during the updated period (2013-2018) is like the one described by Arocha *et al*. (2016), blue sharks are mostly distributed in the lower Caribbean Sea and offshore of the Guianas-Amazon area southeast of Trinidad in the Atlantic side (**Figure 3**). Due to an unbalanced effort in the observer program, most of the information on spatial distribution was strongly biased towards the Atlantic side of the area of operations of the fleet. The bias is mainly caused by the fleets preference to fish in that area of the Atlantic for tropical tunas (fleet´s main target). There were no significant differences in sex ratios between areas (χ^2 = 2.673, *df*=2, *p*=0.2628); however, the proportion of females was higher in the Caribbean Sea (Area1), the Atlantic side (Area2) and in the Billfish hotspot where the artisanal drift-gillnet fishery operates (Area3) (**Figure 4**).

The most noticeable changes observed in the present document with respect to the earlier study on blue shark in the area (Tavares *et al*., 2012, Arocha *et al*., 2016), are that most females and males are mature throughout the overall area caught by the different fleets in recent years. Recently, the spatial segregation of the sex ratio appeared balanced throughout the area and fleets as well. The overall size-frequency distribution continues to show evidence of a bimodal distribution, although the artisanal showed a unimodal distribution due to the nature of the fishing gear used. It is evident that sampling has been reduced over time due to the mentioned constraints. Nonetheless, the need for continued and enhanced sampling in this area of the North Atlantic stock where limited information exists is warranted.

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Table 1. Venezuelan artisanal drift-gillnet (VEN_art_GN) blue shark (*Proinace glauca*) catch and effort for the updated period of 2014-2022 recorded by trained port sampler at the community of Playa Verde from boats targeting billfishes at the Billfish hotspot of *El Placer de La Guaira*.

Year	*Sets (trips)*	*Boats*	*BSH DW (Kg)*	*Longitude*	*Latitude*	*Fleet*
2014	3746	483	2259	-67,00	10,75	VEN_art_GN
2015	3256	478	1728	-67,00	10,75	VEN_art_GN
2016	3690	492	1943	-67,00	10,75	VEN_art_GN
2017	4635	502	2201	-67,00	10,75	VEN_art_GN
2018	3628	436	961	-67,00	10,75	VEN_art_GN
2019	3174	434	835	-67,00	10,75	VEN_art_GN
2020	1692	353	273	-67,00	10,75	VEN_art_GN
2021	2675	473	0	-67,00	10,75	VEN_art_GN
2022	2688	456	172	-67,00	10,75	VEN_art_GN

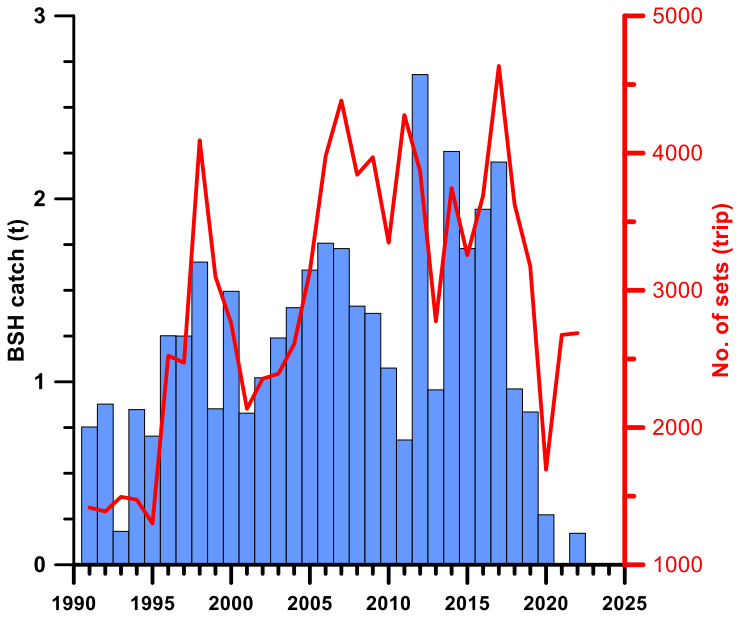

Figure 1. Estimated blue shark (*Prionace glauca*) catch and effort (No. of sets) from the Venezuelan artisanal drift-gillnet fishery operating at the Billfish hotspot of *El Placer de La Guaira.*

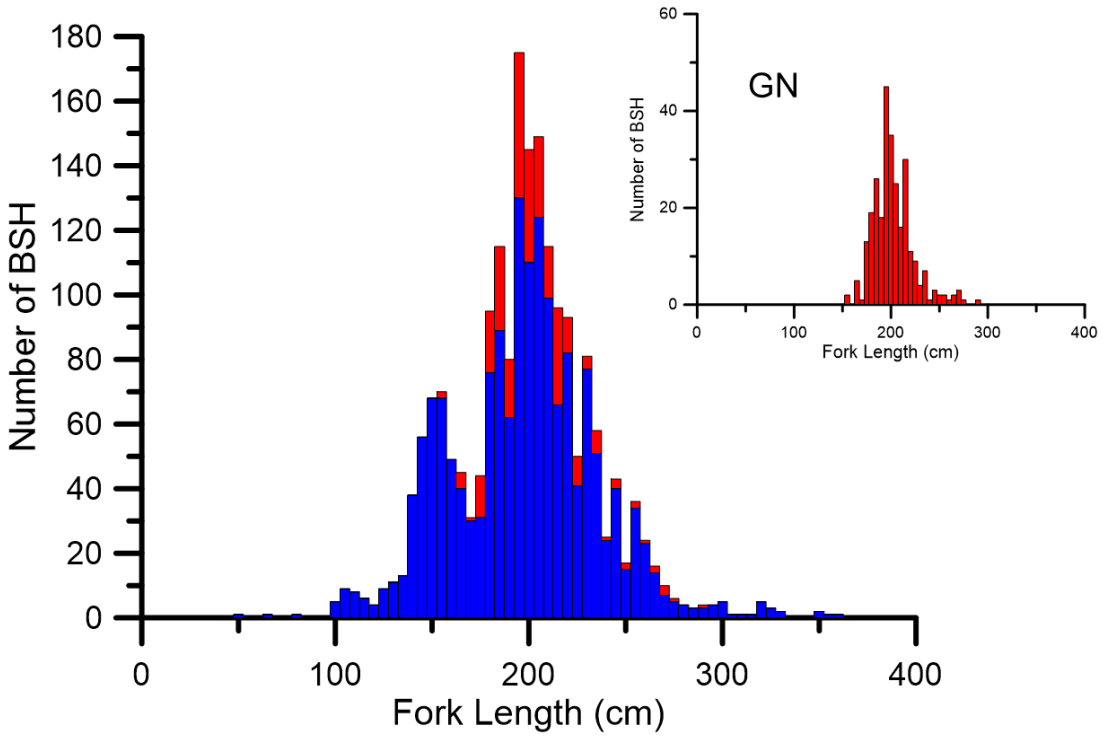

Figure 2. Size frequency distribution of blue shark, *Prionace glauca*, caught by the observed Venezuelan pelagic longline and artisanal drift-gillnet (GN) fisheries in the Caribbean Sea and adjacent North Atlantic waters during 1994-2018 (LL) and 2009-2014 (GN). The inset GN shows the size frequency distribution of blue shark caught by the artisanal drift-gillnet (GN) fishery for the period revised.

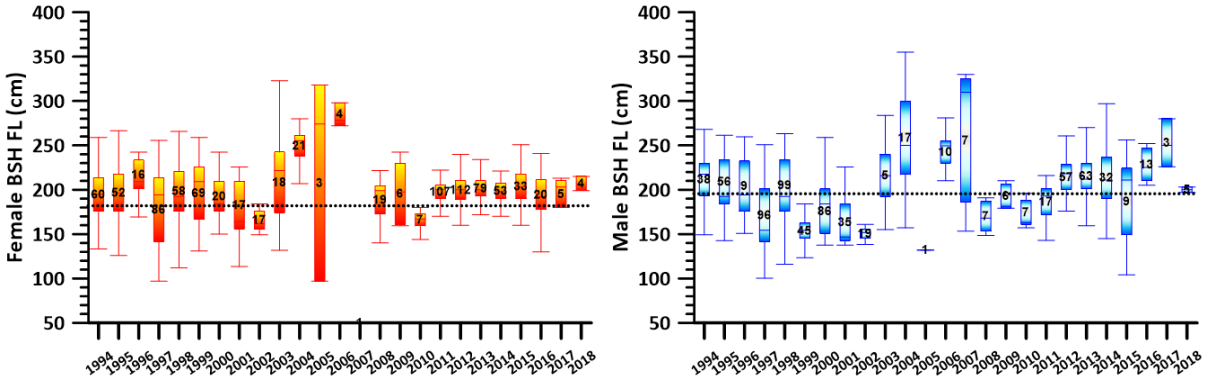

Figure 3. Annual time series for female (left) and male (right) blue shark, *Prionace glauca*, fork length (FL) expressed as a median with the interquartile range (25% qt–75% qt) from individuals caught in 1994-2018 and recorded by the Venezuelan LL observer programs through 2018. The dotted lines separate mature adult stages in males (197.0 cm FL) and in females (182.1 cm FL).

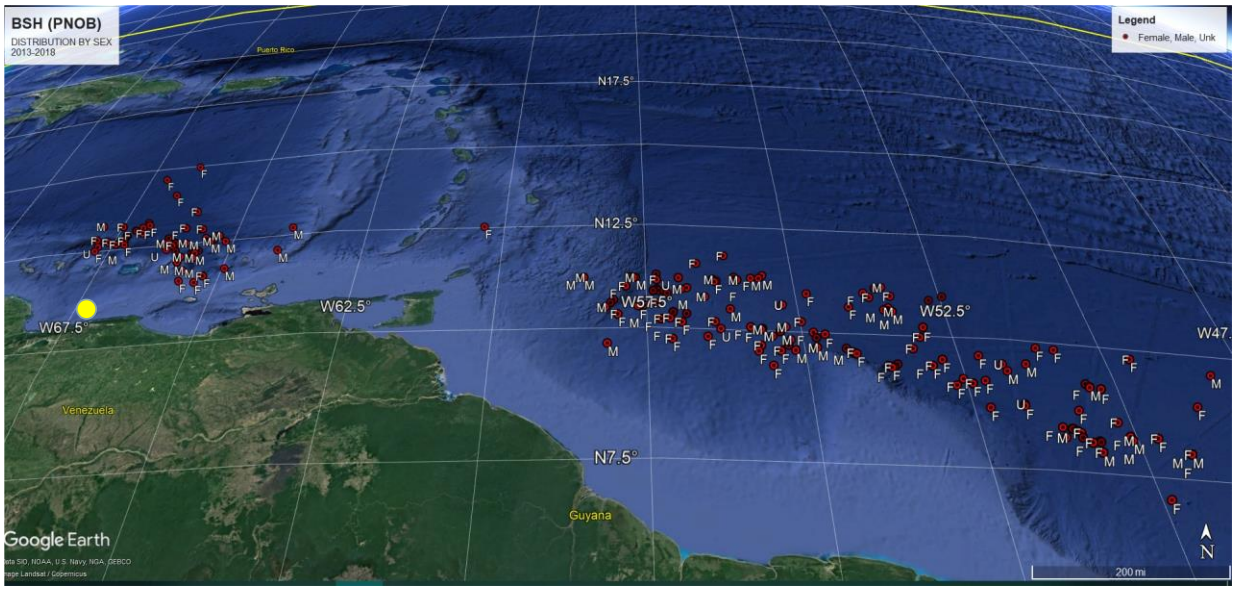

Figure 4. Recent spatial distribution of blue shark (*Prionace glauca*) caught by the Venezuelan pelagic longline fisheries during 2013-2018 from observed sets. The yellow dot indicates the Billfish hotspot *El Placer de La Guaira* where the artisanal drift-gillnet fishery operates.

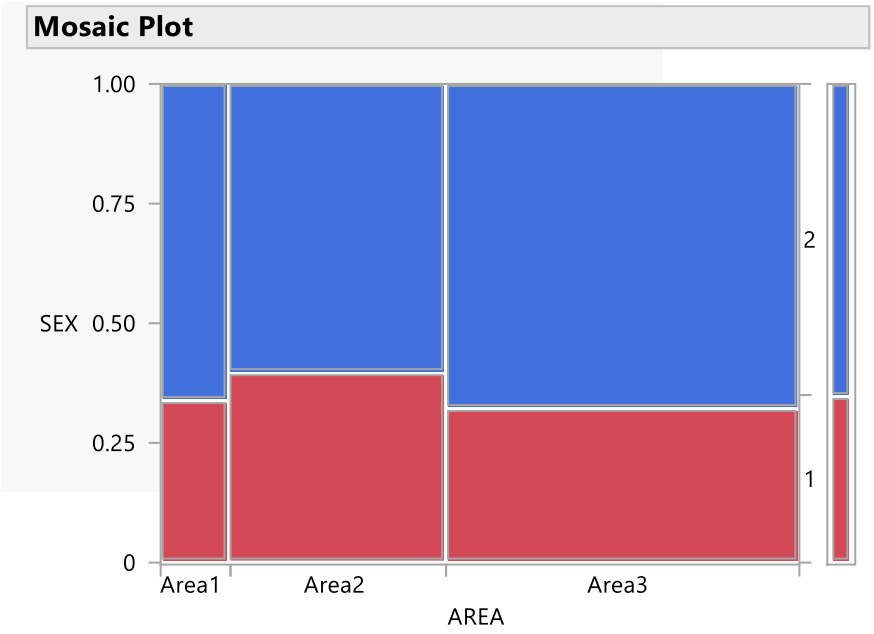

Figure 5. Spatial sex ratio of blue shark (*Prionace glauca*) for the updated period in both fisheries. Male (1:red) and female (2:blue); Caribbean Sea (Area1), Atlantic (Area2), Billfish hotspot (Area 3).