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Best for pleasure, not for business: evaluating recreational marine fisheries in West Africa using unconventional sources of data

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ABSTRACT West African recreational fisheries, previously overlooked, are often assumed to be insignificant, yet they are increasingly present on social media given anglers' tendencies to document their experiences. It is important to catch the trend early on as recreational fisheries develop in order to support their sustainable development and to make the most of the alternative economic opportunities that they offer. Here, the recreational fisheries of 11 West African countries are assessed using tourist records from YouTube, blogs and other unconventional records. We introduce the concept of "Recreational-to-Commercial Ratio (RCR)", that is, the market-equivalent value per tonne of recreational fish injected to the economy, which is similar to "willingness to pay" for fish caught for recreation. Since the recreational fisheries of West African countries gained popularity in the last few years, catches increased and reached a total of 34,000 t annually, none of which was reported in official fisheries statistics. Recreational catches through a total annual revenue of US\$152 million had an RCR of approximately 7, which means that developing recreational fisheries would increase the value of fish (whether caught or released) sevenfold. These findings could have major implications for the economy and conservation of fish stocks in West African countries.

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Introduction

In West Africa, the value of fisheries is often viewed as deriving from the landed value, the fees paid for access to local fishing grounds by foreign distant-water fleets and by the foreign currency gained by exporting locally caught fish (Belhabib *et al.*, 2014b). However, the gains are often trivial compared with the potential economic contribution of the fishery. Indeed, China and Europe, for example, were found to pay as little as 4 and 8% of the landed value, respectively, to access West African fishing grounds (Belhabib *et al.*, 2014b). Moreover, using the landed value of commercial fisheries and access fees as a proxy for economic contribution of fisheries usually excludes the local value chains and the employment they generate. This results in underestimating the contribution of non-commercial and small-scale sectors such as artisanal and subsistence fisheries (Belhabib *et al.*, 2015c). Their contribution to the Gross Domestic Product (GDP) is estimated at 6% on average and can reach up to 40% in the Gulf of Guinea (Belhabib *et al.*, 2015c). In addition, with a high number of people depending on them, (4.9 million people including artisanal fisheries (Belhabib *et al.*, 2015c)), subsistence fisheries can play a vital “buffer” role during wars, civil or other (Medeiros, 1982), and disasters (Anon, 2013), for example, in Angola, act as vector for economic growth, for example, in Guinea Bissau (Dia and Bedingar, 2001) and Ghana (Bennett, 2002), and contribute to poverty alleviation, for example, in Morocco (Belhabib *et al.*, 2012). Similarly, recreational fisheries provide alternative livelihoods through chartering artisanal or other commercial fishing boats (Pawson *et al.*, 2008) and providing jobs for guides and service personnel in resorts (Potts *et al.*, 2009).

However, given the general scarcity of quantitative data on this sector, recreational fisheries are usually assumed to be non-existent in West Africa, and thus their economic contribution is commonly set as zero (Cisneros-Montemayor and Sumaila, 2010). This, along with a general lack of monitoring, further contributes to underestimating the impact of non-commercial fisheries both on coastal communities and on ecosystems.

In West Africa, most recreational fisheries are practiced by foreign tourists (Cabral, 2005; Potts *et al.*, 2009), attracted by exotic destinations and fish stocks perceived as “pristine”, and encouraged by increasing political stability (Potts *et al.*, 2009). Tourism can have a large footprint on a developing economy, but also the social political stability of a country. Thus, maintaining a safe image is one of the prerequisites for tourism development (Richter, 1992). In Morocco, tourism is the second largest source of foreign currency and employs around 6% of the working population (Caffyn and Jobbins, 2003), not accounting for the informal economy, and contributed about 20% of Morocco’s GDP in 2014 (Turner, 2014). Tourism contributes between 1% (Angola) and 23% (Cape Verde) of the GDP,¹ fuelled by an increasing interest in fishing tourism and fishing “safaris”. It is essential to catch the trend early as recreational fisheries develop to allow coastal communities to obtain a sustainable benefit from what could quickly become a long-standing recreational fishing destination. In the absence of catch data in official records (Cooke and Cowx, 2004) often because of budgetary constraints (Aas, 2002; Potts *et al.*, 2009), catch reconstructions provide an alternative that assesses recreational fisheries catches, which will help further address questions regarding the economic contribution of recreational fisheries and how these may be developed sustainably, that is, to avoid negative impacts on the environment.

Recreational fishing generates exceptionally high expenditures because of the high willingness of recreational fishers to pay for catching fish, even when these are released. This means that, in addition to the revenue that recreational fisheries generate, they

also are very important for conservation (Cooke and Schramm, 2007; Cisneros-Montemayor and Sumaila, 2010).

This article reconstructs recreational fishing catches and then analyzes the benefits of recreational fishing, that is, their importance for local economies, and contrasts the results with the view that these fisheries are negligible (Cisneros-Montemayor and Sumaila, 2010). It introduces the Recreational-to-Commercial Ratio (RCR), a concept that compares the value of recreationally caught fish with that of the fish caught commercially; this then leads to policy recommendations differing strongly from the benign neglect so far predominant.

Methods

This article uses three indicators: (1) recreational catches are used to compare recreational fisheries with commercial fisheries rather than a metric as recreational fishing is mainly driven by leisure; (2) the number of participants is assessed to measure popularity and the importance of the recreational fishing activity in each country; and (3) the total expenditure (or total revenue) is assessed, which when combined with (1) allows to estimate the RCR.

Definition of recreational tourism. Recreational fishing includes all fishing activities that are not deemed to be for consumption or commercial purposes. The fish that is caught is usually not sold, not taken for subsistence and cultural purposes (Pawson *et al.*, 2008; Cisneros-Montemayor and Sumaila, 2010). Although this definition is broad enough for the scope and purpose of this analysis, an emerging model of fishing tourism suggests that many tourists pay for their trip by selling the catch they obtained through recreational fishing, particularly in West Africa (Belhabib *et al.*, 2012; Belhabib and Pauly, 2015). Therefore, our definition here should also include the motivation (that is, leisure), regardless of the fate of the fish caught.

Study area. This article analyzes recreational fishing in 11 countries of the Western part of the African continent whose catches could be assessed (Fig. 1), representing each of the Large Marine Ecosystems (LMEs) of West Africa, that is, the Canary Current LME (Morocco, Mauritania, Cape Verde, Senegal, The Gambia and Guinea Bissau), the Guinea Current LME (Ghana, Togo, Equatorial Guinea)

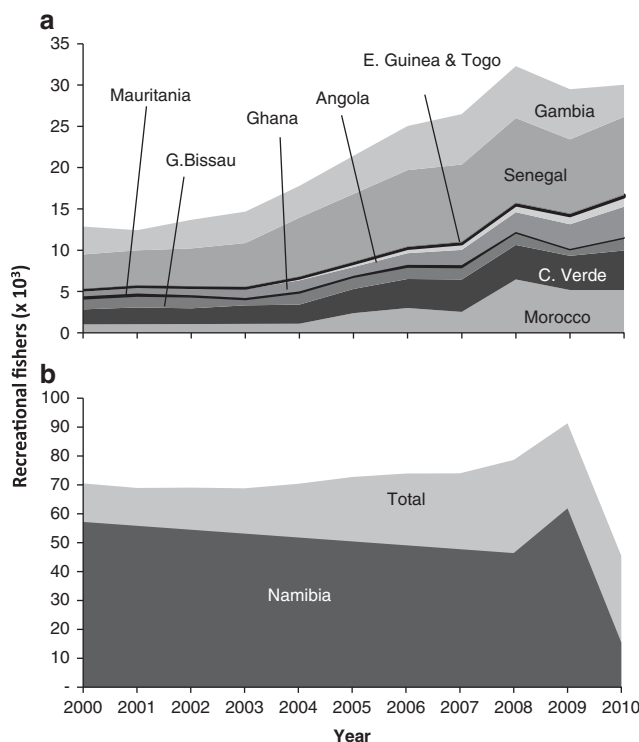


Figure 1 | Estimated number of recreational fishers in West Africa. (a) Ten countries and Namibia; (b) the cumulated number per country for the remaining ten countries, 2000–2010.

and the Benguela Current LME (Angola, Namibia). One common feature shared by these 11 countries is that recreational fishing is known to occur in their marine waters, but that its value was deemed negligible (Cisneros-Montemayor and Sumaila, 2010). Another common feature, beyond poverty and a troubled past (McGrath, 1993; BBC, 2015; Belhabib, 2014), is the emergence of these 11 countries as touristic and eco-touristic destinations, mainly because of their growing political stability and openness to foreign investments. Having coastal waters reputed to be “pristine”, notably because of marine and world heritage parks such as the Bijagos in Guinea Bissau and the Banc d’Arguin National Park in Mauritania (Belhabib *et al.*, 2012), also helps.

Profile of recreational fishers in West Africa. Most recreational fishing in the 11 countries that are emphasized here is conducted by tourists as the purpose or part of their visit as individual adventurers or through an organized model called “fishing safaris” (Belhabib *et al.*, 2012) staying in hotels or fishing camps (Belhabib and Pauly, 2015). We assume that occasional fishing by nationals, also qualified as “Sunday fishers” (Belhabib *et al.*, 2014a), may be—in part—performed for purposes other than recreation, such as subsistence or for trade. Sunday fishing is not included herein, thus making our assessment conservative.

Fishers’ population. The number of recreational fishers, usually foreign (except in Morocco), was estimated using methods that differed between countries. Notably, we found records for and used the number of fishers (domestic and foreign) corresponding to the number of recreational fishing licenses or permits for Morocco (Abdelouai, 2010; Belhabib *et al.*, 2012) and Namibia (Belhabib *et al.*, 2015d), extracted directly from recreational fisheries records for Mauritania (Tomatis, 2001; Diarra, 2009; Ould Mohamed, 2010; Belhabib *et al.*, 2012), the number of tourists availing themselves of fishing safaris, lodges and fishing camp and club services in Guinea Bissau (Anon, 2010; Belhabib and Pauly, 2015), Togo (Belhabib and Pauly, 2015), Equatorial Guinea (Belhabib *et al.*, 2015a) and Angola (Potts *et al.*, 2009; Potts *et al.*, 2011; Belhabib and Pauly, 2015), and extrapolated in proportion to the total number of tourists using rates available from fishing safari companies for Cape Verde (Belhabib *et al.*, 2012) and Senegal (Belhabib *et al.*, 2014a) or official records for Ghana (Nunoo *et al.*, 2014). In all cases, a combination of at least two of these methods, along with interpolations, were used (see Supplementary Information).

Catches and catches per fisher. Fishing can be conducted on beaches or from small boats that may be chartered from small-scale commercial fishers (Belhabib and Pauly, 2015). Catches were estimated as the product of the number of recreational fishers (or effort) and the number of fishing days per country and the corresponding individual catch per unit of effort (CPUE), derived from YouTube, illustrated blogs and/or records kept by fishers themselves (Fig. 6).

YouTube videos were used whenever they showed the number of recreational fishers with their fishing gear (as opposed to number of individuals in the videos) and/or the number of, for example, lines, and considered as the number of fishers (or fishing effort). When a catch is observed, a species is identified (whenever possible) using FishBase (www.fishbase.org [2015]) and its weight extracted from the video description when available. Whenever a measure of the weight was not available, the length of the fish was estimated on the basis of its relation to various objects in the videos, and then used jointly with a length–weight relationship from FishBase to estimate its weight. The total weight observed is recorded and divided by the number of fishers observed in the videos, along with the species composition. Non-successful trips that were recorded are also included, and their catch was set at zero.

The number of fishing days for Morocco was derived from Abdelouai (2010) at 70 days per year. The CPUE was derived from fishers’ observations from recreational fishing company blogs and records and estimated at 58.8 kg-fisher⁻¹.day⁻¹ for rod-fishing and between 17.14 kg-fisher⁻¹.day⁻¹ and 28 kg-fisher⁻¹.day⁻¹ for spear-fishing in the Atlantic and Mediterranean areas, respectively (Belhabib *et al.*, 2012).

Another unconventional data source is the “golden book” (*livre d’or*) kept by the *Baie de l’Etoile* lodge in Mauritania, which contains over 30 years of observations by recreational fishers on their fishing experience, including comprehensive descriptions of catches, species and in many cases the length of the fishing trip and the weather. Using the records of the *livre d’or* (which in effect complements official statistics), the CPUE per tourist for Mauritania was estimated by dividing total catches reported by the number of tourists, that is, 30.5 kg-fisher⁻¹.day⁻¹ for the period between 1995 and 2007 and extracted as an average from a fishing safari company based in Banc d’Arguin National Park at 30 kg-fisher⁻¹.day⁻¹ (Belhabib *et al.*, 2012).

Similarly, a fishing safari company’s blog made it possible to assess the CPUE for Cape Verde recreational fisheries, here set as one quarter of the average catch taken by the most successful fishers, as extracted (Belhabib *et al.*, 2012), that is, the catch of trophy fish at 31 kg-fisher⁻¹.day⁻¹.

For Senegal, the CPUE was taken as the lower limit of the range of 35–350 kg-day⁻¹ provided by the Federation of Sports Fishing of Senegal (M. Mamadou Sow, President of the Senegal Federation for Recreational Fishing, personal communication), which allows for a more conservative estimate.

The CPUE between 2000 and 2010 is the result of an interpolation between an estimated CPUE that is 10% lower in 1950 and the above-estimated CPUE for 2010 to reflect—at least symbolically—on the general overexploitation pattern of nearshore species observed in Senegal (Belhabib *et al.*, 2014a).

To estimate the recreational CPUE for The Gambia, we combined observations from six YouTube videos posted by tourists and recreational fishing companies in The Gambia, with photos of fish catches and their weight provided by www.african-angling.co.uk [2013] between 2008 and 2010. Overall, 54 observations were collected for 63 tourists. The weighted average CPUE was estimated at 14.5 kg-tourist⁻¹.day⁻¹ and assumed constant in the 2000s (Belhabib *et al.*, 2013).

To estimate the catch per fisher for Guinea Bissau, we collected species and weight catch data from 30 YouTube videos documenting the experience of recreational fishers. From these, we could assemble catch data for 25 tourists and 17 fishing days, and estimated the catch per day per tourist by dividing the resulting total catch by the number of tourists and filtering out the released catch (representing 12%). The CPUE was then estimated at 18.7 kg-tourist⁻¹.day⁻¹ (Belhabib and Pauly, 2015).

For Ghana, Nunoo *et al.* (2014) used YouTube records documenting 25 fishers to estimate the average CPUE based on the species and the average weight caught by each tourist at 32.6 kg-tourist⁻¹.day⁻¹.

For Togo, we estimated the CPUE on the basis of four YouTube videos posted by recreational fishers/clubs from Togo, which showed the species caught and the number of recreational fishers (5). We approximated the weight for each species, and then estimated the mean CPUE as 13.6 kg-fisher⁻¹.trip⁻¹ (Belhabib and Pauly, 2015).

As all travelers to Equatorial Guinea need a travel and a photographic permit, YouTube videos were very scarce, and only two of them, documenting four fishers, could be used to estimate an average CPUE of 14 kg-fisher⁻¹.trip⁻¹, which was assumed constant between 2000 and 2010 (Belhabib *et al.*, 2015a).

For Angola, catch per fisher data were recorded for the period between 1992 and 2013 (Anon, 2014), published in www.fapd.co.ao. Although these data may refer to trophy fish catches (average: 2.83 ± 1.07 kg-fisher⁻¹.hour⁻¹), these data were not very different from the catch per fisher data provided by Potts *et al.* (2009) between 2005 and 2010 (average: 2.2 ± 0.03 kg-fisher⁻¹.hour⁻¹). Interestingly, recreational CPUE estimated using nine YouTube videos resulted in similar results (average: 2.56 ± 0.53 kg-fisher⁻¹.hour⁻¹) for 5 h-day⁻¹ (Belhabib and Pauly, 2015).

For Namibia, Barnes *et al.* (2002) estimated the daily catch per angler at 6.06 kg-angler⁻¹.day⁻¹ for 1996 for 8.2 fishing days over a total of 19.7 visiting days per angler (Kirchner and Stage, 2005). The latter argue that the CPUE has strongly declined in the latest years. Assuming the trend remained similar over the last few years, that is, from 2005 onwards, we assumed a decline of 50% between 1996 and 2011, that is, the CPUE is estimated at 3.23 kg-angler⁻¹.day⁻¹ for 2010 after interpolation (Belhabib *et al.*, 2015d).

The taxonomic breakdown of recreational catches, that is, the description of the catch per fisher was available from the original sources used to assess the CPUE, that is, YouTube videos, blogs, company Websites through images and other sources used herein. Whenever a description was not available, catches were recorded under the “marine fishes” category.

Estimating the revenue from recreational fisheries. Expenditure data are herein used as a proxy for the economic contribution of recreational fisheries (Cisneros-Montemayor and Sumaila, 2010). First, an estimate of all recreational fishing-related expenditures, including international travel, accommodation, fishing-related costs such as bait, licence, boat and/or equipment rental, in-country travel such as car rental and other trip associated costs was obtained. In a few instances these costs are all lumped, for example, in the case of fishing safaris, which include all the costs listed above, plus or minus travel expenditure. To avoid overestimating expenditure by including travel costs, whenever such costs were not provided in detail, international tourism expenditures extracted from the World Bank database (www.worldbank.org) were used. These represent payments for goods and services received in the destination country and therefore cover for job-related costs within the host country (Cisneros-Montemayor and Sumaila, 2010).

We investigated the actual expenditure (or the costs of engaging in recreational fishing) in Morocco, Mauritania, Cape Verde, Senegal, The Gambia, Guinea Bissau, Ghana, Togo, Gabon, Equatorial Guinea, Angola and Namibia. Three methods were identified depending on the activity type. The first type assumes that all costs are covered separately; in such cases, 7 cost factors have to be quantified: Travel expenditure, hotel, transportation, visas, bait, boat rental and permits. This applied to Angola, Equatorial Guinea and Morocco, for which data were extracted from the peer-reviewed literature and estimates of recreational fishers online (fishing blogs, fishing guide Websites and so on, see Supplementary Table 1). The second type includes semiinclusive fishing safaris in which all local costs (that is, excluding travel and visa costs) are offered as packages that include hotel, transportation, bait, boat rental and permits. These estimates were available from recreational fishing companies in Mauritania, Togo and Ghana (Supplementary Table 1). The last category represents expenditure of all-inclusive fishing safaris that cover all costs (incl. travel) and that are used here as a proxy for average costs per fisher. These applied to Namibia, The Gambia, Senegal, Guinea Bissau and Cape Verde.

Table 1 | Comparison between the number of artisanal fishers and recreational fishers in 11 countries of West Africa (2010)

Country	Artisanal fisher *	Recreational fishers	%
Morocco	75,600	5,180	7
Mauritania	16,700	100	1
Senegal	56,800	9,405	17
Gambia	1,400	3,890	278
Cape Verde	3,400	4,786	141
Guinea Bissau	5,900	1,476	25
Ghana	249,700	3,724	1
Togo	5,000	68	1
Equatorial Guinea	6,100	192	3
Angola	135,000	1,208	1
Namibia	200	15,461	7,730
Weighted average (Total)	(555,800)	(45,490)	8

*Number of artisanal fishers is extracted from Belhabib *et al.* (2015c)

Expenditures per recreational fishing trip were then multiplied by the total number of tourists to estimate total expenditure for each country as a proxy for the gross revenues generated by recreational fisheries in these countries.

Calculating RCR. The RCR represents the revenue generated from recreational fisheries catch, for example, in USD, relative to the revenue of \$1 in ex-vessel (commercial) value. The RCR is given as:

$$RCR = \frac{\text{Total recreational expenditure per tonne}}{\text{Total commercial revenue per tonne}}$$

The revenue per tonne of fish was derived by dividing the total expenditure (or willingness to pay) for each country by the corresponding total recreational catch. Then, the ex-vessel price per tonne (a proxy for commercial value) was extracted from the ex-vessel database (Swartz *et al.*, 2013), converted to real 2014 USD per tonne using CPI, and then compared with the recreational fish value to obtain the RCR.

Assessing uncertainty of catch estimates. The procedure to assess uncertainty of catches, described by Zeller *et al.* (2015), uses criteria inspired by the Intergovernmental Panel on Climate Change and attributes to the recreational fishing sector a “score” that evaluates their quality within a given time as (4) “very high”, (3) “high”, (2) “low” and (1) “very low” (Supplementary Table 2). Each score is assigned a confidence interval on the basis of a uniform distribution. Confidence interval ranges are determined using a Monte-Carlo simulation adapted from Ainsworth and Pitcher (2005) and Tesfamichael and Pitcher (2007) (Supplementary Table 2).

Results

Recreational fisher population. The number of recreational fishers in the 11 countries emphasized here (Fig. 1a) increased from around 71,000 in 2000 to a peak of 91,000 in 2009 before it declined to 45,000 in 2010. The pattern of peak and decline was mostly driven by the four-fold decrease in Namibia between 2009 and 2010 (Namibia’s fishers constituted 70% of the total number of fishers). However, given the differences in the tourism and popularity between these countries, it is better to report numbers of fishers by country (Fig. 1b). The number of fishers in Morocco, increased 6.5 times overall between 2000 (1,000 fishers) and 2008 (6,500 fishers) and then decreased to 5,200 fishers in 2010 because of a general decrease in tourism during economic downturn of the late 2000s. Similarly, the number of recreational fishers in Mauritania decreased from 315 in 2006 to 100 in 2010 because of socio-political and security-related issues (Belhabib *et al.*, 2012). In contrast, the number of fishers in Senegal has increased steadily from 4,000 in 2000 to over 9,000 in 2010 (Fig. 1b). Despite its relatively small size, The Gambia has beautiful beaches (Belhabib *et al.*, 2013) that attracted 3,000 recreational fishers in 2000, around 6,000 fishers in 2008 and less than 4,000 fishers in 2010 (Fig. 1b). Similarly, the number of recreational fishers increased almost linearly in Cape Verde from 1,200 in 2000 to 5,000 in 2010

because of the stability of the country, which plays a major role in its touristic reputation. This was not the case in Guinea Bissau, which experienced a marked decrease in the number of recreational fishers after the *coups d’état* (here: the illegal military seizure of government power) of 2003 and 2009 (Belhabib and Pauly, 2015). The number of recreational fishers in Ghana increased from 800 in 2000 to 3,700 in 2010. Similarly, the number of recreational fishers in Angola has increased strongly after the end of the civil war to 1,200 in 2010. Recreational fishers in Togo were estimated at only 30 in 2000, which increased to 70 in 2010. Similarly, the number of fishers in Equatorial Guinea increased from 70 in 2000 to almost 200 in 2010. Namibia’s numerous recreational fishers were estimated to have increased from 57,000 in 2000 to a peak of 62,000 in 2009, which declined to 15,000 in 2010 (Fig. 1a).

When compared with commercial figures, that is, the number of artisanal fishers (Belhabib *et al.*, 2015c), recreational fishery participation is estimated at 8% (Table 1). The highest rate of participation (recreational to commercial fishers) was assessed for Namibia, whose small-scale fishers are almost exclusively recreational fishers, The Gambia, whose rate was estimated at around 280%, and Cape Verde (140%). The equivalent of a quarter of the number of artisanal fishers in Guinea Bissau fish recreationally (Table 1).

Recreational fisheries catches. Catch per fisher (Table 2) was highest for Moroccan rod-fishing, which targets large pelagic fishes. Catch per fisher estimates were similar for Mauritania, Cape Verde and Ghana, but lower for Guinea Bissau and Angola, whose recreational fisheries are usually shore-based. The lowest catch per fisher recorded was for Namibia where the stocks commonly exploited by recreational fishers are severely depleted and where recreational fisheries are controlled by bag limits and licence fees (Barnes *et al.*, 2002). Using blogs and YouTube to estimate the catch per fisher yielded for Angola and Mauritania similar to slightly lower results than official and survey records, suggesting that blogs and YouTube can be used to estimate recreational catches. Catches were highest in Morocco because of the high number of fishing days and the inclusion of domestic recreational fishers in the estimation (70 fishing days-year⁻¹).

West African marine recreational catches increased from less than 5,700 t-year⁻¹ in 2000 to 29,800 t-year⁻¹ in 2010. Senegal ranks second in terms of catches, which increased from 700 t-year⁻¹ in 2000 to 1,600 t-year⁻¹ in 2010. Despite the high number of recreational fishers in Namibia, third in terms of catches, and the popularity of its recreational fisheries, a low catch

Table 2 | Number of recreational fishers (2010) and CPUEs per fisher (in kg·fisher⁻¹·day⁻¹), averaged for 2000–2010, as obtained from surveys, blogs and YouTube videos

Country	Fishers	Surveys	Blog	YouTube
Morocco; spearfishing	5,180	—	17.1–28.0	—
Morocco; rod fishing	—	—	58.5	—
Mauritania	100	30.5	30.0	—
Cape Verde	4,786	—	31.0	32.5
Senegal	9,405	35.0	—	—
The Gambia	3,890	—	—	14.5
Guinea Bissau	1,476	—	—	18.7
Ghana	3,724	—	—	32.6
Togo	68	—	—	13.6
Equatorial Guinea	192	—	—	14.0
Angola	1,208	14.2	—	12.8
Namibia	15,461	3.2	—	—

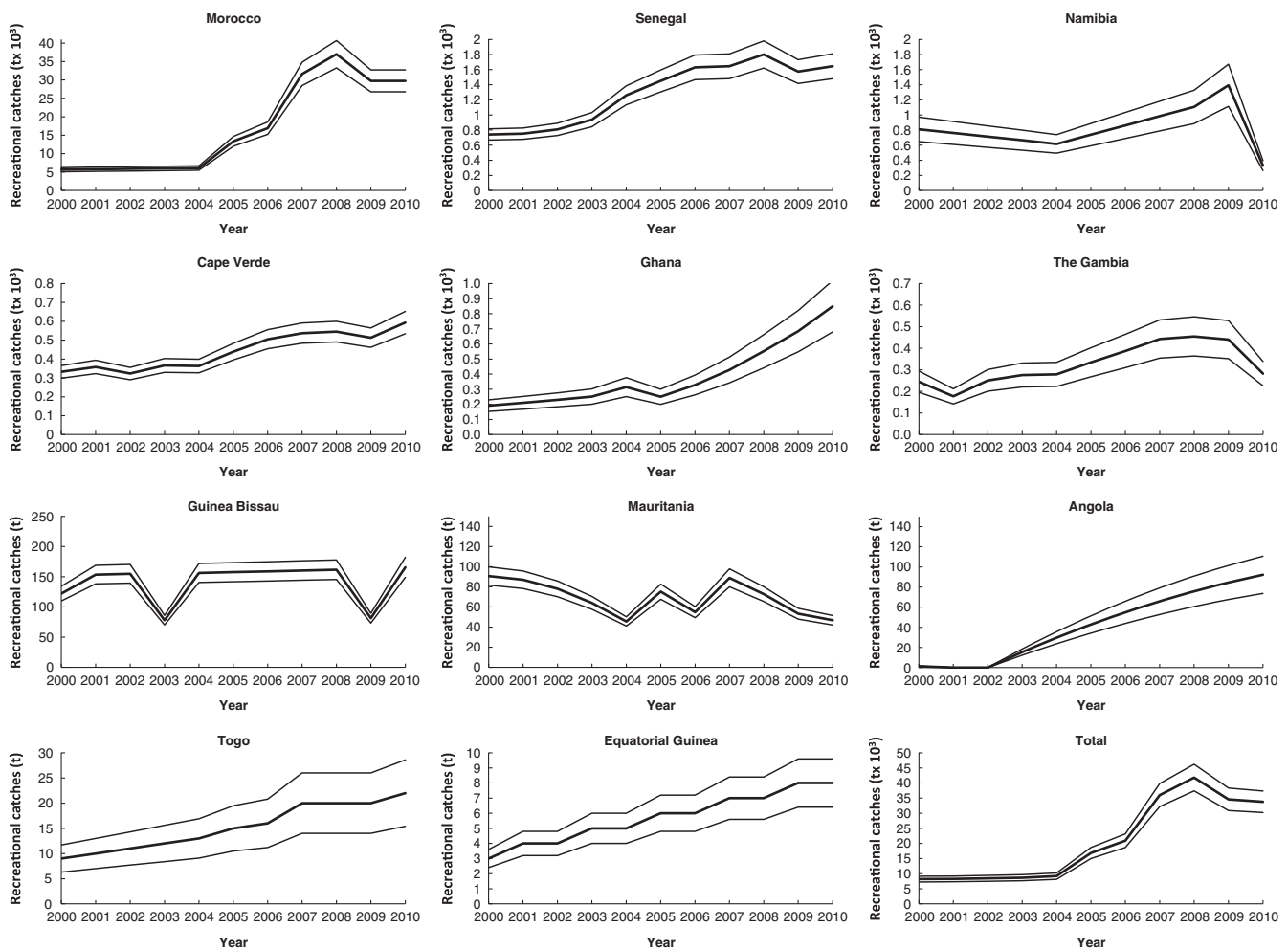


Figure 2 | Reconstructed recreational catches for 11 West African countries, 2000–2010. Thick lines represent the catch estimate for each country and the total, and thin lines represent the upper and lower bounds of the interval of confidence obtained using a scoring system and Monte-Carlo simulations.

per fisher or CPUE contributed to the decrease in catches from 800 t·year⁻¹ in 2000 to 300 t·year⁻¹ in 2010, with a peak of 1,400 t·year⁻¹ in 2009 because of a historical high in the number of recreational fishers. In contrast, recreational catches in Cape Verde increased exponentially from 332 t·year⁻¹ in 2000 to 600 t·year⁻¹ in 2010, in Ghana from 200 t·year⁻¹ in 2000 to

850 t·year⁻¹ in 2010 and in Angola from 1 t·year⁻¹ in 2000 to 90 t·year⁻¹ in 2010 because of the rapid increase in tourism (Fig. 2). Similarly, recreational catches increased in Togo and in Equatorial Guinea because of the increase in the number of fishing clubs and the number of tourists, respectively. However, recreational catches in Gambia have witnessed an important

Table 3 | Recreational fishing expenditure per tourist in West Africa (USD-year⁻¹)

Cost type	Type 1				Type 2			Type 3		Expenditure			
	Travel	Visas	Hotel	Flight	Bait	Boat	Permits	Safari	Flight	Visas	All inclusive	Per person	Total x 10 ⁶
Morocco	1,011	0	562	117	0*	698	150	—	—	—	—	2,538	13.14
Mauritania	—	—	—	—	—	—	—	1,049	—	64	—	1,647	0.16
Cape Verde	—	—	—	—	—	—	—	—	535	—	2,941	2,941	14.08
Senegal	—	—	—	—	—	—	—	—	—	—	3,450	3,450	32.45
Gambia	—	—	—	—	—	—	—	—	—	—	2,528	2,528	9.83
Guinea Bissau	—	—	—	—	—	—	—	—	—	—	3,412	3,412	5.04
Ghana	—	—	—	—	—	—	—	4,159	1,457	100	—	5,716	21.29
Togo	—	—	—	—	—	—	—	3,876	—	—	—	3,876	0.26
Equatorial Guinea	836	100	1,264	86	—	—	—	—	—	—	—	2,286	0.44
Angola	370	148	252	49	4	0	2	—	—	—	—	1,982	2.39
Namibia	—	—	—	—	—	—	—	—	—	—	3,400	3,400	52.57
Total (mean)	—	—	—	—	—	—	—	—	—	—	3,400	(3,336)	151.55

*Bait is included in the cost of boat rental

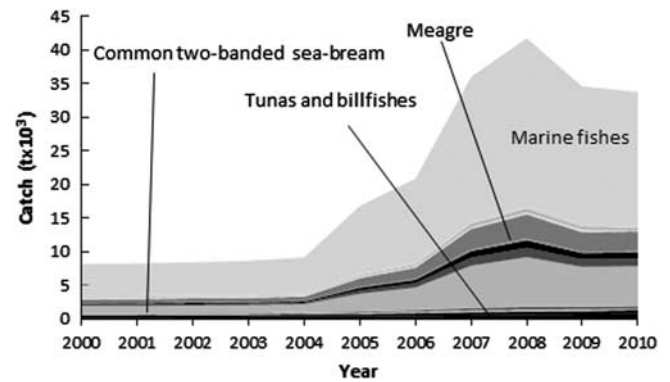


Figure 3 | Taxonomic disaggregation of recreational fisheries in 11 countries of West Africa, 2000-2010.

decrease since 2008 because of a gradual decrease in the number of visitors. Recreational catches decreased in Guinea Bissau and in Mauritania because of political and security upheavals (Belhabib *et al.*, 2012; Belhabib and Pauly, 2015) and were estimated at 170 t-year⁻¹ and 47 t-year⁻¹, respectively, for 2010 (Fig. 2). Overall, total recreational catches from these 11 West African countries, otherwise deemed negligible, were herein estimated at over 8,000 t-year⁻¹ in 2000 and 34,000 t-year⁻¹ in 2010.

The taxonomic breakdown of landed catches (that is, those retained as opposed to released fish) shows at least 50 taxa are targeted and caught. Although over half of catches were not identified and thus listed under the group “marine fishes”, other groups represented an important segment of the total catch, such as seabreams (15%), tunas and billfishes (5%), seabasses (4%). Sharks and rays represented 2%, and groupers (*Epinephelus* spp.) only 1% of the catch (Fig. 3). Other taxa include Alexandria pompano (*Alectis alexandrina*), Atlantic bumper (*Chloroscombrus chrysurus*), blue butterflyfish (*Stromateus fiatola*), bluefish (*Pomatomus saltatrix*), cobia (*Rachycentron canadum*), common dolphinfish (*Coryphaena hippurus*), European conger (*Conger conger*), golden grey mullet (*Liza aurata*), greater amberjack (*Seriola dumerili*), grey triggerfish (*Balistes capriscus*), guitarfishes (rhinobatidae), leerfish (*Lichia amia*), lefteye flounders (bothidae), Mediterranean moray (*Muraena helena*), other moray eels, mullets (mugilidae), porgies (sparidae), Sompat grunt (*Pomadasy jubelini*), tarpon (*Megalops atlanticus*), wahoo (*Acanthocybium solandri*), West African ladyfish (*Elops lacerta*) and other Perch-like fishes.

Economic contribution of recreational fisheries. The total annual expenditure, or “willingness to pay” by recreational fishers (Table 3) was the highest for Ghana (\$5,716·fisher⁻¹) driven by very high international travel and safari costs. Togo, whose recreational fisheries are on the verge of becoming a strong commercial sector (Belhabib and Pauly, 2015), has the second highest expenditure per fisher (\$3,900·fisher⁻¹). Individual expenditures for Guinea Bissau, Senegal and Namibia were also relatively high (\$3,400·fisher⁻¹ on average), whereas costs for Mauritania were lowest (\$1,647·fisher⁻¹), partly because of low international travel costs. Overall, countries with average recreational fishing costs, that is, Cape Verde with \$2,941·fisher⁻¹ and Morocco with \$2,538·fisher⁻¹ had the highest participation rate with 5,000 fishers on average annually, with the exception of Namibia (Fig. 1). Thus, affordability, along with the reputation of the country as a touristic destination, plays a determinant role in the performance of recreational fisheries and thus in participation rate.

Table 4 | Estimation of the RCR

Country	Recreational		Total revenue/tonne		RCR
	Catch	Participants	Recreational	Commercial	
Morocco	29,755	5,180	11,645	3,350	3.5
Mauritania	47	100	54,909	2,824	19.4
Cape Verde	593	4,786	23,718	6,055	3.9
Senegal	1,646	9,405	19,713	2,670	7.4
Gambia	282	3,890	34,867	1,968	17.7
Guinea Bissau	166	1,476	30,406	2,684	11.3
Ghana	849	3,724	25,064	5,486	4.6
Togo	22	68	11,958	2,274	5.3
Equatorial Guinea	8	192	54,851	3,784	14.5
Angola	92	1,208	26,078	4,225	6.2
Namibia	328	15,461	160,262	5,051	31.7
Total (Weighted mean*)	33,788	45,490	—	—	7.4 [†]

*The mean was weighted by the number of fishers in each country

[†]Computed without Namibia that is an outlier; the weighted average RCR value including Namibia is 15.6

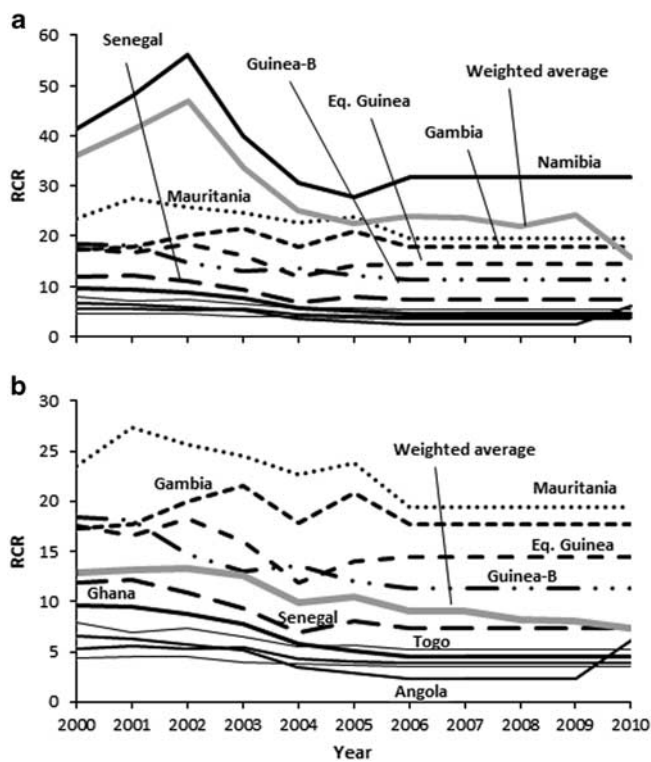


Figure 4 | RCR including Namibia (a) and excluding Namibia (b) 2000–2010.

This is illustrated through the example of Mauritania, which, despite having the lowest expenditure, has the lowest participation rate.

The economic contribution of recreational fisheries for these 11 West African countries totalled \$152 million annually. Mauritania had the lowest contribution with \$62,000 annually, whereas the highest contribution was for Namibia (\$53 million annually), whose recreational fisheries are well established, to the extent that the species they target are overexploited.

Recreational-to-commercial ration. The RCR, which represents the market-equivalent value per tonne of recreational fish injected to the economy, is a proxy to expressing the value that a recreationally caught fish has relative to its value when caught

commercially. In West Africa, the RCR was higher than one in all cases (Table 4), that is, the value of fish is higher in recreational fisheries than in commercial fisheries, regardless of whether the recreationally caught fish were kept or released. The RCR was on average 7.4, and the highest for Namibia (31.7), Mauritania (19.4) reputed for the Banc d’Arguin National Park, The Gambia (17.7), Equatorial Guinea (14.5) and Guinea Bissau (11.3) and, also reputed for its marine park where recreational fishing activities are concentrated, the Bijagos archipelago. Morocco (3.5) and Cape Verde (3.9) had a relatively lower RCR, which may be explained by their common features, notably the high number of visitors (and hence recreational fishers) and the consequent overexploitation of recreationally fishable populations (Belhabib *et al.*, 2012). This means that, despite an overall lower total expenditure value (Table 3), fishers associate a far higher value for the recreational fish taken from areas protected from commercial fishing. This illustrates how “authenticity” (Lucas, 2013) makes destinations such as Mauritania and Guinea Bissau worth visiting (Lucas, 2013). Authenticity relates to a postcolonial theory where one of the aspects of tourism is to maintain the idea of local populations being “traditional” for tourist experience as traditional identity is distinct from tourist identity. This authenticity defines the worthiness of consumption of a destination by independent travelers outside conventional destinations. In addition, this authenticity relates to the fact that fishing in the developed world is a usual experience that is afforded to many. Thus, fishers will pay less for such an experience, but more for a fishing “safari” or an equivalent in an unusual destination.

Recreational fisheries in Angola also had a high RCR (6.2), which is because of the perception that Angolan fishing grounds are more pristine than that in neighboring Namibia and South Africa, where most recreational fishers come from (Potts *et al.*, 2009).

Extracting historical (2000–2010) ex-vessel price data and comparing them with average expenditure per tonne estimated herein allowed the assessment of the historical variations in RCR (2000–2010). Overall, a noticeable decline (by over a third) in the RCR was observed for Ghana (111%), Guinea Bissau (62%), Senegal (60%), Togo (51%) and Cape Verde (37%). A slight decline was observed for Namibia (31%), Morocco (28%), Equatorial Guinea (22%) and Mauritania (21%), whereas the RCR remained overall constant for Angola and Gambia, after, however, a peak in 2002 and 2003 (Fig. 4). Similarly, the average (weighted) RCR declined from 13 in 2000 to 7 in 2010 (excluding Namibia’s RCR, which is an outlier). These variations could be explained by a combination of factors. First, ex-vessel prices increased because of inflation rate (CPI), and a decrease in commercial fishery catches in the region

because of overfishing (Belhabib *et al.*, 2015b). Second, RCR is correlated with the travel expenditure, which represents on average a third of the total expenditure per fisher (Table 3); these decreased since 2006 (Fig. 5).

Discussion

This study addressed the perception that recreational fisheries in West Africa are negligible and that their economic contribution is trivial. This is debunked here using a new metric called RCR, which expresses the value of fish when caught recreationally relative to their value when caught by commercial fisheries. Using YouTube, illustrated blogs and unconventional records to fill in data gaps appeared to be very efficient and reliable, as assessed by comparisons with other, more conventional data sources (in Mauritania and Angola, see Table 2). There are three main findings to this study. The first relates to the methods used,

particularly, YouTube and illustrated blogs to assess recreational fisheries catches and socio-economic contribution through the number of fishers and total expenditures. Catches for instance reached 34,000 t-year⁻¹ in 2010 with a high number of species and taxa recorded. This high diversity illustrates the differences between countries in terms of target species as recreational fisheries are highly selective. Fishers usually target species that are known to be non-threatened. However, the poor knowledge on stock status and hence the resulting poor to non-existing management of recreational fisheries, result in the fishers targeting species that are overexploited, for example, sharks and groupers. Other unconventional tools are now being used, such as Google satellite to estimate the weir fishery in the Persian Gulf, without which their catches were thought to be small (Al-Abdulrazzak and Pauly, 2014) and thus were excluded from management efforts. Second, far from the zero value that was allocated to them, we herein estimated the total economic contribution of West African marine recreational fisheries at \$152 million annually. The number of fishers estimated as the equivalent of 8% of artisanal fishers, appears relatively low at first hand, however, looking at employment generated (fishing guides, hotel and airport staff, and other potential services used) rather than number of fishers (as these are almost exclusively foreign visitors) would be informative. Third, despite the problematic touristic reputation of some of these countries due to conflicts and lack of good governance, the new metric introduced here that relates to the value associated with a unit (tonne or kg) of fish caught by recreational fishers, that is, the RCR, was 7 times higher than its value on fish markets, regardless of whether the fish was caught and/or released. In addition, we found that the RCR was highest in countries with a better reputation, such as Namibia and The Gambia and in countries reputed for having their marine parks (Mauritania and Guinea Bissau), or for fish stocks perceived as being in better shape (Angola) (Fig. 6).

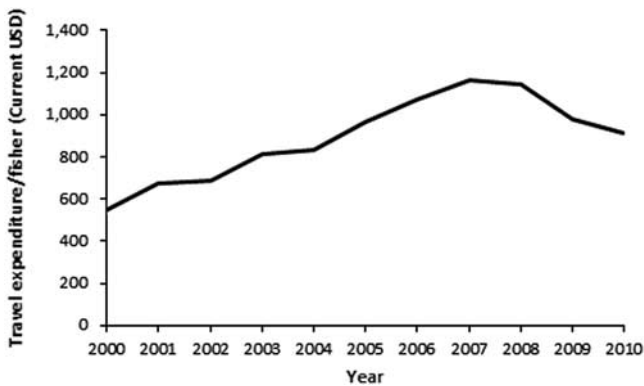


Figure 5 | Average travel expenditure per tourist estimated by dividing the total expenditure by the number of visitors (www.worldbank.org) in the 11 countries of West Africa, 2000-2010.

FIL LB	POIDS KG	C. HIPPOS	POTPANEAU	C. ROUGE	OTHOLITE	BARRACUDA	COBIA	LICHE	M. BONITE	TARPON	RECORD REQUIN . TG	VIOLLEAU	NOLRRICE	P. NDIRE	MARTEAU	TIGRE	CITRON	BOULDOEJE	RATE	PASTENAGIE	GUITARE	LB
12	16	8	5	8.500	8.500	6								7.500	13.5			40				12
	R	MK	MK	R	J.C	DIOVA								G.M	MARC			R				
16	20	5.500	20	6	18	17	4	4.500	91												20	16
	FERD	Corine	JB	Julien	FERD	GM	R	R	B.B												R	
20	21	12	20	10	28.5	17	15	5	99.600													20
	R	JB	P.R	B.B	PGuis	CLAUDE	R	J.B	J.H.G													
30	15	12.5	2.5	14.5	22	24	17		102													30
	ERIC	ALEX	Pierre	G.M	Alain	Henry	G.M		Pierre													
50	19	9.500	52	15	25	35	5.500	5.500	116													50
	C.H	J.C	J.C	DAHY	JB	J.C	MARC	Thery	G.M													
80	20		18	14	27	25			87													80
	G.M		Pierre	J.C	J.H.G	Refaur			HXEL													
130																						130

Figure 6 | Records of recreational fisheries catches found in the Bijagos islands, Guinea-Bissau. source: Photo Credit: Pierre Campredon.

Other factors contribute to a higher RCR. In country workshop discussions in The Gambia conducted by the first author revealed that availability of direct flights and proximity of hotels to the sea plays a major role in determining the affinity and hence the value that is given to recreational fishing. This applies particularly to Namibia, Mauritania and The Gambia.

Historically, the decrease in RCR may result from the effect of perceived overexploitation on the willingness to pay for recreational fishing. Indeed, the number of recreational fishers in Namibia declined drastically in contrast to Angola because of the overexploitation of Namibian fish stocks and the perception of Angolan fisheries as pristine. However, although declining, the recreational value of fish is still higher than its commercial value. Thus, considering that West African stocks are generally overexploited (Belhabib *et al.*, 2015b), the RCR is a crucial indicator that allows to capture the present and future value that a recreational fishery can add to the economy and conservation of fish stocks.

These findings have important implications for conservation, in that higher value is associated with conservation efforts such as marine parks and pristine stocks, and with political stability.

In terms of management, RCR could be used to indicate the level of catch and participation at which recreational fishing should be limited or closed. This is particularly important as the number of fishers is inversely related to their individual catch, that is, CPUE, whose level (size and availability of fish) drives the willingness to fish recreationally, the fishing cost incurred and hence the RCR.

The observed increasing participation rate requires managers to catch the trend early as recreational fisheries develop and create sustainable management schemes to avoid the collapses that occurred in other regions such as South Africa and Namibia (Potts *et al.*, 2009), in part because of the under-estimation of their impact on marine population. Catching the trend early on also means facing rapidly increasing recreational fisheries catches by regulating the activity with tools such as fishing licenses (Barnes *et al.*, 2002; Abdelaoui, 2010), combined with bag limits and area restrictions (Barnes *et al.*, 2002; Potts *et al.*, 2009). Recreational fisheries may generate strong revenue if managed properly and sustainably. They can further offer an alternative livelihood for small-scale fishers whose income is below of approaching the poverty line, such as those in Morocco, Mauritania, Guinea Bissau and Ghana (Belhabib *et al.*, 2015c).

One major recommendation that arises from this work relates to the importance of monitoring recreational fisheries and the use of all available data to establish proper management decisions. Monitoring can be done through a voluntary reporting approach, where fishers report their catches into a logbook (Mauritania) or a board (Guinea Bissau) that is made available to them at the fishing club, the hotel or by the company and then collected or sent to authorities. Other methods of data collection were highlighted in the literature and can be adopted by authorities, such as recording the catch at the exit of the Marine Park in Namibia (Barnes *et al.*, 2002). It is important, however, that these data be transferred from the collection sites to the authorities, as recreational fisheries are usually disregarded and their value is assumed to be zero. However, one step forward is the recent inclusion by, for example, IMROP, of a recreational fisheries definition in official texts (Elimane Abou Kane, IMROP, personal observation). As “authenticity” is key in determining the rate of participation, and hence the economic contribution of recreational fisheries (Lucas, 2013), community participation, not only is relevant for the sustainable development of recreational fisheries (Caffyn and Jobbins, 2003), but also plays a major role in

adding value to the activity itself such as observed in the Banc D’Arguin National Park (Belhabib *et al.*, 2012) and the Bijagos islands (Belhabib and Pauly, 2015).

Notes

- 1 Tourism contribution to the GDP varies between 1% (Angola and Guinea Bissau), 2% (Mauritania), 3% (Ghana), 9% (Morocco) and 23% (Cape Verde) (www.worldbank.org).

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Data Availability

The Datasets on catch amounts and composition generated and analyzed during the current study are available on the *Sea Around Us* Website www.seararoundus.org. Other data generated during the current study are published in this article.

Additional information

Supplementary Information: accompanies this paper at <http://www.palgrave-journals.com/palcomms>

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