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Can Fishing Tourism Contribute to Conservation and Sustainability via Ecotourism? A Case Study of the Fishery for Giant African Threadfin *Polydactylus quadrifilis* on the Kwanza Estuary, Angola

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Abstract: It has been suggested that tourism fisheries can raise the value of landed catch, provide alternative livelihoods for local artisanal fishers and, because recreationally caught fishes are often released, simultaneously conserve stocks. However, for fishing tourism to meet ecotourism standards, sustainable, local economic benefit is imperative. This study aimed to assess the direct economic contribution of the recreational fishery for *Polydactylus quadrifilis* on the Kwanza Estuary, Angola. The recreational fishery contributed significantly to economic productivity in an otherwise rural area, generating a total revenue (TR) of $236,826 per four-month fishing season. Based on TR, *P. quadrifilis* was 3.6–32.6 times more valuable than the same fish caught and sold in the artisanal sector. However, high rates of economic leakage (86.1% of local TR) reduced the value of recreationally caught fish to below that of artisanally caught fish. Important sources of economic leakage were via the non-local sourcing of lodge supplies, services and staff and through the repatriation of profits. Capacity building within the local community is suggested to reduce leakages and to create 'linkages' with the recreational fishery. Greater community involvement, including the provision of business shares and greater communication and control, is suggested to achieve sustainability and incentivise the protection of recreationally important fishery species.

Keywords: tourism fisheries; ecotourism; economics; social–ecological systems (SESs); fisheries management; livelihoods; recreational-to-commercial ratio (RCR)

1. Introduction

Globally, recreational fisheries have been identified as significant contributors towards national economies [1,2]. However, much of the research within this field has taken place in the developed world, where there are high rates of participation and a lower reliance on fish stocks for food [3]. Recreational fisheries in the developing world are, on average, less well developed and therefore receive less scientific attention [4,5]. Here, fisheries research has traditionally focussed on small-scale artisanal sectors [3,6], due to their potential for poverty alleviation [7], and large industrialised fisheries, based on their economic importance. Therefore, the recreational fisheries of much of the developing world are not well understood, with many countries disregarding their impact, both economically and environmentally [5].

Recreational fisheries are characterised by heterogeneous human–nature relationships, and a social–ecological system (SES) approach has been advocated to fully appreciate their complexity [8].

Traditionally, systems of natural resource, such as forestry or fisheries, have been analysed with oversimplified theoretical models that have not taken all aspects into account [8–10]. Therefore, complexity theory and adaptive SES science is now receiving attention as a more holistic approach towards natural resource management [9]. If we are to improve our understanding of recreational fisheries in the developing world, it is critical that we apply an SES approach to our investigations [5]. In terms of Africa, the majority of recreational fisheries work has focussed separately on the biological traits of the angling species [11,12] or on the traits of the user groups [13–15]. These studies have largely taken place in southern Africa with little to no formal information available for the West African region, despite increased evidence of the importance of foreign recreational fishing tourism there [4,7].

It has been widely suggested that recreational fisheries (including those in West Africa—[7]) have the potential to increase the value of fish catches based on the high 'willingness to pay' for recreational fishing [16]. Additionally, recreational fisheries often maintain a non-consumptive or 'reduced-impact' use of fisheries resources, through catch-and-release (C&R) angling, and therefore a number of authors have identified recreational angling as a potential vector for ecotourism [16–18] and conservation [19,20]. However, it has also been acknowledged that many integrated conservation and development projects that utilise ecotourism as a strategy have been prone to failure in the medium to long term [16,21,22]. This is largely because projects are often theorised to be ecotourism ventures (i.e., the concept works on paper) but are not adequately understood or tested from a practical standpoint. This is because researchers have largely failed to appreciate that ecotourism acts within complex SESs. Thus, recreational fisheries should be understood and managed according to their unique social and ecological traits if they are to achieve ecotourism goals, such as the provision of sustainable local employment opportunities, the empowerment of local communities, the provision of high-quality tourism activities and the conservation of natural resources [16,23].

Ecotourism is increasingly popular in the developing world based on the remoteness of the locations and the perception that they harbour 'unspoilt' environments [16]. In many cases, ecotourism has created incentives for national governments to protect and expand wildlife areas where they contribute towards local economic productivity [24]. Similarly, as West African recreational fisheries are increasing in popularity with foreign fishermen due to their remote location, new and attractive angling species and the perceived pristine state of their stocks [7,13], they present an opportunity to contribute to local economic productivity. Unlike harvest fisheries, foreign West African recreational fisheries are often non-consumptive [7]. Therefore, it is possible that their development may incentivise the protection of recreationally important species, with knock-on effects via the protection of associated ecosystems and thereby non-target species. This has been the case in the developed world. For example, in Florida, USA, the strict management and protection of Atlantic tarpon (*Megalops atlanticus*), bonefish (*Albula vulpes*) and important associated ecosystems has been driven largely through the recreational value of the species [25,26]. Additionally, recreational fisheries have the potential to contribute towards human welfare and provide a source of income and livelihoods for local communities [13,16,17,27]. If such benefits are available to consumptive fishery stakeholders, such as artisanal fishermen, they will be more likely to protect the species or habitats that are important to the recreational fishery.

Ecotourism ventures are, however, complicated endeavours and require the commitment and cohesion of numerous stakeholders [17,21]. Similarly, for recreational fisheries to operate as ecotourism ventures, it is critical that there is local participation and that all user groups are committed to, and benefit from, the process. In West Africa, fisheries have diverse user groups and there is a critical reliance on artisanal fisheries for livelihoods and food security [28]. The development of recreational fisheries in these areas is likely to place additional pressure on local ecosystems [29] and may result in conflict between user groups [30,31]. Therefore, it is necessary to understand the ways in which recreational fisheries are able to generate sources of income and livelihoods for local communities whilst promoting sustainability and conservation [5]. It is suggested that an investigatory approach that views recreational fishing as a tourism activity and views fishermen as 'tourists' may be able to

harness new methodologies and the wealth of knowledge that is available within tourism studies and apply them within an SES framework.

A major problem with the development of tourism in developing countries is the potential for leakage of value out of the local economy, thus rendering the contribution made to poverty alleviation insignificant [32–34]. This leakage may take place on both the national and local scales. Leakages out of the national economy have been shown to be significant and are largely through a need for increased importation of goods and services and through the repatriation of profits by foreign tourism operators and owners [34]. Leakage out of local economies is even more significant and is driven by the reduced capacity of local communities to produce skilled staff and quality operational supplies [32]. In certain cases, the local economic benefit from tourism has been shown to be as low as 1% [35]. From the perspective of recreational fishing tourism, it is imperative that leakage is reduced so that local fishing communities receive the maximum possible benefit and can persist even if consumptive fishing is shifted away from the recreational target species.

Therefore, it is necessary to provide comprehensive economic evaluations of tourist recreational fisheries in order to understand their potential value to various stakeholders and in order to improve the management of the resource system. The recreational fishery for the giant African threadfin, *Polydactylus quadrifilis* (Cuvier, 1829) (Actinopterygii: Polynemidae), on the Kwanza (commonly also referred to as Cuanza) Estuary provides a typical example of a highly valuable complex SES that is prone to overuse. The area appears to have large ecological importance as it forms one of few large estuarine habitats in northern Angola. Additionally, the area experiences high rates of use via human activities including recreational and artisanal fishing. Extremely little scientific research has taken place within the system, and, therefore, there is limited information about the fishery. However, the resource system appears to be relatively healthy as anecdotal fishing reports suggest that the fishery is highly productive, producing both large numbers of fish and trophy fish. This study aims to assess the direct economic contribution of the recreational fishery for *P. quadrifilis* on the Kwanza Estuary. In doing so, it provides values in terms of direct economic contribution as well as estimates of local economic benefit following estimated leakage. Additionally, the catch-per-unit-effort (CPUE) for the various species in the area was assessed and used to provide an economic benefit (in US$) per fish and per kilogram of fish caught in the recreational fishery. These values were then compared to the market value of fish caught within the artisanal fishery using the principle of 'recreational-to-commercial ratio' or RCR (see [7]).

2. Materials and Methods

The Kwanza Tarpon lodge was founded in 2007 to cater to foreign fishing tourists. The majority of foreign tourists visit the lodge to target a range of recreational angling species, including *P. quadrifilis*, *Caranx hippos*, *Sphyraena afra*, *Megalops atlanticus* and members of the genera *Lutjanus* (primarily *L. agennes*) and *Pseudotolithus* (*P. typus* and *P. senegalensis*), and usually spend between 5 and 10 days at the lodge per trip. While the local status of these species is unknown, the International Union for Conservation of Nature (IUCN) has categorised the majority (*P. quadrifilis*, *C. hippos*, *S. afra* and *P. typus*) as least concern, while *L. agennes* has been classified as data-deficient, *M. atlanticus* as vulnerable and *P. senegalensis* as endangered. The lodge enforces strict C&R for the majority of fish angled, and only a small proportion of fish caught are kept for consumption, usually following accidental fishing-related mortality. Additionally, there is an increasing market for domestic fishing tourism at the lodge. Many domestic tourists, defined here as either Angolan nationals or working expatriates residing in Angola but not in the local area around the lodge, visit the lodge on weekends and public holidays. The majority of domestic fishing tourists travel from the capital (Luanda) and usually visit the area for the day (arrive early in the morning and return home late in the evening). Occasionally, domestic fishing tourists will stay for longer and will spend a night or two at the lodge. Domestic tourists may pay inflated prices for the use of the lodge's facilities based on the shorter duration of

their stays and their smaller group sizes when compared to foreign guests, who commonly receive package deals.

Apart from fishing tourists, both foreign and domestic tourists (non-fishing) also benefit from the establishment of the lodge whereby they are attracted by the other appealing attributes and activities that have resulted from the lodge's establishment. These include a swimming pool, boat cruises, meals, accommodation and general tranquility and relaxation.

In addition to lodge-based tourism, a number of domestic fishing tourists visit the area to fish recreationally using private or charter vessels owned by local artisanal fishermen. Many of these anglers travel from Luanda on weekends and public holidays and usually visit the area for the day. Many domestic fishing tourists initially used the lodge vessels and guides but have subsequently either switched to the artisanal charter boat services as a cheaper alternative or have purchased and begun using their own vessels. Therefore, at least some of the recent increases in recreational effort can be attributed to the lodge, and thus, it is likely that recreational angling effort in this fishery would be reduced if the lodge did not exist.

2.1. Defining the Fishery 'Sectors'

For the purposes of this study, the recreational fishery for *P. quadrifilis* on the Kwanza Estuary will be divided into two main sectors. These will include the recreational fishery operating out of the lodge (the 'lodge fishery') and the domestic recreational fishery, which operates separately from the lodge through the use of private vessels and artisanal charter vessels (the 'non-lodge fishery') (Figure 1a). The lodge fishery can be further divided into three separate sub-sectors. These include the 'foreign lodge fishery', the 'domestic lodge fishery' and 'lodge casuals', or hereon referred to as 'casuals', who are defined as foreign and domestic tourists who visit the lodge for purposes other than fishing (Figure 1a).

2.2. Catch-Per-Unit-Effort (CPUE)

CPUE—lodge fishery

Catch-per-unit-effort was recorded for the lodge fishery on the Kwanza Estuary during the winter fishing seasons (approximately 1 June–30 September) in 2016, 2017 and 2018. Fishing took place on boats owned by the lodge, and the skipper of the boat was responsible for recording catch and effort data. Skippers took note of the location and time at which fishing began and ended for each session and on each day. The type of fishing (trolling/artificial lure/bait) and number of rods were recorded. The number of *P. quadrifilis* and other species caught was recorded for each session, and each fish was either measured (mm, fork length (FL)/total length (TL)) or allocated an estimated weight (kg). Estimations of weight occurred when the measurement of fish was impossible or would unnecessarily extend the amount of time the fish spent out of the water. Measurements of the primary species were converted into weight in kilograms using the equations developed for the relevant species or, in the case where no length–weight relationships were available, a closely related species:

Polydactylus quadrifilis: $W(g) = 0.0069 \times FL(cm)^{3.14}$ [36]
Caranx hippos: $W(g) = 0.0207 \times FL(cm)^{2.987}$ (*C. ignoblis*—[37])
Sphyraena afra: $W(g) = 0.0192 \times FL(cm)^{2.84}$ (*S. barracuda*—[37])
Lutjanus spp.: $W(g) = 0.028 \times FL(cm)^{2.84}$ (*L. argentimaculatus*—[37])
Pseudotolithus spp.: $W(g) = 0.0075 \times TL(cm)^{3.029}$ [38]

In cases where catch entries did not include a measurement or an estimated weight for a specific fish, the average weight for the species caught during the given fishing season was used.

The CPUE was calculated using the formula $CPUE = \sum_i \left(\frac{C_i}{E_i}\right)$ where C_i is the quantity or mass (kg) of fish captured by the ith fisher and E_i is the effort expended by the ith fisher (measured in angler-hours—one angler-hour is equivalent to one angler fishing with one rod/line for one hour).

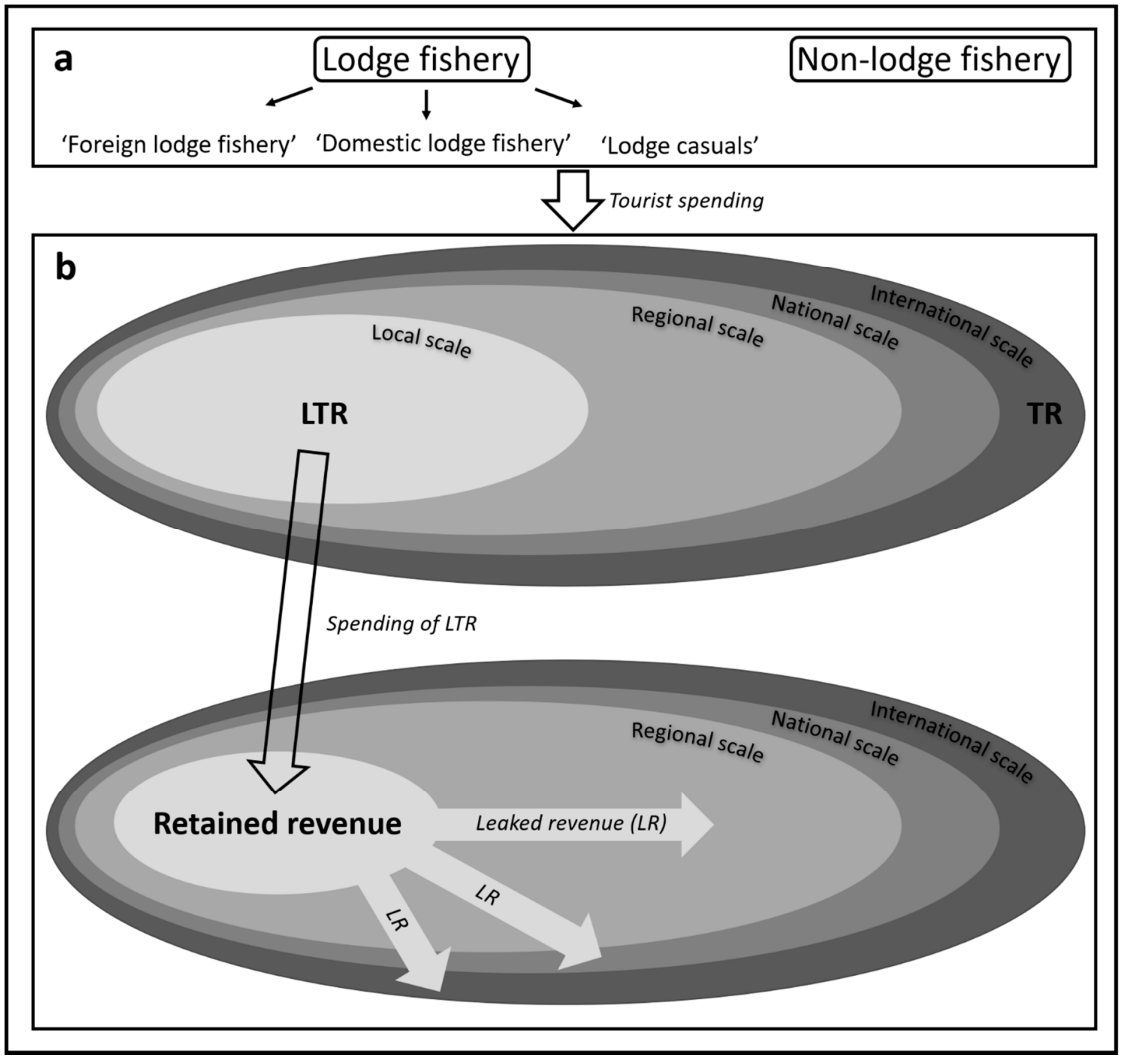

Figure 1. Schematic diagram illustrating the two main sectors of the recreational fishery present on the Kwanza Estuary and the three further sub-sectors within the 'lodge fishery' (**a**). Tourist spending from the fishery sectors contributes to total revenue (TR) on a local, regional, national or international scale. Local expenditure contributes to local total revenue (LTR) and is either retained (retained revenue) or leaked to the regional or national economy or out of Angola (international scale) (**b**).

CPUE—non-lodge fishery

For boats operating separately from the lodge (private recreational anglers and artisanal charters—i.e., non-lodge fishery), total effort was estimated using visual counts (location, number of boats, number of rods and fishing method per boat) that were performed at regular intervals by lodge skippers during fishing outings during 2016 and 2017 only. This was performed separately for private vessels and for artisanal charters.

In 2016, observations of fishing effort were made as regularly as possible with a minimum of eight weekday counts and eight weekend counts performed each month (four counts per week). In order to understand whether the use of less observation days in 2017 would significantly affect results, four observations were randomly selected for each calendar week (two weekdays and both weekend days) and a mean daily effort was calculated per weekday and per weekend in 2016. Thereafter, two observations were randomly selected per week (one weekday and one weekend day) from the same dataset, and an unpaired Student's *t*-test was utilised to assess for difference between the mean daily effort during the week and during the weekend between the 2-day sampling and the 4-day

sampling technique. Based on the result, fishing effort in 2017 was assessed using a reduced sampling methodology where a minimum of four weekday counts and four weekend counts were performed each month (two counts per week).

Species-specific catch was estimated for the non-lodge fishery using the fishing method-specific effort data collected for the non-lodge fishery and the fishing method-specific CPUE from the lodge fishery.

2.3. Economic Assessment

Since the focus of this study is to ascertain the direct economic contribution of the fishery for *P. quadrifilis* on the Kwanza Estuary and estimate the percentage of value retained within the local community, a number of typical methodological considerations need to be made and accounted for. Income and economic activity generated through the lodge is only partly the result of recreational fishermen. A large component of lodge income is derived from casual tourists who are not visiting the area for the purposes of fishing. However, the lodge would not exist if it were not for its establishment as a fishing lodge, and thereby, revenue generated through casual tourist spending may not have taken place without its establishment (or at least not within this location). There are arguments for both the inclusion and exclusion of casual spending within this study [39]. Therefore, economic impact within this study will be presented both with and without the inclusion of casual spending at the lodge.

2.3.1. Definition of the Local, Regional, National and International Scales

Tourist and lodge spending was recorded and estimated at the local, regional, national and international scales (Figures 1b and 2). For the purpose of this study, the international scale incorporated spending outside of the country (Figure 2a). The national scale constituted anywhere outside of the province and included payments to national government (Figure 2b). The regional scale included expenditure in the nearest two towns of Ramiros (39 km by road) and Benfica (65 km by road) and the capital city, Luanda (80 km by road) (Figure 2c). The local scale included the local village, commonly referred to by locals as the 'comuna', and the immediate surrounding area (within an approximately 10 km radius of the lodge—Figure 2d). All expenses were converted to a value in United States Dollars (US$) using an exchange rate of 165 Angolan Kwanza to the Dollar and 15 South African Rand to the Dollar, which was appropriate during the study period [40].

2.3.2. Economic Terminology and Definitions

In order to gain an understanding of the retention of value accruing from recreational fishing for *P. quadrifilis* on the Kwanza Estuary, it was necessary to calculate total revenue (TR), local total revenue (LTR) and leaked revenue (LR) generated through tourism [32]. Within this study, TR is defined as the money spent by tourists that visited the lodge (lodge fishery) or visited the study site for the purposes of recreational fishing (non-lodge fishery). A component of TR is spent locally (within an approximately 10 km radius of the lodge—Figures 1b and 2d) and is referred to as LTR. For example, money spent on guest flights to Angola was considered within TR but not within LTR, whereas money spent at the lodge was considered within both TR and LTR (Figure 1b). Leaked revenue is defined as LTR that does not accrue to a local person, either through payment or profit, even though the initial spending occurred locally (Figure 1b).

Total revenue (TR) and local total revenue (LTR)

Total revenue and LTR were recorded from 1 June to 30 September 2016 and 2017 only and were calculated separately for the lodge fishery and the non-lodge fishery. All tourist spending was considered within TR, while tourist spending at the lodge, at the local fuel pump, within the local village and community and with local artisanal fishermen was considered LTR (Figure 2). The average daily spend per tourist per day was calculated according to the number of tourists and was presented in

terms of TR and LTR (by dividing the value by the number of tourists). This was calculated separately for day tourists and overnight tourists in each sector.

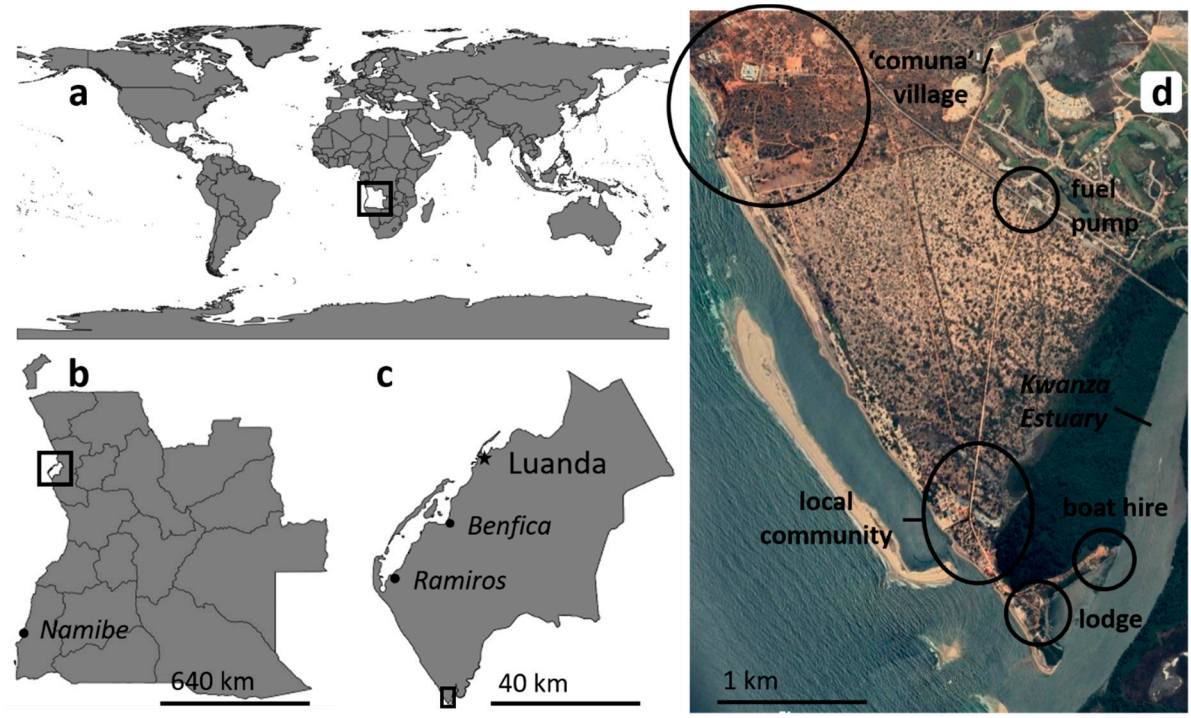

Figure 2. A visual representation of the international (**a**), national (**b**), regional (**c**) and local (**d**) scales as defined within this study. Black boxes on each map refer to the location of the following figure. All fishing tourist spending within the various scales was considered within total revenue (TR). The satellite image (Google Earth, Google inc.) displaying the local area at the Kwanza Estuary mouth (**d**) indicates the locations where local fishing tourist spending took place (including at the lodge, fuel pump and village and for artisanal boat hire) and contributed to local total revenue (LTR).

Lodge fishery (foreign, domestic and lodge casuals)

Total revenue within the foreign lodge fishery was calculated by summing the spending of each foreign fishing tourist. Foreign tourists were transported to and from the airport in Luanda by lodge staff, and they paid a fixed daily rate during their stay, which included their meals, accommodation and boat fees. These tourists did not spend extra money in the local economy, and all spending within the country took place and was recorded at the lodge (except perhaps for some 'out of pocket' regional spending at the airport, which was disregarded). However, some spending took place outside of the country and was recorded. A record was kept of their country of origin, duration of stay and flight details (airline and cost of return ticket). The cost of a tourist visa was calculated per guest according to their country of origin.

For the domestic lodge fishery, expenses at the lodge were recorded. Fishing tourist spend on food, beverages and transport was recorded per group. Transport information that was recorded included their area of origin (in Angola), number of vehicles used during transport and the size of the travelling party. Transport expense was calculated per travelling party using the calculated distance of travel, the fuel price of 160 Kz/L (which remained constant over the sampling period) and an assumed fuel consumption of 10 km/L.

Total revenue accrued from lodge casuals was also recorded according to expenditure at the lodge only. This included spending on accommodation, meals, drinks and river cruises. However, casuals' spending outside of the lodge (including private transport to and from the lodge) was not considered based on the fact that they did not travel to the area for the purposes of fishing and information was

not available to estimate other 'out of pocket' spending within the area, although it was assumed to be minimal.

Non-lodge fishery

The direct economic contribution of the domestic recreational fishery operating separately from the lodge was estimated using the simple equation:

*direct economic contribution of fishermen spending = number of fishermen * average spending per fisherman* [41,42].

Estimates of the number of domestic recreational fishermen fishing privately or with the use of artisanal charters were gained from the fishing effort data collected and described earlier. Since estimates of the number of domestic recreational anglers were only available during the week and weekends in 2016 and 2017, the economic estimates were only made for those years.

Tourist spending was estimated per travelling party instead of per angler since the cost of travel and boat usage was shared amongst anglers (see [42]). Average spending estimates for the non-lodge fishery were collected via interviews with 19 domestic recreational anglers. All interviewees provided their informed consent, and interviews were conducted in accordance with the Declaration of Helsinki of 1975, Ethics approval 2019-0178-820, Rhodes University, Grahamstown, South Africa. Collected information included their daily spending on food and beverages, travel to the study area, accommodation (when applicable) and the cost of the day's fishing (fuel for the boat or boat hire).

Leaked revenue (LR)

Leaked revenue was determined from 1 June to 30 September 2016 and 2017 and was calculated separately for the lodge fishery and the non-lodge fishery. Leaked revenue was considered as LTR that was not retained locally through lodge spending at locally owned businesses or directly with artisanal fishermen, lodge spending on salaries for local staff or profit accrued by local artisanal fishermen for the hiring of their boats (Figure 1, Table 1). Retained revenue was defined as the money that was retained within the local community following estimated leakage. It was calculated by subtracting estimated LR from the LTR and was calculated for each of the fishery sectors. Both LR and retained revenue were expressed in USD and as a percentage of the LTR.

Lodge fishery (foreign, domestic and lodge casuals)

For the lodge fishery, all LTR accrued to the lodge as all tourist spending (locally) occurred at the lodge. Therefore, an analysis of leakage was estimated using lodge expenditure—i.e., tracing guest spending one step further from spending at the lodge to spending by the lodge on supplies and operational costs.

Total spending by the lodge was assessed and leakage was estimated using the guidelines outlined in Table 1. The retained revenue was calculated by subtracting the LR from the LTR. Retained revenue was presented as a percentage of LTR for the lodge fishery. This percentage was then utilised to calculate the retained revenue and LR from the LTR separately for the foreign lodge fishery, the domestic lodge fishery and lodge casuals.

Table 1. Components of local tourist spending considered retained or leaked for the *Polydactylus quadrifilis* recreational fishery on the Kwanza Estuary. Only local tourist spending/local total revenue (LTR) was considered. Leaked revenue (LR) was further defined as LTR leaked to the regional, national and international scales (see Figure 1b).

Local Total Revenue (LTR) Considered Retained	LTR Considered Leaked to the Regional Scale	LTR Considered Leaked to the National Scale	LTR Considered Leaked to the International Scale
All money spent by the lodge and tourists on goods and services from locally owned businesses as well as directly with local fishermen	All money spent by the lodge on goods and services from businesses located outside of the local area but within the region/All money spent by the lodge and tourists at local businesses with regional owners	All money spent by the lodge on goods and services from businesses located outside of the region but within the country/All money spent by the lodge and tourists at local businesses with national owners	All money spent by the lodge on goods and services outside of the country/All money spent by the lodge and tourists at local businesses with international owners
All salaries paid by the lodge to local staff	All salaries paid by the lodge to non-local staff living outside of the local area but within the region	All salaries paid by the lodge to non-local staff living outside of the region but within the country	All salaries paid by the lodge to foreign staff
Profit accrued by local artisanal fishermen for the rental of boats to recreational fishermen	All lodge vehicle permitting and fines	All staff flights on the Angolan airline—TAAG	All staff flights on foreign airlines
	All lodge boat/vessel permitting	Personal income tax paid on lodge employee salaries varying between 9% and 17%	The cost of work visas for foreign staff
		Lodge permitting	Lodge profit
		Lodge communications costs	

Non-lodge fishery

Leakage here was estimated by tracing the spending of domestic fishing tourists using private vessels and artisanal charters. Any money spent locally (LTR) by domestic fishing tourists outside of the lodge was assumed to be spent in either one of two locations—at the local fuel pump, or directly to artisanal fishermen for boat hire (Figure 2). Money spent at the fuel pump was considered leaked because the business was owned by a non-local who did not live in the area. Some fuel pump employees were local but would not disclose their salaries. However, domestic fishing tourists likely contributed relatively little towards the overall income at the fuel pump and therefore contributed little towards local employee salaries. A percentage of the money paid directly to local fishermen for boat hire was considered retained. This percentage was dictated by the cost of daily boat hire ($151.52) minus the daily fuel cost of a charter, which was estimated to be $47.78 by 12 artisanal boat owners during interviews.

Direct economic contribution in terms of fish and per kg of fish

The economic contributions were converted to a monetary value in terms of fish and per kg of fish for all species and for *P. quadrifilis* only. Catch values, in terms of fish and kg of fish, were calculated from the CPUE data. Values were expressed in terms of TR, LTR and retained revenue for each fishery sector and during each season according to the following formulae:

$$Economic\ value\ per\ fish\ (\$) = \frac{TR\ or\ LTR\ or\ retained\ revenue}{Catch\ (no.\ of\ fish)}$$

$$Economic\ value\ per\ kg\ (\$) = \frac{TR\ or\ LTR\ or\ retained\ revenue}{Catch\ (kg)}$$

The calculated values were then compared to the market value of fish in the artisanal sector to present a recreational-to-commercial ratio (RCR) of economic value [7]. The market value of artisanal catch was provided by artisanal fishermen during interviews in July 2017 (approximately $7.44 for all recreational species and $8.38 per kg for *P. quadrifilis*). These values appeared to remain fairly consistent over the study period.

3. Results

3.1. Catch-Per-Unit-Effort (CPUE)

CPUE—lodge fishery

Catch and effort data were collected for lodge clients for a total of 210 days over the three-year period with 85 data-collection days in 2016, 77 days in 2017 and 64 days in 2018. Total angling effort for the three years was 6,014 angler-hours with 1,977 angler-hours recorded in 2016 (23.3 angler-hours per day), 2,075 in 2017 (27.0 angler-hours per day) and 1,962 in 2018 (30.7 angler-hours per day). Fishing effort was dominated by artificial lure fishing (87%), followed by bait fishing (7%) and trolling (6%).

A total of 847 fish were captured during the three periods (CPUE (± SD) = 0.14 ± 0.24 fish per angler-hour) with a cumulative mass of 7,721 kg (mean = 9.2 kg, CPUE = 1.28 ± 2.51 kg per angler-hour), although it varied drastically between years. The best catches were achieved in 2018 with 380 fish (CPUE = 0.19 ± 0.30 fish per angler-hour) caught with a mass of 3,252 kg (CPUE = 1.66 ± 2.84 kg per angler-hour). In contrast, 2017 produced poor catches totalling 156 fish (CPUE = 0.08 ± 0.15 fish per angler-hour) with a total mass of 1,526 kg (CPUE = 0.74 ± 1.67 kg per angler-hour) (Figure 3). Bait fishing produced the highest mean CPUE in terms of both fish number (0.18 ± 0.29 fish per angler-hour) and weight (2.06 ± 4.20 kg per angler-hour) followed by artificial lure angling (0.14 ± 0.25 fish per angler-hour; 1.23 ± 2.48 kg per angler-hour) and trolling (0.07 ± 0.15 fish per angler-hour;

1.14 ± 2.42 kg per angler-hour). In terms of average fish size, trolling produced the biggest fish (mean = 15.46 kg) followed by bait fishing (mean = 11.79 kg) and artificial lure angling (mean = 8.74 kg).

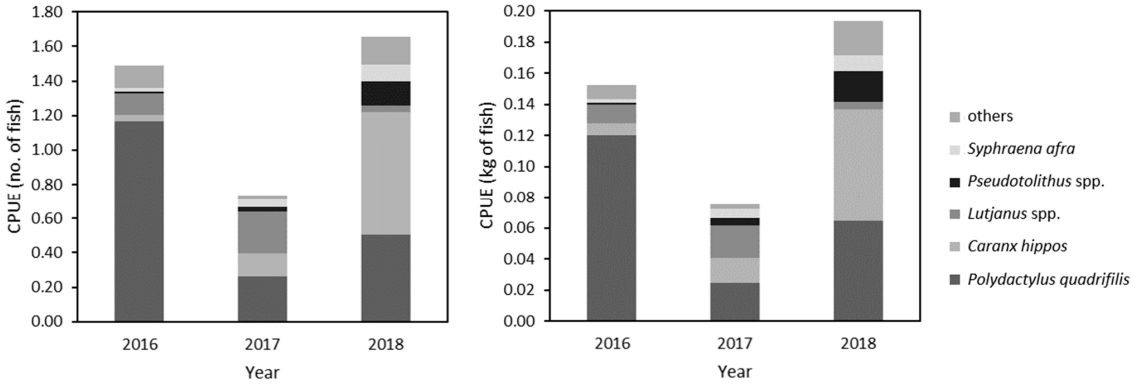

Figure 3. Catch-per-unit-effort (CPUE) of the dominant species caught by the lodge fishery on the Kwanza Estuary in Angola between June and September in 2016, 2017 and 2018.

Polydactylus quadrifilis (50%), *C. hippos* (23%) and *S. afra* (5%) were the dominant species, while members of the genera *Lutjanus* (9%) and *Pseudotolithus* (6%) were also commonly caught. In terms of cumulative numbers, *P. quadrifilis* had the highest CPUE (0.07 fish per angler-hour) followed by *C. hippos* (0.03 fish per angler-hour) and *Lutjanus* spp. (0.01 fish per angler-hour). In terms of cumulative mass, *P. quadrifilis* also had the highest CPUE (0.64 kg per angler-hour) followed again by *C. hippos* (0.29 kg per angler-hour) and *Lutjanus* spp. (0.14 kg per angler-hour).

The species composition varied dramatically among years with *P. quadrifilis* dominating catches in 2016 (238 individuals, 79%) before large reductions in 2017 (51 individuals, 33%) and 2018 (127 individuals, 33%) (Figure 3). In contrast, *C. hippos* did not contribute strongly to the fishery in 2016 (15 individuals, 5%), while it formed a large percentage of catches in 2017 (44 individuals, 28%) and was the most prolific species in 2018 (142 individuals, 37%). Likewise, *Lutjanus* species were scarce in 2016 (23 individuals, 8%) and 2018 (10 individuals, 3%) but were dominant in 2017 (44 individuals, 28%) (Figure 3) where they were heavily targeted with the use of live bait (increase in effort from 98 angler-hours (5% of total effort) in 2016 to 205 angler-hours (10% of total effort) in 2017).

The majority of fish captured during the sampling period were large (mean, 9.22 kg). Mean weights for *P. quadrifilis*, *C. hippos*, *S. afra*, *Lutjanus* spp. and *Pseudotolithus* spp. were 9.2, 9.3, 9.5, 10.7 and 6.8 kg, respectively.

CPUE—non-lodge fishery

Domestic fishing effort within the non-lodge fishery was recorded most frequently during the 2016 season with 50 days of direct observation. During this season, based on four days of observation per week (2 weekdays, 2 weekend days), average effort was estimated to be 35.5 angler-hours per day during weekdays and 94.8 angler-hours per day during weekends. This was not significantly different for weekdays (unpaired Student's *t*-test: $t = -0.21$, d.f. = 31, $p = 0.83$) or weekends ($t = -0.31$, d.f. = 28, $p = 0.76$) from the estimates (33.1 angler-hours per day during weekdays and 89.6 angler-hours per day during weekends) based on two days of observation (1 weekday, 1 weekend day). Based on these findings, fishing effort for the non-lodge fishery during the 2017 season was assessed using two days of observation per week.

In 2017, daily local effort was calculated as 64.3 angler-hours per day during weekdays and 79.4 angler-hours per day during weekends. In terms of fishing method across both seasons, trolling was the most popular technique utilised (81.9%) followed by artificial lure fishing (17.5%). Based on the CPUE calculated for each method in the lodge fishery, the total catch of the non-lodge fishery was estimated as 483 fish with a weight of 7,612 kg in 2016 and 242 fish with a weight of 3,058 kg in 2017.

In terms of *P. quadrifilis*, a total catch of 160 fish with a weight of 1,554 kg was estimated for 2016 and 91 fish with a weight of 973 kg for 2017.

3.2. Economic Assessment

3.2.1. Total Revenue (TR) and Local Total Revenue (LTR)

Total revenue, which consists of spending that takes place locally (LTR) or outside of the local scale (regionally, nationally or internationally), is presented in Table 2. The TR generated from fishing tourism (both the lodge fishery and non-lodge fishery) at the Kwanza Estuary (including lodge casuals) was estimated as $295,638 in 2016 and $268,469 in 2017 (mean of $282,054 per fishing season) (Table 2). Of this, a mean of $236,826 (83.9%) was spent locally and a mean of $33,010 was retained (13.9% of LTR) per season. With the exclusion of lodge casual tourist spending, TR was reduced to $158,259 per season, of which $113,031 (71.4%) was spent locally and $24,670 was retained (21.8% of LTR).

Lodge fishery (foreign, domestic and lodge casuals)

An average of 36 foreign fishing tourists visited the lodge and spent an average of 219 bed nights there per season (Table 2). The average total cost for foreign tourists was estimated at $288.24 per person per day and contributed, on average, $62,981 per season (Table 2). The local contribution of each foreign fishing tourist was estimated at $201.28 per person per day during the study period and contributed an amount of $43,981 towards LTR per season (69.8% of TR). This came in the form of foreign guest spending at the lodge on accommodation (mean per season = $27,850), drinks ($1,994) and fishing days ($14,087).

Non-local spending included the cost of guest visas (mean per season = $3,200) and flights ($15,800) and amounted to an average of $19,000 each season (Table 2). An average of 102 domestic fishing guests visited the lodge, spending an average of 41 bed nights there and generating a mean TR of $28,126 per season (Table 2). The direct total contributions of domestic lodge fishing tourists to LTR were estimated at $355.58 per person per night for overnight guests and $217.70 per person per day for day guests. Local TR averaged $21,646 (77% of total TR) per season and was spent at the lodge on accommodation (mean per season = $6,094), drinks ($1,214), meals ($811) and boat hire ($13,528). Local contributions were estimated at $291.41 per person per night for overnight guests and $153.53 per person per day for day visitors in 2016 and 2017 (Table 2). Non-local spending included guest expenditure on transport to and from the lodge (mean per season = $1,360) and on food and beverages ($5,120).

Non-lodge fishery

A total of 1,925 fishing days (one day's fishing for one fishing tourist) were estimated for 2016 and 2017. Of those, a total of 1,099 fishing days were estimated for local charters, while 826 fishing days were attributed to private vessels. The total estimated contribution per person per night was $196.44 for overnight guests and $63.10 per person per day for day visitors (Table 2). The TR generated averaged $67,152 per season and included local spending on accommodation (mean per season = $6,417), boat fuel for private vessels ($13,223) and boat hire from artisanal fishers ($27,764), averaging $47,404 (70.6% of TR) per season (Table 2). Local contributions were estimated at $175.92 per person per night for overnight guests and $42.58 per person per day for day visitors. Non-local revenue included spending on food and beverages (mean per season = $12,954) and transportation ($6,794).

Table 2. The mean spending per fishing tourist, estimated total revenue (TR), local total revenue (LTR), estimated leaked revenue (LR) and retained revenue per tourist category for the recreational fishery for *Polydactylus quadrifilis* at the Kwanza Estuary, Angola. Values present the means per season across two fishing seasons (1 June to 30 September) in 2016 and 2017.

Sector	Number of Tourists	Number of Bed Nights	Mean Total and [local] Spending pppd for Overnight Guests	Mean Total and [local] Spending pppd for Day Visitors	TR	LTR	Non-Local Spending (TR Minus LTR)	LR (% of LTR)	Retained Revenue (% of LTR)
Lodge Fishery									
Foreign lodge fishery	36	219	288.24 [201.28]	-	62,981	43,981	19,000	40,858.35 (92.9%)	3,122.65 (7.1%)
Domestic lodge fishery	102	41	355.58 [291.41]	217.70 [153.53]	28,126	21,646	6,480	20,109.13 (92.9%)	1,536.87 (7.1%)
Casuals	1,700	408	[175.68]	[58.99]	123,795	123,795	-	115,005.55 (92.9%)	8,789.45 (7.1%)
Lodge fishery excl. casuals					91,107	65,627	25,480	60,967.48 (92.9%)	4,659.52 (7.1%)
Lodge fishery incl. casuals					214,902	189,422	25,480	175,972.77 (92.9%)	13,448.50 (7.1%)
Non-lodge fishery	963	48	196.44 [175.92]	63.10 [42.58]	67,152	47,404	19,748	27,842.72 (58.7%)	19,561.84 (41.3%)
Lodge and non-lodge fishery excl. casuals					158,259	113,031	45,228	88,360.35 (78.2%)	24,670.20 (21.8%)
Lodge and non-lodge fishery incl. casuals					282,054	236,826	45,228	203,815.80 (86.1%)	33,009.51 (13.9%)

3.2.2. Leaked Revenue (LR)

Lodge fishery (foreign, domestic and lodge casuals)

Expenses incurred by the lodge amounted to $159,437 in 2016 and $151,107 in 2017 (mean per season = $155,272). Of this, only a small percentage (7.1% of LTR—$13,449 per season including casuals or $4,660 per season excluding casuals) was considered retained within the local economy (Tables 2 and 3). This came in the form of salaries to local staff (mean per season = $9,151), expenditure on locally sourced fish and seafood ($2,966) and miscellaneous items ($1,322) (Table 3). The lodge employed 17 full-time Angolan staff in both 2016 and 2017 including two boat captains, two cooks, four security guards, three cleaners, three gardeners, one handyman, one carpenter and one driver. However, only seven staff members were from the local community, while three were from Luanda and seven were from the town of Namibe in the south of Angola. Of the 17 Angolan staff, only the driver and the handyman could speak basic English (a necessary skill when interacting with foreign English-speaking clientele).

The majority of lodge supplies were sourced in and around Luanda, and therefore direct leakage into the regional economy was high (77.1% of lodge spending/LTR—$119,745) (Table 3). This was mostly comprised of operational costs (food, beverages, fuel for electricity generation, general maintenance etc.), averaging $101,494 per season. Other direct leakages to the regional economy included lodge transportation costs (fuel and vehicle maintenance) at $13,407 per season and lodge employee salaries at $4,845 per season (Table 3). Leakages of LTR directly to the national economy averaged $20,200 per season and were mostly in the form of leakages via the salaries of non-local Angolan staff and personal income tax paid on employee salaries (Table 3). Direct leakages of LTR out of the country came in the form of salaries paid to foreign staff (mean per season = $7,684) and via the repatriation of lodge profit (calculated as $40,309 and $27,990 before tax in 2016 and 2017, respectively—Table 3).

Non-lodge fishery

Local TR within the non-lodge fishery included spending on local accommodation, boat hire and boat fuel. Over the two-year period, an average of $19,562 (41.3% of LTR) per season was considered retained within the local community (Table 2). This came in the form of money paid directly to artisanal fishermen for boat hire (mean per season = $27,764), minus estimated fuel cost ($8,755), averaging $19,009 per season, and a percentage of the money spent on accommodation at the lodge at $553 per season. Money spent on boat fuel for private vessels ($13,223 per season) was considered leaked to the regional scale.

Table 3. Detailed total spending of a recreational fishing lodge on the Kwanza Estuary, Angola, during the winter fishing season (June 1–September 30) of 2016 and 2017. Lodge expenditure originated as local total revenue (LTR) generated from foreign and domestic fishing as well as casual tourists and is further allocated as money retained within the local economy (retained revenue) or leaked (leaked revenue—LR) to either the regional or national economies. Money leaked out of the country is not indicated in the table but can be identified by subtracting all values from LTR.

	2016				2017				Mean (2016 and 2017)			
	LTR (US$)	**Retained Revenue (US$)**	**Leaked to Regional Economy (US$)**	**Leaked to National Economy (US$)**	**LTR (US$)**	**Retained Revenue (US$)**	**Leaked to Regional Economy (US$)**	**Leaked to National Economy (US$)**	**LTR (US$)**	**Retained Revenue (US$)**	**Leaked to Regional Economy (US$)**	**Leaked to National Economy (US$)**
Lodge Transport costs												
Petrol and Diesel	8,502		8,502		6,012		6,012		7,257		7,257	
Car maintenance	4,054		4,054		2,067		2,067		3,060		3,060	
S&T	2,517		2,517		2,970		2,970		2,744		2,744	
Staff flights	426			426	473			473	450			450
Vehicle permits and fines	570		570		121		121		345		345	
Total	16,069	0	15,643	426	11,643	0	11,170	473	13,856		13,407	450
Lodge Operational costs												
Boats												
Fuel	1,614		1,614		1,729		1,729		1,672		1,672	
Maintenance	1,043		1,043		2,445		2,445		1,744		1,744	
Permits	1,030		1,030		1,030		1,030		1,030		1,030	
Lodge												
Diesel (electricity)	19,988		19,988		17,673		17,673		18,831		18,831	
Food	55,750	3,184	52,566		47,832	2,748	45,084		51,791	2,966	48,825	
Drinking water	3,811		3,811		2,752		2,752		3,281		3,281	
Beverages	10,667		10,667		8,202		8,202		9,435		9,435	
Permits	606		606		606		606		606		606	
Communications	1,342			1,342	1,555			1,555	1,448		0	1,448
Maintenance (building materials and tools)	9,871		9,871		12,326		12,326		11,098		11,098	
Cleaning supplies	3,340		3,340		4,151		4,151		3,745		3,745	
Gas	964		964		594		594		779		779	
Miscellaneous	2,144	1,765	379		1,414	899	515		1,779	1,332	447	
Total	112,171	4,949	105,880	1,342	102,309	3,647	97,107	1,555	107,240	4,298	101,494	1,448
Lodge Salaries and Visas												
Angolan staff	21,597	8,025	4,249	9,323	27,655	10,276	5,440	11,939	24,626	9,151	4,845	10,631
Foreign staff	9,200			1,516	9,200			1,516	9,200			1,516
Staff visas	400			400	300			300	350			350
Total	31,197	8,025	4,249	11,239	37,155	10,276	5,440	13,755	34,176	9,151	4,845	12,497
Lodge Profit												
Total	40,309			6,853	27,990			4,758	34,150	0	0	5,805
Total contribution	**199,746**	**12,974**	**125,771**	**19,860**	**179,097**	**13,923**	**113,718**	**20,541**	**189,422**	**13,449**	**119,745**	**20,200**

3.2.3. Direct Economic Contribution in Terms of Fish and per kg of Fish

The estimated value of fish caught recreationally on the Kwanza Estuary varied between the lodge fishery and non-lodge fishery and between the fishing seasons in 2016 and 2017 (Figure 4, Table 4). Prices per fish and per kg of fish were considerably higher in 2017 based on reduced catches in that year (i.e., a lower 'supply' of fish). In terms of TR, the estimated prices per fish and per kg of fish for all species and for *P. quadrifilis* were generally higher within the lodge fishery (Figure 4, Table 4). Based on the TR accrued within the lodge fishery, with the inclusion (and exclusion) of casual spending, the total direct economic contribution in terms of fish was calculated as \$560.96 (\$231.22 excl. casual spending) per fish and \$57.36 (\$23.64) per kg in 2016 and \$950.11 (\$415.53) per fish and \$97.15 (\$42.49) per kg in 2017 (Table 4). However, when considering retained revenue alone, values dropped to \$31.80 (\$7.30) per fish and \$3.25 (\$0.75) (RCR < 1) per kg in 2016 and to \$65.84 (\$15.45) per fish and \$6.73 (\$1.58) (RCR < 1) per kg in 2017 (Figure 4, Table 4).

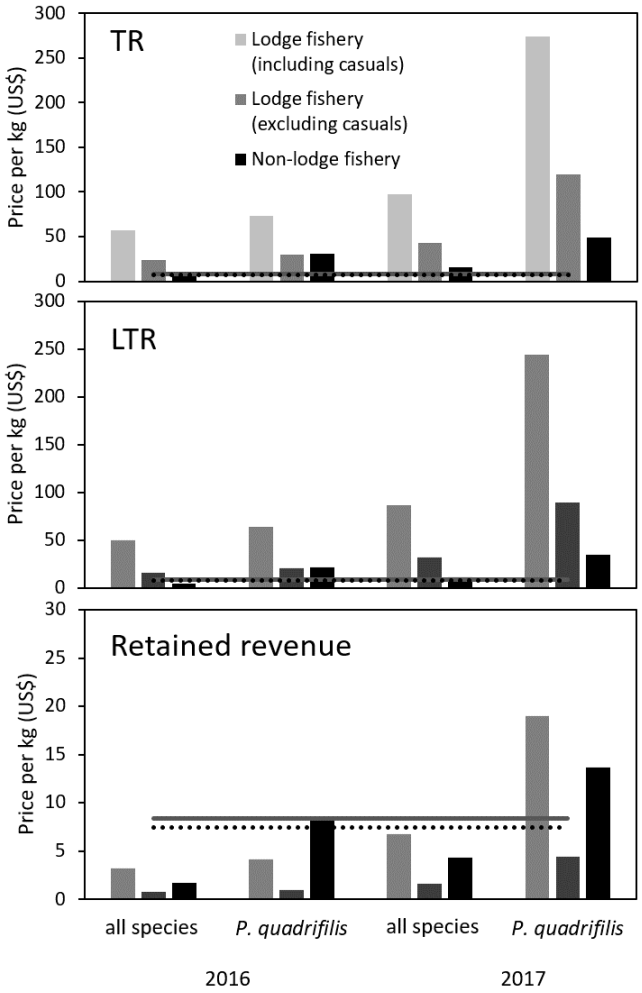

Figure 4. Estimated recreational values of fish (all species) and of *Polydactylus quadrifilis* caught within the lodge and non-lodge recreational fisheries present on the Kwanza Estuary, Angola in 2016 and 2017. Values are estimated in terms of total revenue (TR), local TR and locally retained LTR. Grey solid lines represent the price per kg of *P. quadrifilis* (\$8.38), and black dotted lines represent the price per kg of all species (\$7.44) in the artisanal fishery.

Table 4. The estimated values of recreationally caught fishes and *Polydactylus quadrifilis* from the Kwanza Estuary, Angola in 2016 and 2017 displayed in dollar terms (US$—A) and in terms of recreational-to-commercial ratio (RCR—B) using a commercial market value of $7.44 per kg for all species and $8.38 per kg for *P. quadrifilis*. Values are given using estimates of total revenue (TR), local total revenue (LTR) and retained revenue.

	2016				2017			
	All Species		*P. quadrifilis*		All Species		*P. quadrifilis*	
	per Fish	per kg	per Fish	per kg	per Fish	per kg	per Fish	per kg
A—US$								
Lodge Fishery								
Incl. casual spending								
TR	560.96	57.36	709.46	73.19	950.11	97.15	2,906.22	273.46
LTR	489.55	50.06	619.13	63.87	846.93	86.60	2,590.60	243.77
Retained revenue	31.80	3.25	40.21	4.15	65.84	6.73	201.40	18.95
Excl. casual spending								
TR	231.22	23.64	292.42	30.17	415.53	42.49	1,271.04	119.60
LTR	159.80	16.34	202.10	20.85	312.35	31.94	955.41	89.90
Retained revenue	7.30	0.75	9.23	0.95	15.45	1.58	47.25	4.45
Non-lodge fishery								
TR	99.11	6.29	299.19	30.81	197.81	15.65	526.06	49.20
LTR	69.56	4.41	209.99	21.62	138.83	10.99	369.21	34.53
Retained revenue	27.50	1.75	83.03	8.55	54.90	4.34	145.98	13.65
B—RCR								
Lodge Fishery								
Incl. casual spending								
TR		7.71		8.73		13.06		32.63
LTR		6.73		7.62		11.64		29.09
Retained revenue		0.44		0.50		0.91		2.26
Excluding casual spending								
TR		3.18		3.60		5.71		14.27
LTR		2.20		2.49		4.29		10.73
Retained revenue		0.10		0.11		0.21		0.53
Non-lodge fishery								
TR		0.85		3.68		2.10		5.87
LTR		0.59		2.58		1.48		4.12
Retained revenue		0.24		1.02		0.58		1.63

In terms of the primary target species, *P. quadrifilis*, the total economic contribution for the lodge fishery was estimated as $709.46 ($292.42 excl. casual spending) per fish and $73.19 ($30.17) per kg in 2016 and $2,906.22 ($1,271.04) per fish and $273.46 ($119.60) per kg in 2017 (Table 4). However, in terms of retained value, the estimated value of *P. quadrifilis* caught in the lodge fishery was drastically reduced and fell below that of artisanally caught fish in 2016 ($7.98 per kg—RCR < 1—Table 4), being valued at $40.21 ($9.23) per fish and $4.15 ($0.95) per kg (Figure 4, Table 4). Due to reduced catches in 2017, the estimated value of recreationally caught *P. quadrifilis* remained moderately high, at $201.40 ($47.25) per fish and $18.95 ($4.45) per kg (RCR including casual spending = 2.26, RCR excluding casual spending = 0.53).

Based on increased total catch and lower per person spending within the non-lodge fishery, the estimated value of fish in terms of TR and LTR was lower than what was observed within the lodge fishery (Figure 4, Table 4). However, the value of fish in terms of retained revenue was relatively higher, due to lower rates of leakage (Figure 4, Table 4). Based on TR, fish were estimated to be worth $99.11 per fish and $6.29 per kg in 2016 and $197.82 per fish and $15.65 per kg in 2017. When considering retained revenue alone, fish value was estimated at $27.50 per fish and $1.75 per kg in 2016 and $54.90 per fish and $4.34 per kg in 2017. For *P. quadrifilis*, the estimated fish value based on TR was $299.20 per fish and $30.81 per kg in 2016 and $526.06 per fish and $49.20 per kg in 2017. The estimated retained value of recreationally caught *P. quadrifilis* remained above that of artisanally caught fish (RCR > 1) in both 2016 ($83.03 per fish and $8.55 per kg) and 2017 ($145.99 per fish and $13.65 per kg) (Figure 4, Table 4).

4. Discussion

The recreational fishery for *P. quadrifilis* generated significant economic activity in an area that would otherwise likely receive little input from external sources. However, rates of economic leakage from the study area were found to be high (up to 92.9% in the lodge fishery) and may inhibit the achievement of potential ecotourism goals. It was found that the main sources of economic leakage were via the sourcing of lodge supplies, services and staff outside of the local area and through the repatriation of profit by foreign business owners (at the lodge and the local fuel pump). Capacity building within the local community is likely required in order to reduce leakages and to create 'linkages' between the local community and the recreational fishery [32,43]. Greater community involvement within the fishery, including the provision of business shares and greater communication and control, is suggested in order to achieve sustainability and provide an incentive for the protection of recreationally important fishery species and their associated ecosystems [23].

In terms of the total and local total revenue generated through the winter recreational fishery at the Kwanza Estuary, recreationally caught fishes were considerably more valuable than the same species caught within the artisanal fishery (Figure 4). For example, *P. quadrifilis* consistently fetched the equivalent of $8.38 per kg within the artisanal fishery during the study period. However, the estimated value of *P. quadrifilis* captured within the recreational fishery ranged between 2.5 and 32 times higher depending on the fishery sector and the fishing season (Figure 4, Table 4b). Additionally, many of the fish caught within the recreational sector (particularly within the lodge fishery) would have been released, and, therefore, would have the potential to be caught several times, thus further increasing their value. This suggests that recreational fisheries can potentially raise the value of landed catch, thus incentivising their development and the protection of recreationally important species within other sectors. This scenario represents what has been suggested by a number of authors when evaluating the recreational value of fish species [7,13] and what has been used to demonstrate the potential of recreational fisheries for ecotourism [16].

Despite the economic potential of recreational fisheries, few studies take into consideration the concept of economic leakage and the value of recreational species to other specific fishery stakeholders. For example, a recreational species may generate 100 times more economic activity than the same fish caught within the artisanal fishery. However, if that economic activity is not appreciated by artisanal fishers or their families, there will be no incentive for them to protect that species. Additionally, in this instance, there are few enforced laws governing artisanal or recreational fisheries, and, therefore, sustainable practices would rely on voluntary cooperation between the two fishery sectors. Thus, mutual beneficiation would seemingly play an important role.

When economic leakage was considered, the value of recreationally caught fish dropped considerably and largely fell below the market price of artisanally caught fish (Figure 4, Table 4b). This suggests that although recreational fishing has the potential to raise the value of landed catch, currently, the local benefit is not likely to be large enough to meet ecotourism standards or incentivise a shift for local artisanal fishermen away from targeting recreationally important species or towards involvement within the recreational fishing sector. Therefore, it is imperative that solutions are explored to limit leakage.

The concept of creating 'linkages' between the local community and the recreational fishery may provide one solution towards combatting leakage [32,43]. The area at the Kwanza Estuary mouth is underdeveloped, and currently the lodge sources all food supplies (except for fresh fish and seafood) from outside of the local area. However, there are certain supplies that could, theoretically, be locally sourced. These would, for example, include fresh produce and vegetables. It is suggested that where possible, capacity building and the training of local community members may allow for the provision of local resources. For example, the local community could be approached and offered the opportunity to provide fresh produce on a contractual basis. It is likely that some training may be required and should be facilitated by the lodge or local government.

Another major area of leakage within the lodge fishery was via the employment of non-local staff. This is common in ecotourism primarily because most operations are situated in remote rural wilderness areas where the levels of education are low and where local communities are often unable to meet skilled labour requirements [44]. Here, local employment is ordinarily limited to low-skilled positions including cleaners, bartenders, waiters and general labour [44]. This is identical to what was found in the lodge fishery whereby the higher paying jobs, including the managerial position and position of fishing guide, were occupied by foreigners. Furthermore, other higher paying positions including the head of maintenance (handyman) and the driver were occupied by non-local Angolans. This further limits local economic benefit by reducing the potential for multiplier effects within the local economy, as local staff are earning smaller salaries [44].

The issues surrounding the provision of skilled local staff are more complicated because they are governed by larger socio-political, economic and cultural structures [45]. For example, a very basic yet important barrier that was identified within the lodge fishery was the inability of most local staff to speak English. The majority of foreign clientele are English-speaking, and therefore non-English-speaking staff cannot occupy high-paying jobs within management or as guides. Additionally, where staff could speak English, cultural differences may prevent the appropriate levels of communication expected, for example, from a fishing guide.

In order to break down barriers to local employment, the development of local, skilled staff needs to be prioritised, although it will take time. In many sub-Saharan countries, tourism training 'institutes' and 'academies' exist that are aimed at addressing this need and are funded through national government with technical assistance from the developed world [44]. However, Angola has only recently opened its doors to tourism and does not currently have similar facilities, despite the likely growth of tourism. In the interim, the training of local people to fulfil higher positions could be facilitated outside of Angola [44] and basic English language lessons could be arranged for willing local staff members at the expense of lodges and businesses involved in the tourism industry. Additionally, opportunities or 'ladders' should be provided for local employees to upgrade themselves to higher positions or at least increase their skill-set and employability across other employment categories and within other employment sectors [43].

In the short term, the reduction of leakages may be better addressed through greater community shares and involvement in the fishery [17]. Local community involvement within the recreational fishery is imperative, and the community should maintain some share in profits if it is to successfully meet ecotourism goals. A community-based approach that aims to simultaneously promote the quality of life of local people and the conservation of resources [23] is recommended in this case. This has been achieved elsewhere through a compensatory approach to the restricted access of local people to natural resources through revenue sharing [46]. However, in this case, local fishermen are unlikely to be lawfully 'restricted' in their access to fishing rights as would be the case for local people living within national parks for example. A compensatory approach may be appropriate (see [17]) but may require a higher level of regulation and governance of the fishery, which is not present. Therefore, the reduced harvesting of recreationally important species by local people is reliant on self-governance and mutual agreements between all stakeholders.

One strategy that may help to shift pressure away from artisanal fishing for recreational species may be to maintain a higher level of communication and cooperation between the lodge and non-lodge charter fishery in order to facilitate direct local benefits from the recreational sector. For example, prices for fishing charters should be negotiated and maintained between the two charter providers (the lodge and artisanal fishers). The lodge could then help develop the non-lodge charter fishery through the facilitation of adequate training of artisanal fishers as skippers and guides and by aiding with the marketing of chartered trips on the artisanal boats.

The market for domestic fishing tourism was evident within this study, and it was illustrated that the non-lodge fishery ($134,304 over both seasons) generated similar revenue to foreign fishing tourism ($125,962). Furthermore, a higher percentage of revenue from the non-lodge fishery was

retained locally due to the direct hiring of boats from local artisanal fishermen (41.3% compared with 7.1% in the lodge fishery). Therefore, it may be wise to shift domestic fishing tourism towards charters with local artisanal fishermen. This will not only reduce the overall leakage but will create a local vested interest in the recreational sector. This potential solution is interesting because few authors have approached or appreciated domestic fishing tourism in the developing world and in West Africa specifically [7,13,16,17]. However, the sector appears to be lucrative and may provide an opportunity for higher rates of local job creation because domestic tourists are culturally and linguistically more similar. The single drawback is that the incentive for the domestic recreational fishery to practice C&R fishing is lower, particularly when compared with the foreign recreational fishery, and therefore sustainability goals may be negatively impacted. Although local fish stocks appear to be relatively healthy at present, they have not been formally assessed and are likely to be under significant pressure due to the high number of artisanal and recreational fishermen present. Ultimately, a regulatory framework that sets and enforces catch limits (including bag and size restrictions) may be appropriate. Hopefully, through appropriate devolution of authority by national government, this could be driven and managed by the local community with direct funding through access fees for domestic and foreign recreational anglers [5].

If fishing effort is to shift between recreational sectors, it is important to note the potential differences in catchability between the lodge and non-lodge fisheries. In terms of effort, the lodge fishery was dominated by artificial lure angling (87%) while the non-lodge fishery largely utilised the trolling of lipped crankbaits (82%). These differences in angling methods will likely result in differences in the types of species as well as the number and weight of fishes caught. For example, artificial lure angling largely produced smaller fish (mean of 8.7 kg) compared with trolling (mean of 15.5 kg). However, artificial lure angling produced a higher number of fish indicated by a higher CPUE (0.14 fish per angler-hour compared with 0.07 fish per angler-hour). Additionally, the different methods may have different impacts on the survival rates of released fishes based on differences in specific C&R-related factors (for example, the strength of the equipment used and its effect on fight times, differences in hooking injuries between treble hooks on trolled lures versus single hooks on artificial jigs etc.) [47,48].

It was evident, based on the CPUE data, that recreational fishing effort for different species shifted between years depending on their relative abundance. For example, in 2017 where the catches of *P. quadrifilis* were poor, the lodge fishery shifted effort towards fishing with live bait more frequently in order to target *Lutjanus* species. Similarly, *C. hippos* was extremely abundant in 2018 and became a common target species in the lodge fishery, comprising the highest percentage of catch by number (37%). Therefore, although the recreational fishery revolves around *P. quadrifilis*, other species also play an important role in maintaining the quality of the fishery. Similarly, if the recreational fishery is to provide a source of livelihoods to artisanal fishers, it is important that recreational fishing takes place on a year-round basis. Therefore, the other species that become more recreationally important in the summer months, such as *M. atlanticus*, require research and management consideration. Thus, the co-management of recreational angling species should extend beyond *P. quadrifilis*. For this, education programmes with local communities, and particularly artisanal fishers, may aid in opening the lines of communication between the sectors and facilitating cooperation to achieve mutually beneficial goals.

All in all, a fisheries management strategy that aims to address local community benefit is likely to be the best solution going forward. The potential value of the recreational fishery should be communicated to and realised by the local community in order to build environmental stewardship and conservation mindedness within the community [17], while strategies to reduce leakage through the creation of linkages should be implemented. However, economic benefit alone may not be enough to incentivise sustainability and environmental stewardship [17]. A deeper understanding of the social–ecological system in which the recreational fishery is nested would provide invaluable information for fisheries management, and information should be gathered from a range of other social

and environmental fields. Overall community involvement within the fishery is necessary to negotiate and facilitate mutually beneficial goals that can be incorporated into a holistic management framework.

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