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ARTICLE

Economic impact of resident and nonresident marine anglers to the local economy in Mecklenburg-Western Pomerania, Germany

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Abstract

Recreational fisheries catches are increasingly considered in the assessment and management of mixed recreational-commercial marine fisheries, while the contribution of recreational fisheries to the economy is often overlooked. Using a telephone diary survey targeting marine recreational anglers in Germany, we estimated the number of anglers and their expenditures over the course of 1 year (2014–2015). About 197,000 marine anglers spent €248 million in Germany. We then constructed regional input–output models and contrasted the economic impacts of resident and nonresident anglers fishing in coastal and transitional brackish waters of the state of Mecklenburg-Western Pomerania in north-eastern Germany. On a regional scale, the total economic impact was €210 million supporting 2044 jobs, nonresident anglers were responsible for eight times greater economic impact than resident anglers. Maintaining attractive fishing opportunities for the recreational fishing sector, specifically angling tourism, is critical for maintaining resource flows to local and regional economies.

KEYWORDS
angling tourism, economic impact, expenditures, input–output analysis, nonresident anglers, recreational fisheries

1 | INTRODUCTION

Marine recreational fishing is a globally important leisure activity with high participation and millions of users (Arlinghaus et al., 2015, 2019). While the eco-evolutionary impact of recreational fishing on fish stocks (e.g., Cooke & Cowx, 2004; Lewin et al., 2006; Post et al., 2002; Radford et al., 2018) and in some cases also on habitat of the marine environment (Lewin et al., 2019) has received academic attention, the economic impact of marine recreational fisheries is less studied (e.g., see Cisneros-Montemayor & Sumaila, 2010;

Lew & Seung, 2019; Southwick et al., 2018). While economic impact studies of recreational fishing have a long tradition particularly in the USA (e.g., Steinback, 1999; Storey & Allen, 1993), such studies are rare in Europe and often only focus on a segment of the recreational fishery (Borch et al., 2011; Hyder et al., 2017, 2018; Pita et al., 2018, 2022; Williams et al., 2020). Hence, economic information of marine recreational fisheries is rarely used to inform the management of recreational fisheries (Potts et al., 2019). One problem associated with economic valuation is that concepts and terms are often misused or misunderstood and economic information is regularly misapplied, particularly by political lobbyists to affect decisions on how to allocate marine resources between commercial and recreational fisheries (Edwards, 1991; Scheufele & Pascoe, 2022). In particular, the difference between economic value (the microeconomic value of fishing to the individual participant above the costs incurred in fishing) and economic impact (the macroeconomic output in economies related to expenditure by anglers) and how to use these concepts in allocation decisions is a source of continued confusion and debate (Edwards, 1991; Scheufele & Pascoe, 2022). Economic impact studies track the flow of money generated through recreational fishing activity and are an indicator of the importance of the activity to a local or regional economy, specifically when new money generated in the region would probably not exist without recreational fishing (Weithman, 1999). Expenditure-based studies measure economic activity within the economy, not the value of fishing to the individual participant, so expenditure is not suitable as an indicator of quality of a recreational fishing experience (Edwards, 1991).

The economic contribution of recreational fisheries in terms of economic impact and associated employment is a metric that is popular in public debates among policymakers, despite the conceptual issues economic impact has when justifying allocation decisions (see Edwards, 1991 for full account). Economic impact and employment metrics are especially relevant when the societal contribution of recreational fisheries is compared with other sectors that use or affect aquatic ecosystems (e.g., commercial fisheries) and are therefore often suggested to be one of the primary data needs for justifying investments into a local or regional fishery (Welcomme, 2001). While these data are often available for commercial fisheries through public trade statistics, this is not the case for recreational fisheries.

Many coastal communities that were largely dependent on commercial fishing are becoming more reliant on tourism (Hall, 2001) and marine recreational fisheries are increasingly contributing to this trend (Borch et al., 2011; Ditton et al., 2002). Nonresident anglers traveling into a region spend money on a range of goods and services including fishing tackle, boats, licenses, traveling, and accommodation (Pita et al., 2018; Williams et al., 2020). These expenditure flows are rarely differentiated between their national and regional contribution (Poudel et al., 2018). The regional contribution by tourists is particularly important to capture as the flow of new money into a region that would likely not be present in that region without this tourism. For developing angling tourism and destinations to attract more anglers in the future, proportions of nonresident and resident anglers in an area and their relative economic impact are important to know. Our objective was to quantify national and regional economic impacts of marine recreational fishing by resident and nonresident anglers in Mecklenburg-Western Pomerania (M-V), Germany, during the 2014–2015 angling season to determine the basis for development goals. To achieve our objective, we (1) estimated the total numbers of marine anglers in Germany, (2) collected recreational fisheries expenditure data and built regional input–output tables, (3) estimated the total economic impact of marine angling on national and state level, and (4) identified the relevance of nonresident and resident anglers, particularly for fishing tourism.

2 | MATERIALS AND METHODS

2.1 | Study area

Marine recreational fishing in Germany occurs in two very different seas. In the North Sea, large tidal flats and challenging sea conditions make shore fishing the most popular fishing platform. In the Baltic Sea, alternating sandy beaches and rocky shores, including coastal lagoons (hereinafter called by their German name "Bodden") along the German Baltic coast attract resident and nonresident anglers from all over Germany mainly for angling from boats (Arlinghaus, Braun, et al., 2023; Koemle et al., 2022; Weltersbach et al., 2021). For this study, we focused on one of two German federal states bordering the Baltic Sea, the federal state of Mecklenburg-Western Pomerania (M-V). The coastline of M-V features a large number of transitional water bodies and brackish lagoons (Figure 1). Most of these lagoons are choked, characterized by brackish water, and a mix of freshwater, marine, and diadromous fish species (Arlinghaus, Rittweg, et al., 2023; Schubert & Telesh, 2017; Winkler & Schröder, 2003). Coastal fishing in M-V occurs in both the Baltic Sea and in the Bodden waters. The most important target species for Baltic Sea anglers are cod (*Gadus morhua*), sea trout (*Salmo trutta*), various flatfishes (*Pleuronectoidei*), and herring (*Clupea harengus*) (Weltersbach et al., 2021). Pike (*Esox lucius*), pikeperch (*Sander lucioperca*), perch (*Perca fluviatilis*), herring (*Clupea harengus*), and garfish (*Belone belone*) are the most important target species in the Bodden waters (Weltersbach et al., 2021). Recreational fisheries in M-V are generally open access but anglers must have a valid German fishing license and an additional coastal fishing permit (Arlinghaus et al., 2021).

2.2 | Telephone diary study

No national or state angler registry exists, therefore, the total number of marine anglers in Germany is unknown. To estimate the total number of marine anglers and their annual fishing expenditures, a telephone screening survey of the German population in 2014–2015 was conducted. This representative nationwide survey was based on a computer-assisted telephone interview (CATI)

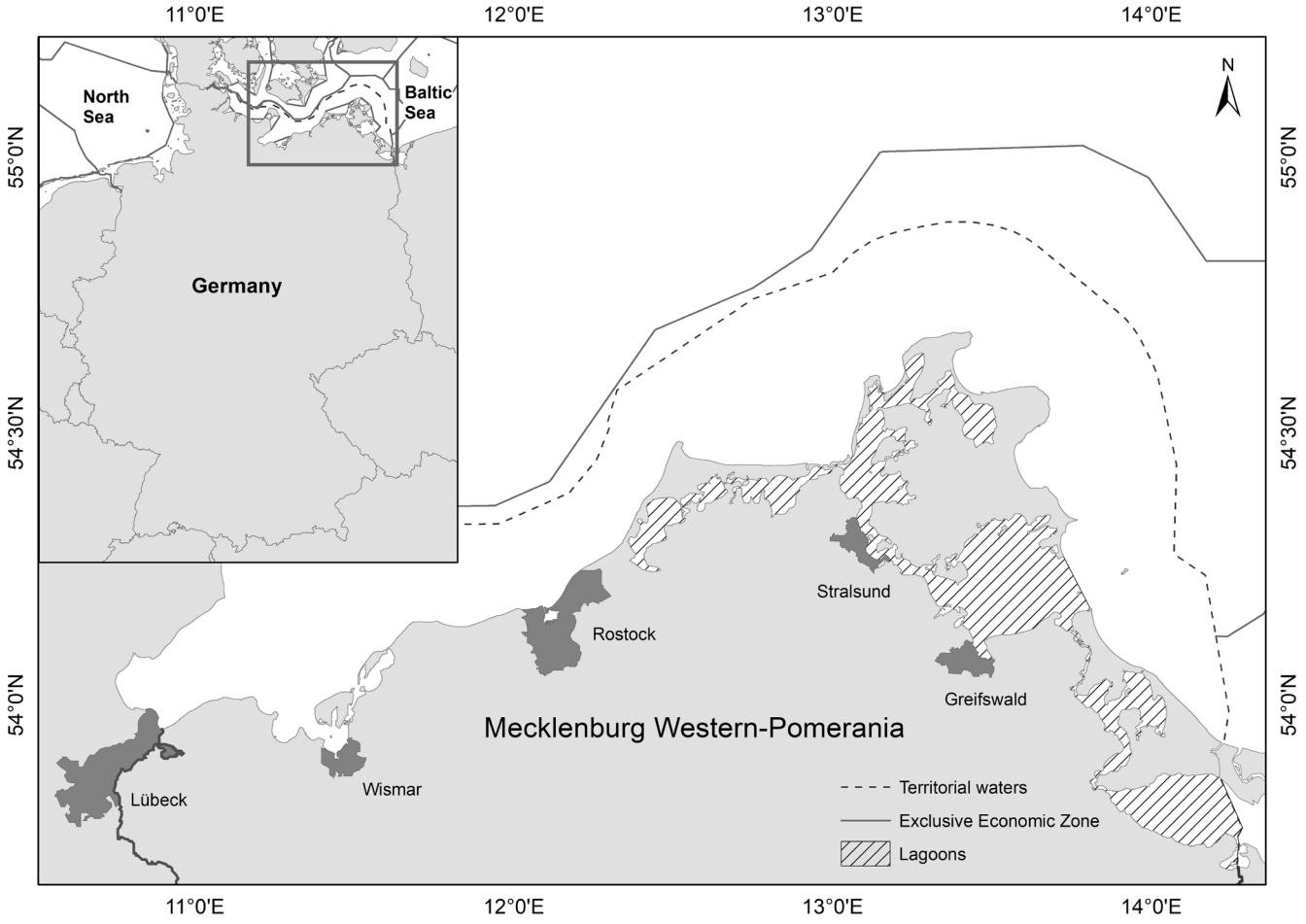

FIGURE 1 Overview of the study area in Germany with the bordering North and Baltic Sea. The detailed map shows the state of Mecklenburg Western-Pomerania in northern Germany, large cities and the bordering Baltic Sea with its various lagoons.

design using random digit dialing (RDD) to generate telephone numbers and contact households, with selection probabilities being proportional to the number of households per municipality. For reasons of cost–benefit, the CATI interviews were conducted in 9 out of 16 German federal states. For the other federal states, angler incidences were estimated using a set of reference federal states (Weltersbach et al., 2021). Up to eight attempts were made to contact households, after which telephone numbers were considered quality-neutral failures. Of 358,411 telephone numbers generated, a gross random sample of 73,213 valid telephone numbers yielded a net random sample of 50,200 telephone interviews (68% screening response rate). A marine angler was defined as a person who had fished at least once in German marine waters, including the Bodden waters, during the last 12 months preceding the survey. During the telephone screening survey, sociodemographic variables of the German marine angler population were collected, and participants were recruited for a subsequent 1-year diary study, similar to Lyle et al. (2002) and Dorow and Arlinghaus (2011). To maintain motivation, retrieve diary data, and reduce recall and nonresponse bias, participants were contacted by telephone follow-ups at quarterly intervals during the entire 1-year observation period. Data were collected between April 2014 and October 2015. Household size and number of marine anglers in the household were determined by the interviewer through inquiry. The representative sample was enhanced with an additional nonrepresentative boost sample to increase the number of diarists. This boost sample consisted of persons who bought a fishing permit for coastal waters of M-V and volunteered online to participate in scientific studies of the Thünen Institute of Baltic Sea Fisheries.

All diary participants were asked to report each individual angling day spent in German coastal waters (including the Bodden waters) over a 12-month period starting from the day they received the diary. For every angling day, the particular fishing area, angling platform (boat, charter boat, or shore), target species, and number of fish caught, harvested, and released were recorded. During the quarterly follow-up calls, panelists were asked to recall their marine recreational fishing expenditures for the preceding 3 months based on a set of categories provided: transport, accommodation, meals, charter vessels, rented boats, own boat, gear, clothes, licenses, media, and others. Quarterly phone surveys have been shown to produce more representative and less-biased estimates of recreational fishing efforts and expenditures than surveys with 12-month recall (Connelly et al., 2000). The telephone

screening survey, the diary study, and quarterly follow-up calls were conducted by an experienced market and social research company (USUMA GmbH, Berlin, Germany) under the supervision of some of the authors.

Data were grouped into two strata: anglers resident in M-V (resident anglers) and anglers resident outside of M-V but within Germany (nonresident anglers) who traveled to M-V to fish in marine waters. To obtain a representative estimate of the size of the German marine angler population and their corresponding fishing expenditures, a design weight was applied to adjust for nonresponse bias depending on the household size following Dorow and Arlinghaus (2011). Nonrepresentative data from the boost sample were also weighted with representative data from the CATI screener using an iterative proportional fitting approach (Battaglia et al., 2009; Gabler et al., 1994; for details on the weighting procedure, see Weltersbach et al., 2021). Expenditure data were extrapolated to the total population based on information collected in the telephone survey to estimate total annual expenditures separately for resident and nonresident anglers. This approach included values from two random distributions, so total numbers of anglers in each population, panel-based expenditures, and 95% confidence intervals around extrapolated expenditure figures were estimated using parametric bootstrapping with replacement. Specifically, empirical expenditure data, from weighted panel data (including zero values), were summed separately for resident and nonresident anglers. To that end, a normal distribution of total expenditures was constructed from summed expenditures per category (with replacement), and the normal distribution of the total number of anglers was used to estimate the mean and standard deviation of the distribution ($N = 10{,}000$ samples per angler group). The resulting distribution from 10,000 samples was used to calculate the 2.5% and 97.5% percentiles. Because bootstrapping needed specific population estimators for each stratum (corresponding to the *n*s of the groups for resident, nonresident, or both), values for each output vector (upper, lower, and total) differed slightly. In other words, sums of resident and nonresident expenditure categories, total economic output, and generated jobs did not equal the exact number for the total.

Estimation of total numbers of anglers fishing in the North Sea, Baltic Sea, and Bodden waters was based on selecting anglers from the nationwide CATI sample that had reported to have fished at least 1 day in the past 12 months in respective fishing areas. For regional estimation of the total numbers of anglers fishing in the Baltic Sea in M-V, Bodden only, or mix area (Baltic Sea & Bodden waters) estimation was based on the proportions of reported fishing areas from the angler diaries. For this estimation, only diary entries from the representative sample were used to reflect angling behavior. The resulting differences between the total number of anglers in each group (Bodden resident and nonresident anglers) and CATI data were considered acceptable because angling effort in the CATI was based on a 12-month recall period, which is often associated with strong bias (Connelly & Brown, 2011; Lewin, Weltersbach, Haase, Riepe, et al., 2021). Similarly, expenditure estimation was based on diary entries for the respective fishing area matching actual angling behavior. Expenditure estimation for the mixed angler group (anglers that had fished in both the Baltic Sea and Bodden waters in M-V) was divided proportionally to the number of fishing trips made in the Baltic Sea and the Bodden waters, and added to respective fishing strata to estimate coastal and lagoon fishery expenditures. Expenditures related to machinery and equipment were not depreciated because total expenditures of all anglers were analyzed rather than the annual expenditures of a specific group of anglers.

2.3 | Expenditure categories

Expenditure categories used to collect angling-related expenditures, purchases of durable goods (such as fishing rods and boats), and semi-durable goods (such as fishing tackle, licenses, and special clothing) related to fishing were separated into the European Classification of Products by Activity (CPA), a classification of products (goods and services) for use in the subsequent input–output analysis. To classify a product, essential elements of the product to be classified must be defined (Eurostat, 2008). Products, like activities, can consist of several components (Eurostat, 2008). For example, expenditure for an owned boat was distributed two-thirds to CPA category 30 (other vehicles) and one-third to CPA category 33 (repair, maintenance and installation of machinery and equipment), based on the industrial origin of goods and services in NACE, the statistical classification of economic activities in European Communities (the acronym is derived from the French name "Nomenclature générale des Activités économiques dans les Communautés Européennes") (Eurostat, 2008). Assumptions used to differentiate between money spent in M-V and in the other 15 federal states (the rest of Germany) are listed in Table 1. For example, we assumed that transportation expenditures by resident anglers were fully spent in M-V, whereas we assumed that nonresident anglers spent only 50% of their transportation expenditures in M-V, while spending the rest for traveling outside M-V.

2.4 | Input–output analysis

A widely used approach for assessing the wider economic importance of activities or entities is input–output analysis, a classical approach dating back to the seminal work of Leontief (1986), but still subject to methodological improvements, especially in the field of regional analyses (Flegg & Tohmo, 2013; Jahn, 2017; Kowalewksi, 2015). An input–output model connects the output of any economic sector to intermediate inputs into production stemming from all other sectors in the economy and to final demand. Any additional demand for products of one sector leads to direct effects as an additional output and value added in that sector as well as to indirect effects stemming from increased production of intermediate goods and to further induced effects from additional income spent by workers employed in all industries. The economic impacts reported in the results section below are total economic effects corresponding to direct + indirect + induced effects.

TABLE 1 Distribution of expenditures within CPA categories and relative share and proportion of resident and nonresident anglers per expenditure category in Mecklenburg-Western Pomerania (M-V), Germany, during the 2014–2015 fishing season.

		Money spent in	M-V		Rest of Germany	
CPA category	Share	Expenditure category	Resident	Nonresident	Resident	Nonresident
49	1	Transportation (fuel, rental car, public transportation, etc.)	1	0.5	0	0.5
55–56	1	Accommodation	0.9	0.9	0.1	0.1
10–12	1	Food (groceries and restaurants)	0.9	0.9	0.1	0.1
50	1/3	Charter vessels and guiding	1	1	0	0
74–75	1/3					
79	1/3					
77	1	Boat rental (including fuel)	1	1	0	0
30	2/3	Boat (fuel, maintenance, equipment, mooring)	1	0.2	0	0.8
33	1/3					
27	1/3	Fishing tackle and gear	0.5	0.3	0.5	0.7
47	2/3					
13–15		Special clothing	0.5	0.3	0.5	0.7
93		Fishing licenses and permits	1	0.6	0	0.4
18	0.5	Media (books, magazines, DVDs, etc.)	0.5	0.6	0.5	0.4
59–60	0.5					
61	1/3	Other	0.5	0.5	0.5	0.5
62–63	1/3					
96	1/3					

In the most basic form, an input–output model calculates effects of additional final demand, such as angling-related expenditures, on production via the following formula:

$$\Delta X = (I - A)^{-1} \Delta E, \tag{1}$$

where X is the vector of sectoral outputs, ΔX is its change after an expenditure shock, ΔE is the vector of angling-related expenditures in each economic sector (treated as an exogenous shock), I is an identity matrix, and A is the core element of the model, a matrix of technical coefficients (a_{ij}) representing intermediate input of sector i per unit of output of sector j. $(I-A)^{-1}$ is the so-called Leontief inverse. Summing columns of the Leontief inverse gives the output multipliers of each industry j. Effects on factor inputs Y (including employment) are calculated as:

$$\Delta Y = V \Delta X, \tag{2}$$

where V is a matrix of technical coefficients v_{kj} representing the final input of factor k per unit of output of sector j. This formula was used to calculate employment impacts ΔY in terms of full-time equivalents (FTEs = jobs, hereinafter referred to as jobs).

The input–output model we used was based on the (type B) input–output table for Germany for the base year 2013 (Destatis (Statistisches Bundesamt), 2017). The input–output model included 72 economic sectors corresponding to the statistical classification of economic activities (NACE) covering all key activities: agriculture, mining, manufacturing, transport, infrastructure, trade, and services. Technical coefficients for the national model were calculated from the input–output table, where all transactions were measured in producer prices. Additional data used to regionalize input coefficients to specific conditions in M-V included employment data from the Federal Employment Agency, taxes, wages, and trade balance statistics from regional statistical offices of the corresponding federal states.

Regionalization to the level of federal states (in particular, Mecklenburg-Western Pomerania) was based on Flegg's Location Quotient methodology (Flegg & Tohmo, 2013) for estimating interregional trade flows, as applied to Germany in Kronenberg and Többen (2013). Equations applied in this step were:

$$FLQ_{ij} = \frac{L_i^R / L_i^N}{L_j^R / L_j^R} * \left(log_2 \left[1 + \left(\frac{L^R}{L^N} \right) \right] \right)^{\delta} \text{ if } i \neq j, \tag{3}$$

$$FLQ_{ij} = \frac{L_i^R / L^R}{L_i^N / L^N} * \left(log_2 \left[1 + \left(\frac{L^R}{L^N} \right) \right] \right)^{\delta} \text{ if } i = j, \tag{4}$$

$$a_{ij}^R = \begin{cases} a_{ij}^N & \text{if } FLQ_{ij} \geq 1 \\ FLQ_{ij} * a_{ij}^N & \text{if } FLQ_{ij} < 1 \end{cases}, \tag{5}$$

where L^N and L^R were national and regional total employment, L_i^N and L_i^R were national and regional employment in a given sector i, δ was a convexity parameter, 0.2 (median value in Kronenberg and Többen (2013)), and FLQ_{ij} was the resulting adjustment coefficient. The a_{ij}^R-s were the sought regionalized technical coefficients, which were then inserted into Equations (1) and (2) to calculate changes in sectoral output and employment. The adjustment from national to

regionalized technical coefficients occurred if $FLQ_{ij} < 1$, which was the case for 75% of all coefficients in the calculations.

This procedure used detailed employment data (number of employees by region and sector) to distribute intermediate and factor input values from the national input–output table across regions. The basic assumption was that technology in each sector did not vary across space. To arrive at realistic regionalized input coefficients, several constraints were considered in Flegg's Location Quotient approach. First, if a certain sector in a given region was relatively small in national comparison, this region would need to import products from other regions. Second, imports did not need to take place if sectors using these products as inputs were also comparatively small in the region. Finally, smaller regions on average needed to import a larger share of their intermediate inputs. These considerations led to the calculation of regional input coefficients that consistently adjusted respective values from the national input–output table.

3 | RESULTS

3.1 | Participation, effort, and expenditure

The screening survey identified 562 German households with marine anglers. In total, 586 participants (63% of the random plus boost sample of $n = 930$) provided diary data and participated in all four quarterly follow-up calls submitting expenditure data. In 2014–2015 ~ 197,000 German marine anglers spent €248.4 million on fishing-related goods and services in the North and Baltic Sea, including the Bodden waters (Table S1), with 161,000 anglers fishing in the German Baltic Sea, 49,000 anglers fishing in the Bodden waters, and 32,000 anglers fishing in the German North Sea (Table 2). Resident and nonresident anglers fishing in the German Baltic Sea and Bodden waters in the state of M-V spent €111.6 million (total spent in Germany and M-V) over the course of the year (Table 3).

In the federal state of M-V, 125,000 anglers fished in coastal waters, of which 77,000 fished in the Baltic Sea, 22,000 fished in the Bodden waters, and 26,000 fished in both the Baltic Sea and the Bodden waters (Table 2). Half of these anglers were nonresident anglers from other federal states of Germany, with 66% fishing in the Baltic Sea and 34% fishing in the Bodden waters.

German marine anglers fished more than 1.6 million days in the North and Baltic Sea, including the Bodden waters in 2014–2015. Anglers fished 1.2 million days in the Baltic Sea, 332,000 days in the Bodden waters, and 147,000 days in the North Sea in 2014–2015. Fishing was mainly from boats in the Baltic Sea and the Bodden waters and from shore in the North Sea (Weltersbach et al., 2021).

In the region of M-V, anglers spent €57.9 million on fishing activities, of which €35 million was spent fishing in saltwater and €22.9 million fishing in the Bodden waters (Table 3). Nonresident anglers spent the largest share (89%) of fishing-related expenditures in M-V (€51.3 million), with €16.6 million in the Bodden waters and €34.7 million in the Baltic Sea.

In the Baltic Sea in M-V, nonresident anglers spent the most on their own boats, whereas resident anglers spent the most on fishing gear (Table 3). For fishing in the Bodden waters in M-V, nonresident anglers spent the most on fishing gear (rod and reels, tackle, etc.), whereas resident anglers spent the most on their own boats (Table 3). Nonresident anglers spent more on regional expenses, particularly transportation (€6.8 million), accommodation (€11.6 million), and meals (€8.0 million) than resident anglers.

3.2 | Economic impact and employment

Expenditures by all German marine anglers generated €472 million in total output value in the German economy and supported 4534 jobs (Table S14). Marine anglers (residents and nonresident) fishing in the German Baltic Sea and the Bodden waters accounted for €412.9 million in total economic impact and supported 3777 jobs (Table S13). On a regional scale, the total economic impact (M-V + Rest of Germany) associated with coastal recreational angling in the state of M-V was €210 million and 2044 jobs

	Number anglers (*n*)	CI_W lower limit (*n*)	CI_W upper limit (*n*)
Germany			
Marine anglers	196,656	181,881	212,959
Baltic Sea anglers	161,450	148,768	177,114
Bodden water anglers	48,706	42,257	57,951
Mecklenburg-Western Pomerania			
Baltic Sea anglers (resident)	35,496	32,708	38,940
Baltic Sea anglers (nonresident)	41,221	37,983	45,221
Bodden water anglers (resident)	27,275	23,664	32,458
Bodden water anglers (nonresident)	21,431	18,593	25,503

Note: CI_W = 95% confidence interval according to Wilson. *n* = estimated number of anglers. Differences in the proportion of nonresident and resident anglers to Weltersbach et al. (2021) result from the assignment of mix-anglers (Baltic Sea and Bodden waters) from the diary to both groups.

TABLE 2 Number of recreational anglers fishing in Germany and Mecklenburg-Western Pomerania (M-V), in marine and transitional waters, including the Bodden in M-V, in the fishing season 2014–2015 as estimated from a telephone diary study (survey-based and extrapolated for the northern states, estimated and extrapolated for the southern states) in marine and transitional waters.

TABLE 3 Expenditures in Germany and Mecklenburg-Western Pomerania (M-V) of recreational anglers fishing in German marine waters and transitional waters, including the Bodden in M-V, in the fishing season 2014–2015 as estimated from a telephone diary study (survey-based and extrapolated for the northern states, estimated and extrapolated for the southern states).

	Germany		Mecklenburg-Western Pomerania			
			Baltic Sea anglers		Bodden anglers	
	Marine anglers	Baltic Sea and Bodden anglers	Residents	Nonresidents	Residents	Nonresidents
Transport	32,858,386.00	28,593,135.00	453,949.85	9,442,154.52	750,607.00	4,157,195.00
Accommodation	27,494,443.00	24,588,534.00	80,468.85	8,554,843.59	92,987.69	4,400,934.00
Meals	19,806,355.00	17,103,241.00	148,701.70	5,710,374.30	160,476.00	3,138,775.00
Charter vessels	9,880,920.00	8,388,662.00	149,649.16	2,609,533.55	171,968.75	319,409.70
Motorboats (rented)	8,413,156.00	7,619,912.00	165,039.06	1,949,847.76	204,288.40	2,221,618.00
Angling boats (own)	54,129,401.00	47,044,454.00	636,623.44	17,489,149.04	2,079,173.50	4,118,995.00
Gear	48,122,098.00	42,579,313.00	1,032,284.72	11,399,375.60	1,818,240.90	6,669,122.00
Clothes	12,210,777.00	10,909,584.00	277,723.12	3,169,658.30	515,557.60	1,434,031.00
Licenses	8,877,763.00	7,799,834.00	296,625.30	1,955,130.78	760,629.30	1,082,240.00
Media	4,588,412.00	3,985,347.00	51,562.09	1,003,072.67	126,300.16	564,579.10
Other	21,987,884.00	18,730,815.00	591,447.67	5,863,428.91	1,787,024.50	2,001,014.50
Total	248,369,595.00	217,342,831.00	3,884,074.95	69,146,569.04	8,467,253.80	30,107,913.30

Note: Please note that the total is the summed value of expenditure categories and deviates from the CPA sum in the supplement tables as these are based on Ns from different sample sizes. Marine anglers: North Sea, Baltic Sea, and Bodden.

(Figures 2 and 3). The contribution of marine recreational fisheries in the Baltic Sea in M-V to the economic impact was 66%, while 34% came from fishing in the Bodden waters. In M-V, coastal recreational angling (Baltic Sea and Bodden waters together) generated €113.1 million of economic impact and 1129 jobs, with €70.5 million and 709 jobs in the Baltic Sea and €42.6 million and 420 jobs in the Bodden waters (Figures 2 and 3).

Resident recreational anglers in M-V generated €23.1 million in total economic output and 217 jobs in 2014–2015 (Figures 2, 3). Of the total economic impact from residents, €17.4 million and 156 jobs were directly generated in M-V and the rest in other parts of Germany (Figures 2 and 3). Resident anglers fishing in the Bodden waters (€11.9 million and 105 jobs) generated twice the economic impact and jobs as those fishing in the Baltic Sea (€5.5 million and 51 jobs).

Nonresident anglers contributed 89% of the total economic impact (€187 million and 1827 jobs). Marine fishing in the Baltic Sea in M-V by nonresident anglers generated €130.6 million in total economic output and supported 1256 jobs. Nonresident anglers fishing in the coastal waters of the Bodden generated €56.4 million and supported 571 jobs. In M-V, nonresident anglers generated €65.0 million and 658 jobs when fishing in the Baltic Sea and €30.7 million and 315 jobs when fishing in the Bodden waters (Figure 3). The ratio of in-state to out-of-state economic impact and employment effects from nonresident anglers was 1:1 for fishing in the Baltic Sea and 3:2 for fishing in the Bodden waters (Tables S1–S12).

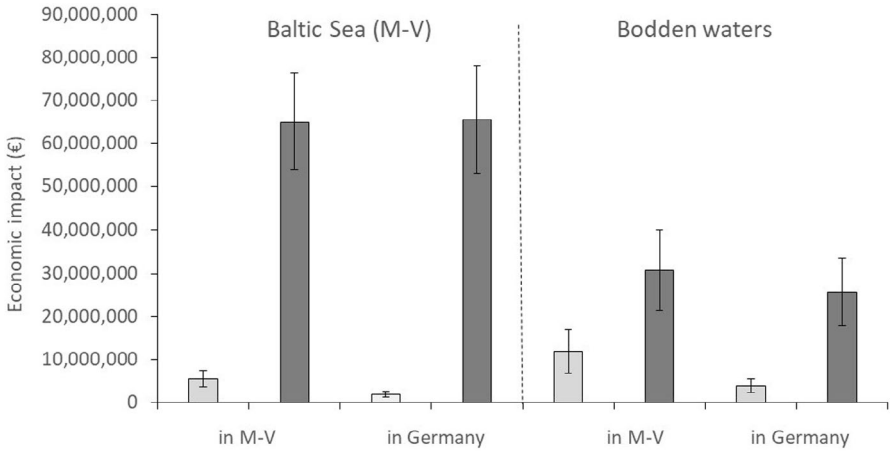

FIGURE 2 Economic contribution of resident (light gray) and nonresident (dark gray) anglers in the state economy of Mecklenburg-Western Pomerania (M-V) and in Germany (other German federal states) fishing in marine and transitional waters, including the Bodden in M-V, in the fishing season 2014–2015 as estimated from the input–output analysis. The 2.5% and 97.5% quantiles were estimated based on the 95% confidence intervals from bootstrapping the extrapolated expenditure figures ($N = 10{,}000$ samples per resident group, see Tables S1–S12 for a detailed overview of economic impact per CPA).

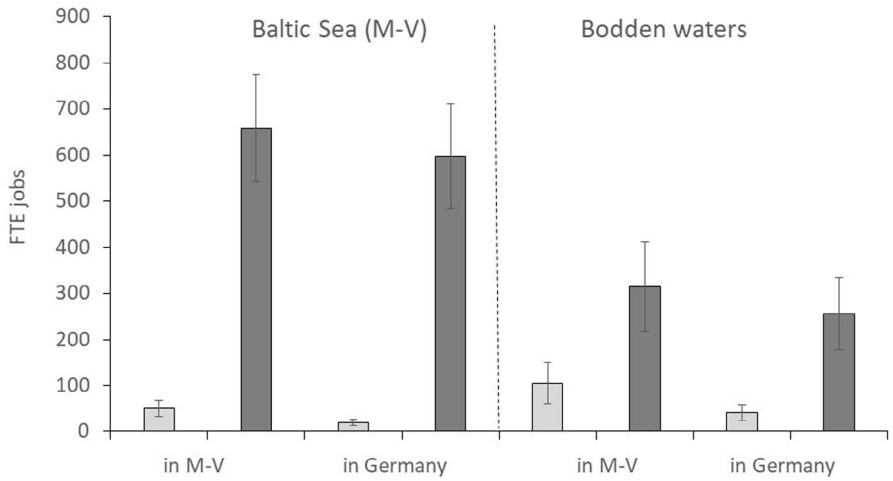

FIGURE 3 Employment effects in terms of full-time equivalents (FTEs) of resident (light gray) and nonresident (dark gray) anglers in the state economy of Mecklenburg-Western Pomerania (M-V) and in Germany (other German federal states) fishing in marine and transitional waters, including the Bodden in M-V, in the fishing season 2014–2015 as estimated from the input–output analysis. The 2.5% and 97.5% quantiles were estimated based on the 95% confidence intervals from bootstrapping the extrapolated expenditure figures ($N = 10{,}000$ samples per resident group, see Tables S1–S12 for a detailed overview of FTEs per CPA).

4 | DISCUSSION

Our study showed that the economic impact of marine recreational fisheries in Germany and that of resident and nonresident anglers was important for the local economy in M-V in 2014–2015. The economic impact of expenditures from nonresident anglers fishing in the Baltic Sea and the Bodden waters in M-V in 2014–2015 was eight times larger than that of resident anglers. More than half of all jobs resulting from marine and coastal fishing in M-V were generated directly in M-V. The estimates are conservative because they are based on recalled expenditure data using expense categories as memory joggers (recall aids), so all angling-related expenses were not likely included, such as incidental purchases by nonfishing companions (Steinback, 1999).

We did not account for angler heterogeneity of target species, fishing platforms, or income, but rather on individual angler trip data to extrapolate estimates to the whole Baltic Sea and Bodden waters angler population. However, different angler types, such as herring or Atlantic salmon (*Salmo salar*) anglers, and their associated spending patterns may be important for individual municipalities for future campaigns and structural considerations (e.g., harbor expansions). Similar recent studies in Europe are rare, but total economic impact of marine recreational fishing in Europe was €10.5 billion and 100,000 jobs (Hyder et al., 2017). In England, marine recreational fisheries contributed €2.41 billion (conversion rate from British pound to euro was €1.15) to the economy and supported 23,600 jobs (Roberts et al., 2017), roughly four times as much as in Germany. In the entire UK, the total economic impact of marine recreational fisheries was €1.93 billion (conversion rate from British pound to euro was €1.22) and provided €399 million of gross value added and supported 13,600 jobs in 2016, and €2.21 billion (conversion rate from British pound to euro was €1.14) provided €443 million of gross value added and supported 16,300 jobs in 2017 (Hyder et al., 2020). In Massachusetts (USA), expenditures by nonresident marine anglers generated €41.2 million (conversion rate from US dollar to euro was €0.77) and supported 3300 jobs, while expenditures by residents generated €227.5 million and supported 16,000 jobs (Storey & Allen, 1993). In Norway, the total economic impact of marine fishing tourism was €112.8 million and 1800 jobs (Borch et al., 2011). In New Zealand, the economic contribution of marine recreational fisheries was €1.8 billion (conversion rate from NZ dollar to euro was €0.64) and supported 8000 jobs (Southwick et al., 2018). In France, total expenditures on marine recreational fisheries were €1.26 billion (Herfaut et al., 2013). In South Africa, economic activity associated with recreational fishing was €2.0 billion (conversion rate from ZAR to euro was €0.06) and supported 94,000 jobs, of which just over half were associated with marine recreational fishing (Potts et al., 2021).

We found that economic impacts generated by nonresident anglers were generally higher than those of resident anglers, similar to results of an onsite survey along the German Baltic Sea coast based on travel distances that found a high percentage of nonresident anglers traveled distances of more than 200 km to the coast (Lewin, Weltersbach, Haase, & Strehlow, 2021). In contrast, resident angler impacts were consistently higher than those of nonresident anglers in the US (Steinback et al., 2004). Similar to our findings, only 30% of all German Baltic Sea anglers originated from one of the two coastal federal states (Strehlow et al., 2012; Weltersbach et al., 2021). Differences between relative economic impacts by resident and nonresident anglers in the US and Germany could result from the much larger size of coastal U.S. states that encompass most of the angling population, compared to the relatively small size of German coastal federal states that draw a higher proportion of nonresident anglers participating in marine recreational fishing. Similar to our findings, the impacts of nonresident angler expenditures were five times greater than resident anglers in the marine party and charter boat fishery of Maine, USA (Steinback, 1999), indicating that coastal recreational fishing, which is attractive to nonresident anglers, contributes new money to the local economy and provides social welfare in expenditure-dependent economic sectors.

Our estimates did not account for the effect of imports and thus may overstate fishing-related impacts because the actual effect of angler expenditures on regional and national economies depends on the level of imports of all goods and services that anglers purchase (Steinback et al., 2004). For example, in a study of the regional effects of angler expenditure in the U.S., imports were 20–66% on a state level and 11% on a national level (Steinback et al., 2004). These imports would need to be deducted from fishing expenditures prior to estimating regional and national economic impacts in our study.

Some of the main target species of marine and coastal recreational fisheries in Germany have either recently collapsed or their stocks are in a poor state, including the eastern and western Baltic cod (ICES, 2021a, 2022a; Möllmann et al., 2021), western Baltic spring spawning herring (ICES, 2021b; Polte et al., 2021), Atlantic salmon (ICES, 2022b), and coastal northern pike (Olsson et al., 2023; van Gemert et al., 2022). Despite a lack of knowledge about the economic and social impacts of regulations on marine recreational fisheries, restrictive harvest regulations and even complete fishery closures have been introduced, and sometimes reduced recreational fishing opportunities considerably leading to welfare losses in the recreational fisheries sector (Bronnmann et al., 2023; Koemle et al., 2022). For example, reduced daily bag limits diminished the utility of angling by German cod anglers and thereby caused a substantial welfare loss (Bronnmann et al., 2023). Moreover, German cod anglers were willing to pay to catch and harvest cod, which suggested that a poor stock status and stricter regulations can reduce participation and shift fishing efforts to other species or fisheries (Bronnmann et al., 2023), thereby reducing resource flows to regional and national economies. Similar developments can be observed in the Bodden pike fishery, which has lost considerable attractiveness to nonresident anglers due to stock declines and travel restrictions associated with the COVID-19 pandemic (Arlinghaus, Braun, et al., 2023). Future research should investigate substitution by anglers in the Baltic Sea or the Bodden waters, such as switching target fish species, switching to freshwater angling over sea angling, or choosing other angling destinations outside Germany (e.g., Norway, the

Netherlands), pursuing other recreational activities, or withdrawing from recreational fishing altogether.

We found that state-wide recreational saltwater and coastal water fishing generated €113.1 million in total production volume and supported 1129 jobs in M-V, which was much lower than the total tourism sector in M-V of €4.1 billion and 131,300 jobs (WM, 2018). The tourism sector in M-V is the most important economic sector of all, so marine recreational fishing, especially by nonresident anglers, despite being relatively small at present, is a development target that should be linked to regional tourism development. Marketing M-V as a fishing destination could develop untapped value-added potential, especially since some of the nonresident money flows outside the peak tourist season in the fall and winter months (e.g., Bodden pike fishing, Arlinghaus, Braun, et al., 2023). Marketing strategies should focus not only on anglers and alternative target species in better stock conditions but also on the attractiveness for their families to increase the number of overnight stays. A marketing concept should specifically identify development potentials and recommendations to strengthen angling tourism in M-V.

We found that marine recreational fisheries contributed more to the German economy (total output = €472 million, gross value added = €214 million, 4534 jobs, this study) than German marine commercial capture fisheries in 2018 (turnover = €357 million, gross value added = €201 million, 1150 employees, BMWi, 2021). The commercial fisheries sector, however, should be viewed including its entire seafood value chain (Gislason et al., 2017; Steinback et al., 2004). When incorporating the entire value chain of German marine capture fisheries and processing in 2018, turnover was €2.9 billion, gross value added was €691 million, and 8827 employees were supported (BMWi, 2021). Therefore, compared to the overall commercial fishing and processing sector in Germany in 2018, marine recreational fisheries were 31% of the gross value added and 51% of the employment. The sectoral importance of German marine recreational fisheries is likely higher because the commercial processing sector relied mainly on imports (1,240,000 tons), rather than landings (106,000 tons) in 2018 (EUMOFA, 2022). However, these comparisons should not be misused for determining the societal value of marine recreational and commercial fisheries because the value and welfare are measured by consumer and producer surplus, not by economic impact (Edwards, 1991; Scheufele & Pascoe, 2022). Rather, we used this comparison to demonstrate that marine recreational fisheries are a relevant economic industry in Germany.

5 | CONCLUSIONS AND IMPLICATIONS

Marine recreational fishing expenditures made a large contribution to local and national economies in Germany. Fishing expenditures from nonresident anglers accounted for the largest share and associated economic contribution. This shows that fishing tourism must be considered as an economic activity that provides income to coastal communities and their economies from outside that area, where those funds would likely not be present without fishing by nonresident anglers (Kauppila & Karjalainen, 2012). Our work is comparable to previous studies in other parts of the world, underscoring that nonresident angling activity is relevant to regional economies. Although parts of this economic contribution at the local level may be lost due to some substitution by other recreational activities (Ditton & Sutton, 2004), the high share of nonresident anglers in the economic impact shows that the commitment of anglers to fish in coastal regions, such as the one in Germany, is high.

Currently, marine recreational fisheries in Germany are in trouble. Strict bag limits on Atlantic cod were recently implemented in association with the collapse of the western Baltic cod stock (Möllmann et al., 2021), and from Janaury 2024 recreational fishing for cod will be banned. Bag limits for Atlantic salmon haven been cut, coastal eel recreational fishing has been banned, and pike stocks in the Bodden fisheries and associated angling catch rates are in decline (Arlinghaus et al., 2023,b; van Gemert et al., 2022). After implementation of angling harvest limits for German Baltic Sea cod, numbers and travel distances of particular nonresident cod charter vessel anglers decreased (Lewin, Weltersbach, Haase, & Strehlow, 2021). Travel restrictions associated with the COVID-19 pandemic further reduced attractiveness of marine fisheries (Pita et al., 2021), including in Germany (Britton et al., 2023). Changes in the attractiveness of marine recreational fisheries may negatively affect participation by nonresident anglers and thereby reduce the economic impact of angling in the region. Maintaining attractive fishing opportunities is critical to sustain local jobs and the local economy that depend on nonresident angling tourism. While our work was a case study in one region, we think similar implications can be drawn beyond Germany to other marine recreational fisheries in the developed and developing world considering nonresident anglers (Butler et al., 2020).

Currently, nonresident anglers account for 85% of the value added in M-V from recreational fishing in marine and transitional waters. Therefore, knowing the preferences of nonresident anglers is important for policy makers to design experiences that are attractive and maintain or increase demand for marine fishing (Bronnmann et al., 2023; Koemle et al., 2021, 2022). In addition, a goal of the tourism sector should be to increase the length of stay of nonresident anglers (Kauppila & Karjalainen, 2012). Measures should also include the development of family activities so that nonresident anglers come with their families and are incentivized to stay or extend their stay. Acknowledging the economic impact of recreational fisheries by policy makers may help further develop the sector (Potts et al., 2021). Many jobs are created primarily in rural disadvantaged coastal areas in the off-season, when most fishing effort and expenditure are in coastal waters (Weltersbach et al., 2021). Economic impact assessments are also useful in encouraging stakeholder engagement in conservation efforts by demonstrating the economic value of their activities (Smith et al., 2022). Due to its relevant economic importance, especially for structurally weak coastal regions, we recommend that marine recreational fisheries particularly by nonresidents be included in state and national economies, the European Common Fisheries Policy (CFP), and as a sector to be developed under the blue growth strategy.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflict of interest to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available upon request from the corresponding author. The metadata are provided in the supplementary materials.

ETHICS STATEMENT

Data derived from survey respondents were anonymized. Panel members (diarists) were provided a privacy statement declaring how data are processed by the market research company and how it is used and shared with third parties. The statement also included an indication of what measures were taken to protect the privacy of the respondents.

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REFERENCES

Arlinghaus, R., Abbott, J.K., Fenichel, E.P., Carpenter, S.R., Hunt, L.M., Alós, J. et al. (2019) Opinion: governing the recreational dimension of global fisheries. *Proceedings of the National Academy of Sciences of the United States of America*, 116(12), 5209–5213. Available from: https://doi.org/10.1073/pnas.1902796116

Arlinghaus, R., Braun, M., Dhellemmes, F., Ehrlich, E., Feldhege, F.H., Koemle, D. et al. (2023) BODDENHECHT–Ökologie, Nutzung und Schutz von Hechten in den Küstengewässern Mecklenburg-Vorpommerns. Berichte des IGB, Band 33.

Arlinghaus, R., Lucas, J., Weltersbach, M.S., Kömle, D., Winkler, H.M., Riepe, C. et al. (2021) Niche overlap among anglers, fishers and cormorants and their removals of fish biomass: a case from brackish lagoon ecosystems in the southern Baltic Sea. *Fisheries Research*, 238, 105894. Available from: https://doi.org/10.1016/j.fishres.2021.105894

Arlinghaus, R., Rittweg, T., Dhellemmes, F., Koemle, D., van Gemert, R., Schubert, H. et al. (2023) A synthesis of a coastal northern pike (*Esox lucius*) fishery and its social-ecological environment in the southern Baltic Sea: implications for the management of mixed commercial-recreational fisheries. *Fisheries Research*, 263, 106663. Available from: https://doi.org/10.1016/j.fishres.2023.106663

Arlinghaus, R., Tillner, R. & Bork, M. (2015) Explaining participation rates in recreational fishing across industrialised countries. *Fisheries Management and Ecology*, 22(1), 45–55. Available from: https://doi.org/10.1111/fme.12075

Battaglia, M.P., Hoaglin, D.C. & Frankel, M.R. (2009) Practical considerations in raking survey data. *Survey Practice*, 2(5), 1–10. Available from: https://doi.org/10.29115/sp-2009-0019

BMWi. (2021) *Maritime Wertschöpfung und Beschäftigung in Deutschland*. Bremen, Germany: Untersuchung für Bundesministerium für Wirtschaft und Energie, Endbericht. Available from: https://www.bmwi.de/Redaktion/DE/Publikationen/Maritime%20Wirtschaft/Maritime-Wertschöpfung-Studie-Kurzfassung.pdf?__blob=publicationFile&v=16

Borch, T., Moilanen, M. & Olsen, F. (2011) Marine fishing tourism in Norway: structure and economic effects. *Økonomisk fiskeriforskning*, 21(1), 1–18.

Britton, J.R., Pinder, A.C., Alós, J., Arlinghaus, R., Danylchuk, A.J., Edwards, W. et al. (2023) Global responses to the COVID-19 pandemic by recreational anglers: considerations for developing more resilient and sustainable fisheries. *Reviews in Fish Biology and Fisheries*, 33, 1095–1111. Available from: https://doi.org/10.1007/s11160-023-09784-5

Bronnmann, J., Koemle, D., Meyerhoff, J., Weltersbach, M.S., Strehlow, H.V. & Arlinghaus, R. (2023) Willingness to pay for harvest regulations and catch outcomes in recreational fisheries: a stated preference study of German cod anglers. *Fisheries Research*, 259, 106536. Available from: https://doi.org/10.1016/j.fishres.2022.106536

Butler, E.C., Childs, A.-R., Saayman, A. & Potts, W.M. (2020) Can fishing tourism contribute to conservation and sustainability via ecotourism? A case study of the fishery for giant African threadfin *Polydactylus quadrifilis* on the Kwanza Estuary, Angola. *Sustainability*, 12(10), 4221.

Cisneros-Montemayor, A.M. & Sumaila, U.R. (2010) A global estimate of benefits from ecosystem-based marine recreation: potential impacts and implications for management. *Journal of Bioeconomics*, 12(3), 245–268. Available from: https://doi.org/10.1007/s10818-010-9092-7

Connelly, N.A. & Brown, T.L. (2011) Effect of recall period on annual freshwater fishing effort estimates in New York. *Fisheries Management and Ecology*, 18(1), 83–87. Available from: https://doi.org/10.1111/j.1365-2400.2010.00777.x

Connelly, N.A., Brown, T.L. & Knuth, B.A. (2000) Assessing the relative importance of recall bias and nonresponse bias and adjusting for those biases in statewide angler surveys. *Human Dimensions of Wildlife*, 5(4), 19–29.

Cooke, S.J. & Cowx, I.G. (2004) The role of recreational fishing in global fish crises. *Bioscience*, 54(9), 857–859. Available from: https://doi.org/10.1641/0006-3568(2004)054[0857:Trorfi]2.0.Co;2

Destatis (Statistisches Bundesamt). (2017) Volkswirtschaftliche Gesamtrechnungen: Input-Output-Rechnung 2013. Fachserie 18, Reihe 2. Erschienen am 17. März 2017.

Ditton, R.B., Holland, S.M. & Anderson, D.K. (2002) Recreational fishing as tourism. *Fisheries*, 27(3), 17–24. Available from: https://doi.org/10.1577/1548-8446(2002)027<0017:Rfat>2.0.Co;2

Ditton, R.B. & Sutton, S.G. (2004) Substitutability in recreational fishing. *Human Dimensions of Wildlife*, 9(2), 87–102. Available from: https://doi.org/10.1080/10871200490441748

Dorow, M. & Arlinghaus, R. (2011) A telephone-diary-mail approach to survey recreational fisheries on large geographic scales, with a

note on annual landings estimates by anglers in northern Germany. In: Beard, T.D., Jr., Arlinghaus, R. & Sutton, S.G. (Eds.) *The angler in the environment: social, economic, biological, and ethical dimensions. Proceedings of the fifth world recreational fishing conference*. Bethesda, Maryland: American Fisheries Society, Symposium 75, pp. 319–344. Available from: https://doi.org/10.47886/9781934874240

Edwards, S.F. (1991) A critique of three "economics" arguments commonly used to influence fishery allocations. *North American Journal of Fisheries Management*, 11(2), 121–130. Available from: https://doi.org/10.1577/1548-8675(1991)011<0121:Acotea>2.3.Co;2

EUMOFA. (2022) Europäische Marktbeobachtungsstelle für Fischerei- und Aquakulturerzeugnisse, Landesprofil Deutschland. Available from: https://www.eumofa.eu/de/germany [Accessed 31st March 2022].

Eurostat. (2008) CPA 2008 *Introductory Guideline*. Available from: https://ec.europa.eu/eurostat/documents/1995700/1995914/CPA2008introductoryguidelinesEN.pdf/df1e8d19-1156-4a1c-b384-4f95a12515e5

Flegg, A.T. & Tohmo, T. (2013) Regional input–output tables and the FLQ formula: a case study of Finland. *Regional Studies*, 47(5), 703–721. Available from: https://doi.org/10.1080/00343404.2011.592138

Gabler, S., Hoffmeyer-Zlotnik, J.H.P. & Krebs, D. (1994) *Gewichtung in der Umfragepraxis*. Opladen, Germany: Westdeutscher Verlag.

Gislason, G., Lam, E., Knapp, G. & Guettabi, M. (2017) Economic Impacts of Pacific Salmon Fisheries. Prepared for Pacific Salmon Commission Vancouver Canada, July 2017. Available from: https://www.psc.org/wpfd_file/economic-impacts-of-pacific-salmon-fisheries/

Hall, C.M. (2001) Trends in ocean and coastal tourism: the end of the last frontier? *Ocean & Coastal Management*, 44(9), 601–618. Available from: https://doi.org/10.1016/S0964-5691(01)00071-0

Herfaut, J., Levrel, H., Thébaud, O. & Véron, G. (2013) The nationwide assessment of marine recreational fishing: a French example. *Ocean & Coastal Management*, 78, 121–131. Available from: https://doi.org/10.1016/j.ocecoaman.2013.02.026

Hyder, K., Brown, A., Armstrong, M., Bell, B., Bradley, K., Couce, E. et al. (2020) Participation, catches and economic impact of sea anglers resident in the UK in 2016 & 2017—Final report of the Sea Angling 2016 and 2017 project. 3 July 2020, UK, 38 pp.

Hyder, K., Radford, Z., Prellezo, R., Weltersbach, M.S., Lewin, W.C., Zarauz, L. et al. (2017) *Research for PECH committee-marine recreational and semi-subsistence fishing—its value and its impact on fish stocks*. Brussels: European Parliament, Policy Department for Structural and Cohesion Policies.

Hyder, K., Weltersbach, M.S., Armstrong, M., Ferter, K., Townhill, B., Ahvonen, A. et al. (2018) Recreational Sea fishing in Europe in a global context—participation rates, fishing effort, expenditure, and implications for monitoring and assessment. *Fish and Fisheries*, 19(2), 225–243. Available from: https://doi.org/10.1111/faf.12251

ICES. (2021a) Cod (*Gadus morhua*) in subdivisions 22-24, western Baltic stock (western Baltic Sea). ICES Advice on Fishing Opportunities, Catch, and Effort, Baltic Sea Ecoregion. Available from: https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2020/2020/cod.27.22-24.pdf

ICES. (2021b) Herring (*Clupea harengus*) in subdivisions 20-24, spring spawners (Skagerrak, Kattegat, and western Baltic). ICES Advice on fishing opportunities, catch, and effort, Baltic Sea and Greater North Sea ecoregions. Available from: https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2021/2021/her.27.20-24.pdf

ICES. (2022a) Cod (*Gadus morhua*) in subdivisions 22–24, western Baltic stock (western Baltic Sea). Report of the ICES Advisory Committee. ICES Advice 2022, cod.27.22-24 https://doi.org/10.17895/ices.advice.19447868

ICES. (2022b) Salmon (*Salmo salar*) in subdivisions 22–31 (Baltic Sea, excluding the Gulf of Finland). Report of the ICES Advisory Committee, 2022. ICES Advice 2022, sal.27.22–31 https://doi.org/10.17895/ices.advice.19932815

Jahn, M. (2017) Extending the FLQ formula: a location quotient-based interregional input–output framework. *Regional Studies*, 51(10), 1518–1529. Available from: https://doi.org/10.1080/00343404.2016.1198471

Kauppila, P. & Karjalainen, T.P. (2012) A process model to assess the regional economic impacts of fishing tourism: a case study in northern Finland. *Fisheries Research*, 127-128, 88–97. Available from: https://doi.org/10.1016/j.fishres.2012.05.004

Koemle, D., Beardmore, B., Dorow, M. & Arlinghaus, R. (2021) The human dimensions of recreational anglers targeting freshwater species in coastal ecosystems, with implications for management. *North American Journal of Fisheries Management*, 41(5), 1572–1590. Available from: https://doi.org/10.1002/nafm.10672

Koemle, D., Meyerhoff, J. & Arlinghaus, R. (2022) How catch uncertainty and harvest regulations drive anglers' choice for pike (*Esox lucius*) fishing in the Baltic Sea. *Fisheries Research*, 256, 106480. Available from: https://doi.org/10.1016/j.fishres.2022.106480

Kowalewksi, J. (2015) Regionalization of national input–output tables: empirical evidence on the use of the FLQ formula. *Regional Studies*, 49(2), 240–250. Available from: https://doi.org/10.1080/00343404.2013.766318

Kronenberg, T. & Többen, J. (2013) Über die Erstellung regionaler Input-Output-Tabellen und die Verbuchung von Importen. In: Institut für Wirtschaftsforschung Halle (IWH): Neuere Anwendungsfelder der Input-Output-Analyse. *Tagungsband. IWH-Sonderheft* 1/2013, Halle (Saale).

Leontief, W. (1986) *Input-Output Economics*, 2nd edition. New York: Oxford University Press.

Lew, D.K. & Seung, C.K. (2019) Measuring economic contributions of the marine recreational charter fishing sector using a resampling approach. *ICES Journal of Marine Science*, 77(6), 2285–2294. Available from: https://doi.org/10.1093/icesjms/fsz027

Lewin, W.C., Arlinghaus, R. & Mehner, T. (2006) Documented and potential biological impacts of recreational fishing: insights for management and conservation. *Reviews in Fisheries Science*, 14(4), 305–367. Available from: https://doi.org/10.1080/10641260600886455

Lewin, W.-C., Weltersbach, M.S., Ferter, K., Hyder, K., Mugerza, E., Prellezo, R. et al. (2019) Potential environmental impacts of recreational fishing on marine fish stocks and ecosystems. *Reviews in Fisheries Science & Aquaculture*, 27(3), 1–44. Available from: https://doi.org/10.1080/23308249.2019.1586829

Lewin, W.-C., Weltersbach, M.S., Haase, K., Riepe, C., Skov, C., Gundelund, C. et al. (2021) Comparing on-site and off-site survey data to investigate survey biases in recreational fisheries data. *ICES Journal of Marine Science*, 78, 2528–2546.

Lewin, W.C., Weltersbach, M.S., Haase, K. & Strehlow, H.V. (2021) Who travels how far: German Baltic Sea anglers' travel distances as precondition for fisheries management and coastal spatial planning. *Ocean & Coastal Management*, 209, 105640. Available from: https://doi.org/10.1016/j.ocecoaman.2021.105640

Lyle, J., Coleman, A., West, L., Campbell, D. & Henry, G. (2002) New large-scale survey methods for evaluating sport fisheries. In: Pitcher, T.J. & Hollingworth, C. (Eds.) *Recreational fisheries: ecological, economic and social evaluation*. Oxford, UK: Wiley-Blackwell, pp. 207–226.

Möllmann, C., Cormon, X., Funk, S., Otto, S.A., Schmidt, J.O., Schwermer, H. et al. (2021) Tipping point realized in cod fishery. *Scientific Reports*, 11(1), 14259. Available from: https://doi.org/10.1038/s41598-021-93843-z

Olsson, J., Andersson, M.L., Bergström, U., Arlinghaus, R., Audzijonyte, A., Berg, S. et al. (2023) A pan-Baltic assessment of temporal trends in coastal pike populations. *Fisheries Research*, 260, 106594. Available from: https://doi.org/10.1016/j.fishres.2022.106594

Pita, P., Ainsworth, G.B., Alba, B., Anderson, A.B., Antelo, M., Alós, J. et al. (2021) First assessment of the impacts of the COVID-19 pandemic on global marine recreational fisheries. *Frontiers in Marine*

Science, 8, 735741. Available from: https://doi.org/10.3389/fmars.2021.735741

Pita, P., Ainsworth, G.B., Antelo, M., Gouveia, L., Martínez-Escauriaza, R., Tubío, A. et al. (2022) Economic contribution and social welfare of recreational charter boat fisheries in the Northeast Atlantic: the cases of Galicia (Spain) and Madeira archipelago (Portugal). *Frontiers in Marine Science*, 9, 939533. Available from: https://doi.org/10.3389/fmars.2022.939533

Pita, P., Hyder, K., Gomes, P., Pita, C., Rangel, M., Veiga, P. et al. (2018) Economic, social and ecological attributes of marine recreational fisheries in Galicia, Spain. *Fisheries Research*, 208, 58–69. Available from: https://doi.org/10.1016/j.fishres.2018.07.014

Polte, P., Gröhsler, T., Kotterba, P., von Nordheim, L., Moll, D., Santos, J. et al. (2021) Reduced reproductive success of western Baltic herring (*Clupea harengus*) as a response to warming winters. *Frontiers in Marine Science*, 8, 589242. Available from: https://doi.org/10.3389/fmars.2021.589242

Post, J.R., Sullivan, M., Cox, S., Lester, N.P., Walters, C.J., Parkinson, E.A. et al. (2002) Canada's recreational fisheries: the invisible collapse? *Fisheries*, 27(1), 6–17. Available from: https://doi.org/10.1577/1548-8446(2002)027<0006:CRF>2.0.CO;2

Potts, W.M., Downey-Breedt, N., Obregon, P., Hyder, K., Bealey, R. & Sauer, W.H.H. (2019) What constitutes effective governance of recreational fisheries? A global review. *Fish and Fisheries*, 21(1), 91–103. Available from: https://doi.org/10.1111/faf.12417

Potts, W.M., Saayman, M., Saayman, A., Mann, B.Q., Van der Merwe, P., Britz, P. et al. (2021) Understanding the economic activity generated by recreational fishing in South Africa provides insights on the role of recreational fisheries for social development. *Fisheries Management and Ecology*, 29(1), 29–43. Available from: https://doi.org/10.1111/fme.12515

Poudel, J., Munn, I.A. & Henderson, J.E. (2018) An input-output analysis of recreational fishing expenditures (2006 & 2011) across the southern United States. *International Journal of Environmental Studies*, 75(4), 650–672. Available from: https://doi.org/10.1080/00207233.2017.1412195

Radford, Z., Hyder, K., Zarauz, L., Mugerza, E., Ferter, K., Prellezo, R. et al. (2018) The impact of marine recreational fishing on key fish stocks in European waters. *PLoS ONE*, 13(9), e0201666. Available from: https://doi.org/10.1371/journal.pone.0201666

Roberts, A., Munday, M., Roche, N., Brown, A., Armstrong, M., Hargreaves, J. et al. (2017) Assessing the contribution of recreational sea angling to the English economy. *Marine Policy*, 83, 146–152. Available from: https://doi.org/10.1016/j.marpol.2017.05.028

Scheufele, G. & Pascoe, S. (2022) Estimation and use of recreational fishing values in management decisions. *AMBIO*, 51(5), 1275–1286. Available from: https://doi.org/10.1007/s13280-021-01634-7

Schubert, H. & Telesh, I. (2017) Estuaries and coastal lagoons. In: Snoeijs-Leijonmalm, P., Schubert, H. & Radziejewska, T. (Eds.) *Biological oceanography of the Baltic Sea*. Netherlands: Springer, pp. 483–509. Available from: https://doi.org/10.1007/978-94-007-0668-2_13

Smith, M., Fedler, A.J. & Adams, A.J. (2022) Economic assessments of recreational flats fisheries provide leverage for conservation. *Environmental Biology of Fishes*, 106, 131–145. Available from: https://doi.org/10.1007/s10641-022-01375-w

Southwick, R., Holdsworth, J.C., Rea, T., Bragg, L. & Allen, T. (2018) Estimating marine recreational fishing's economic contributions in New Zealand. *Fisheries Research*, 208, 116–123. Available from: https://doi.org/10.1016/j.fishres.2018.06.016

Steinback, S., Gentner, B. & Castle, J. (2004) The economic importance of marine angler expenditures in the United States. *NOAA Professional Paper NMFS 2*, 169 p.

Steinback, S.R. (1999) Regional economic impact assessments of recreational fisheries: an application of the IMPLAN modeling system to marine party and charter boat fishing in Maine. *North American Journal of Fisheries Management*, 19(3), 724–736. Available from: https://doi.org/10.1577/1548-8675(1999)019%3C0724:REIAOR%3E2.0.CO;2

Storey, D.A. & Allen, P.G. (1993) Economic impact of marine recreational fishing in Massachusetts. *North American Journal of Fisheries Management*, 13(4), 698–708. Available from: https://doi.org/10.1577/1548-8675(1993)013<0698:EIOMRF>2.3.CO;2

Strehlow, H.V., Schultz, N., Zimmermann, C. & Hammer, C. (2012) Cod catches taken by the German recreational fishery in the western Baltic Sea, 2005–2010: implications for stock assessment and management. *ICES Journal of Marine Science*, 69(10), 1769–1780. Available from: https://doi.org/10.1093/icesjms/fss152

van Gemert, R., Koemle, D., Winkler, H. & Arlinghaus, R. (2022) Data-poor stock assessment of fish stocks co-exploited by commercial and recreational fisheries: applications to pike *Esox lucius* in the western Baltic Sea. *Fisheries Management and Ecology*, 29(1), 16–28. Available from: https://doi.org/10.1111/fme.12514

Weithman, S.A. (1999) Socioeconomic benefits of fisheries. In: Kohler, C.C. & Hubert, W.A. (Eds.) *Inland fisheries management in North America*, 2nd edition. Bethesda, MD: American Fisheries Society, pp. 193–213.

Welcomme, R.L. (2001) *Inland fisheries: ecology and management*. London, UK: Blackwell Science. Available from: https://doi.org/10.1002/9780470995693.ch9

Weltersbach, M.S., Riepe, C., Lewin, W.-C. & Strehlow, H.V. (2021) *Ökologische, soziale und ökonomische Dimensionen des Meeresangelns in Deutschland*. Braunschweig: Johann Heinrich von Thünen-Institut. *Thünen Report* 83., p. 254.

Williams, C., Davies, W., Clark, R.E., Muench, A. & Hyder, K. (2020) The economic contribution of sea angling from charter boats: a case study from the south coast of England. *Marine Policy*, 119, 104066. Available from: https://doi.org/10.1016/j.marpol.2020.104066

Winkler, H.M. & Schröder, H. (2003) Die Fischfauna der Ostsee, Bodden und Haffe. In: *Meer und Museum-Fische und Fischerei in Ost- und Nordsee*, Vol. 17. Stralsund, Germany: Deutsches Meeresmuseum, pp. 25–35. Available from: https://www.deutsches-meeresmuseum.de/fileadmin/01_Stiftung_DMM/04_Wissenschaft/Publikationen/Meer_und_Museum/MuM_Band_17.pdf

WM. (2018) *Landestourismuskonzeption Mecklenburg-Vorpommern*. Schwerin: Ministerium für Wirtschaft, Bau und Tourismus Mecklenburg-Vorpommern. Available from: https://www.regierung-mv.de/serviceassistent/_php/download.php?datei_id=1606891

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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