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Shifting baseline syndrome highlighted by anecdotal accounts from snapper (*Ocyurus chrysurus*) fishery

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ABSTRACT

The fishes of the Lutjanidae family are widely distributed throughout the Atlantic, Indian and Pacific Oceans and have relevant commercial importance. Yellowtail snapper (*Ocyurus chrysurus*) is a targeted species in the small-scale fishery of the northeastern coast of Brazil, notably for hand-line fishing. We used the local ecological knowledge (LEK) of three generations of fishers from Ilhéus (southern Bahia State, Brazil) to evaluate the perception of weight, best day of capture and relative abundance of the species. More experienced fishers captured the largest specimens, had larger catches and were more likely to indicate a decrease in species abundance. On the other hand, younger fishers had smaller catches and were more likely to indicate that the species abundance is stable or increasing. The results suggest the occurrence of shifting baseline syndrome among fishers and emphasize the importance of including information from fishers in the construction of management measures. Fishers can play a key role in developing viable proposals that are aimed at the management of fishing of species with spawning aggregation, such as yellowtail snapper.

Keywords: Lutjanidae; Management; Overfishing; Small-Scale Fisheries; Yellowtail Snapper.

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INTRODUCTION

With continuous environmental degradation at the local, regional and global scales, people of different generations have distinct perceptions about environmental conditions; a psychological and sociological phenomenon called shifting baseline syndrome (SBS; Soga and Gaston 2018). Examples come from changes in bird abundance (Papworth et al. 2009), quantity and quality of water (Alessa et al. 2008) and fishery (Sáenz-Arroyo et al. 2005).

In the context of fisheries, since the seminal insight of Pauly (1995), a growing number of studies have investigated the occurrence of SBS among fishers (e.g., Giglio et al. 2015; Ulman and Pauly 2016). SBS refers to the situation where different generations of fishers exhibit discordant perceptions of the state of the resource because each generation has as reference the environmental conditions of the beginning of their life in the fishery, ignoring continuous environmental degradation (Sáenz-Arroyo et al. 2005; Venkatachalam et al. 2010; Ainsworth 2011). In addition to the finding of the occurrence of SBS, these studies can be used as complementation of scientific data (Venkatachalam et al. 2010; Castellanos-Galindo et al. 2011; Sáenz-Arroyo and Revollo-Fernández 2016).

In Brazil, fishery control and statistics have already been carried out by various governmental agencies (e.g., IBGE 1980; IBAMA 2000; MPA 2012). This frequent change in the control of fishery statistics results in discontinuous data or publication of data in different formats, making comparisons difficult over time. This problem with fishery statistics highlights the importance of research carried out in partnership with fishers. Fishers have been an additional source of information in scientific research as they have a broad knowledge of a range of ecological and biological aspects of the resources they exploit (e.g., Coll et al. 2014; Silvano et al. 2006, 2008). Thus, it adds evidence to the growing literature on the importance of fisher's local ecological knowledge (LEK) in understanding trends in species abundance in marine ecosystems (Sáenz-Arroyo and Revollo-Fernández 2016; Thurstan et al. 2016). From the fishers' LEK, it becomes possible to construct and complement several studies on bony (Bender et al. 2013; Zapelini et al. 2017) or cartilaginous fishes (Baum and Myers 2004; Giglio et al. 2015, 2016), in addition to other species of commercial importance (Turvey et al. 2010; Alleway and Connell 2015).

Species of the family Lutjanidae constitute important fishing resources in several reef environments worldwide (Heyman et al. 2005; Sadovy and Domeier 2005; Freitas et al. 2011). These species are found in the Atlantic, Pacific and Indian Oceans in tropical and subtropical regions (Randall 1967). On the Brazilian tropical coast, some of these species have high commercial value and have suffered high fishing pressure, and the yellowtail snapper *Ocyurus chrysurus* (Bloch 1791; Figure 1) is one of the primary components of the catches in the northeast region (Frédou et al. 2009a,b; Freitas et al. 2011; Bender et al. 2013). Some studies point to an unclear situation with regard to SBS in yellowtail snapper fisheries: fishers of different generations indicate some stability in catches of the species, which may be related to their higher relative abundance when compared to other target species, such as groupers (Bender et al. 2013; Zapelini et al. 2019).

In the Ilhéus municipality (state of Bahia, Brazil), yellowtail snapper is one of the main resources of small-scale fisheries (Cetra and Petrere 2014). Therefore, this work has the following objectives: (i) to verify the temporal dynamics of the environmental references of the fishers regarding the best fishing day (greater quantity captured), (ii) the largest individual weight of yellowtail snapper ever caught, and (iii) the catch per unit effort (CPUE), assuming that the weight and quantity of yellowtail snapper reduced over time.

Figure 1 - Yellowtail snapper (Ocyurus chrysurus), one of the most important fishing resources in the region of Ilhéus / Bahia.

MATERIAL AND METHODS

Study area

The study was conducted in the municipality of Ilhéus (Lat: 14° 47' 50", Long: 39° 2' 8"), southern Bahia state (Figure 2). Small-scale fishing is one of the main economic activities in the region (CEPENE 2003; Souza and Petrere Jr. 2008). The fishing fleet uses a coastal strip approximately 175 km long, between Itacaré (in the north) and Canavieiras (in the south). The most common vessels range from 6-9 m and use fishing gear, such as hand lines and shrimp trawls (Barbosa-Filho and Cetra 2007).

Data collection

Fishers were interviewed between February and August 2014 through a semi-structured questionnaire due to the flexibility provided by this format (Young et al. 2017). Daily, the interview site was shuffled between three different fishing landings sites. The interview included general information such as name or surname, age and fishing time in Ilhéus. Later, the issues focused on the target species of the research: weight of the largest yellowtail snapper ever caught (kg), the largest amount caught (kg) and the perception of relative abundance (decreased, stable or increased). Photographs were used to confirm that the interviewee and the researcher were referring to the same species. All interviews were conducted by the same researcher (P.S.S.). Fishers were interviewed individually to avoid the influence of third parties.

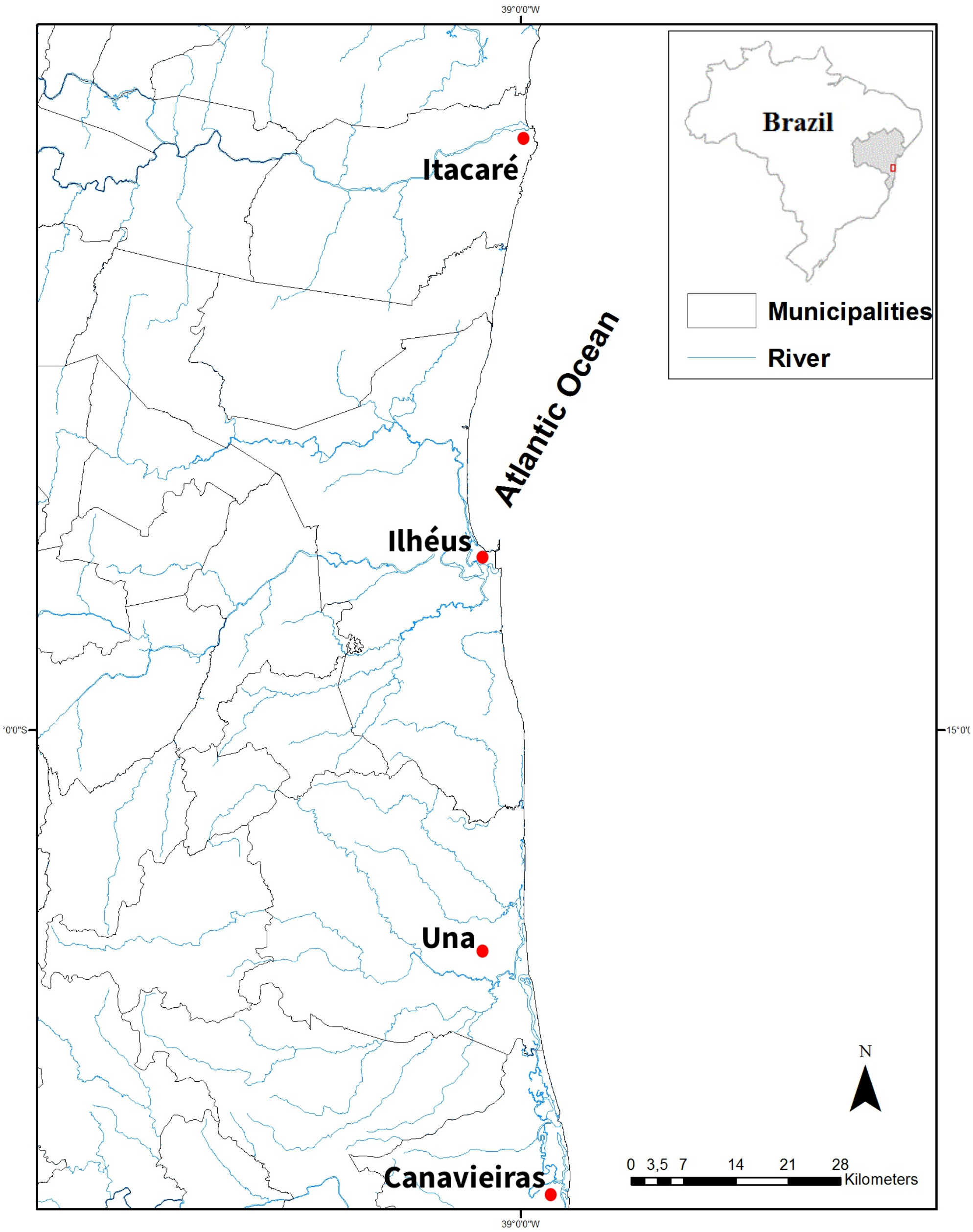

Figure 2. Location of the study area.

Statistical analyses

Fishers were categorized by time of experience: beginners (≤ 15 years of practice); intermediate (16 to 30 years) and experienced (≥ 31 years; Bender et al. 2014). For each fisher, the catch per unit effort (CPUE; kg.fisher-1.day-1) of the best catch day was calculated. Polynomial regression was adjusted to verify the relation of the best catch day (and CPUE) in relation to the decade of the beginning of the fishing career of each fisher. For the analysis of the best catch day (and CPUE), the fishers of the 1940s and 2010s were grouped together with the 1950s and 2000s, respectively. This was done due to the small sample number in these two periods (1940 / 2010).

One-way ANOVA was used to (i) compare the weight of the largest specimen captured as a function of the experience time; (ii) compare the best catch day (and CPUE) according to the respective decades of the beginning of fishing careers. The best capture day values were log-transformed to obtain a normal distribution. Tukey's post hoc test was used to verify differences between groups. Kruskal-Wallis was used in situations with some violation of the parametric assumptions.

The perception of change in relative abundance was verified using an ordinal logistic regression model (OLR) through the 'polr' function (MASS package, Ripley et al. 2014). The function adjusts an OLR model with proportional odds (link function = logistic) for an ordered response variable (perception: decreased, stable, increased). The perception of qualitative abundance was transformed into a quantitative scale with three levels (decreased = -1, stable = 0, increased = 1). We ran the model considering the perception in relation to the experience (in years) of each fisher. The use of the OLR model is appropriate to verify the effect of a predictive variable on all levels of an ordered response variable. It does not assume normality in data distribution and constant variance but requires the premise of parallel lines between all levels of the categorical result (McCullagh 1980; Chen and Hughes 2004).

The premise of parallel lines of the OLR model was verified in SPSS software v.21 (IBM 2012). All other statistical tests were conducted in R (R Core Team 2013) software at a significance level of 5%.

This study was approved by the Committee of Ethics in Research with Human Beings of the Universidade Estadual de Santa Cruz under protocol number 25612313.9.0000.5526.

RESULTS

We interviewed 188 fishers, ranging in age from 22 to 88 years (mean ± sd: 49 ± 12.6) with fishing experience ranging from 4 to 69 years (32.0 ± 13.8). There was a difference between the 'intermediate' and 'experienced' classes of experience in relation to the largest yellowtail snapper ever captured (ANOVA: $F_{2.165} = 5.0$, $p < 0.01$; Figure 3).

There was a difference in the best catch day as a function of the decade (ANOVA: $F_{5.148}$: 12.04, $p < 0.001$; Figure 4A), and we observed a decreasing trend in the best catches (polynomial regression: $r^2 = 0.25$, $p < 0.001$; Figure 4B). There was a difference in CPUE over the decades ($\chi^2 = 22.05$, $p < 0.001$; Figure 4C), and the trend has declined ($r^2 = 0.13$, $p < 0.001$; Figure 4D).

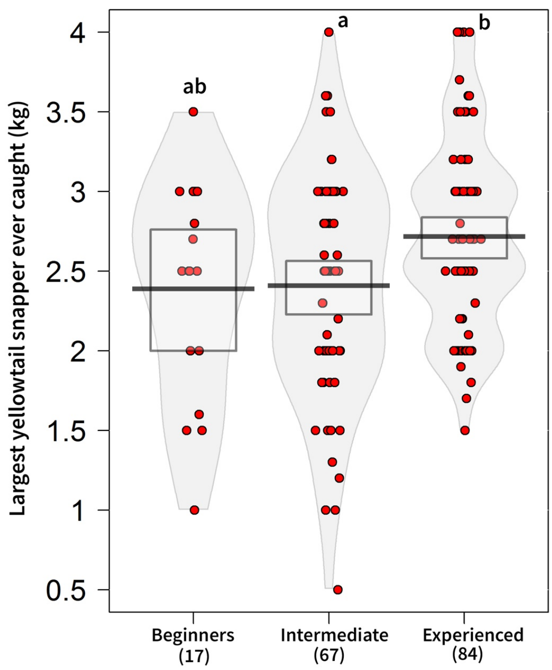

Figure 3. Largest yellowtail snapper caught according to the fishers' experience. Red dots are the raw data, horizontal black line represents the mean, bean is the density and the rectangle is the inference (95% Bayesian range of highest density). Different letters above the plots indicate significant differences (ANOVA, p < 0.01).

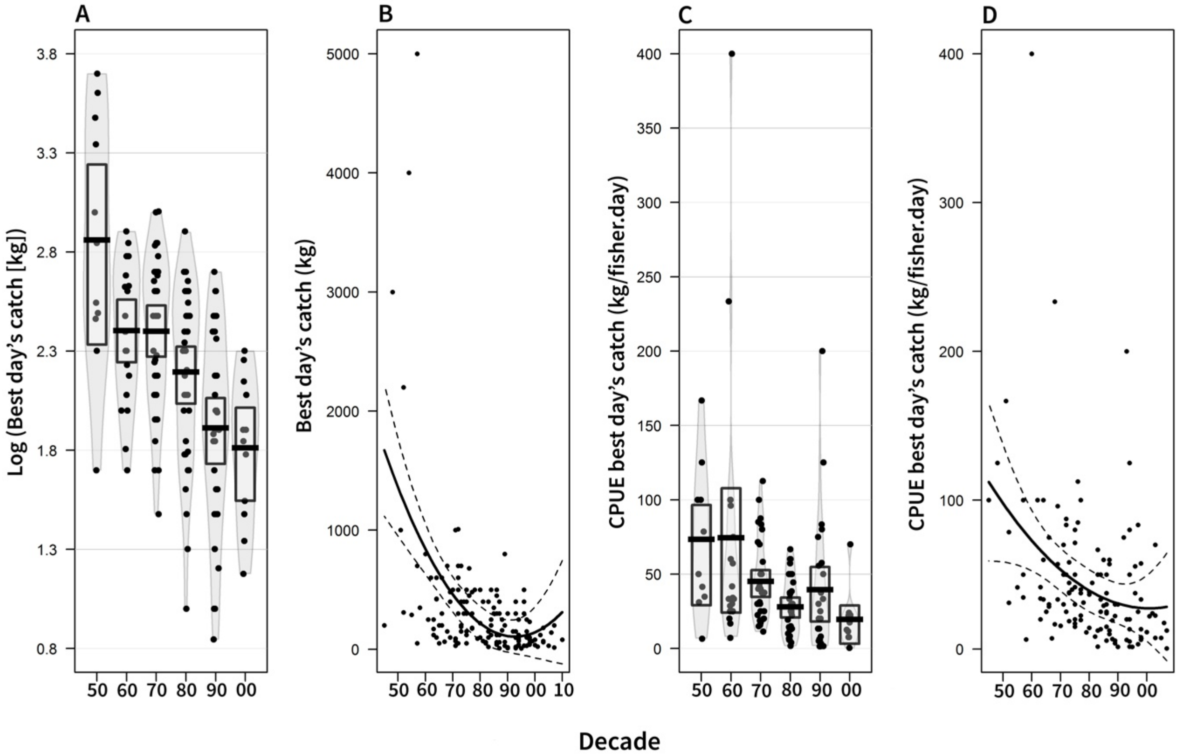

Figure 4. Capture of yellowtail snapper by fishers from Ilhéus: A) Log of the best catch day per decade; B) Relationship of the best catch day over the decades; C) CPUE of the best catch day ($kg.fisher^{-1}.day^{-1}$) per decade; D) CPUE of the best catch day over the decades. In A and C: Points are the raw data, horizontal black line represents the mean, bean is the density and the rectangle is the inference (95% Bayesian range of higher density); in B and D, dashed lines represent the confidence interval (99%).

The OLR result indicates that fishers who started fishing more recently are more likely to indicate that the relative abundance of yellowtail snapper is stable or increasing, whereas more experienced fishers are more likely to indicate that abundance has decreased; that is, we see a shift in perception among generations of fishers (Table 1; Figure 5).

The few historical landing records point to a trend of increasing catches (Figure 6). However, the information is for the regional scale (state of Bahia). Thus, comparisons between scales should be interpreted with caution.

DISCUSSION

Species that have relevant economic importance provide a great opportunity to assess trends of exploitation over decades. Here, we find that different generations of fishers have divergent perceptions regarding yellowtail snapper, and more experienced fishers reported a greater decrease in their abundance, suggesting the occurrence of SBS.

Yellowtail snapper is a species of socioeconomic importance and is the target of fishing along the Brazilian northeastern coast. More experienced fishers were more likely to indicate that species abundance is

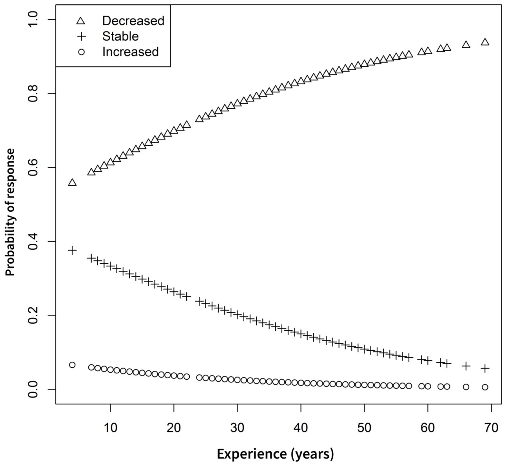

Figure 5. Change in the relative abundance of yellowtail snapper perceived by the fishers of Ilhéus. Triangles indicate the probability of decrease in abundance; crosses indicate the probability of stability; circles indicate the probability of increase. The more experienced the fisher, the more likely it is to indicate that the abundance of the species has decreased.

Table 1. Coefficient indicates the average change perceived with the increase in the fishers' experience time. With the increase of one unit in the fisher's experience, the odds ratio of moving a unit in the perception is multiplied by 0.96. That is, the odds of perceiving change from 'decreased' to 'stable' or 'stable' to 'increased' decreases with fishing experience. *significance ($p < 0.05$).

Model	Coefficient	Standard error	t	Odds Ratio
Perception ~ experience	-0.0381*	0.0141	-2.69	0.9626

decreasing over time. This situation is similar to another study carried out in Porto Seguro, approximately 200 km south of the study area, where more experienced fishers also reported a decrease in the abundance of the species over the last 40 years (Bender et al. 2013). Another study, conducted further south of Ilhéus, found that fishers perceive the abundance of yellowtail snapper as

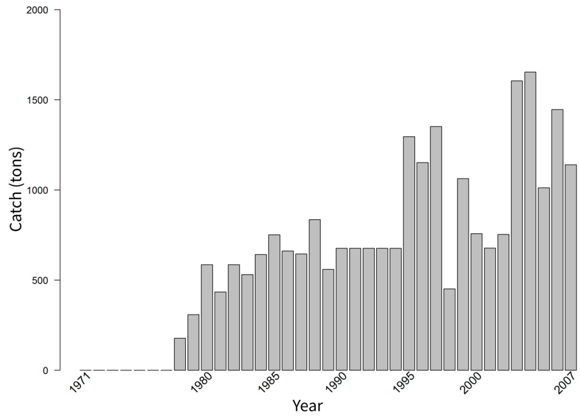

Figure 6. Fishing landings of yellowtail snapper in the state of Bahia between 1971 and 2007.

relatively stable. The authors suggest that the current capture level may not have reached the lowest threshold. In this way, fishers still do not realize the decrease in their abundance (Zapelini et al., 2019). The results complement previous biological studies that indicate over-exploitation of the species in the Brazilian Northeast (Lessa et al. 2004; Klippel et al. 2005; Frédou et al. 2009a,b) and show a tendency of decline in the captured biomass. Although there is no fishing effort data, it is likely that the effort has an increasing tendency, as suggested in other regions of the country (Lima et al. 2016) and in the world (Anticamara et al. 2011). In addition, Nóbrega et al. (2009) noted the decline in abundance in the northeastern region, and the authors suggest that increasing effort directed at the species may be the factor responsible for this.

The increasing fishing effort is compatible with the modernization of fishing techniques. Barbosa Filho (2013) reports that for 30 years, fishers not yet had access to the nylon line. Thus, they used to twist a certain amount of cotton string to make their fishing lines. For the conservation of this line against the action of salt water and also to resist the force that the fish applied, infusions were used with the stem bark of at least three plant ethnospecies found in the mangroves: the “tucum” (*Bactris setosa*), the “red mangrove” (*Rhizophora mangle*) or the “mucuna”. In this way, the current facilities offered by modernization / industrialization enable greater fishing effort and, consequently, a greater impact on fishing stocks.

The decreasing trend in weight and abundance are possible indicators of the occurrence of fishing during critical periods of the species' life cycle. The largest number of landings occur in winter (July to August in the Southern Hemisphere, Costa et al. 2003; Cetra and Petrere 2014), a period that overlaps the peak period of the Gonadosomatic Index (GSI; Freitas et al. 2011). In addition, some intrinsic characteristics of the species, such as the long-life cycle, late sexual development and formation of reproductive aggregations that are predictable in time and space (Sadovy and Domeier 2005; Sadovy de Mitcheson et al. 2012), determine the reduced capacity of population recovery. Although there is still no evidence of fishing directed at reproductive aggregations by Ilhéus vessels, fishers may discover specific aggregation sites and easily contribute to population decline (Claro et al. 2009). Future studies may investigate the seasonal pattern of species capture in addition to evaluating the reproductive cycle. In this way, one can explore the possibility of fishing directed towards aggregations (França and Olavo 2015).

The memory of the more experienced fishers can provide an estimate of the population trend of the species and help reveal the real magnitude of losses caused by overfishing as well as provide us with data on structural and functional changes in marine ecosystems caused by exploitation. Although there is still some mistrust regarding the use of LEK among regulatory resource management agencies (Moller et al. 2004; Butler et al. 2012), there is increasing evidence that fishers can provide accurate information (Sáenz-Arroyo and Revollo-Fernández 2016) and should be included in the process of constructing management measures (Hind 2015).

Studies show that perceptual construction can be influenced by nostalgia, that is, the longing for things, persons, or situations that are not present (Merchant and Ford 2008). Personal nostalgia is a search for an idealized past. The person who experiences this kind of nostalgia remembers things and events in a more positive way than he really was. Although general consensus links nostalgia to older people, this is not necessarily true. Some studies show that nostalgia is not purely a function of age. Nostalgia increases and decreases in different age groups, depending on the experiences and demands imposed by life. For example, Batcho (1995) found that young university students were more nostalgic than the elderly, in certain subjects. Thus, we have no evidence to indicate that nostalgia may be a bias in the results.

Our results add further evidence to those already reported by previous studies on the need to implement management measures directed at yellowtail snapper (Ferreira et al. 2004; Klippel et al. 2005; Begossi et al. 2011). Unfortunately, since Normative Instruction Nº 5/2004, the species has not yet received due attention, remaining outside the most recent fishing management measures established in the country, such as those for southern red snapper (*Lutjanus purpureus*), which has a recovery plan (Brasil 2018). However, any management measure should be constructed in a participatory manner, together with the fishers, to complement and add different knowledge (academic / scientific and empirical / practical) to minimize possible conflicts and lack of respect for decisions (Lopes et al. 2013).

CONCLUSIONS

Our study suggests the occurrence of SBS among different generations of fishers from Ilhéus, where more experienced fishers reported larger total catches and weighter specimens. From the management point of view, we suggest the construction of a partnership between managers, academics and the fishing community with the purpose of investigating possible reproductive aggregation sites of species. In addition, we emphasize the need to re-establish systematic species-level fishery monitoring programmes at the local, regional and national scales. The chronic lack of information causes damage not only to the population of the species but also to the fishing community that depends on the resource for its survival.

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REFERENCES

Ainsworth CH (2011) **Quantifying Species Abundance Trends in the Northern Gulf of California using Local Ecological Knowledge.** Marine and Coastal Fisheries 3(1):190-218.

Alessa L, Kliskey A, Lammers R, Arp C, White D, Hinzma L, Busey R (2008) **The Arctic Water Resource Vulnerability Index: an integrated assessment tool for community resilience and vulnerability with respect to freshwater.** Environmental Management 42: 523.

Alleway HK, Connell SD (2015) **Loss of an ecological baseline through the eradication of oyster reefs from coastal ecosystems and human memory.** Conservation Biology 29(3): 795-804.

Anticamara JA, Watson R, Gelchu A, Pauly D (2011) **Global fishing effort (1950–2010): Trends, gaps, and implications.** Fisheries Research 107:131–36.

Barbosa-Filho MLV (2013) **A Pesca de Cações (Chondrichthyes: Elasmobranchii) Pelos Pescadores do Sul da Bahia, Brasil: Uma Abordagem Etnoictiológica.** MSc dissertation. Universidade Estadual de Santa Cruz, Ilhéus, Bahia, Brasil 220p.

Barbosa-Filho MLV, Cetra M (2007) **Dinâmica da frota pesqueira sediada na cidade de Ilhéus, estado da Bahia.** Boletim Técnico-Científico do CEPENE 15(2):99-105.

Batcho KI (1995) **Nostalgia a psychological perspective.** Perceptual and Motor Skills 80: 141–143.

Baum JK, Myers RA (2004) **Shifting baselines and the decline of pelagic sharks in the Gulf of Mexico.** Ecology Letters 7:135–145.

Begossi A, Salivonchyk SV, Araujo LG, Andreoli TB, Clauzet M, Martinelli CM, Ferreira AGL, Oliveira LEC, Silvano RAM (2011) **Ethnobiology of snappers (Lutjanidae): target species and suggestions for management.** Journal of Ethnobiology and Ethnomedicine 7:11. http://www.ethnobiomed.com/content/7/1/11

Bender MG, Floeter SR, Hanazaki N (2013) **Do traditional fishers recognise reef fish species declines? Shifting environmental baselines in Eastern Brazil.** Fisheries Management and Ecology 20:58–67.

Bender MG, Machado GR, Silva PJA, Floeter SR, Monteiro-Netto C, Luiz OJ, Ferreira CEL (2014) **Local Ecological Knowledge and Scientific Data Reveal Overexploitation by Multigear Artisanal Fisheries in the Southwestern Atlantic.** PLoS One 9: e110332.

Brasil (2018) **Portaria Interministerial Nº 42, de 27 de julho de 2018. Define regras para o uso sustentável e a recuperação dos estoques da espécie *Lutjanus purpureus* (pargo).** Diário Oficial da União, Seção 1, Nº 145, p 5-6.

Butler JRA, Tawake A, Skewes T, Tawake L, McGrath V (2012) **Integrating traditional ecological knowledge and fisheries management in the Torres Strait, Australia: the catalytic role of turtles and dugong as cultural keystone species.** Ecology and Society 17(4):34. http://dx.doi.org/10.5751/ES-05165-170434

Castellanos-Galindo GA, Cantera JR, Espinosa S, Mejía-Ladino LM (2011) **Use of local ecological knowledge, scientist's observations and grey literature to assess marine species at risk in a tropical eastern Pacific estuary.** Aquatic Conservation: Marine and Freshwater Ecosystems 21:37–48.

CEPENE - Centro de Pesquisa e Gestão de Recursos Pesqueiros do Litoral Nordeste (2003) Boletim Estatístico da Pesca Marítima e Estuarina do Nordeste do Brasil. Tamandaré;18 p.

Cetra M, Petrere M (2014) **Seasonal and annual cycles in marine small-scale fisheries (Ilhéus – Brazil).** Fisheries Management and Ecology 21:244–249.

Chen C-K, Hughes Jr. J (2004) **Using Ordinal Regression Model to Analyze Student Satisfaction Questionnaires.** IR Applications 1:1-13.

Claro R, Sadovy de Mitcheson Y, Lindeman KC, García-Cagide AR (2009) **Historical analysis of Cuban commercial fishing effort and the effects of management interventions on important reef fishes from 1960–2005.** Fisheries Research 99:7–16.

Coll M, Carreras M, Ciércoles C, Cornax M-J, Gorelli G, Morote E, Sáez R (2014) **Assessing Fishing and Marine Biodiversity Changes Using Fishers' Perceptions: The Spanish Mediterranean and Gulf of Cadiz Case Study.** PLoS ONE 9(1): e85670. doi:10.1371/journal.pone.0085670.

Costa PAS, Braga AC, Rocha LOF (2003) **Reef fisheries in Porto Seguro, eastern Brazilian coast.** Fisheries Research 60:577–83.

Ferreira BP, Rezende SM, Teixeira SF, Frédou T, Diedhiou M (2004) ***Lutjanus chrysurus.*** In: Lessa RP, Nóbrega MF, Bezerra-Júnior JL, editores. Dinâmica de populações e avaliação de estoques dos recursos pesqueiros da Região Nordeste. Programa de Avaliação do Potencial Sustentável de Recursos Vivos na Zona Econômica Exclusiva (REVIZEE), Subcomitê Regional Nordeste (Score-NE). Relatório Síntese. Recife. Vol. 2, pp. 88-97.

França AR, Olavo G (2015) **Indirect signals of spawning aggregations of three commercial reef fish species on the continental shelf of Bahia, east coast of Brazil.** Brazilian Journal of Oceanography 63:289–302.

Frédou T, Ferreira BP, Letourneur Y (2009a) **Assessing the stocks of the primary snappers caught in Northeastern Brazilian reef systems. 1: Traditional modelling approaches.** Fisheries Research 99:90–96.

Frédou T, Ferreira BP, Letourneur Y (2009b) **Assessing the stocks of the primary snappers caught in Northeastern Brazilian Reef Systems. 2-A multi-fleet age-structured approach.** Fisheries Research 99:97–105.

Freitas MO, Moura RL, Francini-Filho RB, Minte-Vera CV (2011) **Spawning patterns of commercially important reef fish (Lutjanidae and Serranidae) in the tropical western South Atlantic.** Scientia Marina 75(1):135-146.

Giglio VJ, Luiz OJ, Gerhardinger LC (2015) **Depletion of marine megafauna and shifting baselines among artisanal fishers in eastern Brazil.** Animal Conservation 18(4):348-358.

Giglio VJ, Luiz OJ, Reis MS, Gerhardinger LC (2016) **Memories of sawfish fisheries in a southwestern Atlantic estuary.** SPC Traditional Marine Resource Management and Knowledge Information Bulletin 36:28-32.

Heyman WD, Kjerfve B, Graham RT, Rhodes KL, Garbutt L (2005) **Spawning aggregations of *Lutjanus cyanopterus* (Cuvier) on the Belize Barrier Reef over a 6 years period.** Journal of Fish Biology 67:83-101.

Hind EJ (2015) **A review of the present, and future of fishers' knowledge research: a challenge to established fisheries science.** ICES Journal of Marine Science 72:341–358.

IBAMA - Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (2000) **Estatística de Pesca 1999 - Brasil: Grandes Regiões e Unidades da Federação.** Tamandaré, pp. 121.

IBM Corp. (2012) **IBM SPSS Statistics for Windows**, Version 21.0. Armonk, NY: IBM Corp.

IBGE - Instituto Brasileiro de Geografia e Estatística (1980) **Anuário Estatístico de Brasil**, pp. 840.

Klippel S, Olavo G, Costa PAS, Martins AS, Peres MB (2005) **Avaliação dos estoques de lutjanídeos da costa Central do Brasil: Análise de coortes e modelo preditivo de Thompson e Bell para comprimentos.** In: Costa PAS, Martins AS, Olavo G, editores. Pesca e potenciais de exploração de recursos vivos na região central da Zona Econômica Exclusiva brasileira. Série Livros 13, Museu Nacional, Rio de Janeiro, pp. 246.

Lessa RP, Nóbrega MF, Bezerra Jr. JL (2004) **Dinâmica de Populações e Avaliação de Estoques dos Recursos Pesqueiros da Região Nordeste.** Programa REVIZEE, SCORE-NE, Vol. II, Recife, pp. 246.

Lima EG, Begossi A, Hallwass G, Silvano RAM (2016) **Fishers' knowledge indicates short-term temporal changes in the amount and composition of catches in the southwestern Atlantic.** Marine Policy 71:111–20.

Lopes PFM, Rosa EM, Salyvonchyk S, Nora V, Begossi A (2013) **Suggestions for fixing top-down coastal fisheries management through participatory approaches.** Marine Policy 40:100–110.

Merchant A, Ford J (2008) **Nostalgia and giving to charity: a conceptual framework for discussion and research.** International Journal of Nonprofit and Voluntary Sector Marketing 13:13–30.

McCullagh P (1980) **Regression Models for Ordinal Data.** Journal of the Royal Statistical Society: Series B 42(2):109-142.

Moller H, Berkes F, Lyver PO, Kislalioglu M (2004) **Combining science and traditional ecological knowledge: monitoring populations for co-management.** Ecology and Society 9(3):2. [online] URL: http://www.ecologyandsociety. org/vol9/iss3/art2

MPA - Ministério da Pesca e Aquicultura (2012) **Boletim Estatístico da Pesca e Aquicultura - Brasil 2010,** pp.129.

Nóbrega MF, Kinas PG, Ferrandis E, Lessa RP (2009) **Distribuição espacial e temporal da guaiúba *Ocyurus chrysurus* (Bloch, 1791) (Teleostei, Lutjanidae) capturada pela frota pesqueira artesanal na região nordeste do Brasil.** Pan-American Journal of Aquatic Sciences 4(1):17-34.

Pauly D (1995) **Anecdotes and the shifting baseline syndrome of fisheries.** Trends in Ecology & Evolution 10(10):430.

Papworth SK, Rist J, Coad L, and Milner-Gulland EJ (2009) **Evidence for shifting baseline syndrome in conservation.** Conservation Letters 2: 93–100.

R Core Team (2013) **R: A language and environment for statistical computing.** R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

Randall JE (1967) **Food Habits of Reef Fishes of the West Indies.** Institute of Marine Sciences, University of Miami, pp. 183.

Ripley B, Venables B, Bates DM, Hornik K, Gebhardt A, Firth D (2014) **Support Functions and Datasets for Venables and Ripley's MASS.**

Sadovy Y, Domeier M (2005) **Are aggregation-fisheries sustainable? Reef fish fisheries as a case study.** Coral Reefs 24:254–262.

Sadovy de Mitcheson Y, Craig MT, Bertoncini AA, Carpenter KE, Cheung WWL, Choat JH, Cornish AS, Fennessy ST, Ferreira BP, Heemstra PC, Liu M, Myers RF, Pollard DA, Rhodes KL, Rocha LA, Russell BC, Samoilys MA, Sanciangco J (2013) **Fishing groupers towards extinction: a global assessment of threats and extinction risks in a billion dollar fishery.** Fish and Fisheries 14(2): 119-136.

Sáenz-Arroyo A, Revollo-Fernández D (2016) **Local ecological knowledge concurs with fishing statistics: An example from the abalone fishery in Baja California, Mexico.** Marine Policy 71:217–221.

Sáenz-Arroyo A, Roberts CR, Torre J, Cariño-Olvera M, Enríquez-Andrade RR (2005) **Rapidly shifting environmental baselines among fishers of the Gulf of California.** Proceedings of the Royal Society B: Biological Sciences 272:1957–1962.

Silvano RAM, MacCord PFL, Lima RV, Begossi A (2006) **When does this fish spawn? Fishermen's local knowledge of migration and reproduction of Brazilian coastal fishes.** Environmental Biology of Fishes 76:371–386.

Silvano RAM, Silva AL, Ceroni M, Begossi A (2008) **Contributions of ethnobiology to the conservation of tropical rivers and streams.** Aquatic Conservation: Marine Freshwater Ecosystems 18:241–260.

Soga M, Gaston KJ (2018) **Shifting baseline syndrome: causes, consequences, and implications.** Frontiers in Ecology and the Environment, 16(4):222-230.

Souza TCM, Petrere Jr M (2008) **Characterization of small-scale fisheries in the Camamu-Almada basin, southeast state of Bahia, Brazil.** Brazilian Journal of Biology 68(4):711-719.

Thurstan RH, Buckley SM, Ortiz JC, Pandolfi JM (2016) **Setting the Record Straight: Assessing the Reliability of Retrospective Accounts of Change.** Conservation Letters 9(2):98–105.

Turvey ST, Barret LA, Yujiang H, Lei Z, Xinqiao Z, Xianyan W, Yadong H, Kaiya Z, Hart T, Ding W (2010) **Rapidly Shifting Baselines in Yangtze Fishing Communities and Local Memory of Extinct Species.** Conservation Biology 24(3):778-787.

Ulman A, Pauly D (2016) **Making history count: The shifting baselines of Turkish fisheries.** Fisheries Research 183:74–79.

Venkatachalam AJ, Price ARG, Chandrasekara S, Sellamuttu SS, Kaler J (2010) **Changes in frigate tuna populations on the south coast of Sri Lanka: evidence of the shifting baseline syndrome from analysis of fisher observations.** Aquatic Conservation: Marine and Freshwater Ecosystems 20:167–176.

Young JC, Rose DC, Mumby HS, Benitez-Capistros F, Derrick CJ, Finch T, Garcia C, Home C, Marwaha E, Morgans C, Parkinson S, Shah J, Wilson KA, Mukherjee N (2018) **A methodological guide to using and reporting on interviews in conservation science research.** Methods in Ecology and Evolution 9:10-19.

Zapelini C, Giglio VJ, Carvalho RC, Bender MG, Gerhardinger LC (2017) **Assessing Fishing Experts' Knowledge to Improve Conservation Strategies for an Endangered Grouper in the Southwestern Atlantic.** Journal of Ethnobiology 37(3):478–493.

Zapelini C, Bender MG, Giglio VJ, Schiavetti A (2019) **Tracking interactions: shifting baseline and fisheries networks in the largest Southwestern Atlantic reef system.** Aquatic Conservation: Marine and Freshwater Ecosystems. DOI: 10.1002/aqc.3224.

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