CleanAtlantic

Tackling Marine Litter in the Atlantic Area

Assessing the economic impact of marine litter on tourism: Madeira case study

Work Package 4.3

MARE
ARNET AQUATIC RESEARCH NETwork
Parditi agência regional para o desenvolvimento da investigação tecnologia e inovação
Região Autónoma da Madeira Governo Regional
Secretaria Regional de Ambiente, Recursos Naturais e Alterações Climáticas
Direção Regional do Ambiente e Alterações Climáticas

Interreg Atlantic Area European Regional Development Fund
EUROPEAN UNION
Clean Atlantic

WP	4
ACTION	3
LAST UPDATED	30/07/2023
VERSION	1
AUTHORS	**MARE TEAM:** PAOLA PARRETTI, JOÃO GAMA MONTEIRO, MATEJ BUZINKAI, JOÃO CANNING CLODE **DRAAC TEAM:** PEDRO SEPÚLVEDA, NICOLA PESTANA
PARTICIPANTS	CLEANATLANTIC CONSORTIUM

DISCLAIMER

AKNOWLEDGEMENTS

This study has been carried out in the framework of the CleanAtlantic Project: "*Tackling Marine Litter in the Atlantic Area*" from the 2016 Interreg Atlantic Area Call (EAPA_46/2016).

The authors would like to thank Mare-Madeira colleagues for their assistance in the implementation of the questionnaire survey assessment.

The authors would like to thank all the participant in the survey. In particular the managers of hotels the maritime tourism operator and the manager of recreative marina in Madeira and Porto Santo islands.

The authors acknowledge master student Bernardo Leal for the collection of questionnaire survey in Porto Santo Island.

.

Index

Executive summary

Marine litter, also known as marine debris, is a worldwide recognized major environmental problem. Marine litter is composed by a range of different materials which are commonly classified in several categories. The sources of marine litter can be categorized as land- or ocean- based (considering how these debris enter the ocean). Independently of the composition or the origin, the continuous input of marine litter causes several impacts at multiple levels. In the environment, the most common effects are ingestion, entanglement, ghost fishing, secondary pollutants introduction and spread of non-indigenous species. Socially, marine litter is recognized as a health issue, a navigational hazard and a threat to fishermen. Economically, marine litter has substantial direct and indirect impacts. Among the most obvious direct impacts, there are the associated costs to clean-up activities, the cost resulting from litter related accidents (e.g., propeller entanglement) and the losses in revenue in tourism (e.g., inoperational vessel, cancelations due to loss in aesthetic value). Indirect impacts can also be substantial and are due to a decline in the ecosystem services provided by the environment deterioration.

Assessing the full economic cost of the impact of marine litter is complex, due to its compounding nature and because some effects are more readily evaluated than others. For example, beach clean-ups organised by municipalities and loss of fishing revenue can be estimated in traditional economic calculations. But the economic implications due to the ecosystem deterioration are difficult to evaluate and estimate.

Coastal region economies are especially impacted by marine litter, predominantly through the direct cost of clean-ups and its wider implication for tourism and recreation activities. Among coastal regions, oceanic islands are generally more impacted by marine litter because, firstly, are repositories of marine debris, secondly because they often need to “export” litter for processing and thirdly, because many of these islands’ economy is heavily dependent on tourism.

In this context, within the scope of Interreg Atlantic CleanAtlantic project (2017-2023), this study aims to assess the impact of marine litter in the tourism of Madeira Archipelago by estimating some of the economic costs on stakeholders from the tourism sector: hotels with direct access to the sea, marine tourism operators and leisure marinas.

To assess this, a custom designed survey questionnaire was addressed to the three stakeholder groups. The questionnaire was structured in three parts aiming respectively to asses: 1) the perception about marine litter in the region; 2) the opinion about Regional Government (RG) involvement in dealing with marine litter issue; 3) the economic impact of marine litter (i.e. ML associated estimated cost).

Key findings:

1) Perception about marine litter in the region: Overall, almost the totality of stakeholder perceived the presence of marine litter as a problem for the Region of Madeira and as an issue with an impact in the daily work activities. Almost half of the participants that engaged in this study feel ashamed about the quantity of marine litter in the Region. Similarly to other studies, stakeholders report that *plastic* and *fishing gear* are the two types of marine litter most frequently found.
2) Opinion about Regional Government involvement in dealing with marine litter issue: only one third of the stakeholders affirms that RG is dealing properly with marine litter. Overall, there is little awareness about RG actions against marine litter. Only 25% of stakeholder participated in at least one activity about marine litter organized by RG, with leisure marinas being the stakeholder group that is more participative. About future actions that should be adopted by RG, results highlight the need for developing different strategies for each stakeholder group.
3) Economic impact: considering the engaged stakeholders (49 hotels, 18 marine tourism operator and 5 marinas) the minimum cost associated to marine litter is: 175,006.19€ per year.

   The impact of marine litter in hotels was estimated based on the time needed to clean the area in proximity to the ocean. The calculated yearly cost for one hotel is 2,217.6€.

   For marine tourism operators the cost was estimated by summing the cost related to collisions with marine litter (i.e., the cost of repair, the time lost due to small and medium incidents and the refunds due to customers) and the cost of organizing voluntary clean-up activities. The estimated value for each marine tourism operator is 2,873.9€ each year.

   Finally, the cost of marine litter for leisure marinas is estimated based on staff time spent and associated costs for collecting floating and sunked marine litter. Several cleaning options are considered, the lowest estimated value for one marina is 1,748.29€ while the highest estimative is 2,922.68€ each year.

To the best of our knowledge this is the first study in which the staff time lost due to marine litter presence, or damages (i.e., time spent during working hours) is converted to monetary value.

Due to the complex and compounding nature of economic impacts due to marine litter related issues, the costs presented in this study are surely underestimated as they only focus on direct costs and on staff time cost based on national minimum wage.

Overall, this study provides new knowledge about the economic cost of marine litter on the tourism sector. Moreover, this study confirms that assessing the full economic impact of marine litter is complex, since there are several hidden and indirect associated costs.

Introduction

Marine litter, also known as marine debris, can be defined as the persistent, manufactured, or processed solid materials discarded, disposed of, or abandoned in the marine and coastal environment (UNEP, 2009). Marine litter was firstly recognized as a problem during the 1970s (Carpenter and Smith,1972; Carpenter et al., 1972), but was only a few decades later that it gained considerable attention at the political level (Ryan, 2015). In recent years, marine litter has become a priority of national and international agendas (GonzálezFernández et al., 2021; UNEP, 2016). In Europe, marine litter is explicitly addressed by the Marine Strategy Framework Directive (MSFD). This directive classifies marine litter accordingly to its material composition in 8 types: artificial polymer material/plastic, rubber, chemicals, food waste (organic), glass/ceramics, paper/cardboard, processed/worked wood, and cloth/textile. These materials can be deliberately dumped into the sea, coasts, rivers, and beaches or brought indirectly to the ocean by rivers, sewage, stormwater, currents, tides, or wind. Depending on how marine litter enter into the sea can be classified as land or ocean-based. The land-based sources include the recreational use of the coast, unprotected landfills, dumping of garbage (households and industries), public littering and sewage overflow (Galgani et al., 2015). The ocean-based sources are associated with human activities and actions at sea: fishing, merchant shipping, research and military vessels, recreational boats, cruise ships, and offshore petroleum installations (Sheavly and Register, 2007).

Independently of the composition or the origin, the continuous input of marine litter causes several impacts at multiple levels. It can cause ecological damages threatening marine wild life through entanglement or ingestion (Kühn et al., 2015; Gall and Thompson, 2015), or it can act as an introduction vector of invasive species (Miralles et al., 2018; Mghli et al., 2023). Under certain physical and chemical conditions, marine litter, especially plastics, have the ability to adsorb different organic and inorganic matter (Alberghini et al., 2023), which can lead to the introduction of toxic chemicals into the marine food webs (Engler, 2012). Socially, marine litter is responsible for beach pollution, the reduction of water quality and also it poses a navigational hazard to ships (Potts and Hasting, 2011; Sheavly and Register, 2007). The economic impacts of marine litter are probably the ones more difficult to estimate, since includes a mix of direct and indirect costs. Several studies have assessed a significant reduction in the GDP (order of

billions of dollars) due to the loss in revenue from tourism, fishing, aquaculture, clean-up costs, and others (WWF, 2021; Gall and Thompson, 2015; Mouat et al., 2010).

This loss in revenue can be substantial when considering small communities that depends almost completely from the tourism sector, like some oceanic islands. Usually, marine litter is mostly found around the main shipping routes and in coastal waters near urbanized regions (Iglesias et al., 2023). However, when islands are located close to oceanic gyres that accumulate floating litter, the coastlines of these outermost regions display densities of litter items comparable to highly polluted areas in other part of the world (Pieper et al., 2015; Ríos et al., 2018; Pham et al., 2020, Álvarez et al., 2020). Such islands are under the influence of large-scale currents that are transporting considerable amounts of marine litter from far away sources (Ryan et al., 2019) and thus are acting as sentinels of global ocean pollution (Barnes et al., 2018) like the case of Madeira Archipelago (Álvarez et al., 2020).

In this context, within the Interreg Atlantic CleanAtlantic project (2017-2023), this case study aims to contribute to the assessment of the impacts of marine litter in the tourism sector in Madeira by estimating the economic cost associated to marine litter on hotels with direct access to the sea, marine tourism operators and leisure marinas.

This required the evaluation of how much time staff spends cleaning or dealing with marine litter and the evaluation of costs related to marine litter damages on marine tourism activities. To assess this, a survey questionnaire was addressed to the mentioned stakeholder groups. The questionnaire was structured in three parts aiming respectively to asses: 1) the perception about marine litter in the region; 2) the opinion about Regional Government (RG) involvement in dealing with marine litter issue, and; 3) the economic impact of marine litter.

This study focused on direct costs from marine litter damage (such as incident due to marine litter collision), on direct costs from staff time spent dealing with marine litter and on remedial costs from clean-ups. The results are then discussed to illustrate the extent of the marine litter problem for the Autonomous Region of Madeira.

Materials and methods

1. Study area

The archipelago of Madeira is an autonomous region of Portugal, located in the North-Eastern Atlantic Ocean within the Macaronesia ecoregion (Spalding et al., 2007). This archipelago includes two inhabited islands: Madeira and Porto Santo and two uninhabited island complexes: Desertas and Selvagens Islands.

This archipelago hosts three harbours (Funchal and Porto Santo harbour, and Caniçal port) and 5 leisure marinas: Marina da Calheta, Marina do Funchal, Marina de Machico, Quinta do Lorde and Porto Santo Marina (Figure 1). The latter two receive almost 500 vessels per year followed by Marina do Funchal harbouring approximately 300 external vessels per year (Canning-Clode et al., 2013; Castro et al., 2022).

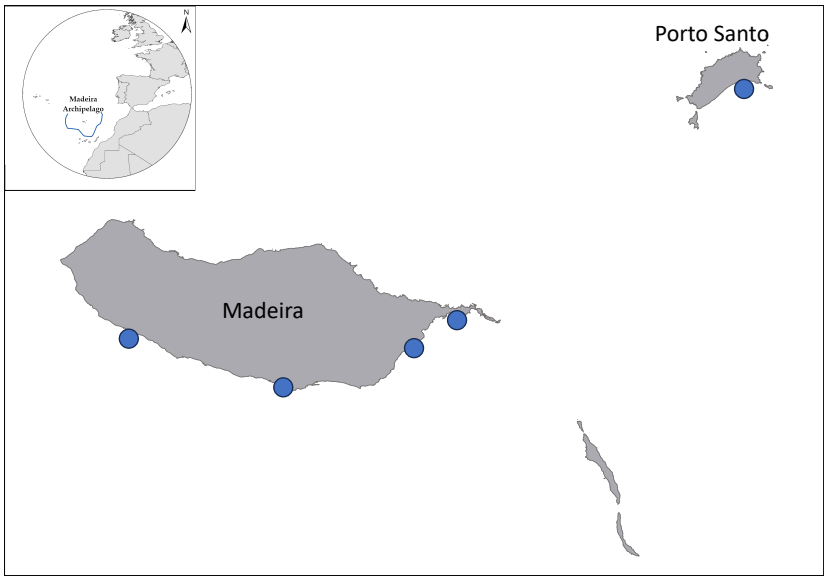

Figure1. Geographic setting and map with location of leisure marinas in the Madeira Archipelago

The economy of Madeira archipelago is mostly based on the service sector (85% GDP), with tourism being the main driver and the largest source of income in the region (www.cp-rup.com). According to the Ocean Satellite Account for the Autonomous Region of Madeira (OSA-RAM) released in 2020, the Ocean Economy in Madeira, defined as all the economic activities that use the ocean directly or indirectly, correspond to the 10% of the regional Gross Value Added (GVA) corresponding to 453.1 million Euros in 2017. These activities can be classified into three types:

1) characteristic: fishing and aquaculture; 2) cross-cutting: ship repair, port activities, maritime transport; and 3) activities favoured by the proximity of the ocean: coastal tourism. The first type accounts for 19.8 % of the Ocean-GVA; the second is responsible for only 2.7% of the Ocean-GVA while the third type is the most important Ocean-GVA (77.5%).

2. Stakeholder group selection

For marine and coastal environment, stakeholders may be considered as individuals, groups, or organisations interested, involved, or affected by a given project or action towards resource use (Munro et al., 2017). For the purposes of this study, three stakeholder groups were selected based on findings from the Ocean Satellite Account for the Autonomous Region of Madeira (section 1 of this report) and on previous studies assessing the socio-economic impact of marine litter (Iglesias et al., 2023; Rodríguez et al., 2020). The activity type with more influence on the Ocean-GVA is the one related to coastal tourism, which includes all the activities related to recreation, sports, culture and tourism.

Hotels were selected as they are the stakeholder group with highest revenue. There are 134 hotels in Madeira and Porto Santo Islands, 49 of which have direct access to the ocean. For the purposes of this study all 134 hotels were contacted and asked to participate in the survey.

Marine tourism operators were selected as second stakeholder group. Based on literature (Rodríguez et al., 2020), these stakeholders, especially whale watching companies, are the ones reporting accidents with floating marine litter more often. For this study we focused mostly on companies offering whale watching, swimming with dolphins and sail trips. According to brief research on the platform “trip advisor”, in Madeira and Porto Santo there are 18 marine tourism operators offering this type of services. We opted to use this list instead of the official one, to ensure that the activity is still running.

Lastly, leisure marinas were selected as a third stakeholder group. Due to the strategic position as an important stopover in the Atlantic Ocean, marinas in the Madeira Archipelago receive a considerable number of vessels every year. Most cleaning activities and marine litter literature and data originates from standardized survey to assess the abundance and diversity of marine litter on coast line and beaches (Maglić et al., 2022). This uneven distribution of survey efforts has left ports, marinas and harbours with limited data and observations on marine litter presence and abundance. Moreover, to the best of our knowledge, there is no information about the economic impact of marine litter on leisure marina revenue. For this work we have selected all 5 leisure marinas present in the Archipelago.

3. Survey structure

The survey questionnaire was structured in three parts. The first part was designed to assess the perception about the presence of marine litter in the Madeira Archipelago. Whitin this part it was also assessed the amount of marine litter found accordingly to its type. The methods used to classify marine litter was according to its material composition with some modification from the definition presented in MSFD recommendations (MSFD Technical Group on Marine Litter – TG-ML., 2013): plastic (artificial polymer material), rubber, fishing material, metal, glass/ceramics, paper/cardboard, processed/worked wood, and cloth/textile. The second part of the survey gather information about the perceived involvement of Regional Government in dealing with marine litter. The third part of the questionnaire was designed to collect information about possible economic lost due to the presence of marine litter (see Annex for more details).

Three questionnaire surveys were detailed to include specific questions to each stakeholder group. Although the aim of the questionnaires was equal, we opted for developing different questions that helped to characterize each stakeholder group and assess specific impact. For example, for hotels we aimed to assess the cost of cleaning the area close to the shore. For marine tourism operators, we evaluated:1) the money lost due to collision with marine litter and; 2) the money spent to organize clean-ups. Finally, for marinas we assessed both the economic impact of floating and sunk marine debris.

The questionnaires included a mix of Likert scale and fixed-choice questions and were distributed using the face-to-face approach or Google form. Several attempts have been conducted to gather responses from the three stakeholder groups. If at the third attempt it was still no possible to reach the responsible person, the questionnaire was considered as “refuse to answer” and not taken into consideration for analysis purposes.

Participants were informed at the begin of the interview about the general scope of the CleanAtlantic project and about the specific objectives of this study and that all responses were anonymous. Moreover, all participants were asked for consent for participating this study and for data use. Following a preliminary pilot survey designed to test and validate the questionnaire (on paper and online), surveys were disseminated and conducted during the autumn-winter 2022.

4. Cost assessment

Marine litter related cost to all stakeholders were initially assessed using two indicators: time and monetary value (€). Subsequently, to transform time to monetary value (in €) we used the national minimum wage of 700€ (www.salaryexplorer.com). We assume a standard 8 hours work day for a total of 252 working days in a year, resulting in a salary value of 4.4€ per hour. In the following subsection the evaluation for each stakeholder group is explained in detail.

4.1. Cost assessment for hotels

For the purposes of this analysis only the responses from the hotels with direct access to the ocean were considered.

Respondents of this stakeholder group were asked if they have specific personnel to clean the area in proximity to the sea, and to estimate how many working hours per day they spend cleaning specifically marine litter (not the one generated by the customers).

The final economic impact of marine litter on hotels with direct ocean access (C_h) was computed using the equation:

$$C_h = p \times t \times 4.4 \text{ €} \times 252 \, days \times n_h$$

Where:

p = average number of employees to clean the area in proximity to the sea

t = time spend cleaning specifically marine litter (in hours) in one day

n_h = the number of hotels with direct access to the sea.

4.2. Cost assessment for marine tourism operators

To assess the cost caused by marine litter within this stakeholder group we used two approaches. First, we evaluated the costs of collisions with marine debris. Secondly, we assessed if marine tourism operators feel the need to organize clean-ups of marine litter and evaluated the possible costs of this activity.

Several studies have assessed the cost of marine litter related incidents focusing only on the cost involved in the repair of marine vessels. In this study, we also wanted to assess the cost of the time lost due to small accidents (more than 15-minute stops) and the eventual refund that the company might have had to provide to customers.

To evaluate this cost, several considerations were needed: 1) for small accidents that were quickly solved (less than 15 minutes) we considered a cost of 0.28 cents (Rodríguez et al., 2020). 2) in cases where the boat needed to stop for a longer period two options were

presented: a) a 10% discount provided by the marine tourism operator to the customer for the next trip; b) a delay in the time of arrival to compensate the time lost due to the accident. For the purposes of this research, we considered a maximum of 1 hour delay in the arriving schedule. This time is then converted to monetary value considering the salary of 4.4€ per hour for the skipper and the guide (4.4€ x 2= 8.8€ per hour), as an incremental cost for the marine tourism operator. Lastly, 3) the cases of a trip cancellation occurred when the damages due to marine litter collision are impossible to solve. In this last scenario, marine tourism operators offer a complete refund to the customers. To estimate the cost of one trip we used the average number of clients per boat and the average price per person. We compared prices of trips provided by operators using publicly available sources (www.tripadvisor.com) and got to an average value of 50€ per person per trip.

The cost of marine litter related incidents for marine tourism operator (Ci_{mt}) was estimated using the formula:

$$Ci_{mt} = Ci_{solved} + Ci_{wait} + Ci_{canceled} + C_{repare}$$

Where:

$Ci_{solved} = \%t_{solved} \times 0.28\ cents$

t_{solved} = number of trips in with the entanglement was solved in less than 15 minutes

$Ci_{wait} = \%\ t_{discount} \times (10\% discount\ of\ 50€ \times average\ n\ client) + (\%\ t_{stay\ more} \times 8.8\ €)$

$t_{discount}$ = number of trips with an offer 10% discount

$t_{stay\ more}$ = number of trips that delay the time of arrival

$Ci_{canceled} = \%\ t_{refund} \times 1\ trip\ €$

t_{refund}= number of trips that the marine tourism operators give a complete refund

$trip\ €$ = $average\ number\ of\ people\ per\ boat \times 50€$

$Ci_{repare} = n\ indidents \times avarage\ cost\ of\ rapair$

This value is extrapolated from literature (Rodríguez et al., 2020) since only one maritime operator was able to report it. The average value per incident considered is 1,618€.

To assess the cost of clean-ups planned by marine tourism operators (Cc_{mt}) we consider the money spend in consumables (gloves, bags, gasoline) plus the money that have not earned in the time frame of the clean-ups, using the formula:

$$Cc_{mt} = \%mt_{cleanups} \times (consumable\ € + money\ not\ earn\ €)$$

Where:

$mt_{cleanups}$ = marine tourism operator that organize cleanups

$$Money\ not\ earn = trip€ \times \frac{average\ n\ trips\ conducted\ in\ 1\ day}{time\ used\ to\ do\ clean{-}ups}$$

Finally, the economic impact of marine litter on marine tourism operators (C_{mt}) was computed using the formula:

$$C_{mt} = Ci_{mt} + Cc_{mt}$$

4.3. Cost assessment for leisure marinas

The economic impact of marine litter (C_m) on this stakeholder group was estimated in three steps.

In the first step it was evaluated the cost related to marine litter incidents inside the marina (Ci_m) using the formula:

$$Ci_m = \%m \times cost\ of\ repair\ €$$

Where:

m= number of marinas in which incidents related to marine litter happen

In the second step, we estimate the cost of cleaning floating marine litter (Ccf_m). We asked if the marina has responsible employees to clean floating marine litter and assess how many working hours per day they spend in cleaning / collecting marine litter. The time used was then converted in monetary value. For this evaluation we consider the minimum salary applicable to civil servants and employees of entities within public perimeter accordingly to the Single Remuneration Table (Tabela Remuneratória Unica by Decree-Law 109-A/2021 of 7 December). This value ranged from a minimum salary of 761.00€ (4.8 € per hour) to a maximum salary of 6,555.60€ per month (41 € per hour). The Ccf_m was estimated based on the minimum wage by applying the formula:

$$Ccf_m = \%m \left[p \times 4.8\left(\frac{€}{h}\right) \times t\ (h)\right] \times 252\ days$$

Where:

m= number of marinas that clean/ collect floating marine litter

p= average number of employees cleaning / collecting marine litter per marina

t = average time spend for cleaning / collecting marine litter per 1 employee per year

In the third step we estimate the cost of cleaning marina seafloor (Ccs_m). To evaluate this cost two options were presented to respondents: 1) it was asked if the marina contracts an external entity to clean the bottom; 2) if the cleaning relies on volunteers, whether marine tourism operators or 3) individuals. The Ccs_m was calculated accordingly to the formula:

$$Ccs_m = \%\, m \times cost\ of\ option\ x€$$

Where:

m = number of marinas that do bottom cleaning

x = option adopted to clean the bottom (1 or 2). In case of option 1, the value corresponds to the cost of contracting an external company to conduct the bottom cleaning. In case of option 2 (cleaning is conducted with the help of marine tourism operators), the cost is equivalent to Cc_{mt}; in case of option 3, individuals volunteers, the cost is Ccf_m.

Finally, the economic impact of marine litter (C_m) on leisure marinas was computed using the equation:

$$C_m = Ci_m + Ccf_m + Ccs_m$$

5. Data analysis

Descriptive statistics were used to summarize results from each survey. Potential differences among the three stakeholder groups and potential relationship between the variable influencing their perceptions were tested using Chi-squared tests ot Krustal-Wallis tests with pairwise comparison in case of significant results. These statistical analisis were conducted using IBM SPSS Statistic Version 27 with a significance level of 5%.

Results

1. Response rate

Overall, a total of 44 respondents completed the questionnaires. All hotels were contacted with an email asking to fill-in the on-line survey and the rate of success was 21% (n=28). Among the hotels with direct access to the sea 20% participated in the survey (n=10). All marine recreation activities were firstly contacted with the request of filling in the online survey and secondly, since the low number of replies, with a face-to-face interview. The rate of success was 61% (n=11). Finally, all the 5 leisure marinas were approached with a face-to-face interview and all 5 agreed to participate in the study (100% success rate).

2. Perception about the presence of marine litter in the Madeira Archipelago

The great majority of respondents stated that they have environmental policy (86.4%) in the company, they provide environmental awareness for employee (81.8%) and that they communicate the environmental efforts to the client (84.1%).

Overall, almost the totality of stakeholder perceived the presence of marine litter as a problem for the Region of Madeira (90.9%) and as an issue with an impact in the daily work activities (84.1%).

When asked if their client comments about the presence of marine litter in the Region, stakeholders answers are not homogeneous: 40.7% stated that clients never comment about marine litter while 40.9% affirm that customers recognized that there is too much marine litter, and only 11.4% affirm that clients have the impression that the Madeira' sea is clean. Moreover, almost half of the interviews (47.7%) affirmed to feel ashamed with their customers about the amount of marine litter in the region. Overall, there are no significative differences among stakeholder groups and the environmental practices that they adopt nor the perception of marine litter in the region (Table 1, chi squared test not significant).

	Response: Yes (%)		
	H	MT	M
Have environmental policy	92.9	63.6	100
Provide environmental awareness for employee	82.1	72.7	90
Communicate the environmental efforts to the client	82.1	90	100
Marine litter is a problem for the region	60	100	100
Marine litter impacts the daily work activities	78.6	80	100
Client comments about the presence of marine litter:			
There is too much marine litter	35.7	40.9	60
Madeira' sea is clean	10.7	11.4	0
Felt ashamed about the amount of marine litter	38.1	81.8	80

Table 1. Environmental practices and perception about the presence of marine litter per each stakeholder groups. Where H = Hotels, MT= marine tourism operators and M= leisure marinas.

3. Frequency of marine litter found

Among all marine litter types *plastic* is the most frequently found element (70.8%) followed by *fishing gear* (54.2%) (Figure 2a). *Plastic* and *fishing material* were also the two marine litter type found with different frequency among stakeholder groups (Figure 2b)

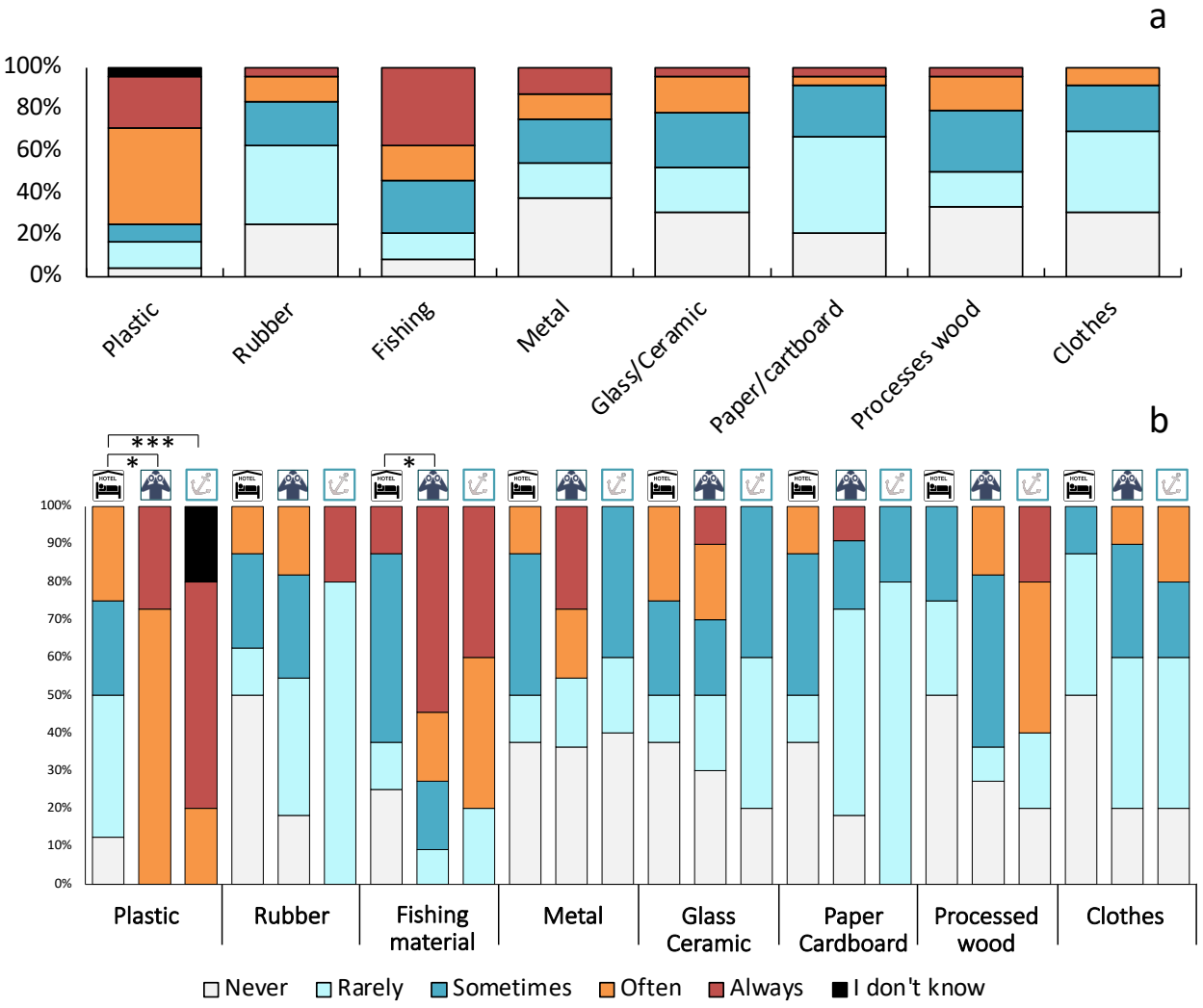

Figure2. Frequency of marine litter encounter by stakeholder groups. Marine litter is classified following a modification of the MSFD recommendations. 3a) Results considering all stakeholders; 3b) Results for each stakeholder groups (Hotels, Marine tourism operators and, leisure marinas). Significant post hoc pairwise results are expressed as *p<0.05; **p<0.01; ***p<0.001

4. Opinion about Regional Government involvement in dealing with marine litter.

According to our responses, only 36.4% of participants affirmed that the Regional Government (RG) is dealing properly with marine litter, while 38.6% declared to have no idea about RG involvement in solving or reducing this issue. When asked about RG measures to reduce the impact of marine litter, 52.3% of interviewed stated to be unaware of any measures implemented by RG, while 40% of stakeholders positively affirmed to have some knowledge about RG initiatives against marine litter. Almost half of hotels and marine tourism operators declared to be unable to evaluate RG actions in dealing with marine litter, while the opinion of 60% of leisure marinas is that RG is not handling marine litter properly (Table 2).
No significant differences were found among the three stakeholder groups.

	RG is dealing properly with marine litter			Aware about RG measures to reduce marine litter impact		
	H	MT	M	H	MT	M
Yes	32.1	45.5	40	42.9	27.3	60
No	25	9.1	60	57.1	54.5	20
I don't know	42.9	45.5	0	0	18.2	20

Table 2. Perception about Regional Government involvement in dealing with marine litter accordingly to the three stakeholder groups where: H = Hotels, MT= marine tourism operators and M= leisure marinas. Responses are expressed in percentage.

Overall, among the actions that the RG is adopting on: awareness, training and cleaning, participants shown a neutral level of satisfaction with no significant differences among stakeholder groups (Table 3).

	Awareness				Cleaning				Training			
	All	H	MT	M	All	H	MT	M	All	H	MT	M
Completely unsatisfied	7.5	7.1	11.1	0	2.5	0	11.1	0	10	10.7	11.1	0
Not satisfied	22.5	25	22.2	0	27.5	35.7	11.1	0	15	17.9	0	33.3
Neutral	35	39.3	22.2	33.3	37.5	32.1	44.4	66.7	45	46.4	33.3	66.7
Satisfied	27.5	21.4	33.3	66.7	27.5	25	33.3	33.3	22.5	17.9	44.4	0
Completely satisfied	7.5	7.1	11.1	0	5	7.1	0	0	7.5	7.1	11.1	0

Table 3 Level of satisfaction about Regional Government actions on: awareness, training and cleaning marine litter accordingly to the three stakeholder groups: Where All= the 3 stakeholder groups analysed together, H = Hotels, MT= marine tourism operators and M= leisure marinas. Results are expressed in percentage

Only 25% of stakeholders participated at least in one activity about marine litter organized by RG and 27.3% declare that they were not aware of such actions. Leisure marinas are the stakeholder groups that participate the most (60%) while hotels are the less involved stakeholder (17.9%) (Table 4).

	Participated at least in one activity about marine litter organized by RG		
	H	MT	M
Yes	17.9	27.3	60
No	50	54.5	20
I was not aware	32.1	18.2	20

Table 4. Stakeholder participation in RG activities about marine litter. Where H = Hotels, MT= marine tourism operators and M= leisure marinas. Results are expressed in percentage.

Overall, interviewed believed that Regional Government should invest more in actions aiming to clean (remove) marine litter (34.15%) and in initiatives to prevent the arrival of litter in the ocean. The three stakeholder groups shown different preference about future actions: 42.9 % of hotels select "cleaning", 54.5% of marine tourism operators preferred that RG invests in "awareness" actions, while 80% of leisure marinas would prefer that RG undertake measures to prevent the arrival of litter in the ocean (table 5).

	All	H	MT	M
Cleaning	34.1	42.9	18.2	20
Awareness	29.5	25	54.5	0
Prevention	31.8	25	27.3	80
Others	4.5	7.1	0	0

Table 5. Preferred future actions to be undertaken by regional government selected by the three stakeholder groups. Where All= the 3 stakeholder groups together, H = Hotels, MT= marine tourism operators and M= leisure marinas. Results are expressed in percentage.

5. Cost assessment for hotels

In the archipelago of Madeira there are 49 hotels with direct access to the ocean. Among these, 40% has employees to clean specifically the area close by the sea (i.e., beach; pontoons, stairs) while the rest of the hotels declared that this job is done, in a sporadic way, by all the cleaning staff. On average there are 4 people dedicated to clean only the area close to the ocean. On average, they spend 3 hours (minimum 30 minutes, maximum 8 hours) to clean. When asked the time spend to specifically pick up marine litter, our interviewed declare that it takes around 30 minutes.

According to the formula presented within this report, the overall cost associated to cleaning marine litter by all 49 hotels with access to the ocean is estimated as 108,662.4€ per year.

6. Cost assessment for marine tourism operators

In the archipelago of Madeira, we consider a total of 18 marine tourism operators that offer whale watching, swimming with dolphin, and sailing trips. The number of boats owned by each marine tourism operator range from 1 to a maximum of 4 boats. Each boat can be used from only one time per day up to a maximum of 5 times. Each company conduces on average 4.63 trips per day (Dev St= ± 3.85), for a total of 1,166.76 trips per year. The number of customers per each trip vary accordingly to the boat size and can range from a minimum of 6 customers to a maximum of 100 (average of 25 customers per trip). The cost of the activity proposed by the marine tourism operator varies accordingly to the duration and type of activity, and ranges from a minimum of 7.5€ to a maximum of 90€.

Overall, 72.7% of the marine tourism operators had an incident with marine litter which correspond to a total of 13 incidents per year. In 37.5% of the cases, the incident was solved in less than 15 minutes. According to our estimative the Ci_{solved} correspond to 1.4 cents. In the 50% of the incidents, the boat needed to stop for a longer period. In this case, 80% of the time marine tourism operators came back later while 20% offers a 10% discount. So, the Ci_{wait} calculated is 240.3€. Among the total of trips that had incidents with marine litter 12.5% needed to be cancelled. The $Ci_{canceled}$ correspond to a value of 2,031.25€.

Overall, the yearly estimated costs for boat repairs corresponds to 21,034€ making the cost of marine litter related incidents for marine tourism operators (Ci_{mt}) is 23,065.39€ per year.

The 54.5% of the marine tourism operators feel the need of organizing clean-ups. During this voluntary activity, the company stops operations and commercial activities and spends on average 50€ to purchase the necessary materials (e.g. gloves, bags, gasoline). Considering that in general a clean-up lasts for half a day, the associated yearly estimated cost for all marine tourism operators (Cc_{mt}) is 28,665€. Finally, the overall impact marine litter in the marine tourism operators in the archipelago of Madeira has an estimated cost of 51,730.39 € per year.

7. Cost assessment for leisure marinas

Five leisure marinas were considered for this study. According to our respondents, 80% of the marinas had at least one case of a boat colliding with marine litter. Since in none of the case the manager of marina had to pay for damages, it is impossible to estimate the cost of incidents inside marinas (Ci_m).

Only two marinas have specific staff, composed by 2 or 5 people, to pick-up marine litter. However, the remaining respondents declared that usually all the staff of the marina collects

marine litter as soon as they have the opportunity. So, we consider that in average 2 people are responsible for cleaning floating marine litter in each marina. Responses showcase that time spent in cleaning varies considerably between minimum of 10 minutes per day to a maximum of 3 days. The latter was reported in very specific conditions following storms and heavy rains that flush rivers and fresh waters courses to sea, resulting in large accumulation of floating litter rafts inside ports and marinas. Thus, time spent cleaning was calculated for two scenarios: a best-case scenario with 24 minutes per day (vary from 10 to 60 minutes) and a worst-case scenario is when are needed from 2 hours per day to the maximum of 3 consecutive days of work. Considering the purpose of this study, which is to provide a baseline estimate of cost associated to marine litter pollution, we opted to ignore the extraordinary events and estimate the cost of collecting floating litter under the best scenario. Total estimated cost for the 5 leisure marinas (Ccf_m) is 4,838.4 € per year.

Among the 5 marinas, only 1 has reported to not clean the seafloor. Another one contracts an external company to clean the seafloor and spends approximatively 1000€ every year (see Option 1 in 4.3 Cost assessment for leisure marinas). The other 3 leisure marinas, rely on volunteers for clean-ups (see Options 2 and 3 in 4.3 Cost assessment for leisure marinas). Since there is no information on how many marine tourism operators contribute for the clean up inside the marinas, to estimate cost from marine tourism operators volunteering in marina clean-ups (see Option 2 in 4.3 Cost assessment for leisure marinas) we assumed the cost estimated for a company per clean- up (Cc_{mt} for one company = 2.925€; see 6-Cost assessment for marine tourism operators) the as minimum value. For marina seafloor clean-ups relying on individual volunteers, (see Option 3 in 4.3 Cost assessment for leisure marinas), we considered the minimum wage as reference to estimate a Ccf_m of 967.68€ per year for each marina.

Thus, the yearly cost for a marina to clean the seafloor ranges from a minimum of 3,903.04 €, in case of relying on volunteer work, to a maximum of 9,775€ in case of asking the collaboration of 1 marine tourism operator in each marina.

Finally, the total cost of marine litter for the five leisure marinas is estimated to range between a minimum of 8,741.44 € (assuming the collaboration of volunteers) and a maximum of 14,613.4€ (in the case of involving one marine tourism operator).

8. Total cost of marine litter for the tourism

Considering the engaged stakeholders (49 hotels, 18 marine tourism operator and 5 marinas) the minimum cost associated to marine litter is: 175,006.19€ per year. In Madeira archipelago there are 81 marine tourism operators registered, assuming that all of them are still active, the total estimated cost associated to marine litter is inflated to 356,062.555 €.

Considering the 4.462 million € reported GDP for the autonomous region of Madeira in 2020, the estimated cost associated to marine litter for the three stakeholder groups considered represents a maximum of 0.008% of the regional GDP (considering only the 18 marine tourism operator this value is 0.004% of the GDP). According to the Ocean Satellite Account for the Autonomous Region of Madeira (OSA-RAM) in 2017, the Ocean Economy in Madeira has a value of 453.1 million € therefore the estimated cost associated marine litter for the stakeholders considered represents a maximum of 0.08% of the Ocean GVA.

Discussion

Results of this study illustrates that marine litter is not only causing damages to the environment and to the society but also carries serious economic implications. In the Archipelago of Madeira, marine litter is affecting different economic activities, but the real overall cost and economic implications is still difficult to assess or estimate. In this study, costs associated to marine litter in the tourism sector was estimated considering the time spent due its presence, direct costs in clean-ups and direct and indirect costs due to damages in vessels. However, the total costs and economic impact still doesn't consider losses in revenue due to marine litter compromising environmental and aesthetic value to tourists, and expenditure on remediation (e.g., authorities and third-party costs associated to clean-ups). Consequently, the estimated cost is still considerably underestimated. To address the problem of marine litter, is fundamental to engage and better understand the implications of marine litter pollution of different activities and local stakeholders (e.g., hotels, restaurants, marine tourism operators, fisherman, aquaculture), prompting for continued work with these stakeholders to tackle marine litter pollution.

Identifying public perception is equally crucial for developing efficient management measures. Public perception on marine litter related issues can be measured as a combination of

awareness, knowledge, and concern. A previous study was conducted in the Region of Madeira aiming to assess people knowledge about marine litter (Bettencourt et al., 2023) while the present case study gave more emphasis to respondent perception of marine litter pollution and impacts in the region. Overall respondents agree that marine litter is an issue for the Region and this result is in line with previous study in which participants considered marine litter a local and actual problem (Bettencourt et al., 2023). Almost half of the interviewed have also stated that their customers recognized and verbalize that there is too much marine litter in the coastal waters of Madeira. Recent studies in other touristic destinations have reported losses in revenue due to poor perception, by visitors and tourists, related to marine litter pollution (Jang et al., 2014; Krelling et al., 2017). One of them, in the APEC region, also includes an estimate of the lost opportunity to the marine tourist sector, arising from tourist taking holidays at alternative locations due to the perception of high amounts of marine litter (McIlgorm et al., 2020). Although this was not the aim of this study, further research should be done in order to evaluate such risks in Madeira.

In addition, this case study also highlights that almost all stakeholders have environmental policies in place and provide environmental awareness training and/or materials for employees and customers. This data concurs the results of a survey addressed to all of the population of Madeira, in which respondents recognized their role in marine litter management (Bettencourt et al., 2023). Interestingly the Regional Government is not identified as the main responsible in reducing marine litter but, when expressly asked, interviewees shared their opinion that the RG should undertake more actions in controlling marine litter. Specifically, some marine tourism operators complained that they were not aware about any Regional Government organised activities (e.g., clean-ups, training and awareness events) and clearly expressed their willingness to participate and be involved in marine litter related activities and events. Regarding future actions to reduce marine litter, all three stakeholder groups have shared different opinions. While hotels would like to see more efforts by the RG in cleaning, managers of leisure marinas would prefer RG to invest more in prevention.
These varying viewpoints are probably influenced by the unique nature of their activities and the challenges associated with waste build-up in marinas following intense rainfall and storms. During such instances, all the accumulated litter and debris in riverbeds and small streams are carried into the sea and sometimes directly towards the marinas.

Since the level of litter accumulation inside marinas is highly variable, it was difficult to make an accurate evaluation of the total cost allocated to remove marine litter. Thus, we opted to estimate the minimum cost associated to marine litter removal and clean-up. Consequently, the value presented corresponds to the estimated cost associated to regular clean-ups and with no major pollutant events (e.g. storms).

The estimated cost associated to marine litter on marine tourism operators is also underestimated. It was almost impossible to assess the factual damage and cost for small incidents due to marine litter collisions. During the survey, it was shocking to notice that marine tourism operator perceived engine entanglement as a normal every day issue and did not immediately recognise it as an impact associated to floating debris. Similarly, long delays (more than 15 minutes) were not seen as a cost or loss in revenue, even though they take up time from the commercial operation.

Lastly, the perception of the costs associated to litter pollution by hotels were equally intricate. This is mostly due to the low participation of this stakeholder group. It was difficult to engage with hotel managers, probably due to their low time availability or because they do not perceive marine litter as a real issue. However, based on a conservative approach that considers the national minimum wage as reference and the time spent in marine litter clean-ups reported by responding stakeholders, this study suggests a relevant cost per year associated to marine litter pollution. The low participation and engagement from the hotels invited to participate, also illustrate that more effort is needed in involving this stakeholder group in future researches.

Up to now, previous studies assessing the cost of marine litter have based their estimations on insurance statistics (Takehama, 1989) interviews to beach visitors (Balance et al., 2000) or damages assessment due to collision with marine litter (Rodríguez et al., 2020). Despite the limitations outlined above, this case study is, to the best of our knowledge, the first to consider staff time spent tackling marine litter pollution as a cost (based on income per hour and minimum wages). Finally, this study and the present estimations serve as a valuable baseline for costs associated to marine litter on local tourism activities.

Conclusion

This study is the first approach aimed at understanding the magnitude of marine litter impacts for the economy of remote islands like the archipelago of Madeira (Portugal). Overall,

stakeholders perceived the presence of marine litter as a problem for the Region of Madeira and as an issue with an impact in the daily work activities. Despite an increase in the actions promoted by the Regional Government to monitor and reduce the impact of marine litter, these are still perceived as insufficient and future specific engagement activities, targeting different stakeholder groups, are recommended.

Overall, the minimum estimated cost associated to marine litter for the selected stakeholder groups is 175,006.19€ per year. If this cost is extrapolated for all the maritime tourism operators that are officially register (81) in the archipelago of Madeira the cost of marine litter inflates to 356,062.555€ per year, which correspond to the 0.008% of the regional GDP in 2020. This value is comparable to estimates for other island states, however it is surely an underestimation as it does not consider costs and losses linked to clean-up activities, damages to shoreline protection infrastructure and many other indirect costs.

Despite the limitations inherent to this case study, the present estimates can be used as a valuable baseline for costs associated to marine litter in the tourism sector and its overall impact for the economy of this region.

References

Alberghini, L., Truant, A., Santonicola, S., Colavita, G., Giaccone, V., 2023. Microplastics in fish and fishery products and risks for human health: a review. Int. J. Environ. Res. Public Health 20, 789. https://doi.org/10.3390/ijerph20010789.

Álvarez, S., Gestoso, I., Herrera, A. *et al.* A Comprehensive First Baseline for Marine Litter Characterization in the Madeira Archipelago (NE Atlantic). *Water Air Soil Pollut* **231**, 182 (2020). https://doi.org/10.1007/s11270-020-04517-x

Barnes, D.K., Morley, S.A., Bell, J., Brewin, P., Brigden, K., Collins, M., 2018. Marine plastics threaten giant Atlantic Marine. Protected Areas. Cur. Biol. 28, R1121eR1142. https://doi.org/10.1016/j.cub.2018.08.064.

Bettencurt S, Freitas DN, Costa S, Caeiro S (2023) Public perceptions, knowledge, responsibilities, and behavior intentions on marine litter: identifying profiles of small oceanic islands inhabitants. *Ocean and Coastal management* 231106406. https://doi.org/10.1016/j.ocecoaman.2022.106406

Canning-Clode, J., Fofonoff, P., McCann, L., Carlton, J., Ruiz, G., 2013. Marine invasions on a subtropical island: fouling studies and new records in a recent marina on Madeira Island (Eastern Atlantic Ocean). Aquatic Invasions 8, 261–270. https://doi.org/10.3391/ai.2013.8.3.02

Carpenter, E.J., Anderson, S.J., Harvey, G.R., Miklas, H.P., Peck, B.B., 1972. Polystyrene spherules in coastal waters. Science 178, 750–753.

Carpenter, E.J., Smith, K.L.J., 1972. Plastics on the Sargasso sea surface. Science 175, 1240–1241.

Castro, N., Gestoso, I., Marques, C.S., Ramalhosa, P., Monteiro, J.G., Costa, J.L., Canning-Clode, J., 2022. Anthropogenic pressure leads to more introductions: Marine traffic and artificial structures in offshore islands increases non-indigenous species introduction. Mar Pollut Bull 181, 113898. https://doi.org/10.1016/j.marpolbul.2022.113898

Engler RE. The complex interaction between marine debris and toxic chemicals in the ocean. Environmental science & technology. 2012 Nov 20;46(22):12302-15.

Galgani F, Hanke G, Maes T. Global distribution, composition and abundance of marine litter. Marine anthropogenic litter. 2015:29-56.

Gall, S.C., Thompson, R.C., 2015. The impact of debris on marine life. Mar. Pollut. Bull. 92 (1–2), 170–179. https://doi.org/10.1016/j.marpolbul.2014.12.041.

Gall, S.C., Thompson, R.C., 2015. The impact of debris on marine life. Mar. Pollut. Bull.92 (1–2), 170–179. https://doi.org/10.1016/j.marpolbul.2014.12.041.

González-Fernández, D., Cózar, A., Hanke, G. *et al.* Floating macrolitter leaked from Europe into the ocean. *Nat Sustain* 4, 474–483 (2021). https://doi.org/10.1038/s41893-021-00722-6

Hall K. Impacts of marine debris and oil: economic and social costs to coastal communities. Kommunenes Internasjonale Miljøorganisasjon; 2000.

Iglesias, I., Lupiac, M., Vieira, L.R., Antunes, S.C., Mira-Veiga, J., Sousa-Pinto, I., Lobo, A., 2023. Socio-economic factors affecting the distribution of marine litter: The Portuguese case study. Mar. Pollut. Bull. 193, 115168. https://doi.org/10.1016/j.marpolbul.2023.115168

Kühn, S., Bravo Rebolledo, E.L., van Franeker, J.A. (2015). Deleterious Effects of Litter on Marine Life. In: Bergmann, M., Gutow, L., Klages, M. (eds) Marine Anthropogenic Litter. Springer, Cham. https://doi.org/10.1007/978-3-319-16510-3_4

Kühn, S., Bravo Rebolledo, E.L., van Franeker, J.A., 2015. Deleterious effects of litter on marine life. Mar. Anthropogenic Litt. 75–116. https://doi.org/10.1007/978-3-31916510-3_4/TABLES/5.

Lavers JL, Bond Al (2017) Exceptional and rapid accumulation of anthropogenic debris on one of the world's most remote and pristine islands Proc. Nat. Acad. Sci 114, 6052-6055 DOI: 10.1073/pnas.1619818114

Maglić, Livia, Maglić, Lovro, Grbčić, A., Gulić, M., 2022. Composition of Floating Marine Litter in Port Areas of the Island of Mallorca. J. Mar. Sci. Eng. 10, 1079. https://doi.org/10.3390/jmse10081079

McIlgorm, D.E., 2020. Update of 2009 APEC Report on Economic Costs of Marine Debris to APEC Economies. A Report to the APEC Ocean and Fisheries Working Group by the Australian National Centre for Ocean Resources and Security (ANCORS), University of Wollongong, Australia, December.

Mghili B, De-la-Torre GE , Aksissou M, Assessing the potential for the introduction and spread of alien species with marine litter, Marine Pollution Bulletin, Volume 191, 2023, 114913,ISSN 0025-326X, https://doi.org/10.1016/j.marpolbul.2023.114913.

Miralles, L., Gomez-Agenjo, M., Rayon-Viña, F., Gyraitė, G., Garcia-Vazquez, E., 2018. Alert calling in port areas_ Marine litter as possible secondary dispersal vector for hitchhiking invasive species. Journal for Nature Conservation 42, 12–18. https://doi.org/10.1016/j.jnc.2018.01.005

Monteiro, R.C.P., Ivar do Sul, J.A., Costa, M.F., 2018. Plastic pollution in islands of the Atlantic Ocean. Environ. Pollut. 238, 103–110. https://doi.org/10.1016/j.envpol. 2018.01.096.

Mouat J, Lozano RL, Bateson H. Economic impacts of marine litter. Kommunenes Internasjonale Miljøorganisasjon; 2010.

Mouat, J., Lozano, R.L., Bateson, H., 2010. Economic impacts of marine litter. KIMO 117.

Munro, J., Pearce, J., Brown, G., Kobryn, H., Moore, S.A., 2017. Identifying `public values' for marine and coastal planning: Are residents and non-residents really so different? Ocean and Coastal Management 148, 1–13. https://doi.org/10.1016/j.ocecoaman.2017.07.016

Pham, C.K., Pereira, J., Frias, J., Carriço, R., Juliano, M., Rodríguez, Y., 2020. Beaches of the Azores archipelago as transitory repositories for small plastic fragments floating in the North-East Atlantic. Environ. Pollut. 263, 114494. https://doi.org/10.1016/j. envpol.2020.114494.

Pieper, C., Ventura, M.A., Martins, A., Cunha, R.T., 2015. Beach debris in the Azores (NE Atlantic): Faial Island as a first case study. Mar. Pollut. Bull. 101 (2), 575–582. https://doi.org/10.1016/j.marpolbul.2015.10.056.

Potts, T., Hastings, E., 2011. Marine Litter Issues, Impacts and Actions. APS Group Scotland. https://www.gov.scot/binaries/content/documents/govscot/publicati ons/impact-assessment/2012/09/marine-litter-issues-impacts-actions/documents/ 00402421-pdf/00402421-pdf/govscot%3Adocument/00402421.pdf.

Ríos, N., Frias, J.P.G.L., Rodríguez, Y., Carriço, R., Garcia, S.M., Juliano, M., Pham, C.K., 2018. Spatio-temporal variability of beached macro-litter on remote islands of the North Atlantic. Mar. Pollut. Bull. 133, 304–311. https://doi.org/10.1016/j. marpolbul.2018.05.038.

Rodríguez Y, Ressurreição A, Pham CK, Socio-economic impacts of marine litter for remote oceanic islands: The case of the Azores, Marine Pollution Bulletin, Volume 160, 2020, 111631, ISSN 0025-326X, https://doi.org/10.1016/j.marpolbul.2020.111631.

Rodríguez, Y., Ressurreição, A., Pham, C.K., 2020. Socio-economic impacts of marine litter for remote oceanic islands_ The case of the Azores. MPB 160, 111631. https://doi.org/10.1016/j.marpolbul.2020.111631

Ryan, P.G., 2015. A brief history of marine litter research. In: Bergmann, M., Gutow, L., Klages, M. (Eds.), Marine Anthropogenic Litter. Springer, Berlin, pp. 1–25.

Ryan, P.G., Dilley, B.J., Ronconi, R.A., Connan, M., 2019. Message in a bottle: rapid in crease in Asian bottles in the South Atlantic Ocean indicates major debris inputs from ships. Proc. Nat. Acad. Sci 116, 20892–20897.

Sheavly, S.B., Register, K.M. Marine Debris & Plastics: Environmental Concerns, Sources, Impacts and Solutions. *J Polym Environ* 15, 301–305 (2007). https://doi.org/10.1007/s10924-007-0074-3

Spalding, M.D., Fox, H.E., Allen, G.R., Davidson, N., Ferdaña, Z.A., Finlayson, M., Halpern, B.S., Jorge, M.A., Lombana, A., Lourie, S.A., Martin, K.D., McManus, E., Molnar, J., Recchia, C.A., Robertson, J., 2007. Marine Ecoregions of the World: A Bioregionalization of Coastal and Shelf Areas. BioScience 57, 573–583. https://doi.org/10.1641/b570707

UNEP , 2009. Marine Litter: A global challenge. United Nations Environment Programme Nairobi

UNEP 2016 ., Marine plastic Debries and microplastic- global lesion and research to inspire action and guide policy chage. United Nations Environment Programme. Nairobi

WWF, 2021. The hidden cost of plastic. Accessed on April 2023. https://www.wwfdrc.org/?36252/The-hidden-cost-of-plastic.

Annex

1. Survey addressed to hotels

Welcome!

Thank you for taking the time to participate in this survey on opinions regarding marine litter in the Autonomous Region of Madeira (ARM). The survey is being administrated by MARE-Madeira (Marine and Environmental Sciences Centre) and by Secretaria Regional de Ambiente, Recursos Naturais e Alterações Climáticas- Direção Regional do Ambiente e Alterações Climáticas as part of the European Project Clean Atlantic.

Marine litter is any persistent, manufactured or processed solid material that is, intentionally and unintentionally, discarded, disposed of, or abandoned in the marine and coastal environment. Marine litter comprises a wide range of materials, including plastic, metal, wood, rubber, glass and paper. It arises as a consequence of the unsustainable consumption and production patterns of many sectors of society, including industry, fisheries, tourism and individuals. Whitin the Clean Atlantic project we aim to understand how marine litter may impact your daily work.

Please notice that responses are voluntary, you can refuse to answer to some questions or withdraw to participate at any time. The survey is anonymous and data will be treated globally.

Perception of Marine litter

1- In general, how frequently do you see marine litter in ARM coastal area (that includes beaches, coasts and sea)? [Using a scale where 1= I never see marine litter, 2= Rarely, 3= occasionally, 4= Frequently, 5= Always]

1	2	3	4	5

2- Do you believe that marine litter is a problem for the ARM?

- Yes
- No
- I don't know

3- Do you believe that marine litter has a direct impact on your work activities?

- Yes
- No
- I don't know

4- Do your customers have ever commented about marine litter in the ARM?
- Yes, in a positive way (they said that there is no marine litter in the ARM)
- Yes, in a negative way (they complain about marine litter in the ARM)
- No

5- Do you ever feel ashamed /embarrassed with your costumers about the amount of marine litter in the ARM?
- Yes
- No

Perception on marine litter and Regional Government

6- Do you think that the local government is handing properly marine litter?
- Yes
- No
- I don't know

7- Are you aware about which measures are implemented by Regional Government?
- Yes
- Not sure
- No

8- How do you feel about local government measures on: [Please use a scale where 1= completely unsatisfied; 2= not satisfied; 3= Neutral; 4= satisfied; 5= Completely satisfied]

	1	2	3	4	5
Cleaning					
Training campaign					
Awareness campaign					

9- Did you ever participated in any activity organized by Regional Government about with marine litter (beach clean-up; training; etc) ?
- Yes
- No
- I have never been aware of such activities

10- Where do you feel is more important to invest to reduce marine litter in the ARM?
- Cleaning (beaches, seabottom inside marinas or harbous, etc)
- Awareness campaign
- Prevention
- Other: Please, specify_____

Hotel waste management:

11- Does your hotel have a sustainability certification (e-g- Green Key):
- Yes, since _____ , name _____
- No

12- Does your hotel have a formal policy statement on environmental programmes or measures?
- Yes
- No

13- Do you provide environmental awareness program for your employees?
- Yes
- No

14- Do you communicate your environmental efforts to the client?
- Yes
- No

15- Do you believe that customers appreciate the concern with the ecological footprint?
- Yes
- No
- I don't know

16- Does your hotel have a direct access to the sea?
- Yes, beach (the survey proceed)
- Yes, access like pontoons (the survey proceed)
- No (the survey end here)

Marine litter impact

17- Does your hotel have specific personnel to clean the area in proximity to the sea?
- Yes, they keep the beach cleaned
- Yes, they keep the access to the sea (like pontoons, stairs) cleaned
- No, the personnel is random

18- If yes, how many are they? _____

19- Do they collect general waste (created by the customers) or do they also collect marine litter (i.e., that arrive from the sea)? [Please select all that apply]
- Customers waste
- Marine litter (it can be on the coast or at sea just in front of your hotel) (if this is selected continue)
- I don't know

20- How many hours they work per day to keep clean the area in proximity to the sea?
_____

21- How much of their working time (hours per day) is it spend to collect only marine litter?
- Less than 30 minutes per day
- 1 hour per day
- More than 1 hour per day, please specify _____
- I don't know

22- Do you have special equipment to collect marine litter? [Please select all that apply]
- Tractor
- Scraper
- Nets
- Gloves (used specifically to pick up marine litter)
- Others: _____
- I don't have it

23- Do you know in general how often they collect the following type of marine litter? [Using a scale where 1= Never, 2= rarely, 3= Sometimes; 4= Often; 5= Always; 6= I don't know]

	1	2	3	4	5	6
Plastic/Polystyrene (e.g. bags, bottles, crates, containers, etc.)						
Rubber (e.g. tyres, rubber tubes/sheets, rubber bands, etc.)						
Fishing materials (e.g. nets, ropes, etc.)						
Metals (e.g. cans, cables, appliances, etc.)						
Glass/Ceramics (e.g. bottles, jars, light bulbs, etc.)						
Paper/Cardboard (e.g. boxes, cartons, cups, newspapers, etc.)						
Processed wood (e.g. pallets, corks, crates, sticks, etc.)						

24- After collecting marine litter, do you separate it in the proper recycling bin?
- Yes
- No

25- How often a client complains about marine litter? (Ask specifically to remove an object like tins, plastic bags, wood)
- Once a day
- Once a week
- Once a month
- Once a year
- I have never received complains about marine litter in my hotel

26- Did you have ever organized an awareness activity about marine litter?
- Yes
- No

27- If yes, how often?

- Once a month
- More than 3 timer por year
- Once a year

28- On average, how many people participated? _____

29- What expenses did you have to organize such activity? (if possible write the estimative value. For example: fuel, gloves, bags to collect litter, etc. _____

THANK YOU FOR YOUR TIME

2. Survey addressed to marine tourism operator

Welcome!

Thank you for taking the time to participate in this survey on opinions regarding marine litter in the Autonomous Region of Madeira (ARM). The survey is being administrated by MARE-Madeira (Marine and Environmental Sciences Centre) and by Secretaria Regional de Ambiente, Recursos Naturais e Alterações Climáticas- Direção Regional do Ambiente e Alterações Climáticas as part of the **European Project Clean Atlantic**.

Marine litter is any persistent, manufactured or processed solid material that is, intentionally and unintentionally, discarded, disposed of, or abandoned in the marine and coastal environment. Marine litter comprises a wide range of materials, including plastic, metal, wood, rubber, glass and paper. It arises as a consequence of the unsustainable consumption and production patterns of many sectors of society, including industry, fisheries, tourism and individuals. Whitin the Clean Atlantic project we aim to understand how marine litter may impact your daily work.

Please notice that responses are voluntary, you can refuse to answer to some questions or withdraw to participate at any time. The survey is anonymous and data will be treated globally.

Perception of Marine litter

1- In general, how frequently do you see marine litter in ARM coastal area (that includes beaches, coasts and sea)? [Using a scale where 1= I never see marine litter, 2= Rarely, 3= occasionally, 4= Frequently, 5= Always]

1	2	3	4	5

2- Do you believe that marine litter is a problem for the ARM?

- Yes
- No
- I don't know

3- Do you believe that marine litter has a direct impact on your work activities?

- Yes
- No
- I don't know

4- Do your customers have ever commented about marine litter in the ARM?
- Yes, in a positive way (they said that there is no marine litter in the ARM)
- Yes, in a negative way (they complain about marine litter in the ARM)
- No

5- Do you ever feel ashamed /embarrassed with your costumers about the amount of marine litter in the ARM?
- Yes
- No

Perception on marine litter and Regional Government

6- Do you think that the local government is handing properly marine litter?
- Yes
- No
- I don't know

7- Are you aware about which measures are implemented by Regional Government?
- Yes
- Not sure
- No

8- How do you feel about local government measures on: [Please use a scale where 1= completely unsatisfied; 2= not satisfied; 3= Neutral; 4= satisfied; 5= Completely satisfied]

	1	2	3	4	5
Cleaning					
Training campaign					
Awareness campaign					

9- Did you ever participated in any activity organized by Regional Government about with marine litter (beach clean-up; training; etc) ?
- Yes
- No
- I have never been aware of such activities

10- Where do you feel is more important to invest to reduce marine litter in the ARM?
- Cleaning (beaches, seabottom inside marinas or harbous, etc.)
- Awareness campaign
- Prevention
- Other: Please, specify_____

Company details:

11- Which type of activities do you provide? [Please select all that apply]

- Whale watching
- Scuba Diving
- Sailing /boat tour /Seaviewing
- Big game fishing
- Swimming with dolphins
- Other_____

12- How many boats do you have? _____

13- On average, how many people per boat? _____

14- On average, how many trips per boat per day? _____

15- Does your activity have a formal policy statement on environmental programmes or measures?

- Yes
- No

16- Do you provide environmental awareness program for your employees?

- Yes
- No

17- Do you communicate your environmental efforts to the client?

- Yes
- No

18- Do you believe that customers appreciate the concern with the ecological footprint?

- Yes
- No
- I don't knok

19- Are there some places in the ARM that you avoid to conduct your activity because you know there is a great deal of marine litter?

- Yes
- No

20- If yes, may you please specify where? _____

Collision or accident with marine litter

21- Have you ever had an accident or collision due to marine litter?

- Yes
- No

22- How frequently in a year?

- Once
- Rarely
- Once a month
- More than once a month

23- Does the boat needed to stop or cancel the trip?

- Yes, stopped for some minutes (more than 15 minuttes)
- Yes, trip cancelled
- No, the issue was solved in less than 15 minutes

24- If you had to cancel the trip, which compensation do you offer to your customers?

- Money refund (completely)
- Offer a new trip to be reschedule accordingly
- No compensation
- Other: _____

25- If the boat had to stop for a while (more than 15 minutes), which compensation do you offer to your customers?

- Come back at the planned time (I shorter the trip)
- Stay a little bit longer to compensate the lost time
- Provide a compensation to customers (like a discount in the next booked activity)
- Other: _____

26- How much did you pay to repair the damage caused by the collision with marine litter?

___

27- How often do you see the following type of marine litter? [Using a scale where 1= Never, 2= rarely, 3= Sometimes; 4= Often; 5= Always; 6= I don't know]

	1	2	3	4	5	6
Plastic/Polystyrene (e.g. bags, bottles, crates, containers, etc.)						
Rubber (e.g. tyres, rubber tubes/sheets, rubber bands, etc.)						
Fishing materials (e.g. nets, ropes, etc.)						
Metals (e.g. cans, cables, appliances, etc.)						
Glass/Ceramics (e.g. bottles, jars, light bulbs, etc.)						
Paper/Cardboard (e.g. boxes, cartons, cups, newspapers, etc.)						
Processed wood (e.g. pallets, corks, crates, sticks, etc.)						

28- How often do you pick up marine litter? [Using a scale where 1= Never, 2= rarely, 3= Sometimes; 4= Often; 5= Always]

1	2	3	4	5

29- If you pick up a piece of marine litter, did you throw it in the appropriate recycling bin?

- Yes
- No

30- How often a client complains about marine litter? (Ask specifically to pick up an object from the sea like tins, plastic bags, wood)

- Once a day
- Once a week
- Once a month
- Once a year
- I have never received such a request

31- Did you have ever organized an awareness activity about marine litter?

- Yes
- No

32- If yes, how often?

- Once a month
- More than 3 timer por year
- Once a year

33- On average, how many people participated? _____

34- What expenses did you have to organize such activity? (if possible write the estimative value. For example: fuel, gloves, bags to collect litter, etc. _____

THANK YOU FOR YOUR TIME

3. Survey addressed to leisure marinas

Welcome!

Thank you for taking the time to participate in this survey on opinions regarding marine litter in the Autonomous Region of Madeira (ARM). The survey is being administrated by MARE-Madeira (Marine and Environmental Sciences Centre) and by Secretaria Regional de Ambiente, Recursos Naturais e Alterações Climáticas- Direção Regional do Ambiente e Alterações Climáticas as part of the European Project Clean Atlantic.

Marine litter is any persistent, manufactured or processed solid material that is, intentionally and unintentionally, discarded, disposed of, or abandoned in the marine and coastal environment. Marine litter comprises a wide range of materials, including plastic, metal, wood, rubber, glass and paper. It arises as a consequence of the unsustainable consumption and production patterns of many sectors of society, including industry, fisheries, tourism and individuals. Whitin the Clean Atlantic project we aim to understand how marine litter may impact your daily work.

Please notice that responses are voluntary, you can refuse to answer to some questions or withdraw to participate at any time. The survey is anonymous and data will be treated globally.

Perception of Marine litter

1- In general, how frequently do you see marine litter in ARM coastal area (that includes beaches, coasts and sea)? [Using a scale where 1= I never see marine litter, 2= Rarely, 3= occasionally, 4= Frequently, 5= Always]

1	2	3	4	5

2- Do you believe that marine litter is a problem for the ARM?

- Yes
- No
- I don't know

3- Do you believe that marine litter has a direct impact on your work activities?

- Yes
- No
- I don't know

4- Do your customers have ever commented about marine litter in the ARM?

- Yes, in a positive way (they said that there is no marine litter in the ARM)
- Yes, in a negative way (they complain about marine litter in the ARM)
- No

5- Do you ever feel ashamed /embarrassed with your costumers about the amount of marine litter in the ARM?

- Yes
- No

6.

Perception on marine litter and Regional Government

6- Do you think that the local government is handing properly marine litter?

- Yes
- No
- I don't know

7.

7- Are you aware about which measures are implemented by Regional Government?

- Yes
- Not sure
- No

8.

8- How do you feel about local government measures on: [Please use a scale where 1= completely unsatisfied; 2= not satisfied; 3= Neutral; 4= satisfied; 5= Completely satisfied]

	1	2	3	4	5
Cleaning					
Training campaign					
Awareness campaign					

9- Did you ever participated in any activity organized by Regional Government about with marine litter (beach clean-up; training; etc) ?

- Yes
- No
- I have never been aware of such activities

10- Where do you feel is more important to invest to reduce marine litter in the ARM?

- Cleaning (beaches, seabottom inside marinas or harbous, etc)
- Awareness campaign
- Prevention
- Other: Please, specify_____

Marina waste management

11- Does your marina have a sustainability certification (i.e., blue flag?)
- Yes, since_____ and name
- No

12- Does your marina have a formal policy statement on environmental programmes or measures?
- Yes
- No

13- Do you provide environmental awareness program for your employees?
- Yes
- No

14- Do you communicate your environmental efforts to the client?
- Yes
- No

15- Do you believe that customers appreciate the concern with the ecological footprint?
- Yes
- No
- I don't know

Marina details

16- How many vessels can your marina harbors? _____

17- When was the marine build? _____

18- On average, what is the annual number of vessels that your marina has harbored? _____

Marine litter impact

19- Have you ever had a boat accident inside the marina due to collision with marine litter?
- Yes
- No
- I don't know

20- If yes, how many in a year?
- Less than one a year
- Once or twice
- Once a month
- More than once a month
- I don't know

21- Did you (marina manager) have to pay to fix the problem?

- Yes
- No
- I don't know

22- Does the marina have specific personnel to clean the floating marine litter?

- Yes
- No

23- If yes, how many are they? _____

24- How many hours they work per day? _____

25- Do you have special equipment to collect floating marine litter?

- Nets
- Gloves (specific to collect marine litter)
- Boat
- Others: _____
- I don't have it

26- Do you know in general how often they collect the following type of marine litter? [Using a scale where 1= Never, 2= Rarely, 3= Sometimes; 4= Often; 5= Always; 6 = I don't know]

	1	2	3	4	5	6
Plastic/Polystyrene (e.g. bags, bottles, crates, containers, etc.)						
Rubber (e.g. tyres, rubber tubes/sheets, rubber bands, etc.)						
Fishing materials (e.g. nets, ropes, etc.)						
Metals (e.g. cans, cables, appliances, etc.)						
Glass/Ceramics (e.g. bottles, jars, light bulbs, etc.)						
Paper/Cardboard (e.g. boxes, cartons, cups, newspapers, etc.)						
Processed wood (e.g. pallets, corks, crates, sticks, etc.)						

27- After collecting floating marine litter, did you throw it in the appropriate recycling bin?

- Yes
- No

28- How often a client complains about marine litter? (Ask specifically to remove an object like tins, plastic bags, wood)

- Once a day
- Once a week
- Once a month
- Once a year
- I have never received complains about marine litter in my marina

29- Do you conduct sea floor cleaning inside the marina?

- Yes
- No

30- If yes, how frequent in a year? ____

31- Do you have to contract a special company?

- Yes
- No

32- How much does it cost to clean the marina sea floor? _____

33- How much marine litter is removed from each the sea floor cleaning of your marina? [Please specify or the weight (kg), or the volume (L or m^3) or the number or recycling container used] _____

34- After the sea floor cleaning, did you throw it in the appropriate recycling bin?

- Yes
- No

35- Did you have ever organized an awareness activity about marine litter?

- Yes
- No

36- If yes, how often?

- Once a month
- More than 3 timer por year
- Once a year

37- On average, how many people participated? _____

38- What expenses did you have to organize such activity? (if possible write the estimative value. For example: fuel, gloves, bags to collect litter, etc. _____

THANK YOU FOR YOUR TIME