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# A conceptual framework to identify and understand conflicts in recreational fisheries systems, with implications for sustainable management

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**Abstract**
Recreational fisheries constitute the dominant fisheries activity in freshwater ecosystems of most countries of the temperate regions. Yet, research on recreational fisheries appears parochial, with a strong national orientation and few theoretical frameworks guiding empirical research. Furthermore, the holistic study of the human dimensions of recreational fisheries has received limited attention, particularly in Europe. This does not correspond with the fact that recreational fisheries management is today as much people as fish stock management. One of the most pressing needs in recreational fisheries governance is to identify, understand and manage 'people conflicts' because such conflicts can hamper any progress towards sustainability. Therefore, in this paper the literature on intrasectoral and intersectoral user and management conflicts is reviewed. The insights gained are summarized in a qualitative conflict model that centres on core variables fostering conflicts in recreational fisheries. These variables include social (cultural, institutional, emotional, communicative and group-related) as well as individual (activity style, resource specificity, mode of experience and lifestyle tolerance) factors that influence and reinforce each other. Ultimately, conflict has to be addressed by appropriate management actions. Thus, the present article ends with implications that might aid in solving conflicts in recreational fisheries management and conservation.

**Keywords** Angling, Habitat management, Human dimensions, Recreational fisheries management, Regulations, Stocking

## Introduction

Human exploitation of fish populations is virtually ubiquitous on earth and since ancient times has benefited humanity for food, income or social goals such as recreation and 'fun'[1–4]. If fishing is conducted for non-sale (i.e. non-commercial) purpose during free time (as opposed to working time), and/or is subjectively defined by the individual as being leisure, this type of fishing can be termed recreational or leisure fishing[5]. This definition of recreational fishing includes subsistence fishing, i.e. part of the catch or the whole catch may be taken home for consumption. With the objective of catching aquatic animals, primarily fish, recreational fishing is today predominantly conducted by angling methods, i.e. line fishing using a hooking method (cf. reference 6). Hence, in the Western societies of the temperate regions, recreational fishing is typically used synonymously for angling, simply because non-angling recreational fishing methods such as gill nets are used only locally, e.g. in the Nordic European countries[1]. Thus, for the purpose of the present article, angling and recreational fishing are used interchangeably.

Recreational fishing has a history as long as human civilization itself[4], and is becoming increasingly important around the world, primarily in freshwater of industrialized countries, but also in developing

countries[1]. In most 'developed' or industrialized societies of the temperate regions, recreational fisheries have long represented the major use of aquatic wildlife, thus constituting the dominant fishing activity in limnetic surface waters[1,7–9]. In contrast to the popular tenet that recreational fishing has little socioeconomic impact/value and negligible ecological impact, several recent studies suggest that this is not the case[1,10–14]. For example, a recently published socioeconomic study from Germany showed that recreational fisheries feeds a 5.2 billion € industry with approximately 52 000 jobs dependent on the expenditure of anglers[9]. Other European jurisdictions (e.g. Nordic countries, England, Wales and Scotland) have recently also conducted economic impact and value studies with the common result that the economic benefits associated with recreational fishing are higher than previously assumed, and of considerable social relevance[15–18]. In many countries of the world (e.g. in Scandinavia, Australia or the U.S.A.), more than 10% of the adult population regularly participates in recreational fishing[8,9]. As a result of this high participation level, in some regions of the world the total harvest of recreational fisheries is larger than the commercial one. Referring again to the German example, the angler harvest was estimated with 45 000 metric tonnes, while commercial freshwater capture fisheries harvested 10 times less[9]. Therefore, recreational fisheries are not only of significant social and economic importance. Furthermore, angling-caused fishing mortality often exceeds the fishing mortality induced by commercial fisheries[13]. This particularly applies in inland fisheries[14], but is also the case among some top-predatory marine fish stocks as was recently documented for some exploited populations in the U.S.A.[13].

Interestingly, the high social and economic importance of recreational fisheries and also the potential negative ecological impacts of angling fisheries are rarely realized and discussed by fisheries researchers in the primary literature[10,12,14]. For example, recent reviews dealing with the sustainability of the world's fisheries[19], the state of the world's fisheries resources[20] or the future of fisheries[21] almost omitted any commentary on recreational fisheries. This is partly the result of the limited research efforts on recreational fisheries as compared to marine commercial fisheries[1]. On the other hand, the great dimension of recreational fisheries from the point of view of total harvest and socioeconomic benefits to society may often remain unnoticed because marine fisheries are highly visible in the media and of high political priority, while recreational fishing is a dispersed activity covering millions of people exploiting hundreds or thousands of different fish stocks. However, fishing activity of any kind, whether commercial in the marine environment or recreational in the freshwater environment, has the potential to negatively affect fisheries resources and entire aquatic ecosystems[1,10–14].

The most basic ecological and potentially evolutionary effect of angling is related to selective angling mortality. For example, many anglers over the world prefer large fish to the catch of small fish[9,22–27] (but see reference 28). Coupled with the fact that most recreational fisheries are managed based on some variants of length-based creel limits[1], this can lead to size-selective removal, i.e. the selective removal of the largest fishes of the population. It has repeatedly been shown that selective angler harvest of the largest fish can force the length- and age-frequencies of fish populations towards smaller and younger fishes[29–34]. Truncation of age and size structure of exploited fish populations may reduce the population's ability to respond to external stress and environmental stochasticity[35]. Selective angling mortality may also result in evolutionary changes if specific phenotypes characterized by specific traits (e.g. slower growth or younger age at maturation) have a higher probability to survive and reproduce. The potential of recreational anglers as engines of evolutionary changes has rarely been studied so far, but first results indicate that angling-induced selection pressures on adaptive life-history traits may be strong if exploitation is intense[36].

However, angling cannot only cause fishing mortality by removal of fish. The practice of voluntary or regulatory catch-and-release fishing[37–40] can cause instant or delayed hooking mortality, and have sublethal effects on reproduction, growth and behaviour of fish populations[41–45]. These effects, however, are species- and context-specific, which limits the potential for general predictions on the effects of catch-and-release practices[42,46]. In some areas of the world, there is a fierce ethical controversy surrounding catch-and-release in circumstances where anglers do not catch the fish for the primary objective of consumption[47–49]. This particularly applies in Germany[50,51]. Other important impacts of recreational fisheries are related to the frequently conducted (and rarely controlled) stockings of fish into open water bodies. In fact, since centuries fish stocking is the standard recreational fisheries management practice[1]. However, evidence is accumulating that fish stocking might be one of the most serious threats to the genetic biodiversity of freshwater fish stocks[52–54] and may lead to the biotic homogenization of fish communities across the catchments[55]. Altogether, intensive angling can be one of the most important variables structuring fish populations, particularly in freshwater ecosystems[11,31,56–58]. Some studies have found that existing angler effort and exploitation is higher than would be demanded from the perspective of ecological sustainability or maximum sustainable yield or effort[11,58–60] (but see reference 61 for another perspective). As a consequence, the normative concept of sustainable

development equally applies to both commercial[19] and recreational fisheries[1], and recreational fisheries should increasingly be discussed and studied in plane with commercial marine fisheries in an effort to be put on a path towards fisheries sustainability[14].

## Status quo and challenges of recreational fisheries research and management with emphasis on conflicts

Against the challenge to achieve harmony between resource use by present and future generations and resource conservation, hence sustainability[1], Cox[57] noted that many of the world's recreational fisheries are today managed on limited experience where results from a few studies are extrapolated to hundreds of independent stocks. As a consequence, management failures such as stock declines and poor angling quality are increasingly common, but proceed virtually unnoticed in many recreational fisheries[11]. This, *inter alia*, results from: (a) the huge number of fish stocks to be monitored and the inability of current management systems to cope with this task due to severe constraints in funding and expert assistance[1,8,57]; (b) the disperse and diffuse nature of recreational fisheries activities, which in contrast to highly visible commercial fish stock declines in the oceans, limits the public exposure to stock declines[10,11]; (c) the inability of anglers and managers (and humans in general) to develop an accurate picture of what healthy fish stocks are occurring at scales longer and larger than their own experience[62–64]; and (d) the effects of fish stocking masking stock declines, which is particularly relevant in inland fisheries[1,65]. Moreover, in some industrialized societies, recreational fishing is even today not accepted as the dominant component of inland fisheries systems[1]. In particular in Germany, the 'evolution' of inland fisheries from an emphasis on commercial fishing and food production towards an emphasis on recreation (and nature conservation) has often been neglected[66]. Consequently, the research efforts on recreational fishing in Central Europe in general[67] and in Germany in particular are pitiful[8,66,68–70]. In contrast, from the 1960s onwards a rich body of empirical research on recreational fishing developed in North America and Canada[5,67]. However, most research on recreational fishing appears parochial, with a strong national orientation and relatively small frames of reference in terms of theory, concepts and empirical bases[5]. Furthermore, most research on recreational fishing has been biologically driven and descriptive with little predictive power[71,72]. As a consequence, recreational fisheries management does not yet have its own models and conceptual frameworks[73,74].

Recreational fisheries management can be defined as the use of all types of information (e.g. ecological, economic, political, sociocultural and institutional) in decision making that results in actions to achieve human goals and objectives established for fish resources[1]. Traditionally, recreational fisheries management has focused on the management of individual fish populations by the use of regulations and fish stockings and introductions to either manipulate the fishery or single recreationally valuable fish stocks[1]. Managers assumed that the demand side (i.e. angler effort) would somehow be self-regulating and often only attempted to increase the supply of fish[59,75,76]. However, the rapid and massive numerical response capacity of the 'apical' or 'top down' predator angler[58,77], the ability of anglers to operate efficiently[11,58], the occurrence of depensatory processes increasing the probability of overexploitation[11], the potential for deleterious recreational fisheries management actions such as ecologically harmful stockings[1,78,79] and the degraded state of many freshwater ecosystems throughout the world[80,81], and particularly in densely populated countries of Central Europe, call for an ecosystem, multispecies view and management system not yet developed by contemporary research and recreational fisheries management institutions[1]. Such system approach to recreational fisheries management is ultimately angler-dependent, because (1) effective enforcement of regulations is impossible in the highly dispersed angling environment and thus sustainability is dependent on resource-conserving behaviour and rule compliance by anglers; and (2) anglers via angling clubs and associations are often demanded by law to manage complex food webs and aquatic ecosystems under conditions of uncertainty on their own[1]. This is particularly relevant in the private property fishing rights systems of Central Europe, where in contrast to the United States, Canada and Australia the right to use and manage fisheries resources lies in the hands of private persons or groups of persons[1,82]. For example, in Germany this private property system results from the legislative framework set by the different fisheries laws in each of the 16 German states ('Hege- und Pflegepflicht') and by many other laws and byelaws such as the German nature conservation law of 25 May 2002 ('Bundesnaturschutzgesetz'). The latter demands, *inter alia*, that fisheries systems (or more abstract recreational fisheries management) have to maintain and promote entire surface waters and their littoral areas (i.e. not only fish populations) by adhering to a good managerial practice ('gute fachliche Praxis'[83]). Thus, the German recreational fisheries systems, as many others in Europe, can be characterized as joint community-federal state cooperative management regimes[84,85]. As such, the government and/or federal states at the public management level set a larger institutional framework (e.g. fisheries laws), and the fishing rights holders (e.g. an angling club) or more generally

angling communities at the private recreational fisheries management level implement and plan local management and enforce, supplement and complement state-wide laws, e.g. by local angling club rules[1]. Due to the deep involvement of the angling community in contemporary recreational fisheries management, sustainability will without doubt only become reality, if 'sustainable' management actions experience a strong constituency support of the majority of anglers potentially affected by the management programmes[86,87].

Consequently, there is an increasing realization that recreational fisheries management has today as much (i.e. angler) management as fish stock management[1,66,67,88–91]. This shift practically requires concerted research efforts on the human dimensions of recreational fisheries that go beyond evaluative studies on the economic benefits generated by recreational fisheries. Similarly to the traditional, biologically driven fisheries management that rests on the knowledge about the biology and ecology of fish species, fish populations and food web dynamics[92], the modern fisheries manager also needs a thorough understanding of the human component of recreational fisheries systems to improve the management of 'unsustainable angler behaviour' and foresee likely effects of management decisions on site choices, harvesting decisions, angler satisfaction, rule compliance, aquatic stewardship and other behavioural antecedents or patterns[1]. Nonetheless, the analyses of the biological, ecological and evolutionary dimensions of fisheries systems remain at the heart of efforts to sustainably manage recreationally exploited fish stocks. Ideally, however, in the future, biological, ecological, evolutionary and human dimensions will be studied, recognized and addressed simultaneously. This constitutes a considerable societal challenge that spans the curricula of 'future' fisheries managers in universities and demands increases in financial and human resources in the management environment including integration of interdisciplinary expertise beyond the fisheries ecological domain[8].

Compared to limnological and ecological studies of aquatic ecosystems and biological analyses of fish stocks, research on the human dimensions of recreational fisheries is a relatively recent arrival to the fisheries management process, primarily taking root in the past 25 years[93]. Human dimensions research of recreational fisheries can be described as identifying what people think and do regarding fishery resources, and understanding why[67]. It is an arena of scientific investigation which attempts to understand, predict and ultimately affect human thoughts and actions (i.e. behaviour) toward natural environments and to acquire such understanding for the primary purpose of improving aquatic stewardship and encouraging long-term commitment for the protection and conservation of natural resources[67,71,94]. Human dimensions research has multiple roles such as describing participation and behaviour; legitimating management policies; investigating markets, people perceptions, preferences, values and attitudes etc.; contributing to conflict resolution; and evaluating management actions and socioeconomic benefits[71]. Human dimensions research uses interdisciplinary methods and concepts from various scientific disciplines such as sociology, psychology, economics, political sciences, human ecology, anthropology, history, pedagogics, geography, and consumer and recreation research[67,94]. Various researchers have synthesized human dimensional concepts and methods concerning recreational fisheries management[8,67,71,95–100]. Unfortunately, in many European countries in general and in Germany in particular, the information base on the human dimensions of recreational fisheries is particularly weak or sometimes not even existent, and most of the existing human-dimensions orientated studies did not appear in peer-reviewed journals. Albeit the notable increase in economic evaluations of European recreational fisheries since 2000, much of the human dimensions work, over and above broad analyses of the economic benefits of leisure fisheries, remains to be done. The present lack of knowledge severely reduces the ability of managers to develop sustainable management strategies that integrate the human dimensions of all stakeholders and strive to balance human interests against resource conservation values. However, unfortunately, biologically trained managers in public agencies often do not see the need for human dimensions research because they perceive they manage only fish[71].

One of the most characteristic features of socio-ecological systems such as recreational fisheries is their complexity and dynamic nature, with its many interactions among ecosystems, natural living resources, humans and institutions (i.e. ways of organizing social systems and activities[101]). As a result, conflicts tend to be the rule rather than the exception in socioecological systems such as fisheries[102]. Krueger and Decker[103] forced the notion that recreational fisheries managers should not be surprised but ready to address conflicts surrounding angling, as they will inevitably occur in a fisheries management career. However, limited attention has been paid in the past to devote research into conflicts in recreational fisheries management. Thus, by typologizing and describing conflict situations prevailing in recreational fisheries, this review paper aims at corresponding with the call of Ludwig *et al.*[90] to 'rely on scientists to recognize problems, but not to remedy them'. It strives to contribute to the understanding of conflict over common pool resources in recreational fisheries, as this knowledge is crucial for sustainable development[104]. Common pool resources

such as fish stocks or angling sites[105] are characterized by the lack or the very costly possibility of excluding users and the fact that one unit of the resource consumed by one individual is no longer available for another, at least temporarily. If fishes are released alive into the water by one angler and are consequently often more difficult to be caught by another individual[41], one might even argue that catchability is the third common-pool-resource of relevance in recreational fisheries system.

The necessity to deal with conflicts surrounding common-pool-resources results from the well-known observation that they are day-to-day practice, but not 'simply material'[104]. Conflicts surrounding natural resources seldom develop based on facts or divergent factual understandings of stakeholders. In most cases, conflicts are related to cognitive or emotional aspects of individuals or social groups[104] – they become a human dimensions issue. At the same time, they are crucial for the performance and the effectiveness of the management system. Because an understanding of conflicts is one prerequisite for sustainability to proceed, this paper develops a human dimensions perspective on conflicts in recreational fisheries. First, a typology of management conflicts will be presented. This was considered necessary to structure the topic. Then the different identified conflict types will be described based on a review of the peer-reviewed literature and against the background of the quasi-public good nature of recreational fisheries in Central Europe[1]. To maintain a meaningful discussion, most of the more specific examples described will be related to Germany. However, abundant international literature is considered to highlight general findings in the human dimensions literature and make this paper of relevance in many fisheries systems world-wide. Finally, a qualitative model of conflicts in recreational fisheries is presented, which might guide future research efforts and is intended to cover all the important variables facilitating conflicts in the leisure fishing environment. To help the fisheries manager, the paper will also provide details on some management implications suggesting ways to address conflicts in recreational fisheries.

## A typology of management conflicts in recreational fisheries

Conflicts in fishery systems are ubiquitous and operate at multiple levels horizontally between users and vertically between users and managers, scientists, politicians and the public, and among managers and management systems (e.g. water versus fisheries management), or managers and researchers[1,7,102,103,106]. In Central Europe, the population density and the lack of sufficient water have created particularly large potentials for social conflicts between stakeholders with divergent human dimensions[67]. All change, including new management direction, will almost certainly produce conflict in recreational fisheries[103].

**Table 1.** Typology of conflicts in recreational fisheries. Conflicting parties not only encompass users but also management institutions (e.g. laws) and management systems in general

| Type | Sector involved | Examples of conflicting parties |
|---|---|---|
| User conflicts | Intersectoral | Angler versus boater |
| | | Angler versus swimmer |
| | Intrasectoral | Angler versus angler |
| | | Angler versus commercial fisher |
| Management conflicts | Intersectoral | Angling/fisheries management versus animal rights law/interest |
| | | Angling/fisheries management versus nature conservation law/interest |
| | Intrasectoral | Angler versus support or opposition to management measures |
| | | Recreational fishing versus allocation of fishing rights to commercial fisher |

Four types of conflicts can occur in fisheries systems[102]: (1) fishery jurisdiction at the policy or planning level (e.g. allocation of fisheries rights and fundamental management paradigms), (2) management mechanisms at the management level (e.g. development, implementation and support of a management plan); (3) external allocation (e.g. conflicts between fisheries and non-fisheries stakeholders); (4) internal allocation (e.g. conflicts among direct participants in the fisheries systems). (1) and (2) can be categorized as management conflicts either between anglers (i.e. users) and the higher hierarchies of the management systems (e.g. a fisheries management agency) or between management players and institutions (e.g. between recreational fisheries management as a rather abstract player and a law restricting certain recreational fisheries management alternatives. (3) and (4) can be termed user-conflicts operating directly between user groups. Some conflict types are nevertheless difficult to group.

Table 1 provides an overview of typical conflicts in recreational fisheries management and their categorization as they will be discussed and treated below. The focus is on freshwater fisheries as most of the published studies are from this environment. Within the typology in Table 1, intersectoral conflicts describe interactions operating cross-sectorally, e.g. between fisheries and other sectors such as non-angling water-based recreation or water management. Intrasectoral

conflicts relate to the whole inland capture fisheries sector including recreational and commercial fisheries and upstream and downstream sectors, but excluding aquaculture.

As an understanding, the nature of conflicts will help a manager anticipate and respond to them appropriately[107,108]; in the following sections, an analysis of conflict related to recreational fisheries is presented. The focus of the empirical research presented is on management conflicts, e.g. whether anglers predominantly support sustainable management measures such as habitat rehabilitation or focus on traditional, less-sustainable actions such as stocking (compare Table 1). As will be discussed below, this type of conflict seems to be the most important one in recreational fisheries management in Central Europe, where most aquatic ecosystems have been anthropogenically degraded and habitat rehabilitation is the most promising management alternative.

## User conflicts

The most visible conflicts prevailing in recreational fisheries in the short term arise from interactions between local users, both intersectorally and intrasectorally (Table 1). Although such problems may reduce angler satisfaction (and the satisfaction of non-angling stakeholders), user conflicts in contrast to management conflicts usually do not inhibit recreational fishing *per se* or produce ecologically disastrous outcomes on larger scales.

### *Intersectoral user conflicts*

Intersectoral conflicting situations at the horizontal level between resource users relate to the interactions between participants in outdoor recreation activities in the vicinity of fishable water bodies, such as angling, walking, wildlife viewing, pleasure boating, canoeing, sailing, diving, swimming, bathing, water-skiing, surfing, wild fowling and tourism in general[109–117]. Such conflict can occur independently of actual contact between the user groups. It is intuitive that some anglers will experience negative feelings and will be conflict prone if a boater disturbs the angling sites, or alternatively a motor boater might be prone to conflict if, say, the angling line gets stuck in the engine or the presence of the angler at a shoreline limits the ability of the boater to anchor the boat near the shoreline. However, some outdoor recreationists may dislike anglers simply because they experience angler litter without having direct contact with anglers. Intersectoral user conflicts often occur if consumptive nature users (e.g. anglers, hunters) interact with non-consumptive resource users (e.g. wildlife viewing). For example, wildlife viewers derive satisfaction by observing an animal in its natural environment. If anglers disturb this environment, conflict is likely. It was suggested that anglers might have lower tolerances for other nature users and perceive more conflict with other people as compared to other stakeholders[108,109,118]. This 'asymmetric antipathy' is a distinctive finding of many conflict studies, i.e. the 'one way' nature of outdoor recreation conflict[110]. In some cases, however, in particular if observed at the national level of angler surveys, intersectoral user conflicts seem to be of comparatively minor importance. For example, in the nationwide angler survey in Germany, the management measures to restrict other water-based stakeholders such as navigation or water sports received considerably less support than other management measures that were not related to constraining other resource users[9]. If anglers were asked in an open-ended question, they did not even mention actions directed at restricting other water usages[9,119]. In some densely populated countries such as Germany, where more frequent contacts between different nature users are common, there might be a tendency to more readily accept other user groups.

### *Intrasectoral user conflicts*

Intrasectorally, conflicts between commercial fishers (or more generally fisheries conducted by non-angling methods) and anglers are common phenomen around the world in situations of coexploitation of fish stocks[120–122]. Usually, both groups blame each other for loss of access, overfishing, damaging or stealing of gears or illegal harvest[106,123,124]. In situations where both fisheries target similar species, the problem of coexploitation is particularly critical enhancing the probability of 'tragedy of the commons' phenomena[125]. According to this 'tragedy', every (selfish) fisher under unrestricted access to common pool resources or public goods takes as much out of the water as he or she can get to avoid that someone else takes it. As overuse of resources reduces carrying capacity, ruin is inevitable under 'unmanaged'[126] conditions. Often commercial and recreational fisheries target similar species, which enhances the conflicting situation. For example, a study in the German capital Berlin showed that commercial and recreational fisheries annually harvested about the same amount of commercially important and recreationally valuable piscivorous fish[127,128]. Furthermore, the urban anglers living in Berlin significantly more often proposed to constrain commercial fisheries as compared to rural anglers living in Berlin, but predominantly fishing outside Berlin[129]. This is presumably related to the fact that there is still intense commercial fishing activity inside Berlin in fisheries coexploited by both fisheries, and recreational fishing is sometimes restricted. For example, for anglers night fishing is forbidden on major sections of the River Havel, *inter alia*, because control and enforcement is

difficult during nighttimes, and stationary commercial fishing gear such as fyke nets 'needs' protection[64]. In the German-wide study, constraining commercial fisheries was not on the list of highest priority for anglers[9,119], presumably because commercial fishing is today only important locally (e.g. Brandenburg and West-Pomerania). Therefore and because commercial fisheries are today often economically dependent on recreational fisheries (e.g. selling angling tickets on their waters), the conflict potential between commercial and recreational fishers is today of subordinate importance in inland fisheries.

Intrasectorally, conflicts between angler segments are common as well[32,109,118,123,130–135]. For example, some anglers, in particular the most specialized, plead for more trophy fisheries and waters with catch-and-release practices while others, in particular the least specialized and more catch-orientated, want liberalized bag limits or more stockings[73,119,132,136]. Conflicts among anglers are conceivable if social contacts between anglers are perceived to be too intense or, alternatively, rarely take place. Example of the too intense contact mechanism is the perception of crowding[108] and associated fear of overexploitation, loss of angling sites or disruption of the multiple motivations of angling such as solitude[129,137]. Thus, these conflicts may be less severe on higher-contact experiences such as urban or put-and-take fisheries[138,139] than on lower-contact experiences such as wilderness fisheries[108,118].

The second mechanism of within-angler conflict due to relatively rare interaction is related to the basic human phenomenon, that humans are more likely to draw on trust, mutual recognition and cooperative behaviour if people know each other and regularly interact than among strangers with little personal interaction and communication[101,140]. Given the high mobility of contemporary society, the issue of perceived similarity or social identity between angler subgroups, or the perception of alikeness is gaining increasing importance with respect to intrasectoral angler conflicts.

Another mechanism of within-angler conflicts can be explained by the symbolic attachment of anglers to a particular site or water body – called place attachment (i.e. the emotional ties to certain angling areas or types of areas[110]) – and 'not in my backyard' phenomena. Resident or local anglers may attach great importance to 'their' waters and might oppose anglers entering 'their backyard' from outside. Several studies have highlighted that intensive conflicts can occur between resident (insiders) and non-resident (outsiders) anglers reflected in management preferences that constrain the 'opponent' (outgroup bias[110]), i.e. the other angler of perceived different social subworlds[123,141–143]. This issue is particularly critical as modern anglers travel long distances regionally and across national and continental scales to reach angling sites[27,129,144]. Ditton *et al.*[144] argued that conflicts between resident and non-resident anglers are more likely to occur if fishing opportunities are perceived as bad by resident anglers. However, often anglers perceive angling opportunities to have decreased since the beginning of their careers as was evidenced in the nationwide angler survey in Germany[9] and noted elsewhere[11,124,145–147]. Therefore, conflicts between anglers of different social subworlds are rather the standard situation than the exception, and conflict can be as great or greater within angling as it is between different outdoor recreation activities[148]. For example, in some angler surveys in Germany, respondents often suggested expansion of enforcement measures, presumably to limit illegal harvest or simply constrain other anglers of different subgroups which are perceived not to comply with regulations and impact on one own's angling[9,64,119]. Nonetheless, angler interactions and associated conflicts differ from location to location and should always be viewed in the regional context.

Specialized carp angling (cf. reference 27) provides an illustrative example of a within-angler conflict that allows elucidating the decisive factors promoting intrasectoral user conflicts in more detail. In this conflict, which typically occurs in Central Europe, numerically less-abundant outsiders (carp anglers) are battled by numerically dominant and more powerful insiders (e.g. angling club members). In contemporary Germany, for example, carp angling practices such as camping, boat use to bring the terminal tackle out, specific baits or markers (site location) are often selectively banned by angling club rules to exclude carp anglers. The following passages are partly based on empirical data and partly derived from personal observations of the carp angler subworld, content analyses of angling magazines and discussions with anglers during the past 15 years.

In Germany and also elsewhere in Europe (e.g. U.K.), specialized carp angling is being heavily criticized by popular writers and less-specialized anglers. The main issues that were brought into the popular press are: (a) catch-and-release practices and (b) damaging of fish and ecosystems by the practice of groundbaiting[27,149–155]. Furthermore, the highly technical equipment of specialized carp anglers, their trophy fish orientation and their sophisticated angling techniques were criticized accusing carp anglers of not pursuing angling as a 'past time' any more[150]. As a result of the carp angler conflict, the use of boilies, i.e. special carp bait, which almost selectively catches carp[27,156], was banned in some water bodies[153,157,158] to selectively exclude carp anglers. However, because of the absence of scientific data, these management measures were set up rather on emotional grounds than on objective grounds. Some of the arguments stated above are understandable in the legislative

environment of Germany (i.e. the sensible issue of catch-and-release[38,50,159]), while others are not scientifically valid to justify banning of carp angling or carp baits[51] (e.g. trophy fish orientation and use of highly developed equipment). The latter 'arguments' simply reflect the well-known diversity of angler characteristics. Four different factors likely explain the intrasectoral management conflicts on carp angling.

*Activity style* Anglers may apply specific norms of proper behaviour to other participants. The more intense the activity style (e.g. specialized carp angling, fly fishing and big game angling), the greater the likelihood of social interaction with less intense anglers, which will result in conflict[160]. Carp anglers specialize to recapture, unique, personal forms of angling to distinguish themselves as 'specialists' from the 'casually involved' causing the development of 'status' and divergent 'experience quality' norms. For carp anglers, the lifestyle angling has 'status' based on equipment and expertise possessed. As other anglers may define angling as more a private affair without visible demonstrations of equipment and skill, conflict results because the private activity style's disregard for status symbols negates the relevance of the other (the carp) angler's status hierarchy. Furthermore, 'experience quality' norms differ between carp anglers and other anglers due to divergent motivations and motivational specificity (cf. motivations of specialized carp anglers[27] with motivations of the general angler population[9,128]). For example, novice anglers typically place great importance on catching fish[161], whereas the specialists such as the carp anglers benefit from many aspects of the whole experience including catching larger sized carp[27,73,136]. Generally, anglers with more specific expectations such as carp anglers are more conflict-prone than those with undefined or very general expected goals[160].

*Resource specificity* Anglers attach varying degrees of importance to the 'accepted use' and the qualities of a particular fishery. Conflict results in anglers with a possessive attitude toward the resource[160]. Many anglers confront carp anglers perceived as disrupting traditional uses and behavioural norms by claiming how a water body 'should' be fished. This mechanism is highly subjective and often takes place if carp anglers travel to new fisheries, and interact with locals being unfamiliar with specialized carp angling. If carp anglers then use new methods and approaches, many anglers resent these as being unacceptable behaviours at 'their' waters.

*Mode of experience* Anglers differ in the way they experience the environment. Carp anglers often have a well-developed sense for natural processes and can be characterized as being in a focused mode, i.e. there are senses on specific entities of the environment (cf. reference 160). When an angler in the focused mode interacts with a person in the unfocused mode, conflict occurs[160]. For example, if a carp angler claims that caught carp should be released because he or she has an understanding of overfishing problems to conserve the resource or the possibility for recapture, this conflicts with other anglers without such knowledge and focused understanding.

*Tolerance of lifestyle diversity* The last source of conflict in carp angling is related to the general unwillingness of anglers to share common pool resources with members of other lifestyle groups[160]. Interestingly, fish caught in carp angling are usually returned alive to the water thus not being subtractive goods *per se* with less potential for rivalry in consumption. However, this catch-and-release behaviour often conflicts with the greater harvest-orientation of other anglers. Due to the positive relationship between angling effort, experience and carp catch[27,162], modern, highly active carp anglers catch much higher amounts of total carp biomass per year as compared to the general angler[9,27]. Other anglers at the waterside probably only see the pictures of the carp or see big carp landed that they have never caught themselves during their angling career. Many of the less-specialized anglers simply lack the experience of catching bigger sized fish[163], which influences their tolerance of other lifestyles. This can lead to denegation of carp anglers due to some form of 'enviousness'. Concerning space, carp anglers often stay very long periods of time at the waterside, thus temporarily limiting angling possibilities for other anglers. Furthermore, they often fish at very large distances from the shore. This conflicts with the interests of other anglers, because the line of carp anglers in the water may limit other angling techniques such as spin fishing. Many anglers also resent technological improvements in outdoor recreation and thus dislike carp anglers using highly sophisticated equipment (cf. reference 160).

*Management* The only scientifically or socially justifiable arguments against specialized carp angling relate to catch-and-release and excessive groundbaiting, which, depending on interpretation, intensity and motivation, may confront with current legislative interpretation of the Animal Rights Act in Germany and may damage aquatic ecosystems[27,155,156]. I do not want to go into great detail concerning the ethical issue of catch-and-release as this was well covered by recent publications[38,39,51]. Instead, to resolve the conflict surrounding catch-and-release in carp angling, it was detailed in reference 27 how the catch-and-release practices of carp anglers might be used by fisheries managers to monitor carp stocks by mark-recapture methods[164] in view of the fact that standing carp biomasses of >25–50 $kg\,ha^{-1}$ may have detrimental effects on aquatic ecosystems due to bioturbation, reduction of submerged macrophytes and competition of carp with other benthivores (cf. reference 27, but compare with references 165 and 166). However, to

encourage participation of carp anglers, the largest carp need to be protected by appropriate regulations, e.g. maximum length limits. In fact, in Germany some angling clubs have set up maximum size limits which aim to protect the largest specimens of carp populations (e.g. >65 cm[167]), presumably for the benefits of carp anglers. Therefore, some catch-and-release under the umbrella of carp stock management and for the benefits of angling specialists is in line with sustainability principles[1,27,38,51]. Irrespective, some carp should be removed from the water bodies to balance nutrient inputs by groundbaiting. The latter issue is particularly critical and needs to be resolved in the future as it seems justified from the point of view of environmental sustainability (see reference 27 for a eutrophication model to be used by fisheries managers on the issue of groundbaiting). A total ban on groundbaiting would severely reduce the coarse angling experience, decrease angler benefit and satisfaction, and is not in agreement with the sustainable development approach in recreational fisheries management, which also has to take into account angler desires[1]. Unfortunately, existing conflicts between carp anglers on one hand and carp angler opponents on the other hand might be already so severe that even the best scientific evidence will not change socially unjust actions of restricting specialized anglers.

## Management conflicts

In addition to user conflicts discussed above, various intersectoral and intrasectoral management conflicts either between anglers and higher hierarchies of the management systems (e.g. public authorities), and among management 'systems' surrounding fisheries, animals, water and ecosystems in general are widespread in recreational fisheries (Table 1[1]). For example, protracted political and legal conflicts are day-to-day practice between anglers and higher hierarchies of management systems, because managers in authorities nearly always have consulted with professionals to set management objectives and less likely with anglers or other user groups[91]. Furthermore, sustainable recreational fisheries management is unlikely to become reality, if managers do not consider sustainability principles in their daily work or differ in their perception about 'sustainable' directions[168], or if anglers do not support sustainable management measures and actively violate them[8,64,119]. These management conflicts may either inhibit recreational fisheries management entirely or limit its effectiveness potentially with detrimental impacts on ecosystem health/integrity, angler satisfaction or angling quality. They are therefore of paramount importance in sustainable recreational fisheries management.

### *Intersectoral management conflicts*

Intersectoral management-related conflicting situations over human interactions with aquatic organisms and ecosystems have the potential to constrain recreational fisheries management or the angling practices *per se*. For instance, various antifishing protests have occurred in several countries around the world by animal right lobby groupings, which can lead to management actions banning angling entirely[169–172] or restricting angling and management practices such as put-and-take fishing, competitive fishing, live-baiting, usage of keep-nets and catch-and-release (see reference 173 for German treatment of these issues). Codes of practice for recreational fishing are a development, which is intended to address key issues of criticism to harmonize divergent stakeholder views[159,174]. Angling organizations and clubs often develop voluntary rules that go beyond existing legislation to consider the criticism of animal welfare activists. For example, in Germany the releasing of legally sized fish is typically not explicitly forbidden according to fisheries legislation[173]. In contrast, in many local angling rules ('Gewässerordnung') throughout the country, it is stated that releasing of every legally sized fish is banned. Therefore, the 'apparent' ban on catch-and-release of legally sized fish in Germany is a self-motivated reaction of the angler community to address animal welfare issues. However, antiangling currents may not represent the social norm of the general population, but instead reflect the more powerful lobbying of certain social groupings[9].

Regardless, the multipurpose nature and use pattern of inland waters have created an environment in developed countries in which recreational fisheries are often not considered of sufficiently high priority or value and thus suffer in the face of economically and socially higher priorities such as agriculture, hydroelectric power production, navigation, flood prevention and recently nature conservation[1,175–178]. This is particularly critical, as many constraints for recreational fisheries, such as long-term and often irreversibly environmental degradation, lie outside the control of traditional fisheries management due to institutional (i.e. legislation, ownership, lack of cooperation and knowledge), socioeconomic, sociocultural or financial reasons[1,117,176,177,179,180]. For example, large-scale habitat rehabilitation projects cannot be conducted by recreational fisheries management alone and require full consultation with nature conservation and water authorities and different non-governmental organizations. Furthermore, in Germany, nature conservation authorities increasingly try to expand their influences on inland fisheries management. The recently amended nature conservation law expanded the obligation of fisheries activities to correspond with a 'good managerial practice' ('gute fachliche Praxis') in order not to be judged as intervention into natural processes ('Eingriffsregelung'[83]). In the case where

fishing would be considered an intervention, fishing rights holders would have to compensate for losses of 'natural' structure and functions attributed to fishing[83,181]. Furthermore, there is an ongoing debate whether nature conservation authorities or fisheries authorities and fishing rights holders are responsible for (and able to assure) the conservation of freshwater fish biodiversity in Germany[182–185], or whether stocking programmes conducted by anglers should be restricted or entirely banned[186–188]. The latter is the result of indiscriminate stocking practices in many recreational fisheries without *a priori* appraisal of potential environmental risks, objectives and efficiency in terms of increasing fish abundance, angler's catches or harvest, genetic contamination and disruption of ecosystem structure and function[1,55,189–194]. Furthermore, recreational fishing activities are often restricted or sometimes banned in nature conservation areas[195–201]. Anglers and fishers therefore often oppose the extension and implementation of protected areas because of the fear of severe restrictions of the fishery activities[202]. Many fishery stakeholders believe that European wide legislation may further restrict fisheries activities and fisheries management in general, e.g. as a result of the 'Fauna–Flora–Habitat Directive' ECC/92/43 of the European Community and the associated 'Natura 2000' network[202,203]. If the angling activity is banned in protected areas, sustainable development of that particular recreational fishery becomes an oxymoron. However, a total ban on angling activities in protected areas seems only tolerable in circumstances where every human use including such 'non-consumptive' uses such as wildlife viewing is forbidden[201,204].

Interestingly, the management preferences and attitudes of the German angler studies indicated less intersectoral management conflicts than assumed[9,64,119,129]. Although, the Berlin angler survey suggested that urban resident anglers were concerned with the public appreciation of the merits of angling and the reduction of conflicts with animal welfare and nature conservation activists[64], the German-wide study did not reveal similar impressions[9,119]. Another example is related to the 'apparent' conflict surrounding fish-eating birds, in particular cormorants, between conservationists and fisheries managers as a result of the European Birds Directive (ECC/79/404)[205]. The anglers in the present studies in Germany, however, did not consider this problem particularly critical[9,64,119] (but see reference 206). Altogether, the studies suggested that anglers in Germany are aware of intersectoral management problems but have other priorities within their management attitudes and preferences. They may have grown accustomed to such influences and may accept the specific situation in Germany. However, direct influences from outside the fisheries sector on recreational fisheries management may impose perhaps the greatest long-term threats for the continued existence of recreational fisheries management and thus for sustainability[1,207,208]. For recreational fisheries systems in general, the challenge ahead is to ensure, e.g. by appropriate socioeconomic evaluation, that recreational fisheries interests are well represented in all developmental activities concerning aquatic ecosystems. This challenge is highly relevant, for example in the implementation of the European Water Framework Directive (2000/60/ECC of 22 December 2000), which might have substantial influences on the development of freshwater fish communities and hence angling opportunity and quality. According to the European Water Framework Directive, in the period to 2009 integrated river management plans need to be established in each member country of the European Union, and fisheries agencies and stakeholders should aim at being proactively involved in the development of such plans. However, as the recent discussion on pain and suffering in fish demonstrates (compare references 209–211), harmonization of mostly anthropocentric (anglers and fisheries managers) and biocentric worldviews (nature conservationists and animal welfare activists) is the paramount prerequisite to resolve existing conflicts, which resembles a sociocultural and political issue[1]. Such intersectoral management conflicts seem to be related to social group processes encouraging social identity together with communication and perception barriers (e.g. lack of empathy), which mutually cause and reinforce each other[212]. For example, the Social Identity Theory[213,214] predicts that social categorization results in social discrimination because people make social comparisons between in-groups and out-groups. The resulting stereotyping negatively affects communication among opposite groups, e.g. conservationists and consumptive users such as anglers[212].

### *Intrasectoral management conflicts*

Intrasectoral management conflicts between anglers and recreational fisheries managers/management, or between recreational and commercial fisheries management, e.g. with respect to allocation of fishing rights, are common in recreational fisheries systems as well[106,107,120,122,215,216]. Greatest opposition to fisheries management actions can be expected from angler groups that experience the greatest real or perceived adverse effects[217]. This can lead to non-compliance of anglers with (or unawareness of) regulations, active violation of rules and non-cooperative behaviour[122,140,147,218–220]. Gigliotti and Taylor[221] demonstrated that angler's non-compliance with regulations might have dramatic effects on fish populations. Opposition to and violations of regulations and other management measures is not only dependent on the angler's human dimensions such as values,

attitudes, perceptions, degree of specialization and other characteristics[64,73,123,129,135,136,222–225], but also strongly depends on type of regulation and catch rates. For example, illegal harvest may be higher in fisheries managed by size limits than in catch-and-release fisheries[220]. Furthermore, Sullivan[220] showed that illegal harvest of undersized fish increased exponentially with decreasing catch rates in Alberta (Canada), thereby creating a strong depensatory response to declining catch rates.

Although angling is more than simply catching fish[128], it was shown that angler satisfaction in Germany predominantly depended on the catch aspects of the activity, primarily if the catch expectations were fulfilled[119]. This was also supported by other studies[26,138,206,226–232], which demonstrates that catching fish remains one crucial aspect of how individual anglers perceive 'angling quality'. Basically, there must be some minimum probability of catch success before non-catch satisfaction components gain increasing importance[233]. If fish stocks decline and fisheries management measures aiming at protecting fish stocks and stabilizing 'angling quality' interfere with the individual's catch expectations, management conflict is highly probable. However, the likelihood and severity of conflict varies with dominant recreational fisheries management strategies that either target the fishery (e.g. regulations), fish stocks (e.g. stocking) or the whole ecosystem (e.g. habitat management) (see reference 1 for rationale behind this categorization).

*Regulations targeting the fishery* Regulations in recreational fisheries management encompass input controls (e.g. allocation of fishing rights, effort limitation, closed seasons and areas) and output controls (e.g. size and bag limits, and protected species)[1,234] that aim at protecting, enhancing or manipulating fish populations (e.g. to promote predation pressures on certain trophic levels[235]), increase angling quality (e.g. size of fish) or distribute fish harvest more equitably (see references 236–238 for details). As regards intrasectoral management conflicts in industrialized societies, mostly angler objections to regulations specifically set by recreational fisheries management are relevant, and thus will be discussed in greater detail below. Some remarks on allocation conflicts between recreational versus commercial fisheries rights will also be given.

Although more efficient and restrictive regulations (e.g. closed areas) can benefit each individual, anglers typically oppose management practices that might more directly restrict their own activity, while they support or more readily accept tools which do not interfere or are perceived to interfere less with own behaviour[8,9,25,119,123,132,139,192,223,224,239–243]. This fact is related to Brehm's Theory of Psychological Reactance which states that reactance of humans rises when personal rights to decide and act are threatened, reduced or eliminated, for example via regulations[244]. Additionally, reactance to change own behaviour can occur due to the fact that anglers tend not to view themselves as a crucial part of the problem of declining fish stocks and angling quality and, in fact, tend to view themselves as a solution[9,113,119,245] (but see reference 246). Anglers seem to overcome any cognitive dissonance by justifying their traditional practices as being beneficial to fish populations instead of considering them harmful. For example, anglers in Germany, on average, negated a potential harmful impact of the angler's activity on the fish stocks and perceived third stakeholders to impact more[9,119]. Consequently, the necessity to change current angler behaviour was not appreciated by the majority of the anglers in Germany[9,119]. This suggests that compliance with more restrictive regulations will be low as a result of the low acceptance as being part of the 'problem'. Generally, anglers seem to be too optimistic about the effects angling can have on ecosystems. Burger[247] suggested that anglers deamplificate risks of hazards (e.g. overfishing) that are familiar and enjoyed. Optimistic biases may arise because no acute effects are experienced or visible[248], and humans in general have difficulties to make reasonable judgements given complex, uncertain, non-linear and slow processes that characterize socioecological systems[63].

Concerning output controls, in recreational fisheries management, predominantly daily bag limits and minimum size limits have been used in the past[1]. Input controls, e.g. restrictions on total allowable angling effort, have been applied only rarely, if at all[59,60,75,145,147,249,250]. In the German nationwide survey, anglers opposed expanding closed seasons, increasing minimum size-limits and lowering daily bag limits, while they, on average, supported a variety of regulations with a lower probability of self-restriction (e.g. increase enforcement[9,64,119]). Gillis and Ditton[251] stated that anglers seem to be willing to accept very restrictive management policies only if the average number of hooked fish or the average size of the catch increases. However, this can hardly be guaranteed before the management programmes are implemented, presumably fuelling the problem of angler opposition.

Given the increasing angling pressure and to allow equitable access to as many anglers as possible, more restrictive harvest regulations will probably always form part of future recreational fisheries management[37,238]. However, opposition of anglers is very likely, and this stems, *inter alia*, from the fact that increasing number of anglers and improved fishing technology typically lead to catch distributions that are more skewed with increasing resource scarcity[252,253], resulting in even more conflict in addition to the perceived or real fear of own restriction. Furthermore,

many regulations in traditional recreational fisheries management are set somewhat arbitrarily[254]. For example, in Germany, certain regulations such as size-limits and bag-limits are set in fisheries byelaws which target whole federal states without consideration of the local diversity of fisheries. This 'one suit fits all' strategy may erode the resilience of the whole socioecological system[255]. Furthermore, the effectiveness of many regulations (e.g. length-based limits or bag limits) remains unsure and dependent on local conditions[60,147,254–269]. Regulations such as size limits may, in fact, have their greatest impact not through restricting harvest of individual anglers but by altering number of anglers or total angler effort[268–271]. Some common techniques, in particular daily bag limits, may provide anglers with an unrealistic benchmark with which they measure fishing quality and their own success[263]. Coupled with the uncertainty about the efficiency of regulations, this can further increase the management conflict as most anglers do not reach daily bag limits and thus their 'expected' catch[254,263,265]. Catch expectations strongly influence the management preferences of anglers suggesting a conflict potential with sustainable management practices such as habitat rehabilitation in the case of unrealistic high expectations or dissatisfaction due to the inverse relationship between expectation and satisfaction[8,9,119].

Other management conflicts surrounding regulations relate to public fisheries management policies/legislation, and allocation of fishing rights between commercial and recreational fisheries[64,122,127,272]. In Berlin, many anglers suggested reducing bureaucracy and regulations in general, which, *inter alia*, is the result of the federal system in which each of the German states has its own fisheries legislation. Thus, if anglers in the city-state of Berlin want to fish outside Berlin, they have to inform themselves about the local rules (both angling club rules and fisheries legislation[64,127,129]). This information is often not easily accessible and causes trouble. Other conflicts between anglers and public fisheries management bodies may occur if price increases or implementation of fishing taxes reduce net benefits for individual anglers, which was apparent in the Berlin study as well[64,127]. This is critical as fishing taxes are paid in Berlin, and substantial fishing effort is directed towards rural fisheries outside the city borders[127,129]. Thus, public fisheries responsibility, which is partly financed by anglers, and angling taxes, effort and impact are spatially decoupled. Finally, in Germany anglers are forced to pass an angling examination before being allowed to receive angling tickets. This creates strong barriers to total angling participation and may be a reason for the substantial fishing activity of German residents outside Germany[9]. Furthermore, foreign tourists are not allowed to angle in Germany, with few states offering exceptions to the obligation to pass an angling examination.

Concerning the allocation issues between commercial and recreational fisheries rights, the long-term trend of commercial fishing is decreasing in Germany as in all industrialized societies[1,66,128,273,274]. As commercial inland fishing is only rarely subsidized, changing consumer demands and high labour costs limit the profitability of the commercial enterprises, which can lead to abandonment of the activity[66]. Anglers sometimes try to eliminate commercial fishing activities by leasing or buying commercial fishing rights[275,276]. As in Germany, every fishing rights holder (either owner of water bodies or leaseholder of fishing rights) has the duty to manage the fish stocks and maintain and promote the health and functioning of entire aquatic ecosystems, unless the fishing rights holder can assure the management by either means, commercial fisheries rights will be taken over by recreational fisheries in the future. Hence, the allocation issue between commercial and recreational fishing rights is relatively self-regulating. However, fishing rights may also be leased by non-fishing stakeholders such as nature conservation organizations who often restrict or ban recreational fishing on their waters. This does not imply that the shift from commercial to recreational fisheries rights will happen immediately. For the future, instead of regarding recreational and commercial fisheries as competitive, it is recommendable to use synergistic effects. Commercial fishing enterprises might increasingly evolve into service industries in the future, managing fish stocks for the benefits of anglers. Furthermore, recreational fishing clubs are envisaged to hire commercial fishers for stock assessment and other management purposes (e.g. reducing unwanted species), because angling alone is rarely able to accurately assess the status of fish stocks[175,277,278]. By a stronger hand-in-hand cooperation of anglers and fishers, win–win situations could be created. This may ultimately lead to self-regulated management systems, which depend only slightly on intervention by the public hand. Synergistic effects may also arise from the implementation of the European Water Framework Directive because the demanded monitoring of fish populations may be done by commercial and recreational fishing stakeholders for the benefits of whole society.

*Stocking as a practice targeting the fish stocks*

Concerning stocking practices in general, apparently less management conflict potential exists from the point of view of the angler – recreational fisheries management interaction. Less angler opposition to stocking in general occurs because this is usually considered a beneficial measure to increase angling quality and protect fish stocks, unless stocking is performed with species that interfere with the angler's species preferences[135]. Schoolmaster and Frazier[222]

noted that the angler's perception of inadequate number of fish in a water body increases support for stocking. Stocking levels and angler effort are often positively correlated[59,279,280]. However, high stocking rates do not necessarily increase total angling participation in terms of increased licence sales[281].

Most studies on the management attitudes and preferences of anglers indicated that anglers generally support enhancement strategies based on stocking[9,26,64,119,123,142,224,282–287]. The explanation is straightforward. Stocking fish is perceived by many anglers as prompting potential immediate rewards in terms of increasing fish abundance and associated catch opportunities. Theorists have found that humans prefer smaller, immediate results (e.g. rewards in terms of catching stocked fish) to larger results (e.g. higher fish abundance due to habitat rehabilitation) in the deferred future[288]. Stocking is the most visible action in an attempt to reduce overharvest or recruitment failures due to environmental disruptions. It is the most widespread measure for management of inland fish stocks in general, and has been performed intensively for decades in the 'technocratic' belief of humankind that technological measures can compensate for ecosystem alteration caused by human actions such as damming of river systems[289]. Therefore, many recreational fisheries managers still believe stocking to be among the most beneficial options[26,290–292], although scientific evidence contradicts this view in some cases[7,189], and inadequate habitat structure is known to predominantly constrain the fishery in many circumstances[291–297]. Hence, although managers often perceive habitat degradation as the most important threat for maintaining self-sustaining fish populations, and anglers often prefer natural to wild fisheries[9,289], in public fisheries agencies and in angling organizations a substantial part of the budget is directed towards maintaining hatcheries and conducting stocking programmes[295]. This disconnect is due to a mix of the institutional history, the way agencies are funded, public expectation[295], and the difficulty for recreational fisheries management to conduct habitat improvement works alone. Unfortunately and similar to the literature on regulations, the existing evaluations of stocking programmes are equivocal making it impossible to derive general recommendations on stocking that will work on a larger scale (compare for example stocking recommendations for walleye, *Stizostedion vitreum*[299–306]).

There is no doubt that stocking will continue to be an important part of recreational fisheries management in the near future. Albeit being ecologically risky, there are circumstances where stocking is justified, e.g. to create a put-and-take fishery in an enclosed fishery. Furthermore, where fish species are on the verge of extinction or where bottlenecks to natural recruitment cannot and will never be eliminated, continuous stocking seems appropriate. The latter is for example the case in artificial, purpose-built water bodies with virtually no natural recruitment. Definitely, however, the current practice of conducting stocking events, which often resemble arbitrary habit than thorough planning[1], has to change with respect to sustainable recreational fisheries management[1]. Therefore, although today stocking seems to induce less management conflicts as compared to harvest regulations and more restrictive regulations in general, controversies and conflicts over stocking will increase in the future, unless managers communicate proactively with anglers, convince them about a more cost efficient use of their resources and the long-term benefits other measures such as habitat revitalization can generate[64]. Conflict is highly probable, though, because the deeply embodied belief in stocking of anglers biases the biological reality, in that anglers may perceive that good angling and healthy fish stocks mainly exist because of 'putting fish into the water' and not because of good quality habitats at sustainable fishing mortality levels. Teisl *et al.*[243] stated that angler preferences for potential management programmes seem to be primarily driven by the size of the resulting fish stock and are less dependent on whether a fishery is natural or stocking based. Thus, if managers achieve to educate anglers that non-stocking-based fisheries management will meet their general goals, less conflict is probable. However, the likely decrease in justified stocking programmes in the future will probably increase stocking conflicts between anglers and managers, in particular if socioeconomic and institutional barriers limit management alternatives, e.g. large-scale habitat rehabilitation projects. Private angling clubs often have internalized a 'do-something' norm meaning that the 'do-nothing' alternative to the management of freshwater fisheries is often disregarded or not accepted as a possible strategy.

*Habitat management targeting the ecosystem*
Typically, the lack of appropriate integrated recreational-fisheries management approaches in developed countries and the lack of familiarity of anglers with the sustainable management paradigms, measures and approaches create conflicts between the desired outcomes of management as perceived by anglers and the necessary outcomes as perceived from a holistic sustainable recreational-fisheries management perspective[64]. Furthermore, managers are rarely able to accurately foresee the preferences, reactions and behaviours of anglers[283,287]. One excellent example of this type of management conflict is the current disparity in the call of fisheries researchers and conservation biologists to move recreational fisheries management from single-species approaches based on stocking of hatchery-reared fish (see above) towards what is called ecosystem-based multispecies recreational-fisheries management[1,307,308]. This

basically means that the traditional focus on stocking fish has to move towards a strategy based on rehabilitation and mitigation of habitat structure and function on larger scales, particularly in densely populated countries of Central Europe. The latter habitat-orientated approach has the ability to provide long-term benefits to anglers and society as a whole in addition to benefiting entire biocoenoses, whereas the former stocking-orientated approach benefits single species, if at all[1,7,189,289,309,310]. However, the most basic prerequisite for habitat-orientated recreational fisheries management to proceed is that the majority of stakeholders in general and anglers in particular support habitat management at the expense of other measures[64]. Basically, anglers need to share the norm of habitat management being the most promising management option to manage complex ecosystems. This is particularly critical as environmental degradation is still the pre-eminent constraint for the sustainability of inland fisheries in general[208]. If anglers indicate the behavioural intention to support habitat management and not stocking as a means to increase angling quality, this can be considered an indirect pro-environmental behaviour based on support and is the best measure of environmental concern of anglers[64]. Environmental concern can be defined as 'insight into the endangerment of natural resources, connected with the willingness to do something against it'[311]. If the majority of anglers would exhibit high levels of environmental concern or indirect pro-environmental behaviour, this would indicate less management conflict potential and less education efforts necessary to proceed with ecosystem-based recreational-fisheries management.*

In the angler survey in Berlin, most anglers indicated the management preference to support stocking over habitat management[64], and no significant differences between urban and rural anglers were found[129]. The low 'environmental concern' of anglers in the urban environment was interpreted as a response to the shifting baseline syndrome. In essence, this syndrome means that fisheries scientists and anglers relate their baseline against which to judge the desirable state and necessary management options to conditions personally experienced at the beginning of their lifetime or in their angling career[62,64]. As most water bodies inside Berlin were degraded before 1900, i.e. before most of the existing anglers started angling, degradation of the environment may no longer be perceived as the primary threat of sustainability (see reference 64 for more details). This is then reflected in the low awareness of habitat management as a beneficial recreational-fisheries management measure. However, other explanations for the response pattern in Berlin are also conceivable. For example, the seemingly irreversible degradation of the urban environment may have led to public pessimism, a feeling of 'helplessness' and low expectations about the possibility to reverse environmental conditions.

The response pattern of the nationwide German angler study differed substantially from the Berlin angler survey, which either reflects lower levels of the shifting baseline syndrome or is the result of the survey procedure (e.g. mail versus telephone survey with the latter increasing the likelihood of socially desirable answers). In a nationwide survey, most anglers expressed the behavioural intention to support habitat management[9,119]. However, nearly as many anglers supported stocking indicating habitat management and stocking as being rather rival management tools. Other management preferences were of minor importance in the German-wide study. Similarly, some other angler studies have reported that habitat management was preferred over stocking by anglers[287,312–314]. However, all of these studies used attitude or opinion measurements, which is a static approach to measure the management orientation of anglers[25].

Altogether, the data from Germany and elsewhere suggested that the angler would follow habitat-orientated recreational-fisheries management as long as protection of the resource base and habitats is compatible with existing behaviour and does not restrict usual habits[9,119,123,142]. Opposition to habitat management and the 'new' ecosystem-based recreational-fisheries management paradigm may occur because of little personal experience with the habitat management concept (lack of familiarity hypothesis). Anglers may also perceive this as an untested theory or a threat to continued angling participation[315], which is particularly critical in Germany. Anglers might simply be afraid that restoration of habitat quality will be quickly followed by restrictions on angling use as a result of the contemporary strong nature-conservation movement. However, we should again be reminded that large-scale habitat rehabilitation projects cannot be conducted by anglers alone, and integrated approaches are needed.

## Towards a qualitative model of conflict explanation

The preceding sections have described various conflicts that can arise in the environment in which angling takes place. The focus of the examples given was on Europe in general and Germany in particular. However, many of the factors facilitating

*It is important to note that the scientifically premature management paradigm 'ecosystem-based fisheries management' does not necessarily equate with habitat management in freshwater fisheries management. However, it is a useful proxy in the discussion here, because a stronger support for habitat management at a reduced belief in stocking would indicate that anglers also consider the wider environment and not only single species of angler interest in their management preferences.

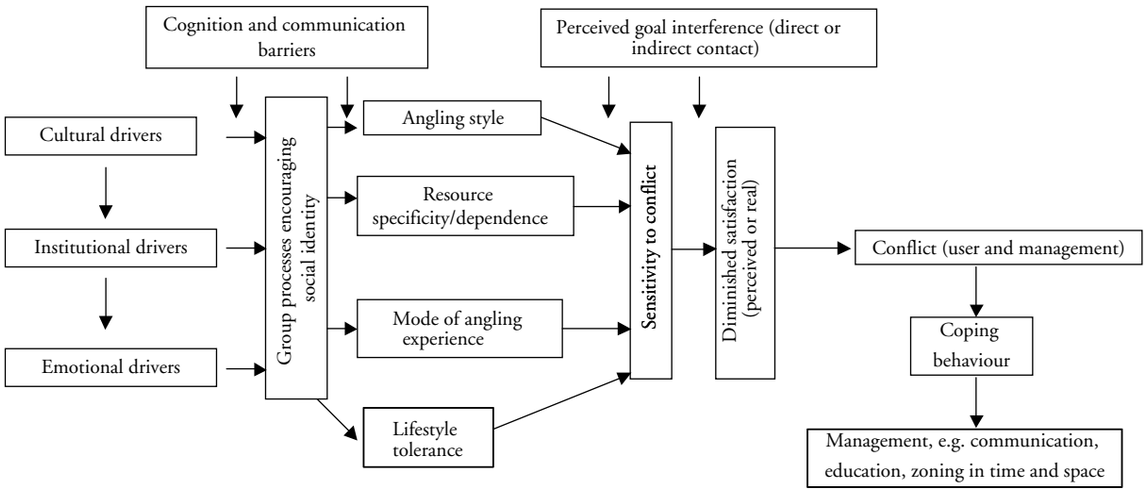


**Fig. 1.** Expanded conflict framework in recreational fisheries management. See text for explanation.

and explaining conflicts in recreational fisheries are broad in scope and will, to varying degree and strength, apply in many regions of the world. Therefore, this section aims at extracting the main variables stimulating conflicts discussed above and unifying them into a qualitative conceptual model (see Fig. 1). The resulting framework builds on two previously described conflict models of Jacob and Schreyer[160] and Stoll-Kleemann[212]. The theoretical underpinning of the model is partly based on empirical evidence discussed above. However, it is not a complete empirical model and further research is needed to test the variables shown in Fig. 1. It may nevertheless serve to derive testable hypotheses for specific investigations in the future. Notwithstanding, a limiting factor in the literature on recreation conflicts is the lack of consensus about its operationalization and measurement[148]. The model in Fig. 1 may help to improve future treatments on conflict in recreational fisheries. However, it should also be noted that in some situations conflicts might be less pronounced than commonly thought[148].

There is no key factor explaining conflicts. The variables shown in Fig. 1 may change in strength, interaction and direction from situation to situation mutually causing and/or reinforcing each other. Central to the conceptual conflict model in Fig. 1 is the observation that many conflicts in recreational fisheries do not necessarily depend on direct interaction between stakeholders and 'goal interference attributed to another's behaviour'[160]. At a higher cognitive level of observation, conflicts, and often the most pervasive conflicts, arise independent of physical contacts between stakeholders[148,316]. These situations are most often related to diverging values, perceptions, attitudes and other human dimensions ('value or social conflicts', e.g. between anglers and non-angler, cf. reference 316). From the social psychological perspective, often there is a special application of the discrepancy theory at an individual conflict level (i.e. the difference between desired and achieved goals), where dissatisfaction is attributed to another individual's or group's behaviour (goal interference hypothesis[160]) or the 'behaviour' of entire management systems (Fig. 1). Some conflicts, in particular conflicts between user groups described in the preceding section, can be explained by the relative deprivation theory (cf. reference 121). Central to relative deprivation is the idea that simply lacking some desired good or opportunity does not by itself lead to feelings of dissatisfaction, resentment or anger (Fig. 1). However, when deprived persons compare themselves with non-deprived persons, the result is 'relative deprivation'. This may occur in two ways. First, another person's or management systems' behaviour can actually alter the desired social and physical components of the angling experience or secondly, no one else may be objectively responsible for the goal interference and scapegoating occurs (i.e. feelings of personal frustration or failure are projected onto another, thus displacing the locus of responsibility[160]).

These phenomena are highly subjective in many cases and are dependent on individual traits and behavioural patterns. In outdoor recreation, these individual factors most importantly are related to activity style, resource specificity, mode of experience and lifestyle tolerance (Fig. 1, see also below[110,160]). These individual traits, however, are influenced and shaped by more general factors at the level of societies or social groups such as anglers, angler subworlds (e.g. specialized fly fishermen), conservationists, agency personnel of a fisheries agency or animal welfare activists. Such societal factors include (1) cultural drivers [i.e. values of specific cultural environments

of societies at the national or regional level (e.g. specific norms of ethical behaviour)], (2) institutional drivers [i.e. formal (e.g. laws) or informal ways (e.g. freely engaged behaviours) of organizing social systems], (3) emotional drivers (i.e. subjective feelings resulting from cultural or institutional influences). These social factors can lead to cognitive and communicative barriers and encourage group processes of social identity[212] (Fig. 1). This process may operate in such a manner as to inhibit any scope for supportive ways of communication and problem-solving interaction between the conflicting groups. What follows briefly describes the single variables of the conflict model in Fig. 1 and how they are interrelated by referring to a specific intersectoral management conflict between nature conservation and recreational fisheries players in Germany.

As was introduced by Jacob and Schreyer[160], in outdoor recreation including angling, at least four types of individual characteristics of single persons may produce conflicts: activity style (i.e. the various personal meanings assigned to an activity), resource specificity (i.e. the significance attached to using a specific recreation resource for a given recreation experience), mode of experience (i.e. the varying expectations of how the environment will be perceived) and lifestyle tolerance (i.e. the tendency to accept or reject lifestyles different from one's own). These individual traits determine the sensitivity of individuals to conflict and may lead to perceived goal interferences, diminished satisfaction and ultimately conflict as was described in the intrasectoral user conflict between specialized carp anglers and non-carp anglers (see the Intrasectoral user conflict section above). These core individual factors of recreational fisheries conflict, however, are dependent on and influenced by more general factors acting at the level of social groups or societies at large. For example, cultural drivers such as the challenge to traditional values (e.g. utilitarian values of consumptive resource users such as anglers challenged by a nature conservationist's or other non-consumptive users group's call for maintenance of biodiversity for its own sake) may lead to the set up of new institutions such as a law imposing a restriction on angling in protected areas or an informal norm that angling for any other reason than catching fish is unethical. Both happened in Germany in the last few decades, where nature conservation and animal welfare legislation constrained angling practices such as catch-and-release fishing, live-baiting, competitive fishing and access to fisheries in nature conservation areas. These cultural and institutional drivers can result in emotional drivers (i.e. subjective feelings) evolving among those involved in the management or extractive use of natural aquatic resources. Such an emotional driver might be the impression among anglers facing restrictions to usual habits due to a new recreational-fisheries management regulation coupled with the perception of not being involved in the planning of the regulation[212]. This feeling is often reinforced due to the lack of structured communication between nature conservationists and resource users because there is no formal institution (e.g. a law) demanding it on a regular basis before taking a management decision[91]. From the perspective of conflict, this will negatively influence the cognition, perception and way of communication of those involved in recreational fisheries and aquatic resource management. For example, this may result in fear among anglers that nature conservationists are always a threat to angling, or alternatively lead to the stereotypic feelings among nature conservationists that anglers are always a threat to the protection of aquatic ecosystems[212]. Many conservationists view themselves to be primarily ecologically orientated rather than considering social and economic dimensions of natural resource use and management. They thus consider their agenda in a narrow ecological sense rather than in terms involving adjacent areas, local people and resource users (e.g. anglers), and other stakeholders. In contrast, anglers and their organizations often perceive the opposite by considering resource use of fishing superior and more important than any other aspect of natural resource management including resource conservation. Thus, the basic value system of nature conservationists and nature users is often opposing (e.g. biocentric versus anthropocentric[317]). This can cause stereotyping and strengthen a sense of group identity (e.g. groups of anglers versus groups of 'greens' as perceived by anglers), further leading to stereotyping and to an increase in communication barriers and social group identity, which ultimately aggravates the conflicting situations[212].

Therefore, at the core of many conflicts there are cultural, institutional and emotional drivers that influence individual factors mediated by communication barriers and group processes leading to social identity, i.e. social discrimination between in-groups (e.g. anglers) and out-groups (e.g. non-angling nature conservationists). The same may apply to the two angler groupings, which differ in cultural background and amount of regular face-to-face interaction (informal institutions), and lack empathy. The differing social perceptions of actors involved in conflicts, shaped by the particular value systems (cultural drivers) of the groups they belong to, lead to differences in particular cognitions (e.g. attitudes) towards conflicting situations and actors. This process can operate in such a way as to inhibit the scope for conflict resolution processes and may lead to the development of conflict-inducing institutions. This causes further negative emotions and reinforces social identity and the associated individual factors (activity style, mode of experience, lifestyle tolerance and resource specificity).

Emotion-focused and problem-solving coping behaviours of anglers such as displacement (i.e. intrasite, intersite or temporal shifts, resource or even activity substitution) or norm shifts (i.e. adjusting expectation or the norm of evaluation) may then occur in response to conflicts[110,318]. However, angling is a fairly unique activity, with few other resources (e.g. other waters and other fish species) or activities (e.g. new leisure activity) offering substitutes that provide the same benefits from the angler's point of view[318]. Ultimately, conflict has to be addressed by appropriate management actions. Some management implications addressing the examples given in the previous section will therefore be given below to move recreational fisheries management closer to sustainability.

## Management implications

Recreational fishing conflicts promise to be much more than mere brushfires. Once conflicting players have allied themselves with interest groups, conflict resolution becomes a costly political and legal process over which the managers and scientists often have little control and influence[135]. A wise recreational fisheries manager must learn to manage and prevent conflicts and, when conflict exists, to negotiate these conflicts to a positive end. Human dimensions research insights may play a crucial role in the conflict resolution process. Communication with and involvement of all (or the majority of) stakeholders can prevent conflict and is therefore highly recommendable[319–321]. Sometimes cooperative conflict resolution based on a facilitator may be needed, although care is taken to seek compromising solutions in every case[103,322]. Ideally, win–win situations should be achieved by 'principled negotiations', where all conflict parties 'win' to avoid the development of the perception of 'winners' and 'losers'[103,323].

Unfortunately, conflicts in recreational fisheries management have created the perception of many involved in the progress of aquatic ecosystem management that expressing one's view and interests antagonistically is the only appropriate way forward. This is considered a generally bad approach to conflict resolution and management. With this so-called positional bargaining, each side states a position, argues for it, and then makes concessions to reach a compromise[103]. In many circumstances, simply to change the current way of argumentation and communication by acknowledging divergent, values, views and multiple stakeholders of aquatic ecosystems, including angling and biodiversity, would constitute a paramount progress towards sustainability. However, diverse players have often more in common than they realize. For example, both nature conservation and recreational fishing would benefit from large-scale integrated habitat rehabilitation projects in regulated rivers or food web manipulations in eutrophied lakes that benefit whole communities instead of single species. Thus, cooperation through strategic alliances between conservationists and anglers, and fisheries managers to increase efforts of habitat rehabilitation or mitigation approaches would be highly desirable for apparently 'conflicting' parties, and efforts initiated by angling stakeholders can substantially improve the dialogue.

It is therefore advisable to first try to resolve most of the conflicts in recreational fisheries, and particularly emotional, value-driven user conflicts, by 'soft paths' (information, persuasive communication, education and cooperative conflict regulation) and by user participation in management decision making[324]. If this does not succeed, stricter regulatory mechanisms should be pursued. When heavy recreational demand threatens the ecological and social carrying capacities of aquatic ecosystems and satisfaction of individual stakeholders, restrictions on individual use, such as space and time zoning, are required[25,112,325]. Such an approach may be most effective where anglers and other recreationists interact directly. For example, concerning Berlin it is recommended to allow, expand and promote night-fishing opportunities to reduce congestion during daytime. Furthermore, site alternatives have to be offered in the case where access restrictions exclude anglers from a particular fishery.

Concerning regulations and stockings, literature suggests that such actions can only be effectively planned, conducted, enforced and evaluated on an ecosystem-specific basis to achieve specific objectives such as increase the mean length of particular fish species[326]. It is necessary to have knowledge about a variety of ecological, institutional and angling parameters such as habitat structure, growth, mortality, structure of the population, catchability, cost, angler preferences and angler behavioural responses to make informed and thus sustainable decisions regarding angling regulations and stockings. Furthermore, factors that specifically determine the success of stockings such as degree of natural recruitment, area of water, stocking rate, origin and size of seed, precondition, acclimatization, and timing and location of stocking have to be considered[7,327–329]. Anglers need to be included in the whole process of regulation, stocking planning and monitoring to increase their knowledge base and ecological understanding, by adapting their expectations and encouraging compliance and support. Managers are envisaged to follow the existing stocking protocols recommended in the literature[1,7,189,329–331], including ecological risk assessments[91,332,333]. This greatly complicates the situation for local recreational fisheries as much more information and effort is needed before the stocking event may take place. In the case where the information cannot be gathered, there is a necessity to comply with

precautionary approaches and principles in an attempt to conserve ecological integrity and biodiversity across all scales (genetic, species, metapopulation, ecosystem and catchment).

However, under certain conditions, stocking may impose less conflict potential between society and recreational fisheries, e.g. intensive stocking of piscivorous fish of autochthonous populations to increase predation pressure on zooplanktivorous fish, which in turn may ease the top-down control of herbivorous zooplankton in standing water bodies[235]. Higher abundances of zooplankton may then reduce algal biomass and increase water clarity (biomanipulation principle[1,235]). There is some potential to combine water quality management with recreational fisheries management under the umbrella of biomanipulation or food web management, because stocking of top-down predators is in agreement with the angler's species preferences in many regions of the world and thus support is very likely[1,235,334,335]. The success of food web manipulations is however dependent on multiple factors such as appropriate restoration efforts in the catchments, continuous fisheries management measures, angler compliance and effective harvest restrictions and is by no means a simple task[235]. Conservationists are envisaged to also acknowledge benefits and interests of anglers and not try to impose bans on stocking irrespective of the local conditions. For example, there are only limited objective arguments against stockings in structure-less, closed water bodies where natural recruitment is low, but angler benefits can be high, e.g. in urban water bodies[310]. Moreover, certain hatchery operating protocols using native fish species originating within the catchment or even the target-ecosystem, and considering population genetic and ecological issues such as effective population size and appropriate social skills (e.g. predator avoidance behaviour) of the individuals to be stocked, may reduce the ecological and genetic risks associated with stocking and constitute a valuable new source of income for smaller aquaculture enterprises.

With regard to various forms of regulations, under conditions of unsustainable high angling effort and harvest, promotion of various forms of catch-and-release angling[336–339], and partial restrictions on access or total allowable effort (input control) or total-harvest limitations (quotas, output control) may be the most promising alternatives to protect fish stocks and their 'natural' age and size structure, and increase angling quality and angler satisfaction[59,60,75,119,145,245,249,250,259,269], e.g. the abundance of larger fish. However, the enforcement of output controls such as daily bag limits is much more difficult and costly than the enforcement of access and/or effort restrictions or input controls in general, and rule compliance behaviour is critical for success of nearly all output control measures. Nonetheless, most regulatory changes will be quickly accompanied by opposition of anglers, e.g. by those excluded or not willing to reduce harvest levels, *inter alia*, due to the limited tradition of input control measures (e.g. effort limitations) in recreational fisheries management[145]. It is a matter of management judgement, if comparatively unrestricted angler access is given priority at the expense of low individual angling quality on larger scales (e.g. catch of large fish in a densely populated region with limited availability of fisheries), or restricted access and partial catch-and-release fishing of legally sized fish* is preferred to increase individual angling quality and conserve and maintain certain fish stock characteristics, at least locally. Under unlimited access, which undoubtedly corresponds to democracy to allow everyone to angle who wishes to, fish stocks will often be 'overfished', or at least measurably be altered in size and age structure, and individual angling quality will be low, unless access costs (time, money and effort) are high[59,60,75,145]. However, much more research efforts are needed to confirm the potential of recreational fishing to negatively affect the structure and recruitment of fish populations, and the effects will vary depending on the availability of fishable waters and angler density/effort in a region. Overall, the great complexity surrounding planning and management of regulations suggests great intrasectoral conflict potential for the future. Increased societal investments in recreational fisheries research and management are needed to comply with the demands set by the sustainability concept. The regional and local agencies and people responsible for recreational fisheries management can only partly be made responsible for existing and often invisible management failures.

With regard to the challenge of increasing the environmental concern of anglers (and the associated support for sustainable management strategies such as large-scale habitat management), the empirical evidence to date[8,9,64,119] suggests that motivations, values and attitudes, i.e. basic human characteristics, might be better suitable to predict the angler's management preferences than behavioural and demographic characteristics including angling experience and school education. However, basic human characteristics at higher levels of the cognitive hierarchy are notoriously difficult to alter by education programmes[317,340]. To increase the support for habitat management at the expense of the support for stocking, managers need to convince anglers about ways to meet their own targets by rehabilitation and mitigation of habitat structure and function. Ultimately, angler satisfaction levels need to

*Catch-and-release fishing in the context discussed here and elsewhere in the present paper does not explicitly mean 'catch-and-release only' regulations. However, the situation of specific fisheries may demand that old and/or large fish be protected which in turn would speak for some or partial catch-and-release of large/old fish.

be enhanced to increase support for habitat management as opposed to stocking[8,9,119,341]. However, it is illusionary to assume that simply enhancing the effectiveness of traditional recreational fisheries management approaches based on harvest regulations and stocking will automatically increase satisfaction levels of anglers and thus support for habitat management as intensively discussed by Arlinghaus[9,341]. Regulations and stockings are not only themselves very difficult to plan. In contrast, even the best planned regulation or stocking programme may be outpaced by strong numerical responses of anglers, if fish stock recover and angling quality increases leading to perverse dynamics which were described in Arlinghaus[9,341] as 'paradox of enhancement' and 'paradox of satisfaction'.

Although these paradoxes remain to be tested in detail, a divergent, parallel approach is suggested for the future: limiting angler access, angling effort (and thus angling mortality) and stocking rates in less degraded, but intensively exploited waters with adequate natural recruitment of recreationally valuable fish species, and relatively unrestricted angling effort without major restrictions on stocking in degraded and artificial waters. Control of angling effort (and indirectly angler harvest) in the less-degraded waters may take place by direct access restrictions, increase in access cost (time and money), lottery systems of access, annual rotating access schemes (e.g. among angling club members), licence price increases, implementations of total allowable angling effort (e.g. days) schemes or a combination of the options. This could lead to high catch rates of naturally reproduced fish and satisfied anglers in the fisheries of 'higher ecological quality' and may help to create the feeling of protection and casual relationships between habitat integrity and angling quality. The parallel approach may also lead to a segregation of angler types with more catch-orientated anglers fishing in the water bodies of 'lower ecological quality', which sometimes may resemble artificial put-and-take fisheries[342] and less catch-orientated anglers seeking fish in the more remote fisheries. Furthermore, it was demonstrated that angler motivations might shift towards reduced catch/consumptive orientation if anglers experience continued rewards in terms of catching fish[343]. This may ultimately reduce the consumptive orientation of anglers and lead to a greater sense for the fact that high angling quality often results from high natural recruitment and moderate angling harvest levels. However, the parallel approach centres on the prerequisite that intensive stocking is practised in the heavily modified waters at lower access costs to meet the demand of anglers excluded, at least temporarily, from the more 'natural' waters. Unfortunately, the contemporary nature conservation movement in Germany battles to ban stocking independent of the water type. Furthermore, catch-and-release practices, even partial catch-and-release of legally sized fish, may be difficult to establish in Germany because of the animal welfare legislation and the traditional harvest orientation of anglers.

Regardless, the parallel approach explained above also needs to be shaped by increased education efforts to overcome rising expectations, which may always occur when fish stocks recover[26,107,344–346]. It seems virtually impossible to increase and sustain fish populations to meet the expanding demand and the shifting expectations of anglers[345,347–349]. The key to avoiding constituency revolution is to keep expectations in line with the biological possibilities for improvement and production. Education of children starting angling may be one of the most important insurances that environmental sensitivity of humankind will evolve and be stable throughout their lifetime (reviewed by Kollmuss and Agyeman[350]). Education programmes will be most successful if they recognize that angler's human dimensions (e.g. motivations, values, beliefs, attitudes, satisfactions, personal relevance, involvement and experience) and various source factors (e.g. communicators credibility), channel factors (e.g. means used to communicate), message factors (e.g. strength of message) and situational factors (e.g. environment) affect how people perceive, elaborate and process information about fisheries management issues[8,119,285,324,351–353]. According to the elaboration likelihood model, anglers will only carefully evaluate information and integrate message contents into existing cognitions and behaviours, when they have the motivation and ability to do so (central route to persuasion[353]). When anglers lack such motivation or ability, factors tangential to the main educational message (i.e. cognitive heuristics) can result in attitude and behaviour change (peripheral route of persuasion[354]). However, the angling public is often in a 'show me' mood and does not necessarily trust people with 'official authority', whether scientists or government/agency officials[285]. Anglers need to be convinced of the wisdom of every restoration plan that will counter traditional ways of doing and local knowledge. Carefully measured and well-communicated results of habitat rehabilitation efforts and other fisheries management measures are important in efforts to encourage angler support for sustainable management[64,285], and scientists should be prepared to share their knowledge with interested laypersons and anglers[355,356].

There is no doubt that effective angler-orientated aquatic stewardship education efforts are extremely difficult tasks. In contrast to the traditional way of environmental 'education' efforts by simply disseminating scientific information in a top-down manner (e.g. via brochures or public seminars), modern education programmes need to address multiple human levels, e.g. pro-environmental entry level

(i.e. environmental knowledge and sensitivity), ownership level (i.e. the personal commitment/investment with environmental issues), and empowerment level (i.e. the sense of being able to make changes) (see references 357 and 358 for details). Aquatic stewardship should be viewed as a set of sequential learning experiences that take place over an extensive time period, in a combination of formal and non-formal settings, within the context of a supportive social environment[358,359]. Such educational approaches can help to change or develop pro-environmental values, beliefs, attitudes, intentions, action skills and ultimately behaviours of anglers. However, interdisciplinary education needs are not only limited to anglers, but also need to be increased for current and future fisheries managers[360–363].

To conclude, concerning the development of sustainable recreational fisheries by overcoming and resolving conflicts prevailing in the angling system, user conflicts seem to be of minor overall importance compared to management conflicts. This results from intersectoral management conflicts (e.g. nature conservation versus recreational fishing) potentially inhibiting the activity as a whole, and intrasectoral management conflicts (e.g. objection to management actions by anglers) potentially reducing the effectiveness of recreational fisheries policies with respect to sustainability. Abutted to the traditional reductionistic fisheries management paradigm of Maximum Sustainable Yield, the new guiding paradigm to address the issues of angler conflict can be termed Optimum Social Yield[1,364–366]. The basic tenets of Optimum Social Yield are that the appropriate goal for recreational fisheries management includes a broad range of considerations beyond traditional thinking of maximizing fish yield (e.g. stabilizing an appropriate size structure of fish stocks or improving environmental conditions), and that a unique management goal exists for each fishery. As we deal primarily with recreational fisheries management here, the more specific goals of future recreational fisheries management policies should be to maintain or enhance the proportion of satisfied anglers without comprising the interests of non-angling stakeholders and ecosystem integrity or health in the long term (ecological, economic, social and institutional dimensions of sustainability[1]). The major challenge for recreational fisheries management is to make sound management decisions to ensure that viable recreational fisheries are compatible with aesthetic and nature conservation values in the 21st century. To achieve this aim, resolving or more general management of conflicts in recreational fisheries is paramount. As many constraints to recreational fisheries originate from outside the recreational fisheries systems (e.g. environmental destruction), and recreational fisheries systems are themselves nested elements of other social-ecological systems such as fisheries in general, water usage systems, agriculture systems, nature conservation and ultimately society, the key to success in sustainable recreational fisheries management involves building up strong and strategic relationships among all the players associated with aquatic ecosystems and their management to consider, understand and respect each other and to work for a common goal based on values such as fairness and justice. Against this background, the best fisheries managers are those who enjoy, understand and work efficiently with both fishes and people[103]. Nowhere is this more apparent than when dealing with conflicts, which clearly are people problems and less fish stock issues.

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