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Do traditional fishers recognise reef fish species declines? Shifting environmental baselines in Eastern Brazil

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Abstract Local fisher knowledge is an important source of information for the adjustment of environmental baselines relative to anthropogenic impacts on marine ecosystems. This knowledge is also susceptible to the shifting baseline syndrome. Four generations of fishers neighbouring a marine park in Eastern Brazil, were surveyed regarding the conservation status of nine reef fish species. Shifts in environmental baselines were detected among fisher generations. Fishers older than 50 years not only caught larger individual fish, but catches of large fish occurred four decades ago, suggesting that bigger fish are in decline in the region. Of nine reef fish species, seven exhibited significant declining catch trends based on information provided by fishers. Such declining status was not reported by all informants of younger generations, so the ability to identify such species increases significantly with fisher age. The fish species most cited as overexploited were *Mycteroperca bonaci* (Poey), *Epinephelus morio* (Valenciennes) and *Ocyurus chrysurus* (Bloch), emphasising that special attention should be given to the management and conservation of these species in Eastern Brazil. These results also showed that knowledge acquired by elder fishers (> 50 years old) can provide valuable insights into the conservation status of reef fish and the adjustment of environmental baselines for proper management of a marine park.

KEYWORDS: coral reefs, environmental changes, local ecological knowledge (LEK), marine protected areas, threatened species.

Introduction

The shifting baseline syndrome is a phenomenon affecting peoples' ability to recognise environmental changes. Pauly (1995) described this phenomenon as the inability of fisheries scientists to accommodate past and historical data and the risks associated with shifts in perceptions of the true status of fisheries and marine biodiversity as a whole. As one generation replaces another, marine scientists tend to accept as baseline the stock size and composition from the starting point of their careers, not relying on data from earlier periods (Pauly 1995; Sáenz-Arroyo *et al.* 2005a; Pinnegar & Engelhard 2007). This results in a gradual shift in environmental perception and inappropriate reference points for fisheries management (Pinnegar & Engelhard 2007). Moreover, shifts in environmental baselines are general and apply to all sectors of society (Sáenz-Arroyo *et al.* 2005a,b).

Humans have been impacting marine ecosystems for millennia and very few pristine systems remain in the world (Jackson *et al.* 2001; Myers & Worm 2003). The exploitation of marine ecosystems has already caused structural and functional changes, such as reductions in the average size of individual fish and species extinctions (Bellwood *et al.* 2004; Jackson 2010). The shifting baseline phenomenon drew attention to past impacts on marine ecosystems, increasing efforts for historical and archaeological searches for adequate marine environmental baselines (Jackson *et al.* 2001; Myers & Worm 2003; Sáenz-Arroyo *et al.* 2005a,b).

Old grey literature, naturalists' observations, historical data and fisher's anecdotes are important sources to adjust current environmental perceptions of marine population status (Sáenz-Arroyo *et al.* 2006; Pinnegar & Engelhard 2007). Additionally, retrospective data can shed light on the underlying causes and rates of ecological change and set different goals for restoration and management of coastal ecosystems (Jackson *et al.* 2001). In this context, fishers local ecological knowledge (LEK) has been increasingly recognised as an important source

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of information to improve the management of artisanal tropical fisheries (Sáenz-Arroyo *et al.* 2005a; Silvano *et al.* 2006; Begossi & Silvano 2008; Silvano & Valbo-Jørgensen 2008), because fishers accumulate knowledge on fish behaviour, ecology and trends in fisheries composition and abundance throughout the years (Johannes 1981; Johannes *et al.* 2000; Rochet *et al.* 2008). LEK is handed down through generations by cultural transmission (Berkes 1999) and is considered a source of far-reaching valuable insights into ecological processes, being used by ecologists and incorporated with data from conventional research (Stave *et al.* 2007; Brook & McLachlan 2008; Turvey *et al.* 2010) to contribute to understanding biological phenomena and their use in conservation (Shackeroff & Campbell 2007).

Nevertheless, local perceptions of the status of species and other ecosystem resources are unlikely to remain constant over time if environmental systems experience biological change (Turvey *et al.* 2010). Previous studies have identified shifts in environmental perceptions of traditional fisher communities, caused by lack of communication between generations (Sáenz-Arroyo *et al.* 2005b; Turvey *et al.* 2010). In systems that have experienced biological change, younger generations may be less aware of local species diversity or abundance from the recent past and interpret more degraded environmental conditions as natural (Sáenz-Arroyo *et al.* 2005b; Papworth *et al.* 2009). Differences in observer perceptions of normality could also result from other processes, such as memory illusion, where older individuals do not remember past conditions accurately, recalling change where there was none (Papworth *et al.* 2009). In addition to its influence on fisheries scientists' stock evaluations – organism size, abundance and composition in the past – baseline shifts might affect knowledge of traditional fisher communities. Thus, the syndrome could influence the interpretation of data related to local ecological knowledge, whose use for species and ecosystems assessments is becoming more common (Van Der Hoeven *et al.* 2004; Jones *et al.* 2008).

Reef ecosystems are in global decline because of growing pressures on biodiversity (Bellwood *et al.* 2004; Jackson 2008, 2010). In Brazil, reef ecosystems are following worldwide trends of degradation with impacts including coral diseases (Francini-Filho *et al.* 2008), bycatch and overfishing (Floeter *et al.* 2006; Francini-Filho & Moura 2008), as well as the aquarium trade (Gasparini *et al.* 2005). As a consequence, many Brazilian reef fish species are currently threatened with extinction, and several others are endangered (Bender *et al.* 2012, in press).

Although little of the vast Brazilian coastline is under any form of protection or management (Amaral & Jablonski 2005), studies have shown positive effects of no-take areas on the abundance and size of reef fish (Floeter *et al.* 2006; Francini-Filho & Moura 2008). For the Recife de Fora Marine Park (16º 24′S, 38º 59′W), a coral reef no-take area located off the city of Porto Seguro in eastern Brazil, the abundance of targeted fish species – top predators and roving herbivores – is lower than other protected areas in the region (Chaves *et al.* 2010). However, baseline data are essential to define a more precise scenario on the current conservation status of the park (Chaves *et al.* 2010) and to set alternative management strategies for its fish populations.

It is still challenging to incorporate traditional knowledge into scientific analyses (Johannes *et al.* 2000); nevertheless, such knowledge can offer important insights into the former state of ecosystems (Pauly 1995; Pitcher 2001), especially in countries where written records are sparse (Johannes 1998; Johannes *et al.* 2000; Sáenz-Arroyo *et al.* 2005b; Helfman 2007), which is the case with Porto Seguro and other fisheries along the Brazilian coastline. The objectives of this study were to: (1) investigate the perceptions of traditional fisher communities adjacent to a coral reef marine protected area (MPA) regarding declines in fish populations and individual sizes; (2) detect possible shifts in environmental baselines occurring in fishers' ecological knowledge; and (3) set a baseline to future management strategies for the Recife de Fora Marine Park.

Materials and methods

The Recife de Fora Marine Park (16° 24′S, 38° 59′W) – a municipal marine protected area – is located 9.25 km off the city of Porto Seguro, Bahia state, northeast Brazil (Fig. 1). It was created in 1997 and includes a coral reef area of 17.5 km^2. Communities surrounding the protected area include Cabrália, Belmonte, Coroa Vermelha, Arraial d'Ajuda and Trancoso, and according to elder fishers, the coral reefs of Recife de Fora were once an important fishing site for those communities because of its proximity to the coast.

Species assessed in interviews were those existing in the area and currently categorised as threatened with extinction (Critically endangered, Endangered or Vulnerable) by different red lists – IUCN Red List (IUCN 2010), Ministério do Meio Ambiente (MMA) national list (MMA 2004, 2005) and state lists (Bergallo *et al.* 2000; Marques *et al.* 2002; Mikich & Bérnils 2004; Passamani & Mendes 2007) (Table 1). Genera belonging to the Epinephelidae family follow Craig *et al.* (2011). From a list of 16 threatened reef fish, seven were selected based on the quality of information provided by fishers in three trial interviews. These interviewees were selected because one or more peers identified them as

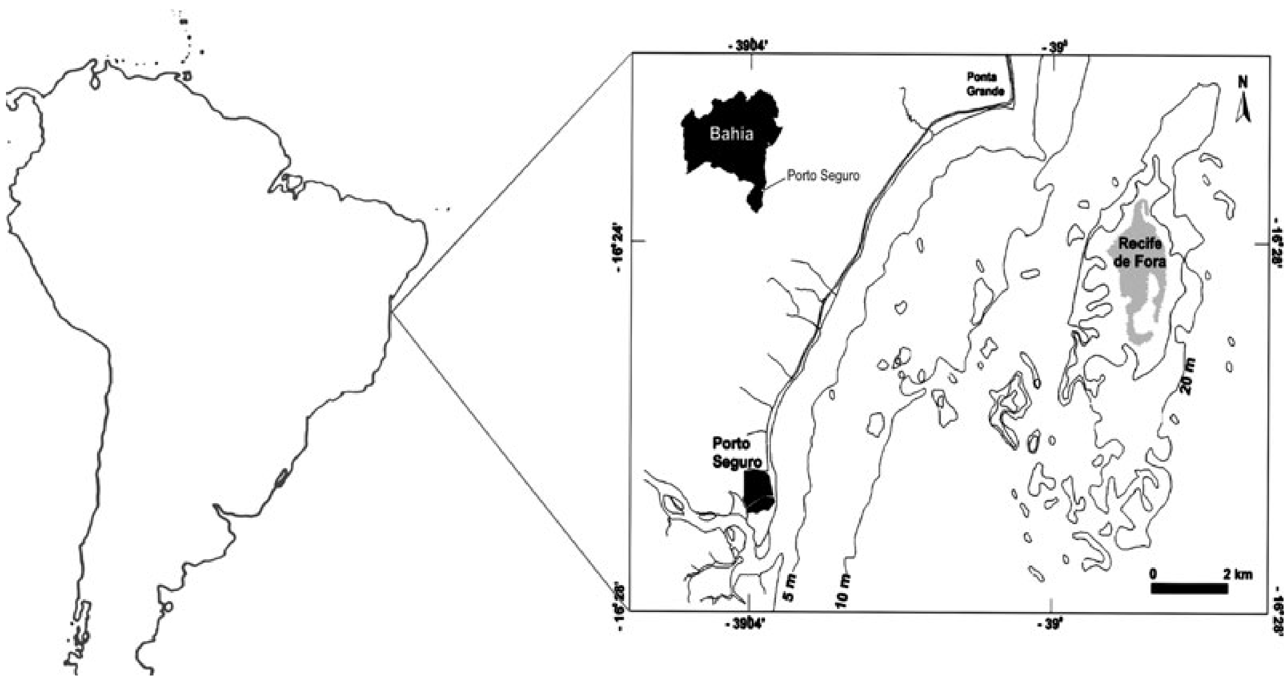

Figure 1. Map of the Recife de Fora Marine Park location and limits in eastern Brazil, Bahia state.

Table 1. Conservation status of Brazilian reef fish species investigated in interviews with Porto Seguro fishers

		Threat status			
Family	Species	IUCN*	MMA†	IUCN regional‡	State lists§
Balistidae	*Balistes vetula*	VU			
Epinephelidae	*Epinephelus itajara*	CR	CR	CR	EN, VU
Epinephelidae	*Epinephelus morio*			VU	
Epinephelidae	*Epinephelus adscensionis*	LC			
Epinephelidae	*Hyporthodus nigritus*	CR		CR	
Epinephelidae	*Mycteroperca bonaci*			VU	
Lutjanidae	*Lutjanus analis*	VU		NT	
Lutjanidae	*Lutjanus jocu*	NE			
Lutjanidae	*Ocyurus chrysurus*	NE			

CR, critically endangered; EN, endangered; VU, vulnerable; LC, least concern; NE, not evaluated.

*IUCN – IUCN Red List of threatened species.

†National environmental agency (MMA) red list.

‡IUCN Regional – Consensus at the regional assessment meeting for Epinephelidae and Lutjanidae species.

§State Lists from Espírito Santo, Paraná, Rio de Janeiro and Rio Grande do Sul states lists.

elder and experienced fishers in the local community. Given the richness of common names for Brazilian reef fish (Freire & Carvalho-Filho 2009), photographs were used for species identifications (Silvano *et al.* 2006) in all interviews. Information quality refers to respondents' ability to identify reef fish species and to provide answers to the questionnaire. First those species identified by at least two of three interviewed fishers were selected; in this group of selected species those with more than two questions not answered by informants were discarded (see questions in item 3, Appendix 1). The reef fish species selected were the queen triggerfish *Balistes vetula* L., goliath grouper *Epinephelus itajara* (Lichtenstein), red grouper *Epinephelus morio* (Valenciennes), Warsaw grouper *Hyporthodus nigritus* (Holbrook), mutton snapper *Lutjanus analis* (Cuvier), dog snapper *Lutjanus jocu* (Bloch & Schneider) and black grouper *Mycteroperca bonaci* (Poey). Two additional species were also included: rock hind, *Epinephelus adscensionis* (Osbeck), and yellowtail snapper, *Ocyurus chrysurus* (Bloch). *Epinephelus adscensionis* was included because of its global declining trend (IUCN (International Union for the Conservation of Nature) 2010) and because the species is targeted by tropical western Atlantic fisheries (Harper *et al.* 2000). The inclusion of *O. chrysurus* was based on its importance in Porto Seguro and Bahia state fish landings (Costa *et al.* 2003; Frédou *et al.* 2006; Nóbrega *et al.* 2009).

To access fishers perception of fish species declines, individual interviews were conducted with 53 fishers selected randomly (approached randomly at interview site) in Porto Seguro communities with ages ranging through four generations: < 31 years (n = 11), 31–40 years (n = 10), 41–50 years (n = 12) and > 50 years (n = 20). Fishers were previously informed on the subject of the research and on the questionnaire content. Interviews were conducted in December 2008, after previous informed consent, at Tarifa market, a trade port where traditional fishers from Porto Seguro land their catches daily. Interviewed fishers belonged to the communities of Boipeba (n = 1), Cabrália (n = 2), Caraíva (n = 1), Canavieiras (n = 1) and Porto Seguro (n = 48).

The questionnaire consisted of structured and open-ended questions, where the interviewees had the opportunity to elaborate on questions as desired. The first part of the interview was designed to determine the sociological characteristics of fishers (name, birth place, age, fishing experience); the second part consisted of displaying fish species images to interviewees and requesting them to name those they recognised; following each fish species identification, informants were questioned on current species individual size, the largest individual ever caught, when and where those large fish were caught, fishing gear used and the best day catch. These steps were repeated for every species identified by fishers. The last part of the questionnaire comprised questions on environment perceptions of informants (past and present catch composition, resource decline and impacts on fish abundance in the region). When fishers were asked about fish sizes and the largest individual of each species, they had ever caught, the majority of informants provided information relative to species weight (in kilograms). However, when fishers referred to fish body length, species length–weight relationships were used to convert to weight (Bohnsack & Harper 1988).

To verify a possible decline in reef fish species based on perceptions of fishers, the relationship between largest fish (of each species) ever caught and fishers' age as well as the largest fish in relation to the year when it was caught was tested through linear regressions ($P < 0.05$). The relationships between the age of fishers and number of fish species identified and number of species reported as in decline were tested as a way to measure the possible shifts in environmental perceptions of informants.

Results

Relationships between the largest fish individuals ever caught by fishers against fisher age revealed changes in fish catch across generations. Older fishers caught larger individuals of *M. bonaci*, *E. itajara*, *E. morio*, *E. adscensionis*, *H. nigritus*, *L. analis*, *L. jocu* and *O. chrysurus* in the past (Table 2). For example, the average size of the largest *M. bonaci* caught by fishers older than 50 years was 49 ± 13 kg, for fishers from 41 to 50 years was 44.2 ± 25 kg; from 30 to 40 years old, the average size was 34 ± 20.5 kg, whereas for the younger generation, the average is 18 ± 17 kg.

Relationships between the year in which fishers landed those largest fish against fish size suggest that catches of large individuals of some species have declined in eastern Brazilian fisheries (Table 2). Relationships were significant for *M. bonaci*, *E. itajara*, *E. morio*, *H. nigritus*, *L. analis*, *L. jocu* and *O. chrysurus*, but not for *B. veluta* and *E. adscensionis*. Only three young fishers (< 31 years) had caught individuals of the species *H. nigritus*, five have never caught an individual of the species, and the other three could not identify the species.

Most fishers were able to identify the majority of fish species assessed in interviews. The unknown species were mainly *H. nigritus* and *E. adscensionis*, not recognised by 11.3% and 15.1% (n = 53) of interviewees, respectively. When it comes to identifying declining fish species, older, more experienced fishers could identify more species that are in decline (Fig. 2). Informants older than 50 years reported on average 2.8 ± 2.6 declining species; fishers from 41 to 50-year-old identified 2.6 ± 1.6 species; fishers of 31–40 and those younger than 31 years, the numbers were 2.2 ± 0.8 and 1.6 ± 0.81 species, respectively.

Mycteroperca bonaci (26.9%; n = 53), *E. morio* (34.6%; n = 53) and *O. chrysurus* (34.6%; n = 53)

Table 2. Correlations of larger individual of fish species caught and fishers age and year caught

Species	r^2 value (larger individual caught vs fisher's age)	r^2 value (larger individual caught vs year caught)
Balistes vetula	0.13	0.03
Epinhephelus itajara	0.09*	0.28**
Epinephelus morio	0.18*	0.23*
Epinephelus adscensionis	0.16*	0.03
Hyporthodus nigritus	0.32**	0.33**
Mycteroperca bonaci	0.16*	0.14*
Lutjanus analis	0.18**	0.12*
Lutjanus jocu	0.29***	0.15*
Ocyurus chrysurus	0.21**	0.16*

*$P < 0.05$.
**$P < 0.01$.
***$P < 0.001$.

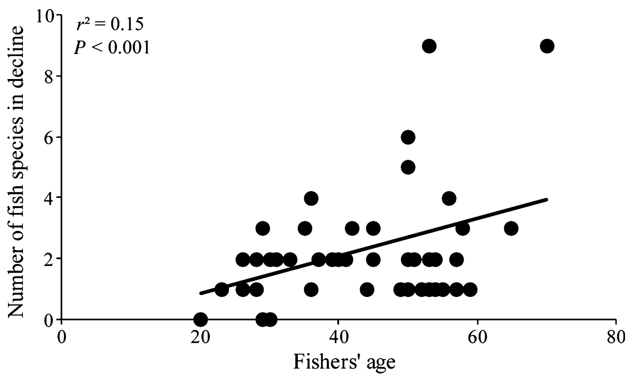

Figure 2. Number of reef fish species in decline reported by fishers and fishers' age linear regression $r^2 = 0.15$; $P < 0.0001$.

were the species mostly cited as overexploited in the region. However, *O. chrysurus* was also recognised as an abundant reef fish nowadays compared with other species evaluated and was the main catch of 37.2% ($n = 53$) of fishers interviewed. The groupers *E. itajara* and *E. adscensionis* were referred to as once abundant by 34.8% and 21.7% of older fisher (>50 years) interviewed ($n = 20$). During interviews, three elder informants (>50 years) mentioned top predators, such as sharks, were common in catches in the old days.

Fifteen (28.8%; $n = 53$) informants referred to *E. itajara* as a reef fish threatened with extinction – explicitly using the word extinction – when interviewed, and nine (17.3%; $n = 53$) mentioned the prohibition of its capture in Brazilian waters. This knowledge regarding *E. itajara* was evenly spread through fisher age categories (Table 3). Nevertheless, only fishers older than 50 years identified *E. adscensionis* as imperilled and currently rare in catches (21.7%; $n = 5$).

When questioned on the causes of resource decline, 35.8% ($n = 53$) of fishers considered that their own fishing activities had led to species depletions. Fishing technology (e.g. sonar, larger boats, powerful boat engines), spear fishing, lobster fishing and compressor divers who also fish were also pointed out as responsible for fisheries decline in Porto Seguro. Only three fishers were not able to identify changes in reef fisheries, and these were less than 30-year-old (20, 23 and 28 years). Many older fishers compared the current status of reef fisheries with old times: '*back then, 2 days were sufficient for 200 kg of fish, nowadays we need 8 days to reach 200 kg landings*' (J.O.B., 50 years old). Fishers interviewed also recorded the days when they would fish in the reef area now enclosed in Recife de Fora Marine Park. Experienced fishers (> 50 years) mentioned fishing in Recife de Fora reefs and landing canoes filled with fish.

Table 3. Reef fish species conservation status according to the IUCN Red list, percentage of fishers (all age categories) and percentage of elder fishers who identified the species as overexploited

Species	Conservation status	Fishers citations	Citations of fishers older than 50 years
Balistes vetula	VU	9.6% (5)	8.7% (2)
Epinephelus itajara	CR	28.8% (15)	34.8% (8)
Epinephelus morio	VU	34.6% (18)	43.5% (10)
Epinephelus adscensionis	LC	9.6% (5)	21.7% (5)
Hyporthodus nigritus	CR	13.5% (7)	30.4% (7)
Mycteroperca bonaci	VU	26.9% (14)	26.1% (6)
Lutjanus analis	VU	3.8% (2)	4.3% (1)
Lutjanus jocu	NE	5.8% (3)	8.7% (2)
Ocyurus chrysurus	NE	34.6% (18)	47.8% (11)

Discussion

Fish species declines and fishers perception

Despite the richness of fish species in the Porto Seguro landings, which is characteristic of tropical reef fisheries, snappers (*O. chrysurus, L. jocu* and *L. analis*) and groupers – such as *M. bonaci* – account for most of the abundance (CPUE) of commercial fish caught (see Costa *et al.* 2003). These and other reef fish are experiencing heavy fishing pressure along the Brazilian coast (Floeter *et al.* 2006), and the overfished state of populations has been demonstrated (Ferreira & Gonçalves 1999; Rezende *et al.* 2003; Frédou 2004; Rezende & Ferreira 2004). Most of the target species that were assessed in the present study reach large body sizes; exhibit slow growth, late reproductive maturity and some also spawn in aggregations (Coleman *et al.* 2000; Morris *et al.* 2000), all critical biological attributes that enhance their vulnerability (see Bender *et al.* 2012).

Traditional fisher communities witnessed the environmental changes, reductions in catches and changes in catch compositions that have been documented in eastern Brazilian marine ecosystems. However, not all fishers recognised the environmental changes because of the different environmental baselines among generations. Fisher awareness of species threat status differed from one generation to other, especially for *H. nigritus* and *E. adscensionis*, which were identified as formerly more abundant only by older fishers. The possible temporal differences in species abundances are not necessarily related to reductions in the size of individual fish caught throughout the years. In addition, the small variation in individual fish size, might explain why no reduction was detected in catches of *B. veluta* and *E. adscensionis* (body size variations: 25.1–49.7 cm and 16–38.7 cm, respectively) (Freitas-Netto & Di Beneditto 2010; Santos *et al.* 2010). The grouper *H. nigritus* was also identified as a rare species associated with deep waters, and its depletion in northeast seamounts has shown its vulnerability to overexploitation (Perez 2007). Fishers also referred to a decrease in fish size in the reefs of Recife de Fora, relating it to reductions in shoals of small-bodied species (e.g. Engraulidae, named manjuba by fishers), which play an important ecological role as prey for many species in the ocean food web (Hildebrand 1963).

The snappers (*L. analis* and *O. chrysurus*) are of special concern as they are classified as overexploited by many fishers, especially older ones, although its importance to local fisheries and current abundance compared with other species masks its overexploited status. Costa *et al.* (2003) emphasised the need for a cautious approach to *O. chrysurus* fisheries in the region because of the seasonality its yields, spawning aggregation behaviour and vulnerability. Most fishers were able to detect reductions in the abundance of *M. bonaci* and *E. morio,* which were once common in catches and are now regarded as rare. The threatened status of *E. itajara* is well known by fishers from Porto Seguro, awareness possibly related to its protection through a law that prohibits its harvesting, commercialisation and possession (Gerhardinger *et al.* 2009). Despite other species being listed as globally and regionally threatened (Table 1), there are no protection or management strategies for them at the national scale (Bender *et al.* 2012, in press).

Apparently, knowledge transmission from older and experienced fishers to following generations has been limited in Porto Seguro communities. Therefore, knowledge of the former abundance and composition of reef fish species and their fisheries might have been poorly incorporated into local knowledge causing shifts in environmental baselines. The changes in informant's perspectives regarding overexploited species in the region and also of the causes of fisheries declines are troubling because such changes might influence public tolerance to biodiversity and biomass loss (Sáenz-Arroyo *et al.* 2005a; Ainsworth *et al.* 2008). Greater community awareness on environmental changes and the activities that contribute to species declines have been reported from other communities, compared with the patterns of fisher perceptions presented here (Bunce *et al.* 2008; Jimémez-Badillo 2008).

The shifting baseline syndrome poses a challenge to knowledge of past ecosystem function, species distribution and population numbers (Jackson *et al.* 2001; Myers & Worm 2003; Sáenz-Arroyo *et al.* 2005a; b). This phenomenon has also spread through society, even reaching traditional fishers (Sáenz-Arroyo *et al.* 2005a,b; Turvey *et al.* 2010). The present results also reveal that the perceptions of younger generations of Porto Seguro fishers of fish species status do not correspond to the declining trends of those fisheries, as reported by other fishers and through biological data (Ferreira & Gonçalves 1999; Costa *et al.* 2003; Rezende *et al.* 2003; Frédou 2004; Rezende & Ferreira 2004). Their perceptions are possibly subjected to the effects of time and compromised knowledge transmission between community members. These changes in fisher baselines are especially troubling given the importance of their knowledge in guiding the adjustments of environmental baselines, along with other sources of historical data (Sáenz-Arroyo *et al.* 2005a). Moreover, traditional knowledge holders, who have long-standing ties to natural environments, can help filling in the gaps in understanding of marine ecosystems (Pauly 1995).

LEK and management

Local ecological knowledge (LEK) should be incorporated to scientific knowledge along with other sources of data (Pauly 1995; Mackinson & Nottestad 1998; Sáenz-Arroyo *et al.* 2005a,b; Ainsworth *et al.* 2008), to help elaborate proper management and conservation strategies for vulnerable species (Pauly 1995; Baum & Myers 2004). Recent efforts to legitimise and fit the LEK of fishers into the current management framework have been based on standards established by science, even though LEK has its own functional and maintenance dynamic (Holm 2003). Sáenz-Arroyo *et al.* (2005b) showed the importance of using historical evidence, naturalists' observations and fishers' perceptions in the assessment of stocks. They found that *M. jordani* might have a high risk of extinction, contrary to fishery statistics that suggested landings were increasing in the Gulf of California. These and other findings emphasise the importance of reassessing the status of marine species using historical methods (Jackson *et al.* 2001; Myers & Worm 2003; O'Donnell *et al.* 2010;) especially if their life-history characteristics suggest they may be vulnerable to human impacts (Sáenz-Arroyo *et al.* 2005b).

Species declines have been corroborated by fisher's perceptions in a number of studies that have assessed marine (Sáenz-Arroyo *et al.* 2005b; Lavides *et al.* 2010; O'Donnell *et al.* 2010) and freshwater fish species (Turvey *et al.* 2010), as well as marine mammals and sharks (Maynou *et al.* 2011). In some cases, fishers failed to provide accurate information on species declines (Pereira Lima *et al.* 2010). Differences in the interpretation of fishery decline might be related to species importance and value (e.g. commercial species), fishing gear and exploited habitat (water depth, coral/rocky reef, mangroves, estuaries) and social position of respondents (see Bush & Hirsch 2005). Although informants were line fishers who mainly exploit reef habitats, the low correlation values for fish catches could be related to the different importance of species to the local fishery – smaller values being associated with fish of lower commercial importance – as well as to the number of respondents. Studies demonstrating fishery declines and species conservation status have relied on additional information from logbooks and other sources of grey literature (Dulvy & Polunin 2004; Sáenz-Arroyo *et al.* 2005a, 2006; O'Donnell *et al.* 2010) that contribute to the accuracy of assessments. However, this type of data was not available to this work.

In addition to environmental perceptions of experienced resource users, marine reserves have been recommended as tools to provide a window on pre-exploitation times by preserving marine biodiversity (Roberts & Hawkins 2000). The knowledge of fishers from local communities surrounding the Recife de Fora Marine Park could be incorporated into the protected area species management by providing insights into the past status of that coral reef ecosystem – including reef fish species currently facing risk of extinction. However, in interpreting such knowledge, there must be an awareness of the way in which the shifting baseline syndrome affects peoples' perceptions and accessing older fisher knowledge is fundamental to any efforts to protect biodiversity and evaluate species conservation status.

The information provided by fishers from Porto Seguro, indicates that there have been serious declines in *M. bonaci*, *E. morio* and *O. chrysurus* abundances in the region over the last 40 years, with fishing activities moving further and deeper into the ocean (Perez & Pezzuto 2006). In addition, older fishers emphasised the threatened nature of *H. nigritus*, in accordance with its IUCN Red List status. In a recent underwater survey conducted in Recife de Fora Marine Park (Chaves *et al.* 2010), neither *M. bonaci*, *E. morio* nor *O. chrysurus* were abundant. Moreover, the conservation status of *O. chrysurus* has not been evaluated on any scale, whether global or national, and its declines in the region indicate that this resource might be overexploited.

It is important to improve the effectiveness of management of the Recife de Fora Park, because of the biodiversity it encompasses and its potential as a source to local fisheries. Recife de Fora Marine Park was created 14 years ago but its management plan is still being developed. This is an opportunity to set a proper baseline for the management of the marine park reef fish community, based on the local ecological knowledge of older fishers. One possible application of the information provided by fishers is to set targets for the recovery of populations of those species within the park. The importance of the LEK of fishers to improve management and conservation of reef fish species occurring in Brazil has already been demonstrated for the threatened grouper species *E. itajara* (Gerhardinger *et al.* 2009) and *Epinephelus marginatus* (Begossi & Silvano 2008), as well as for Lutjanidae species (Begossi *et al.* 2011) in an overexploited fishery in northeast Brazil (Rezende *et al.* 2003). However, Silvano *et al.* (2006) noted that there was an overall lack of knowledge about reproductive patterns of Brazilian coastal fish, although they accessed experienced and older fishers. They argued that one possible explanation for this gradual loss of ecological knowledge among fishers could be their closer contact with urban centres and the replacement of fishing by other economic activities (Begossi *et al.* 2001; Silvano *et al.* 2006). Despite the shifting baseline syndrome being detected in traditional fisher communities (Sáenz-Arroyo *et al.* 2005a; b; Turvey *et al.* 2010), the ability of fishers to perceive recent environmental changes (Rochet *et al.* 2008) and to identify vulnerability and extinction risks of reef fish species (Lavides *et al.* 2010) has been highlighted. Also, it is possible that the older generation of fishers accessed in this study had not incorporated the knowledge of previous fisher's generations, having also shifted environmental perceptions. Nevertheless, these older, more experienced fishers were able to provide more detailed information on fisheries changes at Porto Seguro and therefore could be an important source of information to fill the knowledge gaps of these tropical reef fisheries. Future studies incorporating fisher's knowledge in the assessment of fish species in small-scale tropical fisheries must take into account fisher's age and experience (when possible fishing gear employed and exploited habitat must be considered) (Bush & Hirsch 2005). Additional data (logbooks, naturalists' observations) must be assembled to build the most reliable baseline possible. Only appropriate and long-term baselines will help understand global changes in marine ecosystems.

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Appendix 1

Questionnaire utilized in interviews with fishermen from Porto Seguro.

1 Date/place

2 Fishermen name and age

3 Do you know this fish? (Showing photograph, one by one)

() no () yes

If yes, how is this fish called? ___________________

Which is its regular size of occurrence nowadays? ______________________________

What size is the largest individual you ever caught? ____________________________

Can you draw on the floor its size?_______________

When was this large individual caught? ___________

Where was its capture? _________________________

How was it caught? ____________________________

4 Which of these fish are common in your current catches? (Showing all the photographs the interviewee has identified)

5 And in the past which species were more common?

6 Do you believe any of those species have had its catches declined?

7 How do you compare fisheries in Porto Seguro region currently and in the past (when fishermen started fishing).