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Full length article

Socio-cultural relationship between recreational sea anglers and blue sharks (*Prionace glauca*) in the United Kingdom

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ABSTRACT

The blue shark (*Prionace glauca*) is commonly caught by recreational anglers around the United Kingdom (UK) – part of a population (North Atlantic) which has sustained declines of > 50% over the last three generations (36 years). Therefore, mitigating any detrimental impacts recreational fisheries might have on this species is crucial. This requires understanding anglers' perceptions and behaviours, to co-design appropriate management measures. Here, we explore the socio-cultural relationship between anglers and blue sharks in the UK through structured surveys. A total of seven business operators and 44 recreational anglers responded throughout Aug–Nov 2021. Respondents primarily comprised of over-fifty, educated and wealthy male anglers. A positive relationship was identified: 100% of anglers have respect for sharks; 80% (n = 42) would like their fishing to inform research. We also found that socio-demographic variables correlate with certain perceptions, e.g., education level and political leanings were associated with the level of agreement to the statement “sharks are there for my enjoyment to catch” and “I want to catch the biggest shark possible”, respectively. Operators follow best fishing practices to minimise stress to sharks and 100% of operators wanted to contribute to research. Currently 43% (n = 3) submit catch data and one operator tags sharks. This willingness to contribute to research could improve our understanding of blue shark population structure, habitat use, and post-release mortality rates associated with recreational angling. This will not only help sustain shark stocks but also engage anglers in understanding the threats to sharks and benefit recreational fisheries that rely on stable shark populations.

1. Introduction

1.1. Oceanic shark populations

Oceanic shark stocks have depleted by over 70% in the past half a century owing to an 18-fold increase in relative fishing pressure [46]. By-catch from commercial fisheries (i.e., where catch is sold) has been a major driver of this decline in shark populations, whereby pelagic longlines and seine nets incidentally catch non-target shark species [20, 41]. Direct targeting of sharks for the fin trade and recreational sports fisheries has contributed to further declines in shark stocks [17,24]. Low intrinsic population growth rates and long generation times make sharks inherently susceptible to over-exploitation [30,46]. As a result, the global extinction risk for oceanic sharks has increased to the point that

one third of the species comprising this functionally important assemblage are now thought to be threatened with extinction [25].

1.2. Recreational shark fisheries

Research within recreational fisheries receives little attention relative to commercial fishing (review in Appendix A). Consequently, the role of this practice as both a threat to shark populations and an opportunity to support shark conservation tends to be overlooked [20,30, 34]. Recreational fishing encompasses all leisure fishing activities that are not conducted for commercial purposes (i.e., where catch is not sold) [4,47]. This includes charter and private boat-based anglers alongside shore-based fishers [30,42]. Sports fishing is an example of recreational fishing whereby anglers use rod and reel to catch sharks [47].

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'Recreational' and 'sports' fishing/fishers/anglers will be used interchangeably herein. Sharks have been described as the aquatic 'big game' equivalent, where the largest, 'fiercest' individuals are caught by recreational fishers for the 'thrill of the fight' and displayed as 'trophies' [54,52]. Many recreational fishing practices are now strictly 'catch and release' (C&R). C&R reduces direct mortalities associated with 'catch and keep' (C&K) fisheries; however, the fundamental assumption of C&R fishing is that individuals released will survive [4]. Physical trauma, physiological stressors and extreme homeostatic disruption have been documented as a result of cumulative hauling and handling once onboard fishing vessels [30,38,55,54,57]. This highly anaerobic muscular activity induced by a caught shark impairs normal behavioural and physiological functions upon release [57]. Post-release mortality has been investigated by Shiffman [55], where dead great hammerhead (*Sphyrna mokarran*) and scalloped hammerhead (*Sphyrna lewini*) sharks have washed ashore after fishing tournaments despite being released alive. However, the post-release mortality of other species in association with recreational fisheries such as the blue shark (*Prionace glauca*) is relatively unknown, as this is often delayed and occurs out of sight [29, 57]. Campana, Joyce & Manning [13] estimate the post release mortality of blue sharks from commercial longlines to be 35%. Borucinska et al. [12] provide the first evidence of systemic debilitating disease due to hook retention in a blue shark. Analysis of blue shark blood chemistry reveals a significant reduction in pH, lactate and serum electrolyte levels, alongside periods of vertical swimming after being caught by recreational anglers [58]. Moreover, the directional targeting of the largest (and thus most fecund) individuals from a population has deleterious effects on threatened shark populations [30,54], with overall cumulative lethal and sublethal effects of recreational shark fishing [55]. Catch data from recreational fisheries is also more difficult to monitor compared to commercial fisheries for various reasons. Fundamentally, the diffuse nature of this activity makes it difficult to control the fishing population [32]. It is also difficult to monitor the status of the target species accurately in space and time [4]. Unlike commercial fisheries where licensing is in place, many recreational anglers are not required to report their landings or effort. Moreover, a lack of common landing areas also makes catch records harder to determine, so research coverage becomes restricted and results unrepresentative [9,32]. 'Best practice' guidelines are provided for fishers, which advocate the use of specific hook types to reduce gut hooking (e.g., non-stainless steel circle hooks), avoidance of long-playing times, releasing sharks from the side of boats (i.e., not hauling on land/onboard vessels), and minimal handling [9]. However, with a lack of control and monitoring in recreational fisheries, it is debatable to what extent recreational shark fishers comply. Understanding what motivates recreational fishers can help to determine whether they are likely to adhere to voluntary guidelines, and help to inform future management.

1.3. Attitudes and perceptions of recreational fishers

Mitigating any detrimental impacts of shark fishing requires co-operation from fishers. Therefore, including recreational anglers in fisheries management is crucial for implementation success. One way this can be achieved is by understanding the relationship between fishers and sharks, and the socio-economic drivers of shark fishing [10, 35]. This relationship is important to understand since fishers' attitudes and norms are likely to influence their fishing behaviour [11,3], and ultimately the survival of targeted sharks. Yet very few social science studies have taken place around the world on this topic; angler's perceptions towards sharks have previously been analysed in nine social science studies across the United States and Australia (Appendix B). Graefe and Ditton [31] first documented fisher's motivations behind shark fishing on the Texas Gulf Coast, where feelings were that of fear and hatred towards sharks. The release of the film *Jaws* saw the widespread rise of fishing tournaments and fishing clubs dedicated to hunting a 'man-eating shark' [16]. It was assumed that fishers were motivated by

the danger involved with targeting apex predators [7] and in doing so aimed to hunt down every shark possible [59]. However, Graefe and Ditton [31] proved that, for the most part, fishers perceived sharks with respect and admiration, unlike the perceptions of the public at the time. By the late 20th century, Florida (US) became the global hotspot for recreational shark fishing [29]. Shiffman and Hammerschlag [52] coupled website analysis and online survey entries from Florida fisheries and discovered a strong conservation ethic among respondents. Whilst captains were aware of global declines in shark populations, they felt local populations were not under threat. This could be a failure to acknowledge that their activity might be affecting shark populations, a lack of awareness/environmental education, or a fear of how their business will be affected if restrictions and regulations are implemented on recreational fishing [52]. Online snowball surveys have also been used to determine the perceptions and conservation attitudes of recreational fishers across the US [29,42]. From these surveys, fishers acknowledge the importance of shark conservation; 94% of fishers agree that reproductively mature sharks are valuable to ocean ecosystems. Fishers' knowledge on endangered shark species was also consistent with their conservation status [29]. McClellan Press et al. [42] highlight that 88% of anglers practice catch and release, however, situational factors influenced this decision (e.g., species caught). Fisher's perceptions have also been analysed on the Great Barrier Reef, South Australia, New South Wales, and Victoria [34,40]. Across both studies, 86% and 98% of fishers questioned placed high importance in releasing sharks in good condition. Moreover, Drymon and Scyphers [22] carried out a survey on recreational licence holders in Florida. On top of questioning anglers about their behaviour, knowledge and perceptions towards sharks, this survey was accompanied by questions quantifying their willingness to donate to a hypothetical shark conservation fund. Only 25% of respondents were willing to contribute, with many anglers believing shark populations were increasing and so not in need of protection. Despite positive overall attitudes about sharks, these surveys show that anglers believe their actions have minimal impact on declining shark populations (relative to commercial fisheries) and support management regulations that are least restrictive to their fishing practices [29]. Shiffman et al. [53] showed that Florida's land-based fishers have a lack of trust towards research scientists, indicating a potential lack of co-operation for future resource protection in fisheries management. Anglers may be cautious about highlighting their impact on shark populations out of fear of how management regulations may impact recreational fisheries. Therefore, there is a risk of receiving biased responses from surveys alone. Discussion board analysis provides an unbiased insight to fishers' practices, highlighting numerous incidences of illegal shark fishing [53].

Understanding the initial perceptions of anglers, especially towards stock status and management, is crucial in predicting outcomes and developing successful management strategies [22]. Anglers can also play an important role in species identification as they are knowledgeable about the population of target species [21]. Declining catch rates and the small size of target species has also resulted in the growing desire amongst anglers to become advocates for shark conservation [21, 22].

1.4. Research gaps

The United Kingdom (UK) has been identified as a popular location for shark sport fishing [30,5]. Blue sharks, *Prionace glauca* are one of only a few large pelagic species inhabiting UK waters and so are commonly targeted in UK recreational fisheries. Blue sharks are the most abundant, wide-ranging species of pelagic shark globally [1,45], inhabiting both coastal and oceanic water in tropical and temperate climates in large aggregations [26]. Dominating catch data from both commercial and recreational fisheries [5,56,57,13], blue shark populations have declined by 53–80% across three generation lengths in the Atlantic [23,49]. These dramatic declines are mainly a result of by-catch

from tuna (*Thunnus sp.*) and/or billfish (e.g. swordfish *Xiphias gladius*) longline fisheries [6,18], where a spatial and temporal overlap exists between the vertical niche of blue sharks and expanding fishing efforts – particularly in the North Atlantic [50]. Despite being globally assessed as ‘Near Threatened’ on The International Union for Conservation of Nature (IUCN) Red List of Threatened Species [51], the most recent stock assessment of blue sharks in the North Atlantic conducted by The International Commission of the Conservation of Atlantic Tunas (ICCAT) in 2015 proposed their likely status to be ‘Endangered’ [51]. Blue shark abundance has already decreased by 98% within the Mediterranean Sea [27]. In 2007, their status in this area was listed as ‘Vulnerable’ by the IUCN. By 2009, this changed to ‘Near Threatened’ and further to ‘Critically Endangered’ in 2016 [64]. This indicates how quickly blue shark populations can decline and suggests that populations in the North Atlantic may be at risk of following the same declining trend with increasing fishing pressure. The Shark Angling Club of Great Britain (SACGB) has been recording data on blue shark populations since 1953, consisting of records from 34 fishing boats based out of Looe, Cornwall. The Sportfishing Club of the British Isles (SCBI) also collect data from catch and release competitions, alongside volunteer charter skippers [44,61,62]. Fluctuations in nominal catch per unit effort (CPUE), length and sex data, alongside environmental variables affecting CPUE have been quantified in the western English Channel. Despite these studies, there is limited knowledge on the extent of blue shark fishing around the UK and the drivers behind this practice. This is a concern due to an ambiguous stock status (post 2015) and unknown post-release mortality rates for blue sharks in the Northeast Atlantic [2]. Therefore, there is a

need to evaluate how fishers presently perceive shark fishing and the extent of the issue around the UK to inform future management actions – such as modifications to fishing operations, guidelines on fishing behaviour, changes to shark fishing advertisement or industry shifts to less extractive practices (e.g., swim-with programs). There is currently no published research that quantifies fisher’s perceptions towards sharks in the UK (Appendix C).

1.5. Aims and objectives

Within this context we evaluate the socio-cultural relationship between recreational anglers and blue sharks in the UK. We used structured questionnaires to examine the perceptions of shark fishing operators, alongside their fishing activity and behaviour. Operator perceptions of blue shark population trends was also explored here. We complement this by understanding the opinions, perceptions, and beliefs of anglers through similarly structured questionnaires. We also examine whether angler demographic variables influence their perceptions of sharks. Based on the results we begin to unpick the socio-cultural drivers behind shark angling in the UK and the relationship between recreational anglers and blue sharks.

2. Methods

2.1. Data Collection

Data were collected from 2nd August 2021 until 1st November 2021

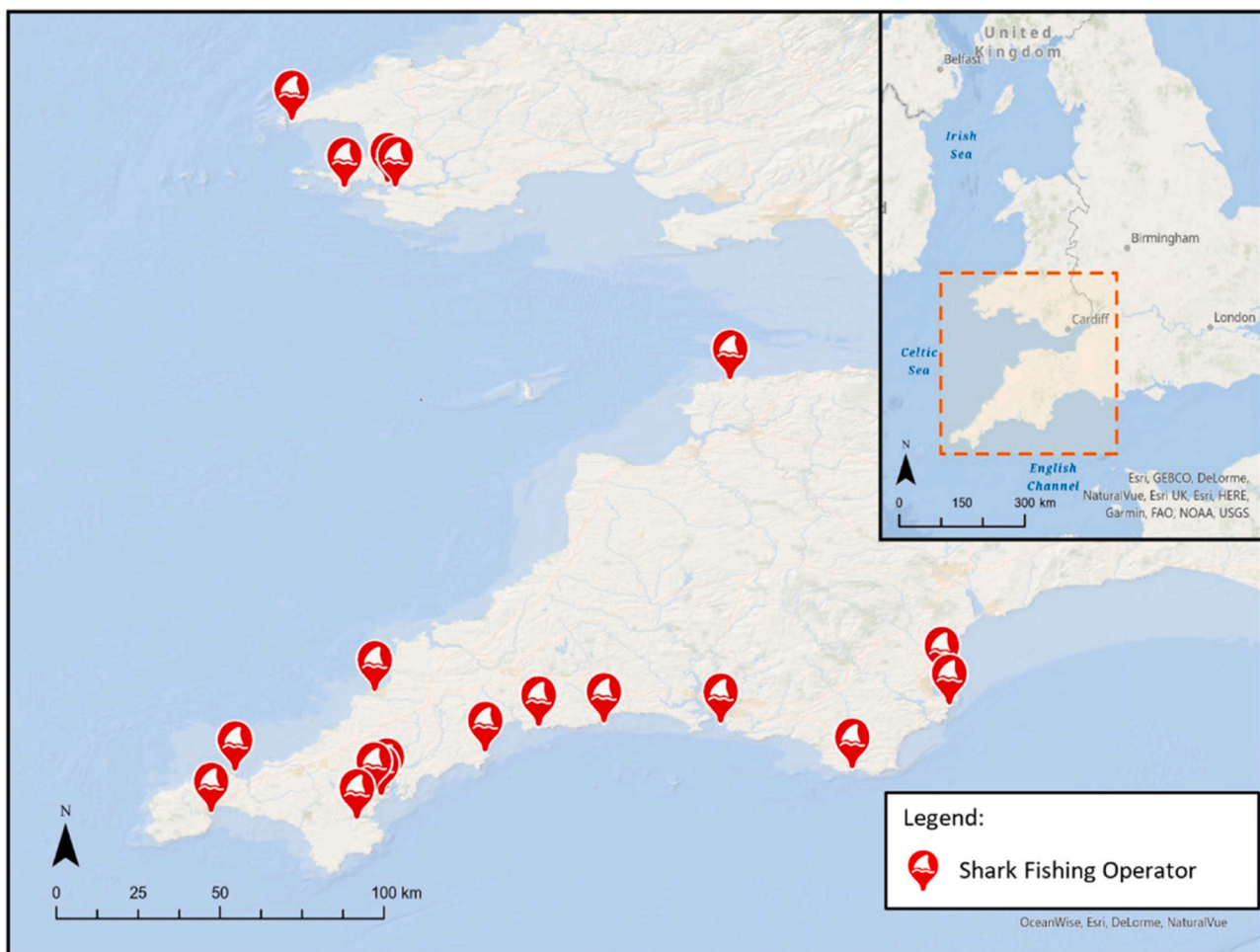


Fig. 1. Map highlighting the 25 shark fishing operators around the UK that advertise blue shark fishing. The names of operations have been removed for anonymity and those who responded to the survey have not been identified.

from two stakeholder groups: shark fishing operators and recreational shark anglers. Due to a lack of pre-existing data on the demographics of these groups we were not able to develop a structured sampling strategy, rather we adopted purposive sampling to target key informants.

For shark fishing operators, we first conducted desk-based research to identify operators around the UK. For this study, our target population was defined as operators who advertise blue shark fishing online. Twenty-five shark fishing operators were identified; sixteen located in the county of Cornwall (West England), five in Devon (West England), and four in Pembrokeshire (West Wales) (Fig. 1). All identified operators were directly contacted and invited to participate in the research. Structured online surveys were used to gather data, distributed by email using the Google Forms platform (Appendix D). The operator survey was split into the following categories: 1) General business operations, 2) Fishing activity, 3) Blue shark activity, 4) Perceptions towards sharks, and 5) Blue shark conservation.

For recreational fishers, an online survey was developed in Google Forms and distributed on various UK shark fishing social media pages (Appendix E) via Facebook, Instagram, and Twitter. This survey was split into the following categories: 1) Fishing activity, 2) Expenditure, 3) Perceptions towards sharks, 4) Shark conservation, and 5) Demographics.

For both surveys, we used a mixture of closed (pre-defined answers) and open (free-form answers) questions. The majority of the closed questions were five-point Likert-style (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree) which allowed us to quantify perceptions [36]. These were supplemented with open-ended questions to allow participants to provide detailed qualitative information and explain their answers [63] (Appendix D & E). Both survey types were optional and did not require completion.

This investigation was approved by the University of Portsmouth's Science Faculty Ethics Committee (Reference Number: SHFEC 2021084) prior to any data collection.

2.2. Data processing and analyses

Survey data were checked, cleaned and prepared for analysis in Microsoft Excel. Data were analysed in RStudio using R (version 4.1.2). We first used descriptive statistics to analyse average responses to structured questions, and thematic analysis with coding and grouping into similar themes to analyse open-ended responses. Kruskal-Wallis tests were also applied to the median Likert-scale responses for each closed-ended question on angler's perceptions towards sharks, to understand pair-wise relationships between socio-demographic variables and attitudes. This test is suitable as it is used for ordinal data and does not assume a particular distribution [43]. Post hoc Dunn's testing with Bonferroni correction was carried out on significant results to determine the driver of differences. This pair-wise comparison in median data accounts for the error involved with conducting multiple tests. Anglers' perceptions were analysed against their age range (20–29, 30–39, 40–49, 50–59, 60+), highest education level (GCSE, A-level, degree level), and political leaning (left, centre, right) to assess the socio-cultural relationship between recreational fishers and sharks in the UK. These demographic variables were chosen as they are common predictors of environmental attitudes. Significance was tested at $\alpha = 0.05$ across all tests.

3. Results

3.1. Operator survey

3.1.1. Business operations

A total of seven shark fishing operators (27%, $n = 25$) responded to the operator survey. Responses were either business owners or boat skippers running fishing trips out of Cornwall, Wales, and Devon. These shark fishing businesses have been running from two months to 22

years, with 60–200 trips running per operation each year. Collectively, businesses cater to a maximum of ten anglers per charter, at a mean cost of £ 630 (range 550–650, \pm SD 44.7) for a full day's charter (based on the five operators who provided this value). Typically, fishing trips last eight to ten hours. The blue shark fishing season starts at the end of May and runs until the end of October.

3.1.2. Shark fishing activity

When asked which pelagic shark species they caught around the UK, anglers listed blue, porbeagle (*Lamna nasus*), and thresher (*Alopias vulpinus*) sharks. All respondent operators ($n = 7$, 100%) stated that blue sharks were the most common species caught, with 85% of operators saying it would be "very likely" to catch a blue shark on a fishing trip. Anglers have caught up to 40 blue sharks a day with a mean of 10.1 (range 0–29, \pm SD 12.3) caught on their last fishing trip across all operators. The majority of these are mature, adult females alongside some juveniles (sex unknown). All respondent operators stated that they carry out catch and release fishing practices, and this is driven by conservation motives in all cases. The following fishing techniques are utilised most frequently by operators to reduce stress to caught sharks: using circle hooks (100%), not in-boarding large sharks (88%), not touching their gills (88%), minimising time sharks are out of the water (88%), minimising fight times (75%), and supporting the body of large sharks (75%). Catch data is submitted by 43% ($n = 3$) of fishers; one of these taking part in a tagging program.

A total of four operators (57%) perceived blue shark populations to be increasing, with one operator (14%) noting major decreases in blue shark populations around the UK. The remaining operators did not respond to this question.

3.1.3. Operator perceptions

Overall, operators had positive attitudes towards sharks and their conservation. For example, 100% ($n = 7$) of operators 'strongly agreed' with the statements that "sharks are important for the oceans" and "sharks should be respected/admired". Similarly, 100% of operators 'strongly agreed' or 'agreed' with the statements "healthy shark populations are important for my business", "I would like to contribute more to scientific or conservation research on the sharks that I catch", and "I would like to learn more about the ecology of the shark species that I catch". A total of 86% ($n = 6$) of operators 'strongly disagreed' or 'disagreed' with the statement "shark populations can take care of themselves" and 'strongly agreed' or 'agreed' with the statement "It is the responsibility of the recreational shark fishing industry to ensure healthy shark populations".

When asked about what aspects of shark fishing they thought most appealed to their clients, all seven operators (100%) answered the 'thrill/challenge'. A total of six (86%) operators also selected 'appreciation for sharks and nature', 'novelty' and 'socialising'. 'Status' (which includes obtaining a trophy/photo) was the least common answer. The following statements highlight other responses from angler operators regarding sharks: "crucial to life in our oceans", "need to be looked after", "need more protection from commercial fisheries", "everyone needs to be responsible for looking after them", "it is up to me to educate my customers on shark welfare and conservation", "without healthy shark populations and looking after our fishery we simply do not have a future in the business", and "it is important for us to administer the best shark fishing practices on our trips as it demonstrates the correct way and also looks after the future fishery we have". Some operators also believe that more regulation is necessary since their impact as individual operators is limited. For example, "we can only do our bit for their protection" and "we can play a part, but there is no industry body to lead this. Governments have to legislate". Another operator stated "recreational fishermen/operators can voice an opinion but there isn't an industry body to lobby for change and protection. I'm sure we would support any 'body' that could...our impact is minuscule".

Overall, a positive relationship was identified between fishing

operators and blue sharks around the UK, with operators recognising their own role in contributing to shark conservation but also identifying a lack of power to drive change at scale.

3.2. Angler survey

3.2.1. Demographics

A total of 44 anglers responded to the online angler survey. Of these, 42 were male (95%) and two were female (5%). The most common age group was 60+ years (32%), followed by 30–39 years (23%), while 20–29 years was the least common (7%) (Fig. 2a). Highest education level achieved was also well represented with 18 respondents (41%) having achieved tertiary-level qualifications (undergraduate/post-graduate). A total of ten respondents (23%) achieved GCSE's and seven (16%) with A-level or equivalent qualifications (Fig. 2b). When asked about their political leanings, almost half preferred not to say ($n = 20$, 46%). Centre was the next most common answer at 23% ($n = 10$), with five responses leaning left (11%) and four leaning right (9%) (Fig. 2c). Around half of the anglers had salaries over £ 40 k ($n = 21$, 48%), followed by £ 25–29 k (14%) and < £ 18 k (2%). In summary, our respondents primarily comprised of older, educated, wealthy male anglers.

3.2.2. Anglers' fishing activity

Most respondents had participated in shark angling less than ten times in their lives ($n = 17$, 44%), followed by 12 respondents (31%) having taken part 10–20 times. Other respondents had participated in shark angling more than 20 to over 100 times (Fig. 3a). These angling trips took place in Cornwall ($n = 21$), Devon ($n = 9$), and Wales

($n = 25$) (Fig. 3b), corresponding with the geographical distribution of operators.

When asked about their reasons for taking part in shark fishing, 'appreciation for sharks and nature' ($n = 43$) and the 'thrill/challenge' ($n = 38$) were the most common answers. These were followed by 'socialising' ($n = 25$), 'novelty' ($n = 20$) and 'relaxation' ($n = 17$). 'Status' ($n = 7$) and 'other' ($n = 5$) were the least common responses (Fig. 4). These answers also corroborated with those of tour operators.

3.2.3. Anglers perceptions

Anglers responded to several statements regarding their attitudes towards sharks, revealing overall positive sentiments about blue sharks and recognition of their ecosystem value (Fig. 5). Of the 43 responses, 100% 'strongly agreed' or 'agreed' with the statements "sharks should be respected/admired" and "catch and release of sharks is important". Similarly, 95% of anglers ($n = 43$) 'strongly agreed' that "sharks are important for our oceans". Furthermore, most respondents were keen to support shark research and conservation. A total of 80% of anglers ($n = 42$) 'strongly agreed' or 'agreed' with the statement "I would like it if the sharks I caught were used to inform research". In addition, 95% ($n = 44$) also agreed or strongly agreed with "I would like to learn more about the shark species that I catch" and "the sustainability of recreational shark fisheries is important to me".

A word cloud showing the words anglers most frequently used to describe sharks is displayed in Fig. 6. All of these words are positive with 'Beautiful' ($n = 11$), 'Majestic' ($n = 7$), 'Awesome' ($n = 5$), 'Fascinating' ($n = 4$) and 'Mysterious' ($n = 3$) being used most frequently.

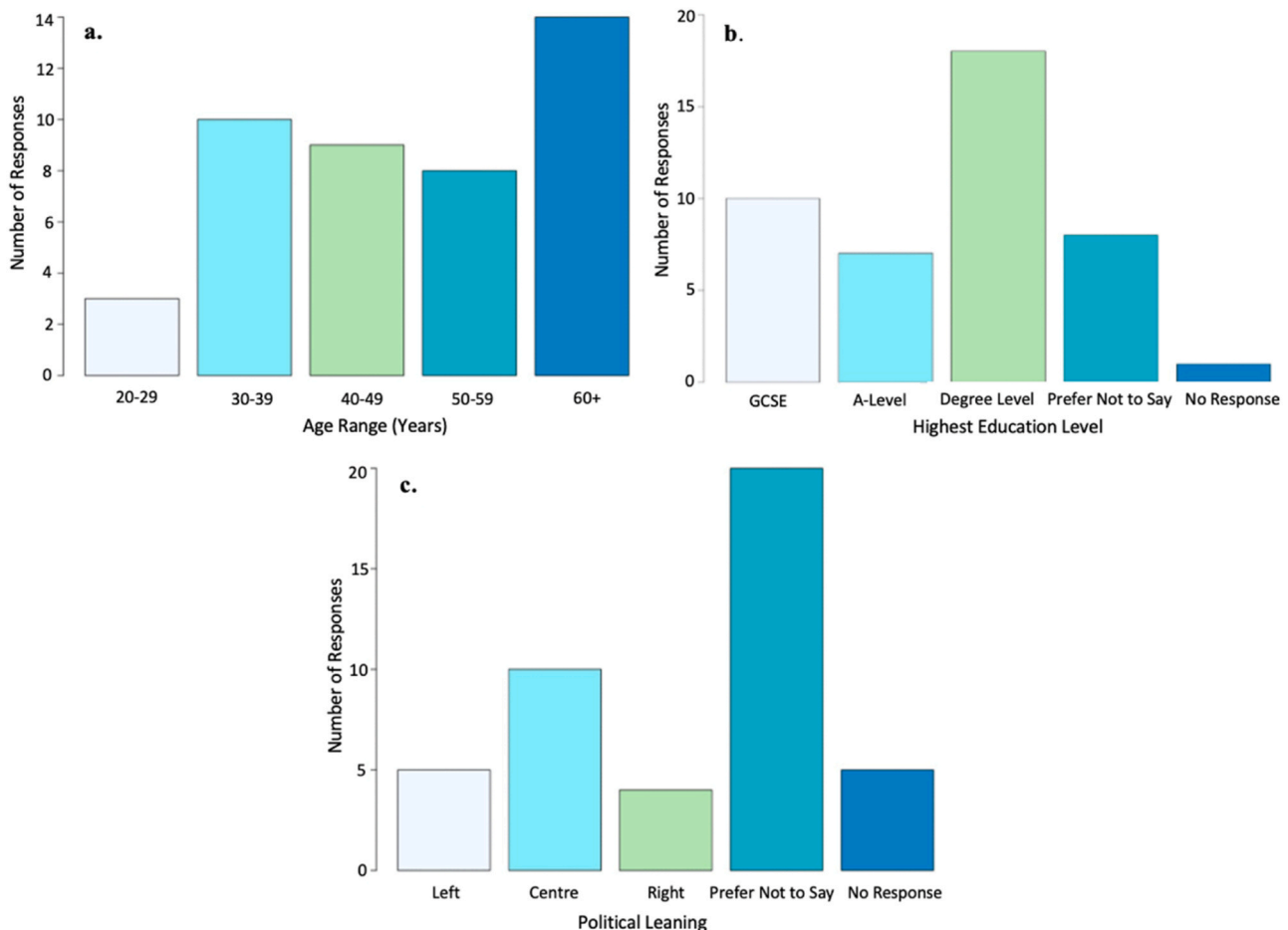


Fig. 2. Bar graphs showing angler demographics for age range (a), highest educational level (b) and political leaning (c).

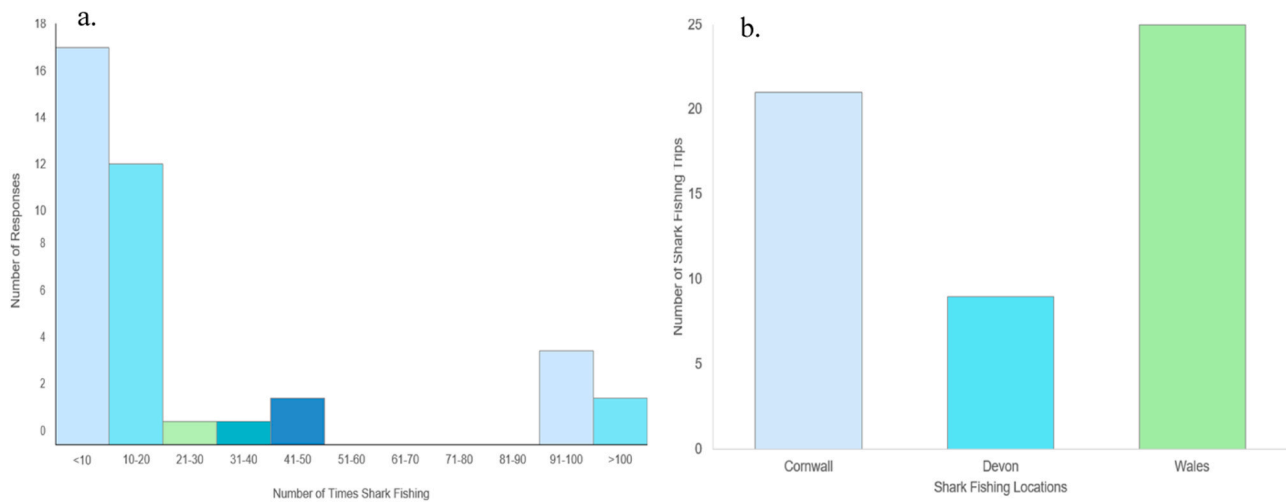


Fig. 3. Bar graphs showing the number of times anglers have been shark fishing (a) and where these fishing trips took place (b) in the UK.

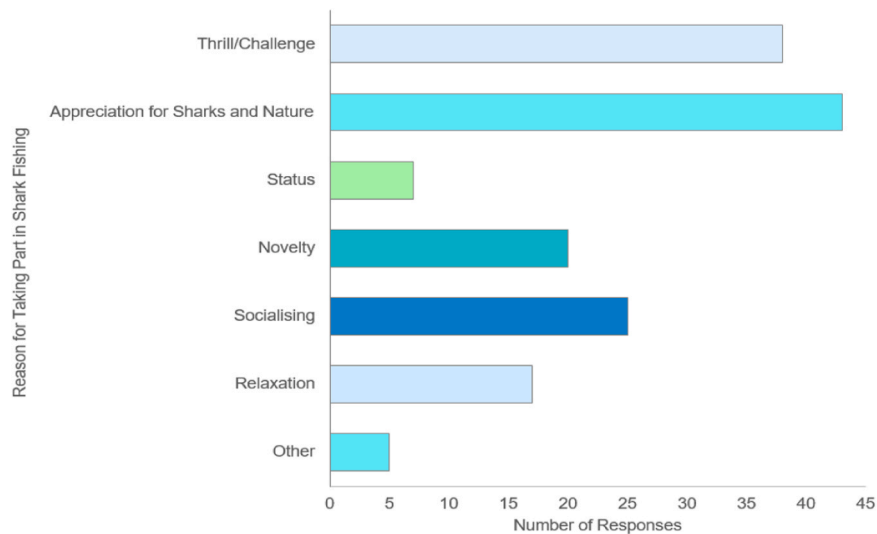


Fig. 4. A bar graph comparing the number of responses to each reason for taking part in shark fishing in the UK.

3.2.4. The relationship between demographic variables and perceptions towards sharks

Kruskal-Wallis tests ($\alpha = 0.05$) indicated no significant difference between age range and median Likert score of angler responses to statements regarding their perceptions towards sharks (Appendix F). Highest education level showed a significant relationship with Likert scores relating to the statement that “sharks are there for my enjoyment to catch” (Kruskal-Wallis test: $\alpha = 0.05$, $\chi^2 = 6.0960$, $df = 4$, $p < 0.05$). A Dunn’s post hoc test with Bonferroni correction showed a significant difference between the median Likert score and the highest education level comparison: A-level vs degree level ($p = 0.02$). The median Likert score responses for this statement were 2 (GCSE), 1 (A-level) and 3 (degree level) (Fig. 7a). Political leaning also showed a significant relationship with Likert scores for the statement “I want to catch the biggest shark possible” (Kruskal-Wallis test: $\alpha = 0.05$, $\chi^2 = 6.1990$, $df = 4$, $p < 0.05$). A Dunn’s post hoc test with Bonferroni correction showed a significant difference in the median Likert score and the following political leaning comparison centre vs right ($p = 0.02$). The median Likert score responses for this statement were 4 (left), 3 (centre), 5 (right) (Fig. 7b).

4. Discussion

The aim of this research was to understand the socio-cultural relationship between recreational sea anglers and blue sharks (*Prionace glauca*) around the United Kingdom. Our findings show that angler respondents primarily comprised of older, educated, wealthy male anglers who overall had positive attitudes towards sharks, and towards shark conservation and research. Operator respondents had similar positive perceptions and stated that they follow best fishing practices to minimise stress to caught sharks and want to contribute to shark research. However, only a few operators currently submit catch data or partake in tagging programs. These results provide a deeper understanding of the perceptions of anglers within recreational fisheries around the UK, and their potential role in shark management.

4.1. Interpretation of angler perceptions and socio-demographics

The large proportion of male respondents suggests that recreational shark fishing in the UK is a male-dominated activity. Women are also more likely to use social media [48] and therefore more likely to access the survey. Younger adults also use social media more frequently [48]. However, all ‘older’ age groups were more represented than younger

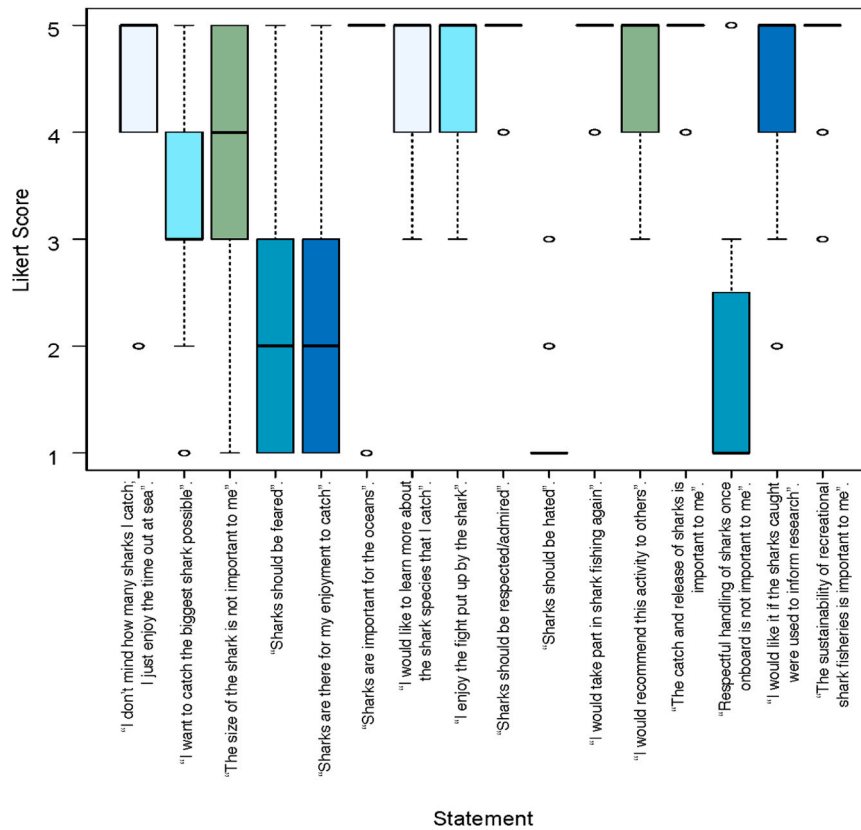


Fig. 5. Multiple boxplots comparing the median Likert Score responses to each Statement within the angler survey (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree).



Fig. 6. A word cloud highlighting the words used by anglers to describe sharks and their relative abundance. The size of each word correlates to its frequency used by anglers to describe sharks; although these words have been repeated in a smaller size to fill the shape of the shark for visual appeal.

ones, with most respondents in the 60 + years category. This could be due to the larger range of ages within this category compared to the nine-year range in the categories of younger ages (e.g., 50–59 y). Although, this could reflect more disposable income in the 60 + years category. This is supported by the fact that nearly half of respondents had degree-level education and salaries over £ 40 k, indicating that shark fishing is an expensive recreational activity. Those of highest income are also more likely to use social media [48]. Over half of respondents chose not to disclose their political leaning. These anglers could be uncertain of how their views or wealth may be perceived as a result of their political leaning. However, these results are not representative of the entire recreational fishing community due to the small sample size and self-selection bias via distribution on social media. Similarly, access was not always granted to some shark fishing pages

which caused a potential geographical bias. For example, Wales was identified as the most popular location for shark fishing trips; however, access was granted to a Welsh shark fishing Facebook page which caused a rise in shark anglers responding to the survey in this area. A positive relationship has been identified between recreational anglers and blue sharks around the UK. All operators reported carrying out best-practice fishing techniques and are willing to contribute more to shark conservation. Anglers are also keen to contribute to research on the sharks that they catch. This positive relationship is important since anglers are ensuring they limit their impact to sharks around the UK. In turn, this will reduce any deleterious effects of being caught upon release. This relationship was expected, coinciding with the positive results from the aforementioned social science studies conducted on recreational anglers in the US and in Australia. Historical fears of sharks in Florida [31] are

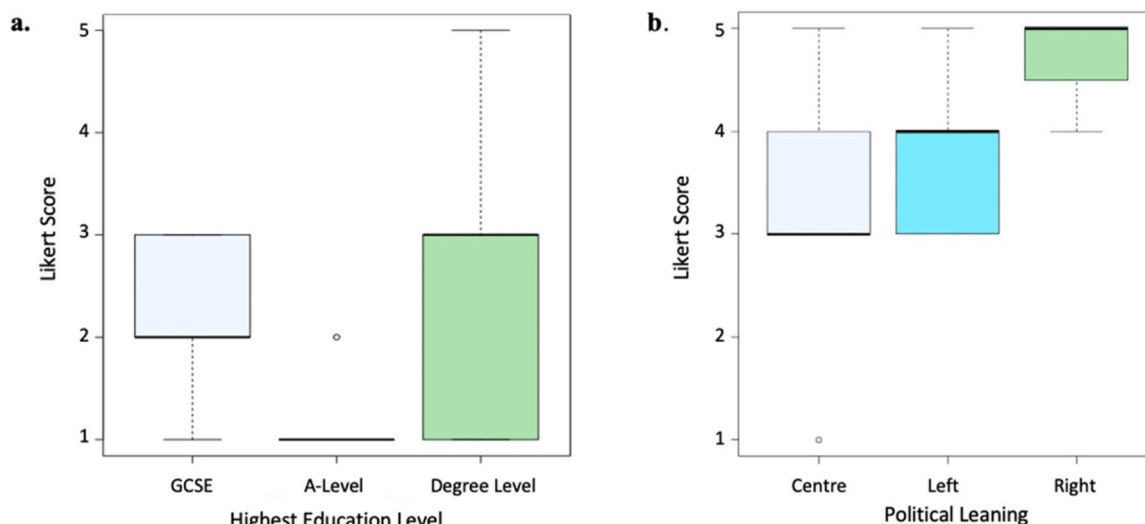


Fig. 7. Statistically significant results of Likert Score responses according to highest education level for the statement “sharks are there for my enjoyment to catch” (a) and political leaning for the statement “I want to catch the biggest shark possible” (b).

contrasted with the fascination and appreciation for the beauty of sharks by present day anglers around the UK. The importance of shark conservation and the value of sharks in ocean ecosystems are key themes identified across similar social science studies [22,29,34,40,42]. The “thrill/challenge” and “appreciation for sharks and nature” were the most popular reasons for taking part in shark fishing in the UK. The “challenge and excitement” is also a main driver behind shark fishing in Florida’s recreational fisheries [52], followed by “getting a photograph to show friends and family”. This contrasts the results from the UK, where obtaining a photo (status) was the lowest response. Human cultural differences and species variation could account for this variation.

Of the 30 Kruskal-Wallis tests between angler demographics and statements regarding their perceptions towards sharks in the UK, only two had a significant difference. These differences were a result of marginal variations in anglers’ perceptions towards the size of the shark and sharks being there for anglers’ enjoyment, based on variations in highest education level and political leaning. This means that nearly all anglers within this study share the same positive perception of sharks in the UK, regardless of their demographics. No extra effort needs to be focused on a particular demographic to gain support for shark conservation; shark anglers share common opinions, which would make potential management decisions easier. However, there is no evidence within the scope of this study that recreational anglers are carrying out these best-practice fishing techniques. Our angler survey was met by confrontation from some anglers on social media who were apprehensive to disclose information about their fishing activity and raised concerns over how the data would be used. For example, “conduct elsewhere”, “probably another anti”, “I’d say it’s the anti-brigade” and “sounds like someone looking to gain info to shut down shark fishing”. This could suggest that some anglers do not carry out best practice techniques or fear how their fishing activity could be impacted as a result of any regulations or imposed management. Our results, therefore, represent the more cooperative, conservation-prone respondents, who may hold differing opinions from those who did not wish to take part in the survey. A similar lack of trust towards scientists has also been identified among Florida’s land-based fishers [53]. Despite this, the positive perceptions identified in this study are promising for future blue shark conservation. This study identifies a population of anglers who are willing to do more to conserve a species whose population in the North Atlantic has declined by > 50% [51].

4.2. Perceptions of blue shark populations trends around the UK

Contrasting the SACGB and stock assessment data where blue shark populations have declined within the North Atlantic [23,49,61], operators mostly reported an increase in blue shark numbers around the UK in recent years. One explanation for this could be inaccurate perceptions or biases amongst the operators. For example, previous studies have shown that fishers are rarely willing to admit to declining shark populations even when objective data suggests it is the case [22]. On the other hand, blue sharks are relatively productive in comparison to other elasmobranchs wherein they can have large litters (>100 pups) and possibly breed annually [14]. This means populations may be able to recover relatively quickly. Respondents shared that blue sharks caught by recreational angling were primarily adult females – contrasting with published literature and the SACGB wherein the majority of blue sharks in UK waters are juvenile and sub-adult females [44,49,61,60,28]. Similarly, blue sharks interacting with swim-with operators off Devon, Cornwall, and Pembrokeshire 10–40 miles from shore are almost exclusively juvenile females (GA, pers. obs.). Increasing populations of blue sharks around the UK could also be attributed to a habitat use shift within the North Atlantic. A single, migratory population of blue sharks inhabits the North Atlantic [15], which could have shifted towards the UK under the influence of environmental changes. These include warming waters, changes in ocean current patterns and prey distribution, alongside ever-increasing fishing pressure within the Atlantic [44, 62]. The post-release mortality rates of blue sharks in the NE Atlantic within recreational fisheries remain unknown – a critical knowledge gap necessary to inform management and science-based best-practices for the industry.

4.3. Management implications for recreational fisheries

Anecdotal data on shark populations, internal politics of angling and simplistic views on fisheries management, has often made collaboration between fisheries scientists and anglers difficult [21,30]. Despite this, our study suggests that the population of recreational anglers who responded to our survey are willing to collaborate and want to contribute to conservation research. Tagging of sharks has also been recognised as a valuable means of studying shark population structure, life history and movement patterns [33,37]. Drake et al. [21] identified that once a shark was tagged by anglers, they considered the fish as ‘theirs’ and subsequently assumed a vested interest in its welfare once it was released. Involving anglers around the UK in the data collection

process means that fisheries scientists are not required to catch more sharks themselves since recreation anglers are already out on the water catching sharks. This reduces the number of sharks that need to be caught for research which in turn reduces the threats this practice poses to sharks. Thomas et al. [61] summarise data from a recreational blue shark fishery in the southwest of England where this has been successful; 108,731 blue sharks were caught by the SACGB and data collected between 1953 and 2021. Despite being widely studied in recent decades, there are still important gaps in our knowledge of blue shark biology and ecology. An increase in bookings for ‘tagging trips’ has also been reported by charter operators, instead of regular ‘shark’ trips [21]. This led to more operators volunteering to get involved in tagging programs due to the increase in customers seeking the opportunity to tag and get involved with research. Anglers around the UK may also benefit from organising such trips. Recreational anglers also have excellent tacit knowledge of shark populations and their variations in space and time. If this information was continued to be shared with fisheries scientists around the UK, blue shark habitat use and distribution would also be better understood; alongside population structure from catch data. Recreational anglers around the UK could, therefore, act as valuable partners with resource managers in developing conservation strategies, as has been demonstrated elsewhere [22]. Anglers around the UK also wish to learn more about the species that they catch. Greater knowledge of their target species would not only improve catches, but operators would become equally mindful of the importance of conservation tools e.g., tagging programs. Despite the common perception of recreational anglers and scientists occupying polarised positions [19], the overall objectives of both stakeholders have proven to be quite similar.

5. Limitations and future research

A limitation of this study is the relatively small sample size and potential self-selection bias in the online survey distribution technique. Therefore, these results are not necessarily representative of the population of recreational shark anglers in the UK. However, this is acceptable for the purposes of an exploratory study of a sub-group which is not a priori characterised by particular demographic variables [39,65,8]. Indeed, it was necessary to attain information from key informants. In the future, it would be beneficial to engage with the wider angling community to ensure all opinions are represented. Further analysis with face-to-face interviews with operators and their anglers after fishing trips could improve the reliability of responses, as it is easier to build a rapport with anglers in person so they may be more willing to engage. Similarly, going out with anglers on fishing trips would help build a relationship and establish trust between stakeholders, paint a clearer picture of their fishing habits and give a better indication of how anglers’ perceptions influence their behaviour. Focus groups held at angling events would also engage a wider community. This was not possible in the current study due to covid restrictions. In addition, if data were collected over a longer time period (i.e., over numerous fishing seasons), a larger sample size would be generated. Operators could also be contacted outside of the shark fishing season where a response is more likely; however, there is a risk of inaccurately recalling information. This research could form a baseline study for future social science studies within recreational fisheries in the UK. The willingness to contribute to conservation identified here could be further explored in order to ascertain what in particular anglers could do to help e.g., donating money to research, lobbying for better legislation to protect them internationally or by participating in data collection themselves. The positive relationship identified between anglers and blue sharks in this study enables follow-up questions for future research: These include: could a viable conservation program be implemented for threatened blue sharks in recreational fisheries around the UK? If so, which higher-level industry body will legislate such management and how will anglers be involved in the decision-making process? It is also essential that we understand post-release survival within recreational

fisheries, and this should be prioritised in order to inform management.

6. Conclusions

This research aimed to understand the socio-cultural relationship between recreational anglers and blue sharks around the UK. Recreational fishing for blue sharks can lead to further mortality in addition to commercial catches. However, understanding the perceptions of anglers, especially towards stock status and management, is crucial in developing successful management strategies. Social science studies have been successful in understanding anglers’ perceptions towards sharks and have identified anglers as valuable tools in shark conservation. A positive relationship has now been identified between anglers and sharks in the UK with anglers recognising the value of shark species and are keen to support shark science. Fishing operators recognise their own role in contributing to shark conservation but also identify a current lack of higher-level management. A total of three operators within this survey submit their catch data and only one operator tags the sharks they catch. Charter operators will now also benefit from this data as they will better understand their target audience’s perceptions. This research highlights an opportunity to do more for shark conservation and can now act as a baseline study for fisheries management working with recreational anglers. Since the recreational shark fishing community around the UK is better understood, appropriate management actions could be implemented. However, it will be essential to include anglers in decision-making and developing strategies that rely on the recreational angling community for support. There could be difficulty engaging anglers if they believe that blue shark populations are increasing, or that their impact is minimal in comparison to commercial fisheries. Further support by anglers for shark conservation could be achieved via outreach initiatives. In turn, this will increase co-operation between anglers and fisheries scientists. Higher-level industry bodies are also required to implement and fund research e.g., tagging programs and post-release mortality studies. Alongside obtaining data on blue shark populations, ‘tagging trips’ could increase operator sales and as a result increase shark catches with enhanced knowledge of target species. Blue shark conservation will therefore not only preserve blue shark populations that are threatened with extinction but also maintain recreational fisheries around the UK that are dependent on stable blue shark populations.

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Declaration of Competing Interest

The authors declare no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.marpol.2023.105831](https://doi.org/10.1016/j.marpol.2023.105831).

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