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Global shark currency: the distribution, frequency, and economic value of shark ecotourism

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Ecotourism represents a highly popularised activity which has exhibited global growth in recent years. In the present paper, we examine the distribution, frequency, and economic value of shark-based ecotourism operations worldwide. A total of 376 shark ecotour operations across 83 locations and 8 geographic regions were identified. Here we describe the global and regional scope of the industry; determine the species utilised in shark ecotourism activities; and examine the recreational usage values of sharks. Further, we conducted a case study of a shark tourism operation based in South Africa by analysing 12 years of demographical and economical data, revealing increasing trends in the total number of customers served and cost per trip over the sampling period. We also compare consumptive and non-consumptive values of shark resources and discuss the potential research and conservation implications of the industry to sharks worldwide.

Keywords: ecotourism; shark diving; biodiversity preservation; shark; economic valuation

Introduction

Ecosystem capital is the sum of all the goods and services provided to global human enterprises by natural systems. These services are conservatively valued at US$41 trillion per year (Wright & Boorse, 2008). Furthermore, such capital depends on the maintenance of ecosystem biodiversity and resilience; nevertheless, many natural systems are experiencing severe losses in both (Dunne, Williams, & Martinez, 2002; Pearce & Moran, 1996; Tittensor et al., 2010; Worm et al., 2007). The drivers of these losses are numerous and include growing anthropogenic threats in the form of (but not limited to) habitat destruction, invasive species, pollution, climate change, and overfishing (e.g. Wilcove, Rothstein, Dubow, Phillips, & Losos, 1998; Worm et al., 2006; Worm & Lotze, 2009). Removing species from habitats can lead to small-scale extirpation and subsequent shifts in food-web dynamics; however, the targeted removal of keystone and/or ecologically important species may be detrimental to ecosystem structure and function, thus impacting biodiversity

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and resilience, ultimately diminishing ecosystem capital (Dunne et al., 2002; Myers, Baum, Shepherd, Powers, & Peterson, 2007; Paine, 1969; Parsons, 1992; Wright & Boorse, 2008). As the exhaustion of natural systems continues to alter ecosystem capital, the value of non-consumptive usage of these natural resources becomes increasingly important in shaping conservation efforts at the local, regional, and international level (Bräuer, 2003; McNeely, 1990; Perrings, Folke, & Maler, 1992).

Species in their natural environments support a variety of recreational activities and aesthetic interests including fishing, hiking, snorkeling, and photography, just to name a few. Nature-based tourism, often referred to as ecotourism (yet treated the same for the purposes of this paper), has become increasingly popular in recent decades and has been described as one of the fastest growing sectors of the tourism industry (Scheyvens, 1999; Wearing & Neil, 2009). Ecotourism is broadly defined as an 'environmentally responsible, enlightening travel to a relatively undisturbed or natural area to enjoy and appreciate nature' (Ceballos-Lascurain, 1996). Established ecotourism operations present visitors with new and exciting ways to experience nature in exchange for money (Liu, 2003; Wearing & Neil, 2009).

While various species sustain nature-based tourism markets, it is the large and charismatic species (including predators) which arguably draw the most attention (i.e. whales, eagles, big cats, sharks) from tourists. Despite their general popularity among tourists, the numbers of threatened and endangered species (notably marine species) continues to rise (IUCN, 2009; Liu, 1994); and marine apex-predators, particularly sharks, have experienced population declines globally in the last few decades (Baum et al., 2003; Burgess et al., 2005; Dulvy et al., 2008; Ferretti, Myers, Serena, & Lotze, 2008; Worm et al., 2006). For example, shark populations on the US east coast have declined an estimated 80–90% since the mid-1980s, as a result of target and non-target fisheries (Baum & Blanchard, 2010; Baum et al., 2003; Clarke, Magnussen, Abercrombie, McAllister, & Shivji, 2006; Myers et al., 2007). Many shark species are inherently vulnerable to population decreases as a result of overexploitation due to their general life-history characteristics (i.e. slow growth, late to reach sexual maturity). As of 2010, an estimated 15% of shark species were listed as critically endangered, endangered, or vulnerable (IUCN, 2010), with an estimated one-third of all pelagic (open ocean) sharks faced with extinction (IUCN, 2009). Furthermore, the continued harvest of these keystone and/or ecologically important species is largely due to their high economic value in various global markets (i.e. shark finning; Figure 1(a)), presenting both existing and potential future users with hard-to-ignore fiscal incentives to target sharks.

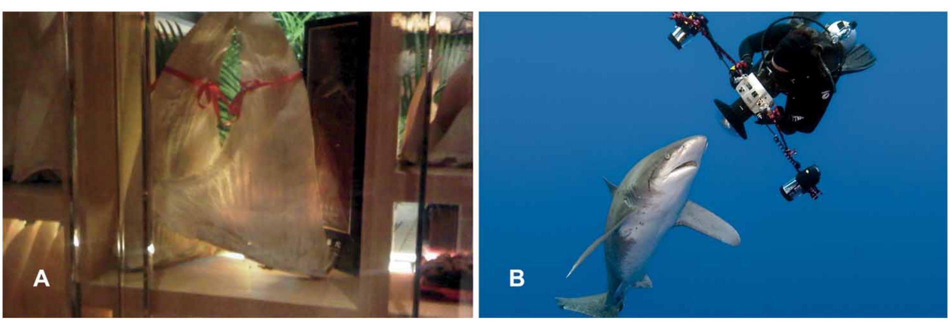

Figure 1. Consumptive and non-consumptive uses of shark resources. (a) Prized shark fins on display in a Hong Kong market, likely originating from a large hammerhead (*Sphyrna spp.*) or white shark (*Carcharodon carcharias*), photo taken September 2010 (photo J. Gallagher). (b) Oceanic white-tip shark (*Carcharhinus longimanus*) with diver during shark ecotourism operation in the Bahamas.

In contrast to harvesting, sharks also provide non-consumptive use potential. In recent years, there has been a surge in shark-directed ecotourism, presenting users with opportunities to observe, photograph, and interact with these marine predators (Orams, 2002; Topelko & Dearden, 2005; Figure 1(b)). Accordingly, there have been several recent studies evaluating both economic and ecological impacts of shark ecotourism (e.g. Catlin, Jones, Jones, Norman, & Wood, 2010; Malkjović & Côté, 2011). Many of these reports, however, have focused on a particular species in a given region, leaving a gap in our knowledge of the global breadth of the shark ecotourism industry.

The present paper provides a global examination of the distribution and frequency of the shark-based ecotourism industry. Although shark ecotourism can include onboard observations and catch & release angling, here we focus solely on in-water ecotourism activities (e.g. diving or snorkeling). Specific areas addressed in this paper include: (1) describing the size and scope of the industry; (2) identifying heavily used regions for these activities; (3) identifying the species utilised in shark ecotourism; and (4) discussing the recreational usage value of sharks. Based on our analyses, we evaluate the relative economic importance of shark-based ecotourism at a global scale and the potential implications of the industry to shark conservation.

Methods

Tourism has long been one of the most important components of online commerce, and the Internet remains a predominant driver for the economic decisions of tourists when planning vacations and excursions (Milano, Baggio, & Piatrelli, 2011; Werthner & Ricci, 2004). Accordingly, this large database may contain novel data useful in both addressing the scope of the shark ecotourism industry and its relative economic value. From October to November 2010, we performed extensive Internet searches (using http://www.google.com) to identify locations directly linked to the shark ecotourism operations, using the following key words: ‘shark ecotourism’, ‘shark diving’, ‘shark trips’, ‘shark operations’, ‘shark photography’, and ‘shark encounters’. After preliminary locations and operations were identified, we then ran subsequent searches by region (and associated species) to further identify ecotourism companies promoting sharks as a recreational resource. We also included operations based on verbal and written communications with marine-based tourism industries.

The overarching criterion used to identify an established shark ecotourism operation was whether an individual company specifically advertised shark encounters as an associated service. Components of an operation which met this criteria generally included: (a) a banner on the website homepage featuring a shark image and/or text advertising a shark encounter; (b) operations directly promoting a specific shark ‘adventure’, ‘encounter’, or ‘package’; (c) operations providing specific pricing for shark-related activities; and (d) verbal descriptions citing sharks as the main goal or objective of a given diving or snorkeling activity. We excluded companies that presented the chance to encounter a shark opportunistically. Such discrimination in our examination filtered out locations where divers may casually observe sharks species on a particular dive. As such, we were able to record the most established, shark-focused operations. To be included in our analysis (Table 1), a recorded operation had to contain at least one currently functioning shark-focused ecotourism activity.

Locations were classified into one of eight regional zones: 1, North America; 2, Central and South America; 3, Greater Caribbean, including the Bahamas; 4, Europe; 5, North Africa and the Middle East; 6, Southern and Eastern Africa, including Seychelles and Madagascar; 7, Asia and Indonesia, excluding Papua New Guinea; and 8, Oceania,

Table 1. Summary table of established global shark ecotourism sites from examination of Internet websites.

Location	Region	No. operators	Main attraction	Category
Rhode Island, USA[a]	NA	2	Blue/mako	P
Long Island, USA	NA	1	Blue/mako	P
Stellwagen Bank, MA, USA	NA	2	Basking	H
Nantucket, MA, USA	NA	1	Blue/mako	P
Outer Banks, NC, USA	NA	8	Sand tiger	CR
Venice, Louisiana[a]	NA	1	Dusky, Silky	CR
Palm Beach, FL, USA	NA	2	Caribbean reef	CR
Farallon Islands, CA, USA	NA	5	White	H
Catalina Island, CA, USA[a]	NA	3	Blue/mako	P
San Diego, CA, USA[a]	NA	1	Blue/mako	P
Hornby Island, BC, CA	NA	1	Six-gill	CR
Haleiwa, HI, USA	NA	2	Galapagos	CR
Honolulu, HI, USA	NA	4	Galapagos, whitetip reef	CR
Isla Guadalupe, Mexico[b]	CSA	5	White	H
Sea of Cortez, Mexico[b]	CSA	4	Whale, S. Hammerhead	H, CR
Socorro Island, Mexico[b]	CSA	4	S. Hammerhead, whale	H, CR
Playa Del Carmen, Mexico	CSA	1	Bull	CR
Isla Holbox, Mexico	CSA	>20	Whale	H
Ambergris Caye, Belieze	CSA	5	Nurse, Caribbean reef	CR
Gladden Spit, Belieze	CSA	4	Whale	H
Bat Islands, Costa Rica	CSA	5	Bull, whitetip reef	CR
Cocos Island, Costa Rica[b]	CSA	4	S. Hammerhead	H, CR
Utila, Honduras	CSA	>20	Whale	H
Galapagos Islands, Ecuador[b]	CSA	6	S. Hammerhead, whale	H, CR
Malpelo Island, Ecuador[b]	CSA	3	S. Hammerhead, whale	H, CR
Canary Islands, Spain	E	3	Angel	CR
Cornwall, UK	E	3	Basking	H
Isle of Man, UK	E	>10	Basking	H
The Azores, Portugal	E	2	Blue/mako	P
St. Maarten, Dutch Antilles	GC	3	Caribbean reef	CR
Tiger Beach, the Bahamas[b]	GC	3	Tiger, hammerhead	CR
Nassau, the Bahamas	GC	3	Caribbean reef	CR
Long Island, the Bahamas	GC	1	Caribbean reef	CR
Bimini, the Bahamas	GC	1	Caribbean reef	CR
Grand Bahama Island, the Bahamas	GC	2	Caribbean reef	CR
Exuma Cays, the Bahamas	GC	3	Caribbean reef, whale	CR
Eleuthera, the Bahamas	GC	1	Caribbean reef, blacktip	CR
San Salvador Island, the Bahamas	GC	1	Caribbean reef, S. Hammerhead	CR
Walker's Cay, the Bahamas	GC	2	Caribbean reef	CR
Turks and Caicos Islands, West Indies	GC	3	Caribbean reef, nurse	CR
Playa Santa Lucia, Cuba	GC	1	Bull	CR
Jardines de la Reina, Cuba	GC	2	Bull, Silky	CR
Fish Rock, NSW, Australia	O	3	Sand tiger	CR
Coffs Harbor, NSW, Australia	O	2	Sand tiger	CR
Forster, NSW, Australia	O	3	Sand tiger	CR
Ningaloo Reef, WA, Australia	O	>10	Whale	H
Port Lincoln, SA, Australia	O	4	White	H

(*Continued*)

Table 1. Continued.

Location	Region	No. operators	Main attraction	Category
Wolf Rock, QLD, Australia	O	4	Sand tiger	CR
Great Barrier Reef, QLD, Australia	O	>20	Grey reef, silvertip	CR
Coral Sea Islands, QLD, Australia[b]	O	5	Grey reef, silvertip	CR
Moorea, French Polynesia	O	4	Blacktip reef, lemon	CR
Fakarava, French Polynesia	O	2	Grey reef, blacktip reef	CR
Rangiroa, French Polynesia	O	6	Blacktip reef, grey reef	CR
Bora Bora, French Polynesia	O	2	Blacktip reef, grey reef	CR
New Georgia/Russell Islands, Solomons	O	3	Blacktip reef, whitetip reef	CR
Vanua Levu, Fiji[b]	O	5	Grey reef, blacktip reef	CR
Mana Island, Fiji	O	4	Grey reef, blacktip reef	CR
Beqa Lagoon, Fiji	O	1	Tiger, bull	CR
Chatham Islands, New Zealand	O	1	White	H
North Island, New Zealand	O	2	White, mako	H, P
Beirut, Lebanon	AME	2	Sand tiger	CR
Hurghada, Egypt	AME	4	Grey reef, whitetip reef	CR
Elphinstone and Daedalus Reef, Egypt[b]	AME	10	Oceanic whitetip	P
Coastal Reefs, Sudan	AME	3	Silvertip, S. Hammerhead	H, CR
Tubbataha Reef Park, Philippines	AI	3	Whitetip reef, blacktip reef	CR
Donsol, Philippines	AI	>10	Whale	H
Malapascua/Pescador Island, Philippines	AI	7	Pelagic thresher	P
Phuket, Thailand	AI	5	Whale	H
Similan, Thailand[b]	AI	>5	Whale	H
Palau Archipelago, Palau[b]	AI	>10	Grey reef, whitetip reef	H, CR
The Maldives (grouped)[b]	AI	>20	Whale, grey reef	H, CR
False Bay, South Africa	SEA	2	White	H
Mossel Bay, South Africa	SEA	1	White	H
Gansbaai, South Africa	SEA	7	White	H
Protea Banks, KZN, South Africa[b]	SEA	7	Sand tiger, bronze whaler	CR
Aliwal Shoal, KZN, South Africa	SEA	>10	Tiger, sand tiger	CR
Sardine Run, KZN, South Africa	SEA	>10	Blacktip, bronze whaler	CR
Sodwana Bay, KZN, South Africa	SEA	3	Sand tiger, whale	H
Dar es Salaam, Tanzania	SEA	3	Whale	H
Inhambane, Mozambique	SEA	5	Whale, S. Hammerhead	H
Bassas da India Atoll, French Territory[b]	SEA	2	White, S. Hammerhead	H
Ponta D'Ouro, Mozambique	SEA	4	S. Hammerhead, whale	H
The Seychelles (various atolls)[b]	SEA	4	Whale	H

Notes: Location, region, number of operators, main species, and category (biological) of shark species are presented. Region: NA, North America; CSA, Central and South America; E, Europe; GC, Greater Caribbean; O, Oceania; AME, North Africa and Middle East; AI, Asia and Indonesia; SEA, Southern and Eastern Africa. Category: H, highly migratory; CR, coastal and reef associated; P, pelagic.
[a]Fishermen who operate ecotours.
[b]Live aboard experience (partial or full).

including Papua New Guinea, Australia, New Zealand, and the South Pacific Islands. These data were then put into a Geographic Information System (ArcView 9.3) to examine for patterns in the frequency and distribution of operations. For each operation within a given region, we recorded the following parameters: total advertised species richness and focal species (major attraction). Species diversity was derived by locating specific mention of species (common name was acceptable) associated with a diving activity on an operator's webpage. The total number and range of species that were promoted (as part of an ecotourism activity) were tallied and recorded at each location. In our examination, we did not discriminate between methods used by operations to foster or create shark encounters (i.e. chumming, baiting, feeding, etc.).

We also conducted a socio-economic case study of a shark-ecotourism company based in South Africa. The company, Apex Expeditions, is run by Chris and Monique Fallows, who have been conducting shark ecotourism activities for 20 years (www.apexpredators.com). Apex Expeditions focuses their activities on observing natural shark predation and cage diving, particularly with white sharks (*Carcharodon carcharias*), and other pelagic species. We quantified the scope of their operation by evaluating a set of demographic and economic focal metrics which included: (a) year of company establishment; (b) total number of trips since inception; (c) total number of trips per year between 1999 and 2010; (d) total number of customers since inception; (e) total number of customers per year between 1999 and 2010; (f) maximum number of passengers per year from 1999 to 2010; (g) total number of staff employed per year between 1999 and 2010; and (h) average cost per person, per trip, per year between 1999 and 2010. Additionally, we also recorded the (i) number of shark species encountered on a daily shark trip, (j) average number of days conducting ecotourism activities per year, (k) the top three countries served by the operation, (l) percentage of repeat customers, (m) the estimated percentage of people who take photo/video, and (n) the estimated percentage of people who publish their photo/video in various media. We also examined the community services provided and monetary contribution to local communities as a result of their operation. All quantitative data were summarised and the means were calculated. Initial raw monetary data (cost of trips, presented in South African Rand) were corrected for inflation based on South African annual average inflation rates (source: International Monetary Fund) and were subsequently converted to USD equivalents. Relationships between total number of customers per year and total number of trips conducted per year were analysed via regression analysis. All analyses were performed using SAS (1990) software and significance was declared at $p < 0.05$.

Results

A global review

Our examination of ecotourism via the Internet websites revealed 376 established shark ecotourism operations (over 500 found and screened), in 83 specific locations, spanning 29 different countries (Figure 2).

Locations and operators

All recorded sites were categorised by location into eight regions (Table 1). Regionally, Oceania contained the highest proportion of different locations offering shark-based ecotourism (18 locations, ~22%; Figure 3). The Greater Caribbean and North America regions each accounted for approximately 16% ($n = 13$, respectively) of all locations offering shark ecotours (Figure 3). Both Europe and North Africa/Middle East had the fewest number of different locations among all regions offering shark-based ecotourism (~4% each; Figure 3).

The specific locations supporting the highest number of established shark-based ecotourism operations included: Holbox, Mexico (>20), Utila, Honduras (>20), Great Barrier Reef,

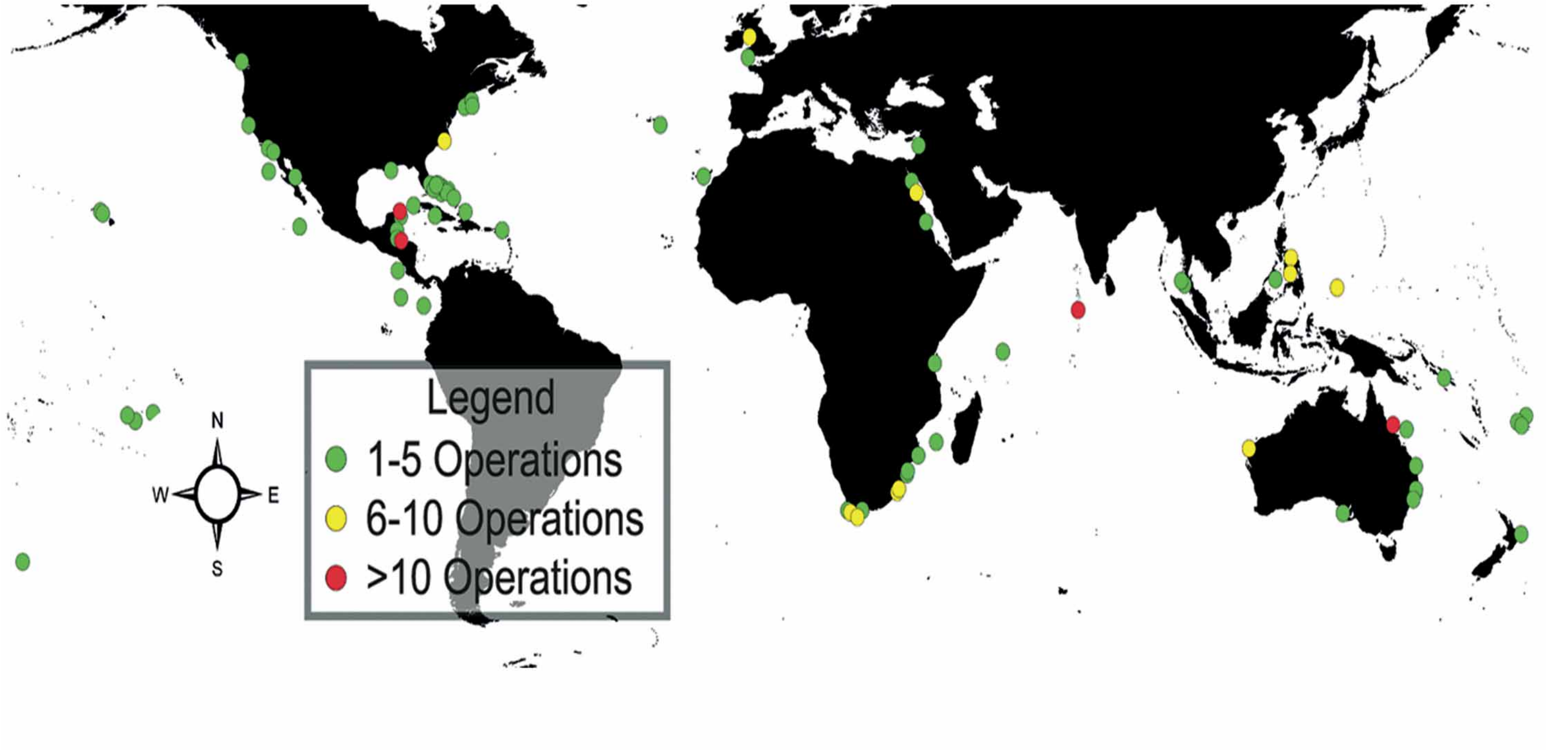

Figure 2. The global distribution and frequency of established shark ecotourism. Results on the distribution and frequency of shark ecotourism as tabulated from extensive Internet searches according to our criteria (see Methods). Green locations, 1–5 operations; yellow locations, 6–10 operations; red locations, <10 locations.

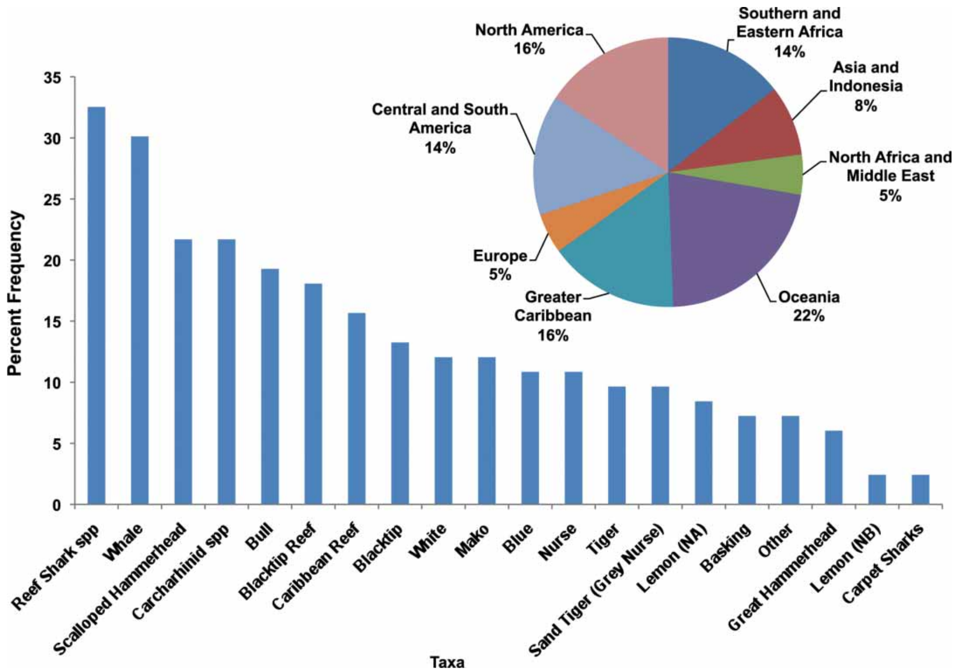

Figure 3. Trends among species and regions. Observed frequency (reported as proportion of total) of advertised species (histogram) and percentage of locations by region (pie chart); data gathered from Internet searches.

Australia (>20), Isle of Man, UK (>10), and Ningaloo Reef, Australia (>10) (Figure 2). Additionally, both Palau and Maldives contained >10 operations each. North Africa and the Middle East region contained the fewest number of operations (Table 1, Figure 2).

Species

We quantified species-specific patterns in shark-based ecotourism activities in order to compare their relative contribution to the global industry. The following species were included in our analysis: whale (*Rhincodon typus*), white (*Carcharodon carcharias*), basking (*Cetorhinus maximus*), shortfin mako (*Isurus oxyrinchus*), blue (*Prionace glauca*), great hammerhead (*Sphyrna mokarran*), scalloped hammerhead (*Sphyrna lewini*), Caribbean reef (*Carcharhinus perezi*), blacktip reef (*Carcharhinus melanopterus*), lemon shark (*Negaprion brevirostris*), sickle-fin lemon shark (*Negaprion acutidens*), tiger (*Galeocerdo cuvier*), bull (*Carcharhinus leucas*), nurse (*Ginglymostoma cirratum*), and blacktip (*Carcharhinus limbatus*). We also included four additional categories that grouped species. Sharks not listed above, but from the family Carcharhinidae were categorised as ‘Carcharhinidae spp.’. The category ‘Reef shark species’ included the silvertip reef (*Carcharhinus albimarginatus*), grey reef (*Carcharhinus amblyrynchos*), and whitetip reef (*Triaenodon obesus*) shark. The category ‘carpet sharks’ was composed of angel sharks (Order Squatiniformes) and wobbegongs (*Orectolobus* spp.). Any species which did not fall into any of the former categories were listed as ‘other’. We also recorded the ‘main attraction’ species, which was the focal species and most frequently advertised from each location (Table 1).

Table 2. Demographical and economical data from the case study of Apex Expeditions ecotourist operation in South Africa.

	1999	2002	2005	2008	2010	Total: 1999–2010	Mean $\pm$ SE: 1999–2010
Trips	83	76	102	121	175	1221	101.75 $\pm$ 8.91
Customers	250	500	650	1100	1700	8570	625.54 $\pm$ 127.87
Cost of trip/per person (USD)*	\$164	\$177	\$208	\$193	\$201	n/a	\$189.17

Notes: Trips, customers and cost per trip/per person are presented across 3-year periods, as well as the total across the 12-year sampling period.
*Monetary amounts were adjusted for inflation using the South African CPI and converted to USD equivalents.

In roughly 33% of all locations globally, 'Reef shark spp.' (excluding Caribbean and Blacktip reef) were advertised among ecotourism operations (all regions, except Europe; Figure 3). Whale shark (the largest fish in the ocean) encounters accounted for 30% of all market locations, which generally supported the highest number of operations. These locations include: the Yucatan Peninsula (Isla Holbox), Honduras, Western Australia (Ningaloo Reef), and Asia and Indonesia (Philippines, Seychelles, and the Maldives).

Sharks from the species groupings 'blacktip reef' and 'Caribbean reef' were highly advertised in shark encounters (18% and 15.6%, respectively; Figure 3). Additionally, pelagic species such as the short-fin mako and the blue shark exhibited modest representation among global ecotourism operations ($>$10% each).

Economic case study

Over the 12-year sampling period of operations by Apex Expeditions, we found general patterns of increase in all metrics examined (Table 2). Data for the number of trips per year exhibited an exponential increase over time ($r^2 = 0.74$, $p < 0.003$; Figure 4), with an overall average of 101.75 $\pm$ 8.91 trips per year (mean $\pm$ SE) over the 12-year period, peaking in 2010 (175 trips). The number of customers per year also exhibited an exponential increase over time ($r^2 = 0.92$, $p < 0.0001$; Figure 4), averaging 624.54 customers per year $\pm$ 127.87 (mean $\pm$ SE) over the period of 12 years. This pattern is further demonstrated by the large spike in the number of customers from 2005 to 2010 (Table 2). Other metrics, such as the number of staff employed (2–6 staff from 1999 to 2010), number

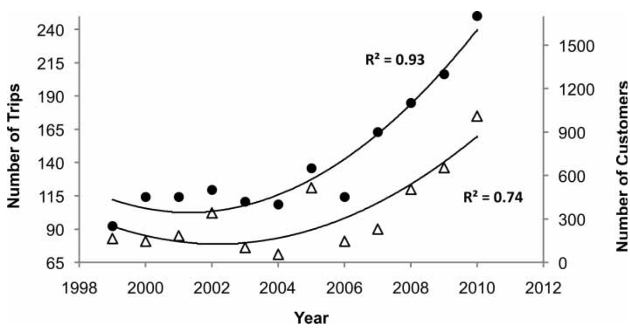

Figure 4. Demographic case study. Regression of the total number of trips (open triangles) and total customers (closed circles) over the 12-year sampling period, data derived from the case study of Apex Expeditions.

of passengers per vessel (6–12 people from 1999 to 2010), and average cost per trip/per person (~23% increase from 1999 to 2010) displayed increasing trends over the 12-year sampling period (Table 2). Since its inception in 1996, Apex Expeditions spends an average of ~200 days a year on the water, bringing customers close to five species of shark (white sharks and four pelagic species). Apex has run 1221 trips since 1996 and catered to approximately 8570 customers from around the world. The top three countries served during the sampling period were: USA, UK, and Canada (in no particular order). An estimated 85% of customers recorded video or took photographs during their trips, with an additional 20% of this group choosing to publish their content in some form of online or print media.

Discussion

Oceania's prevalence of pristine reef habitats and associated shark fauna likely explains its high proportion of shark ecotourism locations (Last & Stevens, 2009). As a corollary, the Greater Caribbean's high number of locations may be explained by feeding and nursery grounds utilised by sharks in this region (e.g. Carrier & Pratt, 1998; Feldheim, Gruber, & Ashley, 2002; Figure 2). The Bahamas alone provides almost 70% of this region's total shark ecotourism, which is not surprising due to its biological richness of shark species (Holland, 2007). Asia and Indonesia contained dense patches of locations advertising shark encounters; however, we noted that operations are still relatively young among this region (Authors, direct observation). Moreover, the burgeoning of ecotourism sites in places such as Palau is tied to recent large-scale developments of shark sanctuaries, which simultaneously seek to protect resources while driving a tourism industry. North Africa and the Middle East region contained the fewest number of operations (Table 1, Figure 2), a finding which could be a consequence of depleted regional populations of sharks (e.g. unregulated shark fishing). Interestingly, the Red Sea's international reputation for reef diving activities (yet lack of established, directed shark ecotourism) may indeed suggest local depletions of shark diversity.

Our examination of species patterns across locations may provide insights into the worth of a species to a location or region's ecotourism. For example, reef sharks (including Caribbean reef and Blacktip reef) were present in over 33% of all global ecotourism locations. The reef shark's widespread presence across ecotourism sites may be explained by industry geography (i.e. a market's proximity to reef habitats), and shark ecology (the high site fidelity observed by reef sharks; Papastamatiou et al. 2011).

Whale shark encounters accounted for 30% of all market locations, where such locations included the Yucatan Peninsula (Isla Holbox), Honduras, Western Australia (Ningaloo Reef), and Asia and Indonesia (Philippines, Seychelles, and the Maldives). While the whale shark-watching industry is still relatively young (began in 1980s; Colman, 1997), these numbers indicate the regional capitalisation on whale sharks as a recreational resource. Additionally, their large size, non-threatening character, coupled with easily accessible snorkeling encounter opportunities, allow for a reliable and profitable industry (Authors, direct experience). Moreover, ecotourism efforts have likely benefitted from international restrictions on the consumptive use of this species. The whale shark is currently listed as 'vulnerable to extinction' on the IUCN's Red List of Threatened Species and international trade in whale shark parts are monitored under Appendix II of the Convention on International Trade of Endangered Species. The basking shark (the second largest fish in the ocean) operations in the UK and white shark ecotours in South Africa and Mexico also demonstrate a similar trend in regional abundance and tight

Table 3. Economic impact of discrete established ecotourism markets as they appear in previous reports.

Location	Value (per year)	Species	Source
Gansbaai, SA	4.4 million	White	Hara, Maharaj and Pithers (2003)
Maldive Islands	2.3 million (1993)	Various reef spp.	Anderson and Ahmed (1993)
Maldive Islands	6.6 million (1998)	Various reef spp.	Waheed (1998)
Ningaloo Reef, AUS	5.9 million (1997)	Whale	Davis et al. (1997)
Seychelles	4.88 million	Whale	Rowat and Engerlhardt (2007)
The Bahamas	78 million (2004)	Various reef spp.	Cline (2008)

Note: Location, annual value, species, and source are presented.

global regulation (Table 1). It is worthy to note that these species represent the three largest and arguably the most charismatic species of shark on the planet, inherently drawing public interest, which no doubt adds to their popularity in terms of ecotourism.

Our case study of a white shark ecotourism operator in South Africa revealed significant economical growth over time. This case study also highlighted an additional level of local economic stimulation emanating from Apex Expeditions. For example, Apex Expeditions hires its employees from surrounding poor local communities. Additionally, we discovered that the average Apex Expedition customer spends an estimated US$350 per day. This figure is based on both the cost of the trip as well as external costs benefiting the local economy incurred from accommodation, food, car rental, and other recreational activities. The company has also developed various professional enterprises with local businesses, including establishing partnerships with other dive and travel companies. Apex Expeditions provides first-aid training for all of its employees as well as setting up their employees with alternative sources of income during each off-season. Our case study also revealed a high degree of community involvement and educational outreach from Apex Expeditions, ranging from an online monthly newsletter (5000 subscribers), to donations to local community enterprises (US$2000.00 per year). Apex frequently provides presentations to local schools. Apex Expeditions also facilitates scientific research, resulting in publications of both popular and peer-reviewed scientific publications (e.g. Hammerschlag, Martin, & Fallows, 2006; Martin, Hammerschlag, Collier, & Fallows, 2005; Martin, Rossmo, & Hammerschlag, 2009). While just one example, we believe our case study highlights the economic potential, community-involvement, and environmentally conscious development of an operator in the shark ecotourism industry.

There is a call for studies taking an interdisciplinary approach to studying top marine predators such as sharks (Jacques, 2010). Our study provides the first attempt to use the Internet to gauge the distribution and frequency of shark ecotourism. A limitation of our study is the validity and quality of data from Internet sources. We realise that these findings cannot be treated as purely absolute, given the potential for overlap among highly clustered markets and possibility for inaccuracies in the source data. Moreover, websites are easily subject to change and may not remain online indefinitely. Despite these issues, our analysis is a 'snapshot' of the industry at a moment in time which reflects the choices that recreational users (i.e. tourists) are offered across the world at any given moment in time.

The monetary value of sharks

It has been previously reported that shark ecotourism can present large economic values across coastal nations (Table 3). In the Maldives, for example, divers engaged in over

76,000 shark-observing dives in just one year, bringing in an estimated US$2.3 million to the local economy in 1993 alone (Anderson & Ahmed, 1993; Anderson & Waheed, 2001). This same study also estimated that a single grey reef shark was worth an average of $3,300 per year, and over $35,000 per year at the most popular dive sites. In 2010, shark fishing in the Maldives was banned since shark-based ecotourism contributed an estimated >30% towards the Maldives GDP (Ndurya & Kihara, 2009).

A similar pattern is apparent in North America, whereby the Bahamas have enjoyed over 25 years of recreational shark usage. In 2007, divers experienced an estimated 73,000 shark interactions in the Bahamas, generating roughly US$78 million in annual revenue (Cline, 2008; Table 3). In over 20 years, the Bahamas have offered over 1 million shark–diver interactions, contributing an estimated gross of US$800 million to the Bahamian economy (Cline, 2008). Our study corroborates this high economic value of sharks in the Bahamas, where we found that the Bahamas alone represented over 70% of all Greater Caribbean ecotourism operations. Accordingly, it may serve the Bahamas well to consider protecting these natural resources for future non-consumptive usage through tourism.

In addition to the profits generated by the tour operators, the economic benefits of shark-based tourism extend throughout the community. Travel, accommodation, and meals are just a few examples of other external costs incurred by shark ecotourists. For example, in the small developing community of Donsol, Philippines, whale shark tourism is solely responsible for bringing the local municipalities out of poverty by creating over 300 jobs and offering over 200 fishermen seasonal employment (as reported in Norman & Catlin, 2007). Another example of community values emanating from shark ecotourism is the Shark Reef Marine Reserve in Beqa Lagoon, Fiji. This project's goal is to preserve the biodiversity of a small patch reef, while sustaining a local community through the economic revenues generated from shark diving (for more information, see Brunnschweiler, 2010; Brunnschweiler & Earle, 2006).

Shark-based ecotourism operations may benefit from the long-lived life-history characteristics of many shark species (provided sharks remain in the system). For example, Anderson and Ahmed (1993) concluded that a grey reef shark was 100 times more valuable alive than dead. It has also been calculated that an individual reef shark may be valued at over US$200,000 over the course of its life (Wells, 2010). Extrapolating this value, a single reef shark would be worth roughly US$13,000 a year (using a conservative life span of 15 years). Moreover, if an ecotourism operator visits this individual every other day during the course of a year, the shark would be worth approximately US$73 a day. In 2004, the average market price for a set of shark fins (from the family Carcharhinidae) was valued at ~US$50 (Clarke, Milner-Gulland, Bjorndal, 2007). The one-time daily usage comparison between $73 (alive, recreation) and $50 (dead, finned) creates a stark dichotomy.

Shark ecotourism, like other marine recreational activities, is driven by the economic decisions of tourists. Studies and reports often attempt to highlight the socio-economic importance of biodiversity and nature by conducting questionnaire surveys to gauge the public's monetary interest in experiencing a particular species. These questionnaires, generally known as the 'willingness to pay' surveys (hereafter referred to as WTP), are often employed in natural resource economics and decision-making (Simpson, 1998). Here, we provide a few examples from the WTP surveys directed to the study of shark ecotourism.

In a study conducted at Duke University in 2004, 504 American scuba divers were asked to assess their maximum WTP for seeing healthy corals, sea turtles, and sharks

(White, 2008). Results from this study suggested that divers hold high non-consumptive values for marine life, ranking sharks as the top attraction, with 71% of all divers willing to pay more to observe sharks than any other species. Two other studies which conducted WTP surveys on divers in the Seychelles and Australia found a WTP range of US$30–900 for observing whale sharks (Cesar, van Beukering, Payet, & Grandcourt, 2003; Davis, Banks, Birtles, Valentine, & Cuthill, 1997). Finally, a recent WTP survey aimed at divers with an average of 1000 logged dives revealed that over 75% of them were willing to pay extra to see sharks on a given trip (Medd, unpublished data). These high WTP values reflect strong socio-economic interests for tourists to experience sharks in the wild, and may reflect the wide distribution and popularity of this industry.

Strong debate currently exists on whether shark ecotourism may alter shark behaviour and/or incur ecosystem-level consequences. Accordingly, there is a blossoming and controversial body of literature on this subject (e.g. Clua, Buray, Legendre, Mourier, & Planes, 2010; Laroche, Kock, Dill, & Oosthuizen, 2007; Malkjović & Côté, 2011). Addressing this topic is beyond the scope of our present study, and those interested are urged to consult the growing stock of literature on this topic.

The issue of shark ecotourism lends itself to investigations from researchers spanning multiple disciplines such as tourism research (Catlin & Jones, 2010; Catlin et al., 2010), economics (Anderson & Ahmed, 1993), community-based resource management (Brunnschweiler, 2010), and ecology (Hammerschlag et al., 2006; Malkjović & Côté, 2011). Additionally, it should be noted that ecotourism can facilitate scientific observations and data collection, affording researchers opportunities to measure inter-annual population changes and the behavioural ecology of various shark species (e.g. Domeier & Nasby-Lucas, 2007; Graham & Roberts, 2007; Malkjović & Côté, 2011; authors' unpublished data). Such a marriage of research and ecotourism could benefit the regional management of shark populations (e.g. Bensley et al., 2009).

Due to the popularity and controversy surrounding shark ecotourism activities, future shark ecotourism investigations will benefit from empirically derived consumer questionnaires, time-scale economic data on regional operations (i.e. case studies), as well as the examination of potential correlations between ecotourism and marine protection area status. While we did not include marine protected areas in our analysis, their coupling with ecotourism will undoubtedly benefit regional shark aggregations and conservation efforts.

Shark-based tourism is a global phenomenon. Once feared and despised, sharks today draw significant attention and allure from people worldwide. Their importance to the diving and marine tourist industry is highlighted by the distribution, frequency, and value of shark ecotourism. We urge managers and NGOs to strongly consider and utilise the economic figures and values of live sharks presented here when shaping and constructing management initiatives. Responsible shark ecotourism can also benefit research and conservation. Moreover, since many shark species are long-lived, these natural resources may accrue revenue over extended periods of time, thus offering potential benefits to local economies that can last decades and beyond.

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