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A PRELIMINARY ASSESSMENT OF THE SPAWNING POTENTIAL RATIO OF FIVE TARGET SPECIES OF THE COASTAL GILLNET FISHERY IN GUYANA AND SURINAME

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ABSTRACT: Data—limited stock assessment methods have the potential to positively impact livelihoods of fishermen around the world by providing management recommendations that aim to optimize sustainable yields from fisheries. Some years ago, a novel length—based (LB) method was developed for the assessment of spawning potential ratio (SPR), a measure of the reproductive capacity of fish stocks. We applied the LB—SPR method to 5 important target species of the coastal gillnet fishery in Guyana and Suriname. *Nebris microps* (Smalleye Croaker; 32% SPR) and *Macrodon ancylodon* (King Weakfish; 34% SPR) had the highest spawning potential, but remained below the 40% target level needed to ensure sustainable exploitation. *Cynoscion acoupa* (Acoupa Weakfish; 13% SPR), *C. virescens* (Green Weakfish; 11% SPR) and *Hexanematichthys proops* (Crucifix Sea Catfish; 14% SPR) had SPR values below the 20% limit reference point, indicating severe and potentially long—term population depletion. There are several sources of potential bias in our SPR estimates, including concerns over the length frequency dataset, potential violation of LB—SPR model assumptions and the poor estimation of certain life—history parameters. Based on our experiences, various recommendations are formulated to be considered in future stock assessment efforts in the region. While our results are preliminary and need careful interpretation, they are in line with anecdotal evidence that the demersal gillnet fishery in Guyana and Suriname is overexploiting the resources it depends upon. We recommend to implement precautionary fisheries management measures that aim to rebuild the stocks and improve their spawning potential.

KEY WORDS: data—limited; length—based assessment; SPR; tropical finfish; central western Atlantic

INTRODUCTION

Fish stock assessment remains an essential tool in marine management, providing policy makers with estimates of optimal exploitation levels to ensure sustainable use of fisheries resources (e.g., Cadrin and Dickey—Collas 2015). The majority of fisheries across the globe, however, are limited in data, capacity and financial resources to estimate stock status, leading to ineffective management (Dowling et al. 2016). This is especially true for developing world countries, where fisheries are often of high socio—economic importance, providing employment, income and protein supply for coastal populations (e.g., Kolding et al. 2014). In tropical latitudes, where fisheries may target dozens of species, stock assessment using traditional data—intensive methods can be a daunting, nearly impossible task (Chrysafi and Kuparinen 2016). Further, implementing management measures that build upon stock assessment outcomes (e.g., effort reduction) while ensuring both environmental and social sustainability can be particularly challenging in the complex socio—ecological context of coastal subsistence fisheries (Batista et al. 2014). Nevertheless, fish stock assessment is a useful tool to provide insight into, and create awareness of, the status of the resources the fishing communities rely upon. Assessment methods that are effective even when data and capacity are limited therefore clearly have the potential to positively impact the livelihoods of millions of people while generating significant conservation benefits (Dowling et al. 2016).

Some years ago, a promising data—limited, length—based (LB) method for the estimation of a fish stock's spawning potential ratio (SPR) was developed (Hordyk et al. 2015a,b, Prince et al. 2015a) and successfully applied to several fisheries (e.g., Prince et al. 2015b, Yonvitner et al. 2021). The SPR is a measure for the reproductive capacity of the fish stock and is the proportion of unfished reproductive potential left at any given level of fishing pressure (Hordyk et al. 2015a). By definition, the SPR equals 100% in an unexploited stock, and zero in a stock with no spawning potential, when all mature fish have been removed, or all female fish have been caught (e.g., Prince et al. 2015a). Put simply, the LB—SPR method estimates the potential of the stock to regenerate itself, so that in order to maintain the stock fish should be allowed to grow and reproduce prior to fisheries exploitation. While most traditional stock assessment methods rely on estimates of life—history parameters of the assessed species, the LB—SPR method makes use of life—history *ratios* (LHRs). While life—history parameters typically vary among species and areas and therefore need to be defined for the stock under assessment, it was found that the ratios between certain life—history parameters, notably the ratio of natural mortality M to the von Bertalanffy growth coefficient *k* and the ratio of the length—at—maturity (L_{50}) to the mean asymptotic length L_{inf}, remain remarkably constant among related taxa and across geographical areas (Hordyk et al. 2014). Consequently, instead of time—consuming and expensive research to define local life—history parameters for each species, LHRs can be established using parameters from the literature on related species or from other countries in the region. These LHRs are then combined with *in—situ* collected length frequency distribution (LFD) data and length—at—maturity parameters L_{50} and L_{95} (the sizes at which 50% and 95% of the population are mature) to estimate the SPR (Hordyk et al. 2015a). An SPR target value of 40% is generally considered precautionary and provides a proxy for maximum sustainable yield (MSY; e.g., Clark 2002, Miethe et al. 2019). A lower SPR value is indicative of a stock in a depleted state. A SPR of 20% is often used as the lower limit reference point which should trigger management action when approached or exceeded (e.g., reduction in fishing effort). Management actions at this level of SPR are necessary to avoid very slowly reversible biological impacts (such as recruitment overfishing), thus protecting against long—term stock depletion (e.g., Caddy and Mahon 1995, FAO 1996, Gabriel and Mace 1999).

Guyana and Suriname are 2 neighboring countries along the north coast of South America where marine fisheries are of major socio—economic importance (Josling et al. 2018, Vandorpe et al. 2020). In the offshore waters, penaeid shrimp, demersal and large pelagic fishes are targeted by trawl and line fisheries, which are mostly export—oriented (GFD 2013, LVV 2021). Both countries also have a significant coastal fishing fleet, which supplies fish for the local market while generating employment and income for coastal communities. The coastal fisheries in Guyana and Suriname are very similar in terms of vessel characteristics, gear types and target species. In estuarine areas, small canoe—type boats catch finfish and shrimp using a variety of gears including fyke—nets, encircling nets, lines, and gillnets. In the coastal waters up to about 20 m depth, larger open wooden boats up to 20 m long are used, equipped with an outboard engine, although some boats are decked and have inboard engines. These vessels mainly use gillnets to target demersal finfish species such as weakfishes (Sciaenidae) and catfishes (Ariidae). The coastal gillnet fishery is the main form of coastal fishing in Suriname and Guyana in terms of catch volume, and is the focus of the current study. The gillnets are set near the bottom and allowed to drift with the tide and current and therefore are also referred to as driftnets. Stretched mesh size in this fishery ranges from 3" to 8" (7.6 to 20.3 cm), depending on the target species (GFD 2013, LVV 2021). Boats deploy up to 4 km of nets and make fishing trips lasting between 3 and 21 days (Maison 2007, Willems 2020). In 2021, 357 coastal gillnet boats were registered in Guyana (D. Husbands, pers. comm., Fisheries Department, Ministry of Agriculture, Georgetown, Guyana) and 443 in Suriname (LVV 2021), although the real number of active vessels is estimated to be considerably higher (WWF Guianas 2018). The coastal gillnet fishery started in Guyana, where it gradually expanded its area of operation along the coast. In the 1970s, the fishery was introduced to Suriname and today it is the main fishery exploiting demersal finfish in the coastal waters of both countries, providing fish for both local and export markets (Bhagwandin 2012).

Information on the status of fish stocks exploited by coastal gillnet fisheries in both Guyana and Suriname is scarce. In 1993, however, it was evaluated that production of several demersal fish species targeted by coastal gillnet fisheries in Suriname was close to or above MSY, and in 1998 declining catch rates indicated that several species were being overfished (Charlier 2000). In Guyana, too, there have been signs of overexploitation: in a poll among 936 fishers done in 1994, 53% of respondents reported that catches were going down (Charles and Shepherd 1997). More recent assessment work confirms the declining trend for several of the most targeted demersal fish species (e.g., CRFM 2007). Today, signs from the field such as declining catch and catch—per—unit—effort suggest that the coastal gillnet fishery of Guyana and Suriname continues to overexploit the resources it relies upon. To compensate for the declining fishing resources, there has been a gradual increase in fishing effort over the last 2 decades, evidenced by longer fishing trips, the introduction of hydraulic winches to retrieve increasingly longer nets, and increasing sizes of the boats (Drugan 2019). While coastal fisherfolk are trying to ensure their livelihoods, without effective management these practices cause further depleting of fish stocks, jeopardizing the future of the coastal fishery.

Besides the notion that certain fish stocks are being overexploited, little recent scientific information is currently available to inform fisheries management about measures that intend to rebuild fish stocks in the region. In this study, we applied LB—SPR models to the coastal gillnet fishery of Guyana and Suriname to provide a preliminary estimate of the overall health and reproductive capacity of 5 main target species in the coastal gillnet fishery: Acoupa Weakfish (*Cynoscion acoupa*), Green Weakfish (*C. virescens*), Smalleye Croaker (*Nebris microps*), King Weakfish (*Macrodon ancylodon*) and Crucifix Sea Catfish (*Hexanematichthys proops*). While these species are to some extent captured by other artisanal and industrial fisheries, they are mainly exploited by the gillnet fishery. In applying the LB—SPR methodology to this fishery, the aim is to generate insight into the stock status of the main target species and provide reference points to guide sustainable fisheries management in Guyana and Suriname.

MATERIALS AND METHODS

Study area

The coastal gillnet fishery operates all along the coasts of Guyana and Suriname, from the coastline up to about 50 km offshore, corresponding to water depths up to 20 m (Figure 1). The coastal waters of both countries are part of the North Brazil Shelf Large Marine Ecosystem (NBS LME), stretching from the Orinoco delta near Trinidad and Tobago in the west down to the Mearim delta near São Luis, Brazil, in the east (Isaac and Ferrari 2017). It is generally assumed that shrimp and groundfish stocks in this LME are to some degree shared among Venezuela, Guyana, Suriname, French Guiana and Brazil (e.g., FAO 2013, Mahon and Fanning 2020). With the majority of coastal fishermen in Suriname being of Guyanese origin, the fishing community is also is well—connected between both countries. It is no secret that coastal fishers do not always respect political borders in the region and fish landed in Guyana might in fact originate from Surinamese territorial waters or vice versa (WWF Guianas 2018). In the current study, it was therefore considered the most precautionary option to consider the Guy-

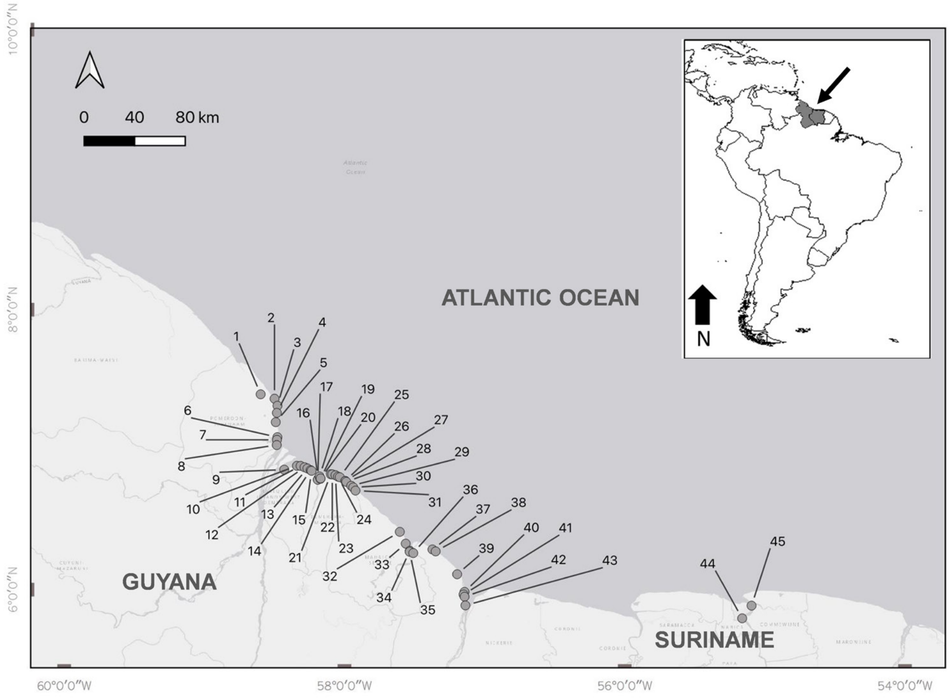

FIGURE 1. *Map of the coastline of Guyana and Suriname with the sites where length—frequency distribution (LFD) data was collected, including 43 sites in Guyana and 2 in Suriname. 1, Charity; 2, Dartmouth; 3, Hampton Court; 4, Anna Regina; 5, Capoey; 6, Adventure; 7, 3 Door Koker; 8, Vilvordeen; 9, Parika; 10, Zeelugt; 11, Zeeburg; 12, Leonora; 13, Hauge; 14, La Jalousie; 15, Windsor Forest; 16, Versailles; 17, Goed Fortuin; 18, Vreed en Hoop; 19, Meadow Bank; 20, Unity Village; 21, Ogle; 22, Better Hope; 23, Pigeon IS—Land; 24, Good Hope; 25, Lusignan; 26, Annadale; 27, Paradise; 28, Enmore; 29, Hope; 30, Bee Hive; 31, Mahaica; 32, Bush Lot; 33, No.7; 34, Rosignol; 35, Blairmont; 36, New Amsterdam; 37, Albion; 38, Port Mourant; 39, No. 43; 40, No. 63; 41, No. 66; 42, No. 67; 43, No. 78; 44, JICA; 45,Nieuw Amerstam.*

ana—Suriname coastal gillnet fishery as a single socio—ecological system, and the data gathered in both countries were combined in a single assessment for each species.

Data collection

The LB—SPR model requires the following inputs for each species: (1) length frequency distribution (LFD) data that adequately describes the size structure of the vulnerable (exploited) portion of the stock; (2) length—at—maturity parameters L_{50} and L_{95}; (3) the mean asymptotic length L_{inf}; (4) the ratio of natural mortality M to the von Bertalanffy growth coefficient *k* and (5) the coefficient of variation on the mean asymptotic length CV L_{inf}. Field data collection was conducted to obtain LFD and length—at—maturity data, while the other input parameters were established through literature review.

The coastal gillnet fishery generally consists of 2 vessel—gear types. Smaller vessels use gillnets with stretched mesh sizes of 3” to 4” (7.6 to 10.2 cm) to target *N. microps* and *M. ancylodon*, while larger vessel use a combination of 5” (12.7 cm) and 7” to 8” (17.8 to 20.3 cm) meshes to catch the larger *C. acoupa*, *C. virescens* and *H. proops.* Data collection included both vessel—gear types, in order to equally sample all 5 species.

Length frequency distributions (LFD)

Length frequency distribution data was collected in both countries. In Suriname, the majority of coastal gillnet fishery catches are landed in or near the capital Paramaribo, where data was collected at 2 major landing sites (Figure 1). Because fishermen using these landing sites fish all along the Suriname coast, sampling these 2 sites was assumed to result in adequate geographical coverage of the LFD data across the Surinamese part of the study area. In Guyana, many smaller fishery landing sites exist along the coast where catches are landed from nearby fishing grounds. The LFD sampling in Guyana was therefore done at 43 different landing sites along the coast (Figure 1). In Suriname, LFD data was collected continuouS—Ly from April 2017 to April 2018 while data gathering in Guyana occurred from April to August in 2017 and from May to August in 2018.

Once a vessel was selected for sampling, LFD data were obtained following a protocol that aimed to avoid length—bias in the samples. Fish might be stored onboard in different sections of the hold according to their size, and landed per size group as the catch is unloaded to the dock. Therefore, length data was collected focusing on one species at a time, making sure to sample the entire catch of one species from a certain boat, before moving on to the next species or boat. Fish total length (TL, cm) was measured using a measuring board. In addition, information on the boat and fishing trip was recorded, including the boat type, gillnet mesh size, days spent at sea and the main fishing area. In Suriname, LFD data was gathered by data collectors of the Fisheries Department (Ministry of Agriculture, Animal Husbandry and Fisheries), while a team from the University of Guyana collected data in Guyana. The data were collected with permission and support of the local fishers at the landing sites, who were informed about the project and cooperated by allowing the data collectors to measure the fish as it was unloaded from the boats.

Length—at—maturity

Length—at—maturity data were collected only in Suriname. Since the coastal waters of Suriname and Guyana are part of the same ecoregion, and length—at—maturity tends to vary little under similar ecological conditions (Pauly 1980), these values were assumed to apply to the entire study area. Data collection was done in an opportunistic manner, collecting information wherever the possibility existed to examine uncleaned fish of the targeted species. Fishes were measured (TL), dissected, sexed and macroscopically scored for maturity (immature, developing, spawning capable, regressing, or regenerating) following Ferreri et al. (2009) and Brown—Peterson et al. (2011). Fish were considered to be mature in all phases except immature and

***TABLE 1.** Overview of the input parameter values used in the LB–SPR assessments for each species, together with the information sources. L_{50} and L_{95} are the sizes (in cm) at which 50% and 95% of the population are mature, L_{inf} is the mean asymptotic total length (in cm), and M/k is the ratio between natural mortality M and the von Bertalanffy growth coefficient k.*

Species	**L_{50}**	**L_{95}**	**Source**	**L_{inf}**	**Source**	**M/k**	**Source**
Cynoscion acoupa	49	59	Levrel 2012	128.9	Espinoza 1972, Montaño 1995	0.74	Prince et al. 2023
Cynoscion virescens	77	83	This study	95.6	Charlier et al. 1999	0.74	Prince et al. 2023
Hexanematichthys proops	67	71	This study	97.8	Froese and Binohlan's (2000) formula	2.26	Azevedo et al. 2010
Macrodon ancylodon	25	31	Ikeda 2003	43.6	Hackett et al. 1997	0.74	Prince et al. 2023
Nebris microps	25	27	Nunes et al. 2020	49.6	Hackett et al. 1999	1.44	Hackett et al. 1999

developing. Most data were collected at fish processing facilities with help from students of the Adek University of Suriname.

Counts of female fish were aggregated per species, size class (1 cm bins) and stage of maturity. The percentage of mature fish was then plotted against size bins and length–at–maturity was estimated as a standard logistic curve of the form:

$$P = A/(1+e^{\wedge}(-b^*(L_t - L_{50})), \qquad \text{Equation 1}$$

where A is the TL at which the curve becomes asymptotic (assumed to be 100% mature for this analysis), *b* is the rate parameter which relates to speed at which change from immature to mature occurs with increasing size, L_t is the length for the proportion mature (P) that is being estimated and L_{50} is the length–at–maturity. Fitting of the logistic curve to the data provided both L_{50} and L_{95}, or the lengths at which 50% and 95% of individuals are mature, respectively. The logistic curves were fitted using the sizeMat package (version 1.1.2) in R (R Core Team 2021). In species where the model poorly fit the available length–at–maturity data (r^2 values <0.2), it was decided not to trust our own estimates and to derive L_{50} and L_{95} from the literature (see Table 1).

Life–history parameters

Other input parameters required to build the LB–SPR model are M/k, L_{inf} and CV L_{inf}. These were obtained from the published literature (Table 1), as Hordyk et al. (2014) found that life–history ratios (LHRs) like M/k and the L_{50}/L_{inf} remain remarkably constant among related taxa and across geographical areas. The L_{inf} was inferred by combining published L_{50}/L_{inf} ratios with L_{50} estimates. Since no information was found on the variation in L_{inf} for any species, a default value of CV L_{inf} = 0.1 was used in all models (e.g., Prince et al. 2015b).

As a general approach, locally collected information was used where possible (all LFD; some L_{50} and L_{95} values), complemented by information sourced from published studies on the same species in the same region (some L_{50} and L_{95} values; most L_{inf} values; some M/k values; Table 1). In one instance (*H. proops*), L_{inf} was calculated based on the maximum observed TL using Froese and Binohlan's (2000) formula. Failing to find estimates at the species level for M/k values for *C. acoupa, C. virescens* and *M. ancylodon*, information provided by a meta–analysis at the family level for Sciaenidae was used (Prince et al. 2023). The M/k value used (0.74) was a mean of 20 published M/k values from 12 species (*Argyrosomus coronus, A. inodrus, A. japonicus, Atractoscion aequidens, Cynoscion guatucupa, C. leiarchus, C. nebulosus, Micropogonias furnieri, M. undulatus, Otolithes ruber, Pogonias cromis,* and *Sciaenops ocellatus*). Table 1 provides an overview of the model input parameters used for each species and where they were sourced.

Model implementation

The LB–SPR model requires as input length composition data of the catch, as well as 5 life–history parameters of the assessed species: L_{50}, L_{95}, L_{inf}, CV L_{inf} and M/k. The model uses maximum likelihood methods to find the values of relative fishing mortality (F/M) and selectivity–at–length (S–L) that minimize the difference between the observed and the expected length composition of the catch, and calculates the resulting SPR (Hordyk et al. 2015a). Model outputs include the spawning potential ratio (SPR), the relative fishing mortality (F/M) (i.e., the ratio between fishing mortality F and natural mortality M) and the lengths at which 50% (S–L_{50}) and 95% (S–L_{95}) of individuals are vulnerable to capture, respectively.

Like any assessment method, the LB–SPR model relies on a number of simplifying assumptions. In particular, the LB–SPR models are equilibrium based, and assume that the length composition data is representative of the exploited population at steady state. Further, the model has shown to be sensitive to inaccurate estimation of the input parameters (Hordyk et al. 2015a). To evaluate potential bias in our SPR estimates due to inaccurate input parameters, 8 sensitivity analyses were carried out for each species, varying the inputs for L_{50} and L_{95}, L_{inf}, M/k and CV L_{inf}. Whenever information on the uncertainty around the original estimates was available, the upper and lower limits of the 95% confidence interval (CI) were used in these sensitivity runs. This was the case for L_{50} and L_{95} when estimated based on own data, and for M/k when estimated from the meta–analysis by Prince et al. (2023). When no CI was available, the input parameters were varied by 15% of their original value (Miethe et al. 2019). In assessing sensitivity to variation in CV L_{inf} (set at 0.1 by default), this parameter was changed to 0.05 and 0.15 in the sensitivity runs. The models were implemented using the LBSPR package (version 0.1.6) in R (R Core Team 2021).

RESULTS

Model inputs

Length frequency distributions (LFD)

A total of 573 fishing trips were sampled to obtain LFD data

TABLE 2. *Overview of collected length frequency distribution (LFD) data for the 5 assessed species from Surinam and Guyana.* Minimum, maximum and mean (± se) total length (TL) are given together with the number of measured fishes (n) per species.

Species			**TL (cm)**			
Scientific name	**Common name**	**Local names**	**Minimum**	**Maximum**	**Mean**	**n**
Cynoscion acoupa	Acoupa Weakfish	grey snapper; bashaw; bang bang	38	126	74.4 ± 15.6	18,957
Cynoscion virescens	Green Weakfish	sea trout; kandra tiki	30	99	72.8 ± 12.1	19,526
Hexanematichthys proops	Crucifix Sea Catfish	cuiras; koepila	37	95	62.5 ± 6.9	8,997
Macrodon ancylodon	King Weakfish	bangamary; dagoetifi	20	44	33.2 ± 5.8	13,956
Nebris microps	Smalleye Croaker	butterfish; botro fisie	18	48	33.2 ± 5.5	11,408

of the catches, totaling 74,949 records of individually measured fish. The most LFD data were available for C. *acoupa* and C. *virescens* and least for H. *proops*. Despite the variations in sample size, the available data for each species was deemed sufficient to provide a representative sample of the length compositions landed by the coastal gillnet fishery (Table 2).

Length–at–maturity

A total of 952 fishes were dissected of which 679 were females, including 51 C. *acoupa*, 94 C. *virescens*, 163 H. *proops*, 239 M. *ancylodon* and 132 N. *microps*. These numbers were on the low end for a robust estimation of length–at–maturity for each species, due to difficulties in obtaining sufficient whole (ungutted) fish for analysis. In particular, sample sizes for C. *acoupa*, M. *ancylodon* and N. *microps* were insufficient, and therefore L_{50} and L_{95} were derived from literature values (Table 1). The available data were used to fit standard logistic curves to estimate L_{50} and L_{95} for C. *virescens* and H. *proops* (Table 1).

Assessment results

Cynoscion acoupa

A total of 18,957 length measurements of C. *acoupa* were obtained (Table 2). Only 51 female specimens could be inspected for maturity, which was insufficient to establish a reliable standard logistic curve ($r^2 < 0.2$). Therefore, the L_{50} (49 cm TL) and L_{95} (59 cm TL) used were from data from French Guiana, and the relative size of maturity L_{50}/L_{inf} was estimated at 0.38 based on data from Venezuela. Using this ratio, and the L_{50} value from the literature, it was calculated that the growth of C. *acoupa* asymptotes at an mean maximum size (L_{inf}) of 128.9 cm TL. Different biological studies were consulted in order to obtain a reliable M/k estimate, but M/k varied rather widely among the different studies; therefore the "general Sciaenidae" M/k of 0.74 was used.

With these input parameters (see Table 1) and the length frequency data (Figure 2A), the LB–SPR assessment model estimated that C. *acoupa* becomes vulnerable to fishing at $S–L_{50}$ = 53 cm TL, around the size that 50% maturity is reached (Table 3, Figure 2B). The species is currently being fished heavily, around 2.7 times (F/M = 2.66) more than the level expected to produce the maximum sustainable yield. Consequently, the population's SPR is just 13% (Table 3). This is below the limit reference point of 20% SPR, indicative of a severely depleted population.

Cynoscion virescens

The assessment of C. *virescens* was based on 19,526 length measurements (Table 2). A standard logistic curve was fitted based on length–at–maturity data for 94 female fishes, estimating L_{50} at 77 cm TL and L_{95} at 83 cm TL. No estimates of L_{50}/L_{inf} were found in the literature, but the L_{inf} value of 95.6 cm

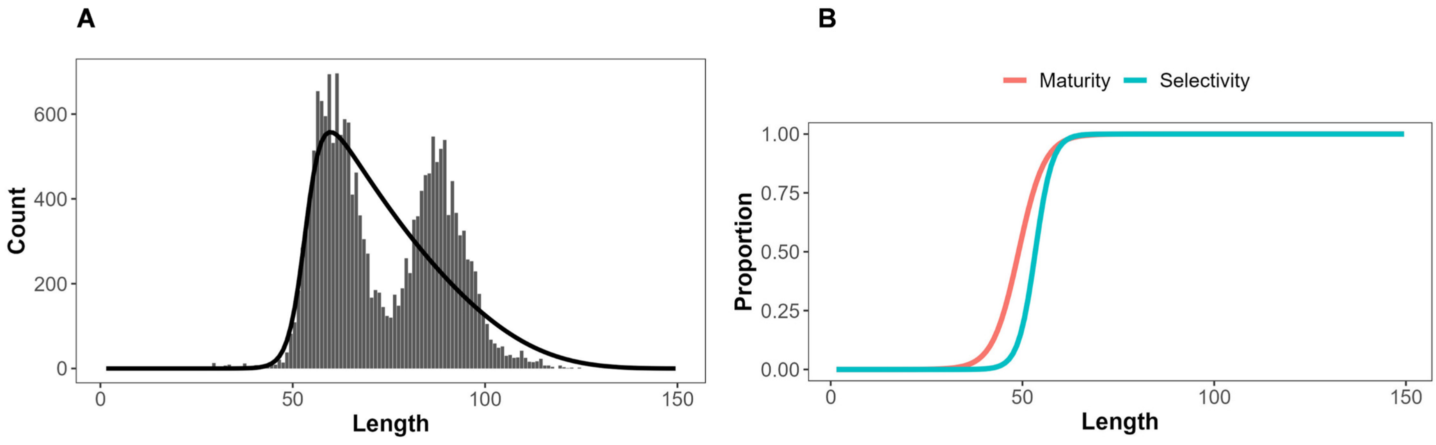

FIGURE 2. Cynoscion acoupa. *A. Observed length composition (in cm TL) of catches (bars) and expected length composition (line) fitted by the LB–SPR model. B. Maturity and selectivity curves. Red line: the proportion of the population mature by length (cm TL). Blue line: the proportion of the population vulnerable to capture by length (cm TL) as estimated by the LB–SPR assessment model (selectivity–at–length [S–L] values).*

TABLE 3. *Overview of the LB–SPR assessment results for each species. SPR–spawning potential ratio; F/M–ratio between fishing mortality F and natural mortality M; S–L_{50} and S–L_{95}–lengths (in cm) at which 50% and 95% of individuals are vulnerable to capture.*

Species	SPR	F/M	S–L_{50}	S–L_{95}
Cynoscion acoupa	0.13	2.66	53	60
Cynoscion virescens	0.11	11.30	89	115
Hexanematichthys proops	0.14	1.57	57	62
Macrodon ancylodon	0.34	1.73	30	40
Nebris microps	0.32	8.51	41	53

TL from Suriname was used for our assessment. We also used the "general Sciaenidae" M/k value of 0.74 in the assessment.

Based on the length frequency data (Figure 3A) and the 4 input parameters discussed above (see Table 1), the LB–SPR assessment model estimated that *C. virescens* becomes vulnerable to fishing at a size (S–L_{50} = 89 cm TL) at which most fish would have reached maturity (L_{95} = 83 cm TL; Table 3, Figure 3B). Nevertheless, the population's SPR was estimated at only 11%, i.e., below the limit reference point of 20% SPR. The relatively low SPR, despite a large S–L_{50}, is probably related to the very high relative fishing mortality (F/M = 11.3) estimated for this species (Table 3).

Hexanematichthys proops

A total of 8,997 individuals of *H. proops* were measured (Table 2). Length–at–maturity information was available for 163 female fishes. Fitting a standard logistic curve to this data, L_{50} was estimated at 67 cm TL and L_{95} at 71 cm TL. No published information on L_{50} and L_{inf} could be found for this species, but L_{inf} was calculated as 97.8 cm TL based on the maximum length (L_{max}) of the measured fishes. The M/k value used (2.26.) was based on the mean of male and female M/k from western Maranhão State, Brazil (Table 1).

Based on these input parameters (see Table 1) and the LFD data (Figure 4A), the LB–SPR assessment model estimated that *H. proops* becomes vulnerable to fishing at a length (S–L_{50}) of 57 cm TL, which is below the size that it matures (L_{50} = 67 cm TL; Table 3, Figure 4B). The species is currently being fished around 1.6 times more (F/M = 1.57) than the level expected to produce maximum sustainable yield. Consequently, the popu-

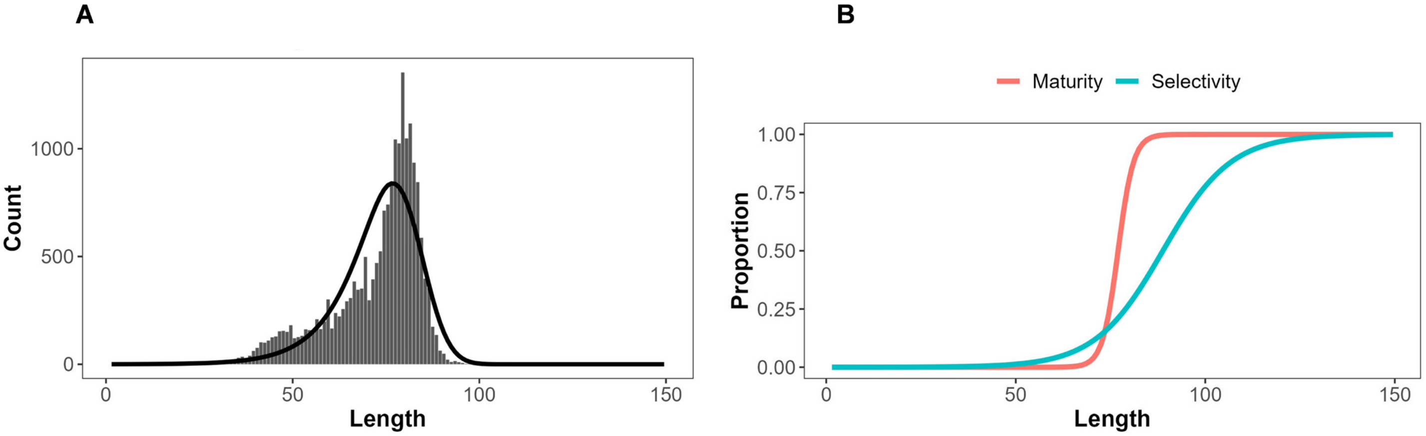

FIGURE 3. Cynoscion virescens. *A. Observed length composition (in cm TL) of catches (bars) and expected length composition (line) fitted by the LB–SPR model. B. Maturity and selectivity curves. Red line: the proportion of the population mature by length (cm TL). Blue line: the proportion of the population vulnerable to capture by length (cm TL) as estimated by the LB–SPR assessment model (selectivity–at–length [S–L] values).*

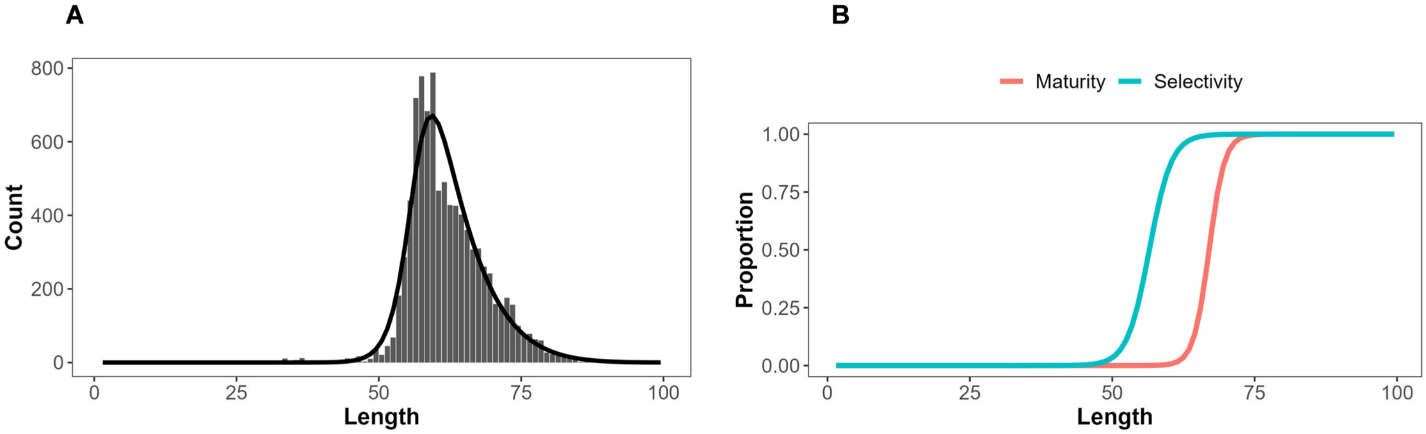

FIGURE 4. Hexanematichthys proops. *A. Observed length composition (in cm TL) of catches (bars) and expected length composition (line) fitted by the LB–SPR model. B. Maturity and selectivity curves for* Hexanematichthys proops. *Red line: the proportion of the population mature by length (cm TL). Blue line: the proportion of the population vulnerable to capture by length (cm TL) as estimated by the LB–SPR assessment model (selectivity–at–length [S–L] values).*

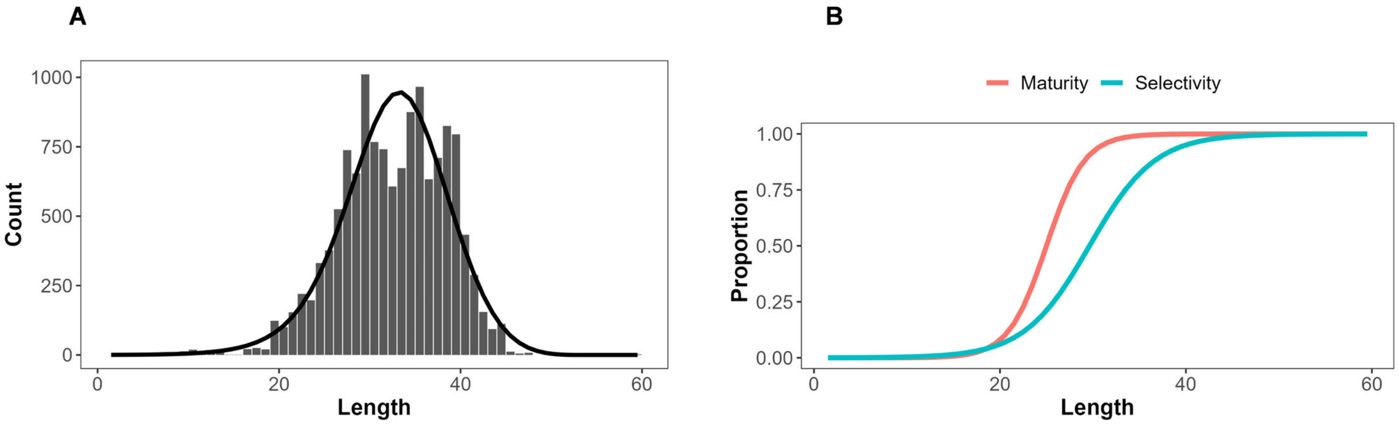

FIGURE 5. Macrodon ancylodon. *A. Observed length composition (in cm TL) of catches (bars) and expected length composition (line) fitted by the LB–SPR model. B. Maturity and selectivaity curves. Red line: the proportion of the population mature by length (cm TL). Blue line: the proportion of the population vulnerable to capture by length (cm TL) as estimated by the LB–SPR assessment model (selectivity–at–length [S–L] values).*

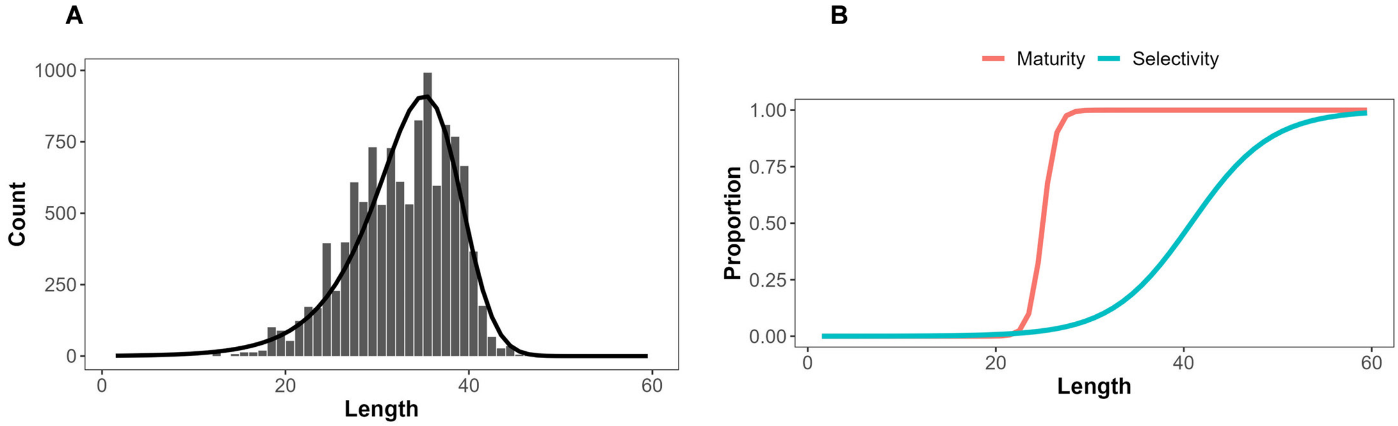

FIGURE 6. Nebris microps. *A. Observed length composition (in cm TL) of catches (bars) and expected length composition (line) fitted by the LB–SPR model. B. Maturity and selectivity curves. Red line: the proportion of the population mature by length (cm TL). Blue line: the proportion of the population vulnerable to capture by length (cm TL) as estimated by the LB–SPR assessment model (selectivity–at–length [S–L] values).*

lation's SPR is just 14% (Table 3), which is below the limit reference point (SPR = 20%).

Macrodon ancylodon

The LFD dataset of *M. ancylodon* contained 13,856 records (Table 2). Although 239 length–at–maturity data points of female fishes were available, it was not possible to establish a proper standard logistic curve ($r^2 < 0.2$), and therefore literature values of L_{50} (25 cm TL) and L_{95} (31 cm TL) from the north coast of Brazil were used (Table 1). Very limited information on L_{50}/L_{inf} ratios was found in the literature and therefore the L_{inf} from Guyana (43.6 cm TL) was used. As with the *Cynoscion* species, the "general Sciaenidae" M/k value of 0.74 was used since reported M/k values varied widely among different studies.

Running the LB–SPR model with these input parameters (see Table 1) and the collected length frequency data (Figure 5A), it was estimated that *M. ancylodon* becomes vulnerable to fishing ($S–L_{50}$) at 30 cm TL, greater than the L_{50} value of 25 cm TL (Table 3, Figure 5B). The species is currently being fished heavily, above the level expected to produce maximum sustainable yield (F/M = 1.73). The population's SPR was estimated at 34% (Table 3). This is above the limit reference point (SPR = 20%), but still below the target value of 40% SPR.

Nebris microps

A total of 11,408 length measurements of *N. microps* were obtained (Table 2). The collected length–at–maturity information from 132 female fishes did not allow fitting a reliable standard logistic curve ($r^2 < 0.2$); thus, literature values of L_{50} (25 cm TL) and L_{95} (27 cm TL) from the Brazilian northeast coast were used. The L_{inf} of 49.6 cm TL was derived from the literature. The species–specific value used for M/k was 1.44 (Table 1) since the M/k ratio estimated at the family level for Sciaenidae (0.74) resulted in unrealistically high values of relative fishing mortality in the model.

Based on the length frequency data (Figure 6A) and the input parameters discussed above (see Table 1), the LB–SPR assessment model estimated that *N. microps* becomes vulnerable

TABLE 4. *Overview of input parameters and model outputs of sensitivity runs of the LB–SPR model for each species. Original values of the input parameters were either varied by ±15% or replaced by the upper and lower limits of the 95% confidence interval. CV L_{inf} is the coefficient of variation on the asymptotic length L_{inf}, L_{50}, L_{95}, S–L_{50} and S–L_{95} are expressed in cm. Numbers in bold differ from the original input and output values.*

		Input parameters					**Model outputs**			
		L_{50}	**L_{95}**	**L_{inf}**	**M/k**	**CV L_{inf}**	**SPR**	**F/M**	**S—L_{50}**	**S—L_{95}**
Cynoscion acoupa										
Original values		49	59	28.9	0.74	0.10	0.13	2.66	53	60
L_{50} & L_{95}	original values +15%	**56**	**68**	128.9	0.74	0.10	**0.12**	2.66	53	60
	original values –15%	**42**	**50**	128.9	0.74	0.10	0.13	2.66	53	60
L_{inf}	original values +15%	49	59	**148.2**	0.74	0.10	**0.08**	**4.00**	**54**	**61**
	original values –15%	49	59	**109.6**	0.74	0.10	**0.30**	**1.25**	53	**59**
M/k	original values +95% CI	49	59	128.9	**1.23**	0.10	**0.27**	**1.22**	53	**60**
	original values –95% CI	49	59	128.9	**0.25**	0.10	**0.03**	**9.74**	53	60
CV L_{inf}	CV L_{inf} = 0.15	49	59	128.9	0.74	**0.15**	0.13	**2.69**	**54**	60
	CV L_{inf} = 0.05	49	59	128.9	0.74	**0.05**	0.13	2.66	53	60
Cynoscion virescens										
Original values		77	83	95.6	0.74	0.10	0.11	11.30	89	115
L_{50} & L_{95}	original values +95% CI	**69**	**75**	95.6	0.74	0.10	**0.18**	11.30	89	115
	original values –95% CI	**87**	**94**	95.6	0.74	0.10	**0.03**	11.30	89	115
L_{inf}	original values +15%	77	83	**109.9**	0.74	0.10	**0.04**	**59.40**	**99**	**126**
	original values –15%	77	83	**81.3**	0.74	0.10	**0.89**	**0.10**	**73**	**102**
M/k	original values +95% CI	77	83	95.6	**1.23**	0.10	**0.19**	**7.08**	89	**113**
	original values –95% CI	77	83	95.6	**0.25**	0.10	**0.03**	**32.14**	**88**	**118**
CV L_{inf}	CV L_{inf} = 0.15	77	83	95.6	0.74	**0.15**	**0.09**	**14.90**	89	**114**
	CV L_{inf} = 0.05	77	83	95.6	0.74	**0.05**	**0.12**	**9.21**	89	**117**
Hexanematichthys proops										
Original values		67	71	97.8	2.26	0.10	0.14	1.57	57	62
L_{50} & L_{95}	original values +95% CI	**65**	**69**	97.8	2.26	0.10	**0.17**	1.57	57	62
	original values –95% CI	**75**	**81**	97.8	2.26	0.10	**0.06**	1.57	57	62
L_{inf}	original values +15%	67	71	**112.5**	2.26	0.10	**0.15**	1.57	57	62
	original values –15%	67	71	**83.1**	2.26	0.10	**0.38**	**0.53**	**56**	62
M/k	original values +15%	67	71	97.8	**2.60**	0.10	**0.18**	**1.25**	57	62
	original values –15%	67	71	97.8	**1.92**	0.10	**0.11**	**2.00**	57	62
CV L_{inf}	CV L_{inf} = 0.15	67	71	97.8	2.26	**0.15**	**0.13**	**1.86**	57	**63**
	CV L_{inf} = 0.05	67	71	97.8	2.26	**0.05**	**0.16**	**1.38**	**56**	62
Macrodon ancylodon										
Original values		25	31	43.6	0.74	0.10	0.34	1.73	30	40
L_{50} & L_{95}	original values +15%	**29**	**36**	43.6	0.74	0.10	**0.30**	1.73	30	40
	original values –15%	**21**	**26**	43.6	0.74	0.10	**0.36**	1.73	30	40
L_{inf}	original values +15%	25	31	**50.1**	0.74	0.10	**0.14**	**6.53**	**34**	**47**
	original values –15%	25	31	**37.1**	0.74	0.10	**1.00**	**0.00**	**29**	40
M/k	original values +95% CI	25	31	43.6	**1.23**	0.10	**0.59**	**0.73**	30	40
	original values –95% CI	25	31	43.6	**0.25**	0.10	**0.09**	**6.69**	**29**	40
CV L_{inf}	CV L_{inf} = 0.15	25	31	43.6	0.74	**0.15**	**0.26**	**4.88**	**36**	**49**
	CV L_{inf} = 0.05	25	31	43.6	0.74	**0.05**	**0.40**	**1.12**	**27**	**36**
Nebris microps										
Original values		25	27	49.6	1.44	0.10	0.32	8.51	41	53
L_{50} & L_{95}	original values +15%	**29**	**31**	49.6	1.44	0.10	**0.26**	8.51	41	53
	original values –15%	**22**	**23**	49.6	1.44	0.10	**0.36**	8.51	41	53
L_{inf}	original values +15%	25	27	**57.0**	1.44	0.10	**0.19**	**18.90**	**43**	**55**
	original values –15%	25	27	**42.2**	1.44	0.10	**0.65**	**1.49**	**37**	**49**
M/k	original values +15%	25	27	49.6	**1.66**	0.10	**0.38**	**7.40**	41	53
	original values –15%	25	27	49.6	**1.22**	0.10	**0.27**	**10.00**	41	**54**
CV L_{inf}	CV L_{inf} = 0.15	25	27	49.6	1.44	**0.15**	**0.29**	**14.04**	**43**	**55**
	CV L_{inf} = 0.05	25	27	49.6	1.44	**0.05**	**0.35**	**4.77**	**38**	**50**

to fishing (S—L_{50} = 41 cm TL) well above the size it matures (L_{50} = 25 cm TL; Table 3, Figure 6B). Still, the species is currently being fished very heavily (F/M = 8.51), much more than the level expected to produce the MSY. This resulted in an SPR of 32%, which is above the limit reference point, but still below the 40% target value.

Sensitivity analyses

Inputs and results of all sensitivity analyses are presented in Table 4. Sensitivity runs for each species using alternative values for L_{50} and L_{95}, L_{inf}, M/k and CV L_{inf} revealed that the estimates of SPR and F/M, and to a lesser extend S—L_{50} and S—L_{95}, were quite sensitive to variation in the input parameters. The estimates of SPR and F/M seemed most susceptible to changes in L_{inf} and M/k, compared to variation in L_{50}, L_{95} and CV L_{inf}. Alternative values of L_{inf} and M/k resulted in SPR values >40% for *C. virescens* (1 run with low L_{inf}), *M. ancylodon* (2 runs with low L_{inf} or high M/k) and *N. microps* (1 run with low L_{inf}). Despite the observed variations, the sensitivity analyses confirmed the low SPR estimates (below the 40% target) for all species in 36 of the 40 sensitivity runs (Table 4).

DISCUSSION

All 5 assessments point out that the studied fish stocks have SPR values lower than 40%, the minimum that is generally considered risk—adverse (Clark 2002). All assessed species are subject to fishing pressures higher than those that would produce MSY. Further, the sensitivity analyses indicate that the SPR for most species is lower than the 20% limit, a minimum SPR intended to protect against long—term stock depletion. The results of our study provide a useful, yet preliminary indication on the health of the assessed fish stocks. Several potential sources of uncertainty exist that might have affected the model outputs. These should be acknowledged and understood, and call for careful interpretation of the results presented in this study.

Sources of uncertainty

Length composition data

The LB—SPR method relies on length composition data that is representative of the portion of the fish stock vulnerable to capture. The gillnet LFD dataset produced in the current study can be considered of high quality and meets critical requirements. While a minimum of 1,000 individuals is recommended (Hordyk 2015a), our study included ~9,000 or more measurements per species. Through data collection in different seasons and landing sites, both spatial and temporal variability was accounted for (Gerritsen and McGrath 2006). Further, the sampling was designed to evenly sample different gillnet mesh sizes and avoid length bias once a catch was being sampled. On the other hand, our samples might not have been fully representative of the vulnerable portion of the population, since the assessed species also occur in the catches of other vessel—gear types. These include estuarine Chinese seine fisheries, coastal pin seine, and hook and line fisheries, as well as trawl fisheries further offshore (e.g., LVV 2021). These fisheries generally have other target species; the ones assessed in this study are considered bycatch, except for *C. virescens* which is actively targeted by the demersal trawl fishery (Meeremans et al. 2017). Further, the relatively small mesh sizes used in Chinese seines, pin seines and shrimp trawls (2" or smaller) result in bycatch of juvenile individuals of the assessed species (e.g., Babb 2008). Gillnets are the main gear type catching the species covered in this study and are mostly selective towards adult individuals. Hordyk et al. (2015a) state that when species are captured by multiple fleets, the LB—SPR model should be applied to data sourced from the fleet that targets the adult portion of the stock. This justifies our study's focus on the coastal gillnet fishery, which is the largest fishery sub—sector in terms of number of vessels and employment in both Guyana and Suriname (GFD 2013, LVV 2021). Nevertheless, future assessments would benefit from including length samples from all vessel—gear types, at least to confirm the arguments discussed above.

Model assumptions

The LB—SPR model assumes that the stock is in equilibrium. The method assesses the current size composition of the stock against the expected size composition if the stock had experienced a constant level of fishing pressure and constant recruitment. The gillnet fishery of Guyana and Suriname operates year—round, and within the study period there have been no reported changes in the fishery or management actions that have affected the fishery (Z. Arjune, pers. comm. Fisheries Directorate, MAAHF, Paramaribo, Suriname). We can therefore assume that fishing pressure has been relatively constant. The second assumption of constant recruitment is unlikely to hold for many fish stocks (Myers 2001) and unfortunately cannot be easily verified in the current study. However, at low levels of recruitment variability and constant fishing pressure, the model estimates SPR with minimal bias (Hordyk et al. 2015a). Four of the species assessed in the current study showed a unimodal length composition which fitted the expected size composition fairly well, which is the result to be expected in equilibrium conditions. In contrast, the bi—modal size composition observed for *C. acoupa* suggests a disparity in year—class strength and thus a non—constant recruitment. The poor fit of the model to the observed size composition is reason for concern (Hordyk et al. 2015a) and the resulting estimates of F/M, selectivity and SPR might be unrealistic for this species.

Another assumption of the LB—SPR model is asymptotic selectivity. While this is typical for trawl fisheries where any fish larger than the codend mesh size are retained by the gear, gillnet fisheries are more size—selective, resulting in a dome—shaped selectivity curve. The Guyana – Suriname gillnet fishery uses a rather large range of mesh sizes from 3" to 8" (7.6 to 20.3 cm). The combined selectivity curve of the different gillnet types in this fishery is likely to result in an asymptotic rather than a dome shaped selectivity pattern, so this assumption is not necessarily violated. Nevertheless, we should consider that the largest individuals of the largest—sized fishes in our assessment (*C. acoupa* and *C. virescens*), are probably not vulnerable to the gillnets. If the largest fish are underrepresented in the length sample, the LB—SPR model will overestimate F/M and underestimate SRP, because the 'missing' (not—retained) large fish are assumed to have already been caught (Hommik et al.

2020). Our estimates of F/M and selectivity–at–length seemed unrealistically high in both *C. virescens* and *N. microps*, which might have been an effect of dome–shaped rather than asymptotic selectivity in these species.

Input parameters

The LB–SPR model relies on accurate estimation of several life–history parameters. Our study attempted to estimate the length–at–maturity parameters L_{50} and L_{95} based on our own observations. While length composition data were collected in both Suriname and Guyana, length–at–maturity information was collected only in Suriname for practical reasons. The nearshore waters of the Guyana and Suriname are similar in ecological properties, generally described as tropical, turbid shelf waters under severe river influence (notably the Amazon River) over muddy seabeds (Artigas et al. 2003). While a species' L_{50} might vary over its geographical range, it is expected to be similar under comparable ecological circumstances (Pauly 1980). This also justifies our use of length–at–maturity information from neighboring countries within the NBS LME (French Guiana and Brazil), when no reliable estimation of L_{50} and L_{95} was possible based on our own data. The sensitivity analyses showed that SPR estimates were quite sensitive to variations in the length–at–maturity parameters. Therefore, more *in–situ* collections of length–at–maturity data to estimate L_{50} and L_{95} locally for all species to inform future stock assessments should be implemented. Collecting length–at–maturity data has proven to be challenging and requires much more effort and training than LFD data collection. Specific approaches and arrangements with fishermen, fish buyers and processors are needed, especially for species that are gutted at sea (e.g., *C. virescens* and *C. acoupa*).

The LB–SPR model requires accurate estimates of M/k, L_{inf} and CV L_{inf}. The age–based population modeling required to estimate these 3 parameters directly from the stock is expensive and time–consuming, limiting this research from being applied to small–scale and developing world fisheries (Hordyk et al. 2015a). It is therefore reasonable to borrow the life–history ratios M/k and L_{50}/L_{inf} (used to infer L_{inf}) from other stocks, since these LHRs have been found to remain remarkably constant among related taxa and across geographical areas (Hordyk et al. 2014), and this was the approach taken in the current study. Nevertheless, establishing reliable estimates of M/k, L_{inf} and CV L_{inf} has proven very challenging, given the paucity of biological studies on the assessed species. For a given species, several studies frequently used the same value for k, cross–referencing to one–another or to Fish Base (Froese and Pauly 2021), while M was often calculated based on Pauly's (1980) formula. This resulted in widely varying M/k ratios (e.g., between 0.5 and 2.3 for *M. ancylodon*), despite the expectation that LHRs should vary little for any given species or closely related species. The M/k was therefore sourced from a meta–analysis performed at family level (Prince et al. 2023) for 3 of the 5 assessed species. While all efforts have been made to get the most reliable values, it is fair to say that M/k, L_{inf} and CV L_{inf} have generally been poorly estimated in our study. It is advised for future stock assessments to reconsider and preferably re–estimate the parameter values used here, rather than re–using them.

Assessment results

Nebris microps (32% SPR) and *M. ancylodon* (34% SPR) had the highest spawning potential of the assessed species, but remained below the 40% target level, which is considered precautionary. *Cynoscion acoupa* (13% SPR), *C. virescens* (11% SPR) and *H. proops* (14% SPR) had much lower values, below the 20% SPR needed to stabilize the populations and avoid long–term or irreversible population depletion (Clark 2002, Gabriel and Mace 1999). Despite the concern over bias in these estimates related to the potential violation of model assumptions and representativeness of our LFD data, the validity of these outputs was to some extend confirmed by sensitivity analyses. In most cases, variation in the model input parameters did not substantially affect the SPR values with respect to the 20% and 40% SPR reference points.

For most of the species, the current study represents the first form of stock assessment in Guyana and Suriname in many years. While Atlantic seabob shrimp *Xiphopenaeus kroyeri* stocks have been recently assessed in both Suriname and Guyana (CRFM 2020), recent assessment work on finfish in the area is very limited. That means that there are no other stock assessments to compare our outputs with. Even indicators like historical trends in catch–per–unit–effort, or total landings at species level are not readily available. Despite the lack of other studies to compare our results with, they seem generally in line with the local perception on the status of the assessed fish stocks.

Cynoscion acoupa and *C. virescens* are the prime targets of the coastal gillnet fleet in both Guyana and Suriname (Willems 2020). They yield the highest price per landed weight of all landed species and support a lucrative trade in swim bladder, making them the most sought–after of all coastal demersal fish species in the region (Chao 2020, Chao et al. 2021). The somewhat lower SPR of *C. virescens* compared to *C. acoupa* might be related to the fact that its mean size at capture (72.8 cm TL) is below the species length–at–maturity (77 cm TL), while *C. acoupa* is generally captured above its L_{50}. Given the high fishing pressure exerted on both species, their low SPR values are not surprising and in line with anecdotical information from the field on declining catches (Z. Arjune, pers. comm. Fisheries Directorate, MAAHF, Paramaribo, Suriname).

Macrodon ancylodon and *N. microps* are 2 medium–sized sciaenids that are mainly targeted with smaller–meshed gillnets (3–4" stretched mesh) operated from smaller vessels (refered to as 'bangamary boats') than those targeting *C. acoupa* and *C. virescens.* Their higher SPR values above 30% might relate to the fact that these species have a lower market value and are hence less targeted than the larger *Cynoscion* species. At least for Suriname, the fleet targeting *M. ancyldon* and *N. microps* is significantly smaller (46 registered vessels in 2022) compared to the fleet targeting *Cynoscion* (392 registered vessels in 2022; M. Wirjodirjo, pers. comm. Fisheries Directorate, MAAHF, Paramaribo, Suriname).

The sea catfish *H. proops* was the only species included in the assessment not belonging to the Sciaenidae. Together with

C. virescens, this is the only species with a mean landed length (62.5 cm TL) below the L_{50} (67 cm TL). This might explain its relatively low SPR, despite not being a highly sought—after species like both *Cynoscion* species. The poorer size selection of *H. proops* could relate to the fact that catfishes are mostly captured by entanglement (Marais 1985), while Sciaenidae are generally gilled in the net.

Conclusions and recommendations

The current study provides an initial estimate of the status of several commercial fish stocks harvested by coastal gillnet fisheries in Guyana and Suriname. We found that all assessed species have a SPR that is too low to ensure MSY from the stocks. Despite the uncertainty surrounding our SPR estimates, our study leads to recommendations for both fisheries management and future stock assessment efforts.

Management advice

The main advice to fisheries managers is to take precautionary action and implement measures that aim to rebuild the stocks and increase their SPR. This should ultimately lead to an increase in both the overall fishery production and the catch—per—unit—effort, improving the income and livelihoods of fishermen. An obvious, yet important management measure is to reduce fishing effort in the gillnet fleet to bring the exploitation rates closer to MSY. This is easier said than done and might have negative short—term socio—economic consequences (Batista 2014). Priority could therefore be given to addressing the fishing effort associated with illegal, unregulated and unreported (IUU) fishing activities, which are commonly occurring in the coastal gillnet fishery. This approach might ensure more buy—in from the fishing communities, as a reduction in IUU fisheries will benefit those fishers who adhere to the rules and regulations (WWF Guianas 2018).

Fisheries management should also consider size—selectivity in the gillnet fishery. At least 2 species (*C. virescens* and *H. proops*) seem to be commonly captured below their length—at—maturity. A study on the optimal gillnet mesh size for the various target species is needed to ensure the gear is selecting only mature fish. For now, the priority should be to monitor and enforce the existing minimum mesh size regulations to make sure these are not violated.

Future assessments

This study is the first attempt in many years at assessing key commercial, yet data—poor fish stocks in Guyana and Suriname. Based on our experiences, some lessons—learned can be shared for consideration in future stock assessment efforts in the region.

First, data collection programs should ensure adequate collection of size—composition samples from all vessel—gear types catching the assessed species, not only from the fishery that is of direct interest. Accurate estimation of M/k, L_{inf} and CV L_{inf} remains challenging. It is advised that future assessments do not re—use the values from this study, but conduct a new literature review and re—estimate the life—history parameters. Meta analyses of LHRs are now being published (e.g., Prince et al. 2023) which may be used if nothing else is available. However, local estimation of life—history parameters should be preferred whenever this is feasible. It is recommended to collect additional length—at—maturity data for local estimation of L_{50} and L_{95}. Further, properly designed LFD data collection programs might allow for length—based estimation of k (e.g., Siegfried and Sansó 2006), which could help in establishing the M/k ratio. Future assessments applying the LB—SPR method to this gillnet fishery should re—consider the potential violation of the assumption on asymptotic selectivity, and potentially apply a modified version of the LB—SPR model that is less sensitive to dome—shaped selectivity curves (Hommik et al. 2020).

Spawning potential ratio is just one indicator of the health of exploited fish stocks. It would be beneficial to verify the outcomes of the current and future stock assessment with other indicators (e.g., trends in catch—per—unit—effort) and data—limited assessment methods (e.g., CMSY; Bouch et al. 2021).

Finally, we should keep in mind that most shrimp and groundfish stocks are most likely shared among countries along the NBS LME. While the current study included both Guyana and Suriname, future stock assessments could benefit from an even wider geographical scope. While this is challenging due to the numerous political and language barriers in the NBS LME, regional initiatives such as the FAO/WECAFC/CFRM/IFREMER working group on shrimp and groundfish of the North Brazil – Guiana Shelf, as well as the CRFM Continental Shelf Fisheries Working Group are trying to overcome these challenges (Mahon and Fanning 2020) and provide a platform for exchange that could lead to more accurate assessments of the important commercial shrimp and groundfish stocks on the North—Brazil shelf.

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