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REVIEW ARTICLE

Recreational fisheries in the UK: natural capital, ecosystem services, threats, and management

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Abstract The island nature of the UK has led to its long history of commercial marine fisheries, with associated recreational fisheries along and near to its extensive shoreline. In addition, an abundance of fresh waters provides extensive recreational fisheries, but few commercial fisheries, on rivers and lakes where catch-and-release is prevalent. Here, an overview is presented of these fisheries by describing their main features using the concepts of natural capital and ecosystem services and then considering the threats that they face and the management that has been developed in response. In the marine environment, a wide range of fish species is targeted, but the Orders Gadiformes, Perciformes, and Pleuronectiformes are particularly important. Far fewer species are available for exploitation in fresh waters, but the Orders Cypriniformes, Perciformes, and Salmoniformes are fished extensively. In total, the UK has in excess of three million recreational anglers in a population of approximately 65 million people. Threats to UK recreational fisheries include overfishing, physical habitat modification, acidification, chemical pollution, eutrophication, endocrine disrupters, nanoparticles, species introductions, and climate change. Great scientific and management advances have been made such that most of the required aquatic biological management activities are now based on mature science and are in many cases now largely operational matters. In addition, the work of the UK statutory bodies for fisheries is increasingly supplemented by the efforts of more independent groups, including through citizen science. Ecosystem-based management is now commonplace and activities have expanded above and away from the water to include the management of anglers and other members of society. The UK's recreational fisheries continue to face substantial challenges, but there are also substantial grounds for great optimism for their future.

Keywords Angling · Ecosystem services · England · Environmental threats · Fisheries management · Fishing · Great Britain · Natural capital · Northern Ireland · Scotland · Wales

Introduction

From a global perspective, the many activities collectively known as recreational fishing are extremely widespread, diverse, and of great importance in countries throughout the world [1] and probably reach their peaks of complexity, magnitude, and social importance in the USA, as recently reviewed by Hughes [2]. However, this ubiquitous nature also makes it very difficult to define the practice in detail. For example, in a recent consideration of the definition of marine recreational fishing just within the confines of Europe, Pawson et al. [3] were forced to define it largely in terms of what it is not, i.e. the catch is not sold, it is not undertaken for predominantly subsistence purposes, it is not undertaken for primarily cultural or heritage purposes, but it is often synonymous with angling, which is itself defined as the activity of catching or attempting to catch fish on hooks, principally by rod and line or hand-held line. This broad definition will be adopted here.

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The UK is a complex political entity, as indicated by its full name of the United Kingdom of Great Britain and Northern Ireland, and as a result, its fish and fisheries are managed by a number of geographically based bodies. Nevertheless, in terms of the natural environment the area commonly known as the UK is relatively homogenous and essentially comprises the island of Great Britain (itself comprising the constituent countries of England, Scotland, and Wales) and the northeastern part of the island of Ireland (the constituent country of Northern Ireland), which together lie to the northwest of Continental Europe. This island nature has given the UK a long history of commercial marine fisheries, with associated recreational fisheries along and near to its extensive shoreline. In addition, an abundance of fresh waters provides extensive recreational fisheries, but few commercial fisheries, on rivers and lakes. Somewhat unusually for Europe, these freshwater recreational fisheries are dominated by catch-and-release practices. The long fishing history of the UK is further emphasised by the appearance of approximately 200 references to fish or fishing within the works of William Shakespeare (1564–1616). With specific reference to recreational fishing, Izaak Walton's "The Compleat Angler" was originally published in 1653 and extended by Charles Cotton in 1676. Few other English language books have been reprinted more often than this classic of angling literature and its most popular version remains available today as Walton and Cotton [4].

Here, an overview is presented of the marine and freshwater recreational fisheries of the UK. Their main features and benefits are first described using the concepts of natural capital (defined as the living and non-living components of ecosystems, other than people and what they manufacture, that contribute to the generation of goods and services of value for people [5]) and ecosystem services (defined as the benefits provided by ecosystems that contribute to making human life both possible and worth living, with sub-components of provisioning, regulating, cultural, and supporting services [6]). Following this, the major threats facing these recreational fisheries and the management that has been developed in response to them are reviewed. Given the author's personal experience and expertise, the emphasis of this treatment will be on freshwater issues.

Natural capital

The environment

As implied above, in biological terms the marine component of the UK environment is effectively contiguous with that of the rest of Europe and as such is typical of temperate parts of the world. There are areas of significant localised impacts from various kinds of anthropogenic discharges in some major estuaries (e.g. Nedwell et al. [7]) together with instances of accumulated contaminants in areas such as current or former shipyards and similar industrial areas (e.g. Turner [8]), but the overall human impact on the marine environment is relatively limited. In contrast, anthropogenic impacts have been and to some extent continue to be more widespread in the UK's freshwater environment and in this respect they share many challenges with freshwater fisheries elsewhere in the densely populated landscapes of Western Europe [9]. Across Europe as a whole there is widespread evidence of anthropogenic impacts on running waters [10] and their fish communities [11], but for standing waters fish species diversity is dominated by geographical factors [12]. For the UK, the persisting effects of the last glaciation are still readily observable and have resulted in a relatively species-poor freshwater fish fauna.

The fishes

The global information system FishBase [13] lists a total of 421 fish species as currently present in the fresh and marine waters of the UK (accessed 15 October 2015). Amongst these, 355 species are recorded as marine and 83 species as freshwater in occurrence (some species are found in both environments as discussed further below). However, the freshwater figure is inflated by a considerable number of introduced species (primarily from Continental Europe and North America) which are of relatively low abundance. As discussed by Etheridge et al. [14], the freshwater figure has also been raised by recent contentious taxonomic revisions which have split some former species into a number of "new" species. In the view of many authorities such as Maitland [15] and certainly in terms of practical implications for fisheries and their management, the effective species number for UK fresh waters is somewhere between 50 and 60 fish species.

In the marine environment, a wide range of Orders is targeted in recreational fisheries, but the Gadiformes (including Atlantic cod, *Gadus morhua*), Perciformes (including Atlantic mackerel, *Scomber scombrus*), and Pleuronectiformes (including European flounder, *Platichthys flesus*) are particularly important. Far fewer species are available for exploitation in the freshwater environment, but the Orders Cypriniformes (including roach, *Rutilus rutilus*), Perciformes (including perch, *Perca fluviatilis*) and Salmoniformes (including Atlantic salmon, *Salmo salar*) are fished extensively. Such a breakdown into marine and freshwater fish is of course compromised by diadromous species which move between these two environments. In a recreational fisheries context, this includes all populations of Atlantic salmon, many populations of brown trout (*Salmo trutta*) usually known by anglers as sea trout, and European eel (*Anguilla anguilla*).

Ecosystem services

Types of fisheries

Although as noted above some fish species migrate between or through rivers, lakes, estuaries, and the sea, the UK's recreational fisheries may be usefully considered to fall into one of the two major types of marine (also commonly known as sea) and freshwater fisheries. In terms of ecosystem services, the main benefit from both types of fisheries is in the form of cultural services. However, a relatively small component of greater importance in the marine environment may also be considered as provisioning services because some of the fish caught are retained and consumed.

Marine fishing is conducted both from the shore and from boats in inshore areas. The former is widespread around the entire coast (no part of the UK is more than approximately 110 km from the sea), whereas the latter is more focused around areas with appropriate infrastructure for boat launching or where charter boats of various kinds are available. Assuming that the individual catch is of appropriate size and condition, many marine species taken in such fisheries are selectively killed and ultimately consumed. No licence is required to fish recreationally in the sea and members of the public have a right to fish below the mean high water mark of tidal waters, either from the bank or from a boat assuming that there is public access. Anglers may need to be aware of local bylaws or other restrictions, but these are generally targeted at commercial rather than recreational fisheries and so have little impact on their sport. As a result, there is relatively little active management of marine recreational fisheries, although some specialised groups of anglers such as those fishing for shark species (e.g. porbeagle shark, *Lamna nasus*) practise catch-and-release on a voluntary basis.

Freshwater fishing is even more extensive than its marine counterpart and few parts of the UK are more than a few kilometres away from the opportunity for some form of recreational fishing. In contrast to the marine situation, the vast majority of fish are traditionally never or rarely consumed, but are instead returned alive to the water. The only long-standing exception is for salmonids such as Atlantic salmon and brown trout, although in recent years there has been a strong move towards catch-and-release practices for these species on conservation grounds. However, in contrast to these long-standing customs there is growing evidence that in some areas of the UK more people are consuming non-salmonid freshwater fish, partly due to increased numbers of migrants from eastern Europe where such practice is common and partly due to encouragement by some celebrity chefs to explore new foods [16]. Angling for salmonids is collectively known as game fishing, while that for all other freshwater species is termed coarse fishing. A licence from the national government is required to fish on fresh waters in England (except the River Tweed), Northern Ireland, and Wales, obtainable from the Environment Agency, Natural Resources Wales, and the Department of Culture, Arts, and Leisure, respectively, but no licence is required to fish in Scotland (except the Border Esk region). In addition, in most fresh waters throughout the UK an additional permit of some kind (e.g. a simple day ticket or a longer-term club or syndicate membership) is required to fish on specific waters. Such permits, which are effectively independent of the leased rights, are usually bought by an individual although they may also be obtained as a benefit of club membership.

The requirement for a licence arises partly because most UK freshwater fisheries require active management, which in turn requires the generation of supporting funds. The range and balance of fisheries management activities funded by fishing licences and undertaken by various public bodies around the UK varies considerably depending on the nature of the local fisheries, but in essence these activities cover law enforcement, the provision of an emergency response for fish populations during pollution incidents, the safe-guarding and development of healthy fish stocks in an appropriate environment, and the encouragement of recreational fishing. Fisheries management activities are frequently conducted in partnership with independent bodies such as the Angling Trust (e.g. Angling Trust [17]) and include the provision of information on fishery locations, river conditions, and other matters at a mobile-friendly website (http://www.fishinginfo.co.uk).

The requirement for a fishing permit in addition to a licence arises primarily because most UK freshwater fishing is in private ownership. Although the precise legal situation may be complex and varies in the different constituent countries (i.e. England, Northern Ireland, Scotland, and Wales) of the UK, the owner of the land adjoining a section of one side of a river or stream usually owns the exclusive fishing rights on the bank of that side, and these rights extend out to the middle of the water. An owner whose land adjoins a pond or lake has similar rights which extend as far as the middle of the water, unless the owned land encircles the water body in which case all of the fishing rights are owned. These fishing rights may be sold or more commonly leased for significant sums of money to third parties, such as angling clubs, as separate rights quite distinct from ownership of the adjacent land.

In some situations, freshwater fisheries are stocked to varying degrees, with funding from sales of fishing permits or club membership fees, by professional staff or volunteers belonging to a local angling club. Such stocking was once very widespread, but its potential negative genetic effects are now appreciated and have been extensively assessed by

specifically commissioned reviews (e.g. Ferguson [18]). Appropriate changes have recently been made to national stocking policies. For example, brown trout stocking into all but totally enclosed waters with no natural recruitment is now restricted to non-fertile, all female triploids or individuals from captive breeding programmes using locally sourced broodstock [19]. Stocking with other species for fishery development purposes is also strongly controlled and subject to stringent checks. As a result, considerably less stocking is now carried out across the UK and much that is undertaken is in response to localised incidences of fish kills due to pollution events. This stocking is supported by statutory bodies such as the Environment Agency and is thus funded in large part by sales of fishing licences. Polluters may also be prosecuted by angling interests for the recovery of financial damages, in addition to being subject to penalty fines pursued by the Environment Agency and similar bodies.

The systems for dealing with non-compliance to the above fishing licence and fishing permit requirements varies in the different constituent countries of the UK, but an individual found fishing for recreation without a licence is liable to prosecution. In England, for example, such prosecutions are handled at a Magistrates Court and may result in a formal caution, warning letter or even a fine. More serious instances of poaching, in which both licence and permit are not held and which may involve the organised use of illegal nets or other equipment, is likely to result in more serious punishment and in extreme cases can lead to imprisonment. Some anti-poaching operations may involve the police, but specialised fisheries enforcement staff of a body such as the Environment Agency have the authority to make arrests. Offences of fishing without a permit are generally handled by the fishery owner and typically result simply in the offender being asked to leave the fishery. Although theoretically possible, legal action on the grounds or theft or trespass is effectively unfeasible or at least not cost-effective in practice.

Socio-economics of fisheries

The extent of recreational fishing in the UK is such that it constitutes a considerable socio-economic force. Consequently, several attempts have recently been made to quantify it in terms of both participation and its contribution to local and national economies (Table 1). Scotland has approximately 149,000 sea anglers who together make an annual spend of approximately £140,900,000, which is as significant as all Scottish freshwater angling combined [20]. Elsewhere in the UK, in Northern Ireland the number of sea anglers has been estimated as approximately 5,000 individuals, spending £7,400,000 annually [21]. Less information is currently available for the rest of the UK, although the number of sea anglers in England and Wales was recently estimated at approximately 1,900,000 individuals [22]. In England, further detailed study has recently been provided by the project "Sea Angling 2012" [23]. This is a government-sponsored project to provide data on recreational sea angling to help improve the scientific understanding of fish stocks, as well as ensuring that the needs of sea angling can be represented as effectively as possible in future marine policy development and provide the sea angling community with information to help it develop its own views and policies.

Table 1 The numbers and annual spend of recreational anglers in the UK

Environment	Country of UK	Number of anglers	Annual spend (£)
Marine	England and Wales	1,900,000	Unknown
	Northern Ireland	5,000	7,400,000
	Scotland	149,000	140,900,000
Freshwater	England and Wales	1,000,000	1,000,000,000
	Northern Ireland	30,000	31,900,000
	Scotland	Unknown	112,600,000

Data are sourced from AFBI Fisheries and Aquatic Ecosystems Branch [21], Scottish Government [20], and Simpson and Mawle [22]

Comparable studies have been made of freshwater angling, which statistically includes the extremely important fisheries for diadromous Atlantic salmon and sea trout, in Scotland, Northern Ireland, England, and Wales. In Scotland [24], total annual spending is approximately £112,600,000, of which approximately £107,700,000 is spent on game fishing and £4,900,000 on coarse fishing. In Northern Ireland [25], there are approximately 25,000 resident and 5000 visiting freshwater anglers who together make annual spends of approximately £25,700,000 on game fishing and £6,200,000 on coarse fishing. In England and Wales [26], approximately 1,000,000 anglers were licensed to fish on fresh waters in 2005 and together fished for approximately 30,000,000 person-days, mostly for coarse fishing, and made an annual spend of approximately £1,000,000,000 which is estimated to be equivalent to 37,000 full-time jobs supported directly and indirectly by such fishing activities.

Clearly, recreational fishing provides significant ecosystem services throughout the UK. It is of great socio-economic importance, providing direct financial benefits to local economies with almost all of the spends described above going directly into the local community and only a very small proportion of them transferring to centralised national fisheries management activities through the sales of fishing licences. This recreational fishing also provides a variety of more intangible ecosystem services to many individuals. The above participation figures indicate that the

UK, which has a population of approximately 65,000,000 people [27], has a total of more than 3,000,000 recreational anglers [22].

Threats

Overfishing

Although overfishing is a major threat facing commercial marine and freshwater fisheries around the world, it is much less of an issue for the recreational fisheries of the UK. The only significant exceptions to this general pattern are some fisheries for species that are also exploited commercially in its marine waters, where commercial overfishing remains a general problem (e.g. Cardinale et al. [28]) although some species such as Atlantic cod are now recovering as a result of strict management [29]. Overfishing has certainly been a historical issue for diadromous salmonids which were once heavily exploited commercially at sea before their return to freshwater recreational fisheries, but such impacts have been greatly reduced in recent years by the active reduction of net fisheries [30]. In freshwater fisheries, catch-and-release has traditionally been practised by coarse anglers as discussed above and the practice also became commonplace amongst game anglers some years ago [31].

Established environmental threats

A number of the environmental threats facing the recreational fisheries of the UK have been established for many decades. As a result, they are now typically well understood and in most specific cases have been subjected to successful past management or are currently being appropriately managed. With the exception of some estuarine impacts noted above, most of these issues are restricted to the freshwater environment and its fisheries.

Physical modification of freshwater fish habitat in the UK has taken many forms, from minor engineering work on river and lake shorelines for flood protection purposes through to near or complete dewatering resulting from water abstraction. In between these extremes, a diverse range of in-river structures has had significant implications for fish migrations and led to the design of a variety of appropriate fish passes and the development of systems for their prioritised deployment [32]. Although such physical habitat modifications tend to be more serious in rivers and streams, they can also be substantial in lakes which have been modified to become reservoirs. In such situations, the common importance of the littoral zone as a fish spawning and nursery area [33] can be seriously undermined. Winfield et al. [34] give one example in which reservoir level falls during the spawning and egg incubation season have had significant negative impacts on the dynamics of a whitefish (*Coregonus lavaretus*) population, but for which the demonstration and understanding of such impacts has subsequently encouraged more sympathetic reservoir management.

The industrial history of the UK brought with it substantial chemical pollution of many of its fresh waters and, as mentioned above, some of its estuaries. However, the adverse effects of freshwater acidification arising from airborne pollutants have now been reduced and sensitive fish species such as brown trout have consequently shown marked recoveries in many upland streams [35]. Similarly, larger rivers have responded to managed reductions in their chemical pollutant loads with notable results, including that of the River Thames as it flows through lowland England [36] and to which Atlantic salmon have now returned [37].

Eutrophication has also been a pervasive problem in the UK, particularly in its lowland rivers and lakes where nutrient sources from agriculture and sewage in particular have been a significant factor for many decades. As reviewed from a global perspective by Winfield [38], the effects on fish populations of such nutrient enrichment may initially be positive through increased production, but in most systems they quickly become negative through deoxygenation, increased sedimentation and shifts in competitive relationships within the fish community. In the UK, this can result in the reduction of highly valued but sensitive salmonid populations such as Arctic charr (*Salvelinus alpinus*) (e.g. Jones et al. [39]) and their effective replacement by more tolerant cyprinids such as roach (e.g. Winfield [40]). However, the fundamental mechanisms and management of eutrophication have now been understood for many years (e.g. Smith et al. [41]) and appropriate measures are now in place in most UK fresh waters where they are required. A notable example of such success is provided by Loch Leven in Scotland, where a renowned recreational fishery for brown trout is benefitting from a reduction in local eutrophication (Winfield et al. [42]).

Developing environmental threats

Although the above environmental threats are now well understood and are generally being well managed, a number of new and emerging problems have arisen in more recent years. Moreover, it is becoming increasingly apparent that many of these new issues and more established threats can interact with each other.

The physiological impacts of endocrine disruptors on fish in the laboratory and their qualitative presence in the wild have been appreciated for some years (e.g. Tyler et al. [43]). However, it is only more recently that their effects at the population level in the natural environment have

begun to be explored quantitatively through modelling (e.g. Brown et al. [44]) and their management implications considered (e.g. Crane et al. [45]). The physico-chemical effects of nanoparticles on fish populations and their environments are similarly at a relatively early stage of understanding and management [46].

The isolated nature of its fresh waters in combination with the eradicating effects of the last glaciation have left the UK particularly susceptible to problems arising from the accidental or intentional introduction of aquatic species. Such problems have been appreciated for some time (e.g. Winfield [40]), but with increased transport infrastructure and a warming environment (see below) they have increased substantially in recent years in line with the common global pattern [47]. Non-native fish species have now been introduced to the largest lakes of England, Northern Ireland, Scotland, and Wales [48] and the problem is particularly acute for species-poor lakes towards the north and west of the UK [49]. Biosecurity procedures addressing the threat of species introductions are now well developed throughout the UK, although recent research has shown that the practices of some user groups must still be further improved [50]. Although not strictly an issue of species introduction, the movement of cormorants (*Phalacrocorax carbo*) onto fresh waters with potential impacts on local fish populations has been appreciated for some time (e.g. Kirby et al. [51]), but it remains a controversial management issue [52].

Finally, climate change has the potential to have immense impacts on the marine and freshwater recreational fisheries of the UK. For example, in the North Sea many fish species have shown changes in their spatial distributions attributable to recent increases in sea temperature [29, 53]. The scope for similar large-scale changes in distribution is of course much more limited in isolated freshwater environments, but instead similar changes are being observed in lakes across Europe such that coldwater salmonids are declining and warmwater cyprinids increasing in abundance [54]. Within the UK, the coldwater Arctic charr is showing a widespread decline which appears to be attributable at least in part to climate change [55]. The specific plight of the extensively studied Arctic charr population in Windermere, England's largest lake, also provides a clear example of the potential interactions between climate change, eutrophication, and species introductions and their adverse consequences for a recreational fishery [56].

Management

Management in and around the water

As discussed above, most of the aquatic biological management activities relevant to recreational fisheries in the UK are now based on mature science and are in many cases now largely operational matters. The example given above of the management of eutrophication to the benefit of the brown trout recreational fishery, and to many other ecosystem services, at Loch Leven in Scotland is an excellent example of such work. D'Arcy et al. [57] describe the importance for this success story of setting specific water quality targets and pursuing them through management initiatives across the entire catchment rather than just at the water body itself, including extensive engagement with stakeholders and the general public. At a national scale, there have been significant recent developments in the general landscape of such management activities in and around the water. In particular, the long-established practical environmental and fisheries management work of the appropriate UK statutory bodies is increasingly supplemented by the efforts of more independent organisations, often enjoying charitable status. One such organisation is the Rivers Trust (http://www.theriverstrust.org), which acts as an umbrella organisation for many individual Rivers Trusts with specific geographical remits within England and Wales (Fig. 1). These hybrid professional-voluntary entities have their origins in small, local "bottom up" voluntary movements that have grown and developed over time. Moreover, while most such organisations started life very much centred on the aquatic inland habitat itself, many have now matured into wider catchment-based conservation programmes and are becoming important mechanisms for the delivery of ambitious national and international environmental actions. These and other organisations have also become very important for the promotion of citizen science, in which data are collected not by scientists, but by informed volunteers [58]. Nevertheless, despite these remarkable developments some environmental problems continue to give great cause for concern.

One problem that is proving to be particularly resilient to effective management is that of fish species introductions. The removal of introduced populations is extremely difficult in most rivers and lakes, although some success has been achieved in England in smaller standing waters from which the invasive cyprinid topmouth gudgeon (*Pseudorasbora parva*) has been successfully removed by the controlled use of rotenone [59, 60]. Nevertheless, the best management option is undoubtedly to prevent undesirable introductions from being made in the first place, and to this end all fish introductions to the UK are now subjected to sophisticated risk analyses [61]. However, many undesirable fish arrivals within the UK have arisen not from ill-informed formal introduction programmes, but from the unauthorised activities of some anglers. In particular, strong circumstantial evidence indicates that the use of live freshwater fish species as bait for larger, predatory species such as pike (*Esox lucius*) is the source of many of these

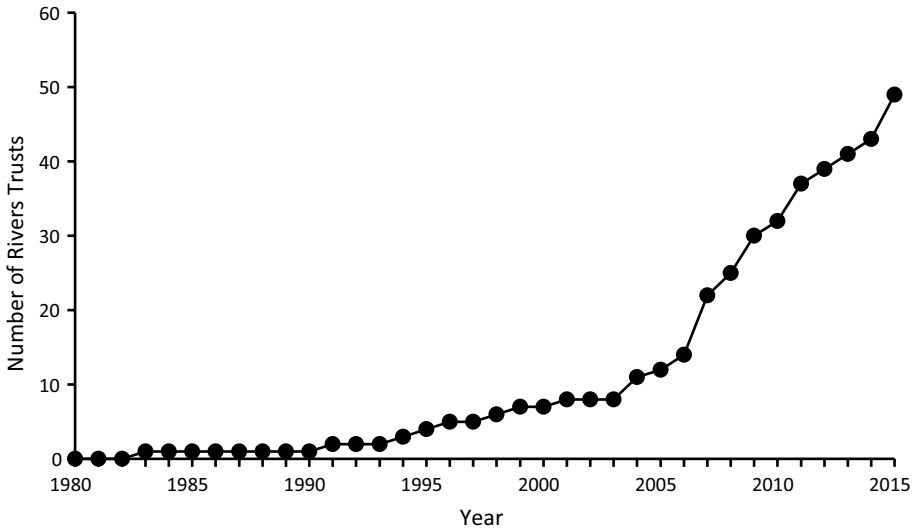

Fig. 1 The growth (represented by the number of member Rivers Trusts) of the Rivers Trust in England and Wales since the start of the movement in 1983. Data are sourced from unpublished data of the Rivers Trust (http://www.theriverstrust.org)

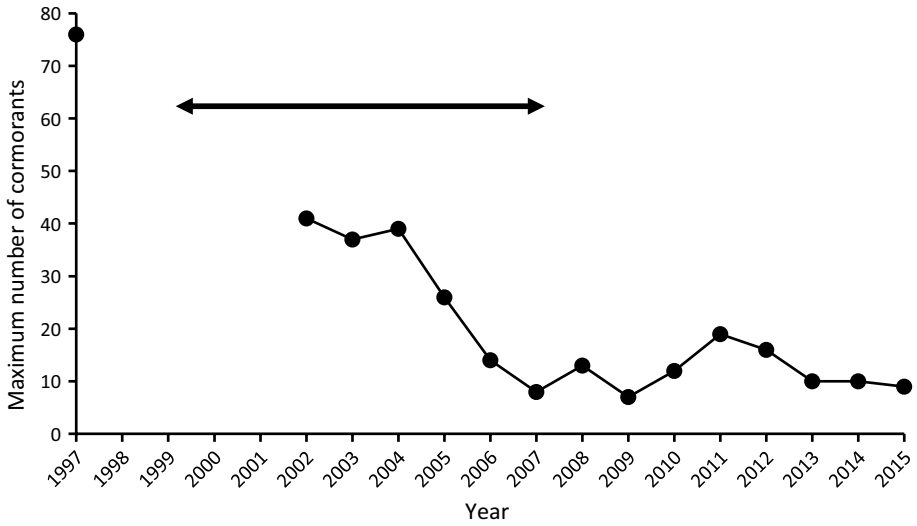

Fig. 2 Annual maximum number of cormorants recorded at the reservoir of Haweswater in north-west England between 1997 and 2015, at the start of which period they had a significant negative impact on a local endangered whitefish population. Although escalating cormorant control measures were limited to between 1999 and 2007 (indicated by a *double-headed arrow*), continued cormorant monitoring has shown that a resulting reduction in abundance has persisted to the present. Note that no cormorant counts were made between 1998 and 2001. See main text for further details

introductions. Consequently, regulatory bodies are pursuing a twin approach of angler education and the banning of such live-baiting in particularly sensitive areas [62, 63].

Similarly, managing the impacts of cormorants on local fish populations remains a significant challenge both in terms of understanding the underlying predator–prey dynamics and in terms of public acceptance of the deliberate culling of such and other piscivorous bird species [52]. Practical experience has shown that rigorous site-specific studies such as that described by Winfield et al. [64] for cormorants predating a lacustrine whitefish population are extremely beneficial to the design, justification and implementation of effective control measures [65] with long-term benefits (Fig. 2). However, such highly detailed studies cannot be undertaken at every location where a cormorant-fishery conflict is perceived to occur and so attempts continue to find a more broad scale solution to this enduring environmental threat.

In an even wider environmental context, the ecosystem-based management of fisheries that had its origins in the marine environment (e.g. Pikitch et al. [66]) has subsequently also been taken up for freshwater fisheries (e.g. Cowx and Gerdeaux [67]), and this holistic approach now pervades the management of recreational fisheries in the

UK. For example, the successful management of the environment of the Loch Leven brown trout fishery mentioned above [42] has been conducted within an ecosystem-based approach for which May and Spears [68] provide a discussion within the context of potentially competing ecosystem services.

Management above and away from the water

Just as the ecological management of water bodies has broadened over recent decades to include their terrestrial catchments, the management of recreational fisheries in the UK has more recently expanded above and away from the water to include the management of anglers and other members of society.

A major driver behind this expansion has been the realisation that the success of recreational fisheries is often, and arguably, usually driven more by human factors above the water than by fish factors within it. A particularly clear example of this new understanding is given by an examination of changes in participation in recreational fisheries in England and Wales by Aprahamian et al. [30], in which it was found that management-induced increases in the abundance of Atlantic salmon had no positive effect on the numbers of anglers. Similarly, for coarse fisheries it was concluded that increased participation is generally dependent less upon stock manipulation and more upon facilitating angling activities. Consequently, in recent years urban fisheries and other development programmes have been initiated to improve access to local fishing opportunities. Such actions have been supported by research to understand better the public perception of environmental problems (e.g. Tsouvalis et al. [69]) and recreational fishing (e.g. Simpson and Mawle [22]) and by specific efforts to encourage new anglers to take up the sport (e.g. Angling Trust [17]).

Undoubtedly, such ambitious activities will encounter a multitude of potential conflicts in our use of environmental systems. In this context, Arlinghaus [70] provides a useful conceptual framework to identify and understand conflicts in recreational fisheries systems, with implications for their sustainable management. It has clearly emerged that one of the most pressing needs in recreational fisheries management is to identify, understand and manage conflicts between the requirements of different user groups, such as between some anglers and some recreational boat users. Moreover, the equitable resolution of such conflicts has been hampered to a large degree by a scarcity of objective assessments of inland fisheries economics and so recent progress in this area such as the overview provided by Grantham and Rudd [71] is to be welcomed. Such socio-economic aspects of fisheries research promise to deliver significant advances for the wise management of our limited and sometimes contested environmental resources.

Closing remarks

Now more than ever, individuals and governments around the world are interested and active in the conservation and sustainable use of the natural environment. In the UK, our post-industrial society has never been more aware of these important issues and our recreational fisheries and their management have much to benefit from and much to contribute to these crucial matters in our wise stewardship of the planet. Moreover, we have a great scientific understanding of most of the threats facing our aquatic environments, including their fishes and fisheries, and now more than ever it is imperative that this knowledge is transferred efficiently and accurately to environmental and fisheries managers [72]. Recent UK developments in citizen science, as described in general terms by Silvertown [58], and in citizen management, as exemplified by the growth of Rivers Trusts described earlier, are greatly aiding the effective nationwide deployment of management resources. In addition, UK society has never been so aware of its natural environment and the threats facing it at both local and global scales. Many substantial challenges still face the conservation and sustainable use of our natural environment, including its resources and services such as fish and recreational fisheries, but the initiatives described above and other developments reviewed by Winfield [73] give substantial grounds for great optimism.

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