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Global insights on Sustainable Development Goal 14: Reviewing willingness-to-pay levels for marine ecosystem protection and conservation

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Abstract
Protection of marine ecosystems is vital for biodiversity conservation as it ensures the health of our oceans and seas, moreover it supports the livelihoods of millions who rely on them. Nevertheless, there are global issues that put at risk biodiversity levels, inter alia, climate change, invasive species, eutrophication, waste, and pollution. This study provides novel policy insights into Sustainable Development Goals (SDG) 14 by reviewing and comparing willingness-to-pay (WTP) levels for marine ecosystem protection and conservation across different locations worldwide. The analysis covered 220 valuation studies conducted between 2000 and 2023, sourced from the Environmental Valuation Reference Inventory (EVRI) and Ecosystem Services Valuation Database (ESVD). WTP levels are presented from both national and sea/ocean perspectives, offering a holistic approach to understanding the non-market values of biodiversity and marine ecosystem protection. Socioeconomic parameters such as age, gender, education, and income were also analyzed, revealing their influence on individuals' WTP for marine conservation initiatives. The findings suggest that WTP levels can serve as a powerful tool for policymakers and demonstrate core policy implications regarding the achievement of SDG 14

Keywords: *SDG 14; marine protection; marine conservation; valuation studies; climate change; sustainable development*

JEL Codes: Q01; Q51; Q57

Author Contribution:
Conceptualization **GH, PK**; Data curation: **GH, AP, PSA**; Formal Analysis: **GH, AP, PSA**; Investigation: **GH, AP, PSA**; Methodology: **GH, PK**; Supervision: **GH, PK**; Validation: **GH, AP, PSA, PK**; Visualization: **AP, PSA**; Writing – original draft: **AP, PSA**; Writing – review & editing: **GH, PK**.

1. Introduction

Various stakeholders, including policymakers, academics, and general public acknowledge marine ecosystem services (ES) conservation and protection as a prerequisite for the survival of humankind. Furthermore, the Millenium Ecosystem Assessment (MEA) (2005) categorized ES into provisioning, cultural, regulating, and supporting services, aiming to prevent the imminent environmental crisis due to rapid biodiversity loss, especially in marine protected areas (MPAs). Thus, marine ecosystems provide complex and important ES that can augment people's well-being (Eggert and Olsson, 2009; Halkos, 2021; MEA, 2005). Therefore, marine ecosystem protection is part and parcel to sustainable development (WCED, 1987), and nowadays, the Sustainable Development Goal (SDG) 14 by the United Nations provide insight on the protection of "life below water" (P. Koundouri et al., 2023; P. C. Koundouri et al., 2023; UN, 2016).

There are alarming issues regarding the global mega-trends that threaten marine biodiversity conservation (Gamfeldt et al., 2015; Halkos and Matsiori, 2014; Pressey et al., 2003). First, the monitoring of the relationship between marine biodiversity and ES functions should consider not only temporal, but also spatial heterogeneity as Stachowicz et al. (2007) noted. Secondly, Beaugrand et al. (2010) called for the dealing with negative externalities and the stability between phytoplanktonic and zooplanktonic biodiversity, for example, Dasgupta (2021) alerted that the overfishing of top-predators resulted in "more planktivorous fish at lower trophic levels", destabilizing in essence the environmental status quo.

Third, eutrophication can lead to significant ecological disruptions in aquatic ecosystems. Green tides are the consequence of hyper-accumulation of macroalgal biomass (i.e., algal bloom) that produces a greenish coloured substance, which can manifest under specific hydrographic and physicochemical conditions (Shan et al., 2019). For example, the reduction in eutrophication can be consequential for marine valuation studies (Ahtiainen and Vanhatalo, 2012).

Fourth, waste pollution is an ever-increasing threat to the marine environment. Waste pollution in the form of abandoned, lost, or otherwise discarded fishing gear (ALDFG) can heavily burder marine ecosystems (Macfadyen et al., 2009; Tonin, 2018). Additionally, microplastics have become a major threatening factor of marine biodiversity, therefore the WTP for microplastic removal gains prominence in the scientific community (Choi and Lee, 2018).

The economic valuation of marine ecosystems has led to an abundance of policy-making tools, most of which attempt to estimate the willingness-to-pay (WTP) via diverse valuation techniques that can provide monetary value for ES (Halkos, 2023; Markandya et al., 2019). In this sense, the significance of ecosystems can be properly evaluated through economic techniques (Tonin, 2018). More specifically, two core reports have shed the scientific spotlight on biodiversity conservation, i.e., "The Economics of Ecosystems and Biodiversity" (TEEB) (Kumar, 2012; TEEB, 2010) and "The economics of Biodiversity: The Dasgupta Review" (Dasgupta, 2021). These reports have proposed a holistic approach to measure the economic characteristics of biodiversity, making efforts to unveil the hidden interconnections between economic growth and environmental sustainability.

Extreme events can deregulate marine biodiversity stability. The hidden economic impact of unexpected events, such as oil spills, has revealed significant aspects of marine ecosystem protection. For instance, economic losses from lower fishing, poor quality goods that lead to lower market prices, and discouragement of tourism and recreational activities (Arrow et al., 1993; Loureiro et al., 2009). Furthermore, the ramifications of unexpected events can heavily influence people's attitudes; for example, there might be heterogeneity and bias in economic valuation results due to emotional reactions (León et al., 2014; Leon and Arana, 2012).

The novelty of the present study is the literature review on SDG 14 (i.e., Life Below Water) regarding the preservation of marine ES, protection of fish populations, and management of marine waste pollution. The research gap that the present research attempts to cover is the lack of a valuation study at a global level regarding SDG 14, whereas the aim of this paper is to reveal the interconnectedness between ecological sustainability and socio-economic development under the scope of SDG 14.

The contributions of this study are fourfold. First, it investigates WTP for marine ES, highlighting the critical role these ES play in supporting both environmental and human well-being. Second, it analyzes socioeconomic parameters, such as income, education, age, and gender, presenting a comprehensive understanding of how these factors influence individuals' WTP for marine conservation initiatives. Third, the findings underscore the importance of tailored policy interventions that account for demographic variations to enhance public support for marine protection. Fourth, this research aligns with SDG 14, offering policy insights for policymakers to develop effective strategies that promote marine biodiversity, mitigate eutrophication, and address waste pollution.

The paper is structured as follows. Section 2 reviews the literature on marine conservation and protection under the scope of SDG 14. Section 3 presents the methodology for monitoring valuation studies, and Section 4 illustrates the main findings and their discussion. Section 5 presents the future directions and limitations of the study, and Section 6 concludes the paper and provides policy recommendations on SDG 14 achievement.

2. Literature Review

The economic valuation of ES under SDG 14 is crucial for recognising and quantifying the benefits provided by marine and coastal ecosystems. These ecosystems offer a range of services, including fisheries, coastal protection, carbon sequestration, and tourism (Halkos and Matsiori, 2012, 2011). By assigning economic value to these services, policymakers can make informed decisions that balance ecological health with economic development. Valuation methods facilitate the demonstration of the tangible benefits of conservation efforts, encouraging investment in marine protection and sustainable management practices, and ultimately contributing to the resilience and sustainability of marine ecosystems.

2.1. Pacific Ocean

Valuations of marine protection in the Pacific Ocean showcase diverse policy-driven approaches. The environmental aspects of coastal park management can influence economic growth, for example, recreational activities in coastal parks can positively influence tourism growth (Jianhua, 2021). Nevertheless, environmental aspects that can negatively impact tourists' and local people's well-being, for instance eutrophication phenomena such as green tides (e.g., Yellow Sea)(Shan et al., 2019).

Marine-related conservation studies, which have been conducted in Coral reefs, observe how socio-economic determinants can affect the environmental conditions. The coral reefs' impacts on people are multifaceted, as they provide ecological benefits (e.g., biodiversity hotspots, coastal protection etc.), economic revenues (e.g., tourism etc.), and social implications (e.g., educational and research opportunities etc.).

First and foremost, one of the most characteristic case studies is the *Great Barrier Reef* (GBR) of Eastern Australia; for example, the degradation of GBR can diminish the profits in different economic sectors (e.g., Tourism) (Roebeling et al., 2006; Rolfe and Windle, 2013, 2012, 2010a,

2010b). Other significant case studies are the economic valuation of non-use values in the Ningaloo Reef of Western Australia, the policies focused on boosting recreation, protecting the Ningaloo Reef, and preserving the Aboriginal heritage (Gazzani, 2009). The literature gave also policy insights regarding other important coral reefs conditions, inter alia, the New Caledonia coral reef (Marre et al., 2015), the Fiji coral reef (Fonseca, 2009; O'Garra, 2012), the coral in Hon Mun islands in Vietnam (Pham and Son, 2001; Xuan et al., 2017), the Philippine coral reefs (White et al., 2000), and the Guam's reef (Xuan et al., 2017).

Invasive species can be detrimental to biodiversity. For example, the potential invasion of aggressive crabs can destabilize indigenous biodiversity and the local economy (Bell et al., 2008). The environmental crisis can threaten the local economies such as Tourism of small islands (e.g., Taiwan, Fiji, and Baekryeong)(Chen and Chen, 2019; Grilli et al., 2021; Kim et al., 2017; Penn et al., 2012).

In essence, the Pacific Ocean is crucial for marine blue growth due to its vast biodiversity (e.g., the coral reefs), providing abundant resources for sustainable fisheries and aquaculture. It supports significant economic activities like tourism and shipping, essential for coastal communities' livelihoods. Additionally, its marine ecosystems play a pivotal role in climate regulation and carbon sequestration, some core aspects of SDG 14.

2.2. Indian Ocean

Coral reefs are crucial to both the environment and human societies; hence their conservation is essential to maintaining ecological balance, protecting coastal communities, and ensuring the continued provision of their valuable services (Ahmed et al., 2005). However climate change can heavily impact coral reefs, primarily due to rising water temperature, which lead to coral bleaching (Ngazy et al., 2005).

More specifically, reefs are threatened by various factors, inter alia, marine traffic, inadequate fishing techniques, alterations of rivers' or streams' flows, sediments from industrial activities, and tourism (Seenprachawong, 2001). Despite these challenges, the combination of environmental protection and conservation with ecotourism can improve the estimation of WTP for marine ecotourism resources in Malaysia (Yacob et al., 2009). Moreover, wetlands are deemed as one of the most diverse marine ecosystems. Still, mangrove deforestation poses significant challenges to the sustainable management of coastal environments (Sathya and Sekar, 2012).

Economic valuation studies have revealed a wide range of econometric techniques such as meta-analyses that monitor the benefit transfer of coral reefs impacts on people and the environment (Londono-Diaz and Johnston, 2010). The economic valuation of marine ES can promote sustainable utilization and management of marine ES. As a result, policymakers, funding agencies, and other stakeholders can undertake important initiatives to preserve these valuable marine resources (Ransom and Mangi, 2010). In essence, coral reef protection should be further strengthened by governmental actions and regulations in the Indian ocean.

2.3. Atlantic Ocean

Valuations on marine protection in the Atlantic Ocean reveal a diverse array of approaches aimed at balancing economic development and environmental conservation. One study by Lew and Wallmo (2017) tested the temporal stability of stated preferences for endangered species protection, finding consistent willingness to pay over time, which underscores the public's enduring support for conservation efforts. Similarly, Wattage et al. (2011) measured the economic value of conserving

deep-sea corals in Ireland, using choice experiments to reveal significant public willingness to pay for the protection of these critical habitats.

In another significant study, Whitehead et al. (2018) estimated the lost recreational use values caused by the BP/Deepwater Horizon oil spill in the Gulf of Mexico. They used the travel cost method to quantify the economic impact of environmental disasters on recreational activities and emphasized the need for robust environmental safeguards and timely restoration efforts. Similarly, Barrio and Loureiro (2018) evaluated management options for marine and coastal ecosystems in Spain, using discrete choice experiments to explore public preferences for various conservation strategies. Their work illustrates how economic valuation can inform and guide effective marine management policies.

Public willingness to pay for marine ecosystem recovery is further evidenced in the study by Wallmo and Lew (2012), which focused on the recovery and downlisting of threatened and endangered marine species in the United States. Their research utilized choice experiments to demonstrate significant public support for investing in marine conservation, reinforcing the role of economic valuation in shaping sustainable marine policies.

2.4. Black Sea

Economic valuation studies in the Black Sea region illustrate the intricate balance between conservation and the utilization of marine resources (Halkos et al., 2024). Kubas and Fatih (2010) through contingent valuation, estimated the willingness to pay of public for ecotourism in the Thrace region of Turkey, highlighting significant support for conservation programs that enhance recreational areas.

Mayer and Woltering (2018) assessed the recreational ecosystem services in the German Black Sea coast using the travel cost method. Their study demonstrated the high consumer surplus derived from recreational activities, underlining the critical role of these coastal areas in local economies. Similarly, Brown et al. (2020) focused on the impact of climate risk on recreational ecosystem services in the Black Sea. By employing choice experiments, they quantified the willingness to pay for adaptive management strategies, providing valuable insights for policymakers on the economic benefits of proactive environmental management.

Taylor and Longo (2010) used choice experiments to value the willingness to pay for mitigating algal blooms, a common environmental issue in the Black Sea region. In a broader context, Turner et al. (2007) conducted a cost-benefit analysis of coastal managed realignment projects, demonstrating their economic viability and long-term environmental benefits.

2.5. Baltic Sea

Economic valuation studies in the Baltic Sea region highlight the crucial role of ecosystem services and the significant public willingness to invest in environmental quality improvements. Navrud and Strand (2018) analyzed assessments among Europeans, including Baltic Sea residents, regarding the value of global ecosystem services. Nieminen et al. (2019) conducted a contingent valuation study to monetize the benefits of achieving good environmental status in the Baltic Sea and their results indicated that Finns are willing to contribute significantly towards reducing eutrophication and improving water quality, illustrating the economic benefits of investing in environmental policies. Similarly, Pakalniete et al. (2021) utilized choice experiments to evaluate the

willingness to pay for various ecosystem service benefits provided by the Baltic Sea, highlighting the readiness of the public to support measures that enhance marine ecosystem health and biodiversity.

Soderquist (1996) provide historical perspectives on the environmental valuation of Baltic Sea and used contingent valuation to estimate public willingness to pay for reducing eutrophication. The study revealed a high compensating variation, indicating strong public demand for improved water quality. Turner et al. (1999) extended this analysis through a cost-benefit appraisal of managing nutrient fluxes and pollution in the Baltic Sea, demonstrating the long-term economic and environmental benefits of such management strategies.

2.6. Macaronesia Sea

Economic valuation studies in the Macaronesia region emphasize the importance of marine resources and ecosystem services in sustaining local economies and preserving biodiversity. Dyck and Sumaila (2010) examined the economic impact of ocean fish populations across several countries, including Cape Verde, by applying a Leontief technology coefficient to estimate the total landed value of wild fish.

Ressurreição et al. (2011) utilized the Contingent Valuation Method (CVM) to estimate public willingness to pay for species preservation in Portugal, revealing substantial support for marine biodiversity conservation. This study, along with subsequent research by Ressurreição et al. (2012), which compared valuation across different cultures, underscores the public's recognition of the intrinsic value of marine species and their willingness to invest in conservation efforts.

Further studies by Ressurreição et al. (2012b) applied contingent valuation to assess public willingness to pay for improved marine management practices in Poland and Portugal. The results demonstrated significant public support for enhancing marine ecosystem health, reflecting a broader understanding of the ecosystem services provided by these marine environments. Murillas-Maza et al. (2011) extended this valuation to open ocean ecosystems, employing the net value-added approach to quantify the economic benefits of ecosystem services in Spain's Basque Country.

2.7. Mediterranean Sea

The impact of algal blooms is tremendous. The socio-economic determinants of algal blooms can deteriorate the environmental conditions, leading to economic losses at local economies and harmful impacts on biodiversity (Hoagland and Scatasta, 2006; Stolte et al., 2004). Another, vitally important problem is climate change, as climate change can provoke unexpected events (e.g., high tides and extreme waves) as well as the rising sea temperatures can attract invasive jellyfish blooms (Remoundou et al., 2015, 2009).

Tourism can fundamentally change the site conditions around a place of environmental interest (Voltaire et al., 2011). In the Adriatic Sea the conservation of coral reefs has been studied in order to bring into existence the monitoring of a “remote and unfamiliar” goods or services (Tonin, 2018). Moreover, it has been stated that tourists want to pay more for the preservation of touristic sites with environmental richness (Batel et al., 2014; Blakemore and Williams, 2008), especially for the amelioration of coastal zones such as beaches in Spain, Italy, France, and Greece (Ariza et al., 2012; Halkos and Galani, 2013; Halkos and Matsiori, 2012; Jones et al., 2008; Kontogianni et al., 2014; Rulleau and Rey-Valette, 2013) or port growth strategies in Mediterranean States (Saz-Salazar et al., 2012).

Therefore, the policymakers can utilize marine-focused non-market valuations as a decision-making tool for integrated water or coastal zone management (Becker et al., 2012; Marzetti et al., 2016). A prerequisite for integrated coastal zone management is the cooperation of the Mediterranean countries, ultimately, which can lead to the achievement of SDG14 in the Mediterranean Sea.

2.8. Caribbean Sea

The Caribbean Sea's abundance in coral reefs, mangrove forests, and seagrass beds renders it into an important biodiversity hotspot, this is the reason why the conservation impacts of coral reef MPAs has attracted the focus in the Caribbean Sea (GLOBAL Americans, 2023). However, multi-crisis has accelerated the phenomenon of biodiversity loss at an alarming rate. Additionally, the biodiversity levels were at risk in Curaçao and Jamaica the previous twenty years (Spash et al., 2000), but these conditions have not changed.

In the Gladden Spit Marine Reserve, the MPA impact on local economy is multidimensional ranging from food security to non-monetary benefits and enhanced environmental knowledge and culture (Hargreaves-Allen, 2010, p. 168). In two choice experiments that took place in Tobago, respondents wanted to visit beaches with higher environmental quality, but the policy insights from this place show that small-island states should reduce the health issues in coastal waters, enhance coastal planning and management, as establish more MPAs (Beharry-Borg and Scarpa, 2010).

Next in order, the economic impact of MPAs protection and conservation provides a necessary prerequisite for sustainable development in the Caribbean. For instance, through a CVM study in Belize, European tourists were willing to pay more for MPAs protection than North Americans, moreover females were more environmentally sensitive as they had greater WTP than males, lastly, the higher the income, the higher the WTP as well. Similarly, in St. Vincent and the Grenadines a choice experiment study revealed that local people were willing to pay less than tourists for MPAs (Christie et al., 2015). Furthermore, a choice experiment for recreational fishing in the Gulf of Mexico showed that anglers in Florida had greater WTP than their counterparts in Louisiana, Alabama, and Mississippi, if they had a relative fishing license (Carter et al., 2020). Overall, the MPAs protection and conservation in the Caribbean Sea is central to local people's wellbeing and sustainable development for the future generations.

3. Material and Methods

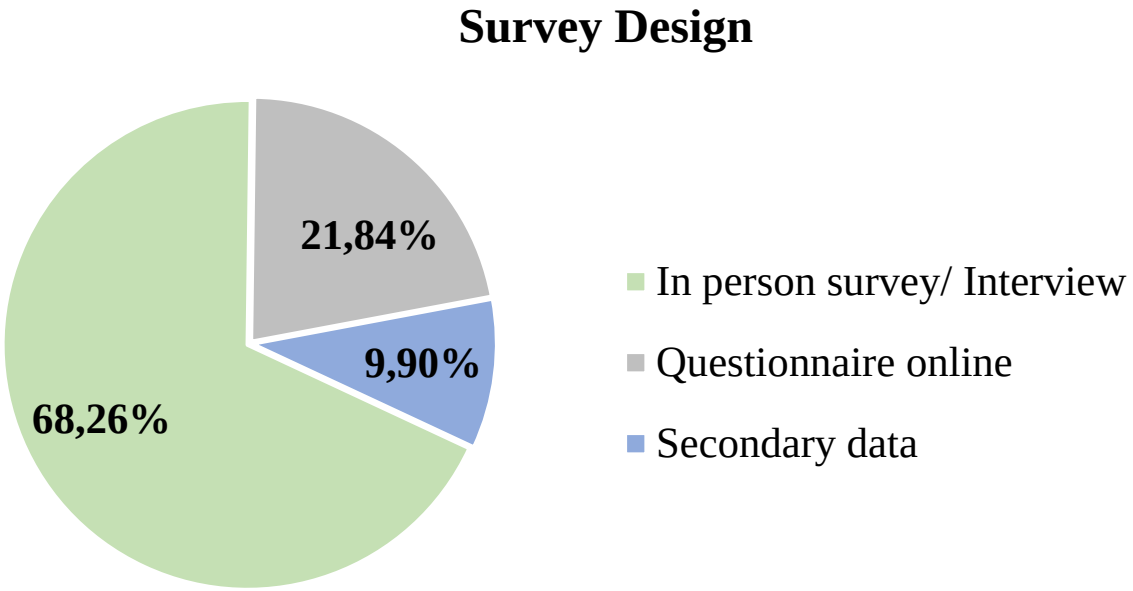
The present review present policy implications on the basis of relevant scientific-based evidence that is in line with several eligibility criteria in order to cover a series of research objective, as to cover the research gap in the lack of a valuation study at a global level regarding SDG 14. Furthermore, the aim of this paper is to reveal the interconnectedness between ecological sustainability and socio-economic development under the scope of SDG 14.

The present review focuses on valuation studies relevant to SDG14, retrieved from the Environmental Valuation Reference Inventory (EVRI). We collected 220 studies used for data extraction for our analysis published during 2000 - 2023. During this process, we gathered information including details on the willingness to pay (WTP) in Euros, elicited from different valuation methods such as choice cards, dichotomous choice, etc. Further, we recorded the type of ecosystem service—categorized as cultural, provisioning, or supporting—and identified the specific ecosystems involved. Additional metadata includes demographic details, such as the average age, income, gender distribution, and educational attainment of survey respondents, allowing us to understand the socio-economic context of each study. We also captured geographical data, marking

whether the studies were conducted in regions like the Mediterranean or the Pacific, contributing to a comprehensive overview of the spatial distribution of ecosystem valuations. The 220 retrieved studies are listed in the Supplementary Material Table S.1.

For the eligibility criteria, the 220 most recent publications were selected by two reviewers (PSA and AP), who independently conducted the search of each publication's eligibility and accuracy, both supervised by a professor (GH). A joint decision led to the conclusion of the final publications sample based on their relevance and the review's objectives. In essence, there was restriction in the date of publications in order to present solely the state-of-the-art research pathways, focusing on the period 2000-2023. Moreover, the authors (PSA and AP) independently extracted the data from all included studies in a Microsoft Excel file, again supervised by a professor (GH). For the data screening, analysis, interpretation of the results, the following parameters were inspected: WTP (€ in April 2024 levels), year of publication, country or region studied, environmental and socio-economic (age, income, gender, and educational status).

Figure 1: Survey design of the studied publications



In addition, we have explored the socioeconomic data of the studies, as the parameters of age, gender, income, and educational level can be of high relevance to the results of SDG 14 achievement. Moreover, we have monitored whether a study takes into account the ES as mentioned in the MEA report through dummy variables (value=0: if there is no mention in the study regarding the ES; value=1 if there is mention on the ES). The majority of the surveys as presented at Figure 1 are by 68% in-person interviews, followed by mail or online surveys that are almost one-fifth of the studies, and lastly, almost one-tenth are studies based on secondary data.

Table 1: The percentage of the studied publications according to their valuation method selection and relevant market category.

Valuation Method	Count	Percentage
Revealed Preferences (Existing Markets)		
Actual expenditure/market price of output	6	2.25%
Count data models	1	0.37%
Change in productivity	3	1.12%
Demand analysis	2	0.75%
Experimental cash market value	2	0.75%
Replacement costs	2	0.75%
Sum	16	5.99%
Revealed Preferences (Surrogate Markets)		
Revealed method (not specified)	7	2.62%
Hedonic Pricing Method	7	2.62%
Travel cost method (not specified)	6	2.25%
Travel cost method: single site	5	1.87%
Travel cost method: multi-site/regional	3	1.12%
Sum	28	10.49%
Stated Preferences (Hypothetical Markets)		
RUM	3	1.12%
Conjoint analysis	4	1.50%
Choice experiment	81	30.34%
Contingent ranking	1	0.37%
Contingent valuation (not specified)	49	18.35%
Contingent valuation - dichotomous choice (referendum)	36	13.48%
Contingent valuation - iterative bidding	4	1.50%
Contingent valuation - open ended	15	5.62%
Contingent valuation - payment card	24	8.99%
Sum	217	81.27%
Rest		
Meta-analysis	2	0.75%
Not Applicable (n.a)	4	1.50%
Sum	6	2.25%
Total Sum	**267**	**100.00%**

*The number shows the 267 applied valuation techniques in the 220 studies (some studies utilized more than one technique).

4. Results and Discussion

The literature review regarding the SDG 14 covers a wide range of environmental, social, and economic parameters. The economic valuation of different studies can unveil hidden aspects of ES that can impact human wellbeing and health status, as well as the preservation of marine biodiversity. Therefore, the estimation of WTP can become a practical policymaking tool for marine ecosystem managers, politicians, and academics.

Table 2 presents the minimum, mean, and maximum WTP levels for marine protection and conservation under the scope of SDG 14. The average WTP level for the whole samples is 88.23€ (range: 0 – 2,582.94€), and the Map A.1 in Appendix A illustrates the average WTP levels in each

ocean and sea studies, whereas Appendix B presents the list of the valuation studied included in this review. On a marine-related basis, the Black Sea expresses the highest mean WTP equal to 190€, followed by Baltic Sea (153€; range: from 4€ to 900€), Atlantic Ocean (108€; range from 0.96€ to 2,582,94€), and the Macaronesia (144€, range from 90€ to 198€), in essence these marine ecosystems present WTP values above one hundred euros.

Table 2: Willingness to pay for marine protection and conservation in the studied publications

	Average	Min	Max	STDEV
Oceans				
Atlantic	108.23	0.96	2582.94	296.05
Pacific	45.56	0.00	1291.09	159.92
Indian	25.62	0.00	95.60	33.38
Seas				
Black	190.00	-	-	-
Baltic	153.47	4.24	900.00	196.87
Macaronesia	144.31	90.61	198.00	75.94
Mediterranean	59.55	0.83	1098.00	143.08
Caribbean	48.32	2.31	372.88	88.42
Total Sample	**88.23**	**0.00**	**2582.94**	**217.03**

Note: 1 US dollar equals to 0.92 Euro in April 2024.

Furthermore, again in Table 2, Caribbean and Mediterranean Seas express a mediocre WTP level ranging on average between 48€ and 59€. More specifically, the Mediterranean Sea ranges between 0€ and 1,098€, whereas the Caribbean range is between 2€ and 372€. Additionally, the Pacific is closely to the aforementioned Seas, reaching a 45€ average WTP (range: from 0€ to 1,291€), whereas the lowest WTP is attributed to the Indian Ocean (25€). Next in order, the socioeconomic parameters of these WTP levels are going to be explained, as the socioeconomic parameters of valuation studies can provide necessary demographic aspects and attitudes that can interpret the WTP levels.

Table 3: The socioeconomic parameters age and gender

	Age*			Gender*		
	Average	(Min; Max)	STDEV	Average	(Min; Max)	STDEV
Ocean						
Atlantic	40.38	(20.9;57.5)	7.01	49.52%	(17.0; 61.3)	6.68%
Pacific	35.12	(20.0;52.8)	7.49	50.36%	(39.0; 59.0)	2.67%
Indian	27.11	(16.3;37.0)	7.17	48.18%	(39.0; 64.6)	6.14%
Sea						
Black	38.50	-	-	53.91%	-	-
Baltic	43.61	(28.5;54.0)	5.44	52.91%	(36.2; 70.0)	5.36%
Macaronesia	39.05	(39.0;39.1)	0.07	50.80%	(50.6; 51.0)	0.29%
Mediterranean	40.70	(27.1;55.6)	5.48	50.28%	(23.0; 59.0)	6.06%
Caribbean	33.32	(20.1;50.4)	9.27	50.32%	(42.5; 66.0)	4.87%
Total Sample	38.46		7.80	50.22%		5.65%

*When a study does not mention the age variable, then the country's mean or median age is utilized.
**The dummy for gender is women=1, when a study does not mention the gender variable, then the country's mean or median gender is utilized.

Firstly, the parameter of responders' age, as exhibited in Table 3, can contribute to WTP by influencing income levels, life stage priorities, and consumer preferences. The average age is 38 years old in the valuation studies, the highest average age is 43 years old (y.o) and belongs to the studies in the Baltic Sea (range: 28-54 y.o). Other high average age levels are in the Atlantic Ocean (40y.o on average; range 20-57y.o), and Mediterranean Sea (40y.o on average; range 27-55 y.o). The lowest average value can be attributed to the Caribbean Sea studies that has on average 33 y.o responders with a range between 20 and 50 y.o.

Secondly, the parameter of gender is illustrated in Table 3 and can influence WTP levels through differences in spending habits, ES preferences, and perceived value of marine protection and conservation. The average gender percentage is 50%, in this way the valuation studies keep a stable gender equilibrium between men and women, this is also the case for studies in the Pacific Ocean as well as the Macaronesia, Mediterranean, and Caribbean. However, there is a majority of women in valuation studies that have occurred in the Black and Baltic Seas. On the contrary, the majority of responders are men in the studies from the Atlantic and Indian Oceans.

Table 4: The socioeconomic parameters of education and income

	Education*			**Income***		
	Average	**(Min; Max)**	**STDEV**	**Average**	**(Min; Max)**	**STDEV**
Ocean						
Atlantic	49.52%	(17.0; 61.3)	6.68%	32,184.43	(570.2; 175,174.1)	25,078.59
Pacific	50.36%	(39.0; 59.0)	2.67%	23,891.92	(739.0; 85,575.7)	20,735.07
Indian	48.18%	(39.0; 64.6)	6.14%	16,274.49	(550.1; 68,827.7)	26,071.15
Sea						
Black	53.91%	-	-	5,820.00	-	-
Baltic	52.91%	(36.2; 70.0)	5.36%	19,892.34	(2,460.0; 57,661.4)	14,669.67
Macaronesia	50.80%	(50.6; 51.0)	0.29%	20,306.68	(12,473.3; 28,140.0)	11,077.98
Mediterranean	50.28%	(23.0; 59.0)	6.06%	19,399.54	(2,522.7; 56,808.1)	11,512.92
Caribbean	50.32%	(42.5; 66.0)	4.87%	23,243.38	(570.2; 103,661.0)	32,195.66
Total Sample	33.27%		17.02%	25,239.18		21,858.26

*The dummy for educational level is University =1, when a study does not mention the education variable, then the country's mean or median educational level is utilized.
**When a study does not mention the income variable, then the country's mean or median income is utilized.

Thirdly, the educational level of the respondents as depicted in Table 4 can affect WTP levels due to environmental sensitivity issues. The educational status of the respondents was relatively low regarding the possession of a university degree as the average educational level was 33%. The highest average educational level is in the Black Sea (53%), whereas the lowest average educational level can be linked to the Indian Ocean.

Fourthly, the respondents' income as noted in Table 4 can contribute to the WTP for marine protection by determining disposable income levels and the ability to allocate funds toward environmental causes. The average income is 25,239€ for the entire sample of valuation studies. According to marine-based studies, the highest average income level is 32,184€ in the Atlantic Ocean, whereas the lowest average responder's income is 5,820€ and can be found in the Black Sea.

Table 5: WTP according to the relevant ecosystem services (in Euros)

	Cultural	Provisioning	Supporting	Regulating
Min	0.00	0.06	0.06	0.06
Average	88.55	77.49	82.17	84.63
Max	2582.94	2582.94	802.47	1098.00
STDEV	273.14	135.47	142.67	149.76

Note: 1 US dollar equals to 0.92 Euro in April 2024.

As noted before, Table 5 contains the MEA ES categories of provisioning, cultural, regulating, and supporting services, which are pivotal determinants of environmental protection regarding biodiversity loss, especially in MPAs. The highest average ES can be linked to cultural services (88€) (e.g., recreational issues); moreover, cultural services express the highest WTP fluctuation from 0€ to 2,582€. Next in order are the regulating services (84€) (e.g., water clarity) and supporting services (82€) (e.g., water conditions). The lowest average ES can be addressed by the provisioning services (77€) (e.g., the conditions of the fish population). The ES discussed in this study are vital for life below water, as they ensure water quality, provide critical habitats, and support marine biodiversity. These services are essential for sustaining healthy aquatic ecosystems, which are crucial for the survival of countless marine species and for the overall health of our planet's oceans.

5. Future work and limitations

The present study focused on examining policy aspects and socioeconomic determinants derived from valuation studies that can be connected to SDG 14, which aims to conserve and sustainably use oceans, seas, and marine resources. By identifying and analysing these links, this research aimed to contribute to a deeper understanding of how various policies and economic factors can influence the achievement of SDG 14. This study highlights the importance of integrating socioeconomic insights into the broader framework of ocean conservation and sustainable use, thereby offering a comprehensive view of the challenges and opportunities in meeting SDG 14's objectives. Future studies should focus on monitoring SDG 14 sub-targets and not on the overall aim of SDG 14, which would facilitate the achievement of SDG 14.

However, a notable limitation of this study is the relatively superficial treatment of specific sub-targets within SDG 14. While the literature review touched upon these sub-targets, it did not delve deeply into each, as this was beyond the scope of the current research. This limitation suggests that future research efforts should place greater emphasis on monitoring and analysing these sub-targets individually rather than focusing solely on the overall goal of SDG 14. Such targeted efforts would provide more detailed insights and facilitate more effective achievement of SDG 14, ensuring that specific areas of concern within ocean conservation and sustainable use are adequately addressed and monitored.

6. Conclusions and Policy Implications

The present study has explored in detail 220 valuation studies regarding their socioeconomic characteristics that can be linked to the prerequisites of SDG 14, which focuses on valuing ES provided by oceans, seas, and marine resources.

The highest average WTP was identified in the Black Sea (190€) and Baltic Sea (153€), with lower levels in the Caribbean (59€) and Mediterranean (48€). Analysis of ecosystem services valuation demonstrated that cultural services garnered the highest average WTP (88€), followed by regulating (84€) and supporting services (82€), while provisioning services had the lowest average WTP (77€).

Socioeconomic factors such as age, gender, education, and income were found to impact WTP across different regions. Therefore, several policy recommendations can be suggested, including the establishment of, or expansion of Marine Protected Areas (MPAs) to safeguard critical habitats and species, enforcement of stricter fishing regulations, like for example ban of destructive fishing techniques, and tailoring conservation policies to account for demographic and regional variations in WTP, utilizing it as a guide for marine conservation initiatives. Moreover, international cooperation is essential to address issues such as illegal, unreported, and unregulated fishing.

Our research highlights the need for future studies to focus on monitoring specific SDG 14 sub-targets and conducting detailed analyses to provide targeted insights for policymakers. This approach would enable a more nuanced understanding of the complex interplay between ecological and socioeconomic factors in marine conservation efforts. In conclusion, these findings underscore the importance of integrating both ecological and socioeconomic considerations in the development of effective marine conservation policies aligned with SDG 14 objectives. By adopting a multifaceted approach that accounts for regional disparities and demographic influences, policymakers can formulate more targeted and impactful strategies for marine ecosystem protection and conservation.

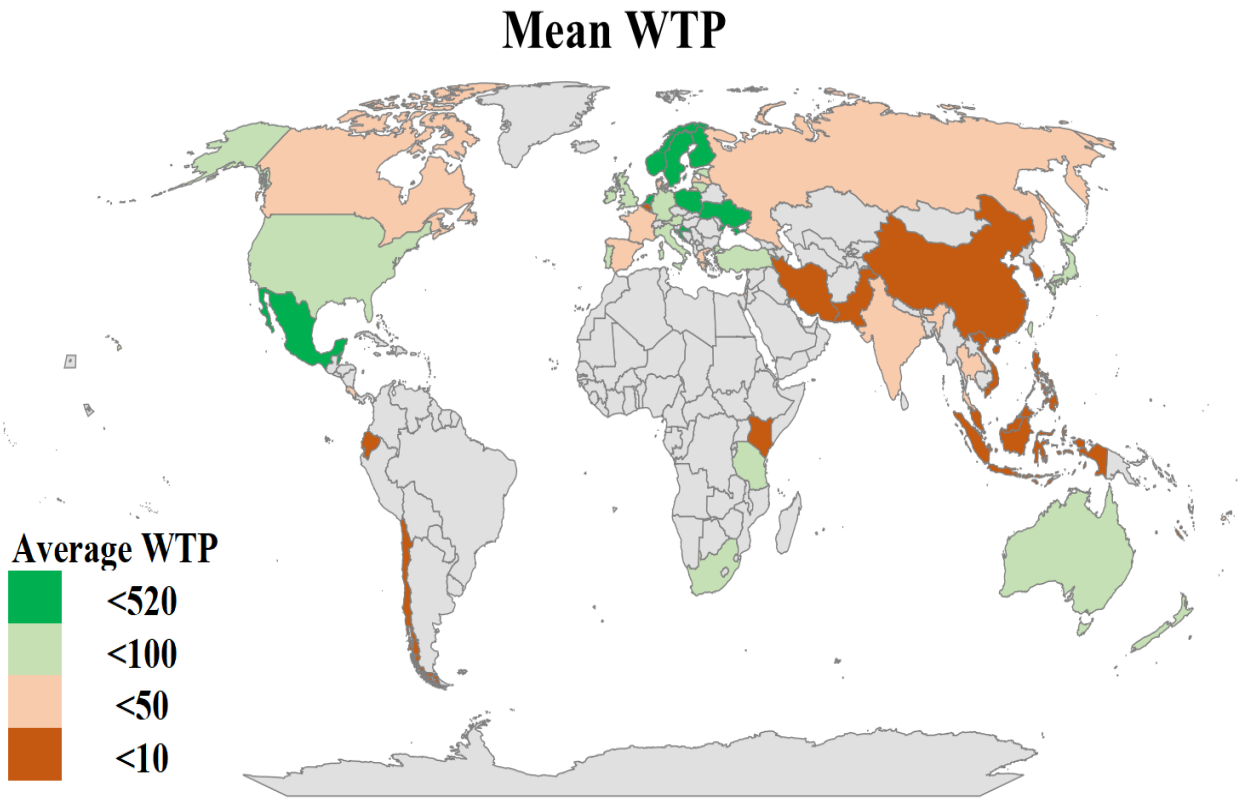
Eutrophication requires comprehensive policy interventions to mitigate its impact on marine ecosystems; therefore, the mitigation of nutrient pollution from agricultural runoff and wastewater discharge should attract more attention from governments. Policies should promote the adoption of sustainable agricultural practices that minimise fertiliser use and encourage the use of organic farming methods. Furthermore, governments should invest in the research and development of technologies to remove excess nutrients from water bodies, thereby preventing harmful algal blooms and dead zones that degrade marine life and water quality.

Waste pollution, particularly (micro) plastic pollution, necessitates a multifaceted policy approach. Governments should ban single-use plastics and provide incentives to develop and use biodegradable alternatives. Additionally, policies that promote better waste management infrastructure and public education campaigns to reduce littering and encourage recycling are essential for minimising the enormous waste flow to marine bodies. In essence, international collaboration is vital to effectively tackle the transboundary nature of marine waste pollution.

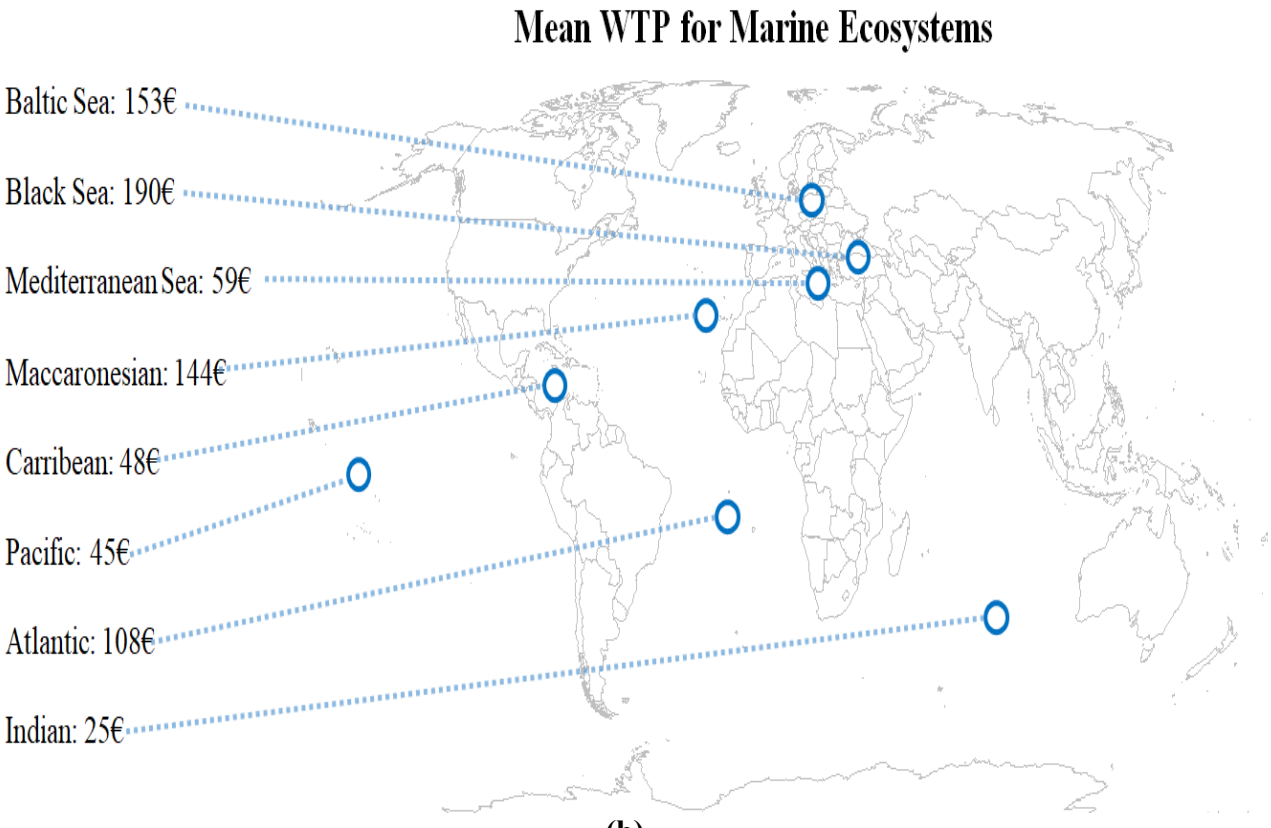
To recapitulate, the present literature review of SDG 14 underscores the need for targeted and comprehensive policy measures to ensure the conservation and sustainable use of marine resources. To achieve the aims of SDG 14, cooperation between governments, businesses, and the common public is needed. Overall, this study's policy implications not only support the achievement of SDG 14 but also contribute to broader environmental sustainability and socio-economic development. In summary, the protection of oceans is essential for sustaining biodiversity, mitigating climate change, and securing livelihoods worldwide.

Appendix A

Map A.1: Mean willingness to pay values for marine conservation. (a) a country-level approach, and (b) a marine-focused approach.



(a)



(b)

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Supplementary Material

Table S.1. List of the observed valuation studies in alphabetical order

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