NRC Research Press

ARTICLE

Effectively managing angler satisfaction in recreational fisheries requires understanding the fish species and the anglers

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Abstract: Whenever satisfied anglers are an important objective of recreational fisheries management, understanding how trip outcomes influence satisfaction reports is critical. While anglers, generally, prefer high catch rates and large fish, the relative importance of these catch outcomes for catch satisfaction has not been established across species and angler types. We examined relationships between angler specialization, trip outcomes (both catch and non-catch characteristics such as crowding), and catch satisfaction across six freshwater fish species in northern Germany. As expected, catch satisfaction was primarily determined by catch rate and fish size in all fish species; however, the relative importance of these two outcomes varied considerably across species and among angler types that differed by commitment to fishing. We found a diminishing marginal return of satisfaction for increasing catch rate for all but small-bodied cyprinid species, while increasing size of largest retained fish monotonically increased catch satisfaction in all species we examined. Non-catch outcomes (e.g., the number of other anglers seen while fishing) also had a significant negative influence on catch satisfaction, suggesting that non-catch factors are important in establishing expectations and for contextual evaluation of catch outcomes. We also determined that diversified trips made anglers more satisfied and that all else being equal, specialized anglers increased catch satisfaction from travel and fishing time. The results highlight the importance for managers to consider their particular mix of anglers as well as the fish species present when setting regulations aimed at increasing angler satisfaction.

Résumé : Dans tous les cas où des pêcheurs sportifs satisfaits constituent un important objectif de la gestion des pêches récréatives, la compréhension de l'influence des résultats de sorties sur la satisfaction signalée revêt une importance capitale. Si les pêcheurs sportifs préfèrent généralement des taux de prise plus grands et des poissons plus gros, l'importance relative de ces résultats de pêche en ce qui concerne la satisfaction découlant des prises n'a pas été établie pour différentes espèces et types de pêcheurs sportifs. Nous avons examiné les liens entre la spécialisation des pêcheurs, les résultats de sorties (les caractéristiques relatives aux prises et autres, comme la densité de pêcheurs) et la satisfaction découlant des prises pour six espèces de poissons d'eau douce dans le nord de l'Allemagne. Comme prévu, la satisfaction découlant des prises était principalement déterminée par le taux de prise et la taille des poissons pour toutes les espèces; cependant, l'importance relative de ces deux résultats variait considérablement d'une espèce à l'autre et d'un type de pêcheurs à l'autre, selon leur engagement envers la pêche. Nous avons constaté une augmentation marginale décroissante de la satisfaction pour des taux de prise de plus en plus grands pour toutes les espèces à l'exception des petits cyprinidés, alors que de plus grandes tailles des plus grands poissons conservés se traduisaient par une augmentation monotone de la satisfaction découlant des prises pour toutes les espèces examinées. Les résultats non associés aux prises, par exemple le nombre d'autres pêcheurs vus durant la sortie, avaient également une influence négative significative sur la satisfaction découlant des prises, ce qui suggère que ces facteurs sont importants dans l'établissement des attentes et pour l'évaluation contextuelle des résultats de prise. Nous avons également déterminé que des sorties variées augmentaient la satisfaction des pêcheurs et que, toutes choses étant égales, les pêcheurs spécialisés tiraient une plus grande satisfaction découlant des prises du temps passé à se déplacer et à pêcher. Les résultats soulignent l'importance pour les gestionnaires de tenir compte des combinaisons précises de pêcheurs, ainsi que des espèces de poissons présentes dans l'établissement de règlements visant à accroître la satisfaction des pêcheurs sportifs. [Traduit par la Rédaction]

Received 9 April 2014. Accepted 7 November 2014.

Paper handled by Associate Editor Charles Ramcharan.

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Introduction

Satisfied users are an important measure of success of recreational fisheries management (Royce 1983). This statement implies that effective fisheries management requires actions that address and ideally increase the satisfaction of anglers. Satisfaction is the ultimate reward that participants receive from their fishing experience (Arlinghaus 2006). Hence, angler satisfaction may serve as a suitable management objective for the elusive concept of optimum social yield (Johnston et al. 2010, 2013, 2015). Accordingly, many fisheries managers would like to tailor policies to satisfy the desires and expected outcomes of fishery users and other stakeholders (Driver 1985).

Satisfaction is regularly confused with motivations by individuals not familiar with human dimensions theory. Although motivations and satisfaction are related, they are distinct concepts that refer to entirely different time steps within a recreational fishing experience (Peyton and Gigliotti 1989; Arlinghaus 2006). While motivations are the ex ante underlying forces that act on a tendency to engage in an activity based on its expected psychological outcomes (Atkinson 1969; Manfredo et al. 1996), satisfaction is the ex post psychological state derived from achieving expected outcomes after engaging in the activity (Holland and Ditton 1992; Arlinghaus 2006). A common finding of past motivation studies in recreational fisheries has been that anglers rank non-catch-related motivations (e.g., to experience nature) as more important than catch-related motivations (e.g., to catch many fish) (Fedler and Ditton 1994). However, this finding only holds when motives are assessed on a general level without considering the context in which specific recreational fishing experiences happen. Indeed, Beardmore et al. (2011) showed that different aspects related to catch are primary motives for many anglers depending on the target species and fishery that is chosen, while the very same anglers rated non-catch dimensions as more important when asked about motivations for engaging in angling "in general". Because species differ in their catch characteristics that are desired by anglers (e.g., European eel (*Anguilla anguilla*) attracts German anglers with consumptive motives, while common carp (*Cyprinus carpio*) may attract those seeking a trophy experience (Beardmore et al. 2011)), one may also expect the influence of different catch outcomes (e.g., catch rate versus size of fish captured) on satisfaction to vary across fish species. So far, research comparing determinants of satisfaction across target species in the same population of anglers is missing.

It is important to realize that anglers exert direct control over most non-catch dimensions of their trip, which are thus comparatively easily satisfied (e.g., by selecting a location that meets expectations for experiencing nature or by choosing the right fishing company; Arlinghaus 2006). By contrast, satisfactorily achieving catch-related outcomes is much more difficult to control by the angler. Indeed, satisfaction with catch-related aspects of the fishing experience has usually been found to be substantially lower than satisfaction with non-catch dimensions of fishing (Arlinghaus 2006). This, in turn, results in catch aspects (e.g., size of fish captured, catch rate), rather than non-catch dimensions, being prime determinants of angling-year satisfaction in both Germany and the USA (Arlinghaus and Mehner 2005; Arlinghaus 2006; Arlinghaus et al. 2008; Hutt and Neal 2010). Similar findings have been reported for angler satisfaction at trip scales (Vaske et al. 1982; Roemer and Vaske 2012). The close relationship between catch outcomes (e.g., catch rates) and ratings of angler satisfaction at a trip level (McMichael and Kaya 1991; Miko et al. 1995; McCormick and Porter 2014) have even prompted suggestions to use catch rates to set thresholds for fishing quality (Schramm et al. 1998) and some modelers to treat catch rate as a linearly related proxy for angler satisfaction (Cox et al. 2003). Moreover, while general angler motivations are useful to differentiate whether a person engages in fishing as opposed to a different recreational activity like golfing, general motivations have not been found to be strong predictors of specific angler behaviors, such as site choice or species substitution behaviors (reviewed in Arlinghaus 2006). By contrast, strong relationships among angler satisfaction and preferred management policies (Arlinghaus and Mehner 2005), social norms as to how to manage a fishery (van Poorten et al. 2011), and site choices (Hunt 2005) have been reported. This body of research implies that angler satisfaction, and particularly satisfaction with catch, is very relevant for understanding how anglers think and feel about given policies and for developing high-quality recreational fisheries that satisfy anglers. Therefore, understanding the relative contribution of various catch outcomes towards satisfaction with catch across species may allow managers to identify opportunities to improve angling experiences.

Satisfaction with catch may not only be determined by catch outcomes, but may also be influenced by non-catch factors, such as the social environment of a trip. For example, crowding negatively affects anglers' choices of fishing sites independent of catch (Hunt 2005). Encounters with other anglers may heighten perceptions of competition over fishery resources and in extreme cases prompt anglers to redefine their expectations for trip outcomes during and after the trip to avoid dissatisfaction (Shindler and Shelby 1995). Similarly, competition among members of the same fishing group may also influence the way catch outcomes are perceived. These and other trip characteristics (e.g., number of species captured, duration of fishing, trip length), therefore, may set the context of a fishing trip and also influence an angler's satisfaction with catch independent of any changes in actual catch outcomes.

While diversity among fishing experiences as described by differing trip characteristics plays a large role in determining satisfaction (Spencer and Spangler 1992; Schramm et al. 1998), diversity among anglers is also important (Kyle et al. 2003). Identifying and understanding management implications of heterogeneity in angler preferences has become a large focus of the human dimensions literature, with recreation specialization (Bryan 1977; Ditton et al. 1992) emerging as the primary research framework for understanding diversity in fishing preferences and behavior. Specialization has been defined as a "continuum of behavior from the general to the particular, reflected by equipment and skills used in the sport and activity setting preferences" (Bryan 1977, p. 175). The concept has been closely associated with psychological and behavioral measures of psychological involvement and commitment (Buchanan 1985). In this context, increased commitment may be associated with differences in catch and harvest orientation (Bryan 1977). Catch orientation refers to an angler's disposition towards catching versus harvesting fish, and the importance attached to the number and the size of fish caught (e.g., Anderson et al. 2007). Specialized anglers have been described as becoming more trophy-oriented (Bryan 1977) and less harvest-oriented (Ditton et al. 1992; Oh and Ditton 2006) than their less specialized counterparts. For some species, however, this characterization does not hold (Dorow et al. 2010), suggesting that the process of specialization may also be context-dependent and that the influence of trip outcomes on an angler's satisfaction with catch may be moderated by degree of specialization. For example, specialized anglers derive greater benefits from their fishing experience because fishing is of high importance in their lifestyle (Arlinghaus and Mehner 2004). Hence, independent of catch, specialized anglers might value fishing time and travel time differently than less specialized anglers, which in turn might affect satisfaction levels with catch.

The objective of our study was to test the consistency with which various trip characteristics affected reported catch satisfaction across a suite of six diverse freshwater species for variously specialized anglers. Working at a trip scale, we focused on what Graefe and Fedler (1986) described as "situational" factors (i.e., objective measures of trip outcomes, such as catch), thought to be

salient to ecologically trained fisheries managers, because these measures may be managed directly by harvest regulations or stocking (Bennett et al. 1978). Our focus thus differed from the emphasis placed on subjective evaluations of individual outcomes common within the human dimensions literature (e.g., Graefe and Fedler 1986; Arlinghaus 2006; Hutt and Neal 2010). While one may expect confirmation of trends previously established in the literature, indicating that anglers prefer fisheries with higher catch rates and larger fish (e.g., Graefe and Fedler 1986; Miko et al. 1995; McCormick and Porter 2014), the relative importance of these two outcomes was largely unknown both across species and among anglers differing in level of recreational specialization. Addressing this knowledge gap was the focus for our study.

Methods

Our study draws from data collected during a 1-year diary program in the German state of Mecklenburg-Vorpommern. Participants were drawn from a random sample of resident and nonresident anglers fishing in Mecklenburg-Vorpommern as described in detail in Dorow and Arlinghaus (2011). In total, 1121 anglers were recruited to record fishing trips between September 2006 and August 2007 (Fig. 1), including information about the timing, location, fishing effort, social group, target species, and catch outcomes. To reduce measurement error associated with estimates of mean length for caught fish, we asked anglers to record only the length of the largest retained fish for each species on a given trip. However, all angling trips, including those without catch, were to be reported. The diary form also elicited anglers' satisfaction with catch using the ten-point scale recommended by Matlock et al. (1991) that ranged from completely dissatisfied to completely satisfied.

Diary participants received a high-quality fishing reel (a €40 value) after completing the diary program. Moreover, all participants were contacted every 3 months by telephone to minimize nonresponse and recall biases that have affected past angler diary studies (Anderson and Thompson 1991; Tarrant et al. 1993; Connelly and Brown 1996; Bray and Schramm 2001). Telephone interviews addressed any emergent concerns that participants might have encountered, were meant to keep them motivated in the study, and collected supplemental information on angler specialization and other angler characteristics. To decrease the dropout rate further, diary participants were promised and given a custom report at the end of the study, which summarized information from their personal diary and related it to the entire sample. In all, 648 anglers (58%) returned diaries and reported a total of 12 937 trips targeting 28 different freshwater and marine fish species.

We focus on freshwater trips with one of six target species receiving the most directed effort on a given trip. This narrowed focus reduced the sample to 525 anglers (49% of the initial sample) representing 8438 angling trips. The six species were chosen both for their popularity among anglers within the region and for their diversity in life history characteristics. The species included two species of piscivores: northern pike (hereinafter referred to as pike, *Esox lucius*) and zander (also known as pike-perch, *Sander lucioperca*). The remaining species have a more general feeding pattern, some of which are entirely nonpiscivorous for their entire life: common carp (*Cyprinus carpio*), European eel, European perch (also known as Eurasian perch, *Perca fluviatilis*), and a group of small-bodied cyprinid species collated under the term "coarse" fish, which included cyprinids like roach (*Rutilus rutilus*) and bream (*Abramis brama*). The six species or species groups provided a range of recreational fishing experiences, including species known for their trophy quality (e.g., carp, pike), fish species prized for their eating quality (e.g., eel, perch, zander), and high catch-rate-fisheries valued for social fishing events (Meinelt et al. 2008) and the general nature experience (e.g., coarse fish; Beardmore et al. 2011). Several species chosen also inhabit brackish (low salinity) coastal waters (e.g., perch, pike, zander, eel and coarse fish). However, we limited the analysis to freshwater trips, as coastal and freshwater fisheries for the same species might be associated with different sets of expectations. For example, the abundance of trophy pike is disproportionately higher in the Baltic Sea than in many small freshwater systems, which likely exerted a differential effect on the relationship of size of fish captured and angler satisfaction with catch for that species.

Operationalizing angler specialization

Collecting information about angler specialization was a major focus of the quarterly telephone interviews (see Beardmore et al. 2013 for details). One metric of specialization is centrality-to-lifestyle, which is the extent that a given leisure activity is connected to one's social network and general lifestyle (Kim et al. 1997). Centrality has emerged as a prominent measure of psychological commitment in outdoor recreation studies and is often used as a proxy for specialization in recreational fishing (Donnelly et al. 1986; Sutton and Ditton 2001; Dorow et al. 2010; Dorow and Arlinghaus 2012). Centrality-to-lifestyle was indeed the best predictor of intended behavior among 11 metrics of specialization for German anglers in our dataset (Beardmore et al. 2013) and was thus chosen as the primary indicator of specialization here. We measured centrality-to-lifestyle using a five-point agreement scale adapted from Kim et al. (1997) (see Beardmore et al. 2013 for details). Principal component analysis (PCA) on the responses to this seven-item scale yielded a single reliable factor explaining 62.2% of the variance ($\alpha = 0.90$; Table 1) containing all items. Factor scores (i.e., z scores) formed the final index of centrality-to-lifestyle (aka, specialization).

Besides centrality-to-lifestyle as an index of personal commitment, we also included the cognitive dimension of angler specialization (i.e., skill, knowledge, and expertise), as it was thought to most directly relate to an angler's catch success. Skill was inferred from each angler's species-specific catch per unit effort (CPUE, fish caught per hour of directed effort) as documented in catch diaries, converted to a standardized z score. To account for variation in an angler's experience across species, these standardized CPUE scores were weighted by proportion of effort devoted to each species as revealed from diary entries (Beardmore et al. 2013). The weighting prevented rarely targeted species from unduly affecting an angler's revealed catch skills. Both dimensions of specialization (centrality and skill) were included in the catch satisfaction model as interactions with other variables in an approach similar to Carlin et al. (2012). In this way, we were able to examine the moderating effect of angler specialization on the importance of individual outcomes (e.g., the influence of centrality-to-lifestyle on preferences for larger fish).

Modeling catch satisfaction

The primary study objective was to predict satisfaction with catch from catch and non-catch-related trip characteristics. Given the ordinal nature of the dependent variable, we used an adjacent-category, ordinal logit model to predict catch satisfaction ratings as a function of independent variables. The logit model of a fishing trip t with Q attributes characterized by an angler (e.g., catch rate, size of largest fish harvested, other anglers seen, centrality score, skill) can be formulated as follows (Vermunt and Magidson 2005):

$$\eta_m = \beta_m^{\text{con}} + y_m^* \times \sum_{q=1}^{Q} \beta_q^{\text{att}} \times z_q^{\text{att}} \quad (1)$$

In this equation, η_m is the systematic component of the catch satisfaction rating of category m, β_m^{con} is the category's alternative specific constant, y_m^* is the fixed category score (here, satisfaction

Fig. 1. Trip reporting form from the angling diary. 525 anglers reported 8438 freshwater fishing trips targeting six primary species taken in Mecklenburg-Vorpommern, Germany.

Please use one page for every angling trip

Timing and Duration

1. Start of the trip (leaving home)	Date:	Time:
2. End of the trip (coming home)	Date:	Time:
3. Total hours fished		

Fished Waterbody

4. Name of the waterbody		
5. Nearest town		
6. Waterbody type	☐ Running water ☐ Canal ☐ Natural Lake ☐ Pond ☐ Put & Take	☐ Brackish area ☐ Coastal area ☐ Open sea ☐ Other type _____

Information about trip type and used gear

7. With whom did you fish?	☐ Alone ☐ With friends ☐ With family ☐ Guide/Party boat	Number of anglers in your group? _____
8. Angling location	☐ Natural shore ☐ Artificial shore ☐ Boat ☐ Commercial Boat	
9. Number of used rods per angling method	___ Fly fishing ___ Fish with dead fish bait ___ Fish with natural baits ___ Carp fishing with boilies ___ Surfcasting	___ Heavy Spin fishing ___ Light Spin fishing ___ Pilk fishing ___ Other method: _____

Target species (How long did you fish for one of these species?)

10.	___h Eel	___h Herring	___h Zander
	___h Perch	___h Carp	___h Coarse fish
	___h Cod	___h Flatfish	___h Other species _____
	___h Pike	___h Salmonids (Trout)	☐ No target species

Information about catch and harvest

	Fish species	Number caught	Number retained	Size of the largest retained fish (cm)
11.	A.			
	B.			
	C.			
	D.			
	E.			
	F.			

Additional Information

12. How many anglers did you see?	
13. Satisfaction with catch?	1 2 3 4 5 6 7 8 9 10 (totally dissatisfied) ⟷ (totally satisfied)

Comments: (For example: Why did you release the fish?)

Table 1. Centrality-to-lifestyle scale used as a measure of recreation specialization for freshwater anglers fishing in Mecklenburg-Vorpommern, Germany in 2006–2007 (n = 525).

	Mean	SE	SD	Factor loading	α if item deleted	Cronbach's α
I would lose a lot of my friends if I stop fishing.	3.94	0.06	1.28	0.83	0.88	0.90
If I could not fish, I would not know what else to do.	3.83	0.06	1.27	0.83	0.88	
Because of my angling passion no time is left for other hobbies.	3.68	0.05	1.25	0.84	0.88	
Most of my friends are connected to angling.	3.58	0.06	1.32	0.81	0.88	
Going fishing is the most enjoyable thing I can do.	3.04	0.05	1.24	0.78	0.88	
Other leisure activities do not interest me as much as angling.	3.01	0.06	1.34	0.77	0.89	
Most of my life revolves around angling.	2.75	0.05	1.08	0.64	0.90	

Note: The agreement scale ranged from 1 = strongly disagree to 5 = strongly agree.

ratings scored from one to ten), and β_q^{att} is the estimate of the contribution to catch satisfaction associated with each attribute of value z_q^{att}. In this way, the ordinal logit model related changes in trip outcomes to corresponding changes in catch satisfaction rating. Analyses that accounted for the panel structure of the dataset (8438 observed ratings made by 525 anglers) were conducted using Latent Gold Choice 4.5 software by Statistical Innovations, Inc. (Vermunt and Magidson 2005). Thus, we were able to account for variation in trip experiences associated with each individual angler in the study. This approach, however, required an assumption that expectations of trip outcomes across our sample did not vary directionally during the timeframe of our study.

The final model was selected after systematically and sequentially testing and if necessary adding groups of related parameters. These tests were conducted to support the testing of specific hypotheses related to the functional form of each outcome's influence on satisfaction, their species specificity, or the moderating influence of our specialization indicators. This sequential approach carefully limited the number of tested candidate models to 11 from the over 1000 candidate models that could be constructed from the same variables. The estimated parameters were consistent with our hypotheses, as the retention of each added set of parameters was contingent on the outcome of likelihood ratio tests (Louviere et al. 2000). While this approach led us to examine models containing large numbers of parameters, it ensured that the effects of both the six targeted fish species and angler specialization on catch satisfaction were conjointly estimated and therefore comparable.

The final model included the 78 parameters, with continuous attributes coded using linear and quadratic terms, and categorical attributes effects coded to center each attribute's values at zero (Bech and Gyrd-Hansen 2005). While this is a large model, the ratio of observations to estimated parameters is consistent with what is often reported in similar choice models (e.g., Greene and Hensher 2003; Dorow et al. 2010). Included parameters fell into one of four groups. First, alternative specific constants (ASC) represented the relative likelihood of a given rating in the absence of additional trip outcomes. The second group of parameters represented the main effects (linear and selected quadratic) of catch and non-catch outcomes on catch satisfaction ratings. The third group of parameters accounted for the moderating effect of primary target species arbitrarily using coarse fish as the base. The fourth group of parameters accounted for the moderating effect of centrality-to-lifestyle, indicating those trip outcomes whose influence on catch satisfaction depended on the angler's commitment to fishing. Three-way interactions were also included to test for variation in species-specific effects across the range of centrality-to-lifestyle. Finally, the angler skill metric was brought into the model as a separate predictor.

Including interactions, as many as five parameters were used to describe the effect of key trip outcomes on satisfaction with catch per species (i.e., linear and quadratic main effects, as well as three possible interaction terms). Given its complexity, effects were combined into a single polynomial function that was assessed graphically. To illustrate the influence of specialization on the relative importance attributable to specific catch outcomes, we selected three indicator values as benchmarks for low, moderate, and high levels of specialization. Moderate specialization was defined as having centrality-to-lifestyle and skill scores consistent with the mean of the sample, while low and high specialization levels reflected the bottom and top 10% of the centrality-to-lifestyle index, respectively.

To further assess the relative importance of CPUE versus size of largest retained fish to satisfaction with catch, we used satisfaction indifference curves to illustrate the combinations of the two catch outcomes (within observed ranges) where CPUE and size of largest retained fish contributed equally to satisfaction with catch. In other words, the sum of parameters (i.e., main effects and interaction terms) associated with "size" equaled the sum of those associated with "CPUE". In this way, we assessed the degree to which anglers of various levels of specialization derived satisfaction from the size or number of caught fish depending on the target species and how angler types were willing to trade off catch rate for size.

Results

An assessment of non-response bias between 525 respondents and 589 non-respondents was conducted using information collected during the initial recruitment telephone interviews. Respondents tended to be slightly older than non-respondents (t = 3.80; p < 0.001), with means of 44.9 (standard error (SE) = 0.6) and 41.4 (SE = 0.7), respectively. Respondents were also much more experienced and avid anglers, reporting fishing an average of 24 years (SE = 0.70) and 35.8 days (SE = 2.76) in the year prior to the study compared with 22 years (SE = 0.63; t = 4.0; p = 0.045) and 20.7 days (SE = 1.32; t = 17.6; p < 0.001) for non-respondents. Based on the differences in avidity between survey respondents and non-respondents, we caution readers from applying findings of this study to the overall angler population in Mecklenburg-Vorpommern. However, given the correlative nature of the models, the results are insightful to understand the potential influences of species and specialization on the catch-related satisfaction levels of anglers.

Catch satisfaction model

Based on the likelihood ratio tests, the best catch satisfaction model significantly outperformed all other candidate models (p < 0.001; Table 2), while also having a relatively high McFadden's pseudo R^2 = 0.42. While this statistic is analogous to the R^2 in a conventional regression model, it typically produces lower values (Ben-Akiva and Lerman 1985, p. 161).

The ASC (Table 3) showed a significant negative trend. In other words, the trip outcomes included in the model had an overall positive relationship with satisfaction with catch. The trend in

Table 2. Selected likelihood ratio tests estimated to choose the final satisfaction model.

Candidate models	LL	N_{par}	df	$-2(LL_1 - LL_2)$	$df_1 - df_2$	p
Constants only	−19 189.8	9	1562			—
+Linear species-specific catch outcomes	−17 168.8	29	1542	−4042	20	<0.001
+Select quadratic species-specific catch outcomes	−17 094.0	39	1532	−149.6	10	<0.001
+Linear non-catch outcomes	−17 069.6	49	1522	−44.6	5	<0.001
+Select quadratic non-catch outcomes	−17 042.1	52	1519	−55	3	<0.001
+Linear species-independent centrality interactions	−17 021.0	63	1508	−42.2	11	<0.001
+Select species-independent quadratic centrality interactions	−17 014.7	67	1504	−12.6	4	<0.001
+Linear species-specific centrality interactions	−17 003.3	77	1494	−22.8	10	0.004
+ASC interaction (centrality)	−17 003.0	78	1493	−0.6	1	0.382
+ASC interaction (skill)	**−16 977.5**	**78**	**1493**	**−51.6**	**1**	**<0.001**
+ASC interaction (centrality, skill)	−16 977.4	79	1492	−0.2	1	0.807

Note: Baskets of parameter estimates (e.g., related groups of interactions) were sequentially tested and retained if they improved model fit. Each row indicates the addition of one basket of parameters and tests this specification against the nearest preceding model ($p < 0.05$). The final selected model is presented in bold. LL = log-likelihood; N_{par} = number of parameters; df = degrees of freedom; ASC = alternative specific constants.

ASC was complemented by a small but statistically significant effect associated with increasing levels of skill; all else being equal, highly skilled anglers were more likely to report lower catch satisfaction ratings than were less skilled anglers.

Among the catch-related predictor variables of catch satisfaction, size of largest retained fish (Fig. 2) and CPUE for the primary target species (Fig. 3) were the driving factors of catch satisfaction, at approximately an order of magnitude more influential than any other trip outcome. For all species and across all specialization levels, anglers were more likely to report greater satisfaction with catch when the size of the fish and catch rates increased. However, the effect of size in the catch was most pronounced for the least specialized anglers when fish size became very pronounced, suggesting that larger fish disproportionately improved satisfaction for the low avidity angler group (Fig. 2). Catch rates had a similarly strong positive effect on satisfaction with catch for most species as did size of fish. However, the positive effect of catch rate on catch satisfaction often, but not always (coarse fish), showed diminishing returns, in contrast with the effect of size (Fig. 3). Differences in the effect of CPUE among centrality levels indicated that more specialized anglers reported higher satisfaction for a given catch rate than did less specialized anglers, for all species but common carp. Variation in catch satisfaction among differently specialized anglers, however, was generally small except for two species: zander and coarse fish. For these species, the effect of CPUE on satisfaction differed considerably with specialization level, with less specialized anglers receiving less satisfaction for a given catch rate.

The relative contribution towards satisfaction with catch made by CPUE and size of largest retained fish illustrated considerable variation among species that was moderated by anglers' levels of specialization (Fig. 4). Interestingly, size of retained fish consistently contributed more than catch rate to satisfaction with catch at current mean outcomes for all species and all specialization levels. However, differences in the shapes of the indifference curves illustrated marked differences in the relative importance of catch rate over fish size depending on both species and degree of angler centrality. Increasing (concave) or near vertical slopes for all anglers targeting perch and pike indicate greater importance of size than catch rate for these species, which increased even further as specialization increased. By contrast, for convex curves (in extreme case, near horizontal) such as for coarse fish, zander, and eel, the relative contribution of catch rate over fish size increased with angler specialization, and lowly specialized anglers placed more emphasis on size rather than catch rate for these species. For carp, the opposite trend was observed, with contributions of fish size to satisfaction with catch increasing with specialization level.

Other trip characteristics that influenced satisfaction with catch related to anglers' choices of primary and secondary target species (Fig. 5). Higher catch rates for secondary species had a positive effect on angler satisfaction with catch. Both the number of species targeted and the number of species that were ultimately caught increased catch satisfaction to a point, but as these numbers increased further, the positive effect diminished. No significant interactions with specialization were found for these attributes. Collectively, results indicated that the most satisfying trips tended to be those where two species were targeted and two or three species were caught. Consistent with this finding, the fraction of effort directed to a single primary target species had a negative influence on satisfaction with catch. So overall, trips in which more than one species were targeted and captured satisfy anglers more than trips devoted to a single species.

While most independent variables focused on catch outcomes, several non-catch aspects of the fishing trip also had small but significant effects on respondents' catch satisfaction ratings (Fig. 6), in some cases moderated by centrality-to-lifestyle. The relevant non-catch aspects included distance traveled, trip duration, group size, and number of other anglers encountered as a measure of crowding. The main effect for distance was not significant (Table 3), indicating that all else being equal, anglers were similarly satisfied with catch regardless of distance traveled. Its interaction with centrality-to-lifestyle, however, was highly significant, with more committed anglers indicating increasing satisfaction for farther trips, while more casual anglers indicating decreased levels of satisfaction for the same far-distant trips (Fig. 6). Across all anglers, satisfaction with catch increased with the duration of the fishing trip, and this effect was enhanced for high-centrality anglers, who derived more satisfaction from longer trips than did low-centrality anglers, all else being equal. The social environment also affected satisfaction with catch (Fig. 6). For example, increasing group size negatively influenced catch satisfaction ratings, and this effect was independent of angler specialization. Finally, the number of other anglers seen while fishing negatively influenced satisfaction with catch, especially for more specialized anglers; however, this effect was not universal across all species. An opposite effect was found for trips targeting primarily coarse fish, indicating the social nature of coarse fishing.

Discussion

In line with previous trip-level angler satisfaction research (e.g., Graefe and Fedler 1986; Miko et al. 1995; McCormick and Porter 2014), our results showed overwhelmingly that catch-related outcomes are important determinants of catch satisfaction for anglers of all specialization levels and all species. In particular, catch rate (CPUE) and size of largest retained fish were the primary determinants of satisfaction with catch. For most species, however, the effect of CPUE featured a significant negative quadratic term, indicating that marginal increases in angler satisfaction

Table 3. Adjacent categories, ordinal logit model with repeated measures predicting satisfaction with catch of freshwater anglers fishing in Mecklenburg-Vorpommern, Germany, in 2006–2007 from trip outcomes, and social environment (anglers seen), interacted (Int.) with skill (S) and centrality (C) indicators of specialization.

Attribute	Coding	Beta	SE	Int.	Beta	SE
Main effect						
Alternative specific constants (ASC)	1	1.941*	0.181	S	−0.055	0.008
	2	1.116*	0.145			
	3	0.988*	0.108			
	4	0.702*	0.072			
	5	0.649*	0.040			
	6	0.077	0.040			
	7	−0.382*	0.068			
	8	−0.695*	0.105			
	9	−1.836*	0.147			
	10	−2.559*	0.189			
Distance (km)	Linear	0.000	0.001	C	0.004*	0.001
No. of anglers in group	Linear	−0.006*	0.003	—	—	—
Total fishing time (per 24 h)	Linear	0.352*	0.058	C	0.068	0.065
	Quadratic	−0.090*	0.019	C	−0.051*	0.023
No. of targeted species	Linear	0.115*	0.028	—	—	—
	Quadratic	−0.015*	0.006	—	—	—
No. of species caught	Linear	0.132*	0.014	—	—	—
	Quadratic	−0.025*	0.004	—	—	—
No. of other anglers seen (per 10 anglers)	Linear	0.080*	0.033	C	0.009	0.020
	Quadratic	−0.001	0.005	C	−0.011	0.006
Fraction of time directed to primary target species	Linear	−0.594*	0.101	—	—	—
	Quadratic	0.441*	0.080	—	—	—
Primary target species	Carp	−0.037	0.020	C	−0.019	0.026
	Coarse fish	0.114*	0.018	—	—	—
	Eel	−0.061*	0.017	C	0.023	0.023
	Perch	−0.085*	0.020	C	0.066*	0.027
	Pike	−0.034*	0.014	C	0.008	0.017
	Zander	0.103*	0.025	C	0.012	0.038
Size (m) of largest retained fish of primary species	Linear	0.675*	0.194	C	0.103	0.166
	Quadratic	0.738*	0.144	C	−0.449*	0.146
CPUE (fish·h^{-1}) of primary species	Linear	0.021	0.013	C	−0.002	0.010
	Quadratic	0.000	0.000	C	0.001*	0.000
CPUE for other species	Linear	0.034*	0.003	—	—	—
	Quadratic	0.001*	0.000	—	—	—
Species interactions (relative to coarse fish)						
Size (linear)	Pike	−0.329	0.199	C	0.263	0.180
	Zander	−0.241	0.215	C	0.221	0.194
	Perch	0.851*	0.209	C	−0.114	0.188
	Carp	−0.246	0.212	C	0.201	0.191
	Eel	−0.402	0.205	C	0.167	0.183
CPUE (linear)	Pike	0.362*	0.034	C	0.014	0.026
	Zander	0.206*	0.056	C	0.042	0.028
	Perch	0.016	0.013	C	−0.006	0.01
	Carp	1.075*	0.158	C	−0.019	0.094
	Eel	0.667*	0.112	C	0.040	0.052
CPUE (quadratic)	Pike	−0.062*	0.009	—	—	—
	Zander	−0.017*	0.008	—	—	—
	Perch	−0.001*	0.000	—	—	—
	Carp	−0.452*	0.120	—	—	—
	Eel	−0.149*	0.071	—	—	—
Other anglers seen while fishing (linear)	Carp	−0.225*	0.092	—	—	—
	Eel	−0.163	0.089	—	—	—
	Perch	−0.251*	0.070	—	—	—
	Pike	−0.283*	0.074	—	—	—
	Zander	−0.154	0.094	—	—	—
Other anglers seen while fishing (quadratic)	Carp	0.058	0.031	—	—	—
	Eel	−0.003	0.043	—	—	—
	Perch	0.077*	0.027	—	—	—
	Pike	0.078*	0.029	—	—	—
	Zander	0.037	0.031	—	—	—

Note: Parameters significant at $p < 0.05$ are indicated by an asterisk (*).

Fig. 2. Effect of fish size on satisfaction with catch across six freshwater species for three levels of centrality-to-lifestyle. Moderate centrality-to-lifestyle represents the average angler, while low and high centralities represent the bottom and top 10% of the centrality range, respectively. In each panel, the component contribution to satisfaction equals the sum of contributions ($\beta_q^{att} \times z_q^{att}$) for size-related parameters (see eq. 1). The lines in the horizontal bars below each panel indicate the size of fish observed in our dataset in increments of 10%, with the thick line representing the median.

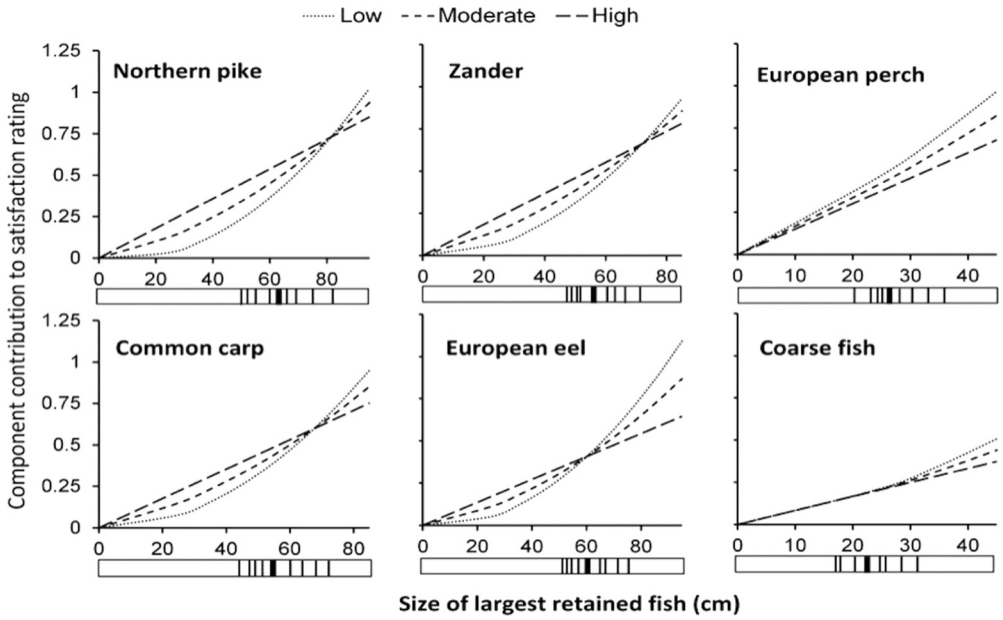
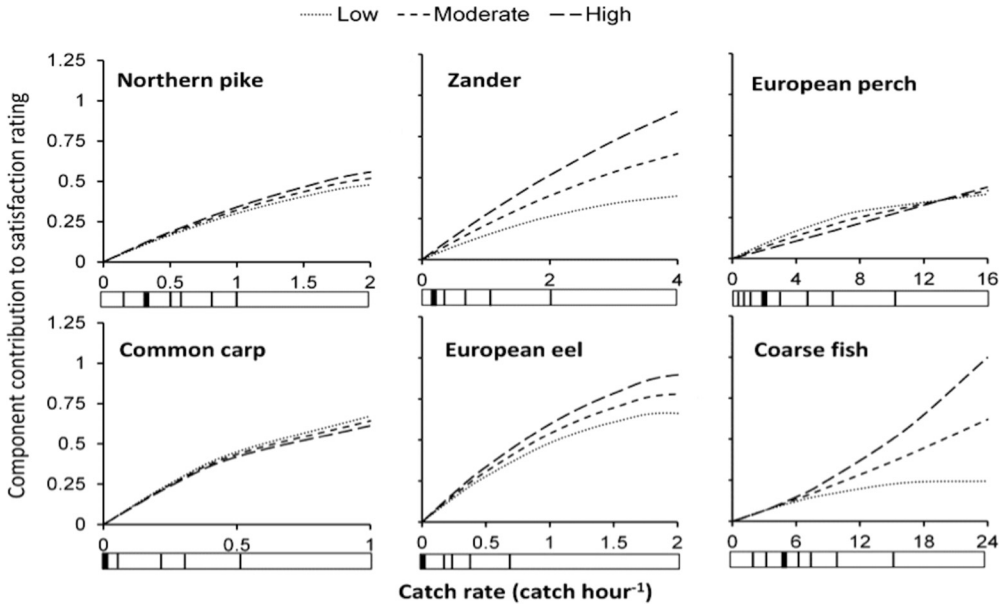
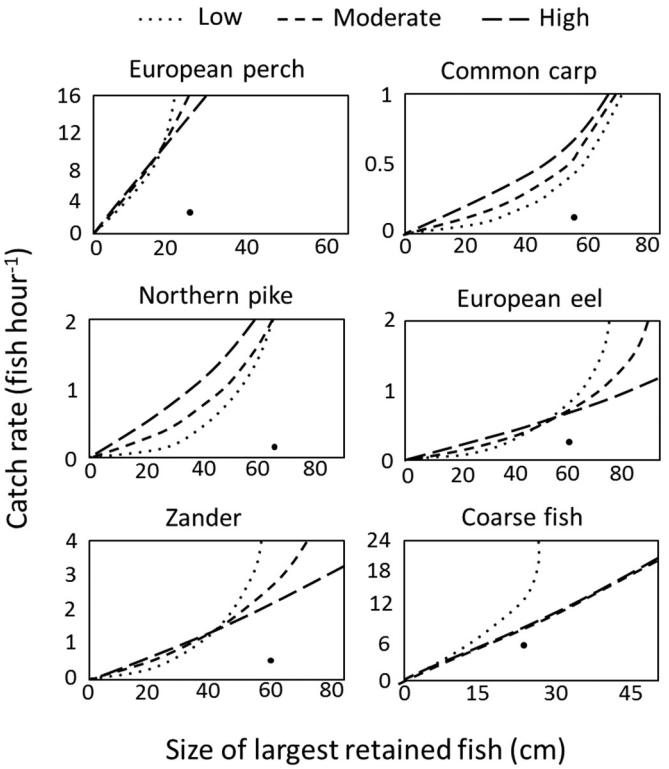


Fig. 3. Effect of catch per unit effort (CPUE) on satisfaction with catch across observed CPUE values for six freshwater species and three levels of centrality-to-lifestyle. In each panel, the component contribution to satisfaction equals the sum of contributions ($\beta_q^{att} \times z_q^{att}$) for model parameters related to catch rate (see eq. 1). Moderate centrality-to-lifestyle represents the average angler, while low and high centralities represent the bottom and top 10% of the centrality range, respectively. The lines in the horizontal bars below each panel indicate the size of fish observed in our dataset in increments of 10%, with the thick line representing the median.



based on improvements in CPUE diminish as catch rates increase. This result is consistent with economic theory of diminishing marginal returns (Samuelson and Nordhaus 2005) and refines previous assumptions of positive linear relationships between CPUE and satisfaction (e.g., Cox et al. 2003) or utility (e.g., Aas et al. 2000; Oh et al. 2005; Beardmore et al. 2013). Put simply, increasing rewards matter more when initial reward levels are low than when they are already high. However, the diminishing effect of CPUE was not universal across species, and in fact, for coarse fish, satisfaction increased monotonically with catch rate. Furthermore, centrality-to-lifestyle as a psychological trait of the angler moderated the effect of CPUE on satisfaction subtly, yet significantly, heightening it for committed anglers of most species. This effect was again particularly pronounced for coarse fish, where diminishing marginal returns of increased catch rates on catch satisfaction were not observed for moderate and highly committed anglers. Coarse fish are a group of highly abundant, small-bodied cyprinid fish that are often the focus of social fishing events in

Fig. 4. The relative importance of catch rate (CPUE) versus size of largest retained fish to angler satisfaction, with catch presented as indifference curves (i.e., $\beta_{CPUE} \times z_{CPUE} = \beta_{Size} \times z_{Size}$). Convex curves indicate increasing relative importance of fish size over catch rates, while concave indifference curves indicate increasing prominence of catch rate over size. Black dots in each panel indicate the mean catch outcome for each species reported from respondents' diaries.



Germany and elsewhere in Europe (e.g., UK), because they promise to offer high catch rates and proliferate in eutrophic waters (Meinelt et al. 2008). In principle, handling time is the only constraint to catch rates of coarse fish, which explains the generally positive effect of CPUE on catch satisfaction with coarse fish. Greater satisfaction with catch for a given CPUE may have reflected the collective expertise and high catch rate expectations of more committed coarse fish anglers, and given their experience they might also have been more acutely aware when catch rates are exceptionally high, in turn leading to higher catch satisfaction with the same catch rate compared with low centrality anglers.

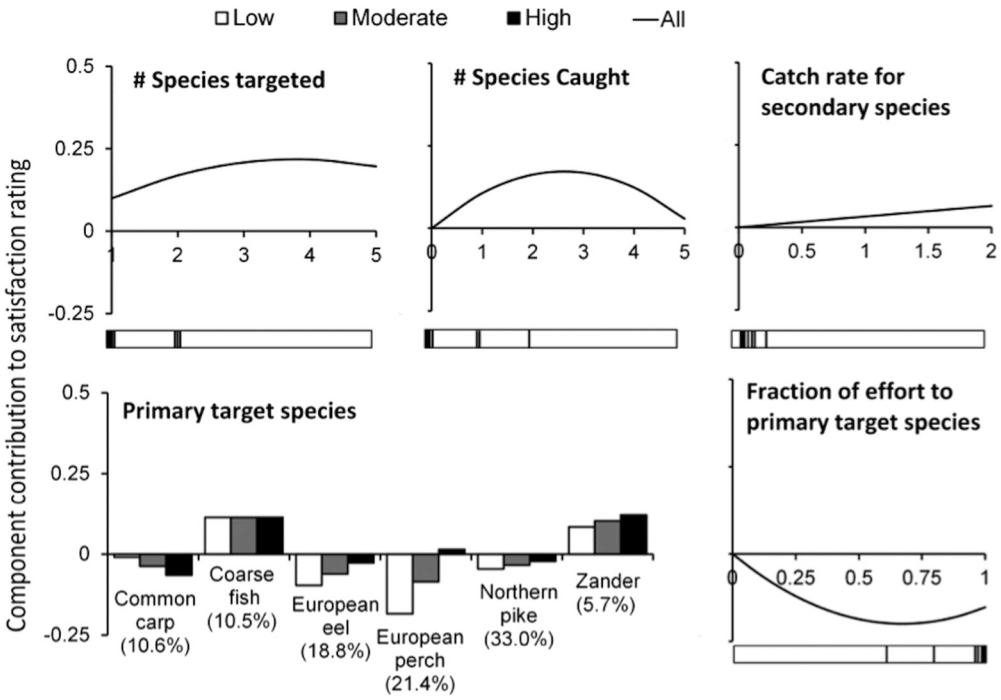
The other primary determinant of satisfaction with catch identified by our model was the size of the largest retained fish. Unlike CPUE, however, the relationship between size and catch satisfaction showed no diminishing marginal return for all species across the size ranges reported in the diaries. The results confirm the exceptional importance of catching low-abundance trophy fish regardless of species (Wilde and Pope 2004; Heermann et al. 2013), such that the rare event of catching a very large fish leads to very high catch satisfaction among anglers across species. As with CPUE, the relationship of size to satisfaction with catch was moderated somewhat by centrality-to-lifestyle. Low centrality anglers tended to more strongly emphasize size of fish relative to catch rate compared with more committed anglers for eel, zander, and coarse fish. These trends may have reflected expectations that catching a trophy fish should be less likely for less skilled, casual anglers than for presumably higher skilled, committed anglers. Economic theory would then predict that utility associated with catching a large fish would be disproportionally greater for casual anglers, in line with our data, because it is a scarce resource. This finding corroborates suggestions by Bryan (1977) that trophy orientation is one characteristic of specialized anglers, which should then be reflected in greater expectations of catching large-sized fish, which are correspondingly harder to satisfy. Size expectations are not the only potential explanation of these results, as previous research has found that for European eel, at least, specialization is associated with increased harvest orientation (Dorow et al. 2010) and may therefore provide greater satisfaction to high centrality anglers from higher CPUE. Eel and zander are both valued for consumptive reasons, and high catch rates for coarse fish during social fishing events enhance anglers' reputations for skill. Therefore, satisfaction associated with catch rates rather than size for more specialized anglers may simply reflect the types of benefits for which these species are most noted among anglers.

Social context, while less influential than CPUE or size of fish, was also an important driver of satisfaction with catch, with the number of anglers in the group being negatively associated with evaluations of catch outcome. Similar findings occurred for the number of other anglers seen while fishing for all species except coarse fish, particularly for the specialized anglers who generally receive greater utility from fishing compared with less specialized anglers (Ditton et al. 1992; Arlinghaus and Mehner 2004; Beardmore et al. 2013). The more committed anglers thus have more to lose when the experience is disrupted by other anglers. Perceptions of crowding among anglers have been well studied (Shelby and Vaske 2007), and the negative influence of crowding on angler utility has been regularly reported in models of fishing site choice (e.g., Aas et al. 2000; Carson et al. 2009; Beardmore et al. 2013), corroborating our results. The divergent finding for trips targeting coarse fish likely reflected the particular context of such fishing experiences as social events (Meinelt et al. 2008) and the high abundance of the species group that may reduce competition among fishers and also reduce the perception of scarcity.

Other determinants of satisfaction with catch in our model, such as target species, number of species targeted and caught, and catch rates of secondary species, were less influential than the primary drivers above. However, it was interesting to find that trips targeting and capturing multiple species resulted in higher satisfaction with catch than single-species trips. Also, the proportion of effort directed towards the primary target species, the number of target species, and the catch rate for secondary species (including bycatch) all influenced satisfaction, suggesting that satisfaction with catch increased when anglers strategically hedged their bets by integrating multiple species into their expectations. Catching more than three species, however, appeared to detract from the experience, possibly indicating trips where bycatch species outnumbered the species of interest. Our findings agreed with common observations that many anglers prefer a species-rich community so as to allow for diverse fishing experiences.

Our satisfaction model revealed that trip context related to target species and social environment played an important role in determining anglers' satisfaction with catch and that these effects were significantly influenced by angler specialization. While our results supported the finding that committed anglers derive more satisfaction from fishing than casual anglers (Spencer 1993; Kyle et al. 2003), we differentiated the effect of psychological involvement (i.e., centrality-to-lifestyle) from that of fishing skill — both of which are subdimensions of the specialization construct (Beardmore et al. 2013). In contrast with centrality-to-lifestyle, increasing skill, all else being equal, was negatively associated with satisfaction ratings. This finding further reinforces the importance of angler expectations in determining angler satisfaction, as more skilled anglers should expect better catch outcomes than should their less skilled counterparts (Spencer and Spangler 1992) and thus should be, all else being equal, less satisfied with a given catch outcome. Our results collectively suggest that anglers who are highly skilled towards a given fish species will be particularly unhappy as fishing quality declines. Specialized anglers are often

Fig. 5. Species composition effects on satisfaction with catch. Interactions with centrality-to-lifestyle were only significant for choice of target species. In each panel, the component contribution to satisfaction equals the sum of contributions ($\beta_q^{att} \times z_q^{att}$) for the relevant parameters (see eq. 1). The vertical lines below each panel depicting a continuous function indicate 10% increments with the median values indicated by a thicker line. Values of percentages given in the primary target species panel indicate the fraction of all trips for which that species was the primary target.

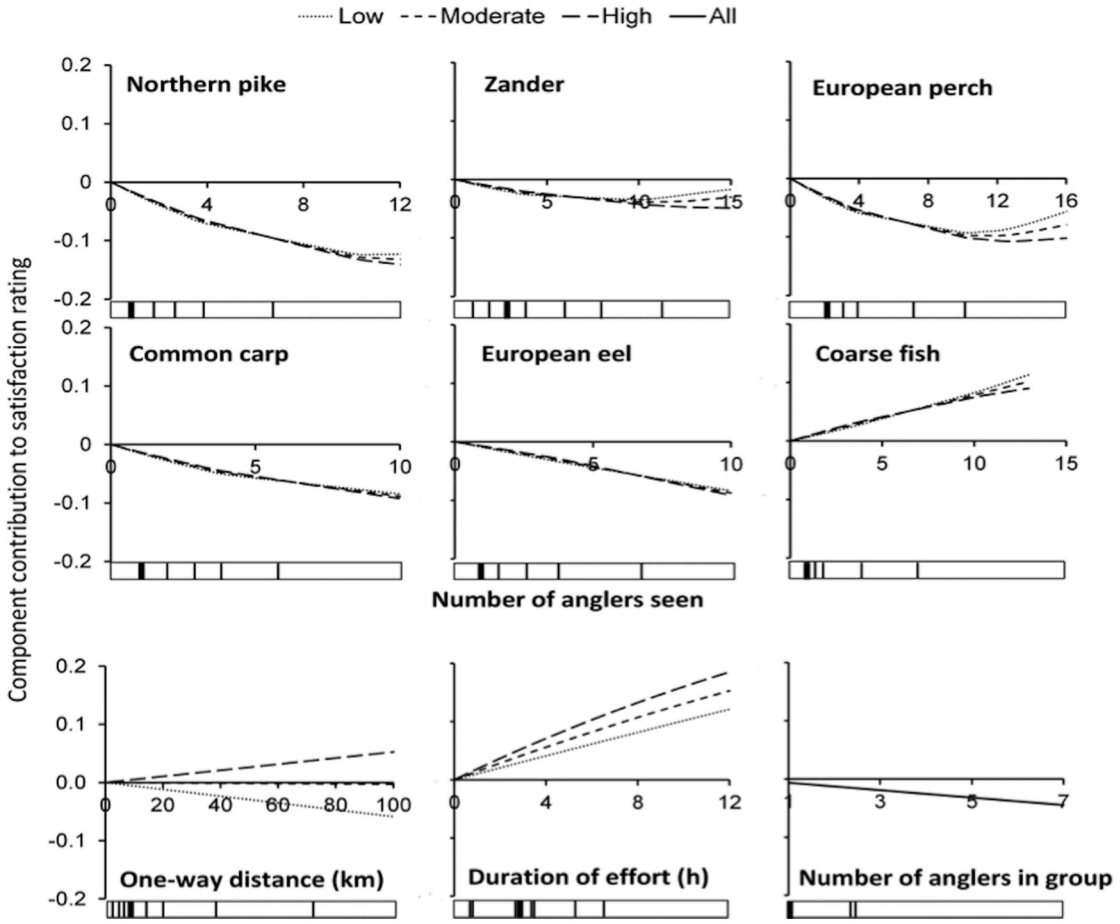


very vocal in the political arena (Hahn 1991). While politically active anglers rarely provide a representative view of the angling public (Hunt et al. 2013), their experience and perceptions of trends in their target quarry might well reflect the state of the ecological system (Bryan 1977).

Non-catch aspects of the trip, while statistically significant, exhibited very small effects on satisfaction with catch. This result was not unexpected given the dependent variable dealing with catch satisfaction, not trip satisfaction. However, omission of non-catch dimensions of the experience significantly reduced the model fit, further emphasizing the importance of trip context in shaping catch expectations. Respondents tended to evaluate trips of longer duration more positively than shorter trips, indicating that besides catch rate, time spent engaged in this leisure activity per se provides utility to anglers. As may be expected, this effect was strongest for committed anglers, for whom fishing is often the most important recreational activity (Arlinghaus and Mehner 2004; Beardmore et al. 2013). While general trends appeared to hold true across anglers of all specialization levels for most trip outcomes (e.g., larger fish of a given species were universally preferred), an exception to this rule occurred among the results for travel distance. Greater distances improved satisfaction among committed anglers, but diminished satisfaction for casual anglers. When satisfaction is regarded as realized utility, travel distance is a measure of willingness to pay, and committed anglers usually have a greater willingness to pay than less committed anglers (Beardmore et al. 2013). Therefore, even travelling large distances will not reduce the realized utility (satisfaction) to the same extent in committed anglers as it will in less committed fishers. Moreover, past research has suggested that product shift, a retroactive revision of expectations to bring them in line with the experienced outcome, is a common coping strategy when experiences fail to meet initial expectations (Heberlein and Shelby 1977; Hendee et al. 1990). Further, experiences requiring greater financial or time commitments may be especially prone to cognitive dissonance, leading participants to rationalize why the experience was better than they initially evaluated (Heberlein and Shelby 1977). These coping mechanisms may collectively contribute to the response of committed anglers, but not those of casual anglers, for whom an equivalent catch outcome achieved with less investment in travel was demonstrably preferred. A final explanation might be that travel time produces utility to committed anglers because it is part of the entire experience that often has a planning phase, the actual travel, a fishing event, and a recollection phase (Pollock et al. 1994).

While our study confirmed past findings suggesting that the desire for larger and more fish seems to be a universal trait among many anglers (e.g., Aas et al. 2000; Oh et al. 2005; Oh and Ditton 2006; Dorow et al. 2010), our modeling approach provided novel insights into the interaction of target species choice, specialization, and determinants of catch satisfaction. We found that as specialization increased, the relative importance of size of fish over catch rate increased for some species as was predicted earlier (Bryan 1977). However, this result was far from universal across species. Previous research has revealed that some angler populations prefer high catch rates over large size, such as for European eel in Germany (Dorow et al. 2010) and walleye (*Sander vitreus*) in Wisconsin (Beard et al. 2003) and Minnesota (Carlin et al. 2012), and our model predicted similar results for zander and coarse fish anglers of northeastern Germany. Thus, Bryan's (1977) assertion that specialized anglers generally should become more trophy-oriented likely depends strongly on the individual target species and local and regional angler culture. These findings further emphasize the importance of the species-specific context of fishing activities, corroborating previous research findings that angling motives vary with target species (Fedler and Ditton 1994; Beardmore et al. 2011). Our research also underscores the importance of accounting for angler heterogeneity in determining fishing regulations (sensu Johnston et al. 2010, 2013, 2015), because some anglers will place a premium on high catch rates while others will prefer

Fig. 6. Trip characteristics affecting satisfaction with catch. Where significant ($p < 0.05$), interactions with centrality-to-lifestyle are presented. In each panel, the component contribution to satisfaction equals the sum of contributions ($\beta_q^{att} \times z_q^{att}$) for the relevant parameters (see eq. 1). Moderate centrality-to-lifestyle represents the average angler, while low and high centralities represent the bottom and top 10% of the centrality range, respectively.



large sizes of fish in the catch. Managers could accommodate the expectations and outcome preferences of different anglers by tailoring regulations and stocking practices to the knowledge of which angler types are locally present (Johnston et al. 2010).

Limitations and extensions

Our study has five important limitations that are worth outlining. The main limitation of our study that prevents generalization of our results to the general angler population level is the avidity bias that was present in our data. While the results presented here are most likely to hold true for avid anglers, it is unclear whether less avid anglers would respond similarly to the relationship of catch and catch satisfaction. Therefore, one can only cautiously derive recommendations for management based on our work, and this can be done safely only as long as one attempts to manage fisheries for avid anglers.

A second limitation is that the satisfaction measure was anchored only at the ends (totally dissatisfied and totally satisfied; Fig. 1). Therefore, it is challenging to define a managerially relevant threshold for satisfaction from which to derive a minimum standard for management. That said, a ten-point scale was recommended by Matlock et al. (1991) as refined enough to detect the effects of small changes in the independent variables, and managers are free to select any value upon which to base a satisfaction threshold objective. Future improvements to this study may be made by including a neutral anchor to mark the midpoint of the scale that would allow respondents to identify trips in which catch expectations were simply met. To this end, we recommend an eleven-point scale ranging from zero to ten, which would allow a labeled midpoint at five. Such an anchor would have provided a managerially relevant threshold to evaluate individual fisheries. Thus, while we were unable to provide explicit recommendations for thresholds of catch outcomes necessary to minimally satisfy (avid) anglers, we succeeded in assessing the relationship between incremental changes in trip outcomes and satisfaction with catch.

A third limitation stems from our omission of expectations. Accounting for expectations may have provided valuable insights into the role of non-catch outcomes on satisfaction with catch. It is possible that non-catch factors, such as group size, encounters with other anglers, or the remoteness of the fishing site, influence anglers' expectations for catch outcomes. Further research should clearly address this important gap.

Other limitations of the model related to the size variable collected in the trip diaries, which pertained only to the largest fish that was retained for a given species. While no associations were found between CPUE and size of largest fish in our data, a relationship may still exist between the number and average size of fish in a given trip (Parkinson et al. 2004). While one might expect trips with high catch rates to be associated with mostly smaller and, therefore, more abundant fish (Askey et al. 2013), such trips offer multiple opportunities to land a single exceptionally large fish just by chance. As the diary did not record the size of every fish that was caught or even an average size, we were unable to

detect any potential relationship between CPUE and average size that may have existed for trips in our dataset.

A fifth and final limitation of our model related to the omission of harvest or retention rate as a determinant of satisfaction with catch. Given the importance of retaining fish for some anglers (Anderson et al. 2007), particularly in Germany (Dorow et al. 2010), one expects harvest to play an important role in determining satisfaction with catch. Unfortunately, colinearity among retention rates, CPUE, and size of largest retained fish prevented inclusion of all three trip outcomes in our model. These relationships in our data likely reflected the current regulatory environment, where daily bag limits and minimum-size limits moderate harvest practices for many species, and was exacerbated by reliance on size information that specifically pertained to retained fish. Unfortunately, harvest rates were found in preliminary analyses to be poorer predictors of satisfaction than catch rates, which was likely due to heterogeneity among anglers in the importance placed on harvesting fish. Put simply, an angler's low harvest rate may reflect either a highly successful fishing trip with voluntary catch and release or a disappointing experience characterized by mandatory release of undersized fish. Without information to distinguish these two situations, we were unable to adequately assess the effect of harvest rate on satisfaction with catch. Consequently, the omission of harvest from our model should not be taken to suggest that harvest is unimportant. Rather, the influences of CPUE and size should be interpreted in light of the current regulatory regime for these species in our study area. Further research of the role of harvest orientation and harvest rate on angler satisfaction is clearly recommended.

Determinants of angling catch satisfaction were dominated primarily by catch rate and size across all six species or species groups and all angler types examined. However, significant effects from non-catch aspects underscored the importance of trip factors in influencing either the establishment of expectations or the evaluation of catch-related outcomes. While slight variations in functional form occurred across species (e.g., catch rates exhibited a strong negative quadratic term for common carp, but a linear relationship for moderately specialized coarse fishers), it is interesting to note that the scale of the effect sizes for each attribute did not differ among species across the range of values present in the study. In other words, the relative contribution of CPUE and size to satisfaction with catch compared with other trip characteristics were similar across species. However, differences in the physiological characteristics across fish species and in their ecology constrained the range of typical catch outcomes, such that the relative influence of size versus CPUE varied across species (Fig. 4). The influence of centrality-to-lifestyle on the contributions of trip characteristics to satisfaction was largely visible only with extreme trip outcomes, suggesting that the primary situational determinants of satisfaction with catch (CPUE and size) were largely universal among the avid anglers we surveyed and that centrality-to-lifestyle exerts a moderating influence to the extent that an angler's experience and involvement relates to their expectations. Our study, therefore, suggests that catch rates, size of fish, and, to a lesser degree, encounter rates among anglers are universally important components of satisfying catch experiences for avid anglers. Given that overall satisfaction with angling primarily depends on satisfaction with catch aspects (Graefe and Fedler 1986; Arlinghaus 2006; Hutt and Neal 2010), managers wishing to maximize angler satisfaction are, therefore, advised to focus on maintaining high catch rates and ensuring a supply of large fish for anglers to take home. When fishing intensity is high in naturally reproducing stocks, harvest slots or constraints on effort may provide suitable compromises to reach both goals (Johnston et al. 2010; Gwinn et al., in press). In fisheries where target species do not naturally recruit, management of stocking density coupled with tailored harvest and effort regulations could be used to produce either high catch rate or trophy fisheries. Ideally, a mosaic of different fisheries can be provided in a landscape to suit the expectations of a diverse population of anglers (Post and Parkinson 2012).

Acknowledgements

Funding for this study was provided by the European Financial Instrument for Fisheries Guidance and the State of Mecklenburg-Vorpommern, with additional funding provided to R.A. through a grant within the Pact for Innovation and Research by the Leibniz-Community (www.adaptfish.igb-berlin.de) and another grant by the Federal German Ministry of Education and Research (www.besatz-fisch.de, grant 01UU0907). Support for B.B. came from the Social Sciences and Humanities Research Council of Canada and the National Science Foundation (DEB-0822700). We also acknowledge USUMA GmbH for conducting the field work and thank Fiona Johnston for valuable discussions related to early versions of this manuscript. We thank the associate editor, David Fulton, and an anonymous reviewer for very encouraging feedback and good comments that helped improve our work.

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