Ocean & Coastal Management 91 (2014) 23–31

Contents lists available at ScienceDirect

Ocean & Coastal Management

journal homepage: www.elsevier.com/locate/ocecoaman

Perceptions on the shifting baseline among coastal fishers of Tanga, Northeast Tanzania

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ARTICLE INFO

Article history:
Available online

ABSTRACT

The baseline for what is 'pristine' or 'healthy' ecosystem shifts over time with each new generation in a phenomenon known as 'shifting baseline syndrome'. The syndrome is particularly important in monitoring and restoration of depleted ecosystems, as such systems often suffer from lack of baseline data on their former pristine state. In this study, 350 fishermen selected randomly from seven fish-landing sites in Tanga, Tanzania, were interviewed for their insights and perceptions on changes in catch size, fishery stock, condition of current fishing grounds, and the number and type of affected groups or species. The majority of fishermen (73%) belonging to older age group perceived that the current size of the fish catch has declined drastically, while only 47% and 19% from the middle and younger age groups, respectively, share the view. The number of fishing grounds identified as depleted differed significantly among the three generations of fishermen (Kruskal Wallis, $\chi^2 = 135.689$, $d.f = 2$, $p < 0.001$), with old, middle-aged and young citing 9, 5 and 2 species, respectively. Additionally, there is significant difference in the number of fishing grounds cited as degraded among the three age groups ($p < 0.001$). Evidence for decline, mostly from old and middle-aged groups, was also revealed by increasing number of fish species with undesirable characteristics such as toughness of meat and unpleasant flavour, which fishermen used to discard to the sea in the past. In areas where long-term ecological data are missing, fishermen's local knowledge accumulated over time can reveal modified ecosystems thus recognising temporal scale of problems facing marine fisheries.

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1. Introduction

Ecological changes are generally a long-term trend and each new generation of scientists and general public alike fail to recognise the changes that have taken place over time. As such, each new generation collectively adopts this pervasive perspective, and therefore we lose track of the inexorable degradation of the native ecosystems (Jackson and Jacquet, 2011; Silvertown et al., 2010). Pauly (1995) says that environmental baselines 'shift' over generations. This is due to the fact each successive generation calibrates its assessment of environmental 'health' via its first association with it, and as ecosystems change so do environmental baselines among society (Kittinger et al., 2011; Lotze and McClenachan, 2013). A baseline is a given set of conditions against which subsequent change is measured (Alagona et al., 2012).

In the past decade, research works that focused on understanding the past status of ecosystems and their perceived health condition increased markedly. Such works can be broadly divided into two: paleobiological studies that help reconstruct the deep historical roots and globally accelerating rates of shifting baseline under the pressure of exploitation (e.g. Jackson et al., 2001; Pandolfi et al., 2003) and historical ecological studies employing interviews and analyse human perceptions to caution the future generations of the risks in degrading the ecosystems (e.g. Bunce et al., 2008; Sáenz-Arroyo et al., 2005).

In coastal and marine ecosystems, for instance, paleobiological and ecological studies have examined the current number of predatory fish species relative to their pre-industrial stock levels (Myers and Worm, 2005), population declines (Dulvy et al., 2003), loss of marine fish diversity (Hutchings and Reynolds, 2004), current biomass of large fish (Jennings and Blanchard, 2004), and more generally, temporal change in abundance, life history and demography (Hutchings and Baum, 2005). Studies that consider the local knowledge of fishermen largely through interviews were initially carried out in developing world (e.g. Ainsworth et al., 2008),

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http://dx.doi.org/10.1016/j.ocecoaman.2014.01.009

although additional examples that consider the use of time-series and archives are from the developed world (e.g. Guénette and Gascuel, 2012). Interview-based studies have proved useful to understand the magnitude and under-perception of ecosystem changes (Turvey et al., 2010). Besides, historical photographs, records of fish catch, and archaeological records help understand the historical ecological conditions where information is lacking (Sáenz-Arroyo et al., 2006).

Scholarly works show that the baseline of today's 'pristine' ecosystem is very different from that available over hundreds of years ago (Jung et al., 2011; Pinnegar and Engelhard, 2008). It shifts through time with each new generation, in a phenomenon known as 'shifting baseline syndrome' (SBS) (Pauly, 1995). For example, Sáenz-Arroyo et al. (2005) through interviews found that the largest groupers caught by older fishermen in the 1940s averaged between 80 and 90 kg, whereas those caught by younger fishermen in the 1990s averaged 60–70 kg. Similarly, in a study of a traditional fishery on coral reefs on Rodriguez Island in the Indian Ocean, older fishermen remembered catching about three times more and five times larger groupers than younger fishermen (Bunce et al., 2008). SBS may be attributed to faulty memory, psychological bias, short life span (Papworth et al., 2009). Other published studies show that more often most of the changes occurred before human beings were there to see them or could record relevant data (McClenachan, 2009).

In fisheries science, SBS has received during the past two decades an increased scientific recognition (Baum and Myers, 2004; Roberts, 2003) as it highlights the importance of using fishermen's knowledge (Thornton and Scheer, 2012) to supplement conventional management tools, which are reported to have failed to reverse the declining fishery (Pita et al., 2010). Given the widely accepted SBS phenomenon, many scientists call for a thorough understanding of the evidence provided by fishermen (Carr and Heyman, 2012), which, in most cases, is viewed as anecdotal lacking rigour.

Although fishermen's knowledge and experience have often been raised in policy debates on coastal resource management (Daw, 2010), little empirical evidence is available to validate such arguments (Ainsworth et al., 2008). However, in this context, approaches typically used in SBS studies may not be sufficient, since perceptions and cognition have emotional dimensions; thus, the responses may not necessarily reflect the true status of the marine ecosystems. Yet, lack of formal approaches in fisheries science in dealing with early accounts such as large catches, stock size and species composition, as well as relationships of trust between fishermen groups (Sáenz-Arroyo et al., 2005) necessitate the need to develop a framework that would incorporate knowledge of historical ecological condition of these natural resources, which in many cases may be anecdotal in character. Hence, maximising the use of fisheries and its related history would not only make it more reliable in the long run but would also help understand and overcome at least in part the SBS and therefore allow us to estimate and evaluate the true social and ecological costs of fisheries (Rose et al., 2011).

In Tanzania, as in many countries of the developing world, knowledge on biophysical status of coastal systems as well as human interaction is limited (Van der Elst et al., 2009). Furthermore, other sources of information such as photographs, articles, and naturalists' records, among other sources, which were found useful in obtaining empirical evidence to demonstrate biological changes in marine and coastal ecosystems (Lotze and McClenachan, 2013) are missing. Although a relatively low number of studies have dealt specifically with the status of marine fisheries resources in Tanzania (ASCLME, 2012; Jacquet et al., 2010; Masalu et al., 2010), there is ample evidence of declining fish yields (Jury et al., 2010), and

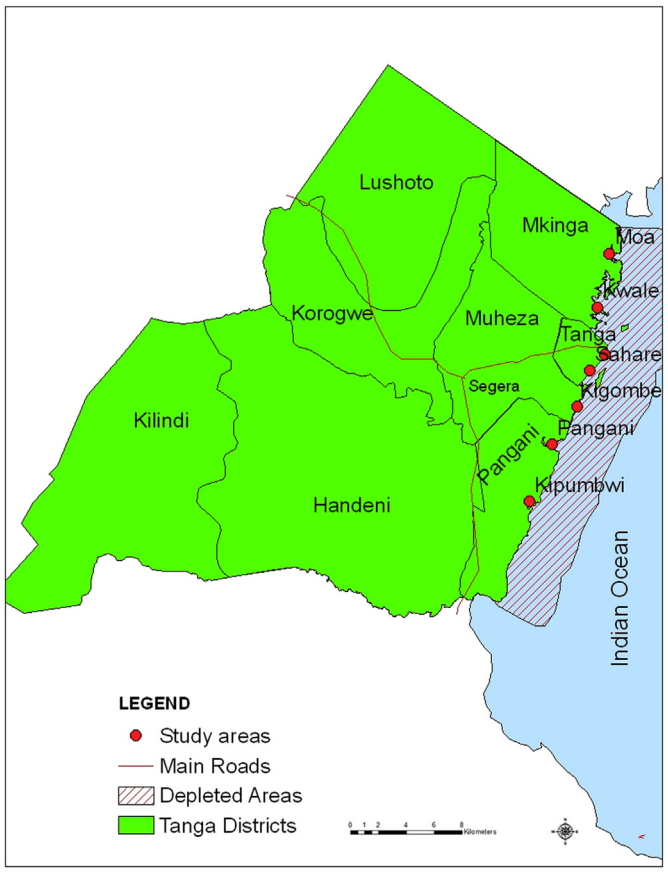


Fig. 1. Location of study sites in Tanga Region.

deteriorating conditions of habitats such as coral reefs, mangroves and seagrass beds (UNEP/CBD, 2013). Given the imprecise and unreliable data on the status of marine and coastal resources in Tanzania (Jiddawi and Öhman, 2002; Van der Elst et al., 2009), attempts to establish a baseline while planning for conservation, and management measures and initiatives are unlikely to succeed at present.

The present study intends to contribute to the body of knowledge on SBS by providing an example of a survey consisting of interviews of local fishermen as a means to overcome the shortage of 'traditional' knowledge on fisheries. It was carried out along the Tanga coastline in north-east Tanzania to systematically capture fishermen's local knowledge from interviews that were analysed to generate knowledge on changes occurring in fisheries' ecosystems over time. Specifically, the study' objectives are to establish how different generations of fishermen understand changes in abundance of species and the status of fishing grounds and identify the species that were affected the most and establish how these effects are manifested.

Tanga region is the northernmost part of the coast of mainland Tanzania bordering Kenya and has a total area of 26 808 km^2 (Wells et al., 2007). Unsustainable use of coastal resources in Tanga region were identified in 1990s, supported by evidence of declining yields of fish, deteriorating conditions of the coral reefs and continuing reduction of the area of mangroves and coastal forests (Horrill et al., 2000; Verheij et al., 2004). However, signs of degradation have been noticed many decades ago, as highlighted by a study carried out in 1968 (Samoilys and Kanyange, 2008) making it suitable for examining the SBS as communities perceptions have been changing. It is likely that many, most likely gradual, changes went

unnoticed until the situation became obviously unsustainable leading to the establishment of Tanga Coastal Zone Conservation and Development Program (TCZCDP) in 1994 to improve the integrity of the coastal zone (Makoloweka and Shurcliff, 1997).

2. Materials and methods

2.1. Study areas

The study was conducted in seven fish-landing sites along the Tanga's 180-km-long coastline (Fig. 1). The sites are Moa and Kwale in Mkinga district, Pangani and Kipumbwi in Pangani district, Kigombe in Muheza district, and Sahare and Deep Sea in Tanga City. The sites were selected on the basis of specific criteria (Tashakkori and Teddlie, 2003). Selection was based on the importance of fisheries activities in the society and the local economy; availability of important habitats such as coral reefs, mangroves and seagrass bed, and a long history of extraction of resources to the extent of destroying fish populations to a certain degree.

Most importantly, the chosen sites have always had good access to markets of the most highly valued marine products in Tanzania, especially finfish and lobsters (Marshall et al., 2001). Recently, however, these resources in nearby waters in those sites are both rare and smaller than they were 20 years ago (Samoilys and Kanyange, 2008). Furthermore, in those sites, high-value species of sea cucumbers (such as *Holothuria scraba*, *H. nabilis* and *H. spinifera*), which used to be among the most abundant species up to the 1980s, show the most marked decline (Wells et al., 2007). Besides, as of January 2011, at least 37 specimens of coelacanth (*Latimeria chalumnae*), the world's oldest and enigmatic fish, a 'living fossil fish' classified as highly endangered according to CITES-Annex 1 species, were captured as by-catch in gill netting fishery mainly in the fishing areas of Kigombe (UNEP/CBD, 2013). This, together with other fauna, especially three species of marine turtles, namely, olive ridley (*Lepidochelys olivacea*); green turtle (*Chelonia mydas*); and hawksbill (*Eretmochelys imbricata*); marine mammals such as dugongs and dolphins, shorebirds; and invertebrates such as octopus, molluscs and echinoderms, which at present appear to decline in availability according to information given by local fishermen, make the selected study sites reasonable for testing the SBS phenomenon.

While most common occupations especially in the hinterland areas of Tanga region are subsistence farming and livestock keeping, the coastal inhabitants depend on fishing and small-scale farming, both of which normally overlap. Others are engaged in trade, fishery ancillary jobs such as boat building, salt harvesting and charcoal making (Harrison, 2010). Fishing is predominantly male activity in the region despite a few women being involved in activities such as fishing in shallow water for shrimp, processing fish, and collecting invertebrates such as octopus and molluscs which normally are consumed locally or sold (Muhando, 2011).

2.2. Data collection

The study replicated the empirical methodology of Sáenz-Arroyo et al. (2005), Bunce et al. (2008), Lozano-Montes et al. (2008) and, Ainsworth et al. (2008) to quantify local ecological knowledge of fishermen to ascertain trends and changes in environmental baselines.

A one-month full-time reconnaissance survey was conducted to identify potential study sites and collect baseline information that could help in designing survey questionnaire. This phase involved semi-structured interviews with 39 head fishermen and other individuals identified using a snowballing sampling method (Bernard, 2006), because of their long-term knowledge and skills in fisheries, ecosystems and community. Also, during this phase, visits were made to nine fishing villages to meet with fishermen and discuss issues related to the study. Informal interviews with fisheries officials were also carried out during this phase.

The primary instruments for data collection were structured interviews (questionnaires) and focus group discussions (FGD), both of which were developed following the guidelines drawn by Bunce et al. (2000). In addition, data were collected from participant observation and secondary sources. Respondents for this study included fishermen, fisheries officials from Tanga, Muheza Pangani, and Mkinga districts, as well as individuals from NGOs dealing with marine resources in Tanga region.

Two FGDs were conducted in each of the study sites with knowledgeable fishermen about fisheries in their areas, ecosystems and community. They were identified using snowballing sampling method (Bernard, 2006). During FGD, participants discussed the historical ecological conditions of marine fisheries and habitats, generated a list of groups of fish and invertebrates within their inshore waters, and their perception of the status of Tanga coastal ecosystems. Furthermore, respected and skilled older fishermen were requested to identify species, e.g., silky shark (*Carcharhinus falciformis*), black tip reef shark (*Carcharhinus melanopterus*), and whale shark (*Rhincodon typus*) whose lifecycles and predation habits mean they could potentially be useful indicators of the health of the local ecosystems (Dulvy et al., 2003). Discussions were held in Swahili. The average number of participants in the FGD was eight. The venue for discussion was mutually agreed upon in advance. Although the maximum time allocated for each discussion was one and a half hour, most meetings ended in an hour. Unfortunately, there were no female participants in FGDs conducted at Kwale, Pangani and Deep Sea.

Structured questionnaire survey was used to interview a random sample of 350 fishermen from all study sites. The questionnaire was pre-tested on a pilot group of 20 fishermen in Moa and Sahare before the start of the main survey to improve its structure and content. At each study site, three clusters of fishermen by age (young 18–30 years old; middle-aged 31–50 years old; and old $>$ 50 years old) were selected. In each cluster, 75 fishermen were randomly selected for the interview. At each study site, all select fishermen willing to be interviewed and available on the day of survey were interviewed. Questions were in Swahili. Interviews, with open and close-ended questions, were conducted face to face at locations convenient to the fishermen, mainly near the coast when they had returned from fishing, or during repairs and mending of their gear as well as while preparing their gear for the next fishing trip. In certain cases, some fishermen were interviewed at their homes, or at locations where they rested and socialised. The number of surveys per fishing community ranged from 50 to 80, depending mainly on the number of fishermen in a particular community, willingness to participate, as well as the influence of other factors, such as weather, frequency and access to transportation means to the researcher to the study site.

Amongst other things, survey questions were aimed at gaining information on fishermen's perception on the decline of fishery and elucidate signs associated with changes in the resources, and the most important fish species as well as fishing grounds they believe to have been significantly depleted by fishing during their career (Bunce et al., 2008). Because of limited information on the known species, it was worth asking about individual species and aggregates them into families of living marine organisms. Respondents were also asked to give the probable period of the onset of the decline of species or group of species (Bunce et al., 2008). The scope of the study was limited to important commercial species most likely to have been caught by fishermen, including sharks as one of the most caught species and indicators of ecosystem health. The

survey resulted in listing a total of 32 families of living marine organisms.

Fishermen surveyed identified fish and invertebrate groups/families with the help of a standard local fish guide prepared from identification guides by Richmond (2002). The perceptions in decline of each species held by each age group were subsequently compared. Furthermore, fishermen were specifically asked to describe the best catch they ever remembered landing, the largest animal they ever caught, and the year in which these catches were made (Sáenz-Arroyo et al., 2005). Other questions concerned with fishing technology (e.g. type of boat and fishing gear, acceptance of new technology), description of fishing activities, and fisheries resources.

Participant observations included direct observation of fish catches at the landing sites and in market places at each study site to better understand fishing practices and the dynamics in day-to-day life of fishing communities.

Secondary data for the study was sought from institutions such as the Division of Fisheries, Tanzania Fisheries Research Institute (TAFIRI), Tanga Resources Centre, and the National Museum. Additional efforts were made to reach scientists working in coastal and marine affairs for unpublished ecological data and grey literature. In addition, an extensive literature search was made using library records and internet sources to acquire historical data on catch and environmental changes. Tanganyika Notes and Records (Hatchell, 1938, 1940, 1954) – the collection of very large historical contexts of Tanzania prior to independence, were particularly useful as a source of historical information of study sites.

2.3. Data analysis

Quantifiable survey responses were collated on a spread sheet using Microsoft Excel (2010) and then analysed using the SPSS (version 19). Exploratory data analysis included summary statistics and frequency tables to describe the socio-demographic characteristics of the respondents, and effect of age groups on perceived changes in ecosystem and resources. Employing Kruskal Wallis Chi-square test for non-parametric tests was done to establish categorical variables such as the number of fishing ground/species/best catch yielded statistical difference with age group of fishermen at a p-value = 0.01. Qualitative information was triangulated and words and statements, as well as researcher notes were organised and coded into themes that highlighted major issues that emerged like fish size and abundance, state of environment, fishing vessels and gear; enforcement and stock management, free access, and lack of alternative livelihood. These were subsequently analysed content wise and used to support most statements in this study.

3. Results

3.1. Profile of the interviewed fishermen

A total of 350 fishermen were interviewed from the study sites. Most respondents were male (96%) with permanent residency in communities along the Tanga coastline. Few (7%) were immigrants, especially from Kojani-Zanzibar, Bagamoyo, Dar es salaam and Mtwara. The mean age of the respondents was 34.8 years and majority of them were in the age group of 20–55 years. Most fishermen had completed primary school, and 20.9% didn't get any formal education indicating a high level of illiteracy. Two-thirds of respondents reported a lack of knowledge of modern fishing techniques to restrict them to catch fish beyond shallow waters, where fish stocks are already scarce. A vast majority of respondents (90%) considered themselves to be vulnerable to extreme weather events particularly winds of the southeast monsoon season (*kusi*). Over 85% of the respondents identified themselves as artisanal fishermen oriented for collecting and gathering fishery products for subsistence. More interestingly, majority of the respondents had at least a long history of fishing along the Tanga coastline. The average number of years spent on fishing was 8 and nearly 10% of the respondents had been fishing actively in Tanga for more than 30 years. At least 10% of the respondents reported using illegal fishing gears including dynamite fishing despite being aware of its ecological and health consequences. The general characteristics of the respondents are shown in Table 1.

3.2. Fishing activities and resource use patterns

The percentage of time spent fishing in different types of habitats both now and from the beginning of careers varied among the fishermen. Most fishermen interviewed (90%) irrespective of age group reported spending more time in the deep reef and reef edge zones far ashore than when they started fishing. Previously, the time spent on fishing activities was less (four on average) and was done mainly in intertidal and inside reef zones in inshore waters. No significant difference was found among the three generations of fishermen with respect to the average number of weekly fishing trips they undertook (Kruskal–Wallis, $\chi^2 = 5.141$, $d.f. = 2$, $p = 0.05$). However, there is clear inter-generational difference on the mean number of trips made in the past (One Way-ANOVA, $F = 18.23$, $d.f. = 2$, $p < 0.001$), with each group reporting fewer trips with larger catches at the beginning of their career. The average number of weekly trips made by all age groups at present is five, each with relatively low catch.

Discussion and interviews about preference of habitats revealed a very limited specialisation among and between different age groups of fishermen. There has been increasing attempt to reach deep waters, as inshore waters become increasingly depleted. This is often restricted by the type of fishing vessels used (Fig. 2).

Fishermen continue to utilise a broad range of fishing gear, a common feature in tropical small-scale fisheries. The most common gear types included handlines, gill nets, surrounding nets, purse seine/ring nets, traps, and long lines. Other gear such as shark nets, spear, and beach seine are used but only to a limited extent. The frequently visited fishing habitats by both age groups are inshore waters. Table 2 shows common gear used and habitats frequently visited by fishermen interviewed. Although majority of fishermen use fishing nets of differing mesh sizes, the adoption of modern fishing gear among different age groups is still low.

While a vast majority of respondents from all age groups remain highly motivated to explore resources in deep waters that are believed to be unexploited, information collected on distribution of fishing gears show little prospect for this attempt. Notwithstanding, focus group discussions revealed a high preference of ring nets by younger fishers that however, is hampered by lack of financial capital to acquire them. Rings nets are said to be useful in deep waters and most fishers believe that they can use them to increase the size of fish catch.

Fishermen interviewed mentioned that they use various ways such as information sharing and cooperation in informal networks in order to cope with uncertainty in fishing activities. Old aged respondents highlighted that in recent years sharing of information has played a substantial role as a way to increase catches rather than to avoid uncertain environmental conditions such as strong winds as it was in the past.

3.3. Perceived decline of current fish stock and catch size

Respondents were asked to assess the status of the fishery stocks and fish catch over time beginning with the start of their

Table 1
General characteristics of the respondents interviewed.

Characteristic	Sampling site N (%)							
Age group (years)	Deep Sea	Sahare	Kigombe	Kipumbwi	Kwale	Moa	Pangani	Grand Total
Young 18–30	18 (38.7)	15 (36.2)	16 (33.3)	14 (34.6)	10 (40.0)	14 (29.6)	7 (45.2)	127 (36.9)
Middle 31–50	24 (32.3)	21 (37.9)	21 (41.3)	18 (38.5)	16 (35.0)	13 (38.6)	14 (32.2)	129 (36.3)
Old >50	20 (29.0)	22 (25.9)	26 (25.4)	20 (26.9)	14 (25.0)	17 (31.8)	10 (22.6)	94 (26.8)
Gender								
Female	–	3 (5,2)	9 (14.3)	2 (3.8)	–	–	–	14 (4.0)
Male	62 (100)	55 (94.8)	54 (85.7)	50 (96.2)	40 (100)	44 (100)	31 (100)	336 (96.0)
Fishing experience (years)								
<5	28	23	23	24	19	12	12	141 (40.3)
5–10	10	11	10	9	7	7	6	60 (17.1)
10–20	10	8	9	5	2	8	5	47 (13.4)
20–30	11	10	14	8	8	9	5	65 (18.5)
30–40	3	6	6	6	2	7	3	33 (9.4)
40–50	–	–	1	–	2	1	–	4 (1.2)

careers in those areas. There was unanimity on the decline in the abundance of fishery stocks and the availability of fish in both age groups. However, the perception of change was high among old age group of fishermen than middle and younger ones (Tables 3 and 4). The majority of fishermen (73%) belonging to older age group perceived that the current size of the fish catch has declined drastically, while only 47% and 19% from the middle and younger age groups, respectively, share the view. As is evident from Table 5, majority of the respondents consider the stocks as depleted and degraded due to overharvesting and the use of damaging methods, especially dynamite fishing. Further probe on causes of degradation shows other factors such as extreme wind events and strong storms, rise in population, and to some extent sewerage discharge, especially in areas around Tanga City. Fishermen in older age group explain how the catch and fish availability declined over time more clearly based on previous experience compared to middle and younger age groups.

In general, fishermen have not explored the whole sea (Van der Elst et al., 2005) and therefore were highly uncertain about the presence and abundance of fish species as many species could still unknown to them. Over 60% of respondents mentioned that decreased level of fish catch has worsened their well-being, for example, they have a fewer meals a day or sell their fishing gear to immigrant and other well-off fishermen to meet their daily needs. At the same time, because of low catch, economies of scale for processing of fish at the landing sites do not work out well as in the past.

Fishermen also identified several commercially important fish groups or species found in their vicinity as highly affected by fishing activities (Table 6). Most of the respondents mentioned groups of finfish, such as *Lethrinidae* and *Lutjanidae* (Swahili: Changu); *Serranidae*; *Siganidae* (Swahili: Chafi); *Mullidae*, sharks (Swahili: Papa), sardines (Swahili: Dagaa); large and small pelagic species (*Carangidae, Scombridae, Cluepidae, Engraulidae*, etc.), as well as prawns, octopi and sea cucumbers as threatened by inappropriate fishing practices, the impact of climate change, and consequently found fewer quantities in their catch. This is consistence with the general exploitation status of commercial fish observed in Tanzania. A current report by TAFIRI (2012) indicates that the fishery for crustaceans; prawn, octopus, rock lobster and fish; small pelagic (sadinella) and tuna all shows a general decline of the resources (see Fig S1 and S2 available as supplementary information).

The mean number of species lost was, however, very different amongst the age groups, as young fishermen on average reported only two species (SD ± 0.1); middle-aged fishermen mentioned an average of five species (SD ± 0.3); and older fishermen reported an average of nine species (SD ± 0.5) to have been lost during the past four decades. The mean number of depleted species is statistically significant (Kruskal–Wallis Test, $\chi^2 = 135.689$, $d.f. = 2$, $p < 0.001$) among the three generations of fishermen.

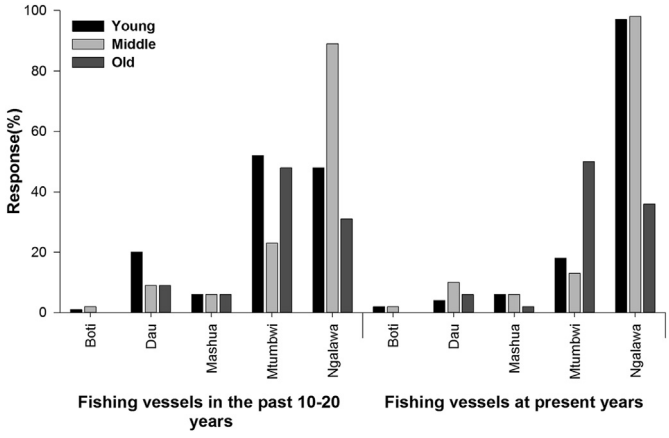


Fig. 2. Common types of fishing vessels used by different age groups of the respondents. Notes to Fig. 2: Respondents said that majority of the vessels are small and sail-powered and often operated by the owners of the vessels. Their names in English are: Ngalawa [dugout canoes, ranging from 3 to 6.5 m long, propelled by sail]. Mtumbwi [simple dugout canoe propelled by paddles or small sail, ranging from 2 to 4.5 m long]. Dau [dhow with wooden plank, ranging from 3 to 6 m long, propelled by sail]. Mashua [large wooden planked boat with flat stern, propelled by sail or engine ranging from 6 to 12 m long]. Boti [fibre glass boat propelled by engine, ranging from 3 to 10 m long]. (Source for names: Masalu et al., 2010).

Table 2
Most frequently visited fishing habitats and distribution of fishing gears as mentioned by respondents ($n = 350$).

Type of habitat[a]	Age groups *N* (% of respondents)			Overall
	Young	Middle	Old	
Deep waters beyond reefs	27 (28.95)	33 (47.37)	54 (23.68)	114 (32.57)
Estuaries and bays	15 (30)	24 (48)	11 (22)	50 (14.29)
Inshore waters (coral reefs, seagrass beds, mangroves)	85 (45.70)	72 (38.70)	29 (15.60)	186 (53.14)
Fishing gear[b] (type)				
Handlines	67 (46.53)	46 (31.94)	31 (21.53)	144 (41.14)
Longlines	3 (42.86)	3 (42.86)	1 (14.28)	7 (2.00)
Nets	42 (33.87)	62 (50.00)	20 (16.13)	124 (35.43)
Traps	9 (14.52)	14 (22.58)	36 (62.90)	62 (17.71)
Others	6 (46.15)	4 (30.77)	3 (23.10)	13 (3.71)

[a] Respondents would prefer deep waters but are restricted by a lack of vessels that could make them reach there.

[b] Multiple gears are embraced by fishermen. Distribution is based on the uses and not preference as most respondents said that they would prefer nets (gill nets) to handlines and traps. Respondents were often using the same name for seine, gill and fine nets, in a collective term as nets (*nyavu*).

Table 3
Fishers' opinion on the current status of the fishery stock ($n = 350$) expressed as the percentage of respondents.

Age groups	Current status of fishery stock (% of respondents)			
	Overfished	Not overfished	Uncertain	Don't know
Young	8.29	20.00	6.00	2.00
Middle	11.14	10.29	10.29	5.14
Old	18.00	2.29	6.29	0.29
Overall	37.43	32.57	22.57	7.43

Table 4
Perceptions of fishers of different age groups on the current catch trend as compared to when they started fishing career ($n = 350$).

Age groups	Current state of the size of fish catch (% of respondents)					
	Decreased a little	Stationary	Decreased strongly	Increased a little	Increased strongly	Do not know
Young	6.29	17.14	1.43	8.29	1.14	2.00
Middle	16.86	9.71	4.00	5.71	–	0.57
Old	10.29	2.86	12.57	1.14	–	–
Overall	33.43	29.71	18.00	15.14	2.57	1.14

Older fishermen remember catching snappers, *Siganidae*, *Labridae*, and *Lethrinidae*, at a short distance (up to 30 m) from the coast and even in beach waters which they now perceive as devoid of these species. During participant observations, some fishermen, especially old and middle-aged ones, recounted how they gave excited chase to several large fish rarely encountered inshore, including several giant trevally (*Caranx ignobilis*). The mean best catches the older ones recalled were in the range of 400–700 kg in 1970s and 1980s. This is substantially higher than that of younger generation that reported estimations of 50–200 kg maximum catches in 1990s and 2000s. In general, the perceived trends on number of species and fishing grounds lost, and the weight of the best catch was clearly highlighted by fishermen (Fig. 3).

Increasingly majority of the old and middle-aged fishermen interviewed reported to catch and keep the fish they would have otherwise returned to the sea in the past. This includes fish with tough meat (e.g. *Acanthurus triostegus*), unpleasant flavour (e.g. *Rhinecanthus aculeatus*), with scales difficult to remove (e.g. *Cofis formosa*), or other undesirable characteristics including many small bones or lots of blood that were not used as food or sold when fish were bountiful. More interestingly, over two-thirds of old-aged fishermen reported that herbivorous fish such as rabbit fish, and a variety of snappers and emperors make up much of their catch today, but these species were less desirable when tuna, marlin, and kingfish were abundant two–three decades ago. Species such as *Coryphaena hippurus* (Swahili: Fulusi), *Hemiramphidae* spp (Swahili: Chuchunge), *Arridae* spp (Swahili: Hongwe), *Nemipteridae* spp (Swahili: Koana) and anchovies (Swahili: Dagaa/Uono) are currently highly sought after even though they were previously invaluable from both social and economic points of view. Supplementary information in Table. S1 show the species considered most important by the respondents.

3.4. Fishermen's perceptions on depletion of fishing grounds and state of environment health

Interviewees were asked to identify areas that have previously been productive (in terms of fish yields), but may now be less productive or degraded and depleted. Anecdotal evidence, based on experience and personal opinions on the number of depleted fishing areas among the three generations of fishermen yielded valid data and the subsequent statistical analysis provided significant results (Kruskal Wallis, $\chi^2 = 139.689$, $d.f. = 2$, $p < 0.001$). There was significant difference among the three age groups ($p < 0.01$) to queries on the condition of coral reefs as an indicator of the health status of the marine environment (Fig. 4). This concurs well with information from other studies such as that of (ASCLME, 2012; León et al., 2004; TCMP, 2003) on the status of marine ecosystems in Tanzania.

4. Discussion

The study findings show substantial differences in the opinions and perceptions of different generations of fishermen, with each age group implicitly attempting to tell what were once present but are no longer recognised within their known coastal and marine ecosystems. The increased decline in commercial and preferred fish species has a negative impact on local eating preferences at these sites as described by old-aged fishermen. For instance, currently there is a growing interest in consuming species such as small pelagic fish species, including small mackerel (*Scrombidae*), sardines (*Cluipeidae*), anchovy (*Engraulidae*) and scad (*Megalaspis cordyla*), which were overlooked in the past. Majority of fish species that were once present would be unrecognisable to younger people now, which were abundant only a few decades ago, and most young fishermen are surprised that certain species were common in their areas at one time.

Regardless of the absence of ecological data, identification of changes occurring in ecosystem over time, at least for the past four decades, highlights how the environmental baseline has shifted to such an extent of not including species that were found in the past. Even though many young fishermen hail from fishing families, the knowledge of historical conditions has apparently not been passed on or at least they have not been assimilated it. Hence since lots of useful information about the past is not recorded, the memory of old fishermen of what things looked like in the past, can serve as valuable information about changes in the fishery. This could help to avoid the shifting baseline syndrome in management goals and in societies where there is no strong data archival systems (Silvano and Valbo-Jørgensen, 2008; Silvertown et al., 2010).

Most fishermen's groups interviewed perceived that fish catches were declining, supporting the little empirical evidence on scarce fish stock assessments in Tanzania (Sobo, 2012). Declines in fish catches observed in the study sites may be due to increasing number of fishermen, evident in the last 2–3 decades, and the pressure exerted on small fishes that do not contribute significantly to total weight in catch (Division of Fisheries, 2013). More

Table 5
Factors mentioned frequently for the causes of the decline in fish catch and degradation of fish habitats ($n = 350$).

Age groups	Cause of decline in fish catch and degradation of habitats (% of respondents)				
	Destructive fishing practices	Overexploitation of marine resources	Population growth	Increased market price for fish	Extreme weather events
Young	11.38	11.38	8.98	3.89	1.50
Middle	8.68	10.18	10.18	5.99	1.50
Old	10.48	5.99	5.99	2.99	0.90
Overall	30.54	27.54	25.15	12.87	3.89

Table 6
Variety of fish families and other marine organisms identified by interviewees as depleted by fishing activities and climate change impacts.

Family or species name	Young (127)	Middle (129)	Old (94)	Total[a]
Serranidae	33	75	79	187
Sharks	54	69	60	183
Sea turtles	36	60	75	171
Sea cucumbers	21	59	89	169
Penaedidae (Shrimps/Prawns)	34	60	67	161
Istiophoridae	42	43	68	153
Scrombidae (Hora Mackerel)	60	51	42	153
Palinuridae (Lobsters)	25	55	73	153
Loliginidae (Squids)	29	49	66	144
Carangidae	26	48	61	135
Octopopidae (Octopus)	19	53	58	130
Lethrinidae	22	43	59	124
Chaetondotidae (Butterfly fish)	35	45	41	121
Lutjanidae	31	45	44	120
Scaridae/Labridae	17	44	59	120
Chanidae	13	36	59	108
Ariidae (Cat fish)	20	33	46	99

[a] The frequency indicates the number of fishers who identified a particular species as depleted.

specifically, the decline in catches constructed from interviews is in line with the information provided by Wells et al. (2007), who found the annual catch per fisherman to have declined from 2.4 metric tonnes in 1970 to 1.0 metric tonnes in 1993, as a result of doubling of the number of fishermen.

Essentially, the novelty of this study is in the ability of respondents to present their perception of the state of resources playing a significant role in shaping the local management of fisheries. Despite sporadic collection of catch data in some areas of Tanzania's coast (Division of Fisheries, 2013), at least for the main species, its reliability has been questioned. By demonstrating the rate at which some fish species are lost, the findings of this study may be important in framing people's perceptions of the marine ecosystems especially in the present time where many younger people are migrating to urban areas and have less contact with the sea now. The interviewed fishermen are able to explain the phenomena and this shows that at least some age groups are aware of the changes taking place. This in turn may help for future ecologists in Tanzania to understand the legacy of environmental change that they will inherit from current generation.

Unfortunately, information collected from interviews does not allow evaluation, for example, of the most abundant species and statistically compare their frequency of occurrence for a multidisciplinary assessment. Thus, it is uncertain to say of relative abundance of those species in the past as long-term catch records are not available. Such information need to be treated cautiously since accuracy of memory could be higher for events that are unique in fishermen's life (Daw, 2008) However, in areas such as Tanga where degradation especially of coral reefs has been significant and fishing control is minimal (Anderson, 2004; Wells, 2009), absence of long-term fisheries records is unlikely to limit delineating varyingly precipitous decline in innumerable fish species. Rather, it would be more appropriate to consider fishermen's local knowledge, which could suggest local harvesting of resources with respect to depletion of fisheries (Daw, 2010), but with well designed and tested interview methods that can give a lot of insight into resource and its users.

Along the Tanga coastline, it is obvious that the main drivers of SBS are socio-economic and cultural factors rather than the biological factors as noted in other areas (Bunce et al., 2008). Although not well established, FGDs attribute the widespread use of destructive fishing gear, especially dynamite with maximisation of fish catches and quick gains, to the decline in fish species. Respondents complained of lack of financial resources and empowerment, which could have boosted their fishing activities. On other hand, some, especially younger fishermen, thought that absence of empowerment has restricted their capacity to reach unexplored fishing grounds and thus they were optimistic that the environment has not changed as badly as described by older fishermen. The other reasons are the growing number of fishermen accompanied by a significant shift from traditional fishing gear to non-traditional ones, such as ring nets (which require significant manpower), as well as increased domestic demand for sardines and anchovies in mid-1990s (Malleret-King et al., 2003). These all contribute to increase in effort, which reduces fish stock, eventually leading to decline in catch per unit effort, which in turn could shape local perception of the status of resources and ecosystems.

All the fishermen interviewed as part of the present study were found to have a good knowledge of the local marine ecosystems. It is clear that their skills and knowledge represent parts of their human capital and this particularly valuable asset could be used for resource management. Indeed, they were found to have strong social networks, which they use to inform each other of the migration destinations in search of good fishing grounds, sightings of fish and their locations, thus reducing cost and time searching for fish. Although this observation was not previously noted in similar studies on SBS, networking is an essential part of social capital and it is obvious that low social capital may contribute to loss of information about the environmental baseline leading to shifting perceptions.

Although the study was limited to most commercially significant species, its findings can be used to draw attention of this extremely important economic sector and serve as a foundation for sustainable management and intervention plans. This is

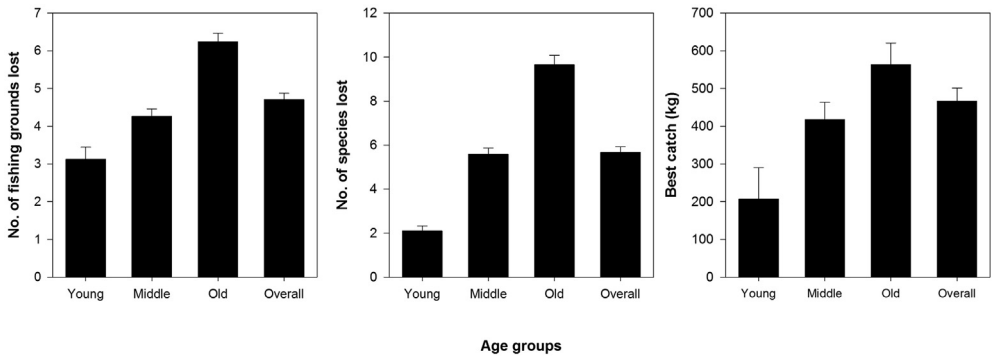


Fig. 3. Fishers' perceptions on the mean number of species and fishing grounds lost, and the best fish catch by the three generations of fishers.

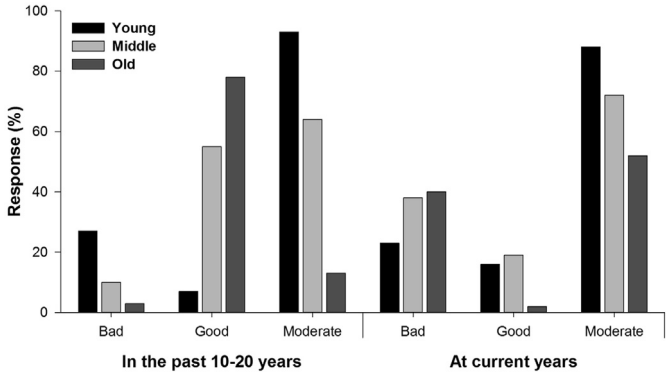


Fig. 4. Fishers' perceptions on the healthy status of the environment expressed as condition of coral reefs.

particularly important given the limitations of currently available scientific knowledge. For instance, widespread failure to sustainably manage fisheries highlight the limitation of conventional data collection approaches to fisheries science and management (Hilborn, 2007). These and similar cases highlight the importance of fishermen's knowledge (even though anecdotal, still highly valuable) in understanding and managing fisheries (Johannes and Neis, 2007; Johannes et al., 2000).

Assessing evidence for shifting environmental baseline represents a major challenge for ecosystem-based management; as such studies suffer from difficulty in validating data and interpreting findings. To alleviate such problems, social and biological information must be integrated (Papworth et al., 2009). The current study reveals that reality and history of the developing world has not provided reason for people to document biological changes as they are more concerned with meeting their basic needs. Furthermore, the availability of photographs, articles among other ways to document change, need cameras and expertise that are unavailable even in the 21st century to many of these communities.

Fishermen's perceptions and opinions were the central sources of information during this study. However, perceptions are accumulated over time from personal experience and information networks and are the result of fishermen's mental processing of data, which is formed by their own prior knowledge, theories and instincts. Thus, fishermen's observations might be biased, erroneous and/or even unrealistic and thus should be treated cautiously and used judiciously as only a source of information. As a future study, one might explore using the knowledge of the fishermen to overcome the shortage of traditional data on fisheries.

5. Conclusion

This contribution suggests that interviews with knowledgeable local fishermen can be useful in studying the past as a way to protect and conserve fisheries resources for the future. This is highlighted by presenting cross-generational differences on perceptions embraced in the SBS, whereby older fishermen appear to be aware of the depletion of various species and fishing grounds, compared to young and middle-aged fishermen. This however, suggests lack of consistent knowledge transfer from one generation to another. It is clear that the fishermen's local knowledge should not be taken as equivalent to scientific knowledge because of large discrepancies and differences in opinions (Shackeroff et al., 2011). However, when no or insufficient formal data is available, as is the case in this study, anecdotal evidence is essentially a starting point for ecological studies (Turvey et al., 2010). Indeed, it may highlight many ways in which humans and their environment are connected as a way to understanding changes in ecosystems and planning for sustainable management (Parsons et al., 2009). Overall, this may be helpful in identifying less contentious plans such as in demarcating Marine Protected Areas. The main challenge in the application of SBS studies is to convince policy makers that environmental changes are occurring and that the ecosystems are not the same as they once were (Al-Abdulrazzak et al., 2012). Moreover, unlike previous studies on shifting baseline, the present findings point to the need to consider external factors such as presence or absence of empowerment to fishing communities and asset endowments when looking for changes in resource base, as this could enhance the ways to harness natural resources.

Acknowledgements

This study was funded by *Deutscher Akademischer Austausch Dienst* (DAAD) – German Academic Exchange Service. I would like to thank Dr. Kathleen Schwerdtner Mánez for her inspiration, supervision, leadership and generous support in the design of this study, and Paul Tuda for his assistance with data analysis. Iam especially grateful to many fishermen and fisheries officials in the field who participated in the interviews, and the logistical support provided by Hassan Kalombo of the Tanga Regional Secretariat. Special thanks to Fatma Sobo for fish catch and effort data; many regards and gratitude to statistic unit of Fisheries Division for some data to this study. Finally, I wish to express my gratitude to three anonymous reviewers for their insightful comments.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.ocecoaman.2014.01.009

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