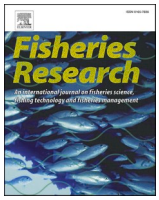
Fisheries Research 255 (2022) 106453

Contents lists available at ScienceDirect

Fisheries Research

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



# Assessment of fishing guide knowledge, attitudes, and behaviours in global recreational fisheries

M.W. Farthing [a,*], J. Mann-Lang [b], A.R. Childs [a], C.S. Bova [a], S.D. Bower [c], A.C. Pinder [d], K. Ferter [f], A.C. Winkler [a,e], E.C. Butler [a], J.W. Brownscombe [g], A.J. Danylchuk [h], W.M. Potts [a]

[a] Department of Ichthyology and Fisheries Science (DIFS), Rhodes University, Makhanda 6140, South Africa
[b] South African Association for Marine Biological Research (SAAMBR), Durban 4056, South Africa
[c] Infinity SES, 507 McLeod St., Ottawa, Ontario, Canada
[d] Faculty of Science and Technology, Bournemouth University, Poole BH12 5BB, UK
[e] Centro de Ciências do Mar (CCMAR), Universidade do Algarve, Faro, Portugal
[f] Institute of Marine Research, Fisheries Dynamics, PO Box 1870, N-5817 Bergen, Norway
[g] Great Lakes Laboratory for Fisheries & Aquatic Sciences, Fisheries and Oceans Canada, 867 Lakeshore Rd, Burlington, ON, Canada L7R 4A6
[h] Department of Environmental Conservation, University of Massachusetts Amherst, Amherst, MA 01003-9485, USA

ARTICLE INFO

*Keywords:*
Recreational angling
Fishing guides
Angler behaviour
Role-model
Knowledge

ABSTRACT

Fishing guides are held in high esteem by recreational fishing clients whom they likely influence (for better or worse) through role-modelling. This, coupled with consensus that angler behaviour is a key determinant of ecological outcomes in the catch-and-release (C&R) process suggests exploring the state of fishing guide knowledge, attitudes and behaviour on trips is critical for effective intervention in the global fish crisis. Fishing guides were recruited for an online survey using collaborator networks and social media (n = 342; 47 countries). The survey assessed the guides' knowledge of C&R best practices, attitudes towards environmental behaviours, attitudes towards environmental responsibility and their current practices on guided-angling trips. While most fishing guides were deemed "knowledgeable" (69.0 %) having answered most (≥ 4/7) of the best practice questions correctly, many had poor knowledge of key C&R processes such as oesophageal unhooking. Most fishing guides were untrained (64.0 %), and only 8.8 % had accredited training. Fishing guides generally had positive environmental attitudes towards C&R behaviour (50.9–96.2 %), suggesting pro-environmental behavioural intentions. Fishing guides deemed "knowledgeable" had significantly more pro-environmental attitudes towards angling behaviours ($p = 0.003$), which suggests that best practice training may improve their C&R behaviours. Most fishing guides had pro-environmental attitudes towards their environmental responsibilities (87.1–89.5 %), but these broad attitudes may have little bearing on actual behaviours when faced with a significant trade-off between client satisfaction and ecological integrity. Despite some fishing guides' good knowledge of appropriate behaviours, positive attitudes towards the environment and towards C&R practices, there is room for improvement to meet sustainability goals for C&R fisheries, which may be facilitated through opportunities for best practice training.

## 1. Introduction

Recreational angling is a popular pastime worldwide with a global average of a 10.6 % participation rate (Arlinghaus et al., 2015). Many anglers travel locally and/or internationally to fish (Barcellini et al., 2013; Smith et al., 2022), representing an important form of ecotourism in many regions (Zwirn et al., 2005; Hoogendoorn, 2017; Butler et al., 2020). Some anglers may employ professional fishing guides to improve chances of success by accessing skilled instruction (Farthing et al., 2022, this issue), local knowledge (Liu et al., 2019), to gain access to a charter boat (Ditton et al., 1978, 1991; Jennings, 1992) or angling concession (Zwirn et al., 2005). Fishing guides earn income by proving angling opportunities and experiences to other anglers (Smith et al., 2022), and their clients may have varying skill levels, specialisations and styles-of-participation (SOP; i.e. "preferred style of fishing as per" Smith et al., 2021a, 2021b). Less experienced anglers may require assistance

* Corresponding author.
*E-mail address:* matthew.farthing.rsa@gmail.com (M.W. Farthing).

https://doi.org/10.1016/j.fishres.2022.106453
Received 21 February 2022; Received in revised form 28 June 2022; Accepted 29 July 2022
Available online 17 August 2022

angling tasks (e.g. knot tying), while more specialised anglers may need more nuanced instruction specific to their SOP (e.g. sight casting). Irrespective of skill level, these anglers rely to some degree on their fishing guide's teaching, instruction, knowledge and/or equipment to improve their success. Correspondingly, fishing guides are likely to attempt to provide as much angling success and enjoyment as possible, given that their employ/business depends on client satisfaction (Ditton et al., 1991; Barcellini et al., 2013).

Given that much of what typically constitutes angling enjoyment depends on fish population health has led many conscientious anglers to adopt pro-environmental catch-and-release (C&R) behaviours (Cooke and Schramm, 2007; Pelletier et al., 2007). Given that the relationship between "angling-success" and environmental integrity can be at odds, the C&R best practice guidelines (e.g. Brownscombe et al., 2017) navigate a fine line between the possible, the practical and the necessary. Short of foregoing participation entirely, the choice or tactic that is least deleterious to fish health in many cases can have an immanent sacrifice for potential angling success or enjoyment, such as reduced catch rates, increased physical effort, or some other perceived cost. While some choices are simple and require little effort (e.g. de-barbing hooks), others may demand more from both anglers and guides (e.g. refrain from angling during spawning season or warm weather). This best practice *sustainability* vs. *satisfaction* conundrum is even more pronounced for fishing guides, who's livelihoods depend on sustainable use of recreational fisheries resources. Fishing guides want to ensure that their clients have success and enjoyment, as potential gratuities, word-of-mouth and repeat business typically depend on client satisfaction. On the other hand, poor angling-practice for these short-term gains may have direct impacts on fishery health, and thereby the long-term sustainability of the fishing guide's business. As such, fishing guides are faced with the quandary of where to draw the line at best practices to ensure both ecologically and economically sustainable recreational angling.

Fishing guides have the difficult choice of how to balance client success with the sustainable use of fisheries resources. For example, circle hooks are generally thought to be the least damaging to fish health but require a considerable change in the anglers' hook set technique (Cooke and Suski, 2004; Cooke et al., 2012). This may initially result in lower strike-to-landing ratios than j-hooks, especially given a circle hook's relatively low tolerance for varying fish size and mouth-morphology (Cooke and Suski, 2004; Cooke et al., 2012). In contrast, treble hooks on lures will almost always yield better strike-to-landing ratios than j-hooks, but cause considerably more physical damage to the fish, and add considerable air-exposure because of the difficulty of unhooking (Brownscombe et al., 2017). A more nuanced illustration of the issue would be a fishing guide choosing to fish in a spot with a high density of sharks or other predators which regularly consume gamefish during retrieval or after release (Danylchuk et al., 2007; Raby et al., 2013). These habitats may represent excellent angling opportunities, but mortality by predation may result in unacceptably high mortality even without any retention of fish (Lennox et al., 2017; Moxham et al., 2019; Holder et al., 2020). These scenarios represent situations where the fishing guide's choices and tactics (legal in many cases) have a direct impact on the survival rate of fishes subjected to C&R. This highlights that sustainable recreational angling relies on the implementation of a suite of *unenforceable behaviours* that go beyond simple compliance with regulations.

The adoption of *unenforceable behaviours* is particularly necessary to improve the sustainability of recreational angling, especially where compliance is low and enforcement capacity is lacking (e.g. in South Africa – Bova et al., 2017; Kramer et al., 2017), or in remote areas where guiding operations can operate with little regulatory oversight. Given that fishing guides are likely influencers (Danylchuk et al., 2017) in the recreational fishing industry, perceived as role-models by their fishing clients (Farthing et al., 2022, this issue) and may provide the only oversight during C&R events at remote tourist fisheries targeting endangered species (Cooke et al., 2016), an understanding of their environmental ethic is necessary. A fishing guide's environmental behaviour not only has important implications for the health of the fishes caught-and-released during the trip, but may also influence how anglers behave after returning home. By setting an anti-environmental norm, fishing guides' poor-practices and low moral regard for fish health may reinforce misconceptions of C&R best practices and/or encourage poor behavioural intentions among their clientele (Farthing et al., 2022, this issue).

An individual's behavioural intention(be it guide or client) is influenced by three antecedent factors: attitude towards the behaviour (how positive do they feel about the behaviour), subjective norms (what do other people expect them to do) and perceived behavioural control (how easy is it for them to engage in this behaviour) (Theory of Planned Behaviour; Ajzen, 2005). When attitudes and subjective norms are favourable towards the behaviour in question, and perceived behavioural control is high, the intention to perform said behaviour should also be high (Ajzen, 1991). Behavioural intentions do not automatically result in behaviours being performed (Ajzen, 1991; Nilsson et al., 2020), but they are a strong predictor (Ajzen and Fishbein, 2005; Salzborn et al., 2012). Many C&R best practices (Brownscombe et al., 2017) will have a relatively high perceived behavioural control (i.e. seen as easily doable), given their simplicity (e.g. choice of hook or how hard to play the fish). As such, attitudes (i.e. how they feel about the practice) and subjective perceptions of the social norm (i.e. what others do and think they should do) are likely more important determinants of C&R best practice behavioural intentions. The bandwidth-fidelity dilemma (Salgado, 2017) highlights that attitudes must be measured specifically to have any predictive value. As such, the measurement of attitudes towards specific C&R best practices may provide insight into the likelihood of those behaviours being exhibited.

The role of recreational angling in the global fish crises is of growing concern (Cooke and Cowx, 2004), and recent consensus that the effectiveness of C&R depends largely on the angler's choices and tactics (Brownscombe et al., 2017) highlights the need to better understand angling behaviours. Fishing guides are likely perceived as role-models by their clientele (Farthing et al., 2022, this issue). Given this, they may be able to affect positive changes in C&R behaviours in the recreational angling community, or may be perpetuating the adoption of poor C&R practices and anti-environmental moral norms, depending on the particular guide's knowledge, attitudes and behaviour. Little is known of the extent of the adoption and use of C&R best practices on guided-angling trips, which represents a pressing gap in our knowledge. Addressing this gap will improve our understanding of the potential impacts of the guided-angling industry on global recreational fisheries resources, and their potential role in redressing those impacts. As such, collecting information on the C&R knowledge, C&R attitudes and actual C&R behaviour of fishing guides is of tremendous utility in efforts to promote C&R best practices to anglers. Consequently the aim of this research is to perform an exploratory assessment of the knowledge, attitudes and environmental behaviour (with emphasis on C&R) of recreational fishing guides globally. This is broken down into five objectives, namely: assess fishing guides' current catch-and-release *practices*; assess fishing guides' *knowledge* of current catch-and-release best practices; assess fishing guides' *attitudes* towards angling related *environmental behaviours*; assess fishing guides' *attitudes* towards *environmental responsibility*; determine the relationship between knowledge, attitudes and other demographic factors of fishing guides.

## 2. Methods and materials

### 2.1. Data collection

Data were collected using an online survey using Google Forms®, distributed using the social media platform Facebook® or directly to fishing guides by email or WhatsApp® (Rhodes University Ethics Clearance Registration Number REC-241114-045). For this study, the

target population was any English-literate individual (18 years or older) from any country who worked as a fishing guide or had done so in the past. It is troublesome to estimate the relative proportion of fishing guides in the global population, given their low incidence, obscurity and lack of a clear sampling frame due to lack of formal registration or fishing guide associations. It was therefore deemed too costly to employ a random sampling approach (Sweetland, 1972; Marpsat and Razafindratsima, 2010; Shaghaghi et al., 2011). As such, non-probability sampling methods were chosen, given their low cost, low demand for human resources, simplicity and suitability for recruiting participants from obscure communities (Faugier and Sargeant, 1997; Browne, 2005; Vehovar et al., 2016).

Potentially eligible respondents were petitioned for their participation (directly and on Facebook® groups) and after participation, were encouraged to share the survey with others in their social circles, rather than asking them to divulge the contact information for those individuals. Following this, several regional and subject-matter experts were asked to distribute the survey within their respective networks, despite not all being fishing guides themselves. This group comprised members of sport fishing associations, members of recreational angling NGOs and several recreational fisheries experts who had close affiliations with existing networks within the guided-angling industry (Supplementary material Appendix A). Additionally, volunteer (aka self-selection) sampling was conducted by banner recruitment using appeals for participation made on 144 popular angling-centric Facebook groups identified by researchers (Supplementary material Appendix B), with a follow-up appeal made on the same groups two weeks after first contact. As a result, sampling incorporated elements of snowball sampling (Vogt, 1999), purposive (judgmental) and volunteer sampling (Vehovar et al., 2016), and a degree of scrounging (Groger et al., 1999) to reach as much of the target population as possible.

Given the non-random respondent recruitment approach chosen, it is impossible to distinguish how each respondent first came to know about the survey, and therefore survey response rates could not be calculated. Snowball sampling has a strong bias towards cohesiveness (Griffiths et al., 1993), and thereby has an inherent selection bias through "within-group sampling". Similarly, this sampling method tends to overlook "isolates", meaning that less connected groups are likely to be poorly represented (Van Meter, 1990). Additionally, the use of regional experts with pre-existing network membership to assist with survey distribution introduces a form of gatekeeper bias (Groger et al., 1999), whereby those with privileged access introduce a form of respondent selection bias. This recruitment approach has also led to an unbalanced distribution of respondents, as recruitment efforts differed between countries (Supplementary material Appendix A, B). There is potential for social-desirability response bias (Edwards, 1953, 1957) as it is impossible to determine whether some respondents with good knowledge of best practices dishonestly chose the socially desirable best practices in response to questions regarding their own behaviours. As such this study must assume that the assurance of anonymity was sufficient for respondents to answer honestly. Furthermore, the survey precluded non-English speakers, and likely overlooked those without access to internet and social media, given that this survey was principally distributed online and only in English. Given the exploratory nature of the sampling, no rigorous quantitative deductions can be made. However, this approach favours broad, diverse representation for qualitative, exploratory purposes at the expense of the generalisability of results for quantitative inferences.

### 2.2. Survey design

The survey was designed to be as short as possible to reduce respondent fatigue (Lavrakas, 2008). Open-ended questions were avoided where possible to reduce response burden and frustration when using mobile devices to respond. The survey began with a summary of the research intent, and assurances of anonymity, and then several demographic and fishery-specific questions (Supplementary material Appendix C). The survey was then broken into four major sections which match the first four objectives:

#### 2.2.1. Current angling practices

To assess current angling practices, ten questions were developed to be as broadly applicable to any of the various angling facets and contexts as possible. Questions were categorised into the different stages of a C&R event as described by Brownscombe et al. (2017), and comprised possible tactics and choices before and during a C&R event during a guided-angling trip (Supplementary material Appendix D). Questions were focussed on choices and tactics associated with hooking, retrieval, unhooking, documentation, handling, recovery, release and harvest. Not all possible stages of a C&R event proposed by Brownscombe et al. (2017) were represented due to their dependency on contextual factors too specific for interpretation in a broad range of fisheries.

#### 2.2.2. Knowledge of best practice

To assess the respondents' Knowledge of Best Practice (KBP), seven non-species-specific questions were designed to assess a fundamental knowledge of widely applicable catch-and-release best practice principles with available scientific evidence (Supplementary material Appendix E). In assessing correctness of KBP question responses, it was essential to consider that best practice recommendations are laden with fishery-specific nuance (Brownscombe et al., 2017). Given this nuance, the KBP questions pertain to understanding of broad principles rather than an absolute behaviour or practice for a given fishery. This structure of assessment was chosen for two reasons: firstly, because it is troublesome to effectively assess the nuance of all potential fisheries, species, SOPs and habitats; secondly, because providing the foundation for improving fishing guides' fundamental understanding of best practice principles is perhaps a more valuable long-term intervention to help them cope with this nuance than simply improving their applied practices for a single fishery.

Responses to questions were scored as either correct (1) or incorrect (0) based on available literature (Supplementary material Appendix E) and consensus on best practices (Brownscombe et al., 2017). For example, the correct answer to the question: *"What hook style/type do you think inflicts the LEAST POSSIBLE DAMAGE and INJURY to the fish?"* is *"Circle hook"* based on a considerable body of literature (e.g. Siewert and Cave, 1990; Cooke et al., 2001; Prince et al., 2002; Cooke and Suski, 2004; Bergmann et al., 2014). The total KBP score was then calculated by summing these scores (1 or 0) for all seven questions. Additionally, a dichotomous "knowledge of best practice" variable was created by classifying respondents as "knowledgeable of best practices" if they answered four or more of the questions correctly, or "poor knowledge of best practices" if they did not.

#### 2.2.3. Attitudes towards environmental behaviour

To assess the respondents' Attitudes towards Environmental Behaviour (AEB), nine questions were formulated based on possible behaviours an angler or fishing guide might exhibit during a trip (Supplementary material Appendix F). Responses were measured on a 5-point Likert scale of agreement, and were awarded a corresponding numerical score between 1 and 5, depending on whether the behaviour portrayed was positive or negative. For scoring responses to positive behaviours, 5 was awarded for the response showing the most pro-environmental attitude towards the given behaviour (e.g. "strongly agree" with de-barbing hooks). Conversely, responses to negative behaviours (i.e. littering) were reverse-scored, with "strongly disagree" showing the most pro-environmental attitude, and therefore being scored as 5. The total AEB score was calculated by summing the scores for each question, and a higher AEB score indicated a more pro-environmental attitude.

#### 2.2.4. Attitudes towards environmental responsibility

To assess the respondents' Attitudes towards Environmental Responsibility (AER), five questions were developed based on the environmental responsibilities a pro-active, environmentally conscientious fishing guide should ideally maintain (Supplementary material Appendix F). Responses were measured on a five-point Likert-scale of agreement, and were scored correspondingly on a 1–5 scale, with a higher score denoting a more pro-environmental attitude towards responsibility. The total AER score was calculated by summing the scores for each question, and a higher AER score indicated a more positive attitude towards environmental responsibility, which is also a more pro-environmental attitude.

### 2.3. Data analysis

All data analyses were performed using the "stats" package in R Studio (version 4.0.2 – R Core Team, 2020). All total scores were treated as continuous variables, while other binary independent variables (i.e. knowledgeable or not, trained or not) were treated as ordinal. Measures of association between variables were chosen based on their level of measurement as proposed by Khamis (2008). Correlation coefficients were interpreted using the general guidelines outlined by Newton and Rudestam (1999). The relationship between respondent's age and the three total scores (KBP, AEB and AER) was assessed using a Pearson Product-Moment Correlation (Pearson, 1948). To assess the effect of training on knowledge and attitudes, the relationship between the two dichotomous training variables (i.e. some formal training or none & accredited training or none) and the three total scores was assessed using a Point Biserial Correlation (Tate, 1954). Similarly, the relationship between the dichotomous knowledge of best practices variable (i.e. knowledgeable or not) and the two attitude scores was assessed using a Point Biserial Correlation. Countries of residence were classified into dichotomous developmental status variable (developed or developing). For this purpose, countries were classified into development groups (UN, 2019), and developing, least developed, small island developing nations and economies in transition were all grouped into "developing" for the analysis given their small sample sizes.

## 3. Results

### 3.1. Demographics and guiding industry information

A total of 342 complete survey responses were received from 47 countries (Fig. 1a; Table 1; Supplementary material Appendix G),

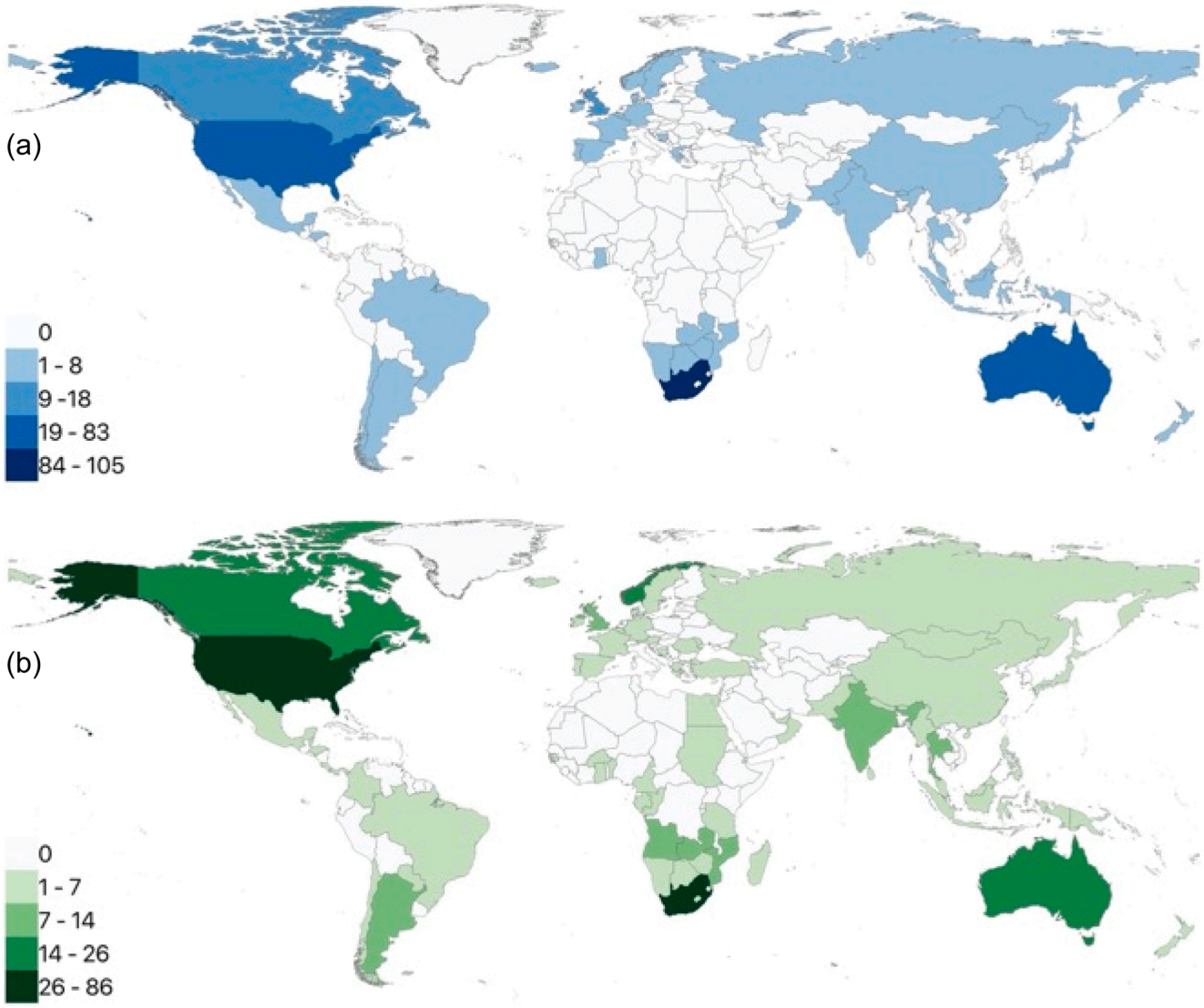



**Fig. 1.** Global distribution of angling-guide survey respondents (n) categorised by their (**a**) resident country and (**b**) guiding locations.

**Table 1**
Summary of demographic information for the 342 angling-guides in the global study response pool.

| Categorical variable | Summary |
|---|---|
| *Respondents (n)* | |
| Residential countries | 47 |
| Guiding countries | 79 |
| *Residential country developmental status [n (%)]* | |
| Developed | 185 (54.1 %) |
| Developing | 140 (40.9 %) |
| Least Developed | 13 (3.8 %) |
| Small island developing state | 2 (0.6 %) |
| Economies in transition | 2 (0.6 %) |
| *Gender [n (%)]* | |
| Male | 335 (98.0 %) |
| Female | 6 (1.8 %) |
| Other | 1 (0.3 %) |
| *Age (yrs.)* | |
| Mean age in years (range) | 41.3 (18–65) |
| *Education [n (%)]* | |
| No education or Junior School/Primary School | 2 (0.6 %) |
| High School/Secondary School/Senior High | 112 (32.7 %) |
| College degree (Associate degree) | 90 (26.3 %) |
| University degree (Bachelor's degree) | 98 (28.7 %) |
| Masters, Doctoral or Higher Degree (e.g. MSc, PhD) | 40 (11.7 %) |

principally South Africa (30.7 %), the United States of America (24.3 %), Australia (7.0 %), Canada (5.3 %) and the United Kingdom (4.4 %). Respondents listed a total of 79 distinct countries as guiding destinations (Table 1), with the United States of America (25.2 %), South Africa (23.4 %), Australia (7.6 %), Canada (6.1 %), Norway (5.3 %), Angola (4.1 %) and the Seychelles (4.1 %) being most popular (Fig. 1b). Respondents were most likely from a developed country (54.1 %; Table 1), and likely only worked as a fishing guide locally in their country of residence (68.1 %), although some respondents guided in as many as eight different countries.

Respondents were predominately high school educated (32.7 %) males (98.0 %) with a mean age of 41.7 yrs. (SD = 12.4 yrs.; Range = 18–65 yrs.) (Table 1). Just over half of the respondents were self-employed (52.9 %) fishing guides, working seasonally or part-time (49.1 %) for an average of 110 days per year (SD = 82.8 days), earning a mean of 49.1 % (SD = 37.5 %) of their total income from guiding anglers, and a mean of 18.1 % (SD = 22.1 %) of their guiding income from gratuities or "tips" (Table 2). Many respondents specialised in multiple facets, with the most common being fly-fishing (70.2 %), followed closely by conventional lure angling (65.5 %). Only 34.2 % indicated that they specialise in all facets of angling (Table 2). Most respondents had no formal guide training (63.8 %), and only 8.8 % had formal accreditation in the form of a certificate, diploma, course or certification dedicated to angling-guiding (Table 2). Salmonids were the most frequently listed target species, followed by Carangidae and Cyprinidae (Table 3).

### 3.2. Current practices

Approximately one third of fishing guides indicated that they would provide/recommend "j-hooks" (34.3 %), while most indicated they would encourage their clients to "minimise fight time by playing/fighting the fish hard to land it as soon as possible" (84.7 %) (Supplementary material Appendix D). Once the fish was landed, 46.0 % of fishing guides suggested that they "leave the fish in the water while unhooking". Should the fish be hooked in the oesophagus 41.4 % of guides stated that they would "always cut the line and leave the hook in place". When photographing a client with their catch, the majority of fishing guides demonstrated that they "photographed the client with the fish out of the water, supported by its head and tail" (64.8 %), and just over half would insist on returning the fish to the water after no more than 30 s of air exposure (54.8 %). When trying to determine the weight of the client's catch, 38.8 % of fishing guides stipulated that they "measure the length of the fish and use length-weight conversion tables", while 31.1 % of guides specified that they "never try to determine the weight of a clients' catch". When releasing a fish, just over half of the fishing guides indicated that they actually committed to releasing the fish "when it kicks its tail" (50.9 %). During guided-angling trips, 50.9 % of fishing guides reported that they "always" released their catch, while 35.7 % "never" harvested their catch.

### 3.3. Knowledge of best practice (KBP)

Respondent's knowledge of best practice varied across the seven topics chosen (Fig. 2). Most respondents correctly answered the questions about handling tactics (KBP 1: 76.3 % correct) and landing choices (KBP 2: 74.0 % correct), while more than half of respondents incorrectly answered the questions about unhooking tactics (KBP 6: 57.9 %

**Table 2**
Summary of employment, experience, income, training and style of participation of 342 angling-guides recruited into the global study response pool.

| Categorical variable | Summary |
|---|---|
| *Employment [n (%)]* | |
| Full-time angling guide. | 116 (33.9 %) |
| Part-time/seasonal angling guide. | 168 (49.1 %) |
| Previously worked as an angling guide. | 58 (17.0 %) |
| *Employment style [n (%)]* | |
| Self-employed angling guide | 180 (52.9 %) |
| Employed and self-employed as an angling guide | 65 (19.1 %) |
| Employed as an angling guide | 95 (27.9 %) |
| *Income from guiding (%)* | |
| Mean percentage of total income from guiding (range) | 49 % (0–100) |
| Mean percentage of guiding income from "tips" (range) | 18.3 % (0–100) |
| *Guiding* | |
| Mean guiding experience in years (range)] | 11.1 (0.4–45) |
| Mean days spent guiding per year (range) | 110 (2–365) |
| *Training [n (%)]* | |
| No guiding training | 217 (63.8 %) |
| Guide training (formal) | 123 (36.2 %) |
| Guide training (accredited) | 30 (8.8 %) |
| *Style of participation [n (%)]* | |
| Fly fishing | 240 (70.2 %) |
| Conventional lure angling | 224 (65.5 %) |
| Organic bait | 174 (50.9 %) |
| All facets | 117 (34.2 %) |

**Table 3**
Summary of the five most targeted fishes listed by the angling-guide respondents during the global angling-guide survey, classified by family.

| Family | n | Family | n | Family | n |
|---|---|---|---|---|---|
| *Salmonidae* | 306 | *Clariidae* | 12 | *Sisoridae* | 3 |
| *Carangidae* | 139 | *Percidae* | 10 | *Characidae* | 2 |
| *Cyprinidae* | 104 | *Channidae* | 9 | *Clupeidae* | 2 |
| *Scombridae* | 95 | *Haemulidae* | 9 | *Cynodontidae* | 2 |
| *Sciaenidae* | 64 | *Siluridae* | 9 | *Merlucciidae* | 2 |
| *Centrarchidae* | 55 | *Sphyraenidae* | 9 | *Mugilidae* | 2 |
| *Istiophoridae* | 46 | *Chanidae* | 7 | *Osteoglossidae* | 2 |
| *Carcharhinidae* | 40 | *Arapaimidae* | 6 | *Anguillidae* | 1 |
| *Esocidae* | 37 | *Odontaspididae* | 6 | *Atherinopsidae* | 1 |
| *Gadidae* | 31 | *Anarhichadidae* | 5 | *Belonidae* | 1 |
| *Lutjanidae* | 31 | *Dasyatidae* | 5 | *Ictaluridae* | 1 |
| *Sparidae* | 31 | *Pimelodidae* | 5 | *Lamnidae* | 1 |
| *Alestiidae* | 24 | *Polynemidae* | 5 | *Lepisosteidae* | 1 |
| *Centropomidae* | 21 | *Acipenseridae* | 4 | *Lophiidae* | 1 |
| *Megalopidae* | 20 | *Distichodontidae* | 4 | *Mormyridae* | 1 |
| *Cichlidae* | 19 | *Labridae* | 4 | *Poeciliidae* | 1 |
| *Coryphaenidae* | 19 | *Lotidae* | 4 | *Potamotrygonidae* | 1 |
| *Pomatomidae* | 19 | *Scaridae* | 4 | *Schilbeidae* | 1 |
| *Albulidae* | 17 | *Arripidae* | 3 | *Serrasalmidae* | 1 |
| *Pleuronectidae* | 17 | *Dichistiidae* | 3 | *Sillaginidae* | 1 |
| *Moronidae* | 16 | *Pangasiidae* | 3 | *Squalidae* | 1 |
| *Serranidae* | 15 | *Platycephalidae* | 3 | *Triakidae* | 1 |
| *Balistidae* | 13 | *Sebastidae* | 3 | *Triglidae* | 1 |

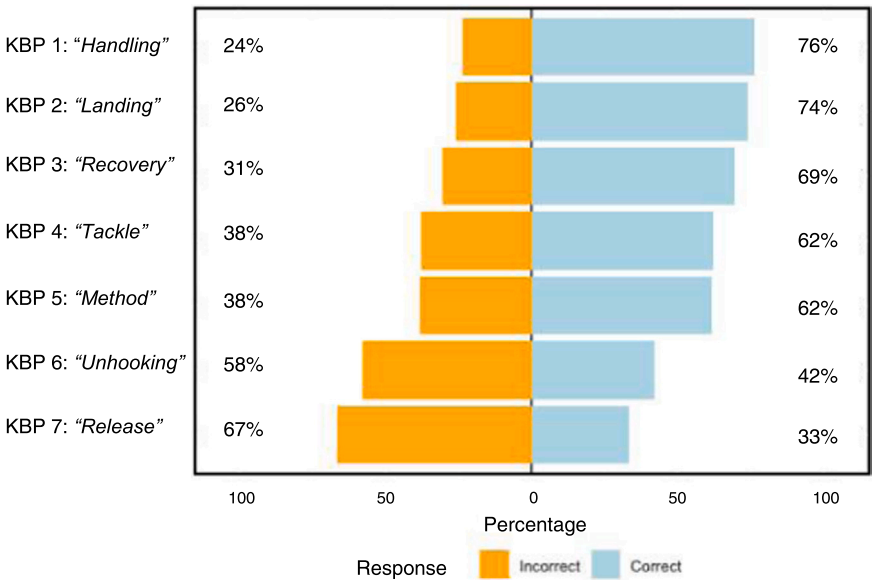



**Fig. 2.** Proportion of angling-guide survey responses (%) to each of the "knowledge of best practise" (KBP) questions scored as correct (blue) or incorrect (orange).

incorrect) and release knowledge (KBP 7: 66.7 % incorrect; Fig. 2). The majority (69.0 %) of respondents answered four or more of the seven questions correctly, and were classified as "knowledgeable of best practices".

### 3.4. Attitudes towards environmental behaviour (AEB)

Respondent's "attitudes towards environmental behaviours" varied across the nine environmental behaviours chosen (Fig. 3). Respondents scored highest in response to behaviours like "littering" (AEB 1: 96.2 % pro-environmental attitudes) and "poor landing practice" (AEB 2: 93.3 % pro-environmental attitudes) (Fig. 3). Respondents scored lower on best practices which could reduce client catch-rate, such as "de-barbing hooks" (AEB 6; 69.6 % pro-environmental attitudes) or "not using treble hooks" (AEB 7; 69.3 % pro-environmental attitudes) (Fig. 3). Respondents scored lowest in response to the practice of "holding the fish above dry ground" (AEB 9: 50.9 % pro-environmental attitudes) (Fig. 3).

### 3.5. Attitudes towards environmental responsibility (AER)

The distribution of respondent's "attitudes towards environmental responsibility" was similar across all five of the statements chosen, with a majority of respondents expressing pro-environmental attitudes (87.1–89.5 %) (Fig. 4). Although only slightly different from other questions, question AER 5: "Guides should be willing to sacrifice client success and enjoyment for sustainable practices" had the lowest proportion of pro-environmental response of any of the five questions (Fig. 4).

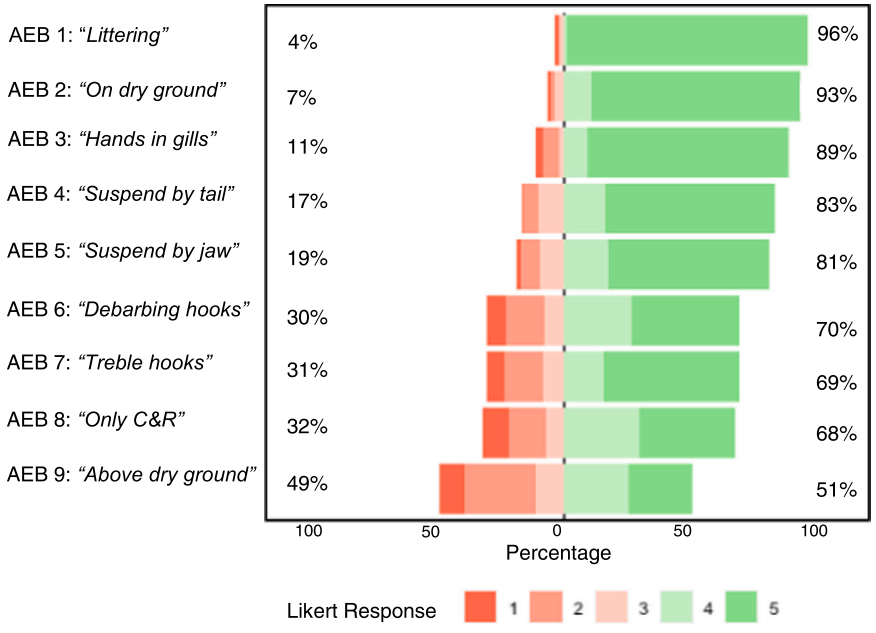



**Fig. 3.** Proportion of angling-guides' *Attitudes towards Environmental Behaviour* (AEB) scores for responses to questions about potential C&R behaviours. Higher scores indicate more pro-environmental attitudes, with only scores of 4 or 5 considered to be responses indicative of a pro-environmental attitude aligned with the best-practices for a particular behaviour.

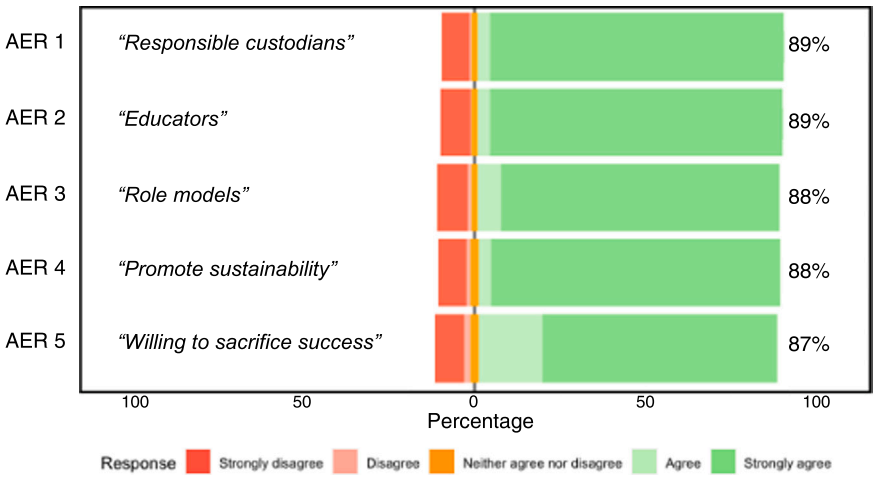



**Fig. 4.** Attitudes of angling-guides (n = 342) to five statements pertaining to their environmental responsibilities as an angling-guide (5 point Likert scale). (AER: *Attitudes Towards Environmental Responsibility*).

### 3.6. Training and knowledge

While both mean attitude scores (AEB & AER) were similar for those with and without training (formal and accredited), the mean KBP score was higher for those with training, (formal: $p = 0.085$, $t(340) = 1.7277$, $\bar{x} = 4.37 \pm 1.58$ SD; accredited: p-value = 0.081, $t(340) = 1.7517$, $\bar{x} = 4.63 \pm 1.33$ SD) than those without any training ($\bar{x} = 4.09 \pm 1.41$ SD), although not significantly so (using unpaired, two-sample, two tailed t-tests). Similarly, those respondents classed as "knowledgeable of best practice" (KBP score $\geq 4$) were more likely to have received some kind of training (37.7 %) than those who were not knowledgeable (32.1 %).

Respondents classified as knowledgeable of best practice (KBP score $\geq 4$) had a significantly higher mean AEB score ($p = 0.003$; $t(340) = 3.002$; effect size – $d = 0.34$; $\bar{x} = 4.24 \pm 0.53$ SD) than those who were not knowledgeable ($\bar{x} = 4.05 \pm 0.58$ SD), and although not significant, also had a higher AER score ($p = 0.087$; $t(340) = 1.716$; $\bar{x} = 4.58 \pm 1.05$ SD) than those who were not knowledgeable ($\bar{x} = 4.36 \pm 1.28$ SD; Table 4). The proportion of respondents who had received formal guide training was similar between developed (37.3 %) and developing countries (34.4 %; Table 4).

**Table 4**
Angling-guide survey response distribution and scaled mean scores (± SD) for knowledge of best practice (KBP), attitudes towards environmental behaviour (AEB) and attitudes towards environmental responsibility (AER) summarised according to their training, knowledgeability and residential country development status. Significant ($p < 0.05$) test results are emboldened.

| Formal guide training: | No | Yes | p-value |
|---|---|---|---|
| *All [n (%)]* | 219 (64.0 %) | 123 (36.0 %) | – |
| *Scaled mean KBP score (± SD)* | 4.09 (± 1.41) | 4.37 (± 1.58) | 0.085 |
| *Scaled mean AEB score (± SD)* | 4.19 (± 0.53) | 4.18 (± 0.60) | 0.900 |
| *Scaled mean AER score (± SD)* | 4.54 (± 1.09) | 4.48 (± 1.20) | 0.655 |
| Accredited guide training: | No | Yes | p-value |
| *All [n (%)]* | 312 (91.2 %) | 30 (8.8 %) | – |
| *Scaled mean KBP score (± SD)* | 4.15 (± 1.49) | 4.63 (± 1.33) | 0.086 |
| *Scaled mean AEB score (± SD)* | 4.18 (± 0.61) | 4.26 (± 0.73) | 0.413 |
| *Scaled mean AER score (± SD)* | 4.52 (± 1.12) | 4.49 (± 1.24) | 0.888 |
| Knowledgeable of best practice (KBP ≥ 4): | No | Yes | p-value |
| *All [n (%)]* | 106 (31.0 %) | 236 (69.0 %) | – |
| *Accredited guide training [n (%)]* | 7 (23.3 %) | 23 (76.7 %) | – |
| *Formal guide training [n (%)]* | 34 (27.6 %) | 89 (72.4 %) | – |
| *Scaled mean AEB score (± SD)* | 4.05 (± 0.58) | **4.24 (± 0.53)** | **0.003** |
| *Scaled mean AER score (± SD)* | 4.36 (± 1.28) | 4.58 (± 1.05) | 0.087 |
| Residential country development status: | Developing | Developed | p-value |
| *Accredited guide training [n (%)]* | 12 (7.6 %) | 18 (9.7 %) | – |
| *Formal guide training [n (%)]* | 54 (34.4 %) | 69 (37.3 %) | – |

## 4. Discussion

The understanding that fishing guides may be emulated by their fishing clients means their knowledge, attitudes and behaviour may influence the ecological outcomes through potential role-modelling. As little is known of fishing guide knowledge of best practice and attitudes towards environmental behaviours, this baseline assessment is critical for shaping future interventions. Fishing guides from 47 countries were recruited to take part in the survey and while they were mostly "knowledgeable" of C&R best practice principles, they showed poor knowledge of some key aspects of the C&R process. Most fishing guides had not received any form of training, but those with training appeared to have slightly better knowledge scores than those without, although this was not significant. Fishing guides generally had pro-environmental attitudes towards C&R behaviour, suggesting that they probably have pro-environmental behavioural intentions. That said, attitudes towards certain behaviours were more pro-environmental than others, which suggests that behaviour is likely to vary considerably between fishing guides, likely due to their individual knowledge and their perceptions of the "costs" associated with the behaviour. Knowledgeable fishing guides had more pro-environmental attitudes, which suggests that training focussed on best practice principles may improve fishing guide C&R behaviour. Encouragingly, almost all fishing guides had pro-environmental attitudes towards their potential responsibilities as influential resource users. However, the bandwidth-fidelity dilemma (Salgado, 2017) suggests that these broad attitudes may have little bearing on the actual behaviours in question, especially when faced with a significant trade-off between client satisfaction and ecological integrity.

Fishing guides understanding the fundamentals of C&R best practice principles is essential to them being able to employ best practices in all contexts. Most respondents (69.0 %) were considered "knowledgeable",

answering most of the C&R best practice questions correctly. However, most erroneous responses were given to the questions KBP 6 and KBP 7 (Fig. 2; Supplementary material Appendix E). Here, 57.9 % of respondents were incorrect in their assessment of how to proceed when a fish is hooked in the oesophagus (KBP 6), and would therefore likely behave at odds with the body of evidence that suggests the best practice is to leave the hook in place and cut the line (Mason and Hunt, 1967; Tsuboi et al., 2006; Warner, 1979; Fobert et al., 2009; Cooke and Danylchuk, 2020). Similarly, most respondents (66.7 %) did not know that "hooking injury and bleeding" plays the biggest role in determining post-release survival (KBP 7; Fig. 2; Supplementary material Appendix E; Muoneke and Childress, 1994; Cooke and Suski, 2005). This suggests that fishing guides may overlook the need to switch tactics or gear when hooking injuries become prevalent, given that they may underappreciate the severity of the injuries. Best practice recommendations are considerably nuanced, but a good understanding of the fundamentals behind their formulation will assist fishing guides in making common-sense best practice choices in all contexts.

Best practices behaviours are contextually specific, and may differ considerably between species, fishery, SOP or habitat. Some species may suffer more acutely than others (Cooke and Suski, 2005), and some situations may call for practices where the practical implications of the choice/behaviour outweigh the broad scientific evidence available. For example, misuse of poorly designed lip-gripping devices typically results in unacceptable injury to fish, especially when used to suspend the fish's entire weight by its jaw (Danylchuk et al., 2008; Gould and Grace, 2009). A best practice recommendation would be to instead use a silicone rubber net for landing and unhooking while leaving it submerged (Brownscombe et al., 2017). However, for sharp-toothed species such as African tigerfish (*Hydrocynus vittatus*), a properly designed, high-quality lip-gripping device used correctly may be a better practice which avoids the damage nets cause to the epithelial slime layer, limits the damage tigerfish cause to expensive nets and reduces the risk of angler injury. These exceptions mean, for example, that it may be acceptable to use a j-hook where contextual probability of hooking injury is practically low, even though a circle-hook is fundamentally less likely to mortally injure fish by design. Consequently, the KBP assessment is an imperfect representation of every fishing guide's practical knowledge. Fishing guides are likely a significant source of local ecological knowledge considering they are typically highly specialised and dedicated anglers with vast amounts of experience and "time on the water". Some fishing guides may have good, applied knowledge of the least deleterious practices for a given species, given SOP or given habitat, but still score poorly in this assessment if they do not have a fundamental understanding of scientifically grounded best practice principles. Promoting understanding of best practice principles, perhaps through high quality, scientifically grounded training, may have considerable implications for sustainable recreational fisheries.

Training is seldom a legal or community-level pre-requisite to operate as a fishing guide, especially in the parts of the developing world (e.g. southern Africa), where recreational fisheries are poorly regulated (Bova et al., 2017; Potts et al., 2020). While approximately one third (36.0 %) of the respondents had received some form of training, only 8.8 % had received accredited training specifically for fishing guides (see Table 2). Despite this, most respondents (69.0 %) were classified as "knowledgeable" of best practices (Table 4). While fishing guides with some kind of formal training had greater mean knowledge of best practice scores (mean score = 4.37; $p = 0.085$; Table 4) than those without (mean score = 4.09), as did those with accredited training (mean score = 4.63; $p = 0.086$; Table 4), these differences were not significant. Firstly, this highlights that best practice knowledge is not restricted to those with training, and that it is possible to acquire best practice knowledge from a variety of other sources, perhaps including other fishing guides, social media (e.g. Facebook®), public-outreach (e.g. www.keepfishwet.org), grassroots angling organisations (e.g. RASSPL competitive angling club) or reference material (e.g. "The Responsible Angler", WWF). Secondly, it highlights that while fishing guides may have received formal training, this does not guarantee that they are highly trained in scientifically grounded best practices for catch-and-release. High-quality, accredited training based on sound science should expose fishing guides to the basic knowledge of best practices and C&R science. One reason, perhaps, for why trained fishing guides in this study were not significantly more knowledgeable of best practice principles is poor quality training which does not adequately address the nuance of best practices. High quality training will likely improve understanding of fundamental C&R science, and thereby improve fishing guides' *knowledge of the problem* and *internal attribution* of the cause, both of which are psycho-social pre-determinants of the attitudes that contribute to pro-environmental behavioural intentions (Bamberg and Moser, 2007). While training only appeared to improve knowledge slightly in this study, high quality training remains important for improving knowledge, and may also enhance attitudes towards C&R practices.

To better understand fishing guide behavioural intentions, we assessed attitudes towards environmental behaviour (AEB). Respondents' AEB scores were generally indicative of a positive attitude towards responsible behaviours, but variation across the behaviours in question highlights that fishing guides have varying attitudes towards different practices (Fig. 3). For example, an overwhelming majority of fishing guides expressed pro-environmental attitudes towards obviously poor practices, such as littering (96.2 %), placing the fish on dry ground (93.3 %) and placing hands and fingers in the gills (88.6 %). In contrast, only half of fishing guides (50.9 %) had pro-environmental attitudes towards holding the fish above dry ground during photographs before release (Fig. 3). While this may seem trivial, a more nuanced best practice would be to hold the fish above the water, or perhaps a bucket (e.g. Fig. 5) as injury to the fish by dropping is common, especially amongst inexperienced anglers who might be more likely to employ fishing guides. These poor attitudes towards positive practices are suggestive of poor understanding. Respondents classified as knowledgeable of best practice (KBP score $\geq 4$) had significantly higher AEB scores


**Fig. 5.** Catch photographs illustrating (a) best practices using "keep-fish-wet" principles for minimising air exposure and limiting risk of sand exposure or injury to fish if dropped, and (b) poor practices which risk damage to fish if dropped and exposure to abrasive beach sand during the shore-based catch-and-release process. (*photo credit: Matthew Farthing, Lyle Taylor, Edward Butler*).

(mean scaled score = 4.24; p = 0.003; $d$ = 0.34; Table 4) than those less knowledgeable (mean scaled score = 4.05). This suggests that respondents who knew more about C&R best practices had more pro-environmental attitudes, and therefore may be more likely to have pro-environmental behavioural intentions, and therefore may be more environmentally responsible.

In a perfect world, every fishing guide would feel a sense of custodial responsibility towards their fisheries resources. Inherent in that sense, would be a resource-use ethic that drives practice choices which carefully balance the satisfaction of the guide's clientele with the sustainability of their fishery resource. Additionally, every effort would be made to exhibit and promote pro-environmental behaviour as a positive role-model, because fishing guides would not only value the integrity of the resources on which they rely, but also acknowledge their ability to influence the norm. Encouragingly, almost all respondents (87.1–89.5 %) had positive attitudes towards environmental responsibility (AER). This suggests that most respondents acknowledged the social and/or ecological value of fishing guides being "*responsible custodians of fisheries resources*", "*role-models to anglers*", "*educators of sustainable practices*", "*promoters of sustainability*" and "*willing to sacrifice client success for sustainability*". This suggests that even fishing guides with poor knowledge of, and negative attitudes towards best practices, still had high AER scores. Despite the general positivity towards the abstract concept, the actual nature of being *environmentally responsible* may be very different for different individuals, based on their understanding and attitudes. As such, a poorly informed fishing guide may consider themselves to be environmentally responsible based on their awareness of environmental issues and knowledge, when their behaviours could in fact be environmentally deleterious. Furthermore, the fidelity-bandwidth dilemma (Cronbach and Gleser, 1957) suggests that attitudes towards a broad concept like environmental responsibility may have little bearing on actual environmentally responsible behaviour (Salgado, 2017). Fishing guides may well appreciate the need to behave responsibly, but may choose not to, as pro-environmental attitudes and behavioural intentions do not always result in pro-environmental practices (Kollmuss and Agyeman, 2002).

Catch-and-release best practice is being increasingly adopted by proactive members of the recreational angling community (Cowx, 2002; Butler et al., 2017; Mannheim et al., 2018). Some best practices are broadly applicable to any fishery, aiming to reduce factors that decrease the survivability of fishes subjected to C&R. Encouragingly, most respondents (84.7 %) stated that they instruct their clients on the best practice of "playing the fish hard" to retrieve the fish quickly and minimise fight time, which in turn limits the risk of predation, exhaustion and excessive physiological stress response (Cooke and Suski, 2005). Likewise, 38.8 % of fishing guides reported that they choose the best practice of length-to-weight conversion (Cooke and Suski, 2005; Brownscombe et al., 2017), or simply foregoing knowing the weight at all (31.1 %), instead of using a scale to determine the weight of their clients' catch (30.1 %). Positively, most respondents (85.2 %) stated that they only allowed their clients 60s or less of air exposure for photographs, with over half (54.8 %) only allowing their clients 30s or less, which greatly reduces the air exposure and potential for injury due to poor handling. Similarly, most fishing guides suggested that they perform some form of reflex impairment test (i.e. RAMP as per Davis, 2010) before releasing their client's catch (87.4 %), such as waiting for a "tail kick" (50.9 %), the "fish to stay upright" (23.3 %) or observation of "steady breathing" (13.2 %). This suggests that there is some form of recovery assessment taking place, as opposed to simply releasing the fish immediately (12.7 %). Thus, there is evidence to suggest that some best practices are used by a considerable proportion of fishing guides which are therefore likely to be adopted by their clients who likely see them as role models. However, there is still evidence that the remainder employ poor practices, and are therefore likely to also promote the adoption of these negative behaviours to the recreational angling public.

While there is strong evidence to suggest that many fishing guides are using C&R best practices, there was also considerable evidence to suggest that poor practices are used. For example, choosing to "unhook the fish while in water" is broadly considered the best tactic, but less than half of the respondents (46.0 %) stated this as their chosen method. Unhooking time contributes greatly to air exposure (Cooke and Suski, 2005; Butler et al., 2017; Brownscombe et al., 2017), especially when unhooking is difficult (e.g. treble hooks or sharp-toothed species). Similarly, choosing to "cut the line immediately when a fish is hooked in the oesophagus" is generally deemed the best tactic (Fobert et al., 2009; Cooke and Danylchuk, 2020), but again less than half (41.4 %) of respondents suggested this was their choice. While understandably paradoxical, leaving the hook in place generally increases fish survival (Cooke and Danylchuk, 2020). When presented with a case of oesophageal hooking, anglers typically spend too much time trying to remove deep hooks, exacerbating hooking injury and air exposure in the process (Brownscombe et al., 2017; Cooke and Danylchuk, 2020). This pervasive misconception, along with others (e.g. carbonated soft-drinks stop bleeding in gill area – Trahan et al., 2021) decreases the survival of released fishes. Considering that half of the respondents stated that they "always" released (50.9 %), and many "never" harvested (35.7 %) their client's catch, it is likely that these pervasive, poor practices are inadvertently contributing to the enigmatic post-release mortality that is becoming increasingly well documented in recreational C&R angling (Muoneke and Childress, 1994; Cooke et al., 2001; Lewin et al., 2006; Danylchuk et al., 2007; O'Toole et al., 2010; Weltersbach and Strehlow, 2013).

The burgeoning consensus that recreational fishing plays a major role in the sustainability of fish populations around the world (Cooke and Cowx, 2004; Lewin et al., 2006; Hyder et al., 2020) should be of particular concern to fishing guides, who rely on the resource to earn their living (Table 2). Just over half of respondents surveyed were self-employed (52.9 %) and earned approximately half of their total income (49.1 %) from guiding seasonally or part-time (49.1 %) for an average of 110 days per year. While guiding anglers was not the sole source of income for all respondents, it likely contributes significantly to their financial security. This is an important consideration for interventions aimed at improving C&R behaviours, given that there are additional financial motivations which may enter the decision-making process at the nexus of intention and actual behaviour on guided-angling trips. As a result of being mostly self-employed and financially dependent on a service-orientated industry which relies on a resource in crisis, fishing guides have the burden of balancing personal, ecological and market-related demands on their behaviour.

There are many factors which may affect a fishing guide's ability and motivation to convert pro-environmental intentions into actual pro-environmental behaviour. On one hand, fishing guides might be motivated to choose behaviours which do not risk losing more immediate financial rewards, such as potential gratuities or repeat business. On the other hand, they may forego immediate rewards for behaviours that ensure the future-integrity of the resources on which they rely. For example, fishing guides may allow their clients to expose a fish to excessive amounts of air-exposure while they admire and photograph their catch, to avoid imposing limits on what may be perceived as the key aspects of the client's C&R enjoyment. Alternatively, they may be motivated to impose air-exposure limits to ensure fish health, either out of high moral regard for ecological integrity, or self-serving concerns over the future utility of the resource. These contrasting *biocentric* or *anthropocentric* values (as per Thompson and Barton, 1994) suggest that fishing guides may have trouble aligning their pro-environmental behavioural intentions with their actual behaviours. This highlights that efforts to promote pro-environmental behaviour in fishing guides must be holistic, and include efforts to not only improve behavioural intentions, but assist fishing guides with overcoming perceived barriers to carrying out those intentions during guided-angling trips.

While this study makes a considerable contribution to our understanding of fishing guide knowledge, attitudes and behaviour, it is not

without its shortcomings. Despite these shortcomings, this preliminary exploration provides important insight into the knowledge, attitudes and behaviour of an understudied, but influential group who rely on resources that are of growing ecological concern. The wide diversity of regions and fisheries sampled suggests that the response pool is likely a good representation of the fishing guide community. As such, this information on fishing guides provides an important steppingstone for more rigorous research to understand their potential role in the endeavour to achieve sustainability goals.

In conclusion, most fishing guides surveyed were considered knowledgeable of best practices, but there were several key areas where many guides were incorrect. A firm understanding of best practices is essential to make correct behavioural decisions, and improving this knowledge is perhaps a pre-requisite for improving attitudes and behavioural intentions. Fishing guides with training appeared to be slightly more knowledgeable, which suggests that high-quality training could improve knowledge considerably. Given that knowledgeable fishing guides likely have a better *knowledge of the problem* and *internal attribution of the cause,* the fact that those who were considered knowledgeable had more pro-environmental attitudes towards practice again highlights the importance of knowledge and understanding in shaping the attitudes associated with pro-environmental behavioural intentions. The fact that even those with poor knowledge and attitudes towards practice could have positive attitudes towards environmental responsibility highlights that knowledge and understanding is critical, as misinformed fishing guides could incorrectly assume that their behaviours were environmentally responsible. It is apparent that while many fishing guides have demonstrably good knowledge, attitudes and practices, there is room for improvement to meet real sustainability requirements. Given that training appeared to improve knowledge, and knowledge of best practices appeared to improve attitudes, it is recommended that fishing guides undergo at least some form of training, ideally science-based and accredited, to improve their behavioural intentions and actual behaviour.

Fishing guides are being increasingly recognised as important role-players in the recreational angling industry. While this study focussed on knowledge, attitudes and stated practices, there is likely a considerable dissonance between these and actual behaviour, depending on contextual factors and competing personal, financial and market driven motivations. Consequently, it is imperative to obtain information about actual behaviour before effective, fishery specific interventions can be developed to assist fishing guides to better align their knowledge, attitudes and ethics with their actual practices.

## CRediT authorship contribution statement

**Farthing MW:** Conceptualization, Data curation, Formal analysis, Investigation, Project administration, Methodology, Visualization, Writing – original draft. **Childs AR:** Supervision, Writing – review & editing. **Mann-Lang JB:** Supervision, Methodology, Validation, Writing – review & editing. **Bova CS:** Supervision, Methodology, Writing – review & editing. **Potts WM:** Supervision, Conceptualization, Funding acquisition, Resources, Writing – review & editing. **Bower SD:** Resources, Methodology, Writing – review & editing. **Pinder AC:** Resources, Methodology, Writing – review & editing. **Ferter K:** Resources, Methodology, Writing – review & editing. **Winkler AC:** Conceptualization, Writing – review & editing. **Butler EC:** Conceptualization, Writing – review & editing. **Brownscombe JW:** Methodology, Resources, Writing – review & editing. **Danylchuk AJ:** Methodology, Resources, Writing – review & editing.

## Declaration of Competing Interest

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

## Acknowledgments

Thanks to all those who assisted with recruiting participants for the survey, and those that provided feedback on the survey structure and design. We also thank the South African National Research Foundation and the Rhodes University Research Council for financial assistance and funding for project costs.

## Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.fishres.2022.106453.

## References

Ajzen, 1991. The theory of planned behaviour. Organ. Behav. Hum. Decis. Process. 50, 179–211.
Ajzen, I., 2005. Handbook of Attitude Measurement. Open University Press, McGraw Hill Education, Berkshire, England.
Ajzen, I., Fishbein, M., 2005. The influence of attitudes on behaviour. In: Albarracín, D., Johnson, B.T., Zanna, M.P. (Eds.), The Handbook of Attitudes. Lawrence Erlbaum Associates, Mahwah, N.J.
Arlinghaus, R., Tillner, R., Bork, M., 2015. Explaining participation rates in recreational fishing across industrialised countries. Fish. Manag. Ecol. 22, 45–55.
Bamberg, S., Moser, G., 2007. Twenty years after Hines, Hungerford, and Tomera: a new meta-analysis of psycho-social determinants of pro-environmental behaviour. J. Environ. Psychol. 27, 14–25.
Barcellini, V.C., Motta, F.S., Martins, A.M., Moro, P.S., 2013. Recreational anglers and fishing guides from an estuarine protected area in southeastern Brazil: Socioeconomic characteristics and views on fisheries management. Ocean Coast. Manag. 76, 23–29.
Bergmann, C., Driggers, W.B., Hoffmayer, E.R., Campbell, M.D., Pellegrin, G., 2014. Effects of appendaged circle hook use on catch rates and deep hooking of black sea bass in a recreational fishery. N. Am. J. Fish. Manag. 34, 1199–1203.
Browne, K., 2005. Snowball sampling: using social networks to research non-heterosexual women. Int. J. Soc. Res. Methodol. 8, 47–60.
Brownscombe, J.W., Danylchuk, A.J., Chapmana, J.M., Gutowskya, L.F.G., Cooke, S.J., 2017. Best practices for catch-and-release recreational fisheries – angling tools and tactics. Fish. Res. 186, 693–705.
Bova, C.S., Halse, S.J., Aswani, S., Potts, W.M., 2017. Assessing a social norms approach for improving recreational fisheries compliance. Fish. Manag. Ecol. 24, 117–125.
Butler, E.C., Childs, A.R., Parkinson, M.C., Potts, W.M., 2017. An assessment of the health and survival of fishes caught-and-released in high-energy surf zones during a South African competitive angling event. Fish. Res. 195, 152–168.
Butler, E.C., Childs, A.R., Saayman, A., Potts, W.M., 2020. 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. Sustainability 12, 4221.
Cooke, S.J., Nguyen, V.M., Murchie, K.J., Danylchuk, A.J., Suski, C.D., 2012. Scientific and stakeholder perspectives on the use of circle hooks in recreational fisheries. Bull. Mar. Sci. 88, 395–410.
Cooke, S.J., Cowx, I.G., 2004. The role of recreational fishing in global fish crises. BioScience 54, 857–859.
Cooke, S.J., Schramm, H.L., 2007. Catch-and-release science and its application to conservation and management of recreational fisheries. Fish. Manag. Ecol. 14, 73–79.
Cooke, S.J., Suski, C.D., 2004. Are circle hooks an effective tool for conserving marine and freshwater recreational catch-and-release fisheries? Aquat. Conserv. 14, 299–326.
Cooke, S.J., Suski, C.D., 2005. Do we need species-specific guidelines for catch-and-release recreational angling to effectively conserve diverse fishery resources? Biodivers. Conserv. 14, 1195–1209.
Cooke, S.J., Danylchuk, A.J., 2020. Hook disgorgers remove deep hooks but kill fish: a plea for cutting the line. Fish. Manag. Ecol. 27, 622–627.
Cooke, S.J., Hogan, Z.S., Butcher, P.A., Stokesbury, M.J., Raghavan, R., Gallagher, A.J., Danylchuk, A.J., 2016. Angling for endangered fish: conservation problem or conservation action? Fish Fish. 17, 249–265.
Cooke, S.J., Philipp, D.P., Dunmall, K.M., Schreer, J.F., 2001. The influence of terminal tackle on injury, handling time, and cardiac disturbance of rock bass. N. Am. J. Fish. Manag. 21, 333–342.
Cowx, I.G., 2002. Recreational fisheries. In: Hart, P.B.J., Reynolds, J.D. (Eds.), Handbook of Fish Biology and Fisheries, II. Blackwell Science, Oxford (United Kingdom), pp. 367–390.
Cronbach, L.J., Gleser, G.C., 1957. Psychological Tests and Personnel Decisions. University of Illinois Press, Urbana, IL.
Danylchuk, A.J., Danylchuk, S.E., Cooke, S.J., Goldberg, T.L., Koppelman, J.B., Philipp, D.P., 2007. Post-release mortality of bonefish, *Albula vulpes*, exposed to different handling practices during catch-and-release angling in Eleuthera, The Bahamas. Fish. Manag. Ecol. 14, 149–154.
Danylchuk, A.J., Adams, A., Cooke, S.J., Suski, C.D., 2008. An evaluation of the injury and short-term survival of bonefish (*Albula* spp.) as influenced by a mechanical lip-gripping device used by recreational anglers. Fish. Res. 93, 248–252.

Danylchuk, A.J., Tiedemann, J., Cooke, S.J., 2017. Perceptions of recreational fisheries conservation within the fishing industry: knowledge gaps and learning opportunities identified at east coast trade shows in the United States. Fish. Res. 186, 681–687.
Davis, M.W., 2010. Fish stress and mortality can be predicted using reflex impairment. Fish Fish. 11, 1–11.
Ditton, R.B., Jarman, R.N., Woods, S.A., 1978. An analysis of the charter boat fishing industry on the Texas Gulf coast. Mar. Fish. Rev. 40, 1–7.
Ditton, R.B., Gill, A.G., MacGregor, C.L., 1991. Understanding the market for charter and headboat fishing services. Mar. Fish. Rev. 53, 19–26.
Edwards, A., 1953. The relationship between the judged desirability of a trait and the probability that the trait will be endorsed. J. Appl. Psychol. 37, 90–93.
Edwards, A., 1957. The Social Desirability Variable in Personality Assessment and Research. The Dryden Press, New York.
Farthing, M.W., Childs, A.R., Mann-Lang, J.B., Bova, C.S., Potts, W.M., 2022. Are recreational angling-guides role-models for their clients? Fisheries Research. https://doi.org/10.1016/j.fishres.2022.106408. In this issue.
Faugier, J., Sargeant, M., 1997. Sampling hard to reach populations. J. Adv. Nurs. 26, 790–797.
Fobert, E., Meining, P., Colotelo, A., O'Connor, C., Cooke, S.J., 2009. Cut the line or remove the hook? An evaluation of sublethal and lethal endpoints for deeply hooked bluegill. Fish. Res. 99, 38–46.
Gould, A., Grace, B.S., 2009. Injuries to barramundi *Lates calcarifer* resulting from lip-gripping devices in the laboratory. N. Am. J. Fish. Manag. 29, 1418–1424.
Griffiths, P., Gossop, M., Powis, B., Strang, J., 1993. Reaching hidden populations of drug users by privileged access interviewers: methodological and practical issues. Addiction 88, 1617–1626.
Groger, L., Mayberry, P.S., Straker, J.K., 1999. What we did not learn because we of who didn't talk to us. Qual. Health Res. 9, 829–835.
Holder, P.E., Griffin, L.P., Adams, A.J., Danylchuk, A.J., Cooke, S.J., Brownscombe, J.W., 2020. Stress, predators, and survival: exploring permit (*Trachinotus falcatus*) catch-and-release fishing mortality in the Florida Keys. J. Exp. Mar. Biol. Ecol. 524, 151289.
Hoogendoorn, G., 2017. Fly-fishing as ecotourism in South Africa: a case study. J. Ecotour. 16, 152–168.
Hyder, K., Maravelias, C.D., Kraan, M., Radford, Z., Prellezo, R., 2020. Marine recreational fisheries — current state and future opportunities. ICES J. Mar. Sci. 77, 2171–2180.
Jennings, C.A., 1992. Survey of non-charter boat recreational fishing in the U.S. Virgin Islands. Bull. Mar. Sci. 50, 342–351.
Kramer, R.W., Mann, B.Q., Dunlop, S.W., Mann-Lang, J.B., Robertson-Andersson, D., 2017. Changes in recreational shore anglers' attitudes towards, and awareness of, linefish management along the KwaZulu-Natal coast, South Africa. Afr. J. Mar. Sci. 39, 327–337.
Khamis, H., 2008. Measures of association. J. Diagn. Med. Sonogr. 24, 155–162.
Kollmuss, A., Agyeman, J., 2002. Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behaviour? Environ. Educ. Res. 8, 239–260.
Lavrakas, P.J., 2008. Respondent fatigue. In: Encyclopaedia of Survey Research Methods. Sage, Thousand Oaks, CA, p. 2008.
Lennox, R.J., Filous, A., Danylchuk, S.C., Cooke, S.J., Brownscombe, J.W., Friedlander, A.M., Danylchuk, A.J., 2017. Factors influencing postrelease predation for a catch-and-release tropical flats fishery with a high predator burden. N. Am. J. Fish. Manag. 37, 1045–1053.
Lewin, W.C., Arlinghaus, R., Mehner, T., 2006. Documented and potential biological impacts of recreational fishing: insights for management and conservation. Rev. Fish. Sci. 14, 305–367.
Liu, Y., Bailey, J.L., Davidsen, J.G., 2019. Social-cultural ecosystem services of sea trout recreational fishing in Norway. Front. Mar. Sci. 6, 178.
Mannheim, S.L., Childs, A.R., Butler, E.C., Winkler, A.C., Parkinson, M.C., Farthing, M. W., Zweig, T., McCord, M., Drobniewska, N., Potts, W.M., 2018. Working with, not against recreational anglers: evaluating a pro-environmental behavioural strategy for improving catch-and-release behaviour. Fish. Res. 206, 44–56.
Marpsat, M., Razafindratsima, N., 2010. Survey methods for hard-to-reach populations: introduction to the special issue. Methodol. Innov. Online 5, 3–16.
Mason, J.W., Hunt, R.L., 1967. Mortality rates of deeply hooked rainbow trout. Progress. Fish Cult. 29, 87–91.
Moxham, E.J., Cowley, P.D., Bennett, R.H., von Brandis, R.G., 2019. Movement and predation: a catch-and-release study on the acoustic tracking of bonefish in the Indian Ocean. Environ. Biol. Fish. 102, 365–381.
Muoneke, M.I., Childress, W.M., 1994. Hooking mortality: a review for recreational fisheries. Rev. Fish. Sci. 2, 123–156.
Newton, R.R., Rudestam, K.E., 1999. Your Statistical Consultant. Sage, Thousand Oaks, CA, p. 1999.
Nilsson, D., Fielding, K., Dean, A.J., 2020. Achieving conservation impact by shifting focus from human attitudes to behaviours. Conserv. Biol. 34, 93–102.
O'Toole, A.C., Danylchuk, A.J., Suski, C.D., Cooke, S.J., 2010. Consequences of catch-and-release angling on the physiological status, injury, and immediate mortality of great barracuda (*Sphyraena barracuda*) in The Bahamas. ICES J. Mar. Sci. 67, 1667–1675.
Pearson, K., 1948. Karl Pearson's Early Statistical Papers. Cambridge University Press.
Pelletier, C., Hanson, K.C., Cooke, S.J., 2007. Do catch-and-release guidelines from state and provincial fisheries agencies in North America conform to scientifically based best practices? Environ. Manag. 39, 760–773.
Potts, W.M., Downey-Breedt, N., Obregon, P., Hyder, K., Bealey, R., Sauer, W.H.H., 2020. What constitutes effective governance of recreational fisheries? A global review. Fish Fish. 21, 91–103.
Prince, E.D., Ortiz, M., Venizelos, A., 2002. A Comparison of Circle Hook and "J" Hook Performance in Recreational Catch-and-release Fisheries for Billfish, 30. American Fisheries Society Symposium, pp. 66–79.
R Core Team. 2020. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. ⟨https://www.R-project.org/⟩.
Raby, G.D., Packer, J.R., Danylchuk, A., Cooke, S.J., 2013. The understudied and underappreciated role of predation in the mortality of fish released from fishing gears. Fish Fish. 15, 489–505.
Salgado, J.F., 2017. Bandwidth-fidelity dilemma. In: Zeigler-Hill, V., Shackelford, T.K. (Eds.), Encyclopaedia of Personality and Individual Differences, 1st edition. Springer.
Salzborn, S., Davidov, E., Reinecke, J. 2012. Methods, Theories, and Empirical Applications in the Social Sciences. VS Verlag für Sozialwissenschaften.
Shaghaghi, A., Bhopal, R.S., Sheikh, A., 2011. Approaches to recruiting 'hard-to-reach' populations into re-search: a review of the literature. Health Promot. Perspect. 1, 86–94.
Siewert, H.F., Cave, J.B., 1990. Survival of released bluegill, *Lepomis macrochirus*, caught on artificial flies, worms, and spinner lures. J. Freshw. Ecol. 5, 407–411.
Smith, W.E., Kyle, G.T., Sutton, S.G., 2021b. Using a styles of participation self-classification measure to characterize highly specialized anglers. Hum. Dimens. Wildl. https://doi.org/10.1080/10871209.2021.1993384.
Smith, W.E., Kyle, G.T., Sutton, S.G., 2021a. Displacement and associated substitution behavior among Texas inshore fishing guides due to perceived spotted seatrout. Mar. Policy 131, 104624.
Smith, W.E., Kyle, G.T., Sutton, S.G., Dunlap, R., 2022. Characterizing style of participation among Texas inshore recreational fishing guides. Hum. Dimens. Wildl. https://doi.org/10.1080/10871209.2021.2023711.
Sweetland, J., 1972. Illusory Correlations' and the Prediction of 'Dangerous Behaviour' (Unpublished Doctoral Dissertation). Indiana University, Bloomington, Indiana, p. 47401.
Tate, R.F., 1954. Correlation between a discrete and a continuous variable, point-biserial correlation. Ann. Math. Stat. 25, 603–607.
Thompson, S.C.G., Barton, M.A., 1994. Ecocentric and anthropocentric attitudes toward the environment. J. Environ. Psychol. 14, 149–157.
Trahan, A.T., Chhor, A.D., Lawrence, M.J., Brownscombe, J.W., Glassman, D.M., Reid, C. H., Abrams, A.E.I., Danylchuk, A.J., Cooke, S.J., 2021. Do Carbonated Beverages Reduce Bleeding from Gill Injuries in Angled Northern Pike? North Am J Fish Manage 41, 639–649. https://doi.org/10.1002/nafm.10571.
Tsuboi, J.I., Morita, K., Ikeda, H., 2006. Fate of deep-hooked white-spotted charr after cutting the line in a catch-and-release fishery. Fish. Res. 79, 226–230.
UN, 2019. United Nations Population Division. World Population Prospects: 2019 Revision.
Van Meter, K.M., 1990. Sampling and cross-classification analysis in international social research. In: Øyen, E. (Ed.), Sage Studies in International Sociology, Vol. 40. Comparative Methodology: Theory and Practice in International Social Research. Sage Publications, Inc, pp. 172–186.
Vehovar, V., Toepoel, Steinmetz, S., 2016. Chapter 22: non-probability sampling. In: Wolf, C. (Ed.), The SAGE Handbook of Survey Methodology. Sage Publication Ltd, UK.
Vogt, W.P., 1999. Dictionary of Statistics and Methodology: A Non-Technical Guide for the Social Sciences, 2nd ed. Sage Publications, London.
Warner, K., 1979. Mortality of landlocked Atlantic salmon hooked on four types of fishing gear at the hatchery. Progress. Fish Cult. 41, 99–102.
Weltersbach, S., Strehlow, H.V., 2013. Dead or alive – estimating post-release mortality of Atlantic cod in the recreational fishery. J. Mar. Sci. 70, 864–872.
Zwirn, M., Pinsky, M., Rahr, G., 2005. Angling ecotourism: issues, guidelines and experience from Kamchatka. J. Ecotour. 4, 16–31.