The Importance of Understanding Angler Heterogeneity for Managing Recreational Fisheries

by

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Abstract

Human Dimensions (HD) research in recreational fisheries is predicated on the understanding that successful management depends on knowing what anglers want from their fishing experience. While researchers have long recognized that diversity exists among anglers in terms of attitudes and preferences, few comparative studies account for the role played by diverse fishing opportunities in fulfilling anglers' goals. Instead, most studies focus either on fishing as a general activity or generalize from fishery-specific case studies. Consequently, HD research has faced criticism from fisheries ecologists and managers regarding its management relevance.

Leveraging an initiative to develop comprehensive catch and harvest information in the German state of Mecklenburg-Vorpommern (M-V) I collected additional angler information to explore HD constructs. I used recreation specialization as a framework for understanding angler heterogeneity while exploring how resource diversity affects preferred recreational outcomes. First, I examined the link between motivations and behavior, demonstrating that the relative importance of catch and non-catch outcomes depends on target species, and that angler specialization and motivations are related. Second, I used random utility theory to test how well different measures of specialization explain preference heterogeneity observed after accounting for target species, finding centrality-to-lifestyle to be the best predictor. Third, I examined the influence of centrality-to-lifestyle and target species on the importance of several catch and non-catch characteristics related to satisfaction-with-catch. While the model parameters suggested that more and larger fish are universally desired, the relative importance of these characteristics depended on both targeted species and specialization level. For my last study, I presented a case study of particular relevance to conservation of the European eel (*Anguilla anguilla*) fishery in M-V, by evaluating the effect of proposed regulatory changes on angling effort and harvest. Overall, and regardless of the specialization level, anglers were largely unresponsive to proposed legislation to partially close the fishery, suggesting more drastic measures may be required to meet ecological objectives. Together, these studies reinforce that researchers and practitioners should be wary of applying general insights of HD research to specific situations. Not only does the 'average' angler not exist, but neither does the 'average' fishing trip.

Keywords: discrete choice; preference; motivation; satisfaction; conservation

For my wife, Jesse and,

for my children, Jack and Maggie.

Thank you for sharing me with

REM for so long.

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List of Acronyms

CE	Choice Experiment
CRA	Catch Related Attitude
CUE or CPUE	Catch per Unit Effort
HD	Human Dimensions
M-V	Mecklenburg-Vorpommern (The German state in which this study was conducted)
PCA	Principal Component Analysis
RP	Revealed Preference
SP	Stated Preference
TPB	Theory of Planned Behavior

Chapter 1.

Introduction: Integrating Ecological and Angler Heterogeneity

This thesis is arranged as a series of separate journal article manuscripts presented as independent, stand-alone chapters. The layout therefore differs from traditional dissertation manuscripts. Each chapter has its own introduction and discussion sections, as well as a list of references, figures, and tables. The format of each chapter differs somewhat as they have been prepared for publication in different journals. Three chapters present previously published papers for which I was lead author, while two closely related publications for which I was a contributing author are included as appendices. When referring to material from these chapters and appendices, the preferred citation is the published journal article. This introductory chapter provides an overview of my research including its rationale in terms of my overarching objective, which was to understand the influence of angler and resource heterogeneity on interactions between anglers and fishery resources.

Recreational fishing is the predominant use of freshwater fish stocks and also many coastal fish stocks in industrialized countries (Arlinghaus, Mehner, & Cowx, 2002). It differs fundamentally from other fisheries in that the aquatic animals targeted by fishers do not constitute their primary resource to meet basic nutritional needs and are not generally sold or otherwise traded in export, domestic or black markets (FAO, 2012). Recreational fishing is thus primarily pursued for pleasure, rather than for subsistence or economic gain (Cooke & Cowx, 2004). In subsistence or commercial fisheries, harvest alone is the primary goal of fishers, while in recreational fisheries; other factors may also contribute to a pleasurable outcome. Thus, managers must satisfy not only the ecological objectives of conserving fish stocks, but also maintain quality recreational experiences for anglers. Research in the field of human dimensions of recreational fisheries has therefore developed in response to this need.

For HD researchers, fishing, like other outdoor recreation behavior, is understood to be driven by achieving psychological objectives (Driver, 1985; Manfredo, Driver, & Tarrant, 1996). Therefore, it comes as no surprise that HD research has traditionally derived a strong focus from social psychology. Despite great contributions from this field towards understanding angler behavior, HD research has occasionally been criticized as lacking management relevance (Hunt, Haider, & Armstrong, 2002; Hunt, Sutton, & Arlinghaus, 2013; Matlock, Saul, & Bryan, 1988). For example, past research on angling motivations suggests that many of the most important drivers of recreational fishing activities are not even related to catching fish (Fedler & Ditton, 1994).

One challenge to improving the management relevance of HD research has been to appropriately match the scale of inquiry to the needs of managers. While some past research has focused at finer scales such as within-trip decisions surrounding harvesting (Hunt et al., 2002) and trip level behaviors such as site choice (Hunt, 2005), most research from the social psychological perspective has relied on one-time or annual surveys to assess angler preferences, norms and attitudes (e.g., Hutt & Neal, 2010; Wilde, Riechers, & Ditton, 1998), or meta analyses of the same (Fedler & Ditton, 1994; Vaske, Donnelly, Heberlein, & Shelby, 1982; Vaske & Roemer, 2013). Often, such studies treat fishing as a generic activity, while focusing on theoretical constructs related to understanding angler diversity.

Much of human dimensions research related to harvesting fish has focused on understanding heterogeneity within the angler population, using concepts such as consumptive orientation (e.g., Anderson, Ditton, & Hunt, 2007) or angling motivations (e.g., Fedler & Ditton, 1994); however, this focus has generally ignored the role of circumstances specific to a given type of fishing experience, in favor of understanding more general attitudes towards catching and harvesting fish. The scale of a study determines the types of insights that may be inferred from its findings, and such studies have often ignored the role of diversity among fishing opportunities in favor of generalizing theoretical constructs. For example, Bryan (1977) first developed his theory of recreation specialization from observations of American trout anglers, noting that more specialized anglers are more prone towards catch-and-release. These specific observations later evolved into Ditton, Loomis and Choi's (1992) proposition that specialization leads to decreasing emphasis on resource consumption in favor of resource conservation. More recent findings, however, suggest that consumptive orientation is highly species dependent. For example, harvesting decisions depend on the species being targeted on a given trip (Gaeta, Beardmore, Latzka, Provencher, & Carpenter, 2013), and for some species, such as European eel (*Anguilla anguilla*), specialized anglers may be more consumptive than casual anglers (Dorow, Beardmore, Haider, & Arlinghaus, 2010[1]). Furthermore, not only do target species drive harvesting behavior among anglers, but also they are also associated with differences in other aspects of the trip experience, such as catch rate and social group (Hunt et al., 2002).

Application of HD research findings to fisheries management, on the other hand, can be expected to depend on the context of a particular experience, and reliance on general principles has been shown to be a poor predictor in specific situations (e.g., Matlock et al., 1988). As a result, fisheries managers, who tend to be biologically trained, have gravitated towards using concepts from fisheries biology, such as predator-prey dynamics for understanding interactions between anglers and fish. In the past, such studies have addressed issues related to resource diversity by parameterizing models to

[1] Appendix A, p218.

reflect species-specific characteristics, and usually assumed that all anglers behaved identically (e.g. Cox, Walters & Post, 2003; Parkinson, Post & Cox, 2004; Post, Persson, Parkinson, & van Kooten, 2008). While heterogeneity among fishing opportunities may be reflected (at least in part) by differences in life history characteristics among modeled target species, accounting for variability in the behavioral patterns of anglers should be of particular interest to fisheries management and, indeed, has been identified as one of the most pressing research needs in recreational fisheries science and management (Post et al., 2008).

To bring human dimensions research on more equal footing with fisheries biology in terms of application to management would require matching the focus of research to the needs of managers for specific fisheries. While narrowly defined case studies may provide insights that are highly applicable to one fishery, comparison across fisheries may be limited, thereby hindering generalization across contexts, and leading to the appearance of conflicting evidence. For example, Oh and Ditton (2006) found committed anglers to be more accepting of restrictive harvest regulations than casual anglers, while Dorow et al. (2010) found the opposite; however, the two studies differed both in the preferred target species of their sample, and also in the population of anglers itself. In the first case, the study involved red drum anglers, while the second focused on European eel anglers. Whether the contrasting results are due to differences among the anglers in each study or between the fish species cannot be determined. Thus, researchers face the challenge to derive information that is at once broadly insightful, and at the same time specifically applicable. Unfortunately, few human dimensions studies (e.g., Hunt, Boots, & Boxall, 2007) have had the resources to develop the multi-scalar datasets necessary to address this issue, and sometimes acquiring the needed funding is dependent on a particular policy window. For my dissertation, I was fortunate to be able to take advantage of such a window.

The European eel population has declined dramatically with current recruitment levels at less than 10% of the average value recorded between 1970 and 1994 (ICES, 2008). This fishery is of great socio-economic importance throughout Europe, and understanding the role of recreational fishing in its decline is an important component of any recovery effort (EC, 2007). Despite the limited availability of information concerning the cause of the eel decline, urgent political and management actions have been initiated to conserve the panmictic eel population throughout Europe. The European eel has been red-listed as critically endangered by the International Union for Conservation of Nature (Freyhof and Kottelat, 2008) and also listed by the Convention on International Trade in Endangered Species of Wild Fauna and Flora to control its international trade. Finally, the European Union (EU) adopted a regulation (EC, 2007), requiring European member states to develop eel management plans by the end of 2008, or face EU imposed reductions in total eel fishing effort by at least 50% or implementation of other measures to reduce eel harvests by half (EC, 2007).

The EU regulation (EC, 2007), then under review, prompted the fisheries management agency of Mecklenburg-Vorpommern (M-V), the northeastern most state in Germany, to address the lack of information on recreational eel harvests within the state in particular and, indeed, on recreational fisheries in general. With around 2,000 inland lakes greater than one hectare (Winkler et al., 2007), several river networks, and bordering the Baltic Sea, M-V provides diverse fishing opportunities for anglers. Unfortunately, very little information was available about the biological and socio-economic importance of recreational fisheries in M-V, including only a rough approximation of the total number of resident anglers in the study area (Hilge, 1998; Arlinghaus, 2004; Brämick, 2007). This lack of information, coupled with the importance of the commercial inland eel fishery to the state (Dorow & Arlinghaus, 2011), provided the impetus for an in-depth regional angler study using a random sample of anglers from M-V and its neighboring states. Data collection included an initial telephone interview in which anglers were recruited to participate, followed by a one-year trip diary. During the diary period, quarterly telephone interviews were conducted to address any emergent concerns, to keep participants motivated in the study, and to collect supplemental information related to angler characteristics such as recreation specialization (Bryan, 1977; Kim, Scott, & Crompton, 1997), and consumptive orientation (Anderson et al., 2007). Of an initial sample of 1131 anglers from northern Germany who began the diary program, 648 anglers returned diaries documenting over 12,000 unique fishing trips within the state in both freshwater and saltwater. Two sub-samples received mail surveys pertaining to the issue of declining eel (Dorow, Beardmore, Haider, & Arlinghaus, 2009[2]; Dorow et al., 2010; Chapter 3), in order to address the question of angler responses to regulatory change for eel, which has been identified as particularly important for conserving this species (Dekker, 2008; Feunteun, 2002). Full details of this data collection effort may be found in Dorow and Arlinghaus (2011), and the resulting data contributed towards both this dissertation and that of Malte Dorow (Dorow & Arlinghaus, 2011, 2012; Dorow et al., 2009, 2010). English translations of questions that are relevant to each chapter are presented as figures, while the surveys themselves, in the original German, are included as appendices A through D.

This already rich dataset was then supplemented by funding separately supplied though the ADAPTFISH project (http://www.adaptfish.igb-berlin.de), which allowed development of a follow-up survey that was distributed to participants after the diary phase was completed. This survey was tailored to each individual by aggregating information about each angler's preferred target species and fishing sites as revealed from their diaries. The focus of this survey was to assess angler preferences for catch outcomes of preferred species given varying regulatory regimes; however, it also elicited information consistent with prominent human dimensions theories such as fishing motivations (Fedler & Ditton, 1994), place attachment (Moore & Graefe, 1994; Williams, Patterson, Roggenbuck, & Watson, 1992), recreation specialization (Bryan, 1977; Ditton, Loomis, & Choi, 1992) and constraints to fishing participation (Sutton, 2007) among others.

By leveraging behavioral data at the trip scale in a multi-species regional fishery system against detailed information regarding angler characteristics and preferences at an annual scale, this dataset provided a unique opportunity to examine the interactions between anglers and fish, and to assess the role of heterogeneity both among anglers and also among fishing opportunities in mediating angler-fish interactions.

[2] Appendix B, p254.

1.1. Heterogeneity among fisheries

Most fisheries rely on policies designed to conserve fish stocks by limiting the amount of harvest on a given water body, either directly through harvest regulations or indirectly by managing effort. Anglers, however, are free agents, and anticipating the effectiveness of these regulations for maintaining healthy stocks is challenging due to the dynamic interactions between components of recreational fishery systems. As angling decisions are distributed among many independent agents who act on a spatial scale that, in many cases, encompasses several fisheries (defined by more or less distinct populations of target species,) heterogeneity both among anglers and among fisheries is an important consideration when trying to understand the dynamics of angler behavior, and their implications for resource conservation.

At a regional scale, heterogeneity in ecological characteristics forms the basis for diversity in recreational fishing opportunities. For example, a region may boast multiple target species each present at several locations that differ in their habitat suitability and thus their angling quality. Anglers exploit these ecologically diverse, spatially structured, independent resource units (e.g., lakes and rivers, Post et al., 2008) selecting a particular combination of target species and location in order to meet their recreational objectives.

Managers are thus charged with the difficult task of developing a regional perspective towards sustainable recreational fisheries management, rather than taking a single-lake approach (Lester, Marshall, Armstrong, Dunlop, & Ritchie, 2003). In this context, fisheries managers must be well prepared to deal with the challenge of a regionally mobile angler population in order to design and tailor regulations for maximized management success. If regulations do not account for the ecological, spatial and temporal structure of the system, management efforts may be rendered ineffective or, worse, counterproductive (Beard, Cox, & Carpenter, 2003; Carpenter & Brock, 2004).

1.2. Heterogeneity among anglers

Human dimensions researchers have long recognized that the “average angler” does not exist (Aas & Ditton, 1998; Shafer, 1969). Recreational fishing, unlike non-human predator-prey systems, has a clear social-psychological dimension to the interaction between predator and prey that largely determines the actual behavior of the human predator. Unlike other predators, humans engaging in recreational fishing activities do so to primarily satisfy various psychological outcomes rather than physiological needs (Manfredo, Driver, & Brown, 1983). Since the 1970s, recreation specialization theory has become the dominant framework for understanding differences among anglers regarding the psychological component of recreational fishing (Aas & Kaltenborn, 1995; Bryan, 1977; Fisher, 1997)

Recreation specialization (Bryan, 1977) is an important research framework for understanding diversity in outdoor recreation behavior. Bryan (1977) observed “a continuum of behavior from the general to the particular, reflected by equipment and skills used in the sport and activity setting preferences” (p. 175) in American trout anglers, concluding that recreationists may be grouped into angler types that share specific values, beliefs, attitudes and behaviors. Early conceptualizations of specialization posited that as one gains experience in a recreational activity, one also becomes more emotionally involved or “specialized” (Ditton et al., 1992); however, the concept has evolved to become multi-faceted, and the notion of clear predictable stages in an angling career being correlated with degree of specialization has been challenged (Scott & Shafer, 2001). Instead, it has been claimed that anglers may “jump” into particular specialization levels without moving progressively through all levels of specialization (Kuentzel & Heberlein, 2006, Oh, Sorice & Ditton, 2011).

Specialization is a multidimensional concept (Ditton et al., 1992). Generally, research has relied on three key dimensions of specialization: affective, cognitive and behavioral (Scott & Shafer, 2001). The affective component concerns the level of personal commitment to the activity (Buchanan, 1985), reflected in the degree to which one self-identifies with the activity (Scott & Shafer, 2001). Beyond merely enjoying the activity, committed anglers are dedicated to the values and norms of the social world of angling (Buchanan, 1985; Ditton et al., 1992) and may also be more likely to show a vested interest in conservation of the resource upon which their favorite activity depends (Ditton et al., 1992; Oh & Ditton, 2006).

A second dimension is cognitive and reflects a range from beginner to expert arising from increasing levels of knowledge and/or skill (Salz & Loomis, 2005). Acquisition of knowledge and skill is another indicator of increased specialization, which may or may not be related to past experience (Scott & Shafer, 2001).

A third dimension is behavioral. Most often, research has focused on behavioral commitment, which reflects the investments into the activity, such that ceasing participation would incur certain penalties (Stebbins, 1992). Typical measures of behavioral commitment include frequency of angling participation, (Ditton et al., 1992) or other indicators of investment of time, money and other resources to the activity.

While these three dimensions form the core of specialization theory, Bryan's (1977) observation also relies on observations of heterogeneous "activity setting" preferences. Preference can be defined as an evaluative judgment in the sense of liking or disliking an object or outcome (Scherer, 2005). Thus, specialized anglers may also be differentiated from one another by their individual preferences for certain fishing experiences to the exclusion of others. For example, in some fisheries, specialization may be associated with a shift in catch orientation (Anderson et al., 2007; Fedler & Ditton, 1986; Graefe, 1980) from a focus on number of fish towards size of fish; and/or a tendency to release more fish (Bryan, 1977; Salz & Loomis, 2005). In this sense, the concept of specialization may be applied to any segmentation of anglers based on preferences for particular fishing experiences. For example, one may refer to the "fly fisherman" (Bryan, 1977) or "specialized carp angler" (Arlinghaus & Mehner, 2003) as technique or species specialists, or the "trophy angler" (Arterburn, Kirby, & Berry, 2002) as someone whose behavior is primarily motivated by the outcome of catching a large fish (Fedler & Ditton, 1986, p. 198). Thus, specialization provides a rich conceptual framework for examining how angler and environmental heterogeneity interact.

1.3. Angler-resource interactions: a conceptual framework

To explore the interaction of heterogeneity among both anglers and fishing opportunities, it is first necessary to define what it means for them to interact. Recreational activities are commonly considered to be goal driven, and pursued primarily in order to achieve certain desired psychological states (Crandall, 1980; Driver, 1985; Manfredo et al., 1996) Much of HD research has been based on the premise for managers to provide quality recreational fishing experiences, they must first understand what anglers want (e.g., Driver, 1985; Fedler & Ditton, 1994). While ecologically minded researchers and managers may be most concerned with anglers' physical interactions with the fish, HD research suggests that insights may be gained from understanding both the antecedents of these interactions and their outcomes. Therefore, I have chosen to expand the notion of interaction with the resource to include not just physical interactions associated with catch and harvest, but also the psychological or intellectual engagement with the resource. In this context, anglers may be considered to interact with the fishery when planning their experience, mentally evaluating the desirability of expected outcomes of each alternative, and the psychological interaction continues through the trip and beyond, as desired outcomes are achieved to various degrees. Thus the conceptual framework (**Figure 1.1**) within which I have positioned the chapters of this dissertation integrates these interactions among cognitive elements that precede behavior to those that come after.

Using recreation specialization as a focus for understanding angler heterogeneity required further consideration of how its various dimensions fit within the behavioral process. Past studies have often focused on aspects of specialization related to an individual's personal or behavioral commitment to the activity (e.g., Buchanan, 1985; Dorow et al., 2010; Oh & Ditton, 2006), with other dimensions assumed to be correlated. This focus follows Ditton et al.'s (1992) reconceptualization of specialization based on individuals' participation in social worlds. This approach reflects a spectrum from outsider to insider (Unruh, 1980) rather than from novice to expert (Bryan, 1977), and emphasizes the role of commitment and personal identity in the process of specialization rather than activity-setting preferences. Nonetheless, understanding the relationship between commitment (often termed specialization) and various preferences may provide important insights for fisheries managers (e.g., Dorow et al., 2010; Oh, Ditton, Anderson, Scott, & Stoll, 2005; Oh & Ditton, 2006). The conceptual framework developed here, extends upon this research by placing the various dimensions of specialization within the recreational behavior process. This framework focuses on the intersection between the individual angler and fishery resources while acknowledging diversity both among anglers (i.e., through specialization) and also within the environment (i.e., many types of fishing experiences).

1.3.1. Diverse fishing opportunities

At the regional level, diverse target species and fishing sites (Hunt, 2005) constitute the opportunities from which anglers may choose. The resource base and the fishing opportunities they provide, however, are also shaped by social systems at many levels, from the institutional to the individual. For example, fisheries management also plays a role in shaping the fishing experience, as anglers may use regulatory cues to inform catch and expectations (Scrogin, Boyle, Parsons, & Plantinga, 2004), which in turn may affect site choice (Aas, Haider, & Hunt, 2000; Hunt, 2005; Oh & Ditton, 2006). Finally, at the scale of the individual angler, the social environment also helps to define a fishing opportunity. For example, a fishing trip with young children is likely to provide a different social dynamic than one taken with angling buddies. Similarly, the number of other anglers one encounters on the trip may also affect perceptions of crowding and interference with recreational goal attainment (Schreyer & Roggenbuck, 1978; Shelby, 1980). Social motives feature prominently in the literature with anglers expressing to various degrees a desire for solitude, or to be with friends or family (Fedler & Ditton, 1994).

1.3.2. Diverse Angers

Within the landscape of fishing opportunities exists a diverse population of anglers, and bi-directional arrows indicate the nature of the interactions between the social and ecological components of the fishery system. Because of the process orientation of the conceptual framework focused at the scale of individual fishing trips, one can begin at any point, but perhaps the most intuitive is at the formation of expectations prior to going fishing.

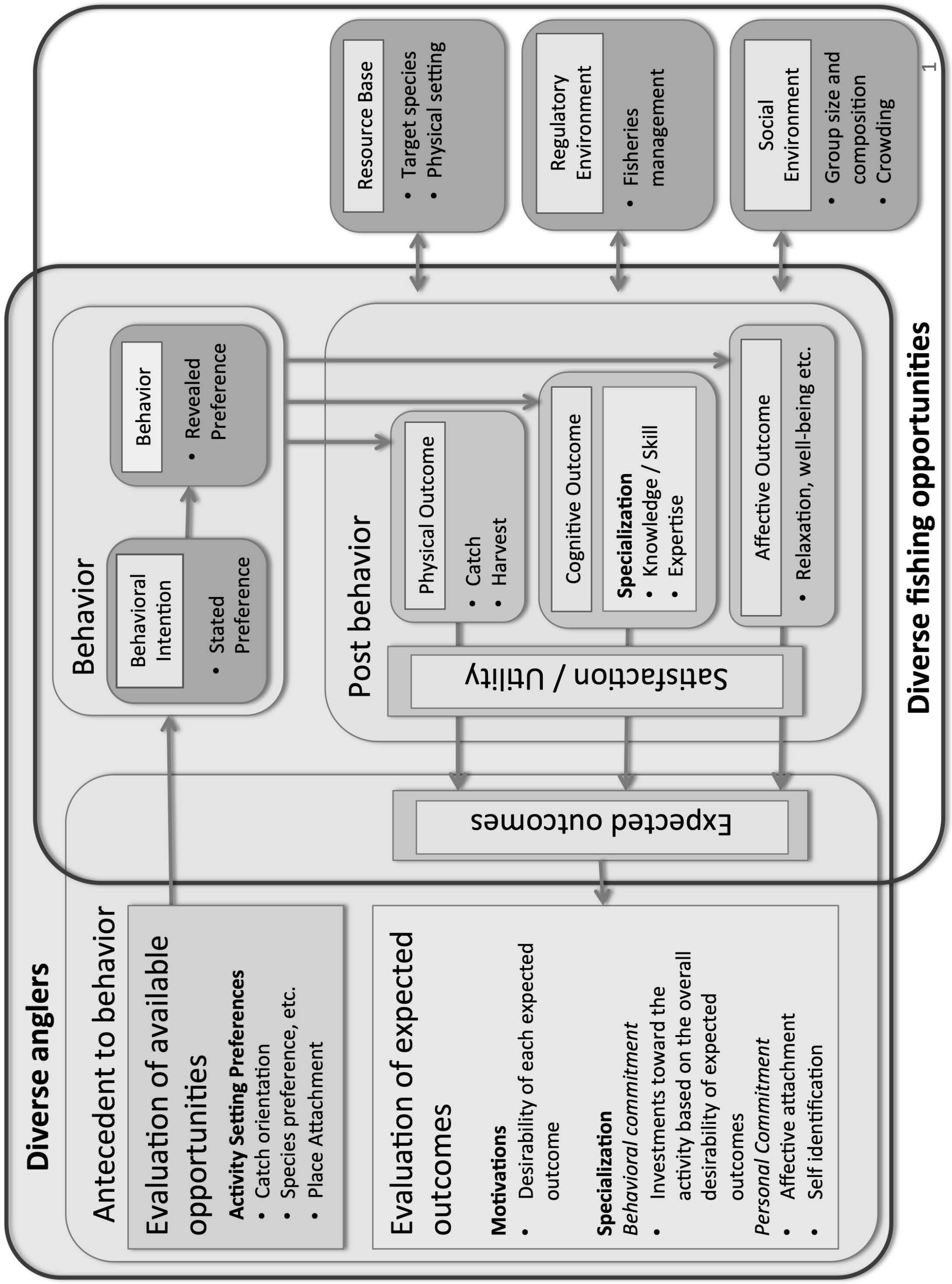

Figure 1.1. Conceptual framework for understanding recreational fishing behavior in the context of resource dependence.

Antecedent to behavior

While some tourism or recreation behaviors may be considered “once in a lifetime” events, recreational fishing is typically a repeated behavior (Hunt, 2005). As such, past experiences of satisfaction with the outcomes of a trip, eventually gives way in anticipation of the next fishing trip, and the formation of expectations for the future.

Expected outcomes

To the extent that anglers are aware of the diverse fishing opportunities available to them, expectations are formed concerning the outcomes of pursuing any one of them. An important source of awareness is the memory of outcomes personally experienced during past trips. Alternative opportunities may then be evaluated based on their expected expectations in light of their desirability to the individual angler, which relates to both motivations to (re) experience certain outcomes, and also to specialization.

Motivations

Motivations are the underlying forces that act on a tendency to engage in an activity based on its expected outcomes (Atkinson 1969). The study of recreational motivations has its origins in psychological expectancy theory, which assumes that people participate in recreational fishing because they are motivated to reach particular psychological outcomes (Manfredo et al., 1996). In recreational fishing, these outcomes have been classified into aspects that are specific to the fishing activity (e.g., catching or consuming fish) and those that may also be derived from other outdoor recreational pursuits (e.g., relaxing or enjoying nature, Fisher, 1997). Angler motivation research has repeatedly documented that angling is multifaceted, providing opportunities for participants to fulfill multiple outcomes simultaneously (Driver & Knopf, 1976; Fedler & Ditton, 1994; Hendee, 1974). While the importance of activity-specific and activity-general motives is known to vary among angler segments (Aas & Kaltenborn, 1995; Fedler & Ditton, 1994; Wilde et al., 1998), most studies have concluded that aspects related to catching fish are generally not as important to anglers as many non-catch aspects of the fishing experience (e.g., Driver & Knopf, 1976; Fedler & Ditton, 1994; Moeller & Engelken, 1972).

Commitment

Whereas motivations may be related with particular expected outcomes at the scale of each fishing trip, specialization operates on a slightly different scale. Commitment, as a key dimension of specialization, is expected to change over time, but is still often considered a characteristic of the individual angler. Commitment has been described as being a function of side bets or investments that impose a cost to the individual of not participating (Buchanan, 1985; Scott & Shafer, 2001), but these investments may simply reflect more general motivations towards fishing, and thus influence the selection of fishing over other leisure activities.

Activity Setting Preferences

The behavioral antecedents culminate in the formation of activity/setting preferences (Bryan, 1977). In much of the human dimensions literature, preferences are evaluated singly using Likert ratings or rankings. For example, an angler might be asked to indicate her/his preferred target species (e.g., Wilde et al., 1998). Thus, in social psychology, preferences are usually considered a behavioral antecedent that leads to behavioral intention, and some evidence exists to suggest that experience may lead to greater specificity of preferred outcomes (McFarlane, Boxall, & Watson, 1998).

In economics, however, multivariate approaches to assessing preferences are more common, and preferences are inferred, not from other behavioral antecedents, but from observations of either behavioral intention (stated preferences assessed in surveys) or actual behavior (revealed preferences from observational data or field reports). In recreational fishing, these econometric approaches have largely focused on site choice among anglers using revealed preference information (Hunt, 2005), however, stated preference approaches have recently gained in prominence due to their ability to introduce novel components such as changes in regulatory controls or catch outcomes (Aas et al., 2000; Dorow et al., 2010; Oh & Ditton, 2006). These types of studies highlight the important interaction between diversity of fishing opportunities (defined by the particular combination of salient characteristics for which anglers express some level of preference). These characteristics operate at many scales, and may exert varying levels of influence on different types of fishing behavior. For example, participation decisions (i.e. the binary decision to fish or not fish) may be influenced by more general preferences than decisions concerning target species, for which species-specific catch expectations and the mediated role of regulations may be more important. Site choice may further refine the salient considerations based on site-specific characteristics that influence an angler's choices. For example, in selecting a fishing site, travel costs, fishing quality, environmental quality, amenities, encounters with other users, and regulations can all affect anglers' decisions (Hunt, 2005). Together, these decisions culminate in angler behavior at the scale of the angling trip.

Behavior

An angler's choice of a fishing trip may be viewed as consisting of several highly linked, yet nevertheless distinct decisions, each of which has implications for the sustainability of fishery stocks through predator-prey type interactions (Johnston, Arlinghaus, & Dieckmann, 2010). Anglers choose frequency of their participation, which when aggregated over the angler population determines the total effort directed on the system at any given time. They also select their target species. In this multi-species context, management actions to direct fishing effort away from overfished or endangered species towards those that are more abundant species may ensure that quality fishing experiences and stock recovery can be achieved simultaneously. Finally, anglers must also select from among the many sites that are available. These choices reflect the angler's preferences based on their awareness of the available options. Managing behavior at this level is important for achieving goals pertaining to conservation of specific stocks by directing effort away from these sites and towards those currently being underutilized. Together, these decisions culminate in angler behavior at the scale of the angling trip, the prediction of which forms the core of my dissertation.

As previously mentioned, angler behavior (either actual or hypothetical) has been used to provide insights into their preferences for various characteristics of fishing opportunities; however, these behaviors also form the basis for physical interaction with the fishery resource, and are thus crucial to meeting both ecological and social objectives for recreational fisheries.

Post behavior – recreational outcomes

Pursuit of a particular recreational fishing opportunity results in recreational outcomes that are directly influenced by the characteristics of the opportunity. These outcomes may be more or less desired by the angler and may be divided into physical, cognitive and affective outcomes.

Physical Outcomes

Physical outcomes include the tangible experiences derived from the activity. Predominant among them are the direct interactions between anglers and the fishery resource through the catch and or harvest process. An obvious, tangible outcome might be to take home a fish for the table. Needless to say, such outcomes are dependent on the biophysical characteristics of the fishery, including the particular target species and the ecosystem supporting it. They are also dependent on the regulatory environment governing the amount and type of harvest, as well as the amount and distribution of angling effort. At the same time, the act of catching fish is associated with fish mortality, either through direct harvesting or in the case of catch and release fishing, hooking mortality.

Cognitive Outcome

Cognitive outcomes include the knowledge and skills gained from the fishing experience. Improvements in these components, reinforced and confirmed by relevant physical outcomes may not only influence future trip expectations, but also affect self-perceptions of expertise. While expertise has been associated with experience by several researchers (Kim, Scott, & Crompton, 1997; McFarlane, 1994, 1996), some individuals may participate frequently in an activity without increasing in expertise (Buchanan, 1985; Scott & Godbey, 1994).

Affective Outcomes

Affective outcomes are widely considered to be the primary reasons for engaging in recreational activity, with the recreational experience defined from the psychological perspective as a "bundle" of psychological outcomes (Manfredo et al., 1996). Thus the Recreation Experience Preference (REP) scales were developed to measure diverse outcomes related to achievement, autonomy, belongingness, escape etc. (Driver, Brown, Stankey, & Gregoire, 1987; Driver, 1985). REP scales have primarily been the focus of motivation researchers seeking to understand the relative importance of such items in the pursuit of various recreational activities (Manfredo et al., 1996).

Affective outcomes may also be negative and/or influence the social and regulatory aspects of the opportunity. For example, crowding that results from many anglers' high expectations for the outcomes of fishing at a certain site, may drive some anglers to pursue other options on their own (Schumann & Schwabe, 2004), or incentivize managers to impose effort restrictions or other measures to limit this negative outcome (Waters, 1991).

Satisfaction

Satisfaction may be considered the ultimate product of recreational experiences (Driver, 1985; Hendee, 1974). The concept of satisfaction has its roots in expectancy theory and is thought to be determined by the differences between expectations and the actual experience (Schreyer & Roggenbuck, 1978). Thus satisfaction stems from fulfillment of desired physical, cognitive and psychological outcomes through engagement in a recreational activity. Therefore, it constitutes an important social objective for managers of recreational fisheries.

The relationship between individuals' motivations for engaging in recreational fishing, and satisfaction has formed the basis for much of the human dimensions research conducted in the field of recreational fisheries (Fedler & Ditton, 1994). Like motivation, satisfaction also has multiple determinants, both catch and non-catch related (Arlinghaus, 2006). For example, perception of poor fishing was not found to be enough for anglers to give trip satisfaction a poor rating (Spencer & Spangler, 1992), suggesting that satisfaction with fishing is probably related to both catch and non-catch aspects of the fishing experience with the importance of these aspects varying among angler groups (Arlinghaus, 2006). In contrast to motivation research that has consistently underscored the importance of non-catch outcomes when fishing (Fedler & Ditton, 1994), satisfaction research has often found that satisfaction with catch-related outcomes is often the limiting factor determining overall satisfaction (Arlinghaus, 2006; Hutt & Neal, 2010; Vaske & Roemer, 2013).

Discrepancy theory suggests that failure to meet desired outcomes may affect individuals in several ways (Arlinghaus, 2006). Some suggested coping mechanisms are purely cognitive: dissatisfied individuals may alter their expectations to bring them in line with their experiences (Heberlein & Shelby, 1977), or they may rationalize their experience to bring it in line with their expectations (Shelby, Vaske, & Harris, 1988), alleviating cognitive dissonance (Festinger, 1962). Alternatively, dissatisfaction may also lead individuals to abandon a recreational experience entirely in search of a better one (Arlinghaus, 2006; Clark, Hendee, & Burgess, 1971). These coping mechanisms illustrate the final link in the conceptual model, highlighting the role of past experiences, evaluated through the lens of satisfaction in shaping expectations for future experiences.

1.4. Research Goal

The overarching goal of my research was to understand the role and influence of specialization, as a metric of angler diversity, on the interactions between anglers and the varying fishery resources found on a regional scale. In doing so, I have attempted to extend the traditional boundaries of human dimensions research to demonstrate linkages relevant to fisheries biology and management, in order to allay any “cynicism” (Hunt, 2007) that fisheries ecologists and managers may feel about the relevance of human dimensions research. At the same time, I have attempted to demonstrate to human dimensions researchers the importance of acknowledging the role that the diversity of recreational fishing opportunities plays in shaping angler behavior.

1.5. Structure of the thesis

The conceptual framework presented above outlines the academic space within which my research has taken place. Each of the four data chapters within this thesis focuses on a different scale and type of angler-resource interaction. The first three chapters re-examine constructs from human dimensions theory related to angling motivations, behavior and satisfaction to examine their relationship to target species. The fourth chapter presents a case study of management directed research, illustrating the potential for human dimensions research to inform policymaking. In each chapter, potential implications of angler heterogeneity (viewed through the lens of recreation specialization) for fisheries management and interdisciplinary recreational fisheries science are examined.

1.5.1. Chapter 2: The relationship between angler motivations and species preference

In the mid-1980s, a winterkill in the Gulf of Mexico resulted in a considerably decline in both red drum and spotted sea trout populations along the Texan coast (Matlock et al., 1988). Given research suggesting that harvests were relatively unimportant to anglers, additional restrictions on harvests were put in place with catch and release only regulations implemented in East Matagorda Bay. The resulting furor from anglers was completely unexpected, touching off a heated debate in the magazine *Fisheries* (Ditton & Fedler, 1989; Matlock et al., 1988; Matlock, 1991; Peyton & Gigliotti, 1989). This case illustrated a disconnection between human dimensions research and the needs of management. One possible reason is the scale at which human dimensions researchers have generally examined angler motivations. While the general structure of angling motivations has consistently shown non-catch motives to be more important than catch motives across segments of the angler population (Fedler & Ditton, 1994), heterogeneity in motivations exhibited by each angler when selecting a particular type of fishing trip has remained largely unexplored, and constitutes a knowledge gap that is addressed in Chapter 2. Hypothesizing that past research into angler motivations failed to account for the diverse fishing products available to a single angler, this paper addresses the issue of angler motivation relevance to fishery management in two ways. First, it re-evaluates the importance of catch versus non-catch motivations given the diversity of catch outcomes inherently associated with different species. Second, it identifies whether “what anglers want” provides an ecologically relevant criterion for grouping anglers based on their motivational similarity and comparing their trip behaviors and catch outcomes.

1.5.2. Chapter 3: General angler preferences in a complex fishery landscape

To date, relating angler specialization to preference heterogeneity has been limited to species-specific case studies (e.g., Oh & Ditton 2006; Dorow et al. 2010). Chapter 3 scales up this type of analysis to a regional, multi-species scale and tests the ability of various measures of specialization to account for differences in preferences for catch and regulatory aspects of fishing experiences among anglers. Heterogeneity in preferences for fishing site choices among German anglers was assessed with an individually tailored, latent class choice experiment that accounted for each angler's preferred target species. This innovative approach served two functions. First, it eliminated options from the survey that may be considered irrelevant or uninteresting to the individual respondent, thereby avoiding dominant selection of the opt-out alternative. Second, it provided a mechanism by which catch outcomes could be standardized across species, thereby eliminating species-specific effects and allowing estimation of a generic preference model. Twelve angler specialization measures were identified and used to predict membership in three angler groups that were identified based on their divergent preferences. From an information-theoretic approach (Burnham & Anderson, 1998), the model with a centrality-to-lifestyle indicator had the strongest evidence for being the best specialization indicator given our data and set of models. Fishing preferences were estimated so as to account for species preference. Accounting for heterogeneous preferences held by differently specialized anglers holds promise for improving predictions from integrated social-ecological models of recreational fisheries. In the absence of fishery specific information, the species-independent parameters of our preference model make them widely applicable for such a task.

1.5.3. Chapter 4: Angler satisfaction with catch across six diverse fisheries

The third data chapter in this dissertation focuses on the influence of various trip characteristics, most notably choice of primary target species and angler specialization on satisfaction with catch at a trip scale using diary data. Some researchers have suggested that increased specialization may be associated with differences in catch orientation (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 & Ditton, 2006) than their less specialized counterparts. This characterization, however, does not appear to be universal (e.g., European eel, Dorow et al., 2010). As in the study of angling motivations, past research on catch orientation has often relied on scales administered to anglers in the general context of fishing. By taking a revealed preference approach to measure the importance of particular catch outcomes in satisfaction achievement, this chapter accounts for species preferences while exploring the relationship between angler specialization and catch orientation.

1.5.4. Chapter 5: Angler preferences for European eel fishing and the implications for eel conservation

The decline of the European eel provides the context for the final data chapter. In 2007, the EU mandated its member states to create specific eel management plans with the goal of achieving 40% of historic escapement of spawners (EC, 2007). Failing to address this mandate would result in a 50% closure of recreational and commercial eel fisheries in order to cut harvests in half. While a prior study (Dorow et al., 2009; Appendix G) found anglers to be supportive of moderately stricter harvest regulations for eel, the likely effect of such regulatory changes on effort was unknown. Using a discrete choice experiment and eel catch and harvest data collected during the one-year angling diary program, the aim of this study was to assess the potential for changes in common and proposed management regulations to achieve EU targets of a 50% harvest reduction, by identifying the likely effort response of eel anglers to changes in fishery regulations, and the resulting potential for harvest reduction. This chapter extends insights from Dorow et al. (2010; Appendix F), which used the same DCE to identify differential effects of regulatory change on the welfare of anglers of various specialization levels, by focusing on predicting angler behavioral responses and their implications for the success in achieving stated management goals.

1.5.5. Chapter 6: Conclusion

Finally, the last chapter concludes this dissertation with a summary of the main findings and a discussion of insights into angler behavior that stem from this dissertation as a whole.

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Chapter 2.

The Importance of Trip Context for Determining Primary Angler Motivations: Are More Specialized Anglers More Catch-Oriented than Previously Believed?

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Abstract

Most conclusions from general assessments of angler motivations indicate that non-catch motives are more important to anglers than catch motives. Such research usually assesses the general motivation structure by anglers. To assess both general and more context-specific angler motivations, we surveyed the same anglers from north-eastern Germany using two phases of a complementary survey design. First, a 1-year diary was used to collect trip-specific information; second, a personalized mail survey was used to elicit context-specific motivation information. Anglers selected their most important motives for their most frequent trip–target species combination (i.e., context) from a list of 10 salient fishing motives. Anglers frequently cited catch motives as the most important across a range of target species, large-bodied species such as northern pike *Esox lucius* being primarily associated with trophy fishing. Some species (such as small-bodied cyprinids) were targeted for noncatch reasons, while others (such as European perch [also known as Eurasian perch] *Perca fluviatilis)* attracted anglers seeking a multitude of psychological outcomes. Five distinct angler types were identified based on similarity of prime fishing motivation, namely, trophy-seeking anglers; nontrophy, challenge-seeking anglers; nature-oriented anglers; meal-sharing anglers; and social anglers. Members of these angler groups were similar in demographics and general angling behaviors but differed with respect to several indicators of angler specialization, indicating that committed anglers are more catch-oriented than previously assumed.

2.1. Introduction

Ever since the pioneering work on angler motivations by Driver and colleagues (e.g., Driver and Knopf 1976), many researchers have grappled with the question, “Why do people go fishing?” Motivations (i.e., the underlying forces that act on a tendency to engage in an activity with an expected outcome; Atkinson 1969) have received considerable attention by researchers studying the human dimensions of recreational fisheries (Ditton 2004). Most researchers agree that fishing, and more generally outdoor recreation, is a goal-oriented behavioral process, in which anglers choose behaviors to achieve desired psychological outcomes (Driver 1985; Manfredo et al. 1996). Understanding motivations can help managers to design policies and interventions that align with anglers’ expected outcomes (e.g., Driver 1985; Fedler and Ditton 1994).

Reasons for fishing relate to either angling-specific aspects of the experience (e.g., a desire to fulfill catch-related psychological outcomes) or more general psychological outcomes that are not specifically related to the process of catching a fish, usually referred to as noncatch motives (e.g., a desire to relax, to experience solitude, or for affiliation; Fisher 1997). Methodologically, angler motivation researchers have primarily asked respondents to rate the importance of both activity-general and activity-specific aspects of the fishing experience to measure underlying latent motivation dimensions (reviewed in Fedler and Ditton 1994; Manfredo et al. 1996). With ratings from anglers for each stated motive in a scale consisting of many different dimensions and aspects (i.e., items) such measurements capture the importance of multiple expected psychological outcomes that are often assessed as general fishing motives by anglers (e.g., Fedler and Ditton 1994; Wilde and Ditton 1999; Ross and Loomis 2001). Because participants might fulfill multiple outcomes simultaneously from their fishing activity (Hendee 1974; Driver and Knopf 1976; Fedler and Ditton 1994), this approach is well suited to reveal the general motivational structure of recreational fishing. A detailed assessment to measure more trip-specific motivations, however, would present a considerable burden on respondents if asked to complete the response task for every type of fishing trip undertaken and has, therefore, not been attempted in cross-sectional survey designs.

While the importance of catch and noncatch motives varies among angler groups (Fedler and Ditton 1994; Aas and Kaltenborn 1995; Wilde et al. 1998), most motivation researchers have concluded that noncatch motives are more important than catch-related motivations as reasons to fish (defined generally), based on analyses aggregated to the population or subpopulation level (e.g., Moeller and Engelken 1972; Driver and Knopf 1976; reviewed in Fedler and Ditton 1994; Ditton 2004). Some fisheries biologists and managers have become concerned about the managerial applicability of these findings. Arguments for example revolved around the observation of unexpectedly strong opposition by anglers to the implementation of restrictions on their catch and harvest opportunities, despite the supposedly high importance placed by angler on noncatch motives relative to catch aspects (e.g., Matlock et al. 1988; Matlock 1991). Many social scientists studying anglers believe that the “cynicism” (Hunt et al. 2002) among some fishery managers and biologists about the practical applications of motivational information has arisen from misunderstandings of survey data or underlying research concepts (e.g., Ditton and Fedler 1989; Peyton and Gigliotti 1989; Arlinghaus 2006). In particular, the issue of trip context is germane to the argument because one cannot expect that general human dimensions concepts, such as the importance that anglers attach to aspects of fishing in general, will explain preferences and behaviors associated with specific types or experiences of fishing (e.g., fishing on a specific water body; Peyton and Gigliotti 1989). Therefore, angler rejection of new catch and harvest constraints on a given fishery is consistent with research that concludes that noncatch motives, in general, are more important to anglers than are catch motives because this does not imply that catching fish is unimportant (Peyton and Gigliotti 1989).

Using the general motivation assessment approach mentioned above, researchers have studied the general structure of the fishing experience in many different applications (e.g., Moeller and Engelken 1972; Driver and Knopf 1976; Fedler and Ditton 1994). Researchers have also long realized that different anglers hold different motivations for fishing (e.g., Driver and Cooksey 1980). Recreation specialization (Bryan 1977) represents one possible reason why different anglers should have different motives for fishing (Ditton et al. 1992). This multidimensional concept (Bryan 1977; Ditton et al. 1992; Scott and Shafer 2001) proposes a range of anglers, from beginner to expert, associated with cognitive (e.g., increasing levels of knowledge and skill), psychological (e.g., centrality of the activity to one's lifestyle and one's commitment to engaging in the activity), and behavioral dimensions (e.g., frequency of participation in an activity; Buchanan 1985). More specialized anglers are more committed and avid (Bryan 1977) and are more dependent on a specific resource to meet their experience preferences (Ditton et al. 1992). While the most specialized anglers in many environments may be less motivated by consumptive motives (Bryan 1977; Ditton et al. 1992), the opposite might hold for more specialized anglers targeting species of high culinary value in different cultural spheres (Dorow et al. 2010). Therefore, depending on the context and culture for fishing, more specialized anglers may engage in voluntary catch-and-release fishing, while in another context the very same specialized anglers might harvest all caught fish. Therefore, motivations by anglers differing by degree of specialization, and equally specialized anglers in different cultural environments might be more variable than previously assumed.

There is an increasing recognition of the importance of context among researchers who have studied the motivations of anglers. For example, the species targeted by anglers (Siemer and Brown 1994; Wilde and Ditton 1999) and the social setting for the activity (e.g., Ross and Loomis 2001; Arlinghaus and Mehner 2004) have been found to influence the importance of specific motivations of anglers. While these studies revealed that catch is more important to some angler groups than to others (e.g., Ross and Loomis 2001; Hutt and Neal 2010), noncatch aspects of the fishing experience were usually reported to be more important than catch aspects across most angler groups (Ditton 2004). Many anglers actually participate in many different types of fishing, which compromises approaches classifying anglers into specific groups based on a single fishing activity. Consequently, considering anglers to have identical motivations for all trip contexts lacks the specificity required to connect motivations to specific angling behaviors. Therefore, making the link between motivations and behaviors requires not only an understanding of heterogeneity among anglers (e.g., recreational specialization), but understanding the intra-angler heterogeneity arising from changing contexts for each fishing trip. This second need is clearly an area where research is required.

We were interested in further understanding how trip context shapes the primary motivations of anglers. To this end, we tested an innovative survey approach to assess angler motivations across a wide range of angling activities. Our objectives were to (1) account for within-angler variation in trip contexts (as defined by choice of target species and fishing site) when assessing primary angling motives, (2) identify groups of anglers with similar context-specific motivations, and (3) test whether these groups differ both in their degree of angler specialization and fishing behavior. We hypothesized that adding trip context to angler motivation assessment would better reveal the importance of catch motives to anglers, or at least to some angler types, based on the assumption that the ability of an angler to fulfill certain catch expectations is dependent on the biological characteristics of the species being targeted. By testing this assumption, we hoped to contribute towards resolving management-oriented conflicts about the importance of catch to anglers.

2.2. Methods

2.2.1. Participant sampling

Our study area was the German state of Mecklenburg-Vorpommern, which is located in the northeastern lowlands of Germany. This state offers anglers diverse, multi-location, multispecies fishing opportunities, including fisheries in salt water on the Baltic coast, freshwater in over 2,000 inland standing water bodies larger than 1 ha (Winkler et al. 2007) and several river networks and canals. Managing the recreational fishery in Mecklenburg-Vorpommern is complex. Coastal waters are managed directly by the state, and freshwater fishing rights are split between angling clubs (organized in a state angling association) and several commercial fisheries operators selling angling licenses (Daedlow et al. 2011). Recreational fishing is a popular pastime in Mecklenburg-Vorpommern; about 387,000 people age 14 and older are engaged in fishing (Dorow and Arlinghaus 2011). Participation rates in fishing are highest in Mecklenburg-Vorpommern among all of the 16 states in Germany (Arlinghaus 2004).

We sampled resident anglers (originating within the state of Mecklenburg-Vorpommern) and nonresident anglers (originating from seven bordering states) who planned to fish in Mecklenburg-Vorpommern between September 2006 and August 2007. Participants were selected from a random sample of state fishing license holders supplemented by anglers recruited by random digit dialing (Dorow and Arlinghaus 2011). All anglers were interviewed by phone to provide demographic and other angler characteristics (e.g., angler experience). In total, 1,121 anglers were recruited into a 1-year angling trip diary program that asked for trip-level information, including target species, catch, harvest, and location (see for details Dorow and Arlinghaus 2011). During the diary period, four telephone contacts were conducted to keep participants motivated in the study and to clarify any emerging concerns or questions. After 1 year, a fishing reel was sent to all participants as an incentive promised at the onset of the study. These efforts resulted in 648 completed and returned diaries, which contained at least one recorded trip (response rate: 58%). Of these, 31 respondents were excluded from further analyses because they were unique in exclusively targeting rare species in small private ponds or because they provided insufficient data about their trips.

For the remaining 617 respondents, a 20-page follow-up mail survey[1], which was pretested intensively with 40 anglers in personal sessions, was mailed in October 2008. The focus of this self-administered questionnaire was to supplement the behavioral information derived from the diaries and the telephone interviews with additional information about the anglers. We added questions on general and context-specific angler motivations to this survey. Survey procedures were based on the tailored design method (Salant and Dillman 1994), which included a reminder postcard and replacement survey sent to nonrespondents at 2-week intervals after the initial mailing. As an additional incentive, the survey package included (1) a summary of angler trip information from the diary for the sample as a whole, (2) a personalized insert summarizing the angler's personal diary[2], and (3) a fishing lure. Using information from the diary, we personalized the follow-up motivation survey by reminding respondents of the types of fishing trips they had taken (i.e., targeting certain species at specific locations), thus enabling us to elicit motivation information associated with specific trip contexts.

[1] Appendix C, p280.
[2] Appendix D, p300.

2.2.2. Angling motivation assessment.

The importance of various angling motivations to respondents was measured in two ways, with both approaches relying on the same list of 10 motivation items (**Figure 2.1**). As Finn and Loomis (2001) noted, research on catch motives has lagged behind noncatch motives. Consequently, our item list emphasized catch-related motivations, adding three of the most salient noncatch-related motivation dimensions (described by Sutton 2007): socializing (represented by the item “to be with friends/family”), enjoying nature (represented by the item “to experience nature”), and enjoying solitude (grouped by Sutton 2007 in a domain representing relaxation). Seven catch-related items were used to represent two distinct subdimensions within catch motives reported by Sutton (2007), i.e., catching fish (trophy, large numbers, or both) and retaining fish. Some items were taken verbatim from Sutton (2007) and translated to German, modifying the wording to reflect common jargon; however, some additional changes were made to other items from the original list. First, we split the item “to catch fish for eating” presented by Sutton (2007) into two items reflecting both immediate (“to catch a fresh fish for a meal with friends/family”) and future consumption (“to generate a supply of fish in the freezer for nonangling times”). While these two items both relate to eating fish, in the context of selecting a particular target species, we considered these two aspects to be different enough to warrant separate treatment. We also supplemented the traditional challenge-seeking item, “to master angling-related challenges” by adding the item, “to outwit difficult-to-catch fish using a sophisticated technique.” This change reflected our belief of a conceptual difference between the general challenge of fishing and the additional challenges associated with targeting potentially wary fish with a particularly sophisticated method (e.g., fly fishing).

The first assessment of angler motivations in our survey (**Figure 2.1**) replicated the traditional approach of angler motivation research (e.g., Driver and Knopf 1976; Fedler and Ditton 1994). Accordingly, respondents were asked to rate the level of importance from 1 (not at all important) to 5 (very important) for each of the 10 reasons to go fishing in Mecklenburg-Vorpommern. This task served two important purposes. First, it familiarized respondents with all reasons, which were used in the context-specific task. Second, it allowed us to uncover the underlying structure of the scale via exploratory factor analysis. This exploration was necessary because our study introduced new items in the motivation scale. Factor analysis with varimax rotation was used to group the 10 items (reasons) into motivation domains. For factors with eigenvalues greater than 1.0 and factor loadings greater than |0.4|, a reliability analysis using the Cronbach alpha criterion was used (Nunnally and Bernstein 1994). Items were combined into factors if reliability was greater than 0.6 (Nunnally and Bernstein 1994), and the mean values from the items within a factor provided indices of each angler's motivational importance for each factor. To compare the importance of individual angling motives, pairwise comparisons between factor item means and individual item means not grouped into factors were conducted using Bonferroni-Holm-adjusted Wilcoxon's signed ranks tests for dependent samples (Holm 1979).

The second, context-specific approach to assessing angler motivations relied on data from the diary to tailor each survey to the specific experiences of the respondent from the previous year. This tailoring aided respondent's recall of their context and allowed us to test for the context-dependency of prime angling motivations. We defined each context as a combination of target species and location. To account for larger water bodies with multiple points of road access, the location description included the nearest town. Across the entire sample of anglers, 757 distinct locations and 9 focal freshwater and marine fish species or species groups were included in the study. To limit the burden on respondents, each personalized questionnaire focused on a maximum of three species and three locations that each angler had previously directed most of his or her effort as reported in the diary (**Figure 2.1**). Therefore, a single respondent evaluated up to nine different contexts. For 68% of the sampled anglers, these nine potential contexts accounted for all trips reported in their diary.

We did not examine motivations for specific fishing sites because with few exceptions fewer than five anglers visited any particular site. Nevertheless, including site-specific references in the motivation assessment gave respondents multiple opportunities to evaluate their motives for targeting a particular species by providing additional and salient context. The following nine freshwater and marine species or species groups were included in the study: common carp *Cyprinus carpio,* coarse fish (small-bodied cyprinids such as roach *Rutilus rutilus* and bream *Abramis brama),* Atlantic cod *Gadus morhua,* European eel *Anguilla anguilla,* European perch (also known as Eurasian perch) *Perca fluviatilis,* northern pike *Esox lucius,* Atlantic herring

Clupea harengus, a “flatfish” species group (marine species such as European flounder *Platichthys flesus,* turbot *Psetta maxima* and sole *Solea solea* [also known as *Solea vulgaris])* and zander *Sander lucioperca.* Species groupings for coarse fish (“Weissfische”) and flatfish (“Plattfische”) were used because they coincide with common angling terms used to define fishing targets, much as North American anglers report targeting “panfish.”

To reduce respondent burden, we restricted the focus of inquiry to the most salient motives associated with each context (**Figure 2.1**). Respondents were asked to indicate the single most important and least important reasons from the previously mentioned list of 10 items for choosing each context. As such, respondents were forced to differentiate among the items on the list rather than evaluate each motive item independently. Asking for both the most and least important motive is similar to the maximum difference conjoint approach in choice modeling (Flynn et al. 2007; for an application to recreational fishing see Dorow et al. 2009). The validity of combining assessments of both the most and least important motive in a single analysis, however, is predicated upon the assumption that the choice (i.e., preference) process for the least important item is inversely proportional to that of the most important (Flynn et al. 2007), an assumption that did not hold in our case. Therefore, the least important motivations were dropped from further analysis, which does not violate the theoretical foundation for the statistical analysis of the most important data.

For each angler, we weighted the most important motivation by the relative effort that the angler expended on that fishing context, which allowed us to plot the relative effort per motive for each species. Species-specific effort was measured in hours of directed fishing as recorded in the diary and scaled between 0 and 1. For example, if a respondent directed all of his or her angling effort in Mecklenburg-Vorpommern to a single species and location, their most important motivation was allocated a weight of 1. A species–location combination that received 9% of an angler’s total effort was weighted 0.09, such that the sum of all weights over all contexts for a given angler equaled 1. In this way, anglers who fished for multiple species and (or) visited multiple fishing sites were not overrepresented in the analysis. Thus, the species-specific motivational profiles reflected anglers’ effort for each species across multiple locations, while treating each angler as a sampling unit.

The context-specific responses were also used to classify respondents into clusters using effort-weighted motives to create an individual angler's motivational profile. Adopting the approach by Specziár and Rezsu (2009) to classify feeding guilds among fish by gut content analysis, we grouped anglers into motivation clusters by using criteria of motivational similarity. The classification for measuring the degree of motivational overlap among individual anglers was based on matrices of the Czekanowski overlap index (Krebs 1989). The overlap index was calculated for each pair of anglers as:

$$D_{jk} = \sum_{i=1}^{m} (\min p_{ij}, p_{ik}) \qquad (2\text{-}1)$$

where D_{jk} is the motivation overlap between angler j and k in the sample of n anglers, p_{ij} and p_{ik} are the proportions of effort where motivation i was considered most important to anglers j and k, and m is the total number of motivations. The index ranges from 0 (no overlap) to 1 (complete overlap; i.e., identical motivation profiles between two anglers). After calculating the index for each pair of anglers in the sample, the resulting $n \times n$ similarity matrix was subjected to Ward's hierarchical cluster analysis using a squared Euclidean distance measure. The final number of classes was chosen to coincide with the increase in slope of proximity coefficient, signalling substantial increases in difference among cluster groupings (Aldenderfer and Blashfield 1984). The effort attributable to each motivation was then described for each resulting angler cluster. The clusters were compared on angler characteristics that were obtained in the telephone and mail surveys, including sociodemographic information (e.g., age, education levels); recreation specialization (Bryan 1977), as defined by the amount of time (e.g., number of fishing trips per year, years of fishing experience); money invested (e.g., rates of boat ownership, angling holidays); and centrality-to-lifestyle (Kim et al. 1997), which was measured on a scale of seven statements, each rated from 1 (strongly disagree) to 5 (strongly agree). These items were subjected to factor analysis, revealing a single factor with high reliability ($\alpha = 0.82$). Consequently, the item mean for each respondent was taken as an indicator of centrality to lifestyle.

Additional comparisons of species-specific fishing behaviors among angling subgroups were conducted using information from the angling diary, including the distribution of effort among species, travel distance, catch per unit effort (CPUE), retention rate, and the size of the largest retained fish. For each of these calculations, we first summarized data across all trips for each angler and then compared across anglers. Categorical data were analyzed using Pearson's chi-square tests; metric or quasi-metric data were analyzed using one-way analysis of variance (ANOVA) and appropriate post hoc tests (Tukey for homogenous variances, Dunnett T-3 for heterogeneous variances). All statistical analyses were conducted with SPSS/PASW 18 at $\alpha = 0.05$. In comparing angler clusters, a less conservative significance value ($P \leq 0.10$) was used due to small sample sizes.

2.3. Results

2.3.1. Survey and Sample Description

Of 617 surveys mailed to diary participants, 463 surveys were returned, for an effective response rate of 79% (discounting 34 nondeliverable surveys). These respondents comprised 41% of all anglers initially recruited into the diary program 2 years earlier. An assessment of nonresponse bias between the respondents to the mail survey and nonrespondents, who were initially recruited into the random sample in Mecklenburg-Vorpommern (from where diary participants originated), was conducted using information collected during telephone interviews from 2006. Respondents were somewhat older than nonrespondents and tended to be more avid anglers, fishing more frequently at both coastal and freshwater sites. Based on the differences in avidity and demographics between mail survey respondents and nonrespondents, we caution readers from generalizing the findings of this study to the overall angler population level in Mecklenburg-Vorpommern.

2.3.2. General Angler Motivations

Factor analysis of the motivational importance rating task revealed four general factors (i.e., latent domains): (1) challenge of fishing, (2) catching and consuming fish, (3) setting, and (4) socializing. However, Cronbach's alpha reliability coefficients indicated an acceptable level of reliability only for the two catch-related dimensions (**Table 2.1**), which together accounted for all catch-related motives. The challenge factor captured all challenge-oriented items ("to master angling-related challenges; to outwit difficult-to-catch fish using a sophisticated technique; to experience a challenging fight") and the trophy fish item ("to catch trophy fish"), suggesting that catching exceptionally large fish is generally considered a challenging aspect of fishing. The item emphasizing the importance of catching large numbers of fish ("to catch as many fish as possible") and both consumption items ("to catch a fresh fish for a meal with friends/family; to generate a supply of fish in the freezer for nonangling times") formed one factor indicating the consumptive aspects of fishing. By contrast, the noncatch motivations ("to experience nature; to enjoy solitude; to be with friends/family") did not produce a reliable underlying latent motivational factor, which reflected the unique constructs underlying each of the three activity-general items included in the survey.

Wilcoxon rank-sum tests comparing the means of the catch-related factors with the item means for the noncatch motivations revealed significant differences between all motivations, except between enjoying solitude and being with friends and family (**Table 2.1**). On average, respondents rated noncatch motivation items as more important than the overall catch motivation factors and experiencing nature as the most important fishing motive (mean=4.4 on a scale from1=not at all important to 5= very important as a reason to fish in the study area), followed by being with friends and family (3.4), and enjoying solitude (3.4). The challenge motive factor (3.0) and consumptive motive factor (2.6) were rated significantly lower. The only catch items with an average item score greater than three were "to catch a fresh fish for a meal with family/friends" and "to experience a challenging fight," indicating that occasional consumption of fish and the challenge associated with landing a fish were rated similarly to two noncatch motives, namely "to be with friends/family" and "to enjoy solitude." The frequency distribution of ratings for each of the 10 motives (**Figure 2.2**) highlighted the consistency with which anglers rated the importance of noncatch motives, whereas the ratings of the catch motives exhibited considerably more variation among individuals.

2.3.3. Context-Specific Angler Motivations

When anglers were asked to indicate the single most important reason for targeting a particular species–location combination, catch motives featured prominently as the primary reason to target many species (**Figure 2.3**). Despite all fish species attracting each of the 10 individual catch and noncatch motivations to some degree, there were some noteworthy trends in the modes of the most prominent motivations for a given species. In particular, between 20% and 30% of effort directed at common carp, northern pike and zander was driven by the primary desire of catching trophy fish. By contrast, Atlantic herring, a marine schooling species offering a seasonal fishery with high daily catch rates, stood out as a species where catching as many fish as possible was frequently cited as the most important motivator of angling activity, accounting for 36% of the directed effort to herring. Small-bodied and abundant coarse fish such as roach and bream were frequently targeted to experience nature (30% of directed effort), and it is noteworthy that the motive “to enjoy solitude” was never cited as a reason for targeting coarse fish. The other freshwater (European perch), catadromous (European eel), and marine fish species (Atlantic cod, flatfish) were not associated with any single motive but attracted effort equally for two or more reasons. More than 10% of effort directed at perch and eel was primarily driven by the desire to experience nature, or by consumptive and trophy motives, and cod was targeted more than 10% of the time for socializing and experiencing a challenging fight. Flatfish attracted the most diverse motivations, 6 of 10 motives each accounting for more than 10% of directed effort. Overall, the species-specific motivation results indicated that catch-related motives and, thus, the expected catch outcomes provided by different fish species to anglers differed greatly among species.

2.3.4. Motivationally Similar Angler Types

We identified five distinct angler groups based on motivation similarity (**Figure 2.4**). Four clusters were clearly defined by their strong preference for a single primary motivation that accounted, on average, for more than 60% of their total directed effort; they were labeled accordingly. Members of cluster 1 (N = 96; 27% of the sample) fished primarily to experience nature and were, therefore, labeled “nature-oriented.” Members of cluster 2 (N = 75; 21%) allocated a similar proportion of their effort to catching trophy fish; consequently, cluster 2 was termed “trophy-seeking.” The members of the third cluster (N = 48; 14%) directed their effort primarily to be with friends and family, and this cluster, thus, was described as “social.” Anglers in the fourth cluster (N = 45; 13%) directed effort primarily to obtain fish for a single meal with family and friends and were, therefore, considered members of the “meal sharing” cluster. For each cluster, less than 10% of effort was attributed to any other motive; however, for all clusters, the mean effort associated with each of the 10 motives was not zero. Members of the fifth cluster, which was the second largest (N = 90; 25%), showed no clearly predominant motive. These anglers tended to pursue fishing opportunities that offered various nontrophy related challenges associated with catching fish somewhat more often than did the other groups and were, thus, characterized as “nontrophy challenge-seeking.” The hierarchical relationship among clusters documented that nature-oriented anglers were related most closely to trophy-seeking anglers, the remaining three clusters grouping together on a separate branch of the dendrogram (**Figure 2.4**).

Members of the five clusters did not differ on many sociodemographic characteristics; no statistically significant differences were apparent in gender, residency in Mecklenburg-Vorpommern, education, or household income. However, the clusters differed significantly by age (ANOVA: $F353$ = 4.68, P < 0.01), with social anglers being the youngest at an average 39.5 years of age (SE, 2.0), while consumptive anglers were the oldest at 49.6 years (SE,1.9; Tukey adjusted P = 0.03). Members of the motivational clusters differed in behavioral and attitudinal characteristics related to angler specialization and commitment (**Table 2.2**, **Table 2.3**). Major differences appeared for years of fishing experience (ANOVA: $F353$ = 2.69, P = 0.03), social anglers being the least experienced (averaged 16.5 years of experience) and meal-sharing anglers being the most experienced anglers (26.4 years; Tukey adjusted P < 0.01). Nontrophy challenge seekers and social anglers were more likely to have taken an angling holiday outside Mecklenburg-Vorpommern during the study period than were meal-sharing or trophy anglers ($\chi2$ = 13.16, df = 4, P < 0.01). Other variables were significant at the 10% level: boat ownership ($\chi2$ = 8.72, df = 4, P = 0.07), average one-way travel distance (ANOVA: $F353$ = 2.29, P = 0.06), and centrality of angling to lifestyle (ANOVA: $F353$ = 2.11, P = 0.08). Social anglers tended to travel farthest to fish within Mecklenburg-Vorpommern. Nontrophy challenge seekers and trophy-seeking anglers had the highest mean centrality scores, followed by meal-sharing anglers; social and nature-oriented anglers exhibited the lowest scores. No statistically significant differences were found for membership in state angling associations ($\chi2 = 7.66$; df = 4; $P = 0.11$) or local angling clubs ($\chi2 = 10.49$; df = 4; $P = 0.23$), mean number of fishing trips in a year (ANOVA: $F353 = 1.52$, $P = 0.20$), or the average duration of fishing trips (ANOVA: $F353 = 1.22$, $P = 0.30$).

While differences among the five motivational clusters were not pronounced in demography or general angler behaviors, greater contrast among the five clusters was evident when more specific fishing behaviors and trip characteristics were compared across species (**Table 2.4**, **Table 2.5**). Members within each cluster targeted each species to some degree, indicating that a particular species might fulfill various fishing motives as perceived by particular angler types (**Table 2.4**). The most targeted species, attracting more than two-thirds of each cluster, were northern pike and European perch, followed by 50–65% of anglers targeting European eel and coarse fish. Common carp and flatfish attracted less than one-third of anglers from each segment. Significant differences ($P < 0.05$) in the fraction of each cluster targeting a particular species were evident in European perch and Atlantic herring (**Table 2.4**). Perch attracted more consumptive and trophy-seeking anglers and fewer social anglers than expected ($\chi2 = 9.01$, $P = 0.05$), while herring attracted more nontrophy challenge-seeking and social anglers but fewer nature-oriented and trophy-seeking anglers than expected ($\chi2 = 9.60$, $P < 0.01$). While differences between motivational clusters in mean one-way travel distance were small when aggregated across all species, differences in travel propensity and distance were more pronounced when examining travel behavior for anglers targeting particular species. Given that an angler targeted the species in question, average travel distance was generally greatest for the marine species: Atlantic herring, flatfish and Atlantic cod. For these species, social anglers tended to travel the shortest distance. The reverse was true for many freshwater species for which social anglers traveled furthest.

Finally, we examined the catch and harvest behavior across clusters (**Table 2.5**). Overall, the species with the highest average CPUEs were the naturally the most abundant and small-bodied species (Atlantic herring, coarse fish and European perch), while zander, common carp, and European eel exhibited the lowest CPUE of all species examined. Herring and eel were associated with the highest retention rates of all species across angler types (>0.8), while retention rates for perch were comparatively low at 0.5–0.6. The CPUE, retention rate, and size of largest retained fish differed substantially among motivation clusters, with few exceptions (e.g., no significant differences in catch rates among angler types for carp and coarse fish). Mean values for catch and retention rates and size of largest retained fish did not follow straightforward patterns across species and angler types, and due to low sample size post hoc tests were often unable to clearly differentiate homogeneous subsets of anglers, despite significant overall ANOVAs.

The most consistent patterns were revealed by trophy-seeking anglers who exhibited among the highest catch rates of all angler types for northern pike, zander, and the three marine species but surprisingly exhibited similar harvest rates to other anglers, except for common carp (63–64% for trophy-seeking and social anglers versus 71–83% for other groups). Trophy seekers, in agreement with their primary motive, were consistently found in homogenous subsets retaining, on average, the largest fish of all angler types (e.g., about 65 cm for carp, European eel, and Atlantic cod). Meal-sharing anglers had particularly low catch rates for eel (mean, 0.18/h) but very high catch rates for European perch (4.32/h). Retention rates for meal-sharing anglers were among the highest for several species (carp, eel, cod, flatfish, and Atlantic herring), mean sizes of the largest retained fish being among the smallest for all freshwater species examined. Nontrophy challenge-seeking anglers exhibited low catch rates for eel, zander, and flatfish but had catch rates similar to meal-sharing anglers for perch. This group had lower retention rates of pike (0.60) and perch (0.54). Carp, coarse fish, and cod retained by nontrophy challenge seekers tended to be smaller; however, this group rivalled trophy seekers in catching the largest pike (67 cm). Nature-oriented anglers had low catch rates of perch, zander, flatfish, and cod but equalled meal-sharing anglers in their retention rates of most species. This cluster was never found among those with the largest mean fish sizes retained but was found among those retaining the smallest carp, coarse fish, and cod. Social anglers exhibited high catch rates of coarse fish and eel but low catch rates for pike, flatfish, and herring. These anglers tended to have low retention rates across several species (carp, coarse fish, pike, zander and perch). Low retention rates were coupled with high mean sizes for their largest fish, rivalling trophy seekers for the largest carp, coarse fish, eel, and zander.

2.4. Discussion

Our study is the first to account explicitly for the effect of trip context on motivation within a single population of anglers, revealing that the importance of catch motives varies considerably depending on context, which in our study was mainly defined by target species in a given location. Furthermore, grouping anglers according to their similarity in primary motives revealed an unexpectedly strong connection between motivations and angler specialization. In particular, we found that trophy and other challenge-seeking anglers were more specialized than other anglers, in turn indicating that the more committed anglers exhibit context-specific primary motivations that are strongly oriented towards the catching aspects of fishing. Finally, the variance in most important fishing motivations was also associated with variation in species-specific angling behaviors and catch outcomes. Overall, our study revealed that catching fish is primarily important for anglers depending on trip context and that grouping anglers based on most the important motivation associated with trip type allows predictions of fishing behaviors as they relate to specific patterns of catching and harvesting.

The above findings gain further support from the fact that the results of angler motivations based on the general motivation scale were consistent with the findings from other angler motivation studies (i.e., general noncatch motives are more important than catch motives; e.g., Fedler and Ditton 1994). This consistency demonstrates that our sampled anglers share a common generic motivational structure with other angler populations and ensures that our novel findings from the context-dependent approach, which emphasized catch motives as prime motives across many trip contexts, are not an artefact of a unique sample of anglers.

Given that angling is a recreational activity, it is not surprising that in the general motivation assessment noncatch-related motivations have always emerged as more important than catch-related aspects of the fishing experience (Ditton 2004). This result arose because relaxation and escape from daily pressures are hallmarks of most leisure activities (Parr and Lashua 2004). By accounting for a species-specific fishing context, however, we documented that catch aspects still played a paramount role in selecting a particular fishing experience by anglers. The questions of why anglers go fishing in general and why anglers choose a particular fishery thus can have very different answers. These differences provide insight to a long-standing controversy among fisheries managers and human dimensions researchers (Matlock et al. 1988; Peyton and Gigliotti 1989). Using general angler motivations to justify very specific fishery regulations (e.g., banning harvest of fish on the assumption that anglers are primarily motivated to relax at the waterside) is unwarranted and will very likely result in conflict with anglers (Arlinghaus 2006). This insight is similar to the finding in social psychology that human behaviors are best predicted by attitudes with equivalent levels of specificity (Fazio 1990). In fact, as we showed, anglers might attach greater importance to noncatch than to catch motives in their general motivations for fishing, while also being predominantly catch-oriented when seeking specific experiences. Therefore, when designing regulations to fit the aspirations of the angler constituency, fisheries managers are advised to study specific contexts and the prime desires of anglers for these contexts.

In our study, certain species systematically tended to attract specific primary catch-related motives, indicating that each species differed in fulfilling specific primary expectations by anglers. For example, large-bodied species like northern pike, common carp, and zander were sought by anglers primarily to meet trophy motives. These species contrasted with the more abundant and easy-to-catch small-bodied coarse fish that were typically chosen by anglers to facilitate an enjoyable and social experience in nature. Our findings corroborate earlier reports on correlations between maximum body size of fish species and trophy orientation (Fedler and Ditton 1994; Wilde and Ditton 1999). Overall, the results indicate that despite some overlap in expected outcomes, each species might fulfill very specific expectations and recreational opportunities for anglers.

Not only do our findings underscore that heterogeneity in available fishing opportunities matches heterogeneity in anglers' expectations, but as in other research (e.g., Fedler and Ditton 1994; Wilde and Ditton 1999), our findings also confirm the existence of considerable variation in primary fishing motives within the angler population. By distinguishing among anglers based on context-specific angler motivations, we identified five different angler groups. While these groups did not differ substantially in their demographic characteristics or general angling participation, comparative analyses of angler characteristics revealed other distinctions that supported a novel link between angler motives and recreational specialization theory (Bryan 1977). In particular, the angling characteristics of the motivation-defined clusters (**Table 2.4**) suggested that nature-oriented and meal-sharing anglers were the least specialized, demonstrating a low commitment to angling (as indicated by low frequency of taking an angling vacation, and boat ownership) and low mean centrality to lifestyle index. By contrast, nontrophy challenge and trophy anglers exhibited the highest values for centrality to lifestyle, suggesting they represent the most specialized anglers. This finding showed that catch motives may be most important to specialized anglers when choosing a specific trip context, and it challenges Ditton et al.'s (1992) proposition of specialization theory that increasing specialization level correlates positively with the importance attached to noncatch aspects of fishing. While our study did not test this proposition explicitly, it indicated that highly specialized anglers should maintain a strong desire to catch fish or pursue other catch-related challenges, despite the possibility that importance attached to noncatch motives might also increase. Ultimately, it is the overall importance attached to fishing that increases with specialization and involves both catch and noncatch aspects.

Although researchers have used angling experience as a behavioral indicator of angler specialization (e.g., Ditton et al. 1992), experience level was not strongly correlated with level of angler specialization in our study. Therefore, any empirical relationships between experience level of anglers and angler motivations might not correspond well with specialization theory as developed by Bryan (1977). A good example is the characteristics of the meal-sharing anglers. This angler group was the most experienced, yet these anglers exhibited a lower centrality to lifestyle index than did the nontrophy challenge and trophy anglers. Therefore, meal-sharing anglers were less specialized despite being the most experienced anglers. The lack of relation of angling experience and specialization level in our study supports previous criticisms of specialization being necessarily progressive with the angling career (Kuentzel 2001; Scott and Shafer 2001; Oh et al. 2011). If angling experience is indeed uncorrelated with level of specialization, earlier propositions relying on angling experience to relate angling motives to specialization (e.g., Ditton et al. 1992) should be revisited.

While trends for trophy anglers, nontrophy challenge anglers, and the more consumptive meal-sharing anglers relating to specialization theory were somewhat straightforward, the evidence for specialization among social anglers was mixed in our study. Members of this cluster were characterized by low centrality to lifestyle and rates of boat ownership, indicating low specialization but high frequencies of angling vacations and mean travel distance, which indicate high behavioral commitment and investment of time and monetary resources, hence, high specialization. The conflicting characteristics of social anglers might reflect the influence of more committed angling friends, and lower levels of commitment to angling in Mecklenburg-Vorpommern may be offset by greater angling participation during leisure periods that allow greater travel (e.g., holidays).

Both trophy and nontrophy challenge-seeking anglers exhibited a high centrality to lifestyle index, indicating that these two angler segments were more specialized in the spirit of Bryan (1977) than were the other three angler groups. This finding is corroborated by other characteristics of these two groups. Besides their higher mean centrality to lifestyle scores, trophy-seeking anglers had higher than expected frequencies of boat ownership, and nontrophy challenge-seekers were more likely to take an angling vacation outside Mecklenburg-Vorpommern and travel greater distances within the state. Our findings thus support early propositions from specialization theory that the importance of consumption decreases while the importance of large trophy fish and the challenge component of fishing increases as anglers develop from novice to expert (Bryan 1977). As mentioned previously, our finding that the most specialized anglers were primarily interested in the catch-related aspects of the fishing experience, however, disagrees with later tenets that the relative importance of noncatch to catch-related aspects of the fishing experience should increase as anglers become more specialized (Ditton et al. 1992). Our findings from an assessment of prime motivations in a given context instead point to an overwhelming importance of challenge-related catch aspects for more specialized anglers, consumptive and noncatch motives playing secondary roles for these committed anglers in a given context. The fact that several challenge-related motives were represented by these specialized angler groups is consistent with suggestions that specialization involves multiple trajectories (Kuentzel and Heberlein 2006), anglers diverging in their primary motives and selecting different fishing opportunities for different reasons. This divergence also suggests a reason for the low scores typically associated with ratings of catch-related items in general motivation assessments. As revealed by the rating distributions (**Figure 2.2**), the importance of individual catch motives varies widely among anglers. A catch motive that drives one angler's choice of fishing activity may be unimportant to another angler, and when aggregated, this overall importance of catch-related aspects is lost. If committed anglers indeed exhibit divergent and specialized preferences for activity-related motives, the actual needs of these anglers may be misrepresented by the summary statistics typically associated with importance scales. This would underscore an old adage of human dimensions literature that the average angler only exists in research reports (Shafer 1969; Aas and Ditton 1998). Such an average perspective might not be particularly suited for deriving management implications because the importance of heterogeneity for informing policies to suit diverse wishes is lost (Johnston et al. 2010).

Our study supports calls from the literature for more research on behavioral heterogeneity among anglers in a relevant way to prepare the empirical ground for application in coupled social–ecological fisheries management models (Post et al. 2008; Johnston et al. 2010; Hunt et al. 2011). From a fisheries biological perspective, one might consider anglers as the top predator in aquatic systems (Johnson and Carpenter 1994). One approach to understand predatory dynamics is the concept of functional similarity, which is the basis for ecological guilds in fish ecology. Guilds are a group of species that exploit the same type of environmental resources in a similar way (Simberloff and Dayan 1991). Applied to recreational fisheries, one might consider distinct angler types whose predatory characteristics differ from each other, but are relatively homogenous within an angler type, as ecological guilds. Our study suggests that some predatory characteristics of anglers are related to context-specific primary angling motivations. Indeed, using the analogy of predatory guilds, characteristic behaviors of members of each motivation cluster were found to exhibit similar characteristics to natural predators, such as prey specificity (target species), foraging range (travel distance), intake rates (catch and harvest efficiencies) and size selectivity (maximum harvest size). Indeed, we found significant differences among characteristics of the five angler groups for each of the nine primary prey species in Mecklenburg-

Vorpommern, species-specific travel, catch, and harvest behavior being associated with each motivational type revealed by distinct behavioral patterns. These findings might be used to inform future agent-based models that simulate the behavior of various angler types exploiting multispecies communities in a multi-location landscape.

Against this background, our study provides further support for the link between the psychological and behavioral dimensions of angler specialization and the actual "predatory" behaviors of different angler types. For example, we found that trophy anglers often exhibited the highest catch rates and retained, on average, larger fish than other angler groups, an indication that these are the most skilled anglers (Bryan 1977; Arterburn et al. 2002; Dorow et al. 2010). It is, however, noteworthy that trophy anglers in our case exhibited quite high harvest rates, which agrees with results from Dorow et al. (2010), who studied European eel angling in the same area. These findings of higher consumptive orientation by trophy anglers contradicts Bryan (1977) who predicted that with increasing commitment and specialization levels, the importance of trophy-sized fish should increase and the propensity to release fish should also increase. However, given the current interpretation of the German Animal Protection Act, the most acceptable reason to angle is to put fish on the table, and subsistence is deeply rooted in German fishing culture. Therefore, voluntarily releasing legal-sized fish is implicitly banned in Germany (Arlinghaus 2007). Also, in the German cultural sphere trophy fishing is not necessarily associated with voluntary catch-and-release fishing, although clear exceptions exist (e.g., trophy carp fishing; Arlinghaus 2007). Because we defined the clusters only by their selection of a single most important motive, our analysis did not account for the influence of secondary motives. Thus, trophy-seeking anglers might be simultaneously motivated, albeit to a lesser degree, by consumption. One interesting exception to the high retention rates of trophy-seeking anglers occurred for common carp. Here, trophy-seeking and social anglers exhibited the lowest retention rates, suggesting that this species could be of particularly high trophy value, but that trophy-size carp might have little consumptive value, thereby providing incentive to release otherwise harvestable fish (Arlinghaus 2007).

Indiscriminate application of our findings to inform fisheries management decisions is not recommended owing to some important study limitations. One limitation stems from the focus on only the single most important motive for any given context.

While this limitation is somewhat mitigated by combining up to three locations around a common species, the importance of secondary motives is conspicuously absent. This omission was made to accommodate the need to alleviate respondent burden in a survey that had many different objectives. We attempted to enhance the quality of our data by using a best–worst design (Flynn et al. 2007); that is, we initially asked anglers to indicate their most and least preferred motive for a given context. However, we observed that the data on the least important motive proved unreliable because of a high level of item nonresponse. This phenomenon might indicate that respondents found it challenging to distinguish among motivation items that were equally unimportant to a given fishing context or that the choice process differs for selecting the least and most important motives. Future studies might consider asking respondents to rank their most important motives for each context rather than asking for extremes.

Our use of a truncated and heavily modified set of motivation items might also have affected our results. Many items we used deviated from those in established scales, and in some cases we combined constructs. For example, the item “to catch a fresh fish for a meal with friends/family” contained both consumptive and social aspects. Overall, it seems that these deviations did not seriously affect our findings because the factor analysis grouped motivational items into coherent dimensions.

Further limitations arise mainly from the small sample size and the level of analytical sophistication applied. When angler groups were identified by species-specific harvesting behavior, we relied on a relatively small sample from a region with a highly diverse recreational fishing system. Thus, our angler groupings were correspondingly small and rendered smaller still once comparisons across groups at a species-specific level were made. This limited the power of our statistical analyses, especially for post hoc pairwise comparison tests. The generality of our results is also limited due to the unique German institutional and regulatory context. Despite these limitations, our study presents a novel approach to link angler motivations and behavior, and our findings suggest that angler motives might provide a suitable classification tool to assess heterogeneity in catch and harvest behavior. We consider it as proof-of-concept warranting application in future studies.

One of our most important findings is that the importance of catch was prominently expressed when anglers were asked for their most important motive in a given context, and that makes this approach worth replicating elsewhere. Although we derived essential trip behavior information from pairing the motivation assessment survey with a year-long trip diary and periodic telephone interviews, the amount of resources required to elicit such information is perhaps the largest methodological obstacle for implementing our context-specific motivation assessment in traditional mail or telephone-based offsite surveys. Future applications might surmount this obstacle by simply asking respondents to list the details of each type of experience (species, location, etc.), including their directed fishing effort. If available and feasible, applying internet-based survey technologies might also assist researchers with dynamically inserting information from earlier questions in the same instrument. With these adaptations, future applications of species or location-specific motivation research might be feasible for off-site state or local fishing surveys. An alternative would be to ask motivation questions in creel surveys. Future research might expand the list of motivation items to include the full spectrum identified by previous research (Fedler and Ditton 1994), as well as include additional context variables, such as the use of specific angling techniques and equipment and the social context. Methodologically, it would be of interest to directly compare the traditional rating approach with our approach, focusing on the single most important item in the context of a similarly framed and contextually defined angling opportunity.

2.5. Conclusions and Implications

Our study demonstrated that catch motives constitute prime motivations for anglers in certain contexts. We also found that assessing prime fishing motives aids in the understanding of heterogeneity in recreational fishing activities and anglers, including their catching and harvesting behaviors. While our results showed that catch is important to anglers in a given context, the importance of particular motives depended on the species targeted by anglers in a given context. As expected, the importance of catch varied within the angler population, though surprisingly, it was most important to anglers demonstrating the highest levels of commitment to the activity. Our finding about the prime importance of catch motives is novel in angler motivation research, but given its focus on specific trip contexts does not contradict previous research reporting that the main reasons for fishing, in general, are often unrelated to motives to catch fish (e.g., relaxation). Overall, the existence of a pronounced diversity of motives within the angling population highlights the fact that it is critically important for managers to maintain diverse fishing opportunities and to market and manage fisheries to adequately meet the expectations of various angler groups. In this context, managing harvesting and catching opportunities will almost inevitably affect the experience of anglers and should thus be of prime consideration for fisheries managers.

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Tables and Figures

Table 2.1. Factor loadings and contrasts among general angler motivations based on importance ratings of motivation importance.

Item name	Wording of item in survey	Descriptive statistics*			Factor loadings**				Wilcoxon's rank sum test (Z score)			
		N	Mean	SE	Challenge	Consumption	Setting	Social	Factor: Consumption	Item: *NATURE*	Item: *SOLITUDE*	Item: *SOCIALIZE*
Challenge (α= 0.782)		447	2.96	0.047					**-7.66[a]**	**-15.78[b]**	**-5.20[b]**	**-6.25[b]**
MASTER	to master angling-related challenges	447	2.95	0.058	0.789	0.125	0.007	0.115				
OUTWIT	to outwit difficult-to-catch fish using a sophisticated technique	448	2.83	0.065	0.783	0.110	-0.010	0.014				
FIGHT	to experience a challenging fight	450	3.29	0.060	0.778	0.079	0.125	0.045				
TROPHY	to catch trophy fish	447	2.78	0.058	0.653	0.382	-0.015	0.058				
Consumption (α= 0.620)		445	2.58	0.042					-	**-16.51[b]**	**-9.75[b]**	**-10.81[b]**
NUMBERS	to catch as many fish as possible	449	2.57	0.055	0.363	0.664	-0.116	0.017				
MEAL	to catch a fresh fish for a meal with family/friends	453	3.39	0.057	0.154	0.668	0.110	0.365				
FREEZER	to generate a supply of fish in the freezer for non-angling times	445	1.76	0.049	0.076	0.808	-0.031	-0.098				
Setting (α= 0.439)												
NATURE	to experience nature	456	4.39	0.046	0.183	-0.227	0.663	0.419	-	-	**-13.25[a]**	**-11.93[a]**
SOLITUDE	to enjoy solitude	452	3.35	0.057	-0.037	0.091	0.875	-0.224	-	-		-.624[b]
	Socialize (α= N/A)											
SOCIALIZE	to be with friends/family	447	3.40	0.060	0.070	0.092	-0.066	0.893	-	-	-	-
	Valid N (listwise)	434										

* Items were rated from 1(not at all important) to 5 (very important); ** Cumulative variance explained = 0.6940; a. Based on positive ranks; b. Based on negative ranks; Z-scores in bold indicate statistically significant differences at p<0.001 (Bonferroni-Holm corrected)

Table 2.2: Sociodemographic characteristics of five motivation-similarity angler clusters.

		Nature-oriented (N=96)		Trophy-seeking (N=75)		Social (N=45)		Consumptive (N=48)		Non-trophy challenge-seeking (N=90)		Pearson Chi²	P
		N (Obs.)	%	N (Obs.)	%	N (Obs.)	%	N (Obs.)	%	N (Obs.)	%		
M-V resident	No	10	10.4	5	6.7	6	13.3	4	8.3	12	13.3	11.696	0.165
	Yes	86	89.6	70	93.3	42	93.3	41	85.4	78	86.7		
Sex	Male	91	94.8	72	96	45	100	43	89.6	85	94.4	0.401	0.982
	Female	5	5.2	3	4	3	6.7	2	4.2	5	5.6		
Education	Basic school without apprenticeship	1	1	1	1.3	2	4.4	0	0	4	4.4	20.43	0.431
	Basic school with apprenticeship	18	18.8	23	30.7	10	22.2	10	20.8	17	18.9		
	Mid-level school	47	49	31	41.3	16	35.6	19	39.6	44	48.9		
	University entrance qualification	8	8.3	4	5.3	3	6.7	1	2.1	5	5.6		
	University study	17	17.7	11	14.7	13	28.9	14	29.2	15	16.7		
	Still in school	4	4.2	5	6.7	4	8.9	1	2.1	5	5.6		
Household income (€)	< 1000	6	6.3	8	10.7	4	8.9	0	0	7	7.8	24.601	0.217
	1000 to 1499	19	19.8	14	18.7	5	11.1	5	10.4	9	10		
	1500 to 1999	17	17.7	13	17.3	9	20	13	27.1	21	23.3		
	2000 to 2499	17	17.7	15	20	7	15.6	9	18.8	21	23.3		
	2500 to 2999	7	7.3	4	5.3	7	15.6	3	6.3	14	15.6		
	3000 and more	15	15.6	7	9.3	8	17.8	9	18.8	8	8.9		
		Mean	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**ANOVA (F)**	**Sig.**
Age (yrs)		47.1^{ab}	1.4	46.0^{ab}	2	39.6^{b}	2	49.6^{a}	1.9	41.8^{ab}	1.4	4.68	0.001

Note: Superscript letters denote homogeneous subsets (P<0.05) based on post-hoc Tuckey test based on homogenous variance.

Table 2.3: Angling characteristics of five motivation-similarity angler clusters.

		Nature-oriented (N=96)		Trophy-seeking (N=75)		Social (N=45)		Consumptive (N=48)		Non-trophy challenge-seeking (N=90)		Pearson Chi²	P
		N (Obs)	%	N (Obs)	%	N (Obs)	%	N (Obs)	%	N (Obs)	%		
Angling holiday >3 days	Yes	14	14.6	6	8.2	12	25.5	6	13.3	21	23.3	13.157	0.001
	No	82	85.4	67	91.8	35	74.5	39	86.7	69	76.7		
Boat ownership	Yes	36	37.5	41	54.7	14	31.1	22	45.8	41	45.6	8.718	0.069
	No	50	52.1	29	38.7	28	62.2	23	47.9	37	41.1		
Angling association member	Yes	58.4	60.8	46.1	61.5	29.5	65.6	27.7	57.7	55.3	61.4	7.663	0.105
	No	32	33.3	25	33.3	26	57.8	15	31.3	38	42.2		
Angling club member	Yes	59	61.5	41	54.7	19	42.2	27	56.3	47	52.2	5.32	0.256
	No	27	28.1	29	38.7	21	46.7	17	35.4	31	34.4		
		Mean	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**ANOVA (F)**	**Sig.**
Fishing experience (years)		23.8[a]	1.7	24.2[a]	2	16.5[b]	2	26.4[a]	2.4	22.6[ab]	1.6	2.69	0.03
Annual number of trips		19.3	1.6	20.3	1.7	17.1	2.3	28.9	3.3	22.6	1.9	1.524	0.195
Average trip duration (hours)		4.2	0.1	4.4	0.3	4.7	0.5	3.8	0.2	4.6	0.2	1.226	0.3
Average one-way travel distance (km)		36.8	6.4	29.1	7.1	52.1	9.9	19.6	2.8	42.5	6.5	2.291	0.061
Centrality scale item mean (Chr. Alpha = 0.817)		2.3	0.1	2.5	0.1	2.3	0.1	2.4	0.1	2.6	0.1	2.107	0.08

Note: Superscript letters denote homogeneous subsets (P<0.05) based on appropriate post-hoc tests: Tuckey for homogenous variances and Dunnett T3 where variance is heterogeneous

Table 2.4. Species-specific targeting frequency and travel distance contrasted among five motivation-similarity angler clusters (Nature-oriented, N=96; Trophy-seeking, N=75; Social, N=45; Consumptive, N=48; Non-trophy challenge-seeking, N=90).

Species	Angler type	Number of anglers targeting species			One-way travel given angler targets species (km)		
		N	%	Pearson Chi^2	Mean	S.E.	ANOVA (F)
Carp	Nature-oriented	30	31%	4.92	24.5	3.0	2.76*
	Trophy-seeking	25	33%		24.6	5.0	
	Social	11	24%		32.8	8.3	
	Consumptive	15	31%		30.5	3.9	
	Non-trophy challenge-seeking	37	41%		16	2.0	
Coarse fish	Nature-oriented	61	64%	6.11	25.3 [a]	3.0	4.37*
	Trophy-seeking	50	67%		14.9 [b]	2.0	
	Social	26	58%		19.0 [ab]	2.6	
	Consumptive	29	60%		14.1 [b]	1.0	
	Non-trophy challenge-seeking	46	51%		22.7 [ab]	2.1	
Eel	Nature-oriented	50	52%	3.08	19.2 [b]	1.6	23.04*
	Trophy-seeking	39	52%		23.6 [b]	2.7	
	Social	25	56%		54.9 [a]	6.5	
	Consumptive	30	63%		20.0 [b]	1.6	
	Non-trophy challenge-seeking	48	53%		21.3 [b]	1.3	
Perch	Nature-oriented	66	69%	9.01*	15.6 [bc]	1.0	12.74*
	Trophy-seeking	62	83%		18.8 [bc]	2.2	
	Social	30	67%		33.7 [a]	3.8	
	Consumptive	37	77%		14.4 [c]	0.6	
	Non-trophy challenge-seeking	68	76%		21.1 [b]	1.5	
Pike	Nature-oriented	76	79%	8.66	26.2 [b]	2.2	15.9*
	Trophy-seeking	61	81%		17.7 [c]	1.5	
	Social	32	71%		39.0 [a]	4.5	
	Consumptive	38	79%		15.4 [c]	0.7	
	Non-trophy challenge-seeking	75	83%		24.9 [b]	1.3	
Zander	Nature-oriented	25	26%	6.75	17.9 [b]	1.9	25.17*
	Trophy-seeking	26	35%		17.7 [b]	4.5	
	Social	17	38%		75.1 [a]	12.4	
	Consumptive	15	31%		14.8 [b]	2.2	
	Non-trophy challenge-seeking	40	44%		23.1 [b]	1.5	

Species	Angler type	Number of anglers targeting species			One-way travel given angler targets species (km)		
		N	%	Pearson Chi^2	Mean	S.E.	ANOVA (F)
Cod	Nature-oriented	42	44%	6.57	68.1^{b}	6.3	8.09*
	Trophy-seeking	24	32%		78.0^{b}	7.9	
	Social	28	62%		42.6^{c}	4.3	
	Consumptive	21	44%		59.1^{bc}	5.4	
	Non-trophy challenge-seeking	40	44%		88.8^{a}	5.6	
Flat fish	Nature-oriented	26	27%	3.12	33.9^{b}	4.2	6.56*
	Trophy-seeking	16	21%		68.6^{a}	4.4	
	Social	14	31%		23.2^{b}	5.2	
	Consumptive	15	31%		30.9^{b}	6.7	
	Non-trophy challenge-seeking	20	22%		42.9^{ab}	5.8	
Herring	Nature-oriented	29	30%	9.60*	32.3^{b}	5.5	4.24*
	Trophy-seeking	23	31%		52.0^{ab}	11.1	
	Social	23	51%		35.3^{ab}	3.2	
	Consumptive	18	38%		51.8^{ab}	6.9	
	Non-trophy challenge-seeking	43	48%		57.0^{a}	4.5	

Notes: * indicates significant differences at $P<0.05$; superscript letters denote Tuckey homogeneous subsets ($P<0.05$) based on findings of variance homogeneity.

Table 2.5: Species specific catch outcomes (catch per unit effort (CPUE), retention rate and the size of the largest fish retained) contrasted among angler types.

Species	Angler type	CPUE (fish h^{-1})				Percent retained				Largest retained fish (cm)			
		N	Mean	S.E.	F	N	Mean	S.E.	F	N	Mean	S.E.	F
Carp	Nature-oriented	30	0.16	0.02	1.26	29	0.71^{ab}	0.05	2.65*	25	53.6^{c}	1.4	10.49*
	Trophy-seeking	25	0.19	0.03		25	0.63^{b}	0.05		23	64.6^{a}	1.6	
	Social	11	0.16	0.03		11	0.64^{b}	0.08		11	63.1^{ab}	2.3	
	Consumptive	15	0.09	0.03		15	0.81^{a}	0.11		15	53.1^{bc}	2.0	
	Non-trophy challenge-seeking	37	0.15	0.02		35	0.83^{a}	0.04		32	55.7^{c}	1.2	
Coarse fish	Nature-oriented	61	3.26	0.43	1.38	61	0.77^{a}	0.06	4.64*	60	20.6^{b}	1.6	9.9*
	Trophy-seeking	50	3.39	0.65		50	0.82^{a}	0.08		47	38.9^{a}	3.5	
	Social	26	5.48	1.19		26	0.25^{b}	0.13		24	33.0^{a}	1.1	
	Consumptive	29	3.76	1.03		29	0.61^{ab}	0.18		28	18.0^{b}	2.6	
	Non-trophy challenge-seeking	46	4.28	0.56		46	0.63^{ab}	0.13		44	18.1^{b}	3.4	
Eel	Nature-oriented	50	0.27^{a}	0.02	6.89*	47	0.8	0.03	1.65	46	57.7^{c}	0.9	9.3*
	Trophy-seeking	39	0.23^{ab}	0.02		36	0.8	0.03		35	64.5^{a}	1.0	
	Social	25	0.27^{a}	0.03		22	0.8	0.04		22	64.7^{a}	1.3	
	Consumptive	30	0.18^{b}	0.02		27	0.84	0.04		27	60.0^{bc}	1.1	
	Non-trophy challenge-seeking	48	0.15^{b}	0.01		44	0.8	0.03		44	62.5^{ab}	0.8	
Perch	Nature-oriented	66	2.60^{b}	0.17	9.59*	65	0.64^{a}	0.02	9.99*	63	27.3^{ab}	0.3	3.42*
	Trophy-seeking	62	3.78^{a}	0.28		62	0.63^{a}	0.02		61	27.8^{ab}	0.4	
	Social	30	2.94^{ab}	0.31		30	0.53^{b}	0.03		29	28.5^{a}	0.6	
	Consumptive	37	4.32^{a}	0.27		36	0.50^{b}	0.02		34	26.5^{b}	0.3	
	Non-trophy challenge-seeking	68	4.30^{a}	0.31		68	0.54^{b}	0.02		65	26.8^{ab}	0.3	
Pike	Nature-oriented	76	0.43^{ab}	0.03	4.83*	72	0.68	0.02	1.18	66	65.1^{b}	0.7	7.16*
	Trophy-seeking	61	0.51^{a}	0.03		60	0.92	0.22		56	67.2^{a}	0.7	
	Social	32	0.31^{b}	0.03		31	0.68	0.05		27	65.9^{bc}	1.4	
	Consumptive	38	0.42^{ab}	0.03		37	0.72	0.03		35	61.9^{c}	0.7	
	Non-trophy challenge-seeking	75	0.41^{b}	0.02		69	0.6	0.02		65	66.6^{a}	0.7	

Species	Angler type	CPUE (fish h^{-1})				Percent retained				Largest retained fish (cm)			
		N	Mean	S.E.	F	N	Mean	S.E.	F	N	Mean	S.E.	F
Zander	Nature-oriented	25	0.14^{c}	0.02	5.87*	21	0.85^{a}	0.05	10.98*	20	55.8^{ab}	1.7	3.97*
	Trophy-seeking	26	0.52^{a}	0.08		23	0.85^{a}	0.04		21	57.9^{a}	1.4	
	Social	17	0.40^{b}	0.12		12	0.31^{c}	0.08		10	63.6^{a}	4.0	
	Consumptive	15	0.44^{ab}	0.15		11	0.63^{bc}	0.11		11	49.8^{b}	1.5	
	Non-trophy challenge-seeking	40	0.23^{c}	0.04		38	0.65^{b}	0.05		36	56.1^{ab}	0.9	
Cod	Nature-oriented	42	1.03^{b}	0.1	8.94*	40	0.95^{a}	0.09	3.28*	39	58.1^{b}	1.1	6.55*
	Trophy-seeking	24	2.12^{a}	0.31		22	0.77^{ab}	0.03		22	63.4^{a}	1.4	
	Social	28	1.00^{b}	0.1		25	0.75^{ab}	0.03		24	53.7^{b}	1.4	
	Consumptive	21	1.09^{b}	0.11		18	0.89^{ab}	0.02		17	59.8^{ab}	1.4	
	Non-trophy challenge-seeking	40	1.08^{b}	0.09		38	0.74^{b}	0.03		38	56.5^{b}	1.2	
Flat fish	Nature-oriented	26	0.28^{bc}	1.41	8.93*	24	0.7	0.02	0.58	23	38.6	1.3	2.03*
	Trophy-seeking	16	0.87^{a}	1.84		15	0.67	0.02		15	35.7	0.8	
	Social	14	0.10^{c}	1.25		12	0.76	0.01		11	35.7	0.9	
	Consumptive	15	0.59^{a}	1.93		14	0.92	0.02		14	34.1	0.9	
	Non-trophy challenge-seeking	20	0.27^{bc}	1.73		17	0.94	0.01		17	33.5	0.5	
Herring	Nature-oriented	29	9.44^{b}	0.08	4.68*	29	0.96	0.08	1.94	29	26.8	2.1	1.28
	Trophy-seeking	23	14.26^{ab}	0.24		23	1.00	0.09		23	28.6	2.1	
	Social	23	7.40^{b}	0.03		23	0.99	0.12		23	28.3	2.3	
	Consumptive	18	14.89^{ab}	0.11		18	1.00	0.04		18	28.8	0.8	
	Non-trophy challenge-seeking	43	16.45^{a}	0.05		43	0.99	0.28		43	26.8	1.0	

Notes: ** indicates significant differences at $P<0.05$; superscript letters denote homogeneous subsets ($P<0.05$) based on appropriate post-hoc tests: Tuckey for homogenous variances and Dunnett T3 where variance is heterogeneous.

11 On the following 5 point scale, please indicate the importance of each of the listed reasons for you to go fishing in M-V.

I go fishing in M-V, ...	Not at all important				Very important
A. to catch trophy fish	☐	☐	☐	☐	☐
B. to master angling-related challenges	☐	☐	☐	☐	☐
C. to experience nature	☐	☐	☐	☐	☐
D. to catch as many fish as possible	☐	☐	☐	☐	☐
E. to generate a supply of fish in the freezer for non-angling times	☐	☐	☐	☐	☐
F . to enjoy solitude	☐	☐	☐	☐	☐
G. to experience a challenging fight	☐	☐	☐	☐	☐
H. to be with friends/family	☐	☐	☐	☐	☐
I. to catch a fresh fish for a meal with friends/family	☐	☐	☐	☐	☐
J. to outwit difficult-to-catch fish using a sophisticated technique	☐	☐	☐	☐	☐

The following table provides information on your fishing trips (target species and location), which were recorded in your diary.

12 **What is the MOST important motive for this type of trip (target species and location)?** | **What is the LEAST important motive for this type of trip (target species and location)?**

Please select ONE item from the list in question 11 as the most important motive and another as the least important motive, and enter the letters of these items in the space provided.

	Most important motive	Least important motive
1. Pike - Baltic Sea (Rostock)		
2. Pike - Lake Müritz (Waren)		
3. Pike - Lake Kummerower (Kummerow)		
4. Perch - Lake Müritz (Waren)		
5. Perch - Lake Kummerower (Kummerow)		
6. Cod - Baltic Sea (Rostock)		
7. Not applicable		
8. Not applicable		
9. Not applicable		

Figure 2.1: Motivation questions showing the ten-item classical rating task and the personalized trip descriptions used to elicit context-specific motives (translated from German).

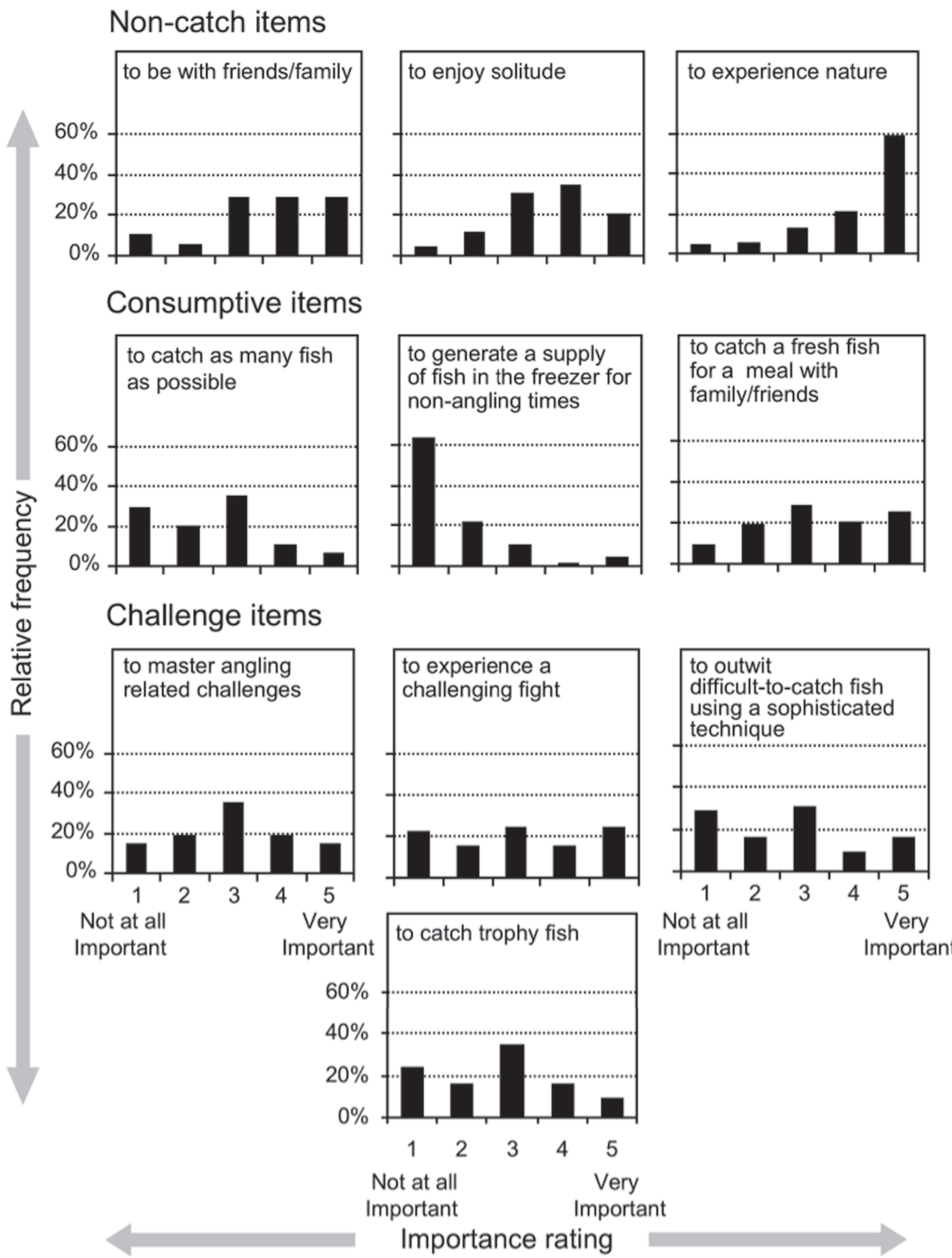

Figure 2.2: Frequency distribution of importance ratings for angling motivation items elicited from anglers in Mecklenburg-Vorpommern, Germany.

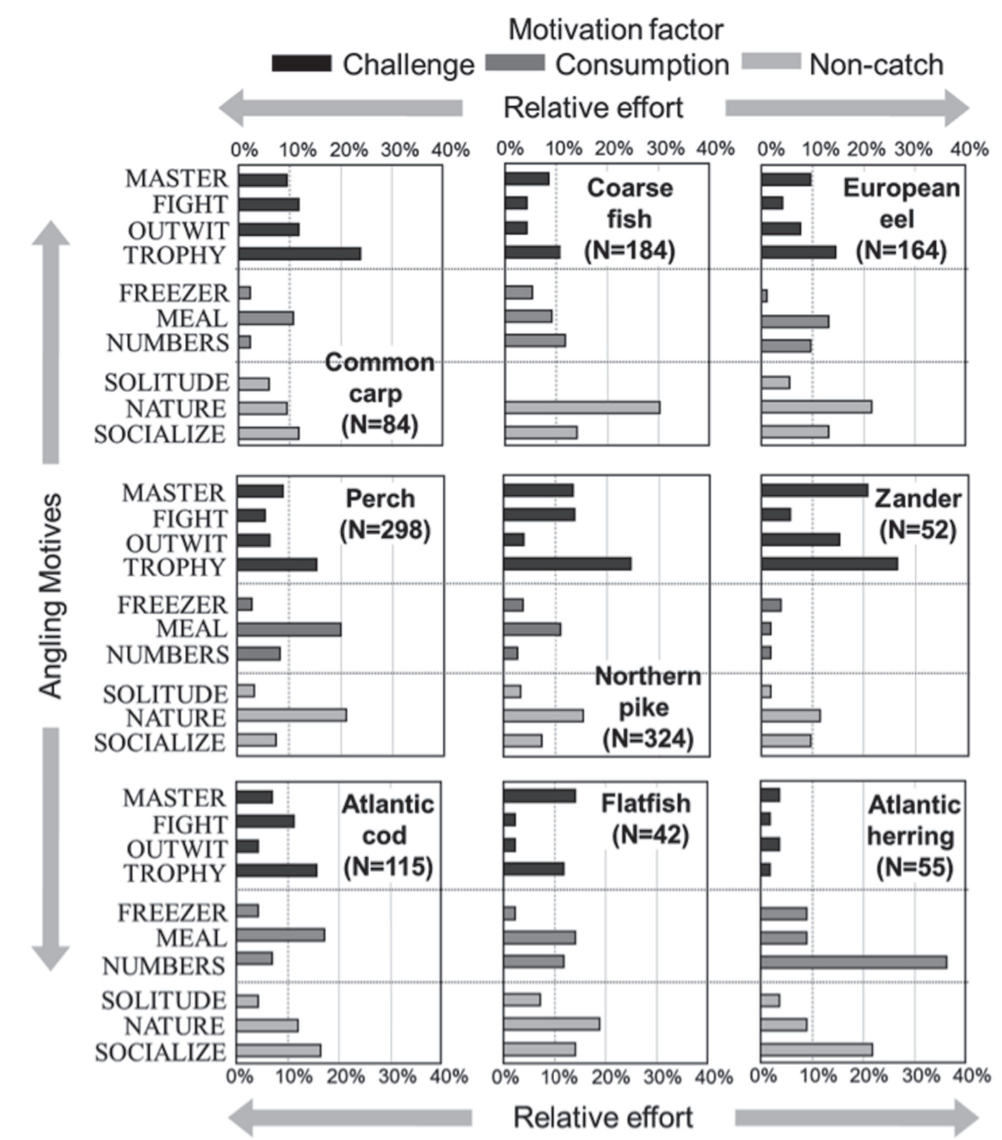

Figure 2.3: Relative effort associated with each most-important motive for targeting each of nine species or species groups by anglers in Mecklenburg-Vorpommern, Germany. The dashed line at 10% indicates the expected frequency if all motivations were chosen equally.

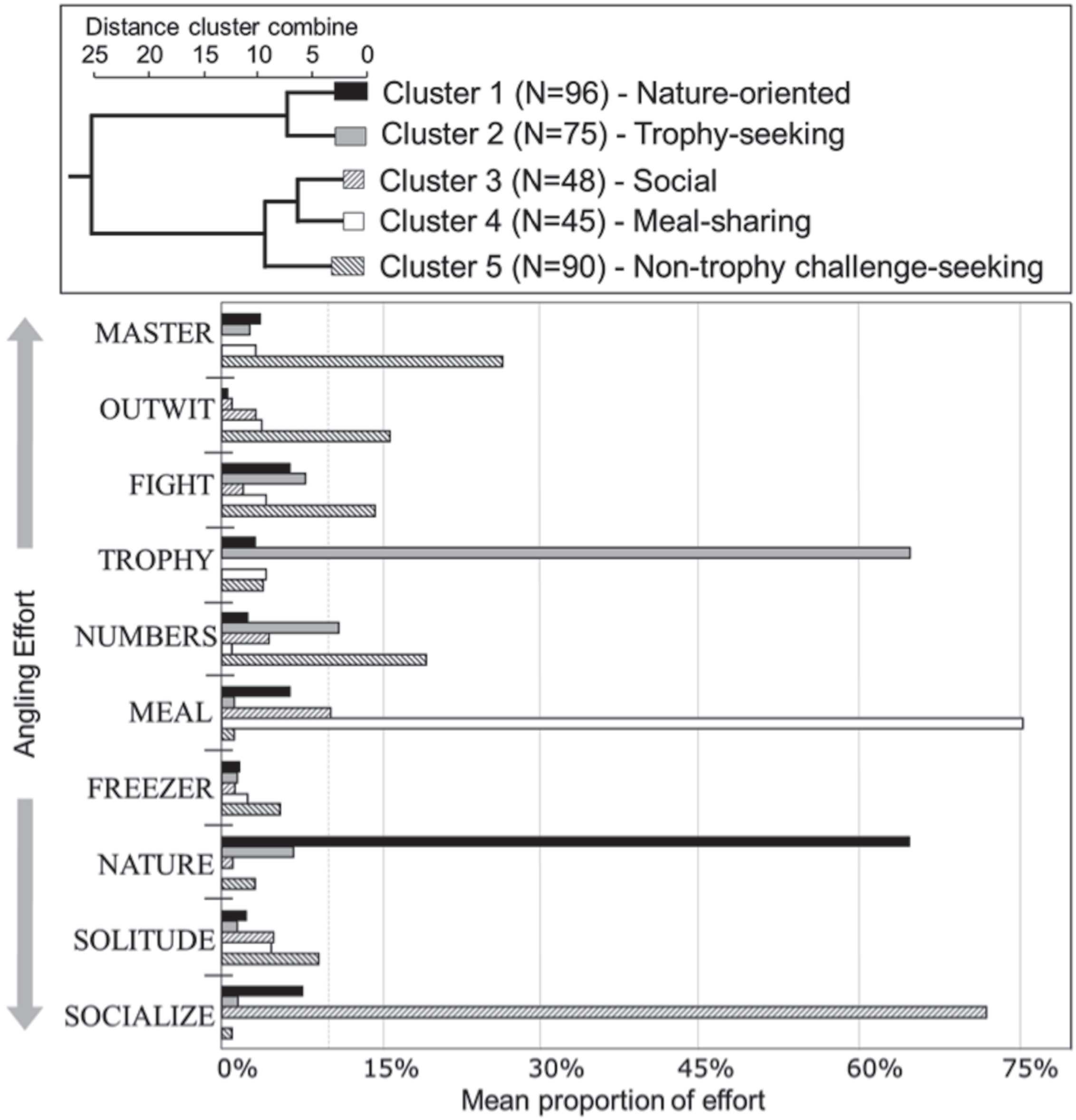

Figure 2.4: Hierarchical clusters based on similarity of most-important motives, and the proportion of effort attributed to each most-important motive by cluster. Note: the scale on the dendrogram indicates the distance separating each bifurcation in the cluster analysis, and the width of the cluster boxes illustrates the variation within each cluster.

Chapter 3. Evaluating the Ability of Specialization Indicators to Explain Fishing Preferences

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Abstract

Understanding the predictive capacity of recreation specialization to explain behavior is important for wildlife and fisheries management given the widespread use of specialization to capture diversity among outdoor recreationists. Using allocation of days among fishing opportunities in a discrete choice experiment, we studied the extent to which specialization predicted preferences for attributes describing the opportunities. Latent class modeling revealed that three groups of anglers optimally captured preference diversity in our sample. To this base model, we sequentially added eleven metrics of angler specialization and used information theory to select the metric that best predicted group membership, namely centrality-to-lifestyle. Weaker evidence existed for the specialization dimensions “importance of catch”, “specialized gear use”, and a multi-dimensional self-classification approach, while indices of skill, media use, trophy fish and harvest orientation were not supported. Thus, general specialization constructs like centrality-to-lifestyle might be best suited to predict general fishing preferences and subsequent behaviors of anglers.

Keywords: discrete choice; information theory; recreational fishing; specialization; preference heterogeneity

3.1. Introduction

Recreation specialization (Bryan, 1977) is an important research framework for understanding diversity in outdoor recreation behavior. Bryan (1977) observed "a continuum of behavior from the general to the particular, reflected by equipment and skills used in the sport and activity setting preferences" (p. 175) in American trout anglers, concluding that recreationists may be grouped into angler types that share specific values, beliefs, attitudes and behaviors. However, despite decades of research, operationalizing the multi-dimensional specialization construct has eluded consensus (Scott & Shafer, 2001). Generally, research has relied on three key dimensions of specialization (Scott & Shafer, 2001). One is affective psychological commitment, such as centrality to lifestyle (Kim, Scott, & Crompton, 1997). A second dimension is cognitive development, including acquiring skills or knowledge (Salz & Loomis, 2005). A third dimension is behavioral involvement, as revealed by frequency of angling participation (Ditton, Loomis, & Choi, 1992). Psychological and behavioral metrics of involvement and commitment (Buchanan, 1985), and in particular the centrality-to-lifestyle construct (Kim et al., 1997), are perhaps the most widely used specialization constructs in outdoor recreation sciences (e.g., Donnelly, Vaske, & Graefe, 1986; Dorow, Beardmore, Haider, & Arlinghaus,2010), possibly because they can be applied across various leisure activities, hence constituting "activity-general" metrics of specialization.

For consumptive leisure activities, such as recreational fishing, researchers have developed a range of more "activity-specific" indicators or correlates of specialization that may explain specific preferences of anglers (Carlin, Schroeder, & Fulton, 2012). Some of these indicators relate to catch orientation, originally called consumptive orientation (Graefe, 1980), and includes the importance of (a) catching "something," (b) catching many fish, (c) catching a large trophy fish, and (d) keeping fish (Anderson, Ditton, & Hunt, 2007). In many angler populations, all four dimensions of catch orientation correlate with commitment and centrality. Bryan (1977), for example, observed greater importance placed on trophy fish among more specialized trout anglers. More committed anglers have tended to be less consumptive than less committed anglers (Arlinghaus, 2007; Oh & Ditton, 2006). However, such relationships have not always held (Dorow et al., 2010; Salz & Loomis, 2005). Thus, while angler specialization provides a sound basis for understanding the diversity in fishing behaviors, there is much to learn from testing how well activity-general and activity-specific specialization indicators explain human dimensions issues, such as angler preferences for particular fishing opportunities. Only a few studies have linked specialization and choice of fishing opportunity (Carlin et al., 2012; Dorow et al., 2010; Oh et al., 2006). By better understanding the associations among specialization metrics and angler preferences and behaviors, one might potentially use specialization to predict their behavior without directly studying it.

To advance the field in this direction, improving operationalization of specialization is necessary. One approach to measure specialization has relied on metrics of several sub-dimensions that are combined into a single composite index (e.g., Chipman & Helfrich, 1988; Fisher, 1997). One limitation of this approach is the burden that it places on respondents having to answer multiple questions/items (Needham, Sprouse, & Grimm, 2009). To alleviate this burden, many researchers have substituted a single salient sub-dimension (e.g., centrality-to-lifestyle, Dorow et al., 2010), or even a single metric (e.g., years of experience, Ditton et al., 1992), as a proxy for the larger specialization construct; however, this alternative approach does not capture the multidimensionality of the specialization construct. More recently, a narrative, self-classification approach has been developed that combines multiple sub-dimensions in three or four narratives describing specialization categories, allowing respondents to select one that best defines their style of participation(e.g., Needham et al., 2009; Scott, Ditton, Stoll, & Lee, 2005). To some extent, self-classification solves the problem of respondent burden, while capturing the multidimensionality of the specialization construct. However, both self-classification and reliance on a single sub-dimension inherently assume co-variance among various specialization dimensions and personal traits (Needham et al., 2009). Little research has evaluated the relationship between specialization and preferences (see Carlin et al., 2012; Dorow et al., 2010; Oh et al., 2006), and no research has systematically evaluated both quantitative and self-classification approaches to assess how well individual specialization indicators explain variation in angler preferences for catch and non-catch attributes of fishing opportunities. Following Bryan (1977), we expected clear relationships between specialization metrics and preferences for trip characteristics.

Our objective was to systematically test the ability of several metrics of specialization to predict variance in intended fishing behaviors among anglers in a regional fishery in Germany, from their preferences for attributes describing available fishing opportunities (e.g., travel distance, expected catch). When framed in this context, preferences may be viewed as evaluative judgments in the sense of liking or disliking one object (e.g., fishing opportunity) relative to another (Scherer, 2005). Following the economic tradition of inferring preferences from behavior, we used a choice experiment (CE) to elicit intended (or stated) behavior from respondents. This approach produces scalar estimates for activity-setting preferences of each aspect (i.e., ecological, regulatory and social environments) of a fishing opportunity, by decomposing their influence on fishing opportunity selection. We then examined the degree to which various specialization dimensions were related to angler preferences for catch and regulatory attributes that differentiate fishing opportunities. While previous angler preference models have found that preferences vary with centrality-of–lifestyle among species-specific angler groups (Dorow et al., 2010; Oh & Ditton, 2006), and that importance placed on harvesting fish is predictably related to preferences for angling regulations (Carlin et al., 2012) no research, so far, has presented an evaluation of the relative performance of multiple metrics of specialization (composite indices, single items, or self-classification) in predicting intention to fish.

3.2. Methods

The population of interest was anglers fishing in the German state of Mecklenburg-Vorpommern (M-V). This northeastern-most state borders the Baltic sea and offers anglers diverse freshwater and marine fishing opportunities. Respondents were drawn from a random sample of M-V fishing license holders as described in detail in Dorow & Arlinghaus (2011). In total, 1121 anglers began a one-year angling trip diary program that asked for trip-level information including target species, catch, harvest, and location (Dorow & Arlinghaus, 2011). Throughout the year, quarterly telephone interviews with all anglers in the sample were conducted to keep participants motivated in the study, to collect supplemental information on specialization[3], and to clarify any emerging concerns or questions. To the 617 (response rate: 58%) diary respondents, a follow-up survey was mailed in October 2008 with a reminder postcard and replacement survey subsequently sent to non-respondents. The questionnaire contained a CE and questions designed to measure various specialization indicators. After accounting for item non-response across all specialization metrics, the final sample size for this study was 398 (65 % of anglers who received the CE survey; 36 % of anglers who began the study two years prior).

3.2.1. Operationalizing Specialization

Eleven indicators of specialization were developed from responses of the 398 anglers (**Table 3.1**). Activity-general indicators included behavioral commitment, centrality-to-lifestyle, and media use. Behavioral commitment consisted of a reliable composite index (Cronbach's $\alpha = 0.73$) related to metrics of fishing participation, intensity, duration, and financial investment. Centrality-to-lifestyle was measured using a five-point agreement scale adapted from Kim et al. (1997). Principal component analysis (PCA) on the responses to this seven-item scale yielded a single reliable factor ($\alpha = 0.81$) containing all items. Media use, including metrics of book, magazine and website use (Chipman & Helfrich, 1988; Ditton et al., 1992) did not reliably combine with the general scale to measure centrality. However, the four items of media use were combined into a separate indicator of media use ($\alpha = 0.63$).

Activity-specific indicators of specialization (**Table 3.1**) included skill and fishing knowledge of anglers from self-reported perceived skill relative to other anglers, relative catch per unit effort (CUE, weighted by proportion of days devoted to each species as revealed from diary entries), and a composite of specialized gear use for fishing adapted from McGurrin (1988). Catch orientation was measured with a mix of rating scales as attitudes towards the catch and consumptive aspects of fishing (adapted from Anderson

[3] Appendix E, p304.

et al., 2007; Graefe, 1980). Harvest orientation was also measured using motives for harvesting fish per trip (Beardmore et al., 2011), and actual harvest rates reported in the diary. Confirmatory factor analysis of the scale of catch and consumptive orientation yielded two separate indices. The first metric measured the overall importance ascribed by anglers to the process of catching fish ($\alpha = 0.70$), while the second, less reliable index focused on the importance attached to catching large fish or trophies ($\alpha = 0.59$). To measure harvest orientation, three separate metrics emerged in our data. The first included three items from a fishing motivation scale (see Beardmore et al., 2011) related to harvest aspects of the experience ($\alpha = 0.62$), while the second and third metrics contained a single item from the catch orientation scale, "release most of the fish that I catch," and mean harvest rates (standardized for each species) reported in the diary.

The last metric of specialization involved a composite self-classification question that was presented to anglers only during the final follow-up mail survey approximately one year after the last telephone interview. Starting from Ditton et al.'s (1992) social world approach that proposed four levels of specialization ranging from "strangers" to "insiders," narratives incorporating multiple dimensions of specialization were developed for four archetypes: the "casual," "active," "advanced," and "committed" angler. Each narrative included statements related to centrality-to-lifestyle, behavioral commitment, skill, catch orientation, media and specialized gear use (**Figure 3.1**). Respondents simply chose the single narrative that best described them. In all, 74 individuals (18.7%) identified themselves as casual anglers, while 212 (53.4%) described themselves as active. As only 10 individuals (2.5%) self-classified as committed anglers, this group was combined with the 82 (20.5%) advanced anglers for further analysis. Such self-classification approaches are gaining prominence in the literature, because they reduce the burden on respondents of answering several long scales, but the relationship of this index with intended fishing behavior is, so far, unknown.

3.2.2. Modeling Intended Behavior

The purpose of the CE was to understand the supply factors relevant for selecting a fishing opportunity. In this method, respondents jointly evaluate salient attributes, and preferences for these attributes and attribute levels are derived from a statistical model. Here, the alternatives of the CE described hypothetical angling opportunities for M-V (**Figure 3.2**). Each opportunity was described by several attributes including trip outcomes (catch: main target species; expected number of fish caught; their average size and the size of the largest; social: number of other anglers seen while fishing as a measure of crowding), harvest regulations (minimum-size limit; daily bag limit) and cost (license fees to fish within the state of M-V; one-way travel distance). An additional attribute simulated the availability of stock assessment data to inform anglers about the biological sustainability of fishing at that location. All attributes were specified at four levels except license fee (eight levels) and were systematically varied in an orthogonal fractional factorial design of 128 choice sets (each containing three fishing experiences) while still allowing estimates of the main effects (Raktoe, Hedayat, & Federer, 1981). In each choice set, respondents were asked to allocate 10 hypothetical angling days among six angling alternatives: three angling opportunities as described above and three base alternatives: (a) fishing elsewhere in M-V for another species, (b) fishing outside M-V, and (c) not fishing. To reduce the burden on each respondent, an additional orthogonal variable grouped the choice sets into 16 blocks each consisting of eight choice sets. One block was randomly assigned to each respondent.

Given the diverse fishing opportunities in M-V and the general nature of our angler sample (i.e., any type of recreational angler), we tailored the available species to each individual respondent from personal diary information, and based all trip outcome and regulatory attributes around species-specific distributions from trips recorded in the diary (**Table 3.2**). We confined the survey to the eight species and two species groups that were targeted by anglers on over 96 percent of their recorded trips (Table 3.3). For each species, we calculated means and standard deviations for catch characteristics and number of anglers seen while fishing from all diary respondents (Table 3.3), and thus defined realistic attribute levels for the CE based on these statistics (**Table 3.2**). Similarly, we developed standardized levels for regulatory attributes (minimum-size limits and daily bag limits) from current or historic regulations applied to each species in the study area. Each choice set contained personalized fishing opportunities of each angler's top three targeted species, with associated travel distances based on their personal average travel characteristics. Two attributes required no tailoring to individual respondents, namely license costs and stock status levels. All final attribute levels were determined following extensive pretesting with anglers from local angling clubs in M-V to ensure saliency and behavioral relevance.

3.2.3. *Analysis of the Choice Experiment*

The CE data were analyzed with a latent class choice model (Swait, 1994). The model is consistent with Random Utility Theory (McFadden, 1974), which suggests that people seek to maximize their well-being (utility) when choosing one alternative, such as a fishing opportunity, over another. Following a long tradition in economics (Lancaster, 1966), we assumed that respondents' well-being arises from linear combinations of the attributes defining an alternative and the associated preferences for these attributes. The latent class choice model estimates angler membership in different groups (classes) and the preferences of each group for the attributes and associated levels that describe a fishing site. Unlike methods relying on *a priori* grouping of respondents into distinct segments (e.g., Dorow et al., 2010), latent class models statistically determine classes to maximize differences in their preferences. Following Swait (1994), we assumed that class membership probabilities and site selection followed conditional logit models of the form:

$$P_{ni} = \frac{e^{\alpha_{nl} + \sum_{c=1}^{C}(\beta_{nlc} * z_{nlc})}}{\sum_{l=1}^{L}\left(e^{\alpha_{nl} + \sum_{c=1}^{C}(\beta_{nlc} * z_{nlc})}\right)} * \frac{e^{\alpha_{ni} + \sum_{a=1}^{A}(\beta_{nia} * z_{nia})}}{\sum_{i=1}^{J}\left(e^{\alpha_{ni} + \sum_{a=1}^{A}(\beta_{nia} * z_{nia})}\right)} \qquad (3\text{-}1),$$

where the probability of individual (*n*) choosing alternative *i* from *J* total alternatives depends on the product of two logistic functions. The first function governs the probability that the individual belongs to class *l* (of *L* classes) as a function of a constant (α_{nl}) and parameter coefficients (β_{nlq}) of *C* angler characteristics (x_{nlc}). In our case, these characteristics were defined by our specialization metrics. The second logistic component of the model governs the probability that members from a class *l* will select an alternative. This selection is influenced by the class' preferences for attributes defined by an alternative specific constant (α_{ni}) and parameter coefficients (β_{nia}) along with the attributes and level of attributes (z_{nia} e.g., catch, management regulations). Latent class parameter functions were estimated using maximum likelihood estimation in Latent Gold Choice 4.5 (Vermunt & Magidson, 2005).

To indicate their fishing preferences, respondents allocated ten fishing days among the alternatives in each choice set (**Figure 3.2**). Each alternative (i.e., fishing opportunity) was then treated as an observation, whose replication weight was equal to the frequency of being chosen (Vermunt & Magidson, 2005). We coded all numeric attributes as linear effects while categorical attributes were effects coded (i.e., the average effect of an attribute was set to zero).

3.2.4. Model Selection

The relationship between each of the eleven specialization indicators and the latent classes was explored in separate predictive models, in which the specialization indicators were treated as covariates to predict class membership. Selection of the best-fit model was conducted using an information-theoretic approach (Burnham & Anderson, 1998), which, given a dataset and suite of competing models, formally examines the relative loss of information associated with each model as measured by the Akaike Information Criterion (AIC; Akaike, 1974). The best model is the one that loses the least information. Because this approach jointly tests evidence among a set of competing models, proponents of this approach consider statistical tests associated with null hypothesis testing to be irrelevant (Burnham & Anderson, 1998).

Given our relatively small sample and large number of estimated parameters, we use the related criterion of AIC_C (Hurvich & Tsai, 1989):

$$AIC_C = -2LL + 2K(\frac{N}{N-K-1}) \qquad \text{(3-2),}$$

where N is sample size, LL is the log likelihood, and K is the number of estimated parameters. The model with the minimum AIC_C has greatest support (Burnham &Anderson, 1998). One usually reports the AIC_C along with the difference between the AIC_C for a model and the minimum AIC_C (Δ) and the probability (Akaike weights, w) that any given model in the set of *J* models is best, as follows:

$$w_i = \frac{e^{-\frac{1}{2}\Delta_i}}{\sum_{j=1}^{J} e^{-\frac{1}{2}\Delta_j}} \tag{3-3.}$$

To limit the number of models under consideration, we used a two-stage approach for model selection. First, we used information theory to determine the appropriate number of latent classes to use for subsequent analyses[4]. Second, we estimated separate models to test each of the eleven specialization measures' ability to predict class membership, and thus, diverse angler preferences. These eleven models were pooled for evaluation with the base model containing the same number of latent classes, but no predictors of class membership. To supplement these analyses, socio-demographic characteristics (age, income, education, gender, and average distance traveled to go fishing) of the latent classes were compared using analysis of variance (ANOVA) and χ^2 tests.

3.3. Results

The first stage of analysis involved selecting the optimal number of latent classes needed to capture diverse preferences observed in our data. Overwhelming support (w ≈ 100 %) emerged for the three-class model over the other models given our data (**Table 3.4**). Given this three-class model, the second stage examined the explanatory power of each of the eleven specialization metrics to predict respondent membership in the three classes. Each metric was included separately in models that were evaluated alongside the three-class model with no specialization measure. The centrality-to-lifestyle model (w = 77%, **Table 3.5, Figure 3.3**) emerged as the best model given our data. Only three other models (self-classed specialization, catch-importance orientation, and specialized

[4] For brevity, **Table 3.4** presents models specifying only one to five classes, as these were sufficient to establish the best-fit model; however models including up to 20 classes, consuming all available degrees of freedom, were assessed.

gear use) had more support than the model with no metric of specialization. The models using metrics of perceived skill, actual skill (effort weighted CPE), media use, consumptive motivations, trophy and harvest orientations, harvest rate and behavioral commitment performed worse than the model without specialization, indicating that these metrics contributed to information loss.

Class 1 comprised 58 percent of the sample, with membership probabilities increasing with centrality-to-lifestyle and importance of catch, and decreasing with specialized gear use. Probability of membership in this group was also higher when anglers self-classified themselves as advanced or committed (**Figure 3.3**). Class 2 accounted for 33 percent of the sample, with probability of membership decreasing as centrality-to-lifestyle and catch importance-orientation increased. Individuals reporting more frequent use of specialized gear and/or self-classifying as either active or casual, were also more likely to be members of Class 2. Class 3 only contained 9% of the sample. Membership in this class was largely independent of centrality-to-lifestyle, catch-importance orientation, or specialized gear use. However, Class 3 members were more likely to self-classify as advanced or committed anglers than were others.

The three latent classes differed in the magnitudes of many of their preference coefficients for attributes that describe M-V fishing site experiences (**Table 3.6**). Class 1 anglers clearly preferred the fishing alternatives within the state of M-V, and demonstrated the lowest sensitivity to license costs for fishing within the state, indicating they were most committed to fishing in M-V. These anglers were also characterized by a moderately high willingness to travel, which is an indication of a high value placed on fishing within M-V. Members of Class 1 attributed the least importance to the average size (expected length) of fish caught, with comparatively more importance placed on the maximum size of caught fish. They also showed the most tolerance for seeing other anglers on the water (i.e., crowding). Class 1 was also only moderately responsive to changes in stock status, falling between Classes 2 and 3.

Class 2 anglers were characterized by the lowest centrality, and preferred the base alternative of “not fishing” over “fishing,” indicating less overall interest in the activity. They were also highly sensitive to both license fees and travel distance, and showed the least preference for a particular target species. For this class, the number of fish caught was more important, while the size of the largest fish was less important than these attributes were to the other classes. Class 2 anglers were most averse to the bag limit of one fish, and exhibited the strongest preference of all angler classes for sites reporting good stock status.

Class 3 anglers preferred to fish outside M-V. Like Class 2 anglers, Class 3 anglers were less willing to pay high license fees, but were willing to travel farther to access more distant sites within the study area. They were most influenced in their site choices by strong preferences for a single target species. Of all the latent classes, this angler type placed the least importance on the number of fish caught, and the most importance on the average size of fish caught. Class 3 anglers were also most sensitive to crowding, but were least sensitive to information about overfishing.

These results suggest that Class 2 anglers are least specialized. The other two classes may are more specialized, depending on the metric by which they are classified. Class 1 is characterized by high centrality-to-lifestyle, while Class 3 represents a multidimensional specialization group as captured by the self-classification metric.

3.4. Discussion

We modeled intended behavior as revealed by fishing days allocated among fishing opportunities in a discrete choice experiment to evaluate the ability of several specialization metrics to explain differences in preferences within our sample of German anglers. Consequently, we tested the internal consistency of the relationship between various dimensions of specialization behavioral intention. Diverse fishing preferences in our sample were mainly driven by varying preferences for general attributes of fishing, such as cost, and travel with much less diverse preferences among classes for catch or management attributes of the fishing experience. Not surprisingly, activity-general measures of angler specialization, in particular centrality-to-lifestyle, rather than activity-specific measures such as trophy fish orientation, best captured the variation in fishing preferences from the latent class models. This finding agrees with the principle of “object specificity” (Smith & Swinyard, 1983) as an activity-general specialization metric best explained variation in general fishing preferences.

Among the eleven metrics of specialization, centrality-to-lifestyle (Kim et al., 1997) was especially suitable to predict anglers' preferences for available fishing opportunities in the context of a regional, multi-species fishery. This result supports previous studies that used centrality-to-lifestyle for *a priori* segmentation of recreational fishers (Dorow et al., 2010; Oh & Ditton, 2006). In our study, centrality-to-lifestyle distinguished among individuals differing in their willingness to pay license fees and travel, confirming that high-centrality anglers derive greater well-being from the fishing experience than do low-centrality anglers (Ditton & Sutton, 2004; Dorow et al., 2010; Oh, Ditton, Anderson, Scott, & Stoll, 2005). Although centrality-to-lifestyle has been linked to diverse preferences for costs, catch expectations, and management preferences (Dorow et al., 2010; Oh & Ditton, 2006; Oh et al., 2005), our study corroborates these findings within a novel statistical framework. Accordingly, Class 1 anglers were more likely to exhibit higher scores for centrality-to-lifestyle, and consistent with Oh et al. (2005), these anglers also showed higher acceptance of license fees, despite no discernible difference in mean household income. Conversely, Class 2 anglers had lower centrality-to-lifestyle scores, consistent with tendencies to choose the non-fishing alternative and low willingness to pay or travel to fish, indicating less attachment to fishing and fewer benefits derived from fishing relative to other leisure activities. Finally, Class 3 anglers' stronger preference for fishing outside the study area and for alternatives presenting highly preferred target species indicated that this group may exhibit the highest species-related resource dependency and be most species-specialist in the spirit of Bryan (1977).

Three additional metrics of specialization also improved predictions of latent class membership relative to the inclusion of no metric, although to a much lesser extent than centrality-to-lifestyle. Of these three, the lower performance of the narrative self-classification approach compared to centrality-to-lifestyle is worth discussing because the narrative included explicit statements about involvement and centrality-to-lifestyle. The various narratives, however, also contained several activity-specific dimensions of specialization whose models did not rank well, and when combined in a single self-classification statement, may have diluted the effect of the single, most important sub-dimension (i.e., centrality-to-lifestyle). This result suggests a possible weakness of the self-classification approach, as its performance is limited by the degree to which the included sub-dimensions co-vary within each specialization level. Lack of covariance among activity-general (e.g., centrality) and activity-specific (e.g., trophy fish orientation) measures of specialization can be expected to reduce the value of narrative specialization constructs to predict attitudes, preferences and behaviors of recreationists. Moreover, although the ease of assessment in surveys is a major advantage, self-classification reduces variance by forcing a few groups rather than allowing a researcher to treat specialization as a scalar variable in statistical models. Despite these limitations, the use of self-classification methods is becoming more popular (e.g., Kerins, Scott, & Shafer, 2011; Scott et al., 2005). Therefore, further work is warranted to determine the range of behaviors and preferences for which a narrative self-classification approach provides salient information, and to determine the key dimensions of specialization necessary for inclusion in the narrative description to maximize predictive capabilities given a particular context.

The other two models that outperformed the one excluding a metric of specialization used catch orientation and gear use covariates to explain membership of anglers to classes. Both specialized gear-use and catch importance are activity-specific components of angler specialization (Fisher, 1997), but they were operationalized here to be independent of the angler's target fish species. Therefore, they retained some level of generality that may explain their ability to predict class membership in our generic choice. Specifically, members of the more specialized Class 1 placed more importance on catching "something". Qualities of catch desired by anglers shifted slightly from high catch rates among less specialized anglers (Class 2) to size and challenge aspects for more specialized anglers in Classes 1 and 3. These patterns corroborate earlier specialization research (Beardmore et al., 2011; Bryan, 1977), but not all past research (e.g., Dorow et al. 2010). Therefore, some caution is encouraged before generalizing relationships between attitudes towards catch and general fishing behaviors.

A few apparent inconsistencies with prior propositions of specialization are worth noting that reduce the value of gear use as operationalized here as a metric of specialization. In fact, specialized gear use was positively associated with the least specialized Class 2. This result appears inconsistent with propositions by Bryan (1977) who associated the most specialized trout anglers with use of specific fly fishing gear. In our study, use of specialized gear may simply not reflect the attributes related to participation that differentiated the three latent classes, suggesting that use of specialized gear may not co-vary with psychological commitment as measured by centrality-to-lifestyle. Almost no evidence existed for an association between other activity-specific metrics of specialization (e.g., harvest orientation, trophy orientation) and different fishing preferences here. In some cases, e.g., trophy orientation, low reliability in the index, i.e., Cronbach's $\alpha < 0.6$, suggests that these dimensions were not captured well in our survey, despite reliance on previously validated scales.

Support for the use of centrality-to-lifestyle to differentiate anglers of diverse preferences reflected differences among the latent classes in their willingness-to-pay to participate (as indicated by aversion to license cost and travel distance). Only minor differences among the three classes were found in preferences for catch expectations and harvest regulations. Thus dimensions of catch orientation did not predict class membership. Just as general constructs have limited ability to predict specific behaviors, so too specific constructs are limited when predicting general ones (Smith & Swinyard, 1983). Indeed, unlike other studies (e.g., Dorow et al., 2010; Fisher, 1997), little variance in preferences for management existed, where others have found them to correlate with harvest orientation (at least among Minnesotan, walleye anglers, Carlin et al., 2012). Our approach to include multiple species may have limited the ability of the choice model to capture preference variation among anglers for such specific attributes (Ditton et al., 1992; Fisher, 1997; Oh & Ditton, 2008). Indeed, certain regulatory preferences may only be relevant in a species-specific context (Dorow et al., 2010). As all catch-oriented attributes were tailored to each respondent's most frequently targeted species and presented a range of levels that reflected species-specific catch distributions, variance associated with targeting a specific species was effectively neutralized, and heterogeneity in our preference estimates was reduced to the extent that catch orientation co-varied with species preference. However, standardizing catch attributes also gave us a more generic model of angler behavior. Therefore, our method was ideal for evaluating the relationship of metrics of specialization and intended behavior for fishing in general. However, further research using species-specific case studies to evaluate the relationships between activity-specific measures of specialization and fishing preferences is needed. Such context-specific research is also likely to be more relevant to management.

Angler preferences differed as expected regarding travel and license costs, with more specialized anglers indicating they would travel farther or pay higher fees. However, some preferences that appear inconsistent with previous assertions were also found. For example, specialized anglers are believed to suffer most from diminished resources (Oh & Ditton, 2008). Therefore, *ceteris paribus*, one would expect specialized anglers to strongly prefer opportunities that offer healthy fish stocks. However, the influence of stock status on effort allocation was greatest for our least specialized (committed) Class 2 anglers. By contrast, Class 1 anglers, having greater centrality-to-lifestyle, and Class 3 anglers, who were the most “travel-prone” and species-specialized, were much less responsive to changes in stock status. Many behaviors of specialized anglers reflect the psychological dependency on fishing (Dorow et al., 2010; Salz & Loomis, 2005). For example, while casual anglers may limit effort to help stocks recover (Dorow et al., 2010), committed anglers may alter other behaviors (e.g., catch-and-release). Consequently, one should take care when referring to the “conservation behavior” (Oh & Ditton, 2008) of differently specialized anglers, as the types of behaviors and not just their magnitude may vary with specialization.

Because this study was focused on one state in Germany, we caution readers about generalizing the findings too broadly. While the study incorporated diverse fishing opportunities across ten species in both freshwater and marine systems, this diversity may be largely unique to the study area. Similarly, anglers’ preferences may also reflect the particular institutional and cultural environment of north-eastern Germany. Finally, there is evidence of non-response bias towards more avid anglers (see Beardmore et al., 2011). Hence, the results likely do not accurately reflect the proportions of casual, intermediate and advanced anglers in the entire population. Despite these limitations, the theoretical insights gleaned from the results have general value.

3.5. Conclusions and Implications

For a regional fishery with multiple species, angler behaviors of choosing fishing opportunities appears to be driven primarily by expenses (as expressed in license fees and travel costs), and specialization accounts for some variation in preferences for spatially segregated, diverse fishing opportunities. For general studies of fishing, researchers interested in a reasonably simple measure of specialization that efficiently explains diverse angler behavior may find centrality-to-lifestyle to be an adequate metric. Our results also underscored an important insight from social-psychology: the explanatory power of constructs is related to matching the scale of the constructs (Smith & Swinyard, 1983). That is, general constructs, such as centrality-to-fishing, explain general behavioral intentions, such as acceptability of costs and distance related preferences for site choices, better than specific constructs, such as trophy fish orientation. That said, our research standardized all context dependent attributes, limiting heterogeneity observed in activity-specific attributes of the fishing opportunities. Thus, other metrics of specialization may be better suited to study anglers in specific fishing contexts. Further studies are warranted to develop suitable context-specific specialization metrics and to examine their relationship with catch and regulatory preferences.

Accounting for diverse preferences and behaviors among anglers is a pressing research need not only for fisheries management, but also in modeling the social-ecological dynamics of recreational fisheries at a regional scale (Hunt, Arlinghaus, Lester, & Kushneriuk, 2011; Hunt, Sutton, & Arlinghaus, in press; Post, Persson, Parkinson, & Kooten, 2008). Enhancing the explanatory power and predictive capacity of choice experiments with behavioral theories such as specialization may also enhance our understanding of ecological fishery dynamics through simulation models (Hunt et al., 2011; Johnston, Arlinghaus, & Dieckmann, 2010). For scientists, it can improve understanding fish and angler dynamics by incorporating multivariate preferences to predict angler behavior in such models (Johnston et al., 2010). For managers, it can reduce implementation uncertainty associated with regulatory change by predicting angler behavioral response more accurately (Hunt et al., in press). Because of the species-independent specification of our choice model, it may be used for many regional fisheries where little or no information about angler behavior is known, with the limitation that our model reflects the cultural norms of behavior of Mecklenburg-Vorpommern anglers.

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Tables and Figures

Table 3.1: Composite indices and single item metrics of specialization.

Metric	Component/item	Min	Max	M	SD	α
Activity-general indicators						
Behavioral indicators of commitment	Total fishing trips in M-V during the 12 months preceding the study	1	240	29.9	42.6	0.73[1]
	Total fishing trips taken on an average year	1	200	31.2	36.3	
	Total trips during study period (one year)	1	112	20.8	17.4	
	Proportion freshwater trips during study period	0.0	1.0	0.8	0.3	
	Total cost of licenses and tackle during study (expressed as % household income)	0.1	16.1	0.8	1.4	
	Total value of equipment (excluding boat, in Euro)	52	40,000	1,333.3	2,674.6	
Centrality-to-lifestyle [2]	I would lose a lot of my friends if I stop fishing	1	5	1.91	0.93	0.82
	If I could not fish, I would not know what else to do.	1	5	1.96	0.98	
	Because of my angling passion no time is left for other hobbies.	1	5	2.10	0.99	
	Most of my friends are connected to angling	1	5	2.28	1.12	
	Going fishing is the most enjoyable thing I can do	1	5	2.79	1.09	
	Other leisure activities do not interest me as much as angling	1	5	2.80	1.21	
	Most of my life revolves around angling	1	5	3.08	0.98	
Media use[3]	Angling books	1	5	2.53	1.00	0.63
	Angling magazines	1	5	2.60	1.08	
	Angling DVDs/videos	1	5	2.14	1.15	
	Websites about angling	1	5	1.72	1.00	

Metric	Component/item	Min	Max	M	SD	α
Activity-specific indicators						
Revealed skill (CUE)	Mean species-specific z-score of catch rate (weighted by effort allocated to each species)	-3.26	85.4	1.59	7.10	
Skill perception[1]	How would you judge your angling skills compared to other anglers?	1	4	1.94	0.60	
Catch importance orientation[2]	When I go fishing and nothing happens, I still keep pushing to catch something	1	5	3.49	1.19	0.70
	I go fishing to earn respect from my angling friends through my catches	1	5	2.29	1.10	
	I go fishing because catches satisfy my ambitions.	1	5	2.72	1.16	
	I go fishing because catching fishes is very enjoyable for me	1	5	4.30	0.78	
	I go fishing because every caught fish improves my angling skills	1	5	3.06	1.14	
Trophy size orientation[2]	I prefer angling spots where I have the chance to catch trophy fish	1	5	3.30	1.15	0.59
	The bigger the fish the better the angling day	1	5	3.81	1.13	
	I prefer to catch 1 or 2 big fishes instead of catching 10 smaller ones	1	5	3.81	1.07	
Consumptive motivations[4]	To catch as many fish as possible	1	5	2.55	1.17	0.62
	To obtain fresh fish for a meal with family/friends	1	5	3.38	1.22	
	To generate a supply of fish in the freezer non-angling times	1	5	1.74	1.03	
Voluntary release orientation[2]	I release most of the fish that I catch	1	5	2.93	1.15	
Revealed retention behavior	Mean z-score of species-specific harvest rates	-0.83	7.90	.23	1.01	
Use of specialized gear[3]	High quality angling gear	1	5	2.58	1.18	0.55
	Special angling gear for specific fish species	1	5	2.81	1.28	
	Improving artificial baits	1	5	2.04	1.15	
	Personal angling diary	1	5	1.49	0.95	

Note: Abbreviated table headers: Min – minimum, Max – Maximum, M – mean, SD – standard deviation, α – Cronbach's alpha; [1]based on reliability analysis of the z-scores for each item; [2] Four-point scale as follows: 1 (less than others), 2 (equal to others), 3 (better than others), 4 (much better than others); [3] Five point scale as follows: 1 (Strongly disagree), 2 (somewhat disagree), 3 (neutral), 4 (somewhat agree), 5 (strongly agree); [4] Five point scale as follows: 1 (never), 2 (rarely), 3 (regularly), 4 (often), 5 (very often); [5] Five point scale from 1 (not-at-all important) to 3 (somewhat important) to 5 (very important)

Table 3.2: Standardized attribute levels used in the discrete choice experiment of fishing site selection for German anglers.

Trip costs	Expected outcomes	Fishery regulations and stock status
Annual license costs[1]	**Number caught**	**Minimum-size limit**
10€ ($14USD; 1.25 SD < mean)	0.4SD < species mean	None
25€ ($35 USD; 1.0 SD < mean)	Species mean	Current/Historic
60€ ($84 USD; 0.5 SD < mean)	1SD > species mean	20% larger
95€ ($133 USD; current mean expenditure)	1.5SD > species mean	40% larger
130€ ($182 USD; 0.5 SD > mean)		
165€ ($231USD; 1 SD > mean)	**Maximum expected size**	**Daily bag limit[3]**
235€ ($329USD; 2 SD > mean)	0.5SD < species mean	None
270€ ($378USD; 2.5 SD > mean)	0.5SD > species mean	2 fish more
	2SD > species mean	Current
	3.5SD > species mean	2 fish less
One-way travel distance	**Average expected size[2]**	**Stock status**
Current Personal Mean	1.75SD < maximum size	No Information
Personal mean +20km	1.3SD < maximum size	Stable (no risk of collapse)
Personal mean +40km	0.9SD < maximum size	Lightly overfished (50% chance of collapse in the next 25-50 years)
Personal mean +60km	0.5SD < maximum size	Overfished (50% chance of collapse in the next 2-5 years)
	Number of other anglers seen	
	0.5SD <mean for species	
	Mean number for the target species	
	1SD >mean for species	
	2SD >mean for species	

Note: SD = Standard Deviation of population-level distribution. Expected outcomes levels were based on the species-specific distributions of catches by the entire sample, while travel distance was personalized to each angler individually; [1]US dollar amounts are based on the mean exchange rate in October, 2008 (1€ = $1.40USD); [2] Average expected size was expressed relative to the maximum expected size presented in the profile. Consequently, 4X4=16 possible values were shown for each species; [3] For species with no current bag limit, the 'current' bag limit was set as the current average number caught, which then varied by ± 0.5 SD. Most species have a current daily bag limit of 3 fish.

Table 3.3: Species-specific trip characteristics used to tailor the choice experiment for each survey respondent.

		Marine species				Freshwater species					
		Atlantic cod (*Gadus morhua*)	Atlantic herring (*Clupea harengus*)	Flatfish	Gar (Belone belone)	Common carp (*Cyprinus carpio*)	Coarse fish	Eel (*Anguilla anguilla*)	European Perch (*Perca fluviatilis*)	Northern Pike (*Esox Lucius*)	Zander (*Sander lucioperca*)
Number of anglers	Primary target species	97	26	11	10	54	65	84	130	129	11
	Secondary target species	44	45	26	16	44	83	67	112	147	33
	Tertiary target species	52	43	22	22	41	73	90	115	120	39
	Total Anglers	193	114	59	48	139	221	241	357	396	83
Number of trips	Total Trips	1091	634	575	281	1235	2100	1964	3575	3827	1222
Number of other anglers seen	Mean	12.8	47.7	6.1	29.3	2.7	3.0	3.3	4.5	3.4	4.5
	SD	14.6	63.0	8.3	51.9	4.4	5.0	4.5	6.4	5.3	6.1
Number of fish caught/trip	Mean	6.0	53.5	1.7	10.8	0.8	1.4	1.0	8.4	1.1	1.0
	SD	7.7	76.8	4.0	11.8	1.4	6.9	1.5	12.2	1.5	2.1
	Frequency of trips where at least 1 fish was caught	82%	88%	35%	90%	41%	8%	46%	76%	58%	38%
Percent fish retained	Mean	78.2%	95.4%	72.8%	96.1%	73.3%	65.3%	81.6%	58.6%	66.8%	65.6%
	SD	30.6%	19.2%	35.6%	16.4%	39.3%	40.5%	33.2%	38.7%	41.5%	41.6%
	Number of trips retaining at least 1 fish	834	538	178	251	421	139	819	2196	1731	380
Size of largest retained fish (cm)	Mean	58.8	25.3	33.5	71.1	58.4	24.0	61.7	27.3	66.9	57.3
	SD	13.4	5.2	5.9	12.1	12.3	6.5	10.5	5.9	13.6	10.1

Table 3.4: Selection of latent class preference model.

Classes	Npar	LL	AIC_C	R^2	ΔAIC_C	w
3	56	-4756.2	9643.1	0.15	0.00	100.00%
4	75	-4745.9	9677.2	0.16	34.1	0.00%
5	94	-4729.1	9705.1	0.17	62.1	0.00%
1	18	-5067.3	10172.5	0.04	529.4	0.00%
2	37	-4830.5	9742.9	0.12	99.8	0.00%

Note: All models are based on the same attribute specification, and are limited to anglers without any missing values; $N_{anglers}$=398; $N_{choicesets}$=3007, LL – log likelihood, AIC_C – corrected Akaike Information Criterion, R^2 – McFadden's R^2, ΔAIC_C – Change in AIC_C, w – AIC_C weight.

Table 3.5: Model selection to predict membership in each of three latent classes using specialization indicators as covariates.

Specialization covariate(s)	Npar	LL	AIC_C	ΔAIC_C	w
Centrality-to-lifestyle	58	-4750.1	9636.4	0.0	76.98%
Catch importance orientation	58	-4753.0	9642.2	5.8	4.24%
Self-classification	60	-4750.3	9642.3	5.9	4.03%
Specialized gear use	58	-4753.3	9642.9	6.5	2.98%
Base (no specialization covariate)	56	-4756.2	9643.1	6.6	2.84%
Skill perception	58	-4753.5	9643.1	6.7	2.70%
Media use	58	-4754.1	9644.3	7.9	1.48%
Revealed skill (CPUE)	58	-4754.5	9645.2	8.7	0.99%
Consumptive motivations	58	-4754.5	9645.2	8.8	0.95%
Trophy size orientation	58	-4754.5	9645.3	8.8	0.95%
Behavioral indicators of commitment	58	-4754.8	9645.7	9.3	0.74%
Voluntary release orientation	58	-4754.9	9646.1	9.6	0.63%
Revealed retention behavior	58	-4747.1	9646.6	10.1	0.49%

Note: $N_{anglers}$=398; $N_{choicesets}$=3007, Npar – number of parameters, LL – log likelihood, AIC_C – corrected Akaike Information Criterion, ΔAIC_C – Change in AIC_C, w – AIC_C weight.

Table 3.6: Latent class preference model for fishing intentions of differently specialized German anglers.

Attribute	Type	Unit	Class 1[1] β	Class 1[1] SE β	Class 2[2] β	Class 2[2] SE β	Class 3[3] β	Class 3[3] SE β
Intercept	Nominal	fish in MV	0.79	0.073	-0.194	0.094	-0.578	0.186
		fish outside MV	-0.286	0.092	-1.181	0.131	1.074	0.149
		not fish	-0.504	0.111	1.376	0.086	-0.496	0.18
Cost	Numeric	10 € increment	-0.029	0.01	-0.118	0.01	-0.132	0.023
Distance	Numeric	20km increment	-0.105	0.016	-0.226	0.029	-0.085	0.06
Effort to species	Numeric	percent	0.497	0.171	0.412	0.285	1.365	0.605
Fish number	Numeric	SD from species mean	0.133	0.043	0.156	0.076	0.093	0.164
Average expected length	Numeric	SD from species mean	0.028	0.057	0.181	0.102	0.412	0.229
Maximum expected length	Numeric	SD from species mean	0.114	0.028	0.046	0.049	0.106	0.103
Expected number of anglers seen	Numeric	SD from species mean	-0.072	0.035	-0.104	0.061	-0.132	0.135
Minimum-size limit	Nominal	no limit	0.009	0.057	0.023	0.098	0.007	0.214
		current/historic	0.041	0.057	-0.061	0.101	-0.143	0.225
		20% larger than current	0.015	0.058	-0.005	0.103	0.084	0.21
		40% larger than current	-0.064	0.059	0.043	0.103	0.052	0.217
Daily bag limit	Nominal	no limit	0.028	0.057	0.063	0.104	-0.134	0.231
		2 more / 0.5 SD higher than mean catch	0.057	0.057	0.103	0.098	0.197	0.218
		current bag limit / current mean catch	0.018	0.058	0.037	0.099	0.048	0.208
		2 less / 0.5 SD less than mean catch	-0.102	0.059	-0.203	0.107	-0.111	0.224
Stock status	Nominal	no Information	0.095	0.056	0.064	0.098	0.011	0.222
		good	0.317	0.055	0.391	0.092	0.319	0.192
		lightly overfished	-0.064	0.059	0.007	0.103	-0.089	0.226
		overfished	-0.348	0.062	-0.461	0.117	-0.241	0.249

Note: β– parameter estimate, SEβ– standard error of the estimate; [1] Class size =58.3%; R^2 =0.025; $R^2(0)$= 0.073; [2] Class size =33.1%; R^2 =0.118; $R^2(0)$= 0.252; [3] Class size =8.6%; R^2 =0.091; $R^2(0)$= 0.209.

Part 4: Personal Information

16 **There are many different types of anglers. Which of the four angler descriptions below is most similar to yourself? Please note that not every criterium must be met, but select the description that generally describes you the best.**

(Please choose only one)

☐	Committed Angler	Someone for whom fishing is the central focus of life and whose social life revolves around angling. The committed angler fishes as often as possible, devoting most of his free time to angling related activities. Some characteristics of the ***committed angler*** may include: • Usually selects fishing waters based on their premium fishing quality even if they are distant. • Uses high-quality, species-specific fishing tackle and applies the latest innovations in fishing techniques and equipment: has an impressive collection of specialized fishing tackle. • Always targets a particular species on a given trip and tends to release any fish that are caught. • Typically continues to fish even when the fish do not appear to be biting • Uses many sources of information about fishing and may subscribe to angling magazines devoted to certain species or fishing styles
☐	Advanced Angler	Someone for whom fishing is the most important leisure activity and whose circle of friends includes many anglers. The advanced anglers fishes often, devoting a substantial fraction of his leisure time to fishing. Some characteristics of the ***advanced angler*** may include: • Usually selects fishing waters according to fishing quality and may travel long distances to particularly good waters • Prefers high quality fishing tackle and is aware of the latest innovations in fishing techniques and equipment: may have a considerable amount of fishing equipment, including some specialized equipment to target certain species. • Usually targets a particular species and often releases fish back into the water. • Rarely loses interest even when the fish are not biting. • Uses various information sources and may subscribe to a general angling magazine.
☐	Active Angler	Someone for whom angling is one leisure activity among many, and who occasionally goes fishing with a few friends. The active angler fishes regularly but also invests considerable time in other leisure activities. Some characteristics of an ***active angler*** may include: • Usually selects fishing sites that are relatively easy to access, often close to home. • Prefers common techniques and proven fishing tackle, and has some knowledge of the latest innovations in fishing techniques and equipment; has a moderate amount of fishing equipment, primarily consisting of general-purpose tackle • Often targets a particular species of fish on a given day, and usually takes home any legal fish that are caught. • Occasionally loses interest when the fish do not appear to be biting • May use easily available general angling media and buy the occasional issue of an angling magazine.
☐	Casual Angler	Someone for whom fishing is not an important leisure activity and whose social life does not involve angling. The casual angler fishes only occasionally and spends much of his leisure time pursuing other activities. Some characteristics of a ***casual angler*** may include: • Almost always selects fishing waters based on convenience and easy access. • Prefers common techniques and proven tackle and us not aware of the latest innovations in techniques and equipment; has a small amount of general fishing tackle. • Primarily targets whatever species is biting on a given trip, and harvests all fish that are legal to keep. • Often loses interest when the fish are not biting well. • Very rarely uses information in the public domain about fishing.

Figure 3.1: Specialization self-classification question from the follow up survey.

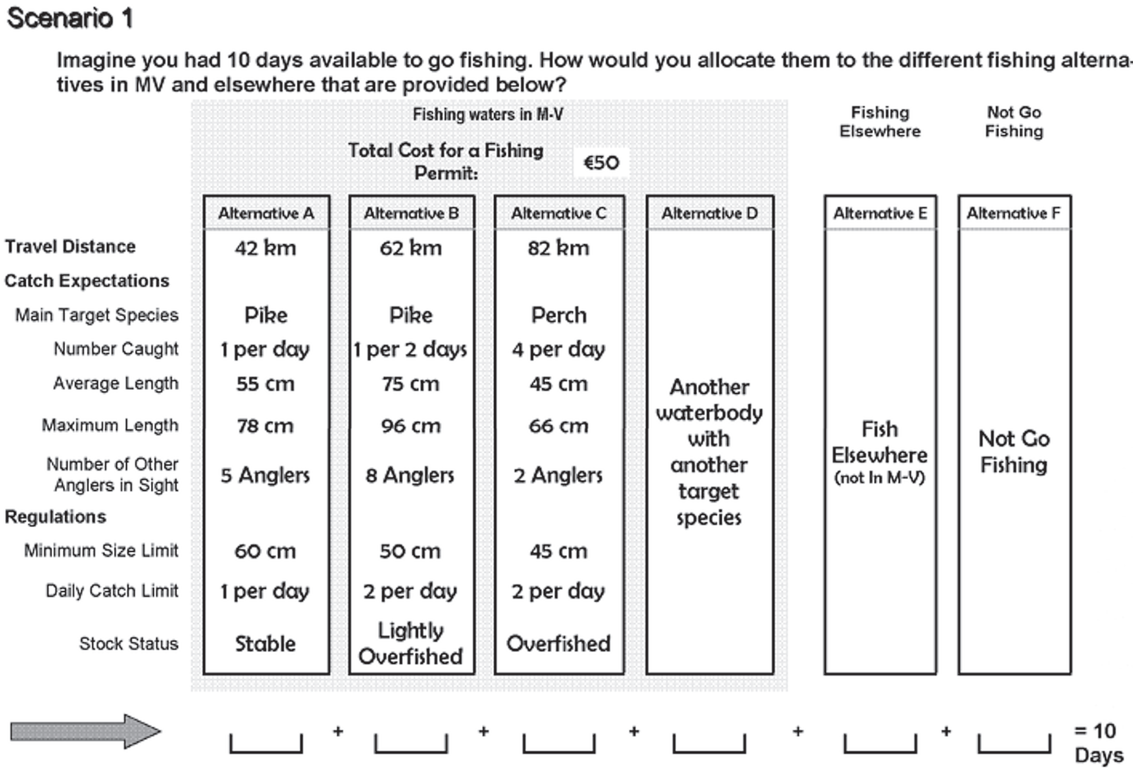

Figure 3.2: Example of a stated preference choice task shown from the follow-up mail survey. Several attributes were tailored to each respondent based on their preferred species and travel habits. Catch attributes were chosen around species-specific averages and standard deviations (see **Table 3.2**).

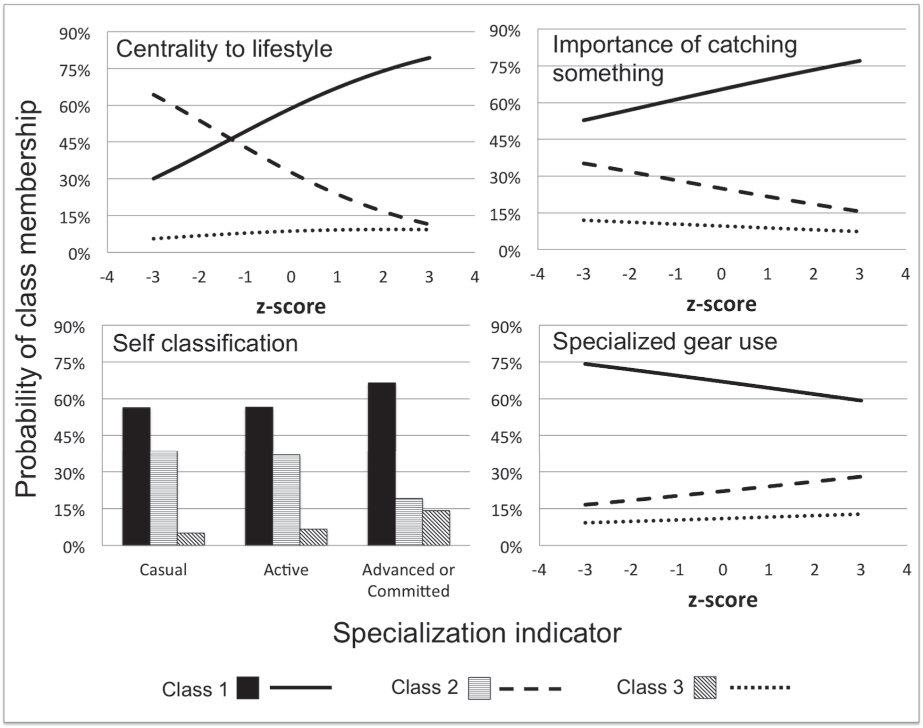

Figure 3.3: Latent class membership predicted by four metrics of specialization.

Chapter 4. The Influence of Angler Specialization on Determinants of Satisfaction with Catch across Six Fish Species

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Abstract

Our study aimed to quantify the influence of various trip characteristics and angler specialization on satisfaction with catch across six diverse and recreationally important freshwater fish species in northern Germany. As expected, across all species and species groups, satisfaction with catch was primarily determined by catch rate and size; however, these relationships varied across species, suggesting their relative contribution to satisfaction is species-dependent. Satisfaction with catch for zander, for example depends more on catch rate, while for European perch, size of largest retained fish appears to be more important. These relationships, however, are also moderated by angler specialization, as measured by centrality to lifestyle. Finally, significant effects from non-catch aspects of the experience, such as the number of other anglers seen, underscored the important role of other factors in influencing either the establishment of expectations or the evaluation of outcomes. For common trip outcomes, trends in the relationships between catch outcomes and satisfaction remained similar across all anglers, suggesting that regardless of species, more fish and larger fish imply happier anglers.

Keywords: recreational fishing; specialization; satisfaction; angler diary

4.1. Introduction

Satisfaction has become an important focus for both outdoor recreation research and management, as it is arguably the ultimate product of recreational experiences (Driver, 1985; Hendee, 1974). Satisfaction is closely related to motivations. While motivations are the underlying forces that act on a tendency to engage in an activity based on its expected outcomes (Atkinson, 1969), satisfaction is the psychological state of fulfillment of expected outcomes from engaging in recreational activities (Holland & Ditton, 1992) and is determined by the differences between expectations and the actual experience (Schreyer & Roggenbuck, 1978). In other words, while motivations relate to the expected psychological outcomes of the experience, satisfactions indicate how well those expectations were ultimately met (Arlinghaus, 2006).

In recreational fisheries, satisfying anglers is an important management goal (Driver, 1985; Hendee, 1974), and its achievement requires managers to be aware of the many factors that influence angler satisfaction (Holland & Ditton, 1992). These factors may be classified as either catch or non-catch related (Fedler & Ditton, 1994), and anglers may pursue several goals simultaneously, each of which may be determined by different factors (Arlinghaus, 2006; Driver & Knopf, 1976; Fedler & Ditton, 1994; Hutt & Neal, 2010). Thus anglers may consider different aspects of their experience to be more or less satisfactory than others, with their overall satisfaction reflecting a composite of multiple component satisfactions (Hendee, 1974; K. Hunt, Hutt, Schlechte, & Buckmeier, 2013).

Recent research has shown that catch can be a primary motivator depending on target species (Beardmore, Haider, Hunt, & Arlinghaus, 2011), and, satisfaction with catch has been identified as a primary determinant of angling satisfaction in studies that have asked anglers to evaluate their angling year (Arlinghaus, Barnes, & Fladung, 2008; Arlinghaus, 2006; Hutt & Neal, 2010). Two meta-analyses of dozens of trip-based satisfaction studies on various recreational activities (Roemer & Vaske, 2012; Vaske, Donnelly, Heberlein, & Shelby, 1982) have arrived at similar results, suggesting that consumptive recreationists such as anglers have less control over the consumptive outcomes of their experience, i.e., the catch process, than non-consumptive outcomes which may be more certain at the time of activity and site selection. The close relationship between catch outcomes (e.g., catch rates) and ratings of angler satisfaction at a trip level (McMichael & Kaya, 1991; Miko, Schramm, Arey, Dennis, & Mathews, 1995) have prompted some modelers to assume a linear relationship between catch rate and angler satisfaction (Cox, Walters, & Post, 2003), and some managers to use catch rates to set thresholds for fishing quality (Schramm, Arey, Miko, & Gerard, 1998). Because catch characteristics of species that "attract" or motivate anglers differ (e.g., European eel *Anguilla anguilla* attracts anglers with consumptive motives, while common carp *Ciprinus carpio* may attract anglers seeking a trophy experience, Beardmore, Dorow, Haider, & Arlinghaus, 2011), one may also expect the influence of catch outcomes on satisfaction to vary across fish species. So far, no research has examined the effect of target species on the relative importance of catch outcomes as determinants of satisfaction.

Non-catch factors, such as the social environment of a trip, may also influence satisfaction with catch. For example, crowding has been found to negatively affect fishing site choice independent of catch (Hunt, 2005). Encountering large numbers of other anglers while fishing may be associated with perceptions of competition over fishery resources and lead to increased incidence of "product shift" (Shindler & Shelby, 1995) in which anglers redefine their expectations for trip outcomes during and after the trip, in order to avoid dissatisfaction. Competition may also be perceived with other members of the same angling group. These and other trip characteristics therefore may set the context of a fishing trip and play an important role in how trip outcomes are evaluated.

In addition to trip characteristics (Schramm et al., 1998; Spencer & Spangler, 1992), satisfaction may be also influenced by characteristics of the anglers, themselves. Heterogeneity among anglers has become a large focus of the human dimensions literature, with recreation specialization (Bryan, 1977) as the primary research framework for understanding diversity in fishing preferences and behavior. Specialization is 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) and has been closely associated with psychological and behavioral measures of involvement and commitment (Buchanan, 1985). Activity involvement has been found to relate positively to leisure satisfaction (Kyle, Graefe, & Manning, 2003); however, no research has examined the interaction of activity involvement and trip outcomes to influence satisfaction.

Another dimension of specialization relates to cognitive processes associated with increasing knowledge or skill (Bryan, 1977), which may be manifested in higher catch rates (Dorow, Beardmore, Haider, & Arlinghaus, 2010). Although previous findings imply that committed anglers are generally more satisfied with fishing than are casual anglers (Aas & Kaltenborn, 1995; Kyle et al., 2003), highly skilled anglers might also have greater expectations, which may diminish satisfaction with catch for a given catch outcome. No research has tested the relationship between skill and satisfaction with catch.

Some researchers have suggested that increased specialization may be associated with differences in catch orientation. Catch orientation refers to an angler's disposition towards catching and harvesting fish, and the importance of the number and size of fish caught (D. K. Anderson, Ditton, & Hunt, 2007). Specialized anglers have been described as becoming more trophy oriented (Bryan, 1977) and less harvest oriented (Ditton, Loomis, & Choi, 1992; Oh & Ditton, 2006) than their less specialized counterparts. For some species, however, this characterization does not appear to hold (e.g., European eel, Dorow et al., 2010). Unfortunately, it appears that no study currently exists to compare the relative importance of various catch outcomes across angler specialization levels in a multi-species context.

Most studies so far have taken one of two approaches to identify the relative importance of various determinants of satisfaction. Many rely on subjective evaluations of catch outcomes that are aggregated to predict overall satisfaction (the sum of satisfactions approach, e.g., Arlinghaus, 2006; Hutt & Neal, 2010). Alternatively, some studies have taken a gap score approach, which focuses on the difference between the importance of achieving certain outcomes (i.e., motivations) against evaluations of their achievement (i.e., multiple satisfactions) (Baker & Crompton, 2000; Burns, Graefe, & Absher, 2003; Pollock, Jones, & Brown, 1994). Of the two approaches, the sum of satisfactions approach has been found to better predict overall satisfaction (Burns et al., 2003). However, neither approach directly links satisfaction to measureable trip outcomes. Additionally, reliance on component satisfactions that have often been aggregated over an entire year (Arlinghaus et al., 2008; Arlinghaus, 2006; Hutt & Neal, 2010) may provide insights relevant only to angling in general. While a few studies have focused on the influence of trip outcomes on angling satisfaction (e.g., Graefe & Fedler, 1986; Miko et al., 1995), these studies have been limited to single species fisheries. To the best of our knowledge, no one has examined how such relationships might vary among multiple species. Consequently, the role of trip context (i.e., the role of target species and social environment in defining a specific fishing opportunity) in shaping the relative importance of various trip outcomes for angler satisfaction constitutes an important knowledge gap and poses a challenge for managers seeking to provide specific experiences in order to maximize satisfaction.

This study addresses this knowledge gap by examining the determinants of satisfaction with catch across six diverse and recreationally important species at a trip scale. Our focus on satisfaction with catch stems from two considerations. First, catch-satisfaction has been found to be the limiting factor on overall angling satisfaction (Arlinghaus, 2006; Hutt & Neal, 2010). Second, catch outcomes are the most salient aspects of the fishing experience to ecologically trained fisheries managers (Bennett, Hampton, & Lackey, 1978), because they may be managed directly. Therefore, we chose to focus on what Graefe et al. (1986) described as the 'situational' factors, i.e. objective measures of trip outcomes, rather than the subjective evaluations of such outcomes that are more commonly addressed within the human dimensions literature (e.g., Arlinghaus, 2006; Graefe & Fedler, 1986; Hutt & Neal, 2010). Our overall objective was to test the consistency with which various trip characteristics affect reported catch satisfaction across a diverse suite of freshwater species for anglers differing in activity involvement and skill. Catch-related outcomes of fishing trip were expected to follow the intuitive trends previously established in the literature (e.g., Graefe et al 1986; Miko et al. 1995), whereby anglers prefer fisheries with higher catch rates and larger fish. That said, the relative importance of catch rate and size of fish was expected to differ across species and also to be influenced by anglers' degree of specialization. While different species have been shown to vary in their expected outcomes as indicated by differences in angler motivations (e.g., consumptive species versus trophy species; Beardmore, Haider et al. 2011), the extent to which species-specific trip outcomes differentially affect angler satisfaction among variously specialized anglers is unknown, but holds promise to shed light on the generality of the relationship between specialization and catch orientation.

4.2. Methods

The entire state of Mecklenburg-Vorpommern (M-V) served as our study area. Bordering the Baltic sea, this lowland region of Germany offers diverse freshwater and marine fishing opportunities and attracts anglers from across the country (Wichmann, Hiller, & Arlinghaus, 2008). For our diary study, respondents were drawn from a random sample of resident and non-resident anglers fishing in M-V as described in detail by Dorow & Arlinghaus (2011). In total, 1121 anglers recorded trip-level information about their fishing behavior in M-V in an angling diary between September 2006 and August 2007 (**Figure 4.1**[5]). For each trip, information about the timing, location, fishing effort, social group, target species and catch outcomes were recorded. In an attempt to reduce measurement error associated with estimates of average 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 reported. The diary form also elicited anglers' satisfaction with catch using a ten-point scale that ranged from completed dissatisfied to completely satisfied (Figure 1, Matlock, Osburn, Riechers, & Ditton, 1991). We chose not to include additional questions eliciting angler expectations for individual trip outcomes for three reasons. First, participants retained their diary booklets for the duration of the study period, and therefore we were unable to control the timing of each entry. Thus we would not have been able to distinguish between true expectations recorded before the trip from responses made afterward that have been influenced by actual outcomes (Heberlein & Shelby, 1977; Hendee, Stankey, & Lucas, 1990). Second, we did not wish to overly burden respondents requiring them to complete parts of each entry at both the beginning and also the end of each trip. Finally, trip outcomes have been shown to predict satisfaction (Graefe & Fedler, 1986), and

[5] The original German version of the diary form may be found in Appendix F, p311.

while they might be less predictive than subjective evaluations of the same outcomes, direct measures may be more easily related to ecological benchmarks for fisheries management.

As past angler diary studies have suffered from low response rates and associated non-response biases (L. E. Anderson & Thompson, 1991; Bray & Schramm Jr, 2001; Connelly & Brown, 1996; Tarrant, Manfredo, Bayley, & Hess, 1993), participants to our diary were promised an expensive fishing reel as an incentive for completing the diary program, and all participants were contacted every three months by telephone. These telephone interviews addressed any emergent concerns that participants might have, kept them motivated in the study, and collected supplemental information on angler specialization. To further decrease the dropout rate, diary participants were also promised a custom report at the end of the study, which summarized information from their personal diary and related it to the sample as a whole. In all, 648 anglers (58%) returned diaries and reported a total of 12,937 trips targeting 28 different freshwater and marine fish species.

For the analysis presented in this paper, we chose to focus on freshwater trips with the primary target (i.e., the species receiving the most directed effort on a given trip) of one of six common freshwater species. The six species were chosen both for their popularity among anglers within the region, and for their diversity in life history characteristics. They included two species of piscivores: northern pike *Esox lucius*, and zander (also known as pikeperch) *Sander lucioperca.* The remaining species have a more general feeding pattern and are often non-piscivorous: common carp *Cyprinus carpio*, European eel *Anguilla anguilla*, European perch (also known as Eurasian perch) *Perca fluviatilis,* and coarse fish (small-bodied cyprinids such as roach *Rutilus rutilus* and bream *Abramis brama).* These six species or species groups provide a range of recreational fishing experiences, including trophy fish (e.g., carp, pike), fish prized for eating (eel, perch, pike, zander) and high catch rate fisheries valued for social fishing events (i.e., competitions, Meinelt, Jendrusch, & Arlinghaus, 2008) and the nature experience (e.g., coarse fish, Beardmore, Haider, et al., 2011; Meinelt et al., 2008). Several of the species chosen may also be found in brackish coastal waters (e.g., perch, pike, zander, eel and coarse fish); however, we limited our 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 than in many small freshwater systems.

4.2.1. Operationalizing Specialization

Collecting information about angler specialization was a major focus of the quarterly telephone interviews, and were analyzed in detail by (Beardmore, Haider, Hunt, & Arlinghaus, 2013). One metric of specialization, centrality-to-lifestyle, i.e. the extent that a given leisure activity is connected to one's social network and general lifestyle (Kim, Scott, & Crompton, 1997), has emerged as a prominent measure of psychological commitment that is often used as a proxy for specialization more generally (Donnelly, Vaske, & Graefe, 1986; Dorow et al., 2010). Furthermore, centrality-to-lifestyle was found to be the best predictor of intended behavior among eleven metrics of specialization for anglers in our dataset (Beardmore, Haider et al., 2013), and was thus chosen as the primary indicator of specialization in our study. We measured centrality-to-lifestyle using a five-point agreement scale adapted from Kim et al. (1997). Principal component analysis (PCA) on the responses to this seven-item scale yielded a single reliable factor explaining 62.2% of the variance (α= 0.90; **Table 4.1**) containing all items. Factor scores (i.e., z-scores) formed the final index of centrality-to-lifestyle.

In addition to centrality-to-lifestyle, the cognitive dimension of specialization (i.e., skill, knowledge and expertise) was also included in our analysis, as it was thought to most directly relate to an angler's catch success. Skill was inferred from each angler's relative catch per unit effort (CUE, fish caught per hour). To account for variation in an angler's skill across species, standardized CUE scores were weighted by proportion of effort devoted to each species as revealed from diary entries (Beardmore et al., 2013), preventing rarely targeted species from unduly affecting an angler's indicated skill. These two dimensions of specialization were then included in the satisfaction model as interactions with other variables in an approach similar to Carlin et al. (2012).

4.2.2. Modeling Catch Satisfaction

The primary goal of our study was to predict satisfaction with catch as a function of trip characteristics directly. Given the ordinal nature of our dependent variable, we used an adjacent-category ordinal logit model to predict satisfaction ratings as a function of our independent variables. The adjacent-category ordinal logit model for a fishing trip *t* with *P* attributes characterized by an angler *i* (e.g., catch rate, size of largest fish, other anglers seen, centrality score) can be formulated as follows:

$$\eta_m = \beta_m^{con} + y_m^* * \sum_{p=1}^{P} \beta_p^{att} * z_p^{att} \tag{4-1}$$

In this equation, η_m is the systematic component of the satisfaction rating of category m, β_m^{con} is the category's alternative specific constant, y_m^* is the fixed category score (in our case, satisfaction ratings are scored from one to ten), and β_p^{att} is the estimate of the contribution to satisfaction associated with each attribute of value z_p^{att}. In this way, the ordinal logit model related marginal changes in trip outcomes to corresponding changes in satisfaction rating. Analysis was conducted using Latent Gold Choice 4.5 software by Statistical Innovations, Inc. (Vermunt & Magidson, 2005), and accounted for the panel structure of the data set. 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 do not vary directionally across our sample during the timeframe of our study.

The final model was selected after systematically and sequentially adding groups of related parameters, retention of which relied on the outcome of likelihood ratio tests (Louviere, Hensher, & Swait, 2000). These parameters included both main effects as well as their two-way and three-way interactions with species and specialization indicators. For continuous attributes, both linear and quadratic terms and their interactions were explored, while categorical attributes were effects coded (Bech & Gyrd-Hansen, 2005). Preliminary model runs also tested for possible interactions between species-specific CUE and size of largest retained fish, based on the hypothesis that high catch rates may be associated with smaller fish. However, these interactions did not improve model fit, and indeed, separate bivariate tests of correlation between these two variables remained insignificant (P>0.05). In the final model, insignificant main effects were retained when coupled with significant interactions. Similarly, insignificant linear terms were retained if quadratic terms for the same attribute were statistically significant.

The resulting model predicted satisfaction as a function of trip characteristics interacted with skill and centrality-to-lifestyle and had an excellent goodness of fit with a relatively high McFadden's pseudo $R^2 = 0.42$. This statistic is analogous to the R^2 in a conventional regression model, but typically produces lower values (Ben-Akiva & Lerman, 1985, p. 161). The model included the following groups of parameters. First, alternative specific constants (ASC) represented the relative likelihood of a given rating in the absence of additional trip outcomes. The next group of parameters represented the main effects of catch and non-catch outcomes on catch satisfaction ratings. A third group of parameters introduced two-way interactions with the primary target species using coarse fish as the base, represented by the main effect. Therefore significant species interactions indicated differences in how relevant outcomes affected satisfaction with catch for each species compared to coarse fish. The next group of parameters introduced two-way interactions with centrality-to-lifestyle, indicating those trip outcomes whose influence on 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. While none of these three-way interactions were statistically significant, their inclusion in the model improved model fit, according to our likelihood ratio tests. Finally, our metric of skill was brought into the model as a separate predictor. This parameter estimated the effect of skill on satisfaction ratings, independent of trip outcomes. As such, it served to adjust ASC estimates based on an angler's mean CUE. Because the sample means for our metrics of centrality and skill were defined by zero, the average angler was taken as the base against which the effects of changing specialization on satisfaction with catch were compared. Given the complexity of the model, which included as many as five types of parameters to describe the effect of key trip outcomes (i.e., linear and quadratic main effects, as well as three possible interaction terms), the functional form of the effect of each trip outcome was most easily assessed graphically.

As the satisfaction model treated each indicator of specialization as a continuous term, to graphically represent the effect of angler heterogeneity on the influence of each catch outcome, we defined three specialization levels along the continuum. The first level was defined as having centrality-to-lifestyle and skill scores consistent with the mean of the sample (labeled as moderate). The two remaining levels differed in centrality-to-lifestyle, with scores of -1.33 and 0.92, which were selected to reflect the bottom and top 10% of the centrality-to-lifestyle index respectively. This approach simplified efforts to document the influence of specialization on satisfaction with catch by providing a few illustrative snapshots along the specialization continuum.

To more directly compare the relative contribution of CUE versus size of largest retained fish to satisfaction with catch, the difference in parameter values between these two outcomes was ascertained across all combinations of the observed ranges of these parameters. Specifically, we subtracted the sum of parameters (i.e., main effects and interaction terms) associated with size from the sum of those associated with CUE. This produced an index where zero represented trip outcomes in which size and catch rate contributed equally to satisfaction with catch, while positive values illustrated outcomes where catch rate was more influential and negative values indicated greater influence of size. In this way, we assessed the degree to which anglers of various levels of specialization derive satisfaction from the size or number of caught fish depending on the target species.

Finally, we used the model to predict the mean satisfaction with catch rating for anglers of each specialization level given current mean species-specific catch outcomes. To ensure that trip outcomes used to simulate variation in catch outcomes were within a plausible range; descriptive statistics for trip characteristics for each of the six species were calculated. For each of these calculations, we first summarized data across all trips for each angler and then compared across anglers, thereby accounting for intra-personal repeated measures. Mean values for species-specific trip characteristics served as the basis of comparison to assess whether species differ in the extent to which they satisfy anglers depending on their involvement in fishing. In other words, are some species likely to appeal more to specialized anglers than others?

4.3. Results

After accounting for item non-response and restricting the sample to anglers who primarily targeted at least one of the six most popular species on a given freshwater trip, the final sample for this study retained 525 anglers (49%) representing 8,438 angling trips taken throughout the year long diary period. An assessment of non-response bias between these 525 respondents and 589 non-respondents, who were initially recruited into the random sample but declined to return their diary at the end of the year, was conducted using information collected during the initial recruitment telephone interviews. Respondents were somewhat older with a mean age of 44.9 (s.e. = 0.6) compared to 41.4 years (s.e. = 0.7) for non-respondents. Respondents also tended to be much more avid anglers, reporting fishing an average of 35.8 days (s.e. = 2.76) in the year prior to the study, compared to 20.7 days (s.e. = 1.32; $t = 17.6$; $p < 0.001$) for non-respondents. Respondents also reported having fished for an average of 24 years (s.e. = 0.70) compared to non-respondents' 22 years (s.e. = 0.63; $t = 4.0$; $p = 0.045$). Based on the differences in avidity and demographics between mail survey respondents and non-respondents, we caution readers from generalizing the findings of this study to the overall angler population in Mecklenburg-Vorpommern; however, theoretical implications of the study still hold.

One-way ANOVA comparing mean trip characteristics across species revealed significant differences in most aspects (**Table 4.2**). For catch outcomes of these primary target species, these differences followed expectations based on physiological, behavioral and population characteristics, and should be intuitively obvious to any recreational fisheries manager or angler.

Differences in other trip characteristics, however, were less intuitive but equally important for characterizing the recreational experience typically associated with each species. First, the average fraction of effort devoted to the primary target species differed across species with common carp and European eel trips directing on average 91% of their fishing time to those species compared to coarse fishers, who directed only 75% of their time to their primary target. European perch, northern pike and zander trips were similar, with an average effort level per trip of 88%. Differences were also observed in the mean number of species that were targeted on any given trip, and the mean number of species that were caught. On average, carp (1.63 species) and eel trips (1.69 species) targeted the largest number of species, while coarse fishers targeted the fewest (1.35 species). Perch, pike and zander were intermediate (1.51, 1.56, and 1.47 species respectively.) While targeting the fewest number of species, coarse fishing trips were associated with the greatest average number of species caught (1.39), followed by eel and carp trips (0.71 and 0.63 species respectively). Perch, pike and zander trips, on average, caught the fewest number of species. Catch rates for secondary species were similar across all species except for trips targeting coarse fish, which were substantially higher (5.88 fish per hour compared to approximately 1.5 fish per hour for trips targeting other species.)

4.3.1. Satisfaction model

In the satisfaction model, the ASC (**Table 4.3**, **Figure 4.2**) showed a significant negative trend reflecting the decreased likelihood of reporting higher levels of satisfaction with catch if none of the trip outcomes were included in the model. In other words, the trip outcomes included in the model tended to have an overall positive relationship with satisfaction with catch. The trend in ASC was complemented by a small but significant effect associated with increasing levels of skill: all else being equal, highly skilled anglers were more likely to report slightly lower satisfaction ratings than were less skilled anglers.

Consistent with the focus of the dependent variable on catch satisfaction, size of largest retained fish **Figure 4.3**) and CUE for the primary target species (**Figure 4.4**) were the driving factors in the model. For all species and across specialization types, anglers were more likely to report higher satisfaction with catch with an increasing size of the fish in their catch; however this effect was most pronounced for casual anglers, suggesting that larger fish disproportionately improved satisfaction for this group (**Figure 4.3**). Catch rates (**Figure 4.4**) had a similarly strong positive effect on satisfaction with catch, however, for most species, this effect diminished somewhat at very high catch rates. Differences in the effect of CUE 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. These differences, however, were generally small for all but two species. For Zander and coarse fish, the effect of CUE on satisfaction differed considerably with specialization level, with less specialized anglers receiving less satisfaction for a given catch rate.

Other trip characteristics that influenced satisfaction with catch related to targeting behavior and species other than the primary target species (**Figure 4.5**). Higher catch rates for secondary species also had a positive effect on angler satisfaction. 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, this positive effect diminished. No significant interactions with specialization were found for these attributes. These effects 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. Different species were associated with varying levels of satisfaction with catch that were dependent on centrality-to-lifestyle. Absent specific catch outcomes, trips targeting coarse fish were the most satisfying across all satisfaction levels, closely followed by zander. European perch and European eel trips were the least satisfying for casual anglers, while trips targeting common carp were least satisfying for committed anglers.

While the majority of independent variables focused on catch outcomes, several non-catch aspects of the fishing trip also had small but significant effects on respondents' satisfaction ratings (**Figure 4.6**), depending in some cases on centrality-to-lifestyle. These aspects included distance traveled, trip duration, group size and number of other anglers encountered. The main effect for distance was not significant (**Table 4.3**), 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 indicated decreased levels of satisfaction at large distance **Figure 4.6**). 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. The social environment also affected satisfaction with catch (**Figure 4.6**). Increasing group size negatively influenced satisfaction ratings, and this effect was not found to be influenced by angler specialization. Finally, the number of other anglers seen while fishing also negatively influenced satisfaction, especially for more specialized anglers; however, this effect was not universal across all species. The opposite effect was found for trips targeting primarily coarse fish.

Contour plots (**Figure 4.7**) depicting the difference in contribution towards satisfaction with catch made by CUE and size of largest retained fish indicated both similarities and differences among species for anglers of different levels of specialization. The first thing of note is that the panels differ in their areas shaded in gray versus white. The larger the area in white, the more important is the role of catch rate relative to the size of largest retained fish in determining satisfaction with catch, while the opposite is true for areas shaded in gray. The direction and density of the contours also illustrates the relative importance of these two catch outcomes. While the isocline for each panel tends to run diagonally, indicating that satisfaction goes up as catch rate and size increase, the slope of the isocline in each panel also provided insight into the relative importance of these two outcomes. For example for high levels of centrality, the closely spaced and nearly vertical contour intervals for European perch, contrast with the nearly horizontal intervals characteristic for European eel fishing, indicating that while size of retained fish tends to drive satisfaction for specialized perch anglers, catch rates are most important to specialized eel fishers. The density of contour intervals also varies across species, indicating the relative importance of catch outcomes more generally. For example, decreasing density of contour lines with specialization in perch anglers suggests that the relative importance of size may diminish somewhat for committed anglers. This result contrasts with that for coarse fishers, for whom increasing commitment is associated with greater relative influence of higher catch rates. Finally, for all species and centrality levels, the current mean trip outcome (indicated by the circular black dot in each panel) suggests that the size of the largest retained fish currently contributes more to satisfaction with catch than does the catch rate.

Not only did the relative contributions of size and CUE to satisfaction with catch differ somewhat among species and by degree of centrality, but the model also predicted differences in overall ratings of satisfaction with catch across species and by centrality level. To illustrate these differences, mean trip characteristics (**Table 4.2**) for each target species were taken as inputs of the model to evaluate patterns in satisfaction with catch across species for anglers differing in specialization (**Figure 4.8**). Overall, northern pike and zander achieved slightly higher satisfaction ratings than the other four target species, and this trend increased with centrality to lifestyle. Average trips for the other species were similarly rated overall, with European perch and European eel trips slightly favored by lower centrality anglers, and average coarse fishing trips slightly favoring high centrality anglers. The average common carp trip strongly favored casual anglers, whose predicted satisfaction rated similar to those for the same group when targeting pike or zander. On the other hand, the average carp trip was rated lower than any other average experience by high centrality anglers.

4.4. Discussion

Past studies have deepened understanding of satisfaction as the primary psychological outcome of engaging in recreational activity, but have often focused on the relationship between respondents' subjective evaluations of the various aspects of the experience and overall satisfaction (Arlinghaus, 2006; Connelly & Brown, 2000; Hutt & Neal, 2010). Relatively few studies examined the role of objective trip outcomes as determinants of satisfaction, usually in species-specific case studies (Graefe & Fedler, 1986; Miko et al., 1995). This kind of research poses a challenge for fishery managers wishing to benchmark angler satisfaction against catch data, which are routinely collected through creel surveys, which indicate the extent to which various fishing opportunities (here defined by species) provide satisfying experiences for different types of anglers. To address this void, our study focused on what Graefe et al (1986) called "situational" determinants, applying them to a model of satisfaction with comparable catch information across six important freshwater target species, and examining the effect of angling specialization on satisfaction with catch.

4.4.1. The satisfaction model

Our satisfaction model reveal that trip context related to target species and social environment play an important role in determining anglers' catch satisfaction, and also that these effects may be significantly but subtly influenced by angler specialization. These results support past research that has found that committed anglers tend to derive more satisfaction from fishing than do casual anglers (Kyle et al., 2003; Spencer, 1993). Our model, however, provides more detailed insights into the relationship between specialization and satisfaction, by identifying significant interactions between centrality-to-lifestyle and individual trip outcomes; and by differentiating the effect of psychological involvement (i.e., centrality to lifestyle) from that of fishing skill. In contrast to centrality-to-lifestyle, increasing skill - all else being equal - was associated with a slight decrease in 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 their less skilled counterparts (Spencer & Spangler, 1992).

In keeping with previous research (e.g., Graefe & Fedler, 1986; Miko et al., 1995), our study found overwhelming support that catch outcomes are important determinants of satisfaction for anglers of all specialization levels and all species. Catch rate (CUE) and size of largest retained fish were the primary determinants of satisfaction with catch. For most species, however, the effect of CUE featured a significant negative quadratic term, suggesting that marginal increases in angler satisfaction based on improvements in CUE diminish as catch rates increase. This result refines previous assumptions of positive linear relationships between CUE and satisfaction (e.g., Cox et al., 2003) or utility (e.g., Aas, Haider, & Hunt, 2000; Beardmore et al., 2013; Oh, Ditton, Gentner, & Riechers, 2005), in keeping with neoclassical economic assumptions of diminishing marginal returns (Samuelson & Nordhaus, 2005). That said, the diminishing effect of CUE was not entirely universal. Furthermore, centrality-to-lifestyle was found to subtly mediate the effect of CUE on satisfaction, heightening it for committed anglers for most species. This effect was particularly pronounced for coarse fish, where diminishing marginal returns of increased catch rates were not observed for moderate and highly committed anglers, as they were for anglers of low centrality. Coarse fish are highly abundant, small-bodied fish that are often the focus of fishing competitions due to their high catch rates (Meinelt et al., 2008). Greater satisfaction with catch for a given CUE may have reflected the collective expertise of committed anglers, such that they were more accepting of unsuccessful trips and acutely aware when catch rates are exceptionally high.

The other primary determinant of satisfaction with catch in our model was the size of the largest retained fish. Unlike CUE, however, the relationship between size and satisfaction showed no diminishing marginal return in satisfaction for all species across the size ranges reported in the diaries. These trends may have reflected the exceptionality of catching ever larger fish regardless of species (Heermann et al., 2013; Wilde & Pope, 2004). As with CUE, the relationship of size to satisfaction with catch was moderated somewhat by centrality to lifestyle. Casual anglers tended to show an increasing slope associated with increasing the size of fish, whereas committed anglers showed a linear relationship. In essence casual anglers were disproportionately more satisfied than committed anglers were with ever larger fish. This trend may have reflected different expectations for size among increasingly specialized anglers. Committed anglers may have higher expectations of catching big fish than would casual anglers, for whom it is a rarer event (Arlinghaus, 2004). Consequently, the same catch outcome would more greatly exceed the casual angler's expectation leading to greater feelings of satisfaction. This finding corroborates suggestions by Bryan (1977) that trophy orientation is one characteristic of specialized anglers.

Interestingly, social context, while less influential than CUE 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. Perceptions of crowding among anglers have been well studied (Shelby & Vaske, 2007), and in a generic sense, the negative influence associated with greater numbers of other anglers observed in our satisfaction model and also in random utility models of fishing site choice (e.g., Aas et al., 2000; Beardmore et al., 2013; Carson, Hanemann, & Wegge, 2009) corroborate each other. Given, however, the similar influence of the respondent's group size, our findings potentially indicated that perceptions of competition for locally scarce fishery resources may influence satisfaction. The divergent finding for trips targeting coarse fish may have been related to the relative abundance of these species, and the emphasis on fishing as a social event within that fishery (Meinelt et al., 2008), which may have reduced perceived competition, thereby improving anglers' evaluation of their own catch success.

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. Corroborating findings by Kyle et al.

(2003), committed anglers were (all else being equal) more satisfied than their casual counter parts for most target species. Two exceptions to this finding were for common carp and for coarse fish. Committed carp anglers were less satisfied than casual carp anglers. This finding might reflect differences in fishing expectations along the specialization continuum, with committed carp anglers being more trophy-oriented, while casual carp anglers might be considered more consumptive. For coarse fish, all anglers appeared to be equally satisfied by the species.

Not all catch outcomes had significant interactions with centrality-to-lifestyle. The proportion of effort directed towards the primary target species, the number of target species and the catch rate for secondary species (including bycatch) suggested 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.

Non-catch aspects of the trip, while statistically significant, tended to exhibit very small effects on satisfaction with catch; however, omission of these parameters significantly worsened the model fit, further emphasizing the importance of trip context in shaping catch expectations. Trips of longer duration tended to be evaluated more positively than shorter trips, suggesting that in addition to catch rate, time spent engaged in this leisure activity is also important. As may be expected, this effect was strongest for committed anglers, for whom fishing is often the most important recreational activity (Arlinghaus & Mehner, 2004; Ditton et al., 1992). 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 are universally preferred), an exception to this rule occurred among the parameters for travel distance. Greater distances improved satisfaction among committed anglers, but diminished satisfaction for casual anglers. 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 & 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 & Shelby, 1977). These coping mechanisms may explain the response of committed anglers, but not those of casual anglers, for whom an equivalent catch outcome achieved with less investment in travel is demonstrably preferred. This disparity among angler types may reflect the endogeneity in the relationship between satisfaction and involvement such that one may choose to become more involved because the activity is satisfying, or conversely satisfying activities encourage greater involvement (Kyle et al., 2003).

4.4.2. Satisfying anglers

Recreational fisheries managers often use thresholds for certain catch outcomes to set their objectives related to harvest rates (Bennett et al., 1978) or catch rates (Schramm et al., 1998). In addition, some lakes are managed specifically to produce trophy-sized fish (Wilde & Ditton, 1994). While our study confirmed past findings suggesting that the desire for both larger fish and also more of them is a universal trait among anglers (e.g., Aas et al., 2000; Dorow et al., 2010; Oh et al., 2005; Oh & Ditton, 2006), our modeling approach allowed comparison of the relative contribution of these two characteristics across multiple species. This integrated model provided insights into the relationships between aspects of catch orientation (i.e., disposition to catch larger fish and disposition to catch many fish), and preference for target species. Our study revealed that as specialization increases, the relative importance of size of fish over catch rate increases for some, but this trend is far from universal. While the importance of catch rates over size have been shown for European eel (Dorow et al., 2010), and walleye *Sander vitrieus* (Beard, Cox, & Carpenter, 2003), two fisheries of high consumptive value, our model predicted similar patterns for zander and coarse fish. Thus, Bryan's (1977) assertion that specialized anglers become more trophy oriented likely depends strongly on the individual target species. These findings further emphasize the importance of the species-specific context of fishing activities, corroborating previous research which has found angling motives to vary with species (Beardmore, Haider, et al., 2011; Fedler & Ditton, 1994).

4.4.3. Management implications

That satisfaction with catch appeared in our model to be driven primarily by CUE, size of largest retained fish as well as the number of other anglers seen while fishing implies that by managing these outcomes, satisfaction can be improved. Realizing that goal would require consideration of the correlations among these outcomes. For example, in a published social-ecological model of a recreational fishery consisting of naturally recruiting fish stocks (see Johnston, Arlinghaus, & Dieckmann, 2010, 2012), average CUE and size of largest retained fish were found to be negatively correlated with annual effort by harvesting anglers. Assuming that the number of anglers seen on a given trip is an adequate proxy for harvest driven effort, then satisfaction with catch should be maximized by limiting effort to a single angler, an unfeasible prospect to be sure. In situations where fisheries are stocked, such as for common carp (Lorenzen, 1995) however, catch rate and size are decoupled (see Askey, Parkinson, & Post, 2013; Parkinson, Post, & Cox, 2004) and inversely related. For a fixed financial investment one may choose to either stock many small fish, or fewer large fish. Understanding the relative importance to satisfaction of CUE and size of fish for a given species-specific fishery may provide insight into identifying the likely effect of various stocking strategies on angler perceptions of fishing quality. Furthermore, by jointly modeling satisfaction with catch across multiple species and accounting for angler specialization, our study suggests that managing specific catch outcomes (through stocking or other means) to increase angler satisfaction should not necessarily follow the same strategy, as some species appear to be judged more for their size than their catch rate, while for others the reverse is true.

4.4.4. Study limitations

The main limitation of our study was that the satisfaction measure was anchored only at the ends (totally dissatisfied and totally satisfied; **Figure 4.1**), and therefore did not define a managerially relevant threshold from which to derive a minimum standard. In other words, the scale was only capable of assessing whether a trip was more or less satisfactory than another, but did not identify a point of indifference. 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 adapting this scale to include a neutral anchor indicating the mid-point of the scale that would allow respondents to identify trips in which catch expectations were simply met. Such an anchor would have provided a managerially relevant threshold by which to evaluate individual fisheries. Thus, while we were unable to provide explicit recommendations for thresholds of catch outcomes necessary to minimally satisfy anglers, we succeeded in assessing the relationship between incremental changes in trip outcomes and satisfaction with catch.

Other limitations of the model relate 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 correlations were found between CUE and size of largest fish in our data, a relationship may still have existed between the number and average size of fish in a given trip. 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 large fish. 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 CUE and average size that may have existed for trips in our dataset, while we found no relationship between CUE and size of largest retained fish.

Another limitation of our model stemmed from 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; Dorow et al., 2010), one would expect harvests to play an important role in determining satisfaction with catch. Unfortunately, colinearity between retention rates, CUE and size of largest retained fish resulted in decreased model fit when retention rates were included. The relationships among these variables likely reflected the current regulatory environment, where bag limits and minimum size limits moderate harvest practices for many species. Colinearity is likely increased further by reliance on size information that specifically pertained to retained fish. Consequently, the omission of harvest from our model should not be taken to mean that harvest is unimportant. Rather, the influences of CUE and size should be interpreted in light of the current regulatory regime for these species in M-V and the harvest orientation of the anglers in our sample.

4.4.5. Conclusions

This study aimed to improve understanding of the determinants of satisfaction across a diverse set of freshwater target species. These determinants were found to be dominated primarily by catch rate and size across all six species or species groups and all angler types examined, while significant effects from non-catch aspects underscore the significance of trip factors in influencing either the establishment of expectations or the evaluation of outcomes. Jointly estimating the effects of trip and angler characteristics allowed us to test the generality of the relationships of these factors to satisfaction with catch across species and among angler types. 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 CUE and size to satisfaction with catch compared to other trip characteristics were similar, across species. However, differences in the physiological characteristics across fish species and in their ecology constrain the range of typical catch outcomes, such that the relative influence of size versus CUE varies across species. 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 (CUE and size) are largely universal among anglers, and that centrality-to-lifestyle exerts a moderating influence to the extent that an angler's experience and involvement relates to their expectations. This last aspect in particular would warrant further research. Our study suggests that catch rates, size of fish and, to a lesser degree, encounter rates are universally important components of satisfying catch experiences. Given that overall satisfaction with angling is primarily dependent on satisfaction with catch aspects (Arlinghaus, 2006; Graefe & Fedler, 1986; Hutt & Neal, 2010), managers wishing to maximize angler satisfaction should focus on these three components of the fishing experience.

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Tables and Figures

Table 4.1: Centrality-to-lifestyle scale used as a measure of angler specialization (N =525 anglers).

	Mean	s.e.	s.d.	Factor loading	α if item deleted	Cronbach's α
I would lose a lot of my friends if I stop fishing.	3.94	.06	1.28	.83	.88	.90
If I could not fish, I would not know what else to do.	3.83	.06	1.27	.83	.88	
Because of my angling passion no time is left for other hobbies.	3.68	.05	1.25	.84	.88	
Most of my friends are connected to angling.	3.58	.06	1.32	.81	.88	
Going fishing is the most enjoyable thing I can do.	3.04	.05	1.24	.78	.88	
Other leisure activities do not interest me as much as angling.	3.01	.06	1.34	.77	.89	
Most of my life revolves around angling.	2.75	.05	1.08	.64	.90	

Table 4.2: Comparison of mean recreational fishing trip characteristics across six species

		N	Mean	s.d	s.e.	F
CUE for primary species (Fish/hour)	Carp	188	0.18^{w}	0.22	0.02	122.7
	Coarse fish	231	4.63^{z}	2.60	0.17	
	Eel	288	0.23^{w}	0.30	0.02	
	Perch	319	2.92^{y}	2.79	0.16	
	Pike	409	0.40^{x}	0.37	0.02	
	Zander	123	0.50^{x}	0.86	0.08	
Size of largest retained for primary species (cm)	Carp	121	55.7^{x}	13.1	1.2	708.8
	Coarse fish	110	22.8^{v}	9.2	0.8	
	Eel	208	61.1^{y}	10.8	0.7	
	Perch	277	26.5^{w}	6.0	0.4	
	Pike	333	65.9^{z}	11.1	0.6	
	Zander	79	59.4^{y}	11.1	1.2	
Fraction of effort to primary species	Carp	188	0.91^{z}	0.16	0.01	27.6
	Coarse fish	241	0.75^{y}	0.26	0.02	
	Eel	287	0.91^{y}	0.14	0.01	
	Perch	320	0.88^{y}	0.16	0.01	
	Pike	409	0.88^{y}	0.16	0.01	
	Zander	123	0.88^{y}	0.16	0.01	
Number of species targeted	Carp	188	1.63^{x}	0.69	0.05	8.6
	Coarse fish	241	1.35^{z}	0.53	0.03	
	Eel	288	1.69^{x}	0.76	0.04	
	Perch	320	1.51^{yz}	0.65	0.04	
	Pike	411	1.56^{xy}	0.56	0.03	
	Zander	123	1.47^{yz}	0.59	0.05	
Number of species caught	Carp	188	0.63^{xy}	0.82	0.06	84.4
	Coarse fish	241	1.39^{z}	0.80	0.05	
	Eel	288	0.71^{y}	0.82	0.05	
	Perch	320	0.48^{wx}	0.56	0.03	
	Pike	411	0.31^{w}	0.55	0.03	
	Zander	123	0.39^{w}	0.48	0.04	

		N	Mean	s.d	s.e.	F
Catch rate for secondary species (Fish/hour)	Carp	188	1.67^{y}	3.41	0.25	64.9
	Coarse fish	231	5.88^{z}	6.77	0.45	
	Eel	288	1.14^{y}	1.70	0.10	
	Perch	319	1.47^{y}	2.64	0.15	
	Pike	409	1.31^{y}	2.30	0.11	
	Zander	123	1.57^{y}	3.16	0.28	
One-way travel distance (per km)	Carp	183	32.1	46.2	0.34	1.5
	Coarse fish	234	25.7	37.0	0.24	
	Eel	281	32.3	49.0	0.29	
	Perch	310	25.7	37.6	0.21	
	Pike	410	28.7	42.6	0.21	
	Zander	122	24.1	38.2	0.35	
Fishing Duration (hours)	Carp	188	7.41^{x}	11.54	0.84	34.7
	Coarse fish	241	2.60^{z}	1.49	0.10	
	Eel	288	5.15^{y}	3.06	0.18	
	Perch	320	3.32^{z}	1.89	0.11	
	Pike	411	3.30^{z}	1.77	0.09	
	Zander	123	3.37^{z}	1.75	0.16	
Group size	Carp	188	1.76^{z}	1.85	0.13	6.6
	Coarse fish	241	2.79^{y}	5.71	0.37	
	Eel	288	1.75^{z}	1.49	0.09	
	Perch	320	1.61^{z}	1.78	0.10	
	Pike	411	1.70^{z}	1.98	0.10	
	Zander	123	1.62^{z}	1.14	0.10	
Number of anglers seen	Carp	188	2.61^{z}	3.89	0.28	4.0
	Coarse fish	241	3.50^{yz}	5.57	0.36	
	Eel	288	2.62^{z}	3.33	0.20	
	Perch	320	3.68^{yz}	5.00	0.28	
	Pike	411	2.92^{z}	3.75	0.18	
	Zander	123	4.15^{y}	5.75	0.52	

Table 4.3: Adjacent categories ordinal logit model with repeated measures predicting satisfaction with catch as a function of trip outcomes, social environment (crowding) and specialization.

Attribute	Coding	Beta	s.e.	z-value	Wald	p-value
Alternative Specific Constants (ASC)	1	1.941	0.181	10.70	754.0	0.000
	2	1.116	0.145	7.69		
	3	0.988	0.108	9.18		
	4	0.702	0.072	9.73		
	5	0.649	0.040	16.22		
	6	0.077	0.040	1.93		
	7	-0.382	0.068	-5.59		
	8	-0.695	0.105	-6.62		
	9	-1.836	0.147	-12.47		
	10	-2.559	0.189	-13.54		
Main effects						
Distance (km)	Linear	0.000	0.001	-0.25	0.1	0.810
Number of anglers in group	Linear	-0.006	0.003	-2.54	6.5	0.011
Total fishing time (per 24 hours)	Linear	0.352	0.058	6.05	36.6	0.000
	Quadratic	-0.090	0.019	-4.71	22.2	0.000
Number of targeted species	Linear	0.115	0.028	4.16	17.3	0.000
	Quadratic	-0.015	0.006	-2.40	5.8	0.016
Number of species caught	Linear	0.132	0.014	9.23	85.2	0.000
	Quadratic	-0.025	0.004	-5.75	33.1	0.000
Number of other anglers seen (per 10 anglers)	Linear	0.080	0.033	2.45	6.0	0.014
	Quadratic	-0.001	0.005	-0.27	0.1	0.790
Fraction of time directed to primary target species	Linear	-0.594	0.101	-5.88	34.6	0.000
	Quadratic	0.441	0.080	5.54	30.7	0.000
Primary Target Species Name	Carp	-0.037	0.020	-1.87	82.4	0.000
	Coarse fish	0.114	0.018	6.44		
	Eel	-0.061	0.017	-3.64		
	Perch	-0.085	0.020	-4.31		
	Pike	-0.034	0.014	-2.33		
	Zander	0.103	0.025	4.10		

Attribute	Coding	Beta	s.e.	z-value	Wald	p-value
Size (m) of largest retained fish of primary target species	Linear	0.675	0.194	3.48	12.1	0.001
	Quadratic	0.738	0.144	5.12	26.2	0.000
CUE (fish/hour) of primary target species	Linear	0.021	0.013	1.66	2.7	0.098
	Quadratic	0.000	0.000	0.41	0.2	0.680
CUE for other species	Linear	0.034	0.003	13.41	179.7	0.000
	Quadratic	0.000	0.000	-7.65	58.5	0.000
2-way interactions with primary target species (Coarse fish taken as the base)						
Size (Linear)	Pike	-0.329	0.199	-1.65	2.7	0.099
	Zander	-0.241	0.215	-1.12	1.3	0.260
	Perch	0.851	0.209	4.08	16.6	0.000
	Carp	-0.246	0.212	-1.16	1.3	0.250
	Eel	-0.402	0.205	-1.96	3.8	0.050
CUE (Linear)	Pike	0.362	0.034	10.57	111.8	0.000
	Zander	0.206	0.056	3.70	13.7	0.000
	Perch	0.016	0.013	1.19	1.4	0.230
	Carp	1.075	0.158	6.81	46.4	0.000
	Eel	0.667	0.112	5.93	35.2	0.000
CUE (Quadratic)	Pike	-0.062	0.009	-6.74	45.4	0.000
	Zander	-0.017	0.008	-2.18	4.8	0.029
	Perch	-0.001	0.000	-2.13	4.5	0.033
	Carp	-0.452	0.120	-3.78	14.3	0.000
	Eel	-0.149	0.071	-2.11	4.5	0.035
Other anglers seen while fishing (Linear)	Carp	-0.225	0.092	-2.46	6.0	0.014
	Eel	-0.163	0.089	-1.83	3.3	0.067
	Perch	-0.251	0.070	-3.57	12.7	0.000
	Pike	-0.283	0.074	-3.81	14.5	0.000
	Zander	-0.154	0.094	-1.63	2.7	0.100
Other anglers seen while fishing (Quadratic)	Carp	0.058	0.031	1.87	3.5	0.061
	Eel	-0.003	0.043	-0.07	0.0	0.950
	Perch	0.077	0.027	2.85	8.1	0.004
	Pike	0.078	0.029	2.69	7.2	0.007
	Zander	0.037	0.031	1.17	1.4	0.240

Attribute	Coding	Beta	s.e.	z-value	Wald	p-value
2-way Interactions with centrality-to-lifestyle						
Distance	Linear	0.004	0.001	3.00	9.0	0.003
Total fishing time	Linear	0.068	0.065	1.06	1.1	0.290
Total fishing time	Quadratic	-0.051	0.023	-2.18	4.7	0.029
Anglers seen	Linear	0.009	0.020	0.42	0.2	0.670
Anglers seen	Quadratic	-0.011	0.006	-1.77	3.1	0.077
Target species	Carp	-0.019	0.026	-0.73	0.5	0.460
	Eel	0.023	0.023	1.01	1.0	0.310
	Perch	0.066	0.027	2.42	5.9	0.016
	Pike	0.008	0.017	0.46	0.2	0.650
	Zander	0.012	0.038	0.32	0.1	0.750
Size	Linear	0.103	0.166	0.62	0.4	0.530
Size	Quadratic	-0.449	0.146	-3.07	9.4	0.002
CUE	Linear	-0.002	0.010	-0.15	0.0	0.880
CUE	Quadratic	0.001	0.000	3.15	9.9	0.002
3-way interactions with primary target species and centrality-to-lifestyle						
Size (Linear)	Pike	0.263	0.180	1.46	2.1	0.140
	Zander	0.221	0.194	1.14	1.3	0.260
	Perch	-0.114	0.188	-0.61	0.4	0.540
	Carp	0.201	0.191	1.05	1.1	0.290
	Eel	0.167	0.183	0.91	0.8	0.360
CUE (Linear)	Pike	0.014	0.026	0.53	0.3	0.600
	Zander	0.042	0.028	1.53	2.3	0.130
	Perch	-0.006	0.010	-0.57	0.3	0.570
	Carp	-0.019	0.094	-0.20	0.0	0.840
	Eel	0.040	0.052	0.76	0.6	0.450
2-way interaction with Alternative Specific Constant						
	Skill	-0.055	0.008	-7.14	51.0	0.000
LL	**L^2**	**BIC(LL)**	**AIC(LL)**	**df**	**$R^2(0)$**	**R^2**
-16955.6879	34393.6575	34065.4	33911.4	448	0.431	0.428

Note: Parameters significant at p<0.05 are in bold.

Please use one page for every angling trip

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

Fished Waterbody

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

Information about trip type and used gear

7. Who do you fish?	☐ Alone ☐ With family ☐ With friends ☐ Guide/Party boat	Number of the fishing person: ____
8. Angling location	☐ Natural shore ☐ Artificial shore ☐ Boat ☐ Commercial Party Boat	
9. Number of used rods per angling method	___ Pole fishing ___ Fish with death 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 Pikeperch
	___h Perch	___h Carp	___h Cyprinids
	___h Cod	___h Flatfish	___h Other species ____
	___h Pike	___h Salmoniden (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 the harvest?	1 2 3 4 5 6 7 8 9 10 (totally dissatisfied) ← → (totally satisfied)

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

Dairy

LANDESFORSCHUNGSANSTALT FÜR LANDWIRTSCHAFT UND FISCHEREI – *INSTITUT FÜR FISCHEREI*

Figure 4.1: Trip reporting form from the angling diary.

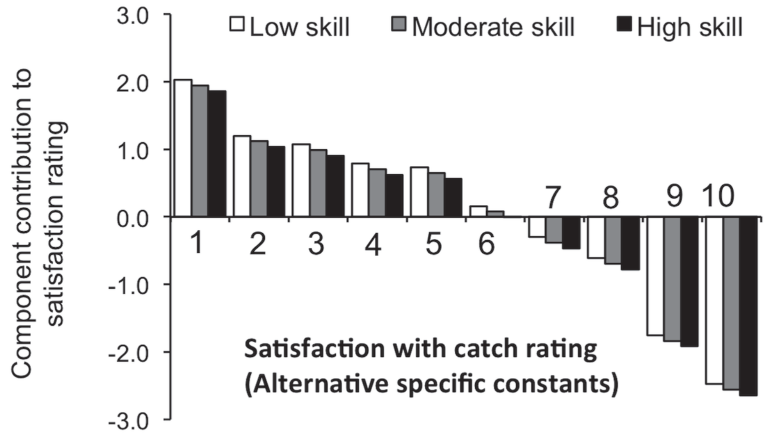

Figure 4.2: The effect of angling skill and the alternative specific constant on satisfaction with catch, all else being equal. Skill levels were defined by z-scores of -1.3 (low), 0 (moderate), and 1.3 (high.)

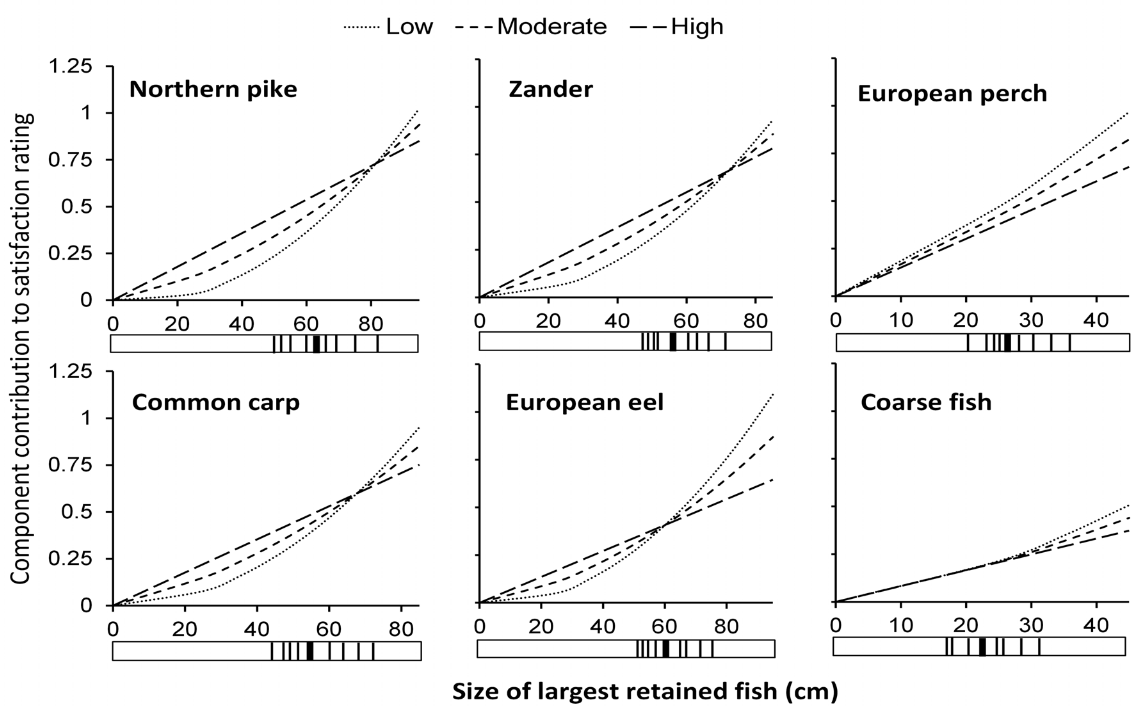

Figure 4.3: Effect of fish size on satisfaction with catch across six freshwater species for three levels of centrality-to-lifestyle. Moderate centrality-to-lifestyle represents the average angler, while low and high centralities represent the bottom and top 10% of the centrality range respectively. The lines in the horizontal bars below each panel indicate the size of fish observed in our dataset in increments of 10%. The thick line in the bar represents the median size observed.

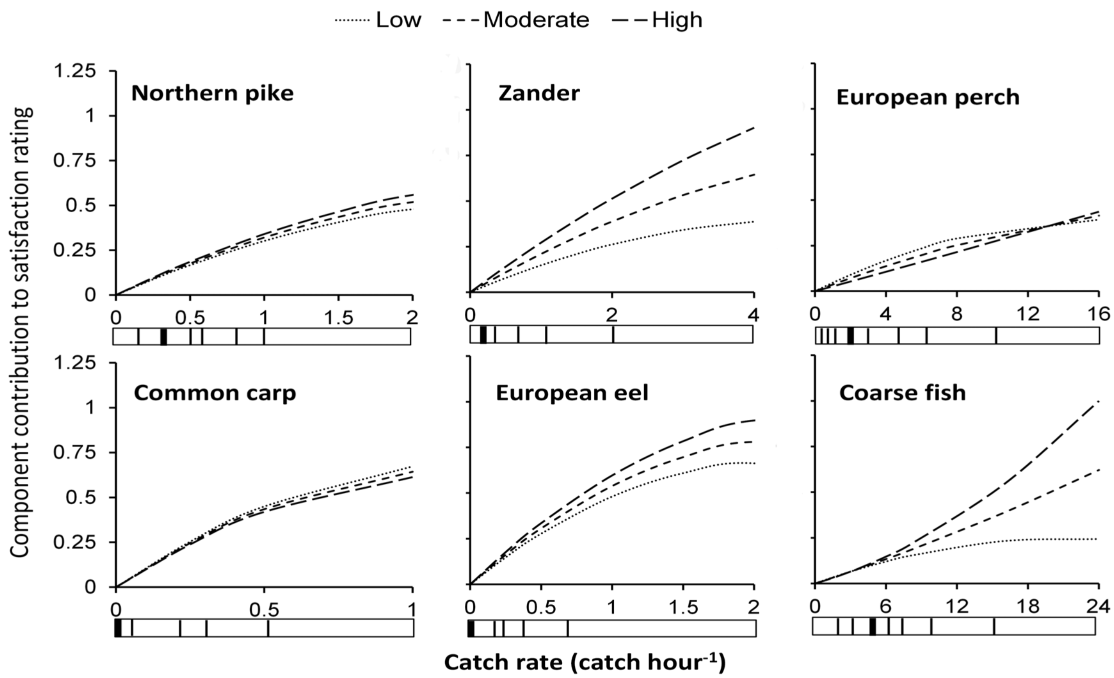

Figure 4.4: Effect of catch per unit effort (CUE) on satisfaction with catch across observed CUE values for six freshwater species and three levels of centrality-to-lifestyle. Moderate centrality-to-lifestyle represents the average angler, while low and high centralities represent the bottom and top 10% of the centrality range respectively. The lines in the horizontal bars below each panel indicate the size of fish observed in our dataset in increments of 10%. The thick line in the bar represents the median size observed.

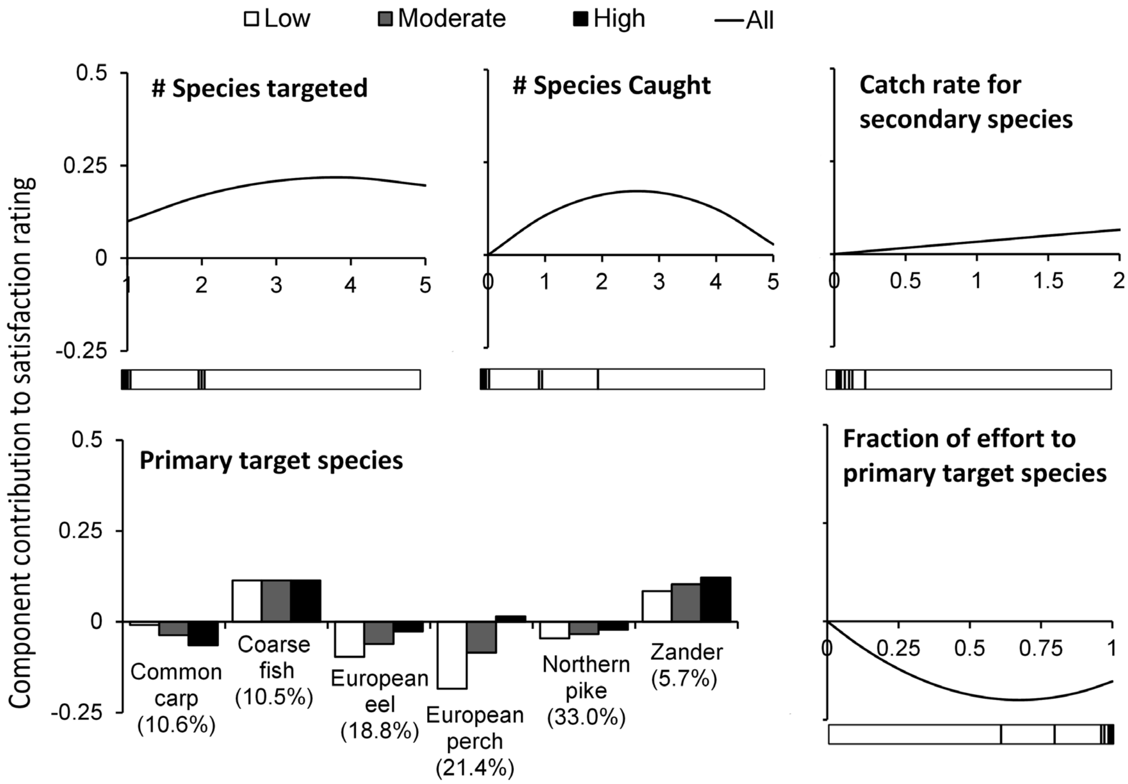

Figure 4.5: Species composition effects on satisfaction with catch. Interactions with centrality-to-lifestyle were only significant for choice of target species. The vertical lines below each panel depicting a continuous function indicate 10 percentile increments with the median values indicated by a thicker line. Values of percent given in the primary target species panel indicate the fraction of all trips for which that species was the primary target.

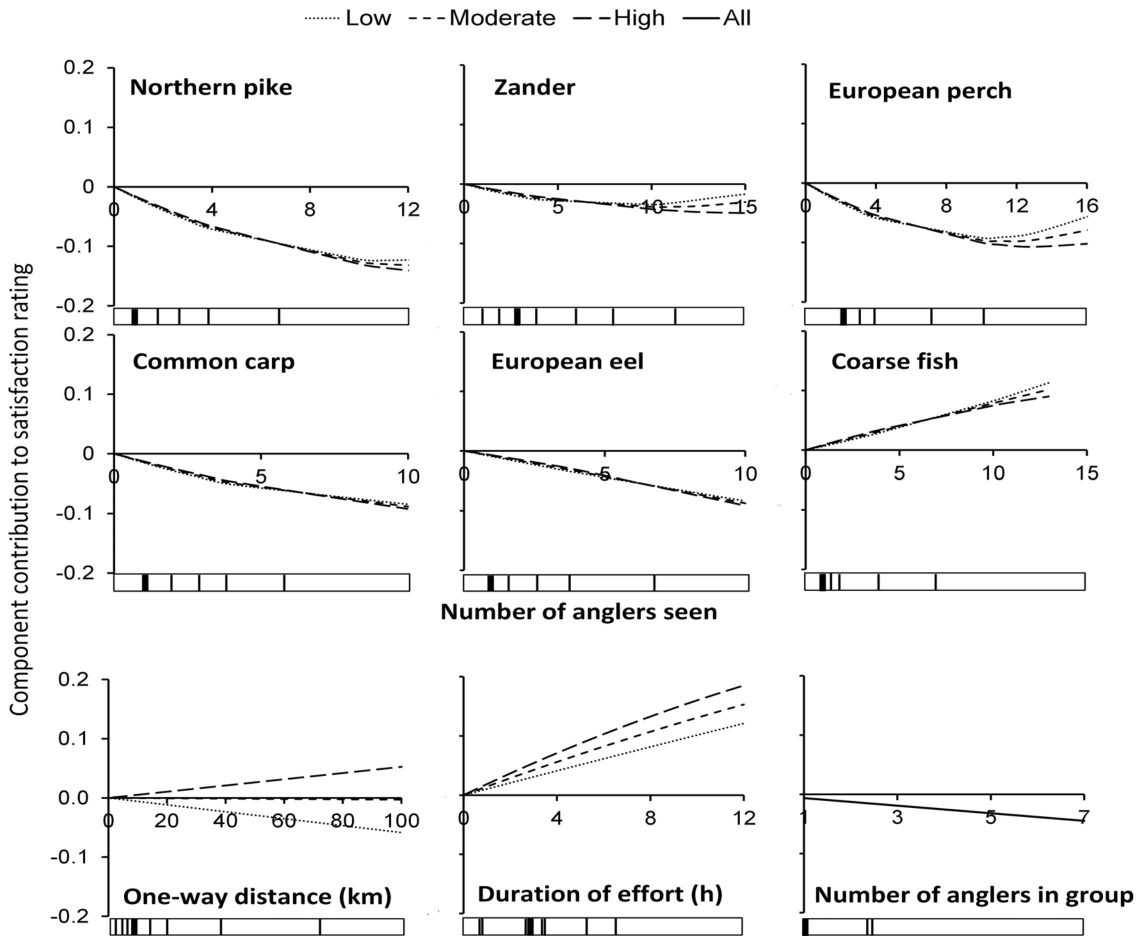

Figure 4.6: Trip characteristics affecting satisfaction with catch. Where significant, interactions with centrality-to-lifestyle are presented for three levels of specialization characterized by index values of -1.3 (Low), 0 (Moderate) and 0.9 (High) representing the 10th, 50th and 90th percentiles respectively.

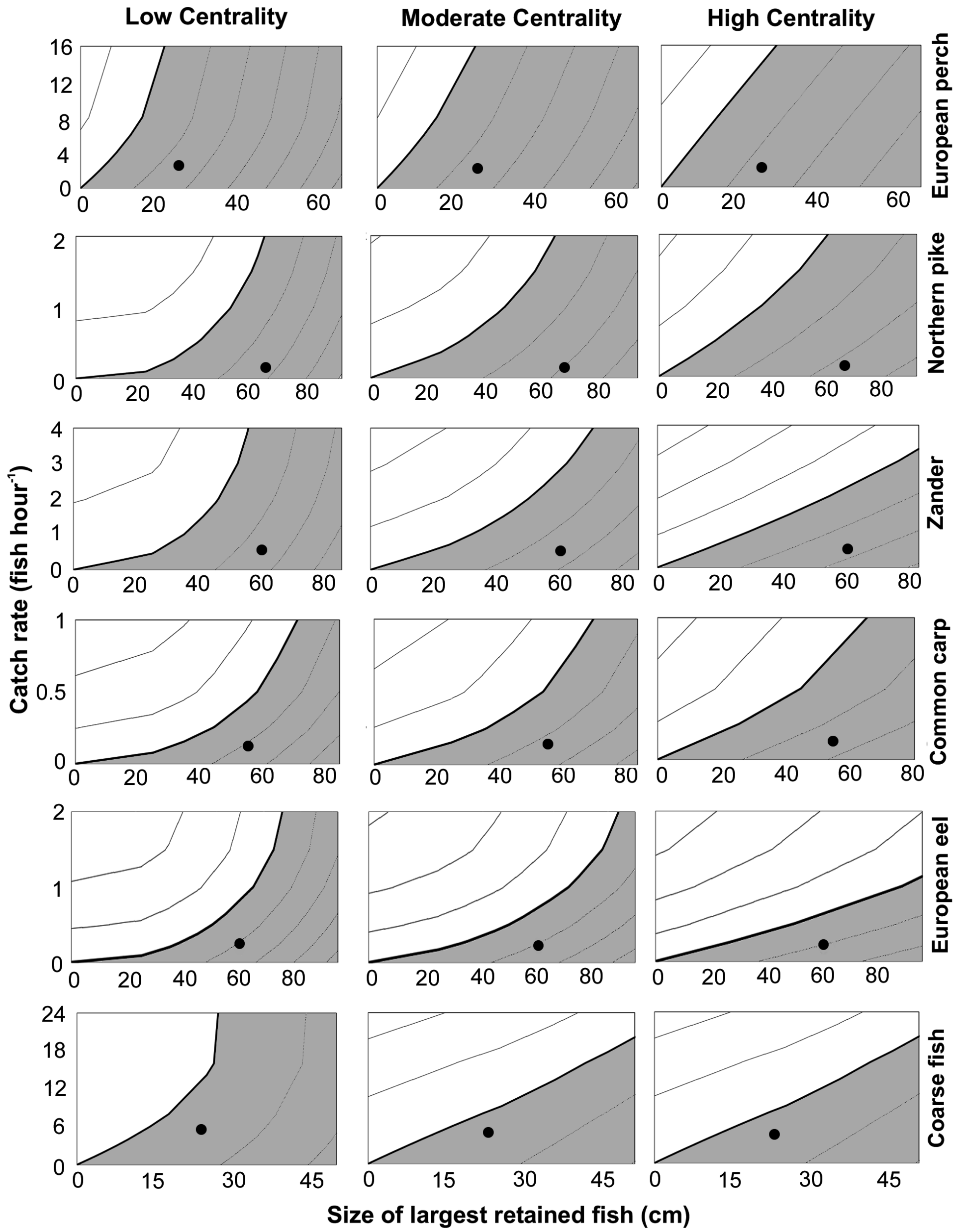

Figure 4.7: The relative importance of catch rate (CUE) versus size of largest retained fish to angler satisfaction with catch calculated as $\beta_{CUE} - \beta_{Size}$. The solid black line represents equality between the two catch outcomes' influence on satisfaction with catch, while contours indicate increments of 0.25. Grey shaded areas of each plot indicate trip outcomes where size of fish contributes more to satisfaction with catch than does CUE. Black dots in each panel indicate the mean catch outcome for each species reported from respondents' diaries.

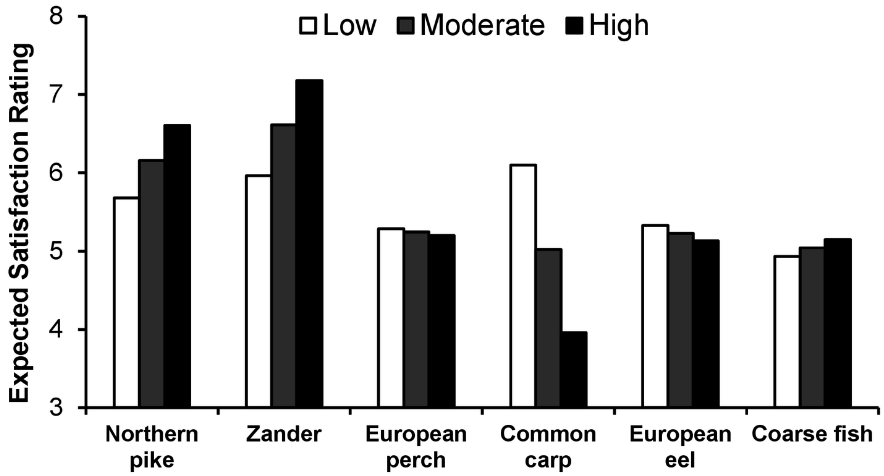

Figure 4.8: Expected satisfaction ratings for average fishing experiences across six species for three levels of centrality-to-lifestyle.

Chapter 5. The Elasticity of Fishing Effort Response and Harvest Outcomes to Altered Regulatory Policies in Eel (*Anguilla anguilla*) Recreational Angling

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Abstract

Understanding how fishing effort responds to management interventions is important for conserving threatened fisheries resources such as the European eel (*Anguilla anguilla*). In this paper, we use a discrete choice survey to predict the allocation of recreational angling days directed at eel versus potential substitute fishing opportunities in northern Germany as a function of eel angling regulations, catch attributes and hypothetical eel fishing costs. We found the allocation model to accurately predict current eel effort allocation patterns. Using the validated statistical model as a forecasting tool, we found eel angling effort to be largely resilient to changes in individual eel angling regulations, including daily bag limits, daily rod limits and fishery closures for up to two weeks each month. An inelastic effort response to the most commonly discussed policy interventions suggests that managers cannot expect to substantially reduce eel fishing effort, and thus mortality exerted by anglers on eel, using moderate management interventions. However, when severe regulations, including a two week closure per month, with remaining days limited to a harvest of 1 eel, 60 cm or larger, per angler using a single rod, would be implemented, angling effort devoted to eel can be expected to be reduced by about 42% relative to current conditions at unaltered expected catches. This would reduce landings of eel by anglers by 73%. This reduction in landings has unknown effects on the future recruitment of eel while at the same time substantially reducing angler welfare. Angler welfare can be largely maintained by increases in minimum-size limits and reductions in daily bag limits, while at the same time reducing eel landings by anglers substantially. Such actions are therefore preferred from an angler welfare perspective.

Key words: bag limit; discrete choice experiment; effort allocation; minimum-size limit; recreational fisheries; substitution; temporal closure

5.1. Introduction

Recreational fisheries constitute the dominant use of wild fish stocks in all freshwater and many coastal zones in all industrialized nations (Arlinghaus et al., 2002; Arlinghaus and Cooke, 2009). When fisheries resources become scarce, recreational angling effort, and the mortality it induces on fish populations, may need to be regulated (Post et al., 2002; Lewin et al., 2006). Any form of effective planning of recreational fishing regulations, however, necessitates understanding of anglers' behavioral responses to new regulations because almost inevitably changes in regulations change the attractiveness of a given fishing opportunity to anglers (e.g., Radomski and Goeman, 1996; Johnston et al., 2010; Metcalf et al., 2010). Anglers may respond to a suite of changes in the fishing experience (e.g., type of regulation in place, catch rates, size of fish, crowding) by (i) changing angling frequency, (ii) substituting alternative sites, or (iii) substituting other species to target (e.g., Post et al., 2002; Beard et al., 2003; Ditton and Sutton, 2004). When angler behavior does not align with regulatory objectives, management policies may fail (Pierce and Tomcko, 1998; Cox et al., 2002; Sullivan, 2003). Therefore, it is important to understand angler behavior when designing management regulations for a particular fishery or fish species. However, little human dimensions research is available on this topic so far (Radomski et al., 2001; Johnston et al., 2010).

Choosing the right fishing regulation to meet stated management objectives is a hotly disputed topic in recreational fisheries, with contrasting opinions occurring because regulations differ in their biological and social effects (e.g., Radomski et al., 2001; Paukert et al., 2001; Arlinghaus, 2007). For example, daily bag limits may fail to meet management objectives to reduce fishing mortality, because they do not necessarily curtail total angling effort on a given fishery (Radomski et al., 2001). One line of argument advocates more active management of angling effort rather than reliance on traditional output-oriented harvest regulations (e.g., daily bag limits or size-based harvest limits), and stock enhancement tools (i.e., stocking practices) (Cox and Walters, 2002; Pereira and Hansen, 2003). Managers tasked with the responsibility of limiting recreational fishery harvests are then faced with the issue of predicting the biological effects of regulatory changes. One important component of this context is answering a critical social scientific question: how do changes in angling regulations and catch quality impact angling frequency for a certain fish species in the future? This question may be rephrased in economic terms (Case and Fair, 1999): how elastic is the angling demand (i.e., angling effort) to changes in the fishing environment?

Previous studies examining angling effort responses to altered fishery conditions have reported conflicting findings, with angling effort either decreasing strongly (Beard et al., 2003) or remaining largely unaltered despite changes in the fishing environment (Prayaga et al., 2010). Inelastic angling effort responses to changes in regulations or other attributes of the fishing experience are most likely to occur when few substitute species or locations are available, as in fisheries-sparse landscapes, or for species that have largely unique qualities. One such species is the European eel (Anguilla anguilla), which is highly valued by recreational anglers for its consumptive qualities in central and western Europe where no other fish species share similar culinary characteristics (Dorow et al., 2009, 2010). Eel anglers in these regions may therefore be either largely unresponsive to changing eel harvest regulations due to a lack of available substitutes or they may react strongly to additional constraints on harvesting possibilities.

As with eel populations worldwide, the European eel population has declined dramatically. Current recruitment levels have fallen to less than 10% of the average value recorded between 1970 and 1994 (ICES, 2008), and the stakes are particularly high, given that the species comprises a single panmictic population (Dannewitz et al., 2005) and the fishery is of great socio-economic importance throughout Europe (Dorow et al., 2009, 2010). Understanding angler effort responses to altered regulations for eel is thus particularly important for this species (Feunteun, 2002; Dekker, 2008). A range of potential causes for the eel decline affecting both the oceanic and continental stages of this catadromous species have been identified (Feunteun, 2002; Dekker, 2009), Sources of eel mortality in the marine environment include the effect of changing nutrient conditions in the spawning grounds and climate change-induced shifts in the Gulf stream on the survival and transport of the eel larvae to the European continental shelf (Knights, 2003; Friedland et al., 2007). During the continental stage, exploitation of the different life stages by commercial and recreational fishing, pollution, predation by piscivorous birds, habitat loss, parasites, and hydropower use have all been identified as contributors to the decline in the European eel population (Feunteun, 2002; Starkie, 2003; ICES, 2008; Dekker, 2009). Unfortunately, these factors act simultaneously, and their relative contribution to the eel decline is as yet unquantified (Starkie, 2003; Dekker, 2009). In many river catchments, basic information on eel escapement during annual spawning migrations is also inadequate (Bilotta et al., 2011). Uncertainty about the causes of the eel decline thus poses a significant challenge for identifying effective interventions to conserve this species.

Despite the limited availability of information concerning the cause of the eel decline, urgent political and management actions have been initiated to conserve the panmictic eel population throughout Europe. The European eel has been red listed as critically endangered by the International Union for Conservation of Nature (Freyhof and Kottelat, 2008). In 2007, the species was also listed by the Convention on International Trade in Endangered Species of Wild Fauna and Flora to control its international trade, and the European Union (EU) adopted a regulation (EC, 2007), requiring European member states to develop eel management plans at a river basin scale by the end of 2008. States whose management plans are not approved by the EU would face immediate reductions in total eel fishing effort by at least 50% or implementation of other measures to reduce eel harvests by half (EC, 2007). While the effectiveness of such measures from a biological perspective is as uncertain as our understanding of the causes of decline, a 50% reduction in fishing mortality would have significant socioeconomic welfare impacts on recreational as well as commercial eel fisheries in central and western Europe (Dekker, 2008; Dorow et al., 2010). Thus, in countries where eel is highly valued for its meat (e.g., Germany), banning recreational eel take altogether (as for example implemented in Norway and Sweden since 2009; ICES, 2010) is not a priority for managers. Instead, policy alternatives that implement less drastic fishing regulations that allow for continued access to the resource while meeting the management goals set by the European Union are emphasized (Dorow et al., 2009, 2010).

Traditional recreational fishing regulations, such as daily bag limits, size-based harvest limits or gear restriction, or even partial temporal closures to eel fishing (EC, 2007), can only be “effective” to the extent they affect fishing-induced mortality (Cox and Walters, 2002; Cox et al., 2002). Fishing-induced mortality may be reduced by directly restricting harvest rates of captured fish (e.g., by increasing a minimum-size limit) and/or by reducing fishing effort, either indirectly as a correlated response to altered harvest regulations or directly. Indirect effort limitations retain angler sovereignty over individual participation levels, relying instead on (dis)incentives (e.g., higher licence fees, gear restrictions). Direct regulation of effort includes such regulations as permit lotteries, or spatial or temporal closures. Certain regulatory policies combine these mechanisms to compound their intended conservation benefits. For example, daily bag limits, in addition to their direct influence on harvest rates, have been found to also reduce effort from consumptively oriented angler populations (Beard et al., 2003; Cox et al., 2002). It is currently unclear how such traditional harvest regulations would affect eel angling effort and harvests. Consequently, the ability of eel management plans using such strategies to meet E.U. targets for recreational eel fisheries also remains obscure. This void provides the impetus for our study to understand likely angling effort responses to altered policies. However, our study stops short of modelling of the impact of regulatory changes on the eel stock given the lack of evidence relating stock size in a given catchment to recruitment along the European coast.

5.2. Material and Methods

5.2.1. Study area and data collection

To predict anglers' allocation of effort towards European eel, a mail survey was sent to a random sample of eel anglers residing in the German state of Mecklenburg–Vorpommern (M–V). This region is particularly suitable for our study given the importance of eel to both the commercial and recreational fishing sectors. This species comprises the largest inland commercial fishery in the state, harvesting ~136 t yr−1 (Statistisches Amt M–V, 2007). Eel are also highly prized for consumption by recreational fishers, and while harvest data on recreational fisheries is sparse, initial estimates for Mecklenburg–Vorpommern suggest that resident and non-resident anglers harvest as much as 187 t yr−1 (Dorow and Arlinghaus, in press). This indicates that the size of the recreational eel-fishing sector is substantial.

Anglers were recruited to participate in a twelve-month angling diary program (September 2006 to August 2007) using a combination of random digit telephone calls and random selection from a M–V recreational fishing licence database (see Dorow and Arlinghaus, in press, for details). From this sample, eel anglers, defined as those who had targeted or caught eel within 12 months prior to the start of the diary program, were selected for a mail survey. A 14 page questionnaire[6] incorporating a choice-experiment and a series of other questions designed to characterize eel angler types and their opinions about eel management (see Dorow et al., 2010, for details) was mailed in April 2007 to 381 eel anglers, with a telephone reminder following two weeks later. This yielded a final sample of 193 (53%) eel anglers for this study.

5.2.2. Survey instrument

The main component of the survey comprised a discrete choice experiment that presented respondents with several choice sets consisting of pairs of hypothetical eel angling days (i.e., scenarios, **Figure 5.1**). Each eel scenario was characterized by certain catch expectations (average number and average length of eel in the catch), distinct eel angling regulations supposed to be in effect (daily bag limit, minimum-size limit, daily rod limit, duration of a monthly eel fishery closure) and the hypothetical change in costs associated with angling for eel under those conditions. For the purposes of this study, the cost of fishing was purposely represented in broad terms, to include increased costs associated with permit fees, bait/tackle or travel to more remote angling locations. For each of these attributes three or four levels were identified (**Table 5.1**), which were systematically varied in the survey using a fractional factorial experimental design to produce 64 pairs of eel angling scenarios blocked into 16 survey versions (**Figure 5.1**). This design allowed estimation of the main effects, and certain interactions (compare Raktoe et al., 1981). The page prior to this section of the survey presented a sample choice set and provided detailed instructions on how to interpret the scenarios. Anglers were informed to assume that only the displayed criteria and no others differed from the current state of recreational eel fishing in M–V. Respondents were then asked to complete two separate tasks. The first response task, presented in detail elsewhere

[6] Appendix G, p312.

(Dorow et al., 2010), was to simply select their preferred eel angling scenario from each pair (**Figure 5.1**). The second response task, upon which the present study is focused, required anglers to allocate a total of 10 days available for fishing among six alternative types of angling opportunities in the region and included the eel fishing scenarios presented. Alternatives thus consisted of one of the two eel scenarios from the first task and five base alternatives: freshwater non-predatory species (hereafter called coarse fish for simplicity), freshwater predatory species, unspecified freshwater targets, coastal fishing, and a non-fishing activity. The allocation task was repeated for both eel scenarios in each pair, thereby ensuring full use of the orthogonal design space, and yielding eight separate allocations per respondent.

While a choice experiment relies on anglers' statements of behavioral intention rather than observations of actual choice behavior, a hypothetical survey-based approach was warranted to meet study objectives, because many of the examined eel fishing regulations were not currently in use (Hunt, 2005). The response task was also behaviorally more realistic than traditional single item opinion-type surveys where anglers rate individual regulations or their components independently from each other (Aas et al., 2002).

Our choice experiment is unique in the recreational fisheries literature in the manner it elicits and models effort allocation decisions over multiple hypothetical fishing trips. Typical choice experiments ask respondents to choose their single most preferred option from among the alternatives (Louviere and Timmermans, 1990), whereas we asked respondents to allocate ten choices (i.e., days) among the alternatives provided in each choice set (compare Louviere and Hensher, 1982; Borgers et al., 2007). When dealing with repeated behaviors, as with anglers who hold annual licences, this frequency-based approach offers an important advantage over a conventional choice experiment (Christie et al., 2007), because the allocation task refines measurements of angler preferences. It does so by allowing preferences for marginally less acceptable alternatives (i.e., fishing alternatives that receive some, but not most of an angler's effort) to be included in the analysis. For this reason, frequency-based choice experiments may provide better predictions of actual behavior than traditional choice experiments (Christie et al., 2007).

5.2.3. *Theoretical grounding and statistical modelling*

Analyses of all discrete choice experiments are grounded in random utility theory (McFadden, 1974). This theory states that human decisions are a function of the attributes of the available alternatives, and individuals select options that maximize personal utility, an unobserved (i.e., latent) measure of well-being for an individual (McFadden, 1974). Most commonly, analysis of choice experiments assumes that error in the utilities follows a Gumbel distribution (Louviere et al., 2000) allowing researchers to fit a multinomial logit (MNL) regression model to observed choices (McFadden, 1974), such as those expressed in our choice survey:

$$P_i = \frac{e^{\alpha_i + \sum_1^j \beta_{ij} x_{ij}}}{\sum_{i=1}^k e^{\alpha_k + \sum_1^k \beta_{ik} x_{ik}}} \qquad (5\text{-}1)$$

where the probability of choosing alternative i is equal to the exponent of utility of alternative i, consisting of the sum of the alternative specific intercept value (i) and the contributions, termed part worth utilities (PWU), attributed to each of j attributes of that alternative ($\beta_{ij}x_{ij}$, where β_{ij} represents the regression coefficient and x_{ij}, the attribute value) divided by the sum of utilities raised to the exponent for all k alternatives available to that individual.

The analysis of frequency-based choice experiments differs from simple choice tasks only in the treatment of the dependent variable modelled with Eq. (1). Accordingly, rather than treating each choice expressed by the respondent in the survey as a single discrete event, each alternative is assigned a probability of being chosen in proportion to its allocation of units in the task. In our application, the units of allocation are angling days (**Figure 5.1**). Each alternative (e.g., eel, coarse fish, predatory fish, etc.) is then treated as an observation, whose replication weight is equal to the probability of being chosen (Vermunt and Magidson, 2005). Unchosen alternatives have a weight of zero and therefore drop out of the calculation, while every alternative that receives at least one allocated day is retained when fitting the model. In this way, the sum of replication weights for all alternatives in an individual's choice set equals one. To analyse our eel angling choice data, we fitted a MNL using the software Latent Gold Choice 4.5 (Vermunt and Magidson, 2005). Preliminary analyses were conducted with all attributes effects-coded (Louviere et al., 2000) to produce separate, unbiased PWU estimates for each level of an attribute that sum to zero within each attribute and are therefore independent of the model constant. Using this treatment, all main effects as well as the interactions between each attribute and the six alternatives were examined. In the interest of model parsimony, further reductions were made to the number of parameters by treating the cost attribute as a simple linear function and eliminating all insignificant interactions. These reductions resulted in no appreciable loss in model fit, as indicated by the Akaike Information Criterion (AIC).

5.2.4. Model validation

Before applying the parameterized MNL model as a forecasting tool to predict the impact of changes in eel angling regulations on effort, we first validated it using the model's ability to predict current eel angling effort. To this end, we compared angling effort for eel under current conditions in the study region of M–V estimated from our statistical model with observed eel angling effort using information from a complimentary year-long diary study conducted with the same survey respondents (Dorow and Arlinghaus, in press). Predicting the proportion of effort allocated to eel under the status quo required specifying attribute levels for eel angling regulations and catch characteristics that reflected current conditions. Specific eel angling regulations in M–V may have differed across the state, as some water bodies were managed by different fishing rights holders (Daedlow et al., in press). In most cases, however, eel regulations across M–V conformed to the minimum standards set by state fisheries legislation, consisting of a minimum-size limit for eel of 45 cm, a daily bag limit of three eels, a maximum of three rods per angler and no closures for eel fishing (M–V, 2005, 2006).

The mean number of eel caught during an angling trip was calculated as an average of the ratio of summed catches over the total number of trips for each angler. Because the diary did not ask respondents to report average sizes of their eel catch, but rather the size of the largest retained eel (Dorow and Arlinghaus, in press), to estimate the average size of caught eel, the mean size of the largest eel for trips where only one eel was caught was used. Similar to the number of eels caught per trip, the mean size was first calculated for each angler and then averaged across anglers. A total of 186 trips reported catching a single eel, with the mean length caught by each angler being 59.5 cm (±s.e. = 1.16 cm, n = 72 anglers). Their catch attributes were used in the status quo modelling exercise.

The cost attribute in the survey was presented as an increase over the current daily expenses associated with eel angling; therefore respondents were asked to provide an estimate of their total cost per day to go eel fishing excluding licence fees. We added to this estimate the self-reported yearly licence expenses incurred for all angling in M–V divided by the number of angling days for each survey respondent. Accordingly, the current mean cost of an eel angling day was estimated at 17.44€ (±s.e.=1.40€, n=127 anglers). This value was taken as the base for calculations of the relative change in cost from the status quo.

The above-mentioned regulations and average eel catch characteristics reflected conditions under which angling days are currently allocated to eel fishing. Accordingly, we defined a status quo as having an average catch of a single 60 cm eel per day, with a daily bag limit of 3 eels, a minimum-size limit of 45 cm, a maximum of three rods per day and no increase in current financial costs for eel fishing. The status quo scenario also included no temporal closure because this management approach had not as yet been implemented in the study region. These attribute levels were imported into the statistical effort allocation model, and the predicted eel fishing effort was compared with the observed angling effort allocation in the study region as derived from self-reported effort allocation in the diary. This procedure was intended to test the predictive validity of using behavioral intention as revealed by the allocation task to predict actual behavior towards eel angling in the study region.

5.2.5. Effect of regulations on effort

After validating the statistical model, two sets of scenario analyses to predict eel angling effort to changes in configuration of eel angling attributes were conducted. First, we calculated the elasticity of demand for all significant catch (catch rate and size of eel) and regulation (daily bag limit, daily rod limit, temporal closure, cost) attributes by altering each attribute from its status quo baseline to each level given in the choice experimental design (see **Table 5.1**). The percent change in the attribute level from the status quo (Δxj) and the associated percent change in predicted angling days allocated to eel (Δy) were then calculated. With this information, elasticities (E) of demand were calculated as the ratio, $E_{x,y} = \Delta xj / \Delta y$ (Case and Fair, 1999). These calculations were conducted for all attributes significant in the choice model at $p < 0.10$, and this liberal significance value was chosen to model potential angling effort responses that were not statistically significant due to the low sample size of the survey, but that might be managerially relevant. A value of $E_{x,y} < 1$ indicates an inelastic angling demand, whereas values $E_{x,y} > 1$ are considered elastic demand (Case and Fair, 1999). The elasticity analysis was used to examine the magnitude of eel angling effort and its sensitivity or responsiveness to changes in attributes of the eel angling experiences. By removing the unit of analysis and expressing only the relative change within each regulation, effort response to all types of regulations can be directly compared.

5.2.6. Scenario analysis of effort changes to altered regulatory policies

Additional analysis using the parameterized effort allocation model was conducted to explore the combined effect of changes in multiple eel catch qualities and regulations on eel angling effort. To this end, the status quo was compared to various predetermined policy and management scenarios in the study region for illustrative reasons. These scenarios reflected an increasing degree of regulatory strictness and were designed because narrative interviews with eel managers in the study region indicated that forthcoming regulatory changes would most likely involve multiple eel regulations. Note, however, the scenarios presented in this paper represent only a few potential regulatory combinations, and managers may wish to test other combinations using the results presented below. This analysis was also restricted to attributes significant at $p < 0.10$. First, a set of moderately stronger regulations relative to the current situations composed of a daily bag limit of two eels, a daily rod limit of two eel rods, and a seven-day monthly closure was explored. Second, we examined a scenario comprising highly restrictive regulations composed of daily bag limits of a single eel, and a daily rod limit of one rod combined with a fourteen-day monthly closure. Finally, we investigated a potential outcome if the severe regulations mentioned above were to lead to increased stock abundance and improved eel catch expectations that may again attract effort. The goal of all scenario analyses was to help decision-makers understand how eel anglers will likely react to eel management policies and their resulting impacts on catch quality.

5.2.7. Effect of regulations on harvest

As the stated management objective for the EU regulation threatened a 50% closure of the fishery is a reduction in fishing mortality rather than effort to achieve a certain prescribed escapement level of silver eels, establishing a relationship between effort levels and eel harvests is insightful for evaluating the potential for success. To this end, we performed a linear regression to predict changes in total eel harvests due to total effort reductions based on the diary data (Dorow and Arlinghaus, in press) for 149 water bodies (i.e., sampling units) where eel were targeted. Additionally, direct effects of certain regulations, namely minimum-size limits and daily bag limits, were also estimated based on the distributions of daily harvest number and size of creel as reported in the diary data. By assuming that every legally harvestable eel in this highly consumptive fishery is retained, these distributions provided a baseline from which to establish harvest reduction associated with more stringent input and output regulations. Assuming that reductions in effort act proportionally on all harvest characteristics (i.e., the distribution of catch numbers and sizes does not differ with varying levels of effort) we then estimated total harvest reductions that accounted for changes in effort plus any direct harvest reduction as a consequence of changes to output regulations. From this analysis, we calculated the effect on harvest, both of individual attributes from within the discrete choice experiment, and also of each scenario described above.

5.3. Results

5.3.1. Survey responses and sample description

The survey yielded a response rate of 53%, with n=193 eel anglers returning completed questionnaires. A comparison of respondents and non-respondents, based on information collected at the time of recruitment, (n = 173) revealed no significant differences in socio-demographics (age, education, monthly income and household size) or angling specific criteria (angling experience, annual angling frequency, importance of fishing, angling club membership) (see Dorow et al., 2010, for details). Consequently, non-response bias was assumed to be negligible.

Respondents were overwhelmingly male (97.7%), of mean age 42 years (±s.e. = 1.1, n = 193). The majority (63.5%) were members of a local angling club. Respondents to our survey had a mean of 22.4 years (±s.e. = 1.4, n = 193) of fishing experience with a long history of targeting eel (mean = 18.7 years, ±s.e. = 1.02, n = 182). In 2006, they reported fishing for eel an average of 11.8 days (±s.e. = 1.2, n = 180). Of these days 89.7% were reported in freshwater systems (61.1% in lakes and ponds and 28.7% in rivers and canals) with the remaining effort occurring in coastal waters and estuaries. The majority of respondents (77.8%) reported using worms as their primary bait for catching eels. Typical bait worms used in the region are of the earthworm family (*Lumbricidae*).

5.3.2. Effort allocation model

Model selection was based on maximizing overall fit while including all main effects and significant interactions with the model constants (**Table 5.1**). Effort allocation to eel was strongly affected by the alternative specific constants, i.e. the types of fishing opportunities presented as alternatives, irrespective of the level of eel regulations and expected eel catches (**Table 5.1**). These constants indicated that all things being equal, respondents allocated a significantly higher proportion of their intended effort to eel relative to other fishing experiences, but they also allocated significant effort to predatory fish in freshwater fisheries. The non-fishing option was the least chosen of all alternatives. Note that model constants were only significant for eel and predatory fish (both positive) and coastal fishing and not fishing (both negative).

The parameter estimates for the eel catch and regulation attributes and their impact on effort allocation followed expected trends (**Table 5.1**). Anglers' allocation of effort to eel was significantly and positively influenced by the average number of eel caught ($p < 0.01$) with catch rates of three eels increasing allocations to eel. The average size of eels also had an effect on effort allocation, with anglers avoiding the eel alternative when presented with the smallest average size of captured eel in our scenarios (50cm in length; $p < 0.05$). Larger average sizes had no significant effect on effort allocation to eel. We cannot extrapolate outside the attribute levels presented in our survey, but it is likely that disutility was also high for fish smaller than 50 cm total length in the catch.

In terms of regulations, eel effort allocation was significantly negatively affected by stringent daily bag limits consisting of one eel per day and a proposed 14-day temporal closure per month ($p < 0.001$), while more relaxed daily bag limits of two or three eel per day and monthly closures up to seven days had a significantly positive effect on eel angling effort. By contrast, effort allocation to eel remained largely unaffected by changes to minimum-size limits (minimum $p = 0.136$). While daily rod limits had only a moderate effect on allocation to eel (minimum p value of 0.07 for a 1 rod limit), this attribute also exhibited significant interactions with the other non-eel fishing alternatives (**Table 5.1**). At low rod limits, anglers allocated significantly more effort to all other non-eel fishing activities and avoided eel, while at high rod limits, anglers more strongly avoided fishing in freshwater for other predatory species or in coastal waters and instead targeted eel more frequently. Finally, an increase in financial cost to eel fishing implemented, for example, through a daily eel permit, was associated with the expected significant decline in angler utility indicated by reduced effort allocated to eel as costs increased. These findings jointly highlighted that eel angler effort responses were non-linearly dependent on the type and degree of eel regulatory measures, the eel catch qualities expected and the financial cost for eel fishing.

5.3.3. Model validation

The fully parameterized choice model from **Table 5.1** allowed us to predict the fraction of total effort by the surveyed anglers devoted to eel for various combinations of regulations and eel catch qualities (exemplified in **Figure 5.2**), but it was based on hypothetical responses by anglers in the survey. Under the current conditions for regulations and catch attributes, the model predicted 24% of all days are allocated to eel with the remaining effort divided among the other non-eel fishing alternatives (**Figure 5.2**). By comparison, for survey respondents who reported targeting eel in M–V in their diaries, the mean fraction of angling days devoted to eel was 22.4% (±s.e. = 2.3%, n = 114 anglers) in the angling season of 2006–2007. The point estimate of the predicted eel angling effort allocation fell within the confidence interval (22.4% ± 4.5%), of the true eel allocation behavior, providing a validity test of the choice model in **Table 5.1**. The statistical model could thus be used to forecast eel angling effort as a function of eel angling regulations, catch attributes and costs.

5.3.4. Effect of regulations on eel angling effort

Elasticity analysis for all significant attributes independent of one another revealed that angling demand for eel was strongly inelastic (i.e., $E_{x,y} < \pm 1$) to changes in individual attribute levels relative to current conditions across all individual regulations tested (**Table 5.2**). The sign of the elasticity value indicates the direction of the angling effort responses relative to the change in attribute levels. For example, as costs for eel fishing increased by 2.5 Euro, demand for eel angling decreased by 2.05% relative to the current situation resulting in a negative and highly inelastic value for total elasticity. The highest, yet still inelastic, elasticity values were found for decreases in the average size of eel from 60 to 55cm, followed by increases in average size to 65 cm, decreasing the supply of eel angling days per month by implementing a 14-day closure, implementation of a daily bag limit of 1 eel and a daily rod limit of 1 rod. All other attributes exhibited elasticity values close to zero.

Of similar interest are also the absolute changes to angling effort that may be expected by modifying certain regulations. Effort may be suppressed by approximately 15–17% relative to current levels by implementation of restrictive daily bag limits of 1 eel per day, daily rod limits of 1 eel rod per day or temporal closures of 14 days per month. By contrast, a similar increase in effort (+15%) may be stimulated by increasing the average catch from one to three eel per day. Thus, a combination of regulations and expected catches determine eel angling effort in a non-linear way.

While changing individual attributes exerted comparatively little effort response from eel anglers in the study region (i.e., inelastic effort response), combining regulatory policies into a mix of tools may have a greater effect on eel angling effort. This however was not the case for moderate changes to eel angling regulations compared to current conditions. Indeed, by moderately increasing the stringency of various eel harvest regulations jointly, anglers were predicted to reduce eel angling effort allocation by only

3% relative to current effort levels (**Table 5.3**). Thus, moderate changes in daily bag limits, daily rod limits and small temporal closures of 7 days per month can be expected to have a negligible effect on the total effort devoted to eel. By setting significant regulations to their strictest levels, however, managers can expect to achieve reductions in eel angling effort of about 42% relative to the current situation. Under this scenario, anglers are predicted to devote approximately 14% of their total angling days to eel compared to the 22–24% allocated to eel under current conditions (**Table 5.3**). Should anglers enjoy improved catch rates, effort is predicted to increase. With the addition of a second eel, eel angling effort can be expected to be 37% less than current, and with 3 eels per day (potentially a result of the conservation benefits stricter regulations), eel angling effort would fall by only 28% relative to the current conditions rather than 42% under the same policies without catch prospect improvements. Effort displaced from eel under this and other scenarios would be distributed among the remaining non-eel alternatives, predominantly to predatory fish in freshwater fisheries (**Table 5.3**).

5.3.5. Effect of regulation changes on eel harvest

To predict the potential reduction in eel harvest as a result of input or output regulatory changes, we first estimated a linear regression of total harvest on total effort for 149 water bodies receiving directed eel angling effort in the study region. This regression revealed a strongly positive relation between total angler days (x) and total harvest (y) ($y = 1.601x - 0.37$, $R^2 = 0.85$, $p < 0.001$). The slope of the regression suggested that 1.6 eel are harvested per angling day on an average water body (**Figure 5.3**). The regression intercept was found to be insignificant (ß = −0.37; s.e. = 0.33; t = −1.11; p = 0.28), while the slope of the regression of harvest on effort was highly significant (ß = 1.601; s.e. = 0.056; t = 28.36; p < 0.001).

Using the current distribution of daily eel harvests (**Figure 5.4**) and the size distribution of eel harvest by anglers (**Figure 5.5**), the potential savings of eel landing by anglers in response to changes to traditional harvest regulations and other tools was estimated. Under conditions of full compliance with regulations, a daily bag limit of two eels, alone, may directly reduce eel harvests by anglers by 13% (**Figure 5.4**). When the landings reduction effect stemming from reductions and daily bag limits and associated effort reductions are combined, eel take under this regulation could be reduced by as much as 15% (**Figure 5.4**). A more stringent daily bag limit of only a single eel could reduce overall eel harvests by as much as 51%.

Similar reductions in harvest may also be achieved using minimum-size limits (**Figure 5.5**). An increase in minimum-size limit to 50 cm would decrease harvests by up to 12%, while size limits of 55 cm and 60 cm could reduce harvests by 36% and 55% respectively. As our model found minimum-size limits within the range tested to have insignificant effects on effort, only direct effects on harvest are reported.

Combining various regulatory tools into more comprehensive management scenarios, the potential reduction in total eel harvest ranged from the moderate scenario of 17–73% harvest reduction (**Table 5.3**) relative to the current case of about 187 metric tonnes of eel harvest in the study region (Dorow and Arlinghaus, in press). Note that the combinations of regulations and catch qualities examined in **Table 5.3** represent only a few conceivable options for eel management. Other scenarios of specific interest may also be examined using parameters in **Table 5.1** as exemplified in **Figure 5.2**.

5.4. Discussion

Our case study of eel anglers in northern Germany highlights the importance of understanding recreational fisher behavior when planning for biological outcomes associated with regulatory changes, which is especially critical in the case of threatened populations. Regulations may either repel or attract fishing effort. Using a novel frequency-based choice experiment to predict angling effort responses to altered regulations, we found that eel angling effort response was inelastic to changes in catch and regulation attributes of the eel fishing experience. Thus, eel fishery managers across Europe should not necessarily expect proportional changes in recreational eel angling effort and subsequent harvest savings in line with changes to any individual input regulation. Instead, our model suggests that substantial changes to eel angling mortality are only likely once multiple regulations become highly restrictive and/or direct output control measures are implemented. Under such conditions, landings savings up of to 73% relative to current levels are conceivable. Whether this has any positive impact on the panmictic eel stock, however, is biologically unknown.

Respondents to our survey preferred all five fishing alternatives presented in our choice experiment over the non-fishing alternative, reflecting respondents' avidity for recreational fishing in general (Dorow et al., 2010). Of the fishing alternatives, freshwater options were preferred over coastal fishing, which may reflect higher travel costs for eel anglers living in inland communities. As may be expected for the angler subpopulation constituting our sample, the most preferred alternative was fishing for eel, with pronounced effort also occurring for other predatory fishes (e.g., pike (*Esox lucius*), perch (*Perca fluviatilis*), and zander (*Sander lucioperca*). These results confirm previous findings from German fisheries that anglers prefer predatory over non-predatory fish species (Arlinghaus and Mehner, 2004; Arlinghaus et al., 2008) and target eel primarily in freshwater (Dorow and Arlinghaus, in press).

Most of the attributes that we examined exerted significant, yet small individual effects on the number of days allocated to eel angling. The effect of catch qualities on eel angling effort allocation was apparent in both the number of eel caught and also their size. However, an increase of expected size beyond 55 cm was not associated with a significant increasing allocation in favor of eel, and once catch rates exceeded three eel per day, respondents actually decreased their rate of allocation to eel. These findings may be perceived as counterintuitive in light of other recreational fishing studies where larger sizes and higher catch rates were found to increase utility to anglers (e.g. Aas et al., 2000; Laitila and Paulrud, 2006; Oh et al., 2007), but they support the consumptive character of recreational eel fisheries in Germany and agree with existing harvest regulations for several reasons. First, size may exert little influence on effort allocation because aspects of trophy fishing are of low importance to eel anglers, possibly because smaller eels are judged to have a higher culinary value (Dorow et al., 2010). Second, as a recreational meat fishery, higher catch rates of eel are only important to anglers to the extent that catches may be retained. Daily bag limits in our study region as well as in our study never exceeded three eels per day; therefore, a fourth eel may not provide additional benefit to anglers.

Angler intentions to fish for eel were also significantly affected by changes in eel regulations, yet these angling effort responses were not commensurate with the relative change in the underlying regulatory attributes. Significant attribute levels were found for daily bag limits, daily rod limits and temporal closures, but not for minimum-size limits.

The latter finding was unexpected given previous findings that showed strong preferences of eel anglers for intermediate minimum-size limits in the study region of 50–55 cm. This preference for increasing the minimum-size limit over the status quo may reflect a perceived obligation to contribute to eel conservation, without the associated hardship imposed by more burdensome regulations such as temporal closures (Dorow et al., 2010). Our study, however, indicates that such preferences do not influence the amount of time allocated to eel fishing. Nevertheless, minimum-size limits may contribute substantially to conservation efforts through their direct effect on fishing induced mortality (Dorow et al., 2010). We found that increasing minimum-size limits to 55 cm may reduce harvest levels by 36%, representing 67 fewer tonnes harvested by anglers in the study region (assuming a current harvest level of 187 t yr^{-1}, Dorow and Arlinghaus, in press).

In contrast, we found that stricter daily bag limits of two or one eel per day (relative to three eel per day as currently the case) did reduce total eel angling effort. Similar effects of harvest control measures have also been described in another highly consumptive recreational fishery – walleye (*Sander vitreus*) in Wisconsin (U.S.A.) (Beard et al., 2003). Changes to angling effort through implementation of lower daily bag limits can be explained by their effect on reducing potential eel harvests, a primary benefit of this particular angling experience; however, angler perceptions of their ability to harvest eel also strongly contribute to this effect. The effect of perceived harvest constraints on angling effort dynamics is particularly clear when comparing the effect of minimum-size-limits and daily bag limits on harvest savings in our results. Both regulations act directly on harvests by anglers by constraining the sizes or numbers of eel that people can take home from each trip. Our findings suggest, however, that given current catch quality and regulatory levels, stricter minimum-size limits have greater potential to directly limit harvests than daily bag limits. Fifty five percent (103 t yr^{-1}) of harvested eel fall below the current mean size of 60 cm, while only 38% of harvested eel are in excess of the current average catch of one eel per day. Consequently, increasing minimum-size limits to 60 cm would directly reduce harvests more than decreasing daily bag limits to a single eel. Daily bag limits, however, compound their effects on harvest by also significantly reducing angling effort, whereas minimum-size limits apparently do not. As a result, predicted harvest reductions for a daily bag limit of one eel (51%, 94 t yr^{-1}) are similar in overall magnitude to increasing the minimum-size limit 60 cm. These results support previous findings that daily bag limits are ineffective when they do not constrain angling harvests but they affect angler expectations and behavior (Radomski et al., 2001; Cox et al., 2002; Beard et al., 2003). Thus, when appropriately set, output controls such as daily bag limits can be very effective at limiting recreational harvests due, in part, to their impacts on angling effort.

Allocation of angling days to eel was not only influenced by output control measures (e.g., daily bag limit), but was also significantly influenced by restrictive input (i.e., effort) control measures, namely the implementation of a 1 rod per angler daily limit and a 14-day/month temporal closure. Regarding daily rod limits, the complimentary diary study showed many anglers in the study region devote only a fraction of their rods to eel, preferring instead to target multiple species simultaneously (Dorow and Arlinghaus, unpublished data). A limit of two rods does not constrain eel anglers because there is little opportunity cost to directing one rod towards catching an eel while using the other rod to pursue other fishing prospects. Only at a limit of one rod are anglers forced to select a single target species. Hence, significant effects of daily rod limits on eel angling effort and displacement to other fisheries, mainly predatory fish in freshwaters, occurred only once this severe rod limit was implemented. The challenge that managers face when implementing any form of rod limits for eel, however, is enforcement, because eel anglers typically apply generic baits used also for other species. As a result, to be effective daily rod limits may require implementation across all angling activities, not just eel fishing, which will have high social costs (Dorow et al., 2010).

Effort allocated to eel was predicted to decline by 15% relative to current levels when a temporal closure of 14 days per month was implemented in the survey. This represented an inelastic effort response. Indeed, limiting the amount of time that can be devoted to fishing is among the most drastic measures to control effort. It is therefore disliked by eel anglers (Dorow et al., 2010) and thus not unexpectedly negatively affected eel angling effort in the present study. However, this response was still relatively small given that a 14-day closure represents 47% of the current number of open fishing days. Unlike commercial fishing, recreational fishing, by definition, takes place during discretionary, leisure time. Moreover, few anglers spend their entire leisure time fishing.

As a result, anglers may accommodate temporary closures by concentrating their eel angling during times when the fishery is open. This argument is supported by previous findings that a closure of 7 days per month has been found to be acceptable to anglers in the study region (Dorow et al., 2009) and did not significantly reduce the proportion of effort directed to eel (this study). Only when fishery closures span a time period sufficient to limit one's ability to reschedule angling activities can they be expected to markedly affect the effort. Our study, however, made no separation between weekdays and weekends when examining the impact of temporal closures. Because angling activities are often concentrated during the weekend (Hunt et al., 2007), eel fishery closures throughout a month may actually have a greater effect on eel angling effort than predicted by our survey if they are selectively timed to occur during peak fishing periods. One should note, however, that the predicted reduction of effort was only 15% at a temporal closure of 14 days per month, with similar reductions also found for a daily bag limit of 1 eel per day. Previous findings, however, have shown that the welfare loss to anglers is considerably larger from a 14-day temporal closure than from a daily bag limit of 1 eel per day (Dorow et al., 2010). Managers are well advised to consider the differential social impacts of imposing new and therefore unfamiliar forms of effort regulation such as temporal closures over modifying existing measures, such as daily bag limits and minimum-size limits, and consider trade-offs between the potential biological effects of regulations versus their social costs. Otherwise, intensive conflict and loss of stewardship behavior, such as stocking and habitat management, by anglers is to be expected, which may contribute to further decline of eel stocks.

While individual regulations alone did not strongly affect eel angling effort, we also examined the joint effects of implementing multiple tools simultaneously. In doing so, we found that moderate regulatory changes (2 eels day−1, 7 day closure, 2 rod maximum) altered the allocation of eel angling effort by only 3%. A possible explanation may relate to media coverage of the eel decline to which anglers in Germany have been exposed. This result corroborates previous findings that moderate additional regulation for the purpose of conserving eel stocks is quite acceptable to anglers (Dorow et al., 2009). From our diary data, it appears that such regulations do not substantially restrict harvests (a 4% decrease relative to current) and thus provide little incentive to substitute another activity. In conclusion, moderate eel fishing restrictions do not appear to pose a barrier to fishing participation and will therefore only contribute to meeting management goals to the extent they directly constrain harvests.

Angling effort changes were more pronounced once regulations become very strict (daily bag limit of 1 eel, 14-day monthly closure, maximum of 1 rod), which supports previous findings by Dorow et al. (2010) showing that severe restrictions have strong welfare consequences for the eel anglers in northern Germany. The 41% effort reduction associated with our strict regulation scenario is less than might be expected a priori given the draconian regulations that included only half the allowable days per month, severe daily bag and size-based harvest limits (1 eel day−1), and a maximum of one allowable rod. This reluctance to abandon eel fishing or reallocate effort more strongly to other fish species can be explained by the surveyed anglers' strong commitment to the eel fishery and the lack of substitutes for eel (Dorow et al., 2010). Thus, only with the implementation of a set of highly restrictive regulations in addition to a temporal closure of 14 days per month (EC, 2007) can a 50% reduction of effort be expected. This will then reduce annual harvests by as much as 137 tonnes relative to the present (73% less than current).

Another finding of our study is that effort reductions stemming from regulatory restriction may be partly compensated by increased eel abundance and its corresponding effect on catch rates. Considering the potential for successful conservation efforts to attract anglers back to the fishery with improvements in catch quality (this study; Cox and Walters, 2002), long term eel fishing effort may be higher than predicted in our scenarios if the eel stocks recover. This effect is well documented in the fisheries literature, known as the "paradox of enhancement" (Johnson and Staggs, 1992) or the "success breeds failure pathology" (Cox and Walters, 2002). The implication for the conservation of eel stocks is that without constraining total effort and harvest, conservation efforts may not be as effective as initial results indicate.

Ultimately, any recommendations inferred from our study are dependent on the conditions and mortality sources (e.g., loss at hydropower turbines, predation by fish-eating birds, commercial fishing) in each catchment and should not be uncritically applied at a local scale. Therefore, our scenarios should not be seen as quantitative predictions for individual catchments, but as an exercise to highlight the complex interplay of angler behavior in response to regulatory policies that may create unexpected results from a management perspective. In particular, our predictions for eel effort responses and associated harvest reductions should be applied with caution as there are large gaps in our understanding of the biology of *Anguilla anguilla* and the dynamics of eel fishing in each catchment. Data needs specific to recreational fishing include information regarding size-related recapture rates. As all eel captured in freshwater have not yet spawned, the conservation benefits of output controls are dependent on probabilities of recapture prior to migration. Therefore, minimum-size limit regulations may concentrate fishing mortality on larger eels, but the overall fishing mortality may not be appreciably affected in contrast to what we assumed in our scenarios. Second, better information regarding the interaction of size and number based harvest controls is needed. If stricter daily bag limits are imposed, anglers may be tempted to retain only the largest specimens (with the lowest probability of recapture), continually releasing smaller (but still legally harvestable) fish to maximize harvestable biomass. Moreover, for many catchments there are no empirical studies to determine the catchability of eel using angling gear, although our regression of total effort on total harvest across water bodies suggests a proportionality of effort to landings. However, without quantifying catchability in a recreational setting and the stock–recruitment relationship, it is impossible to estimate the contribution of any changes in harvest in a single catchment to the overall pan-European population.

From a methodological perspective, our study illustrates the usefulness of stated preference surveys to forecast human responses to changes in recreational fishery management. While this type of forecasting necessitates the use of hypothetical scenarios, our predictions are validated by the congruence between our model results and eel angling effort allocation currently observed in the study region. Our study presents a method by which managers can assess the potential for proposed conservation measures to affect consumptive recreational users, and ultimately succeed in meeting biological outcomes. While application of specific findings beyond our study area and across other threatened fish species is strongly discouraged, our results provide unique insights into the possibilities of angler behavior affecting the outcome of any well-intended biological regulations. Thus, our study underscores the need to account for the human dimensions of recreational fishing in biological planning.

5.5. Conclusions and Implications

The broad geographic range for this species requires concerted conservation efforts across Europe, and commercial and recreational fisheries management are mandated requirements of the European Union's eel regulation directive (EC, 2007). However, very little is known about the contribution to the decline in eel abundance made by commercial and recreational fisheries relative to other sources of eel mortality. To identify regulatory actions that are capable of achieving stated management goals of increased escapement of eel from European catchments (EC, 2007), it is crucial to anticipate stakeholder responses (Dorow et al., 2009, 2010). This is particularly evident given the need for voluntary compliance with regulations, a characteristic of all freshwater recreational fisheries, where regulatory enforcement is limited by a large population of independent agents (i.e., anglers) dispersed across complex fishery landscapes (Gigliotti and Taylor, 1990; Pierce and Tomcko, 1998; Walker et al., 2007). Our study showed that the effort responses of eel anglers are likely to be inelastic to individual changes in regulatory policies. Strong reductions in eel angling effort, and associated reductions in eel landings, are only likely if regulatory policies become very restrictive. Should such policies be implemented, managers then face the difficult task of trading off uncertain conservation benefits associated with reducing recreational harvests by up to 73% against substantial welfare losses associated with such policies of up to several million Euro per year (Dorow et al., 2010).

Our case study provides several additional insights of relevance to both eel conservation and also recreational fisheries more generally. First, reducing angling effort and corresponding harvest levels may, depending on the fishery, necessitate implementing severe input and output regulations jointly. Should the EU or national eel managers intend to implement temporal closures of 14 days month^{-1}, our study shows that additional regulation (i.e., restrictive harvest limits) will be necessary to reduce fishery mortality by 50%, but these angling regulations will come at a cost of considerable welfare losses for anglers (Dorow et al., 2010). The consumptive orientation of eel fishing coupled with the anglers' determination to continue eel fishing constitutes the key management challenge that results in an inelastic effort response. Overcoming this challenge will most likely require that managers and scientists establish the extent to which recreational fishing contributes to the decline of the European eel population. The continuing and alarming decline of the European eel (ICES, 2010) raises concerns that the targets set by the EU (EC, 2007) may be inadequate to effect conservation success. This is however for managers to decide and is not the task of a researcher. Giving current management goals, we recommend focusing on increases in minimum-size limits and decreases in bag limits first, because such tools may reduce recreational harvests considerably without causing major welfare losses to anglers. Otherwise, opposition and conflict between managers and anglers is a likely outcome, especially if recreational angling is perceived to have been selectively targeted by decision-makers, excluding other sectors that have been identified to induce mortality on eel (Dorow et al., 2009). Should more conservative management targets for recreational eel harvests be implemented, our model provides a useful tool to allow managers to develop more restrictive regulatory options that are likely to achieve the desired biological outcome. For recreational fisheries research and management more broadly, our study thus emphasizes the need to better understand how management actions influence angler behavior in a nonlinear, complex way. Neglecting human behavioral responses in crafting conservation-oriented regulations may otherwise lead to misguided management and result in some unexpected dilemmas (Sullivan, 2003). Future application of similar allocation-based choice experiments will enhance a priori understanding of angler effort dynamics in the context of regulatory and ecological change.

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Tables and Figures

Table 5.1: Results of the multinomial logit model testing the effects of catch and regulatory attributes on eel angler's fishing effort allocation decisions. Estimated coefficients for each attribute level are called part-worth utilities (PWU).

	Attributes	PWU	s.e.	z-value	p-value
Alternative specific constants (ASC)	Eel	0.340	0.021	16.554	0.000
	Coarse fish	-0.013	0.021	-0.624	0.533
	Predatory fish	0.335	0.019	18.075	0.000
	Undirected freshwater fishing	-0.028	0.021	-1.337	0.181
	Coastal fishing	-0.208	0.023	-9.123	0.000
	Not go fishing	-0.425	0.024	-17.665	0.000
Catch attributes					
Average catch number per day	1 eel	-0.089	0.036	-2.446	0.015
	2 eels	-0.002	0.035	-0.055	0.956
	3 eels	0.099	0.035	2.840	0.005
	4 eels	-0.008	0.036	-0.230	0.818
Average size of eels	50 cm	-0.076	0.036	-2.100	0.036
	55 cm	0.056	0.036	1.549	0.121
	60 cm	-0.017	0.036	-0.475	0.635
	65 cm	0.037	0.035	1.067	0.286
Regulations					
Minimum-size limit	45 cm	-0.046	0.036	-1.265	0.206
	50 cm	-0.032	0.036	-0.907	0.364
	55 cm	0.052	0.035	1.491	0.136
	60 cm	0.026	0.036	0.705	0.481
Daily bag limit	1 eel	-0.132	0.033	-3.975	0.000
	2 eels	0.057	0.027	2.066	0.039
	3 eels	0.076	0.032	2.370	0.018
Daily rod limit	1 rod	-0.059	0.033	-1.794	0.073
	2 rods	0.020	0.028	0.718	0.473
	3 rods	0.039	0.032	1.200	0.230
Monthly eel fisheries closure	0 days	0.065	0.032	2.044	0.041
	7 days	0.080	0.027	2.933	0.003
	14 days	-0.146	0.033	-4.399	0.000
Increase in daily cost of eel fishing[1]	Linear per 2.50 €	-0.027	0.014	-1.936	0.053

	Attributes	PWU	s.e.	z-value	p-value
Daily rod limit interactions with ASC					
Coarse fish	1 rod	0.089	0.042	2.108	0.035
	2 rods	-0.051	0.036	-1.397	0.162
	3 rods	-0.039	0.042	-0.916	0.359
Predatory fish	1 rod	0.102	0.038	2.672	0.008
	2 rods	-0.019	0.033	-0.579	0.563
	3 rods	-0.083	0.038	-2.177	0.030
Undirected freshwater fishing	1 rod	0.105	0.043	2.461	0.014
	2 rods	-0.066	0.037	-1.798	0.072
	3 rods	-0.039	0.042	-0.917	0.359
Coastal fishing	1 rod	0.112	0.045	2.488	0.013
	2 rods	-0.036	0.039	-0.924	0.356
	3 rods	-0.076	0.045	-1.683	0.092
Summary statistics	**Log Likelihood (LL)**	**BIC(LL)**	**N**	**R^2(Adj)**	**R^2**
	-2364.5	4744.5	193	0.017	0.001

Note: [1]Level values: “No increase”, 2.50 €, 5 €, 10 €

Table 5.2: Elasticity of demand (i.e., angling effort allocation) for changing eel catch attributes and regulations compared to the current base scenario (only for significant attributes at $p < 0.1$, see Table 3-1); an elasticity value < 1 indicates an inelastic demand response.

Catch Attributes	Level	% change in attribute	% change in eel angling days	Elasticity of demand
Average number of eels per eel angling day	1 eel	Base		
	2 eels	100%	6.8%	0.07
	3 eels	200%	15.0%	0.08
	4 eels	300%	6.3%	0.02
Average size of eels caught	65 cm	8%	4.2%	0.50
	60 cm	Base		
	55 cm	-8%	5.6%	-0.67
	50cm	-17%	-4.4%	0.26
Regulations				
Daily bag limit	3 eels	Base		
	2 eels	-33%	-1.5%	0.05
	1 eel	-67%	-15.0%	0.23
Daily rod limit	3 rods	Base		
	2 rods	-33%	-2.7%	0.08
	1 rod	-67%	-17.0%	0.26
Monthly eel fishery closure (assumes 30 fishing days/month)	0 days closure	Base		
	7 days closure	-23%	1.1%	-0.05
	14 days closure	-47%	-15.1%	0.32
Linear increase in daily cost of eel fishing	17.44 €	Base		
	+ 2.50 €	+14%	- 2.05%	-0.14

Table 5.3: Change in eel angling effort for different eel angling scenarios compared to the current scenario. Only significant attributes are varied, hence minimum-size limits are held constant (see Table 3.1). Attribute levels altered from current are indicated in bold.

Scenario summary	**Current**	**Regulatory change only**		**Improved catch**
Regulatory change	None	Moderate	Strict	Strict
Catch improvement	None	None	None	High
Scenario details				
Daily catch number	1 eel	1 eel	1 eel	3 eels
Average catch size	60 cm	60 cm	60 cm	65 cm
Daily bag limit	3 eels	2 eels	1 eel	1 eel
Minimum-size limit	45 cm	45 cm	45 cm	45 cm
Monthly eel fishery closure	0 days	7 days	14 days	14 days
Daily rod limit	3 rods	2 rods	1 rod	1 rod
Increase in daily cost of eel fishing	0.00 €	0.00 €	10.00 €	10.00 €
Scenario outcome	**Predicted allocation of days across all alternatives**			
Eel	24.0%	23.3%	12.8%	15.8%
Coarse fish	15.8%	15.5%	17.9%	17.3%
Predatory fish	21.4%	22.6%	25.6%	24.7%
Undirected freshwater fishing	15.5%	15.0%	17.9%	17.3%
Coastal fishing	12.5%	12.9%	15.0%	14.5%
Not go fishing	10.9%	10.8%	10.8%	10.4%
% change in eel effort	Base	- 3.0%	- 46.6%	- 34.3%

	Eel angling day A	Eel angling day B
Expected Catch		
Average catch number	1 eel	2 eels
Average catch size	60 cm	65 cm
Regulations for eel angling		
Minimum-size limit	60 cm	55 cm
Daily bag limit	3 eels	1 eel
Monthly fishery closure	7 days	No closure
Daily rod limit	1 rod	2 rods
Increase in cost per day of eel fishing	5 € increase	No increase

① Which eel angling option do you prefer? *Please choose only one!*	☐ Angling day A	☐ Angling day B

② Please imagine that the scenarios depicted for either your <u>preferred</u> or <u>disliked</u> eel angling day are in place. How would you allocate 10 days for which you have the opportunity to go fishing to the following alternatives?

<u>Preferred angling day</u>		<u>Disliked angling day</u>
	Eel angling days	
+	**Days fishing for coarse fish in freshwater areas**	+
+	**Days fishing for predatory fish in freshwater areas**	+
+	**Days fishing in freshwater with no specific target species**	+
+	**Days fishing in coastal areas**	+
+	**Not fishing**	+
= 10 days	**Total sum**	= 10 days

Figure 5.1: Example of a choice set used to examine allocation decisions of German eel anglers (translated from German). Only the allocation task (question2) is analysed in this paper. Note that coarse fish refers to non-predatory and non-salmonid fish of high abundance in the study region. The daily cost reflects increases to the overall costs from any source including licence fees, travel costs, specialized tackle etc.

	Current scenario	*Eel*	*Coarse fish*	*Predatory fish*	*Undirected freshwater fishing*	*Coastal fishing*	*Not go fishing*
Average catch number	1 eel	-0.089	-	-	-	-	-
Average catch size	60 cm	-0.017	-	-	-	-	-
Daily bag imit	3 eels	0.076	-	-	-	-	-
Minimum-size limit	45 cm	-0.046	-	-	-	-	-
Monthly fishery closure	0 days	0.065	-	-	-	-	-
Daily rod limit	3 rods	0.039	-0.039	-0.083	-0.039	-0.076	-
Increase in daily cost of eel fishing	0.00 €	0.002	-	-	-	-	-
Constant		0.340	-0.013	0.335	-0.028	-0.208	-0.425
SUM		0.370	-0.052	0.252	-0.067	-0.285	-0.425
EXP		1.448	0.950	1.286	0.935	0.752	0.654
Effort allocation = *EXP/(SUM(EXP))*		24.0%	15.8%	21.3%	15.5%	12.5%	10.8%

Part Worth Utilities

Figure 5.2: Sample calculation of angling effort allocation using equation 3-1. For illustrative purposes the predicted allocation of angler days under the status quo is shown. Part-worth utilities represent the model coefficients from Table 3-1.

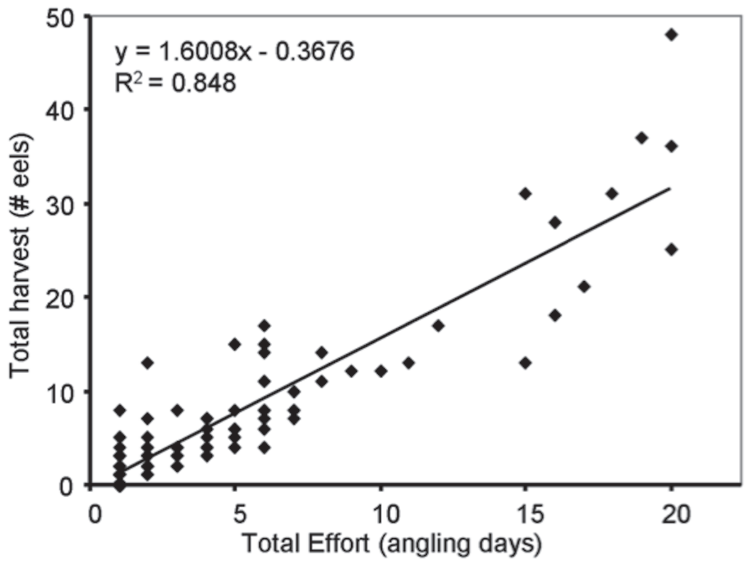

Figure 5.3: Linear regression of total eel harvest on water body-specific total directed eel effort across 149 water bodies in Mecklenburg–Vorpommern, Germany.

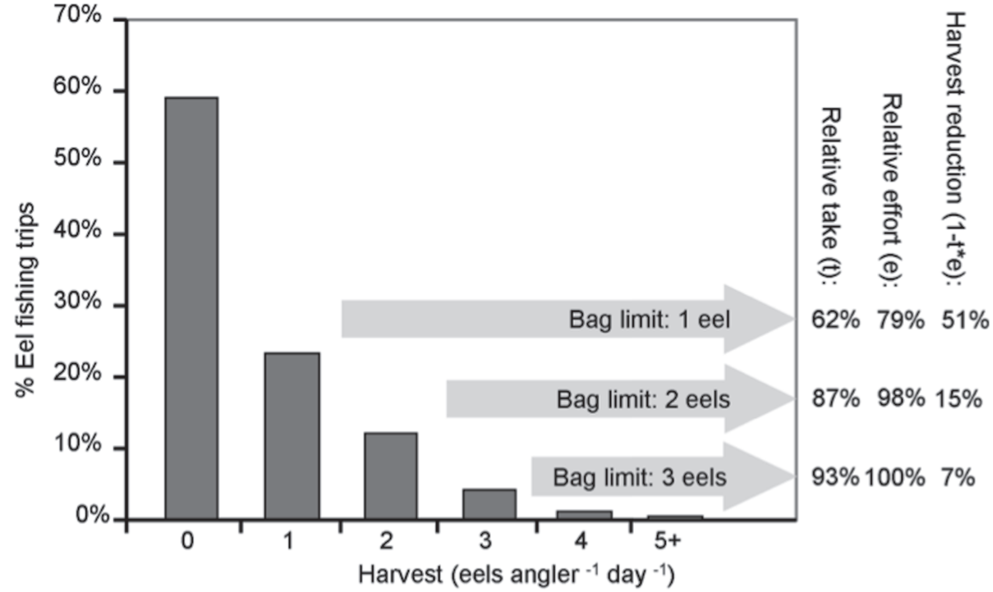

Figure 5.4: Distribution of daily eel catch characteristics and predicted harvest reduction associated with increasingly stringent daily bag limits. Direct effects on harvest, indirect effects though associated changes in fishing effort, and their combined effects on overall harvest are presented.

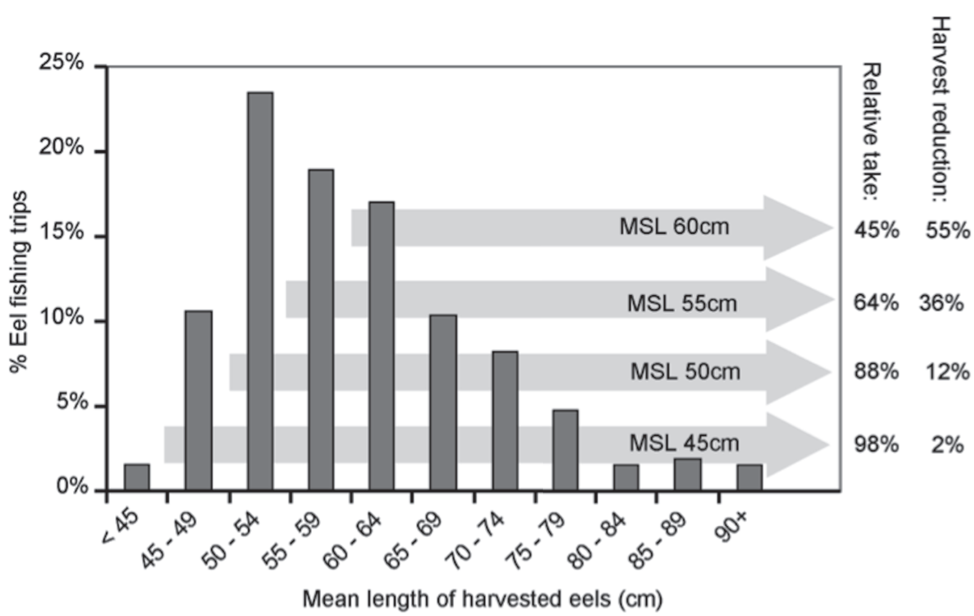

Figure 5.5: Distribution of eel sizes per successful trips and predicted harvest reduction associated with increasingly stringent minimum-size limits (MSL). Effort was not found to significantly change across the range of levels examined; hence it was not assumed to affect harvest.

Addendum to published article

The article in this chapter was one of a number of articles on the human dimensions of eel angling (Dorow et al. 2009[7]; Dorow et al. 2010[8]; Dorow and Arlinghaus 2011, 2012), each of which focused on different insights into managing the recreational eel fishery in the face of the declining European eel population. In addition to identifying effective management tools at a local scale, these studies highlighted the importance of the socio-economic dimension of eel angling in order to balance biological and socio-economic outcomes associated with regulatory change.

The article of this chapter examined the implications of effort and harvest under various regulatory regimes for recreational eel fishery management. This analysis was based on the overall stated preference responses of the entire sample, without considering possible heterogeneity within the sample. The existence of its heterogeneity has been confirmed by Dorow et al. (2010) who identified three segments of eel anglers based on recreation specialization theory (Bryan 1977), and discussed the resulting differences in welfare loss associated with the loss of this unique resource. This addendum expands the elasticity of effort analysis of Chapter 3 by presenting the implications of changing eel regulations on the effort and harvests of specialized eel anglers as defined by Dorow et al. (2010).

Methods

In addition to the discrete choice experiment (DCE) reported in this chapter, the mail survey also contained a number of questions about respondents' experience with eel angling, including several multi-item scales measuring various dimensions of recreation specialization, namely the centrality of eel angling to each angler's lifestyle and consumptive orientation (Bryan 1977; Sutton 2003). Each of these measures relied on a five-point Likert-type agreement scale ranging from 1 – strongly agree to 5 –

[7] Appendix B, p254.
[8] Appendix A, p218.

strongly disagree. The items were adapted from published scales for centrality to lifestyle (Kim et al. 1997; Sutton 2003) and consumptive orientation of anglers (Fedler & Ditton 1986; Aas & Vittersø 2000; Anderson, Ditton & Hunt 2007) by rewording them to fit the context of eel angling, and translating them into German (**Table 5.4**).

Centrality-to-lifestyle scales measure the extent to which a participant's lifestyle and social network are connected to leisure activities like angling (Sutton 2003). As eel angling becomes a more central part of life relative to other leisure activities, including fishing, participation in targeted eel angling becomes more important as a means of self-expression and satisfaction of personal leisure needs (Sutton 2003). Consumptive orientation is defined as the degree to which an angler values different aspects of the angling experience that are related to catch (Arlinghaus 2006a, b; Anderson et al. 2007). Past research suggests that these dimensions of consumptive orientation include simply catching something, catching many fish, catching large/trophy-sized fish and harvesting caught fish (Aas & Vittersø 2000; Anderson et al. 2007). Due to the assumed consumptive nature of eel angling, several items were added to the original scale (Anderson et al. 2007) to measure the retention orientation of eel anglers more reliably. Other questions in the survey assessed anglers' perceptions of their own skill level and their sensitivity to stricter eel angling regulations (**Table 5.4**)

Following the specialization analysis by Dorow et al (2010), the centrality-to-lifestyle and consumptive orientation scales were subjected to principal component analysis (PCA) using varimax rotation to identify the factor structure of the scales. Reliability analysis based on Cronbach's alpha was used to justify creation of specialization indices based on item means when Cronbach's alpha exceeded 0.7 (Nunnally and Bernstein 1994). In total, four subdimensions of recreational eel angling specialization were identified resulting in four indices: centrality of eel fishing to lifestyle, general catch eel orientation, eel retention orientation and sensitivity to eel regulations (**Table 5.1**). To identify differentially specialized eel anglers, a Ward hierarchical cluster analysis was performed on these indices. The resulting three clusters reflected varying degrees of eel angling specialization (Dorow et al. 2010) These specialization groups were compared on their specialization indices and the importance placed of eels to their fishing experience) by one-way analysis of variance (ANOVA) and appropriate post hoc tests (Tukey for homogenous variances, and Dunnett-T-3 for heterogeneous variances). Significance was assessed at $P < 0.05$.

This addendum includes the three specialization clusters into the DCE based allocation model. Specialization clusters were brought into the model as known classes, a procedure that allows joint estimation of the models for each cluster thereby facilitating comparison (Vermunt and Magidson 2005). The remaining analyses (calculation of elasticities of demand, and estimation of effort and harvest effects) for each specialization cluster follows exactly the published article.

Results

Eel angler specialization

Principal component analysis identified the following four indices of specialization, all applied specifically to angling for eel: centrality-to-lifestyle; catch orientation; harvest orientation, and sensitivity to stricter restrictions (**Table 5.4**). Cronbach´s alpha for the centrality scale was 0.84 and for the catch orientation scale were 0.84 and 0.72 respectively, indicating sufficient internal reliability of each scale to combine items. The Ward cluster analysis resulted in three eel angling specialization segments (**Table 5.5**): advanced eel anglers (*N* = 88; 45.6%), intermediate eel anglers (*N* = 64, 33.2%) and casual eel anglers (*N* = 41; 21.2%). These groups significantly differed from each other in the four indices of angler specialization (**Table 5.5**). Advanced eel anglers exhibited the highest centrality to lifestyle, the highest catch orientation and the highest harvest orientation of all angler segments. Intermediate eel anglers were similarly high in centrality-to-lifestyle, catch orientation and harvest orientation, but differed significantly from the other groups in indicating they would abandon eel fishing once regulations would become too strict whereas advanced and casual anglers would not necessarily discontinue fishing. Casual eel anglers had significantly lower centrality-to-lifestyle, catch orientation and harvest orientation scores than the more specialized groups.

While these groups did not differ in their sociodemographic characteristics (Dorow et al. 2010), most characteristics related to commitment (e.g., frequency of fishing, value of tackle, number of water bodies fished in a given year and number of angling friends) were consistently highest values for advanced anglers, with intermediate values for intermediate anglers and low values for casual eel anglers. Most of these differences, however, were not significant (**Table 5.5**). However, ratings of one statement relating to the importance of eel significantly differed, as expected, for the three angler groups (**Table 5.5**).

Further evidence to support the validity of our segmentation came from angling behavior reported in respondents' trip diaries (compare Dorow & Arlinghaus 2011). Advanced eel anglers were more active, avid and successful compared to intermediate and casual anglers. For example, advanced anglers targeted eel more often than intermediate and casual eel anglers. Advanced anglers were also more likely than casual anglers to catch more than one eel in a given trip, while casual eel anglers were more likely to catch smaller eel than the other groups (**Table 5.5**).

Effort allocation model

Aside from the inclusion of the three specialization clusters as known classes in the allocation model, all other specifications were kept identical to the overall model presented earlier in this chapter (**Table 5.6**). Effort allocation to eel differed among the groups as expected, with the advanced anglers showing the highest intercept for eel, while casual anglers had the lowest respective intercept (**Table 5.6**). In other words, all things being equal, advanced anglers allocated a significantly higher proportion of their intended effort to eel relative to other fishing experiences, than did the other groups. In fact, intermediate and casual anglers were more likely to target predatory fish than eel, all else being equal.

The parameter estimates for the eel catch and regulation attributes also differed among the three groups (**Table 5.6**). Anglers' allocation of effort to eel was not significantly influenced by the average number of eel caught, with the exception of casual anglers' preference for catch rates of three eels. Similarly, the average size of eels also had little significant effect on effort allocation, although intermediate eel anglers did show a significant preference for 55cm eel. While catch expectations were largely not significant, the trends in these parameters followed expectations, and it is likely that the small sample size of each group is to blame.

In contrast to the catch expectations, allocation of effort to eel fishing was influenced more by regulations for all anglers, although significant differences in the magnitude of these effects were found among the three groups. Advanced anglers were unaffected by minimum size limits, while they significantly disliked a daily bag limit of one eel and strongly preferred the status quo of three eels per day. Advanced anglers also most disliked the most restrictive rod limit, preferring the status quo of three rods. When limited to a single rod, this group was most likely to switch to predatory target species. Advanced anglers were also the only group to be significantly put off by increasing daily costs. They also showed the most marked preference for no closures to the fishery as well as the strongest dislike of the proposed 14-day closure. Unlike advanced anglers, intermediate eel anglers were unaffected by daily bag limits, but significantly disliked a 45cm minimum size limit, and preferred a 2-rod limit. Intermediate anglers were most likely to switch to undirected freshwater fishing when limited to a single rod. This group was indifferent to rises in the cost of eel fishing, and while they disliked the 14-day closure, they no significant preference for either the 7-day closure or no closure. Like advanced anglers and unlike intermediate anglers, casual eel anglers were unaffected by the size limits, and disliked the most stringent daily bag limit, but unlike advanced anglers, their most preferred harvest limit was two eels per day. This last group remained unaffected by changes in rod limits, rising costs and temporal closures to the fishery. These findings jointly highlighted that eel angler effort responses while dependent on the type and degree of eel regulatory measures, they also depend on the characteristics of the angler himself.

Effect of regulations on eel angling effort

As in the overall model presented earlier in the chapter, elasticity analysis for each attribute across the three levels of specialization revealed that angling demand for eel was strongly inelastic (i.e., $E_{x,y} < \pm 1$) to changes in individual attribute levels relative to current conditions across most individual regulations tested (**Table 5.7**); however, these values differed for each of the three clusters. For example, as a bag limit of 2 eels per day resulted in a decrease in demand for advanced anglers of 5.5% ($E_{x,y} = 0.16$), whereas for intermediate anglers demand dropped by only 0.3% (E = 0.01) and for casual anglers, demand increased by over 10% (E = -0.31). While the overall model (**Table 5.2**) revealed inelasticity of demand across all regulations, the segmented model indicates that demand for certain regulations is elastic for certain groups but not others. For example, an 8% increase in the expected size of eel associated with a change from 60cm to 65cm, resulted in an increase in effort of 9.8% among casual anglers, and a decrease in the expected size of eel from 60cm to 55cm increased demand among intermediate anglers by 11.8%. These groups also differed in their elastic response to a change in minimum size limit from 45cm to 50cm. Whereas intermediate anglers increased their effort by 13%, casual anglers decreased their effort by 12%. Advanced anglers showed an elastic response to a reduction in allowable rods from three to two (E=1.37).

These differences were further revealed when combining regulatory policies to reduce eel angling effort. Moderately increasing the stringency of various eel harvest regulations jointly, resulted in the overall model in only a 3% decrease in effort (**Table 5.3**), but the segmented analysis demonstrates that underlying this effect is a 14% decrease in effort among advanced anglers, and a considerable 44% increase in effort among casual anglers (**Table 5.7**). By setting significant regulations to their strictest levels, however, managers can expect to achieve reductions in eel angling effort of 50% and 46% for advanced anglers and intermediate anglers respectively; however among casual anglers, the reduction is expected to be only 3% (**Table 5.7**). Improvements in catch expectations associated with stricter regulations do mitigate reductions in effort among advanced and intermediate anglers somewhat; but their largest impact is on casual anglers who would respond with increasing effort by 44% (**Table 5.7**).

Effect of regulation changes on eel harvest

To predict the potential reduction in eel harvest as a result of input or output of regulatory changes, we first estimated a linear regression of total harvest on total effort for 149 water bodies receiving directed eel angling effort in the study region. This regression revealed a strongly positive relation between total angler days (x) and total harvest (y) for each of the three clusters. For advanced anglers ($y = 0.88x$, $R^2 = 0.60$, $p < 0.001$), the slope of the regression suggested that ~0.9 eel are harvested per angling day on an average water body for this group (**Figure 5.6**). The regression intercept was found to be insignificant ($\alpha = 0.25$; s.e. = 0.33; $t = 0.24$; $p = 0.81$), while the slope of the regression of harvest on effort was highly significant (ß = 0.88; s.e. = 0.081; $t = 10.8$; p <

0.001). For intermediate anglers ($y = 0.72x$, $R^2 = 0.49$, $p < 0.001$), the slope of the regression suggested that only 0.7 eel are harvested per angling day on an average water body for this group (**Figure 5.6**). The regression intercept was found to be insignificant ($\alpha = -0.08$; s.e. = 0.93; $t = -0.09$; $p = 0.93$), while the slope of the regression of harvest on effort was highly significant ($ß = 0.72$; s.e. = 0.01; $t = 7.1$; $p < 0.001$). Casual anglers ($y = 1.23x$, $R^2 = 0.95$, $p < 0.001$), on the other hand, showed the catch rate per angling day with approximately 1.2 eels per day of effort (**Figure 5.6**). However, for this group, a significant and negative intercept ($\alpha = -1.81$; s.e. = 0.35; $t = -5.22$; $p < 0.001$) indicates that catch success occurs only on water bodies for which considerable effort towards eel occurs. The slope of the regression of harvest on effort was highly significant ($ß = 1.23$; s.e. = 0.05; $t = 24.1$; $p < 0.001$).

Using the current distribution of daily eel harvests (**Figure 5.7**) and the size distribution of eel harvest by anglers (**Figure 5.8**), the potential savings of eel landing by angler segment in response to changes in the traditional harvest regulations and other tools was estimated. Under conditions of full compliance with regulations, a daily bag limit of two eels, alone, may directly reduce eel harvests by advanced and intermediate anglers (by 14% and 8% respectively), but will likely attract more casual anglers (10%; **Figure 5.7**). A more stringent daily bag limit of only a single eel could reduce overall eel harvests by as much as 39% for active anglers, and 43% for casual anglers, but would have a less effect on intermediate anglers (26% reduction; **Figure 5.7**).

Minimum-size limits appear to be even more selective in the angling groups they most affect (**Figure 5.8**). An increase in minimum-size limit to 50 cm would disproportionately impact casual eel anglers, reducing their harvests by up to 38%. This disproportionate effect carries through more stringent size limits, while also achieving sizeable reductions in harvest from the other groups (31% and 44% for advanced and intermediate anglers respectively for a 60cm size limit, compared to an 85% reduction in harvest for casual anglers; **Figure 5.8**).

Discussion

This addendum to the original article underscores the importance of taking angler heterogeneity into account when introducing new regulations. Whereas the published paper indicates that on the whole anglers can be expected to respond inelastically to changes in individual regulations, this addendum indicates that changing eel angling regulations differentially affects anglers based on their specialization towards the resource. Furthermore, these differences are consistent with the catch and harvest distributions described in the angler diary dataset. Casual eel anglers tended to catch smaller eels (**Figure 5.8**) than do more specialized eels, and they also showed the greatest sensitivity to increasingly strict minimum-size limits (**Table 5.6**; **Figure 5.8**), preferring the current limit of 45cm over more stringent size regulations. In contrast, both intermediate and advanced anglers indicated they would increase their relative effort with stricter size limits. Casual eel anglers also had a higher proportion of trips in which only a single eel was caught (**Table 5.5**), and their effort was most influenced by increasing expectations of catching three eels in a trip (**Table 5.6**). At the same time, casual anglers were also negatively influenced by stricter bag limits, suggesting that while they tended towards fewer catches, in the event they could catch more than one eel, they did not want to be limited in their harvest by regulation. These trends were also evident in the elasticity of demand for eel angling expectations and regulations, where angler groups often differed in the direction of their response.

These results complemented those of Dorow et al. (2010) in demonstrating the considerably different consequences of changing regulations for different eel specialization groups; however, this present analysis extended these insights to predict the effects of such changes on recreational eel harvests. Both studies used the same DCE and respondent segmentation in their analyses; however, Dorow et al. (2010) focused strictly on angler preference and welfare, i.e. the felt loss of reduced access to the fishery resource, whereas, this study focused on the associated behavioral intention, i.e., allocation of fishing effort and its expected harvest outcome. In the former case, advanced eel anglers were found to be most negatively impacted with correspondingly high estimates of welfare loss. We found that predicted effort for this group followed a similar trend, with advanced anglers showing consistently more reduced effort than the other groups (**Table 5.8**); however, this group was ultimately least impacted by harvest regulations, particularly minimum-size limits (**Figure 5.8** ; **Table 5.8**), as they tended to catch larger eels than did the other two groups. As advanced anglers also tended to catch more eels than did the other groups, the impact of more stringent bag limits to reduce harvests was also somewhat mitigated advanced anglers, who would catch their limit more often than the other groups.

Implications and Conclusion

To identify regulatory actions that are capable of achieving stated management goals of increased escapement of eel from European catchments (EC, 2007), it is crucial to anticipate stakeholder responses to identify potential conflicts (Dorow et al., 2009, 2010). This considerable challenge increases when the heterogeneity within the angler population needs to be considered, as each angler type appears to differ in their management preferences, reacting to restrictions in different ways

The results presented in this addendum showed that the effort responses of eel anglers are likely to differ among groups depending on their level of specialization in fishing for eel. Consistent with other overall model presented earlier in this chapter, strong reductions in eel angling effort, and associated reductions in eel landings, are only likely if regulatory policies become very restrictive. However, such policies affect angling groups in different ways. While implementing stricter regulations was found to have an incremental effect of reducing effort by intermediate and advanced anglers, such changes had little impact on the effort of casual anglers (**Table 5.8**), and indeed, induced a strong upsurge in effort from casual anglers unless the strictest scenario was implemented.

These differences among angler groups also suggested that the “paradox of enhancement” (Johnson and Staggs, 1992) may be most prevalent among anglers who are less adept at meeting certain catch outcomes, as casual anglers appear to be most drawn to eel angling in scenarios where strict regulations lead to improved catch expectations. This phenomenon may be related to the challenge of catching eel and its relationship to satisfaction (Arlinghaus, 2006a), and further research in this regard is warranted.

That said, while effort from casual anglers was least affected by changes in regulations, direct effects to reduce harvests was much higher for this group, as these anglers tend to catch both fewer and smaller eels than more specialized eel anglers. Advanced anglers, on the other hand, currently tend to catch more successful in catching larger eel so direct harvest effects of minimum restrictions are not as strong for this group. In other words, to reduce advanced angler harvests by 50%, would require a larger minimum size-limit than would be necessary to effect a similar harvest reduction for casual anglers. Consequently, as shown by the results the conservation effects of more stringent regulation are achieved through different mechanisms depending on an angler's specialization in the resource. From a management perspective, curbing harvests by advanced anglers may be most effectively achieved through severe effort controls, while direct harvest regulations may be more effective for limiting harvests by casual eel anglers, with intermediate anglers falling between these two strategies. Overall, the results of this addendum reinforce the message of the published chapter that much stricter regulations involving a combination of effort and harvest limits are likely to be necessary to achieve the biological goals set by the E.U. (E.C. 2007) while aiming to equitably distribute welfare losses among recreational users of the resource.

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Tables and Figures

Table 5.4: Items and reliability analysis of the specialization dimensions used for the segmentation of eel anglers in northern Germany. Reprinted with permission from Dorow et al. 2010. * indicates item was reverse coded before calculation of index.

	Mean	SD	Correlation	α (del.)	α
Centrality to lifestyle					
When I go fishing eel is my favorite fish species	2.90	0.99	0.56	0.82	0.84
Most of my friends are in some way connected with eel angling	4.03	1.00	0.47	0.83	
If I could not go eel fishing, I would not know which other species to target	4.15	0.93	0.50	0.82	
I consider myself to be an eel angling expert	3.47	0.94	0.6	0.82	
Compared to other anglers I own high quality eel angling gear	3.16	0.86	0.49	0.82	
Other anglers would probably say that I spend too much time eel fishing	4.19	0.88	0.51	0.82	
Eel angling is very important to me	3.02	1.06	0.71	0.81	
Eel angling provides me the greatest angling satisfaction	3.17	1.10	0.72	0.8	
A restriction of eel angling would not bother me a lot*	2.63	1.15	0.30	0.84	
If somebody fishes for eel regularly, it tells a lot about this person	3.68	1.01	0.26	0.84	
I like to talk with my friends about eel angling	2.63	1.02	0.45	0.83	
I am not really interested in eel angling*	2.03	0.96	0.43	0.83	
Catch Orientation					
I would rather catch 1 or 2 big eel than 10 smaller partly undersized eel	1.64	0.9	0.22	0.73	0.72
I like to fish for eel because of the challenge	2.42	0.88	0.21	0.73	
I like to fish for eel where I know I have a chance to catch a trophy fish	2.29	0.90	0.31	0.72	
When I go eel fishing, I am not satisfied unless I catch at least one eel	3.35	1.10	0.56	0.67	
The more eel I catch, the better	3.03	1.24	0.42	0.70	
The bigger the eel I catch, the better the fishing trip	2.3	1.08	0.61	0.65	
I am happiest with the fishing trip if I catch a challenging game eel	2.24	1.05	0.59	0.66	
Overall, I am satisfied with an eel angling day if I catch the bag limit	2.86	1.21	0.41	0.7	
Retention orientation					
The most important reason for eel fishing is my personal consumption; other reasons such as relaxation are secondary	3.01	1.13	-	-	-
Usually I retain every eel I catch	2.42	1.14	-	-	
Sensitivity to restriction					
Stricter eel angling regulation would entice me to discontinue of my angling activities	4.29	0.97	-	-	-
In the case of stricter eel angling regulation I would stop fishing specific for eel	3.43	1.07	-	-	

Table 5.5: Characteristics (average ± SD) for the specialization subdimensions, behavioral commitment characteristics, observed eel angling behavior and eel harvests of differently specialized eel anglers in northern Germany. Different letters indicate statistically significant differences between the eel anglers segments; n.s. – not significant. Reprinted with permission from Dorow et al. (2010).

	Advanced eel anglers (N=88)		Intermediate eel anglers (N=64)		Casual eel anglers (N=41)				
	Mean	SD	Mean	SD	Mean	SD	F	df	P
Specialization subdimension									
Centrality to lifestyle [1]	3.1	± 0.5y	3.2	± 0.6y	3.7	± 0.6z	14	192	0.0001
Consumptive orientation[1]	2.3	± 0.5y	2.4	± 0.5y	3.1	± 0.6z	29.6	192	0.0001
Retain orientation[1]	2.4	± 0.6y	2.5	± 0.7y	3.7	± 0.7z	63.6	192	0.0001
Sensitivity to restrictions[2]	4.3	± 0.5y	3.0	± 0.6z	4.3	± 0.6y	114.8	192	0.0001
Behavioral commitment (12 month recall period)									
Eel angling experience (years)	18.9	± 14.5	18.3	± 13.7	18.2	± 12.6	0.1	184	n.s.
Total angling days in 2006	40.9	± 33.8	35.2	± 32.9	32.1	± 31.9	1.1	185	n.s
Total eel angling days in 2006	12.3	± 15.1	11.8	± 16.1	11.3	± 18.6	0.6	182	n.s.
Number of eel caught in 2006	9.6	± 14.4	6.6	± 9.1	5.9	± 9.8	1.8	183	n.s
Importance of eel[3]	2.7	± 1.1y	2.9	± 1.2y	3.5	± 0.9z	7.2	190	0.001
Importance of angling[4]	1.9	± 1.2	2.16	± 1.2	2	± 1.8	0.6	189	n.s.
Angling behavior in 2006/2007[5]									
No of angling trips per year	28	± 21.2y	21	± 17.2z	17.7	± 10.6z	4.3	153	0.05
No of eel trips per year	3.4	± 5.2	2.1	± 5.3	2.1	± 4	1.2	153	n.s.
Total hours fished for eel per year	18.5	± 31.4	9.6	± 22	8.8	± 14.4	2.4	153	n.s.
No of eel caught per year	7.8	± 12.8	5.1	± 14.6	3.8	± 6.5	1.4	153	n.s.
No of eel retained per year	6.2	± 9.1	3.9	± 10.4	2.9	± 5.3	1.8	153	n.s.
Size of retained eel (cm)	62	± 8.6	60.4	± 12	59.8	± 8.2	0.9	91	n.s.
Size of the largest retained eel	64.4	± 9	63.1	± 9.2	60.8	± 7.1	0.9	91	n.s.

	Advanced eel anglers (N=88)	Intermediate eel anglers (N=64)	Casual eel anglers (N=41)	Chi²	df	P
Relative frequency of length classes of retained eel per trip (%)						
45-55 cm length class	28.9	54.3	45.2	11.1	4	0.05
55-65 cm length class	37	21.7	22.6			
over 65 cm length class	33.1	23.9	32.3			
Relative frequency of No of eel retained per successful eel trip (%)						
1 eel per trip	53.4	49.1	69.9	15.8	6	0.05
2 eel per trip	29.1	31.5	23.8			
3 eel per trip	7.7	14.8	9.1			
4 and more eels	9.7	4.6	1.6			

Note: [1] the lower the value, the higher the centrality to lifestyle, catch orientation and retain orientation; [2] the lower the value, the higher the sensitivity to regulations; [3] items was measured on the scale: 1- most important, 2 - second most important, 3 - third most important, 4 - one species between other ones; [4] item measured on the scale: 1- most important, 2- second most important, 3 - third most important, 4 - one leisure activity among others; [5] diary data for one complete fishing season (Dorow & Arlinghaus 2011) were available for 74 advanced eel anglers, 49 intermediate eel anglers and 31 causal eel anglers

Table 5.6: The conditional logit effort allocation model applied to three anglers groups defined by specialization level.

	Attributes	Advanced eel anglers			Intermediate eel anglers			Casual eel anglers			wald	p-value
		PWU	s.e.	z-value	PWU	s.e.	z-value	PWU	s.e.	z-value		
Alternative specific constants (ASC)	Eel	0.471	0.030	15.949	0.263	0.036	7.270	0.127	0.050	2.552	906.5	0.000
	Coarse fish	-0.022	0.032	-0.683	-0.052	0.037	-1.421	0.101	0.045	2.244		
	Predatory fish	0.368	0.027	13.515	0.334	0.032	10.526	0.290	0.042	6.878		
	Undirected freshwater fishing	-0.080	0.032	-2.479	-0.009	0.036	-0.237	0.072	0.046	1.585		
	Coastal fishing	-0.193	0.034	-5.715	-0.315	0.041	-7.706	-0.049	0.048	-1.014		
	Not go fishing	-0.545	0.038	-14.450	-0.223	0.038	-5.881	-0.543	0.057	-9.564		
Catch attributes												
Average catch number per day	1 eel	-0.069	0.053	-1.301	-0.068	0.065	-1.038	-0.155	0.088	-1.758	14.2	0.120
	2 eels	-0.014	0.051	-0.276	0.078	0.062	1.258	-0.085	0.086	-0.991		
	3 eels	0.070	0.051	1.368	0.070	0.061	1.143	0.189	0.084	2.249		
	4 eels	0.013	0.051	0.255	-0.080	0.064	-1.263	0.051	0.085	0.598		
Average size of eels	50 cm	-0.057	0.052	-1.094	-0.110	0.064	-1.723	-0.015	0.087	-0.173	9.4	0.400
	55 cm	0.044	0.052	0.859	0.130	0.063	2.066	-0.082	0.090	-0.911		
	60 cm	-0.026	0.052	-0.508	-0.014	0.063	-0.216	-0.007	0.086	-0.086		
	65 cm	0.039	0.050	0.773	-0.007	0.062	-0.107	0.104	0.083	1.260		
Regulations												
Minimum-size limit	45 cm	-0.047	0.051	-0.920	-0.163	0.065	-2.493	0.116	0.087	1.339	13.8	0.130
	50 cm	-0.067	0.052	-1.287	-0.007	0.062	-0.120	-0.035	0.086	-0.408		
	55 cm	0.089	0.051	1.769	0.054	0.062	0.872	-0.016	0.084	-0.184		
	60 cm	0.024	0.053	0.455	0.116	0.063	1.842	-0.065	0.090	-0.726		
Daily bag limit	1 eel	-0.157	0.049	-3.208	-0.062	0.058	-1.078	-0.220	0.083	-2.639	20.8	0.002
	2 eels	0.039	0.039	0.997	0.029	0.048	0.609	0.169	0.066	2.550		
	3 eels	0.118	0.047	2.515	0.033	0.057	0.581	0.051	0.078	0.654		

	Attributes	Advanced eel anglers			Intermediate eel anglers			Casual eel anglers			wald	p-value
		PWU	s.e.	z-value	PWU	s.e.	z-value	PWU	s.e.	z-value		
Daily rod limit	1 rod	-0.100	0.048	-2.085	-0.101	0.058	-1.731	0.108	0.077	1.401	14.5	0.024
	2 rods	-0.015	0.042	-0.368	0.112	0.049	2.292	-0.024	0.068	-0.355		
	3 rods	0.115	0.047	2.464	-0.011	0.057	-0.194	-0.084	0.080	-1.050		
Monthly eel fisheries closure	0 days	0.104	0.047	2.221	0.095	0.055	1.724	-0.080	0.080	-1.000	24.8	0.000
	7 days	0.064	0.039	1.633	0.084	0.048	1.736	0.117	0.066	1.771		
	14 days	-0.168	0.048	-3.487	-0.179	0.059	-3.049	-0.037	0.080	-0.458		
Increase in daily cost of eel fishing	Linear per 2.50 €	-0.044	0.020	-2.151	0.001	0.025	0.045	-0.036	0.034	-1.061	5.8	0.120
Daily rod limit interactions with ASC												
Coarse fish	1 rod	0.098	0.064	1.546	0.152	0.073	2.077	0.028	0.094	0.299	8.1	0.230
	2 rods	-0.070	0.055	-1.282	-0.043	0.062	-0.692	-0.075	0.080	-0.932		
	3 rods	-0.028	0.062	-0.445	-0.109	0.073	-1.495	0.047	0.094	0.495		
Predatory fish	1 rod	0.117	0.056	2.070	0.132	0.066	2.006	0.089	0.089	1.002	15.3	0.018
	2 rods	-0.090	0.049	-1.838	0.064	0.055	1.164	-0.058	0.076	-0.764		
	3 rods	-0.026	0.055	-0.478	-0.196	0.066	-2.977	-0.031	0.091	-0.339		
Undirected freshwater fishing	1 rod	0.118	0.065	1.828	0.233	0.071	3.274	-0.076	0.097	-0.790	17.7	0.007
	2 rods	-0.050	0.056	-0.899	-0.093	0.062	-1.496	-0.095	0.081	-1.174		
	3 rods	-0.068	0.064	-1.056	-0.141	0.072	-1.949	0.172	0.093	1.839		
Coastal fishing	1 rod	0.133	0.067	1.997	0.151	0.080	1.882	0.064	0.098	0.649	10.9	0.090
	2 rods	-0.119	0.058	-2.050	0.015	0.068	0.214	0.007	0.084	0.088		
	3 rods	-0.014	0.066	-0.210	-0.166	0.081	-2.044	-0.071	0.101	-0.705		
Summary statistics	**Log Likelihood (LL)**	**BIC (LL)**	**N**	**Npar**	**R^2 (Adj)**	**R^2**						
	-23768.1277	48004.6	193	89	0.0038	0.02						

Table 5.7: Elasticity of demand for eel angling among anglers of three specialization levels.

	Level	% Change in Attribute	% Change in Effort: advanced eel anglers	% Change in Effort: intermediate eel anglers	% Change in Effort: casual eel anglers	Elasticity of demand: advanced eel anglers	Elasticity of demand: intermediate eel anglers	Elasticity of demand: casual eel anglers
Catch Expectations								
Number of eel	1 eel	Base	-	-	-	-	-	-
	2 eels	100%	3.9%	11.9%	6.1%	0.04	0.12	0.06
	3 eels	200%	10.0%	11.3%	32.5%	0.05	0.06	0.16
	4 eels	300%	5.9%	-1.0%	18.6%	0.02	0.00	0.06
Size of eel	65 cm	8%	4.6%	0.6%	9.8%	0.56	0.07	1.17
	60 cm	Base	-	-	-	-	-	-
	55 cm	-8%	5.0%	11.8%	-6.1%	-0.60	-1.42	0.73
	50cm	-17%	-2.1%	-7.4%	-0.6%	0.13	0.44	0.04
Regulations								
Minimum Size Limit	45 cm	Base	-	-	-	-	-	-
	50 cm	11%	-1.0%	13.0%	-12.0%	-0.09	1.18	-1.09
	55 cm	22%	10.0%	18.0%	-11.0%	0.45	0.82	-0.50
	60 cm	33%	5.0%	24.0%	-16.0%	0.15	0.73	-0.48
Bag Limit	3 eels	Base	-	-	-	-	-	-
	2 eels	-33%	-5.5%	-0.3%	10.4%	0.16	0.01	-0.31
	1 eel	-67%	-18.2%	-7.3%	-20.7%	0.27	0.11	0.31
Rod Limit	3 rods	Base	-	-	-	-	-	-
	2 rods	-33%	-45.8%	11.3%	-0.3%	1.37	-0.34	0.01
	1 rod	-67%	-22.6%	-25.4%	17.3%	0.34	0.38	-0.26
Monthly Season (30 days per month)	30 (0 days closure)	Base	-	-	-	-	-	-
	23 (7 days closure)	-23%	-2.8%	-0.9%	17.8%	0.12	0.04	-0.76
	16 (14 days closure)	-47%	-18.0%	-19.9%	3.7%	0.39	0.43	-0.08
Price Increase	17.44 €	Base	-	-	-	-	-	-
	+ 2.50	14.3%	-3.05%	0.1%	-3.00%	-0.21	0.01	-0.21

Table 5.8: Change in eel angling effort for different eel angling scenarios compared to the current scenario for three differently specialized angler groups. Only significant attributes are varied, hence minimum-size limits are held constant (see **Table 5.1**). Attribute levels altered from current are indicated in bold.

		Current	**Regulatory change only**		**Influence of improved catch**
	Regulatory Change	None	Moderate	Strict	Strict
	Catch Improvement	None	None	None	High
Attribute levels	Catch number	1 eel	1 eel	1 eel	**3 eels**
	Catch size	60 cm	60 cm	60 cm	**65 cm**
	Bag Limit	3 eels	**2 eels**	**1 eel**	**1 eel**
	Size Limit*	45 cm	45 cm	45 cm	45 cm
	Closure	0 days	**7 days**	**14 days**	**14 days**
	Rod Limit	3 Rods	**2 rods**	**1 rod**	**1 rod**
	Price Increase	0.00 €	0.00 €	0.00 €	0.00 €
% Change in angler days for eel	Advanced eel anglers (Base allocation = 29.7%)	Base	-13.9%	-50.4%	-41.1%
	Intermediate eel anglers (Base allocation = 21.1%)	Base	-1.2%	-45.8%	-38.5%
	Casual eel anglers (Base allocation = 15.7%)	Base	44.4%	-2.8%	40.9%

Note: *No significant effect.

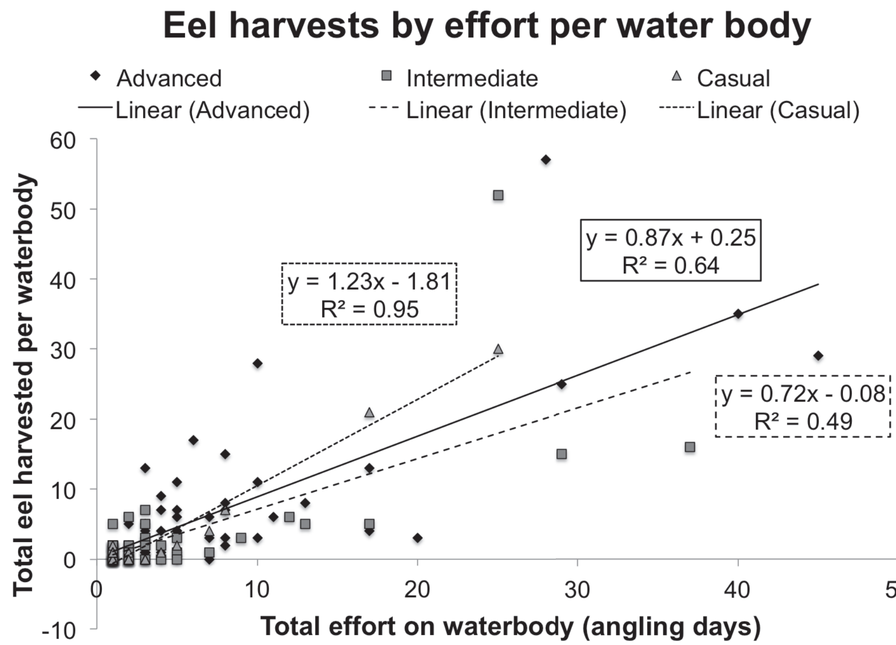
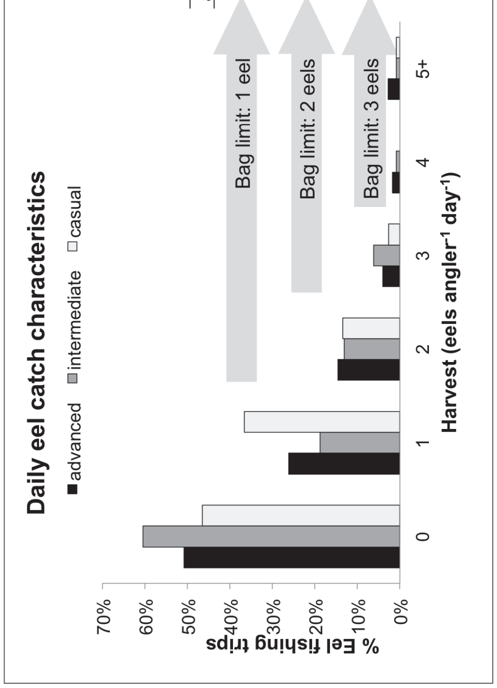
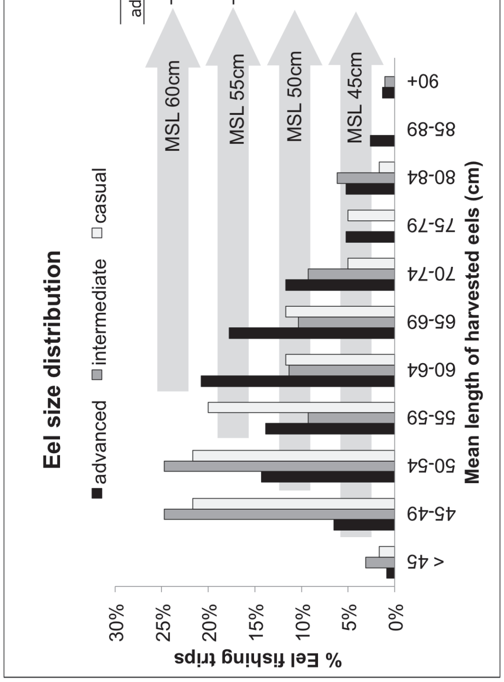


Figure 5.6: Linear regression of total eel harvest on water body-specific total directed eel effort across 118 water bodies in Mecklenburg–Vorpommern, Germany. Note, this relationship comes from N=154 anglers (74 advanced; 49 active; 31 casual)



	Change in take (Δh) (direct effect)			Change in effort (Δe)			Total Change in take (combined direct and effort effects)		
	advanced	intermediate	casual	advanced	intermediate	casual	advanced	intermediate	casual
Bag limit: 1 eel	-23%	-21%	-17%	-18%	-7%	-21%	-35%	-25%	-38%
Bag limit: 2 eels	-9%	-8%	-4%	-6%	0%	10%	-13%	-8%	8%
Bag limit: 3 eels	-4%	-2%	-1%	0%	0%	0%	-4%	-2%	-1%

Figure 5.7: Distribution of daily catch characteristics and predicted harvest reduction associated with increasingly stringent daily bag limits for eel. Direct effects on harvest, indirect effects though associated changes in fishing effort, and their combined effects on overall harvest are presented.



	Change in take (Δh) (direct effect)			Change in effort (Δe)			Total Change in take (combined direct and effort effects)		
	advanced	intermediate	casual	advanced	intermediate	casual	advanced	intermediate	casual
MSL 60cm	-35%	-62%	-65%	+5%	+24%	-16%	-33%	-55%	-72%
MSL 55cm	-22%	-53%	-45%	+10%	+18%	-11%	-15%	-46%	-52%
MSL 50cm	-7%	-28%	-23%	-1%	13%	-12%	-8%	-21%	-35%
MSL 45cm	-1%	-3%	-2%	0%	0%	0%	-1%	-3%	-2%

Figure 5.8: Distribution of eel sizes per successful trips for three eel angling groups and predicted harvest reduction associated with increasingly stringent minimum-size limits (MSL). Effort was not found to significantly change across the range of levels examined; hence it was not assumed to affect harvest. Note: because effort was not found to correlate strongly with harvest for active and casual anglers, reduction in harvest estimates for these groups are negligible.

Chapter 6. Conclusion

The purpose of this dissertation was to address concerns regarding the management relevance of human dimensions research (Hunt, Boots, & Boxall, 2007; Hunt, Sutton, & Arlinghaus, 2013; Matlock, Saul, & Bryan, 1988) by examining how angler heterogeneity affects trip scale interactions with fishery resources in terms of motivations, preferences and satisfaction from a novel and unique perspective. Proponents of HD research have argued that successful resource management depends on understanding what anglers want from their fishing experience (Driver, 1985; Fedler & Ditton, 1994), while recognizing that considerable diversity in this regard exists within the angler population (Bryan, 1977; Connelly, Knuth, & Brown, 2001; Holland & Ditton, 1992). Differences in catch related attitudes (Anderson, Ditton, & Hunt, 2007; Hutt, Hunt, & Anderson, 2013; Nguyen, Rudd, Hinch, & Cooke, 2013) and harvesting behavior (Hunt, Haider, & Armstrong, 2002) have underscored growing recognition of their importance among fisheries biologists (Johnston, Arlinghaus, & Dieckmann, 2010, 2012; Post, Persson, Parkinson, & Kooten, 2008). Conversely, fisheries biologists regularly consider in their research the diversity within and across communities of fish, with model parameters reflecting the life history traits of particular species (e.g., Johnston et al., 2010, 2012; Miranda, 1999; Post, Mushens, Paul, & Sullivan, 2003). This ecological diversity is the basis for angler selection of individual fishing opportunities at a trip scale; however, HD research has generally treated angling related attitudes and preferences as characteristics of the angler without necessarily accounting for the role of context set by type of the fishing chosen for a particular trip. Some researchers have narrowed the angler population within their study to include only those targeting a certain species (e.g., Bryan, 1977; Dorow, Beardmore, Haider, & Arlinghaus, 2009; Oh & Ditton, 2006; Wilde, Riechers, & Ditton, 1998); however, with diverse types of fishing available in a region, anglers are free to pursue different recreational outcomes from one fishing trip to another. Consequently, recreational fishing can be viewed, not as a single recreational experience, but as a set of related ones. While past research has focused on angler groups defined by their preferred target species (e.g., Dorow et al., 2009; Oh & Ditton, 2006; Wilde et al., 1998), an angler's preferences may be much more fluid, and depend on the type of fishing under consideration. This perspective has been absent from much of the human dimensions literature and may explain some of the "cynicism" about the relevance of social science to recreational fisheries management (Hunt et al., 2007). Hence, it is a primary focus for my dissertation.

Capitalizing on a unique opportunity to collect a high-resolution dataset that matched trip details over an entire year with additional information to characterize each angler, I was able to tackle popular topics in human dimensions research from unique perspectives and identify how species preference contributes to our understanding of anglers' attitudes and behavior. Traditional research on anglers' motivations (Fedler & Ditton, 1994) and satisfaction-with-catch (e.g., Arlinghaus, 2006) has typically referenced fishing as a general activity. Using target species as a proxy for different types of fishing experiences and integrating trip specific information into the assessment of motivations (Chapter 2) and satisfaction with catch (Chapter 4) at a regional scale generated unique insights into the primary forces that might drive participation in certain types of fishing and the relative importance of various catch and non-catch outcomes. For example, the fact that the importance of non-catch outcomes of fishing dominates the literature on angling motivations (Fedler & Ditton, 1994) may simply be associated with the fact that these aspects are common among most, if not all, fishing experiences. Indeed, enjoying nature or relaxing may represent fundamental motivations for many outdoor recreational experiences besides fishing. Catch outcomes, on the other hand, are much more variable and dependent on target species (Chapter 2). Consequently, general motivation assessments may underestimate the importance of catch aspects when applied to specific fisheries. These differences also emerged in anglers' satisfaction ratings (Chapter 4), where the importance of size versus number of fish depended on species. For example, while size was more important for northern pike *Esox Lucius*, and common carp *Cyprinus carpio*, satisfaction-with-catch for European eel *(Anguilla anguilla)* was driven more strongly by catch numbers. These results highlight the importance of taking fishery specific factors into account before applying general insights.

While comparative studies, like those presented in chapters 2 and 4, highlight the role that target species play in defining the types of recreational experience provided by a fishing trip, chapter 3 takes another approach to account for anglers' species preferences. This chapter addresses an issue with past discrete choice experiments in recreational fisheries that have been limited by their application to one single fishery, in case study fashion. Typically they have focused on species-specific case studies (e.g., Aas, Haider, & Hunt, 2000; Carlin, Schroeder, & Fulton, 2012; Dorow, Beardmore, Haider, & Arlinghaus, 2010; Oh & Ditton, 2006; Oh, Sutton, & Sorice, 2013). While these case studies have provided insights into the relative importance of trip or fishery characteristics related to specific fisheries, with general insights made possible through qualitative comparison across studies, extrapolation of parameter estimates from such models to other fisheries may be inadvisable. Discrete choice models have been identified as potentially rich sources of information for designing complex, but empirically derived, decision rules in simulation modeling (Heckbert, Adamowicz, Boxall, & Hanneman, 2010; Hunt et al., 2013; Johnston et al., 2010, 2012), and may therefore be of interdisciplinary interest, as past efforts to model predator prey dynamics of recreational fisheries have treated angling effort as a simple linear function of catch rate (Cox, Walters, & Post, 2003). One constraint to the integration of preference models has been their specificity to a single species or spatially confined fishery, thus limiting the scope of the integrated model (Johnston et al., 2010). For example, recreational fisheries for which no preference information exists may have to derive preference estimates from assumptions inferred from multiple sources (Johnston et al., 2010, 2012). Chapter 3 addresses this concern to a certain extent, by providing a generic choice model that integrates angler preferences across several species-specific fisheries. As such, it might be suitable for modeling angler-fish interactions in a wider range of fisheries for which specific information is not available[9]. The innovative choice experiment used in this chapter relied on *a priori* information about anglers' species preferences and the distributions of catch outcomes for each species to derive a generic model of angler preferences for catch and regulatory outcomes. Because species-specific attribute values were derived from standardized rather than absolute measures (i.e., z-scores), the resulting model generated estimates of angler preference that

[9] With the caveat that the anglers behave similarly to those in my study area of Mecklenburg-Vorpommern.

averaged across the ten most popular targets of recreational fishing in the study region. Preliminary analyses evaluated interactions between species and catch aspects of the proposed experience and found none. The resulting model therefore suggested that catch rates and size of fish may be judged by anglers in the context of what is usual for a given target species, and that preference estimates for these characteristics may apply across species, once species-specific distributions of catch outcomes have been standardized (Chapter 3). The generic parameter estimates presented in this study may therefore be more broadly applicable for mechanistic models of predator-prey interactions between anglers and fish (Johnston et al. 2010, 2012), than has been previously available, provided that the distributions of characteristics for each fishing opportunity are known, and do not deviate too strongly in functional form from those observed from our diary study.

While accounting for the effect of target species on angler motivations, experience preferences and satisfaction presents a unique and insightful perspective, these chapters also account for diversity among anglers along a specialization gradient in order to test the generality of propositions relating angler commitment to fishing and specific activity-setting preferences and behaviors. Although angler diversity has become a prominent focus of human dimensions studies, much of this research has centered on behavioral antecedents, such as stewardship norms (e.g., Bruskotter & Fulton, 2008), motivations (e.g., Wilde et al., 1998), catch related attitudes (e.g., Kyle, Norman, Jodice, Graefe, & Marsinko, 2007), and preferences (measured using individual statements, e.g., Connelly et al., 2001). This research tradition has clearly demonstrated that important differences exist among angler groups (e.g., Connelly et al., 2001; Fisher, 1997; Hutt & Neal, 2010). While such studies may be interesting and informative, few studies have addressed diversity among anglers in a way that is relevant to ecologically driven fisheries management (Johnston et al., 2010; Post et al., 2008), where anglers may be considered the top predator (Johnson & Carpenter, 1994). Consequently, the predatory behaviors of anglers may be considered as most relevant for managing fisheries. Chapter 2 suggests that some predatory (i.e., behavioral) characteristics of anglers may be related to the importance placed on reasons for targeting a particular species. By placing emphasis on differences in angler behaviors, managers and fisheries biologists can group anglers based on functional similarity (Simberloff & Dayan, 1991), i.e., based on how they exploit fishery resources.

Specialization theory (Bryan, 1977) is a popular framework for understanding differences among anglers, and while much of the literature on specialization has emphasized angler's affective and/or behavioral commitment to fishing, the purpose of Bryan's (1977) original conceptualization was to explain 'activity-setting' preferences and behaviors. To this end, recreation specialization provided a common lens with which to view diversity among angler within the studies in this dissertation, making disciplinary contributions within the human dimensions field. In Chapter 2, I demonstrated that motivational similarity may be a useful basis for grouping anglers into behaviorally distinct types, that were also found to differ in several key indicators of commitment, a pillar of specialization theory (Buchanan, 1985). In particular, it suggests that specialized anglers are often more strongly motivated by outcomes related to the challenges of fishing. While past research has suggested that specialized anglers are more trophy-oriented (Bryan, 1977), catching large fish may only represent one type of challenge. This finding was also supported in Chapter 4, wherein centrality-to-lifestyle mediated the effect of size and number of caught fish. While the importance of size increased with centrality for some species (e.g., northern pike and common carp), for others catching greater numbers may constitute a greater challenge.

In contrast to Chapter 2, the discrete choice experiment in Chapter 3 did not find such clear evidence of a relationship between commitment and the importance of different aspects of catch. Instead, preference heterogeneity was observed primarily as aspects related to the cost of participation, which was best explained by centrality-to-lifestyle. While such a relationship between centrality-to-lifestyle and apparent commitment to participation may be expected, the study used a novel application of latent class segmentation to capture differences among anglers independent of the specialization measures, thereby constituting a true test of the relationship between specialization constructs and preference heterogeneity. The absence of significant heterogeneity among utility estimates for catch or regulatory aspects likely stemmed from the multi-species context of the choice experiment, wherein the detailed options were limited to each angler's preferred target species, and anglers' preferences related to size of fish and catch rate were already captured in the distributions of catches observed for each species. Given the evidence of Chapter 2 that species are targeted for different reasons, the results of Chapter 3 suggested that heterogeneity in preferences for size and number of fish is to a certain extent endogenous to the species presented.

The examination of satisfaction with catch in Chapter 4 provided additional support for the important interaction between species preference and the relative importance of fish size compared to catch rates to anglers. As in the utility model presented in Chapter 3, the satisfaction model of Chapter 4 found evidence to support the universal preference of anglers for both larger fish and also greater numbers. While the utility model used standardized attribute levels to derive estimates based on the distribution of sizes and catch rates expected for each species, the satisfaction model relied on absolute values. This distinction and the extensive use of interaction effects to derive species-specific estimates for varying levels of specialization revealed differences in the importance of size versus catch rates among species that were not apparent in the utility model.

Together the first three studies in this dissertation examined the interactions of a diverse sample of anglers with an equally diverse suite of fishery resources. For studies of fishing in a more general context, angler diversity may be best captured through measures of commitment, which are related to participation rates (Chapter 3). Heterogeneity among activity-setting preferences related to catch orientation, on the other hand, appear to be much more context dependent, with target species being a key factor. Thus researchers should be wary of generalizing proposed correlates of specialization such as trophy orientation (Bryan, 1977), or harvest orientation (Bryan, 1977; Dorow et al., 2010).

While the first three data chapters provide new perspectives and insights into what anglers want from fishing and the role that target species play in offering different experiences a diverse user base, the final study presents an application of human dimensions research to address a pressing fisheries management issue. Traditionally, recreational fisheries have been considered to be self-regulating, as anglers are free to move among fishing opportunities. Thus when stocks diminish at one site, anglers were assumed to shift their effort to more abundant stocks at other sites thereby allowing the former to recover until an ideal free distribution is reached (Cox, Beard, & Walters, 2002). In the last decade, however, fisheries ecologists have raised concerns that recreational fisheries may not be self-regulating and instead overfishing is a likely outcome (Lewin, Arlinghaus, & Mehner, 2006; John R. Post et al., 2002). At the root of these concerns is the ability of anglers to adapt to changing ecological and regulatory conditions. This issue is ultimately one of human behavior, which has largely been absent from consideration by ecological studies concerned with resource conservation (Hunt et al. 2013), leaving the task of integrating social and ecological insights with the fisheries manager (Radomski & Goeman 1995). Chapter 5 examined this issue in the context of declining European eel abundance.

In recent years, discrete choice experiments have gained prominence in the field of recreational fisheries (e.g., Aas et al., 2000; Hunt, 2008; Dorow et al., 2010; Oh & Ditton, 2006), holding promise for improving predictions of angler behaviors. Most applications of DCEs to recreational fishing have followed a classic "pick one" format and have emphasized angler preferences in terms of acceptance or support for policy change (e.g., Aas et al., 2000; Dorow et al., 2009; Oh & Ditton, 2006; Oh et al., 2013). For example, eel anglers were shown to prefer moderately stricter regulations than were currently in place (Dorow et al., 2010). Chapter 5 built on this foundation, but relied on an effort allocation task rather than a strict preference. This format allowed variation in angler commitment to eel fishing to be included in the model intercepts, and therefore emphasized changes in angling effort as a result of changing regulations for eel fishing. This chapter also demonstrates the usefulness of integrating information that is typically the purview of fisheries ecologists into an analysis of angler preferences. In this case, the additions of eel catch and harvest information provided insight into the potential for proposed policy changes to achieve targeted reductions in eel harvest. In doing so, it demonstrates that the moderately stricter regulations supported by anglers (Dorow et al., 2010) are too unrestrictive to achieve stated conservation goals (EC, 2007).

In the past, ecologists have typically modeled recreational fisheries systems under the assumption that all anglers behave identically (e.g., Cox et al., 2003; Parkinson, Post, & Cox, 2004; J. R. Post et al., 2008) and are behaviorally driven by simple linear functions of catch rates (Cox et al., 2002), while parameterizing these same models to account for specific characteristics of the fish stocks under study. By contrast, human dimensions research coming from a largely social-psychological perspective has focused on diversity among anglers (Bryan, 1977; Shafer, 1969), while largely ignoring the role of ecological diversity in providing fishing experiences. Simultaneously accounting for diversity within both social and ecological components of recreational fisheries poses a considerable challenge: while one angler can be a participant in many types of fishing, each type of fishing can simultaneously attract many types of anglers. Such relationships, referred to as "many-to-many" in the field of database administration, are exceedingly complex, and are usually intractable unless data is available at a fine enough scale to identify one or more underlying "one-to-many" relationships. Fortunately for my dissertation, such an opportunity was available through ADAPTFISH to collect detailed angler information as well as trip specific information from which the interactions with different primary target species could be assessed for each angler. That said, even such highly detailed information as was available from the ADAPTFISH dataset, limited my analyses on the level of trip scale. As such, each study within this manuscript focused only on the primary species targeted on each trip, and was unable to account for the diversity of recreational experiences that may be available by targeting multiple species within a trip.

Much of HD research has been based on the premise that a better understanding of what anglers want is necessary for managers in order to provide quality recreational fishing experiences (e.g., Driver 1985; Fedler and Ditton 1994); however, the field has been criticized in the past for a lack of management relevance (e.g., Matlock et al., 1988), with other researchers arguing that HD research has been underutilized in managing fishery resources (e.g., Ditton 2004; Hall-Arbor, Pomeroy, & Conway, 2009; Hunt et al., 2013; Fenichel, Abbott, & Huang, 2013; Fulton & Adelman, 2003). The conceptual framework presented in Chapter 1 integrates three approaches that researchers have used to address the issue of what anglers want, and I have attempted to provide a unique perspective and new insights through each approach with papers on angler motivations, utilities and satisfactions in the context of a diverse set of fishing opportunities. In so doing, I have attempted to demonstrate interdisciplinary relevance of human dimensions research for fisheries management. Recently, calls have been made to bridge the disciplinary divide, by adopting a social-ecological framework for recreational fisheries research (Hunt et al., 2013). This dissertation represents a step in this direction for human dimension research, by examining the interaction of ecological diversity of recreational fisheries reflected by the types of fishing opportunities available at a regional scale and a diverse angler population.

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Appendix A. Winners and Losers of Conservation Policies for European Eel (*Anguilla anguilla L.*): An Economic Welfare Analysis for Differently Specialized Eel Anglers

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Abstract

Recreational specialization theory was coupled with a discrete choice experiment to understand eel (*Anguilla anguilla* L.) angler's heterogeneity in their reaction to regulatory changes and the associated welfare changes. Differently specialized eel anglers exhibited distinct preferences for catch variables and eel angling regulations. All anglers preferred slightly to moderately stricter regulations than are currently in place; however, such policies particularly benefited casual eel anglers. In contrast, advanced eel anglers would be most penalised by highly restrictive regulations as indicated by substantial reductions in economic welfare. Aversions to stricter regulations found for advanced anglers contradicted predictions from specialization theory. From an eel management perspective, the implementation of some simple tools such as increased minimum-size limits will reduce angling mortality on eel and simultaneously increase the welfare of anglers. In contrast, highly restrictive eel angling regulations will result in considerable economic welfare losses of several million € per year for northern Germany alone.

Keywords: *Anguilla anguilla*, angling, catch, discrete choice experiment, management preferences, recreational fishing, recreational specialization, welfare

Introduction

The panmictic population of the European eel (Dannewitz, Maes, Johansson, Wickstrom, Volckaert & Jarvi 2005), Anguilla anguilla L., is considered to be outside safe biological limits (Dekker 2003; FAO & ICES 2006). A number of anthropogenic and natural causes for the eel decline have been discussed, which can be broadly classified to operate in either the oceanic or continental life phases of eel. In the former, climate change is thought to have affected the larval survival of eel (Knights 2003). In the continental life phase, overfishing, habitat loss, destruction of migrating routes, pollution as well as parasites and diseases have been suggested as factors potentially contributing to the eel decline (Kirk 2003; Knights 2003; Winter, Jansen & Breukelaar 2007; Dekker 2008). Some have also suspected excessive predation by fish eating birds such as cormorants (Phalacrocorax carbo) to affect the eel population in particular river systems (Brämick & Fladung 2006). Unfortunately, the relative importance of these factors for the eel decline is unknown (Starkie 2003). Irrespective, effective management action to conserve the rapidly declining eel population is urgently needed, inter alia because the loss of the eel resource will have considerable impact on the socio-economic state of many fishing communities in Europe (Dekker 2008).

Halting the alarming eel decline is probably the most pressing need that contemporary European inland fisheries management faces. Several recent political actions in support of the eel population have thus been undertaken. In 2007, the European eel was listed by the Convention on International Trade in Endangered Species (CITES) in its Appendix II to control its international trade. In the same year, the European Union (EU) adopted an eel recovery action plan (EC 2007). Accordingly, each Member State of the EU must develop eel management plans to achieve a target escapement rate of 40% adult silver eels from all river basins relative to an "undisturbed" situation. In the management plans, measures have to be prescribed to achieve this objective, and these can include various ways to control fishing mortality as well as measures related to reducing mortality at hydropower facilities, improving longitudinal connectivity of river ecosystems and other stock-enhancement activities such as increased stocking (EC 2007). If no eel management plan is submitted to the European Commission (EC) for approval by the end of 2008, temporal constraints on eel fishing can be implemented by the EC. These temporal closures would not only affect commercial eel fishing, but also threaten recreational fishing for eel, which is popular in many European countries (Starkie 2003; Tesch 2003; Arlinghaus 2004). In fact, recreational fisheries constitute the most important use of most inland (and migrating) fish stocks in all industrialised countries (Arlinghaus, Mehner & Cowx 2002), and thus must be explicitly considered in the development of eel management plans (EC 2007).

To conserve the eel population in Europe reducing fishing mortality through more stringent harvest regulations has been suggested (Dekker, Pawson & Wickstrom 2007). However, stricter harvest, gear and effort regulations will most likely reduce the quality of the angling experience for eel anglers and may therefore affect their behavior and welfare. Understanding which future management strategies are likely to receive support from various eel angler groups would help the decision makers to match regulatory changes with angler preferences to avoid conflicts as much as possible and also improve rule compliance (Aas & Ditton 1998; Arlinghaus 2005). It is known that support for harvest regulations such as bag limits or minimum-size limits among recreational anglers is not only dependent on the type of regulation (Beard, Cox & Carpenter 2003) but is also influenced by catch and harvest variables (Aas, Haider & Hunt 2000) due to their relation to the ultimate product of a recreational fishing experience, which is angler satisfaction (Arlinghaus & Mehner 2005; Arlinghaus 2006; Arlinghaus, Bork & Fladung 2008). Eel anglers might be willing to trade-off stricter harvest, gear and effort regulations against improved catch or harvest but this is likely to vary significantly with the angler type (Aas *et al*. 2000; Oh & Ditton 2006).

The theory of recreational specialization (Bryan 1977; Ditton, Loomis & Choi 1992) is particularly suited to capture some of the heterogeneity in preferences among anglers for trading-off regulations with catch expectations and other quality-determining attributes of a fishing experience (e.g. licence price) (Oh & Ditton 2006). Recreational specialization is a multi-dimensional concept originally conceptualised by Bryan (1977) for trout anglers as a “continuum of behavior from the general to the particular”. More specialized anglers are characterised by a higher level of involvement, psychological commitment to and dependency on fishing (Ditton *et al.* 1992). Consequently, the psychological benefits received through fishing experiences are higher for more specialized anglers compared to less specialized anglers (Arlinghaus & Mehner 2003, 2004; Oh, Ditton, Anderson, Scott & Stoll, 2005b). These benefits can be quantified by the economic concept of consumer surplus and net willingness-to-pay (WTP), which are measures to express the utility experienced by anglers in their outdoor experience in monetary units (Arlinghaus & Mehner 2004; Oh & Ditton 2006).

In addition to experiencing higher benefits (alternatively termed utilities or welfare by economists), more specialized anglers were also found to be more receptive to stricter regulations than less specialized anglers, in part due to their supposedly higher concern for preservation of fish stocks that facilitate high quality fishing experiences (Ditton *et al*. 1992; Salz, Loomis & Finn 2001; Oh & Ditton, 2006). More specialized anglers also exhibit a distinctly different preference structure for catch and harvest variables, typically favoring fish size over number of fish and emphasising the release of fish over retention of fish for consumption (Bryan 1977; Aas *et al*. 2000; Arlinghaus 2007; Arlinghaus, Cooke, Lyman, Policansky, Schwab, Suski, Sutton & Thorstad 2007). It is unclear whether such patterns also hold for eel anglers that according to anecdotal evidence are supposed to be highly consumptively oriented irrespective of degree of specialization, at least in Germany. It might thus be assumed that more specialized eel anglers will be particularly penalized by highly restrictive eel harvest regulations and therefore be “losers” of such policies.

A method that is capable to analyse the trade-offs between utility-determining attributes of an eel angling experience (i.e. catch/harvest variables, regulations) an angler is willing to make is the stated preference discrete choice experiment (Louviere, Hensher & Swait 2000; Paulrud & Laitila 2004). Inclusion of a cost variable in such survey experiments allows calculation of the economic welfare changes associated with different hypothetical management policies based on the concept of consumer surplus (Edwards 1991; Freeman III 2003). Consumer surplus is the utility non market goods, such as a recreational fishing experience, provide to an angler. In other words, it is an economic measure of the welfare consumer's gain from using a resource that is not traded on formal markets or conducting a leisure activity at prices below what they would be willing to pay for the good (Freeman III 2003). Estimating the economic welfare changes via changes in the consumer surplus to hypothetical, yet plausible, modifications in utility-determining attributes of a fishing experience (e.g. harvest regulations, size of fish) is of particular interest to decision makers because it allows quantifying objectively the consequences of policy changes for social well-being (Lawrence 2005; Paulrud & Laitila 2004). Because consumer surplus is the quantification of the quality of fishing experiences as perceived by anglers, this concept developed to value non market goods does not involve the flow of real money, which sometimes creates confusion among fisheries managers and other decision makers (Edwards 1991). Only few applications of this technique are available from the recreational fishing sector (e.g. Paulrud & Laitila 2004; Lawrence 2005; Oh, Ditton, Gentner & Riechers 2005a) and only one study has linked the concept of angling specialization to angler welfare changes in response to modifications in regulations (Oh & Ditton 2006). No study is available in the context of recreational angling for eel, yet such studies are important to facilitate formal cost-benefit analyses of future eel management policies where changes in angler welfare, and not angler expenditure, in association with altered regulations or catch qualities is the appropriate economic concept to apply (see Edwards 1991 for review).

The objectives of this paper are (1) to understand the preferences of eel anglers for various regulations and catch and harvest variables; (2) to identify the heterogeneity within eel anglers regarding preferences for regulations and harvest variables using the concept of angler specialization; and (3) to evaluate the economic welfare consequences of different eel conservation policy scenarios for eel angling in general and for specialized eel angler segments in particular. It was hypothesized that more specialized eel anglers would be willing to accept stricter harvest regulations but that overly strict harvest regulations would reduce their welfare to a greater extend compared to less specialized anglers.

Materials and methods

Study area

The study was conducted among anglers with a residence in the state of Mecklenburg-Vorpommern (MV) located in the north east of Germany. Eel is found in all running and most standing waters and in the coastal area of MV (Lemcke 2003), and is exploited by commercial and recreational fisheries. Eels are currently managed by a set of harvest regulations together with routine stocking activities, which are often funded by angling organizations and clubs. Harvest regulations for eel in inland waters rely heavily on minimum-size limits (45 cm), rod limits (3 rods per day), and sometimes a daily bag limit of 3 eel is in place but this depends on local, fishery-specific regulations.

According to recent surveys of anglers in MV conducted by Dorow & Arlinghaus (2008), in 2006 the total population of anglers with residence in MV is 153.000 (± 16.000 at 95% CI). This estimate encompasses active anglers fishing at least once in the 2006 fishing season. Around 47 % of the active anglers (i.e. 72.000 in total) targeted eel at least once during a one year fishing season.

Selection of the angler sample

Anglers participating in this study were recruited by telephone by random digit dialling (RDD) as well as random selection from a recreational fishing license frame of MV (see Dorow & Arlinghaus 2008 for details). From this sample of anglers, people that indicated they had fished for eel at least once in the previous season or who had reported catching eel in reminder telephone calls as part of a complementary diary study (see below) were selected.

Questionnaire design

The survey was conducted by mail and consisted of two sections. In the first part, the respondents were asked about their experience with eel angling and were presented a series of multi-item scales designed to measure the specialization level of anglers. In these scales, each angler evaluated items intended to measure the angler's centrality to lifestyle to eel angling and consumptive orientation on a 5 point Likert-type agreement scale ranging from 1-strongly agree to 5-strongly disagree. Previous research has shown that both centrality of life-style and consumptive orientation are valid sub-dimensions of angler specialization (Bryan 1977; Sutton 2003). The administered items were derived from published scales for centrality to lifestyle (Kim, Scott & Crompton 1997; Sutton 2003) and consumptive orientation of anglers (Fedler & Ditton 1986; Aas & Vittersø 2000; Anderson, Ditton & Hunt 2007); they were reworded specifically towards eel angling and used in a translated form in German (Table A.1).

Centrality to lifestyle scales measure the extent to which a participant's lifestyle and social network are connected to angling (Sutton 2003). As eel angling becomes a more central part of life relative to other leisure activities, including fishing, participation in targeted eel angling becomes more important as a means of self-expression and satisfaction of personal leisure needs (Sutton 2003). Consumptive orientation of anglers is defined as the degree to which an angler values different catch related aspects of the angling experience (Arlinghaus 2006; Anderson *et al.* 2007). Dimensions of consumptive orientation may include catching something, numbers of fish, catching large/trophy sized fish and fish retention orientation (i.e. harvest versus release) (Aas & Vittersø 2000; Anderson *et al.* 2007). Due to the assumed consumptive nature of eel angling, several items were added to the original ones (Anderson *et al.* 2007) to measure retention orientation of eel anglers more reliably (Table A.1). In addition to these scales, specific items also assessed anglers' perceptions of skill level and their self-reported behavioral sensitivity to stricter eel angling regulations (Table A.1).

The second part of the questionnaire presented respondents with a discrete choice experiment consisting of hypothetical eel angling experiences composed of several attributes including catch variables (number and size of catch), various types of regulations (harvest regulations: size limit, daily bag limit; gear regulations: rod restrictions; effort regulations: temporal closure) and a price variable (increase in daily costs of eel angling over current costs) (Table A.2). Each attribute had three to four levels that were systematically varied to allow estimation of preferences for varying conditions.

To familiarize respondents with the layout of the choice task, anglers were first presented with an example choice set, followed by four choice sets composed of attribute levels that followed an orthogonal statistical design (Figure A.1, see below). In each choice set, anglers first were forced to choose between two hypothetical eel angling experiences. Thereafter, respondents were asked to allocate ten hypothetical angling days among eel angling and all possible other angling alternatives: fishing for eel, freshwater non-piscivorous species, freshwater piscivorous species, undirected freshwater fishing, fishing in coastal areas or not fishing. This allocation task was undertaken for both the chosen and not chosen eel angling alternative.

To combine attributes and their levels in choice sets, a full factorial experimental design would require 84,934,656 ($4^{10} \times 3^4$) different combinations. Administering this enormous number of choice sets is neither feasible nor needed. Instead, an orthogonal fractional factorial design was applied to reduce the number of combinations to 64, while still allowing estimation of the main effects (Raktoe, Hedayat & Federer 1981; Hensher, Rose & Greene 2005). To further reduce the burden on each respondent, an additional orthogonal variable grouped the choice sets into 16 blocks consisting of 4 choice sets. One of these blocks was randomly assigned to each respondent.

Survey administration and non-response bias

A 14-page final questionnaire was mailed in April 2007 along with a personalized cover letter and stamped mail-back envelopes to N = 381 eel anglers fishing in MV. After two weeks, a reminder telephone call was conducted to non-respondents and new questionnaires were mailed as needed. As this study was part of a larger study (Dorow & Arlinghaus 2007, 2008, see also below), some basic information on demographic background and angler characteristics was available for the gross sample of anglers that received the questionnaire. A comparison between respondents (*N* = 214) and non-respondents (*N* = 173) to this survey revealed no significant differences in average age, average monthly income, distribution of educational levels, average number of angling trips in MV in 2006 and average years of angling experience. There was therefore no indication of non-response bias in the present study such that we assumed the data to be representative for eel anglers in MV.

Complementary diary study

Eel anglers receiving the above-mentioned mail questionnaire were part of a large-scale diary study on angler catches in MV (see Dorow & Arlinghaus 2007, 2008 for details). The sample of eel anglers responding to this survey were matched to the sample of anglers providing information on catches and fishing effort in the diary study. Diaries recorded angler-specific fishing behavioral information from September 2006 to August 2007 in the state of MV. These data were used to compare the intensity of fishing and the harvest rates of eel anglers to better understand fishing behaviors of differently specialized eel anglers.

Statistical analysis

Eel anglers were segmented into specialization groups to investigate heterogeneity in preferences for eel angling regulations and angler segment-specific welfare changes associated with changes in eel angling and regulation scenarios. To segment the eel angler population, a list of items designed to measure centrality of life-style and consumptive orientation were subjected to principal component analysis using varimax rotation to identify the factor structure of the scales. Reliability analysis based on Cronbach´s alpha was used to justify creation of specialization indices based on item means when Cronbach's alpha exceeded 0.7 (Cortina 1993). In total, four subdimensions of recreational eel angling specialization were identified resulting in four indices: centrality of eel fishing to lifestyle, general catch eel orientation, eel retention orientation and sensitivity to eel regulations (Table A.1). A Ward hierarchical cluster analysis was performed on these indices resulting in three clusters that reflected varying degrees of eel angling specialization similar to the approaches of angler segmentation conducted by Oh *et al*. (2005a) and Oh & Ditton (2006). Specialization groups were compared on a number of variables (e.g. specialization indices, number of fishing days, expenditure for fishing) by one-way-analysis of variance (ANOVA) and appropriate post-hoc-tests (Tuckey for homogenous variances, Dunnett-T-3 for heterogeneous variances) or chi-square analysis for categorical data (e.g. educational level). Significance was assessed at $P < 0.05$. All analyses were conducted with the SPSS software package version 14.0 (SPSS Inc., Chicago, USA).

The statistical analysis of preferences for catch quality variables and fishing regulations as articulated by the respondents in the discrete choice part of the survey was grounded in random utility theory (McFadden 1974). The underlying assumption is that the utility (benefit/welfare) of an alternative is a function of its components, and that individuals make choices in order to maximize their overall utility (Ben-Akiva & Lerman 1985, Louviere *et al*. 2000). To obtain the so-called part-worth utility (PWU) for attributes and attribute levels, i.e. the contributions of each attribute and attribute level to the overall utility of the alternative, the indirect utility function was estimated, which was comprised of a deterministic component and a random error component (Louviere *et al.* 2000). The coefficient of the deterministic component represents the PWU of an attribute level. Each PWU represents the proportion of utility that can be attributed to a specific attribute or attribute level. In our study, utility was modelled using a conditional logit model, which assumes that the error term follows a Gumbel distribution (Ben-Akiva & Lerman 1985; for applications of this approach to recreational fishing see Aas *et al*. 2000; Lawrence 2005; Oh & Ditton 2006). The distributional assumption for this model requires the satisfaction of the independence of irrelevant alternatives (IIA) property. A likelihood ratio test comparing the unweighted conditional logit model with a constructed base alternative of not fishing for eel and the forced choice model of eel angling alternatives (see below for explanation) revealed no significant violation of the IIA property ($P > 0.05$, compare Hensher *et al*. 2005).

To estimate the conditional logit model, preferences articulated in the forced choice of eel alternatives were weighted by the number of eel fishing days as indicated in the subsequent allocation task (Figure A.1). In addition, a base alternative was constructed by aggregating the number of days allocated to all non-eel fishing activities. In cases where anglers allocated at least one day of angling to their chosen eel angling alternative, weights for the chosen alternative ranged from a single day to all ten days; in cases where both eel angling alternatives were rejected, a weight of ten was assigned to the non-eel angling alternative.

Separate parameter estimates were derived for each angler specialization segment in a jointly estimated model using the known class function of Latent Gold 4.0 (Statistical Innovations Inc., Belmont, MA.). This approach ensured identical parameter specifications for each segment to facilitate comparison between groups. To test for significant differences of preferences between the eel angler segments a Wald-test was performed at $P < 0.05$. Overall model fit was assessed based on the pseudo-R^2 statistic, where values ~ 0.3 and above indicate a good model fit (Hensher *et al.* 2005).

An advantage of stated preference models over models based on observed angler behavior (i.e. revealed preferences) is that model results can be used to rank hypothetical but realistic management scenarios (Oh et al. 2005a; Oh, Ditton & Riechers 2007), with the base condition being the *status quo* (Lawrence 2005). In the present paper, first four alternative policy scenarios compared the current state were developed (see Table A.5; scenarios 2-5), reflecting possible management approaches to reduce the impact of recreational eel fishing on eel stocks. The severity of regulatory control increased from scenario 2 to scenario 4 by launching increasingly stricter eel angling regulations (e.g. decreasing bag limit and increasing minimum-size limit). With the exception of scenario 5, the catch variables were held constant to isolate the impact of increasing regulation severity from altered catch qualities on angler welfare. Additionally, in scenarios 6-10 the effects of changes of individual harvest regulations (minimum-size limit or bag limit) on angler welfare were simulated. For scenarios 6-10 also the predicted changes in eel angler harvest were estimated based on the distribution of sizes of eel in the angler harvest and daily eel harvest numbers based on data reported in the above-mentioned diary study from the fishing season September 2006 to August 2007. Only eel harvest data for the anglers responding to the choice experiment were included in the analysis.

Inclusion of an appropriate payment vehicle (here increase in overall costs for fishing for eel) in the choice experiment allowed calculation of changes in economic welfare (as perceived by anglers) associated with changes to the angler utility-determining attributes of the fishing experience that were compared relative an alternative situation (Lawrence 2005). Relative change in net willingness-to-pay (WTP) (i.e. a measure of consumer surplus) for an eel angling day was estimated based on changes in eel angling regulations relative to the *status quo*. Because the coefficient of the cost variable is equivalent to the marginal utility of income (Kaoru, Smith & Liu 1995), it can be used to quantify the net WTP for a fishing trip, which is a measure of the net economic value (consumer surplus) experienced by the angler. This approach was pioneered by Hanemann (1984) using the coefficient for the cost variable (termed PWU of cost) from a conditional logit model $\beta_{trip\cos t}$ as a means to monetize utility measures from choice experiments as follows:

$$\Delta WTP = \frac{1}{\beta_{trip\cos t}}(V_0 - V_1),$$

where ΔWTP is the change in WTP from the base to the alternative state, V_0 indicates the utility acquired from the fishing trip under baseline conditions, and V_1 is the utility from the angling trip under the modified conditions. WTP estimates were computed using segment-specific parameters (PWUs) representing the increase or decrease of the non market value of a fishing experience in a specific eel angling scenario. Extrapolated to the entire eel angler population in MV, this economic measure represents the loss or gain in economic welfare from changes to attributes of the fishing experience as perceived by anglers, which can be used to rank different management scenarios or to be included in cost-benefit analyses (Edwards 1991) of eel conservation policies.

Results

Of the 378 selected eel anglers, 214 anglers responded to the survey resulting in a response rate of 57%. In the final analysis, only respondents that resided in the state of MV (*N* = 193) were included, and the response rate for these anglers was 53%.

Eel angler specialization

Four indices of eel angling specialization were identified (Table A.1), namely centrality of eel fishing; eel catch orientation; eel retain orientation, and sensitivity against eel angling restrictions (Table A.1). Cronbach´s alpha for the centrality scale was 0.84 and for the catch orientation scale 0.72, indicating satisfactory internal reliability. Ward cluster analysis generated three eel angling specialization segments (Table A.3), which were labelled advanced eel anglers (*N* = 88; 45.6%), intermediate eel anglers (*N* = 64, 33.2%) and casual eel anglers (*N* = 41; 21.2%), respectively (this terminology followed Oh & Ditton 2006). The resulting groups significantly differed from each other in the four indices of angler specialization (Table A.3). As expected, advanced eel anglers exhibited the highest centrality to lifestyle. They also showed the highest catch orientation and the highest retain orientation of all angler segments supporting anecdotal evidence about the high consumptive orientation of German eel anglers. Intermediate anglers were quite similar to the advanced anglers in terms of centrality to lifestyle, catch orientation and retain orientation, but differed significantly from advanced and causal anglers in their sensitivity against restrictions. Specifically, intermediate anglers indicated to abandon eel fishing once regulations would become too strict while advanced and casual anglers would not necessarily discontinue fishing (see Table A.1 for item wording). Casual eel anglers were characterised by a significantly lower centrality to lifestyle of eel angling, a lower catch orientation and a lower retain orientation compared to advanced and intermediate eel anglers.

The different eel angler segments were characterized by similar demographic background (Table A.3). However, most behavioral variables characterizing commitment to fishing such as self-estimated frequency of fishing, investment into tackle, number of water bodies fished and number of angling friends showed a consistent trend of high values for advanced anglers, intermediate values for intermediate anglers and low values for casual eel anglers. However, most of these differences were not significant due to high inter-segment variability and low power to detect significant differences given the low sample size (Table A.3). However, further reinforcing the appropriateness of the eel angler segmentation procedure, the variable “importance of eel” was rated significantly different by the three angler groups. As to be expected, advanced anglers attached the highest, and casual anglers the lowest, importance to eel as a target species (Table A.3).

The appropriateness of the eel angler segmentation based on measures of commitment and catch orientation was also confirmed by the observed angling behavior as revealed by diary reports in the fishing seasons from beginning of September 2006 to the end of August 2007 (Table A.3). Although not significant in all cases, there was a consistent trend for advanced eel anglers being more active, avid and successful eel anglers compared to intermediate and casual anglers. For example, advanced anglers exhibited a significant higher overall annual fishing activity and tended to fish more often specifically for eel compared to intermediate and causal eel anglers. Significant differences between the eel anglers segments were observed in the distribution of the number of eel harvested per successful eel angling trip. While the majority of eel anglers in each segment captured 1 eel per successful eel angling trip, this situation was much more common more common for casual anglers (70%) than for advanced anglers (53%) (Table A.3). Eel angler segments also differed significantly in the relative frequency of length classes of eel retained over the fishing seasons as indicated by casual and intermediate eel angler capturing significantly more fish of the length class 45 – 55 cm compared to advanced eel anglers.

Fit of angler preference models

All eel anglers preferred eel fishing over stopping fishing for eel as indicated by a significant intercept in the conditional logit models (Table A.4). The explanatory power of the overall conditional logit model of angler preferences for catch variables, regulations and price was high as indicated by a high goodness-of fit measure (pseudo-R^2 = 0.27, Table A.4). For the segment specific models, the pseudo-R^2 statistic was similarly good varying between 0.26 and 0.32 (Table A.4). The specialized angler segments exhibited different preferences for eel catch variables, regulations and costs, and differences between angler groups were significant except for the cost variable (Table A.4). Differences in preferences between angler groups were evident in improvements to the model fit (as measured by the Bayesian Information Criterion, BIC) when a model with angler segmentation was compared with a single class model (BIC=2807.8 for the segmented model versus BIC=3360.7 for the overall model).

Preferences of eel anglers for catch variables

Anglers differing in specialization level exhibited pronounced differences in their preferences for eel catch variables (Table A.4). Advanced eel anglers were the only angler segment placing strong emphasis on both catch number and size as quality determinants of the fishing experience. In contrast to intermediate and casual anglers, most attribute levels were significant for advanced eel anglers. They preferred eel catches of 3 eels per day the most and significantly disliked a 1 eel per day option.

Advanced anglers also strongly preferred an average catch size of 60 cm and were not supportive of an average catch size of only 50 cm. The catch preferences of intermediate eel anglers differed significantly for the number of eel caught but not for the length of eels caught. Intermediate anglers strongly preferred to catch 3 eel per day, but significantly disliked catching either 4 eel per day or 1 eel per day. In contrast, the number of expected eel did not significantly influence casual anglers' trade off decisions. For this angler segment, only the expected size of the eel was of relevance and casual anglers preferred the largest size of eel (65 cm).

Preferences of eel anglers for eel angling regulations

Significant heterogeneity in preferences for eel angling regulations between the three specialization segments was observed (Table A.4). The preferences of advanced eel anglers with regards to angling regulations were most pronounced as indicated by the fact that except for the 2 eel bag limit all other coefficients (part worth utilities, PWU) for the different regulatory levels were significant (Table A.4). Advanced eel anglers preferred moderate regulations but strongly opposed the strictest levels of the different regulations. They favored a moderate increase of the minimum-size limit to either 50 or 55 cm but strongly disliked the current minimum-size limit of 45 cm and an increase of size limits to 60 cm. Daily bag limits of 1 eel per day were not approved and the alternative of 3 eel per day was strongly favored. Similarly, a temporal closure of 14 days per month was strongly disliked by advanced anglers who favored no closure or a moderate closure of 7 days per month. Regarding gear regulations, a 1 rod limit was significantly disliked and a 2 or 3 rod limit was preferred.

Intermediate eel anglers were less clear in their preferences for regulations compared to the advanced eel anglers indicated by the fact that 4 coefficients were insignificant (Table A.4). They were also less supportive of some of the harvest regulations compared to advanced anglers. For example, intermediate eel anglers preferred a minimum-size limit of only 50 cm, while advanced anglers also preferred a size limit of 55 cm. Intermediate anglers preferred a comparatively large bag limit of 3 eel per day, and a lower bag limit of only 1 eel per day was disliked. Similar to advanced eel anglers, intermediate anglers also disliked a temporal closure of 14 days a month and preferred less strict restrictions on access temporally. Two rods was the most acceptable rod limit level for intermediate anglers.

Compared to advanced and intermediate eel anglers, casual eel anglers appeared to be the least affected by overly restrictive eel angling regulations. In other words, they objected less to the strictest regulations in the choice sets (Table A.4). Casual anglers preferred minimum-size limits of 55 cm and strongly disliked the current state of 45 cm. While a very restrictive bag limit of 1 eel per day was disliked, casual eel anglers showed a marked preference for bag limits of 2 or 3 eel per day. In contrast, both advanced and intermediate anglers were most happy with a large bag limit of 3 eel per day. Moreover, casual anglers did not significantly dislike a 14 days per month temporal closure, while advanced and intermediate anglers did. In fact, casual anglers objected to a no closure option and preferred a closure of 7 days per month. In contrast, intermediate and advanced eel anglers preferred the no closure alternative. In contrast to the other two angler groups, casual anglers did not show any pronounced preference for rod limits.

For the cost variable, preference results were as expected for all eel specialization segments. Increasing costs per eel angling day compared to the status quo were significantly disliked by all eel anglers as indicated by a negative coefficient for the cost variable (Table A.4).

Policy scenario evaluation

Model results in Table A.4 were used to evaluate the change compared to the current state in probability of choice and in associated consumer surplus changes (Table A.5) for four different eel conservation policy scenarios (scenarios 2-5) that varied in catch expectation and degree of harvest, gear and effort regulations. Furthermore, the effects of single measures (size limit and bag limit, scenarios 6-10) were estimated. Policy analysis was performed for each specialization segment separately (Table A.5).

The distinct preferences for the choice model attributes exhibited by differentially specialized anglers were reflected in the proportion of respondents predicted to choose the alternative scenario over the current state and the no fishing option, and the marginal WTP change per day for eel angling under these scenarios (Table A.5). Different policies were desired by each angler segment with winners and losers resulting from the application of a specific eel conservation policy (scenarios 2-5). As indicated by scenarios 2 and 3 in Table A.5, casual eel anglers would be winners under slightly or moderately stricter eel angling regulations as indicated by the comparatively high proportion of anglers choosing this alternative, which also resulted in a relatively high and positive change in welfare per angling day. In contrast, advanced, and to a lesser extent intermediate, eel anglers would become losers when eel angling regulations would become overly strict and the catch variables deteriorate relative to the *status quo* (scenario 4 and 5; Table A.5). The highest marginal welfare change (-29 € per eel angling day) and change in choice probability (almost 100 %) in response to the attributes of scenario 5 was estimated for advanced eel anglers. Casual anglers would also experience a marginal welfare loss (-6 € per eel angling day) from scenario 5, but this decline in the marginal WTP would be much less than experienced by advanced eel anglers. These results reflect the overall higher value attached to eel angling by advanced eel anglers and the pronounced heterogeneity in preferences towards eel angling within the eel angling population in MV. The results also indicate the differential behavioral reaction to new eel conservation policies that can be expected in differently specialized eel anglers.

Increasing the minimum-size limit or implementing a stricter bag limit or (scenarios 6-10) compared to the current state would lead to divergent marginal welfare changes in the angler segments. Implementing a size limit of 50 or 55 cm would be positively perceived by all segments and would result in positive marginal welfare changes (scenarios 6 and 7, Table A.5). A further increase of the size limit to 60 cm would reduce the support by intermediate and causal eel anglers but still result in positive welfare change, but for advanced eel anglers such measure would already result in a slight welfare loss (scenario 8, Table A.5). The implementation of a daily bag limit of 2 eel per day would result in welfare gains only for causal eel anglers, whereas for advanced and intermediate eel anglers the quality of eel angling trip would be reduced as indicated by negative welfare (scenario 9, Table A.5). Finally, the choice probability for an eel angling day with a daily bag limit of 1 eel and the associated welfare would be negative for all eel angler segments (scenario 10, Table A.5)

To extrapolate the marginal economic welfare changes to the total eel angler population in MV (*N* = 72.000) it was assumed that the proportion of the eel angler segments (45.6% advanced; 33.2% intermediate, and 21.1% casual anglers, respectively, Table A.3) observed in this study would reflect the situation in the finite population of eel anglers in MV. Further, it was assumed that the segment-specific average days fished for eel in 2006 from Table A.3 would be preserved in response to altered regulations and catch qualities (in reality stricter eel angling regulations might lead the decreasing eel angling effort in the segments). The total welfare change is then the sum of the marginal welfare changes per angling day per segment for each scenario multiplied by the population size of the segments and the average eel angling days. By taking these simplifying assumptions, scenario 2 and 3 would result in positive welfare change equivalent to 2.47 and 2.78 million €, which could be generated by implementing slightly or moderately stricter eel angling policies (Table A.6). However, increasing regulatory strictness and further decreasing the catch quality of eel fishing would result in drastic welfare losses of 12.48 million € (scenario 4) or 15.49 million € (scenario 5) at the level of the entire state of MV.

Regarding the effects of changing individual harvest regulations the increase of the minimum-size limit to 50 cm or 55 cm would produce an positive total economic welfare change of 3.59 or 2.99 million € respectively (scenario 6 and 7, Tab.6). Such measures would also be effective in biological terms by reducing the total number of retained eels by 10.1% and 30.2% respectively. A further increase of the size limit (60 cm) would be more effective at reducing the total eel harvest to about 50% of current levels but the resulting positive welfare change is substantially lower compared to welfare associated with size limits of 50 or 55 cm. By implementing a daily bag limit of 2 eel the total harvest of eel by anglers could be reduced by 18.2% of current levels but the associated welfare loss would amount to 1.86 million € annually. A much higher welfare loss would be the consequence of a daily bag limit of 1 eel per day, which would reduce the total harvest nearly by 44%.

Discussion

The present study is unique in explaining the trade-offs that differently specialized eel anglers make to maximize their utility from a mix of harvest, gear and effort regulations and catch-related outcomes of the eel fishing experience. Preferences expressed in the present choice experiment are more realistic than traditional assessments of attitudes towards catch attributes or regulations in single-item opinion-type questions can indicate, because the latter approaches do not present context for realistic trade-off decision making (Aas *et al*. 2000; Oh *et al*. 2005b). Results of the present study are of immediate practical interest when designing management plans for eel recovery in the study area (northern Germany), and presumably elsewhere, by allowing objective evaluation of the angler's preferences for various eel conservation policies and the likely economic welfare consequences these will entail. The estimates of the marginal WTPs presented in the present papers are also useful for decision-makers interested in conducting cost-benefit analyses of different eel conservation management scenarios, and results of these exercises together with complementary biological studies on the effectiveness of particular measures for enhancing the eel population can inform the development of eel management plans at river basin scales.

However, results are also insightful from a basic scientific perspective because eel anglers differing in their degree of specialization showed important deviations from predictions from recreational specialization theory (Bryan 1977; Ditton *et al.* 1992) in both their preferred catch qualities and also their preference for regulations. Angling specialization theory predicts that as specialization increases an angler's emphasis on size of fish relative to number of fish increases (Bryan 1977; Chipman & Helfrich 1988; Fisher 1997; Arlinghaus & Mehner 2003; Arlinghaus 2007). The present study showed that this prediction does not hold for eel anglers in Germany. In fact, casual (i.e. less specialized) eel anglers exhibited a strong preference for the largest-sized eel (65 cm), while more specialized angler segments (termed advanced and intermediate in the present study) either exhibited no preferences for size of eel (intermediate anglers) or preferred smaller fish of 60 cm total length (advanced anglers). Moreover, advanced and intermediate eel anglers preferred to catch 3 eel per day, while casual anglers had no preference for the number of eel, which is contrary to predictions from specialization theory (Bryan 1977). It appeared that as specialization on eel increased catching the current bag limit of 3 intermediately-sized eel per day became more important.

One might be initially inclined to interpret the aversion towards very large eel by advanced eel anglers as a conservation attitude to protect these fish because they are to become migrating silver eels earlier than smaller eels. However, alternative explanations are more likely since preferences of more avid anglers for catching intermediately-sized eel might be related to the disposition of eel catches in Germany and largely reflect the current average size of eel captured by advanced eel anglers in the study area (62 cm, Table A.3). Eel are typically retained and consumed smoked, and more avid eel anglers might have embraced the idea that as the size of eel increases its culinary value decreases due to increasing fat content and potentially higher levels of pollutants (Bilau, Sioen, Matthys, De Vocht, Goemans, Belpaire, Willems & De Henauw 2007; FAO & ICES 2007; ICES 2008). In contrast, preferences of casual anglers for large eel might be an expression of the fact that relative to more avid eel anglers casual angler less often catch eel such that if occasionally an eel is caught it is preferred to be large. The greater fishing experience of advanced eel anglers might have taught them that catching more than 3 eel per successful eel angling day is a rare event (Tab 3). The lack of preference for the largest-sized eel in the present study along with a preference for a catch of three eel per day among more specialized eel anglers thus seems to largely reflect current eel angling success patterns and is likely driven by the high degree of consumptiveness of targeted eel angling in Germany. Indeed, retention aspects (as opposed to releasing fish) were rated significantly more highly by specialized eel anglers in the present study, in stark contrast to predictions from angling specialization theory (Bryan 1977). However, even among trout anglers, for which Bryan (1977) developed his initial proposition of decreasing consumptiveness with increasing specialization level, Hutt & Bettoli (2007) reported two groups of specialized anglers: one that is consumptive and one that is non-consumptive. Similarly, Salz & Loomis (2005) reported specialized saltwater anglers being more consumptive than less specialized marine anglers in the U.S.A. Among specialized eel anglers in Germany, releasing fish seems out of question, as indicated by the non-significant differences in the retain orientation dimension among advanced and intermediate eel anglers in the present study, which was also supported by a complementary diary study in which voluntary catch-and-release of eel was rarely documented (Dorow & Arlinghaus 2008).

Regarding preferences for regulations, recreation specialization theory predicts that support of management actions designed to prevent overexploitation of the fish stocks should be positively correlated with angler specialization (Bryan 1977; Ditton *et al.* 1992). Reasons for this include a greater awareness among specialized angler about anthropogenic factors, including fishing, causing population declines (Salz & Loomis 2005) as well as an overall greater dependency on the fishery resource to meet psychological needs, in turn stimulating support for resource-conserving management tools (Ditton *et al*. 1992; Oh & Ditton 2006). Assessment of attitudes towards traditional harvest regulations such as minimum-size limits or daily bag limits have generally supported this notion for a number of North American angler populations (Chipman & Helfrich 1998; Fisher 1997) but some exceptions were also noted in harvest-oriented recreational fisheries (Wilde & Ditton 1999). Using a comparable choice approach to the one presented here among marine anglers in Texas (U.S.A.), Oh & Ditton (2006) reported that advanced anglers were less supportive of relaxing currently relatively strict harvest regulations, while casual anglers opted for further relaxations. Oh & Ditton (2006) interpreted these preferences of more specialized anglers as an indication of higher concern for preservation of a currently not threatened resource (red drum, *Sciaenops ocellatus*) by keeping strict regulations of fish harvest in place.

In the present study on eel anglers, only weak support for the above-mentioned positive relationship between support for restrictive regulations and angler specialization was found. While advanced eel anglers indeed preferred a slightly higher minimum-size limit (55 cm) than intermediate anglers (50 cm), preferences expressed by casual anglers were generally more supportive of stricter harvest and gear regulations compared to anglers of higher eel specialization level. Preferences for most regulatory tools to conserve eel thus contradicted previous suggestions that more restrictive regulations would be more highly preferred by more specialized anglers. For example, advanced eel anglers opposed a high minimum-size limit of 60 cm, while intermediate and casual anglers were indifferent. Similarly, casual anglers equally preferred a daily bag limit of 3 or 2 eel per day, while advanced and intermediate exclusively favored a daily bag limit of 3 eel per day. Casual eel anglers thus exhibited stronger support for slightly more stringent traditional harvest regulations compared to more specialized eel angler segments. In addition, advanced and intermediate anglers preferred rod limits of 3 or 2 rods per day, while casual anglers were indifferent towards rod limits.

The results of the present study concerning temporal closures of eel fishing were particularly insightful, as this regulation is the most drastic form of regulating eel angling mortality. More specialized anglers strongly opposed a 14 days temporal closure per month and preferred the no closure option. In contrast, casual anglers actually opposed the no closure option and were indifferent towards a closure of 14 days per month. These findings support previous research showing that the supposedly higher support for recreational fishing regulations designed to preserve the fishery resource from more specialized anglers does not necessarily hold for effort-related regulations such as closed areas or seasons (Chipman & Helfrich 1988; Salz & Loomis 2005). Explanation for these patterns is related to the dependency of fishing as an activity, which typically increases with level of specialization (Ditton *et al*. 1992) and is consequently reflected by higher consumer surpluses experienced by high specialization anglers (this study, Arlinghaus & Mehner 2004; Oh & Ditton 2006). To temporally restrict the use of a specific fishery resource such as eel is thus more consequential for advanced anglers (higher resource dependence) than for causal anglers (Salz & Loomis 2005), which is strongly reflected in the substantial welfare losses experienced by advanced anglers in the strictest eel angling scenarios in Table 5.

A typical finding from earlier specialization research is that specialized anglers are more aware of the state and vulnerability of resources (Salz & Loomis 2005) and thus support actions, including regulations of excessive fishing mortality, to conserve the resources (Ditton *et al*. 1992). Given the poor state of European eel stocks (Dekker 2003, 2008), one could have assumed that the preferences of advanced eel anglers would have critically reflected their own potential to contribute to eel declines through harvest leading to support of more stringent harvest regulations (Salz & Loomis 2005). While their aversion towards restricted access to eel fishing is understandable, and in fact agrees with literature reports as explained above (Chipman & Helfrich 1988; Salz & Loomis 2005), the lower support for traditional harvest regulations expressed by specialized eel anglers in the present study was initially unexpected, thus requiring further explanation. It is suspected that three important reasons play a role.

First, the great consumptive and retention orientation among advanced and intermediate eel anglers may have offset their generally supportive attitudes towards eel conservation because there are few, if any, substitutes to eel among the species mix in central Europe. Thus, any actions that limit the possibility to keep eel likely contradict the motivations and experience preferences of more specialized (and consumptive) eel anglers. Hence, the assumed positive relationship between support for harvest regulations and angler specialization seems to be mediated by degree of consumptiveness (Wilde & Ditton 1999; Salz & Loomis 2005).

Second, acceptance of stricter harvest regulations assumes that anglers perceive themselves of contributing to stock declines (Salz & Loomis 2005). While there is no scientific evidence that recreational angling for eel actually contributes significantly to the current eel decline, recent catch statistics of recreational eel catches in some Member States of the European Union (ICES 2008) and a survey in the study area (Dorow & Arlinghaus 2008) indicate that recreational angling harvest can exceed the commercial harvest of eel in some river basins. This, of course, does not indicate that recreational fishing is overharvesting eel (Arlinghaus & Cooke 2005) but nevertheless suggests that eel harvest by recreational fishing can be an important source of mortality for eel during their freshwater life stage (ICES 2008). However, the angling media in Germany have not publicised any concerns about recreational angling contributing to eel populations to anglers in recent years and have instead focused on emphasising other reasons for the eel decline, e.g. glass eel harvest or mortality at hydropower turbines. Although more specialized anglers typically have an increased media use to be informed about current developments (Ditton *et al*. 1992), in Germany they have likely not been exposed to the potential for angling to impact on eel stocks (compare Arlinghaus 2006b). Thus, if there is no awareness that angling mortality may contribute to eel stock declines, there is also no cognitive need for specialized anglers to accept particularly strict regulations to conserve eels. Yet, it should be noted that all eel anglers in the present study were prepared to accept slightly stricter harvest regulations (e.g. increased minimum-size limit), and this is in close agreement with recent proposals by angler organizations in Germany on future eel conservation measures or recreational fishing (VDSF & DAV 2008).

Finally, previous predictions for higher support for harvest and gear regulations by specialized anglers were based on abundant resources (Oh & Ditton 2006), a situation that does not hold for eel, which is negatively affected by multiple factors and in sharp decline for unknown reasons (Dekker 2003; Starkie 2003). Such circumstances may influence attitudes toward personal restrictions because anglers may fear that they will be singled out by eel management plans despite the existence of multiple stakeholders and factors impacting on eel, while perceiving themselves as the user group that is most innocent for the eel decline (compare Arlinghaus 2006b). Thus, eel anglers in MV, and probably elsewhere, may fear that implementation of stricter regulations could be the first step towards a complete ban of recreational eel fishing as has happened in some European countries already (e.g. Sweden). One may expect that such concern is higher for advanced eel anglers than for casual eel anglers, because of their higher resource dependency and their higher motivation to fish for eel in the future. This might have resulted in greater opposition to overly strict harvest restrictions among more specialized eel anglers in the present study.

In agreement with the overall higher benefits experienced by high specialization anglers and their aversion towards stricter harvest and effort regulations, results of the scenario analysis revealed that overly strict regulations would disproportionally affect high specialization anglers. In contrast, disproportionate welfare gains are likely to be experienced by casual anglers at moderately stricter regulations of eel angling relative to the current state. These differences can be explained by the higher levels of commitment and psychological bonding towards eel angling found in highly specialized eel anglers. According to Buchanan (1985), the most committed (i.e. advanced) anglers have higher monetary and psychological investments (such as costs or investments into angling skills, social groups) associated with angling than less committed (i.e. casual) anglers. Due to their higher investments and resource dependency, advanced eel anglers have thus more to lose if stricter regulations were implemented. Additionally, due to the greater importance of eel as fishing resource, advanced eel anglers will likely have a harder time finding acceptable substitutes (other fish species or other recreational activity) for eel angling than casual eel anglers (compare Ditton & Sutton 2004). This bond with eel angling is reflected in the higher relative welfare loss experienced under highly restrictive eel angling regulations by advanced anglers compared to casual anglers. In contrast, being less committed and having lower resource dependency, casual eel anglers experienced relatively low welfare losses even under extreme regulations. Thus, among the entire eel angler population advanced eel anglers may be considered the losers if overly stricter eel angling regulations are implemented, while all angler segments, but particularly casual anglers, would benefit from slightly to moderately more restrictive regulations as indicated by positive welfare changes relative to the status quo (Table A.5).

Conclusions and implications

Eel conservation managers should be interested in matching future regulations with the preferences of eel anglers taking due notice of the angler heterogeneity within eel anglers as long as this is compatible with biological objectives to preserve the vanishing eel population. The high intensity of activity, purpose and conviction that characterise specialized anglers can have major consequences for resource users, managers and the fishery resources. These anglers often serve as role models for less specialized anglers (Salz & Loomis 2005). Moreover, highly specialized anglers are likely to voice the strongest opinions in response to future more restrictive management actions to conserve eel, as they have more to lose from such policies. Bringing specialized anglers onboard seems crucial if eel managers decide to implement stricter harvest or effort regulations for recreational eel angling, but it is clear that to avoid conflict and high losses of angler welfare any restriction to eel angling should be justified by scientific studies. Increasingly stringent regulations for eel recreational fishing should be carefully balanced with actions aimed to reduce the impact of other sources of eel mortality (e.g. commercial fishing, hydropower, fish-eating birds, Dorow & Arlinghaus 2008). Otherwise, implementation of regulations exclusively directed at recreational eel angling might lead to conflict, resulting in high losses of angler welfare as the present economic welfare analysis indicates. Furthermore, strict regulation of recreational angling without any associated restrictions on other known sources of eel mortality will likely also raise the impression among anglers that their proactive actions, including licence sale-driven investment of funds to conserve the eel population in selected river systems by stocking is not acknowledged by decision makers and society. Consequently, substantially restricting recreational eel fishing could, and likely will, lead to reduction of eel stocking by recreational fishing clubs and angling associations, which might reduce the eel escapement further. However, one should not forget that slightly or moderately restrictive harvest regulations might actually pay off for eel populations. For example, by reducing the daily bag limit from 3 to 2 eel per day and assuming the distribution of eel catches per day in the fishing season from 2006/2007 the total annual angling harvest of eel in the study area could likely be reduced by 18% (Table A.6). At the same time such restriction would result in an angler welfare loss of 1.86 million €. Restricting angler's eel daily harvest limits further to 1 eel per day would reduce the total catch per year by 43% relative to the *status quo*, but the resulting welfare loss would add up to 5.5 million € for the study area, which is probably unacceptably high. However, by increasing the minimum-size limit from 45 to 50 cm the total eel harvest by anglers could be reduced by 10 % and the associated welfare gain is 3.59 million €. A further increase of the size limit to 55 cm would reduce the eel harvest by anglers by 30 % and would still result in a positive welfare change of 2.99 million € (Table A.6). Therefore, increasing the minimum-size limit is more preferable than the reduction of the bag limit if managers aim to balance the biological and economic effects of individual measures.

Any type of future regulatory change must be carefully communicated before their implementation to prepare anglers to the typical unusual regulations. Communication efforts should include the purpose of new regulations and their expected outcomes as well as the legal need to allow escapement rates to increase. While reductions in eel mortality from recreational fishing will likely contribute to increased escapement rates, overly strict eel angling regulations, including temporal closures, would lead to considerable consequences for angler welfare in excess of several millions of Euro if aggregated to the entire eel angler population in Germany. These consequences for angler welfare must be reflected in the development of future eel management plans against potential gains in terms of increased escapement.

To conclude based on the results presented in this paper; minimal opposition by anglers to slightly more stringent harvest regulations (e.g. increased minimum-size limit from the current state of 45 cm to 50 or 55 cm) can be expected. This can also increase the eel population by a sizable reduction of the eel harvest by anglers (Table A.6). Any effort restrictions, however, are unlikely to be well received and may result in issues of enforcement.

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Tables and Figures

Table A.1. Items and reliability analysis of the specialization dimensions used for the segmentation of eel anglers in northern Germany.

Eel angling specialization dimensions and items[a]	Mean	SD	Item total correlation	Cronbach`s alpha if item deleted	Cronbach`s alpha
Centrality to lifestyle					0.84
When I go fishing eel is my favorite fish species	2.90	0.99	0.56	0.82	
Most of my friends are in some way connected with eel angling	4.03	1.00	0.47	0.83	
If I could not go eel fishing, I would not know which other species to target	4.15	0.93	0.50	0.82	
I consider myself to be an eel angling expert	3.47	0.94	0.60	0.82	
Compared to other anglers I own high quality eel angling gear	3.16	0.86	0.49	0.82	
Other anglers would probably say that I spend too much time eel fishing	4.19	0.88	0.51	0.82	
Eel angling is very important to me	3.02	1.06	0.71	0.81	
Eel angling provides me the greatest angling satisfaction	3.17	1.10	0.72	0.80	
A restriction of eel angling would not bother me a lot [b]	2.63	1.15	0.30	0.84	
If somebody fishes for eel regularly, it tells a lot about this person	3.68	1.01	0.26	0.84	
I like to talk with my friends about eel angling	2.63	1.02	0.45	0.83	
I am not really interested in eel angling [b]	2.03	0.96	0.43	0.83	
Catch Orientation					0.72
I would rather catch 1 or 2 big eel than 10 smaller partly undersized eel	1.64	0.90	0.22	0.73	
I like to fish for eel because of the challenge	2.42	0.88	0.21	0.73	
I like to fish for eel where I know I have a chance to catch a trophy fish	2.29	0.90	0.31	0.72	
When I go eel fishing, I am not satisfied unless I catch at least one eel	3.35	1.10	0.56	0.67	
The more eel I catch, the better the fishing trip	3.03	1.24	0.42	0.70	
The bigger the eel I catch, the better the fishing trip	2.30	1.08	0.61	0.65	
I am happiest with the fishing trip if I catch a challenging game eel	2.24	1.05	0.59	0.66	
Overall, I am satisfied with an eel angling day if I catch the bag limit	2.86	1.21	0.41	0.70	

Eel angling specialization dimensions and items[a]	Mean	SD	Item total correlation	Cronbach`s alpha if item deleted	Cronbach`s alpha
Retention orientation[c]					
The most important reason for eel fishing is my personal consumption; other reasons such as relaxation are secondary	3.01	1.13	-	-	-
Usually, I retain every eel I catch	2.42	1.14	-	-	-
Sensitivity to restriction [c]					
Stricter eel angling regulation would entice me to discontinue of my angling activities	4.29	0.97	-	-	
In the case of stricter eel angling regulation I would stop fishing specific for eel	3.43	1.07	-	-	-

Note: [a] items coded on a 5-point scale: 1 – strongly agree, 2 – agree, 3 – neutral, 4 – disagree, 5 strongly disagree; b item reverse coded before calculation of index; [c] no reliability analysis was conducted as item number per factor was < 3

Table A.2: Attributes and levels used in the choice experiment (underlined levels reflects the current state) to assess the angler's preferences for eel angling in northern Germany.

	Attribute	Levels
Expectations	Catch number	1 eel/day, 2 eel/day, 3 eel/day, 4 eel/day
	Average length	50 cm, 55 cm, 60 cm, 65 cm
Regulations	Minimum-size limit	45 cm, 50 cm, 55 cm, 60 cm
	Daily bag limit	1 eel/day, 2 eel/day, 3 eel/day, 4 eel/day
	Temporal closure	0 days/month, 7 days/month, 14 days/month
	Rod limit	1 rod, 2 rods, 3 rods
Cost	Cost increase per eel trip	same as today, + 2.50 €, + 5.00 €, + 10 €

Table A.3: Characteristics (average ± SD) for the specialization subdimensions, behavioral commitment characteristics, demographic characteristics and observed eel angling behavior and eel harvest of differently specialized eel anglers in northern Germany. Different letters indicate statistically significant differences between the eel anglers segments; n.s. – not significant.

	Advanced eel anglers (N=88)		Intermediate eel anglers (N=64)		Casual eel anglers (N=41)		F or Chi² value	df	P
Specializations subdimension									
Centrality to lifestyle [1]	3.1	± 0.5y	3.2	± 0.6y	3.7	± 0.6z	14	192	0.0001
Consumptive orientation[1]	2.3	± 0.5y	2.4	± 0.5y	3.1	± 0.6z	29.6	192	0.0001
Retention orientation[1]	2.4	± 0.6y	2.5	± 0.7y	3.7	± 0.7z	63.6	192	0.0001
Sensitivity against restrictions[2]	4.3	± 0.5y	3.0	± 0.6z	4.3	± 0.6y	114.8	192	0.0001
Behavioral commitment (12 month recall period)									
Eel angling experience (years)	18.9	± 14.5	18.3	± 13.7	18.2	± 12.6	0.1	184	n.s.
Angling days total in 2006	40.9	± 33.8	35.2	± 32.9	32.1	± 31.9	1.1	185	n.s
Eel angling days in 2006	12.3	± 15.1	11.8	± 16.1	11.3	± 18.6	0.6	182	n.s.
Number of eel caught in 2006	9.6	± 14.4	6.6	± 9.1	5.9	± 9.8	1.8	183	n.s
Importance of eel[3]	2.7	± 1.1y	2.9	± 1.2y	3.5	± 0.9z	7.2	190	0.001
Expenditure for an eel angling day	10.3	± 7.7	9.3	± 7.8	10.4	± 10.3	0.3	182	n.s.
Water bodies visited in MV in last 10 years	18.5	± 87.2	9.5	± 11.1	7.3	± 5.6	0.6	173	n.s.
No of angling friends	7.1	± 8.6	5.8	± 6.3	5.3	± 4	1.0	170	n.s.
Annual gear and bait expenditures (€)	251.3	± 468.7	158.4	± 225.4	117.3	± 94.7	2.2	170	n.s.
Importance of angling[4]	1.9	± 1.2	2.16	± 1.2	2	± 1.8	0.6	189	n.s.
Demographic variables									
Age	41.2	± 15.7	42	± 15.5	39.8	± 15.1	0.3	189	n.s.
Monthly income[5]	3.5	± 1.5	3.0	± 1.5	3.4	± 1.5	1.9	155	n.s.
Household size	3.1	± 1.1	2.8	± 0.9	3.0	± 1.0	1.4	189	n.s.
Percentage high school[6]	8		6.3		7.3		4.3	10	n.s.

	Advanced eel anglers (N=88)		Intermediate eel anglers (N=64)		Casual eel anglers (N=41)		F or Chi² value	df	P
***Angling behavior in 2006/2007*[7]**									
No of angling trips per year	28	± 21.2y	21	± 17.2z	17.7	± 10.6z	4.3	153	0.05
No of directed eel trips per year	3.4	± 5.2	2.1	± 5.3	2.1	± 4	1.2	153	n.s.
Total hours fished for eel (h) per year	18.5	± 31.4	9.6	± 22	8.8	± 14.4	2.4	153	n.s.
No of eel caught per year	7.8	± 12.8	5.1	± 14.6	3.8	± 6.5	1.4	153	n.s.
No of eel retained per year	6.2	± 9.1	3.9	± 10.4	2.9	± 5.3	1.8	153	n.s.
Relative frequency of No of eel retained per successful eel trip							15.8	6	0.05
1 eel per trip (%)	53.4		49.1		69.9				
2 eel per trip (%)	29.1		31.5		23.8				
3 eel per trip (%)	7.7		14.8		9.1				
4 and more eels (%)	9.7		4.6		1.6				
Average size of retained eel (cm)	62	± 8.6	60.4	± 12	59.8	± 8.2	0.9	91	n.s.
Average size (cm) of the largest retained eel per trip	64.4	± 9	63.1	± 9.2	60.8	± 7.1	0.9	91	n.s.
Relative frequency of length classes of retained eel per trip							11.1	4	0.05
45-55 cm length class (%)	28.9		54.3		45.2				
55-65 cm length class (%)	37		21.7		22.6				
over 65 cm length class (%)	33.1		23.9		32.3				

Note: 1 the lower the value, the higher the centrality to lifestyle, catch orientation and retain orientation; 2 the lower the value, the higher the sensitivity to regulations; 3 items was measured on the scale: 1- most important, 2 - second most important, 3 - third most important, 4 - one species between other ones; 4 item measured on the scale: 1- most important, 2- second most important, 3 - third most important, 4 - one leisure activity among others; 5 income categories were: 1 – under 1000 €, 2 – 1000 to 1500 €, 3 – 1500 to 2000 €, 4 – 2000 to 2500 €, 5 – 2500 to 3000 €, 6 – over 3000 €; 6 education categories were: 1- basic school without apprenticeship, 2 – basic school with apprenticeship, 3 – secondary school, 4 – high school, 5 – academic degree, 6 – scholar; 7 diary data for one complete fishing season (Dorow & Arlinghaus 2008) were available for 74 advanced eel anglers, 49 intermediate eel anglers and 31 causal eel anglers

Table A.4: Results of conditional logit models for specialized eel angler segments in northern Germany; PWU = part worth utility, SE = standard error. Parameters in bold indicate are statistically significant at P < 0.05.

Attribute	Level	Advanced eel anglers		Intermediate eel anglers		Casual eel anglers		Wald-test	P-value
		PWU	SE	PWU	SE	PWU	SE		
Intercept	Stop eel fishing	-1.859	0.161	-0.684	0.068	-0.370	0.085	0.007	1.000
	Fish for eel	1.859	0.161	0.684	0.068	0.370	0.085		
Catch number	1 eel /day	-0.399	0.092	-0.512	0.124	0.297	0.187	24.017	0.001
	2 eel /day	0.001	0.094	0.112	0.130	-0.105	0.182		
	3 eel/day	0.312	0.095	0.692	0.127	-0.002	0.184		
	4 eel/day	0.086	0.089	-0.293	0.124	-0.190	0.203		
Average length	50 cm	-0.513	0.111	-0.142	0.123	-0.418	0.217	14.024	0.029
	55 cm	0.005	0.095	0.095	0.126	-0.410	0.223		
	60 cm	0.344	0.096	0.098	0.127	0.282	0.182		
	65 cm	0.164	0.094	-0.051	0.113	0.546	0.179		
Minimum-size limit	45 cm	-0.234	0.102	-0.591	0.135	-0.634	0.208	12.596	0.050
	50 cm	0.308	0.091	0.598	0.135	0.239	0.190		
	55 cm	0.260	0.101	0.067	0.133	0.540	0.191		
	60 cm	-0.334	0.088	-0.074	0.114	-0.145	0.199		
Daily bag limit	1 eel/day	-0.732	0.092	-0.302	0.109	-1.051	0.172	21.122	0.000
	2 eel/day	0.100	0.077	-0.052	0.091	0.547	0.149		
	3 eel/day	0.632	0.090	0.353	0.118	0.504	0.155		
Temporal closure	0 days/month	0.332	0.086	0.418	0.111	-0.367	0.166	21.271	0.000
	7 days/month	0.507	0.069	0.243	0.097	0.587	0.154		
	14 days/month	-0.838	0.097	-0.661	0.115	-0.220	0.176		

Attribute	Level	Advanced eel anglers		Intermediate eel anglers		Casual eel anglers		Wald-test	P-value
		PWU	SE	PWU	SE	PWU	SE		
Rod limit	1 rod	-0.765	0.092	-0.515	0.114	0.062	0.199	17.510	0.002
	2 rods	0.402	0.079	0.458	0.097	0.043	0.153		
	3 rods	0.363	0.084	0.057	0.103	-0.105	0.171		
Cost increase per eel trip	Linear slope per € 2.50	-0.159	0.038	-0.213	0.053	-0.236	0.079	1.168	0.560
Model fit	pseudo-R^2	0.256		0.256		0.327			

Note: Overall Model Summary: LL=-1264.9; BIC(LL)=2807.7; AIC(LL)=2634.9; pseudo-R^2 = 0.266

Table A.5: Change in support (probability of choice) for management scenarios compared to the current state and the associated change in consumer surplus change (marginal WTP per eel angling day) of proposed eel angling management scenarios relative to the current situation (scenario 1). Scenarios are arranged by increasing degree of regulatory strictness, with scenario 5 also including reduced catch quality in addition to highly restrictive regulations; scenario 6-10 simulate the economic and biological effects of implementing stricter minimums size limits or bag limits; – indicates the base level against which the change in support and WTP is expressed.

	Number of eel per day	Average length of eel (cm)	Daily bag limit	Min. size limit (cm)	Temporal closure (days per month)	Rod limit	Advanced eel anglers		Intermediate eel anglers		Casual eel anglers	
							Change in support	Marginal WTP (€ per eel angling day)	Change in support	Marginal WTP (€ per eel angling day)	Change in support	Marginal WTP (€ per eel angling day)
Scenario 1 (base, status quo)	1	60	3	45	0	3	-	-	-	-	-	-
Management scenarios												
Scenario 2 (slightly stricter)	1	60	2	50	0	2	1.2%	0.31 €	26.6%	5.56 €	24.4%	4.52 €
Scenario 3 (moderately stricter)	1	60	2	55	7	2	4.4%	1.11 €	11.7%	2.25 €	41.%	9.84 €
Scenario 4 (as strict as possible)	1	60	1	60	14	1	-47.7%	-23.68 €	-35.7%	-8.40 €	-18%	-3.20 €
Scenario 5 (as strict as possible and with reduced catch experience)	1	50	1	60	14	1	-49%	-29.07 €	-38.4%	-9.53 €	-31%	-6.17 €
Change in individual harvest regulations												
Scenario 6 (size limit = 50 cm)	1	60	3	50	0	3	13.2%	3.41 €	26.7%	5.58 €	20.5%	3.71 €
Scenario 7 (size limit = 55 cm)	1	60	3	55	0	3	12.1%	3.11 €	15.9%	3.09 €	26.4%	4.98 €
Scenario 8 (size limit = 60 cm)	1	60	3	60	0	3	-2.5%	-0,63 €	12.7%	2.43 €	12%	2.08 €

Table A.6: The predicted total welfare changes (in million € per year) of different policy scenarios for different eel anglers segments and aggregated for the total eel angler population in MV, northern Germany. N refers to the assumed finite population size. Scenarios are from Table 5. For scenario 6-10 the change in eel harvest was estimated based on the distribution of eel angler harvest in the fishing season 2006/2007.

	Welfare change in the segments (in million € per year)				
	Advanced eel anglers (*N* = 32,832)	**Intermediate eel anglers (*N* = 23,904)**	**Casual eel anglers (*N* = 15,264)**	**Total economic welfare change**	**Change of the total eel angling harvest (%) relative to current harvest levels**
Management scenarios					
Scenario 2	0.125	1.568	0.779	2.473	-
Scenario 3	0.448	0.634	1.697	2.780	-
Scenario 4	-9.562	-2.369	-0.551	-12.484	-
Scenario 5	-11.739	-2.688	-1.064	-15.491	-
Change in individual harvest regulations					
Scenario 6	1.377	1.575	0.639	3.591	-10.1
Scenario 7	1.255	0.872	0.859	2.986	-30.2
Scenario 8	-0.254	0.685	0.358	0.790	-49.7
Scenario 9	-1.351	-0.537	0.032	-1.856	-18.2
Scenario 10	-3.467	-0.868	-1.139	-5.473	-43.7

	Option A	Option B
Expected Catch		
Catch number	1 eel	2 eels
Average length	60 cm	65 cm
Regulations for eel angling		
Minimum-size limit	60 cm	55 cm
Daily bag limit	3 eel/day	1 eel/day
Temporal closure	7 days/month	No closure
Rod limit	1 rod	2 rods
Increase of cost for an angling day	5 € increase	No increase
① Which eel angling option do you prefer? *Please choose only one!*	☐ **Angling Day A**	☐ **Angling Day B**

② How would you allocate 10 days on which you have to opportunity to go fishing on the following alternatives? Please consider in your responses that the criteria of your preferred and disliked eel angling day are in place.

Preferred angling day		**Disliked angling day**
	Eel angling days	
+	Days fishing for non-piscivorous species in freshwater areas	+
+	Days fishing for piscivorous species in freshwater areas	+
+	Days fishing in freshwater without a specific target fish species	+
+	Days fishing in coastal areas	+
+	Not fishing	+
= 10 days	**Total sum**	= 10 days

Figure A.1 Example of a choice set for the identification of eel angling day preferences and the associated allocation task (translated from German)

Appendix G. Using a Novel Survey Technique to Predict Fisheries Stakeholders' Support for European Eel (*Anguilla anguilla L.*) Conservation Programs

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Abstract

A novel variation of a multivariate stated preference method (the maximum difference conjoint approach) is presented in a survey designed to elicit the preferences of a fisheries stakeholder group (recreational anglers fishing in northern Germany) for a portfolio of measures to conserve European eel (*Anguilla anguilla* L.). Unlike other survey methods, our approach allows the separation of weight (i.e., relative importance of different conservation actions) and scale (i.e., perceived utility associated with different levels within one action) ascribed by stakeholders to conservation measures. The method also allows for trade-off decision-making and joint preference articulation for various conservation actions, and thus provides more realistic decision situations than other survey methods can achieve. We found that anglers prefer tighter than current eel fishing regulations but object to highly restrictive temporal closures. Confronted with an integrated eel conservation program, anglers were overwhelmingly willing to compromise, accepting tighter angling regulations provided that other sources of eel mortality are regulated concomitantly and eel stocking increased. Willingness to accept stricter regulation increased further when the suite of regulations delivered success in terms of increased eel escapement. We encourage the replication of the presented survey technique with other eel stakeholders groups, but also in other conservation contexts, to see if similar patterns of response behavior emerge that would not have been visible in traditional opinion-type preference assessments. Our results suggest that implementation of eel conservation policies should consider joint regulation of sectors that potentially affect eel stock negatively. Otherwise, management failure and conflict is likely.

Keywords: Anguilla anguilla; Best–worst; Choice experiment; Maximum difference conjoint; Recreational fisheries; Stocking

Introduction

The need for quantitative surveys to help conservation planning

Many issues in conservation management require consideration of both ecological and societal issues (Groom et al., 2006 and Carpenter et al., 2009). Understanding the social aspects of conservation planning such as the willingness of different stakeholders to participate in conservation programs is particularly important when (1) an urgency for conservation action exists, (2) the biological mechanisms about a natural resource decline are unclear resulting in uncertainty about the success of conservation actions, and (3) a high social and economic importance is associated with the resource. The latter two points facilitate that stakeholders are less prepared to accept personal restrictions on exploitation (Granek et al., 2008). In these situations, neglecting the views (i.e., attitudes and values) of affected stakeholders can, and most likely will, result in opposition to tight conservation measures (Stoll-Kleemann, 2001a and Stoll-Kleemann, 2001b), rule-breaking behavior (Salz and Loomis, 2005), loss of management credibility (Arlinghaus, 2005), and collectively, failure of conservation policies.

While most modern conservation planning processes account for the perceptions of various stakeholders via formal participatory processes or public hearings, quantitative social science methods can unravel the preferences and attitudes of diffusely organized stakeholder groups providing decision-makers an objective view on stakeholder's attitudes towards conservation programs (e.g., Arlinghaus and Mehner, 2005 and Cooke et al., 2009). This can add credibility when establishing conservation policies and generally improve conservation management planning by for example proactively predicting conflicts.

When conservation issues become socially and biologically complex (e.g., migrating species affected by multiple anthropogenic factors) assessing stakeholder preferences for particular conservation measures may require multivariate modeling approaches (Cooke et al., 2009), in which a large sample of survey participants are asked to trade-off between multiple management tools. Results of such studies lead to predictive integrative models (Cooke et al., 2009). Layers of complexity arise around divergent preferences between different stakeholders as well as stakeholders' perceptions of strategies that are appropriate to other stakeholder groups. Unraveling this complexity in quantitative surveys is challenging, yet possible with novel quantitative survey approaches.

The context of eel (Anguilla anguilla) conservation

An urgent resource conservation issue that shares the characteristics expounded above currently exists around the catadromous European eel (Anguilla anguilla), which is an economically and culturally important fishery resource throughout Europe (

Feunteun, 2002 and Ringuet et al., 2002). Recently, the panmictic eel population (Dannewitz et al., 2005) has dramatically declined (Dekker, 2008). A range of potential causes have been discussed, including oceanic-climatic factors, overexploitation, pollution, parasite infection, predation by piscivorous birds, obstacles to migration (e.g., hydropower plants), and habitat loss (Feunteun, 2002, FAO and ICES, 2007 and Dekker, 2008). These factors act simultaneously, and their relative contribution to the eel decline is unknown (Starkie, 2003). This biological uncertainty hampers identification of effective eel conservation actions. However , the socio-economic and cultural importance of this species for many commercial fisheries and the recreational fishery in Europe also need to be considered in conservation programs to balance biological and socio-economic management objectives (Bevacqua et al., 2007). Conserving the European eel population at a Pan-European scale involving multiple stakeholders and nations hence constitutes a considerable challenge given the large uncertainty about the causes of the decline and the conflicting interests of various stakeholders in different life-stages of eel across Europe (Ringuet et al., 2002).

Various political initiatives have been undertaken to halt the eel decline. The European eel was recently included in the IUCN (International Union for Conservation of Nature) red list as critically endangered (Freyhof and Kottelat, 2008). In 2007, the European eel was also listed by CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) to control its international trade. In the same year, the European Union (EU) adopted an eel recovery action plan (EC, 2007), requiring each member state to develop eel management plans at a river basin scale to guarantee the escapement of adult silver eels (mature life stage) at a rate of 40% relative to undisturbed conditions. If no management plan was submitted for approval to the European Commission (EC) by the end of 2008, temporal closures on eel fishing could be implemented, endangering the livelihood of many small-scale inland fisheries in Europe (Bevacqua et al., 2007).

Most recent studies on eel conservation across Europe have had a biological focus, largely ignoring the social, psychological and cultural dimensions of eel conservation. However, as discussed above, by taking the human factor into account, eel managers could more easily implement measures that agree with the preference structure of stakeholders or alternatively react proactively if opposition to biologically needed intervention is identified.

Unfortunately, no scientifically robust information exits on the preferences for eel conservation measures by any stakeholder group (e.g., fishery sector, conservationists) anywhere in Europe, leaving eel conservation managers with subjective “gut feelings” about the views of various stakeholder groups. One of the most important, yet constantly undervalued (Arlinghaus et al., 2002 and Lewin et al., 2006), user group of eel in Europe are recreational anglers (Dorow and Arlinghaus, 2008 and ICES, 2008). As a vocal stakeholder group, anglers are instrumental in supporting conservation in aquatic habitats in general (Granek et al., 2008), and the EU eel recovery legislation (EC, 2007) explicitly requests consideration of recreational eel harvest in the design of eel management plans.

Given that the recreational take of eel can be substantial (Dorow and Arlinghaus, 2009 and ICES, 2008), understanding eel anglers' preferences for conservation measures can help identify management actions that both contribute to eel conservation and also receive the support of recreational fishers. Two different types of management-related preference questions emerge: preferences for management of recreational eel fishing, and preferences for the control of other potential sources of eel mortality. Traditionally, human dimensions research has assessed stakeholder preferences with opinion-type questions using Likert-scales, wherein each action is evaluated independent of all other options (Aas et al., 2000). To consider the much more realistic trade-offs that stakeholders are willing to make between individual management tools, one requires a multivariate approach, because traditional attitudinal measurements cannot capture such trade-offs (Aas et al., 2000 and Oh et al., 2005).

To solve this challenge, multi-attribute survey research techniques such as conjoint and discrete choice experiments are advisable (Aas et al., 2000 and Oh et al., 2005). In these approaches, respondents are forced into making trade-offs by evaluating an entire scenario described by several management measures, each measure providing essential context for the whole, adding realism to the task and thereby contributing to the reliability and validity of the results. Multi-attribute survey techniques also allow predictive modeling of stakeholders' support for future management policies (Oh et al., 2005), thus providing crucial information for integrative models (Cooke et al., 2009) and proactive decision-making.

Objectives

The objectives of this study were twofold. The first general methodological aim was to test an innovative survey design that forces the participants to make trade-offs decisions between possible conservation tools and policies and that may be applied in other complex conservation problems where preferences of one or several stakeholder groups need to be estimated for solving contentious conservation issues. This approach allowed the separate estimation of weight (=importance given by the stakeholders to a particular management action or policy) and scale (=importance given to variation within each management action or policy). The second more specific aim was to assess the preferences of recreational anglers for a suite of eel conservation measures so as to inform European eel conservation planning.

Methods

Study area

We studied angler preferences for possible eel management actions in the German State of Mecklenburg-Vorpommern (M-V), north-eastern Germany. Eels are found in all running and most standing waters as well as in the coastal area of M-V, and they are exploited by both commercial and recreational fisheries. In 2007, the commercial eel landings amounted to approximately 136 t in M-V. In Germany and elsewhere in Europe as in France, Poland and The Netherlands, eel is also targeted by recreational anglers because it is highly valued for personal consumption (ICES, 2008). Nearly 50% of all resident anglers (N = 153.000) in the study area targeted eel at least once during the 2006 season (Dorow et al., 2009). Dorow and Arlinghaus (2008) estimated the total annual recreational eel harvest at 187 t, or about 1.5 times the commercial landings. Presumably these harvest levels are only possible given the current stocking activities, since recent local studies reported that the natural recruitment of upstream migrating juvenile eel had dropped dramatically (Ubl et al., 2007). Other studies undertaken in the largest river basin (Warnow/Peene) of the study area have estimated cormorant (Phalacrocorax carbo) predation at approximately 83 t eel per year, and a current migrating silver eel stock at approximately 105 t eel per year (LFA–MV, unpublished data, coastal and freshwater areas together). This suggests that the current mortality levels of commercial and recreational fishing as well as cormorants are substantial. Eel are currently managed using separate harvest regulations for commercial and recreational fishing, and routine stocking activities often funded by angling organizations and commercial fishing enterprises, regularly supported by tax money.

Questionnaire design and survey

Our study aimed at assessing the preferences of recreational fisheries stakeholders for eel conservation measures. Several management actions that might form part of future eel management plans for M-V were identified in a review of the EU eel recovery plan (EC, 2007) and in consultation with state-specific eel conservation planners. The final list of conservation tools included both recreational fishing regulations designed to reduce mortality on eel (harvest regulations: minimum-size limit, daily bag limit; gear regulation: number of rods; effort regulation: temporal closure), and other more general regulatory policies affecting various other stakeholders (reduction of commercial eel harvest, reduction of the cormorant population to control predation on eel, extension of eel stocking programs, and reduction of the impact of hydropower on migrating silver eel, Table B.1). Investigating preferences of stakeholders for such a combination of management options call for a stated preference or choice experiment approach. Separating the preference for selected management actions (i.e., weight) and the preference for the degree of regulation pertaining to each action (i.e., scale) was desirable, and, therefore, we applied an innovative variation of stated preference research, the maximum difference conjoint (MDC) approach (Finn and Louviere, 1992), for the first time in a conservation context. In this approach, respondents are asked to identify their most and least preferred items from an experimentally designed list. Each eel management scenario consisted of several management actions (called attributes) each of which was described by several levels: the current state and two or three alternative states (Table B.1). Angling regulations were described very specifically, reflecting the high level of knowledge anglers possess about these types of regulations. Levels for the other management regulations were described more broadly as percent decreases or increases relative to the current state.

One challenge in developing our stated preference survey was to combine all these attributes (recreational fisheries regulations and the more general regulatory measures) in such a manner that they become part of one eel conservation portfolio. This objective was achieved by structuring the recreational fisheries regulations and the other management regulations as separate bundles within the same scenario (i.e., one management portfolio), and guiding respondents through a series of questions (Figure B.1). Respondents were asked to complete three different tasks for each scenario. In the first MDC task, respondents chose their most and least preferred components from a suite of eel angling regulations (question 1 in Figure B.1). The second MDC task pertained to overall eel conservation measures, which included the set of recreational angling regulations as whole, and various other conservation tools unrelated to recreational fishing (question 2 in Figure B.1). The third task was a referendum-style conjoint question (question 3 in Figure B.1), asking respondents whether they would support the entire portfolio of eel conservation actions if it was to be implemented and lead to a specified improvement of the eel stock (i.e., a varying increase of escapement, Table F1). This innovative sequential structure of the MDC task coupled with an overall acceptability question allowed estimating three specific preference models, each serving a particular objective: preferences for eel angling regulations, preferences for management across sectors and overall support for management portfolios.

MDC tasks have several advantages over more traditional survey formats. Cognitively, identifying the most distinct pair of a set of management preferences constitutes a fairly easy task for respondents (Marley and Louviere, 2005). Moreover, by identifying the most distinct pair rather than rating every item individually on a given scale (e.g., agreement scale) trade-off decisions are forced, which also prevents the occurrence of scale bias (Haider and Hunt, 1997). Also, a single pair of best–worst choice contains more information then just the “pick one” task in the more traditional discrete choice experiments (Flynn et al., 2007).

The statistical analysis of MDC surveys assumes that the relative choice probability of a given pair is proportional to the distance between the two attribute levels on an underlying latent scale of preference, alternatively called utility by economists (Finn and Louviere, 1992). Therefore, estimates for each attribute and attribute level can be derived, which are interval scaled to a chosen base level (e.g., the status quo regulations). The coding matrix for the independent variables may be set up to separate inter-item comparisons of management attributes (weights) from the corresponding intra-item comparison of levels (scales) (Cohen, 2003). The weight thus reflects the importance (i.e., the preference or utility) of each management action relative to others. The scale parameter indicates the importance of a single level relative to the other levels within the same management attribute. No other survey format developed so far allows such detailed derivation of weight and scale of management actions as perceived by stakeholders.

To estimate a statistical model, repeated evaluations of different combinations of attributes are required. An orthogonal fractional factorial design was used to create 64 profiles, which was sufficient to estimate all main effects in an unbiased way (Raktoe et al., 1981). The 64 choices sets were grouped in 16 blocks (i.e., versions of the survey) with four choice sets each, which was part of the orthogonal design. These blocks were randomly assigned to respondents. Hence, each respondent only evaluated one block of four choice sets to reduce respondent fatigue. To ensure understanding of the survey instrument, we conducted three pretests with N = 24 anglers in the study area to control the understandability of the survey instrument. In addition to one MDC block, the questionnaire also contained general questions about eel angling and eel management as well as demographics and other angler characteristics.

The final version of the 15-page questionnaire was mailed along with a personalized cover letter to N = 640 randomly chosen active anglers fishing in M-V. Such angler was defined as a person 14 years or older who had fished in the study area at least once in the last 12 months. After the mail-out on January 19, 2007, one reminder telephone call was made two weeks later to encourage participation and increase response rate.

The selected anglers from which the sample was drawn were already participants in a 1 year diary study and had been previously recruited via telephone by random digit dialling. Thus, we already knew basic socio-demographic and fishing-related information from every angler participating in the present study (for details, see Dorow and Arlinghaus, 2008). This information allowed comparison of the characteristics of respondents and non-respondents to test for potential avidity bias among respondents.

Statistical analysis

Statistical analysis of MDC surveys is grounded in random utility theory, a widely accepted economic theory of human decision-making (McFadden, 1974). It assumes that respondents choose the option among a set of alternatives that provides maximum utility or benefit. In the classical discrete choice analysis, the probability of choosing one alternative over another alternative is calculated with a multinomial logit (MNL) model (Louviere and Woodworth, 1983). Finn and Louviere (1992) showed that this statistical method can be applied in the MDC as well. The MNL estimates the differences between one particular attribute level relative to all other attribute levels on an underlying preference scale by setting one level as the point of origin (i.e., the base). Further description of the statistical background is provided in Finn and Louviere (1992) and Marley and Louviere (2005).

The conjoint question (question 3 in Figure B.1) was analyzed within a standard conjoint analysis framework. If the conjoint question solicits a simple binary response of support, as in our case, then the data are consistent with random utility theory allowing the estimation of the relative importance of attribute levels using a binomial logit model. More detailed information on conjoint study design and statistical analysis is given in Green and Srinivasan (1978).

For all analyses, the independent variables were dummy coded (Hensher et al., 2005). One base alternative was defined arbitrarily, against which the respondents' preferences were assessed. Significance of estimated parameters (called part worth utilities, PWU) was determined with the Z-statistic (significance level, $p < 0.05$). PWUs are coefficients of MNL models that reflect the relative difference in importance or preference relative to a chosen origin (i.e., the base level). These PWUs need to be interpreted somewhat differently in the three models. In the MDC, the PWUs serve as an indicator of preference for each attribute level compared to the level chosen as the point of origin. In contrast, the PWUs for the conjoint task indicate the contribution of each attribute level to the preference for the entire management profile. We used a t-test to detect statistical differences between attribute levels. With the significant parameters of the conjoint model we created a decision support tool (Hensher et al., 2005) to predict angler support for hypothetical eel conservation scenarios.

To account for angler heterogeneity in preference articulation, models were compared between eel anglers and those who had not fished for eel, because we expected pronounced differences in management preferences among these angler groups (see Dorow et al., 2009). All statistical analyses on the stated preference task were performed with Latent Gold Choice 4.0 (Statistical Innovations Inc., Belmont, MA.).

To analyze differences between responding and non-responding anglers a Chi2 analysis was used for categorical data (e.g., education level). For parametric data (e.g., annual angling frequency), a t-test was applied in case of variance homogeneity and a non-parametric U-test was used if variances were heterogeneous (Levené test).

Results

A total of 392 surveys were completed and returned for a response rate of 61.3%. Nearly 46% of the anglers indicated they had targeted eel at least once during the fishing season of 2006. On average ± SD, active eel anglers spent 12.6 ± 15.8 days fishing for eel in 2006. A comparison between respondents and non-respondents (N = 248) to our survey revealed no significant differences in average age, monthly income, distribution of educational levels, importance of angling and average years of angling experience (Table B.1). However, non-respondents fished significantly less frequently in the study area, which may have caused some level of avidity bias in our survey (Table B.1). However, none of the three estimated models improved when accounting for eel versus non-eel anglers, indicating that all anglers shared similar opinions and preferences about how to manage eel stocks regardless whether they targeted eel or not.

Preference for recreational fishing regulations

Anglers exhibited distinct preferences for eel angling regulations (question 1 in Figure B.1). Relative to minimum-size limits (i.e., the chosen base regulation), all other recreational fishing regulations were less preferred as indicated by the negative PWU-coefficients of the attribute weights (Figure B.2). However, only preferences for restrictions on number of eel rods and the temporal closure of eel angling during certain days per month differed significantly from the anglers' preference for minimum-size limits.

To assess preferences of anglers for levels within each recreational fishing regulation, the current situation in M-V, or in the case of daily bag limit the most liberal regulation (i.e., a daily bag limit of four eel), were set as the base levels (Figure B.3). A positive PWU-coefficient indicates a preference over the respective base. Respondents preferred a moderate increase in the minimum-size limit (50 cm or 55 cm) over the current state (45 cm), but a further increase to 60 cm was not considered any more desirable over the status quo. In a similar fashion, anglers preferred two eel rods per angler over either one or three rods. A moderate reduction in the daily bag limit from four to two or three eel was viewed positively, whereas a bag limit of one eel per day was strongly disliked. Anglers also significantly opposed any form of temporal closure compared to the current state of no temporal closure during each month.

Overall conservation measures for eel

When preferences for recreational angling regulations for eel were assessed jointly with those for management options unrelated to angling (question 2 in Figure B.1), anglers preferred increased management action directed at any other sector as well as increased eel stocking over the option of regulating recreational fishing (Figure B.4). The highest preference was expressed for enhanced stocking, but regulating cormorants and hydropower were also preferred. Reducing the commercial eel fishery was considered somewhat less important by anglers, but was still preferred over recreational angling regulations.

The strictness of recreational fishing regulations did not influence the preferences for other management actions unrelated to angling, when explored as cross-effects between recreational fishing and other management actions. Recreational fishing regulations were, therefore, included as a constant in the final model to examine preferences for specific non-recreational fishing regulations (Figure B.5). In this model, recreational anglers strongly favored reductions of commercial eel harvesting, but the major preference was for a modest level of harvest reduction to 25% of the current commercial fishing intensity. A 50% reduction of the commercial eel fishery was preferred over the current level, but preference for this extreme level was significantly less than for the moderate reduction of commercial eel harvest by 25%. In contrast, anglers liked to see a moderate or high reduction of the cormorant population compared to the current state. Higher stocking levels were also preferred, peaking at the second highest level of 25% increase in stocking relative to the current level, but an increase of 50% was equally preferred. To manage the impact of hydropower, anglers most strongly preferred the use of smaller grates in combination with installing fish ladders to reduce eel mortality at turbines and to aid in eel migration. While the most stringent hydropower regulation, shutting down power generation during times of silver eel migration, was also preferred over the status quo, this alternative was not as desirable as reducing grate size and installing fish ladders.

Overall support for eel conservation contingent on eel recovery success

In evaluating anglers‘ support for a complex eel conservation portfolio including angling and non-angling related eel conservation measures (question 3 in Figure B.1) the strong negative intercept for “no support” indicated an overall high support for eel conservation programs (Figure B.6). Interestingly, only a few parameters of the model remained significant, indicating that only these few attributes of the eel management portfolio significantly affected the overall high support for implementation of eel conservation programs. None of the recreational fishing regulations were significant at the 5% level, and only two parameters were significant at the 10% level (Figure B.6). The one rod limit per angling day was perceived negatively and reduced support for the eel conservation program, while the reduction of the daily bag limit to two eel per day was perceived positively, i.e. this measure increased support for eel conservation programs. The only other management factor significantly increasing support for an integrated eel management portfolio was a reduction of the commercial fishery by 25% relative to the current level, which agreed with the model results in Figure B.5. As to be expected, the support of the overall management portfolio increased significantly as the likelihood of eel escapement increased from 5% to 20% compared to the current state.

However, anglers' support for eel conservation programs did not increase further at expected increases of eel escapement by 30% or 50% indicating a saturating effect.

We used the parameters at the 10% level of significance (rod limit, bag limit, commercial fishery reduction, escapement increase in Figure B.6) to predict the overall support for selected management combinations, in effect serving as an eel conservation decision-making support tool (Table B.2). Scenario 1 reflected a status quo situation for recreational fishing regulations and commercial fishery management; it received support by 74% of respondents, if eel escapement would increase by 5% relative to the current state. In Scenario 2, angler support decreased slightly to 68% when the recreational fishery was the only target for stricter regulation. Predicted support remained unchanged from the current state if recreational and commercial fisheries were to be restricted without a guaranteed change in eel escapement (Scenario 3). Elevating eel escapement to a maximum hypothetical level, and restricting recreational and commercial fishing as much as possible, increased the overall support for eel conservation policies to 87% (Scenario 4). The highest level of predicted support close to 100% (95%) was achieved when all regulations for recreational and commercial fishing were set moderately and the likely increase in eel escapement level was 30% (Scenario 5).

Discussion

Survey method

In the present study, we successfully applied the MDC approach to evaluate the preferences for multiple conservation actions and policies by one specific stakeholder group (recreational anglers) in a multi-stakeholder and biologically uncertain eel conservation context. Presenting a single management portfolio allowed us to estimate three management preference models for recreational fishers, each shedding light on a particular area of eel conservation (eel angling regulations, overall eel conservation measures, willingness to support complex multi-action conservation programs). No other survey method developed so far is capable of developing such a rich set of stakeholder preference models, while allowing stakeholders to make realistic trade-offs to express their preferences towards both personal restrictions and also restrictions placed on other stakeholders.

Our survey approach offers a number of advantages over more traditional survey approaches. For example, despite the inherent complexity of attributes and their descriptions, our integrated approach to preference assessment constitutes a realistic and cognitively fairly simple task for respondents. By presenting one management package, which was to evaluated by the respondents in three steps (questions 1–3 in Figure B.1) forcing trade-offs, generates quantitative data on preferences for different management plains and thus provides more realistic results (compared the Likert-type agreement scales) for conservation policy decision-making. This relevance in turn may stimulate a more objective discussion about conservation policies and prevent situations where speculation about the perceptions of affected stakeholders are the only basis by which management decisions include social considerations.

Furthermore, the MDC survey approach offers the considerable benefit of separating the weight of a particular management action relative to other actions and scale (most desired management level of a particular action). These insights allow decision-makers to understand if stakeholders object in principle to a management approach or merely to the degree to which that approach is implemented. This result cannot be achieved with other stated choice methods. This benefit alone illustrates the usefulness of the MDC approach when dealing with complex conservation issues where different stakeholder groups must cooperate to achieve a common goal, as in the case of eel conservation. While we offered our MDC only to one specific stakeholder group, ample opportunity exists to apply this method to other stakeholder groups (e.g., commercial fisheries stakeholders) affected by eel conservation measures. For an effective eel conservation planning at a local scale, we thus recommend the replication of the presented survey technique with other affected stakeholders wherein specific relevant regulations should be used for the targeted stakeholder group. A further application in the eel conservation context as well as in other conservation contexts would clarify, if similar patterns of response behavior also emerge in other stakeholder groups. Therefore, we encourage conservation managers to take advantage of the presented survey method. While the MDC method is designed to elicit preferences, readers should be made aware that stated preference techniques frequently integrate explanatory attitudinal and other theoretically driven variables in the questionnaire to explain underlying mechanisms of the preference articulation (e.g., Oh and Ditton, 2006, Semeniuk et al., 2009 and Dorow et al., 2009). Thereby, an assessment of preferences coupled with cognitive and emotional mechanisms can generate a better understanding of stakeholder behavior.

Insights for eel conservation

The fairly consistent support for moderately stricter regulations on traditional eel angling harvest regulations (minimum-size limits, daily bag limits) by anglers in this study indicates their acceptance of personal restrictions to conserve eel up to a certain threshold. Such a preference articulation could either reflect a true conservation concern, or it could reflect pragmatic reasoning around current fishing patterns and successes by typically consumptively oriented eel anglers (Dorow et al., 2009). For example, preference for more restrictive minimum-size limits dropped when these limits exceeded 55 cm. This pattern corresponds with the actual catches and harvest experiences of resident eel anglers in the study area, where eel below 60 cm account for around 50% of the recreational eel harvest, and the average size of harvested eel is around 60 cm (Dorow et al., 2009). Increasing a minimum-size limit to 60 cm would thus halve the harvest by anglers (Dorow et al., 2009). Eel provide high angler utility through harvest; therefore, penalizing anglers through reduced harvest opportunities explains why the highest level of minimum-size limits was disliked in our study. Concerning the bag limit preferences expressed in our study, catching more than three eel per day was a rare event during the 2006/2007 season in the study area (Dorow et al., 2009). The average eel harvest rate per successful eel angling trip was 1.7 (±1.3 SD, unweighted mean, Dorow and Arlinghaus, unpublished data), and only on 16% of the successful eel angling trips in the study area were more than two eel kept by anglers (Dorow and Arlinghaus, unpublished data). This observation again explains why a daily bag limit of 2–3 eel per day was preferred, while a bag limit of one eel per day was perceived as too strict, as it would limit the recreational eel harvest and thus angler utility considerably.

Concerning effort regulations, anglers opposed any form of temporal closure in our study, which was evident in the attribute weight as well as in the preferences articulation regarding the degree of temporal restriction (attribute scale). This strong opposition against temporal indicate that anglers reject closure of eel angling in principle. Opposition to temporal restriction might relate to the fact that anglers are not used so far to such management measures in the study area. However, such top down regulation approach to regulate the fishery sector might be implemented on local scale by the EU (EC, 2007) if management plans submitted by member states of the EU fail to meet certain criteria. Anglers were also sensitive to the length of the closure, suggesting that if a closure is absolutely necessary, managers would be advised to make it as short as possible. Such detailed insights regarding the weight and scale assigned to a specific management action are only detectable by using the MDC approach.

Obviously, the reason for anglers objecting temporal closures of recreational angling is that anglers want to secure access to the important resource eel, because there are limited substitute species available that provide similar angling experiences (Dorow et al., 2009). Similar aversion against effort controls was found among other consumptive angler populations in the USA (Wilde and Ditton, 1999 and Salz and Loomis, 2005). To avoid conflicts with the angling constituency, we, therefore, recommend managers implement a moderate increase of the minimum-size limit (50 or 55 cm) and/or a moderate reduction of the bag limit to two eel per day, because these measures appear to be perceived positively by the anglers while also capable of considerably reducing eel mortality by recreational fishing by up to 30% (Dorow et al., 2009).

In agreement with earlier reports from Germany (Arlinghaus and Mehner, 2005 and Arlinghaus et al., 2008), the surveyed anglers preferred to regulate other sectors or enhance stocking over increasing the severity of angling regulations, independent to the strictness of angling regulations. We speculate that one explanation for this kind of preference articulation rests within the theory of psychological reactance of humans (Brehm, 1966). Anglers may fear restriction of their personal freedom to use a fisheries resource resulting in a strong opposition to stricter regulations for themselves while favoring the control of other eel mortality sources. The assumed reactance behavior is likely to occur in other stakeholder groups as well (e.g., commercial fishers), which complicates the development of conservation policies in a multiple stakeholder environment (Stoll-Kleemann, 2001a). However, it is noteworthy that anglers did not prefer utterly strict regulation of the most direct human competitor for eel, which likely are commercial fishers. In fact, an intermediate reduction of commercial fishing harvest and a moderate regulation of hydropower, respectively, were most preferred. Apparently, anglers did not indiscriminately target the perceived or real "competitor" when evaluating conservation measures directed at other mortality sources of eel, and preferred a somewhat balanced suite of management measures affecting all stakeholders. Consequently, local eel managers should include numerous stakeholders and consider as many influencing factors as possible to prevent opposition by a single stakeholder group.

Irrespective of the tendency to avoid personal restrictions and to prefer other measures unrelated to recreational fishing, all anglers, irrespective of whether they were eel anglers or not, exhibited overwhelming support for developing integrative and balanced eel management portfolios that targeted anglers as well as other sectors. Based on this finding, a unilateral tightening of angling regulations should be avoided because it would be rejected by anglers and induce considerable opposition to the conservation program. In general, targeting a single stakeholder group like the recreational eel fishery should be prevented because the probability is high that multiple stakeholders share joint responsibility for the current eel population decline (Dekker et al., 2007). Moreover, any management decisions, which are perceived as unfair and heavy handed may result in conflict and decrease the likelihood of stakeholder cooperation with the conservation efforts, further endangering the eel resource.

The support of anglers for integrated eel conservation portfolios ranged between 75% and 95 %, which was a function of the degree of hypothetical eel escapement (Table 2). Unfortunately, the escapement rate after implementing any conservation policy is highly uncertain because the exact causes for the eel decline are not understood (Starkie, 2003). Thus, precise predictions about the outcomes of different combinations of eel conservation measures are impossible (Dekker et al., 2007). However, as soon as biologically effective eel conservation measures are identified, eel conservation mangers can use models like those presented to predict the anglers' support. Although our data were generated from one state in northern Germany, we contend that similar patterns are likely to emerge in other European countries where anglers consumptively fish for eel. However, this outlook must be viewed with caution due to the potential for cultural differences among angler populations (Aas, 2002).

Conclusions

As a stakeholder group, recreational anglers are sometimes perceived as exhibiting selfish preferences (Arlinghaus, 2006). In contrast to these common perceptions, we found that anglers are very open to compromise to conserve the endangered European eel, as long as responsibility is shared with other stakeholders. In that sense, our study, by considering stakeholder trade-off behavior explicitly, may help avoid management conflicts emerging from political debates on the Europe-wide conservation of the eel population. Bringing the perspective of stakeholders on board by means of innovative quantitative surveys as the one presented in this paper may facilitate the finding of acceptable management tools. Obtaining the acceptance of stakeholders, in turn, may improve the likelihood of successful implementation of conservation programs, benefiting both the eel population and those that depend on eel for livelihood or recreation.

In the absence of other local studies, eel managers can use the presented scenario analysis (Table 2) to predict angler support for any combination of eel conservation measures included in our study. This might be of particular relevance if future biological studies identify one of these measures as particularly effective for eel recovery. Effective communication of any proposed management action and policy is still needed (Decker and Krueger, 1999) as there is no guarantee that a specific regulation will indeed contribute to the recovery of the eel population in the foreseeable future (Åström and Dekker, 2007; Dekker et al., 2007). However, we hope that by presenting this study to decision-makers and other stakeholders, communication might be improved, as the results provide 'hard currency' to show how recreational fisheries stakeholders view eel conservation. Eel management efforts must contend with extensive biological uncertainty, and the potential for highly emotional debate. Informing management efforts of stakeholder preferences can also be the starting point for building a trustful relationship between managers and stakeholders, fostering cooperation and active involvement for a common conservation aim.

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Tables and Figures

Table B.1 Attributes and corresponding levels for different management actions used in the maximum-difference-conjoint study on preferences of anglers for eel conservation actions. Underlined levels indicate the “current situation”, percentage values for measures other than recreational fishing refer to the current level.

Attribute	Levels
Recreational fishing regulations	
Minimum-size limit	45 cm, 50 cm, 55 cm or 60 cm
Number of rods	3 rods/day, 2 rods/day or 1 rod/day
Daily bag limit	4 eel, 3 eel, 2 eel or 1 eel
Temporal closure	No closure, 7 days/month or 14 days/month
Non-recreational fishing regulations	
Commercial fishery	Reduction of harvest by 5%, 25% or 50% relative to status quo
Cormorants	Reduction of population by 5–10%, 10–20% or 30–40% relative to status quo
Stocking	Increase in total volume by 5%, 25% or 50% relative to status quo
Hydropower	Smaller grate, smaller grate and fish ladder, or shutdown during migration relative to the status quo
Hypothetical success of the program	
Increase of escapement	5%, 20%, 30%, or 50%

Table B.2 Support for select eel management portfolios (in % of anglers); scenarios were calculated with significant parameters from Fig. 6 (using only the significant values at $p < 0.1$).

	Recreational fishing regulations	Regulation of commercial fishing	Increase of eel escapement (%)	Overall support (%)
Scenario 1 (current state)	Current (45 cm, 3 rods, 4 eel, no closure)	Current (no reduction)	5	74
Scenario 2	Strict (60 cm, 1 rod, 1 eel, 14 days)	Current (no reduction)	5	68
Scenario 3	Strict (60 cm, 1 rod, 1 eel, 14 days)	Strict (50% reduction)	5	74
Scenario 4	Strict (60 cm, 1 rod, 1 eel, 14 days)	Strict (50% reduction)	50	87
Scenario 5	Moderate (55 cm, 2 rods, 2 eel, no closure)	Moderate (25% reduction)	30	95

Note: Values in parentheses in second column for each scenario are: minimum-size limit, daily rod limit, daily bag limit and temporal closure (days per month).

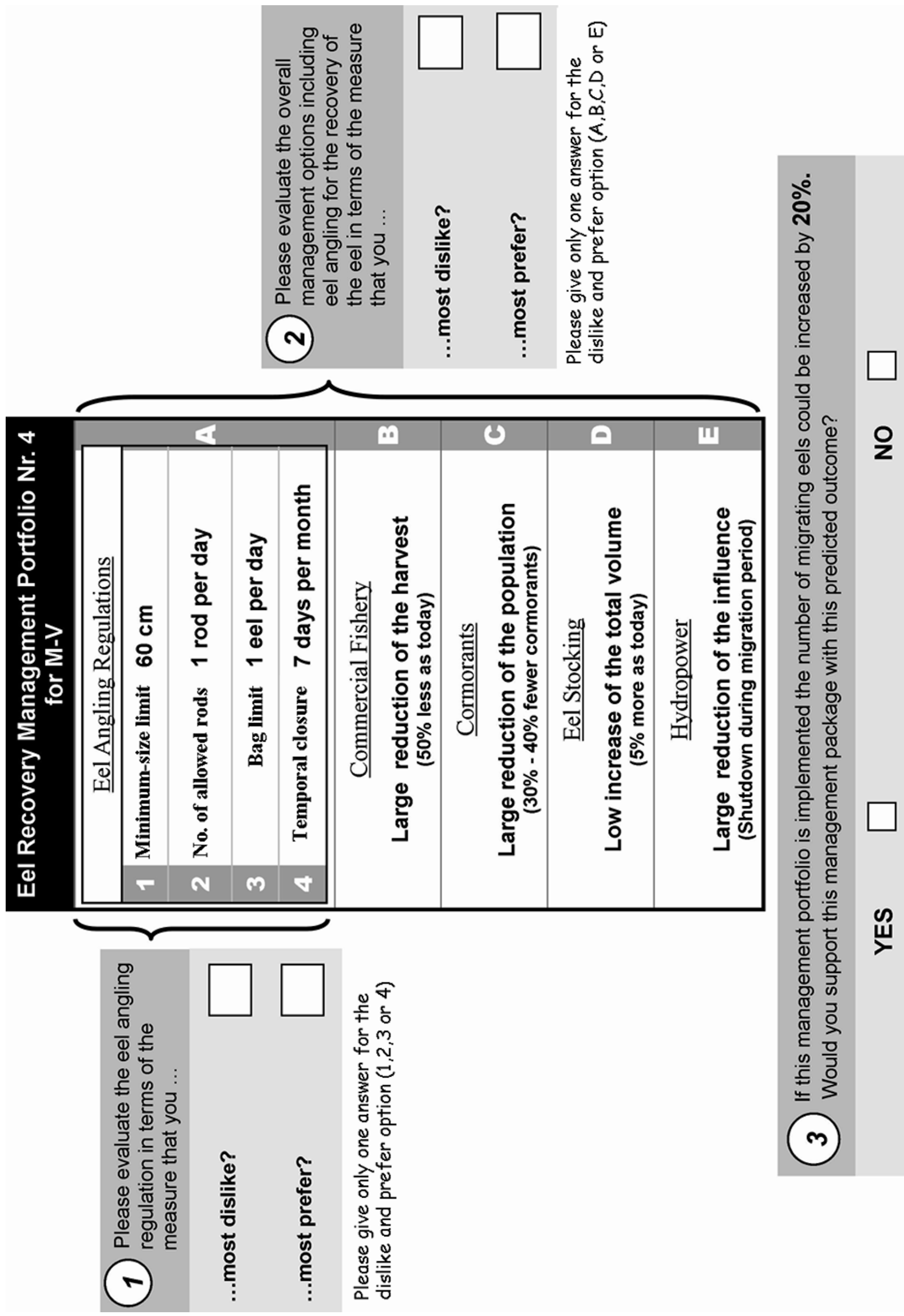

Figure B.1 Example of the survey task (two maximum difference conjoint questions and one conjoint question) on a management portfolio for eel conservation.

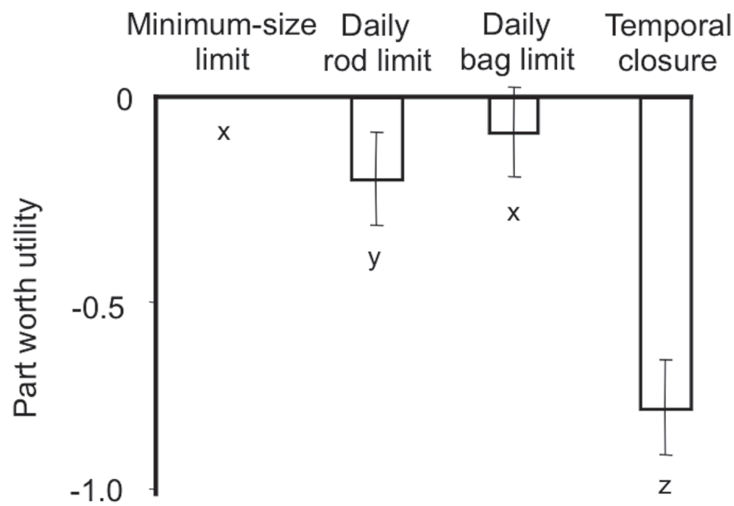

Figure B.2 Preferences of anglers for eel recreational fishing regulations (attribute weight derived from question 1 in Figure B.1); the minimum-size size limit was set as the base indicated by a part worth utility value of 0; dissimilar letters indicate significant differences between the attributes (p < 0.05), error bars represent the standard error; model parameters: log-likelihood (LL) = −3093.76, BIC (based on LL) = 6263.68, L-squared (L2) = 4313.57, R2 = 0.0574.

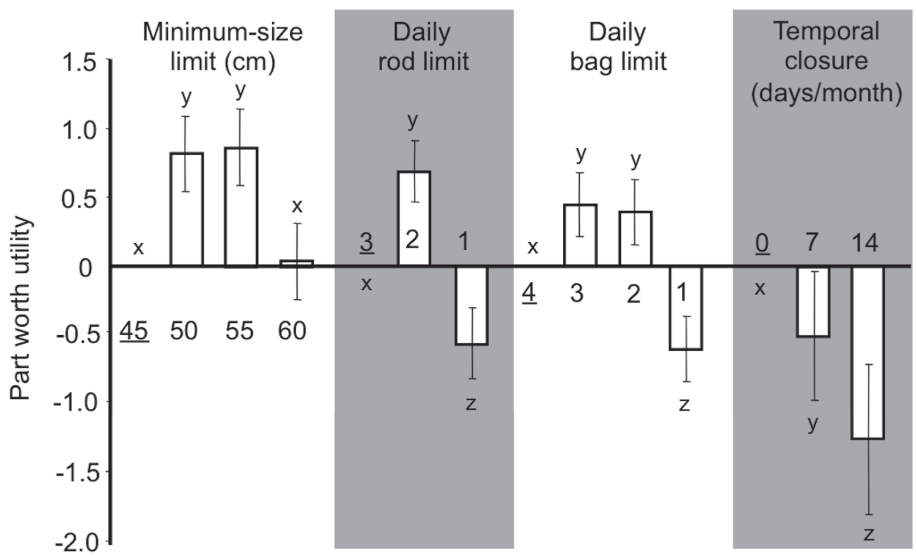

Figure B.3: Preferences for the magnitude of single eel angling regulations (attribute scale, derived from question 1 in Figure B.1); within each attribute, one level was selected as base (part worth utility = 0) indicated by underlined attribute levels; dissimilar letters indicate significant differences between the attribute levels ($p < 0.05$), error bars represent the standard error, model parameters: log-likelihood (LL) = −3093.76, BIC (based on LL) = 6263.68, L-squared (L^2) = 4313.57, R^2 = 0.0574.

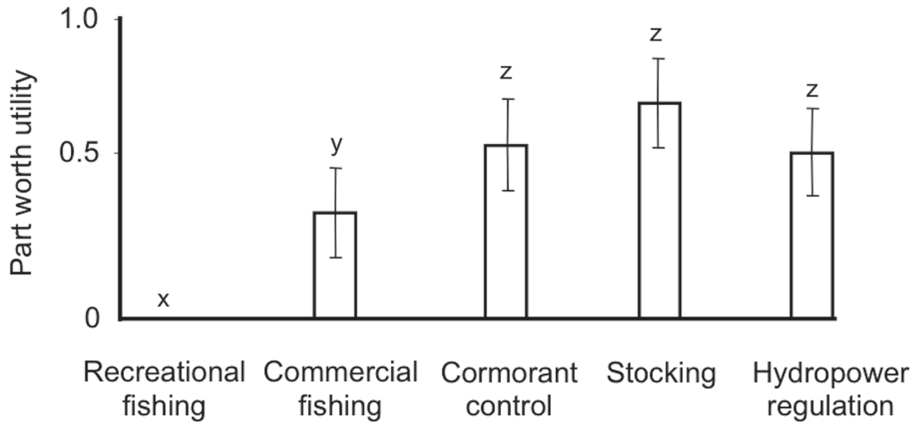

Figure B.4: Preferences of eel anglers for eel conservation measures (attribute weight derived from question 2 in Figure B.1); for the preferences estimation, recreational fishing was set as the base (part worth utility = 0), dissimilar letters indicate significant differences between the attributes ($p < 0.05$), error bars represent the standard errors, model parameters: log-likelihood (LL) = −3681.03, BIC (based on LL) = 7455.78, *L*-squared (L^2) = 5509.87, R^2 = 0.066.

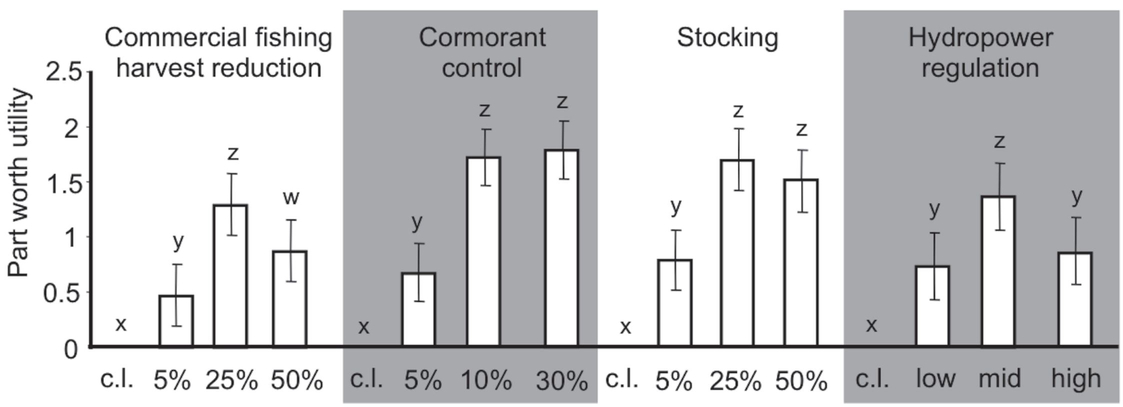

Figure B.5: Preferences of anglers for the magnitude of individual eel conservation measures (attribute scale derived from question 2 in Figure B.1), all recreational fishing regulations are excluded because they remained insignificant, preference were measured against the current level (c.l.) indicated by a part worth utility = 0, dissimilar letters indicate significant differences between attribute levels ($p < 0.05$), error bars indicate the standard error, model parameters: log-likelihood (LL) = −3681.03, BIC (based on LL) = 7455.78, *L*-squared (L^2) = 5509.87, R^2 = 0.066.

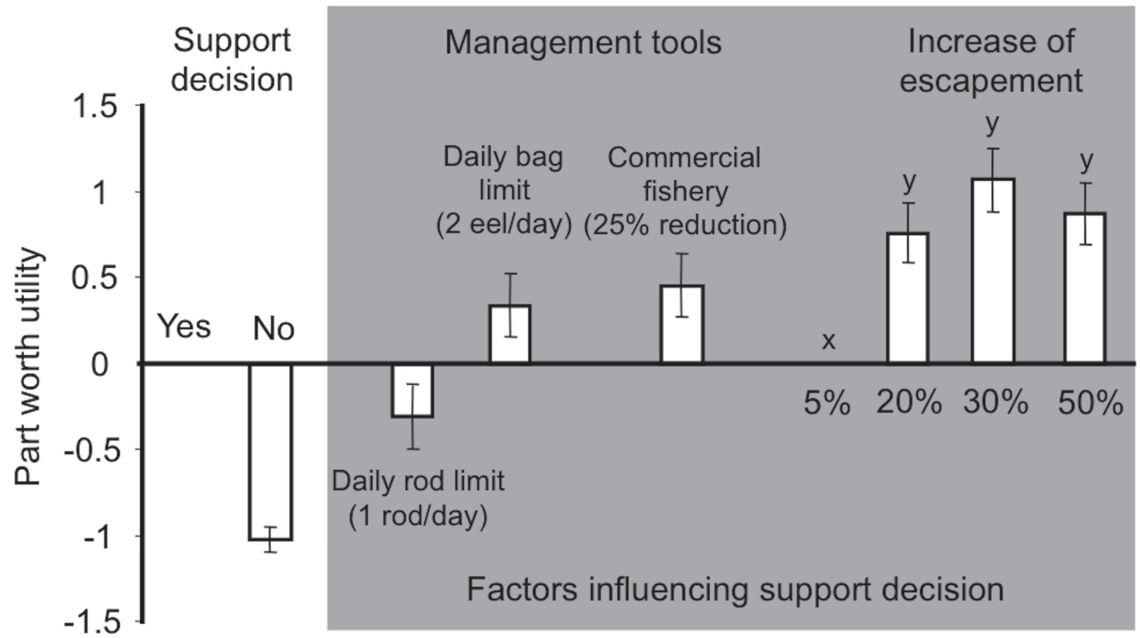

Figure B.6: Support for the overall eel management portfolio by anglers (question 3 in Figure B.1) together with management tools that significantly ($p < 0.1$) influence the support decision and the effects of varying eel escapement level on the anglers' support, dissimilar letters indicate significant levels ($p < 0.05$) between the effects of the escapement levels, error bars indicate standard errors, model parameters: log-likelihood (LL) = −1621.29, BIC (based on LL) = 3394.60, L-squared (L^2) = 2249.94, $R^2(0)$ = 0.156.

Appendix C. Follow-up Mail Survey (in German)

Landesforschungsanstalt für Landwirtschaft und Fischerei Mecklenburg-Vorpommern
Institut für Fischerei, Rostock

Nachbefragung zur wissenschaftlichen Angelstudie Mecklenburg-Vorpommern 2006/2007

Rückschau und Ausblick

Dieser Fragebogen berücksichtigt anonymisierte Angaben, die im Rahmen der Angelbuchstudie M-V zwischen September 2006 und August 2007 durch den folgenden Teilnehmer der Angelbuchstudie

10022

mitgeteilt wurden

Teil 1: Allgemeine Fragen zu Ihrer Angelleidenschaft

1 **Seit wie vielen Jahren angeln Sie ohne Unterbrechung mindestens einmal jährlich an Gewässern in Mecklenburg-Vorpommern (M-V)?**

[ ] aufeinanderfolgende Jahre

2 **Wenn Sie auf Ihre Angelkarriere zurückschauen, wie hat sich Ihre Angeleidenschaft mit der Zeit entwickelt?**

Meine Angeleidenschaft ...

...hat stark nachgelassen	...hat etwas nachgelassen	...ist in etwa gleich geblieben	...ist etwas angestiegen	...ist stark angestiegen
☐	☐	☐	☐	☐

Die folgenden Fragen beziehen sich auf die Fischarten, die Sie während der Angelstudie (September 2006 bis August 2007) in M-V vorrangig beangelt haben.

3 **Seit wie vielen Jahren angeln Sie bereits gezielt auf jede der drei folgenden Fischarten, egal ob in M-V oder andernorts?**

A. Salmoniden (z.B. Forelle, Lachs)	Seit [ ] Jahren	
B. Hecht	Seit [ ] Jahren	
C. Barsch	Seit [ ] Jahren	

4 **Gibt es Fischarten, die Sie in der Vergangenheit regelmäßig gezielt beangelt haben, dies aber heute nicht mehr tun?**

☐ Nein **...Falls Nein, bitte weiter mit Frage 5**

☐ Ja

4a **Bitte listen Sie bis zu drei Fischarten auf, die Sie früher gezielt geangelt haben, dies aber heute nicht mehr tun. Geben Sie bitte auch das Jahr (z.B. 1985) sowie den Grund (z.B. Fischart nicht mehr anglerisch reizvoll) an, weswegen Sie die Angelei auf die entsprechende Fischart eingestellt haben.**

Fischart (bitte eintragen)	Jahreszahl (bitte eintragen)	Grund für die Aufgabe der Beangelung der Fischart (bitte eintragen)
A. ______	[ ]	______
B. ______	[ ]	______
C. ______	[ ]	______

5 **Seit wie vielen Jahren beangeln Sie jedes der nachfolgend aufgeführten Gewässer in M-V?**

A. Greifswalder Bodden (Putbus)	Seit [ ] Jahren
B. Tromper Wiek (Ostsee) (Lohme)	Seit [ ] Jahren
C. Prorer Wiek (Ostsee) (Mukran)	Seit [ ] Jahren

6 Gibt es irgendwelche Gewässer, die Sie in M-V früher regelmäßig beangelt haben, dies aber heute nicht mehr tun?

- ☐ Nein **...Falls Nein, bitte weiter mit Frage 7**
- ☐ Ja

6a Bitte listen Sie bis zu drei Gewässer mitsamt nächstgelegener Ortschaft in M-V auf, die Sie früher gezielt beangelt haben, dies aber heute nicht mehr tun. Geben Sie bitte auch das Jahr (z.B. 1985) sowie den Grund (z.B. zu viele Angler) an, weswegen Sie die Angelei an dem betreffenden Gewässer eingestellt haben.

	Gewässernamen (bitte eintragen)	nächste Ortschaft (bitte eintragen)	Jahreszahl (bitte eintragen)	Grund für Aufgabe der Beangelung des Gewässers (bitte eintragen)
A.	____________	____________	____	____________
B.	____________	____________	____	____________
C.	____________	____________	____	____________

Die folgenden zwei Fragen beziehen sich auf Ihren Angelkartenkauf und den Bekanntheitsgrad von Angelkartenanbietern.

7a In welchen der unten aufgeführten Zeiträume haben Sie bei den verschiedenen Anbietern Angelkarten (Tages-, Wochen, Monats- oder Jahresangelkarten) gekauft? (Bitte jeden Anbieter einzeln beurteilen).

7b Im Falle, dass Sie bei einem oder mehreren dieser Anbieter noch nie eine Angelkarte gekauft haben, geben Sie bitte an, ob Ihnen Gewässer des jeweiligen Anbieters überhaupt bekannt sind.

Anbieter	7a. Angelkarte gekauft			7b. Angelkarte nicht gekauft	
	vor **2006**	im Zeitraum **2006/2007**	in **2008**	Ich kenne **wenigstens ein** Gewässer	Ich kenne **kein** Gewässer
A. Küstenangelkarte M-V	☐	☐	☐	☐	☐
B. Landesanglerverband M-V im VDSF	☐	☐	☐	☐	☐
C. Deutscher Anglerverband M-V im DAV	☐	☐	☐	☐	☐
D. Fischereiunternehmen Müritz-Plau	☐	☐	☐	☐	☐
E. Schweriner Seenfischerei	☐	☐	☐	☐	☐
F. Seenfischerei Obere Havel	☐	☐	☐	☐	☐
G. Salemer Fischerei	☐	☐	☐	☐	☐
H. BIMES Fischerei	☐	☐	☐	☐	☐
I. Seenfischerei Neustrelitz	☐	☐	☐	☐	☐
J. Dabeler Fischerei	☐	☐	☐	☐	☐
K. Seenfischerei Raden	☐	☐	☐	☐	☐
L. Fischereibetrieb Feldberg	☐	☐	☐	☐	☐
M. Fischereiunternehmen T. Priegnitz	☐	☐	☐	☐	☐
Andere: (bitte eintragen)					
O. ____________	☐	☐	☐		
P. ____________	☐	☐	☐		
Q. ____________	☐	☐	☐		

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Teil 2: Fragen zu Ihren Angelerlebnissen während der Angelbuchstudie in M-V im Zeitraum September 2006 bis August 2007

8 **Inwiefern unterschieden sich die Angelbedingungen und Ihr Angelverhalten während der Angelbuchstudie von anderen, eher typischen Angeljahren in M-V? Bitte beurteilen Sie dies anhand der nachfolgend aufgeführten Aspekte.**

	Weniger als sonst	Wie sonst auch	Mehr als sonst
A. Gesamtanzahl der Angeltage	☐	☐	☐
B. Zurückgelegte Kilometer fürs Angeln	☐	☐	☐
C. Anzahl gefangener Fische	☐	☐	☐
D. Anzahl gezielt beangelter Fischarten	☐	☐	☐
E. Größe der gefangenen Fische	☐	☐	☐
F. Zufriedenheit mit dem Fang	☐	☐	☐
G. Anzahl beangelter Gewässer	☐	☐	☐
H. Anzahl der Angelausflüge an die Küste	☐	☐	☐
I. Ausgaben für Angelkarten	☐	☐	☐

9 **Gemäß Ihren Angaben im Angelbuch beangeln Sie in M-V am häufigsten folgendes Gewässer:**

`Greifswalder Bodden (Putbus)`

Bitte geben Sie auf der 5-stufigen Skala an, inwieweit Sie den folgenden Aussagen über dieses Gewässer zustimmen.

	stimme stark zu	stimme zu	neutral	lehne ab	lehne stark ab
A. Dieses Gewässer ist für mich einzigartig	☐	☐	☐	☐	☐
B. Ich fühle mich diesem Gewässer sehr verbunden	☐	☐	☐	☐	☐
C. Ich würde dieses Gewässer gegen kein anderes Gewässer eintauschen wollen	☐	☐	☐	☐	☐
D. Dieses Gewässer entspricht meiner Persönlichkeit	☐	☐	☐	☐	☐
E. Dieses Gewässer bedeutet mir sehr viel	☐	☐	☐	☐	☐
F. Ich kenne keine vergleichbaren Gewässer, die mit diesem Gewässer mithalten können	☐	☐	☐	☐	☐
G. Ich identifiziere mich stark mit diesem Gewässer	☐	☐	☐	☐	☐
H. Verglichen mit diesem Gewässer gibt es wenige zufriedenstellende Alternativen	☐	☐	☐	☐	☐
I. Ich empfinde dieses Gewässer fast schon als Teil von mir	☐	☐	☐	☐	☐
J. Dieses Gewässer ist das beste Angelrevier, das ich kenne	☐	☐	☐	☐	☐
K. Ich empfinde eine größere innere Genugtuung beim Beangeln dieses Gewässers als beim Beangeln anderer Gewässer	☐	☐	☐	☐	☐
L. Ich verbinde viele positive Erinnerungen mit diesem Gewässer	☐	☐	☐	☐	☐
M. Ich genieße das Angeln an anderen Gewässern genauso wie ich das Angeln an diesem Gewässer genieße	☐	☐	☐	☐	☐
N. Verglichen mit anderen Gewässern hat das Angeln an diesem Gewässer eine größere Bedeutung für mich	☐	☐	☐	☐	☐

FBNR: 10022 1 - 4

10 **Gab es während der Angelbuchstudie (September 2006 bis August 2007) irgendwelche Gründe, die Sie davon abgehalten haben, häufiger als tatsächlich der Fall war angeln zu gehen?**

- ☐ Nein **...Falls Nein, bitte weiter mit Frage 11**
- ☐ Ja

10a **Nachfolgend sind einige Gründe aufgeführt, die dazu geführt haben könnten, dass Sie während der Angelbuchstudie weniger häufig als gewünscht zum Angeln gefahren sind. Bitte bewerten Sie jede einzelne Aussage anhand der 5-stufigen Skala.**

	stimme stark zu	stimme zu	neutral	lehne ab	lehne stark ab
A. Mein gesundheitlicher/körperlicher Zustand hat meine Angelaktivitäten eingeschränkt	☐	☐	☐	☐	☐
B. Die Kosten für Angelkarten waren mir zu hoch	☐	☐	☐	☐	☐
C. Ich hatte keinen Zugang zu guten Angelmöglichkeiten in akzeptabler Entfernung zu meinem Wohnort	☐	☐	☐	☐	☐
D. Ich hatte zu wenige Anbisse	☐	☐	☐	☐	☐
E. Die bestehenden Angelvorschriften waren zu streng	☐	☐	☐	☐	☐
F. An den Gewässern waren mir zu viele andere Angler	☐	☐	☐	☐	☐
G. Die notwendigen Angelvorbereitungen haben mich gestresst und vom Angeln abgehalten	☐	☐	☐	☐	☐
H. Ich hatte beruflich zu viel zu tun	☐	☐	☐	☐	☐
I. Die mit dem Angeln verbundenen Kosten waren mir zu hoch	☐	☐	☐	☐	☐
J. Die Gewässer waren zu schwer erreichbar (e.g. Zuwegung, Schilfbestände am Ufer)	☐	☐	☐	☐	☐
K. Die Fische, die ich gefangen haben, waren mir zu klein	☐	☐	☐	☐	☐
L. Die bestehenden Angelvorschriften waren mir unklar	☐	☐	☐	☐	☐
M. Andere Gewässernutzer (z.B. Motorbootfahrer, Segler) haben mich stark eingeschränkt	☐	☐	☐	☐	☐
N. Meine eingeschränkten Angelfähigkeiten hinderten mich, häufiger Angeln zu gehen	☐	☐	☐	☐	☐
O. Andere Freizeitaktivitäten haben meine freie Zeit stark in Anspruch genommen	☐	☐	☐	☐	☐
P. Die Dienstleistungen vor Ort (z.B. Bootsverleih, Slipanlage) waren ungenügend	☐	☐	☐	☐	☐
Q. Ich habe zu wenige Fische meiner Zielfischarten gefangen	☐	☐	☐	☐	☐
R. Ich hatte keinen passenden Angelpartner	☐	☐	☐	☐	☐
S. Ich hatte zu viele anderweitige familiäre Verpflichtungen	☐	☐	☐	☐	☐

11 **Bitte geben Sie auf der 5-stufigen Skala an, wie wichtig jedes der aufgeführten Motive für Ihre Entscheidung war, in M-V dem Angelhobby nachzugehen.**

Ich bin in M-V angeln gegangen, ….	unwichtig				sehr wichtig
A. um kapitale Fische zu fangen	☐	☐	☐	☐	☐
B. um anglerische Herausforderungen zu meistern	☐	☐	☐	☐	☐
C. um die Natur zu erleben	☐	☐	☐	☐	☐
D. um möglichst viele Fische zu fangen	☐	☐	☐	☐	☐
E. um einen Fischvorrat in der Kühltruhe für die angelfreie Zeit anzulegen	☐	☐	☐	☐	☐
F . um die Einsamkeit zu genießen	☐	☐	☐	☐	☐
G. um einen herausfordernden Drill zu erleben	☐	☐	☐	☐	☐
H. um mit Freunden/Familie zusammen zu sein	☐	☐	☐	☐	☐
I. um einen frischen Fisch für ein Fischessen für Familie/Freunde zu fangen	☐	☐	☐	☐	☐
J. um schwierig zu fangende Fische durch eine ausgeklügelte Angelmethode zu überlisten	☐	☐	☐	☐	☐

In folgender Tabelle finden Sie Angelausflüge (Fischart und Gewässer) aufgelistet, die durch Sie im Angelbuch festgehalten wurden.

12 **Was war das WICHTIGSTE Motiv für diesen Angelausflug (Zielart und Gewässer)?**

Was war das UNWICHTIGSTE Motiv für diesen Angelausflug (Zielart und Gewässer)?

Wählen Sie bitte jeweils EIN Motiv als wichtigstes bzw. unwichtigstes Motiv aus der Liste in Frage 11 aus und tragen Sie die entsprechenden Buchstaben in die Tabelle ein.

	Wichtigstes Motiv	Unwichtigstes Motiv
1. Hecht – Greifswalder Bodden (Putbus)		
2. Salmoniden – Tromper Wiek (Ostsee) (Juliusruh)		
3. Salmoniden – Tromper Wiek (Ostsee) (Lohme)		
4. Salmoniden – Prorer Wiek (Ostsee) (Mukran)		
5. Barsch – Greifswalder Bodden (Putbus)		
6. Hornhecht – Greifswalder Bodden (Putbus)		
7. Salmoniden – Tromper Wiek (Ostsee) (Glowe)		
8. Salmoniden – Ostsee (Dranske)		
9. Hecht – Großer Jasmunder Bodden (Sagard)		

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13 **Bitte geben Sie auf der 5-stufigen Skala an, inwieweit Sie den nachfolgenden Aussagen zu Ihren Angelgewohnheiten zustimmen**

	stimme stark zu	stimme zu	neutral	lehne ab	lehne stark ab
A. Wenn ich angeln gehe, suche ich gern neue Gewässer auf, selbst wenn ich nicht sicher bin, dass ich sofort erfolgreich bin	☐	☐	☐	☐	☐
B. Ich bevorzuge es, an jedem Angeltag möglichst viele verschiedene Fischarten zu beangeln	☐	☐	☐	☐	☐
C. Bei den meisten Angelausflügen wende ich ganz unterschiedliche Angelmethoden an	☐	☐	☐	☐	☐
D. Der Anreiz, neue Gewässer auszuprobieren, ist bei mir eher gering ausgeprägt	☐	☐	☐	☐	☐
E. Während eines Angelausflugs bevorzuge ich es, neue Angelmethoden auszuprobieren	☐	☐	☐	☐	☐
F. Wie viele und mit welchen Methoden andere Angler Fische fangen, ist mir egal und beeinflusst mein eigenes Angelverhalten kaum	☐	☐	☐	☐	☐
G. Wenn ich von einem neuen Gewässer höre, das gute Fänge verspricht, probiere ich dieses häufig selbst aus	☐	☐	☐	☐	☐
H. Ich bevorzuge es, Fische mit Angelmethoden zu fangen, die mir seit Jahren bestens vertraut sind	☐	☐	☐	☐	☐
I. Wenn ich Angeln gehe, interessieren mich die Methoden anderer erfolgreicher Angler, um mein eigenes Angeln anzupassen	☐	☐	☐	☐	☐
J. Ich bin mit meinen derzeitig angewendeten Angelmethoden bestens vertraut und nicht daran interessiert, neue Angelmethoden kennenzulernen	☐	☐	☐	☐	☐
K. Mir macht es Freude, über alle möglichen Angelmethoden Bescheid zu wissen, selbst wenn ich keine Möglichkeit habe, diese selbst anzuwenden	☐	☐	☐	☐	☐
L. Ich habe eine Lieblingsangelmethode, die ich an vielen meiner Angeltag anwende	☐	☐	☐	☐	☐
M. Ich beangele an den meisten Angeltagen in der Regel nur eine stark begrenzte Anzahl von Fischarten	☐	☐	☐	☐	☐
N. Ich genieße es, durch die Verbesserung meiner Angelfertigkeiten einige wenige Fischarten gezielt und effektiv beangeln zu können	☐	☐	☐	☐	☐
O. Mir macht es Spaß, neue, von mir bisher noch nicht gezielt befischte Fischarten zu beangeln	☐	☐	☐	☐	☐
P. Auf Grund meiner Angelerfahrung weiß ich, dass ich an meinen Stammgewässern gute Bedingungen vorfinde, so dass ich keine neuen unbekannten Gewässer ausprobieren muss	☐	☐	☐	☐	☐

14 **Wenn Sie Fische fangen, welchen Anteil spielt dabei das sprichwörtliche Anglerglück?**
Wenn ich Fische fange, ist das…

...nahezu gänzlich dem Glück zuzuschreiben	...überwiegend Glück mit etwas anglerischem Geschick	...genausoviel Glück wie anglerisches Geschick	...überwiegend anglerisches Geschick und weniger Glück	...nahezu gänzlich dem anglerischen Geschick zuzuschreiben.
☐	☐	☐	☐	☐

15 **Inwieweit treffen die folgenden Aussagen Ihrer Meinung nach zu? Nutzen Sie zur Abstufung Ihrer Antwort bitte die 5-stufige Skala.**

	trifft überhaupt nicht zu	trifft eher nicht zu	unsicher	eher zutref-fend	trifft voll und ganz zu
A. Im Sommer sind die meisten tiefen, trüben Seen im Tiefenwasser sauerstofffrei	☐	☐	☐	☐	☐
B. Der Zander gedeiht besonders gut in flachen, trüben Seen	☐	☐	☐	☐	☐
C. Sobald die Unterwasserpflanzen in einem Gewässer zurückgehen, geht auch der Hechtbestand zurück	☐	☐	☐	☐	☐
D. Jedes Gewässer hat eine Obergrenze für die Gesamtmenge einer sich natürlich fortpflanzenden Fischart, die durch Besatzmaßnahmen nicht weiter erhöht werden kann	☐	☐	☐	☐	☐
E. Wenn ein hoher Beangelungsdruck vorhanden ist, ist es notwendig, einen Teil der Fische nach dem Fang zurückzusetzen, um den Fischbestand vor der Überfischung zu bewahren.	☐	☐	☐	☐	☐
F. Fischbesatz ist meistens notwendig, um Fischbestände langfristig zu erhalten, auch dann, wenn die Zielart sich in dem zu besetzenden Gewässer natürlich vermehrt	☐	☐	☐	☐	☐
G. Die meisten untermaßigen Fische, die nach dem Angelfang zurückgesetzt werden, sterben.	☐	☐	☐	☐	☐
H. Durch starke Beangelung werden die im Bestand verbleibenden Fische immer kleiner	☐	☐	☐	☐	☐

Teil 3: Die Zukunft des Angelns in M-V: Welche Angelmöglichkeiten wünschen SIE sich?

INFORMATION

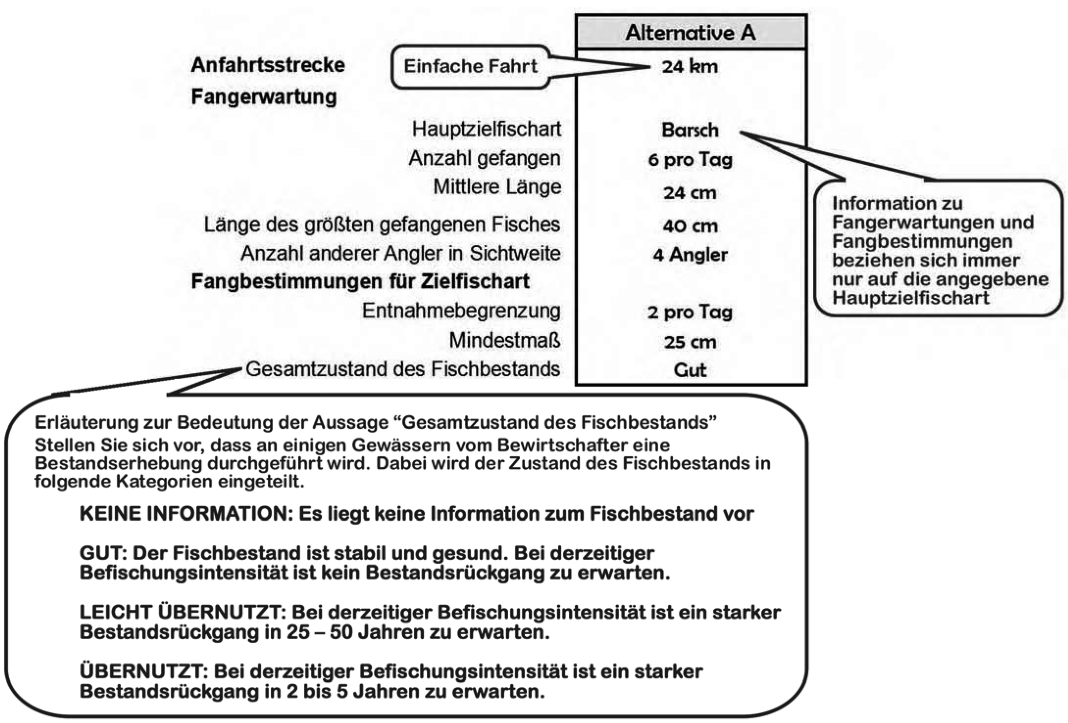
Nun möchten wir mehr darüber erfahren, wie sich Ihre persönliche Angelaktivität unter veränderten Angelbedingungen entwickeln würde. Dazu haben wir verschiedene Angelalternativen für Sie persönlich zusammengestellt (teilweise beruht dies auf Ihren Angaben im Angelbuch). Die folgende Tabelle gibt Ihnen zunächst einen Überblick über Ihre Durchschnittswerte für das Angeljahr 2006/2007. Bitte lesen Sie diese Angaben sorgfältig durch, da später darauf Bezug genommen wird.

Durchschnittliche Anfahrtsstrecke (Binnengewässer)	40 km
Durchschnittliche Anfahrtsstrecke (Küstengewässer)	40 km
Zielfischart 1	**Hecht**
Durchschnittlicher Fang pro Angeltag	2 pro Tag
Durchschnittliche Länge des größten Fisches	76 cm
Zielfischart 2	**Barsch**
Durchschnittlicher Fang pro Angeltag	9 pro Tag
Durchschnittliche Länge des größten Fisches	37 cm
Zielfischart 3	**unbekannt/keine**
Durchschnittlicher Fang pro Angeltag	~
Durchschnittliche Länge des größten Fisches	~

Auf den folgenden 8 Seiten finden Sie nun Beschreibungen von Angeltagen mit Ihren wichtigsten Zielfischarten. Zusätzlich werden Ihnen Informationen über Fangbestimmungen und den Zustand der Fischbestände gegeben.

Nehmen Sie an, dass alle genannten Bedingungen tatsächlich gelten, selbst wenn sie heute in dieser Form nicht zu finden sind. Wir bitten Sie, für die Beantwortung der folgenden Fragen anzunehmen, dass die restlichen anglerischen Bedingungen mit denen während der Angelbuchstudie 2006/2007 identisch sind.

Das folgende Beispiel und die dazugehörigen Erläuterungen (in Kästchen) sollen Ihnen zunächst aufzeigen, wie die auf den folgenden Seiten zusammengestellten Angelbedingungen zu verstehen und von Ihnen zu beantworten sind. Nehmen Sie sich bitte etwas Zeit und schauen Sie sich die Zusammenstellung genau an!



Ausfüllbeispiel: Hier zeigen wir Ihnen, wie die auf den folgenden Seiten kommenden Fragen zu beantworten sind.

Stellen Sie sich vor, Sie hätten 10 Tage zur Verfügung, an denen Sie angeln könnten. Wie würden Sie diese auf die verschiedenen Angel-Alternativen in M-V und außerhalb verteilen?

> Die Gesamtkosten für alle Angelkarten in M-V. Diese Kosten müssen Sie bezahlen, um die Alternativen A bis D beangeln zu dürfen.

Angelgewässer in M-V

Gesamtkosten für Angelkarten: 50 €

	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
					Woanders Angeln	**Gar Nicht Angeln**
Anfahrtsstrecke	24 km	48 km	92 km	Anderes Gewässer mit anderer Hauptzielfischart	Woanders Angeln (nicht in M-V)	Gar Nicht Angeln
Fangerwartung						
Hauptzielfischart	Barsch	Karpfen	Hecht			
Anzahl gefangen	6 pro Tag	2 pro Tag	2 pro Tag			
Mittlere Länge	24 cm	70 cm	45 cm			
Länge des größten gefangenen Fisches	39 cm	78 cm	82 cm			
Anzahl anderer Angler in Sichtweite	4 Angler	1 Angler	2 Angler			
Fangbestimmungen						
Mindestmaß	25 cm	60 cm	60 cm			
Entnahmebegrenzung	Keine Begrenzung	2 pro Tag	3 pro Tag			
Gesamtzustand des Fischbestands	Gut	Übernutzt	Leicht übernutzt			
→	4	+ 1	+ 2	+ 1	+ 2	+ 0 = 10 Tage

BEISPIEL

Szenario 1

Stellen Sie sich vor, Sie hätten 10 Tage zur Verfügung, an denen Sie angeln könnten. Wie würden Sie diese auf die verschiedenen Angel-Alternativen in M-V und außerhalb verteilen?

	Angelgewässer in M-V				Woanders Angeln	Gar Nicht Angeln
	Gesamtkosten für Angelkarten: 10 €					
	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Anfahrtsstrecke	60 km	80 km	100 km	Anderes Gewässer mit anderer Hauptzielfischart	Woanders Angeln (nicht in M-V)	Gar Nicht Angeln
Fangerwartung						
Hauptzielfischart	Hecht	Hecht	Barsch			
Anzahl gefangen	3 pro Tag	4 pro Tag	21 pro Tag			
Mittlere Länge	44 cm	66 cm	29 cm			
Länge des größten gefangenen Fisches	60 cm	73 cm	40 cm			
Anzahl anderer Angler in Sichtweite	3 Angler	14 Angler	1 Angler			
Fangbestimmungen						
Mindestmaß	60 cm	70 cm	28 cm			
Entnahmebegrenzung	3 pro Tag	1 pro Tag	2 pro Tag			
Gesamtzustand des Fischbestands	Leicht Übernutzt	Leicht Übernutzt	Gut			

→ ___ + ___ + ___ + ___ + ___ + ___ = **10 Tage**

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Szenario 2

Stellen Sie sich vor, Sie hätten 10 Tage zur Verfügung, an denen Sie angeln könnten. Wie würden Sie diese auf die verschiedenen Angel-Alternativen in M-V und außerhalb verteilen?

Angelgewässer in M-V

Gesamtkosten für Angelkarten: 60 €

	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
	Angelgewässer in M-V				Woanders Angeln	Gar Nicht Angeln
Anfahrtsstrecke	80 km	60 km	40 km	Anderes Gewässer mit anderer Hauptzielfischart	Woanders Angeln (nicht in M-V)	Gar Nicht Angeln
Fangerwartung						
Hauptzielfischart	Hecht	Hecht	Barsch			
Anzahl gefangen	1 pro Tag	1 pro 2 Tage	27 pro Tag			
Mittlere Länge	54 cm	69 cm	19 cm			
Länge des größten gefangenen Fisches	60 cm	91 cm	30 cm			
Anzahl anderer Angler in Sichtweite	14 Angler	9 Angler	11 Angler			
Fangbestimmungen						
Mindestmaß	50 cm	50 cm	24 cm			
Entnahmebegrenzung	3 pro Tag	1 pro Tag	8 pro Tag			
Gesamtzustand des Fischbestands	Übernutzt	Übernutzt	Gut			

→ ___ + ___ + ___ + ___ + ___ + ___ **= 10 Tage**

Szenario 3

Stellen Sie sich vor, Sie hätten 10 Tage zur Verfügung, an denen Sie angeln könnten. Wie würden Sie diese auf die verschiedenen Angel-Alternativen in M-V und außerhalb verteilen?

Angelgewässer in M-V

Gesamtkosten für Angelkarten: 270 €

	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E (Woanders Angeln)	Alternative F (Gar Nicht Angeln)
Anfahrtsstrecke	60 km	40 km	80 km	Anderes Gewässer mit anderer Hauptzielfischart	Woanders Angeln (nicht in M-V)	Gar Nicht Angeln
Fangerwartung						
Hauptzielfischart	Barsch	Hecht	Hecht			
Anzahl gefangen	4 pro Tag	3 pro Tag	3 pro Tag			
Mittlere Länge	41 cm	44 cm	99 cm			
Länge des größten gefangenen Fisches	50 cm	60 cm	110 cm			
Anzahl anderer Angler in Sichtweite	4 Angler	14 Angler	1 Angler			
Fangbestimmungen						
Mindestmaß	Keine	Keine	Keine			
Entnahmebegrenzung	Keine	5 pro Tag	5 pro Tag			
Gesamtzustand des Fischbestands	Keine Information	Leicht Übernutzt	Keine Information			
→	___ +	___ +	___ +	___ +	___ +	___ = 10 Tage

Szenario 4

Stellen Sie sich vor, Sie hätten 10 Tage zur Verfügung, an denen Sie angeln könnten. Wie würden Sie diese auf die verschiedenen Angel-Alternativen in M-V und außerhalb verteilen?

Angelgewässer in M-V

Gesamtkosten für Angelkarten: 165 €

	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
	Angelgewässer in M-V				Woanders Angeln	Gar Nicht Angeln
Anfahrtsstrecke	80 km	100 km	60 km	Anderes Gewässer mit anderer Hauptzielfischart	Woanders Angeln (nicht in M-V)	Gar Nicht Angeln
Fangerwartung						
Hauptzielfischart	Barsch	Hecht	Hecht			
Anzahl gefangen	27 pro Tag	1 pro Tag	4 pro Tag			
Mittlere Länge	47 cm	99 cm	49 cm			
Länge des größten gefangenen Fisches	50 cm	110 cm	60 cm			
Anzahl anderer Angler in Sichtweite	17 Angler	9 Angler	9 Angler			
Fangbestimmungen						
Mindestmaß	28 cm	60 cm	50 cm			
Entnahmebegrenzung	Keine	5 pro Tag	Keine			
Gesamtzustand des Fischbestands	Gut	Übernutzt	Keine Information			

→ ___ + ___ + ___ + ___ + ___ + ___ **= 10 Tage**

Szenario 5

Stellen Sie sich vor, Sie hätten 10 Tage zur Verfügung, an denen Sie angeln könnten. Wie würden Sie diese auf die verschiedenen Angel-Alternativen in M-V und außerhalb verteilen?

	Angelgewässer in M-V				Woanders Angeln	Gar Nicht Angeln
	Gesamtkosten für Angelkarten: 235 €					
	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Anfahrtsstrecke	40 km	40 km	80 km	Anderes Gewässer mit anderer Hauptzielfischart	Woanders Angeln (nicht in M-V)	Gar Nicht Angeln
Fangerwartung						
Hauptzielfischart	Barsch	Barsch	Hecht			
Anzahl gefangen	8 pro Tag	4 pro Tag	1 pro 2 Tage			
Mittlere Länge	29 cm	13 cm	66 cm			
Länge des größten gefangenen Fisches	40 cm	24 cm	73 cm			
Anzahl anderer Angler in Sichtweite	1 Angler	4 Angler	14 Angler			
Fangbestimmungen						
Mindestmaß	Keine	20 cm	Keine			
Entnahmebegrenzung	15 pro Tag	8 pro Tag	3 pro Tag			
Gesamtzustand des Fischbestands	Übernutzt	Keine Information	Übernutzt			

→ ___ + ___ + ___ + ___ + ___ + ___ **= 10 Tage**

Szenario 6

Stellen Sie sich vor, Sie hätten 10 Tage zur Verfügung, an denen Sie angeln könnten. Wie würden Sie diese auf die verschiedenen Angel-Alternativen in M-V und außerhalb verteilen?

Angelgewässer in M-V

Gesamtkosten für Angelkarten: 25 €

	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
	Angelgewässer in M-V				Woanders Angeln	Gar Nicht Angeln
Anfahrtsstrecke	40 km	80 km	100 km	Anderes Gewässer mit anderer Hauptzielfischart	Woanders Angeln (nicht in M-V)	Gar Nicht Angeln
Fangerwartung						
Hauptzielfischart	Hecht	Barsch	Barsch			
Anzahl gefangen	4 pro Tag	8 pro Tag	4 pro Tag			
Mittlere Länge	51 cm	25 cm	16 cm			
Länge des größten gefangenen Fisches	73 cm	30 cm	24 cm			
Anzahl anderer Angler in Sichtweite	1 Angler	4 Angler	17 Angler			
Fangbestimmungen						
Mindestmaß	60 cm	24 cm	28 cm			
Entnahmebegrenzung	1 pro Tag	Keine	Keine			
Gesamtzustand des Fischbestands	Gut	Keine Information	Leicht Übernutzt			

→ [ ] + [ ] + [ ] + [ ] + [ ] + [ ] **= 10 Tage**

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Szenario 7

Stellen Sie sich vor, Sie hätten 10 Tage zur Verfügung, an denen Sie angeln könnten. Wie würden Sie diese auf die verschiedenen Angel-Alternativen in M-V und außerhalb verteilen?

	Angelgewässer in M-V				Woanders Angeln	Gar Nicht Angeln
	Gesamtkosten für Angelkarten: 95 €					
	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Anfahrtsstrecke	100 km	60 km	40 km	Anderes Gewässer mit anderer Hauptzielfischart	Woanders Angeln (nicht in M-V)	Gar Nicht Angeln
Fangerwartung						
Hauptzielfischart	Hecht	Barsch	Barsch			
Anzahl gefangen	1 pro 2 Tage	21 pro Tag	8 pro Tag			
Mittlere Länge	61 cm	32 cm	41 cm			
Länge des größten gefangenen Fisches	73 cm	40 cm	50 cm			
Anzahl anderer Angler in Sichtweite	9 Angler	1 Angler	4 Angler			
Fangbestimmungen						
Mindestmaß	50 cm	Keine	24 cm			
Entnahmebegrenzung	1 pro Tag	Keine	15 pro Tag			
Gesamtzustand des Fischbestands	Keine Information	Gut	Leicht Übernutzt			

→ ____ + ____ + ____ + ____ + ____ + ____ **= 10 Tage**

Szenario 8

Stellen Sie sich vor, Sie hätten 10 Tage zur Verfügung, an denen Sie angeln könnten. Wie würden Sie diese auf die verschiedenen Angel-Alternativen in M-V und außerhalb verteilen?

	Angelgewässer in M-V				Woanders Angeln	Gar Nicht Angeln
	Gesamtkosten für Angelkarten: 130 €					
	Alternative A	Alternative B	Alternative C	Alternative D	Alternative E	Alternative F
Anfahrtsstrecke	100 km	100 km	60 km	Anderes Gewässer mit anderer Hauptzielfischart	Woanders Angeln (nicht in M-V)	Gar Nicht Angeln
Fangerwartung						
Hauptzielfischart	Barsch	Barsch	Hecht			
Anzahl gefangen	21 pro Tag	27 pro Tag	1 pro Tag			
Mittlere Länge	34 cm	47 cm	85 cm			
Länge des größten gefangenen Fisches	40 cm	50 cm	91 cm			
Anzahl anderer Angler in Sichtweite	11 Angler	1 Angler	3 Angler			
Fangbestimmungen						
Mindestmaß	28 cm	28 cm	50 cm			
Entnahmebegrenzung	15 pro Tag	8 pro Tag	1 pro Tag			
Gesamtzustand des Fischbestands	Leicht Übernutzt	Gut	Übernutzt			

→ ___ + ___ + ___ + ___ + ___ + ___ **= 10 Tage**

Teil 4: Persönliche Informationen

16 **Wie Sie selbst vielleicht schon festgestellt haben, gibt es den „durchschnittlichen Angler“ nicht. Welcher der vier folgenden „Anglertypen“ beschreibt Sie als Angler am besten? Bitte kreuzen Sie die Beschreibung an, die Ihnen persönlich am nächsten kommt.**

(Bitte nur ein Antwortkreuz setzen)

☐ “Angelverrückt”	Jemand, für den das Angeln eine zentrale Stellung im Leben einnimmt und ein Großteil des Freundeskreises aus Anglern besteht. Der **„Angelverrückte“** investiert den Großteil seiner Freizeit in das Angeln. Eigenschaften eines **„Angelverrückten“** können sein: • Wählt Angelgewässer streng nach der Angelqualität aus, selbst wenn die Gewässer weit entfernt vom Wohnort liegen • Benutzt hochwertiges Angelgerät und wendet die neuesten Angelmethoden an; besitzt eine beeindruckende Sammlung spezialisierter Angelgeräte • Angelt nahezu ausschließlich gezielt auf eine bestimmte Fischart, setzt viele Fische nach dem Fang zurück • Angelt auch dann weiter, wenn die Fische nicht gut beissen • Benutzt zahlreiche Informationsquellen und kauft/abboniert spezialisierte Angelmagazine
☐ Fortgeschrittener Angler	Jemand, für den das Angeln die wichtigste Freizeitaktivität darstellt und dessen Freundeskreis auch viele Angler umfasst. Der **fortgeschrittene Angler** investiert einen erheblichen Anteil seiner Freizeit in das Angeln. Eigenschaften eines **fortgeschrittenen Anglers** können sein: • Wählt Angelgewässer häufig nach der Angelqualität aus und reist manchmal auch weite Strecken zu besonders guten Gewässern • Bevorzugt hochwertiges Angelgerät und ist sich der neuesten Angelmethoden bewusst; besitzt eine große Angelausrüstung, darunter einige spezialisierte Geräte • Angelt meist gezielt auf eine bestimmte Fischart, setzt Fische auch mal zurück • Angelt meistens auch dann weiter, wenn die Fische nicht gut beissen • Benutzt verschiedene Informationsquellen und kauft/abboniert Angelmagazine
☐ Aktiver Angler	Jemand, für den das Angeln eine Freizeitaktivität unter vielen darstellt und in dessen Freundeskreis sich auch einige Angler befinden. Der **aktive Angler** angelt regelmäßig, investiert aber viel Zeit in andere Freizeitaktivitäten. Eigenschaften eines **aktiven Anglers** können sein: • Wählt Angelgewässer meist nach dem einfachen Zugang aus, häufig in der Nähe zum Wohnort • Bevorzugt gängige und bewährte Angelgeräte und -methoden; kennt nur wenige der neuesten Angelmethoden; besitzt eine mittelgroße Angelausrüstung, hauptsächlich aus Allround Gerät bestehend • Angelt nur an manchen Angeltagen gezielt auf eine bestimmte Fischart, nimmt den Fang meist mit nach Hause • Verliert manchmal die Lust am Angeln, wenn die Fische nicht gut beissen • Benutzt machmal allgemein zugängliche Informationsquellen über das Angeln
☐ Gelegenheits-Angler	Jemand, für den das Angeln keine überaus bedeutsame Freizeitaktivität darstellt und der Freudeskreis nur wenige Angler umfasst. Der **Gelegenheitsangler** angelt selten und investiert den Großteil seiner Freizeit in andere Aktivitäten. Eigenschaften eines **Gelegenheitsanglers** können sein: • Wählt Angelgewässer fast immer nach dem einfachen Zugang aus, meist in der Nähe zum Wohnort • Bevorzugt gängige und bewährte Angelgeräte und -methoden; kennt die neuesten Angelmethoden meist nur vom Hörensagen; besitzt eine kleine Angelausrüstung von Allround Geräten • Angelt meist auf das, was gerade beißt, nimmt den Großteil des Fangs mit nach Hause • Verliert schnell die Lust am Angeln, wenn die Fische nicht gut beissen • Benutzt sehr selten allgemein zugängliche Informationsquellen über das Angeln

Nachdem Sie seit mehr als 2 Jahren all unsere Fragen gewissenhaft beantwortet haben, möchten wir abschließend noch etwas über Sie als Mensch erfahren. Wer sind Sie? Welchen Biorythmus haben Sie? Welche Persönlichkeit haben Sie? Es wäre toll, wenn Sie sich auch für den letzten Abschnitt noch kurz Zeit nehmen würden, selbst wenn die Fragen keinen direkten Bezug zum Angeln haben.

17 **Manche Menschen sind Morgentypen, andere dagegen Abendtypen. Zu welchem Typ würden Sie sich zählen ?**

Eindeutig ‚Morgentyp'	Eher ‚Morgen-' als Abendtyp	Eher ‚Abend-, als ‚Morgentyp'	Eindeutig ‚Abendtyp'
☐	☐	☐	☐

18 **Bitte geben Sie jeweils die Uhrzeit (z.B. 08:00 Uhr) zu Ihren Aufsteh- und Schlafgewohnheiten an. Wenn Sie keinen Mittagschlaf machen, lassen Sie bitte die entsprechende Kategorie frei.**

	An Wochentagen	Am Wochenende (mit Angeltrip)	Am Wochenende (ohne Angeltrip)
A. Wann stehen Sie auf...	Uhr	Uhr	Uhr
B. Mittagsschlaf (von – bis)	- Uhr	- Uhr	- Uhr
C. Wann gehen Sie zu Bett...	Uhr	Uhr	Uhr

19 **Inwieweit treffen die folgenden Aussagen auf Sie persönlich zu?**

Ich...	trifft überhaupt nicht zu	trifft eher nicht zu	weder/ noch	eher zutref-fend	trifft voll und ganz zu
A. ...bin eher zurückhaltend, reserviert	☐	☐	☐	☐	☐
B. ...schenke anderen leicht Vertrauen, glaube an das Gute im Menschen	☐	☐	☐	☐	☐
C. ...bin bequem, neige zur Faulheit	☐	☐	☐	☐	☐
D. ...bin entspannt, lasse mich durch Stress nicht aus der Ruhe bringen	☐	☐	☐	☐	☐
E. ...habe nur wenig künstlerisches Interesse	☐	☐	☐	☐	☐
F. ...gehe aus mir heraus, bin gesellig	☐	☐	☐	☐	☐
G. ...neige dazu, andere zu kritisieren	☐	☐	☐	☐	☐
H. ...erledige Aufgaben gründlich	☐	☐	☐	☐	☐
I. ...werde leicht nervös und unsicher	☐	☐	☐	☐	☐
J. ...habe eine aktive Vorstellungskraft, bin phantasievoll	☐	☐	☐	☐	☐

20 **Und zum Abschluss eine Spassfrage: Wie viele Bierflaschen (0,5 Liter) trinken Sie an einem typischen Angeltag? (Geben Sie bitte 0 an, wenn Sie kein Bier trinken.)**

____ Bier pro Angeltag

21 **Während einer 7-Tages-Woche, wie viele Bierflaschen (0,5 Liter) trinken Sie für gewöhnlich? (Geben Sie bitte 0 an, wenn Sie kein Bier trinken.)**

____ Bier pro Woche

Vielen Dank für das Ausfüllen des Fragebogens!
Bitte senden Sie den ausgefüllten Fragebogen mit dem bereits frankierten Rückumschlag an uns zurück!

FBNR: 10022 1 - **20**

Appendix D. Angler Personalized Diary Report (in German)

Landesforschungsanstalt für Landwirtschaft und Fischerei
Mecklenburg-Vorpommern,
Institut für Fischerei, Rostock

Wissenschaftliche Angelstudie
Mecklenburg-Vorpommern 2006/2007

Persönliche Zusammenfassung der Angelbuchstudie

Teilnehmer der Angelbuchstudie:

10122

Einleitung

Nachdem Sie das Angelbuch ein Jahr lang gewissenhaft geführt haben, möchten wir Ihnen auf Basis Ihrer gelieferten Daten eine persönliche Zusammenfassung Ihres Angeljahres überreichen. Nachfolgend finden Sie z.B. Informationen über Ihre Angelhäufigkeit oder Ihren Fangerfolg. Wir hoffen, dass dieser persönliche Rückblick einige interessante Einblicke auf Ihre Angelaktivität bereithält.

Teil 1: Zusammenfassung Ihrer Angelbucheinträge

Wie Sie sich vielleicht erinnern können, begann die Abfrage für einen Angelausflug im Angelbuch mit Angaben zum Datum, Angelzeit und Gewässer. Ausgehend von diesen Daten kann z.B. Ihre mittlere reine Angelzeit während der Studie oder die mittlere Anfahrtsstrecke zum Gewässer bestimmt werden. Im folgenden sind hierzu einige Daten aufgelistet.

Ausflugsinformation	
Anzahl der Angelausflüge	9
Mittlere Gesamtdauer eines Angeltrips	6,9 Std.
Mittlere reine Angelzeit	5 Std.
Gesamtangelzeit während Studie	45 Std.
Längster Angelausflug	10 Std.
Mittlere Anfahrtsstrecke	16 km
Längste Anfahrtsstrecke	32 km
Am häufigsten beangelter Gewässertyp	Fließgewässer

Ferner lässt sich aus diesen Angaben ableiten, welche drei Gewässer Sie während der Angelbuchstudie am häufigsten aufgesucht haben. Diese finden Sie in der nachstehenden Auflistung.

Ihre drei am häufigsten genutzten Gewässer (nächste Ortschaft)	
Gewässer Nr. 1	Warnow (Kessin)
Gewässer Nr. 2	Ostsee (Graal-Müritz)
Gewässer Nr. 3	keine/unbekannt

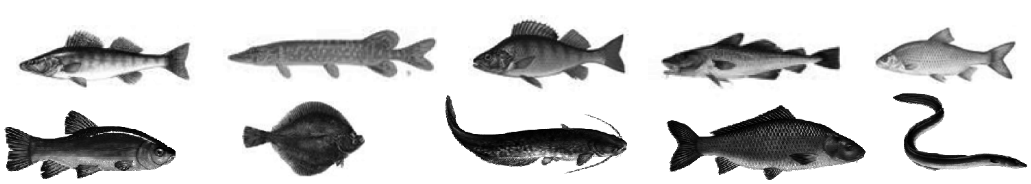
Teil 2 : Zusammenfassung Ihrer Angaben zum Angeln

Anschließend sollten Sie im Angelbuch durch zusätzliche Angaben den Angelausflug näher umschreiben. Sie wurden z.B. gefragt, mit wem Sie angeln waren oder welche Angelmethode genutzt wurde. Eine Zusammenfassung Ihrer Angaben ist in der folgenden Tabelle dargestellt.

Angaben zum Angeln	
Sie angelten am häufigsten...	Mit Angelfreunden
Mittlere Größe Ihrer Angelgruppe	3,2
Meist genutzter Angelplatz	Natürliches Ufer
Häufigste Angelmethode	Stippangeln

Ferner wurden Sie gebeten, für jeden Angelausflug anzugeben, welche Zielfischart Sie ins Auge gefasst hatten und wie lange Sie gezielt auf diese geangelt haben. Mit Hilfe dieser Angaben lässt sich herausfiltern, welche drei Fischarten Sie am häufigsten beangelt wurden und wie Sie Ihre Angelzeit anteilig auf diese Fischarten verteilt haben.

Angaben zu Zielfischarten		
	Zielfischart	Anteil der Angelzeit
Am häufigsten beangelt	Dorsch	40%
Am zweithäufigsten beangelt	Weißfische	30%
Am dritthäufigsten beangelt	Aal	11%
Anteil für andere Zielarten		19%



Teil 3: Informationen über Ihre Fänge

Nachstehend finden Sie eine Auflistung von Daten zu Ihren Fängen, die Sie im Angelbuch notiert haben. Aufgeführt sind die Angaben zu Fangerfolg oder Längen für Ihre 3 am häufigsten beangelten Fischarten. Sicherlich interessiert Sie auch, wie Sie im Vergleich zu anderen Anglern der Studie abschneiden. Dies können Sie anhand der Angaben zu allen Anglern selbst ablesen.

Ihr Fangerfolg bei Ihren 3 häufigsten beangelten Fischarten			
Fischart	Dorsch	Weißfische	Aal
	Sie / Vergleich zu anderen Anglern		
Gesamtzahl gefangen	11 / weniger	44 / weniger	1 / weniger
Gesamtzahl entnommen	8 / weniger	12 / weniger	1 / weniger
Maximale Anzahl entnommen bei einem Angelausflug	8 / weniger	6 / weniger	1 / weniger
Länge des größten entnommenen Fisches	45 cm / weniger	18 cm / weniger	55 cm / mehr
Mittlere Länge der entnommenen Fische	45 cm / weniger	11,8 cm / weniger	55 cm / mehr

Abschließend hatten wir Sie gebeten, für jeden Angelausflug die Anzahl der Angler anzugeben, die Sie gesehen hatten, sowie Ihre Zufriedenheit mit dem Fangergebnis einschätzen. Für beide Angaben finden Sie nachstehend den Mittelwert für die gesamte Dauer der Angelbuchstudie.

Zusätzliche Information	
Mittlere Anzahl gesehener Angler	5
Ihre mittlere Zufriedenheit mit dem Fangergebnis	6,9 / 10

Appendix E. Angler Characteristics asked in Quarterly Telephone Interviews (in German)

Angler characteristics were asked during the third and fourth quarterly telephone calls.

Panel 3

Damit ist der Befragungsteil zum Angelbuch abgeschlossen. Ich würde nun noch gerne mit einigen wenigen Fragen mehr über Ihre persönliche Einstellung zum Angeln erfahren. Vor wie vielen Jahren haben Sie mit dem Angeln begonnen?

1. Seit wie vielen Jahren gehen Sie mindestens einmal im Jahr angeln?
2. In …, auf wie viele Angelausflüge kommen Sie in etwa durchschnittlich pro Jahr?

   In Bezug auf Frage 1 wurde Frage 2 entsprechend angepasst.

3. Wie viele verschiedene Gewässer im Binnen- und Küstenbereich von Mecklenburg-Vorpommern haben Sie in … in etwa zum Angeln aufgesucht?

In Bezug auf Frage 1 wurde Frage 3 entsprechend angepasst.

4. Haben Sie ein festes Hausgewässer, an dem Sie den Hauptteil Ihrer Angelzeit verbringen?

Ja
Nein

5. Seit wie vielen Jahren beangeln Sie dieses Gewässer regelmäßig?
6. Wie viel Prozent Ihrer Angelzeit verbringen Sie meist pro Jahr an Ihrem Hausgewässer

Skale zur konsumtiven Orientierung

7. Bitte geben Sie auf einer 5-stufigen Skala an, inwieweit Sie den folgenden Aussagen zustimmen, wobei die Skala von 1=„stimme stark zu", 2=„stimme zu", 3=„neutral/unentschieden", 4=„lehne ab" und 5=„lehne stark ab" reicht.

1. Ein Angeltag kann auch dann erfolgreich sein, wenn ich keinen Fisch fange.
2. Wenn ich angeln gehe, bin ich ebenso zufrieden, wenn ich nichts fange.

3. Ich gehe angeln, um Speisefische zum eigenen Verzehr zu fangen.
4. Die meisten meiner gefangenen Fische setze ich in das Gewässer zurück.
5. Ich gehe bevorzugt dort angeln, wo die Chance besteht, einen kapitalen Fisch zu fangen.
6. Je größer der gefangene Fisch, desto besser ist der Angeltag.
7. Je mehr Fische ich fange, desto zufriedener bin ich.
8. Ich fange lieber 1 oder 2 große Fische als 10 kleinere.
9. Wenn ich angeln gehe und es ist Beissflaute, versuche ich trotzdem mit vollem Einsatz, mindestens einen Fisch zu fangen.
10. Weil für mich das Erleben der Natur im Vordergrund steht, machen mir mehrere Angeltage ohne Fischfang nichts aus.
11. Angeln bedeutet für mich vorrangig Erholung von Alltagsstress, weshalb mir eine längere Zeit ohne Fischfang nichts ausmacht.
12. Ich verbinde mit Angeln hauptsächlich das Zusammenkommen mit Freunden und Familie, deshalb machen mir Angeltage ohne Fang nichts aus.
13. Ich angele gern, weil gute Fangergebnisse mir bei meinen Angelkollegen Anerkennung verschaffen.
14. Ich angele gern, weil durch den Fischfang mein Ehrgeiz befriedigt wird.
15. Ich angele gern, weil mir der Fischfang große Freude bereitet.
16. Ich gehe zum Angeln, weil ich mich mit jedem gefangenen Fisch als Angler weiterentwickle.
17. Beim Angeln hängt es zumeist vom Glück ab, ob die Fische beißen oder nicht.
18. Ich kann durch eine genau abgestimmte Angelmethode meinen Fangerfolg entscheidend beeinflussen.
19. Die Wahrscheinlichkeit, einen kapitalen Fisch zu fangen, kann ich als Angler kaum beeinflussen.
20. Ich benutze seit Jahren eigentlich immer dieselben Angelmethoden, ohne diese großartig zu verändern.

Stellenwert des Angelns für das Leben eines Anglers

8. Nun würden wir abschließend für heute gern noch von Ihnen erfahren, welchen Stellenwert das Angeln in Ihrem Leben einnimmt. Wir bitten Sie wieder die nachfolgenden Aussagen, anhand der Skala 1=„stimme stark zu", 2=„stimme zu", 3=„neutral/unentschieden", 4=„lehne ab" und 5=„lehne stark ab" zu bewerten. Wie ist das mit der Aussage:

1. Würde ich mit dem Angeln aufhören, könnte ich eine Vielzahl meiner Freunde verlieren.
2. Wenn ich nicht angeln könnte, wüsste ich nicht, was ich stattdessen tun sollte.

3. Wegen meiner Angelleidenschaft bleibt fast keine Zeit für andere Hobbys.
4. Die meisten meiner Freunde kenne ich durch das Angeln.
5. Ich gehe lieber angeln als irgendetwas anderes zu tun.
6. Andere Hobbys interessieren mich nicht so sehr wie das Angeln.
7. Ich finde, dass ein Großteil meines Lebens sich um das Angeln dreht

Panel 4

Damit ist der Befragungsteil zum Angelbuch abgeschlossen. Angler unterscheiden sich in vielerlei Hinsicht voneinander. Um diese Unterschiede besser zu verstehen, hätte ich noch einige wenige *Zusatzfragen. Die daraus gewonnenen Ergebnisse tragen dazu bei, die Bedürfnisse der Angler besser darzustellen bzw. verbesserte Rahmenbedingen für das Angeln in M-V zu schaffen*

1. Anzahl der Jahres-/Wochen-/Tagesangelkarten für Gewässer in M-V?

   Anzahl Jahreskarten

   Anzahl Wochenkarten

   Anzahl Tageskarten

2. Wie hoch waren ungefähr die Gesamtkosten für Angelkarten in M-V während der Angelstudie?

Angelaktivität außerhalb von M-V

3. Haben Sie während der Angelstudie einen reinen Angelurlaub im In- oder Ausland unternommen, der mindestens drei aufeinander folgende Tage umfasste?
4. Wie viele Tage dauerte dieser Urlaub?
5. Wo fand dieser Angelurlaub statt?

Aufnahme des besuchten Bundeslandes oder im Fall eines Angelausflugs ins Auslands, Name des Landes notieren

6. Wie oft waren Sie seit dem Beginn der Angelstudie im September 2006 außerhalb von M-V angeln?
7. Wie hoch waren ungefähr die Gesamtkosten für Angelkarten für das Angeln außerhalb von M-V?

Kosten/Angaben zur Angelausrüstung

8. Kommen wir nun zu Ihren allgemeinen Angelausgaben. Welchen ungefähren Anschaffungswert in Euro hat Ihre gesamte Angelausrüstung ohne Boot, wenn diese morgen komplett ersetzt werden müsste?
9. Wie viele Angelruten besitzen Sie?
10. Können Sie kurz überschlagen, wie viel Sie ungefähr während des Angelstudienzeitraums für Angelgerät, Zubehör und Köder ausgegeben haben? (Kosten für Angelkarten nicht berücksichtigen)

Verhaltensweisen/Angaben zur Nutzung von bestimmten Methoden

11. Wie häufig betreiben bzw. nutzen Sie die Angeltechniken und Handlungsweisen, die ich Ihnen gleich vorlese. Nutzen Sie für die Bewertung die 5-stufige Skala von mache ich 1=„gar nicht", 2=„selten", 3=„regelmäßig", 4=„häufig" bis 5=„sehr häufig".

1. Der Kauf von Markengeräten bei der Anschaffung von neuem Angelgerät
2. Der Einsatz elektronischer Geräte wie Echolot und GPS als Hilfsmittel beim Angeln
3. Der Einsatz von Angelgerät, das speziell nur auf eine Zielfischart ausgerichtet ist
4. Die Verwendung von Methoden und Ködern, die den Fang vieler verschiedener Arten erlauben
5. Das Ausprobieren neuer Gewässer, die einen guten Fangerfolg versprechen
7. Das Lesen von Büchern über das Angeln
8. Das Anschauen von Angel-Videos und DVD
9. Das Lesen von Angelmagazinen
10. Das Lesen von Internetseiten über das Angeln
11. Die Führung eines persönlichen Angelbuchs
12. Die Herstellung eigener Köder und Futtermittel z.B. für die Anfütterung
13. Die Gezielte Veränderung von gekauften Ködern für einen größeren Angelerfolg, z.B. das Anbringen von Zusatzdrillingen bei Gummifischen beim Raubfischangeln oder die Ergänzung von Stippfutter durch eigene Zusätze beim Friedfischangeln
14. Die Nutzung von weit abgelegenen, schwierig erreichbaren Angelstellen

Selbsteinschätzung der Angler

12. Wie würden Sie im Vergleich zu anderen Anglern, die Sie kennen, Ihre Angelfertigkeiten einschätzen? Sind sie...

weniger gut

genauso gut
besser
wesentlich besser

13. Angler unterteilt man in verschiedene Anglertypen, z.B. Allroundangler oder Friedfischangler bzw. Stippangler. Wenn Sie an Ihre Zielfischarten und Angelmethoden denken, wie würden Sie sich am ehesten selbst bezeichnen?

Aalangler
Allroundangler
Barschangler
Boilieangler
Brandungsangler
Dorschangler
Fliegenfischer
Forellen-/Salmonidenangler
Friedfischangler
Grundangler
Hechtangler
Karpfenangler
Kunstköder- /Spinnangler
Kutterangler
Meeresangler
Naturköderangler
Pilkangler
Posenangler
Raubfischangler
Spaßangler
Stippangler
Welsangler
Wurmangler
Zanderangler
Sonstiges, was?
Keine Spezialisierung

Informationsquellen

14. Zur Information über Angelmöglichkeiten und -methoden sowie Gewässertipps stehen verschiedene Informationsquellen zur Verfügung. Wie häufig nutzen Sie die nachfolgend genannten Möglichkeiten. Nutzen Sie für die Bewertung die 5-stufige Skala von mache ich 1=„gar nicht", 2=„selten", 3=„regelmäßig", 4=„häufig" oder 5=„sehr häufig".

Internet
Angelfreunde
Angelverein
Berufsfischer
Gewässerkarten
Angelgerätehändler
Angelzeitschriften und -magazine
Landesanglerverband
Angelmessen
sonstige?

15. Mit wie vielen Angelfreunden tauschen Sie Fang- und Gewässertipps aus?

16. Wie häufig tauschen Sie mit Personen aus diesem Kreis Fang- und Gewässertipps aus?

täglich
wöchentlich
alle 14 Tage
monatlich
alle paar Monate

Fischartenpräferenzen (einheitliche Kodierung für Fragen 17-19)

17. Zum Abschluss würde ich gern noch von Ihnen erfahren, welche Fischarten für Sie am wichtigsten in M-V sind. Können Sie mir bitte in absteigender Reihenfolge Ihre 3 Lieblingsfischarten in M-V nennen.

Welches ist die wichtigste/zweitwichtigste/drittwichtigste Fischart?

18. Können Sie mir bitte in absteigender Reihenfolge die 3 Fischarten, die Sie am häufigsten in M-V beangeln, nennen.

Und welches ist die häufigste/zweithäufigste/dritthäufigste Fischart?

Appendix F. Angler Diary Trip Form (in German)

Please use one page for every angling trip

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

Fished Waterbody

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

Information about trip type and used gear

7. Who do you fish?	☐ Alone ☐ With family ☐ With friends ☐ Guide/Party boat	Number of the fishing person: ______
8. Angling location	☐ Natural shore ☐ Artificial shore ☐ Boat ☐ Commercial Party Boat	
9. Number of used rods per angling method	___ Pole fishing ___ Fish with death 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 Pikeperch
	___h Perch	___h Carp	___h Cyprinids
	___h Cod	___h Flatfish	___h Other species ________________
	___h Pike	___h Salmoniden (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 the harvest?	1 2 3 4 5 6 7 8 9 10 (totally dissatisfied) ← → (totally satisfied)

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

Dairy

LANDESFORSCHUNGSANSTALT FÜR LANDWIRTSCHAFT UND FISCHEREI – *INSTITUT FÜR FISCHEREI*

Appendix G. Eel Angler Survey with Discrete Choice Experiment (in German)

Wissenschaftliche Angelstudie Mecklenburg-Vorpommern 2006/2007

Fragebogen

Landesforschungsanstalt für Landwirtschaft und Fischerei M-V
Institut für Fischerei, Rostock

<u>Hintergrund</u>: Von der EU vorgeschlagene Maßnahmen zum Aalschutz

Für Sie als Angler ist der Aal eine wichtige Fischart und spielt bei der Gesamteinschätzung der Qualität des Angelns in Mecklenburg Vorpommern (M-V) sicherlich eine wesentliche Rolle. Die Europäische Union (EU) hat vor etwa einem Jahr ein Dokument vorgelegt, das Bewirtschaftungsmaßnahmen zum Aalbestandschutz vorschlägt. Diese denkbaren Maßnahmen, die derzeit europaweit diskutiert werden, betreffen neben einer Verbesserung der Durchgängigkeit von Fließgewässern, Steigerung des Fischbesatzes usw. auch mögliche geänderte Bestimmungen zum Aalangeln und für die Berufsfischerei auf Aal. Mit dem vorliegenden Fragebogen möchten wir mehr über das Aalangeln in M-V und die möglichen Folgen neuer Bestimmungen auf Ihr persönliches Angelverhalten erfahren. Ihre Antworten erlauben uns eine bessere Beurteilung der Konsequenzen geänderter Bewirtschaftungsmaßnahmen zum Aalangeln. Ziel der Umfrage ist es, die Auswirkungen bestimmter Managementmaßnahmen auf die Qualität der Angelei auf Aal in M-V abzuleiten.

<u>Hinweise zur Beantwortung</u>:

Bitte beantworten Sie die Fragen **der Reihe nach und spontan**. Nutzen Sie dabei die vorgegebenen Antwortmöglichkeiten bzw. setzen Sie pro Frage **ein Antwortkreuz**.

Einige Fragen können Sie vielleicht nicht beantworten. Bitte nutzen Sie in diesen Fällen die jeweils angegebene Antwortmöglichkeit „weiß nicht“.

Abschnitt 1 – Allgemeine Angaben zum Angeln auf Aal in Mecklenburg Vorpommern

1.1 Seit wann angeln Sie mindestens einmal pro Jahr mehr oder weniger gezielt auf Aal?

__________ (Bitte Jahreszahl angeben, z.B. 1985)

1.2. An wie vielen Tagen waren Sie im Jahr 2006 in M-V angeln?

__________ (ungefähre Anzahl der Angeltage)

1.3. An wie vielen Tagen haben Sie 2006 in M-V gezielt auf Aal geangelt?

__________ (ungefähre Anzahl der Angeltage auf Aal)

1.4. Wie viele Aale haben Sie im Jahr 2006 in M-V gefangen?

__________ (ungefähre Anzahl der gefangenen Aale)

1.5. Mit wem gehen Sie zum Aalangeln in M-V?

Zum Angeln auf Aal gehe ich …
(Bitte nur eine Aussage ankreuzen.)

immer allein	☐01
meistens allein	☐02
zur Hälfte allein und zur Hälfte mit Angelfreunden	☐03
meistens mit Angelfreunden	☐04
immer mit Angelfreunden	☐05

1.6. An welchem Gewässertyp in M-V angeln Sie am häufigsten gezielt auf Aal?
(Bitte nur einen Gewässertyp ankreuzen.)

Seen und andere stehende Gewässer	☐01
Küstengewässer	☐02
Bodden und Haffe	☐03
Fließgewässer	☐04
Kanäle	☐05
Sonstige: ______________________	☐06

1.7. Welche Köder benutzen Sie hauptsächlich zum Aalangeln in M-V?
(Bitte nur einen Köder ankreuzen.)

Wurm	☐01
Köderfisch	☐02
Fischfetzen	☐03
Andere Köder ______________________	☐04

1.8. Welche der folgenden Aussagen beschreibt am besten Ihre Köderauswahl beim Aalangeln in M-V?
(Bitte nur eine Aussage ankreuzen.)

Ich weiß genau, welchen Köder ich je nach Gewässer und Jahreszeit für den Aalfang benutzen muss, damit ich gezielt Aale fange.	☐01
Beim Aalangeln achte ich darauf, dass ich mit meinem gewählten Köder überwiegend Aale fange.	☐02
Beim Aalangeln wähle ich meinen Köder so, dass ich möglichst auch andere Fischarten fange.	☐03
Bei der Auswahl der Köder beim Aalangeln mache ich mir eigentlich keine großen Gedanken.	☐04

1.9. Wie beschaffen Sie sich Ihre Köder zum Aalangeln in M-V
(Bitte nur eine Aussage ankreuzen.)

Die Köder zum Aalangeln fange/sammle ich ausschließlich selbst.	☐01
Die Köder zum Aalangeln fange/sammle ich überwiegend selbst.	☐02
Die Köder zum Aalangeln kaufe ich überwiegend im Laden.	☐03
Das Verhältnis zwischen fangen/sammeln und kaufen der Köder ist bei mir in etwa gleich.	☐04

1.10. Welche der folgenden Aussagen beschreibt am besten Ihr derzeitiges Angelverhalten auf Aal in M-V?
(Bitte nur eine Aussage ankreuzen.)

Wenn ich auf Aal angle, weiß ich meistens genau, welche Angelmethode je nach Gewässer und Jahreszeit am erfolgreichsten ist.	☐01
Zum Aalangeln benutze ich in der Regel eine bestimmte Methode, die es mir erlaubt, gezielt Aale zu fangen.	☐02
Wenn ich auf Aal angle, stelle ich mich auf andere Fischarten als Beifang ein.	☐03
Die meisten meiner gefangenen Aale sind Beifänge, wenn ich auf andere Fischarten angle.	☐04

Abschnitt 2 – Wichtigkeit des Aals und des Aalangelns

2.1. Wie wichtig ist Ihnen persönlich der Aal im Vergleich zu anderen Fischarten, die Sie beangeln?

Von allen Fischarten, die ich beangle, ist der Aal meine …
(Bitte nur eine Aussage ankreuzen.)

wichtigste Fischart	☐01
zweitwichtigste Fischart	☐02
drittwichtigste Fischart	☐03
eine Fischart unter vielen	☐04

2.2. Nachfolgend finden Sie einige Aussagen über das Angeln auf Aal.
Bitte bewerten Sie die Aussagen mit der Skala „stimme stark zu“ bis „lehne stark ab“.

		stimme stark zu	stimme zu	neutral	lehne ab	lehne stark ab
1	Beim Angeln bevorzuge ich den Aal mehr als jede andere Fischart.	☐01	☐02	☐03	☐04	☐05
2	Die meisten meiner Freunde kenne ich durch das Aalangeln.	☐01	☐02	☐03	☐04	☐05
3	Wenn ich nicht mehr auf Aal angeln könnte, wüsste ich nicht, welche andere Fischart ich befischen sollte.	☐01	☐02	☐03	☐04	☐05
4	Ich würde mich selbst als einen Experten für das Aalangeln bezeichnen.	☐01	☐02	☐03	☐04	☐05
5	Verglichen mit anderen Anglern habe ich besonders gutes Angelgerät zum Aalfang.	☐01	☐02	☐03	☐04	☐05
6	Andere Angler könnten vielleicht behaupten, dass ich zu häufig auf Aal angle.	☐01	☐02	☐03	☐04	☐05
7	Aalangeln ist sehr wichtig für mich.	☐01	☐02	☐03	☐04	☐05
8	Das Aalangeln verschafft mir persönlich die größte Angelbefriedigung und den meisten Spaß.	☐01	☐02	☐03	☐04	☐05
9	Eine Einschränkung des Aalangelns würde mir nichts ausmachen.	☐01	☐02	☐03	☐04	☐05
10	Wenn jemand regelmäßig auf Aal angelt, sagt dies viel über diese Person aus.	☐01	☐02	☐03	☐04	☐05
11	Ich mag es, mit meinen Freunden über das Aalangeln zu fachsimpeln.	☐01	☐02	☐03	☐04	☐05
12	Strengere Bestimmungen zum Aalangeln würden dazu führen, dass ich das gezielte Aalangeln aufgeben würde.	☐01	☐02	☐03	☐04	☐05
13	Aalangeln interessiert mich kaum.	☐01	☐02	☐03	☐04	☐05
14	Bei erheblichen Einschränkungen des Aalangelns würde ich das Angeln komplett aufgeben.	☐01	☐02	☐03	☐04	☐05

2.3. Um mehr über die Wichtigkeit des Aals und Ihre Motivation für den Aalfang zu erfahren, bitten wir Sie die folgenden Aussagen zu bewerten.
Nutzen Sie hierbei die Skala „stimme stark zu“ bis „lehne stark ab“.

		stimme stark zu	stimme zu	neutral	lehne ab	lehne stark ab
1	Ein Angeltag auf Aal kann auch dann erfolgreich sein, wenn ich keinen Aal fange.	☐01	☐02	☐03	☐04	☐05
2	Ich angle in erster Linie auf Aal, um ihn später zu essen. Andere Gründe, wie Erholung, sind eher zweitrangig.	☐01	☐02	☐03	☐04	☐05
3	Ich würde lieber 1 oder 2 große Aale fangen als 10 kleine, zum Teil untermaßige Aale.	☐01	☐02	☐03	☐04	☐05
4	Ich angle gern auf Aal, weil er schwierig zu überlisten ist.	☐01	☐02	☐03	☐04	☐05
5	Normalerweise entnehme ich alle maßigen Aale, die ich fange.	☐01	☐02	☐03	☐04	☐05
6	Ich bevorzuge dort zu angeln, wo ich zumindest die Chance auf den Fang eines kapitalen Aals habe.	☐01	☐02	☐03	☐04	☐05
7	Gehe ich auf Aal angeln, bin ich erst zufrieden, wenn ich zumindest einen Aal gefangen habe.	☐01	☐02	☐03	☐04	☐05
8	Je mehr Aale ich fange, desto zufriedener bin ich.	☐01	☐02	☐03	☐04	☐05
9	Je größer der gefangene Aal, desto besser ist der Angeltag.	☐01	☐02	☐03	☐04	☐05
10	Ein Angeltag ist besonders gelungen, wenn ich einen herausfordernden Drill mit einem großen Aal erlebt habe.	☐01	☐02	☐03	☐04	☐05
11	Ich bin rundum mit einem Angeltag auf Aal zufrieden, wenn ich die Fangbegrenzung beim Aal (z.B. 3 Stück) erzielt habe.	☐01	☐02	☐03	☐04	☐05

2.4. Innerhalb der Angler in M-V herrschen unterschiedliche Sichtweisen über den Rückgang des Aals, dessen Ursachen und den möglichen Einfluss des Aalangelns vor.

Wir bitten Sie, Ihre Erfahrung mit dem Rückgang des Aals, Ihre Meinung über den Einfluss der Angelfischerei und mögliche Lösungsansätze durch die Bewertung der folgenden Aussagen wieder zu geben. Nutzen Sie hierbei die Skala „stimme stark zu“ bis „lehne stark ab“.

		stimme stark zu	stimme zu	neutral	lehne ab	lehne stark ab	**weiß nicht**
1	Meine Aalfänge sind in den letzten Jahren spürbar zurückgegangen.	☐01	☐02	☐03	☐04	☐05	☐06
2	Das gezielte Aalangeln lohnt sich seit Jahren nicht mehr.	☐01	☐02	☐03	☐04	☐05	☐06
3	Bei meinen Aalfängen konnte ich keinen deutlichen Rückgang in den letzen Jahren verzeichnen.	☐01	☐02	☐03	☐04	☐05	☐06
4	Die Aalbestände in M-V befinden sich in einem guten Zustand.	☐01	☐02	☐03	☐04	☐05	☐06
5	Angler können niemals so viele Aale entnehmen, dass dies zum Rückgang der Aalbestände in M-V beiträgt.	☐01	☐02	☐03	☐04	☐05	☐06
6	Dadurch, dass in M-V tausende von Anglern auf Aal angeln, könnte dies lokal zur Überfischung des Aalbestandes führen.	☐01	☐02	☐03	☐04	☐05	☐06
7	Angler können für den Rückgang des Aals nicht mitverantwortlich gemacht werden.	☐01	☐02	☐03	☐04	☐05	☐06
8	Durch die wachsende Zahl von Anglern in M-V steht immer weniger Aal pro Angler zur Verfügung.	☐01	☐02	☐03	☐04	☐05	☐06
9	Die Aalbestände in M-V sind aufgrund der Überfischung durch die Berufsfischerei zurückgegangen.	☐01	☐02	☐03	☐04	☐05	☐06
10	Durch den zurückgehenden Besatz ist der Aalbestand in M-V stark rückläufig.	☐01	☐02	☐03	☐04	☐05	☐06
11	Würde es zu einer Reduzierung der Kormoranbestände kommen, wären wieder mehr Aale in M-V für Angler vorhanden.	☐01	☐02	☐03	☐04	☐05	☐06
12	Durch Wasserkraftwerke und Verbauung der Wanderwege sind die Aalbestände in M-V zurückgegangen.	☐01	☐02	☐03	☐04	☐05	☐06
13	Die Aalbestände in M-V sind durch den Klimawandel zurückgegangen.	☐01	☐02	☐03	☐04	☐05	☐06

		stimme stark zu	stimme zu	neutral	lehne ab	lehne stark ab	**weiß nicht**
14	Sollte der Aalbestand weiter zurückgehen, sollten Angler ihr Angelverhalten darauf einstellen.	☐01	☐02	☐03	☐04	☐05	☐06
15	Eine Anhebung des Mindestmaßes beim Aal für Angler könnte helfen, dass zukünftig ein größerer Aalbestand beangelbar ist.	☐01	☐02	☐03	☐04	☐05	☐06
16	Strengere Bestimmungen zum Aalangeln tragen dazu bei, dass zukünftig mehr Aale aus M-V abwandern könnten.	☐01	☐02	☐03	☐04	☐05	☐06
17	Eine Begrenzung der erlaubten Rutenzahl für das Aalangeln würde zum Schutz des Aalbestandes beitragen.	☐01	☐02	☐03	☐04	☐05	☐06
18	Eine Einschränkung des Angelns auf Aal ist nicht geeignet, um die Anzahl abwandernder Aale zu erhöhen.	☐01	☐02	☐03	☐04	☐05	☐06
19	Die Einführung einer Schonzeit, würde dazu beitragen, dass zukünftig ein größerer Aalbestand beangelbar ist.	☐01	☐02	☐03	☐04	☐05	☐06
20	Der Aalbestand kann durch die Einführung bzw. Reduzierung der Fangbegrenzung für Angler geschützt werden.	☐01	☐02	☐03	☐04	☐05	☐06
21	Ich halte die derzeitigen Bestimmungen zum Aalangeln für völlig ausreichend.	☐01	☐02	☐03	☐04	☐05	☐06
22	Die meisten meiner Angelfreunde würden von mir erwarten, dass ich Maßnahmen zum Erhalt des Aalbestandes unterstütze.	☐01	☐02	☐03	☐04	☐05	☐06
23	Personen, die mir wichtig sind, würden von mir erwarten, dass ich den Erhalt des Aals mit unterstütze.	☐01	☐02	☐03	☐04	☐05	☐06
24	Ohne wirksame Maßnahmen besteht die Gefahr, dass künftig kein nutzbarer Aalbestand mehr für Angler in M-V zur Verfügung steht.	☐01	☐02	☐03	☐04	☐05	☐06
25	Ich halte die derzeitige Diskussion über den Zustand der Aalbestände für reichlich übertrieben.	☐01	☐02	☐03	☐04	☐05	☐06
26	Als Aalangler würde ich strengere Fangbestimmungen akzeptieren, wenn dafür zukünftig wieder mehr Aale vorhanden sind.	☐01	☐02	☐03	☐04	☐05	☐06
27	Bevor es zur Einschränkung des Aalangelns kommt, sollten zunächst andere Maßnahmen, z.B. Reduzierung des Kormoranbestandes, getroffen werden.	☐01	☐02	☐03	☐04	☐05	☐06

Abschnitt 3

Bei der Entscheidung Angeln zu gehen spielen ganz verschiedene Aspekte eine Rolle. Rufen Sie sich bitte kurz ins Gedächtnis, was Ihnen bei der Entscheidung für oder gegen einen Angelausflug wichtig ist.

Auf den folgenden Seiten werden Ihnen jeweils zwei unterschiedliche Angeltage auf Aal vorgestellt, bei denen sich sowohl die Fangmenge und Fangbestimmungen als auch die anfallenden Kosten unterscheiden.

Bitte gehen Sie davon aus, dass die angegebenen Fangmengen, Bestimmungen und Kosten zum Aalangeln tatsächlich gelten (auch wenn Sie die aufgeführten Merkmale für unrealistisch erachten).

Die veränderten Bestimmungen beziehen sich nur auf den Aal. Für andere Fischarten gelten die derzeitigen Bestimmungen.

Lesen Sie sich bitte sorgfältig die sich von Vergleich zu Vergleich unterscheidenden Merkmale zu den beiden Aalangeltagen durch. Entscheiden Sie danach, welchen der beiden Aalangeltage Sie bevorzugen würden (**Frage 1**).

Im Anschluss beantworten Sie bitte die **Frage 2**. Hierbei sind jeweils 10 Ihnen zur Verfügung stehende Tage auf verschiedene Zielfischarten unter der Annahme zu verteilen, dass für das **Aalangeln** die Bedingungen der zuvor in Frage 1 bevorzugten sowie nicht bevorzugten Angelvariante gelten.

Bitte beurteilen Sie die Angeltage einzeln und unabhängig voneinander.

Zur besseren Orientierung betrachten Sie bitte zunächst das folgende Beispiel.

Vorabfrage

3.1 Um Ihnen den Vergleich der beiden Angeltage zu erleichtern, bitten wir Sie, kurz zu überschlagen, welche Kosten für Sie bei einem typischen Angeltag auf Aal anfallen. Berücksichtigen Sie hierbei die Kosten für An- und Rückfahrt, Köder usw.

Für einen Angeltag auf Aal gebe ich durchschnittlich ca. _______ **€** aus. (Bitte eintragen)

3.2 Wie viele Kilometer (einfache Strecke) legen Sie dabei zu Ihrem hauptsächlich beangelten Aalgewässer zurück?

ca. _______ **km** (Bitte eintragen)

Beispiel

Beispiel

	Angeltag "Aal" A	Angeltag "Aal" B
Voraussichtlicher Aalfang		
Anzahl der Aale pro Angeltag	1 Aal	2 Aale
Mittlere Größe der Aale	50 cm	60 cm
Bestimmungen zum Aalangeln		
Mindestmaß	45 cm	45 cm
Fangbegrenzung pro Angeltag	2 Aale	1 Aal
Schonzeit pro Monat	7 Tage	14 Tage
Anzahl der erlaubten Ruten pro Angler	3 Ruten	1 Rute
Gesamtkosten für Aalangelausflug	5 € mehr	wie bisher
① Welchen der beiden Angeltage würden Sie bevorzugen? *Bitte nur einen auswählen!*	☒ Angeltag A	☐ Angeltag B

Hier bitte Ihren bevorzugten Angeltag ankreuzen!

② Wie würden Sie 10 Tage, an denen Sie Zeit hätten, Angeln zu gehen, auf die verschiedenen Angelmöglichkeiten verteilen. Bitte füllen Sie zuerst unter Annahme der obigen Bestimmungen für Ihren <u>bevorzugten Angeltag</u> und danach unter der Annahme der Bestimmungen für Ihren <u>nicht bevorzugten Angeltag</u> die nachfolgende Tabelle aus.

Bevorzugter Angeltag	Angelmöglichkeiten	Nicht bevorzugter Angeltag
4	**Angeltage auf Aal**	2
+ 2	**Angeltage im Binnenbereich auf Friedfisch**	+ 3
+ 1	**Angeltage im Binnenbereich auf Raubfisch**	+ 1
+ 1	**Angeltage im Binnenbereich - Fischart egal**	+ 1
+ 2	**Angeltage im Küstenbereich auf dort vorkommende Fischarten**	+ 2
+ 0	**Nicht Angeln gehen**	+ 1
= 10 Tage	**Gesamtsumme**	= 10 Tage

Hier bitte die Verteilung Ihrer Angeltage eintragen.

Vergleich 1

	Angeltag "Aal" A	Angeltag "Aal" B
Voraussichtlicher Aalfang		
Anzahl der Aale pro Angeltag	1 Aal	3 Aale
Mittlere Größe der Aale	55 cm	65 cm
Bestimmungen zum Aalangeln		
Mindestmaß	60 cm	45 cm
Fangbegrenzung pro Angeltag	1 Aal	2 Aale
Schonzeit pro Monat	7 Tage	Keine Schonzeit
Anzahl der erlaubten Ruten pro Angler	2 Ruten	1 Rute
Gesamtkosten für Aalangelausflug	10 € mehr	Wie bisher

(1) Welchen der beiden Angeltage würden Sie bevorzugen? *Bitte nur einen auswählen!*

☐ **Angeltag A**

☐ **Angeltag B**

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(2) Wie würden Sie 10 Tage, an denen Sie Zeit hätten, Angeln zu gehen, auf die verschiedenen Angelmöglichkeiten verteilen. Bitte füllen Sie zuerst unter Annahme der obigen Bestimmungen für Ihren bevorzugten Angeltag und danach unter der Annahme der Bestimmungen für Ihren nicht bevorzugten Angeltag die nachfolgende Tabelle aus.

Bevorzugter Angeltag	Angelmöglichkeiten	Nicht bevorzugter Angeltag
	Angeltage auf Aal	
+	**Angeltage im Binnenbereich auf Friedfisch**	+
+	**Angeltage im Binnenbereich auf Raubfisch**	+
+	**Angeltage im Binnenbereich - Fischart egal**	+
+	**Angeltage im Küstenbereich auf dort vorkommende Fischarten**	+
+	**Nicht Angeln gehen**	+
= 10 Tage	**Gesamtsumme**	= 10 Tage

MD 1:1-1

Vergleich 2

	Angeltag "Aal" A	Angeltag "Aal" B
Voraussichtlicher Aalfang		
Anzahl der Aale pro Angeltag	**3 Aale**	**4 Aale**
Mittlere Größe der Aale	**65 cm**	**60 cm**
Bestimmungen zum Aalangeln		
Mindestmaß	**50 cm**	**55 cm**
Fangbegrenzung pro Angeltag	**2 Aale**	**3 Aale**
Schonzeit pro Monat	**7 Tage**	**14 Tage**
Anzahl der erlaubten Ruten pro Angler	**2 Ruten**	**2 Ruten**
Gesamtkosten für Aalangelausflug	**2,50 € mehr**	**10 € mehr**

(1) Welchen der beiden Angeltage würden Sie bevorzugen?
Bitte nur einen auswählen!

☐ **Angeltag A** ☐ **Angeltag B**

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(2) Wie würden Sie 10 Tage, an denen Sie Zeit hätten, Angeln zu gehen, auf die verschiedenen Angelmöglichkeiten verteilen. Bitte füllen Sie zuerst unter Annahme der obigen Bestimmungen für Ihren <u>bevorzugten Angeltag</u> und danach unter der Annahme der Bestimmungen für Ihren <u>nicht bevorzugten Angeltag</u> die nachfolgende Tabelle aus.

Bevorzugter Angeltag	**Angelmöglichkeiten**	**Nicht bevorzugter Angeltag**
	Angeltage auf Aal	
+	**Angeltage im Binnenbereich auf Friedfisch**	+
+	**Angeltage im Binnenbereich auf Raubfisch**	+
+	**Angeltage im Binnenbereich - Fischart egal**	+
+	**Angeltage im Küstenbereich auf dort vorkommende Fischarten**	+
+	**Nicht Angeln gehen**	+
= **10 Tage**	**Gesamtsumme**	= **10 Tage**

MD 2:1-2

Vergleich 3

	Angeltag "Aal" A	Angeltag "Aal" B
Voraussichtlicher Aalfang		
Anzahl der Aale pro Angeltag	**2 Aale**	**1 Aal**
Mittlere Größe der Aale	**60 cm**	**55 cm**
Bestimmungen zum Aalangeln		
Mindestmaß	**45 cm**	**50 cm**
Fangbegrenzung pro Angeltag	**3 Aale**	**1 Aal**
Schonzeit pro Monat	**14 Tage**	**7 Tage**
Anzahl der erlaubten Ruten pro Angler	**3 Ruten**	**3 Ruten**
Gesamtkosten für Aalangelausflug	**Wie bisher**	**2,50 € mehr**

(1) Welchen der beiden Angeltage würden Sie bevorzugen?
Bitte nur einen auswählen!

☐ **Angeltag A**

☐ **Angeltag B**

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(2) Wie würden Sie 10 Tage, an denen Sie Zeit hätten, Angeln zu gehen, auf die verschiedenen Angelmöglichkeiten verteilen. Bitte füllen Sie zuerst unter Annahme der obigen Bestimmungen für Ihren <u>bevorzugten Angeltag</u> und danach unter der Annahme der Bestimmungen für Ihren <u>nicht bevorzugten Angeltag</u> die nachfolgende Tabelle aus.

Bevorzugter Angeltag	**Angelmöglichkeiten**	**Nicht bevorzugter Angeltag**
	Angeltage auf Aal	
+	**Angeltage im Binnenbereich auf Friedfisch**	+
+	**Angeltage im Binnenbereich auf Raubfisch**	+
+	**Angeltage im Binnenbereich - Fischart egal**	+
+	**Angeltage im Küstenbereich auf dort vorkommende Fischarten**	+
+	**Nicht Angeln gehen**	+
= **10 Tage**	**Gesamtsumme**	= **10 Tage**

MD 3:1-3

Vergleich 4

	Angeltag "Aal" A	Angeltag "Aal" B
Voraussichtlicher Aalfang		
Anzahl der Aale pro Angeltag	**4 Aale**	**2 Aale**
Mittlere Größe der Aale	**50 cm**	**50 cm**
Bestimmungen zum Aalangeln		
Mindestmaß	**55 cm**	**60 cm**
Fangbegrenzung pro Angeltag	**2 Aale**	**2 Aale**
Schonzeit pro Monat	**Keine Schonzeit**	**7 Tage**
Anzahl der erlaubten Ruten pro Angler	**1 Rute**	**2 Ruten**
Gesamtkosten für Aalangelausflug	**5 € mehr**	**5 € mehr**

① Welchen der beiden Angeltage würden Sie bevorzugen? *Bitte nur einen auswählen!*	☐ **Angeltag A**	☐ **Angeltag B**

② Wie würden Sie 10 Tage, an denen Sie Zeit hätten, Angeln zu gehen, auf die verschiedenen Angelmöglichkeiten verteilen. Bitte füllen Sie zuerst unter Annahme der obigen Bestimmungen für Ihren bevorzugten Angeltag und danach unter der Annahme der Bestimmungen für Ihren nicht bevorzugten Angeltag die nachfolgende Tabelle aus.

Bevorzugter Angeltag	**Angelmöglichkeiten**	**Nicht bevorzugter Angeltag**
	Angeltage auf Aal	
+	**Angeltage im Binnenbereich auf Friedfisch**	+
+	**Angeltage im Binnenbereich auf Raubfisch**	+
+	**Angeltage im Binnenbereich - Fischart egal**	+
+	**Angeltage im Küstenbereich auf dort vorkommende Fischarten**	+
+	**Nicht Angeln gehen**	+
= **10 Tage**	**Gesamtsumme**	= **10 Tage**

MD 4:1-4

Anschnitt 4 - Anmerkungen und Kommentare

Vielen Dank für das Ausfüllen des Fragebogens.
Bitte senden Sie den ausgefüllten Fragebogen im bereits frankierten Umschlag bis zum 10.5. 2007 zurück.

Sollte Ihrerseits Interesse an den Ergebnissen dieser Umfrage bestehen, bitten wir Sie dies durch die Angabe Ihrer Adresse bzw. E-Mail Adresse im obigen „Anmerkungsfeld" kenntlich zu machen. Wir würden Sie dann gerne über die Ergebnisse dieser Umfrage informieren.