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ARTICLE

The Human Dimensions of Recreational Anglers Targeting Freshwater Species in Coastal Ecosystems, with Implications for Management

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Abstract

Little is known about whether brackish coastal ecosystems attract specific angler types that are characterized by site-specific preferences and behaviors while targeting freshwater fishes living in a low-salinity environment. Using the lagoon ("Bodden") fisheries in northeastern Germany, we compared the human dimensions among anglers fishing in Bodden sites, anglers fishing primarily in freshwater sites, and other, less-setting-specialized anglers that use both marine and freshwater fisheries. Data were generated from a 1-year telephone–mail–diary study involving over 1,000 study participants. The general characteristics, demographics, specialization level, motives, catch orientation, and catch-and-release behaviors of the three angler groups were rather similar. However, when targeting specific freshwater fish (i.e., Eurasian Perch *Perca fluviatilis*, Northern Pike *Esox lucius*, and Zander [also known as Pikeperch] *Sander lucioperca*), the motives of anglers choosing the Bodden versus freshwater sites differed. Specifically, Bodden anglers targeting freshwater species in brackish waters were more catch oriented, trophy fish oriented, and challenge seeking compared to freshwater anglers. Bodden anglers were also more likely to fish with friends rather than alone compared to the other angler groups, and they were more likely to use motorboats and to take guides compared to freshwater anglers. Correspondingly, a revealed preference choice model showed that anglers expecting high catch outcomes and social experiences with friends and boat fishing were more likely to select the Bodden waters relative to freshwater sites. Additionally, anglers with a stronger orientation toward the noncatch, experience-based aspects of fishing were more likely to fish in the Bodden and coastal sites compared to freshwater, suggesting that coastal sites satisfy both catch- and non-catch-related expectations. We suggest that given their specific preferences and characteristics, Bodden anglers will be particularly sensitive to constraints imposed on using motorboats and to declines in catch rates and trophy sizes in the catch, specifically for Northern Pike.

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Fisheries management is as much about managing humans and their behavior as it is about managing fish or the supporting habitat (Ditton and Hunt 2001; Hilborn 2007a). In this context, addressing recreational fisheries as part of coastal and marine fisheries is increasingly important (Ihde et al. 2011; Hyder et al. 2018). Three key reasons play a role. First, in many countries, landings from recreational fisheries in coastal areas have been recognized as a relevant part of total fishing mortality (Coleman et al. 2004; Ihde et al. 2011; Radford et al. 2018). Second, the objectives of recreational and commercial fishers often differ (Caddy 1999; Hilborn 2007b), motivating research that offers insights into how to meet the aspirations of both sectors (Ahrens et al. 2020). Third, in several coastal ecosystems, the use of fish resources and space by commercial and recreational fishers has led to enduring conflict, particularly in small-scale coastal fisheries (Kearney 2001; Boucquey 2017).

To address the potential for conflicts around coastal fisheries resources, it is important to understand the nature of the user groups involved, including their goals, motivations, attitudes, and behaviors (Ditton and Hunt 2001; Arlinghaus 2005). Here, we focus on one specific group of users: namely, recreational fishers that exploit coastal and freshwater fish in lagoon ecosystems of northeastern Germany. Human dimensions researchers have developed an array of tools to understand the values, beliefs, norms, attitudes, and behaviors of recreational anglers, including the level of angler commitment (Bryan 1977; Scott and Shafer 2001; Beardmore et al. 2013), motives (Fedler and Ditton 1994; Manfredo et al. 1996), and the attitudes toward the catch and noncatch characteristics of an angling experience, referred to as "consumptive or catch orientation" in the literature (Aas and Vittersø 2000; Anderson et al. 2007). These tools can help us to understand how recreational anglers choose fishing sites and experiences (Pollock et al. 1994).

One key component of the human dimensions of anglers is understanding the determinants of site choice behavior. Research on angler site choice is well developed, mainly relying on variants of choice models using stated or revealed preference data (Morey et al. 1993; Hunt 2005; Johnstone and Markandya 2006). Hunt et al. (2019) recently reviewed the field and showed that anglers seek sites depending on a set of catch-related (e.g., expected catch rate or size of fish) and non-catch-related (e.g., environmental quality, facilities, type of regulations, costs) dimensions. Revealed preference studies have been declining in recent years (Hunt et al. 2019), although the benefit of these data is that they represent actual and not just hypothetical angler behavior.

Low-salinity coastal lagoons along the Baltic Sea in Europe have been colonized by freshwater top predators that are common in the Northern Hemisphere (e.g., Eurasian Perch *Perca fluviatilis*, Northern Pike *Esox lucius*, and Zander [also known as Pikeperch] *Sander lucioperca*; Olsson 2019). These freshwater fish use the brackish coastal sites as foraging habitat or have even undergone local adaptation to fulfill their full life cycle under oligohaline to mesohaline conditions (Jacobsen and Engström-Öst 2018). Inshore lagoon ecosystems with brackish water offer a suitable habitat for freshwater top predators for several reasons. First, these ecosystems may receive energy from marine food webs through spawning migrations of species such as spring-spawning Atlantic Herring *Clupea harengus*, which can foster growth (Winkler 1987; Nolan et al. 2019b). Moreover, due to the runoff from tributaries and the reduced exchange with seawater, many lagoons are eutrophic or even polytrophic, often shallow and thus polymictic, and hence productive in terms of fisheries yield (Winkler 1989, 1991). Indeed, the growth rate of freshwater top predators, such as Northern Pike, can be very high in coastal sites relative to the average freshwater site (Rypel 2012). Fast-growing predators in turn may constitute an attractive resource for those angler types that seek trophy fish.

Angler populations are highly heterogeneous, with different angler types seeking specific experiences (Bryan 1977; Fedler and Ditton 1986; Chipman and Helfrich 1988; Fisher 1997; Dorow et al. 2010). To understand whether angling experiences in brackish environments attract a specific subset of anglers or satisfy specific motivations and expectations, targeting the same set of species thriving in either freshwater or brackish waters offers an interesting model. Such research is pursued in the present paper to learn whether anglers targeting top predators in lagoon ecosystems are systematically different from their freshwater angler counterparts targeting the same top predators in freshwater ecosystems. For nonresidents of coastal communities, the effort to reach brackish sites is usually greater as one often needs to travel farther (Ditton et al. 2002) and have access to a boat or even rely on guides. These differences might attract a specific subset of anglers to brackish fishing sites, such as avid and specialized anglers who are more willing to invest the resources (Ditton et al. 1992; Oh and Ditton 2006) needed to fish for freshwater top predators in brackish environments.

In this paper, we study the specific case of the brackish lagoons around the island of Rügen in Germany, where the lagoons are named "Bodden" (Figure 1). As with most coastal fisheries, the Bodden are co-exploited by a small-scale, multispecies commercial fishery, as well as by recreational anglers (Arlinghaus et al. 2021), but no research on the human dimensions of recreational anglers exists for this region (Weltersbach et al. 2021). We start by comparing Bodden anglers to those who primarily fish in freshwater to understand whether the Bodden ecosystems attract a

specific subset of anglers. Angler heterogeneity is captured by within-angler characteristics, including angler specialization, general motives, catch orientation, angling skill, and education, as well as other characteristics, such as the equipment used, preferred fishing modes, angling club memberships, and social group. Next, we present data on the outcomes of the site choice behavior, specifically catch outcomes as well as release rates for typical target species present in the Bodden: Northern Pike, Eurasian Perch, Zander, Atlantic Herring, Atlantic Cod *Gadus morhua*, and Garfish *Belone belone*. Finally, we present a revealed preference site choice model that uses classical determinants of site choice in angling research (e.g., expected catch and travel distance) as well as underused measures of angler heterogeneity (i.e., motives and catch orientation) to predict site choice of the Bodden brackish ecosystems or coastal marine sites as opposed to freshwater sites.

STUDY SITE DESCRIPTION AND HYPOTHESES

To develop expectations about which aspect of angler heterogeneity or the expected fishing experience (e.g., expected size of the fish) should differ between anglers using the Bodden and those using freshwater sites, a brief description of the typical fishing conditions and modes of Bodden top predator fishing is needed. At the time this paper was written, the fishery was regulated by a mix of input and output controls. For the main commercial target species, Atlantic Herring and Atlantic Cod, as well as Atlantic Salmon *Salmo salar*, individual vessel quotas existed for commercial fishers only. Landings by recreational fishers were subject to daily bag limits of three fish for Northern Pike and Zander and five fish for Atlantic Cod (two fish during the spawning season). Minimum landing sizes were enforced for Northern Pike (50 cm), Eurasian Perch (20 cm), Zander (40 or 45 cm depending on location), and Atlantic Cod (35 cm) for both commercial and recreational fishers. Furthermore, Northern Pike and Zander were subject to protected seasons (March 1–April 30 and April 22–May 23, respectively). Brackish-water anglers in the Bodden typically fished using three modes: from small boats (guided or unguided), from shore using waders (guided or unguided), or from jetties or other harbor structures (typically unguided). Fishing from boats requires skills and resources, including knowledge of navigation and rules on the distance to maintain from other water users, protected zones (for conservation or other reasons), and meteorology (to avoid dangerous weather), as well as boat handling skills (typically acquired in the form of a license in Germany for boats >15 hp).

Depending on the commitment of the angler, he or she might own a private boat or might decide to rent a boat on location or book a guide. Boat ownership has previously been linked to specific fish- or fishing-related

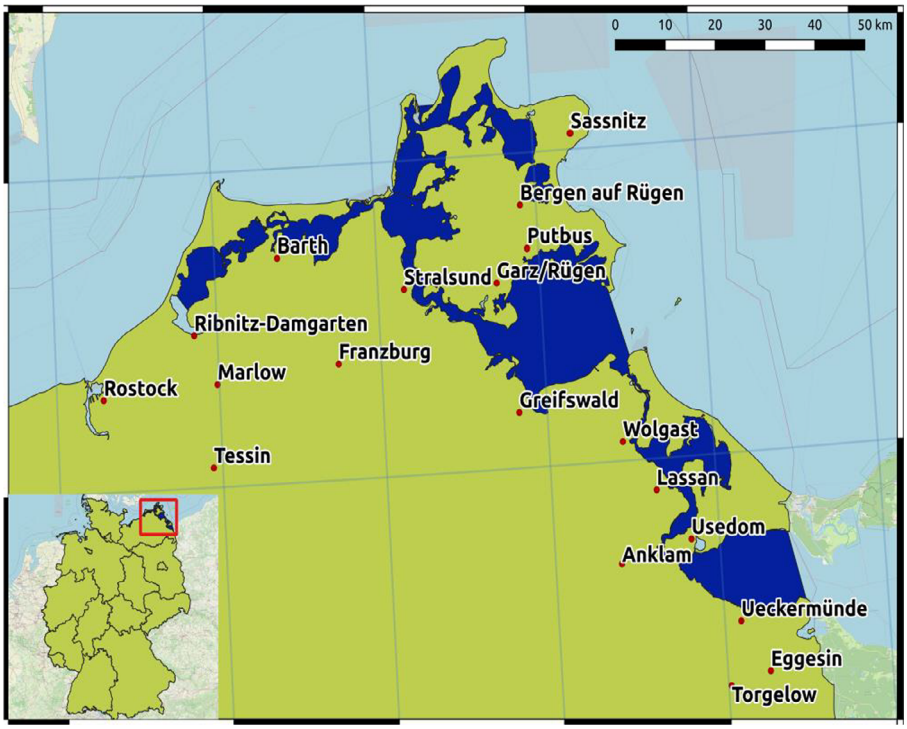

FIGURE 1. Map showing the locations of lagoon ("Bodden") water bodies (dark blue) in northeastern Germany. [Color figure can viewed at af sjournals.org.]

preferences by Morey et al. (2006), and we expected that the more committed and specialized fishers (in the spirit of Bryan 1977) would be more likely to choose Bodden sites over freshwater sites (hypothesis 1 [H_1]).

Moreover, the weather conditions of the Bodden can be quite harsh in the prime fishing season for Northern Pike and Zander, which is the autumn and winter, when strong winds and waves are not unusual. The entire Bodden system, including other inland brackish waters, spans about 1,900 km^2, and anglers required proper knowledge to find and target the fish. We thus expected that anglers exhibiting a high achievement or challenge motivation would be more likely to choose Bodden sites over freshwater sites (hypothesis 2 [H_2]).

The size of the top predators, specifically Northern Pike, was known among anglers to be quite large in the Bodden compared to nearby freshwater systems (Fuhrmann and Balkow 2013), which is why we expected that people being motivated by the size of the fish would be more likely to choose Bodden sites over freshwater sites when targeting species such as Northern Pike (hypothesis 3 [H_3]).

Finally, the social context of angling may further influence water body choice. Given whether an angler goes fishing alone, goes with friends or family, or hires an angling guide, he or she may have different preferences for safety, modes, infrastructure, and other amenities. The social context in which an angler prefers a specific type of experience has only been studied sparsely (e.g., Hunt and Ditton 1997) but has nevertheless been mentioned as a key determinant of site choice behavior (Pope et al. 2016; Kaemingk et al. 2018; Valdez et al. 2019). We expected that fishing in the Bodden was more likely to happen with a social group that was composed of fishing friends (as opposed to being alone or with families) given the challenge of fishing in harsh weather conditions typical of the Northern Pike fishing season (Kuparinen et al. 2010) and the need to fish from boats in many situations (H_4).

METHODS

Study design and sampling.— The target population in this study consisted of anglers who fished in the German state of Mecklenburg-Vorpommern (MV). This state offers a wide variety of freshwater, brackish, and coastal angling opportunities. Sampling for this study was conducted in 2006–2008 and was documented extensively by Dorow and Arlinghaus (2011). It included (1) a random-digit-dialing, Germany-wide screener (10,183 households) to sample nonresident anglers, combined with a representative sample from the state of MV (2,025 households) and holders of a fishing license for MV to sample residents (4,752 households); (2) a postscreener telephone recruitment to the diary study; (3) a pre-diary mail-out survey to diary participants and nonparticipants; (4) a full-year diary study with four reminders by telephone and elicitation of additional angler characteristics, attitudes, and motives (of 1,121 initial participants, 648 participants recorded at least one trip); and (5) an additional comprehensive questionnaire on angler characteristics, motives, and attitudes, which was mailed out in October 2008 and described in detail by Beardmore et al. (2011, 2013) and Beardmore (2013). Diarists were incentivized by provision of (1) a reel at the end of the diary study, (2) studywide and personal reports provided with the follow-up survey, and (3) a lure provided upon completion of the follow-up survey. Respondents who were recruited into the diary study were asked to keep a diary on every fishing trip within the study year. Records included (1) start and end of the fishing trip; (2) type of water body (e.g., freshwater, Bodden, or coastal/marine); (3) social group (alone, with friends, with family, or with a professional guide); (4) fishing mode (fishing from shore or from a boat); (5) fishing methods; and (6) target fish and number of hours fished. Furthermore, catch outcomes, fish retained, and the length of the longest fish retained were recorded for each species.

Centrality, angling motives, and catch orientation.— Angler characteristics can be described by concepts that are well established in the outdoor recreation and leisure science literature, and typical concepts measured in recreational fishing studies include centrality to lifestyle as a measure of psychological commitment (a subdimension of specialization; Bryan 1977; Beardmore et al. 2013), motivations (Fedler and Ditton 1994), and catch orientation (Aas and Vittersø 2000).

Centrality to lifestyle has been a frequently used measure to describe an individual's commitment (Sutton 2003; Beardmore 2013). Originating from consumer research (e.g., product involvement), it has been adapted by Kim et al. (1997) and others to the recreation context. Commitment in the context of leisure is defined as "those personal and behavioral mechanisms that bind individuals to consistent patterns of leisure behavior" (Kim et al. 1997:323). For the recreational fishing context, the centrality-to-lifestyle scale was adapted by Sutton (2003) and has been considered a suitable measure of the psychological commitment dimension of the multidimensional specialization construct (Scott and Shafer 2001; Beardmore 2013). We measured the anglers' centrality to lifestyle using seven items from Sutton's original scale (Appendix Table A.1) and obtained a Cronbach's α of 0.85. All items were averaged to create an individual-specific centrality-to-lifestyle index.

Motivations are described as the underlying forces that act on a tendency to engage in an activity with an expected outcome (Atkinson 1969). Angler motives can be divided into (1) motives directly related to the activity of fishing (also referred to as catch-related or activity-specific motives; e.g., catching many or large fish) and (2) motives

related to more general characteristics of the outdoor recreational activity (noncatch or activity-general motives: e.g., being outside, enjoying nature, or socializing; Hendee 1974; Driver and Knopf 1976; Fisher 1997). Noncatch motives can be satisfied by any outdoor recreation activity, not necessarily fishing (Finn and Loomis 2001). While early studies emphasized the role of noncatch motives as primary drivers behind the recreational fishing activity (e.g., Driver and Knopf 1976; Fedler and Ditton 1994), more recent research has focused on the catch-related aspects of angling motives (Finn and Loomis 2001; Beardmore et al. 2011). Fedler and Ditton (1994) separated angler motives further and identified five specific categories of motivations: general psychological and physiological, natural environment, social, fishery resource, and skill and equipment. A more fundamental categorization provided by Manfredo et al. (1996) assumes that aspects such as catching fish do not represent an underlying motive but rather a means to reach more fundamental expected psychological outcomes (e.g., achievement).

Measurement scales for assessing motives in outdoor recreation were originally developed by Driver and colleagues in the 1970s (Driver and Knopf 1976; Driver 1977; Driver and Cooksey 1977; Manfredo et al. 1996). For our study, we used a 10-item angling motive scale based on Finn and Loomis (2001) and presented in detail by Beardmore et al. (2011). The item list included seven catch-related motives (e.g., catching large fish, catching many fish; Finn and Loomis 2001; Sutton 2007) as well as three non-catch-related motives (to be with friends/family, enjoying nature, and enjoying solitude; see Beardmore et al. 2011 for more information on the selection of items). Anglers were asked about the importance of the specific motive for going angling in MV, with answers on a five-point scale ranging from "not at all important" to "very important." As our goal was to uncover an underlying latent structure of these motives in this new context and because we did only use a selection of published motivational items, we used exploratory factor analysis with varimax rotation (Revelle 2019) rather than confirmatory factor analysis (e.g., Finch and French 2015). The number of factors was determined using parallel analysis. Items with loadings less than 0.4 were removed until a reasonable specification was found. The final specification consisted of three latent factors (trophy, challenge, and consumptive motives; Table 1) and three single items (to experience nature [Nature], to enjoy solitude [Solitude], and to socialize with friends/family [Socialize]). To facilitate further analyses, indicators were calculated by averaging item values related to each factor or, in the case of single items, we kept the item score. A general summary of all items is presented in the Appendix (Table A.2).

In addition to the assessment of general motives for angling in MV, in a follow-up survey after having completed a 1-year diary, respondents were confronted with personal trips documented in their diary recordings and were asked which single motive was most important for a specific target fish × location combination (i.e., context; see Beardmore et al. 2011 for details). Each respondent was presented with up to nine species × location combinations from trips they had taken in the previous season as reported in diaries (Beardmore et al. 2011). For our analysis, we extracted the water body type from the location to specifically compare the context-specific motives for taking freshwater or Bodden trips for the same freshwater species. We specifically studied combinations of location and target species that focused on Northern Pike, Eurasian Perch, and Zander, as they are typical freshwater predators that are frequently targeted in both water body types.

While general motives describe an angler's predisposition for an expected outcome (Manfredo et al. 1996), catch orientation is an attitude and therefore an evaluation of catch-related characteristics of angling (Anderson et al. 2007). Although not a motive, the attitude toward the catch can be regarded as a measure of how relevant certain catch outcomes are in the experience of recreational fishing (Aas and Vittersø 2000; Anderson et al. 2007; Schroeder and Fulton 2013). Catch orientation is a multidimensional construct, and previous research has identified four subdimensions: (1) catching something, (2) catching many fish, (3) catching big/trophy fish, and (4) keeping (or releasing) fish (Aas and Vittersø 2000;

TABLE 1. Results from a factor analysis with varimax rotation on general angling motives for anglers in Mecklenburg-Vorpommern, Germany.

Motive statement	Challenge	Catch/ consumption	Trophy
To catch a trophy fish	0.323		0.801
To master fishing's challenges	0.623		
To catch as many fish as possible		0.511	0.42
To stock the freezer for future meals		0.621	
To experience a challenging fight with a fish	0.55		0.303
To obtain fresh fish for a single meal with family/friends		0.541	
To outwit a fish	0.855		
Sum of squared loadings	1.601	1.082	1.023
Proportion of variance explained	0.229	0.155	0.146

TABLE 2. Results from a factor analysis with varimax rotation on catch orientation items for anglers in Mecklenburg-Vorpommern, Germany.

Item	Catch many and trophy fish	No catch
A fishing trip can be successful even if no fish are caught		0.601
When I go fishing, I'm just as happy if I don't catch fish		0.883
I like to fish where I know I have a chance to catch a trophy fish	0.514	
The bigger the fish I catch, the better the fishing trip	0.718	
The more fish I catch, the happier I am	0.540	
I would rather catch 1 or 2 big fish than 10 smaller fish	0.412	
Sum of squared loadings	1.253	1.218
Proportion of variance explained	0.209	0.203

Anderson et al. 2007; Schroeder and Fulton 2013). Catch orientation in this study was measured using an abbreviated eight-item, five-point agreement-to-disagreement Likert scale (see Table A.3). As the items were translated into German with slight variations in wording compared to those previously used by Aas and Vittersø (2000) and others (e.g., Anderson et al. 2007) to reflect the German cultural context, and because we used a reduced number of items compared to the original scale, we re-examined the latent structure of catch orientation using factor analysis with varimax rotation. Two latent factors (named "catch many and trophy fish" and "no catch") were identified (Table 2) along with two single items (I go fishing for my personal consumption [Consumption] and I release most of caught fishes [Release orientation]). As with motivations, items were only kept if loadings were greater than 0.4. Similar to the motivation scale, we computed average values of the items within each factor and used the item scores for single items. A general summary of all items is presented in the Appendix (Table A.3).

Describing angler heterogeneity.— We split our sample into three different angler groups in an ad hoc fashion based on revealed water body choice from the diary data set. Anglers with 80% or more of trips to inland water bodies (i.e., natural and artificial lakes, ponds, creeks, and streams) were named "inland specialists." Anglers with more than 20% of trips going to Bodden water bodies were named "Bodden anglers." Finally, the remaining anglers with no clear preference according to our definition were named "mixed anglers." While this definition is admittedly arbitrary, it produced sample sizes that were large enough to warrant meaningful interpretation of results. Given this definition, we compared various angler characteristics along the lines of demographics (age and education) and commitment (number of angling trips, self-perceived skill, club membership, centrality, and boat ownership). Finally, we also compared measurements of general motives based on motive scales as well as the dimensions of catch orientation, as elaborated above. Comparisons between the angler types were conducted using the Kruskal–Wallis test and appropriate post hoc tests (Dunn's test). Categorical variables (e.g., boat ownership) were compared over angler types by using chi-square tests and the associated post hoc tests. Differences were interpreted as significant if P-values were less than 0.10.

Discrete choice model.— As above, we categorized the water body of each trip into freshwater, Bodden, and coastal/marine types. This constituted our categorical dependent variable in a discrete choice model estimated from the revealed preference data in the diaries. For each trip, we observed a number of trip-specific and person-specific explanatory variables. In the discrete choice literature, the random utility model (McFadden 1974; Louviere et al. 2000; Train 2009) is commonly employed to conceptualize an individual's decision. Individuals are assumed to maximize their utility, $u()$. A researcher, however, will only observe a part of the characteristics that drive the decision; therefore,

$$u_{ij} = v_{ij} + \varepsilon_{ij}, \tag{1}$$

where i indexes the individual and j indexes the chosen water body type. Stochasticity may enter the model through unobserved variables as well as measurement error and preference heterogeneity. We conceptualize v to be a function of trip-specific and individual-specific characteristics x: that is, $v_{ij} = \sum_k \beta_{jk} x_{ik}$, where β are parameters to be estimated. Estimation of parameters requires choosing an appropriate distribution for the unobserved error term in equation (1). Choosing an extreme value type 1 distribution leads to the convenient and easily estimable functional form of the probability of choosing a water body type k for fishing: $P(wb = k) = \frac{e^{v_k}}{\sum_j e^{v_j}}$. For the case in which explanatory variables vary over individuals and choice occasions but not over alternatives, the multinomial logit model can be used to estimate alternative-specific parameters of the utility function (Verbeek 2008). To be identified, the multinomial logit model requires the utility of one of the alternatives to be used as a reference by setting it to an arbitrary number (e.g., zero; Verbeek 2008:299). Utility from the nonreference alternatives is then interpreted in contrast to this reference alternative.

A key limitation of the ordinary multinomial logit model is the assumption of homogeneous preferences across individuals. By allowing parameters to vary, we can account for preference heterogeneity—that is, the marginal utility associated with a characteristic may follow some random distribution. If it can be reasonably assumed that the parameter can be positive or negative and is symmetric around a mean, the β_i are typically assumed to follow a normal distribution. The resulting model, referred to as the random parameters logit (RPL) model, can be estimated by simulation (Train 2009). The likelihood is expressed as

$$L = \prod_{ni} P_{ni} = \prod_{ni} \int \left(\frac{e^{\beta_i x_{ni}}}{\sum_j e^{\beta_j x_{nj}}} \right) f(\beta) d\beta, \tag{2}$$

which is simply the product over all individuals and choice occasions n over the integral over all possible values of the heterogeneous preferences β. For further details, we refer the reader to Train (2009).

We estimated two separate models. First, we estimated an RPL model assuming that the parameters for Bodden and coastal angling site choice are equal except for alternative-specific constants (ASCs; model 1). Second, we estimated separate parameters for each alternative (i.e., a full set of parameters for Bodden angling and coastal/marine angling, respectively; model 2).

The explanatory variables for this estimation required some choices. Our specification had three alternatives: freshwater trip, Bodden trip, and coastal/marine trip. As explained above, to be identified, one alternative must be chosen as a reference alternative, whereas the other two alternatives are interpreted relative to the reference alternative. It is important to note that not all activities can be pursued in all three water body types (e.g., one cannot catch marine fish in freshwater sites). We therefore focused on in-person characteristics (catch orientation and motivations) as well as the trip-specific variables Euclidean distance, season, and fishing platform (from boat versus other). In addition, while theoretically possible, our empirical data suggested that only three guided trips were taken in freshwater environments. For the choice model, the four levels of the social context variable (i.e., alone, with family, with friends, and with guide) were reduced to three by combining "with friends" and "with guide" into "with friends or guide" to facilitate the estimation and mitigate convergence issues. Within the block of angling motives, trophy and challenge motives were highly correlated, so we removed the challenge motive from the estimation.

An important component of the utility function related to fishing site choice is the number of fish expected to be caught on a given trip (Hunt et al. 2019). This catch per trip may be influenced by many factors, including the stock size, fishing mode and gear, angler skill and experience, tides, and weather, among others (McConnel et al. 1995). McConnel et al. (1995) demonstrated how to estimate this number using Poisson models and thereby derived a measure of an expected catch for each angling trip. In our application, we use the mean catch per day from a single trip computed from the diary data as a proxy for fishing success, which may be any number (including nonintegers) on the interval $(0, \infty)$. A convenient distribution to model this interval is found with the zero-adjusted gamma model (ZAGA; Stasinopoulos et al. 2017). We therefore estimated a ZAGA model to explain the expected CPUE using various angler characteristics and target fish of a particular trip. Subsequently, we added the trip-specific fitted value of the ZAGA catch model as expected CPUE to our site choice model. Parameter estimates of the ZAGA model are shown in the Appendix (Table A.4).

In the empirical specification, all explanatory variables (including the expected catch rate and distance) were the same across alternatives, thereby requiring the estimation of alternative-specific parameters. In other words, we assumed that the angler chooses the water body after all characteristics of and expectations about the trip are fixed. As all parameters reflect preferences for attributes relative to taking a freshwater trip, it is intuitive to choose a symmetric distribution that can take both positive and negative values, including zero. This means that for some anglers, a given variable can make it more likely to choose the nonreference alternative over the reference alternative (i.e., the parameter has a positive sign), while for others, this variable makes it more likely to choose the reference (i.e., the parameter has a negative sign) or this variable does not affect the probability (the parameter is zero). For the present paper, we chose the normal distribution for all parameters, which is widely used (Train 2009). Choice analysis was conducted in the software package PandasBiogeme (Van Rossum and Drake 2009; Bierlaire 2018) using a panel RPL model with 500 normal draws. To facilitate the estimation, expected CPUE values were scaled by 1/100 and indicators based on Likert scales (motives and catch orientation) were scaled by 1/10. All data handling and comparative analysis procedures were conducted in R (R Core Team 2020) using the package psych (Revelle 2019); the tidyverse packages dplyr (Wickham et al. 2020), ggplot (Wickham 2016), and haven (Wickham and Miller 2019); and the package rstatix (Kassambara 2020).

RESULTS

General Angler Characteristics

Regarding angling avidity, inland specialists were found to take significantly more trips in a year than Bodden anglers

(23 versus 18 on average, $P < 0.001$; Table 3). However, all angler groups seemed to attach similar importance to their hobby, as was revealed from a comparison of the centrality-to-lifestyle index ($P = 0.207$). Membership in angling associations also did not differ significantly among the angler groups ($P = 0.196$), but inland specialists were more likely to be members of local angling clubs than were Bodden anglers (61% versus 45%, $P = 0.003$). Regarding boat ownership, inland specialists were more likely than Bodden anglers to own a rowboat, while Bodden anglers were more likely than inland specialists to own a motorboat with an engine under 5 hp (Table 4). All angler types were of similar average age (Table 3; $P = 0.990$), and the distribution of education levels was also similar across angler types ($P = 0.333$).

In relation to social group, Bodden anglers would go with friends (46%), alone (31%), or with family (18%) or would take a guide (4%). Inland specialists were more likely to go alone (52%) compared to going with friends (30%) or family (16%) and almost never took a guide (0.4%). Finally, mixed anglers would most likely go with friends (47%) compared to going alone (28%), with family (15%), or with a guide (8%; Table A.5).

The Kruskal–Wallis test revealed significant differences for all social contexts except for "going with family" (Table A.6). Specifically, post hoc tests showed that inland specialists were more likely to go alone compared to Bodden anglers and mixed anglers. However, inland specialists were less likely to go with friends compared to Bodden anglers and mixed anglers. Finally, taking a guide or a charter boat was less likely with inland specialists compared to Bodden anglers and mixed anglers, whereas Bodden anglers were more likely to hire a guide than were mixed anglers (Table A.7).

General Motives and Catch Orientation

Angler motives were largely similar among the three angler groups (Table 5). All angler groups scored high on the nature motive and low on the catch/fish consumption motive. Kruskal–Wallis tests for each item or domain revealed differences in only two motives between Bodden anglers and inland specialists—namely in socializing ($P = 0.0798$) and seeking solitude ($P < 0.01$). Socializing was more important to Bodden anglers compared to inland specialists, while inland specialists were more motivated by seeking solitude.

Regarding catch orientation, the attitudes toward catching trophy/many fish were significantly more pronounced among Bodden anglers than among inland specialists ($P = 0.067$). All other items and latent constructs did not reveal significant differences among the angler groups (Table 5).

Context-Specific Angling Motives

The context-specific motives were quite different among target species and showed some relationships with water bodies. Figure 2 shows the distribution of the relative frequency of each context-specific angling motive by target species (Eurasian Perch, Northern Pike, and Zander) and water body type (Bodden or freshwater).

The most important motive for catching Eurasian Perch in a Bodden context was to master fishing-related challenges (40% versus 7% in the freshwater context), while in a freshwater context more than 30% of targeted effort toward Eurasian Perch was mainly driven by the desire to obtain a fresh fish for a single meal with family or friends (<5% in a Bodden context). Additionally, more than 20% of targeted effort toward Eurasian Perch in the Bodden was driven by the desire to catch a trophy fish (12% in the freshwater context). Experiencing nature drew 20% (freshwater) or 16% (Bodden) of trips targeting Eurasian Perch.

By contrast, Northern Pike trips were mainly driven by the trophy motive in both freshwater (28%) and Bodden (34%) contexts. A close second motive for targeting Northern Pike in Bodden water bodies was the desire to master fishing-related challenges (23% versus 12% in freshwater). Further important motives were to experience a challenging fight with Northern Pike (15% in the Bodden; 14% in freshwater), to stock the freezer for future meals (15% in the Bodden), and to experience nature (16% in freshwater).

Finally, Zander in a freshwater context was mostly targeted for the challenge (36% versus 24% in the Bodden), while in the Bodden context experiencing nature was most often mentioned (35% versus 3% in

TABLE 3. Results from group comparison of angler characteristics (N = 648). Comparisons were tested using Kruskal–Wallis tests (including a Dunn's test for post hoc pairwise comparisons with P-value corrections; dissimilar letters [z, y] indicate significance). Significance of post hoc tests is expressed at the 0.10 level; α is Cronbach's alpha.

	Inland specialist		Bodden anglers		Mixed angler		
Variable	Mean	SD	Mean	SD	Mean	SD	P-value
Number of trips	22.6 z	19.1	14.7 y	12.0	18.3 zy	15.8	<0.001
Centrality to lifestyle (α = 0.85)	3.53	0.764	3.68	0.790	3.50	0.803	0.2071
Age in years	45	16	45	13	45	14	0.990

TABLE 4. Results from group comparison of angler characteristics ($N = 648$). Comparisons were tested using chi-squared tests including post hoc tests for categorical variables; dissimilar letters (z, y) indicate significance. Significance of post hoc tests is expressed at the 0.10 level. DAV and VDSF refer to two angler associations (Deutscher Anglerverband (DAV) and Verband Deutscher Sportfischer [VDSF]).

	Inland specialist		Bodden angler		Mixed angler		
Variable	*n*	%	*n*	%	*n*	%	*P*-value
Membership in angling association							0.1958
DAV	161	41	61	34	24	34	
VDSF	62	16	21	12	12	17	
DAV and VDSF	33	8	12	12	4	6	
No membership	138	35	83	47	30	43	
Total	394	100	177	100	70	100	
Member in local angling club	224	61 z	61	45 y	33	53 zy	0.0028
Boat ownership							0.0170
No boat	189	52	79	57	32	52	
Rowboat	85	23 z	23	17 y	4	6 zy	
Motorboat, <5 hp	24	7 z	12	9 y	11	18 y	
Motorboat, ≥5 hp	41	11	17	12	10	16	
Other boat	27	7	8	6	5	8	
Total	366	100	139	100	62	100	
Education							0.3332
Secondary school	13	3	2	1	1	1	
Apprenticeship	87	22	41	23	11	15	
Comprehensive school	178	45	83	47	31	44	
A-levels	27	7	9	5	5	7	
University	65	17	38	21	19	27	
School student	23	6	5	3	4	6	
Total	393	100	178	100	71	100	

TABLE 5. Comparison of general angling motives and catch orientation across three angler types. The *P*-values indicate significance of a Kruskal–Wallis test. Dissimilar letters (z, y) indicate significant differences between angler groups (Dunn's post hoc tests at the 0.10 level), and α is Cronbach's alpha.

	Inland specialists			Bodden anglers			Mixed anglers			
Motive or orientation	*n*	Mean	SD	*n*	Mean	SD	*n*	Mean	SD	*P*-value
General motives										
Catch/consumption ($\alpha = 0.63$)	282	2.6	0.9	131	2.7	0.9	50	2.5	0.8	0.4561
Challenge ($\alpha = 0.76$)	282	3.1	1.1	132	3.1	0.9	50	2.8	1.0	0.2743
Nature	292	4.5	0.9	133	4.3	1.0	51	4.2	1.2	0.1548
Socializing	285	3.3 z	1.3	132	3.6 y	1.1	50	3.3 zy	1.3	0.0798
Solitude	290	3.6 z	1.2	131	3.0 y	1.3	51	3.0 y	1.1	<0.001
Trophy	285	2.8	1.3	132	2.7	1.2	50	2.7	1.2	0.636
Catch orientation										
Consumption	365	2.1	1.1	166	2.0	1.1	67	2.0	1.0	0.4813
No-catch orientation ($\alpha = 0.7$)	364	2.0	0.8	166	2.0	0.8	67	2.1	0.9	0.7137
Release orientation	364	3.1	1.2	166	3.0	1.1	67	3.1	1.14	0.4057
Trophy/catch many fish ($\alpha = 0.63$)	364	2.3 z	0.8	165	2.5 y	0.8	67	2.4 zy	0.7	0.06733

freshwater). Catching a trophy fish drew 23% in freshwater and 18% in Bodden water bodies. Stocking the freezer was important in the Bodden context (14%) but not in freshwater, whereas outwitting a fish was more often deemed important in freshwater (14%) compared to the Bodden (8%).

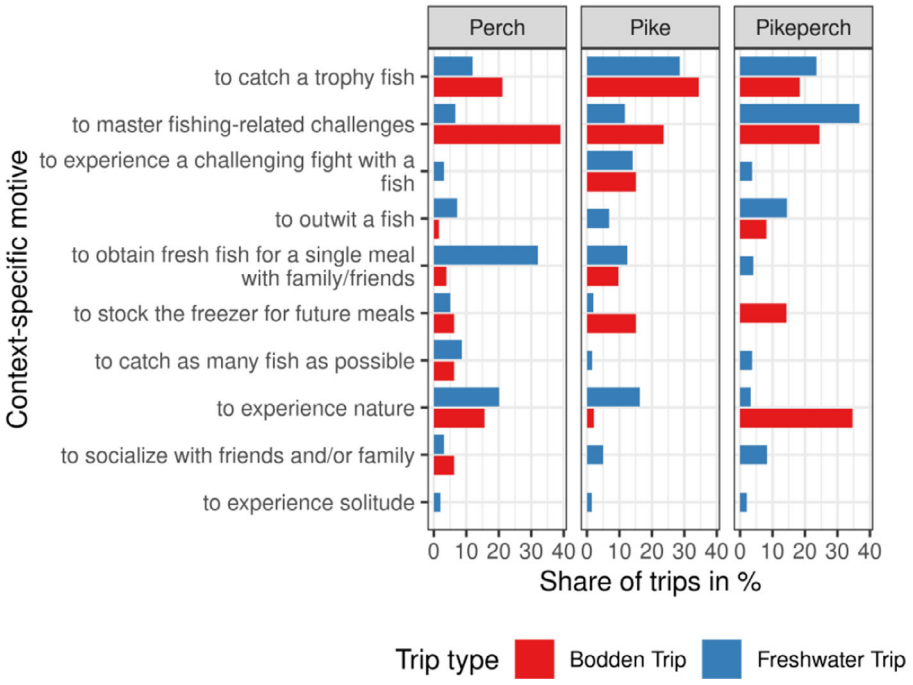

FIGURE 2. Distribution of context-specific angling motives by target species (Eurasian Perch [Perch], Northern Pike [Pike], and Zander [Pikeperch]) and water body type. Respondents were confronted with an actually taken trip from the diary study and were asked what the most important motive for that trip was. Represented is the share (%) of trips with a given main motive by species. [Color figure can viewed at afsjournals.org.]

TABLE 6. Average catches (fish/trip) by angler type and target fish species. The *P*-values indicate significance of a Kruskal–Wallis test. Dissimilar letters (z, y) indicate significant differences between angler groups (Dunn's post hoc tests at the 0.10 level).

	Inland specialists			Bodden anglers			Mixed anglers			
Target fish	*n*	Mean	SD	*n*	Mean	SD	*n*	Mean	SD	*P*-value
Northern Pike	326	1.0	1.0	112	1.2	1.1	53	1.1	0.9	0.186
Eurasian Perch	305	6.4	6.2	99	5.7	6.6	53	8.1	9.0	0.794
Zander	154	0.6 y	0.9	51	0.7 z	1.0	35	1.0 y	1.3	0.014
Atlantic Herring	82	76.6 zy	115	103	47.7 z	48.1	46	69.2 y	59.8	0.014
Atlantic Cod	86	5.9 zy	6.5	159	5.6 z	5.5	34	4.2 y	5.3	0.08
Garfish	29	10.5	11.2	64	10.2	11.5	37	13	10.5	0.361

Species-Specific Catch Rates and Catch-and-Release Behavior

We compared the catch rates and catch-and-release behavior across six target species (Northern Pike, Eurasian Perch, and Zander as typical freshwater predators; Atlantic Herring, Atlantic Cod, and Garfish as marine species) at the average trip level (i.e., total annual catches independent of location divided by total annual days fished by an angler). In this analysis, we only included trips that targeted a certain species.

Catches.— Overall, average targeted catch rates were similar across angler groups for Northern Pike and Eurasian Perch, showing, for example, a mean of around one Northern Pike per targeted Northern Pike angling day (Table 6). By contrast, catches of Zander (a low-catch-rate species) by Bodden anglers were significantly higher than those of inland specialists. Targeted catch rates of Atlantic Herring (a high-catch-rate species) were significantly lower for Bodden anglers than for mixed anglers, but no significant difference was found relative to inland specialists when they fished marine sites. Similarly, Bodden anglers seemed to catch more Atlantic Cod (5.6 fish/trip) on a targeted Atlantic Cod trip than did mixed anglers (4.2 fish/trip) but statistically caught the same amount as inland specialists.

Catch-and-release rates.— Release rates ranged from 2% (Garfish caught by Bodden anglers) to 44% (Eurasian

TABLE 7. Average catch-and-release rates by angler type and target fish species. The *P*-values indicate significance of a Kruskal–Wallis test. Dissimilar letters (z, y) indicate significant differences between angler groups (Dunn's post hoc tests at the 0.10 level).

	Inland specialists			Bodden anglers			Mixed anglers			
Target fish	*n*	Mean %	SD	*n*	Mean %	SD	*n*	Mean %	SD	*P*-value
Northern Pike	327	35	30	61	26	29	104	34	35	0.111
Eurasian Perch	305	44	34	57	36	31	95	40	34	0.262
Zander	154	24	34	42	35	35	44	41	44	0.076
Atlantic Herring	82	3	16	60	5	19	89	6	20	0.464
Atlantic Cod	86	15 z	23	52	17 zy	22	141	20 y	22	0.022
Garfish	29	5 zy	19	44	2 z	11	57	10 y	26	0.020

Perch caught by inland specialists). In general, the marine fish (Atlantic Herring, Atlantic Cod, and Garfish) were less often released compared to the freshwater predators; among the freshwater fish, Northern Pike and Eurasian Perch were released more often than Zander (Table 7). A Kruskal–Wallis test revealed significant differences in catch-and-release behavior among angler groups for Zander, but post hoc tests revealed no significant differences after correcting *P*-values in pairwise comparisons. For Atlantic Cod, inland specialists had a slightly lower release preference compared to mixed anglers. Finally, Garfish were least released by Bodden anglers and were released significantly less often by Bodden anglers compared to mixed anglers. No other differences in release rates were revealed.

Determinants of Fishing Site Choice

In the RPL model, a "Bodden trip" refers explicitly to a trip taken to the brackish inshore areas of MV while targeting marine and freshwater species, whereas a "coastal/marine trip" refers to trips taken to marine water bodies while exclusively targeting marine species (Table 8). Due to missing variables for a number of observations, the final model specification was estimated with 7,315 observations from 401 individual respondents. A likelihood ratio test suggested that model 2 provided a better fit than model 1 ($P < 0.01$). We therefore mainly interpreted the means and SDs of model 2. For significant SD estimates, we report the positive share of the probability distribution.

The expected catch rate showed a significant effect on water body choice. In both models, mean expected CPUE was positive and highly significant, suggesting that anglers were particularly interested in going on Bodden and coastal/marine trips because high catch rates (or species with high catch rates, such as Atlantic Herring) can be expected. Bodden and coastal/marine trips were also more likely when fishing from a boat. However, as the consistently significant SD on expected CPUE indicated, there was ample preference heterogeneity regarding the catch rate (Bodden trips: 86% positive; coastal/marine trips: 64% positive). Anglers were also more likely to choose Bodden and coastal/marine trips when fishing from a boat (Bodden trips: 74% positive; coastal/marine trips: 75% positive). The Euclidean distance parameter was only significant for coastal/marine trips in model 2, indicating that travel distance did not differentially affect the choice of a Bodden trip relative to freshwater. For coastal/marine trips, the mean parameter was positive and, along with its significant SD, suggested that 63% associated a lower disutility of distance when going to a coastal/marine site compared to a freshwater site. Although economic theory predicts that the marginal utility of costs (i.e., distance) is negative, this result indicated that relative to freshwater, the marginal utility for coastal/marine trips becomes less negative.

While we found significant heterogeneity for the context of fishing with family, there were no significant mean estimates for this parameter. However, fishing with friends or with a guide was associated with a higher likelihood of choosing a coastal/marine trip (88% positive). In terms of seasons, anglers were on average more likely to choose a Bodden trip over freshwater in spring (81% positive), yet anglers would be less likely to choose a coastal trip relative to freshwater sites in summer (10% positive).

We found strong evidence that general angling motives were associated with angling site choice. Respondents scoring high in catch and consumption motives were more likely to choose coastal trips (100% positive), whereas motives associated with enjoying nature were less likely to attract anglers to coastal/marine sites (insignificant SD) relative to freshwater sites. Socializing motives, on the other hand, were positive for both Bodden trips and coastal/marine trips and also showed significant heterogeneity for Bodden trips (100% positive). Similarly, anglers mainly seeking solitude were less likely to fish in Bodden or coastal/marine environments, although with significant heterogeneity for the coastal/marine context (0% positive). Although trophy motives showed some significant positive effects in model 1 (92% positive for choosing Bodden or coastal/marine trips over freshwater trips), the effect was nonsignificant in model 2 apart from the heterogeneity.

TABLE 8. Results from two random parameters logit models relating the choice of a fishing site to angler characteristics and target species (AIC = Akaike's information criterion; BIC = Bayesian information criterion; *$P < 0.10$; **$P < 0.05$; ***$P < 0.01$). The reference alternative is a freshwater trip. Model 1 restricts parameters for nonreference alternatives to be equal (except for alternative-specific constants [ASCs]). Model 2 estimates separate parameters for each alternative. Expected CPUE was scaled by 1/100. Motives and catch orientation were scaled by 1/10 to facilitate estimation in PandasBiogeme. Values in parentheses are standard errors.

	Model 1		Model 2			
	Bodden and coastal/marine		Bodden		Coastal/marine	
Parameter	Mean	SD	Mean	SD	Mean	SD
ASC Bodden	−5.95***	2.54***				
	(1.74)	(0.17)				
ASC coastal/marine	−4.40**	2.07***				
	(1.73)	(0.15)				
ASC			−18.20***	5.82***	−8.89***	6.10***
			(2.33)	(0.31)	(1.51)	(0.66)
Expected CPUE	9.41***	14.90***	8.38***	7.50***	3.82***	10.90***
	(1.18)	(1.47)	(1.07)	(0.85)	(1.10)	(1.22)
From boat	2.71***	5.02***	2.46***	3.75***	3.23***	4.79***
	(0.27)	(0.45)	(0.36)	(0.32)	(0.34)	(0.33)
Euclidean distance	−0.00	0.20***	0.03	0.03	0.05**	0.15***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)
Social context						
Family	0.13	1.09***	0.17	1.54***	−0.21	0.88**
	(0.33)	(0.33)	(0.51)	(0.53)	(0.40)	(0.35)
Friends or guide	2.52***	2.96***	−0.06	2.41***	2.49***	2.12***
	(0.27)	(0.32)	(0.31)	(0.42)	(0.21)	(0.22)
Season						
Fall	−0.13	0.56*	0.47	0.06	−0.29	0.76***
	(0.25)	(0.29)	(0.36)	(0.24)	(0.25)	(0.28)
Spring	0.56**	1.23***	1.93***	2.15***	0.02	1.14***
	(0.26)	(0.20)	(0.37)	(0.30)	(0.29)	(0.25)
Summer	−0.72**	1.67***	−0.33	2.28***	−1.71***	1.33***
	(0.28)	(0.25)	(0.41)	(0.30)	(0.29)	(0.27)
Motives						
Catch and consumption	3.02*	1.75***	−0.50	1.05	13.60***	2.65***
	(1.75)	(0.67)	(2.77)	(0.79)	(2.87)	(0.85)
Nature	−5.01***	7.47***	−3.78	1.46	−4.72**	0.60
	(1.80)	(0.56)	(2.75)	(0.90)	(1.90)	(0.46)
Socializing	1.58	6.05***	5.23**	1.80***	3.96***	0.51
	(1.06)	(0.53)	(2.11)	(0.56)	(1.24)	(0.46)
Seeking solitude	−13.40***	4.82***	−8.37***	0.56	−4.23***	1.22***
	(1.50)	(0.72)	(1.97)	(1.38)	(1.51)	(0.41)
Trophy	2.48*	1.78***	2.77	4.00***	0.34	4.49***
	(1.43)	(0.54)	(2.01)	(0.67)	(1.95)	(0.74)
Catch orientation						
Consumption	−13.40***	7.19***	0.65	2.07***	1.51	0.46
	(2.15)	(0.69)	(2.11)	(0.77)	(2.13)	(1.36)
No catch	3.16	1.77***	13.80***	3.68	3.81*	1.18
	(2.09)	(0.57)	(2.69)	(3.22)	(2.00)	(0.79)
Release	3.43**	4.68***	1.78	0.56	−4.83***	2.16***
	(1.54)	(0.55)	(1.83)	(1.16)	(1.49)	(0.36)
Trophy/catch many fish	7.96***	6.92***	21.00***	2.70***	−0.26	3.00***
	(2.53)	(0.65)	(2.79)	(0.80)	(2.31)	(0.63)

TABLE 8. Continued.

	Model 1		Model 2			
	Bodden and coastal/marine		Bodden		Coastal/marine	
Parameter	Mean	SD	Mean	SD	Mean	SD
Number of anglers	401		401			
Number of observations	7,315		7,315			
Log likelihood	−2,118		−2,003			
AIC	4,312		4,150			
BIC	4,464		4,437			

The impacts of catch orientation on fishing site choice were somewhat inconsistent across subdimensions and therefore variable in interpretation. A clear finding was related to the attitudes toward catching trophy fish and catching many fish, which were strongly associated with Bodden trips in both models, with some heterogeneity but all remaining in the positive domain. Relatedly, attitudes toward the non-catch-related aspects of fishing were strongly positive for Bodden and coastal/marine trips. By contrast, while model 1 suggested a high and negative association between consumptive orientation and choosing Bodden or coastal/marine trips, those effects were negligible in model 2. The effects of attitudes toward catch-and-release fishing were again inconsistent: they were positive in model 1 but negative in model 2 for coastal/marine trips, including significant heterogeneity (1% positive).

We found that the ASCs were large and negative in both remaining alternatives. This was expected, as our data set had substantially more freshwater trips than trips from the other two categories. The ASCs therefore controlled for other, unobserved determinants of Bodden trips and coastal/marine trips compared to freshwater trips, which were invariant over respondents. It is likely that several unobserved characteristics, such as social embedding and convenience, largely contributed to the choice of a freshwater site compared to the other two water body types. The SDs of the ASCs also indicated heterogeneity across the sample (Bodden trips: 0% positive; coastal/marine trips: 7% positive).

DISCUSSION AND MANAGEMENT IMPLICATIONS

In this paper, we studied the characteristics, motives, catch orientation, and (revealed) behavior of anglers fishing in freshwater, brackish, or marine sites in northeastern Germany. To single out whether lagoon fisheries attracted specific segments of anglers, we compared three angler groups along a series of dimensions using three subsamples that aligned in a gradient of water body use from freshwater over lagoon fisheries to marine sites. Our study hypotheses received mixed support. In disagreement with expectations, we did not find evidence that Bodden anglers had a different psychological commitment level (H_1; as assessed by the centrality-to-lifestyle index), which is one of the three subdimensions of the angler specialization construct (Scott and Shafer 2001). However, we found that the Bodden conditions attracted a specific subset of anglers, particularly those that used boats, sometimes with a guide, fished primarily with friends as opposed to alone (H_4), and carried challenge-seeking (H_2), catch-oriented, and trophy fish motives (H_3) when targeting freshwater species (e.g., Eurasian Perch, Northern Pike, and Zander) in the Bodden context.

Our work accords with findings from previous studies (e.g., Driver and Knopf 1976; Driver 1977; Fedler and Ditton 1994; Beardmore et al. 2011), revealing that non-catch-related motives and attitudes—in particular, expectations to enjoy nature and the outdoors—were prevalent among the anglers we surveyed. This is a typical finding that has been well established in the literature (e.g., Driver and Knopf 1976; Fedler and Ditton 1994; Ross and Loomis 2001; Arlinghaus 2006; Beardmore et al. 2011). However, it has previously been found that independent of the underlying motives, most anglers derive satisfaction from the catch aspects of fishing (Arlinghaus 2006; Birdsong et al. 2021). In line with this, both expected CPUE and orientation toward catching many fish and trophy fish revealed that catch-related aspects were highly relevant, in agreement with other research from the UK on the motives of anglers targeting freshwater predators (Nolan et al. 2019a). Moreover, lagoon sites attract anglers with social experiences to target freshwater predators with friends and to master fishing-related challenges, such as fishing for Zander. Accordingly, we detected higher catch rates of Zander by Bodden anglers than by inland specialists, suggesting that the Bodden offer suitable Zander fishing conditions relative to freshwater locations.

Given the relevance of sufficiently high catch rates for some species, such as Northern Pike, the expectation of the presence of large trophy fish in our study suggests

that the angler subpopulation seeking lagoon fisheries will react sensitively to declining abundances and sizes, as is currently happening in the area (van Gemert et al., in press). Managers seeking to increase the number of anglers could foster the abundance and the size of fish captured in the lagoon fisheries by reducing fishing mortality. For Northern Pike, a popular trophy fish in the Bodden (Fuhrmann and Balkow 2013), managers could refer to introducing harvest slots instead of the current minimum size limit regulations (Arlinghaus et al. 2010; Ahrens et al. 2020) so as to reduce fishing mortality and increase the abundance and size of fish. Consumptive anglers targeting Atlantic Herring or other marine species that are regularly taken home could be attracted by providing facilities that help to safely store and process the captured fish, either directly or through the support of owners of private vacation homes. As Bodden anglers seem to follow their prey (e.g., the spring season is well known for the Atlantic Herring migration in the area; Dorow and Arlinghaus 2009; Weltersbach et al. 2021), managers could expect large numbers of anglers coming to the Bodden during the spring and could plan monitoring and enforcement accordingly. Bodden waters are prone to strong winds and currents; therefore, authorities may also adjust safety and emergency measures during this season.

The latter objective can be seen in combination with the social objectives that drive Bodden trips. The fact that social motives (socializing in the Bodden versus seeking solitude, with the latter being predominantly pursued in freshwater) were strongly prevalent in the choice model and in the general motive structure of Bodden anglers indicates that the angling experience sought in the Bodden is indeed motivated by going angling with peers. To attract anglers to the Bodden rather than catering to the individual angler, managers could provide facilities and experiences that are attractive for groups (e.g., Hunt and Ditton 1997). For example, regional marketers could advertise group fishing trips to the Bodden using facilities aimed at the specific target group, including preparing touristic venues for groups and guided trips.

In light of the fishing motives, attitudes, and preferences revealed in our study, we would expect that Bodden anglers might be particularly prone to conflict with other user groups when the catch rates and sizes of fish start to decline in response to rising mortality levels or other environmental changes. For some species, such as Eurasian Perch or Zander, current removal rates are dominated by either cormorants *Phalacrocorax carbo sinensis* or commercial fishers, while anglers are currently the major mortality factor for Northern Pike (Arlinghaus et al. 2021). Reducing mortality is, thus, user group specific and species specific. Fishing mortality from recreational fishing may in general be reduced by engaging in catch and release (Arlinghaus et al. 2007). Catch and release can be a self-motivated, voluntary behavior of anglers related to the perception of conserving fish stocks (Arlinghaus et al. 2007; Nolan et al. 2019a). Although we found that the general catch-and-release orientation and the actual catch-and-release behavior of Bodden anglers were not different from those of the other angler groups, recent results have suggested that catch-and-release rates, particularly for Northern Pike, have increased in the Bodden between when our data were collected (2006–2008) and the present (Arlinghaus et al. 2021). In general, however, freshwater fishes tend to motivate higher release rates than the marine fishes (Salz and Loomis 2005; Ferter et al. 2013), such that changing angler behavior and increasing release rates might also help to reduce fishing mortalities on selected species, such as Northern Pike. For the marine species we studied (Atlantic Cod, Atlantic Herring, and Garfish), we found lower release rates than the European average (Ferter et al. 2013), indicating substantial interest in the consumption of these species. German anglers have been found to be mainly consumptive and prefer to keep fish for dinner (Arlinghaus 2004, 2007). Because the anglers in our diary study were not asked to record the lengths of all captured fishes, we were unable to clearly understand whether our catch-and-release rates involved voluntary release or the mandatory release of undersized fish and, in most cases, are likely to involve both.

Our study has a number of limitations. First, the survey data were generated in 2006–2008 and conditions, attitudes, and angling norms may have changed since then. Second, the classification of the three angler groups is somewhat arbitrary, and alternative classifications may reveal a different picture. Our classification was mainly driven by the need to produce sufficiently large subsample sizes for the Bodden angler group. A sharper definition (e.g., 50% Bodden trips) might have increased the contrast with other groups but would have substantially reduced the power of any statistical tests. Third, the diary data were biased toward resident anglers, and nonresidents might have different expectations and behaviors. Finally, participants in the diary study may have been a particular subset of all anglers, thus biasing results toward the more involved anglers. The fact that catch and trophy attitudes emerged so prominently in the choice model to predict Bodden trips could be an artifact of this, and management implications should be carefully considered. After all, a larger share of the Bodden angler population may be those that only fish as part of their vacation rather than going to the Bodden specifically to fish. Catering to both groups may be advisable to mitigate the risk of singly following recommendations accrued from a selective, probably more avid sample (Dorow and Arlinghaus 2011). Other limitations of revealed preference models, such as the possibility of correlated site descriptors, of course also exist.

Future research could combine typical angler metrics used in this study (motives and catch orientation) with experimental data (e.g., by using a choice experiment) to mitigate some of the effects of nonorthogonality among site variables that may have biased our results. Further research that considers a careful experimental design to tease out the relationships is warranted. These estimates could then be used in more elaborate demand estimations and predictions of how management measures may change angler behavior in the Bodden fishery.

Conclusions

Bodden waters are shallow, brackish ecosystems with high productivity and high growth potential for freshwater predators. Therefore, the probability of catching a (very large) freshwater predator, such as a Northern Pike or Eurasian Perch, is high relative to many freshwater sites, which in turn attracts anglers that have specific expectations for catch and achievements. However, the specific preferences carried by Bodden anglers render the system conflict prone because changes to actual catches and sizes of fish in the catch or constraints in accessing specific sites or using motorboats (e.g., due to conservation regulations) will affect the satisfaction of Bodden anglers and may in turn promote conflict. As Northern Pike are declining in the area (van Gemert et al., in press), it is likely that this conflict will spiral toward aversion against those groups that are considered to be prime competitors for a scarce resource (e.g., commercial fisheries or southern cormorants; Arlinghaus et al. 2021) and may also result in conflict among anglers (e.g., between resident and non-resident anglers that may vary in preferences and the specificity of expectations; Arlinghaus 2005). Any emerging conflict may be proactively managed (Vogt 2020) while considering the specific expectations held by lagoon anglers, as revealed in the present work.

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Appendix: Additional Data

TABLE A.1. Descriptive statistics of centrality-to-lifestyle items in the survey.

Item	Mean	SD	Min	Max
Because of fishing, I don't have time to spend participating in other leisure activities	3.9	1.01	1	5
Going fishing is the most enjoyable thing I can do	3.2	1.11	1	5
I find that a lot of my life is organized around fishing	2.9	0.97	1	5
If I couldn't go fishing, I am not sure what else I would do	4.0	1.02	1	5
If I stopped fishing, I would probably lose touch with a lot of my friends	4.2	0.96	1	5
Most of my friends are in some way connected with fishing	3.8	1.12	1	5
Other leisure activities don't interest me as much as fishing	3.2	1.21	1	5

TABLE A.2. General angling motivation items used in the survey.

Item	Mean	SD	Min	Max
To catch trophy fish	2.8	1.25	1	5
To master angling-related challenges	3.0	1.23	1	5
To experience nature	4.4	0.98	1	5
To catch as many fish as possible	2.6	1.17	1	5
To generate a supply of fish for nonangling times	1.8	1.05	1	5
To enjoy solitude	3.4	1.21	1	5
To experience a challenging fight	3.3	1.27	1	5
To socialize with friends/family	3.4	1.28	1	5
To obtain fresh fish for a single meal with family/friends	3.4	1.22	1	5
To outwit a fish	2.9	1.37	1	5

TABLE A.3. Summary of catch orientation items used in the survey.

Item	Mean	SD	Min	Max
A fishing trip can be successful even if no fish are caught	1.9	0.93	1	5
I go fishing for my personal consumption	2.1	1.14	1	5
I like to fish where I know I have a chance to catch a trophy fish	2.6	1.15	1	5
I would rather catch 1 or 2 big fish than 10 smaller fish	2.2	1.08	1	5
I release most of caught fishes	3.1	1.15	1	5
The bigger the fish I catch, the better the fishing trip	2.2	1.11	1	5
The more fish I catch, the happier I am	2.6	1.18	1	5
When I go fishing, I'm just as happy if I don't catch fish	2.2	1.02	1	5

TABLE A.4. Results from a zero-adjusted gamma model explaining catch per day by target fish and angler characteristics (AIC = Akaike's information criterion; $*P < 0.05$; $**P < 0.01$; $***P < 0.001$). Additional controls were added for interactions between age, coastal license holdership, and avidity (not shown).

	Catch per day	
Characteristic	Estimate	SE
Winter	−0.064*	0.029
Spring	−0.034	0.025
Summer	−0.048*	0.024
Targeted European Eel *Anguilla anguilla*	−0.577***	0.028
Targeted Eurasian Perch	0.653***	0.021
Targeted Atlantic Cod	0.086*	0.036
Targeted Northern Pike	−0.584***	0.022
Targeted Garfish	0.505***	0.061
Targeted Atlantic Herring	1.791***	0.043
Targeted Common Carp *Cyprinus carpio*	−0.348***	0.033
Targeted flatfish	0.032	0.052
Targeted Zander	−0.111***	0.032
Targeted whitefish	0.866***	0.025
Employed: yes	0.148***	0.019
Household size	0.005	0.009
N	12,780	
Log likelihood	−39,839.788	
AIC	79,719.575	

TABLE A.5. Average over social context of angling trips per individual (values are expressed in %).

Context	Bodden anglers	Inland specialists	Mixed anglers
Alone	31	53	28
With angling friends	46	30	47
With family	18	16	15
With guide or charter boat	4	0	8

TABLE A.6. Kruskal–Wallis test results for share of social context when angling across different angler types.

Context	*n*	Statistic	df	*P*-value
Alone	648	83.4	2	<0.01
With angling friends	648	40.0	2	<0.01
With family	648	1.1	2	0.57
With guide or charter boat	648	61.4	2	<0.01

TABLE A.7. Results of Dunn's test for share of social context when angling across different angler types.

Social context	Angler type 1	Angler type 2	N_1	N_2	Test statistic	$P_{adjusted}$
Alone	Bodden anglers	Inland specialists	84	398	5.7	0.000
Alone	Inland specialists	Mixed anglers	398	166	−8.2	0.000
With angling friends	Bodden anglers	Inland specialists	84	398	−4.1	0.000
With angling friends	Inland specialists	Mixed anglers	398	166	5.6	0.000
With guide or charter boat	Bodden anglers	Inland specialists	84	398	−2.8	0.009
With guide or charter boat	Bodden anglers	Mixed anglers	84	166	2.8	0.009
With guide or charter boat	Inland specialists	Mixed anglers	398	166	7.8	0.000