Angler Behaviors and Motivations for Exploiting Invasive and Native Predatory Fishes by Catch-and-Release: A Case Study on the River Severn Catchment, Western England

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Abstract

Catch-and-release sport angling for large-bodied fishes is a popular recreational pastime, but is also a major introduction source of invasive fishes that can impact native biodiversity. Introductions of large non-native fishes are often part of fisheries management practices to diversify angler opportunities and increase satisfaction. Interviews with sport anglers (n = 12) targeting native pike (*Esox lucius*) and invasive pikeperch (*Sander lucioperca*) in the River Severn, Western England, were conducted to determine angler motivations, behaviors, and perceptions. Although motivations were catch orientated, they also related to catching wild fish in natural surroundings. Conservation values were reflected in the behavioral safeguarding of pikeperch populations, including catch-and-release practices that are contrary to current fisheries policy. Anglers perceived pikeperch as enhancing the fishery without causing long-term ecological impacts and were opposed to current management practices and policy. These results suggest considerable disjuncture between angler motivations and behaviors, and non-native fish policy and management.

Keywords: interview, management, non-native, perceptions, recreational fishery, specialist anglers

Introduction

It is generally agreed that recreational fishing is a goal-orientated behavioral process driven by psychological desires (Fedler & Ditton, 1994; Manfredo, Driver, & Tarrant, 1996). However, there are many reasons why people fish, including both catch and non-catch aspects of the fishing experience (Arlinghaus, 2006; Young, Foale, & Bellwood, 2016). Activity general, non-catch related motivations include relaxation, getting away from the daily routine ('escaping'), and being outdoors, whereas activity specific, catch motivations include catching specific species, sizes, and numbers of fish; the challenge and experience; developing skills; and testing equipment (Fedler & Ditton, 1994). Non-catch related motivations tend to be more ubiquitous among angler groups than catch motivations that can vary widely depending on angler type (Chipman & Helfrich, 1988; Fedler & Ditton, 1994).

Understanding how activity specific motivations translate into actual angling behaviors is important for managing fisheries (Arlinghaus, 2006; Beardmore, Hunt, Haider, Dorow, & Arlinghaus, 2014; Fedler & Ditton, 1994). For example, a preference for fish attributes that meet trophy motivations has resulted in unregulated releases of large bodied, non-native predatory fishes by anglers (Banha, Diniz, & Anastácio, 2017; Elvira & Almodóvar, 2001). Indeed, sport angling has been responsible for approximately 12% of global fish introductions (Gozlan, Britton, Cowx, & Copp, 2010). Participatory fishery management approaches such as these are common and can exert a strong influence on management agencies (Eden & Bear, 2012). Species that have been introduced around the world for angling include Peacock basses (*Cichla* genus) (Britton & Orsi, 2012), European catfish (*Silurus glanis*) (Cucherousset et al., 2017), and largemouth bass (*Micropterus salmoides*) (Britton, Harper, & Oyugi, 2010). A common feature of these fish species is their generally high trophic position that results from their piscivory (i.e., their predation upon other fishes, herein referred to as 'predator') (Eby, Roach, Crowder, & Stanford, 2006). The aim of this study was to understand how the motivations and preferences of anglers who

target large-bodied native and invasive predatory fish translate into actual behavioral practices and perceptions.

The pikeperch (*Sander lucioperca*; commonly referred to as zander by the angling community of England) were first introduced into Britain in the late 19th Century (Sachs, 1878), but became more widespread following translocations in the 1960s to the River Great Ouse Relief Channel in Eastern England (Wheeler & Maitland, 1973). From there, their colonization and dispersal through river and canal systems was rapid, aided by unregulated movements by anglers (Fickling & Lee, 1985). The result was their subsequent invasion of many river basins in central and southern England (Copp, Wesley, Kovac, Ives, & Carter, 2003; Nunn, Bolland, Harvey, & Cowx, 2007). Associated with these introductions were reported deleterious impacts on the native fish community (Fickling & Lee, 1983; Hickley, 1986; Linfield & Rickards, 1979; Smith, Leah, & Eaton, 1998), although evidence remains equivocal.

The majority of British recreational freshwater anglers practice catch-and-release (i.e., returning the fish alive after capture; North, 2002), including anglers targeting pikeperch. Mandatory catch-and-release practices for species such as Atlantic salmon (*Salmo salar*) are commonly used as a conservation tool (Aprahamian, Hickley, Shields, & Mawle, 2010), although these activities can generate conflict within angling communities. For example, in Germany, conflict arises between specialist anglers practicing voluntary catch-and-release and those who see these practices as cruel, illegal (despite not being so), or contrary to consumptive fishing practices (Arlinghaus, 2007). Despite the apparent popularity of pikeperch for sport angling in British rivers such as the River Severn, and the propensity for anglers to practice catch-and-release, it is an offence for an angler to release a pikeperch that has been caught (Schedule 9, Section 14(1), Wildlife and Countryside Act 1981). Conversely, under different legislation, the species can be legally stocked into enclosed waters [Import of Live Fish (England and Wales) Act 1980, (ILFA); Keeping and Introduction of Fish (England

and River Esk catchment Area) Regulations 2015, (KIF)]. These contradictory policies and practices could be heightening conflicts between anglers of opposing motivational drivers.

In England, freshwater anglers tend to be classified as either ‘coarse’ or ‘game’ by management agencies (Environment Agency, 2018a). Game anglers target species such as salmon, trout (*Salmo trutta*), and grayling (*Thymallus thymallus*), whereas coarse anglers, who represent the majority of freshwater recreational anglers in England (Environment Agency, 2018b), tend to target cyprinid species including carp (*Cyprinus carpio*), barbel (*Barbus barbus*), and chub (*Squalius cephalus*). However, coarse anglers also include those that target large-bodied predator species, such as Northern pike (*Esox lucius*) and pikeperch. Nevertheless, anglers are a heterogeneous ‘public’ (Eden & Bear, 2011) and, according to their own descriptions, coarse anglers in England can be categorized into three groups: (a) ‘match’ anglers, who compete against others in an attempt to catch the largest weight of fish in a given period; (b) ‘pleasure’ anglers, where the overall fishing experience is important; and (c) ‘specialist’ anglers, who focus on a particular species or on catching a large individual ‘specimen’ or ‘trophy’ fish (Bear & Eden, 2011).

Here, specialist predator anglers are defined as those whose primary fishing activity is involved in the targeting of large-bodied obligate predatory fishes such as pike and pikeperch. Sophisticated rod and line techniques, including lures, as well as live- and dead-bait angling are used to target these species. Where species coexist, targeting of one species over the other can be difficult, although size selectivity is possible. This definition of specialization follows that of Scott and Shafer (2001) where there is a focusing of behavior, skill development, commitment, and the acquisition of knowledge. For the specialist predator angler, catch orientated motivations are known to be important drivers of behavior (Beardmore, Haider, Hunt, & Arlinghaus, 2011; Chipman & Helfrich, 1988), with ‘trophy seeking’ among their most important motivations (Beardmore et al., 2011).

Recreational fisheries have been defined as complex adaptive socio-economic systems and it is argued that equal recognition should be given to both the human and ecological dimensions for effective management (Arlinghaus et al., 2017; Cooke et al., 2013; Hunt, Sutton, & Arlinghaus, 2013). In the last decade, interdisciplinary methods have been used for integrating recreational fishing practices with conservation (Cooke, Danylchuk, Danylchuk, Suski, & Goldberg, 2006). Emerging research on perceptions can also be used for assessing, informing, and gauging support for conservation initiatives and policy (Gelcich & O'Keeffe, 2016), and assessments of angler perceptions relating to introductions have been successfully used for optimizing awareness campaigns and understanding risk behavior (Gozlan, Burnard, Andreou, & Britton, 2013; Lindgren, 2006). Although such assessments can improve management and governance (Boone & Ryder, 2017), they often rely on quantitative analyses of social data that might not fully consider the complexities of managing fisheries as social adaptive systems (Barclay et al., 2017; Fenichel, Abbott, & Huang, 2013). In contrast, qualitative methods such as interviews can provide greater insight into the perceptions and behavioral processes of recreational anglers (Barclay et al., 2017).

Consequently, the objectives of this study were to use in-depth interviews with specialist anglers of the Severn basin in Western England who exploit pike and / or pikeperch to understand the motivations and preferences of these specialist anglers and how they translate into behavioral practices and perceptions concerning the management and regulation of native and invasive predatory fish, particularly in relation to their catch-and-release activities.

Methods

Study River

The River Severn basin covers an area spanning central and western England, and parts of Wales (Figure 1). The River Severn is an important fishery in England, where freshwater angling contributes £1.5 billion per year to the economy (Environment Agency,

2018a). Pikeperch were first reported in the catchment in 1976, with reports of captures by anglers from the lower River Severn in 1980 (Hickley, 1986). Pikeperch are now established throughout much of the canal and river network in Central and Southern England, and in the Severn are considered an important fishery resource. The British rod-caught record pikeperch weighing 9.67 kg was caught from the lower River Severn at Tewkesbury (British Record (Rod Caught) Fish Committee, 2016). Some of the interviewed anglers also fish on the River Wye for pike, where pikeperch are absent.

Figure 1 about here

Data Collection

Semi-structured interviews with specialist predator anglers within the River Severn catchment were conducted (n = 12). Anglers were chosen based on the criteria that: (a) their primary fishing activity was centred on freshwater predator species including pike and/or the non-native pikeperch, and (b) the majority of their angling activity occurred within the Severn catchment. These criteria were determined by means of a survey prior to these interviews, and were essential to ensuring that the views expressed represented specialist freshwater predator anglers practicing catch-and-release from lotic environments where pikeperch were present. All anglers either identified as 'dedicated predator anglers' where they only target predator species or 'dedicated predator anglers, but also target non-predator species' (Table 1). The initial survey also provided an opportunity to collect angler demographic information. Candidates for interviews were originally identified through facilitation with the Environment Agency, the inland fishery regulatory body of England, who had established a predator angling network within the River Severn catchment. As the interviews progressed, interviewees would sometimes refer the interviewer to other potential candidates for interviews as appropriate (snowball sampling). To maintain anonymity, anglers are identified here as angler #1 through to #12.

Table 1 about here

The interviews followed a semi-structured, open-ended approach (Gall, Gall, & Borg, 2003; Jennings, 2005) and included five main topics: (a) the development of their angling interest, (b) their predator angling participation, (c) their fishing preferences, (d) their views on management and conservation, and (e) their experience with pikeperch. Within these themes, questions were developed and designed to be used as a conversational guide. The aim of the interview was to be informal, with topics introduced in a non-rigid manner to encourage reflection and self-expression (Turner III, 2010). Interviews followed the ethical code of conduct for social research with anglers assured anonymity and given information relating to the study prior to their interview. Interviews were recorded and transcribed verbatim to written text by the interviewer immediately after each interview, allowing for reflection by the interviewer on the emergent themes. Sampling continued until the interviews yielded consistent themes (i.e., data saturation; Jennings, 2005).

Data Analyses

A thematic analysis framework was used for identifying, analyzing, and reporting themes within the data generated by the interviews and was conducted using NVIVO qualitative analysis software (QSR International, 2012). Thematic analysis was used for developing categories of meaning within the data through a six-step approach. The data were initially assigned to non-hierarchical open codes that identified interesting features of the data (Miles, Huberman, Huberman, & Huberman, 1994). Then, codes that showed commonality were grouped and re-focused, enabling collation into identified themes (Graneheim & Lundman, 2004). This was followed by reviewing the themes to ensure clear and identifiable distinctions that offered clearer insight into the meanings contained within. Finally, the themes were refined and named before producing an analytical narrative around the data (Braun & Clarke, 2006). It should be noted that in Britain, pikeperch are commonly referred to as zander by the angling community and this is reflected in the interview data.

Results

Interviewees and Main Themes from Interviews

All of the interviewed anglers identified themselves as dedicated predator anglers, with only two anglers also targeting non-predator species (Table 1). The 12 interviewees were predominantly male (n = 10), and the majority had been recreationally angling for more than 40 years (n = 7). Of the remaining anglers, three had been fishing for predator species for more than 20 years, one for more than 10 years, and one for more than five years. Ages ranged between 25 and 74 years. All of the anglers interviewed practiced catch-and-release angling for both pike and pikeperch.

The analyses revealed six main themes: (a) the predator angler identity; (b) angler led management; (c) catch orientated motivations; (d) angling preferences; (e) angler reconciliation on the introduction, establishment and exploitation of pikeperch; and (f) current views on the management of pikeperch.

The predator angler identity. The interviewed anglers often reflected that their desire to fish was a way of life, with wording such as: "*it's in my blood,*" "*it gets under your skin,*" and "*the gene*" used regularly to reflect their feelings toward fishing generally. There was also a strong sense of the predator angler identity, which in part had been formed out of pike angler conflict with other angling groups: "*we saw pike fishing and being a pike angler as being a bit elite, I suppose, compared to round here - they were all either match anglers or salmon anglers*" (angler #1). The majority of interviewed anglers spoke about this conflict and separation between angler groups, which seemed to arise from the historical practice by 'coarse' anglers of killing captured pike as a way to reduce predation pressure on non-piscivorous fish population: "*in those days, this is the early 1970s, match anglers threw all the pike up the bank, they weren't kept, no pike were returned and they weren't kept for the table - they were just thrown up the bank"* (angler #2).

Most anglers in this study still referred to the opposition of some modern day 'coarse' anglers to predatory fish species: "*there are still many clubs which are very anti-predators*"

(angler #10); "*some of them they hate predators because they think they are eating my fish, the coarse fish*" (angler #4). For the pike angler, a commonly displayed trait was the fostering of a conservation attitude toward pike. This attitude was reflected in their fishing practices: "*it's a natural resource that needs to be looked after; there are other anglers coming up behind us and hopefully there will be a few decent fish for them to enjoy*" (angler #9). This conservation attitude was apparent in their education and influences on other anglers regarding the ecological role of predator species in maintaining a healthy and balanced fishery: "*it is very important to promote the understanding of these magnificent creatures which preform a role in nature, they are not the voracious pirates that they have been made out to be in years past*" (angler #1).

Angler led management. The interviewed anglers often revealed a feeling of ownership toward their target species, and employed a variety of measures that they see as vital for protecting the species and for sustainable resource use: "*you do have to protect the fish as well as your own fishing interests*" (angler #5). The most commonly used 'management' tool among all interviewed anglers was secrecy, and it seemed to be a well-established rule among specialist predator anglers that favorite fishing locations are never or rarely shared, even among friends: "*they don't tell me where they fish and I don't tell them where I fish*" (angler #1); '*it's anti-social and secretive generally speaking and it's different to most types of fishing, that's the thing*' (angler #3), *"the pike fishers are quite secretive and they don't like giving their positions away"* (angler #12). Secrecy is perceived as a means of reducing the fishing pressure to a particular area or even to individual fish: "*many people just want to protect the fishery, they think if it is just my spot I will catch this fish and no one else*" (angler #4), *"you do have to protect the fish as well as your own fishing interests*" (angler #5).

These anglers had very defined views on the care that should be taken throughout the catch-and-release process, with good handling techniques an important part of being a

respected predator angler: "*I like to pride myself on it, I think I have a certain level of skill in handling a fish and putting it back in excellent condition*" (angler #5). There was also contempt shown toward other predator anglers with inadequate handing methods: "*When you see a pike, it's like I said before, it is a delicate fish and when you see it in a picture covered in crap so you can tell they haven't used a mat and you can guess it's been thrashing around and you just think for God's sake, that's the kind of thing that really annoys me, it's just totally undermining everything that proper anglers are trying to do*" (angler #10).

Catch orientated motivations. The chance of catching a large 'trophy' fish was mentioned by all of these anglers as an important motivation for targeting predatory species: "*we were all brought up 'biggest is best' and that's what we have always been about, trying to catch the biggest fish"* (angler #1). However, it was not necessarily about beating national records, as these anglers also often spoke about the size in weight of their biggest predator captures and their aspirations to beat their own personal best (pb) record: "*ultimately if I am doing it then what I want is a pb*" [angler #7); "*It's competing with yourself, challenging to catch your personal best, so I think the most beautiful thing is when you catch that fish*" (angler #4). Thus, personal challenge motivations were important.

As national record catches of pike in Britain now usually come from managed lake fisheries (British Record (Rod Caught) Fish Committee, 2016), river angling is less likely to achieve a record pike. Correspondingly, the anglers revealed their motivations were to catch what they considered as a natural river fish: "*A river pike is a wild fish, so much more appealing, to me, than the artificially fed giants of trout reservoirs, which are of no interest to me"* (angler #10]; "*if you are talking a 30 lb trout water fish, as nice as it is, and a great achievement it still doesn't scratch a 30 lb wild Wye river fish, not at all, and that's my sort of fishing*" (angler #9). This motivation to fish for large river fish exists despite low catch returns in relation to effort expenditure, with the anglers often reflecting on this: "*if you expected to catch every time you went you would probably give up quite quickly"* (angler #3).

However, for the anglers specifically fishing on the River Severn for pikeperch, catching a record fish is an important motivation: "*The chance of a record fish would be the zander. So, it's always at the back of your mind the Severn will produce a 20lb zander and the chance that there is a record there, I think that's probably what keeps me going*" (angler #12).

Activity general motivations to fish rivers were also important with interviewed anglers mentioning a main motivation to fish rivers as an opportunity to enjoy nature and to be in a natural setting: "*I enjoy being out, the bird life the fresh air and that and just chilling*" (angler #7); "*the way the trees are with the way the sun sets and the light through them, you just find a pleasant spot to be, it's away from the crowds and stuff*" (angler #8). Rivers also provided an angling opportunity that was distinct, compelling, and related to the catch uncertainty: "*like you go up the lake and you know you are going to catch, you go on a river and you could catch anything*" (angler #11). This ties into the acknowledgement by these anglers that the anticipation of catching provided nearly as much pleasure as the act of catching itself: "*it's always nice to catch fish, but even if you are getting takes the anticipation is there*" (angler #12). It was particularly apparent that not knowing which species might be caught added an additional element of excitement to the fishing experience: "*my favourite species are pike; always have been, but every time the float dips and we strike into a fish and it feels like a good one, we both say, please be a zander*" (angler #2). These anglers acknowledged that if they fish for pike in a water that also supports populations of pikeperch, they are likely to catch both: "*caught it* [pikeperch] *by accident my first one, I was float ledgering a dead roach for pike and one took and that was just over 4lb and that was the first one I ever caught*" (angler #5). To some degree, predator fishing in England has thus become non-selective in terms of target species.

Angling preference. The preferences of interviewees in catching pike and pikeperch seemed to be toward a diversification in fishing styles: "*there is that many different methods for catching them, we are sitting here legering now, but we can paternoster a live bait,*

dropshot, dead-bait, lure fish, vertical jig, you know, so there are that many different methods" (angler #7). Specifically, lure fishing was often acknowledged as helping to increase the popularity of predator fishing: "*the one thing that is turning people into predator anglers is lure fishing, that is the massive deal these days*" (angler #1). It was also the opinion of the interviewed predator anglers that lure fishing is more popular when targeting pikeperch than for pike: "*there a significant proportion of the lure angler population that fishes canals that don't want to catch a pike, it's more like a bycatch*" (angler #6), and more popular among the younger generation: "*kids are getting into it, chucking their lures, you know, catching little zander, brilliant. You know I see it as a huge benefit"* (angler #10), whereas another angler commented: "*there are lot more younger people in the lure angling side of things. Now we're not talking teens, we are talking people in their 20s and 30s*" (angler #6). All of the anglers interviewed used lures in their fishing to some degree, even if they had a preference for using baits, and all of these anglers talked about lure fishing and its importance to angling generally, making it the most talked about topic overall: "*it's probably the biggest growing sport now, I think carp fishing has levelled out and lure fishing is taking its place*" (angler #7). The popularity of lure fishing was attributed to its success as a method for catching predatory species and as a more convenient and accessible method compared to bait fishing: "*It's a good way of getting a few hours fishing in, or an hours fishing in if you are pushed for time, most lure gear will fit in the boot of your car quite easily*" (angler #5).

Reconciliation. One angler's opinion on the introduction of pikeperch to the Severn nicely summarised the opinion of many of those interviewed: "*we knew the pike weren't a problem because the pike perform a function of natural fishery management and I think we thought the pike would sort them* [pikeperch] *out anyway, and those that did get through the pike gauntlet would be big enough to be worth catching so it didn't really bother us*" (angler #1). However, many interviewed anglers who had experience of fishing the river during the time of pikeperch introduction also recognized an impact to their fishing at the time: "*it was*

really the zander round about that time that took me away from the river because we were struggling to catch the pike, we were just getting hit by little zander all the time" (angler #2). The same recollection was given by an angler who fishes the adjoining canal systems: "*when people introduced zander to the canal it changed the structure of the fishery completely, if you went to catch a roach it was impossible to catch a small roach, the only thing you could catch was 8 to 10 oz because the zander had them* [the smaller roach]" (angler #7).

Angler knowledge and experience with the introduction and subsequent establishment of pikeperch, a conservation attitude toward piscivorous species, and unique catch orientated motivations and preferences appear to foster a favorable understanding toward pikeperch: "*I actually think it's better than it's ever been and I think that's down to the zander being there because the zander are a food source for the pike - they are benefiting if anything, pike are eating them up, they are controlling other fish and it's balanced out*" (angler #10). The use of the word 'balance' was common among these anglers when asked about pikeperch introduction and establishment. However, for something to be in balance suggests a perception of imbalance; when anglers were asked to clarify this dichotomy they said things such as: "*I think the zander population has maybe stabilized a bit and pike have come back because I guess they do compete in some way*" (angler #7). When asked specifically about the view that pikeperch can have a negative impact to native species, the anglers then recollected that it is only in recent years that they have seen an improvement in pike fishing since the introduction of pikeperch: "*I think 30 years on from when zander came into our rivers, the pike are the dominant predator again, it's taken that time for them to get back to where they are now*" (angler #2).

Current views on management of pikeperch (perceptions). It was apparent that the interviewed anglers saw major potential in pikeperch as a species in providing new angling opportunities and commented on a perceived increase in popularity from pike to pikeperch fishing within the predator angling community: "*a lot of my friends who were pike anglers,*

they now go for zander, I think they find it more exciting" (angler #4). The anglers also highlighted fishing for pikeperch as a means to help promote angling more generally: "*my perception is that fishing is more on the decrease than the increase as a sport and having another species that is going to encourage people to go fishing, like zander, that can only be a good thing really*" (angler #3). In addition, these anglers often talked about the economic importance of the fishing resource: "*You only have to think about it in economic terms, a lot of people are coming to fish for these zander"* (angler #1).

Interviewed anglers were opposed to the culling of pikeperch and had a pragmatic view on the subject: "*they are in there now, we are never going to eradicate them*" (angler #8). Well-developed opinions were also expressed on the validity of pikeperch removal operations: "*by actually not removing them, you end up with a situation where they self-regulate and it doesn't take a very long time to get the zander population in control. They are widespread, you can't eradicate them and I'm not sure what the rationale is for doing it"* (angler #6). These anglers were speaking of their distress at seeing a culling operation where pikeperch were removed from a section of canal and dispatched via electric-fishing: "*for me I think it's awful. It was maybe 3 tonne of zander from maybe 4 km of the river, so that's a lot and I don't understand why they do it, why they remove fish*" (angler #4).

The practice of catch-and-release was never defended or questioned by the interviewed anglers and it was apparent that it was seen as the moral thing to do and that it was their right. In fact, one particular angler had even successfully lobbied for an angling club to change their rules in relation to the catch-and-release of pikeperch: "*about 3 years ago I persuaded the* [club name removed for anonymity] *to do away with their archaic rule of killing zander on site*" (angler #1). Interviewed anglers also recognized the current legislation: "*legally and technically, zander are still on the alien species register*" (angler #1), and would like to see them having some sort of legal protection: "*they are naturalized I would class them as now and deserve some kind of protection*" (angler #8). However, these

same anglers were opposed to the introduction of pikeperch to an important pike river fishery in an adjacent river basin: "*I'm happy enough they are not in the Wye; I'd be on absolute tenterhooks if they turned up in the Wye*" (angler #9); "*the great thing for me is that when I go pike fishing on the Wye if I get a take it's going to be a pike, it's not going to be a zander so that's great*" (angler #1).

Discussion

Motivations of these predator anglers to the voluntary catch-and-release of an invasive species were revealed here to be connected to an underlying conservation attitude that has developed out of cultural norms, an awareness of the consequences of their activity and unique motivations and preferences. Findings revealed a lack of support for current management and policy relating to pikeperch in England, with the perception by these anglers that the practice of catch-and-release for pikeperch does not cause adverse ecological impacts and that culling is an ineffective management tool. For this group of anglers, catch orientated motivations to fish (e.g., size, anticipation, challenge) were important, but so too were motivations related to catching wild fish in natural surroundings. These anglers saw pikeperch as providing angling opportunities and as contributing to a growing sport with economic importance, but they also showed support for maintaining pristine wild populations of pike, unconstrained by pikeperch, and so some opposing perceptions relating to the ecological impact of pikeperch were apparent.

The behavioral intentions of these anglers to practice voluntary catch-and-release are influenced by angling norms and an awareness of their consequences, where aspects such as ecological or stock status, setting, species and social factors are all considered (Stensland, Aas, & Mehmetoglu, 2013). Development of angling specialization through angling style and/or species preferences can also cause divergent experience-quality norms and motivations (Arlinghaus & Mehner, 2003). For this group of anglers, voluntary catch-and-release behavior of a non-native species seemed to be connected to inherent conservation

values and unique motivations and perceptions of the ecological consequences of pikeperch to native populations. These predator anglers often invoked a model of nature as normally being in equilibrium (i.e., 'the balance of nature,' Eden & Bear, 2011) to make sense of their fishing experience and behaviors.

Catch-and-release angling is practiced widely in recreational fishing (Arlinghaus et al., 2007) and has become a useful tool for resource conservation (Brownscombe, Danylchuk, Chapman, Gutowsky, & Cooke, 2017; Cooke & Schramm, 2017). However, it can also generate conflict both within the angling community and between anglers and managers due to opposing cultural, institutional, and emotional drivers; divergent motivation and ethics; and varying expectations and tolerance (Arlinghaus, 2007). This group of anglers spoke of conflict within the predator angling community that resulted in angler-led management responses with the aim of protecting personal fishing motivations. These indirect responses were most apparent with the adoption of secretive fishing behaviors, seen as protecting individual fish from over-exploitation. Management measures often develop out of angler led initiatives and include best practice guidance relating to appropriate fish handling techniques, fishing gear restrictions, size and catch regulations, and the implementation of catch-and-release policies (Eden & Bear, 2012). This is especially true of the interviewed anglers who demonstrated instances of peer influence to, for example, change club rules relating to the catch-and-release of pikeperch. Sanctioning actions carried out by and within the angling communities can be used for promoting and maintaining best practices in relation to catch-and-release angling (Guckian, Danylchuk, Cooke, & Markowitz, 2018), and could be explored further in relation to pikeperch in England.

Interviewed anglers also described their experience of conflict with other angling groups and managers that was generated from their catch-and-release behavior toward pikeperch. In England, most freshwater recreational anglers target cyprinid species (Environment Agency, 2018a), and pikeperch introduction has been linked to perceived

declines to cyprinid populations (Smith, Leah, & Eaton, 1996). Specialist predator anglers may also have experienced similar declines to pike populations or at least impact to fishing experiences as a result of pikeperch introduction. However, findings here suggest that if these declines existed, fishing motivations were being altered to incorporate the introduced species. Removal of pikeperch (culling) as a management measure after their initial introduction was widely employed, with the desired outcome of reducing pikeperch biomass and maintaining native cyprinid populations (Smith et al., 1996; Smith, Leah, & Eaton, 1997). The practice of culling is still employed by fisheries managers in the hope of controlling the spread and establishment of pikeperch, despite them also becoming a popular and valuable target species for some anglers (Hickley & Chare, 2004). The effectiveness of removal operations is often debated and, indeed, it has been demonstrated that removals of low intensity could increase the predation pressure of pikeperch on prey populations, thus exacerbating their potential deleterious impact on native cyprinid prey species (Smith et al., 1996, 1997).

Anglers are known to be one of the main drivers of non-native introductions (Gozlan et al., 2010) due to their catch specific motivations and preferences for certain fish attributes, such as large body size (Banha et al., 2017; Elvira & Almodóvar, 2001). Illegal non-native introductions to enhance sport fishing are often more common in regions with fewer native sport fish (Johnson, Arlinghaus, & Martinez, 2009). For example, introductions of species with high trophic positions, such as largemouth and smallmouth bass (*Micropterus dolomieu*), can have significant ecological impact (Eby et al., 2006; Jackson, 2002), but can also provide substantial benefits for angling (Carey, Sanderson, Friesen, Barnas, & Olden, 2011). Additionally, anglers are not only drivers of introductions of non-native species, but they can also increase the rate of their spread (García-Llorente, Martín-López, González, Alcorlo, & Montes, 2008). A major management goal in freshwater fisheries is to diversify angling opportunities for increased angler satisfaction, such as through the permitted movement or transplantation of non-native fishes into waters that minimize their potential of

developing invasive populations (Cowx, 1994, 1998; Cowx & Gerdeaux, 2004; Hickley & Chare, 2004). Different stakeholder groups will, however, have unique perceptions about the impacts or benefits of non-native introductions and diverse attitudes regarding their management (García-Llorente et al., 2008). Recognition of angler perceptions and motivations of invasive species is, therefore, important when trying to discourage the deliberate spread or introduction of these species through angling activity.

In this study, catch orientated motivational drivers leading to overall satisfaction were complex, with catch expectation in relation to a natural wild fish being an important factor. Gaining these types of data on the characteristics, preferences, and behaviors of recreational anglers can enable managers to gauge the effectiveness of management decisions and policies (Brooks et al., 2015). Preferences of anglers for different target species can change with time, with national surveys in England showing a shift in preferences of target species from roach (*Rutilus rutilus*) and pike in the 1960s to carp, roach, bream (*Abramis brama*), and tench (*Tinca tinca*) since the 1990s (Aprahamian et al., 2010; Simpson & Mawle, 2001). The ability of anglers to constantly evolve and adapt is an important mechanism for the sustainability of recreational fishing (Aprahamian et al., 2010), especially under current climate projections that will likely drive fish assemblage reorganizations that could favor non-native species (Kuczynski, Legendre, & Grenouillet, 2018; Ruiz-Navarro, Gillingham, & Britton, 2016).

Conclusions

Based on these findings, it is important that these angling groups are not marginalized by current policies and management practices. Engagement between management organizations and anglers to improve knowledge relating to the effectiveness of pikeperch policies, and promoting practices to limit the species' further spread, could help facilitate more effective relationships among all parties, and enhance management outcomes. Further support could also be gained if the motivational characteristics of predator anglers in England were aligned to maintaining pristine wild populations of fish. Understanding how the

motivations and the perceived impacts of pikeperch to native fish populations vary within the wider angling community could assist determination of more effective management programs and regulation. There is a need for clarity regarding the current legislation relating to pikeperch in England given they can be stocked into waters under permitted regulations, yet where it is also illegal to release captured individuals back into the wild. This includes all open water (rivers and canals). Moreover, this clarity is important, as results highlight considerable disjuncture between angler motivations and behaviors, and current non-native fish policy and management.

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Figure 1. Maps of: (A) Western Europe showing the position (inset) of Great Britain, (B) the main rivers shown within the Severn River basin (inset) within England, and (C) a detailed outline of the Severn River basin showing the main rivers and their tributaries within which the approximate limits of pikeperch fishing are shown (inset).

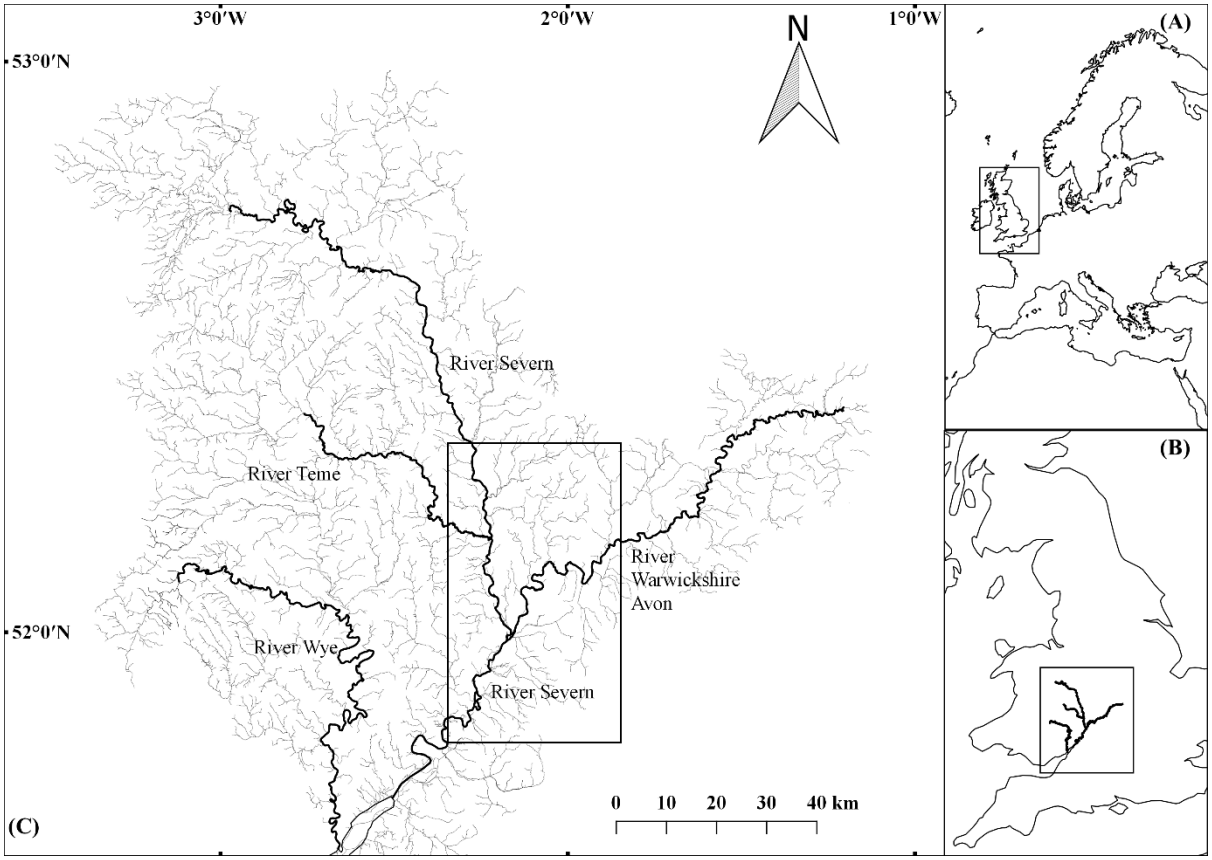

Table 1. Participant profile including age, sex, years of experience, predator angling activity, preferred target species, and specialization. Anglers are identified by number from 1 to 12, those described as 'dedicated predator anglers' only fish for pike and/or pikeperch and do not target other species.

Angler ID	Predator angling specialization	Preferred target species	Predator angling activity (days per year)	Years fishing	Years predator fishing	Age category	Sex	Interview duration (minutes)
1	Dedicated predator angler	Pike	13 to 35	> 40	> 40	55 - 64	M	59
2	Dedicated predator angler	Pike and pikeperch	> 35	> 40	> 40	55 - 64	M	35
3	Dedicated predator angler	Pike	2 to 5	< 10	< 10	45 - 54	F	56
4	Dedicated predator angler	Pike and pikeperch	13 to 35	> 30	> 30	25 - 34	F	47
5	Dedicated predator angler, also targets non-predatory species	Pike and pikeperch	> 35	> 40	> 20	35 - 44	M	53
6	Dedicated predator angler	Pikeperch	> 35	> 40	< 5	45 - 54	M	38
7	Dedicated predator angler	Pikeperch	> 35	> 40	> 20	55 - 64	M	53
8	Dedicated predator angler, also targets non-predatory species	Pike and pikeperch	> 35	> 30	> 20	45 - 54	M	62
9	Dedicated predator angler	Pike	13 to 35	> 40	< 10	65 - 74	M	63
10	Dedicated predator angler	Pike	13 to 35	> 20	> 20	25 - 34	M	68
11	Dedicated predator angler	Pike and pikeperch	> 35	< 5	< 5	65 - 74	M	33
12	Dedicated predator angler	Pikeperch	> 35	> 40	> 40	55 - 64	M	53