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Determinants of management preferences of recreational anglers in Germany: Habitat management versus fish stocking

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Abstract

In Europe research and policy debates point to the need to increase efforts to rehabilitate or restore habitat structure and function at the expense of the traditional recreational fisheries management approach to intensively stock fish. Against this background it is paramount to understand and explain the management preferences of anglers. No research has empirically examined key factors explaining whether anglers prefer various forms of habitat management (HM) over stocking. By means of a telephone survey, we investigated the management preferences of a nationwide random sample of anglers in Germany to fund either HM or fish stocking. Management strategies potentially restricting the own activity were, on average, opposed. Anglers with high pro-ecological and low traditional management beliefs, negative stocking and positive HM attitudes, satisfied with the previous angling year, less catch orientated, successful (catch) and committed, fishing most frequently in natural water bodies, and living in more rural areas exhibited the preference to fund HM as opposed to stocking. Basic human characteristics such as beliefs, attitudes and the angler's consumptive orientation were more meaningful predictor variables than typical angler variables such as demographics, angler experience or angler preferences (e.g. species preference). Angler catch and satisfaction emerged as the only near-term managerially manipulable variables that could be addressed to increase support for HM. Traditional management approaches without effort limitation will probably fail to initiate this shift. Anglers should be increasingly involved personally in designing and implementing management programs to facilitate their "education" about the outcomes and risks of various management actions.

Keywords: Attitude; Cognitive hierarchy; Human dimensions; Recreational fisheries; Environmental concern; Habitat rehabilitation; Stocking

Introduction

A prominent subject of human dimension research in recreational fisheries has been to analyze the opinion of anglers with respect to different management options, e.g. concerning harvest regulations or other management alternatives such as fish stocking (e.g., Aas & Skurdal, 1996; Reed & Parsons, 1999; Connelly, Brown, & Knuth, 2000). This is perhaps the area of application where the utility of human dimension research is most obvious to resource managers (Aas, Haider, & Hunt, 2000; Ditton, 2004). Traditionally such opinion measurement implied a relatively static method of asking about the anglers' attitude or preference towards

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individual management alternatives. However, in opinion measurements the complexity of the resulting effects of recreational fisheries management actions on either the ecosystem, the fishery, the fish stock or the satisfaction of anglers is lost, which may reduce the practical utility of the research results (Aas et al., 2000; Ditton, 2004). Therefore, survey research in recreational angling has repeatedly tried to overcome this limitation, e.g. by using several variants of choice experiments where anglers were asked to evaluate a set of management tools simultaneously (Teisl, Boyle, & Roe, 1996; Aas et al., 2000; Gillis & Ditton, 2002). However, one constraint of all of these research designs has been that the angler evaluated pre-determined answer options. This may bias the results as the attention of the respondent may be directed towards answer alternatives which he or she would otherwise overlook or evaluate differently (Diekmann & Franzen, 1999). Therefore, in surveys to elicit management preferences of anglers the use of open-ended questions can yield less biased results as compared to closed-ended answer formats with pre-determined items (Arlinghaus & Mehner, 2003). This statement applies without questioning the research results of previous investigations applying pre-determined answer options.

Irrespective, it is not only necessary to assess the management preferences of anglers as accurately and precisely as possible, but also to identify factors that explain the answer pattern. Limited research efforts have been directed at explaining the support of anglers for certain management directions in recreational fisheries management. Most investigations grouped anglers into specific subsegments and contrasted the differences in management orientation between the segments (e.g., Gigliotti & Peyton, 1993; Teisl, Boyle, & Fenderson, 1993; Arlinghaus & Mehner, 2004). However, such approaches do not offer insights into differences that are independent of the grouping variable (Wilde & Ditton, 1994). In order to improve our understanding of angler support for fishery management alternatives and expand the single-dimensional angler segmentation approach discussed above, some researchers used multivariate statistical approaches (Schoolmaster & Frazier, 1985; Jakus, Fly, & Wilson, 1996; Teisl et al., 1996; Aas et al., 2000; Gillis & Ditton, 2002). All of these studies used angler attributes (e.g., demographics, angling experience, angler type), visit characteristics (e.g., length of angling day, number of visits), angler preferences (e.g., preferred location or species) or perceived site problems (e.g., number of fish, number of other users) as explanatory (independent) variables. The low amount of explained variance in some of the above quoted studies suggested that other, previously unmeasured factors may also be powerful explanatory variables of angler preferences for management (Gillis & Ditton, 2002).

Against the background discussed above, this study used an open-ended question format to elicit the management preferences of anglers in Germany. It then measured a variety of independent variables spanning traditionally used angler variables (e.g., demographics, angler experience) and more basic human parameters such as underlying beliefs, motivations, satisfaction and management attitudes as explanatory parameters of the angler's management preference. Particular emphasis was placed in discriminating independent variables between two recreational fisheries management strategies that are currently under intense debate in Central Europe in general (e.g., Austria, UK, The Netherlands) and in Germany in particular: (1) expansion of habitat management (HM) to mitigate, rehabilitate or restore the structure and function of the mostly degraded aquatic ecosystems as well as the natural reproduction of the recreationally valuable fish populations, or alternatively (2) expansion of stocking (see Arlinghaus, Mehner, & Cowx, 2002; Arlinghaus, 2004a, for the European perspective and literature references).

We specifically investigated the behavioral intention of a random sample of anglers at the national level of Germany to fund either the multi-species HM or the traditional single-species stocking approach. A behavioral intention is the closest antecedent of actual behavior according to the socio-psychological cognitive hierarchy model (Fig. 1; Ajzen & Fishbein, 1980). Factors discriminating between both management directions were analyzed based on hypotheses derived from general theories on human behavior, with the cognitive hierarchy model as the dominant framework (Fig. 1, for description of hypotheses see below). A discriminant analysis was conducted to identify factors fostering either a HM or stocking orientation among anglers. The significant factors together with some descriptive data were used to infer potential management implications to influence the management preferences of anglers.

Methods

Angler survey

A nationwide telephone survey was conducted targeting the angler population older than 14 years living in Germany (see Arlinghaus, 2004b, for details and descriptive data). Since a separate listing of anglers was not available, in the angler screening phase sampling of households by the random digit dialing technique was used ($N = 19,394$ valid numbers; the number included a large proportion of companies and non-angler households). Angler households identified were asked for permission to recall them, and the interview was conducted with every angler in the

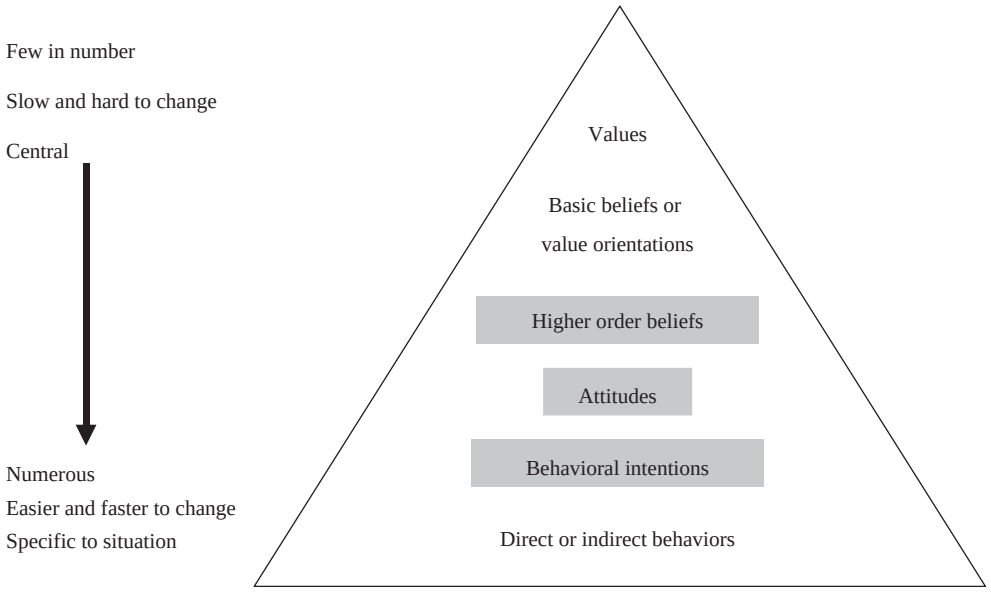

Fig. 1. The cognitive hierarchy model of human thought and action (figure modified from Fulton et al., 1996). Gray marks indicate variables measured in this study.

household to avoid "household-leader bias". In-depth interviews (20–25 min each) were conducted with active anglers only (i.e. having fished in the previous 12 months). This was done because only active anglers were supposed to provide managerially relevant data. From October 15 to November 8, 2002, 38 professional interviewers gathered the data using computer assisted telephone interview facilities at USUMA GmbH (Berliner Allee 96, D-13088 Berlin, Germany). In total, 474 completed interviews were gained, with an effective response rate of 79.7%. This response rate is related to the total number of identified and recalled angler households in the screening phase. Given the high response rate and the hypothesis-testing nature of this study, potential non-response bias was assumed to be negligible (cf. Dolsen & Machlis, 1991).

Overall, in the questionnaire an emphasis was placed on eliciting the lower order cognitions within the angler's cognitive hierarchy (gray in Fig. 1) to improve the predictive power of the variables. Moreover, the question wording of the intensively pre-tested questionnaire aimed at achieving high object (i.e. management) specificity. This was achieved by posing the questions related to a specific action (i.e. management-orientated behavioral intention or attitude), performed towards a specific target (i.e. increasing angler satisfaction) within a certain context (i.e. main fishing water) at a defined time (i.e. fishing season) (coined principle of compatibility), because this also should result in higher explanatory power of the variables (Ajzen & Fishbein, 1980; Eagly & Chaiken, 1993). In all questions, the water type the respondent had previously indicated to have used most frequently in the past fishing season was named by the interviewer to minimize recall and measurement bias. Furthermore, items of all multiple-item questions were randomly ordered when presented to each respondent, thereby further reducing methodical bias.

Variables and hypotheses

To investigate predictors of the management orientation of anglers, their stated management preference for either HM or stocking was measured and treated as a nominal dependent variable. Due to the way of questioning, the management preference was interpreted as a behavioral intention because the anglers were informed that their funds (e.g., licence fees) would be used to implement their stated management preference. It was assessed by asking the angler in an open-ended question about the most desired management action he or she would fund with money to increase its personal satisfaction with the angling condition. Answers can be considered a behavioral intention or a management preference, because the respondent answered freely and against the explicitly stated background of using his or her funds in the future. To avoid bias of answers in the course of the interview, the open-ended question was asked early in the interview (question 3). It was assumed that this procedure ensured an unbiased solicitation of the angler's management preference/behavioral intention. Content analysis was used to draw inferences from survey responses on the open-ended question (Diekmann, 1995). The coding system was based on a pre-test of the questionnaire and slightly refined during the

coding procedure. Inferences were drawn from the frequencies in each management dimension that combined categories falling within the same dimension (i.e. categories such as "expand stocking" or "more stocking" were combined to form the "stocking" dimension). The whole sample was coded independently by two coders to calculate inter-coder reliability according to Diekmann (1995). Most responses (93.6%) were placed in the same dimensions, indicating that statements and meanings of the written messages were interpreted similarly by each coder. Irrespective, we acknowledge that analyzing written or verbal communication to open-ended questions may pose problems with subjectivity of interpretation that closed-ended question with pre-determined answer choices can avoid.

Multiple independent variables were measured for testing the associations of the predictor variables with the anglers' management-orientated behavioral intentions. Some predictor variables were operationalized by single items. However, most socio-psychological constructs such as beliefs are complex and multi-faceted, and therefore cannot be accurately measured using a single item. To improve measurement validity, a scaling technique was used to combine answers to multiple-item questions (by summing individual item scores) supposed to measure the same construct into a single numerical index. In this case, items were ordinated by factor analysis (principal component extraction with varimax rotation), and a reliability analysis using Cronbach's α was conducted with all items having factor loadings >0.5. Only factors with eigenvalues >1 and factor loadings >0.5 were considered relevant (Lozán & Kausch, 1998). This was done to drop inappropriate items from the construct to be measured. Internal consistency of the scale was accepted if Cronbach's α was >0.6 (Tarrant, Bright, & Cordell, 1997). Then the score was calculated by summing the individual items scores to an index which was finally used as the independent variable. Items with divergent scales to be summed to one index were standardized to a z-score (mean $= 0$, SD $= 1$) before index calculation. Other items measuring a construct were recoded before summing if they were negatively worded compared to others. A brief rationale behind the hypotheses that were set up before the study was conducted together with the wording and operationalization of the hypotheses will follow.

Pro-ecological beliefs

According to the cognitive hierarchy model (Fig. 1), the angler's management orientations should be influenced by management beliefs. Pro-ecological beliefs of anglers were measured on a five-point scale ranging from strongly agree (coded as 1) to strongly disagree (5) using modified items of the New Ecological Paradigm scale (Dunlap, van Liere, Mertig, & Jones, 2000) and statements used to measure environmental concern in Germany (Preisendörfer, 1999). However, to increase object specificity with respect to angling and fisheries management and hence to increase predictive value, all items were used in a reworded form. Two indices measuring two facets of a pro-ecological belief construct were extracted and interpreted as follows (Table 1): ecological management belief and traditional management belief. The following hypotheses were analyzed.

H_1. The stronger the ecological belief, the more likely the angler intends to fund HM as opposed to stocking.

H_2. The stronger the traditional management belief, the more likely the angler intends to fund stocking as opposed to HM.

Note that these and the following hypotheses are worded in a way implying that the negative wording of the hypothesis is also tested. For example H_1 also implies that the weaker the ecological belief is, the more likely the angler intends to fund stocking as opposed to HM. This is true because discriminant analyses were used for testing the hypotheses (see below).

Specific management attitudes

The freely articulated management preference of an angler should also be dependent on specific management attitudes as measured by pre-determined items (Fig. 1). This is not a circular reasoning, as attitudes are not necessarily related to behavioral intentions or management preferences. However, demonstrating that management attitudes explain the angler's management preference would also underpin the use of pre-determined attitudinal items in further studies. The traditional way in eliciting the attitudes of an angler towards management tools (i.e. objects) in a rating question was based on items which were derived from a previous study in Germany (Arlinghaus & Mehner, 2003). Anglers were asked for attitudinal agreement on a five-point scale ranging from strongly agree (coded as 1) to strongly disagree (5). The closed-ended question format contained two HM orientated items and one statement related to stocking. The HM items were combined to an index measuring the attitudinal agreement with HM. The single item was used as a measure of the angler's attitude towards stocking (Table 1). The respective hypotheses were:

H_3. The more favorable the attitude towards HM, the more likely the angler intends to fund HM as opposed to stocking.

H_4. The more favorable the attitude towards stocking, the more likely the angler intends to fund stocking as opposed to HM.

Table 1. Descriptive statistics and reliability analysis of the independent variables used for the analysis whether anglers experience the behavioral intention to fund habitat management or stocking

Number of hypothesis: variable/index and items used	Increasing scores indicate	Variable mean (SD)	Variable range	Cronbach's α	α if item deleted
H_1. Ecological management belief	Low belief	24.25 (4.44)	10–35	0.66	
When we anglers interfere with an aquatic ecosystem, it often produces disastrous consequences					0.60
The balance of the aquatic ecosystems is strong enough to cope with the impacts of us anglers[a]					0.64
We are approaching the limit of the number of anglers that the aquatic ecosystems can support					0.65
We anglers are well qualified to manage and protect the aquatic ecosystems[a]					0.65
If we anglers continue in the present course, we will soon experience an ecological catastrophe in the aquatic ecosystems					0.59
It is still a fact that we anglers do not do enough to protect the aquatic ecosystems					0.62
For the protection of the aquatic ecosystems we anglers should be willing to change our present angling behavior					0.63
H_2. Traditional management belief	Low belief	11.49 (3.08)	5–22	0.54	
When we anglers interfere with an aquatic ecosystem, it often produces disastrous consequences[a]					0.49
It is still a fact that we anglers do not do enough to protect the aquatic ecosystems[a]					0.45
We anglers are well qualified to manage and protect the aquatic ecosystems					0.44
As anglers our ability to learn and our power of observation will insure that we do not overfish the aquatic ecosystems					0.50
We anglers impact on the aquatic ecosystems less than other stakeholders					0.51
H_3. Pro-habitat management attitude	Favorable attitude	8.63 (1.23)	2–10	0.61	
Create natural spawning places					—
Rehabilitate natural shorelines structures and fish refuges					—
H_4. Pro-stocking attitude	Favorable attitude	4.09 (0.9)	1–5	—	
Expand stocking programme					—
H_5. Perception of habitat quality development	Deterioration of quality	10.98 (2.5)	4–19	0.64	
Cleanliness of water					0.48
Bathing suitability of water					0.63
Existence of natural spawning habitats such as submerged macrophytes and gravel					0.55
Existence of diverse natural shorelines and fish refuges					0.60
H_6: Perception of fish stock quality development	Deterioration of quality	6.39 (1.58)	2–10	0.60	
Existence of a dense fish stock that offers good catch opportunities					—
Existence of trophy fish					—
H_7. Consumptive orientation	Non-consumptive	12.12 (2.66)	3–15	0.78	
When I go angling, I'm not satisfied unless I catch something					0.81
An angling day can be successful to me even if no fish are caught[a]					0.64
When I go angling, I'm just as happy if I don't catch a fish[a]					0.67
H_8. Overall satisfaction with the angling year	High satisfaction	6.73 (2.32)	1–10	—	—
H_9. CPUE[b]	High CPUE	0.17 (0.28)	0–25.5	—	—

H_{10}. Angling commitment[c]	High level of commitment	0.045 (4.3)	−3.9–27.9	0.81	
Annual effort (h)					0.76
Annual catch (kg)					0.79
Annual harvest (kg)					0.80
Annual expenditures (€)					0.80
Annual angling days in Germany (d)					0.74
Annual angling days in the foreign (d)					0.76
H_{11}. Angling experience (years)	Experienced angler	24.78 (14.40)	0–77	—	—
Explorative variables					
Main water type fished was artificial[d]	Experience with artificial water	—	0 or 1	—	—
Main water type fished was flowing[d]	Experience with flowing waters	—	0 or 1	—	—
Club membership	Experience with club rules	—	0 or 1	—	—
Preference to fish at natural shorelines[e]	Preference for natural shorelines	4.03 (1.26)	1–5	—	—
Preference to fish clear waters[e]	Preference for turbid waters	2.75 (1.29)	1–5	—	—
Preference to catch salmonid fish[e]	Preference to catch non-salmonids	3.26 (1.56)	1–5	—	—
Preference to catch piscivorous fish[e]	Preference for non-piscivores	2.93 (1.28)	1–5	—	—
Preference to fish for naturally spawned fish[e]	Preference for stocked fish	2.12 (1.27)	1–5	—	—
Age (years)	Older people	40.44 (15.91)	14–85	—	—
Scholarly education[f]	Higher education	4.10 (1.39)	1–6	—	—
Children younger than 18 years in household	Experience with children education	—	1 (yes) or 0	—	—
Population in home residence[g]	Living in more densely populated area	3.64 (1.84)	1–7	—	—

[a]Items were recoded before summing of index.

[b]CPUE (Catch per Unit Effort) was calculated as the self-reported yearly catch (kg) divided by the self-reported yearly effort (average angling hours per angling day multiplied with angling days per year).

[c]Index is based on self-reported angling behavior in the previous 12 months. All variables were standardized to a z-score before summing. Reliability analysis excluded the following variables because of lowering Cronbach's α below the threshold level of 0.6: share of harvest on total catch (%), average travel distance (km).

[d]These dichotomous variables were based on the water type that was fished most often during the past 12 months. If the water type was an artificial water body (either artificially constructed standing water such as gravel pit or reservoir, pond or canal), then the code was 1, otherwise 0. Similarly, if the water type was a flowing system (either stream or river), then the code was 1, otherwise 0.

[e]These variables were measured individually by asking the anglers on a five-point scale how much of the one option they preferred compared with the generally opposite type.

[f]Variable was measured on a scale ranging from 1 = without school leaving certificate to 6 = university entrance qualification.

[g]Variable was measured on a 7-point scale ranging from $1 \leqslant 2000$ eligible voters to $7 \geqslant 500{,}000$ eligible voters.

Angler perception of site quality development (subjective knowledge)

In the metropolitan area of Berlin (Arlinghaus & Mehner, 2003) we found that the behavioral intention of anglers to support HM was positively related to the subjective knowledge of current ecosystem status. Here, we operationalized subjective ecological knowledge by asking anglers on a five point scale ranging from strongly improved (coded as 1) to strongly deteriorated (5) about their perception of the development of certain angling site quality attributes (both fish stock and habitat-related) since the beginning of their angling career. Two facets were distinguished (Table 1): development of habitat quality (index of four items) and development of fish stock quality (index of two items). The respective hypotheses were as follows:

H_5. The more the habitat quality is perceived to have decreased, the more likely the angler intends to fund HM as opposed to stocking.

H_6. The more the fish stock quality is perceived to have decreased, the more likely the angler intends to fund stocking as opposed to HM.

Consumptive orientation

The consumptive orientation of an angler was measured with three general items described by Fedler and Ditton (1986) and Aas and Kaltenborn (1995). Agreement responses (1 = strongly agree to 5 = strongly disagree) to the items were combined to an index of consumptiveness (Table 1). Because anglers with high consumptive orientation place high importance on the catch-related aspects of the angling experience, this may be an incentive to prefer short-term measures (i.e. stocking) to enhance fish abundance. The hypothesis was worded as follows:

H_7. The higher the consumptive orientation, the more likely the angler intends to fund stocking as opposed to HM.

Satisfaction

Angler satisfaction [i.e. the perceived fulfillment of the expected outcomes (= motivations) of the activity] was measured by asking the anglers on a 10-point differential scale ranging from very dissatisfied (coded as 1) to very satisfied (10). Satisfaction components were constructed with items reflecting the major subdimensions of angler motivations (Fedler & Ditton, 1994; Arlinghaus & Mehner, 2004). In contrast to motivations, which have been shown to be independent of the habitat-orientated management preferences of anglers (Arlinghaus & Mehner, 2003), satisfaction was supposed to be a relevant predictor of the angler's management orientation (Table 1). To investigate whether non-catch related or catch-related satisfaction components contributed most to overall satisfaction, indirect measurement based on multiple regressions was chosen to minimize strategic bias (Connelly & Brown, 2000). We hypothesized that satisfaction will be primarily dependent on catch-related satisfaction components (Connelly & Brown, 2000; Cox, Walters, & Post, 2003). As humans in general prefer those measures that are likely to provide short-term rewards (Fehr, 2002), stocking was assumed to be perceived by dissatisfied anglers as being the most appropriate short-term measure to increase fish abundance to satisfy catch expectations. Furthermore, we assumed a shift of expectations with increasing catch rates (Miko, Schramm, Arey, Dennis, & Mathews, 1995). Anglers may become conditioned to high catch rates and shifting expectations may therefore reinforce the belief in the short-term measure stocking. Thus, we formulated:

H_8. The higher the satisfaction level, the more likely the angler intends to fund HM as opposed to stocking.

H_9. The higher the fishing success (e.g. higher Catch Per Unit Effort, CPUE), the more likely the angler intends to fund stocking as opposed to HM.

Angler commitment

One specific subdimension of the multidimensional construct angler specialization, angler commitment, was operationalized by a quantitative procedure similar to Chipman & Helfrich (1988) (compare Table 1 for variables used). Because a quantitative procedure based on actual behavior was used to measure "specialization", it was assumed that angler commitment rather than angler specialization as defined by Bryan (1977) was measured (cf. Arlinghaus & Mehner, 2004, for similar reasoning). Bryan (1977) stated that more specialized and consequently more committed anglers are more likely to favor HM. The according hypothesis reads as follows:

H_{10}. The higher the commitment level, the more likely the angler intends to fund HM as opposed to stocking.

Angler preferences and characteristics

Angler preferences for fish stock characteristics, species and ecosystem attributes were assessed using a procedure described by Connelly, Knuth, and Brown (2001). Anglers were asked on a five-point scale to indicate how much of one type of fishing they preferred compared with the general opposite. We expected angling preferences having an influence on the suggested management tools. For example, it is intuitive that anglers preferring naturally spawned fish over stocked

fish intend to fund HM and not stocking (see Table 1 for other preference variables used). Besides, research by Schoolmaster & Frazier (1985) and Jakus et al. (1996) suggested that angler attributes, angling characteristics and habits might influence anglers' management preferences. However, because of lack of empirical data that might predict the direction of the association, most variables on demographics, angling preferences and characteristics (see Table 1 for variables) were used exploratorily. One exception was angling experience. Because more experienced anglers usually have a higher resource dependency (Ditton, Loomis, & Choi, 1992) and a greater probability of acquiring knowledge about ecological processes and the limitations of fish abundance by degraded habitats, we hypothesized:

H_{11}. The higher the angling experience, the more likely the angler intends to fund HM and not stocking.

The independent variables in Table 1 were subjected to 253 pairwise spearman rank correlations. Some ($N = 74$) significant spearman rank correlations coefficients R_s were found at $P<0.05$. However, they were generally very low ($R_s<0.35$) which indicates the independency of the variables. Exceptions were the variables age and traditional management belief. Age was significantly related to angling experience ($R_s = 0.726, P<0.001$) and presence of children in the household ($R_s = -0.417, P<0.001$). The index measuring the traditional management belief was significantly correlated with the ecological management belief ($R_s = -0.705, P<0.001$) raising come concern about the validity of treating both beliefs separately. This is further substantiated by the comparatively low Cronbach's α value of the traditional management belief variable which did not reach the acceptance level of 0.6 (Table 1).

Using discriminant analysis the contribution of each independent variable on the management-orientated behavioral intention/management preference (either HM or stocking) was assessed by the standardized canonical discriminant coefficients (Backhaus, Erichson, Plinke, & Weiber, 2000). Furthermore, independent tests were performed analyzing the differences in mean variable/index scores between the two groups by ANOVA. Variables with very low canonical discriminant coefficients <0.1 and not significant differences between the management groups were removed from the final discriminant function model. It is important to note that for the purpose of the discriminant analysis as applied here, it was not necessary to achieve extraordinarily high percentages of correctly classified cases. Instead, the power of the analysis stems from the evaluation if the direction of the assumed association between the independent variables was supported by the empirical data. All calculations were performed at the 95% CI with the SPSS software package version 9.0.1.

Results

Selected descriptive data

Anglers were above average (item mean = 5) satisfied with their previous angling year (item mean 6.73). Differences were apparent when differentiating between satisfaction components dependent on the fishing activity and components, which are not necessarily dependent on the actual fact of catching fish (cf. Table 2 for item wording). Anglers were generally less satisfied with the more consumptive satisfaction components compared to the less consumptive ones. For instance, over 50% of the angler sample was satisfied or very satisfied (combined ratings 7–10) with activity independent aspects of angling. In contrast, with the exception of the item "quantity of consumable fish caught", less than 50% of the sample was satisfied or very satisfied with the activity dependent satisfaction components. Stepwise regression revealed six significant components that explained overall satisfaction (Table 2). Satisfaction components included both catch and non-catch related factors. The standardized coefficients, however, indicated that fish quantity and catch-related satisfaction components contributed the most to explaining overall satisfaction. Interestingly, one non-catch related satisfaction component was even negatively related to overall satisfaction.

Concerning attitudes towards management measures to increase angler satisfaction, anglers in particular agreed with habitat and stocking related management measures (Table 3). Furthermore, the item to "increase enforcement measures" received a favorable support of the large majority of anglers. Generally, anglers agreed with those management tools that had a low probability of self-restriction, and disagreed with measures with a high probability of self-restriction. For example, all traditional regulatory measures such as expansion of closed seasons, increase of minimum size limits and reduction of daily harvestable fish were, on average, rejected by the anglers (compare item means in Table 3 with the neutral = 3).

In the open-ended question on the management options that anglers would be willing to fund (behavioral intention), as expected, two main tools emerged (Table 4). HM ranked first and stocking second. Other management tools were of very low overall relevance (relative frequency $<5\%$). The answer patterns of the most and least desirable management measures (preferences) were relatively similar to the one on management attitudes (Table 3). For example, HM was found to rank first in both question formats, and stocking was also among the most deserved tools. However, expansion of enforcement measures received strong support in the attitude question but was of negligible relevance in the open-ended question on

Table 2. Results of stepwise multiple regression of 12 satisfaction components (independent variables) on overall satisfaction with the previous angling year (dependent variable) of anglers living in Germany[a,b]

Significant satisfaction components (items)[c]	Standardised coefficient (beta)	SE	*P*-value
Constant	1.765	0.459	<0.000
Catch-related or consumptive			
Quantity of consumable fish caught	0.256	0.056	<0.000
Quantity of trophy fish caught	0.188	0.054	0.001
Quantity of bites	0.176	0.058	0.002
Non-catch-related or non-consumptive			
Possibility to be untroubled in an environment which is hardly disturbed by humans	−0.149	0.041	0.003
Possibility to experience a remote water	0.112	0.049	0.037
Possibility to enjoy clear water while fishing	0.105	0.052	0.049
$R = 0.621$, corrected $R^2 = 0.371$, df= 299, $P < 0.000$, Durbin–Watson = 2.050, $N = 299$			

[a]Question wording for overall satisfaction: ''How satisfied were you with the previous angling year at the (here the specific water type as previously indicated by the angler was repeated by the interviewer) you fished most often? You can indicate your satisfaction by a number ranging from 1 to 10, where 1 means very dissatisfied and 10 is very satisfied. By means of numbers between 1 and 10 you may graduate your response''.

[b]Question wording for satisfaction components: ''Please indicate again by a number ranging from 1 to 10 your satisfaction with each of the following components during the past fishing season at the (here the specific water type as previously indicated by the angler was repeated by the interviewer) you fished most often''.

[c]Not significant items ($P > 0.05$) were: (1) possibility to compete with other anglers for the biggest or most fish (consumptive), (2) possibility to experience exiting fights with fishes (consumptive), (3) possibility to master angling-related challenges (consumptive), (4) possibility to use sufficient angling sites and parking places (consumptive), (5) possibility to fish in pleasant companionship (non-consumptive), (6) possibility to relax in the outdoors at the waterside (non-consumptive).

management preferences. In both question formats, measures that directly targeted individual anglers (e.g. ''increase minimum size limits'' in attitude measurement or ''expand regulatory measures'' in preference measurement) were opposed by the anglers.

Determinants of the angler's management preference

Of 23 independent variables included in total in the discriminant analysis (Table 1), 10 were found to contribute substantially to the discriminant function, i.e. standardized canonical discriminant coefficients were relevant or significant differences in mean variable scores were found between the pro-HM and the pro-stocking group (Table 5). Seven of the eleven hypotheses received empirical support, whereas three did not (Table 5). One hypothesis was rejected. Moreover, two of the associations tested exploratively were significant.

The greatest contribution to the discriminant function was found in the variables derived from the cognitive hierarchy model, and the direction was as assumed a priori. Thus, anglers with a strong pro-ecological management belief and with favorable HM attitudes more likely intended to fund HM, whereas anglers indicating favorable stocking attitudes and holding strong traditional management beliefs optioned for stocking. However, there was no significant difference in mean index scores for the traditional management belief index between both management groups. Thus, the discriminatory contribution of the traditional management belief was due to the interaction with other variables (mainly with the pro-ecological management belief). Irrespective, the cognitive hierarchy model and the hypotheses H_1–H_4 received substantial empirical support in our study.

Similarly, the hypothesis H_8 that more satisfied anglers would opt for HM and not for stocking received significant support in the discriminant analysis. The canonical discriminant coefficient was slightly lower than the variables of the cognitive hierarchy but higher than the coefficients of the other significant variables. Furthermore, mean satisfaction scores were significantly different between the management groups.

The same trend was found for the concept of consumptive orientation in that the index of consumptiveness significantly discriminated between the management groups. Less consumptive anglers more likely suggested HM as compared to more catch-orientated anglers (H_7 supported).

As hypothesized, more efficient anglers (higher CPUE) intended to fund stocking and not HM (H_9 supported). Furthermore, anglers fishing predominantly in artificial water bodies (e.g. ponds, reservoirs) showed a behavioral intention to fund stocking and not HM.

Table 3. Frequency distribution (%) and item means[a] (±SD) of the response pattern on management attitudes of anglers living in Germany[b]. Items were arranged according to increasing probability of self-restriction

Do you agree or disagree with:	Item mean ± SD (N, P-value[d])	SA[c]	A[c]	U[c]	D[c]	DS[c]	DN[c]
Measures with low probability of self-restriction							
Rehabilitate natural shoreline structures and fish refuges	1.65 ± 0.73 (471, <0.001)	45.7	46.3	4.7	2.3	0.6	0.4
Increase control and enforcement and punish violators	1.66 ± 0.86 (472, <0.001)	51.8	36.6	6.1	4.0	1.3	0.2
Create spawning habitats	1.72 ± 0.73 (468, <0.001)	40.0	50.5	5.7	1.9	0.8	1.0
Conduct stocking programmes	1.91 ± 0.90 (467, <0.001)	34.5	46.7	10.8	5.1	1.7	1.3
Reduce nutrient inputs	2.36 ± 1.08 (453, <0.001)	23.7	33.0	23.5	12.7	3.0	4.2
Reduce fish-eating birds such as cormorants	2.81 ± 1.31 (470, <0.001)	18.2	29.8	16.5	22.4	12.5	0.6
Restrict other water-based stakeholders such as navigation or water sports	2.85 ± 1.12 (460, <0.001)	11.8	28.3	24.9	27.1	5.1	2.8
Improve physical access to the waters, e.g. by creating angling sites, driving routes or parking places	2.87 ± 1.26 (470, <0.001)	15.2	29.8	16.5	27.9	9.9	0.6
Measures with high probability of self-restriction							
Restrict amount of allowed angling licences	2.92 ± 1.20 (462, <0.001)	12.5	27.5	22.4	26.0	9.3	2.4
Expand closed season during spawning times	3.07 ± 1.16 (469, <0.001)	10.4	23.3	24.3	31.7	9.5	0.8
Increase minimum size-limits	3.11 ± 1.18 (473, <0.001)	9.9	23.9	22.4	32.8	11.0	0.0
Reduce number of daily harvestable fish (lower bag limits)	3.23 ± 1.12 (467, <0.001)	7.0	20.1	27.1	32.6	12.1	1.2

[a]The calculation of the item mean was based on the sample excluding those that indicated not to know.

[b]Question wording: "Please indicate whether you Strongly Agree, Agree, are Unsure or Neutral, Disagree or Strongly Disagree that the following management measure might increase your satisfaction with the angling conditions at the (now the specific water type as indicated previously by the angler was named) you fished most often during your previous angling year".

[c]SA = Strongly Agree, A = Agree, U = Unsure or neutral, D = Disagree, SD = Strongly Disagree, and DN = do not know.

[d]P-values indicate significant differences from the expected frequency distribution. χ^2 tests were performed by testing the frequency distribution of the angler sample against the expected distribution which would have occurred by chance alone.

Table 4. Frequency of response (%) for each management dimension suggested by anglers living in Germany to improve angling opportunities and enhance angler satisfaction[a]

Management measure (dimension)	Relative frequency (%)
Conduct habitat management	36.6
Expand stocking	32.9
Restore salmon	4.8
Improve physical access	4.0
Other fish stock measures except stocking	3.7
Promote angling of children and youth	2.9
Reduce populations of cormorants	2.7
Expand enforcement measures	2.4
Reduce regulatory measures	2.4
Enhance cleanliness of shorelines	1.9
Enhance angling opportunities	1.6
Reduce monetary cost	1.1
Constrain commercial fisheries	1.1
Modify aquatic ecosystems	0.6
Reduce probability of flooding events	0.3
Expand regulatory measures	0.3

[a]Question wording of the open-ended question that was asked in the very beginning of the interview: "Please name one management measure for improving angling opportunities at your most frequently fished water that you would fund to increase your angling satisfaction".

Although there were significant differences in angler commitment level between the anglers optioning for either HM or stocking, the direction was opposite to that predicted. Less committed anglers optioned for HM and more committed favored stocking. Thus, the angler commitment hypothesis H_{10} was not supported by the empirical data.

Neither perceptions of fish stock (H_4) or habitat quality development (H_5), angling experience (H_{11}), angler's preferences for fish stock or ecosystem attributes, angling characteristics (e.g. club membership) nor demographic variables substantially explained the management preferences of anglers (Table 5). However, there was a significant effect in that anglers living in less densely populated areas intended to fund HM and not stocking (Table 5).

Discussion

Seven out of 11 hypotheses tested in this study received empirical support (Table 5). Basic human characteristics such as management beliefs and attitudes (and not angler variables such as angler experience, commitment or preferences), explained most of the

Table 5. Summary of the discriminant analysis to discriminate between the angler's behavioral intention to fund either habitat management or stocking as the preferred measure to increase satisfaction with the angling conditions at the most frequently used water type. Index mean $\pm$ SD as well as the *P*-value of the two group comparisons using *ANOVA* are presented

Independent variable[a]	Standardized canonical discriminant coefficient[b]	Index mean $\pm$ SD of habitat management group	Index mean $\pm$ SD of stocking group	*P*-value[c]	Support of original hypothesis
Ecological management belief	0.708	23.71 $\pm$ 4.30	25.00 $\pm$ 4.33	0.026	H_1 (yes)
Stocking attitude	0.570	3.93 $\pm$ 0.87	4.38 $\pm$ 0.74	$<$0.000	H_4 (yes)
Traditional management belief	0.409	11.47 $\pm$ 3.09	11.04 $\pm$ 3.08	0.304	H_2 (yes)
Habitat management belief	−0.389	8.89 $\pm$ 1.07	8.41 $\pm$ 1.27	0.002	H_3 (yes)
Angling satisfaction	−0.329	6.93 $\pm$ 1.98	6.20 $\pm$ 2.53	0.016	H_8 (yes)
Main water type artificial	0.311	0.17 $\pm$ 0.38	0.28 $\pm$ 0.45	0.050	Explorative
Consumptive orientation	−0.265	0.10 $\pm$ 0.86	−0.12 $\pm$ 0.98	0.049	H_7 (yes)
Population density of residence	−0.245	3.81 $\pm$ 1.82	3.41 $\pm$ 1.81	0.101	Explorative
CPUE	0.242	0.14 $\pm$ 0.17	0.21 $\pm$ 0.35	0.049	H_9 (yes)
Angler commitment	0.217	−0.20 $\pm$ 3.22	0.97 $\pm$ 5.19	0.042	H_{10} (no)

Model statistics: eigenvalue 0.279, canonical correlation 0.467, 71.6% correctly classified, Wilks' $\lambda = 0.782$, $\chi 2 = 53,603$, $df = 10$, $P < 0.000$, $N = 225$

[a]See Table 1 for coding of all independent variables. The following 13 variables were found irrelevant in the discriminatory function, and were removed from the final analysis: perception of fish stock quality development, perception of ecosystem quality development, angling experience, main water type flowing, club membership, preference for natural shorelines, preference for clear water, preference for salmonid fish, preference for piscivorous fish, preference for naturally spawned fish, age, education, children in household. Thus, the hypotheses H_5, H_6, H_{11} were not supported by the data.

[b]Positive values indicate that anglers with high scores support stocking, negative values indicate that anglers with high scores support habitat management (compare mean values, see Table 1 for interpretation of index scores).

[c]Note that *P*-value indicates single group comparisons. Regardless, insignificant variables at $P > 0.05$ can have substantial discriminatory importance through the interaction with other variables.

variance of management preferences of anglers (Table 5). The significant associations between pro-ecological beliefs and attitudes and the behavioral intention to support HM confirmed other studies pointing to the validity of the cognitive hierarchy model in natural resource management (Fulton, Manfredo, & Lipscomb, 1996; Tarrant et al., 1997). Consequently, appropriately worded pre-determined items in attitude questions may replace open-ended questions eliciting management preferences as similar tendencies are expected. Although fundamental values, value orientations, basic beliefs and attitudes apparently are powerful predictors of the management-related behavioral intention of anglers, attempts of managers to promote the support of anglers for HM are extremely difficult to accomplish, in particular concerning a change of beliefs or higher order cognitions such as values. This is true as beliefs are typically deeply rooted cognitions that change slowly, if at all (Fulton et al., 1996). The same applies to the consumptive orientation of anglers, which was also found to significantly discriminate between the HM and stocking proponents (Table 5). Consumptiveness of anglers can be interpreted as a motivational construct (Aas & Kaltenborn, 1995). Motivations are, however, relatively stable human characteristics (Manfredo, Driver, & Tarrant, 1996). Therefore, the consumptive orientation of anglers is relatively fixed or changes slowly over time. It is therefore not easy to alter by education outreaches or other interventions by managers. Consequently, lessening the consumptiveness of anglers in an effort to increase the angler's support for HM (Table 5) may not be easily achieved in the short-term.

The most promising near-term manipulable variables, that emerged in our analysis in fostering angler support for HM were angler satisfaction and CPUE (Table 5). These parameters have traditionally been the focus of recreational fisheries management efforts worldwide (e.g. maximizing angler satisfaction or catch/harvest quality or rate). Two mechanisms likely explain the discriminating power of angler satisfaction and CPUE. First, humans typically chose those pro-ecological behaviors that demand the least cost with cost including not only money, but time, energy and effort (Diekmann & Preisendörfer, 1992). Therefore, if anglers are satisfied, i.e. mainly with respect to catch expectations (Table 2; Graefe & Fedler, 1986; Connelly & Brown, 2000; Cox et al., 2003), anglers may perceive the opportunity costs (i.e. the cost of the forgone alternative to increase fish stocks which is stocking) of optioning for HM to be low. Hence, they can "afford" to support HM which constitute long-term fish stock recovery and enhancement measures, with rewards in terms of increasing fish abundance likely to occur in the (uncertain) future. Second, various researchers pointed out that an increase in stock abundance and angler's catch quality (e.g. CPUE) is paralleled by an increase in the angler's expectations of the catch (McMichael & Kaya, 1991; Miko et al., 1995), i.e. the norm against to judge catch quality increases. Because satisfaction is negatively related to expectations (Spencer & Spangler, 1992), satisfaction ultimately depends on how anglers evaluate their catch in light of their expectations rather than on the actual number of fish caught (Graefe & Fedler, 1986). These relationships very likely explain the associations found in the present study with more successful (higher CPUE) and more dissatisfied anglers intending to fund stocking policies and not HM (Table 5).

Similarly to another study conducted by the authors (Arlinghaus & Mehner, 2003) and somehow contradictory to Schoolmaster & Frazier (1985) and Jakus et al. (1996), angler's characteristics and habits related to experience, preferred angling sites, club membership and demographic background were not found to discriminate substantially between the management preferences of anglers. In addition, ecosystem and fish stock related angler preferences, e.g. the preference for naturally spawned fish over stocked fish, were incapable in predicting the angler's management orientation. This suggests that angler variables such as angler preference data are of relatively limited value to managers to predict whether anglers will support certain management actions. In fact, basic human characteristics such as beliefs and attitudes had a by far greater explanatory power in our analysis (Table 5). In some cases, however, the low sample variability might have inhibited the detection of significant influences. For example, only 13.3% of the angler sample preferred stocked fish over naturally reproduced fish.

The angling commitment variable behaved contrary to predicted (Table 5). Therefore, based on this and another study (Arlinghaus & Mehner, 2003), the original thesis of Bryan (1977) that more specialized, hence committed anglers favor HM over stocking policies is questioned, at least concerning commitment as a subdimension of angler specialization (Sutton & Ditton, 2001). The questioning of Bryan's hypothesis was also indicated by Chipman & Helfrich (1988) and Vittersø (1997) who, albeit using different operationalization procedures, could not find significant differences in preference for HM across angler specialization levels. However, angler specialization as discussed by Bryan (1977) and Ditton et al. (1992) is a multi-dimensional construct that is very difficult to operationalize objectively. Among the independent variables measured in this study, consumptive orientation, commitment and experience are related to angling specialization, although recent studies question the relationship between experience and degree of specialization (Scott & Shafer, 2001). Theoretically, as specialization increases, the angler's consumptive orientation should decrease

and the degree of commitment should increase (Ditton et al., 1992; Sutton & Ditton, 2001). In this study conflicting effects of the independent variables consumptiveness and commitment were revealed, with ess consumptive (hence more specialized) anglers preferring HM over stocking and more committed (hence more specialized) anglers preferring it the other way round. Angling experience was not significant. It may be the case that the greater dependence of more committed anglers on the angling activity as a whole coupled with the fact that in Europe stocking of fish from hatchery production was the standard mitigation practice in the twentieth century (Arlinghaus et al., 2002), has created the perception among more avid and committed (specialized) anglers that hatcheries are often the only solution to environmental destruction (Meffe, 1992). However, more research on angler specialization is needed because of the current debate about the correct way of operationalization of the angler specialization construct (Scott & Shafer, 2001). If angler specialization is defined quantitatively in terms of behaviors (e.g., expenditure, annual effort), contemporary anglers may exhibit high-end of commitment (alleged high level of specialization) without having an "appropriate ethical conduct" to guide the behavior (Bryan, 2001). This pattern might have influenced the results of this study.

Surprisingly, we could not find a significant influence of the subjective knowledge of habitat and fish stock quality development on the management orientation of anglers. However, compared to Arlinghaus & Mehner (2003), we used a different knowledge operationalization by asking the anglers about their perception of status development and not status per se. Ecosystem quality has steadily decreased during the past centuries and in Europe reached its hit rock bottom in the 1970–1990s. This might have shifted the perception of good ecological quality among living angler generations from natural to impacted waters, e.g. a regulated river or a polytrophic lake and the impoverished fish stocks therein may be judged as being the "natural condition" today (coined shifting baseline syndrome, Pauly, 1995). Due to low intergenerational memory, over the centuries this might have reduced the angler's perception about the degraded state of many freshwater habitats. Then, small improvements in ecosystem "quality" (e.g. the re-oligotrophication tendencies in lakes during the past decade, Brönmark & Hansson, 2002) coupled with the policies of the mass media to promote environmental "success" stories (e.g. returning migratory salmonids in Germany), can lead to an image among anglers that ecosystem status has improved, and ecosystem and fish stock development are decoupled. Ultimately, this decoupled relationship may result in a view that environmental problems are no longer critical for the fish stocks and the angling quality (Lappalainen, Hildén, & Leinonen, 1994; Arlinghaus & Mehner, 2003). This could explain the lack of a significant association between subjective knowledge and the behavioral intention to fund HM in this study. Regardless of the validity and severity of the shifting baseline syndrome (see Arlinghaus & Mehner, 2003, for a discussion related to angling), it was shown in other studies that subjective knowledge can have an effect on pro-ecological awareness and behavior of anglers (Tarrant et al., 1997; Arlinghaus & Mehner, 2003). Therefore, our results should not be misinterpreted that objective or subjective knowledge is without any effect on the angler's management preference.

Many additional variables to the ones identified in the present research might be relevant predictors of the management preferences of anglers and deserve increased research efforts in the future. These include norms, direct and indirect past experiences, actual and perceived possibility to implement measures, beliefs concerning consequences, concernment, habituation, information and various internal (e.g. cultural) and situational factors.

Management implications

Rehabilitation of habitat on larger scales can be considered as the most sustainable recreational fisheries management strategy (cf. Arlinghaus et al., 2002; Meffe, 1992, for details). This particularly applies in densely populated countries such as Germany, where most aquatic ecosystems have experienced anthropogenic disturbances dating back several centuries (Arlinghaus et al., 2002; Wolter, Arlinghaus, Grosch, & Vilcinskas, 2003). Although habitat-orientated recreational fisheries management offers solutions to many management problems, major advances in research and training, restructuring of institutions and support from all stakeholders including the public are needed (Fluharty, 2000; Arlinghaus, 2004a). Anglers are amongst the key players in this shifting fisheries management policy as they are often users and at the same time managers in Central Europe, but other stakeholders are clearly equally important (e.g., water management authorities, land owners). In this study, multiple factors responsible for anglers being orientated towards a more sustainable HM as opposed to a less sustainable stocking management approach were determined. These factors offer insights into paramount variables that might be targeted by managers.

Obviously, the most promising way is to increase the pro-ecological values and attitudes of anglers, e.g. by appropriate education outreaches. The most efficient ones will include anglers in HM project design, implementation and evaluation, which ensures that

anglers directly experience potentially positive effects of habitat improvements, or alternatively negative effects of habitat modifications. Personal experiences can be judged as the most effective ways of environmental education. Irrespective, care is advocated to emphasizing habitat improvement in every instance. Every habitat rehabilitation project has to be carefully planned and executed in order to minimize unexpected outcomes (Cowx & van Zyll de Jong, 2004). There are also situations where continuous stocking seems appropriate, e.g. in artificial fisheries or to preserve fish at risk of extinction (Arlinghaus et al., 2002; Hickley & Chare, 2004).

One paramount factor that emerged in our analysis to satisfy anglers thereby fostering support for HM is essentially catching fish respectively meeting the catch expectations. The most straightforward implication might be that angler satisfaction should be enhanced by increasing the catch quality, which in turn would increase the probability of HM as opposed to stocking to be supported by anglers (Table 5). This might most easily be achieved by simply improving the effectiveness of traditional inland fisheries practices such as appropriately planned harvest regulations or closed seasons or promotion of catch-and-release practices. However, increasing the fish stock quality as perceived by the anglers may not always increase the catch quality for individual anglers due to increased angling effort/mortality directed at the recovering water at unlimited access (Johnson & Staggs, 1992; Johnson & Carpenter, 1994; Miko et al., 1995; Cox & Walters, 2002; Cox, Beard, & Walters, 2002; Post et al., 2002). Some access restrictions may therefore be needed in specific vulnerable fisheries to preserve high catch rates and high angler satisfaction. This may be achieved by partially limiting effort, because high quality (here equalled with high catch rates) angling is often only found in waters where: (1) high cost/time required to access the fishery (e.g. remote waters without driving routes) exclude anglers, or (2) access and effort is strictly controlled by private or local interests (Cox & Walters, 2002). Angling effort to indirectly increase stock abundance, catch quality, angler satisfaction and support for HM may be controlled by lottery or license rotating systems, individual transferable effort or access quotas, protected areas or high access costs (e.g., time, money). This procedure is already being pursued in some of the highest quality recreational fisheries, which is particularly feasible in private property fisheries that characterize large parts of Central Europe. Irrespective, the necessity to limit effort should always be properly analyzed because such measures are very likely followed by outright rejection by anglers (compare Tables 3 and 4). However, disagreement may quickly die off if improved fishing becomes visible.

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