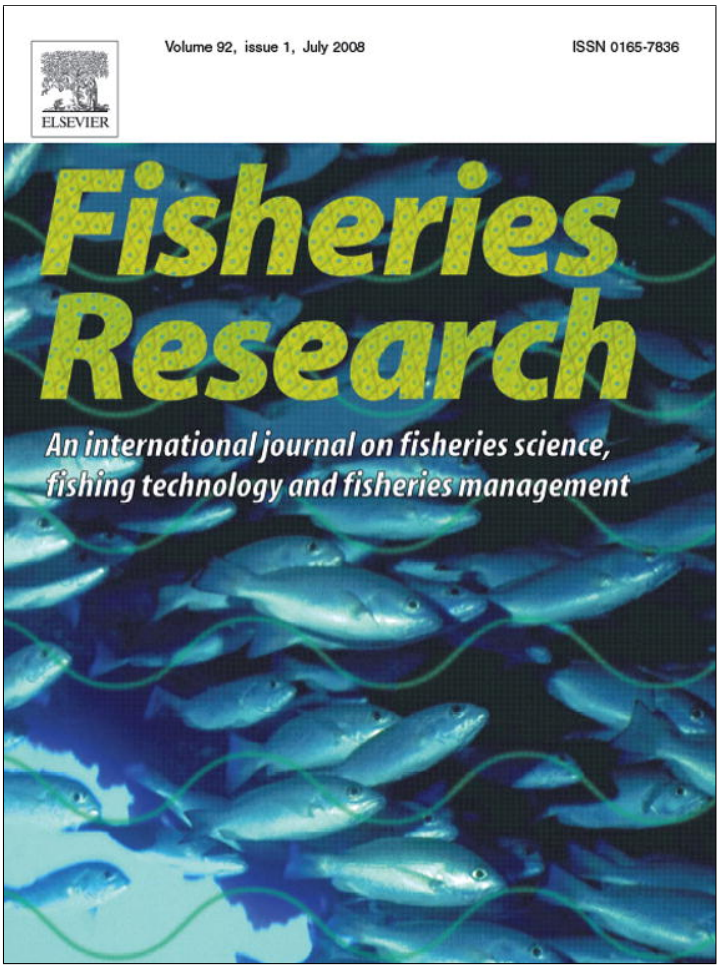

Available online at www.sciencedirect.com
ScienceDirect
Fisheries Research 92 (2008) 53–62
FISHERIES RESEARCH
www.elsevier.com/locate/fishres

Understanding the heterogeneity of recreational anglers across an urban–rural gradient in a metropolitan area (Berlin, Germany), with implications for fisheries management

Robert Arlinghaus [a,b,*], Martin Bork [b], Erik Fladung [c]

[a] *Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Department of Biology and Ecology of Fishes, Müggelseedamm 310, 12587 Berlin, Germany*
[b] *Humboldt-University of Berlin, Faculty of Agriculture and Horticulture, Institute of Animal Sciences, Inland Fisheries Management Group, Philippstrasse 13, Haus 7, 10115 Berlin, Germany*
[c] *Institute of Inland Fisheries, Im Königswald 2, 14469 Potsdam-Sacrow, Germany*

Received 19 September 2007; received in revised form 5 December 2007; accepted 15 December 2007

Abstract

Increasing urbanization world-wide challenges recreational fisheries management due to its negative impact on angling participation rates. To be prepared to confront this challenge, a better understanding of the human dimensions of urban and rural angler groups is needed. Based on a mail survey, this paper describes the differences in demographics, participation, satisfactions and management preferences among four segments of anglers across an urban–rural gradient of Berlin, Germany. Angler segments included: rural residents, suburban residents, urban residents who fished only in rural areas, and urban residents who also fished in urban areas. Urban residents who fished urban fisheries were the most committed and avid anglers, whereas urban residents who fished rural fisheries were least committed. Urban and rural residents differed in species preferences and catch and harvest levels. Angler satisfaction was related to the catch aspects of the fishing experience irrespective of the place of residence, but individual satisfaction components differently affected angling-year satisfaction in urban and rural anglers. Most anglers perceived stocking to be the most promising approach for improving angling conditions. To promote the fishing experience of urban residents, managers could increase catch opportunities and relax the current ban on night fishing in Berlin. However, given the large out-of-the-city angling effort of urban residents, rural fisheries managers need to consider urban people as important users of rural fisheries. Urban residents who fish exclusively outside the city represent a unique target market for rural fisheries as these anglers are highly mobile and willing to spend large amounts of money, while at the same time catching less fish than rural residents or urban anglers.

Keywords: Angler; Human dimensions; Recreational fisheries; Urban fisheries management; Constraints; Satisfaction; Catch

1. Introduction

Urbanization is a dominant demographic trend and a growing form of land use change. This development has focused attention on management of and research into urban ecosystems (Paul and Meyer, 2001) and improvement of recreation opportunities in urban areas (Allen, 1984; Hickley et al., 2004). Urbanization is known to reduce the interest of urban residents in consumptive outdoor recreation activities such as recreational fishing and this can have implications for participation in recreational fishing (Hendee, 1969; Arlinghaus, 2006a). Because many people live in cities, urban populations are often seen as a potential source of new recruits to recreational fishing and as a source of increased or continued license sales that support public natural resource agencies programs and aquatic ecosystem management (Allen, 1984). As new anglers from urban areas become more avid, some might extend their angling into more rural fisheries outside towns and cities (Ditton et al., 2002; Arlinghaus and Mehner, 2004a). Therefore, increased or sustained angling participation among urban populations may not only affect towns and cities but less developed rural areas surrounding metropolitan centres (Arlinghaus and Mehner, 2003a, 2004a).

To develop targeted marketing and management approaches for urban and rural fisheries management, it is imperative to know not only about the biological components of fisheries

* Corresponding author at: Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Department of Biology and Ecology of Fishes, Müggelseedamm 310, 12587 Berlin, Germany. Tel.: +49 3064181 653; fax: +49 3064181 750.
E-mail address: arlinghaus@igb-berlin.de (R. Arlinghaus).

0165-7836/$ – see front matter © 2007 Elsevier B.V. All rights reserved.
doi:10.1016/j.fishres.2007.12.012

systems, but also the characteristics and behaviours of anglers (Pollock et al., 1994). However, despite increasing research into urban angling and the human dimensions of urban anglers (Allen, 1984; Manfredo et al., 1984; Schramm and Edwards, 1994), we know of only three studies specifically addressing differences between urban and rural anglers (Manfredo et al., 1984; Schramm and Dennis, 1993; Arlinghaus and Mehner, 2004a). The latter two studies investigated differences among urban residents that fish either or predominantly in urban or rural fisheries. Only Manfredo et al. (1984) contrasted the human dimensions of people who live and fish outside urban areas from urban anglers. There is therefore a considerable lack of knowledge about the similarities and differences of angler segments along an urban–rural gradient. The objectives of the present study were (i) to contrast the human dimensions of urban and rural anglers based on a case study from the metropolitan area of Berlin, Germany and (ii) to derive implications for fisheries management.

2. Methods

2.1. Study area

The study was conducted in the German states of Berlin and Brandenburg, located in the north-eastern lowlands of Germany (Fig. 1). The German capital of Berlin is a city-state with a population of more than 3.4 million inhabitants, covering an area of 892 km^2 (population density around 4000 people km^{-2}), of which 59.6 km^2 (6.7%) consist of rivers and lakes. Berlin is characterized by glacial deposits, slow-flowing lowland rivers, and shallow lakes with a maximum depth of 16 m (Grosch et al., 2000). There are approximately 60 lakes which are >1 ha and more than 500 natural pond-like waters (Grosch et al., 2000). The primary fishing waters are the rivers Spree and Havel, which are large lacustrine-like ecosystems. Their impounded areas comprise two-thirds of the total Berlin water area. As a result of high population density and associated anthropogenic impacts, the diversity of fish species in Berlin is impaired (36 species, Wolter et al., 2000, 2003). Tolerant (eurytopic and phyto-lithophilic) zooplanktivorous species of comparatively low fisheries value such as small perch (*Perca fluviatilis*), roach (*Rutilus rutilus*), bream (*Abramis brama*) and white bream (*Abramis bjoerkna*) occur in high abundances, particularly in the navigation waterways of the German capital (Wolter and Vilcinskas, 2000; Wolter et al., 2003).

Berlin is surrounded by the state of Brandenburg (Fig. 1), which has a population number of 2.6 million people at a population density of only 88 people km^{-2} (total area 29,479 km^2, water area 1006 km^2 = 3.4%). Similarly to Berlin, the water systems in Brandenburg are mostly of glacial origin creating a mosaic of different lakes, rivers, and waterways. There are >10,000 lakes in total, with 2800 lakes >1 ha (of which 18 lakes are >450 ha), and a large and widespread flowing water system of an extension of about 33,000 ha (Mietz, 1996; Quast et al., 1997). There are also 4200 ha of ponds and a couple of small lowland salmonid rivers. Recreational fishing predominantly takes place on the vast amount of lakes as well in the large lowland rivers Elbe, Oder, Havel and their tributaries. As a result of habitat modification and human-induced nutrient inputs, tolerant species such as roach, perch, eel (*Anguilla anguilla*), bream, along with some phytophylic species such as tench (*Tinca tinca*), rudd (*Scardinius erythrophthalmus*), and carp (*Cyprinus carpio*) are abundant in most water bodies in Brandenburg. Among the top-predators, pike (*Esox lucius*) and eel are abundant, and zander (*Sander lucioperca*) occurs regularly (Brämick et al., 1999). In Brandenburg and Berlin, there is exploitation of fish stocks by both commercial and recreational fisheries (Brämick et al., 1999; Arlinghaus and Mehner, 2003a; Wolter et al., 2003).

Fig. 1. Map of the study area in north-eastern Germany. The angler survey was conducted by random sampling of angling license holders in the city of Berlin and the surrounding state of Brandenburg.

2.2. Survey

To gather data on the human dimensions of anglers living in the metropolitan area of Berlin, a simple random sample was drawn from a purposely compiled address list of angling license holders (i.e., those people having passed an angling examination and registered at the fisheries agency at state, regional, or local levels) in Berlin (31,621 registered anglers as of October 2005) and Brandenburg (112,106 people as of October 2005). The questionnaire was pre-tested face-to-face with ten members of a local angling club in Potsdam-Sacrow (Brandenburg).

The final self-administered, 10-page mail survey was sent on December 14, 2005 to 2137 randomly selected anglers. The subsample size of anglers living in Berlin and Brandenburg matched the proportion of licensed angler in the respective states. Questionnaires with a personalized cover letter and postage-paid mail-back envelope were mailed first class in stamped envelopes. Follow-up mailings to increase response rate followed a modified Dillman method (Salant and Dillman, 1994). Specifically, a reminder post card was sent to non-respondents after 20 days on January 4–5, 2006, and those who still did not respond were mailed a new questionnaire on January 18–20, 2006. One hundred and twenty questionnaires were undeliverable, and 1114 responses were received for an adjusted response rate of 55.3%.

A telephone non-response survey was conducted with 90 non-respondents, of which 56 provided a full set of answers to an abbreviated telephone questionnaire. There was no indication for non-respondents being underrepresented among either urban or rural anglers as the response rates were similar among Berlin residents and those living in Brandenburg. Furthermore, the goals of this study were to analyze differences between urban and rural anglers. Therefore, a potential non-response bias is of less concern in this comparative study as compared with studies that target accurate information about, say, percentage of females at the angler population level (Arlinghaus and Mehner, 2004a).

The questionnaire assessed data including demographics, angling activity, preferred species, satisfaction, and management preferences. The level of angler satisfaction was measured using the approach of Arlinghaus (2006b). We assessed satisfaction with the angling year, and satisfaction with a number of activity general (i.e., non-catch related) and activity specific (i.e., catch related) aspects of the fishing experience. All satisfaction items were assessed on a 10-point scale ranging from 1 (very dissatisfied) to 10 (very satisfied). Factor analysis with principal component extraction and varimax rotation was conducted to identify dimensions of satisfactions (e.g., factors of catch-related or non-catch related satisfactions), and reliability analysis was conducted on the dimensions identified through factor analysis. Determinants of angling-year satisfaction were assessed using multiple regression models as described in Arlinghaus (2006b). In this so-called sum-of-satisfactions approach, the sum of the scores of individual angler satisfaction components is assumed to be correlated with the angler's overall or total of satisfaction with the angling year (Pollock et al., 1994). Using multiple regressions, the respondent's indications of satisfaction with individual satisfaction components (independent variables) were modeled as determinants of the respondent's overall satisfaction with the previous angling year (dependent variable) (Arlinghaus, 2006b).

The management preferences of anglers were assessed in an open-ended question as described in Arlinghaus and Mehner (2003b, 2005). Written information was analyzed by content analysis based on a previously developed and verified coding scheme of categories of management preferences (e.g., enhancing fish stocks through stocking, improving habitat quality, improving cleanliness of shorelines) (Arlinghaus and Mehner, 2003b).

2.3. Comparative analysis

To test for significant differences among anglers along an urban–rural gradient, the total sample was divided into four segments. First the distribution of the population density of the place of residence was assessed. This revealed a clear separation between anglers living in Berlin at a population density of >3000 people/km^2 (urban residents of Berlin) from those living outside Berlin in Brandenburg (rural residents). To further distinguish the segments within either urban or rural residents, all Berlin residents that had fished at least once in the previous fishing season inside the urban waters of Berlin were clustered together (hereafter termed urban anglers) and distinguished from those living in Berlin, but fishing exclusively in rural fisheries outside Berlin (hereafter termed urban residents with rural fishing). The large group of rural residents in Brandenburg was further portioned using a criterion used in Germany by the Federal Bureau of Statistics to distinguish rural from suburban areas. Rural people were those living in a county with a population density of <100 people km^{-2} (rural residents). All rural residents living in areas with 100 to <3000 people km^{-2} were categorized as suburban residents. Most of them (>95%) were living in area with a density <1000 people km^{-2}. To account for a possible segmentation effect on the group comparisons, other segmentations modes were tested (e.g., segmenting anglers into 25%-percentiles or 33%-percentiles of the total sample). Negligible differences in main results were found, which suggested that different segmentation modes produced similar results. Therefore, only the stated segmentation mode is presented in this paper.

Group comparisons between the four angler segments on the variables of interest were performed by one-way analysis of variance on metric (e.g., age, number of angling days) or quasi-metric (e.g., Likert scales) data and by chi-square analysis for categorical data (e.g., gender, management preferences). To determine significant differences between the four angler segments, analysis of variance were followed by Student–Newman–Keuls *post-hoc* tests in case of homogeneous variances (Levené-test, $p > 0.05$) or Dunnet-T3-tests in the case of non-homogenous variances. In the factorial analyses, factor loadings >0.5 were considered meaningful. Reliability analyses were considered acceptable when Cronbach-α was >0.7. If exploratory factor analyses and reliability analyses found subdimensions for a scale, a factor score was calculated as the average of the items forming the factor. Differences in the importance of factors were assessed by Wilcoxon signed rank tests. All statistical analyses were conducted with SPSS, version 13.0, at a type-1-error probability of $\alpha = 0.05$.

3. Results

Of $N = 1114$ responding anglers, 8.7% ($N = 96$) were classified as urban residents fishing at least partly inside the urban environment (i.e., urban anglers) (35% of all urban residents), 16.1% ($N = 178$) were found to be urban residents fishing exclusively outside the urban environment (i.e., urban residents, rural fishing) (65% of all urban residents), 40.3% ($N = 446$) were

suburban residents (i.e., living and fishing outside Berlin), and 35.0% ($N = 387$) were found to be rural residents living and fishing outside Berlin in rural areas.

Compared to responding anglers, non-respondents fished less (average ± S.D., respondents: 39.0 ± 41.9 days year^{-1}, non-respondents: 20.2 ± 23.4 days year^{-1}, $p < 0.05$) and rated angling a less important leisure activity (on a scale from 1 = angling most important leisure activity to 4 = one leisure activity among many, respondents: 2.2 ± 1.2, non-respondents: 2.6 ± 1.3, $p < 0.05$). There were on average also more anglers per household in responding angler households (1.3 ± 0.6) compared to non-responding ones (1.2 ± 0.6, $p < 0.05$). There were no differences between respondents and non-respondents in age, education, type of employment, preferred fish species, and harvested fish species ($p > 0.05$ in all cases). These results indicate that more avid anglers were overrepresented among the respondents compared to the sample. Therefore, caution is encouraged when generalizing the results of this study to the population of anglers in Berlin-Brandenburg.

3.1. Demographics

The anglers in the different segments across the urban–rural gradient were relatively old (average age 46–50 years), well-educated (average educational years >10) and modestly wealthy (average net monthly income, €1500–2000) (Table 1). Urban residents that fished exclusively outside Berlin exhibited the highest level of education (significant compared to rural residents), the greatest net monthly income of all angler segments, and included the significantly highest proportion of females (about 8%) compared to other angler segments. There were no differences in demographic variables comparing rural and suburban residents.

3.2. Participation

In terms of participation variables, urban anglers were found to be more avid and committed compared to rural anglers as indicated by highest values in most commitment-related variables such as importance attached to angling as a pastime, annual angling frequency (average 47 trips per year), angling duration of a typical angling trip (7.1 h per trip), replacement value of angling tackle (€2448), and frequency of boat ownership (53%, Table 2). However, not all of these variables were statistically significant comparing urban anglers to the other three angler subgroups (Table 2). When looking at participation, the least-engaged group of anglers were the urban residents who fish in rural fisheries. This angler segment rated the importance of angling significantly lower and fished less frequently (average 27 trips per year) at locations further from their residences (115 km, one way). Moreover, the frequency of organised anglers was lowest in this angler group (41.5%) compared to other angler segments (>60%). In addition, the frequency of boat ownership was lowest among the urban residents with rural fishing (31.8%), but the average replacement value of tackle (€2129), the annual expenditure for angling holidays (€504) and the frequency of angling holidays (55%) were among the highest among all angler segments (Table 2). All angler segments – with the exception of urban residents fishing in urban waters – fished most frequently in the state of Brandenburg and infrequently fished outside Berlin-Brandenburg (i.e. in other parts of Germany or abroad).

Nearly all (90%) of rural residents identified their primary fishery in Brandenburg. Similarly, 70% of urban residents with rural fishing identified a location in Brandenburg as the main fishery. In contrast, nearly two-thirds (63.5%) of the urban residents with urban fishing indicated that their main fishery was located in Berlin.

3.3. Target species

Urban and rural anglers differed in their species preferences measured as the most preferred species (Table 3). Whereas both rural and suburban residents expressed a strong preference for carp (>20% of anglers), pike (>18%), and eel (>15%), urban residents indicated pike (20%), zander (>13%), and carp (>13%) to be their preferred target species. Among urban residents fishing in rural fisheries, the preference for salmonid species (in particular brown trout, *Salmo trutta*, 12.5%) and the marine species cod (*Gadus morhua*, 11.4%) was significantly higher than for rural residents (<3.5% for trout, <6.3% for cod). The urban residents that fished in urban waters expressed a higher preference for perch (7.6%) and roach (9.8%) compared to all other angler segments (<4% for perch, <5.7% for roach). Although, carp

Table 1
Demographic characteristics (average ± S.D., or percent of total) of four segments of anglers living across an urban–rural gradient in Berlin-Brandenburg, Germany

Demographic variable	Rural residents ($N = 397$)	Suburban residents ($N = 446$)	Urban residents with rural fishing ($N = 178$)	Urban residents with urban fishing ($N = 96$)	Significance
Age (years)[a]	46.8 ± 14.9	48.9 ± 14.8	50.6 ± 14.5	48.8 ± 14.1	*
Angler number per household[a]	1.4 ± 0.6	1.2 ± 0.5	1.2 ± 0.5	1.2 ± 0.5	*
Net monthly income (€)[b]	5.4 ± 2.4a	5.4 ± 2.3a	6.1 ± 2.2b	5.4 ± 2.3a	**
Educational years	10.5 ± 2.6y	10.7 ± 2.6y	11.9 ± 3.2z	11.2 ± 2.9yz	***
Percentage employed (%)	54	52.1	53.0	49.4	ns
Percentage females (%)	2.1	4.0	7.9	3.1	*

Different letters indicate statistical differences between angler segments. Level of significance is denoted as *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$; ns = not significant.

[a] Post-hoc-tests did not detect any significant differences between the four segments.

[b] Income categories were 1 = €<500, 2 = €500 to <900, 3 = €900 to <1300, 4 = €1300 to <1500, 5 = €1500 to <2000, 6 = €2000 to <2600, 7 = €2600 to <4500, 8 = €≥4500.

Table 2
Participation characteristics (average ± S.D., or percent of total) of four segments of anglers living across an urban–rural gradient in Berlin-Brandenburg, Germany

Participation variable	Rural residents ($N=397$)	Suburban residents ($N=446$)	Urban residents with rural fishing ($N=178$)	Urban residents with urban fishing ($N=96$)	Significance
Commitment variables					
Angling experience (years)	36.6 ± 14.4	36.7 ± 14.8	36.9 ± 15.6	35.5 ± 12.9	ns
Importance of angling[a]	2.1 ± 1.2y	2.1 ± 1.1y	2.6 ± 1.2z	1.9 ± 1.1y	***
Angling frequency (trips year^{-1})	42 ± 43y	37 ± 40yz	27 ± 34z	47 ± 42y	**
Average angling hours per day on main fishery (h day^{-1})	5.8 ± 3.6y	6.7 ± 4.4z	6.4 ± 3.3yz	7.1 ± 4.3yz	*
Distance to main fishery (km, one way)	46 ± 223y	64 ± 241az	115 ± 206z	44 ± 195yz	*
Replacement value of tackle without boat (€)	1181 ± 1878y	1180 ± 1498y	2129 ± 1832yz	2448 ± 4391z	***
Angling holidays (%)	39.5	40.4	55.1	55.8	**
Annual expenditure for angling holidays (€ a^{-1})	261 ± 530y	327 ± 962yz	504 ± 823z	353 ± 566yz	*
Annual expenditure for durable goods (€ a^{-1})	337 ± 435	367 ± 696	411 ± 547	382 ± 407	ns
Expenditure per trip (€ trip^{-1})	45 ± 78	51 ± 93	56 ± 90	53 ± 87	ns
Boat owners (%)	43.9	43.3	31.8	53.0	*
Organised in angling club (%)	61.7	62.3	41.5	62.5	***
Annual fish catch (kg a^{-1})	44 ± 70y	44 ± 75y	20 ± 41z	62 ± 86y	**
Annual harvest (kg a^{-1})	27 ± 41y	26 ± 46y	14 ± 27z	38 ± 53y	***
Harvest rate (%)	65	63	70	58	ns

Different letters indicate statistical differences between angler segments. Level of significance is denoted as *$p<0.05$, **$p<0.01$, ***$p<0.001$; ns = not significant.
[a] Measured on a scale from 1 = most important leisure activity, 2 = second most important leisure activity, 3 = third most important leisure activity, 4 = one leisure activity among others.

was a preferred target for some urban residents (<13.3%), these anglers placed significantly less value on this species compared to rural residents (>20%).

Noteworthy differences among the four angler segments were apparent in terms of the amount of annual catch and harvest, both of which were significantly smaller among the urban residents fishing in rural fisheries (average catch 20 kg a^{-1}, average harvest 14 kg a^{-1}) compared to the other three angler groups (average catches > 44 kg a^{-1}, average harvest > 26 kg a^{-1}, Table 2). There were also differences in the main fish species removed from the fisheries (Table 3), but there were no differences in harvest rates, which were high (>50–70% of the catch) in all anglers (Table 2). For urban residents fishing in urban waters, small cyprinids – especially roach (24.7%)

Table 3
Relative frequency (%) of four segments of anglers living across an urban–rural gradient in Berlin-Brandenburg, Germany, in terms of the single most preferred target species and the species most often harvested

Species	Rural residents ($N=397$)	Suburban residents ($N=446$)	Urban residents with rural fishing ($N=178$)	Urban residents with urban fishing ($N=96$)
High valued freshwater piscivores				
Eel (*Anguilla anguilla*)	17.2/7.9	15.3/5.4	6.7*/6.4	10.9/4.3
Perch (*Perca fluviatilis*)	2.6/10.5	4.0/11.0	1.9/8.5	7.6*/14.0*
Pike (*Exox lucius*)	18.1/14.8	18.4/11.4	20.0/10.6	19.6/10.8
Pike-perch (*Sander lucioperca*)	11.0/3.2	10.8/1.9	17.1*/1.1	13.0/5.4*
Trout species (e.g., *Salmo trutta*)	2.9/2.9	3.4/3.8	12.5*/10.6*	4.4/3.3
High valued freshwater cyprinids				
Common carp (*Cyprinus carpio*)	21.7/11.9	22.7/11.0	13.3*/5.3*	13.0*/1.1*
Tench (*Tinca tinca*)	2.9/1.8	2.5/2.2	2.9/1.1	2.2/2.2
Widespread, low value freshwater cyprinids				
Bream (*Abramis brama*)	1.0/6.5	2.5/10.1	1.9/5.3	2.2/15.1*
Roach (*Rutilus rutilus*)	4.2/20.2	5.7/22.7	5.7/17.0	9.8*/24.7
Rudd (*Scardinius erythrophthalmus*)	0.0/1.8	1.1/2.5	0/2.1	1.1/2.2
Asp (*Aspius aspius*)*	0.0/0	0.3/0	0/0	2.2/1.1*
Marine species				
Cod (*Gadus morhua*)	6.8/5.8	5.4/6.3	11.4/13.8*	10.9/8.6
Herring (*Clupea harengus*)	1.3/2.9	0/3.8	1.9/6.4*	0/1.1

The left value indicates the percentage of anglers preferring a particular species most. The right value indicates the percentage of anglers for which the particular species form the main fraction of the harvest. *indicates significant overrepresenation or underrepresenation.

Table 4
Degree of satisfaction with various satisfaction dimensions among four segments living across an urban–rural gradient in Berlin-Brandenburg, Germany

Satisfaction items	Rural residents ($N=397$)	Suburban residents ($N=446$)	Urban residents with rural fishing ($N=178$)	Urban residents with urban fishing ($N=96$)	Significance
Activity-specific satisfaction (factor 1, eigenvalue = 5.6, variance explained 39.8%, Cronbach's $\alpha=0.89$)					
Stocking amount of primary target species	4.8 ± 2.6	5.1 ± 2.4	5.6 ± 2.5	5.2 ± 2.5	ns
Quantity of large fish of primary target species captured	5.0 ± 2.7	5.0 ± 2.5	5.1 ± 2.7	5.2 ± 2.6	ns
Quantity of consumable fish captured	5.7 ± 2.5	5.9 ± 2.5	5.8 ± 2.9	6.1 ± 2.6	ns
Stock size of primary target species	5.5 ± 2.6	5.3 ± 2.5	5.6 ± 2.6	5.7 ± 2.7	ns
Quantity of fish strikes	5.8 ± 2.3	5.9 ± 2,4	5.9 ± 2.5	6.5 ± 2	ns
Mastering angling-related challenges	6.2 ± 2.2	6.4 ± 2.2	6.4 ± 2.3	6.6 ± 2.3	ns
Activity-general satisfaction (factor 2, eigenvalue = 2.0, variance explained 14.3%, Cronbach's $\alpha=0.80$)					
Enjoyment of sufficient angling sites	6.8 ± 2.6	6.9 ± 2.7	6.7 ± 2.8	7.1 ± 2.5	ns
Possibility to be undisturbed by others	6.8 ± 2.3	6.9 ± 2.4	7.2 ± 2.4	7.1 ± 2.7	ns
Access to the fishery	7.1 ± 3.0y	6.9 ± 3.0y	7.8 ± 2.6yz	8.0 ± 2.1z	***
Fishing in pleasant companionship	7.2 ± 2.1	7.2 ± 2.1	7.3 ± 2.3	7.3 ± 2.3	ns
Relaxation outdoors	8.3 ± 2.4	8.5 ± 2.4	8.5 ± 2.4	8.4 ± 2.5	ns
Experiencing nature	8.8 ± 2.1	8.6 ± 2.2	8.6 ± 2.3	8.4 ± 2.5	ns
Single items without clear factor loadings					
Experiencing services (e.g., boat rental) at the waterside	4.6 ± 2.0y	4.7 ± 2.1y	5.8 ± 1.9z	5.3 ± 2.0yz	***
Competition with others for the largest or largest quantity of fish	6.2 ± 1.8	6.0 ± 1.8	6.1 ± 1.9	6.5 ± 1.9	ns

Satisfaction was assessed as related to the previous angling year and the main fishery. The scale ranged from 1 = very dissatisfied to 10 = very satisfied. Items are arranged according to factorial and reliability analysis into two factors and some additional satisfaction items without clear factor loadings. Level of significance is denoted as $*p<0.05$, $**p<0.01$, $***p<0.001$; ns = not significant.

and bream (15.1%) – as well as perch (14.0%) were the main fish species harvested. The frequency of bream, perch, zander, and asp (*Aspius aspius*) forming the main harvest species was significantly elevated in this angler segment. For urban residents fishing outside Berlin, the frequency of marine species (e.g., cod, 13.8%) and trout species (10.6%) as the main species harvested was significantly elevated. In contrast, rural residents caught more carp (>11%) than urban residents did (<5.3%). In all angler segments, roach was the main species in the angler harvest (>17% of anglers for all angler segments).

3.4. Satisfaction

There were no significant differences in overall angling-year satisfaction among the four angler segments (average ± S.D. on a scale from 1 = 10; rural residents 5.4 ± 2.4, suburban residents 5.6 ± 2.4, urban residents/rural fishing 5.9 ± 2.7, urban residents/urban angling 5.9 ± 2.7). Among a set of 14 items reflecting different satisfaction components two distinct factors were identified (Table 4). The two factors related to activity-specific satisfactions (i.e., mainly fish and catch related) and activity-general satisfaction components (i.e., unrelated to catching fish). Overall, satisfaction with activity-general aspects of the fishing experience ($\bar{x} = 7.5 \pm 1.7$) was higher for all angler segments than satisfaction with activity-specific satisfaction components ($\bar{x} = 5.6 \pm 1.9$) (all p values < 0.05, Table 4). In terms of satisfaction with the 14 individual satisfaction items, there were only two significant differences among the four angler segments (Table 4). Specifically, satisfaction with access to the fishery was higher among urban residents compared to rural residents. Also, satisfaction with services at the waterside was higher for urban residents (albeit still relatively low) compared to rural residents.

Catch-related aspects of the angling experience predicted angling-year satisfaction in all four angler groups (Table 5). However, noteworthy differences were found in the determinants of angling satisfaction among the four angler segments. Satisfaction of urban residents fishing urban waters was predominantly related to the perceived level of stocking, size of fish captured, and the possibility to be undisturbed by others while fishing. In contrast, the quantity of fish strikes and number of consumable fish predicted satisfaction among urban residents that fished outside Berlin; these dimensions were unrelated to overall satisfaction among urban anglers who fished urban waters. For the suburban angler group, angling-year satisfaction was positively related to number of consumable fish captured, number of large fish captured, perceived amount of supplementary stocking of target species, perceived stock size of target species, number of fish strikes, in addition to social aspects. Among the rural residents, three catch-related satisfaction dimensions and two non-catch related aspects of the fishing experience, namely services at the water-side (e.g., boat rental) and availability of sufficient angling sites, explained angling-year satisfaction. Overall, the multiple regression models explained about 50% of variability in angling-year satisfaction for each angler segment.

3.5. Management preferences

In terms of management preferences, there were only subtle differences among the four angler segments (Table 6). The great majority of anglers irrespective of place of residence wanted enhanced fish stocking (31–40% of anglers). Rural anglers

Table 5
Stepwise multiple regression of individual satisfaction components (ß-value) on overall satisfaction for four groups of anglers living across an urban–rural gradient in Berlin-Brandenburg, Germany

Satisfaction measure	ß-value			
	Rural residents	Suburban residents	Urban residents with rural fishing	Urban residents with urban fishing
Catch related				
Quantity of large fish of primary target species captured	0.327***	0.168**	0.319***	0.268**
Stock size of primary target species	ns	0.143*	ns	ns
Quantity of fish strikes	0.270***	0.132*	0.175*	ns
Quantity of consumable fish captured	ns	0.201***	0.256**	ns
Mastering angling-related challenges	ns	ns	ns	ns
Stocking amount of primary target species	0.127**	0.154**	ns.	0.427***
Non-catch related				
Fishing in pleasant companionship	ns	0.110**	ns	ns
Possibility to be undisturbed by others	ns	ns	ns	0.189*
Experiencing services (e.g., boat rental) at the waterside	0.079*	ns	ns	ns
Relaxing outdoors	ns	ns	ns	ns
Enjoyment of sufficient angling sites	0.203***	ns	ns	ns
Competition with others for the biggest or most fish	ns	ns	0.158**	ns
Experiencing nature	ns	ns	ns	ns
Access to the fishery	ns	ns	ns	ns
Constant				
R^2 corrected	0.479	0.438	0.517	0.474
F-value	72.068	58.747	48.352	29.583
d.F.	386	445	177	95
P-value	<0.001	<0.001	<0.001	<0.001
Durbin–Watson statistic	2.028	2.008	2.030	2.310

Level of significance is denoted as $*p<0.05$, $**p<0.01$, $***p<0.001$; ns = not significant.

Table 6
Management preferences of four angler segments living across an urban–rural gradient in Berlin-Brandenburg, Germany

	Rural residents	Suburban residents	Urban residents with rural fishing	Urban residents with urban fishing
Increased stocking	38.9	36.8	31.0	40.0
Improved access	12.5	16.7	15.5	6.2
Habitat enhancement	9.0	5.8	6.7	8.3
Reduced competition (e.g., commercial fisheries, cormorants)	7.2	9.2	7.3	8.3
Reduced littering	4.1	4.9	5.6	3.1
Improved enforcement and control	3.4	3.8	4.5	1.0
Improved angling conditions (e.g., allow night fishing)	3.6	2.9	1.1	7.3
Reduced angling costs	1.8	2.2	2.2	3.1
No need for action	1.0	1.3	1.1	1.0
No Opinion	27.6	27.6	34.8	32.3

The angler's opinion on the best strategy to increase angling quality was assessed in an open-ended manner. Overall differences in frequency of responses (% of responding anglers per group) were not significantly different ($p>0.05$).

expressed a greater preference for improving physical access (12–17% of all anglers) than urban anglers (6.2%), whereas urban anglers exhibited a greater preference for improving angling conditions (7.3% versus <3.6% in other angler segments), particularly relaxing the ban on night fishing that exists in Berlin. Measures aimed at improving physical habitat structure were mentioned by a minority of anglers (<9%), and many anglers exhibited no opinion on future directions of fisheries management (about one-third of all anglers).

4. Discussion

Our analysis of four angler segments across an urban–rural gradient in Berlin-Brandenburg demonstrated that urban fisheries are only attractive for a comparatively small fraction of the anglers in the region (around 9%). This finding agrees with previous reports from Germany (Arlinghaus and Mehner, 2004a) and the U.S.A. (Manfredo et al., 1984) and indicates the difficulty of attracting anglers to urban fisheries. We found that about two-thirds of all Berlin residents fished outside the city, and in addition also urban anglers regularly visited rural fisheries. Rural angling participation by urban residents may result from city residents' desire to minimize social contracts with others, escape from the artificialities and pressures of modern living, and simply "get away from it all" (Hendee, 1969). Travelling outside cities also offers less crowded and more remote angling experiences that are not available in an highly urbanized environment (Manfredo et al., 1984). However, one should be

reminded that the urban waters of Berlin cannot be compared with what is typically associated with the term "urban fishery" (e.g., small, artificial, densely-stocked, polluted, Alcorn, 1981; Birch and McCaskie, 1999). Indeed, Berlin offers unique fishing opportunities and secluded fishing experiences, if one knows where and when to fish. So, it is unclear if the large out-of-city fishing effort of many urban residents is reinforced by a lack of awareness of quality urban fishing or if it is related to a demand for special fishing experiences in rural landscapes that urban fisheries cannot offer. The distinct species preferences, particularly for cod and salmonid species, among Berlin residents who fish exclusively outside the metropolis suggests that rural fisheries indeed offer unique fishing experiences that are not available in cities. It was contented that even the best urban fisheries management programme is unlikely to meet the experience preferences of all city residents (Schramm and Dennis, 1993), and this is likely to be true for our study area as well.

Our results agree with previous research on differences in demographics and participation between urban and rural anglers from the U.S.A. (Manfredo et al., 1984; Schramm and Dennis, 1993) and Germany (Arlinghaus and Mehner, 2004a), but also differ from earlier research findings in a number of ways. For example, earlier research finding that urban anglers were younger and less educated (Schramm and Dennis, 1993; Arlinghaus and Mehner, 2004a) was not verified in this study. A potentially confounding factor was that we segmented anglers according to place of residence. However, there are differences in demography and socio-economic features between the populations in Berlin and Brandenburg. For example, in Germany educational level is usually higher in urban areas compared to the more rural ones (Statistisches Bundesamt, 2006). These *a priori* urban–rural differences might have influenced the results of the present study.

We found strong support for the hypothesis proposed by Arlinghaus and Mehner (2004a) that the urban residents who fish frequently inside the city are more committed and avid anglers than other angler groups. This may be a common feature of urban fisheries (Manfredo et al., 1984; Arlinghaus and Mehner, 2004a). If urban anglers are indeed more committed, this is highly relevant for recreational fisheries management in general as more committed anglers usually also receive higher personal benefits from angling than less committed anglers (Arlinghaus and Mehner, 2004b). Because anglers face time constraints, more committed anglers in the city may be "forced" to use urban waters to satisfy their high intrinsic demand for angling experiences (Arlinghaus and Mehner, 2004a). Indeed, it is difficult and time consuming to travel outside Berlin to fish, with travel time easily exceeding 1 h each way. So, it is not surprising that more avid anglers in a city fish close to home after work or on weekends. In line with this, Manfredo et al. (1984) found that the most important reason for fishing an urban environment was close access.

We found distinct species preferences with some overlap between urban and rural residents. It is conceivable that urban fisheries satisfy specific species preferences for certain segments of urban residents providing an incentive to use urban waters. The urban waters of Berlin offer populations of smaller cyprinid species, perch, zander and asp, a cyprinid top-predator that is attractive to some anglers and endangered in all of Europe (Wolter and Vilcinskas, 2000; Wolter et al., 2003). We found that urban anglers harvested small cyprinids, perch and zander more often compared to other angler groups. The distinct species preferences of urban anglers thus agreed well with species availability, and this may encourage urban angling in Berlin. However, we should be reminded that all anglers preferred piscivorous fish such as pike and eel over non-piscivorous fish irrespective of place of residence. Therefore, declining abundances of top-predators due to overfishing, mismanagement or anthropogenic changes will affect urban and rural anglers to the same degree.

In agreement with a previous study from Germany (Arlinghaus, 2006b), we found that catch-related aspects of the fishing experience were the primary determinants of angling-year satisfaction for both rural residents and urban residents. This is not to say that non-catch aspects such as appreciation of the outdoors, relaxation, mental rejuvenation, and affiliation with others are not important to anglers in the metropolitan area of Berlin, which according to Arlinghaus and Mehner (2004a) clearly is not true. However, we found that for all angler segments overall satisfaction with non-catch aspects of the fishing experience was higher than satisfaction with catch aspects of the fishing experience. This suggests that non-catch aspects are easier satisfied, which in turn results in catch-aspects to ultimately constrain angler satisfaction (Arlinghaus, 2006b). The explanation for this is that the anglers have greater control over non-catch aspects of fishing, such as selection of appealing locations, companions, and weather conditions (Vaske et al., 1982; Fedler and Ditton, 1986; Arlinghaus, 2006b). In contrast, anglers have less control over catch-related aspects of the fishing experience, and therefore satisfaction with catches seems to be less than ideal on most angling trips (Vaske et al., 1982). In agreement with this reasoning, in this study satisfaction was consistently higher for non-catch aspects of the fishing experience than for catch-related elements in all angler groups. Ultimately, due to the differential ease of satisfying non-catch and catch aspects of the fishing experience, satisfaction of all anglers seems to be catch-dependent, at least in Germany (Arlinghaus, 2006b) and in the metropolitan area of Berlin (this study).

In this study, satisfaction with access to fisheries was rated higher by urban anglers than by rural anglers, and adequate access to angling sites was an important determinant of angler satisfaction for rural residents. One reason could be that many rural fisheries outside Berlin are difficult to access due to the limited or constrained availability of driving routes, thick and dense reed belts, and limited parking at the water side. This reasoning is supported by Arlinghaus and Mehner (2003b) who found that improved access was rated among the priorities for fisheries management by anglers that live in Berlin but predominantly fish in rural fisheries.

Even though a substantial part of the variance on angling-year satisfaction was explained by the individual satisfaction components in this study, about 50% of the variance remained unexplained. Various situational variables, such as specific circumstances experienced in the main fishery, the institu-

tional environment in Germany (e.g., high level of bureaucracy, Arlinghaus and Mehner, 2003b), and simply those satisfaction components not included in this study, might explain total angling-year satisfaction (Arlinghaus, 2006b). Irrespective of these possibilities, the amount of explained variance in this study is relatively high and comparable in magnitude to that of other angling studies (summarized in Arlinghaus, 2006b).

In terms of preferences for future management, we found limited differences between rural and urban residents. Overall, fish stocking was suggested as the best management strategy to increase angling quality. Respondents' focus on stocking is not unexpected, given previous research from Germany (Arlinghaus and Mehner, 2003b, 2004a, 2005) and the fact that stocking has been the panacea of recreational fisheries management for decades (Arlinghaus et al., 2002). Therefore, many anglers irrespective of place residence belief in stocking as an effective means to increase fish stocks, catch quality and angler satisfaction. Stocking can indeed be a successful and sustainable management practice particularly when natural recruitment is low, which is often the case in heavily modified urban water bodies (Hickley et al., 2004). However, fisheries management that emphasizes stocking reduces the development of aquatic stewardship, because anglers are led to believe that good fishing results simply from "putting fish in the water" (Schramm and Edwards, 1994; Arlinghaus and Mehner, 2003b).

5. Implications for fisheries management and research

The divergent characteristics of rural and urban residents presented in this paper suggest the need to employ differential fisheries management strategies for urban and rural fisheries. We recommend a parallel approach in urban and rural areas to maximize the social and economic benefits of angling to anglers, angler-dependent industries, and other stakeholders. However, managers need to view anglers across an urban–rural gradient as an inter-connected population. In the case of Germany, this population is only separated by distinct fisheries administrations in Berlin and Brandenburg. Further cooperation between these two states in terms of fisheries administration and inland fisheries management and planning is recommended.

In the urban fisheries of Berlin, some straightforward changes might improve the quality of the fishing experience of those that already use urban fisheries. Specifically, night fishing could be allowed and promoted by providing safe conditions to fish after dark. City planners could include protected shoreline fishing access, boat ramps and reasonably priced boat-parking facilities in water development works. Fisheries managers could also pay close attention to conservation or enhancement of the quality of populations of species targeted by urban anglers. Managers could for example promote availability of larger sized fish that are safe to eat by culling stunted populations of perch and protecting zander from overexploitation through harvest regulations and protection of spawning sites. Pike is also an important species for urban anglers in Berlin. To promote pike, the Berlin Fisheries Board regularly stocks pike into urban fisheries to compensate for losses of spawning habitats (Wolter et al., 2003). This stocking programme may need to be expanded and publicized to improve visibility of the actions.

It is unclear if even the best urban fisheries management programme would attract urban residents that currently fish outside the city. However, it could be worthwhile to increase public outreach campaigns about the availability and quality of urban fisheries. Moreover, to increase participation and halt the current decline in fishing licenses sold in Berlin and other urban areas (Arlinghaus and Mehner, 2003a), it could be advisable to reduce the Berlin fishing license tax, communicate how license fees are used, and decrease bureaucratic barriers to recreational fishing participation (Arlinghaus and Mehner, 2003a,b).

Urban residents who fish exclusively outside the city represent a unique target market for rural fisheries that are owned or leased by angler associations or commercial fishing enterprises for promotion of angling tourism. Rural fisheries managers and tourism operators within and outside Germany can take advantage of the high mobility of this segment of anglers who have high willingness to spend money, high willingness to travel large distances, and high demand for specific angling holidays. By attracting these anglers to fisheries outside the city, a fraction of the economic benefits associated with recreational fisheries can be shifted to less developed rural areas.

Angling opportunities for suburban and rural residents in the state of Brandenburg might be improved by increasing access to fisheries and providing high quality catch opportunities for species such as carp, pike, and eel. Commercial fishermen might further the already constructive relationships with angler associations to profit from recreational fishing by providing services for anglers (e.g., offering boat rentals, high quality fish stocks, trophy fish).

Our study has shed light into the differences and similarities of urban and rural anglers, but suffers limitations in its predictive value given that the differences in the human dimensions depend on the mode of segmentation and very likely on the particular culture and institutional environment of the study area. Therefore, management implications are likely only valid for the study area, here Berlin and Brandenburg. To advance the science, in the future more theoretical research is needed to foster development of a theory of angling along urban–rural gradients that helps to develop testable predictive hypotheses about why people chose to fish in particular locations.

Acknowledgements

We thank Ingo Borkmann and Uwe Brämick for logistical help and the Fisheries Agencies in Berlin and Brandenburg for granting access to the fishing license frame. Funding of this study was provided by the Brandenburg Fishing Tax (Fischereiabgabe), by the Adaptfish-Project granted by the Leibniz-Community to RA within the Pact of Innovation and Research, and by the Humboldt-University of Berlin. The reviewers and Stephen G. Sutton provided helpful advice that improved our paper.

References

Alcorn, S.R., 1981. Fishing quality in two urban fishing lakes, St. Louis, Missouri. N. Am. J. Fish. Manage. 1, 80–84.

Allen, L.J., ed., 1984. Urban Fishing Symposium Proceedings. Am. Fish. Soc., Bethesda, Maryland.

Arlinghaus, R., 2006a. Understanding recreational angling participation in Germany: preparing for demographic change. Hum. Dimens. Wildl. 11, 229–240.

Arlinghaus, R., 2006b. On the apparently striking disconnect between motivation and satisfaction in recreational fishing: the case of catch orientation of German anglers. N. Am. J. Fish. Manage. 26, 592–605.

Arlinghaus, R., Mehner, T., 2003a. Characteristics of anglers living in the metropolitan area of Berlin (Germany): implications for urban fisheries management and research. In: Coleman, A.P.M. (Ed.), Regional Experiences for Global Solutions. The Proceedings of the 3rd World Recreational Fishing Conference 21–24 May 2002, Northern Territory, Australia. Fisheries Report 67. Fisheries Group, Department of Business, Industry and Resource Development, Darwin, Australia, pp. 117–120.

Arlinghaus, R., Mehner, T., 2003b. Management preferences of urban anglers: habitat rehabilitation measures vs. other options. Fisheries 28 (6), 10–17.

Arlinghaus, R., Mehner, T., 2004a. A management-orientated comparative analysis of urban and rural anglers living in a metropolis (Berlin, Germany). Environ. Manage. 33, 331–344.

Arlinghaus, R., Mehner, T., 2004b. Testing the reliability and construct validity of a simple and inexpensive procedure to measure the use value of recreational fishing. Fish. Manage. Ecol. 11, 61–64.

Arlinghaus, R., Mehner, T., 2005. Determinants of management preferences of recreational anglers in Germany: habitat management versus fish stocking. Limnologica 35, 2–17.

Arlinghaus, R., Mehner, T., Cowx, I.G., 2002. Reconciling traditional inland fisheries management and sustainability in industrialized countries, with emphasis on Europe. Fish Fish. 3, 261–316.

Birch, S., McCaskie, J., 1999. Shallow urban lakes: a challenge for lake management. Hydrobiologia 395/396, 365–377.

Brämick, U., Rothe, U., Schuhr, H., Tautenhahn, M., Thiel, U., Wolter, C., Zahn, S., 1999. Fische in Brandenburg – Verbreitung und Beschreibung der märkischen Fischfauna. Ministerium für Ernährung, Landwirtschaft und Forsten Brandenburg, Institut für Binnenfischerei Potsdam-Sacrow, Potsdam.

Ditton, R.B., Holland, S.M., Anderson, D.K., 2002. Fishing as tourism. Fisheries 27 (3), 17–23.

Fedler, A.J., Ditton, R.B., 1986. A framework for understanding the consumptive orientation of recreational fishermen. Environ. Manage. 10, 221–227.

Grosch, U., Rennert, B., Hilge, V., 2000. Development and use of surface waters and the fate of the related fisheries in the Berlin area of Germany. Fish. Manage. Ecol. 7, 179–188.

Hendee, J.C., 1969. Rural–urban differences reflected in outdoor recreation participation. J. Leis. Res. 1, 333–341.

Hickley, P., Arlinghaus, R., Tyner, R., Aprahamian, M., Parry, K., Carter, M., 2004. Rehabilitation of urban lake fisheries for angling by managing habitat: general overview and case studies from England and Wales. Ecohydr. Hydr. 4, 365–378.

Manfredo, M.J., Harris, C.C., Brown, P.J., 1984. The social values of an urban recreational fishing experience. In: Allen, L.J. (Ed.), Urban Fishing Symposium Proceedings. Am. Fish. Soc., Bethesda, Maryland, pp. 156–164.

Mietz, O., 1996. Allgemeiner hydrogeographisch-limnologischer Überblick über die Seen Brandenburgs und die Entwicklung eines Klassifikationsmodells für die glazialen Seen des Norddeutschen Tieflandes. Studien und Arbeitsberichte, Natur & Text GmbH Rangsdorf, Heft 2, 1–336.

Paul, M.J., Meyer, J.L., 2001. Streams in the urban landscape. Ann. Rev. Ecol. Syst. 32, 333–365.

Pollock, K.H., Jones, C.M., Brown, T.L., 1994. Angler survey methods and their applications in fisheries management. Am. Fish. Soc. Spec. Publ. 25, Bethesda, Maryland.

Quast, J., Krüger, F., Görlach, J., Ritzmann, A., Steidl, J., 1997. Fischaufstiegsanlagen und ökomorphologischer Zustand der Hauptfließgewässer in Brandenburg. Bericht 29 des Zentrum für Agrarlandschafts- und Landnutzungsforschung e.V., Müncheberg.

Salant, P., Dillman, D.A., 1994. How to Conduct your Own Survey? John Wiley and Sons, New York.

Schramm Jr., H.L., Dennis, J.A., 1993. Characteristics and perceptions of users and nonusers of an urban fishery program in Lubbock, Texas. N. Am. J. Fish. Manage. 13, 210–216.

Schramm Jr., H.L., Edwards, G.B., 1994. The perspectives on urban fisheries management. Fisheries 19 (10), 9–15.

Statistisches Bundesamt, 2006. Die Bundesländer: Strukturen und Entwicklungen. Statistisches Bundesamt, Wiesbaden.

Vaske, J.J., Donnelly, M.P., Heberlein, T.A., Shelby, B., 1982. Differences in reported satisfaction ratings by consumptive and nonconsumptive recreationists. J. Leis. Res. 14, 195–206.

Wolter, C., Vilcinskas, A., 2000. Characterisation of fish species diversity in waterways and urban waters. Wasser Boden 52, 14–18.

Wolter, C., Minnow, J., Vilcinskas, A., Grosch, U.A., 2000. Long-term effects of human influence on fish community structure and fisheries in Berlin waters: an urban water system. Fish. Manage. Ecol. 7, 97–104.

Wolter, C., Arlinghaus, R., Grosch, U.A., Vilcinskas, A., 2003. Fische & Fischerei in Berlin. VNW Verlag Natur & Wissenschaft, Solingen.