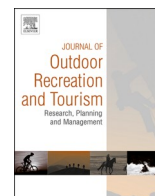


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Journal of Outdoor Recreation and Tourism

journal homepage: www.elsevier.com/locate/jort

Research Article

European water recreation values — A systematic review and meta-analysis of travel cost studies published between 2000–2021

J. Artell^{a,*}, A. Juutinen^b, J. Kostensalo^c, T. Lankia^a, E. Pouta^a, H. Ahtiainen^{d,1}, A. Tolvanen^b^a Natural Resources Institute Finland, Latokartanonkaari 9, FI-00790, Helsinki, Finland^b Natural Resources Institute Finland, Paavo Havaksen tie 3, FI-90570, Oulu, Finland^c Natural Resources Institute Finland, Yliopistokatu 6B, FI-80100, Joensuu, Finland^d European Chemicals Agency (ECHA), Risk Management Unit, Telakkakatu 6, 00150, Helsinki, Finland

A B S T R A C T

European surface waters provide a wide variety of opportunities for outdoor recreation. Also, the economic value of the waters has been extensively studied over the last few decades. We conducted a systematic literature review and meta-analysis of the European water recreation that examined the travel cost valuation studies published between 2000 and 2021. Following the well-established PRISMA guidelines, we found 40 separate studies with a total of 85 consumer surplus estimates based on data from over 113,000 persons. The data were analysed using 1) a multilevel random-effects model for estimating the average consumer surplus of a trip and 2) a meta-regression model with publication year, region, GDP per capita, multi-day trips and the type of recreation were included as covariates. The potential presence of publication bias was tested using Eggert's test. Studies on multiday trips and a variety of water recreation activities were observed to provide larger value estimates than studies focusing on specific single-day activities. In-water activities, such as boating, were more highly valued than activities in the vicinity of water, such as recreational activities on a beach. The average consumer surplus (CS) per trip was €158 (95 % C.I. [€107, €232]) in year 2019 PPP-corrected EU-27-country euros. No statistically significant differences in consumer surplus were found across regions. The average CS was also not found to have changed over the study period adjusted for inflation.

Management implications

The implementation of the European Unions' Bathing Water and Water Framework Directives and the Nature Restoration Law are supported by economic valuation studies for water recreation. In the absence of previous valuation studies there is interest to use studies from other locations. We raise concern over the high variability of values across primary valuation studies for benefit transfers in cost-benefit analyses. Our results and list of existing studies can still help in conducting scoping analysis before conducting a new primary valuation study.

For water recreation site managers, we show that on a European scale water recreation values have remained stable in real terms over two decades and there are little regional differences. Diverse recreation opportunities allowing overnight stays and physical water contact are generally highly valued.

1. Introduction

Recreation is one of the most highly valued cultural ecosystem services in water-adjacent areas — at least among those that have been economically valued (Hynes et al., 2018). Europe offers a diverse set of opportunities for water recreation, which can be enjoyed in the vicinity of the many seas, lakes, and rivers of the continent. However, there are no existing systematic reviews of the economic value of water recreation across the region. Our study addresses this gap in knowledge by conducting a systematic review and meta-analysis of travel cost valuation studies published between 2000 and 2021.

Quantifying the economic value of water recreation and how it varies across recreation types and regions is vital for conducting informed cost-benefit analysis for water resource management. This information is needed to facilitate a socially sustainable implementation of the Bathing Water Directive (European Commission, 2006), and the Water Framework Directive (European Commission, 2000) which aims to improve European surface waters to good ecological status by 2027. The recently adopted Nature Restoration Law (European Commission, 2024) adds

* Corresponding author.

E-mail address: janne.artell@luke.fi (J. Artell).¹ (Statements in this publication reflect the author's professional views and opinions and should not be construed to represent any determination or policy of the European Chemicals Agency.)<https://doi.org/10.1016/j.jort.2025.100899>

Received 14 May 2024; Received in revised form 5 May 2025; Accepted 21 May 2025

Available online 30 May 2025

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further pressure on water management, requiring prioritisation and a systemic understanding of the environmental and societal implications of management decisions at the watershed level.

There is a lack of standardised and widely applicable information regarding the value of water recreation across Europe. Most valuation studies are site-specific and, scaling their results for the purposes of national or EU-level cost-benefit analyses could introduce a significant bias into the estimates. A meta-analysis offers a transparent and systematic approach to pool scientific findings and derive useful generalisations for policy assessments (e.g. Bateman & Jones, 2003). Our meta-analysis of water recreation offers insights into the valuation of water-recreation activities across Europe, while also supporting cost-benefit analyses for European water policy measures (Bateman & Kling, 2020). Finally, our results benefit the implementation of the Ecosystem Accounting extension of the System of Environmental-Economic Accounting (SEEA, United Nations, 2021) as the exchange values and average consumer surplus estimates are related (Grammatikopoulou & Vačkářová, 2021; Scheufele & Pascoe, 2023).

Several meta-analyses of outdoor recreation valuation studies have been carried out in the past two decades. The studies have focused on specific activities (hunting: Gren & Kerr, 2023; Huber et al., 2018; fishing: Gren & Marbuah, 2022; Johnston et al., 2006; Johnstone and Markandya, 2006), ecosystems (forests and woodlands: Bateman & Jones, 2003; Zandersen & Tol, 2009; coral reefs: Brander et al., 2007; wetlands: Ghermandi et al., 2010) or spatial scales ranging from the national (De Salvo & Signorello, 2015; Wang et al., 2013) to the global level (Shrestha & Loomis, 2001). The meta-analytic literature of water recreation values consists largely of studies on marine and coastal areas conducted in the United States. These studies combine both stated and revealed preference value estimates.² For example, Newbold and Johnston (2020) and Johnston et al. (2005, 2017) conducted meta-analyses on the valuation of water quality improvement focusing on North America and with an emphasis on stated preference methods. European valuation studies were included in Hynes et al. (2018) who performed a global meta-analysis appending data from Ghermandi and Nunes (2013) on coastal (marine) recreation valuation, using both stated and revealed preference studies. The role of freshwater recreation is not fully represented in the meta-analytic literature.

The travel cost method offers a clear and controllable domain for our systematic review and meta-analysis. First, this methodology has been well established for decades compared to stated preference studies, which are arguably under constant methodological development. Second, the valued good is straightforward: water recreation visits are tangible and can be classified with relatively well-defined covariates such as the type of recreation, location, water-body type, and the length of the visit. Previous studies have shown that the value of water recreation is influenced by several factors such as recreation type (Hampson et al., 2017; Johnston et al., 2017; Platt & Ekstrand, 2001) and cultural differences (Hynes et al., 2018). These factors must be accounted for in any generalization (e.g., benefit transfer). Third, as a revealed preference method, the travel cost method examines the economic value under current conditions. In contrast, stated preference studies rely on hypothetical scenarios, where respondents are asked to value changes in the recreation conditions. These studies may focus on areas of high policy relevance, leading to a concentration on “hot spot analyses” – locations and themes with particular significance – rather than providing a broader and a more representative view of everyday water recreation. Finally, the meta-analysis and subsequent benefit transfers require welfare measures that are directly comparable for consistency (Johnston et al., 2017). Revealed and stated preference valuation welfare measures are generally incomparable without specific assumptions about the size

² See Schaafsma and Turner (2015) who conducted a literature review on coastal and marine ecosystem service valuation studies covering valuation methods beyond stated and revealed preferences.

of income effects (Bockstael & McConnell, 2007).

Consumer surplus estimates for recreation visits to water ecosystems have been provided by several studies. De Salvo and Signorello (2015) offered a comprehensive overview of outdoor recreation meta-analyses running up to 2015. Platt and Ekstrand (2001) focused on water recreation on sites in North America finding a mean value of I\$³50 (2013). Johnston et al., 2006 reported estimates of I\$21 for fishing trips, and Ghermandi (2015) reported a European coastal recreation estimate of I \$22. More recently, Gren and Marbuah's (2022) meta-analysis of fishing trips in the United States reported values ranging between \$138 and \$379 per day. Additionally, two large-scale European primary valuation studies have analysed water recreation values using the travel cost method. Börger et al. (2021) surveyed 14 European countries to assess the value of recreation in accessible water prominent environments, while Czajkowski et al. (2015) focused on the nine Baltic-Sea littoral countries to assess the value of coastal recreation. Despite these ambitious efforts, there is still a lack of readily available estimates and synthesis of studies exploring water recreation benefits for benefit transfer across different regions, times and recreational activities in Europe.

Our main research question was to address the identified gap in knowledge and to provide a synthesis to support policy implementation. Thus, we carried out a systematic literature review and meta-analysis of valuation studies utilizing the travel cost method in the context of water recreation in the European Union and its surrounding regions published between 2000 and 2021. The review was structured according to the PRISMA 2020 guidelines (Page et al., 2021) and reported in line with the SPAR-4-SLR framework (Paul et al., 2021; Sauer & Seuring, 2023) with detailed justifications provided for methodological decisions and the rationale behind the review.

2. Methods and data

Our analysis was restricted to a) the European continent, b) travel cost method studies providing consumer surplus values per individual and per day or trip, c) water recreation activities closely connected to water, including beach recreation or walking along trails by the water-line, d) publications from 2000 to 2021 and e) both peer-reviewed and gray-literature studies.

We limited the scope of the systematic review and meta-analysis to publications on the European continent (including *Türkiye and Russia*) due to the lack of systematic reviews and need for policy support in the EU. Since the number of publications meeting this criterion satisfied the 40-study threshold outlined by Paul et al. (2021), we refrained from using the sizeable number of publications from other continents. This decision ensured that our study focused on European water recreation culture (see e.g. Hynes et al., 2018 on effects of cultural differences).

We restricted our analysis to results obtained using the travel cost and contingent behaviour methods, focusing on studies that provided consumer surplus (CS) values for actual recreation days or trips per person. Random utility models of recreation site choices rarely report values for a recreation trip or day, and were therefore excluded from the analysis. Choosing a revealed preference method ensured a comparable welfare measure⁴ across studies, thus facilitating the use of meta-regression for an internally consistent estimation of benefit transfer (Johnston et al., 2017). For meta-analyses with a broader scope, including stated preference studies, please see the studies by Johnston

³ International dollar.

⁴ Under the assumption of negligible income effects in recreation demand, the CS would be comparable to the Hicksian welfare measures provided by stated preference methods (Bockstael & McConnell, 2007). This assumption may not hold for all water recreation activity types as their price elasticities can differ. Further, while stated preference studies give valuable information *per se*, our focus is on the values of actual recreation visits instead of hypothetical scenarios. This decision reduces variability across study settings.

et al. (2017), Newbold and Johnston (2020) and Hynes et al. (2018).

We defined water recreation to include activities with varying degrees of physical contact with water. Swimming and diving are examples of activities with a high degree of water contact. Fishing, boating and beach activities are highly dependent on water, but can be enjoyed without physical contact. Additionally, land-based recreational activities such as walking, hiking or biking in water-dominated landscapes were also included in our analysis to assess their value compared to the other activities. This category was present in some studies as part of bundled recreation activities.

The time frame of our analysis covered publications from 2000 to 2021.⁵ This period coincided with an active period of the European Union Water Framework Directive (European Commission, 2000). Schaafsma and Turner (2015) have suggested a “decade or so” as a prudent limit for including valuation studies in meta-analysis; their study included stated preference studies with case-specific scenarios covering 14 years of research. We argue revealed preference studies to be less sensitive to temporal bias than stated preference studies, but still consider that studies published before 2000 would unlikely reflect the contemporary water recreation culture required for benefit transfer. We also note that publications may use surprisingly old primary data, in our case reaching as far back as 1992.

Our analysis incorporated both peer-reviewed and gray literature. Schaafsma and Turner’s (2015) literature review included a wide variety of peer-reviewed valuation studies conducted in the United Kingdom, considering peer-review as a seal of study quality. For stated preference studies, the quality of data collection, reporting and modelling is particularly important. The travel cost method is, however, a relatively simple approach in comparison, and the three working papers and one report (Table 1) provided enough information to judge their quality to be sufficient for our purposes while enhancing the spatial and activity coverage of our analysis.⁶ This approach aligned with the rationale set out by Paul et al. (2021).

The choice of permissive search terms ensured a broad range of publications were captured in the initial screening. We used “travel cost”, “contingent behavior” and “contingent behaviour” as methodology-describing keywords. Contingent behaviour studies provided measures compatible with the travel cost method studies when they measured current, non-hypothetical recreational values. Given the variety of surface water types, we included keywords: “water”, “marine”, “sea”, “lake” and “river”. To ensure that fishing related studies would be included, we conducted separate searches using the additional keywords “fishing” and “angling” with the methodology-describing keywords. We did not conduct a similar, separate search for activities such as boating, sailing or other specific recreational pursuits (e.g. diving, parasailing, white-water rafting), which may limit our analysis if water-related keywords are not mentioned in the studies.

We used three main sources to collect data: the Web of Science⁷ (WoS, www.webofscience.com), the Environmental Valuation

Reference Inventory⁸ (EVRI, www.evri.ca) and Google Scholar⁹ (scholar.google.com). Paul et al. (2021) recommend using WoS to “curate a manageable collection of articles for review”. As our research questions focus on a subset of environmental valuation literature, using a dedicated valuation information repository, such as EVRI, allowed us to capture publications that might not have been found in the WoS. Additionally, Google Scholar provided a broader, and more up-to-date view of peer-reviewed and gray literature, ensuring that studies meeting our inclusion criteria were fully represented.

All search hits from the WoS and EVRI, and the 300 first search results from Google Scholar, were examined based on the pre-determined inclusion criteria during the first half of 2022. Three researchers independently and sequentially searched for studies published between 2000 and 2021. While the publication period was restricted to this timeframe, some studies relied on older data, with the earliest dating back to 1992 (Curtis, 2003).

A flow-chart visualising the exclusion and inclusion of publications limited to the 40 studies included in the meta-analysis is shown in Fig. 1. We identified altogether 1225 studies. After removing duplicates (184 studies) and studies published before the study period (102 studies), six more studies were found to be *missing*. These include mainly theses and reports which we, despite considerable effort, could not obtain for the analysis.

The screening phase involved reading (at minimum) the titles, abstracts and keyword lists of each of the remaining 937 studies. The *other valuation method* was the single largest exclusion criterion with 668 excluded studies. This category contains studies where the travel cost method was not applied. This exclusion removed the studies that reported results using contingent valuation, discrete choice experiments and hedonic pricing studies, as well as general reports and statistics on water recreation. The *other recreation* exclusion criteria refer to remaining studies which had no direct or significant link to the water environment (52 studies). Subsequently, 138 non-European studies were found and removed.

We found 79 studies or reports which were thoroughly inspected for use in the meta-analysis. Of these studies we found 15 pre-publication duplicates, where working papers had been released using the same data by the same authors prior to a peer-reviewed publication with near-identical results. These studies were screened from the analysis. For 24 studies we had the problem of the *CS* or *other critical data missing*, and thus could not calculate the required consumer surplus value or its 95 % confidence interval for a single water recreation trip or day using information provided by the study.¹⁰ This screening process left us with 40 studies with a total of 85 consumer surplus value results included in the systematic review and meta-analysis. The included studies are listed in Table 1¹¹. We acknowledge that the manual labour involved examining over 1200 studies leaves room for human error, and we take full responsibility for any mistakes and omissions in compiling the database for review.

Our analysis used readily available or derivable estimates of consumer surplus per day and their respective 95 % confidence intervals; where confidence intervals were not reported, we calculated them using the available standard error or z-score information. Studies which

⁵ At the time of revision, in early 2025, we are not aware of new studies matching our inclusion criteria.

⁶ In addition, we found one master’s thesis by Lehtonen (2019). The thesis was excluded as it used the same data as another published journal article included in the meta-analysis. Ahtiainen et al. (2022) use the same data and were therefore also excluded.

⁷ By Clarivate, through the Web of Science Core Collection. Search terms: (TS=(“travel cost*”) AND TS=(water OR marine OR sea OR lake OR river)), Timespan = All Years. Databases = SCI-EXPANDED, SSCI, A&HCI. SSCI, A&HCI. | (TS=(“contingent behavior?”) AND TS=(water OR marine OR sea OR lake OR river)), Timespan = All Years. Databases = SCI-EXPANDED, | TS=(“travel cost*” OR “contingent behavior?”) AND TS=(fishing OR angling), Timespan = All Years. Databases = SCI-EXPANDED, SSCI, A&HCI. SSCI, A&HCI.

⁸ Search terms: continent: Europe, Environmental asset: water general; Valuation technique: Revealed preference.

⁹ Search terms included: Europe; recreation; travel cost; contingent behavior; contingent behaviour; water; marine; sea; lake; wetland; river; fishing; angling.

¹⁰ Alberini et al., 2007; Blakemore & Williams, 2008; Buchli et al., 2003; Chae, Wattage, & Pascoe, 2012; Gillespie et al., 2016; Lienhoop & Ansmann, 2011; Logar & van den Bergh, 2014; Nunes & van den Bergh, 2004; Tunca & Lindroos, 2016.

¹¹ The study data is included as supplementary material also including information on the data collection method, modelling family, inclusion of zero-trips and travel time costs, and inclusion of substitute sites.

Table 1

Studies included in the meta-analysis listed with publication type, the range of average consumer surplus in the studies, the corresponding recreation types (rec. type), the type of waterbody, countries included in the study, observations of primary results (result obs.) and sample size. The consumer surplus types are per trip values, per day values and “multi” for studies explicitly studying (also) overnight trips. The abbreviations used in the recreation column are general (Gen.), recreation (rec.), and the publication types are abbreviated: journal article (A), report (R) and working paper (WP).

Study (pub. type)	Consumer surplus, €	CS type	Recreation	Waterbody	Country	Result obs.	Sample size
Aydın et al., 2013 (A)	15.61	Day	Fishing	Sea, lake	TUR	1	120
Barry et al., 2011 (A)	21.11	Trip	Beach rec.	Sea, lake	IRL	1	285
Bertram et al., 2020 (A)	68.07–432.44	Trip, multi	Gen. rec.	Sea	FIN, DEU, LVA	3	522–1011
Blayac et al., 2016 (A)	279.57	Trip	Gen. rec.	Sea, lake	FRA	1	565
Börger et al., 2021 (A)	18.63–89.38	Trip	Gen. rec.	Sea, lake, river	BGR, CZE, EST, FIN, FRA, DEU, GRC, IRL, ITA, NED, POR, ESP, SWE, GBR	14	17,811
Breen et al., 2018 (A)	56.92–65.11	Day, multi	Gen. rec.	Sea	IRL, GBR	2	346–513
Carlén et al., 2021 (A)	7.76–64.25	Day	Fishing	Sea, lake, river	SWE	3	6310
Chegrani, 2007 (R)	13.39–14.28	Trip	Boating, fishing	River	FRA	3	49–83
Clara et al., 2018 (A)	197.58	Day, multi	Gen. rec.	Sea, lake	POR	1	361
Curtis, 2003 (A)	169.81	Day, multi	Fishing	River	IRL	1	118
Curtis & Stanley, 2016 (A)	154.47	Day, multi	Fishing	Sea, lake, river	IRL	1	707
Curtis & Breen, 2017 (A)	212.35–671.46	Day, multi	Fishing	Lake	IRL	2	138–303
Czajkowski et al., 2015 (A)	33.09–538.36	Trip, multi	Gen. rec.	Sea, lake	DEN, EST, FIN, DEU, LVA, LTU, POL, RUSSIA (coastal), SWE	9	8893
Deely et al., 2019 (A)	78.89–251.45	Day, multi	Fishing	Lake, river	IRL	2	123
Deronzier & Terra, 2006 (WP)	9.55–18.37	Trip	Boating, fishing	River	FRA	2	215
Getzner, 2015 (A)	7.00–28.81	Trip	Gen. land, boating	River	AUT	7	538
Getzner et al., 2016 (A)	534.10	Trip, multi	Gen. rec.	Sea, lake	HRV	1	157
Grilli et al., 2018a (A)	359.09	Day, multi	Fishing	River	IRL	1	134
Grilli et al., 2018b (A)	269.36	Day, multi	Fishing	Sea, lake	IRL	1	230
Grilli, Mukhopadhyay, Curtis, & Hynes, 2020 (A)	115.45–154.98	Day, multi	Fishing	Lake, river	IRL	3	199
Grossmann, 2011 (A)	22.96–40.37	Trip, multi	Boating	River	DEU	2	250–383
Hanley et al., 2003 (A)	53.93 ^f	Trip	Beach rec.	Sea, lake	GBR	1	597
Hynes & Hanley, 2006 (A)	80.81	Trip	Boating	River	IRL	1	144
Hynes, O'Reilly, & Corless, 2015 (A)	42.65–198.00	Trip, multi	Fishing	Sea, lake, river	IRL	2	451
Hynes et al., 2017 (A)	213.36	Trip, multi	Fishing	Sea, lake	IRL	1	228
Lankia et al., 2019 (A)	14.86	Trip	Beach rec.	Sea, lake, river	FIN	1	539
Latinopoulos, 2014 (A)	220.64	Trip, multi	Gen. rec.	River	GRC	1	379
Paccagnan, 2007 (WP)	169.69	Trip, multi	Gen. rec.	Lake, river	ITA	1	155
Pokki et al., 2018 (A)	206.18	Trip, multi	Fishing	River	FIN	1	263
Pokki et al., 2020a (A)	83.93	Day, multi	Fishing		FIN	1	2778
Pokki et al., 2020b (A)	98.70–129.87	Trip, multi	Fishing	River	FIN	2	149–170
Pouso et al., 2018 (A)	6.72–9.05	Trip	Beach rec.	Sea, lake	ESP	3	59–205
Rosato & Defrancesco, 2002 (WP)	877.37	Trip	Gen. water	Sea, lake	ITA	1	129
Terra, 2004 (WP)	24.25–26.60	Trip	Gen. rec.	River	FRA	2	111–1526
Tienhaara et al., 2021 (A)	58.33	Trip	Gen. water	Lake, river	FIN	1	189
Tunca et al., 2012 (A)	19.51	Trip	Fishing	Sea, lake	TUR	1	50
Vesterinen et al., 2010 (A)	9.13	Day, multi	Gen. water	Sea, lake	FIN	1	234
Voltaire et al., 2017 (A)	112.03	Trip, multi	Beach rec.	Sea	ESP	1	435
Voltaire, Djongon, & Carrard, 2021 (A)	127.94	Trip	Fishing	Sea, lake	FRA	1	187
Wallentin, 2016 (A)	54.14	Trip, multi	Fishing	River	SWE	1	66,129

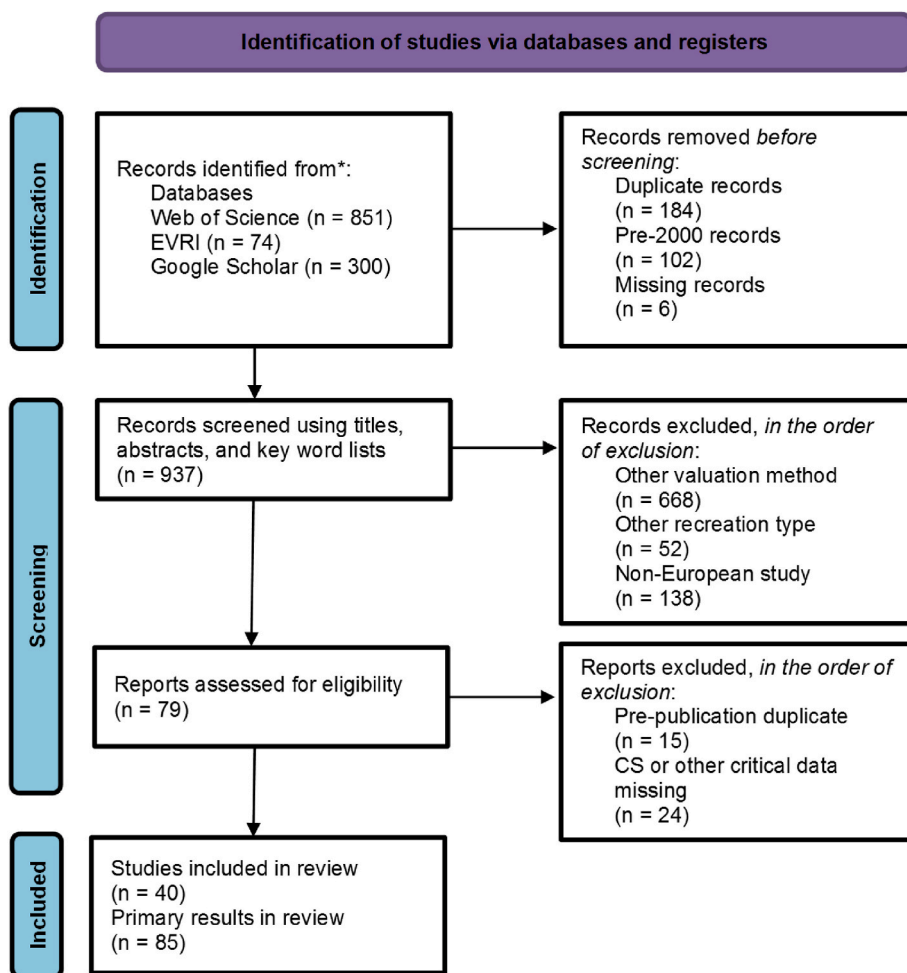


Fig. 1. A flow-chart representing the systematic identification and selection of studies to be used in the systematic review and meta-analysis.

reported per trip values that we could not convert to per day estimates were flagged. We also created a dummy variable for results explicitly indicating values for longer than single-day visits. For studies employing multiple models using the same data to assess the value of the same recreational service, we chose the primary CS result preferred by the authors in text, referred specifically to in policy context, or – if competing models are presented – we used results from the model with the smallest Bayesian information criterion (BIC) value. If a study presented estimates for separate recreation activities, user groups or regions, all estimates were included in the meta-analysis. We left out all hypothetical scenarios of contingent behaviour studies to avoid bias.

Given that the estimates span two decades and several countries using different currencies, the values needed to be adjusted for inflation and the purchasing power in each country. To ensure commensurability, we adjusted the values in three steps. First, all values were corrected for national inflation to bring them to a common base year of 2019, using the harmonised consumer price index by Eurostat.¹² Second, pre-euro currencies were converted to euros.¹³ Finally, the Eurostat¹⁴ data on purchasing power parities (PPP) was used to convert the euro-values to a common currency that reflects the purchasing power of each country.

¹² [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Harmonised_index_of_consumer_prices_\(HICP\)](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Harmonised_index_of_consumer_prices_(HICP)).

¹³ https://www.ecb.europa.eu/press/pr/date/1998/html/pr981231_2_en.html.

¹⁴ https://ec.europa.eu/eurostat/databrowser/view/PRC_PPP_IND/default/table?lang=en.

Therefore, all euro-values reported in this study refer the PPP-adjusted EU-27 euros of the year 2019. We also acquired data on the gross domestic products from the World Bank¹⁵ and converted them to euros, to include this as a covariate in the meta-regression model.

The analysis is based on data from 113,847 individuals who have provided information on their water recreation trips across the 40 included studies. About one half of these (66,129) come from the Swedish fishing permit registry data (Wallentin et al., 2016). The other sources utilised surveys with far fewer observations. The overwhelming majority of the studies were published as journal articles with multiple types of activities and waterbodies represented from 24 different countries or regions. We grouped recreation activities into six categories based on the specificity of activities in each study. The categories include specific activities (fishing, boating), general but spatially defined activities (beach rec.) and general water specific (gen. water), general land specific (gen. land) and general activities on either land or water (gen. rec.) directly linked to water. Land-specific recreation typically took place along the coastline. Cases falling under the most generic activity categories often did not separate or specify the recreation activity.

The reported consumer surplus estimates for different recreation activities are the welfare measure of interest. Since the CS is non-negative and heavily skewed towards large values, we worked on a log-transformed scale to better satisfy the model assumptions. First, to obtain a single estimate describing the average CS of water recreation,

¹⁵ <https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD>.

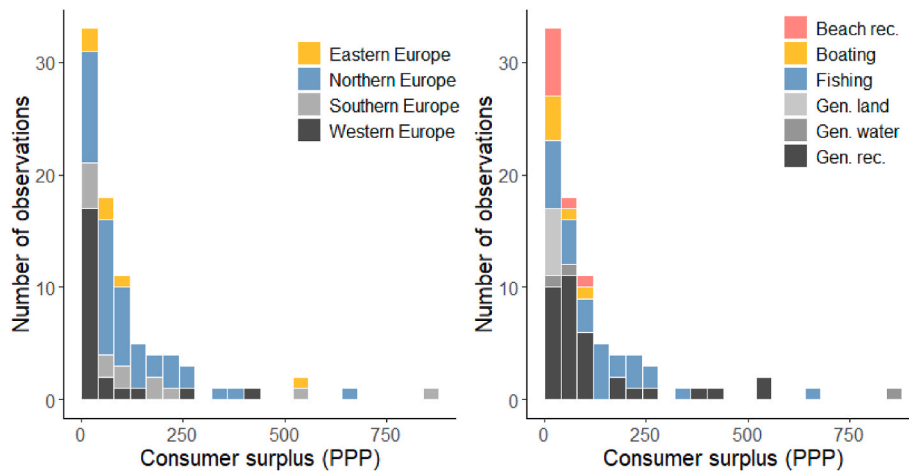


Fig. 2. The distribution of reported consumer surplus broken down by geographical region (left panel) and type of water related recreation (right panel).

we fitted a multi-level random effects model

$$\log CS_{s,i} = \mu + \zeta_s + \xi_{s,i} + \epsilon_{s,i}, \tag{1}$$

where the $CS_{s,i}$ is the consumer surplus observed in model i of the study s . The μ is the average log-transformed CS, and the ζ_s is a normally distributed random effect capturing between-study heterogeneity in CS. The $\xi_{s,i}$ is a random effect for within-study differences in effect sizes and the $\epsilon_{s,i}$ captures the sampling error. The results were back transformed to the original scale with bias correction (see e.g. Zeng & Tang, 2011). While Wallentin et al. (2016) had a large sample size, the log-scale estimate does not have the smallest standard error. Furthermore, as there is only one model from this paper, both random effects were applied to this observation, further diminishing its weight. The weights of each observation varied between 0.23 and 1.95 %, so no single observation had an outsized impact on the result.

To explain the heterogeneity between studies, we fitted a mixed-effects meta-regression model with both fixed and random effects, where the model presented in equation (1) was expanded by adding GDP per capita (centred at €45,575, corresponding to the mean of the sample), the CS type (per trip vs. per day), whether the recreation was multiple days or not and its interaction with the CS type, year of data collection as measured by the last year included in the study (centred at 2010), region (Northern, Western, Eastern, or Southern Europe) and the recreation type. The effect on the type of waterbody studied (river, lake, sea alone or a combination of two or more types) was also explored as a possible covariate.¹⁶ Waterbody type did not have a statistically significant effect on the CS in the meta-regression model, and the inclusion of waterbody type also lead to a significantly higher AIC. Hence, we opted for the simpler model presented in the results section and, the final mixed-effects meta-regression model is of the form

$$\log CS_{s,i} = \mu + \beta_1(GDP - \epsilon45,575) + \beta_2CStype + \beta_3Multiday + \beta_4CStype \times Multiday + \beta_5(Last_Year_Of_Data - 2010) + \sum_{r \in Region} \beta_{Region=r} Region_r + \sum_{r' \in Rec...Type} \beta_{Rec...Type=r'} Rec.Type_{r'} + \zeta_s + \xi_{s,i} + \epsilon_{s,i}, \tag{2}$$

where the β s are the fixed-effects regression coefficients to be fitted,

¹⁶ Similarly, we saw no statistically significant differences in the mean consumer surplus estimates if the original studies explicitly considered non-visitor data or opportunity costs of time.

GDP is GDP per capita, $CStype$ is 1 for “per trip” and “0” for “per day”. $Multiday$ is 1 for multiday trips and 0 for single-day trips and trips where this has not been specified. $Last_Year_Of_Data$ is the last year of data included in the model fit of the study and the $Rec.Type$ -variables are dummy variables for each recreation type with beach recreation as the reference level. The $Region$ variables are dummy variables for geographical regions of Europe, with Western Europe as the reference level.

As water recreation is dependent not only on the presence of water, but also its quality, we attempted to include common quality measures (i.e. the ecological status of surface waters in the EU¹⁷) into the analysis. While the ecological status can serve as a proxy for the usability of a water area for recreational activities (Artell et al., 2013), the different spatial scales, shapes (water areas only, land areas enclosing water areas, land around water areas, single sites, regional, and national scope etc.) and vaguely defined study areas could not be included in the modelling in a reasonable way. On the other hand, the studied areas with active water recreation have, intuitively, at least adequate water quality for recreation to have been researched.

Publication bias occurs when the probability of a study being published depends on its results (Rothstein et al., 2005), for example studies reporting high CS would be more likely to be published. We explored publication bias graphically using a funnel plot constructed of the residuals of the meta-regression model (see, e.g., Harrer et al., 2021). In addition, we performed the classical Egger’s test (see Egger et al., 1997) for the test and (Viechtbauer, 2010) for technical details). When publication bias is not present, 95 % of the residuals should fall within the funnel. The lack of significant graphical asymmetries or anomalies indicates that publication bias is most likely absent, and the model estimates should provide representative estimates of the consumer surplus.

All statistical analyses were carried out using the statistical software R, version 4.3.2 (R Core Team, 2023). The models were fitted using the

¹⁷ 61 % of coastal waters, 33 % of transitional waters, 56 % of lakes, and 44 % of rivers at least in Good Ecological Status in 2021. <https://www.eea.europa.eu/en/analysis/indicators/ecological-status-of-surface-waters>.

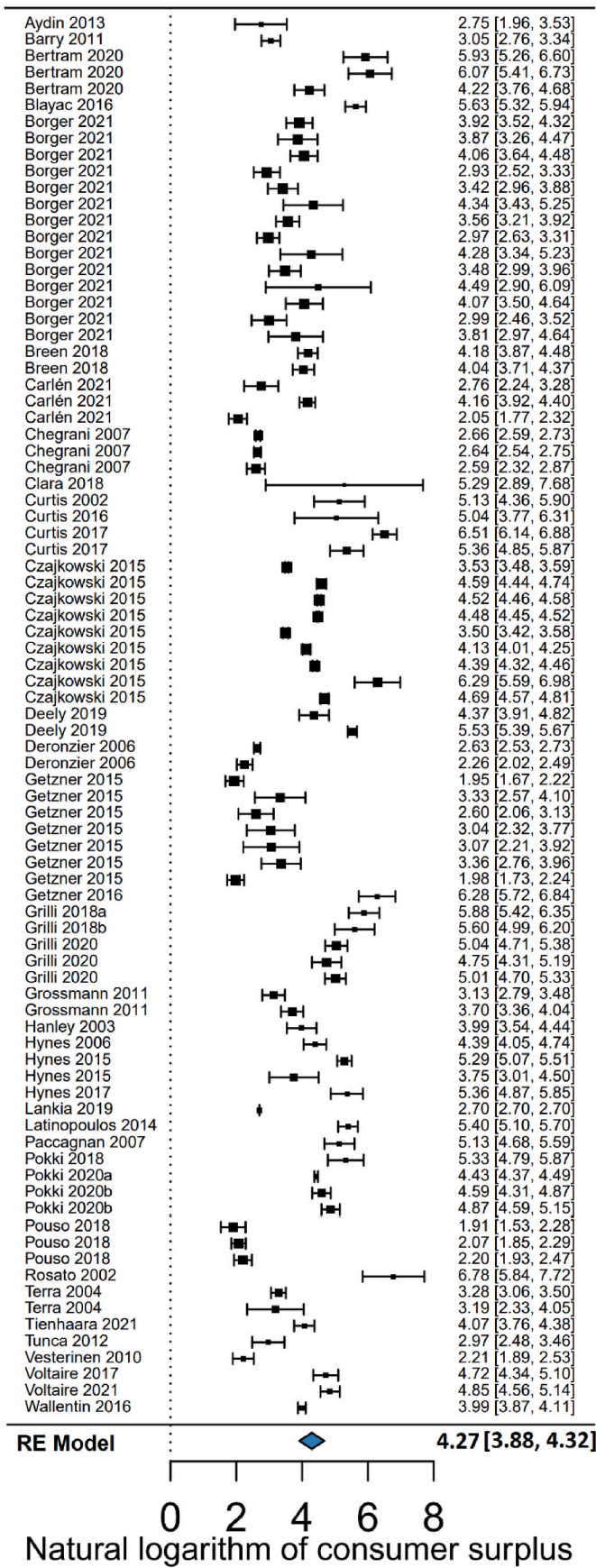


Fig. 3. A forest plot based on the random effects model (eq. (1)) of the CS for water recreation in European studies on a logarithmic scale.

Table 2

Fixed effects of the mixed-effects meta-regression model (eq. (2)) explaining the log CS per day values (N = 85).

Variable	Level ⁽¹⁾	Coefficient	95 % C.I.	p-value ⁽²⁾
Intercept		1.68*	[0.24, 3.12]	0.02
GDP per capita (PPP) ⁽³⁾		0.53	[-0.27, 1.32]	0.19
CS Type	Per trip	1.30*	[0.13, 2.48]	0.03
Multiday	Yes	2.69***	[1.45, 3.93]	<0.0001
CS Type × Multiday	Per trip × yes	-1.54*	[-2.90, -0.18]	0.03
Last year of data ⁽⁴⁾		-0.03	[-0.09, 0.03]	0.39
Region	Western	reference		
	Eastern	0.60	[-0.27, 1.47]	0.17
	Southern	0.56	[-0.21, 1.33]	0.15
	Northern	-0.22	[-0.78, 0.34]	0.47
Rec. Type	Beach recreation	reference		
	Boating	0.29	[-0.69, 1.26]	0.56
	Fishing	0.85	[-0.03, 1.73]	0.06
	Gen. land	-0.44	[-1.80, 0.91]	0.51
	Gen. water	1.65*	[0.32, 2.98]	0.02
	Gen. water & land	0.89	[-0.05, 1.82]	0.06
Fit quality	Pseudo-R ²	0.62		
Marginal effects	Multiday = "yes" (per day)	1.15	[0.43, 1.86]	0.002
	Multiday = "yes" (per trip)	2.69	[1.45, 3.93]	<0.0001
	CS Type = "per trip" (multiday)	-0.24	[-1.05, 0.57]	0.58
	CS Type = "per trip" (single day)	1.30	[0.13, 2.48]	0.03

⁽¹⁾ For categorical variables. ⁽²⁾ Significance codes (*) p < 0.05, (**) p < 0.01, (***) p < 0.001. ⁽³⁾ Centred at €45,575.00 and log transformed. ⁽⁴⁾ Centred at 2010.

library *metafor* (Viechtbauer, 2010) with Restricted Maximum Likelihood (REML).

3. Results

Descriptive information of the CS estimates reported in the studies are presented in Fig. 2 by geographical region [left] and recreation type [right]. Regional differences appear relatively minor: Western Europe has lower CS estimates than other regions, whereas Southern Europe has larger ones. Among the various activities, beach recreation and general land-based activities are less valued than water-related activities. However, there is substantial variation in the estimated CS estimates in all activity types.

The estimate for the average CS on the logarithmic scale is $\hat{\mu} = 4.27$ (SE($\hat{\mu}$) = 0.19; 95% C.I. = [3.88, 4.66]). The heterogeneity of the CS values can be seen in the forest plot constructed from the studies (Fig. 3). There is substantial between-study and within-study heterogeneity in the CS, which cannot be explained by sampling error alone. After a back transformation to the original scale, we get an estimate for average consumer surplus per day of $\widehat{CS} = \text{€}158$ (95% C.I. = [€107, €232]).

The results from the meta-regression model are presented in Table 2 and the corresponding forest plot is in Fig. 4. To account for differences in the good each CS value reflects, the model includes variables for

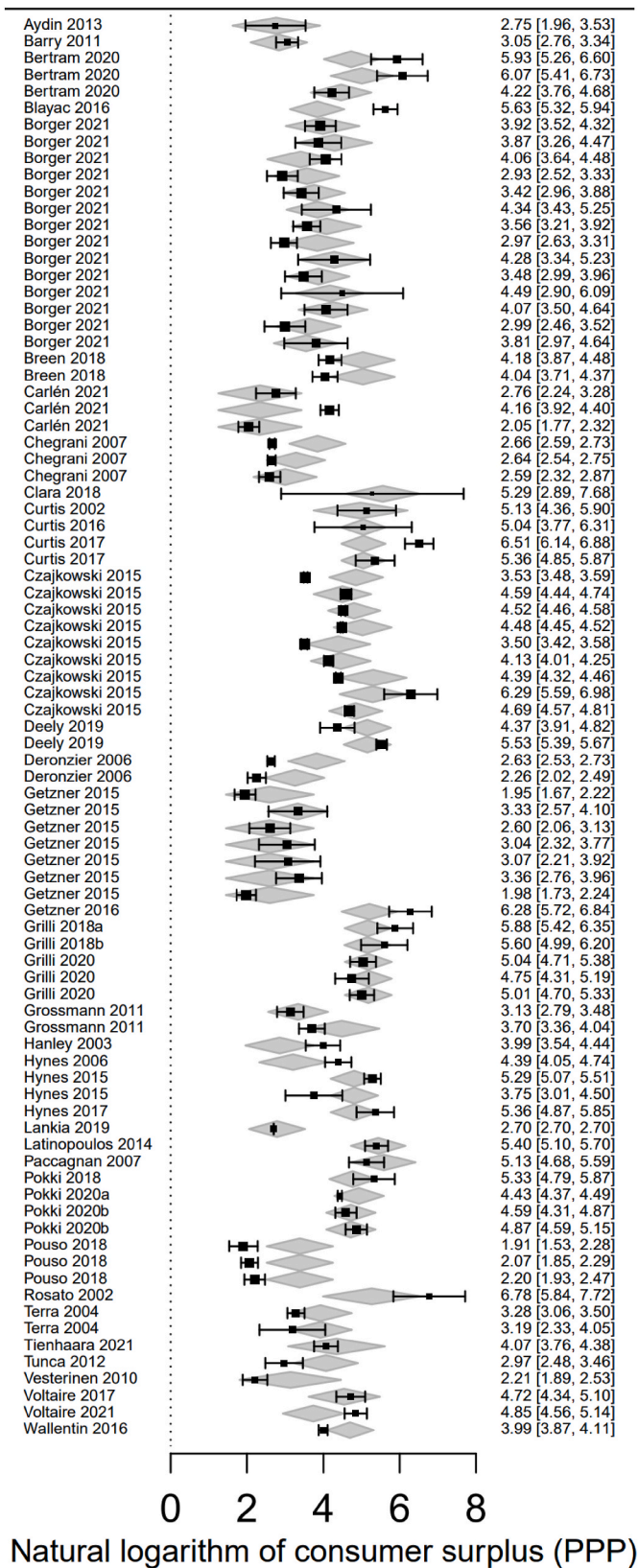


Fig. 4. A forest plot based on the mixed-effects meta-regression model (eq. (2)) of the CS for water recreation in European studies on a log scale.

multiday visits, the CS type (per day/per trip), and their interaction. The CS values are generally higher for multiday trips and if the CS is reported per trip rather than per day. It should be noted that 11 studies (35 CS estimates) did not specify whether the estimated trip values included multiple day visits. Thus, studies reporting values per trip for non-multiday trips are not comparable to studies reporting per day values for multiday trips. To account for this, we included an interaction term, which would cancel out this effect and account for any differences in the CS when calculated per trip or per day. The results indicate that people are willing to pay on average 14.7 times more (95 % C.I. [4.3, 50.9]) for multiday trips than single day trips, when measured per trip and 3.2 times more (95 % C.I. [1.5, 6.4]) when measured per day. As expected, for multiday trips there is no statistical significance whether the results are reported per trip or per day. For the single-day trips the CS values were on average 3.7 times higher (95 % C.I. [1.1, 11.9]) when reported per trip.

For water recreation activities, the largest consumer surplus can be found in studies focusing on general water activities (5.21 times more compared to beach recreation, 95 % C.I. [1.38, 19.69]), while general activities incorporating both land and water (2.44 times more, 95 % C.I. [0.95, 6.17]) and fishing (2.34 times more, 95 % C.I. [0.97, 5.64]) are just below the cutoff for statistical significance, having a p-value of $p = 0.06$. Despite having no statistically significant effect, the signs of the coefficients (positive for boating, general water and land, and fishing, negative for general land activities) are consistent with the idea that physically touching water was considered to be more highly valued than land-based activities.

We find no statistically significant effect of GDP per capita or region on consumer surplus per day values. We also find no significant trend in values in the transformed CS values over the study period of 2000–2021.

For a water recreationist in a Western European country with a GDP of €45,575 (sample mean) engaging in beach recreation, the average CS is just €8 (95 % C.I. [€2, €33]) for single-day activities but €116 (95 % C.I. [€28, €490]) for overnight activities.

A funnel plot of the meta-regression model residuals is presented in Fig. 5. We find no clear asymmetry or anomalies in the residuals. Approximately 95 % of the residuals appear in the funnel. Thus, we find no reason to believe that there is any significant publication bias which would skew the meta-regression results. Egger's test performed by regressing the standardised effect sizes against the precision of the estimates provides a p-value of 0.10.

4. Discussion and conclusions

This paper presents a meta-analysis of water recreation values and examines which factors explain differences in values and whether the estimates can be used for benefit transfer to different types of water bodies and recreation activities. We carried out a systematic literature review and meta-analysis of European water-recreation related travel cost studies that were published between 2000 and 2021. Despite considerable variation across the 40 studies in water recreation values, our meta-regression model did not reveal statistically significant regional or publication time effects. Instead, studies considering multi-day visits and a general set of water recreation activities provided greater value than studies focusing on specific single day activities. Activities in water, including fishing, were more highly valued than activities in the vicinity of water, such as beach recreation. Surprisingly, the inclusion of water body type neither improved the meta-regression model nor had a statistically significant effect on the values. No indication of publication bias was found.

Our work corroborates earlier results indicating that water recreation is highly valued in Europe and has remained so for at least two decades. The average consumer surplus per day in the reviewed studies is €158 (as year 2019 EU-27 PPP and inflation-corrected euros), with a 95 % confidence interval of [€107, €232], or I\$235, 95 % C.I. [I\$159, I\$345]. This value can be divided into single day trip values, with an

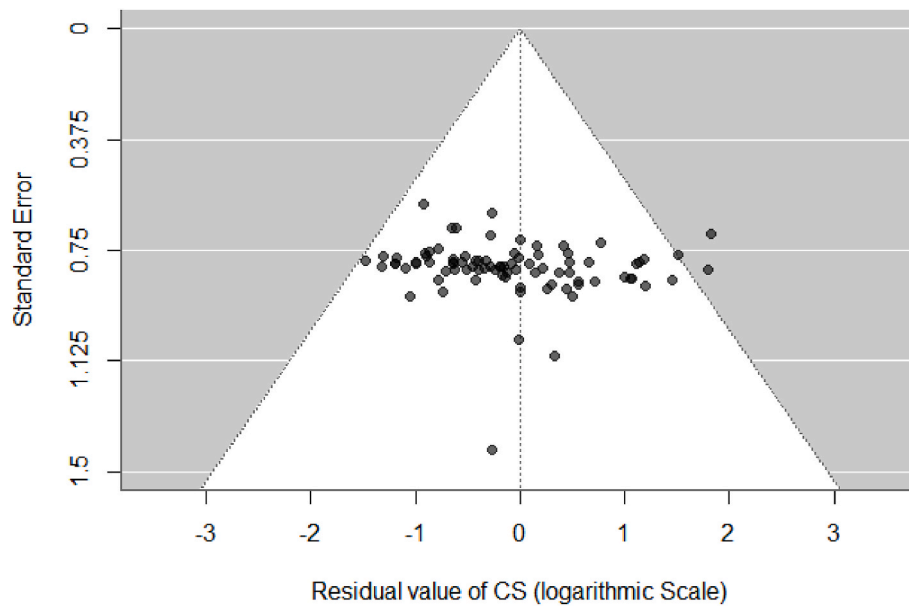


Fig. 5. A funnel plot of the meta-regression (eq. (2)) residuals for exploring publication bias.

average consumer surplus of €27 (*median* €14) and, similarly, overnight trips with an average of €168 (*median* €104). We conclude that our results can support European-wide benefit transfer, albeit with some caveats.

The value-estimates found in our study exceed those found in the previous meta-analyses on recreation activities in Europe, even after accounting for inflation. Ghermandi (2015) found a *median* estimate of I \$22 for coastal recreation activities, where sport fishing, hiking, sight-seeing and swimming were the lowest valued activities. Contrary to Ghermandi's (2015) result, we find no significant effect of GDP on purchasing power parity and inflation corrected water recreation values. Zandersen and Tol (2009) reviewed 26 studies on the recreational value of forests in Europe and found that the *median* value of €4.5 per trip and a large range of values in studies from a low of €0.7 to a high of €112. Similar large variation can be seen across studies with the reported CS ranging between €6.7 to €877.0, and the *median* reported value at €58.6.

Czajkowski et al. (2015) also observed large variation in values across countries in the Baltic-Sea-littoral countries. Börger et al. (2021) found that the average consumer surplus per adult visit was €41.3 in 14 EU countries. They also reported significant differences between countries, with values ranging from €23.0 in Finland to €83.0 in Germany. Large variation and a skewed distribution of the CS values across water recreation values can be partially affected by studies focusing on iconic or otherwise important water recreation activities over their more mundane counterparts. Despite the large variation in the primary studies and meta-analyses, water recreation appears to be more highly valued than land-based general recreation activities near aquatic environments.

The strength of choosing one valuation method for analysis lies in the capability to single out improvements needed in reporting and analysing travel cost studies and expanding their coverage. Carrying out the systematic review was challenging due to differences in reporting standards across the studies. We suggest that future travel cost studies should remain meticulous in their reporting on consumer surplus especially when it comes to the definition of the object which is valued (per trip, per day, multiple days, recreation activity, study population characteristic etc.), as well as in reporting confidence intervals. The consumer surplus values should be explicitly tied to a specific point in time to allow more accurate inflation adjustments and PPP correction in meta-analysis and benefit transfers. We also note that the spatial boundaries of the study area were often vaguely reported, leading to uncertainties in

the *ex-post* interpretation of the study area, and further linking external water and other relevant quality indicators to the studies – maps delineating the study area and its careful qualitative description – would also help assessing simulated exchange values in ecosystem accounting (Lankia et al., 2023). A European or even a global travel-cost-method-based meta-analysis comparing water recreation values and other recreation activities, in different environments in natural and restored states, would provide an interesting point of comparison for the implementation of the EU's Nature Restoration Law (European Commission, 2024). Water environments are closely linked to neighbouring terrestrial ecosystems, influencing recreational quality. Future valuation studies should explore aquatic-terrestrial interactions, along with conflicts and synergies between recreation, nature restoration and conservation activities. Finally, we would like to point out that surveys can provide data on both revealed and stated preferences in relation to leisure activities, which could enrich the analysis of future scenarios.

We acknowledge there are limitations to our study. First, water quality is known to affect consumer surplus (Börger et al., 2021; Czajkowski et al., 2015), but could not be reliably included in our analysis. Most studies did not include water quality or precise borders of the study region that would serve as a proxy for estimating water quality (e.g. a share of waterbodies in good ecological status or other metric). Second, our results are not generalizable globally, as we only included studies from Europe. Third, there is a limited number of observations, six out of 85, observations from Eastern Europe and only in some water recreation activities – general water recreation with three observations, and boating and general land recreation with six observations each. Our study does not explicitly account for additional entry or seasonal fees prominent in fishing and sometimes private beach visits, if they were not included in the studies, nor do we consider any annualised costs of recreation equipment. We also note that we did not pre-register the systematic review.

Despite its limitations, as argued by Zandersen and Tol (2009), conducting a systematic review across similar recreation activities and analysis methods helps reduce variation stemming from confounding factors. This aligns with our findings, which demonstrate that even within water recreation studies, differences in the precise nature of the activity, for example fishing or boating, can have a large impact on how the activity is valued. On the other hand, limiting analysis to specific activities alone would come at the cost of generalisability of the results.

We recommend exercising caution when applying our meta-analysis findings, emphasising the importance of context-specific national or regional travel cost studies for greater precision. However, in the absence of primary studies, the meta-analysis provides valuable insights into the potential value of water recreation and its similarities across diverse activities.

CRedit authorship contribution statement

J. Artell: Writing – review & editing, Writing – original draft, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **A. Juutinen:** Writing – original draft, Validation, Supervision, Project administration, Funding acquisition, Conceptualization. **J. Kostensalo:** Writing – review & editing, Writing – original draft, Visualization, Validation, Methodology, Investigation, Formal analysis. **T. Lankia:** Writing – review & editing, Writing – original draft, Investigation, Funding acquisition, Data curation, Conceptualization. **E. Pouta:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Project administration, Investigation, Funding acquisition, Conceptualization. **H. Ahtiainen:** Writing – review & editing, Validation, Methodology, Funding acquisition, Data curation, Conceptualization. **A. Tolvanen:** Writing – review & editing, Supervision, Project administration, Funding acquisition, Conceptualization.

Funding

The study was funded by NordForsk Nordic Center of Excellence BIOWATER (82263).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors are grateful to the three anonymous reviewers for their efforts. Their comments substantially improved the manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jort.2025.100899>.

Data availability

Data included as supplementary material.

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