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Overcoming human obstacles to conservation of recreational fishery resources, with emphasis on central Europe

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SUMMARY

Recreational fisheries are the dominant or sole user of many coastal and most inland fish stocks in industrialized societies. Recreational angling can negatively affect fish populations, but appropriate management approaches to address these impacts are often lacking. Overall, privately-governed European recreational fisheries systems offer suitable conditions to reconcile resource use with resource conservation because access restriction is possible, decision-making structures are simple and management scales are small. This increases the hope that the race to fish may be less pronounced than in open-access commercial fisheries. To achieve harmony between use and conservation values, a thorough understanding of the human dimension is paramount, yet approaches including this are underrepresented in contemporary recreational fisheries science and management. Based on theoretical considerations, literature review and personal experiences, this paper presents key human obstacles to the reconciliation of recreational fishery resource use and resource conservation, with emphasis on private fishing rights regimes of central Europe. Nine obstacles are identified: (1) lack of social priority; (2) lack of integrated approaches; (3) lack of cooperative institutional linkages; (4) lack of systems thinking; (5) lack of research and monitoring; (6) lack of shared values and dominance of stereotyped perceptions; (7) lack of consideration for regional fish-angler dynamics; (8) lack of objective communication of scientific findings; and (9) lack of critical self-reflection among individual anglers. Potential solutions to overcome the identified constraints briefly discussed include: (1) evaluation of the socioeconomic benefits of angling; (2) rehabilitation of ecosystem structure and function on larger scales; (3) facilitation of structured cooperation between stakeholders and management units; (4) application of complex systems approach; (5) increased funding for long-term monitoring; (6) fostering of common values of different stakeholders; (7) active adaptive management of angling effort on regional scales; (8) intensified communication of research findings; and (9) conviction of anglers to meet personal targets by more restrictive regulations. Increasing research and management efforts related to the social component of recreational fisheries will improve reconciliation of resource use and resource conservation in traditional recreational fisheries management. It is a matter of societal values whether it is judged necessary to do so on a broader scale.

Keywords: angling, environmental concern, freshwater fisheries management, human dimensions, inland fisheries, sustainability

INTRODUCTION

Recreational fishing is now firmly established as the dominant or sole user of many coastal and most inland fish stocks in so-called developed societies of the temperate regions (Arlinghaus *et al.* 2002). Fishing activity of any kind, whether commercial or recreational, can and does negatively affect fish communities (for example size and age structure, and recruitment), food webs (such as trophic relationships) and indirectly entire aquatic ecosystems (Pauly *et al.* 2002; Post *et al.* 2002). Given the cumulative fishing mortality of millions of people fishing for recreation, primarily by angling, it is expected that angler-exploited fish stocks can be depleted or collapse in a similar manner to commercially-exploited species such as cod (*Gadus morhua*) (Goedde & Coble 1981; Post *et al.* 2002). Although the dramatic effects that commercial fisheries have had on marine fish stocks are widely recognized, the potential role of recreational fishing in global fish crises seems to be ignored (Cooke & Cowx 2004, 2006). This is partly because inappropriate monitoring and the diffuse nature of recreational fishing in the landscape leads to invisible stock declines (Post *et al.* 2002). Therefore, the potential negative biological impact of recreational fishing is less obvious to stakeholders, fisheries managers and politicians (Post *et al.* 2002). It follows, however, that recreational angling can constitute an often-overlooked conservation issue of global relevance, particularly in freshwater fisheries (Arlinghaus & Cooke 2005). Recreational fisheries should increasingly be studied like commercial marine fisheries with a view to sustainability.

There is limited research on the performance of European recreational fisheries management in the context

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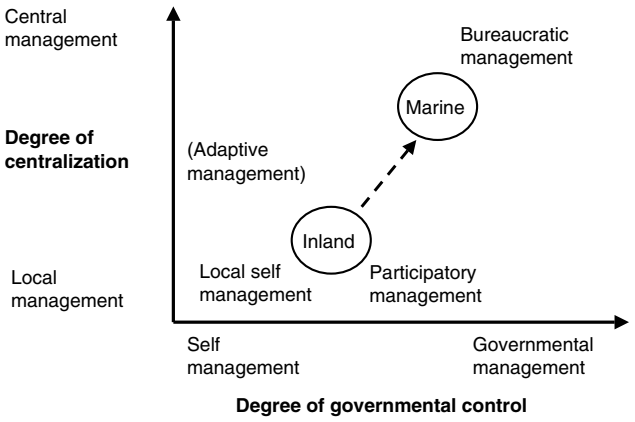

Figure 1 Conceptual representation of the different management forms used in fisheries management that vary by degree of centralization and governmental control (modified from Bruckmeier & Neumann 2005). Increasing governmental control and centralization from the inland to the marine environment is indicated by the broken arrow.

of sustainability (Arlinghaus *et al.* 2002), yet several traits of these fisheries are favourable to the establishment of sustainable governance, while others are counterproductive. To illustrate this complexity, in this paper a theoretical analysis of institutional and social elements known and/or hypothesized to influence fisheries management is conducted for privately-governed recreational fisheries. Such property-rights regimes are characteristic of large parts of central Europe, where the right to use, and right and duty to manage fishery resources lie mainly in the hands of private fishing rights holders, such as angling clubs, as owners or leaseholders of a fishery. In contrast, public fishing rights and management duties are characteristic for much of North America, Australia and Canada. With fishing rights in large parts of Europe being private entities, the management regime in place can be characterized as a decentralized hybrid of local self-management by local fishing rights holders and governmental management (Fig. 1). Local management is a form of self-management of local resources by local resources users (for example anglers), not simply a decentralization of management responsibility from national to local bureaucracy. In central Europe, recreational fisheries management (RFM), at least in fresh water, has elements of local self-management and participatory management that can be characterized as joint community-federal state cooperative management regimes (*sensu* Pinkerton 1994). That is, government and/or regional authorities at the public RFM level set the larger institutional framework (for example fisheries laws); fishing rights holders or more generally angling communities at the private RFM level then implement and plan local management, for example by devising local regulations. In contrast, the Common Fisheries Policy of the European Union in the marine environment is a classic example of centralized, bureaucratic management.

Different property-rights regimes substantially influence the probability of overexploitation of common-pool resources such as fish stocks (Hardin 1968; Ostrom *et al.* 1999; Hilborn *et al.* 2005). For example, obvious differences in management opportunities and approaches exist if fisheries resources are public, common or private property, i.e. if access to the resource is relatively unlimited or more restricted, where overexploitation is less likely (Hardin 1968). Proper analysis of the opportunities and threats to sustainable RFM has to focus on specific jurisdictions sharing the same property-rights regimes concerning fisheries resources as it is impossible to transfer management approaches arbitrarily across different institutional and cultural environments (Arlinghaus *et al.* 2002; Blann *et al.* 2003). Distinct analysis of privately-governed recreational fisheries as in central Europe is thus needed.

Based on a literature review and anecdotal information, this paper argues that (1) human obstacles are the primary determinants of management success in recreational fisheries to be overcome at different societal and individual scales, and (2) the importance of these obstacles for sustainable management is typically ignored or not accepted by many stakeholders, managers, non-governmental organizations (NGOs) and fisheries scientists. In contrast to the current trend of continued but limited involvement of social science in solving RFM issues (Ditton 2004), available information suggests the most pervasive challenge to reconciling resource use with resource conservation is related to human dimensions of these fisheries and their management (Arlinghaus *et al.* 2002; Arlinghaus 2004*a*, 2005). However, biologically-trained managers in public agencies, and many anglers and fisheries scientists often have not seen the need for human-dimensions research because they perceive they are exclusively or predominantly concerned with fish (Ditton 2004). The situation is particularly disappointing in Europe, where limited social science research on recreational fishing has been conducted so far (Aas & Ditton 1998; Arlinghaus 2004*a*).

Publications in two leading applied fisheries science journals reinforce the notion of limited human-dimensions research in recreational fisheries worldwide. Each of the 1994–2004 volumes of the *North American Journal of Fisheries Management* (NAJFM) and the European journal *Fisheries Management and Ecology* (FME) contained at most 20% of papers dealing with recreational fisheries (Fig. 2), however, on average only 4% (*c.* 5 per year, NAJFM) and 5% (*c.* 2 per year, FME) of the articles considered human-dimensions issues. Lack of scientific studies can preclude establishment of effective resource management. To complement emphasis on understanding of the human dimensions of fisheries *per se* (for example Aas & Ditton 1998), in this paper, human-centred obstacles and potential solutions to the reconciliation of RFM with conservation are addressed.

The objectives of the paper are to (1) present critical human obstacles currently preventing reconciliation of recreational use with resource conservation, and (2) suggest how the identified human obstacles might be overcome. The goal is to

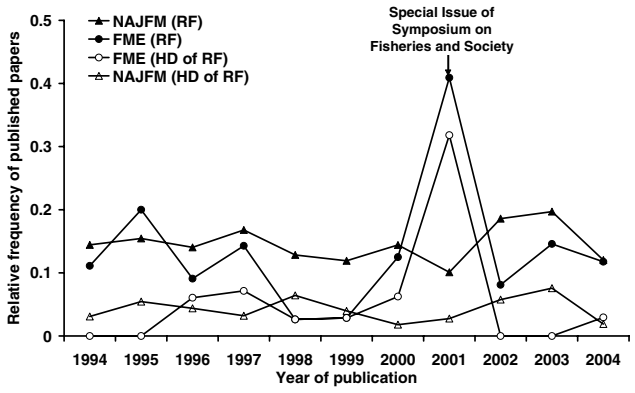

Figure 2 Relative frequency of published papers dealing either with recreational fisheries (RF) overall or specifically with the human dimensions of recreational fisheries (HD of RF) in two journals, *North American Journal of Fisheries Management* (NAJFM) and *Fisheries Management and Ecology* (FME), from 1994 to 2004.

(1) increase awareness of the crucial importance of human-dimensions issues among researchers, managers and other stakeholders, (2) facilitate development of general strategies to overcome the identified constraints, and (3) stimulate increased human-dimensions research in recreational fisheries science, management and conservation.

GENERAL PREREQUISTES FOR RESOURCE-CONSERVING MANAGEMENT IN RECREATIONAL FISHERIES

Hilborn *et al.* (2005) identified three primary influences on fisheries management success: (1) the way in which individuals are allowed access to fish resources (access), (2) the decision-making structure of the institutions (decision making), and (3) the spatial scale of management (scale). Review of several case studies indicates there is no single prescription for successful fisheries management, however, a better outcome is more likely with more restrictive access, more appropriate incentives, increasingly simpler institutions and appropriate management scales (Hilborn *et al.* 2005).

The notion of limited access and appropriate incentives to stimulate rule-preserving behaviour goes back to the seminal paper of Hardin (1968) and the apparently inevitable 'tragedy of the commons' under unmanaged conditions (Hardin 1998). That the individual fisher is more likely to conserve the resource when it is in his or her interest has been the backbone of most economic and bioeconomic arguments for limited entry and private or state property-rights in fisheries (Hilborn *et al.* 2005). More restrictive opportunities for users to assess the fishery increase the likelihood of efficient resource conservation (Hilborn *et al.* 2005). Therefore, under the private fishing rights regimes characterizing large parts of the European recreational fisheries systems, conservation seems to be more likely than under open-access conditions.

That the prerequisites for sustainable management are met in privately-governed recreational fisheries systems, can also be derived from the observation that simple decision-making structures (direct line of responsibility of Hilborn *et al.* 2005) improve management performance. If fishers know who is in charge, and who to blame when things go wrong, management success is more likely. Direct line of responsibility results in fishers having better incentives to comply and managers exhibiting better decision-making opportunities compared with the situation in complex, rigid institutional settings (such as management councils in the USA or the Common Fisheries Policy of the European Union; Hilborn *et al.* 2005). Ostrom (2005) has shown that small groups of resource users can organize for their self-interest when the institutional setting is appropriate. In large parts of central Europe, recreational anglers are not only users, but also institutionally-enforced managers of their fisheries. Thus, within the boundaries set by nature conservation, water and fisheries legislation, many individual angling clubs are self-responsible for their fisheries. Typically, a limited number of representatives of the angler community form a management board that takes management decisions (for example on stocking, habitat enhancement and regulation change). This situation can be advantageous to conserving fishery resources, because there is a small group, often fewer than 10 people, who are in charge of management and there is a direct line of responsibility.

In privately-owned recreational fisheries, all members of the angling community (for example a club) have the exclusive right to use the fish, with no significant competing user group. This includes the management responsibility via the representatives of the angling club or organization. Under such circumstances, many incentives are in place for the recreational fishing group to behave in a societally-desirable fashion by operating as a sole user (Hilborn *et al.* 2005). Hilborn *et al.* (2005) asked rhetorically: why should a fishing group with exclusive rights to a resource overharvest its resource? There are some human-related reasons that still promote mismanagement that will be addressed later. Nevertheless, the conditions of exclusive rights to use recreational fisheries resources are generally very favourable for resource conservation in central European recreational fisheries.

The last factor for successful management mentioned by Hilborn *et al.* (2005) is related to the spatial scale of management. For example, if there is a mismatch between the scale of management authority of an angling club and the impacts on the fish stocks, management is weakened. This can for example occur, if the angling community is only leaseholder of a river reach, not the whole river. In such a situation, impacts on fish stocks may occur outside the management unit. Often, however, angling clubs are responsible for entire closed fish populations (for example in gravel-pits, ponds, lakes or reservoirs), and there is a good match in management scales in inland fisheries. Small-scale structures are also a characteristic of many angling clubs in Europe, with often less than 100 members and a couple

Table 1 Human dimensions obstacles, consequences and potential solutions to the reconciliation of traditional recreational fisheries management and resource conservation under private-property rights regimes at the societal scale.

Obstacle	*Consequences*	*Potential solutions*
Lack of social priority	Interests of anglers rarely considered by water and ecosystem managers or nature conservationists	Evaluate the socioeconomic benefits of angling on regional and national scales; lobby based on hard scientific data
	Fishery stakeholders not involved in consultation processes	Proactively seek input in water and ecosystem management
Lack of integrated approaches	Erodes social-ecological resilience	Rehabilitate ecosystem structure and function on larger scales
	Often disrupts ecosystem structure and function	Create win-win situations for all stakeholders
Lack of cooperative institutional linkages	Creates severe intrasectoral and intersectoral conflicts among stakeholders	Facilitate structured cooperation and communication
	Unsustainable management measures taken	Provide expert advice and management plans
Lack of systems thinking	Rudimentary understanding of system behaviour leads to short-sighted management and shifting perceptions	Take complex systems approach; incorporate anglers in system studies
	Management failure occurs at larger scales	Shift thinking and approach, empower actors
Lack of research and monitoring	Invisible declines of fish stocks occur	Conduct cooperative research, gain funding for long-term monitoring
	Low fishing quality provided	Educate for realistic expectations
	Data-less management occurs	Be precautionary

of waters jointly managed. Under such circumstances, good outcomes of resource governance are more likely than when scales are decoupled or mismatched (Hilborn *et al.* 2005).

To conclude, the general prospects for conservation of recreational fishery resources are positive in privately-governed recreational fisheries, where there can be strong incentives for resource conservation *inter alia* because participation in angling is less dependent on high physical yield than in commercial fisheries. Why then have many management systems in recreational fisheries failed or are supposed to fail (Post *et al.* 2002)? The conclusion presented above is to a certain degree naïve because many potential influences on resource conservation behaviour of fisheries systems are not addressed by access, incentives, decision-making structures and scale-matching alone (see Ostrom 2005).

HUMAN OBSTACLES TO CONSERVATION OF RECREATIONAL FISHERIES RESOURCES

In order to reconcile resource use with resource conservation in recreational fisheries and develop successful management systems, several human obstacles identified from the literature must first be overcome before real progress can be made. Human-dimensions related barriers operate at the societal level (Table 1) or at the level of individual stakeholders (or groups of stakeholders; Table 2). Therefore, these two divergent scales are treated separately here. Some of the obstacles are interrelated, mutually reinforce each other and are therefore difficult to categorize, and the insights described below are in part the result of personal experiences in recreational fisheries. This is *inter alia* the result of the limited human-dimensions research on European recreational fisheries, and is subject to further modification in the future. The following obstacles to sustainable RFM do not operate in every recreational fishery in Europe and elsewhere. Some of the obstacles apply in different localities and jurisdictions to different degree, which reflects the great heterogeneity in the human dimensions of recreational fisheries worldwide. However, the list of barriers to successful RFM described below encompasses the main social issues affecting the performance of RFM in central Europe, and thus their description, along with potential solutions (Tables 1 and 2), should be of some value over and above Europe.

Societal scale

Lack of social priority

The multipurpose nature and use pattern of freshwater ecosystems has created a climate in developed societies in which recreational fisheries are subject to economically and socially higher priorities such as agriculture, hydroelectric power production, navigation and flood prevention. In the marine environment, commercial fishing is often given higher priority to recreational fishing. Lack of public acceptance of the social and economic importance of recreational fisheries *inter alia* results from the rarely assessed socioeconomic benefits of recreational fisheries (Arlinghaus *et al.* 2002).

Consequences. In freshwater recreational fisheries it is safe to assume that non-fishing impacts such as habitat modifications and nutrient inputs have had stronger modifying impacts on fish communities than fishing influences (Arlinghaus *et al.* 2002; Allan *et al.* 2005). Anthropogenic activities such

Table 2 Human dimensions obstacles, consequences and potential solutions to the reconciliation of traditional recreational fisheries management and resource conservation under private-property rights regimes at the individual or group scale.

Obstacle	*Consequences*	*Potential solutions*
Lack of shared values and stereotyped perceptions	Intense inter- and intrasectoral conflicts occur	Foster common values such as fairness and justice
	Leads to low level of cooperation and mutual acceptance, consumer attitude, free-riding behaviour	Facilitate face-to-face interaction, sometimes with a facilitator
Lack of consideration for fish-angler dynamics	Homogenized angling quality	Apply active adaptive effort management
	Angler's satisfaction reduced on regional scales	Partially limit angler effort, first indirectly by soft paths
	Management fails	Create protected areas
Lack of communication of scientific findings	There is unawareness of potential negative impacts; no research is funded	Increase communication of research results about positive/negative impacts
Lack of critical self-reflection	Awareness of the need for responsibility is low. Little support for more restrictive management	Convince anglers to meet their own targets by more restrictive regulations
	Level of environmental concern is low	Facilitate personal experiences
	Unsustainable management measures supported	Reduce fear of new approaches

as river damming for flood control have severely altered aquatic ecosystems in industrialized societies and often contradict conservation of biodiversity and fishery resources worldwide (Collares-Pereira *et al.* 2002). Recreational fisheries are often given low priority in any consultation process and it is difficult to attract investments for development of a fishery (Cowx 2002). The result is that non-fishery stakeholders such as water management authorities rarely, if at all, solicit the input and consider the interests and demands of fishery stakeholders, leading to management actions that are often detrimental to ecosystem structure and function and fishery performance (Arlinghaus *et al.* 2002).

Solutions. To increase awareness of the high social and economic importance of recreational fishing among decision makers, thorough socioeconomic evaluations of the importance of recreational fisheries, fishing impacts and fish resource conservation at local, regional and national scales are needed (Arlinghaus *et al.* 2002). This can ensure that recreational and fish conservation values are well represented in development activities concerning aquatic ecosystems (Cowx 2003). If recreational fishing stakeholders are to increase their input to these activities, better communication of scientific research results to non-fishery stakeholders and public bodies can be useful.

Lack of integrated approaches

Increasing pressures on and multiple uses of freshwater ecosystems dictate that recreational fisheries and resource conservation can no longer be treated in isolation (Arlinghaus *et al.* 2002). Therefore, an integrated approach to aquatic resource management is required, spanning all stakeholders potentially affected by the management actions (Costanza *et al.* 1998). Integrated management is characterized as management across scientific disciplines and stakeholder groups, and considering, conceptually at least, future generations. Such approaches are currently rarely pursued in traditional RFM (Arlinghaus *et al.* 2002). The most important reason is that many fishery agencies and private fishing rights holders responsible for management of an extensive and diverse array of recreational fisheries often do not have adequate human and financial resources (and political power) for monitoring either the fishery or the fish stocks supporting the fishery (Post *et al.* 2002; Pereira & Hansen 2003). Furthermore, freshwater fishery resources are strongly dependent on non-fishery activities such as land-use changes and water management activities (Arlinghaus *et al.* 2002).

Consequences. The inability of RFM to alter non-fishing activities affecting fishery resources has led in the past *inter alia* to a focus on single-species management of recreationally valuable fish stocks (Arlinghaus *et al.* 2002). This has been mainly achieved by stocking practices of hatchery-reared fish, translocation of fish species and populations across catchments and introductions of exotics, which today is perhaps the greatest concern regarding conservation of genetic, species and community biodiversity of freshwater fish (Meffe 1992). Worldwide, however, degradation of the environment and loss of fishery habitat are the pre-eminent barriers for the sustainability of inland fisheries (FAO [Food and Agricultural Organization of the United Nations] 1999). This is particularly relevant in densely-populated countries of Europe (Arlinghaus *et al.* 2002). Altogether, lack of integrated approaches can result in loss of social-ecological system resilience, namely loss of the system's ability to absorb external disturbance and cope with change (Gunderson & Holling 2002).

Solutions. Rehabilitation of ecosystem structure and function and the associated fishery resources is a goal that fishery and conservation stakeholders might pursue together in an

integrated approach benefiting all stakeholders (Pinkerton 1994). This is necessary as large-scale environmental engineering or habitat rehabilitation techniques need a full consultation with water resource managers and environmental experts (Arlinghaus *et al.* 2002). However, if anglers and fishery managers cannot carry out complex aquatic ecosystem rehabilitation/restoration projects independently, conservation and traditional RFM can hardly be reconciled. This is because the most sustainable management strategy to conserve fishery resources in the long-term, namely habitat rehabilitation on larger scales, usually lies outside the domain of traditional RFM. Thus, there is no scale-matching of problem-causing and problem-solving institutions. Matching scales of ecosystem and governance is one of the most important aspects of effective resource management (Costanza *et al*. 1998).

Lack of cooperative institutional linkages

Since public fisheries authorities and private fishing rights holders are often politically too weak to take effective actions to deal with policy problems in RFM, many aspects affecting fishery resources and conservation can only be addressed by non-fishery bodies such as water management agencies. However, there is seldom a structured, open, honest and fair communication demanded by a formal and informal institution (such as a bye-law) between water or nature conservation agencies and fisheries agencies before actions are taken (Raat 1990). Lack of institutional linkages and communication, however, is not only prevalent between fishery and non-fishery stakeholders, but can also be found intrasectoral, for example within an angling club where the private fishery management authority might not incorporate inputs from the anglers. Moreover, in many central European recreational fisheries systems, local management traditionally takes place without approval of or advice on management plans by experts trained in ecology or sociology. In addition, there are often only weak institutional linkages between angling clubs and public fishery authorities. Thus, in some European countries, the local RFM remains more or less in the hands of angling clubs and organizations, which are often inadequately trained or untrained in fisheries science or conservation biology (Walder & van der Spiegel 1990).

Consequences. Likely consequences of the lack of cooperative institutional linkages are intrasectoral and intersectoral conflicts (Arlinghaus 2005) and the development of non-sustainable management actions. For example, in Germany many angling clubs as fishing rights holders expand the legal state-wide regulations such as minimum-size limits without scientific evaluation of the biological and social effects of such measures, and enforcement of regulations is often inadequate (*sensu* McPhee *et al.* 2002). Other examples include most stocking events taking place without a priori appraisal of the ecological and evolutionary risks or social and economic costs and benefits (Arlinghaus *et al.* 2002). Evaluation of such stocking practices is rarely conducted such that sustainable RFM may become an oxymoron.

Solutions. In an attempt to reconcile conservation with resource use, local community-driven RFM might need some kind of expert advice, productive communication, education and control to better manage unsustainable knowledge of (often voluntary) private fisheries managers. Blann *et al.* (2003) provided an interesting overview of case studies of successful and fruitful cooperation between public fisheries agencies and stakeholders to solve recreational fisheries issues in the USA. This could be a good way forward under private governance of recreational fisheries in Europe.

Lack of systems thinking

RFM involves uncertainty, information gaps and correlations between slow (for example habitat modifications, legislative change) and fast (for example population dynamics, angler responses) variables (Carpenter & Brock 2004), yet voluntary fishery managers of angling organizations in Europe often do not accept that some of their traditional management practices are, in part at least, threatening fish communities. In fact, many still have an agrarian view of human management and control and an entitlement view of the rights of humankind to fully exploit natural resources wherever and whenever they can (Blann *et al.* 2003). This agrarian view results in popular views of fish stocking as a management mandate (Blann *et al.* 2003), perhaps from lack of exposure to scientific findings and from management history. In fact, RFM in central Europe has traditionally been sectoral in orientation (Arlinghaus *et al.* 2002). Cowx (2003) calls this attitude piscicentric, where considerations of the needs of other resource users or of the non-consumptive world are often ignored or given little respect.

Consequences. Given the complexity und uncertainty inherent in all social-ecological systems including recreational fisheries, it is often difficult for fishery (and other) stakeholders, managers and scientists to see and understand the larger system as a whole and be aware of processes occurring at scales larger and longer than their own experience (Post *et al.* 2002; Arlinghaus & Mehner 2003). In practice, most people are overtaxed to make reasonable decisions given complex, uncertain and slowly-changing (time lag between cause and effect) processes of dynamic social-ecological systems (Berkes *et al.* 2003). Thus, they tend to focus on local conditions and short-term solutions (Fehr 2002). This problem is not unique to recreational fisheries, but is a common and central feature of the whole sustainability debate (Folke 2003). Ultimately, the consequences can be rudimentary understanding of the whole system, short-sighted short-term gain orientated management and mismanagement on larger scales (Walters & Martell 2004).

Solutions. Recreational fisheries as social-ecological systems in general are nested elements of other social-ecological systems, such as agriculture, water management, aquatic ecosystems, society and ultimately the biosphere. Therefore, the sectoral approach to management, in which an angling club manages single species in a single fishery, has run its

course (Cowx 2003) and a new management paradigm for managing fisheries resources is needed. From an academic standpoint, a complex systems approach might be needed for sustaining aquatic ecosystems under fishing pressure, linking ecological resilience to functioning governance structures, social needs and society (Hughes *et al.* 2005). It seems necessary to develop a trustful, fair and honest management process and build actor empowerment by developing local knowledge, emotional commitment, shared experience and social relationships (Blann *et al.* 2003). In this respect, traditional ecological knowledge can be very useful for fishery researchers and managers fostering the intellectual input of anglers. However, over the generations, expectations about what a healthy fish community or aquatic ecosystem constitute may shift towards lower optima. Anglers, managers and researchers may perceive a highly modified aquatic ecosystem and impoverished or artificial fish stocks as being natural, and may use this perception to define conservation or management targets (Arlinghaus & Mehner 2003).

Lack of research and monitoring

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 (Cox 2000). There are few instances where declines in fish stocks could be clearly attributed to recreational fisheries, however, four high profile fisheries have shown evidence of angling-induced declines in Canada that were largely unnoticed by the angling public, a characteristic that may be widespread in recreational fisheries (Post *et al.* 2002). This results *inter alia* from (1) 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 (Cox 2000; Arlinghaus 2004*a*), (2) the diffuse nature of recreational fisheries activities (Post *et al.* 2002), (3) the inability of anglers, managers and scientists to develop an accurate picture of what healthy fish stocks are at scales longer and larger than their own experience (Arlinghaus & Mehner 2003), and (4) fish stocking masking stock declines, which is particularly relevant in inland fisheries (Arlinghaus *et al.* 2002). Furthermore, many of the modern management concepts (such as human dimensions research on the diversity of angler subgroups) are often not accepted as being critical for management (Ditton 2004).

Consequences. Invisible management failures and poor angling quality are increasingly common (Post *et al.* 2002). The lack of research also leads to data-poor management. At the moment, funding for applied research is limited, and the private-property systems of Europe necessitate the willingness of fisheries owners to allow such research to take place. Research to answer management questions initiated by fishing rights holders is practically non-existent. Limited applied research and monitoring to guide management can reduce the system's ability to respond appropriately to the demands set by the sustainability concept, including judgement whether actions are needed at all (Arlinghaus *et al.* 2002). Implementation of actions without data to support them can invisibly erode the quality of the fisheries and ecological integrity. Moreover, arguments in defence of management can hardly be given if there are no data available to support actions.

Solutions. To increase the understanding of angler behaviour and effects of angling activities on the ecology and evolutionary biology of fish stocks, long-term monitoring programmes coupled with rigorous experimentation on regulations are needed (active adaptive management; Pereira & Hansen 2003). However, according to Cowx (2003), there is no need and no time to research every aspect of the system before management actions are taken, and Ludwig *et al.* (1993) urged managers to rely on scientists to recognize problems, but not to remedy them. Precaution is a wise approach to guide day-to-day management actions, for example for planning stocking programmes, and education for realistic expectations may sometimes be needed (Arlinghaus *et al.* 2002; Arlinghaus 2004*a*).

Individual and group scale

Lack of shared values and dominance of stereotyped perceptions

There has been a gradual shift away from traditional wildlife values that emphasize the use of wildlife for human benefit towards wildlife conservation and protection (Arlinghaus *et al.* 2002; Manfredo *et al.* 2003). One of the greatest challenges for recreational fisheries is to make sound management decisions to ensure viable recreational fisheries are compatible with aesthetic and nature conservation values in the 21st century (Arlinghaus *et al.* 2002). Confusion and strong conflicts arise, in part at least, because of the different visions or worldviews of multiple stakeholders under the umbrella of sustainable development (Arlinghaus 2005). For example, conservation biologists often only consider ecological sustainability, whereas consumptive/extractive stakeholders often emphasize the socioeconomic domain of the sustainability concept (Arlinghaus *et al.* 2002). Divergent attitudes may transcend into stereotypical viewpoints on how one stakeholder or interest group views another (Arlinghaus 2005). This can for example form an attitude among some anglers or their representatives that conservation *per se* is threatening (Stoll-Kleemann 2001). Alternatively, stereotypical attitudes among conservationists may lead to the perception that anglers are always a threat to the protection of aquatic ecosystems (Stoll-Kleemann 2001). Stereotypical thinking can also occur in angler-fishery management interactions if the ultimate decision maker does not achieve or is not willing to integrate the anglers in the process of decision taking.

Consequences. Lack of shared values and development of stereotyping attitudes in multiple stakeholders groups can profoundly affect the development of recreational fisheries (Arlinghaus 2005). They can foster intensive intra- and intersectoral conflicts, such as between fishery stakeholders and conservationists and animal welfare supporters, or within

the fishing community (Arlinghaus 2005). Stereotypical thinking and acting can also reduce the potential for cooperation to low levels or inhibit it (Stoll-Kleemann 2001; Arlinghaus 2005). Stereotypical thinking within angler groups can foster increased free-riding behaviour if certain anglers consider other anglers in a stereotypical sense as not belonging to their group. This perspective can aggravate rivalry in consumption of common-pool resources and increase the likelihood of overuse of the shared resource (Arlinghaus 2005). The angler may also develop a feeling of frustration, which can result in rule-breaking behaviour and development of a consumer attitude, where a certain amount of fish has to be taken out of the water to balance the fishing license cost, with potential detriment to fishery resource conservation.

Solutions. Overcoming the lack of shared value systems acting at different levels in RFM is particularly difficult, as once developed, values and beliefs are notoriously resistant to change (Manfredo *et al.* 2003). Therefore, only very vague recommendations can be given here. It is recommended to provide a productive environment for face-to-face interaction and facilitate conflict resolution processes to achieve mutual acceptance. Sometimes a facilitator may be needed to achieve this aim. Much progress to overcome stereotyped perceptions and unproductive communicative environments is dependent on individual characteristics of people involved in local management. Westley (2002) provided an illustrative case study of how an individual fisheries manager brought stakeholders together and overcame stereotypes and divergent perspectives of stakeholders. RFM often requires strong personal values as opposed to rational analysis. Managers need huge patience when it comes to identifying the stake each group has and in bringing different stakeholders together to negotiate (Westley 2002).

Lack of consideration for regional fish–angler dynamics

The generic problem of large-scale resource management has some common elements, namely multiple regimes of ecosystems and social dynamics, landscape of diverse ecosystems, spatial connections by flows of water, chemicals, organisms and people, and often pervasive human actions that erode social-ecological resilience (Carpenter & Brock 2004). Management of social-ecological recreational fisheries needs to consider conceptually all of the above at the same time, which is challenging. One often-overlooked pattern affecting management outcome is the regional mobility of anglers and the resulting angling effort dynamics (Walters & Martell 2004). Modern anglers link spatially-separated aquatic ecosystems by shifting effort, and hence mortality and other impacts at regional scales if angling quality declines in the main fishery (Johnson & Carpenter 1994; Cox & Walters 2002). Until now, most RFM decisions were made on a case-by-case basis, whereby quality of individual fisheries was assumed to be independent of management actions and fishery dynamics elsewhere (Cox *et al.* 2003). However, angler effort shifts from one ecosystem to another driven by the subjective perceptions of angling quality seem to be the rule rather than the exception (Carpenter & Brock 2004).

Consequences. RFM has traditionally concentrated on the supply side (fish abundance) of the dynamic relationship between fish stocks and anglers (fishing quality), with a tacit assumption that the demand side (angling effort) will somehow be self-regulating (Cox & Walters 2002; Post *et al.* 2002). However, under conditions of low to moderate access costs (such as time, energy and money) and particularly under open or quasi-open access, anglers can regionally shift angling effort, and hence mortality from bad to good fishing waters (Cox *et al.* 2003). This can result in declining fish stocks on regional scales in a competitive situation from which recreational species might not recover when angling effort/mortality declines (Post *et al.* 2002). Moreover, catch-dependent angler satisfaction may be reduced by fishing down angling quality on regional scales or be very difficult to increase, with potentially detrimental effects on environmental concern and the management support by anglers in the case of dissatisfaction (Arlinghaus & Mehner 2005). Dissatisfied anglers are more likely to support stocking of fish, whereas more satisfied anglers are more supportive of habitat rehabilitation measures that have greater probability of conserving entire communities instead of single species (Arlinghaus & Mehner 2005). To overlook dynamics between prey (fish) and predator (angler) on regional scales may ultimately lead to losses in total socioeconomic benefits (Cox *et al.* 2003).

Solutions. One possible solution is active adaptive management of angling effort, which is rarely pursued by contemporary RFM (Pereira & Hansen 2003). Partial control of angling effort (and indirectly angler harvest/mortality) in waters needing protection may take place by direct access restrictions, increases of access cost (time, money), lottery systems of access, annual rotating access schemes (for example between angling club members), licence price increases, implementations of total allowable angling effort (for example days) schemes or a combination of the options (Cox & Walters 2002; Arlinghaus & Mehner 2005). However, it might be more advisable to first try to change angler behaviour indirectly, for example by more passive means (such as education and zoning) instead of implementing more stringent controls on angler effort (Arlinghaus 2004*a*). Other strategies may include the implementation of large-scale protected areas that receive none or only limited angler effort to help species to recover.

Lack of objective communication of scientific findings

Often recreational fishing can take place without causing harm to wild living resources or entire ecosystems (see Isermann *et al.* 2005). By considering millions of anglers, however, the impact of recreational fishing might sometimes even be greater than the influence of commercial fishing, at least locally (Coleman *et al.* 2004). However, there is a tendency to consider impacts at isolated fishery-specific scales (Cox 2000). As a consequence, recreational fishing has rarely come

under close scrutiny of conservation groups (McPhee *et al.* 2002), in part at least because anglers and their representatives often portray themselves as purely non-consumptive in the media, while pointing to others (such as commercial fishing, water management and cormorants) as causing more harm to fish communities than recreational fishing (Nussmann 2005). Although there are no biological impacts of angling in every fishery, some impact is inevitable (Cooke & Cowx 2006). In order to avoid raising awareness of these issues amongst the public, there is the tendency among angler lobbyists to keep the size of the sector low and negate scientific findings. For example, in Germany, scientific findings published in languages other than German are disregarded and rarely communicated in the angler media and network. Very rarely are potential biological impacts through harvest, size-selective exploitation and stocking critically discussed in popular angling magazines and seminars.

Consequences. A non-destructive image results in potential biological impacts of recreational fishing being attenuated or not accepted by the angling community, and research to analyse potential ecological or evolutionary effects of selective angling mortality is not being funded by angling organizations. Instead, research is funded that analyses the economic benefits of recreational fisheries, and the results are used to lobby about the socioeconomic importance of angling. From the political perspective, this procedure is understandable. However, if not even the angling lobbyists and the angling media try to inform their constituencies about the potential negative effects of selective angling exploitation and other impacts, awareness, environmental concern and common understanding among anglers will very likely develop more slowly or not at all. Ostrom (2005) identified a common understanding among resource users about how their actions affect each other and the resource system to be critical for management success.

Solutions. Fisheries researchers should try to inform angler organizations and angler media about all aspects of the activity, including the negative impacts of certain angling practices, such as biological and evolutionary effects of selective angling mortality (Arlinghaus *et al.* 2002; Cooke & Cowx 2006), lethal and sublethal effects of catch-and-release (Cooke *et al.* 2002) or the effects of excessive nutrient inputs by groundbaiting (Niesar *et al.* 2004).

Lack of critical self-reflection among individual anglers

Awareness among anglers of the potential of angling exploitation or RFM practices to negatively affect fish populations and a feeling of responsibility are essential antecedents to changing angler behaviour directly, or indirectly complying with more restrictive regulations (Arlinghaus & Mehner 2005). It has been assumed that simple involvement in recreational angling leads to increased environmental concern because people are exposed to instances of ecosystem deterioration, thus creating a commitment to the protection of habitats, cultivating an aesthetic taste for a natural environment and fostering a general opposition to environmental degradation (Dunlap & Heffernan 1975). Although this assumption seems reasonable and was often uncritically cited as an ecological benefit of recreational fishing, empirical results are at best weak (Theodori *et al.* 1998; Bright & Porter 2001).

A recent angler survey in Germany showed three distinct patterns concerning environmental beliefs of anglers (Table 3). The majority of German anglers agreed on pro-ecological statements measuring a more general ecological worldview. Available evidence to date suggests that the environmental concern of anglers is high if their environmental attitudes are solicited about very general ecological aspects (such as the limited nature of fishery resources *per se* or the equal rights of animals/plants; Gill *et al.* 1999; Table 3). However, pro-environmental attitudes appear less pronounced when anglers are asked to evaluate a potential biological impact of recreational fishing. Anglers in Germany, on average, denied a potential harmful impact of their own activity on aquatic ecosystems and fish stocks (Table 3), although some angler groups have been found to be aware of the possibility that angling can overharvest fish stocks (Schramm *et al.* 1999). Also, anglers held a strong belief in the traditional way in which anglers manage their own waters in Germany. Most anglers thought that their learning and observational capabilities will result in fish stocks not being overfished (Table 3). Consequently, anglers did not perceive the necessity to change current angling behaviour for the protection of the resources. Less than half of the anglers surveyed indicated that they would be willing to change current behaviour for the protection of aquatic ecosystems (Table 3). As the German example showed, some angler populations show a relatively low level of self-criticism and critical self-reflection about the potential effects of their personal behaviour.

Consequences. The low awareness among some anglers that they are part of the problem of declining fish stocks (Reed & Parsons 1999) can *inter alia* result in lack of support for more restrictive regulations (Arlinghaus 2004*a*). If regulations are in direct conflict with fishing practices that are familiar and enjoyed, optimistic biases about the risks of overfishing (Weinstein 1982) may ultimately result in low support of conservation goals. Opposition to conservation goals may occur because of little experience with the ecosystem management concept, which may be perceived by anglers as an untested theory or threat to continued enjoyment of the activity (Jacobson & Marynowski 1997).

Solutions. Managers might convince anglers about ways to meet their personal targets by conserving the resource. To achieve this, anglers need to be included in the whole process of fishery and ecosystem management decision-making (Blann *et al.* 2003). However, the angling public does not necessarily trust people in authority, whether scientists or government/agency officials (Smith *et al.* 1997). Acceptance of angling impacts as being sometimes crucial for sustainability will very likely only develop if personal experiences are gained,

Table 3 Item means ± SD and frequency distribution (%) of the response pattern in a representative angler telephone survey using a modified new ecological paradigm scale (Arlinghaus & Mehner 2005) to measure environmental concern of anglers living in Germany. Answers to statements were on a five-point scale: 1 = strongly agree (SA), 2 = agree (A), 3 = unsure/neutral (U), 4 = disagree (D), 5 = strongly disagree (SD); the calculation of the item mean was based on the sample excluding those that indicated they did not know (DN). Items were arranged according to three hypothesized facets of a pro-ecological worldview (see Arlinghaus 2004*b* for methodological details of survey). [1]Agreement with these items was assumed to indicate pro-environmental concern; [2]disagreement with these items was assumed to indicate pro-environmental concern. Results of χ^2-tests on frequency distribution compared with random distribution: *** = $p < 0.001$.

Do you agree or disagree that	*Item mean ± SD*	*SA*	*A*	*U*	*D*	*SD*	*DN*	*p*
Related to general ecological worldview								
Fishes and other animals have as much rights as we anglers have[1] ($n = 452$)	2.30 ± 1.16	25.6	38.5	14.4	11.4	5.7	4.4	***
Aquatic ecosystems are like spaceships with limited room and fish resources[1] ($n = 454$)	2.32 ± 1.03	19.7	44.0	16.3	13.7	2.3	4.0	***
We anglers have the right to modify the natural aquatic ecosystems to suit our needs[2] ($n = 468$)	4.09 ± 0.95	1.7	7.0	9.1	44.2	37.0	1.0	***
Related to perception of potential angling impact								
When we anglers interfere with an aquatic ecosystem it often produces disastrous consequences[1] ($n = 470$)	3.49 ± 1.19	5.9	19.2	15.9	37.4	20.9	0.6	***
The balance of the aquatic ecosystems is strong enough to cope with the impacts of us anglers[2] ($n = 466$)	2.46 ± 1.06	15.9	44.4	18.4	16.5	3.4	1.4	***
We are approaching the limit of the number of anglers that the aquatic ecosystems can support[1] ($n = 456$)	2.93 ± 1.18	10.1	30.7	20.9	25.2	9.5	3.6	***
We anglers impact on the aquatic ecosystems less than other stakeholders[2] ($n = 467$)	2.19 ± 1.00	23.5	48.6	14.4	9.1	3.2	1.2	***
The so-called ecological crisis of the aquatic ecosystems has been greatly exaggerated[2] ($n = 466$)	2.87 ± 1.05	7.6	32.8	28.1	24.5	5.5	1.5	***
If we anglers continue in the present course, we will soon experience an ecological catastrophe in the aquatic ecosystems[1] ($n = 467$)	3.98 ± 1.05	1.5	11.6	11.2	37.2	37.2	1.2	***
Related to management aspects of anglers								
We anglers are well qualified to manage and protect the aquatic ecosystems[2] ($n = 469$)	1.88 ± 0.89	37.6	42.5	13.5	4.2	1.3	0.8	***
As anglers our ability to learn and our power of observation will insure that we do not overfish the aquatic ecosystems[2] ($n = 469$)	2.15 ± 0.92	23.0	49.0	17.8	7.6	1.7	0.8	***
It is still a fact that we anglers do not do enough to protect the aquatic ecosystems[1] ($n = 466$)	3.24 ± 1.23	7.2	27.9	13.3	38.8	16.3	1.5	***
For the protection of the aquatic ecosystems we anglers should be willing to change our present angling behaviour[1] ($n = 467$)	2.91 ± 1.14	10.4	30.0	24.9	25.2	8.2	1.2	***

because many anglers tend to rely on personal experiences or knowledge of peers that are known and respected.

CONCLUDING REMARKS

Most traits characterizing privately-governed recreational fisheries systems in central Europe (such as restricted access, simple decision-making structures and small scales of management) constitute a framework beneficial to reconciling resource use with resource conservation. However, nine human obstacles to different degrees and strengths in different European jurisdictions and social-ecological environments need to be overcome to move recreational fisheries towards sustainability. Potential solutions to address the identified social barriers include: (1) evaluation of the socioeconomic benefits of angling; (2) rehabilitation of ecosystem structure and function on larger scales; (3) facilitation of structured cooperation between stakeholders and management units; (4) application of complex systems approach; (5) increased funding for long-term monitoring; (6) fostering of common values of different stakeholders; (7) active adaptive management of effort on regional scales; (8) intensified communication of research findings; and (9) greater convincement of anglers to meeting personal targets by more restrictive regulations. Some of these propositions are scientifically and operationally challenging and in part economically costly (such as rehabilitation of ecosystem structure and function, long-term monitoring and application of a complex systems approach). Other proposed ways forward, however, mainly demand changes in current approaches and incur small financial costs (for example

facilitation of cooperation, fostering of common values, increased communication of scientific findings and angler education) and are therefore more realistic if internalized by a majority of fishery stakeholders. However, this demands that fisheries researchers proactively solicit communication with local anglers and angler groups and that large-scale aquatic ecosystem management activities currently underway, such as the implementation of the European Water Framework Directive, actively seek the input and cooperation of recreational fisheries stakeholders. The scope for cooperative initiatives between academic professionals and private fishing rights owners is huge, if awareness of the necessity to apply scientific rigor to day-to-day management is increased and funding is made available, or already available funds are appropriately invested in management-supporting research. For example, in many regions of Europe, anglers pay taxes when being issued with angling licences that can be used for the development of resource-conserving human and social capital or invested in scientific inquiries of regional recreational fisheries systems. There are some examples in Europe where such approaches have already been initiated, for example in some Scandinavian countries and partly in the UK, where the Environment Agency takes an active and lively role in developing recreational fisheries in England and Wales.

All of the proposed ways forward outlined above have in common that they tackle human dimensions issues that (1) go far beyond standard stock assessment and other natural science approaches to achieve biologically determined management objectives such as maximum sustainable yield, and (2) are traditionally not fully addressed in privately-governed European RFM. Here the private RFM level, namely angler communities, have traditionally relied on information from the biological sciences. Common rules of thumb state that wildlife management today is 90% people and 10% natural resource management (Decker *et al.* 2001). However, despite the already decades-old adage that fisheries management is as much people management as fish stock management, the fisheries profession is stabilizing with a mix of professionals which suggests that biologically-trained professionals largely dominate (Fulton & Adelman 2003; Ditton 2004). Despite significant improvement in understanding the human dimension of European recreational fisheries, the information base is still insufficient and highly biased towards North America (Aas 2002). The consequence of the lack of knowledge about social dynamics of RFM is the possibility that myths, personal views and opinions of strong interest groups guide management decisions in this arena, replacing or circumventing scientific knowledge.

Unfortunately, in many parts of Europe, particularly in central Europe, the necessity of a structured approach to RFM as advocated in this paper and elsewhere (Arlinghaus 2004*a*) is still in its infancy somewhere between the innovators and early adopters stages, according to the adoption-diffusion theory (Fig. 3). In the case that early majority or late majority stages are achieved, that is it is agreed to be of societal value to manage recreational fisheries for sustainability, experts that

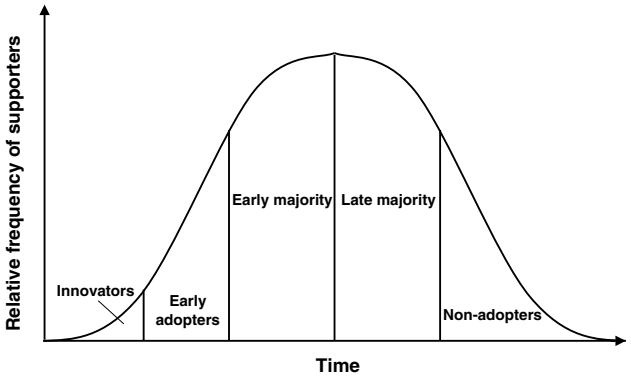

Figure 3 Schematic presentation of the adoption-diffusion theory: relative frequency of the different types of people in society regarding their tendency to adopt a new idea such as the will to increase efforts towards sustainable recreational fisheries management (modified from Decker & Krueger 1999).

are trained in interdisciplinary scientific disciplines should be increasingly involved in local management of recreational fisheries (for example by extension services of public agencies supporting anglers or fishing-rights holders in general). This is necessary because complete devolution of management to angling communities may not be appropriate in every situation (Feeny *et al.* 1990). It therefore makes sense for the public to play a role in the management and conservation of recreational fisheries. Thus, shared governance of state regulations coupled with user self-management may be a viable option (Feeny *et al.* 1990). The likelihood of angler communities designing successful resource-preserving institutions will be improved if the group is relatively small and stable, if there is reciprocity, trust and a common environmental understanding, if there are reliable and valid indicators of the condition of the resource system, if autonomy in decision making by the resource users themselves is preserved, and if the transaction costs of making and enforcing rules are low (Berkes & Folke 1998; Ostrom 2005). Effective community-based management assisted by fisheries experts could capitalize on the local knowledge and long-term self-interest of anglers, while providing coordination with relevant other uses and users over a wide geographical area at potentially low transaction costs.

What might be needed as agents of change in management approach and understanding is the development of a new type of manager and/or consultant that ideally would be derived from the angler community itself to increase credibility. There are many examples of local anglers, often the most specialized fishers, who invest tremendous efforts into studying and understanding fish population and social dynamics, but the approach could be facilitated by the public at comparatively low financial costs. The role of this new type of fishery manager or fisheries management advisor can be to motivate and empower local anglers and angling clubs to research, monitor and manage their own localized fishery resources. For each new angler community and fish stock, the starting point for the fisheries management consultant would be the application

of data-poor management, gleaning local knowledge, reading the comparative literature, offering basic information and recommending sensible pragmatic management including the human dimension. This type of advisor role is well developed and accepted in the agricultural sector, but almost non-existent and even frowned upon in fisheries (Prince 2003).

A shift in approach, funding and thinking might sometimes be needed to reconcile conservation and use values in freshwater RFM. Before this becomes reality, it is important to note that anglers or RFM in general are not responsible for sustainable management approaches being sometimes, clearly not always, lacking. This is a societal issue and results from the traditional way by which fish resources are managed, often localized in a small angling club without external expert assistance and funding in a research-poor environment. In fact, voluntary fisheries managers at the private level in central Europe are often highly active, willing to improve fisheries management and have contributed to effective management in many cases (Arlinghaus *et al.* 2002). Therefore, political decision makers dealing with the total environment are envisaged to provide the resources and the environment in which this potential is capitalized towards sustainability.

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