Funded by the European Union's Horizon Europe programme under grant agreement No.101060213.

Ref. Ares(2024)4284544 - 13/06/2024

SOS-ZEROPOL2030

D2.3 Stakeholder survey report

Public and stakeholder survey results

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Document Info

Version	Date	Description			
		Responsible	Authors	Reviewed by	Approved by
V 1.0	30/11/2023	UNIVIE, VLIZ, UCC, MaREI	UNIVIE, VLIZ, UCC, MaREI	UNIVIE, VLIZ, UCC, MaREI	Kathrin Kopke
V 2.0	29/5/2024	UNIVIE, VLIZ, UCC, MaREI	UNIVIE, VLIZ, UCC, MaREI	UNIVIE, VLIZ, UCC, MaREI	Kathrin Kopke

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Citation: Vaupotič, N., Nijssen, S., Joziasse, R., Devriese, L., Kopke, K., Pahl, S. (2024). SOS-Zeropol2030: Deliverable D2.3 Stakeholder survey report.

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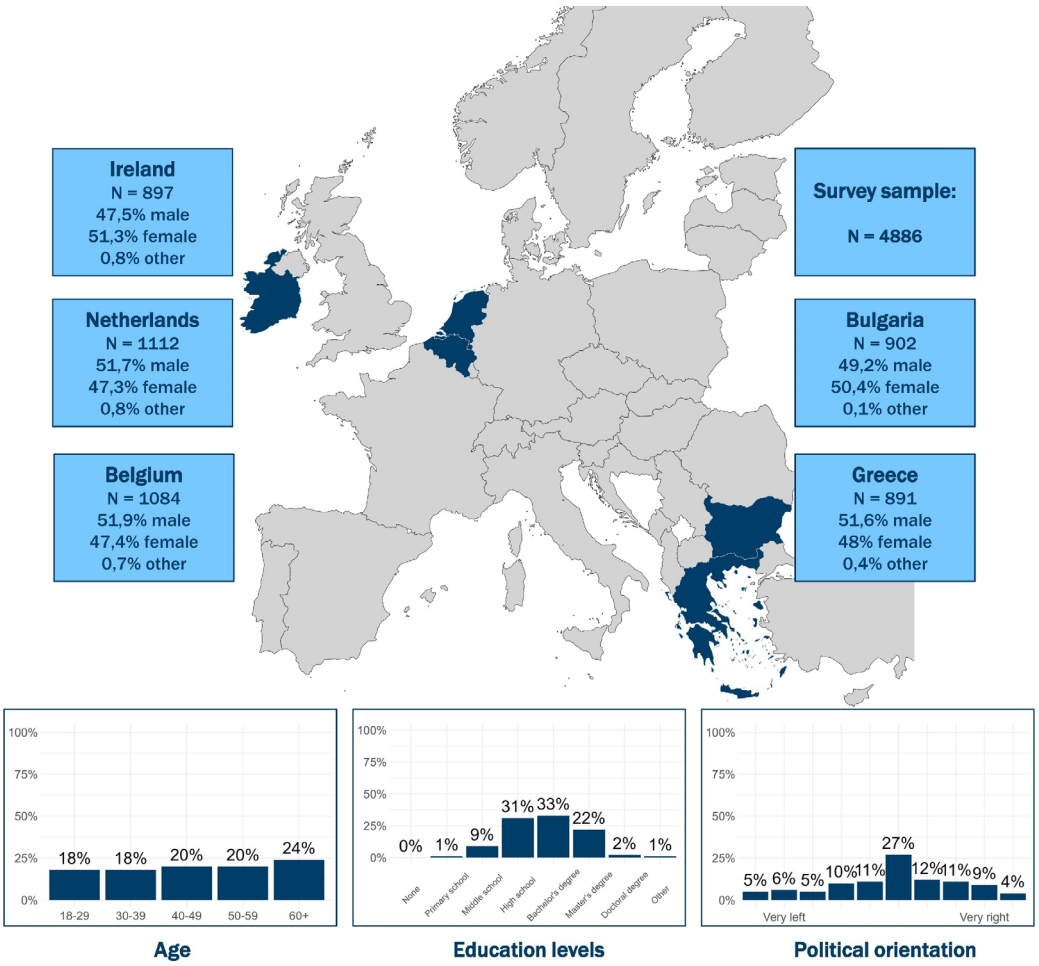
1. Executive Summary

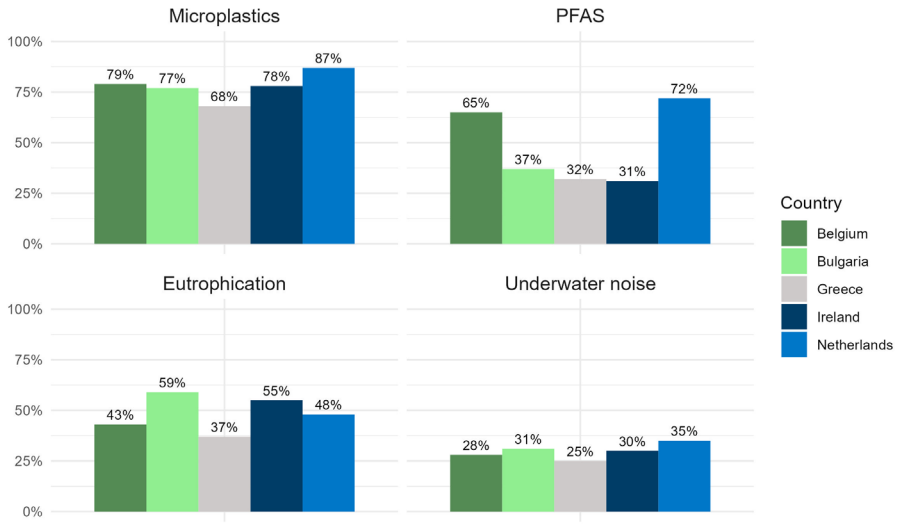
As part of the EU-funded SOS-ZEROPOL project, the current report details the results of **the public survey** and **stakeholders** survey on the **risk perception** of four environmental pollutants (**microplastics**, **PFAS**, **eutrophication**, and **underwater noise**) and **support for environmental policies** across different European countries. The survey methodology, adapted to separately measure the perceptions of the public and other stakeholder groups (**industry**, **governmental and non-governmental organisations**, **research**), considers factors influencing support for environmental policies, such as policy intrusiveness, goals, and fairness as well as the role of socio-psychological factors in determining risk perceptions of different environmental issues.

Key findings from the public survey



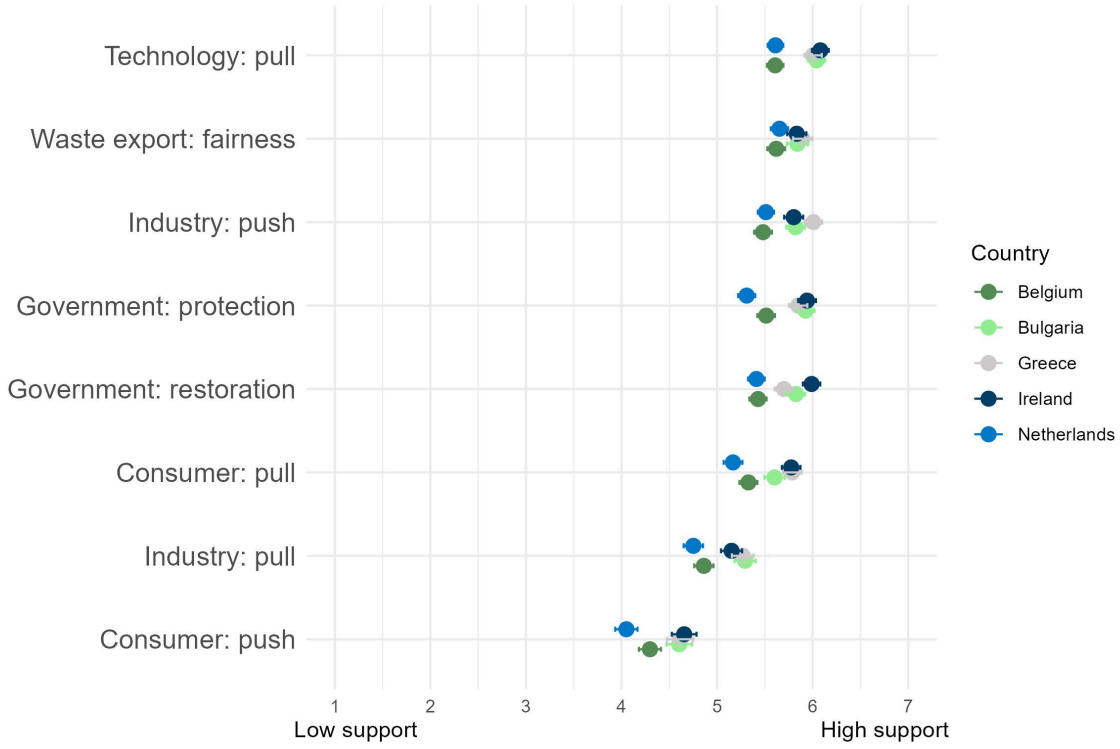
A **large, representative sample of participants** from **five European countries was selected**, ensuring diversity in **age, gender**, and **region of residence**, **educational background,** and **political orientation**.

Public awareness of microplastics, PFAS, eutrophication and underwater noise



Across all countries, awareness was **highest for microplastics** and **lowest for underwater noise**. The differences between countries were most pronounced for **PFAS**, with public awareness being **higher in Belgium and the Netherlands** compared to Greece, Ireland, and Bulgaria.

Public support for pro-environmental policies

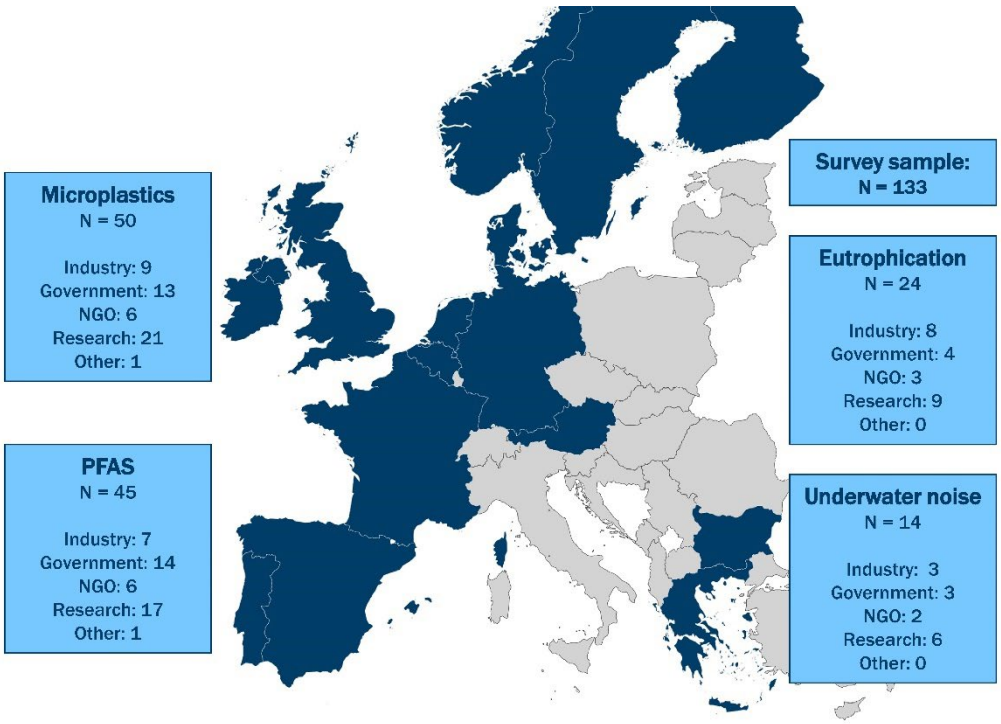


On average, **subsidies for the development of environmentally friendly technologies** received the most support, followed by a **ban on the export of waste to low-income countries** and policies aimed at pushing industry towards more environmentally friendly processes through **higher taxes and penalties**. In the middle were policies aimed at protecting and restoring the environment. Finally, the least supported policies were those that use **financial subsidies to encourage consumers and industry** to adopt more environmentally friendly behaviour, and those that **financially penalise** consumers for non-environmentally friendly behaviour.

Key take-aways:

- The public concern is the highest for microplastics, followed by PFAS, eutrophication, and underwater noise.
- Awareness of PFAS is considerable higher in Belgium and the Netherlands than in Greece, Ireland, and Bulgaria.
- Awareness of underwater noise in low across all five countries.

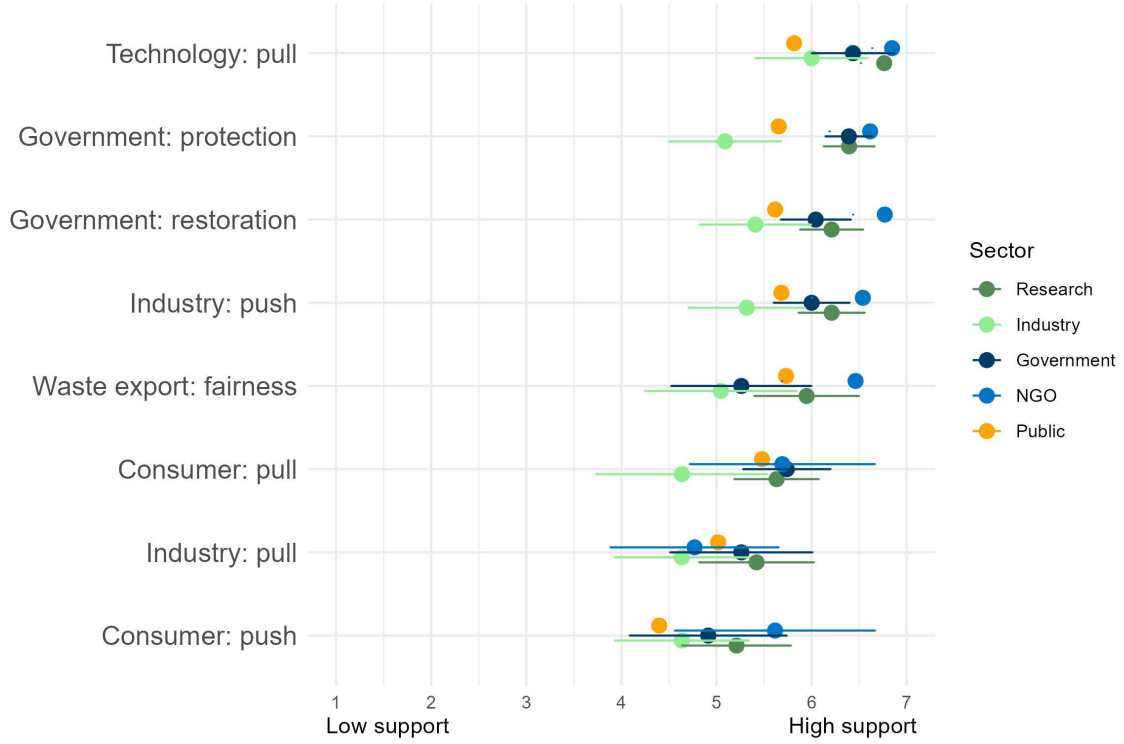
Key findings from the stakeholder survey



Stakeholders from **18 different countries** (as represented in the visual above, including one person from the United States) participated in the stakeholder survey as representatives of **industry, governmental organizations, non-governmental organizations**, and **research** related to **all four pollutants**. The stakeholder survey results come from a much smaller sample size compared to the

extensive public survey results; however, they provide essential context to the public survey results, allowing for a better understanding of policy implications.

Stakeholders' support for pro-environmental policies



On average, subsidies for **the development of environmentally friendly technologies** received the most support from stakeholder groups. This was followed by policies to **protect and restore the environment**. In the middle were policies that push industry through taxes and penalties, policies to ban waste exports to low-income countries and policies to that pull consumers towards more sustainable consumer choices. On average, the **least supported measures were policies that push consumers** through taxes and penalties, and **policies that pull industries** towards more pro-environmental production through subsidies. There were **important differences between stakeholder groups:** industry representatives supported government protection and restoration less the other stakeholder groups. Additionally, industry and government representatives were less in favour of banning waste exports to low-income countries than other groups.

Key take-aways:

- Support for various pro-environmental policies is high across all stakeholder groups.
- Support is highest for technological solutions and government protection of natural areas.
- Support is lowest for taxes and penalties directed at consumers.
- Building trust in institutions and industry is necessary for policy success.

Implications for policy

Public opinion from different European countries is relatively **aligned**, particularly regarding the concern for health, the environment, and the urgency of mitigation across different pollutants as well as for pro-environmental policy support. The differences in public perceptions of various pollutants indicate where **concrete action is needed and potentially well-received** (e.g., microplastics) and **which pollutants need more awareness** (e.g., underwater noise) and **in which countries** (PFAS in Ireland, Greece, and Bulgaria). Insights into **policy support** indicate **high approval for technological solutions** and **governmental protection** of natural areas but **lower support for consumer-focused policies**. This is critical for implementation strategies and management of expectations since technological improvement may not be a one-size-fits-all solution. Increasing **trust in the EU and in local authorities**, especially among the public, is an important prerequisite for successful policy implementation.

2. Introduction

The present report on stakeholder perceptions of environmental pollution is part of the Horizon Europe-supported project 'Source to Seas - Zero Pollution 2030' (SOS-ZEROPOL2030). The project aims to develop a holistic zero pollution framework to achieve zero pollution of European seas by 2030 seeking to address the main pollutants, which were identified as microplastics, PFAS (per- and polyfluoroalkyl substances), eutrophication, and underwater noise.

The overarching objective of WP2 'Building Blocks for Zero Pollution Governance' is in capturing the stepping stones needed to develop best practices in reducing environmental and marine pollution. While the complementary deliverables D2.1 (Devriese et al., 2023) and D2.2 (van Leeuwen et al., 2023) focus on describing the current state of zero pollution governance and identifying best practices and barriers in governance efforts to achieve the zero pollution objectives, D2.3 takes a closer look at stakeholder perceptions of risks associated with different pollutants and support of different solutions, from citizens to government, industry, NGO, and research representatives). To achieve this aim, the D2.3 effort involved a number of key sequential steps: literature reviews and expert interviews to inform the development of the survey, the subsequent implementation of the public survey, and finally the implementation of the stakeholder survey.

Deliverable D2.3 (Stakeholder Survey Report) consists of two interrelated parts[1]: a survey of the public and a survey of stakeholders (representatives from research, governmental and non-governmental organizations, and industry). A major strength of the public survey is its investigation of public perceptions in five European countries (Belgium, Bulgaria, Greece, Ireland, and the Netherlands), which vary in historical, social, and economic backgrounds, access to different European seas (Black Sea, Mediterranean Sea, North Sea, The North-east Atlantic Ocean), and levels of media attention to various pollutants. The samples in each country were representative in terms of age, gender, and region of residence, making the results generalizable to the populations of these countries. The stakeholder survey consisted of representatives from research, governmental and non-governmental organizations, and industry. It complements the public survey results by highlighting (mis)alignments in concern and policy support between different stakeholders. As argued previously, collaboration and mutual understanding between stakeholders are essential for holistic approaches to achieving zero pollution (Lampitt et al., 2023).

[1] While the general public is considered a stakeholder group, we distinguish between representatives of research, governmental and non-governmental organizations, and industry (as referred to in the stakeholder survey) and the general public (as referred to in the public survey). This distinction is necessary for methodological reasons.

Our empirical approach allows for comparing public perceptions of different pollutants and provides the opportunity to compare risk perceptions between different groups (e.g., public, industry, experts) as well as within individuals. Furthermore, it serves to identify possible barriers to governance (e.g., lack of public awareness of some pollutants, lack of trust in institutions) as well as potential facilitators (e.g., information on preferences for different policy measures). These insights from Deliverable D2.3 provide a foundation for other parts of the SOS-ZEROPOL2030 project and its development of a zero-pollution framework. Importantly, D2.3 has built on the knowledge and stakeholder mapping efforts of other groups within the SOS-ZEROPOL2030 consortium and has benefited from the extensive knowledge of pollution governance.

The specialized focus of D2.3 on understanding the public perceptions yields reliable data on what drives public concerns and mitigation preferences, which is an essential part of successful zero-pollution governance. Furthermore, it provides valuable information for other tasks of the SOS-ZEROPOL2030 project, for instance it identifies facilitators and barriers that different stakeholders have when entering experimental co-creation processes such as living labs and supports communication materials by providing reliable information about the current awareness of the public and their support for different mitigation policy measures.

2.1. The role of social and behavioural sciences in pollution mitigation

Social and behavioural sciences contribute to solving environmental issues by investigating perceptions of different societal groups and aiding communications between experts, the general public, and policy-makers. Key research questions include: How can we raise awareness among the public and, if needed, instil concern about environmental issues, such as land and marine pollution? Which environmental policy measures may be valued and embraced by the public, and what social and psychological factors contribute to these preferences? Additionally, why do some individuals and groups swiftly embrace pro-environmental behaviours while others tend to lag behind? Surveying a large group of individuals from different backgrounds can yield insights into addressing these questions and shed light into the relationships between science, society and public to foster risk management and regulation.

However, the role of social and behavioural science is not only in supporting a smooth translation of knowledge between experts and the public; behavioural variables themselves fit into models explaining environmental pollution as the causes of environmental problems are, at least in part, human-made (Fischhoff, 2021; Pahl et al., 2017). Therefore, it is essential to consider the human factor at all life cycle stages of environmental pollution: at the source, during the process and at the end of the pollution cycle. In a similar vein, different stakeholders, the public, experts, decision-makers and industry, are influencing environmental pollution at different stages.

2.2. Understanding risk perception

Risk perception is an important outcome of people's beliefs, knowledge, values, and experiences. At the same time, it functions as a predictor of pro-environmental (or pro-health) behaviour, as well as a predictor of support for various governmental and non-governmental policy measures. Risk perception is a subjective and psychological construct that informs how people think about potential hazards and uncertain situations. Risk perception is therefore a critical component of the system in which policy makers operate (Leiserowitz, 2006). Furthermore, public awareness of these different pollutants may vary due to their presence in the media as well as people's personal experiences. There may be regional differences in public perception due to specific events, such as reports of chemical spills from factories or cases of excessive algal blooms in the area where they live.

The present study aims to investigate risk perceptions of the following environmental pollutants:
Microplastics are plastic pieces that measure less than five millimetres across. Some microplastics are formed by larger plastic items breaking down over time. Other microplastics are made intentionally for use in consumer products, such as cosmetic microbeads used in facial scrubs. There is some evidence that microplastics may be harmful for human health and the environment, especially marine species, however, the evidence especially for human health impacts is inconclusive and still lacking (Lim, 2021).
PFAS stands for "per- and polyfluoroalkyl substances," also referred to as “forever chemicals”. These chemicals are notable for their resistance to heat, water, and oil, which has led to their use in a wide range of industrial and consumer products such as non-stick cookware (Teflon), water-resistant clothing, hygiene products, food packaging, and more. Strong links have been found between PFAS and human health outcomes (Devriese et al., 2023; *European Environment Agency (EEA)*, 2019), as well as limited evidence of negative impacts of PFAS on the natural environment.
Excess of nutrients (eutrophication) is a process that involves an excessive accumulation of nutrients such as nitrogen and phosphorus in lakes, rivers, or coastal areas. These excessive nutrients can enter into the environment through agriculture or wastewater management. The nutrient enrichment can lead to an overgrowth of algae and other aquatic plants, can harm water quality, increase bacterial growth, and decrease oxygen that fish need to survive (Wu, 1999). Direct effects on human health have been demonstrated and include respiratory illness or infection from contact with affected water surfaces.
Underwater noise refers to human-made sounds that are generated and propagated underwater. These sounds can come from various human-made sources (shipping, military sonar, pile driving, construction activities) and can interfere with natural sounds of animals in the ocean. Underwater

noise probably does not have a direct effect on human health, but does directly affect marine animals. Specifically, prolonged exposure to underwater noise can lead to animal stress, hearing damage, and habitat displacement, threatening marine biodiversity and environment (Devriese et al., 2023).

In general, there are differences in the available evidence on the harmful effects and pathways of these four different pollutants on human health and the environment. Furthermore, while some pollutants may be particularly harmful to human health, others may only pose a direct threat to the natural environment. In the specific context of ocean hazards for human health, the public reported being most concerned about plastic pollution, chemical and oil pollution, followed by loss of marine species and seafood contamination (Davison et al., 2021). Comparisons with other social, economic and climate issues may help to understand the perceived urgency of addressing potential threats from environmental pollutants beyond the ocean context.

2.3. Environmental policy support

Environmental and social issues are addressed through a mix of measures from voluntary action to financial incentives or legal rulings. Thus, they can include laws and regulations, monitoring, education campaigns, tax incentives and subsidies to behavioural interventions such as nudges. Whether a policy is successful or not depends to some extent on public support, especially in democratic societies. In turn, support for public policies can facilitate compliance with them (Grelle & Hofmann, 2023). Typical individual-difference predictors of policy support are political orientations, perceptions of the issue, as well as contextual factors such as trust in governments (Drews & van den Bergh, 2016; Schuitema & Bergstad, 2018). However, the success and support of a policy also depend on the type of policy, the perceived quality and fairness of the policy and the policy target (Grelle & Hofmann, 2023; Swim & Geiger, 2021). More specifically, these policy characteristics include:

Perceived costs and benefits. Unsurprisingly, public support depends on the perceived effectiveness of a policy in tackling or mitigating the issue at hand. Higher costs related to the policies are perceived negatively, and perceived environmental, economic and social benefits are important positive correlates of policy support.

Pull and push dynamics. Policies that *pull* stakeholders toward environmentally friendly behaviour through incentives and (financial) subsidies are generally viewed more positively than those *pushing* stakeholders to act environmentally friendly to avoid negative consequences, such as higher taxes or penalties. This division between pull and push policies can be framed in terms of

intrusiveness, where highly intrusive policies may be perceived as threats to autonomy (an important human motive) and are therefore supported less.

Transparency. Policies are more likely to be supported if the objective they pursue is clear and transparently communicated to the stakeholders. If the motivation for a policy is unclear or non-transparent, it can be perceived as manipulative.

Fairness. Fairness judgements are based on different social comparisons, and extend beyond the individual. For instance, interpersonal comparisons are made when own outcomes are compared with outcomes of others. When making fairness judgements in the context of environmental pollution, it is also considered who is responsible for pollution and who bears the consequences. It is important to consider the extent to which a policy satisfies the principles of equality (the effects are the same for everyone) and equity (the relative effects are the same for everyone). However, the perceived fairness of a policy can be influenced by self-interest and personal costs.

Policy target and responsibility Whether or not stakeholders support a mitigation policy or action may depend on what or whom a policy targets. In general, the support for the use of disincentives is higher when targeting industries than when targeting consumers. This may also be related to perceived responsibility, for example in the context of environmental issues, industries (in comparison to individuals) are larger and more direct contributors to climate change and environmental pollution (e.g., Lampitt et al., 2023; Maniates, 2001).

3. Part I: Public survey

3.1. Understanding the perceptions of the public

Apart from characteristics of environmental pollutants and public policies, socio-psychological factors may help explain individuals' risk perception and policy support. Why some people are more concerned about environmental pollution, and tend to support pro-environmental policies more, may depend on the following factors:

Socio-demographics factors

Socio-demographic factors include gender, age, income, education, and political ideology. In case of environmental issues such as marine threats, older individuals, women, highly educated individuals, and left leaning individuals have been found to be more concerned about human health effects (Davison et al., 2021). This pattern is consistent with individual differences in risk perceptions of other environmental hazards, for instance climate change (van der Linden, 2015). In a similar vein, the same socio-economic factors have also been shown to be positively correlated with people's support of environmental policies (Swim & Geiger, 2021).

Knowledge and cognitive factors

While awareness of an environmental issue is an important determinant of risk perception and policy support, it is not clear to what extent cognitive understanding of environmental issues and fact-based knowledge drive non-experts' risk judgements. Risk perception is much more than a rational analysis of potential harms and risks for health and environment, and the correlations between knowledge and risk perception are typically small (Brody et al., 2008; Tobler et al., 2012).

Emotions and experiential factors

Some researchers equate risk perception with affective reactions to the potential threat (e.g., "the affect heuristic"), and the idea that people's information processing is driven by emotions is widely recognised (Slovic & Peters, 2006). In fact, higher risk perception is highly correlated with people's negative feelings about environmental issues, and is one of the strongest predictors of people's support of pro-environmental policies (Leiserowitz, 2006).

Values and social norms

Study have consistently shown that people with higher biospheric values – a strong internal motivation to respect and protect nature – exhibit higher risk perception and more policy support in the context of environmental issues. In a similar vein, social norms, i.e., expectations regarding acceptable and desired behaviour may influence people's judgements about environmental issues and policy measures adapted to counter them. Individuals who believe that it is expected of them

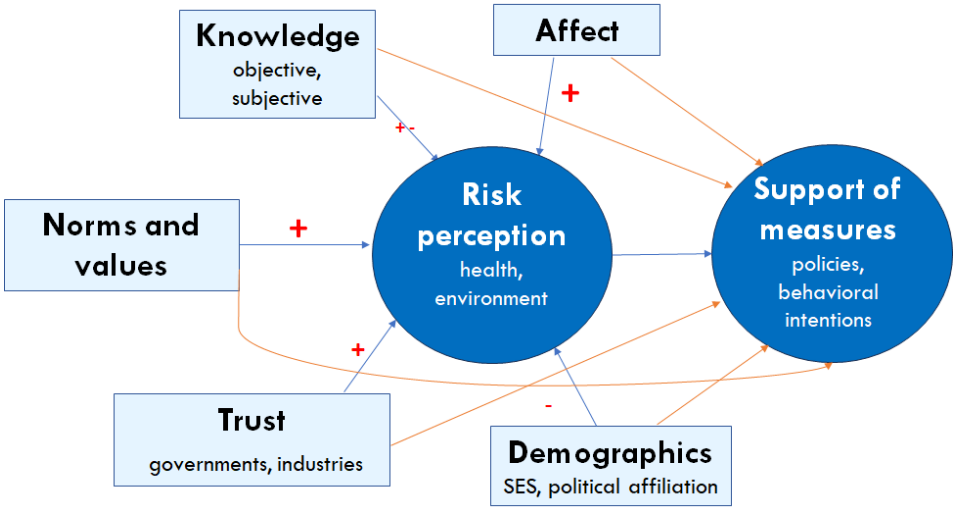
to help mitigate climate change, perceive the risks related to climate change as higher. The same pattern has been shown for marine environments amongst individuals who live close to the coast. Namely, amongst coastal residents, those who cared more for the ocean felt a moral obligation to act in favour of a healthy ocean, felt more responsible for their actions, and were more aware of the negative impacts humans can have on marine environments (Engel et al., 2020).

Trust

Scientific knowledge about the environment and consequences of pollution is technical and complex, therefore most people - with the exception of experts in highly specialised fields - do not have a full and deep understanding of those issues. People's trust in scientists and governments is therefore essential in predicting their beliefs, risk perceptions and support for different pro-environmental policy measures (Cologna & Siegrist, 2020). Additionally, viewing different stakeholders as trustworthy partners in reducing environmental pollution, positively influences individuals' support for policies like carbon capture and storage (Moon et al., 2020).

A summary of how these different characteristics may affect risk perception and support of different policy measures (policies and behavioural change) in individuals is illustrated in Figure 1.

Figure 1
Socio-psychological predictors of risk perception and support for measures



3.1.1. Aim of the public survey

The present survey investigated public perceptions of environmental pollution related to microplastics, PFAS, eutrophication and underwater noise across five European countries. Our aim was to capture the average concerns and policy support of the public from Belgium, Bulgaria, Greece, Ireland, and the Netherlands. Although, it must be acknowledged that it is difficult to

generalise about the public as a homogeneous stakeholder and that there is considerable variation within the population, we aimed for a sample that is representative for the population in terms of gender, age, and region of residency. We were particularly interested in the general awareness of different pollutants, concern for health and environment as a consequence of exposure to different pollutants, and what kind of policies do they support for mitigating environmental pollution?

These questions were investigated using survey methodology and analysed using statistical methods. While public perceptions of some pollutants (e.g. plastics) have gained prominence in recent years, others (e.g. underwater noise) remain relatively understudied (for example, in November 2023, a search in the PsycArticles and PsychInfo databases yields 1149 results with the keywords "plastics" and "perception", and only 3 results with the keywords "underwater noise" and "perception"). The public is therefore expected to be more informed about some pollutants and less informed about others. Our aim was to investigate how the levels of awareness, concern, and policy support differed between pollutants and across different countries. Furthermore, we sought to examine the support among citizens for various pro-environmental policies, their intended pro-environmental behaviours, and the trust they placed in different institutions to manage environmental issues.

3.2. Public survey methodology

3.2.1. Interviews with experts

To better understand the specific context of environmental pollution from microplastics, PFAS, eutrophication, and underwater noise, interviews were conducted with experts (N = 7) from various fields of environmental pollution. The full interview protocol is included in Appendix 1. The interview data were analysed to support the survey questions on health and environmental concerns and to create a pool of general and specific pro-environmental policies that were relevant and supported by experts.

3.2.2. Survey development

The survey includes relevant socio-demographics and psychological questions (e.g. age, gender, education, subjective income, region, norms, beliefs) as well as questions relevant for risk perception and policy support that were extracted from the expert interviews and literature reviews. Justification and detailed descriptions of the public survey items are provided in the section on Materials.

The sample size was based on a statistical power analysis, as recommended best practice and in line with Open Science approaches. According to power analysis for a multiple regression model for one country with β=.80, α=.05, and f^2=0.02 (small effect), the minimum required sample size per country was *N*=880 – yielding an overall target sample of *N*=4,400. Furthermore, we aimed for a representative sample that reflects the demographic distribution in the selected countries well enough to make the findings generalizable. With a sample of 880 participants for the Netherlands, the largest country in our sample with 17.000.000 inhabitants, we achieved a 3% margin of error at a 95% confidence level.

The procedure was approved by the ethics board of the University of Vienna under approval number 01037. The complete survey can be found at the end of the report in Appendix 2. In the following chapter, we describe the variables analysed and presented for the purpose of this report. The data and the analysis code will be made available at the end of the SOSZEROPOL2030 project.

3.2.3. Sampling strategy

After obtaining several competitive bids, we chose the most economical option to recruit our participants: NORSTAT (https://norstat.co; certified under ISO 20252). This professional participant recruitment service offered the most competitive bid for the current survey design. Participants were recruited in November and December 2023. For inclusion, participants needed to be at least 18 years old as well as citizens and residents of one of the five countries (Belgium, Bulgaria, Greece, Ireland, and The Netherlands). Furthermore, participants who failed to correctly respond to the attention check and completed the survey in a time that was +/- 2SD from the mean duration were not included in the analytic sample. For each country, the sample was recruited using interlocking quotas for age and gender, and non-interlocking quotas for regions. Participants were compensated according to the panel's standard criteria.

3.2.4. Materials

We aimed to measure all constructs with previously validated instruments, to maximise validity and comparability and thereby data quality and scientific rigour. If required measurements did not exist or the purpose of the study required a certain specific formulation, we based measurements as closely as possible on validated instruments.

Socio-demographics

For demographics, we assessed participants' country and region of residence, gender ("*Woman", "Man", "Transgender", "Non-binary", "Other", "Prefer not to say"*), age and education level (*"Primary school", "Middle school", "High school or secondary school (vocational, general)", "First level higher education (Bachelor's degree, applied university degree*", *"Second level higher*

education (Master's degree)", "PhD or doctoral degree", "Other", "None", "Prefer not to answer"). Furthermore, we also assessed participants' political orientation by asking them to place their political views on a scale from 1 ("*Left*") and 10 ("*Right*"). Lastly, participants' financial scarcity was measured with three items: "*I am content with my financial situation", "I have to save up to make ends meet", and "I get by well with my income*". All were rated on a Likert scale from 1 ("*Strongly disagree*") to 7 ("*Strongly agree*"). Where categories might be different due to country differences (e.g., education systems), translations were verified by national partners in the relevant country.

Furthermore, *beliefs* about environmental pollution were measured with one item: "*To what extent is environmental pollution caused by natural processes or human activity?*" (adapted from van der Linden, 2015). Participants responded on a scale from 1 to 9, with 1 indicating "*100% natural*", the scale midpoint indicating "*50% natural / 50% human activity*", and 9 indicating "*100% human activity*". Participants could also select the option "*I don't know*".

Lastly, *norms* were measured in the form of participants' personal injunctive norms (the extent to which they feel they ought to do something; based on the European Social Survey and adapted from Engel et al., 2020). Two statements ("*I feel personal responsibility to help reduce environmental harm and pollution"* and "*I feel I should do more to help reduce environmental harm and pollution*") were presented and participants responded on a 7-point Likert scale from 1 ("*Strongly disagree*") to 7 ("*Strongly agree*").

General pollutant perception

The following measures were obtained regarding participants' perception of the pollutants: awareness, subjective knowledge, affect, personal experience, and risk perception. Measures were obtained for each pollutant (PFAS, microplastics, eutrophication, and underwater noise) separately and in a random order to avoid any systematic influences of pollutant order.

Awareness was measured with one categorical item (based on Janzik et al., 2023): participants responded "*Yes*", "*No*", or "*Prefer not to say*" in response to the question: "*Have you ever heard of [pollutant] before participating in this survey?*".

Subjective Knowledge was measured with one item (based on Frey, 2021): participants were asked "*How much knowledge do you have about the effects of [pollutant] on the environment and human health?*" and responded on a 7-point Likert scale from 1 ("*No knowledge at all*") to 7 ("*A lot of knowledge*").

Personal experience was measured with one categorical item (adapted from van der Linden, 2015). Participants were asked "*Have you ever been directly affected by [pollutant] in your everyday life (e.g., health issues, restrictions)*?" and responded by selecting one of five categories: "*Never*", "*Once*", "*Twice*", "*More than three times*", and "*I don't know*".

Risk perception was measured with three items regarding the perceived urgency, health risks, and environmental risks of the pollutant. The items were phrased as follows: "*In the context of all the pressing issues society is facing (social, economic, environmental), how urgent is it to tackle [pollutant] pollution*?" (urgency), "*How concerned are you personally about the effect of [pollutant] on people's health?*" (health risks), and "*How concerned are you personally about the effect of [pollutant] on the environment (nature, animals)?*" (environmental risks). Items were adapted from Wilson and colleagues (2019) and Waters and colleagues (2013) and responded to on a scale from 1 ("*Not concerned at all*") to 7 ("*Very concerned*"). Participants could also select "*I don't know*".

Support for environmental policies

Support for environmental pollution mitigation strategies was obtained for three policy target groups: industry, consumers, and government. For each stakeholder, one pull- and one push-measure was presented. An example of a "pull" policy measure was: "*Penalties and monitoring for industries should be implemented to counter environmental pollution*". An example of a "push" policy was: "*A certification system that labels products 'environment-friendly' should be established to inform consumers about their environmental impact.*" Participants rated their support for each measure on a 7-point Likert scale from 1 ("*Strongly disagree*") to 7 ("*Strongly agree*"). The policy measures were based on prior interviews with experts and partners in the SOS-ZEROPOL2030 project. Moreover, to avoid ceiling effects and minimise response biases (e.g., acquiescence), participants were instructed to consider potential additional effects the measures might have, such as reduced comfort of living or increased living costs.

Behavioural intention

To assess participants' behavioural intentions, we included three items measuring their intentions to vote for parties with a strong environmental agenda, pay more attention to own consumer behaviour (such as avoiding plastics), and sign petitions with an environmental agenda. Again, these measures of individual differences were rated on a 7-point Likert scale from 1 ("*Strongly disagree*") to 7 ("*Strongly agree*").

Trust

Trust was measured with four items, three of which were adapted from Cologna and colleagues (2021) and one was constructed by the authors for the purpose of having a reverse-coded item in the scale, again to minimise responses biases. The first item measured trust in the government at EU-level ("*I trust the EU government to lead an effective environmental pollution mitigation*

strategy"). The second item measured trust in local government ("*I trust the local government to lead an effective environmental pollution mitigation strategy*"). The third item measured trust in industry ("*When I come across labels on products indicating sustainable production, I trust their authenticity*"). The fourth, self-constructed item measured trust in industry in terms of greenwashing ("*I think that industry efforts are often "greenwashing*"). All items were rated on a 6-point scale from 1 ("S*trongly agree*") to 6 ("*Strongly agree*").

Pollutant-specific questions

Based on randomization (see *Figure 2*), participants answered several follow-up questions about one of the four pollutants.

Specific pollutant perception was assessed with the same set of questions for each pollutant and phrased as follows: "*When you think about [pollutant], to what extent do you see it as: useful/toxic/durable/mobile/natural/disgusting*?" Participants rated the pollutant on each of these dimensions on a scale from 1 ("*Not at all*") to 7 ("*Very much*"). Participants could also select "*I don't know*".

Specific policy support was assessed with several potential mitigation strategies regarding the environmental impact of each pollutant. Prior to these, participants read a short vignette describing the environmental problems caused by the pollutant and a possible area of improvement (see Annex 1). Subsequently, participants were asked to indicate their support for different mitigation strategies on a scale form 1 ("*Strongly disagree*") to 7 ("*Strongly agree*"). For all pollutants, different measures were presented. Since the specific mitigation strategies differed per pollutant, we will only present a few examples here, but the overall list can be found in Annex 1. An example of a "pull" measure for microplastics was: "*Manufacturers should be incentivized to remove and replace the most toxic additive chemicals used in car tyres*." An example of a "push" measure for PFAS was: "*Governments should hold industries accountable for the responsible production, use, and disposal of PFAS chemicals through penalties."* All vignettes and mitigation measures were developed in collaboration with experts from the interview study and SOS-ZEROPOL2030 partners to make sure they were not only accurate but also realistic strategies that could be pursued in society.

Translation

All materials were translated to local languages using a forward translation procedure. For Greek, Flemish, and Dutch, the English version of the survey was sent to internal SOS-ZEROPOL2030 team members who were native speakers of the language. The translators translated the materials and shared the translation with 2-3 lay native speakers who reviewed the survey for language and comprehensibility. The internal translators also served as experts in the field and reviewed the final

materials for correctness in terminology. For Bulgarian and French, the survey was translated by external translators who translated the survey and shared it with 2-3 lay native speakers to check for language and comprehensibility. The translated survey was sent back to the survey coordinator, and they asked internal native speakers to check the translations for correctness in terminology one final time.

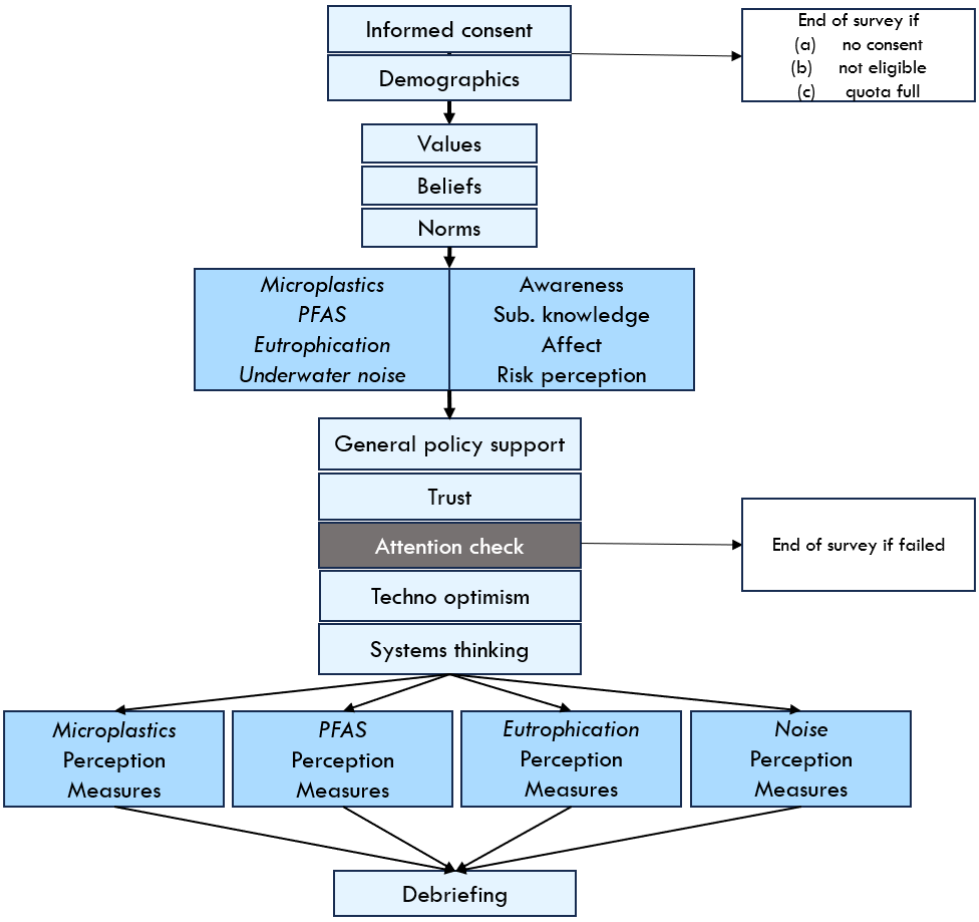
Procedure

The survey was conducted in Qualtrics and lasted on average 18,26 minutes. Participants completed the survey in the local language. After providing informed consent, they indicated their age, gender, and region for the quota sampling. Participants who did not give consent or were not citizens of one of the five countries were redirected to the end of the survey. After providing additional demographic information, participants started the survey. For all scales, and to avoid order effects, individual items were presented in random order. First, participants' values, beliefs, and norms regarding environmental impact and the various pollutants was measured. Subsequently, participants completed the pollutant perception measurements (awareness, subjective knowledge, affect, and risk perception). The presentation order of the pollutants was also randomized for each participant. Afterwards, participants responded to the general policy support items as well as trust items.

Approximately halfway through the survey, an attention check was included to make sure participants read all instructions and questions properly. This is an approach commonly used in large panel surveys to check concentration on the survey and thereby improve data quality. In this attention check, participants were asked to indicate which environmental issues the present study focused on. The correct answer included the four environmental pollutants: microplastics, PFAS, eutrophication, and underwater noise. Other answers substituted one of these pollutants for the terms 'wildfires', 'radiation', or 'air pollution'. Participants who incorrectly filled out the attention check were redirected to the end of the survey.

After completing the attention check, participants responded to questions about their optimism about technology and tendency for systems-thinking. Upon completing these items, participants were randomly but evenly assigned to one of four (between-subjects) pollutant-specific blocks: each block continued with items specifically measuring participants' perception of one of the pollutants, as well as their support for various mitigation strategies. After completing the pollutant-specific block, participants were debriefed and thanked for their participation. An overview of the survey procedure can be found in Figure 2.

Figure 2
Overview of the survey flow



3.2.5. Sampling strategy

A total sample of 7073 participants completed the survey. After exclusion of participants who failed the concentration check, took considerably more or less time to complete the survey than average (+/- 2SD), or were straightlining (more than 9 replies in a row were the same; Curran, 2016), we were left with a total sample of 4886 participants. Each country's sample is semi-standardized, with interlocking quotas for gender[2] and age, and single quotas for regions. The per country descriptives are summarized in the sections below.

[1] There is a lack of census data on non-binary/transgender gender identities in different European countries. The proportion of people who identify as non-binary/transgender may be less than 1%

Belgium

Altogether, 1460 participants from Belgium completed the survey. After applying the exclusion criteria (see above), 1084 participants remained. The gender, age and regional distribution are summarized in Tables 1 and 2. The distribution of education levels in the sample was as follows: 3% completed primary school, 52% completed either a general or vocational high school, 28% attained a first-level higher education bachelor's degree (applied university degree), and 16% attained a master's degree or higher. On a spectrum from the far left (rated as 1) to the far right (rated as 10), the average political orientation was at *M* = 5.4 (*SD* = 2.3).

Table 1
Belgian sample (age, gender)

Age	Gender	Frequency	Proportion	Target
<29	female	104	9,6%	8%
30-39	female	110	10,1%	10,5%
40-49	female	94	8,7%	10,5%
50-59	female	84	7,7%	9,5%
>60	female	121	11,2%	11,5%
<29	male	88	8,1%	8%
30-39	male	104	9,6%	10, 5%
40-49	male	121	11,2%	10,5%
50-59	male	122	11,3%	9,5%
>60	male	128	11,8%	11,5%
<29	non-binary/transgender/other	3	0,3%	< 1%
30-39	non-binary/transgender/other	4	0,4%	< 1%
40-49	non-binary/transgender/other	0	0,0%	< 1%
50-59	non-binary/transgender/other	1	0,1%	< 1%
>60	non-binary/transgender/other	0	0,0%	< 1%

Table 2
Belgian sample (regions)

Region	Frequency	Proportion	Target
Brussels	136	12,9 %	12%
Flanders	532	50,7 %	57%
Wallonia	380	36,3 %	31%

(https://commonslibrary.parliament.uk/2021-census-what-do-we-know-about-the-lgbt-population/), however, capturing the actual numbers of non-binary/transgender individuals remains challenging (Data collection in relation to LGBTI People; EU commission, Bell, 2017).

Bulgaria

Altogether, 1485 participants from Bulgaria completed the survey. After applying the exclusion criteria (see above), 902 participants remained. The gender, age and regional distribution are summarized in Tables 3 and 4. The distribution of education levels in the sample was as follows: 1% completed primary school, 54% completed either a general or vocational high school, 24% attained a first-level higher education bachelor's degree (applied university degree), and 43% attained a master's degree or higher. On a spectrum from the far left (rated as 1) to the far right (rated as 10), the average political orientation was at *M* = 5,7 (*SD* = 2.2).

Table 3
Bulgarian sample (age, gender)

Age	Gender	Frequency	Proportion	Target
<29	female	76	8,4%	8,0%
30-39	female	85	9,4%	9,5%
40-49	female	95	10,5%	10,5%
50-59	female	101	11,2%	11, 5%
>60	female	98	10,9%	10,5%
<29	male	74	8,2%	8,0%
30-39	male	76	8,4%	9,5%
40-49	male	87	9,6%	10,5%
50-59	male	108	12,0%	11,5%
>60	male	99	11,0%	10,5%
<29	non-binary/transgender/other	1	0,1%	< 1%
30-39	non-binary/transgender/other	0	0,0%	< 1%
40-49	non-binary/transgender/other	0	0,0%	< 1%
50-59	non-binary/transgender/other	0	0,0%	< 1%
>60	non-binary/transgender/other	2	0,2%	< 1%

Table 4
Bulgarian sample (regions)

Region	Frequency	Proportion	Target
North central	105	11,6%	11,0%
North eastern	123	13,6%	13,0%
North western	96	10,6%	10,0%
South central	168	18,6%	20,0%
South eastern	133	14,7%	15,0%
South western	277	30,7%	30,0%

Greece

Altogether, 1215 participants from Greece completed the survey. After applying the exclusion criteria (see above) and drawing a sample for reliability calculation, 891 participants remained. The gender, age and regional distribution are summarized in Tables 5 and 6. The distribution of education levels in the sample was as follows: 1% completed primary school, 31% completed either a general or vocational high school, 41% attained a first-level higher education bachelor's degree (applied university degree), and 26% attained a master's degree or higher. On a spectrum from the far left (rated as 1) to the far right (rated as 10), the average political orientation was at *M* = 5,2 (*SD* = 2.3).

Table 5
Greek sample (age, gender)

Age	Gender	Frequency	Proportion	Target
<29	female	78	8,8%	9%
30-39	female	79	8,9%	9%
40-49	female	100	11,2%	10,5%
50-59	female	104	11,7%	11,5%
>60	female	62	7,0%	10,5%
<29	male	82	9,2%	9%
30-39	male	77	8,6%	9%
40-49	male	96	10,8%	10,5%
50-59	male	109	12,2%	11,5%
>60	male	96	10,8%	10,5%
<29	non-binary/transgender/other	2	0,2%	< 1%
30-39	non-binary/transgender/other	1	0,1%	< 1%
40-49	non-binary/transgender/other	2	0,2%	< 1%
50-59	non-binary/transgender/other	3	0,3%	< 1%
>60	non-binary/transgender/other	0	0,0%	< 1%

Table 6
Greek sample (regions)

Region	Frequency	Proportion	Target
Anatoliki Makedonia	50	5,6%	6%
Attiki	370	41,5%	36%
Dytiki Elláda	36	4,0%	6%
Dytiki Makedonia	20	2,2%	2%
Ionia Nisia	12	1,3%	2%
Ipeiros	27	3,0%	3%
Kentriki Makedonia	160	18,0%	17%
Kriti	40	4,5%	6%
Notio Aigaio	15	1,7%	3%

Peloponnisos	47	5,3%	5%
Sterea Elláda	30	3,4%	5%
Thessalia	68	7,6%	7%
Voreio Aigaio	16	1,8%	2%

Ireland

Altogether, 1248 participants from Ireland completed the survey. After applying the exclusion criteria (see above), 898 participants remained. The gender, age and regional distribution are summarized in Tables 7 and 8. The distribution of education levels in the sample was as follows: 1% completed primary school, 32% completed either a general or vocational high school, 38% attained a first-level higher education bachelor's degree (applied university degree), and 25% attained a master's degree or higher. On a spectrum from the far left (rated as 1) to the far right (rated as 10), the average political orientation was at *M* = 4,7 (*SD* = 1,8).

Table 7
Irish sample (age, gender)

Age	Gender	Frequency	Proportion	Target
<29	female	91	10,1%	10,4%
30-39	female	98	10,9%	11,0%
40-49	female	100	11,1%	10,5%
50-59	female	84	9,4%	8,7%
>60	female	89	9,9%	9,5%
<29	male	95	10,6%	10,4%
30-39	male	81	9,0%	11,0%
40-49	male	97	10,8%	10,5%
50-59	male	65	7,2%	8,7%
>60	male	88	9,8%	9,5%
<29	non-binary/transgender/other	5	0,6%	< 1%
30-39	non-binary/transgender/other	0	0,0%	< 1%
40-49	non-binary/transgender/other	1	0,1%	< 1%
50-59	non-binary/transgender/other	0	0,0%	< 1%
>60	non-binary/transgender/other	4	0,4%	< 1%

Table 8
Irish sample (regions)

Region	Frequency	Proportion	Target
Northern and Western	161	17,9%	17,0%
Southern	276	30,7%	33,0%
Eastern and Midland	461	51,3%	50,0%

Netherlands

Altogether, 1865 participants from the Netherlands completed the survey. After applying the exclusion criteria (see above), 1153 participants remained. The gender, age and regional distribution are summarized in Tables 9 and 10. The distribution of education levels in the sample was as follows: 48% completed either a general or vocational high school, 33% attained a first-level higher education bachelor's degree (applied university degree), and 18% attained a master's degree or higher. On a spectrum from the far left (rated as 1) to the far right (rated as 10), the average political orientation was at *M* = 5,6 (*SD* = 2,3).

Table 9
Dutch sample (age, gender)

Age	Gender	Frequency	Proportion	Target
<29	female	117	10,5%	10,5%
30-39	female	93	8,4%	8,5%
40-49	female	86	7,7%	9,5%
50-59	female	97	8,7%	10%
>60	female	133	12,0%	12%
<29	male	136	12,2%	10,5%
30-39	male	99	8,9%	8,5%
40-49	male	91	8,2%	9,5%
50-59	male	92	8,3%	10%
>60	male	157	14,1%	12%
<29	non-binary/transgender/other	7	0,8	< 1%
30-39	non-binary/transgender/other	2	0,2	< 1%
40-49	non-binary/transgender/other	0	0	< 1%
50-59	non-binary/transgender/other	1	0,1	< 1%
>60	non-binary/transgender/other	1	0,1	< 1%

Table 10
Dutch sample (regions)

Region	Frequency	Proportion	Target
North	126	11,3	10,0
East	228	20,5	21,0
West	511	45,9	48,0
South	247	22,2	21,0

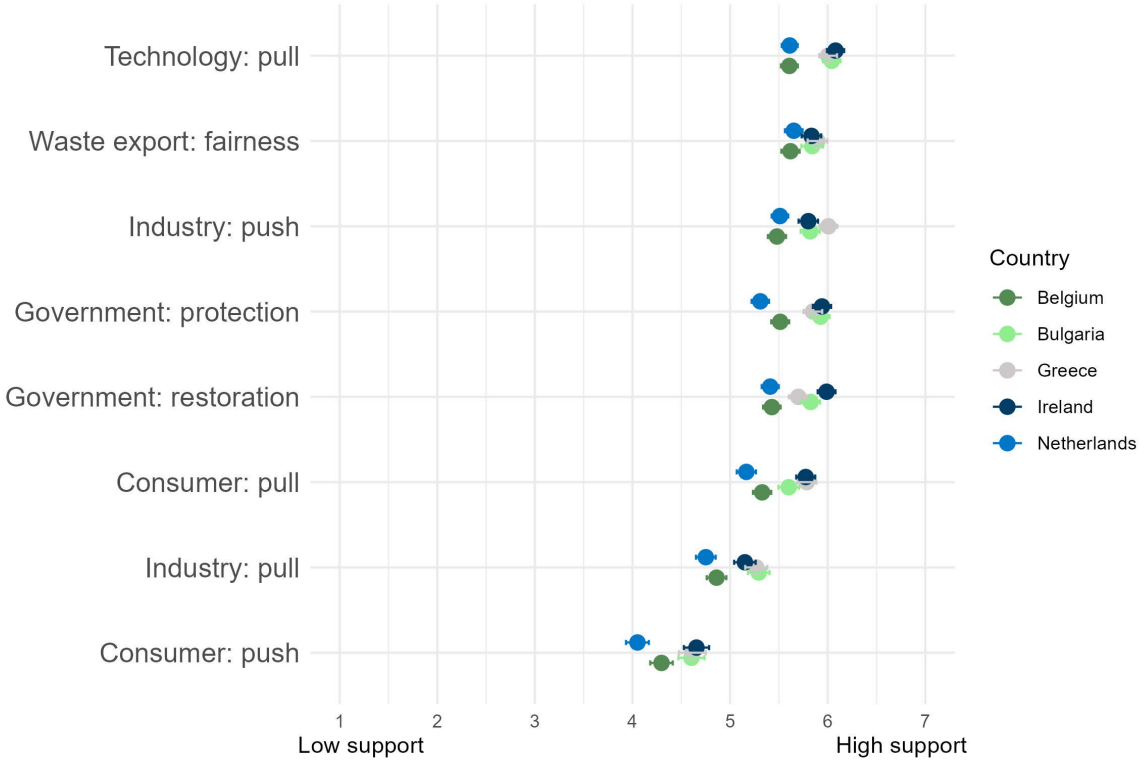
3.3. Public survey results

In the following Section, we present descriptive visualizations of the public survey results with respect to differences in perceptions of different pollutants and between different countries. A full summary of the means and standard deviations of the dependent variables that were measured using numeric scales can be found in Appendix 3. Additionally, pairwise t-test comparisons with Bonferroni correction were calculated and reported to describe the differences between perceptions of different pollutants and the support of different policies. A threshold of $p < .05$ was considered for determining statistical significance.

3.3.1. Participants' awareness, subjective knowledge, and experience

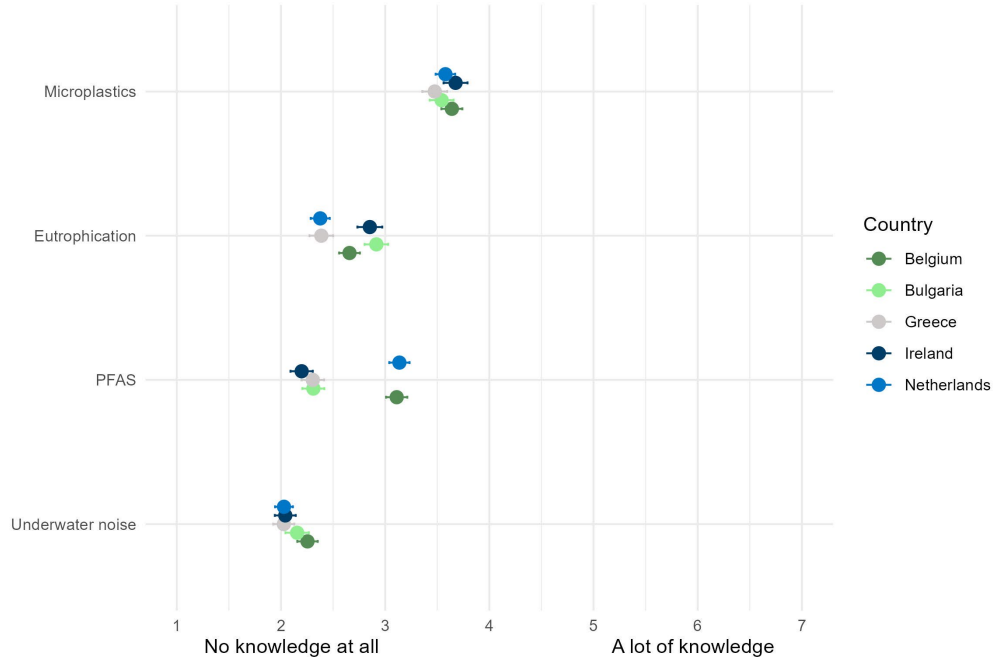
Figure 3 shows the percentage of participants' awareness of different pollutants in each of the selected countries from the public survey. While awareness of microplastics, eutrophication and underwater noise was similar across countries, awareness of PFAS was by almost 30% higher in Belgium and the Netherlands.

Figure 3
Awareness of environmental pollutants: Have you ever heard off...



Note. The option "I prefer not to say" was excluded from the figure as its prevalence was 1% or lower across all pollutants.

Figure 4
Subjective knowledge: How much do you know about...



Before receiving a short explanation of each of the pollutants, participants from the public survey reported their subjective knowledge, i.e. how much they feel they knew about the topic. On average, participants reported to know most about microplastics, then eutrophication, then PFAS, and lastly about underwater noise. The differences in subjective knowledge for different pollutants were significant ($p < .05$).

Figure 5
Personal experience: Have you ever been directly affected by...

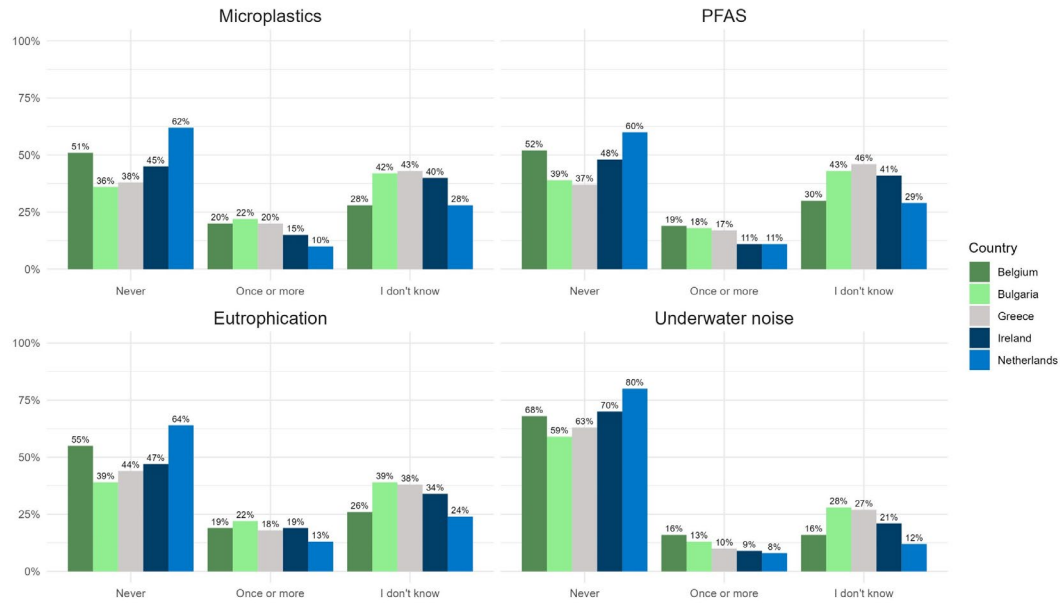
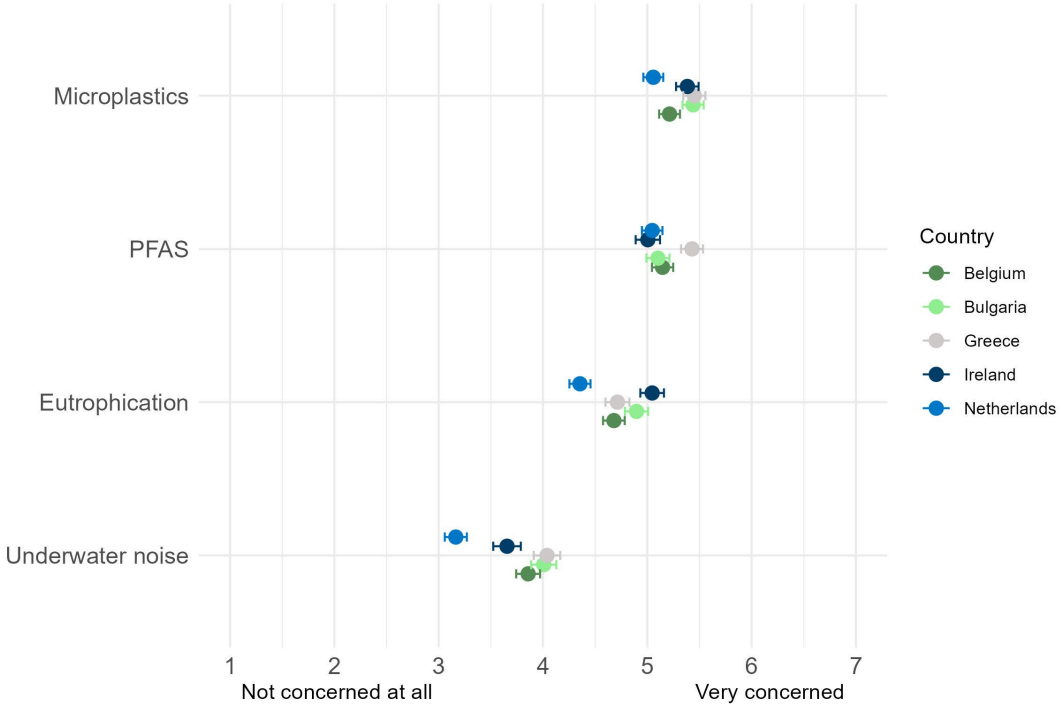


Figure 5 illustrates whether participants from the public survey felt they were directly affected by the pollutant in question. The response "Once or more" represents the combined responses of "Once," "Twice," and "Three or more times." In general, 20% or fewer participants felt affected by any of the pollutants, with a relatively high proportion reporting that they were never affected by the pollutant (ranging from 39% for microplastics, PFAS, and eutrophication to 80% for underwater noise). Interestingly, the lack of knowledge about being personally affected by any of the four pollutants was relatively high, ranging from 11% for underwater noise to 44% for PFAS.

3.3.2. Risk perception

Participants from the public survey reported their risk perception by rating their health and environmental concerns regarding various pollutants. Furthermore, as an additional measure of risk perception, they reported their perception of the urgency of reducing pollutants compared to other current societal issues (environmental, social, economic).

Figure 6
Health concern: How concerned are you about the effects on health because of...



Across countries, microplastics were perceived as more concerning for health (Figure 6) and the environment than PFAS (Figure 7), which, in turn, were perceived as more concerning for health and the environment than eutrophication. Furthermore, eutrophication was perceived as more

concerning for health and the environment than underwater noise. These differences were statistically significant ($p < 0.05$).

Figure 7
Environment concern: How concerned are you about the effects on environment because of...

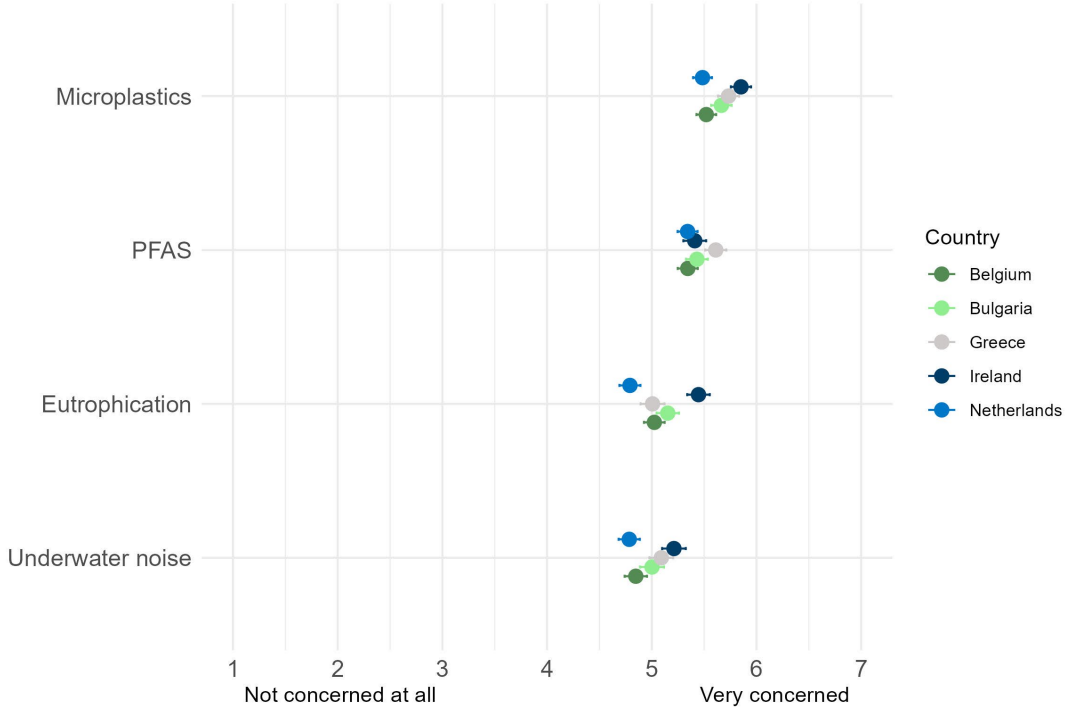
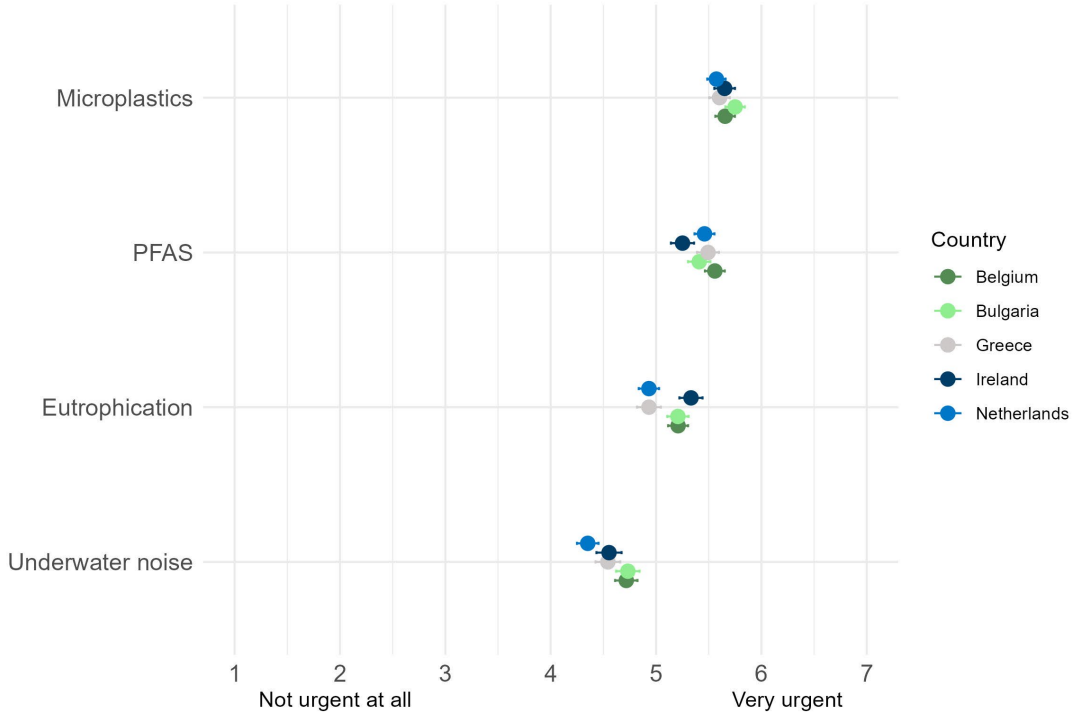


Figure 8
Mitigation urgency: In the context of all the pressing issues society is facing (social, economic, environmental), how urgent is it to tackle pollution from...

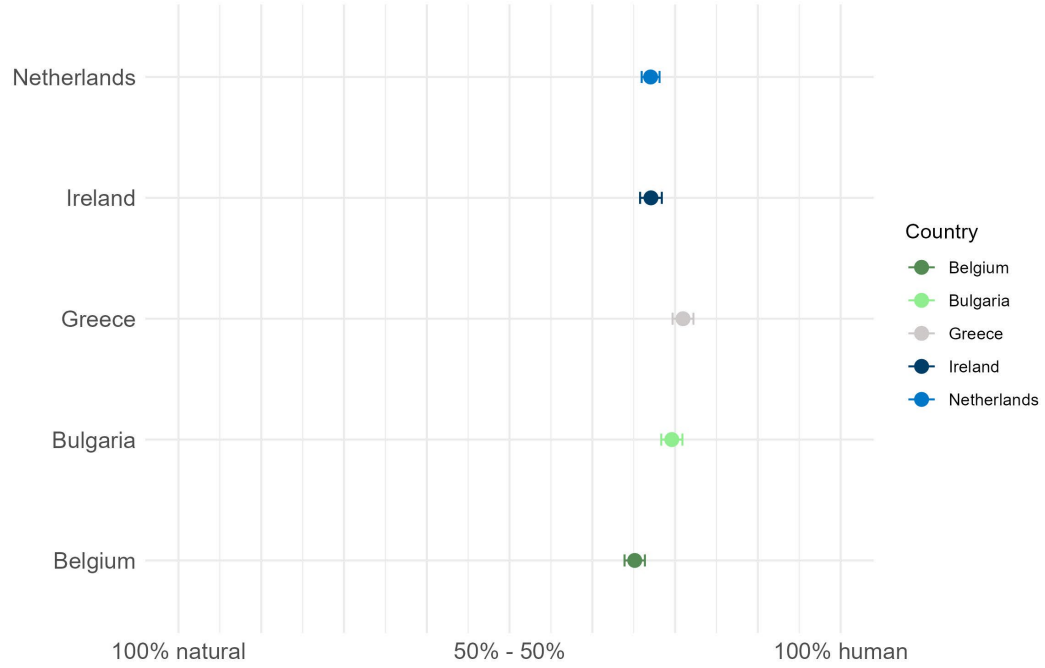


The pattern of responses for urgency mirrored the pattern of concern for health and the environment; across all countries, the differences between the mitigation urgency of pollutants were statistically significant ($p > 0.05$), with the following order: microplastics, PFAS, eutrophication, and underwater noise. Generally, participants across all included countries perceive the urgency for addressing all pollutants as relatively high (rated above 4 on the scale from 1 to 7).

3.3.3. Beliefs about environmental pollution, personal norms and behavioural intention

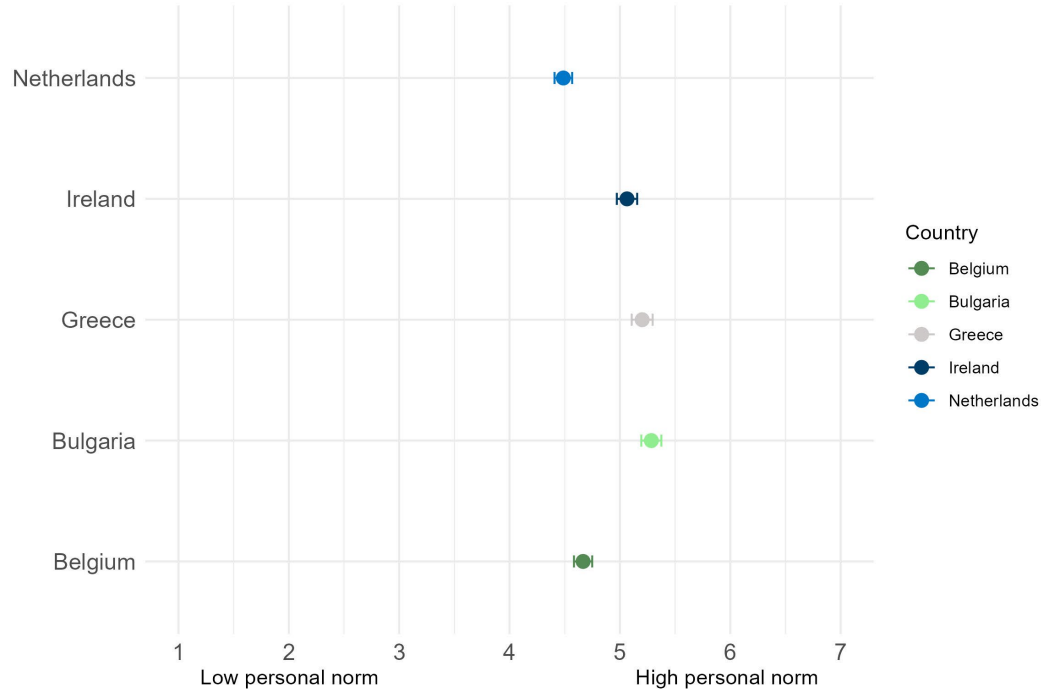
The readiness of participants from the public survey to personally support pollution mitigation was gauged through their beliefs about the causes of environmental pollution, presented in Figure 9, their perceived social norms about pollution mitigation presented in Figure 10 and their intention to adopt different kinds of behaviour in Figure 11.

Figure 9
Belief about the causes of environmental pollution



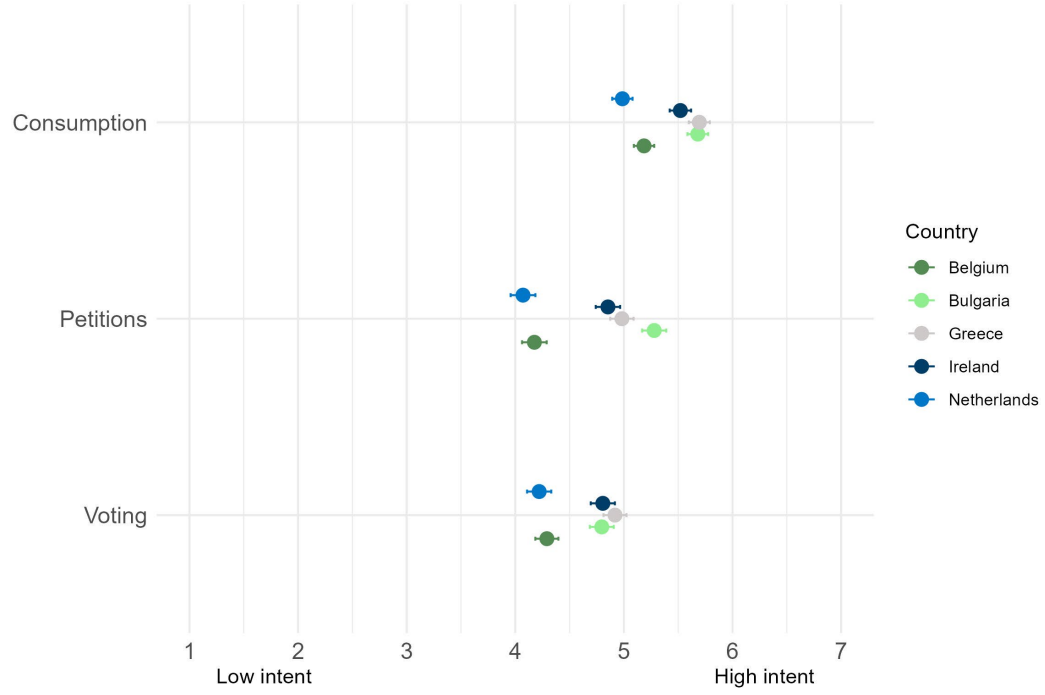
Across all countries, participants from the public survey believed that environmental pollution is caused more by human activity than by natural processes. The rating was the highest in Greece and the lowest in the Netherlands. The pro-environmental personal norms (Figure 10) were reported to be higher in Bulgaria, Greece, and Ireland than in Belgium and the Netherlands, however, across all countries, people felt more responsible than not to support pollution mitigation with the averages above 4 on the scale from 1 to 7.

Figure 10
Personal norms about environmental pollution mitigation



Note: Personal norm represents averaged individuals' agreement with two statements, namely "I feel personally responsible to help reduce environmental harm and pollution" and "I feel like I should do more to help reduce environmental harm and pollution"

Figure 11
Behavioural intention to help mitigate environmental pollution

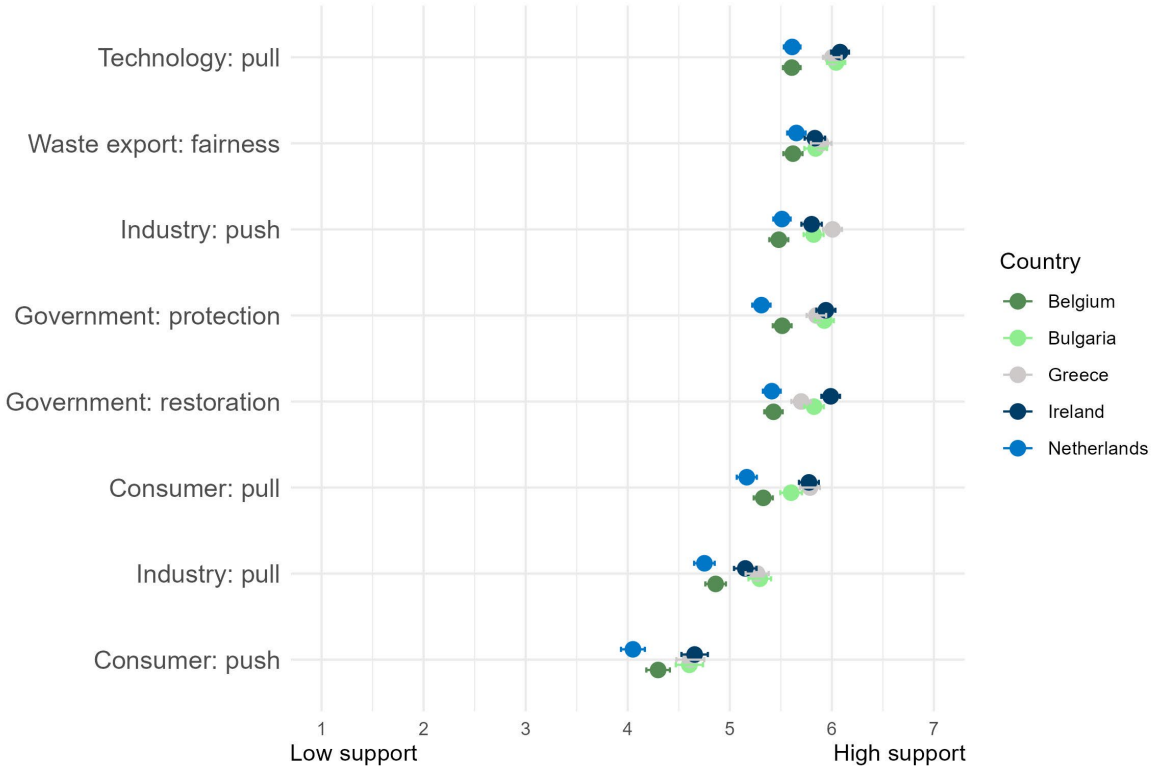


As illustrated in Figure 11, the behaviour that public survey participants across all countries intended to engage in most was sustainable consumption, followed by signing petitions and lastly voting for pro-environmental parties. The differences between these behavioural intentions were statistically significant ($p < .05$). Participants from the Netherlands and Belgium reported a lower intent to adapt the selected pro-environmental behaviours in comparison to Greece, Ireland, and Bulgaria.

3.3.4. Policy acceptance: general and pollutant-specific

The data from the public survey on the pro-environmental policy acceptance was split into two parts. First, participants reported their support for policies that could help reduce pollution in general. Second, participants were randomly divided into four groups and responded to questions about support for policies aimed at reducing specific pollutants (see Figure 2).

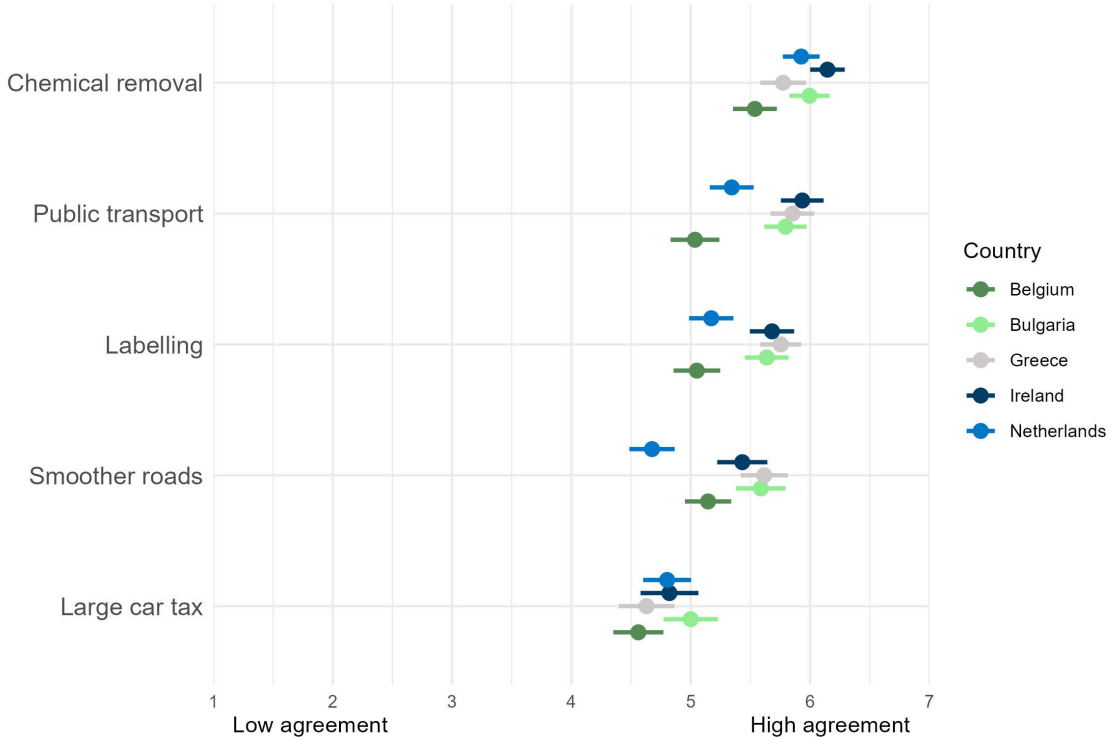
Figure 12
Support for different pro-environmental policies



The pattern of policy support was similar for all countries. On average, subsidies for the development of environmentally friendly technologies received the most support, followed by a ban on the export of waste to low-income countries and policies aimed at pushing industry towards more environmentally friendly processes through higher taxes and penalties. In the middle were

policies aimed at protecting and restoring the environment. Finally, the least supported policies were those that use financial subsidies to encourage consumers and industry to adopt more environmentally friendly behaviour, and those that financially penalise consumers for non-environmentally friendly behaviour. Support for all policies were significantly different from each other ($p < 0.05$), except for the difference between pushing industries and governmental protection.

Figure 13
Support for different mitigation policies to reduce tyre wear particles



Among potential mitigation policies to reduce microplastics pollution from tyre wear particles, participants from the public survey expressed the highest support for removing chemicals from the microplastic particles, followed by subsidizing public transport, labelling tires, investing in smoother roads, and imposing a tax on large cars. In general, support for different policies was relatively high (> 4 on a scale from 1 to 7 for all policy suggestions) as presented in Figure 13. The differences in support for different microplastics mitigation policies were statistically significant ($p < 0.05$)

Among potential mitigation policies to reduce PFAS pollution, participants from the public survey expressed the highest support for labelling products containing PFAS, followed by penalties for industry, banning consumer products containing PFAS, and lastly, allowing PFAS in essential products. In general, support for different policies was relatively high, with all policy suggestions receiving ratings above 4 on a scale from 1 to 7, as illustrated in Figure 14 (below). All differences

in support for eutrophication mitigation policies were statistically significant ($p < 0.05$) but the difference between support for labelling and industry penalties.

Figure 14
Support for different PFAS mitigation policies

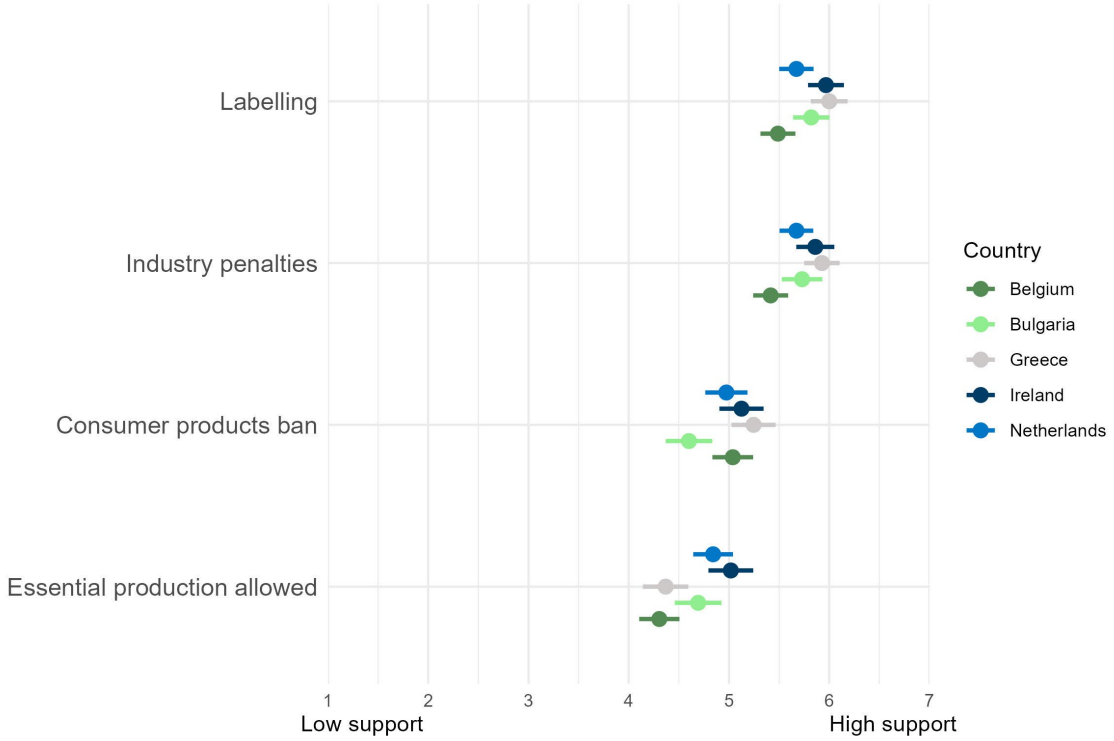
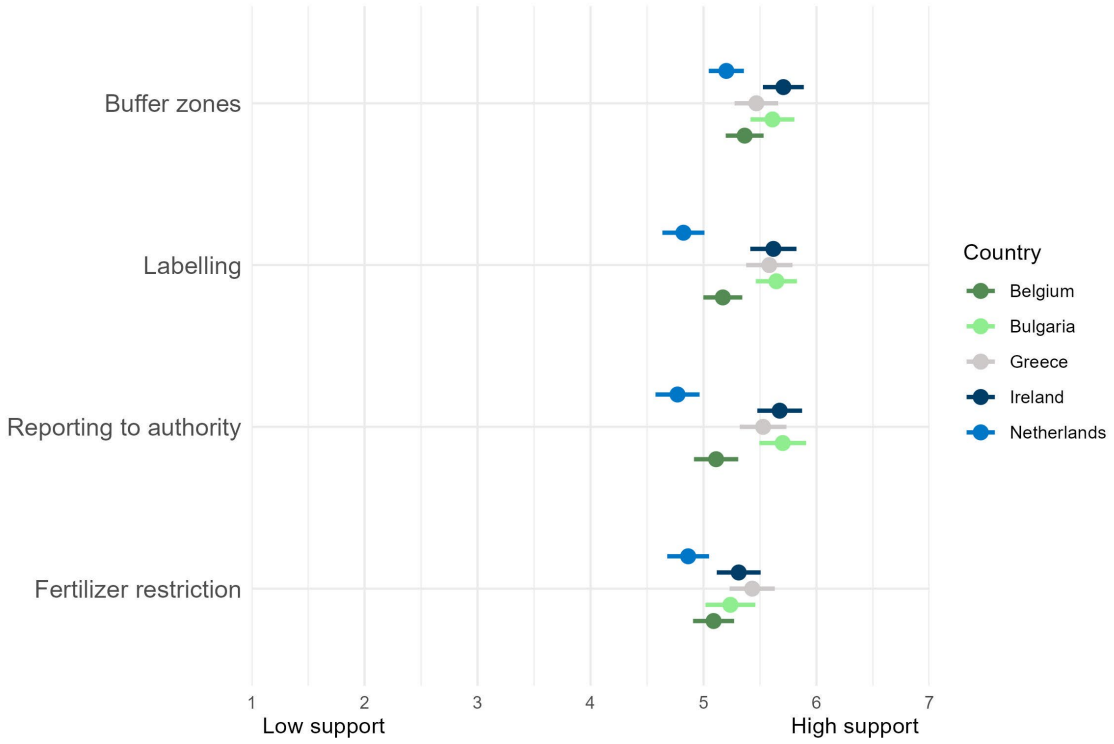
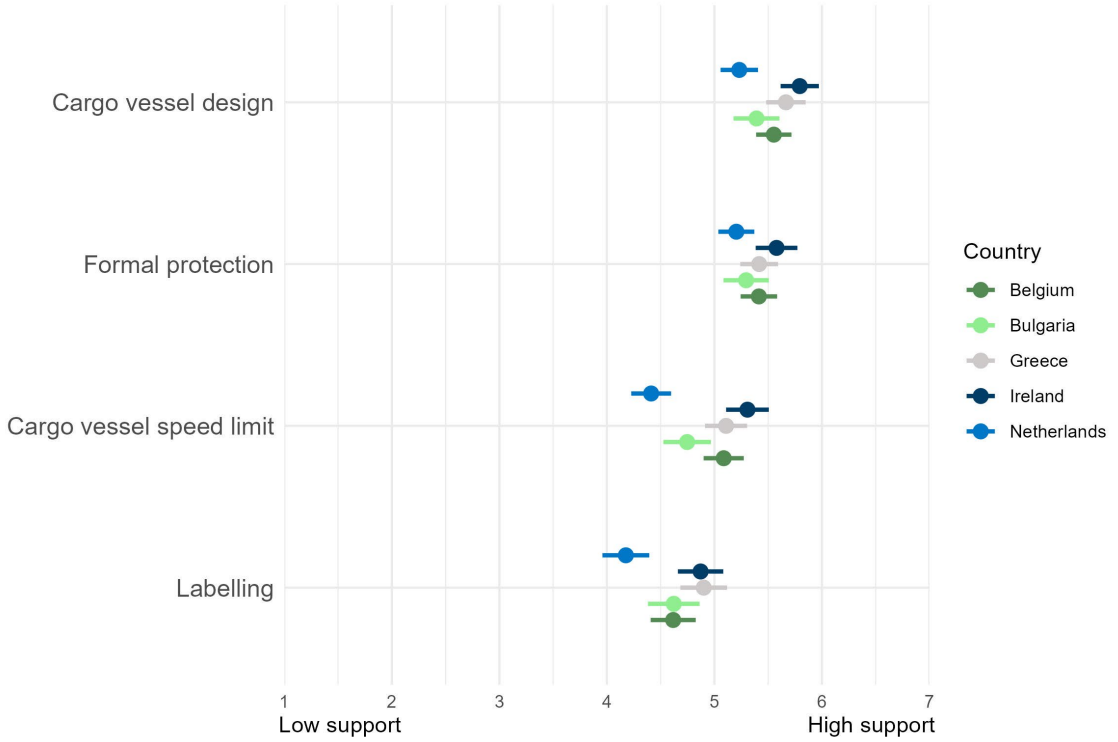


Figure 15
Support for different eutrophication mitigation policies



Among potential mitigation policies to reduce eutrophication, participants from the public survey expressed the highest support for buffer zones, followed by labelling products causing eutrophication, increased reporting to authorities, and lastly, fertilizer restrictions. In general, support for different policies was relatively high, with all policy suggestions receiving ratings above 4 on a scale from 1 to 7, as illustrated in Figure 15. All differences in support for PFAS mitigation policies were statistically significant ($p < 0.05$) but the difference between support for labelling and reporting to authorities.

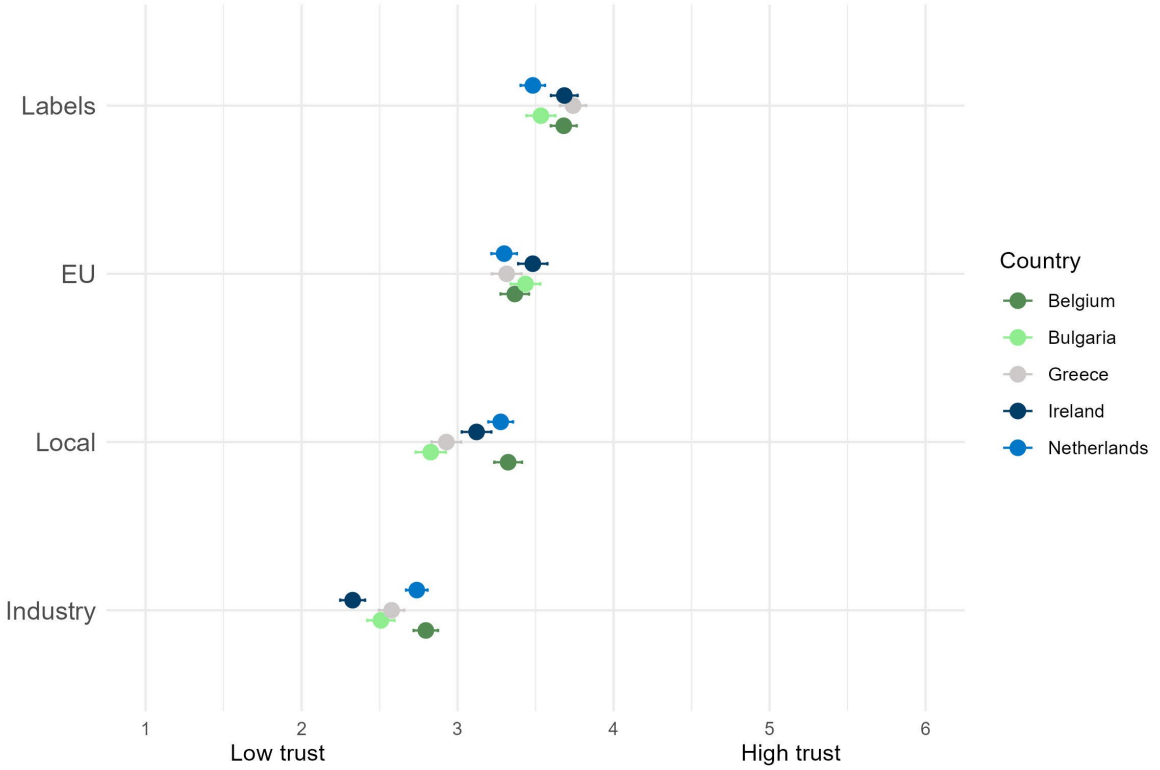
Figure 16
Support for different underwater noise mitigation policies



Among potential mitigation policies to reduce underwater noise pollution, participants from the samples expressed the highest support changing the design of cargo vessels causing underwater noise, followed by formally including underwater noise in assessments on protecting sensitive marine environments, restricting the speed of cargo vessels, and lastly, labelling consumer products. In general, support for different policies was relatively high, with all policy suggestions receiving ratings above 4 on a scale from 1 to 7, as illustrated in Figure 16. All differences in support for underwater noise mitigation policies were statistically significant ($p < 0.05$).

3.3.5. Trust

Figure 17
Perceived trustworthiness of different actors/tools by the public



Across all countries, the trust in different actors/tools was between middle and low (<4 on the scale from 1 to 6). The trust in labels was the highest, followed by trust in the EU institutions, local institutions and industry. As illustrated in Figure 17, there were some differences between countries. For example, participants from Greece, Ireland, and Bulgaria seem to trust EU government more than their local government, however, this was not the case for the Netherlands and Belgium.

3.3.6. Perceptions of pollutants

Participants from the public survey reported their perceptions of the characteristics of microplastics, PFAS, eutrophication, and underwater noise. The adjectives they were asked to attribute to different pollutants by providing ratings were toxic, persistent, mobile, disgusting, useful, and natural. For both microplastics (Figure 18) and PFAS (Figure 19), participants perceived them as toxic, followed by persistent, disgusting, and mobile. They perceived them as useful and natural only to a low degree. The patterns were similar for eutrophication (Figure 20) and underwater noise (Figure 21), however not the same. Eutrophication was considered particularly

disgusting in comparison to other environmental issues, while underwater noise was considered more mobile than the other pollutants.

Figure 18
Perceived characteristics of microplastics

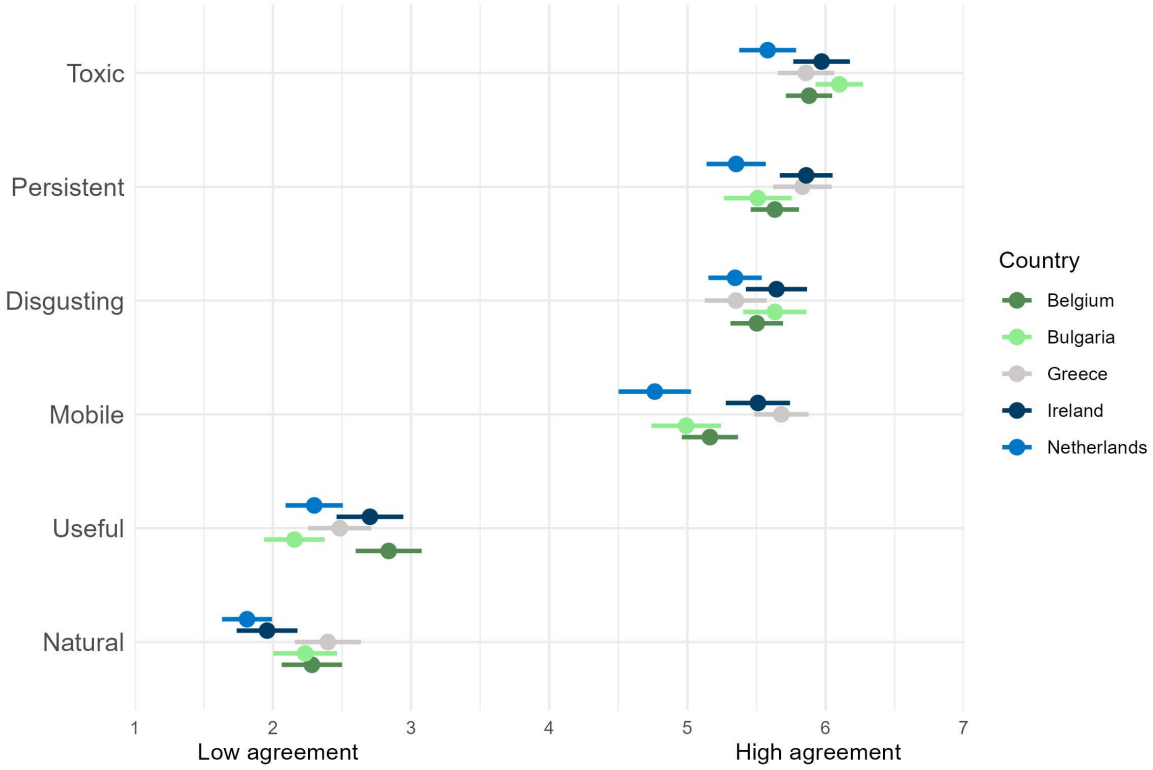


Figure 19
Perceived characteristics of PFAS

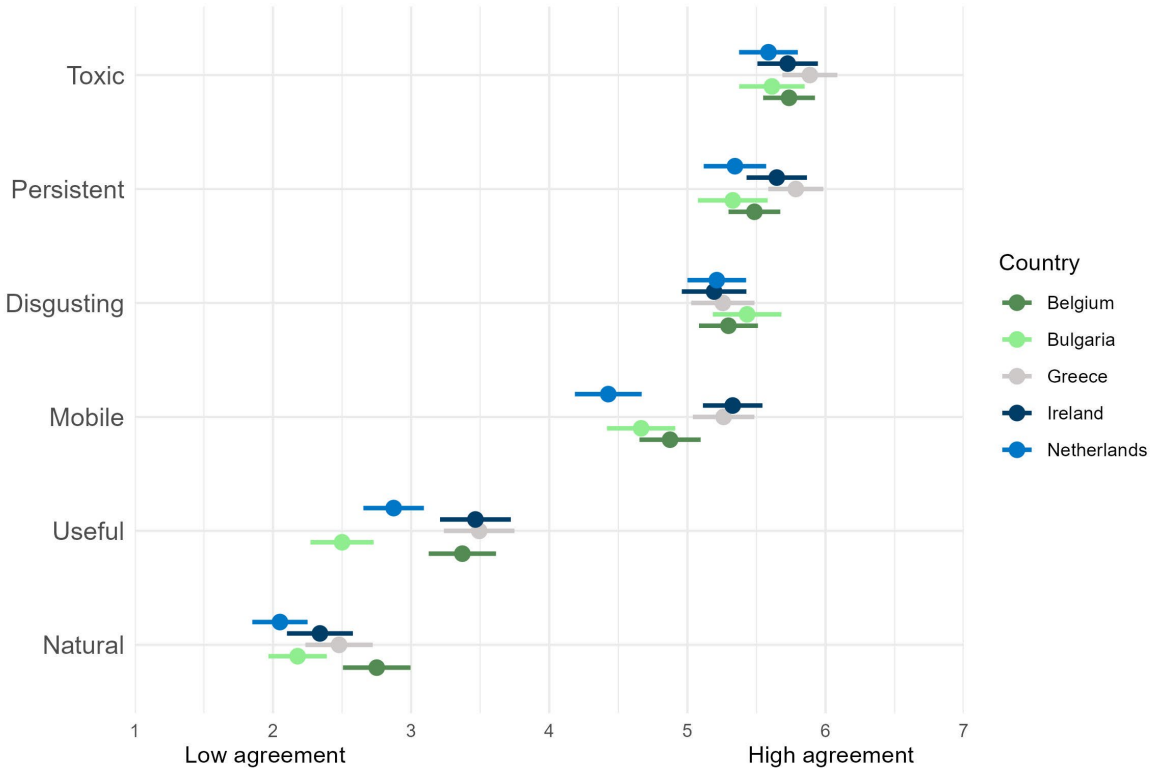


Figure 20
Perceived characteristics of eutrophication

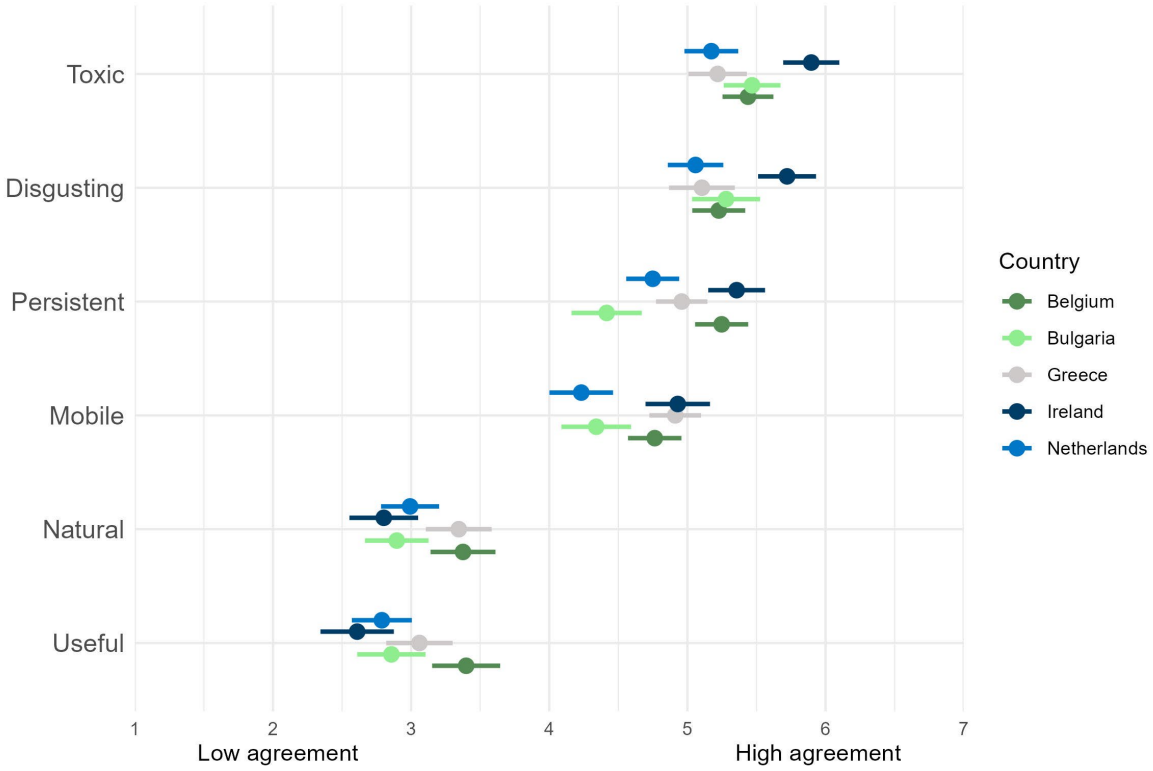
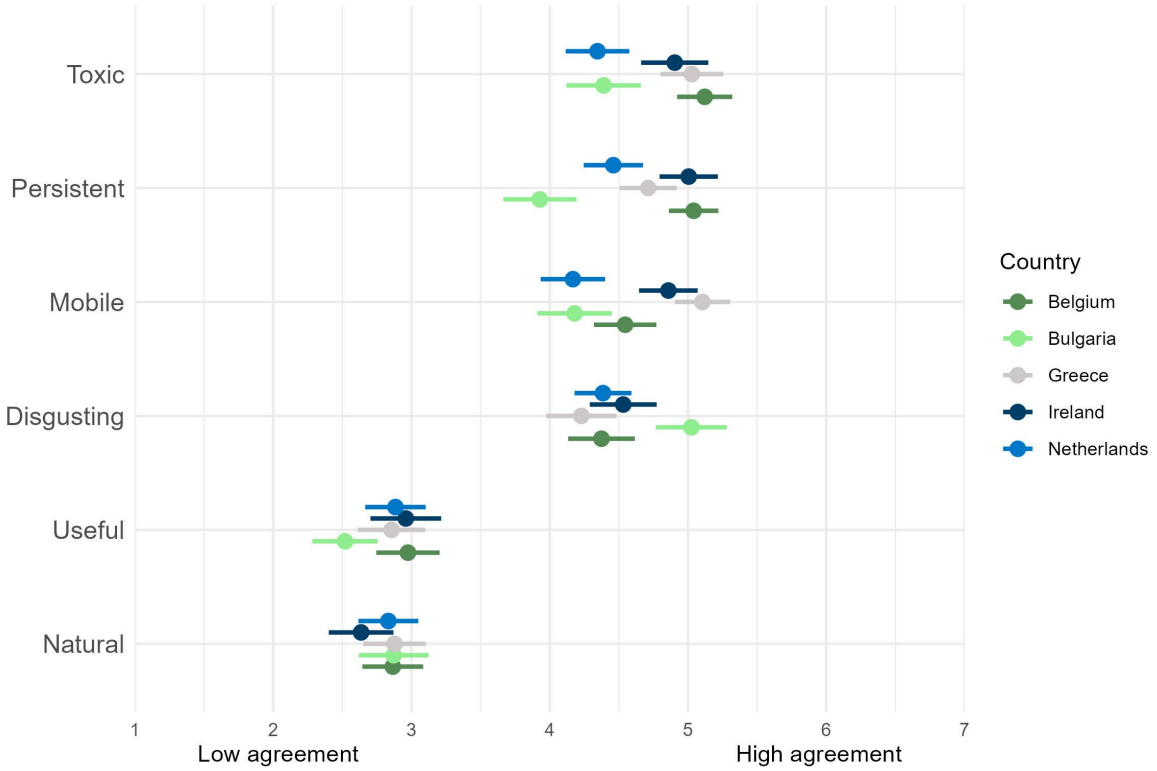


Figure 21
Perceived characteristics of underwater noise



4. Part II: Stakeholder survey

4.1. Understanding the perceptions of stakeholders

In the second part of the report, we focus on obtaining perceptions from stakeholders[3] on pollutants and policy measures, i.e. from representatives of research, governmental and non-governmental organisations and industry. Solving complex issues such as environmental pollution cannot be achieved by a single stakeholder group. For instance, Lampitt et al. (2023) argued that due to the nature of the plastics supply chain, efforts to address plastic pollution must be coordinated globally and involve all key actors, and Pahl and colleagues (2022) point out the importance of bottom-up and top-down processes to jointly determine change. This principle can be generalized to other environmental pollutants, which, despite being produced locally, can have global repercussions and thus require coordinated management strategies from policy makers, industries, scientists and the public. At the same time, representatives of research, governmental and non-governmental organisations and industry bring their own set of beliefs and needs to the table when approaching environmental issues (van den Broek, 2019).

A few examples have demonstrated the usefulness of such investigations. An interview study by Trubetskaya and colleagues (2022) showed that European policymakers, consumers, and plastic producers agree on the necessity to reduce plastics in food packaging and view circular approaches as a main solution. The qualitative analysis showed that how to achieve it may depend more on aligning policies and mindsets between stakeholders than on technical aspects. Dessi and colleagues (2022) further illustrate the value of psychological factors in understanding stakeholders' perceptions, such as the importance of values and emotions for scientific experts and the importance of process fairness for government stakeholders. Contrary to the popular belief that industry representatives are driven mainly by profit, a study of farmers from the Midwest showed their stewardship attitudes (in comparison to business attitudes) were high and significantly related to their willingness to take action to improve water quality (Floress et al., 2017). Lastly, stakeholders who recognize the benefits of preserving marine and coastal ecosystems are more likely to support related policies, underlining the importance of tailored engagement strategies (Nguyen et al., 2023). Together, these insights highlight the need for research with stakeholder groups to better understand and join different perspectives.

[3] See Reed et al. (2024) for a critical take on the „stakeholder" terminology.

4.1.1. Aim of the stakeholder survey

Following Lampitt and colleagues (2023), we identified the key stakeholder groups as industry, independent researchers, policymakers, and the public, and we added NGOs as a core influence group in the domain of environmental pollutants. Public perceptions (see above Part I) were captured through a public survey, while stakeholder perceptions were obtained from representatives of the remaining stakeholder groups through an adapted survey tool (e.g. stakeholder survey) that maintained comparability in core aspects while targeting this different group in a more tailored manner.

The industry stakeholder group is characterized by its capacity to innovate and adapt, its critical role in implementing sustainable practices, and its responsibility to operate transparently and efficiently within a regulatory framework. Typically, industry stakeholders are involved in production, distribution, supply, or retailing, and are subject to various environmental regulations. Policymakers are characterized by their crucial role in developing and enacting legislation to address plastic pollution, setting standards, and coordinating efforts across regions and different stakeholders. The scientific community stakeholder group (or: independent researchers) is characterized by its commitment to advancing knowledge, addressing societal challenges, and promoting the well-being of both humans and the environment. Although Lampitt and colleagues (2023) did not identify NGO groups as stakeholders, we included them due to their role in advocating for environmental protection, raising public awareness of plastic pollution, and holding industry and governments accountable for their environmental impacts.

With the stakeholder survey, we aimed to better understand the differences and similarities in pollutant risk perception across different stakeholder groups, the types of policies they support, and whom they consider trustworthy partners in achieving zero pollution. While stakeholders are also part of the public with their own personal values and beliefs, we sampled them as representatives of their stakeholder groups through their professional affiliations. Our goal was to fill a gap in the stakeholder survey data in the context of pollution literature. Furthermore, we also added the option of open-ended responses in order to capture their perspectives beyond the (close-ended) quantitative items. By understanding the beliefs of different stakeholder groups and how they differ from each other, collaborative efforts to address plastic pollution can be better informed.

4.2. Stakeholder survey methodology

To achieve the stakeholder survey aim, the core questions about risk perception and policy support were taken from the public survey and adapted to the stakeholders' context. Special care was

given to making questions applicable to all groups and allowing stakeholder participants to elaborate on their views with providing answers to open questions.

4.2.1. Sampling strategy

To be eligible for taking part in the stakeholder survey, the professional role of potential stakeholder participant needed to be relevant to one of the four pollutants: microplastics, PFAS, eutrophication, or underwater noise. Stakeholder survey participants were informed that the specific pollutant had to be pertinent to their own work or to the work of their organization. Furthermore, to be eligible, they either needed to possess extensive knowledge about the pollutant, be involved in following or making regulations concerning it, or work in a sector that produces or uses it. Lastly, stakeholder participants needed to be at least 18 years old.

Based on these specific requirements, a snowball convenience sampling method was employed. Previous stakeholder mappings (e.g. van Leeuwen et al., 2023) were used to define the target groups. Participants were recruited through the SOS-ZEROPOL network, personal networks of researchers, mailing lists, and newsletters. An example invitation letter can be found in Appendix 4. Data collection took place between April and May 2024. In total, over 400 emails were sent out to different individuals, who also shared the survey with further eligible associates. The survey was started by 157 individuals and 31 dropped out before finalizing it.

Stakeholder groups sample

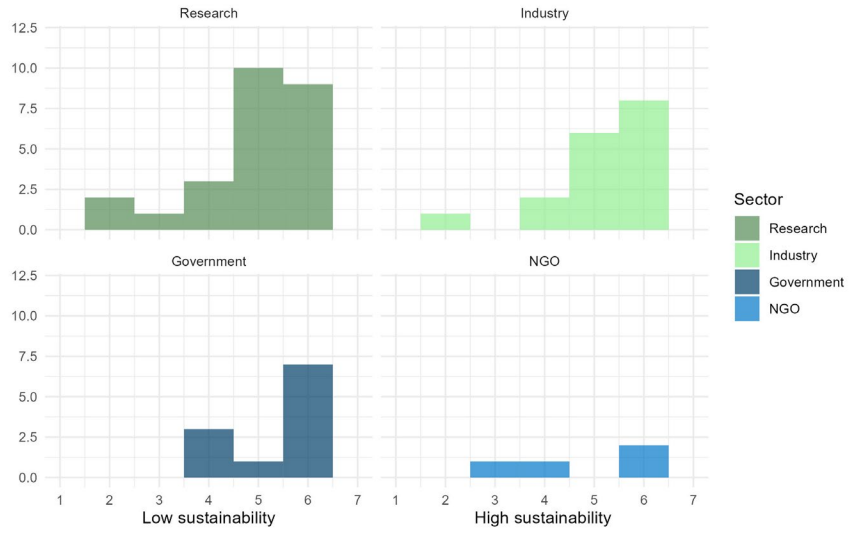
The final sample size for each stakeholder group and pollutant is described in Table 11. Stakeholders from Austria, Belgium, Bulgaria, Denmark, France, Finland, Germany, Greece, Italy, Ireland, Netherlands, Norway, Portugal, Spain, Sweden, UK, and USA took part in the stakeholder survey. The gender identity was as follows: 33.33% female, 64.58% male, and 2% preferred not to report their gender. Furthermore, most of the stakeholder participants (85.4%) worked at their organization for longer than 5 years. They had various managerial responsibilities, with 30.29% without managerial responsibility, 18.75% with some managerial tasks, 25% with high managerial tasks, and 26.04% were part of the top management. Lastly, their organizations varied in size, with 23.95% having less than 50 employees, 20.83% with between 51 and 250 employees, and 55% with more than 250 employees. Furthermore, the stakeholders described their organisations as relatively sustainability driven as presented in Figure 22.

Table 11
Stakeholder groups' sample sizes

Pollutant	Stakeholder group	N
Microplastics	Industry	9
	Government	13

	NGO	6
	Research	21
	Other	1
PFAS	Industry	7
	Government	14
	NGO	6
	Research	17
	Other	1
Eutrophication	Industry	8
	Government	4
	NGO	3
	Research	9
	Other	0
Underwater noise	Industry	3
	Government	3
	NGO	2
	Research	6
	Other	0

Figure 22
Reported sustainability of stakeholders' organisations



Materials

When possible, validated measurements from the public perception study were used to allow for group comparisons. However, the questions were adapted to fit the new target groups. For example, the item "*How concerned are you about…*" was adapted to "*How concerned is your organization/working group about…*". In the demographics section, additional measurements were included to gain a more comprehensive view of the stakeholder participants. To shorten the survey

and reduce the workload, other measurements that were less relevant for stakeholder group representatives were omitted. This applies to their general awareness of the pollutant, specific pollutant perception, measures of affect, personal experiences, beliefs, values, behavioural intentions, political views, financial situation, techno-optimism, and system thinking. The complete stakeholder survey can be found in Appendix 5.

Stakeholder descriptive variables

For stakeholder demographics, most measurements were retained from the public survey. In addition, the stakeholder survey assessed the scope of the organization they worked at ("*Local*", "*EU*", "*Global*") and the number of employees in their organization ("*1 to 10 employees*", "*11 to 50 employees*", "*51 to 250 employees*", "*More than 250 employees*"). Their personal role was assessed by asking how long the participants have been working in their sector *("Less than 1 year", "2 to 5 years", "More than 5 years"*) and the managerial responsibility they have *("I am an employee without managerial responsibilities", "I have managerial tasks, but the employees below me have no management tasks", "There are other managers above and below me", "I am part of the top management"*). The extent to which the organization has an environmental or sustainability agenda was assessed on a scale from 1 ("*No sustainability at all*") to 7 ("*Sustainability is the main priority*"). Additionally, an open question was included asking whether they knew other organizations that might be relevant to contact for the purpose of the survey. No personal addresses were collected this way.

Support for environmental policies

For environmental policy support, the items from the public survey were retained to maximize comparability between the two samples. However, participants in the stakeholder survey were asked to answer them from the perspective of their organization.

Trust

In addition to the public survey items on trust in the EU government, local government, labels, and industry, several other items were added for the stakeholder survey. These additional items measured trust in independent researchers (”My organisation / working group trusts independent researchers to provide reliable information about environmental pollution”) and trust in non-governmental organisations (”*My organisation / working group trusts non-governmental organisations to lead an effective environmental pollution mitigation strategy*”). Lastly the trustworthiness of their own organisation was assessed (”*My organisation / working group is a trustworthy contributor to solving environmental problems*”). All items were rated on a 6-point scale from 1 (”*Strongly disagree*”) to 6 (”*Strongly agree*”).

Translation

The translations from the public survey were reused. The required adaptations were translated to Belgian, Bulgarian, Dutch, French and Greek and checked again by native speakers of the languages.

Open-ended questions

In contrast to the public survey, the stakeholder survey included open questions that were optional to fill in. These allowed for participants to explain their perspectives and to provide insights not captured by the closed survey items. After the questions of concern for health and environment, they were offered to explain their answers (*"Can you explain your answers above a little more? Which factors are relevant here for your organisation that might explain concern or lack of concern*?"). Other open questions were related to the drivers and barriers to mitigating the pollutant ("*In your opinion, what are the drivers and barriers to reducing [pollutant]*?"), their suggestions for the focus of action ("*Where should the focus of action be in your opinion*?"), and their policy suggestions ("*Do you have any policy suggestions*?").

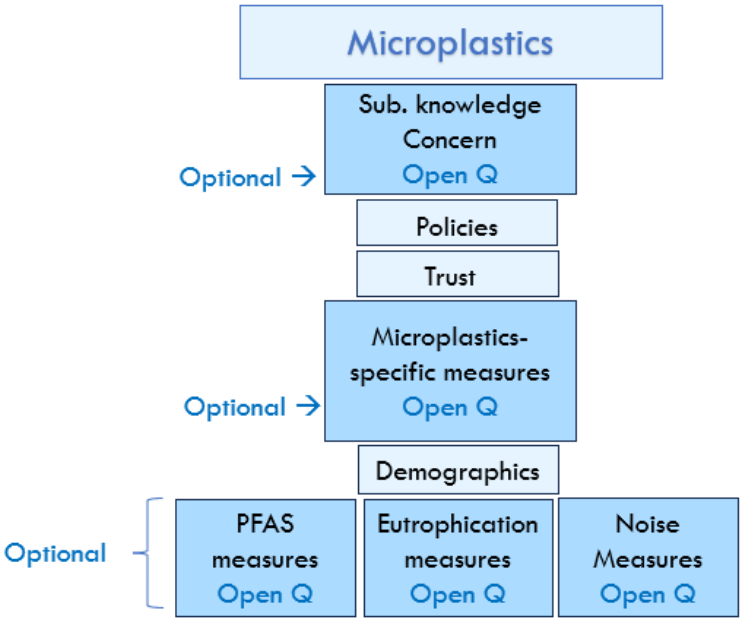
Questions on other pollutants

Within the survey, participants were asked whether they were professionally involved with or knowledgeable about any of the remaining pollutants and whether they would be willing to respond to questions about that pollutant. If so, they were directed to the specific questions for one other pollutant.

Procedure

The survey was conducted in Qualtrics and lasted approximately 10 minutes. Participants completed the survey either in English or in their native languages if they were from Belgium, Bulgaria, France, Greece, or the Netherlands. First, participants provided informed consent; if they did not give consent, they were redirected to the end of the survey. Participants then completed the pollutant perception measurements for their organization (knowledge and risk perception). Next, they responded to the general policy support items, trust items, specific policy items corresponding to the pollutant of their survey, and optionally to open questions to support their answers. After the open questions, participants answered the demographic questions. If related to their work, they optionally answered general and specific questions for one other pollutant. Finally, participants were debriefed and thanked for their participation. An overview of the survey procedure for the example of microplastics can be found in Figure 23.

Figure 23
Stakeholder survey flow



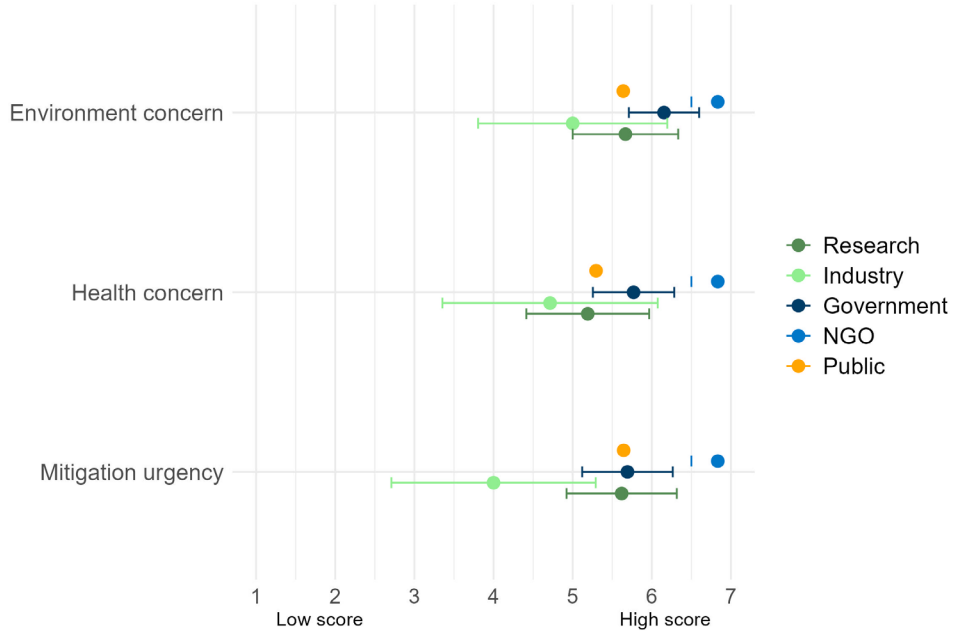
4.3. Stakeholder survey results

In Section 4.3, we provide descriptive visualizations of the survey results along with descriptions of open-ended responses. The results from the public survey were added to the visualisations where applicable[4]. They are represented in figures as orange dots. Additionally, a summary of sample sizes, means, and standard deviations of the numeric variables measured using numeric scales is provided in Appendix 4. It is worth noting that the generalizability of stakeholder results is constrained due to small sample sizes[5], particularly evident in eutrophication and underwater noise perceptions.

4.3.1. Concern for health, environment, and urgency

Figures 24-27 show stakeholder groups' perceptions of environmental concern, health concern and mitigation urgency with respect to all four pollutants. On average and across all pollutants, environmental concern for the environment was higher than health concern. Furthermore, across all pollutants and all stakeholder groups, concern for health and environment was relatively high (on average above>4 on the scale from 1 to 7).

Figure 24
Microplastics: Stakeholder groups' risk perception



[4] Public results represent the average across all surveyed countries.
[5] The variability of the data and the small sample sizes are visually represented with error bars.

As represented in Figure 24, the NGO representatives reported the highest concern and mitigation urgency concerning microplastics while the industry representatives reported the lowest concern and mitigation urgency. The public, government representatives and research representatives were relatively close to each other's assessments.

Figure 25
PFAS: Stakeholder groups' risk perception

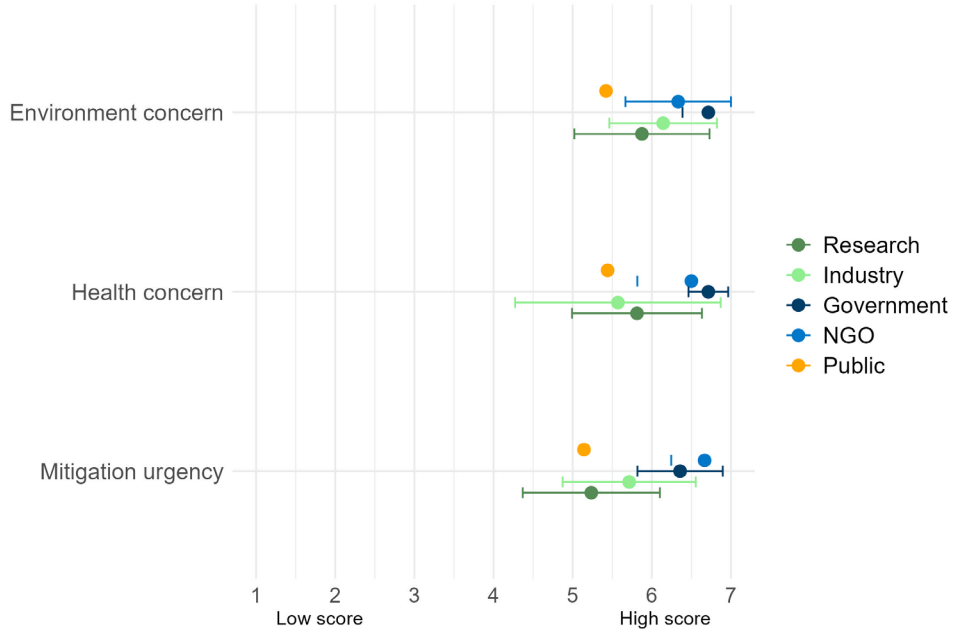
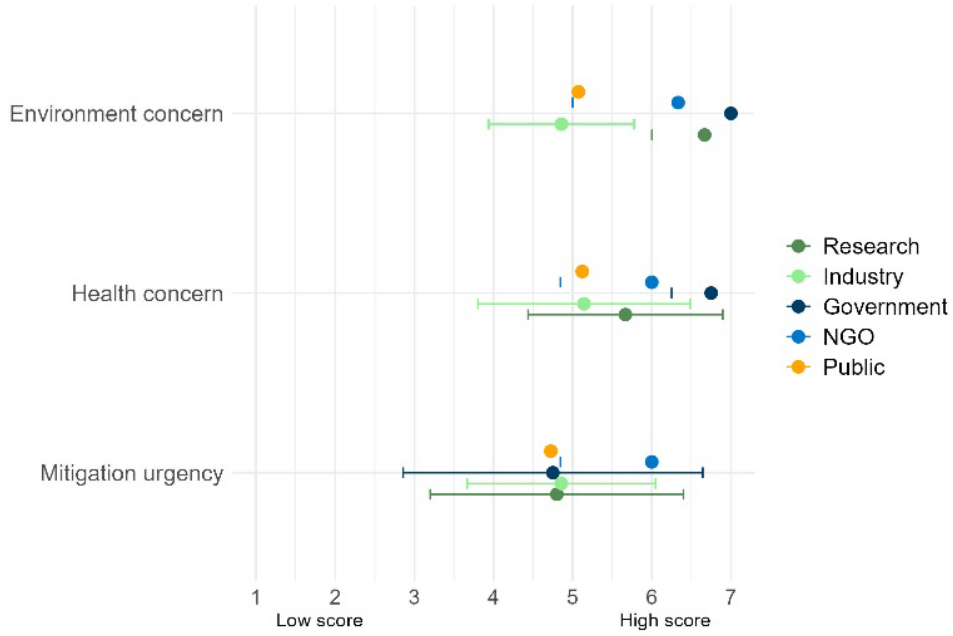


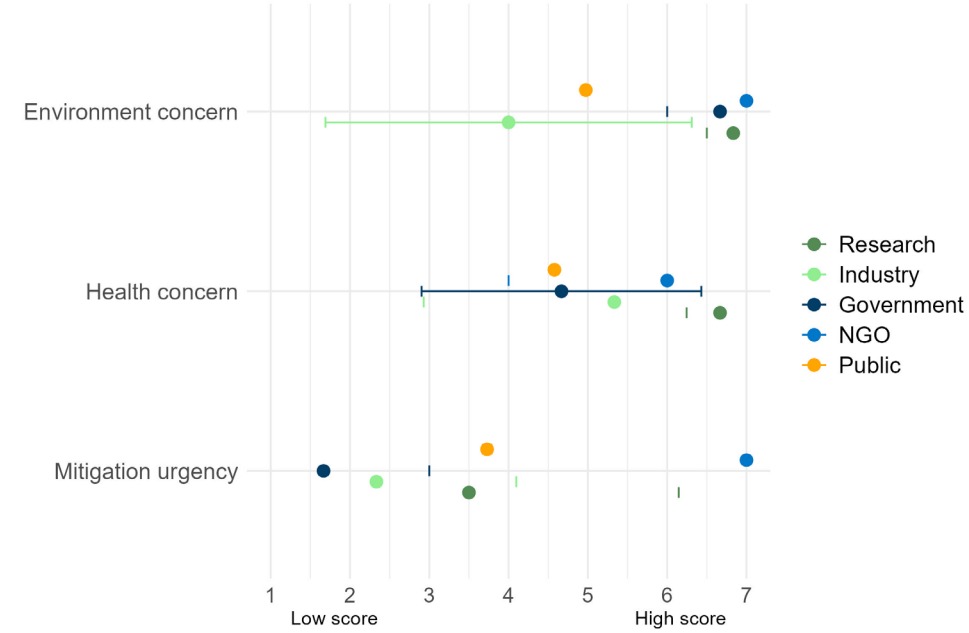
Figure 26
Eutrophication: Stakeholders' risk perception



As represented in Figure 25, the reported average levels of environmental concern, health concern and mitigation urgency due to PFAS, were very high across all stakeholder groups (> 5 on the scale from 1 to 7). The most concerned were the representatives of NGO groups and governments while the public, research representatives, industry representatives reported a slightly lower concern, possibly indicating that this is a “newer” risk compared to microplastics.

Furthermore, as represented in Figure 26, the government representatives reported the highest level of concern regarding eutrophication, however, they assessed the urgency of mitigation similarly to other representatives. Industry representatives and the public showed less concern for health and the environment compared to other groups, whereas experts expressed very high concern for the environment and a slightly lower concern for health. Results here have to be interpreted with caution due to very low sample sizes for stakeholders.

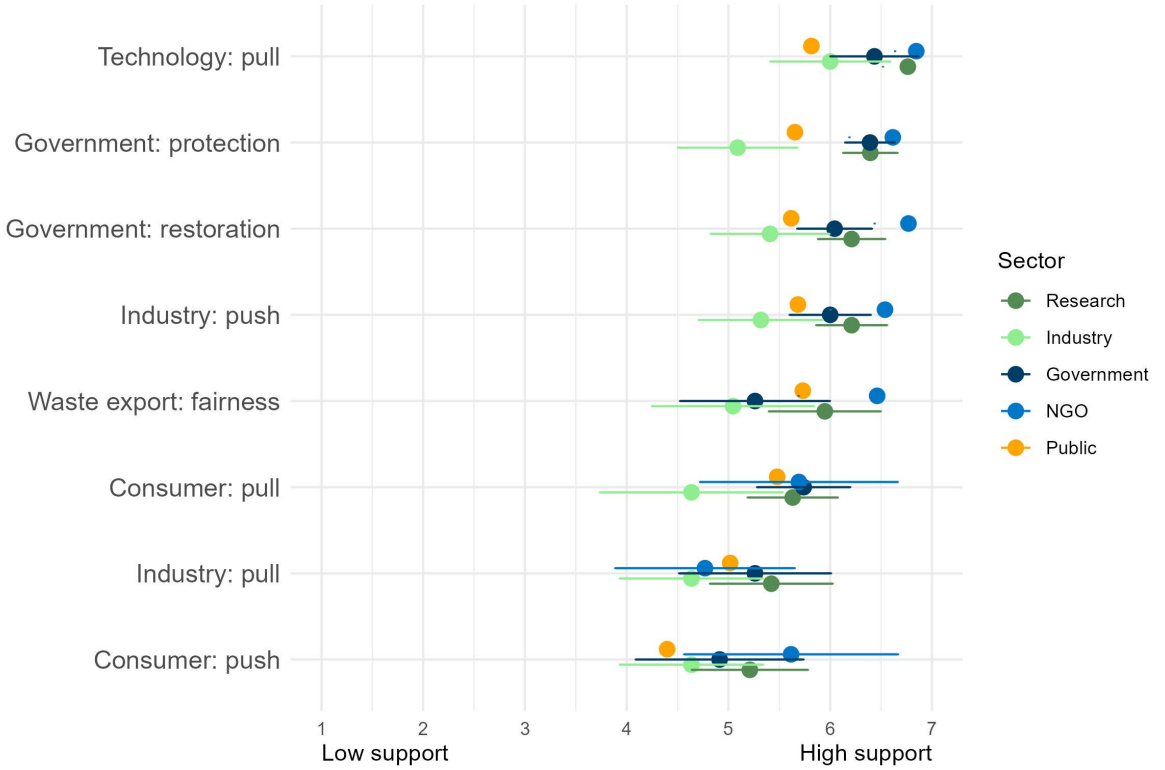
Figure 27
Underwater noise: Stakeholders' risk perception



Lastly, as represented in Figure 27, research, government, and NGO representatives displayed a higher level of environmental concern due to underwater noise. However, aside from NGO representatives, the perceived urgency for mitigating underwater noise was relatively low across all groups, with an average score below 4 on a scale from 1 to 7. Notably, industry representatives exhibited a greater concern for health compared to the environment. Results here have to be interpreted with caution due to very low sample sizes for different stakeholder groups (except for the public).

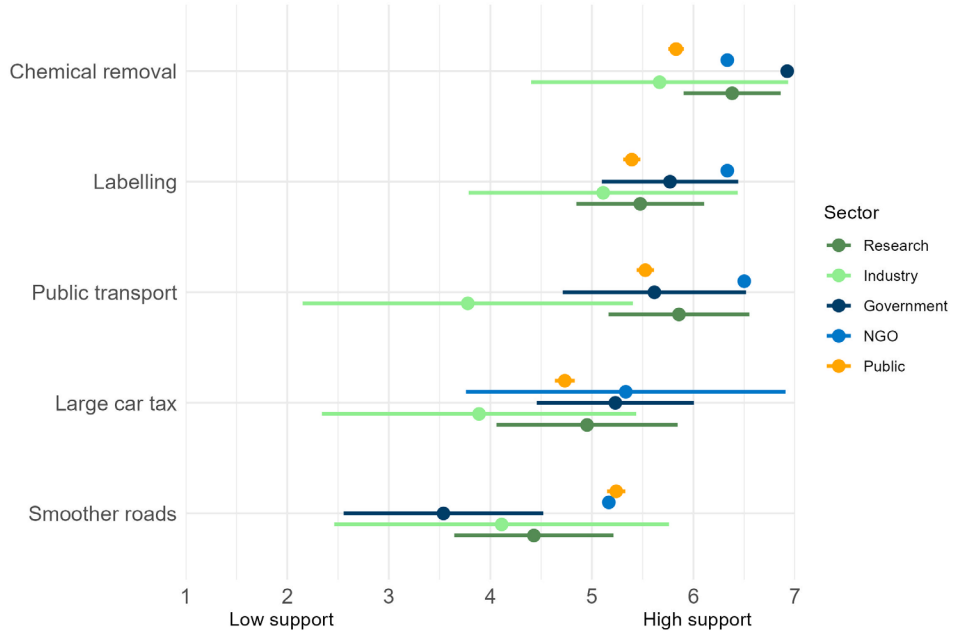
4.3.2. Policy support: general and specific

Figure 28
Stakeholder pro-environmental policy support (general)



On average, subsidies for the development of environmentally friendly technologies received the most support from stakeholders. This was followed by policies to protect and restore the environment. In the middle were policies that push industry towards more pro-environmental production through taxes and penalties, policies to ban waste exports to low-income countries and policies to that pull consumers towards more sustainable consumer choices through labelling and subsidies. On average, the least supported measures were policies that push consumers to make more sustainable consumer choices through taxes and penalties, and policies that pull industries towards more pro-environmental production through subsidies. There were important differences between stakeholder groups. Namely, industry representatives supported government protection and restoration less the other stakeholder groups. In addition, industry and government representatives were less in favour of banning waste exports to low-income countries than were NGOs and researchers. Finally, NGO representatives were less supportive than the other stakeholder groups of policies to encourage industry to produce in a more environmentally friendly way. If compared with the public policy preferences (see Figure 12 for details), the ban on exporting waste to low-income countries, received more support amongst the public. Furthermore, the public' support for pushing industry with penalties is also slightly higher than the support for protection and restoration.

Figure 29
Stakeholders' support for mitigation policies for microplastics



Note. The selected policies described policy measures to reduce emission of tyre wear particles.

Figure 29 illustrates stakeholder participants' support for different policies that would reduce the emission of tyre wear particles into the environment. Across different stakeholder groups, the most support received chemical removal, followed by labelling and large car tax. Relatively less support received large car tax and construction of smoother roads.

Figure 30
Stakeholders' support for mitigation policies for PFAS

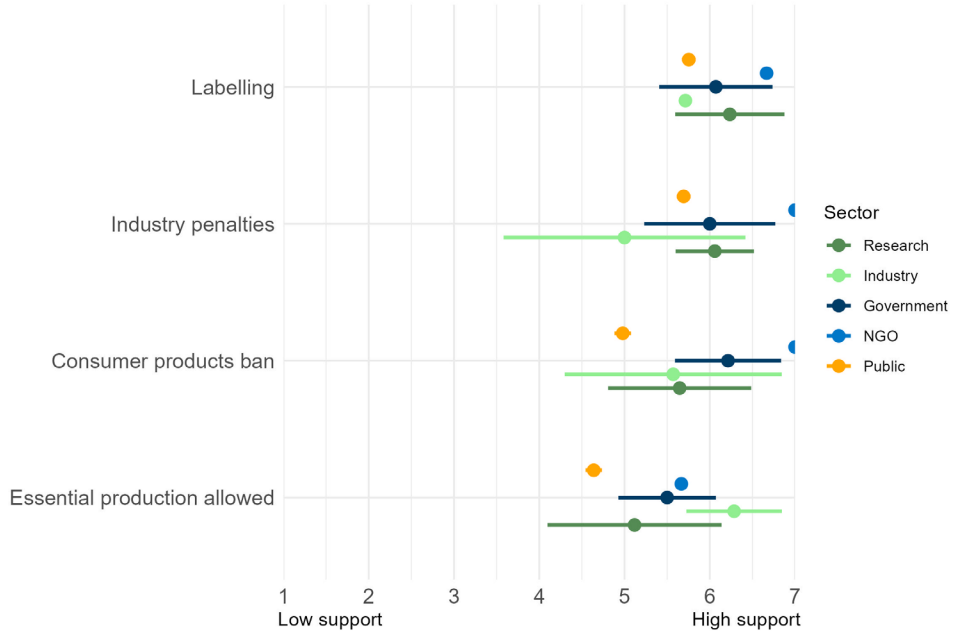
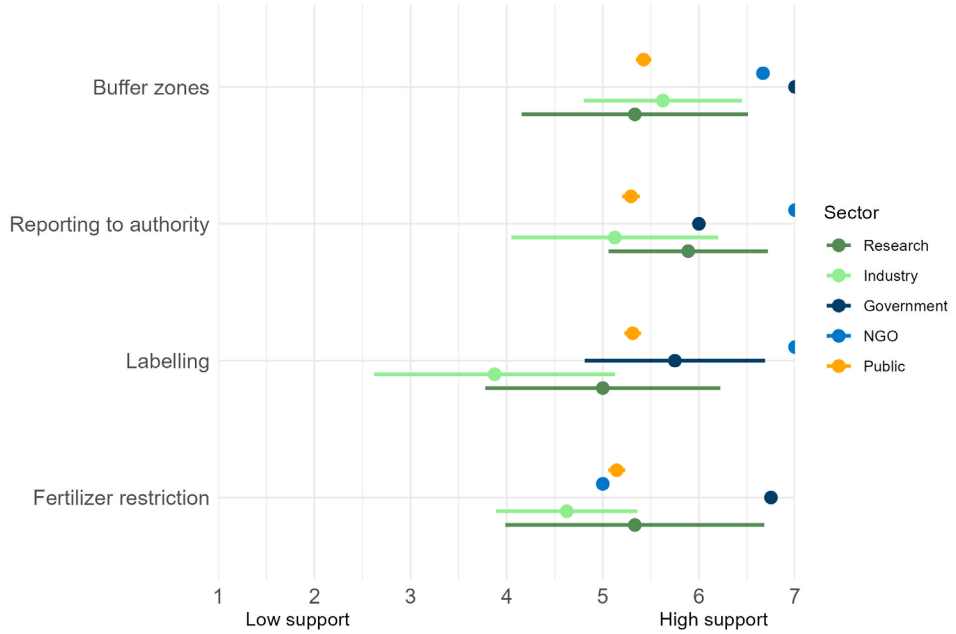


Figure 30 illustrates stakeholder participants' support for different policy measures that would reduce emissions of PFAS into the environment. Across the different stakeholder groups, labelling received the most support, followed by a ban on consumer products and penalties on industry. The least supported policy was the continued use of PFAS in essential products. Notably, stakeholder support was high for all policy measures included.

Figure 31
Stakeholders' support of policies for euthophication

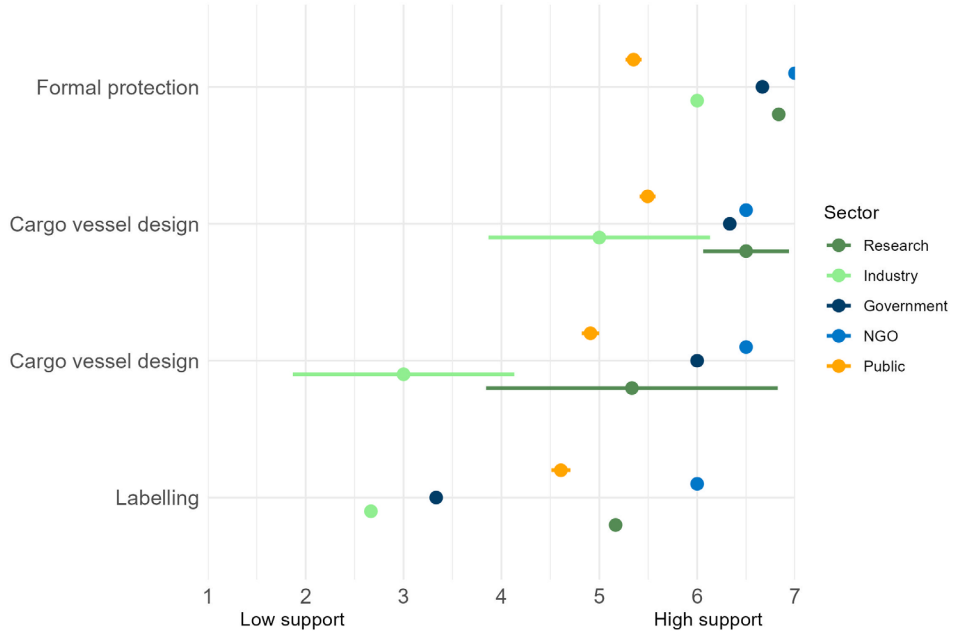


Note. The selected policies described measures to reduce eutrophication as a result of agricultural practices.

Furthermore, Figure 31 illustrates stakeholder participants' support for different policy measures that would reduce eutrophication. Across all groups, the creation of buffer zones received the most support, followed by reporting nutrient emissions to authorities and labelling products that contribute to eutrophication. The least supported policy was the restriction of fertilisers.

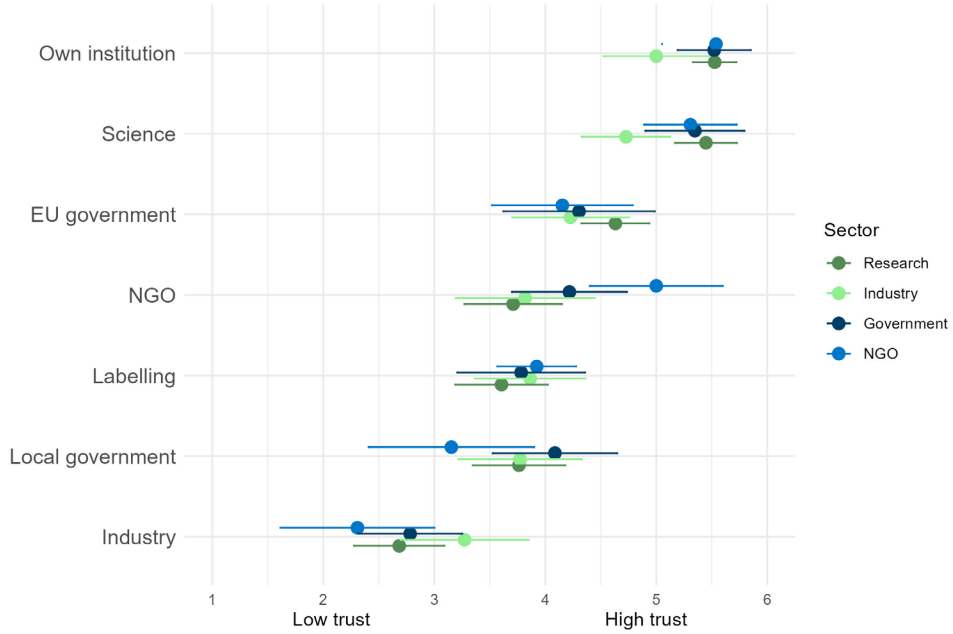
Lastly, Figure 32 (below) illustrates stakeholder participants' support for different policy measures that would reduce underwater noise. Across all groups, formal inclusion of underwater noise in assessments and environmental protection reports received the most support, followed by adaptation of cargo vessel designs and cargo vessel speed limits. The least supported policy was labelling of products that have caused underwater noise.

Figure 32
Stakeholders' support for policies for underwater noise



4.3.3. Trust

Figure 33
Trust in different stakeholder groups



Note: Refer to Figure 17 for an overview of public trust in different stakeholder groups.

Stakeholder participants across governmental organizations, NGOs, industry, and research institutions viewed their respective institutions as the most trustworthy contributors to addressing environmental pollution among the selected options. Then followed trust in science, EU governments, NGOs, and the practice of labelling products to signal sustainability. Notably, NGOs

displayed the highest self-trust but the lowest trust in local authorities compared to other stakeholders. Lastly, industry received the lowest trust ratings from stakeholders, with many stakeholders perceiving their efforts as often greenwashing. These findings must be evaluated critically, as the sample of stakeholder participants was not representative. Furthermore, stakeholder participants rated their respective organisations highly in terms of sustainability agendas, which may have influenced the trust in their own institutions compared to the sector in general.

4.3.4. Qualitative responses: facilitators, barriers, and solutions

Thematic analysis was used to identify commonalities in responses to the open-ended questions regarding environmental pollution. Across all pollutants, there was a significant overlap between the facilitators, barriers, and solutions identified by stakeholders from different groups.

Facilitators:

One facilitator mentioned by participants from all stakeholder groups for all pollutants was a *strong concern for nature,* which is related to a recognition of the importance of environmental protection. Other facilitators included the *urgency of managing environmental pollution*, particularly PFAS (per- and polyfluoroalkyl substances), *concern for human health*, the *presence of financial incentives* that support industries in becoming more environmentally friendly.

Barriers

A *lack of awareness* was mentioned as a significant obstacle, particularly for PFAS and underwater noise. Furthermore, *scientific uncertainty* was mentioned as an important barrier for mitigation efforts, in particular for microplastics and underwater noise. Additionally, stakeholders pointed out a *lack of clarity and urgency* in planning and phase-out strategies for PFAS and eutrophication. An industry representative highlighted this by stating, "*We are also doing our best for this, but we do not know how it is working out NOW. Does it go from bad to sufficient or does it go from sufficient to good? We have no knowledge about this.*"

Other barriers, particularly for microplastics, were identified as *too much freedom for companies*, dealing with *consequences rather than causes*, *poor regulation compliance* and *a lack of (European) legislation*. In addition, a significant barrier was attributed to *industry lobbies* (notably for PFAS and microplastics) and to *financial obstacles* (across all pollutants). For both PFAS and microplastics, the *essentiality and lock-in effect* of these substances were identified as another significant barrier. Lastly, the lack of *viable alternatives* for PFAS were mentioned as an important obstacle.

Solutions

To overcome these barriers, several solutions were proposed by stakeholders. *Raising awareness* and *shaping public opinion* were suggested by all participants of all stakeholder groups and for all pollutants. The importance of *governmental responsibility* in tackling these issues was also frequently mentioned. *Cooperation between stakeholders* was also highlighted as crucial, along with the *adoption of environmentally friendly alternatives* for all pollutants as well as *shrinking the group of essential products* for PFAS. Concrete regulation rules were deemed necessary, with specific pull (optimizing roads or offering subsidies for more silent cargo vessels), and push (e.g. banning substances or boycotting products).

5. Discussion

Taking Part I (the public) and Part II (stakeholders: industry, governments, independent scientists and NGOs) together, the present stakeholder survey results provide a comprehensive overview of perceptions regarding various environmental pollutants (microplastics, PFAS, eutrophication and underwater noise) across different selected European countries. In the following Section, we summarize the main findings as well as provide implications and limitations of the survey results.

Insights from the public survey

The results from the public survey indicate a disparity in perceptions of different pollutants. In general, the awareness, subjective knowledge and risk perception was highest for microplastics, followed by PFAS, eutrophication and underwater noise. Even though the awareness of PFAS was lower than awareness of eutrophication, the risk perception of PFAS was higher than for eutrophication. This may be explained by individuals' tendency to have negative attitudes towards chemical substances in general (Saleh et al., 2019). The perceptions of pollutant characteristics reveal insights into how the public views different pollutants in terms of their usefulness, persistence, toxicity, and others. Conversely, microplastics and PFAS were perceived as highly toxic and persistent, which may influence risk perception judgements. Another factor contributing to risk perception is uncertainty (Slovic & Peters, 2006), which may be illustrated by a high percentage of people who did not know whether or not they had directly been affected by PFAS (46%) and microplastics (43%). Lastly, descriptive analyses revealed variations between countries. Particularly notable was higher public awareness and subjective knowledge of PFAS in Belgium and the Netherlands in comparison to Bulgaria, Greece, and Ireland.

In line with relatively high levels of concern were the reported beliefs, norms, and behavioural intentions of the public sample. Across all countries, pollution was largely attributed to human activities rather than natural processes, indicating widespread recognition of anthropogenic impacts on the environment. Personal norms and behavioural intentions to support pollution reduction were generally positive, with sustainable consumption being the most favoured behavioural intention. Again, there were notable differences between countries, with individuals from Belgium and the Netherlands showing slightly lower pro-environmental behavioural intentions and pro-environmental norms than those from Greece, Ireland, and Bulgaria. This could reflect economic factors, or different levels of already existing environmental policies and educational interventions, but also a cultural difference in the tendency to give socially desirable answers.

The perceived urgency of tackling environmental pollution was relatively high, reflected in the broad support for pro-environmental policies across all countries. However, certain policies were consistently preferred over others. The most support was given to subsidizing pro-environmental

technologies, followed by a ban on exporting waste to low-income countries. The former reflects high techno-optimism (Cologna et al., 2024), while the latter underscores the importance of fairness. Conversely, financial penalties for consumers' non-environmentally friendly behaviours received the least support, indicating potential resistance to policies perceived as restrictive, financially burdensome and potentially exacerbating social inequalities. These findings align with other research showing lower preference for push policies (Grelle & Hofmann, 2023). The question of policy support is closely linked to the trust afforded to various actors involved in pollution mitigation. Generally, individuals seem to trust sustainability labelling the most, followed by the EU governments, local governments, and industry. In general, trust in all these important stakeholders was relatively low.

Insights from the stakeholder survey

The stakeholder survey results provide insight into perceptions and attitudes towards various environmental pollutants from representatives of four different groups: industry, governmental and non-governmental representatives and independent researchers. Based on our data, representatives across all stakeholder groups exhibit significant concern for both health and environmental impacts of pollutants, with environmental concerns generally surpassing health concerns. For microplastics, NGO representatives expressed the highest levels of concern and urgency, contrasting with industry representatives who reported the lowest. PFAS elicited high levels of concern and urgency across all stakeholder groups. Eutrophication concerns varied, with government representatives showing the highest concern, particularly for environmental impacts; however, the urgency for mitigation was moderate across all groups. Lastly, for underwater noise, research, government, and NGO stakeholders showed high environmental concern, but the urgency for mitigation was low, except among NGO representatives.

Policy support varied among stakeholders, with subsidies for environmentally friendly technologies receiving the highest overall support. Government protection and restoration policies were less supported by industry representatives. Similarly, industry and government representatives were less supportive of banning waste exports to low-income countries, a policy suggestion based on a fairness approach, compared to NGOs, researchers, and the public. These preferences indicate a generally higher support for pull policy measures over push policy measures, which has previously been found in public samples (Swim & Geiger, 2021).

Trust levels varied among stakeholders, with each group viewing their own institution as the most trustworthy. This high self-trust may be explained by a generally high reported sustainability agenda in stakeholders' respective institutions. Trust in their own institution was followed by trust in research and trust in the EU government. In contrast, the trust in local governments and industry were the lowest in relative terms.

The analysis of open-ended questions complemented the results from the close-ended questions. The thematic analysis of identified common facilitators, barriers, and solutions across all pollutants and stakeholder groups. Stakeholder groups saw rising awareness and shaping public opinion as a strong facilitator of pollution mitigation. Importantly, scientific uncertainty and complexity of management were named as important barriers that also highlighted the need for clarifying the priorities and regulation processes. There was a sentiment that efforts from industry are not always followed up with clear evaluations and a desire for evidence-based practices. Adoption of environmentally friendly alternatives, concrete regulatory measures, and specific pull and push strategies were also recommended.

Implications

Understanding the perceptions of the general public and other stakeholder groups provides important input for developing zero-pollution frameworks, especially at the EU level. For instance, an important implication of the study was the finding that individuals from different European countries seem to be relatively aligned, especially regarding the measures they support and their concern for health, the environment, and the urgency of mitigation. The observed differences between pollutants indicate the next steps in managing pollution. On the one hand, increased public awareness and education on lesser-known pollutants, such as underwater noise or PFAS in Greece, Bulgaria, and Ireland, through effective communication strategies, are necessary. On the other hand, high concern and public opinion regarding some pollutants, such as microplastics and PFAS, indicate a shared sense of urgency for mitigation and support for measures to address them. Among policies, different stakeholder groups appear to give special support to technological development that may benefit the environment. It is intriguing to see such high expectations for technical and innovative solutions when it has been long established that technical solutions often include side effects and may incur delays in other changes and therefore involve some new risks (Gee & Krayer von Krauss, 2005). Furthermore, the support for governmental protection and restoration of natural areas is highly endorsed among all stakeholder groups, which may be an important indication for the currently discussed EU Nature Restoration Law (Publications Office of the European Union, 2022). Especially among the public, policies focusing on consumers (pull and push) received relatively less support. An important question that comes up is where the funding of subsidies comes from, if push policies (e.g. taxes) receive little endorsement.

Furthermore, labelling is a relatively trusted strategy for signalling environmental friendliness, and it may also be relatively easy to implement and leave room for different choices. However, labelling may not be an effective mitigation strategy for all pollutants; it received relatively high support for microplastics and PFAS but relatively low support for eutrophication and underwater noise.

Importantly, labelling is related to cognitive effort (Herbes et al., 2020) and prioritizes consumers' responsibility above other pro-environmental behaviours (Nielsen et al., 2021).

The task of suggesting and implementing policies falls to decision-makers, and the relatively low trust in EU and local governments may be an important barrier to the implementation of these measures. Similarly, the trust stakeholders place in each other is not high and may impede cooperative efforts to pollution mitigation. Building trust in institutions and industry through transparent and participatory governance (for instance, living lab protocols) could increase cooperation and mutual trust.

Limitations and strengths of the report

An important strength of the report is the large public sample that is representative of age, gender, and region of residence for all involved countries. Significantly, the survey focused on four different pollutants and therefore enabled comparisons between them with respect to awareness, risk perception, subjective knowledge, and personal experience. In addition, the results encompass a large pool of responses about support for different policies and pathways to mitigation of environmental pollution, from general policies and policies tackling specific pollutants to behavioural intentions. This can help policymakers orient themselves when making judgments about the acceptability of pro-environmental policy measures.

Government policy planning and individual perceptions and behaviours go hand in hand; while different policies influence the public's behaviour, the public's views and attitudes can also indicate what kinds of policies are acceptable, perceived as appropriate and fair, and therefore likely to be successful, integrating top-down and bottom-up processes (Pahl et al., 2020). Furthermore, we gathered qualitative and quantitative information from four additional stakeholder groups. This is a hard-to-reach sample, especially for quantitative methodological approaches. However, the gathered data allows for a comparison between different needs and beliefs that stakeholders have and sets a stage for much-needed collaborative approaches and strategies towards zero pollution.

Nonetheless, important limitations must be considered when interpreting the results of the stakeholder survey specifically. The purposive snowball sampling method used for the stakeholder data implies that the sample is not representative of all stakeholder groups. Despite significant efforts to gather the data, the response rates were relatively low, especially for the topics of eutrophication and underwater noise, whereas for microplastics and PFAS, we were able to collect a substantial number of responses. This may reflect the existing network of the SOS-ZEROPOL2030 partners but also the coverage in scientific publications and the media, indicating topicality and broader interest. Additionally, the relatively high reported sustainability agenda of the institutions represented by our stakeholder participants suggests that those who participated were more likely

to have a pro-environmental outlook and/or that the survey was directed to those, for example in industry, who are tasked with the sustainability agenda in a particular company.

5.1. Conclusion

The present work extends our insights in several ways, contributing substantially to the other activities of SOS Zeropol2030:

- First, it is one of the few studies to take a comparative approach between pollutants and associated risks.
- Second, it applies a risk perception approach and framework fundamentally based in the best available scientific literature, carefully considering relevant factors that determine how risk perception by a range of societal groups for the diverse pollutants in the focus of SOS-ZEROPOL2030.
- Third, it applies best practice scientific methods including representative public sampling and statistical power analysis for the public survey.
- Fourth, it offers comparative insights into stakeholder support for a wide range of general and pollutant-specific policies, developed in collaboration with topic experts.
- Fifth, it integrates both quantitative and qualitative methodologies to provide a comprehensive account of risk perception and policy support among different stakeholder groups.

In sum, we present substantial new social science data for the EU public, policy and other stakeholders that will help inform the path to zero pollution in the EU.

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7. Appendixes

Appendix 1: Expert interview protocol

Appendix 2: General public survey

Appendix 3: Invitation letter for stakeholders

Appendix 4: Tables with descriptives

Appendix 5: Stakeholder survey

Appendix 1: Expert interview protocol

Thank very much for agreeing to participate in this interview! This pilot interview study is a part of the SOS-ZEROPOL project, a HORIZON Europe project developing a holistic zero pollution framework to guide the process towards achieving zero pollution in European seas by 2030. I would like to ask you some questions about PFAS/microplastics/nutrients/underwater noise, especially with regards to the risks this pollutant poses for marine environments, the sources of the pollution and strategies for mitigation. I am interested in your expert knowledge and understanding; however, I am not an expert myself. Thus, I'd like to ask you to keep the conversation on the level that is understandable for non-experts. If you agree, I would audio record our meeting, so that I can go back to it later when working on the survey. The interview would not be transcribed, and the file would be anonymized; the audio file will only be shared within the WP2 team.
Question area: Definition
What is microplastics/PFAS/nutrients/underwater noise and how prevalent it is in the seas?
Aim: defining the pollutant and making sure that we are on the same page as to what the topic of the interview is.
Question area: Risk
What are the risks related to this pollutant?
If not mentioned ask specifically about: (a) people's health (b) planetary health (environment, animals) (c) what are the uncertainties regarding those risks
Aim: understanding risks related to people, animals, environment. Understanding what is not yet known about these risks.
Question area: Responsibility
How is the pollutant ending up in the environment?
Ask about: (a) Which stakeholders are polluting? (b) In what ways are they benefiting (e.g. economically)?
Aim: understanding the fairness and accountability pertaining the pollutants, understanding whether group agency/efficacy is important for tackling the pollutants.
Question area: Mitigation
What can be done to reduce the risks?
Ask about: (a) What mitigation strategies are most effective? (b) Which stakeholders are involved in mitigation? (c) In what way can different stakeholders contribute to the solution? (d) What are the costs of those strategies? (e) What can the general public do?
Aim: gaining knowledge about effectiveness of different mitigation strategies and possible drawbacks (costs for people, etc.). Understanding what is in the realm of general population and what is not.

Introduction **Information for participants**
Please read this information carefully before deciding whether or not to participate in the study. If you decide to participate, thank you. If you decide not to participate, thank you for considering participation.

What is the goal of the survey?
With the present study, we would like to better understand how the public in Europe views the issue of environmental pollution, including marine pollution. There are many different environmental pollutants, for example microplastics, PFAS (also referred to as "forever chemicals"), excess of nutrients (eutrophication) and underwater noise. With this survey we would like to investigate whether people perceive them as concerning for health and environment. To complete the survey, no prior knowledge about these pollutants is required on your part.

What do you have to do?
The survey should take about 15 minutes to complete. We are interested in your opinions and views on the topic of environmental and marine pollution; there are no right or wrong answers. We also collect some personal information, such as your age, gender identity, your views and attitudes.

Can you change your mind and withdraw from the survey?
You can cancel the survey at any time by closing your browser window. If at a later date (up to 48 hours after the data collection) you would like your data removed from the study, please contact us with your participant number.

What data or information is collected and how is it used?
All answers you give are anonymous - you cannot be personally identified in any way from the survey data or the analyses. All data will be openly available on research sharing platform, but your identity will remain anonymous. Research papers may be published using this data, but again, your responses will not be identifiable in the research results.

Are there any benefits or risks related to the participation in the survey?
We do not expect any special benefits or risks related to participation in the survey. You may learn something new about different environmental pollutants.

Contact
The survey is being conducted by the researchers from the **University of Vienna** and is a part of a project funded by the European Union entitled **Source to Seas – Zero Pollution 2030**.

If you have any further questions or concerns about this research, please contact us using the details below:

Dr. Nina Vaupotič (study lead): nina.vaupotic@univie.ac.at
Prof. Dr. Sabine Pahl (project lead): sabine.pahl@univie.ac.at

Consent form and acceptance of conditions

Please, confirm the following:
• I am at least 18 years old.
• I can ask for removal of my data up to 48 hours after completing the survey referring to my "participant ID".
• My participation in the survey is completely voluntary.
• I can terminate the survey at any time by closing the browser window.
• I confirm that the context of the survey was explained sufficiently and that I had the opportunity to contact the survey lead at nina.vaupotic@univie.ac.at in case of any questions. • I acknowledge that the results and the data of the project may be published, but my anonymity will be preserved.

If you do not want to participate, please close this window. Thank you for your consideration!

- **I confirm and want to participate** (1)

Values, beliefs and norms			
Variable name	**Variable type**	**Item**	**Response options**
Values: How important is each of the following values as a guiding principle in your life?			
Values: biospheric	Likert	(a) Being one with nature (b) Protecting the environment (c) Preventing environmental pollution	Not important at all (1) – extremely important (7)
Values: altruistic	Likert	(a) Equality (b) Social justice (c) Helping others	Not at all (1) – Very much (7)
Values: egoistic	Likert	(a) Authority (b) Wealth (c) Social power	Not at all (1) – Very much (7)
Belief	Likert	To what extent is environmental pollution caused by natural processes or human activity?	100% natural (1) processes - o 50% natural processes 50% human activity (6) – 100 human activity; I don't know

Personal_norm1	Likert	I feel personal responsibility to help reduce environmental harm and pollution.	Strongly disagree (1) – strongly agree (7)
Personal_norm2	Likert	I feel like I should do more to help reduce environmental harm and pollution.	Strongly disagree (1) – strongly agree (7)

Questions about pollutants

In the following part of the survey, we will ask about your views and feelings about **four different environmental pollutants**: microplastics, PFAS, excess of nutrients (eutrophication) and underwater noise

Randomization: The pollutant blocks were randomized

Microplastics block

Variable name	Type	Short description	Response options
Microplastics: awareness	Categorical	Have you ever heard of microplastics before participating in this survey?	Yes, no, prefer not to say
Microplastics: sub. knowledge	Likert	How much knowledge do you have about the effects of microplastics on the environment and human health?	No knowledge at all (1) – A lot of knowledge (7)
Microplastics are plastic pieces that measure less than five millimetres across. Some microplastics are formed by breaking away from larger plastic items as they fragment over time. Other microplastics are made intentionally for the purpose of consumer products, for example cosmetic microbeads used in facial scrubs.			
Microplastics: affect	Likert	I see microplastics in the environment as something that is: Overall, I feel that microplastics in the environment are something that is: To me, microplastics in the environment are something that is:	… very pleasant (1) – very unpleasant (7) … very positive – very negative …very favourable (1) – very unfavourable
Microplastics: experience	Likert	Have you ever been directly affected by microplastics in your everyday life (e.g., health issues, restrictions)?	Never (1) Once (2) Twice (3) More than three times (4) I don't know (5)
Risk perception			

Microplastics: urgency	Likert	In the context of all the pressing issues society is facing (social, economic, environmental), how urgent is it to tackle microplastics pollution?	Not urgent at all (1) - Very urgent (7); I don't know
Microplastics: health	Likert	How concerned are you personally about the effect of microplastics on people's health? (on the economy) Effects of microplastics on the economy of Europe?	Not concerned at all (1) – very concerned (7); "I don't know"
Microplastics: environment	Likert	How concerned are you personally about the effect of microplastics on the environment (nature, animals)?	Not concerned at all (1) – very concerned (7); "I don't know"

PFAS block

Variable name	Type	Short description	Response options
PFAS: awareness	Categorical	Have you ever heard of PFAS before participating in this survey?	Yes, no, prefer not to say
PFAS: sub. knowledge	Likert	How much knowledge do you have about the effects of PFAS on the environment and human health?	No knowledge at all (1) – A lot of knowledge (7)
PFAS stands for "per- and polyfluoroalkyl substances," also referred to as "forever chemicals". These chemicals are notable for their resistance to heat, water, and oil, which has led to their use in a wide range of industrial and consumer products such as non-stick cookware (Teflon), water-resistant clothing, hygiene products, food packaging, and more.			
PFAS: affect	Likert	I see PFAS in the environment as something that is: Overall, I feel that PFAS in the environment are something that is: To me, PFAS in the environment are something that is:	… very pleasant (1) – very unpleasant (7) … very positive – very negative …very favourable (1) – very unfavourable
PFAS: experience	Likert	Have you ever been directly affected by PFAS in your everyday life (e.g., health issues, restrictions)?	Never (1) Once (2) Twice (3) More than three times (4) I don't know (5)
Risk perception			
PFAS: urgency	Likert	In the context of all the pressing issues society is facing (social, economic, environmental), how urgent is it to tackle PFAS pollution?	Not urgent at all (1) - Very urgent (7); I don't know

PFAS: health	Likert	How concerned are you personally about the effect of PFAS on people's health?	Not concerned at all (1) – very concerned (7); "I don't know"
PFAS: environment	Likert	How concerned are you personally about the effect of PFAS on the environment (nature, animals)?	Not concerned at all (1) – very concerned (7); "I don't know"

Eutrophciation block

Variable name	Type	Short description	Response options
Excess nutrients (eutrophication): awareness	Categorical	Have you ever heard of excess nutrients (eutrophication) before participating in this survey?	Yes, no, prefer not to say
Excess nutrients (eutrophication): sub. Knowledge	Likert	How much knowledge do you have about the effects of excess nutrients (eutrophication) on the environment and human health?	No knowledge at all (1) – a lot of knowledge (7)
Excess nutrients (eutrophication) is a process that involves an excessive accumulation of nutrients such as nitrogen and phosphorus, in lakes, rivers, or coastal areas. These excessive nutrients can enter into the environment through agriculture or wastewater management. The nutrient enrichment can lead to an overgrowth of algae and other aquatic plants.			
Excess nutrients (eutrophication): affect	Likert	I see excess nutrients (eutrophication) in the environment as something that is: Overall, I feel that excess nutrients (eutrophication) in the environment are something that is: To me, excess nutrients (eutrophication) in the environment are something that is:	… very pleasant (1) – very unpleasant (7) … very positive – very negative …very favourable (1) – very unfavourable
Excess nutrients (eutrophication): experience	Likert	Have you ever been directly affected by excess nutrients (eutrophication) in your everyday life (e.g., health issues, restrictions)?	Never (1) Once (2) Twice (3) More than three times (4) I don't know (5)
Risk perception			
Excess nutrients (eutrophication): urgency	Likert	In the context of all the pressing issues society is facing (social, economic, environmental), how urgent is it to tackle excess nutrients (eutrophication) pollution?	Not urgent at all (1) - Very urgent (7); i don't know
Excess nutrients (eutrophication): health	Likert	How concerned are you personally about the effect of excess nutrients (eutrophication) on people's health?	Not concerned at all (1) – very concerned (7); "i don't know"

Excess nutrients (eutrophication): environment	Likert	How concerned are you personally about the effect of excess nutrients (eutrophication) on the environment (nature, animals)?	Not concerned at all (1) – very concerned (7); "I don't know"

Underwater noise block

Variable name	Type	Short description	Response options
Underwater noise: awareness	Categorical	Have you ever heard of underwater noise before participating in this survey?	Yes, no, prefer not to say
Underwater noise: sub. Knowledge	Likert	How much knowledge do you have about the effects of underwater noise on the environment and human health?	No knowledge at all (1) – a lot of knowledge (7)
Underwater noise refers to human-made sounds that are generated and propagated underwater. These sounds can come from various human-made sources (shipping, military sonar, pile driving, construction activities) and can interfere with natural sounds of animals in the ocean.			
Underwater noise: affect	Likert	I see underwater noise in the environment as something that is: Overall, I feel that underwater noise in the environment are something that is: To me, underwater noise in the environment are something that is:	… very pleasant (1) – very unpleasant (7) … very positive – very negative …very favourable (1) – very unfavourable
Underwater noise: experience	Likert	Have you ever been directly affected by underwater noise in your everyday life (e.g., health issues, restrictions)?	Never (1) Once (2) Twice (3) More than three times (4) I don't know (5)
Risk perception			
Underwater noise: urgency	Likert	In the context of all the pressing issues society is facing (social, economic, environmental), how urgent is it to tackle underwater noise pollution?	Not urgent at all (1) - Very urgent (7); I don't know
Underwater noise: health	Likert	How concerned are you personally about the effect of underwater noise on people's health?	Not concerned at all (1) – very concerned (7); "I don't know"
Underwater noise: environment	Likert	How concerned are you personally about the effect of underwater noise on the environment (nature, animals)?	Not concerned at all (1) – very concerned (7); "I don't know"

Mitigation strategies: policies for industries, consumers, governmental protection programs and individual action			
In the next part of the survey, we provide some examples of measures that can be implemented to counter environmental pollution. We would like to know to what extent you agree or disagree with these measures. Please note that these measures could also have additional effects (e.g., less comfort, higher costs, protected natural areas would not be used for other purposes such as industry or housing).			
Variable name	**Variable type**	**Item**	**Response options**
Measures can be directed at industries. For instance, governments can give subsidies or tax incentives to help industries transition to eco-friendly practices. Governments can also penalize and monitor industries when they manufacture materials contributing environmental pollution.			
Policy1_industry_pull	Likert	Subsidies and tax incentives for industries should be implemented to counter environmental pollution.	Strongly disagree (1) – strongly agree (7)
Policy2_industry_pull	Likert	Penalties and monitoring for industries should be implemented to counter environmental pollution.	Strongly disagree (1) – strongly agree (7)
Other measures can be directed at consumers. For instance, consumers can be informed about the impact of products they are buying (e.g., through labels). Consumers can also be requested to pay an environmental tax for products that contribute to environmental pollution (e.g., single-use plastic bags).			
Policy3_consumer_push	Likert	A certification system that labels products as "environment-friendly" should be established to inform consumers about their environmental impact.	Strongly disagree (1) – strongly agree (7)
Policy4_consumer_push	Likert	A certification system that labels products as "environment-friendly" should be established to inform consumers about their environmental impact.	Strongly disagree (1) – strongly agree (7)
Lastly, governmental and non-governmental action plans can also be implemented to help reduce environmental pollution.			
Policy5_govern_restore	Likert	The restoration of coastal habitats (e.g., salt marshes, seagrass beds), which act as natural carbon sinks and help mitigate pollution should be supported by the EU government.	Strongly disagree (1) – strongly agree (7)
Policy6_govern_protect	Likert	Stronger restrictions to protect endangered and threatened plant and animal species from habitat destruction should be implemented.	Strongly disagree (1) – strongly agree (7)
Policy7_govern_fair	Likert	Countries should not be allowed to export their waste to other countries (e.g., typically richer countries export some of their waste to less rich countries that may not have the	Strongly disagree (1) – strongly agree (7)

		means of dealing with the waste in an environmentally friendly manner).	
Policy8_govern_tech	Likert	Governments should support research and innovation in developing sustainable technologies and materials for the future.	Strongly disagree (1) – strongly agree (7)
Individual action			
Individual_behavior_pol	Likert	I intend to vote for parties with a strong environmental agenda.	Strongly disagree (1) – strongly agree (7)
Individual_behavior	Likert	I intend to pay more attention to my own consumer behaviour (e.g., avoiding plastics).	Strongly disagree (1) – strongly agree (7)
Individual_behavior_pol	Likert	I intend to support/sign petitions with an environmental agenda.	Strongly disagree (1) – strongly agree (7)

Variable name	**Variable type**	**Item**	**Response options**
Trust_governments	Likert	I trust the EU government to lead an effective marine pollution mitigation strategy.	Strongly disagree (1) – strongly agree (6)
Trust_governments_local	Likert	I trust the local government to lead an effective marine pollution mitigation strategy.	Strongly disagree (1) – strongly agree (6)
Trust_industries	Likert	When I come across labels on products indicating sustainable production, I trust their authenticity.	Strongly disagree (1) – strongly agree (6)
Trust_industries_green	Likert	I think that industry efforts are often "greenwashing".	Strongly disagree (1) – strongly agree (6)

Variable name	**Type**	**Item**	**Response options**
Techno_optimism1	Likert	Technological advancements will solve future problems.	Strongly disagree (1) – strongly agree (7)
Techno_optimism2	Likert	Risks connected to new technologies should be seen as temporary problems that will be solved later.	Strongly disagree (1) – strongly agree (7)
Techno_optimism3	Likert	Science and technology will make our lives easier.	Strongly disagree (1) – strongly agree (7)
Techno_optimism4	Likert	Future innovation will ensure that we adapt to changes and overcome environmental issues.	Strongly disagree (1) – strongly agree (7)

Systems thinking (randomized items)			
Variable name		**Item**	**Response options**

System_thinking1	Likert	When I have to decide in my life, I tend to see all kinds of possible consequences to each choice.	Strongly disagree (1) – strongly agree (7)
System_thinking2	Likert	Social problems, environmental problems, and economic problems are all separate issues. (R)	Strongly disagree (1) – strongly agree (7)
System_thinking3	Likert	I like to know how events or information fit into the big picture.	Strongly disagree (1) – strongly agree (7)
System_thinking4	Likert	Only very large events can significantly change big systems like economies or ecosystems. (R)	Strongly disagree (1) – strongly agree (7)
System_thinking5	Likert	All the Earth's systems, from the climate to the economy, are interconnected.	Strongly disagree (1) – strongly agree (7)
System_thinking6	Likert	Everything is constantly changing.	Strongly disagree (1) – strongly agree (7)
System_thinking7	Likert	Ultimately, we can break all problems down to what is simply right and wrong. (R)	Strongly disagree (1) – strongly agree (7)
System_thinking8	Likert	The Earth, including all its inhabitants, is a living system.	Strongly disagree (1) – strongly agree (7)
System_thinking9	Likert	Rules and laws should not change a lot over time. (R)	Strongly disagree (1) – strongly agree (7)
System_thinking10	Likert	If I make plans and control my behavior, I can accurately predict how my life will unfold. (R)	Strongly disagree (1) – strongly agree (7)
System_thinking11	Likert	Seemingly small choices we make today can ultimately have major consequences.	Strongly disagree (1) – strongly agree (7)
System_thinking12	Likert	My health has nothing to do with what is happening in the world. (R)	Strongly disagree (1) – strongly agree (7)
System_thinking13	Likert	It is possible for a community to organize into a new form that was not planned or designed by an authority or government.	Strongly disagree (1) – strongly agree (7)

In the last part of the survey, we would like to ask you to focus on one of the four environmental pollutants. First, please share your views on the presented pollutant. Second, carefully read the text describing one of the sources and the issues related to a specific pollutant. Lastly, please share the extent to which you agree or disagree with different measures.

Instruction: Randomize the order of blocks between participants

Microplastics			
Variable name	**Variable type**	**Item**	**Response options**
Plastics _characteristics	Likert	When you think about microplastics, to what extent do you see it as:	Not at all (1) – very much (7); I don't know

		(a) Useful (b) Toxic (c) Durable (d) Mobile (e) Natural (f) Disgusting	
Mitigation strategies: policies for industries, consumers, governmental protection programs			
Tyre wear is a significant but often overlooked source of microplastics pollution. As vehicles travel on roads, tyres gradually wear down due to friction with the road, releasing 'tyre wear particles (TWP)' in the process. These TWP microplastics find their way into our oceans, rivers, and even the air we breathe. They contaminate soil and contain toxic chemicals that are hazardous to both humans and the environment. To what extent do you agree or disagree with the following measures? Please note that these measures could have additional effects (e.g., higher costs, change in driving comfort, tyre performance).			
Variable name	**Variable type**	**Item**	**Response options**
Plastics_policy1_push	Likert	The release of tyre wear particles increases with the weight of the car; therefore, individuals buying larger cars should be subject to an additional environmental tax.	Strongly disagree (1) – strongly agree (7)
Plastics_policy2_push	Likert	The release of tyre wear particles increases with the weight of the car; therefore, individuals buying larger cars should be subject to an additional environmental tax.	Strongly disagree (1) – strongly agree (7)
Plastics_policy3_pull	Likert	Car tyres should be labeled according to their eco-friendliness to help consumers make environmentally conscious decisions.	Strongly disagree (1) – strongly agree (7)
Plastics_policy4_pull	Likert	Manufacturers should be incentivized to remove and replace the most toxic additive chemicals used in car tyres.	Strongly disagree (1) – strongly agree (7)
Plastics_policy5_pull	Likert	Governments should increase funding for accessible public transport to indirectly reduce tyre wear.	Strongly disagree (1) – strongly agree (7)

PFAS or “forever chemicals”			
Variable name	**Variable type**	**Item**	**Response options**
PFAS _characteristics	Likert	When you think about PFAS or “forever chemicals”, to what extent do you see it as: (a) Useful (b) Toxic (c) Durable (d) Mobile (e) Natural (f) Disgusting	Not at all (1) – very much (7)

Mitigation strategies: policies for industries, consumers, governmental protection programs			
PFAS or “forever chemicals” are used in a variety of different products (non-stick cookware, water resistant clothing, hygiene products, etc.). The issue with PFAS chemicals is that they do not break down easily and can accumulate in natural environments as well as in humans and animals. High levels of PFAS in human bodies are related to numerous health issues. PFAS pollution demands both immediate actions to mitigate ongoing contamination and long-term strategies to prevent further environmental and health risks. To what extent do you agree or disagree with the following measures? Please note that these measures could have additional effects (e.g., higher costs, change in product performance).			
Variable name	**Variable type**	**Item**	**Response options**
PFAS_policy1_push	Likert	Governments should hold industries accountable for the responsible production, use, and disposal of PFAS chemicals through penalties.	Strongly disagree (1) – strongly agree (7)
PFAS_policy2_pull	Likert	User items (clothing, wax for cars and skis, post-it papers) should be labeled for containing PFAS.	Strongly disagree (1) – strongly agree (7)
PFAS_policy3_push	Likert	Manufacturing of PFAS for the purpose of consumer goods should be banned in the EU.	Strongly disagree (1) – strongly agree (7)
PFAS_policy4_pull	Likert	Manufacturing of PFAS for the purpose of essential products (e.g., medical equipment) should continue to be allowed in the EU.	Strongly disagree (1) – strongly agree (7)

Eutrophication			
Variable name	**Variable type**	**Item**	**Response options**
nutrient_characteristics	Likert	When you think eutrophication of surface waters (i.e., algae overgrowth), to what extent do you see it as: (a) Useful (b) Toxic (c) Durable/persistent (d) Mobile (e) Natural (f) Disgusting	Not at all (1) – very much (7); I don't know

Mitigation strategies: policies for industries, consumers, governmental protection programs

Agriculture plays a significant role in excess of nutrients (eutrophication) as it often involves the use of fertilizers containing nitrogen and phosphorus. Overflow from agricultural fields can carry these nutrients into nearby waters and causes algal bloom. This process can harm water quality and habitats, increase bacterial growth, and decrease oxygen that fish need to survive. Sustainable agricultural practices and responsible nutrient management are essential to reduce these negative impacts.

To what extent do you agree or disagree with the following measures? Please note that some of these measures could lead to higher costs and more effort.

Variable name	Variable type	Item	Response options
Nutrient_policy1_push	Likert	The use of fertilizers on farms, lawns, and golf courses should be restricted.	Strongly disagree (1) – strongly agree (7)
Nutrient_policy2_pull	Likert	Agricultural products should be labeled to help consumers make informed choices about their impact on excess of nutrients (eutrophication).	Strongly disagree (1) – strongly agree (7)
Nutrient_policy3_pull	Likert	Farmers should be required to report to the regularity authorities how they use the nutrients and if any flow off their land.	Strongly disagree (1) – strongly agree (7)
Nutrient_policy4_push	Likert	Strips of land that reduce the movement of nutrients into streams and rivers should be used as buffers to protect the environment	Strongly disagree (1) – strongly agree (7)

Underwater noise			
Variable name	**Variable type**	**Item**	**Response options**
noise_characteristics	Likert	When you think about underwater noise, to what extent do you see it as: (a) Useful (b) Toxic (c) Persistent (d) Mobile (e) Natural (f) Disgusting	Not at all (1) – very much (7); I don't know

Mitigation strategies: policies for industries, consumers, governmental protection programs			
Underwater noise pollution arises from human activities, amongst which are water transport and shipping. Underwater noise interferes with the communication, navigation, and behavior of marine species, particularly marine mammals like whales and dolphins. Prolonged exposure to underwater noise can lead to stress, hearing damage, and habitat displacement, threatening marine biodiversity and environment. To what extent do you agree or disagree with the following measures from the transport sector? Please note that some of these measures could lead to higher costs of goods and transport.			
Variable name	**Variable type**	**Item**	**Response options**
Noise_policy1_push	Likert	Cargo vessels should be required to use measures (e.g., low-noise propellers or innovative hull designs) that enable quieter transport.	Strongly disagree (1) – strongly agree (7)
Noise_policy2_push	Likert	Cargo vessels should be required to slow down to enable quieter transport.	Strongly disagree (1) – strongly agree (7)
Noise_policy3_push	Likert	Products should come with labels that tell consumers whether the way they were transported might have disturbed animals that are sensitive to noise.	Strongly disagree (1) – strongly agree (7)
Noise_policy4_push	Likert	Impact of noise should be included in assessments and protection of important or sensitive marine environments.	Strongly disagree (1) – strongly agree (7)

Variable name	**Variable type**	**Short description / item**	**Response options**	**Reference**
Country	Categorical	Please select your country of residence.	Netherlands, Germany, Greece, Bulgaria, Ireland	
Region	Categorical	Please select your region of residence	Vary by country (NUTS2)	
Gender	Categorical	Please select your gender identity.	Woman, man, transgender, non-binary, other, prefer not to say	

Age	Numeric	Please enter your age.	18 and higher
Education	Categorical (ordered)	What is your highest education level?	o Primary school (1) o Middle school (2) o High school or secondary school (vocational, general) (3) o First level higher education (bachelor's degree, applied university degree) (4) o Second level higher education (master's degree) (5) o PhD or doctoral degree (6) o Other (7) o None (8) o Prefer not to answer (9)
Political ideology	Categorical	In political views, people often refer to "left" and "right." Imagine a scale from 1 to 10, where 1 represents the farthest left option and 10 represents the farthest right option. Where would you place your political views on such a scale? 1 = Left, 10 = Right; I prefer not to answer.	Left (1) – Right (10)
Financial scarcity	Likert	I am content with my financial situation. I have to save up to make ends meet. I get by well with my income (rev).	

Debriefing

Thank you for participating in this survey!

If you want to finish the survey, please go to the next page. If you want to learn more about our research questions and the topic of environmental pollution, please read on.

Environmental contamination and pollution occur as a direct result of human activities on both land and in the marine environment. Instances of environmental pollution require urgent attention as healthy and clean nature and seas provide numerous ecosystem services (e.g. food, oxygen production, climate regulation), which are critical for our survival and well-being. The purpose of this study is to better understand human perceptions of microplastics, PFAS, excess of nutrients (eutrophication), and underwater noise. Our focus is on risk perception for human health and the environment. Moreover, we aim to explore the types of measures that receive public support, and to understand how other factors (values, trust in institutions, and optimism about future technological developments) can illuminate the relationship between risk perception and support for measures.

If you would like to learn more about the Source to Seas – Zero Pollution 2030 project, please visit our web page: https://soszeropol2030.eu/

Furthermore, if you would like to learn more about the four pollutants, you can visit the following pages:
- Microplastics: https://oceanservice.noaa.gov/facts/microplastics.html and https://www.nhm.ac.uk/discover/what-are-microplastics.html
- PFAS: https://www.oecd.org/chemicalsafety/portal-perfluorinated-chemicals/
- Eutrophication (Excess of nutrients): https://education.nationalgeographic.org/resource/dead-zone/ and https://www.unwater.org/news/water-pollution-agriculture-global-review
- Underwater noise: https://clearseas.org/en/underwater-noise/

If you have any questions about this research, please contact:
the study lead Dr. Nina Vaupotič (nina.vaupotic@univie.ac.at)
the project lead Prof. Dr. Sabine Pahl (sabine.pahl@univie.ac.at)
We would like to thank you once again for your valuable contribution to this study. Your participation is greatly appreciated!

Appendix 3: Invitation letter for stakeholders (example microplastics)

Perception of (micro)plastics among interest groups

Dear Sir/Madam,

We are kindly inviting you to participate in our survey about different environmental concerns, in particular regarding **microplastics or plastics**. The research is a part of a project funded by the European Commission's Horizon Europe programme entitled "Source to Seas - Zero Pollution 2030".

In winter 2023, we surveyed the general population of Belgium, Bulgaria, Greece, Ireland, and the Netherlands about different environmental concerns. Now, we are interested in perspectives from **interest groups**, including representatives of **industry** (production, distribution, supply, retail), **governmental** and **non-governmental** organizations, and **independent research institutions.** If your work or organisation involves dealing with **microplastics or plastics**, we would greatly appreciate your input in this survey.

Our aim is to have a **fair representation** across representatives from various organisations and to gain perspectives into **barriers** and **opportunities** experienced by different groups. Your **ideas** are immensely valuable and will be fed back to decisionmakers in Europe to help develop and implement diverse policies and measures.

We have taken special care in designing a **short survey** that should take no more than **10 minutes** to complete. The summarized outcomes of interest groups will be published in scientific reports; therefore, your personal identity will remain fully **anonymous**. Please note that you can fill out the survey in Bulgarian, Dutch, English, Flemish, French, Greek.

Please follow this link to access the survey and additional information: https://univiepsy.qualtrics.com/jfe/form/SV_czIDkNt10dYK6cC

You can change the **language** in the upper right corner of the survey.

We would be very grateful if you could forward this invitation to other relevant individuals who may be interested in filling out our survey.

Please do not hesitate to reach out to our team in case of questions or comments!

Warm regards,

Dr. Nina Vaupotič (study lead): nina.vaupotic@univie.ac.at
Prof. Dr. Sabine Pahl (project lead): sabine.pahl@univie.ac.at

Led by the Environmental Psychology Group, University of Vienna: https://env-psy.univie.ac.at/
Supported by SOS-ZEROPOL2030: https://soszeropol2030.eu/#

Appendix 4: Tables with descriptives

Public survey results

Knowledge, Health Concern and Environmental concern Public Survey

Pollutant	Country (N)	Knowlegde		Health_concern		Envir: concern	
		M	SD	M	SD	M	SD
Microplastics							
	Belgium (*N* = 952)	3.7	1.6	5.3	1.7	5.6	1.5
	Bulgaria (*N* = 821)	3.6	1.7	5.5	1.5	5.8	1.4
	Greece (*N* = 792)	3.5	1.8	5.5	1.6	5.8	1.5
	Ireland (*N* = 793)	3.8	1.7	5.5	1.6	5.9	1.4
	The Netherlands (*N*= 1027)	3.6	1.5	5.2	1.6	5.6	1.5
PFAS							
	Belgium (*N* = 952)	3.2	1.7	5.3	1.7	5.5	1.6
	Bulgaria (*N* = 821)	2.3	1.6	5.3	1.6	5.6	1.5
	Greece (*N* = 792)	2.3	1.6	5.5	1.6	5.7	1.5
	Ireland (*N* = 793)	2.3	1.6	5.2	1.8	5.6	1.6
	The Netherlands (*N*= 1027)	3.1	1.6	5.2	1.7	5.5	1.6
Eutrophication							
	Belgium (*N* = 952)	2.7	1.7	4.9	1.8	5.1	1.7
	Bulgaria (*N* = 821)	2.9	1.7	5.0	1.7	5.3	1.6
	Greece (*N* = 792)	2.4	1.7	4.9	1.8	5.1	1.7
	Ireland (*N* = 793)	2.9	1.8	5.2	1.7	5.6	1.6
	The Netherlands (*N*= 1027)	2.4	1.5	4.7	1.8	5.1	1.7
Underwater noise							
	Belgium (*N* = 952)	2.3	1.6	4.1	2.0	5.0	1.8
	Bulgaria (*N* = 821)	2.2	1.7	4.3	1.9	5.1	1.7
	Greece (*N* = 792)	2.1	1.5	4.4	2.1	5.2	1.7
	Ireland (*N* = 793)	2.1	1.5	4.1	2.2	5.4	1.7
	The Netherlands (*N*= 1027)	2.0	1.4	3.7	2.1	5.0	1.7

Beliefs and Norms Descriptives Public Survey

Country (*N*)	Belief		Norms		Beh1Consumption		Beh2Voting		Beh3Petitions	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Belgium (*N* = 952)	6.5	2.0	4.7	1.3	4.3	1.8	5.2	1.5	4.2	1.8
Bulgaria (*N* = 821)	6.9	1.9	5.3	1.3	4.8	1.6	5.7	1.4	5.3	1.7
Greece (*N* = 792)	7.1	1.8	5.2	1.4	5.0	1.5	5.7	1.4	5.0	1.6
Ireland (*N* = 793)	6.8	1.9	5.1	1.4	4.8	1.7	5.5	1.5	4.9	1.7
The Netherlands (*N*= 1027)	6.7	1.8	4.5	1.3	4.2	1.8	5.0	1.5	4.1	1.9

Policy Acceptance Public Survey

Country (*N*)	Ind: pull		Ind: push		Cons: pull		Cons: push		Restoration		Protection		Gov: waste		Gov: tech	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Belgium (*N* = 952)	4.9	1.6	5.5	1.5	5.3	1.5	4.3	1.9	5.4	1.5	5.5	1.5	5.6	1.5	5.6	1.4
Bulgaria (*N* = 821)	5.3	1.7	5.9	1.4	5.6	1.6	4.6	2.0	5.9	1.4	6.0	1.4	5.9	1.6	6.1	1.3
Greece (*N* = 792)	5.3	1.7	6.0	1.4	5.8	1.4	4.6	2.0	5.8	1.4	5.9	1.4	5.9	1.5	6.0	1.4
Ireland (*N* = 793)	5.2	1.6	5.8	1.5	5.8	1.4	4.7	1.9	6.0	1.4	6.0	1.4	5.8	1.5	6.1	1.3
The Netherlands (*N*= 1027)	4.8	1.6	5.5	1.4	5.2	1.6	4.1	1.9	5.4	1.4	5.3	1.5	5.6	1.5	5.6	1.3

Microplastics Specific Policies Public Survey

Country (*N*)	Large car tax		Smoother roads		Labelling		Chemical removal		Public transport	
	M	SD	M	SD	M	SD	M	SD	M	SD
Belgium (*N* = 234)	4.6	1.7	5.2	1.6	5.1	1.6	5.6	1.5	5.1	1.7
Bulgaria (*N* = 209)	5.1	1.7	5.6	1.6	5.7	1.4	6.0	1.3	5.8	1.3
Greece (*N* = 196)	4.7	1.8	5.7	1.5	5.8	1.2	5.9	1.4	5.9	1.3
Ireland (*N* = 196)	4.8	1.8	5.5	1.6	5.7	1.4	6.2	1.1	5.9	1.3
The Netherlands (*N*= 256)	4.8	1.7	4.7	1.6	5.2	1.6	5.9	1.3	5.4	1.5

PFAS Specific Policies Public Survey

Country (*N*)	Industry penalties		Labelling		Consumer products ban		Essential production allowed	
	M	SD	M	SD	M	SD	M	SD
Belgium (*N* = 237)	5.4	1.4	5.5	1.4	5.0	1.7	4.3	1.6
Bulgaria (*N* = 199)	5.8	1.5	5.8	1.5	4.6	1.7	4.7	1.8
Greece (*N* = 205)	5.9	1.4	6.0	1.4	5.2	1.7	4.4	1.7
Ireland (*N* = 197)	5.9	1.4	6.0	1.3	5.2	1.6	5.0	1.6
The Netherlands (*N*= 256)	5.7	1.4	5.7	1.4	5.0	1.8	4.8	1.7

Eutrophication Specific Policies Public Survey

Country (*N*)	Fertilizer restriction		Labelling		Reporting to authority		Buffer zones	
	M	SD	M	SD	M	SD	M	SD
Belgium (*N* = 238)	5.0	1.5	5.1	1.5	5.0	1.6	5.3	1.4
Bulgaria (*N* = 218)	5.3	1.7	5.6	1.4	5.7	1.6	5.6	1.5
Greece (*N* = 190)	5.4	1.5	5.6	1.6	5.5	1.6	5.5	1.5
Ireland (*N* = 194)	5.3	1.5	5.6	1.6	5.7	1.5	5.7	1.4
The Netherlands (*N*= 272)	4.9	1.6	4.8	1.6	4.8	1.7	5.2	1.4

Underwater noise Specific Policies Public Survey

Country (*N*)	Cargo vessel design		Cargo vessel speed		Labelling		Formal protection	
	M	SD	M	SD	M	SD	M	SD
Belgium (*N* = 243)	5.5	1.4	5.1	1.6	4.6	1.8	5.4	1.4
Bulgaria (*N* = 195)	5.5	1.5	4.8	1.6	4.6	1.8	5.3	1.5
Greece (*N* = 199)	5.7	1.4	5.1	1.5	4.9	1.6	5.4	1.3
Ireland (*N* = 198)	5.8	1.4	5.3	1.6	4.8	1.6	5.5	1.5
The Netherlands (*N*= 243)	5.2	1.4	4.4	1.6	4.2	1.8	5.2	1.4

Trust in institutions/tools

Country (*N*)	EU government		Local government		Labelling		Industry (reversed)	
	M	SD	M	SD	M	SD	M	SD
Belgium (*N* = 1084)	3.3	1.4	3.3	1.4	3.7	1.2	4.2	1.2
Bulgaria (*N* = 902)	3.4	1.4	2.8	1.4	3.5	1.3	4.4	1.3
Greece (*N* = 891)	3.3	1.4	2.9	1.4	3.7	1.2	4.4	1.2
Ireland (*N* = 897)	3.4	1.4	3.1	1.4	3.6	1.1	4.6	1.2
The Netherlands (*N*= 1112)	3.3	1.4	3.3	1.3	3.4	1.1	4.2	1.1

Stakeholder survey results

Knowledge, Health Concern and Environmental concern Stakeholder Survey

Pollutant	Country (N)	Knowlegde		Health_concern		Envir: concern	
		M	SD	M	SD	M	SD
Microplastics							
	Government (*N* = 13)	5.1	1.7	5.8	0.9	6.2	0.8
	Industry (*N* = 9)	4.0	2.1	5.4	2.1	5.3	1.9
	NGO (*N* = 6)	5.7	1.4	6.8	0.4	6.8	0.4
	Research institute (*N* = 21)	5.9	1.3	5.2	1.8	5.7	1.5
PFAS							
	Government (*N* = 14)	6.0	1.5	6.4	1.0	6.7	0.6
	Industry (*N* = 7)	5.6	1.1	5.7	1.1	6.1	0.9

NGO (*N* = 6)	4.5	1.4	6.7	0.5	6.3	0.8
Research institute (*N* = 17)	5.6	1.7	5.2	1.8	6.0	1.7
Eutrophication						
Government (*N* = 4)	6.8	0.5	4.8	1.9	7.0	0.0
Industry (*N* = 8)	4.9	1.7	4.8	1.5	5.0	1.2
NGO (*N* = 3)	5.7	1.5	6.0	1.0	6.3	1.2
Research institute (*N* = 9)	6.9	0.3	5.7	1.7	6.7	0.7
Underwater noise						
Government (*N* = 3)	6.7	0.6	1.7	1.2	6.7	0.6
Industry (*N* = 3)	4.7	2.5	2.3	1.5	4.0	2.0
NGO (*N* = 2)	6.5	0.7	7.0	0.0	7.0	0.0
Research institute (*N* = 6)	6.8	0.4	5.0	3.1	6.8	0.4

Policy Acceptance Stakeholder Survey

Sector (*N*)	Ind: pull		Ind: push		Cons: pull		Cons: push		Restoration		Protection		Gov: waste		Gov: tech	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Government (*N* =23)	5.3	1.8	6.0	1.0	5.7	1.1	4.9	2.0	6.0	0.9	6.4	0.6	5.3	1.8	6.4	1.0
Industry (*N* = 22)	4.6	1.7	5.3	1.4	4.6	2.1	4.6	1.7	5.4	1.4	5.1	1.4	5.1	1.9	6.0	1.4
NGO (*N* = 13)	4.8	1.6	6.5	1.0	5.7	1.8	5.6	1.9	6.8	0.6	6.6	0.8	6.5	1.4	6.9	0.4
Research institute (*N* = 38)	5.4	1.9	6.2	1.0	5.6	1.4	5.2	1.8	6.2	1.0	6.4	0.8	6.0	1.7	6.8	0.8

Microplastics Specific Policies Stakeholder Survey

Sector (*N*)	Large car tax		Smoother roads		Labelling		Chemical removal		Public transport	
	M	SD	M	SD	M	SD	M	SD	M	SD
Government (*N* = 13)	5.2	1.4	3.5	1.8	5.8	1.2	6.9	0.3	5.6	1.7
Industry (*N* = 9)	3.9	2.4	4.1	2.5	5.1	2.0	5.7	1.9	3.8	2.5
NGO (*N* = 6)	5.3	2.0	5.2	2.4	6.3	1.2	6.3	1.2	6.5	1.2

Research institute (*N* = 21)	5.0	2.1	4.4	1.8	5.5	1.5	6.4	1.1	5.9	1.6

PFAS Specific Policies Stakeholder Survey

Sector (*N*)	Industry penalties		Labelling		Consumer products ban		Essential production allowed	
	M	SD	M	SD	M	SD	M	SD
Government (*N* = 14)	6.0	1.5	6.1	1.3	6.2	1.2	5.5	1.1
Industry (*N* = 7)	5.0	1.9	5.7	1.8	5.6	1.7	6.3	0.8
NGO (*N* = 6)	7.0	0.0	6.7	0.5	7.0	0.0	5.7	1.8
Research (*N* = 17)	6.1	1.0	6.2	1.4	5.7	1.8	5.1	2.2

Eutrophication Specific Policies Stakeholder Survey

Sector (*N*)	Fertilizer restriction		Labelling		Reporting to authority		Buffer zones	
	M	SD	M	SD	M	SD	M	SD
Government (*N* = 4)	6.7	0.5	5.8	0.9	6.0	1.4	7.0	0
Industry (*N* = 8)	4.6	1.1	3.8	1.8	5.1	1.6	5.6	1.2
NGO (*N* = 3)	3.4	3.4	7.0	0	7.0	0	6.6	0.6
Research (*N* = 9)	2.1	2.1	5.0	1.8	5.9	1.3	5.3	1.8

Underwater noise Specific Policies Stakeholder Survey

Sector (*N*)	Cargo vessel design		Cargo vessel speed		Labelling		Formal protection	
	M	SD	M	SD	M	SD	M	SD
Government (*N* = 3)	6.3	1.2	6.0	1.7	3.3	3.2	6.7	0.6
Industry (*N* = 3)	5.0	1.0	3.0	1.0	2.7	1.5	6.0	6.0
NGO (*N* = 2)	6.5	0.7	6.5	0.7	6.0	1.4	7.0	7.0
Research (*N* = 6)	6.5	0.5	5.3	1.9	5.2	2.3	6.8	0.4

Trust in institutions/tools

Country (*N*)	EU government		Local government		Labelling		Industry (reversed)		Research		NGO		Own	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Government (*N* = 23)	4.3	1.6	4.1	1.4	3.8	1.3	4.2	1.1	5.4	1.1	4.2	1.1	5.5	0.7
Industry (*N* = 22)	4.2	1.2	3.8	1.3	3.9	1.2	3.7	1.4	4.7	0.9	3.8	0.9	5.0	1.1
NGO (*N* = 13)	4.2	1.1	3.2	1.3	3.9	0.6	4.7	1.3	5.3	0.7	5.0	0.7	5.5	0.8
Research (*N* = 38)	4.6	0.9	3.8	1.3	3.6	1.3	4.3	1.3	5.4	0.9	5.4	0.9	5.5	0.6

Appendix 5: Stakeholder survey (example PFAS)

What is the goal of the survey?
In winter 2023, we surveyed the general population of Belgium, Bulgaria, Greece, Ireland, and the Netherlands on the topic of environmental concerns such as PFAS or "forever chemicals". We now want to gather different perspectives from representatives from industry (production, distribution, supply, retail), governmental and non-governmental organizations and independent research institutions.
We are interested in how you view PFAS or "forever chemicals", how concerned you are about it, and what kind of mitigation options you support. Our aim is to understand what you see as barriers and facilitators to action in order to better inform government decision-making.
What makes you an ideal participant for this survey?
The topic of PFAS or "forever chemicals" is relevant to your own work or in the work of your organization. You may have a lot of knowledge about it, have to follow or make regulations about it, or work in a sector that produces or uses it. In addition, you are at least 18 years old.
What do you have to do?
The survey should take about 10 minutes to complete. We are interested in your opinions and views on the topic of PFAS or "forever chemicals" from the perspective of your organization; there are no right or wrong answers.
Can you change your mind and withdraw from the survey?
You can withdraw from the survey at any time by closing your browser window. If at a later date (up to 48 hours after the data collection) you would like your data removed from the study, please get in contact with us (see contact details below).
What data or information is collected and how is it used?
All answers you give are anonymous. This means that you cannot be personally identified in any way from the survey data or the analyses. Some of the data will be openly available on research sharing platform but your identity will remain anonymous; despite asking some demographic questions (gender, age, professional role), these responses will not be a part of the openly available data. Research papers may be published using this data, but again, your responses will not be identifiable in the research results.
Are there any benefits or risks related to the participation in the survey?
We do not expect any special benefits or risks related to participation in the survey.
Contact
The survey is being conducted by the researchers from the University of Vienna and is a part of a project funded by the European Commission's Horizon Europe programme entitled "Source to Seas - Zero Pollution 2030". If you have any further questions or concerns about this research, please contact our team from the University of Vienna, Environmental Psychology group using the details below:

Dr. Nina Vaupotič (study lead): nina.vaupotic@univie.ac.at
Prof. Dr. Sabine Pahl (project lead): sabine.pahl@univie.ac.at

Please confirm the following: • I am at least 18 years old.
• The field in which I work is related to PFAS or "forever chemicals".
• I can ask for removal of my data up to 48 hours after completing the survey referring to my "participant ID" = ${e://Field/Random%20ID}.

• My participation in the survey is completely voluntary.
• I can terminate the survey at any time by closing the browser window.
• I confirm that the context of the survey was explained sufficiently and that I had the opportunity to contact the survey lead at nina.vaupotic@univie.ac.at in case of any questions.
• I acknowledge that the results and the data of the project may be published, but my anonymity will be preserved.

If you do not want to participate, please close this window. Thank you for your consideration!

Questions about PFAS

In the following part of the survey, we will ask about your organisation's / working group's views about PFAS or "forever chemicals". Your input is invaluable in our efforts to better understand and address this environmental concern. **Please put yourself in the position of your organisation, rather than responding solely based on your own opinion.**

Variable name	Type	Short description	Response options
PFAS: sub. knowledge	Likert	How much knowledge is there in your organisation / working group about the effects of PFAS or "forever chemicals" on the environment and human health?	No knowledge at all (1) – A lot of knowledge (7)
PFAS stands for "per- and polyfluoroalkyl substances," also referred to as "forever chemicals". These chemicals are notable for their resistance to heat, water, and oil, which has led to their use in a wide range of industrial and consumer products such as non-stick cookware (Teflon), water-resistant clothing, hygiene products, food packaging, and more.			
Risk perception			
PFAS: health	Likert	How concerned is your organisation / working group about the effects of PFAS or "forever chemicals" on human health?	Not urgent at all (1) - Very urgent (7); I don't know
PFAS: environment	Likert	How concerned is your organisation / working group about the effects of PFAS or "forever chemicals" on the environment (nature, animals)?	Not concerned at all (1) – very concerned (7); "I don't know"
PFAS: urgency	Likert	In the context of all the pressing issues society is facing (social, economic, environmental), how urgent is it for your organisation / working group to tackle PFAS or "forever chemicals"?	Not concerned at all (1) – very concerned (7); "I don't know"
PFAS: Open	Open question	Can you explain your answers above a little more? Which factors are relevant here for your organisation that might explain concern or lack of concern?	

Mitigation strategies: policies for industries, consumers, governmental protection programs and individual action			
In the next part of the survey, we provide some examples of measures that can be implemented to counter environmental pollution. We would like to know to what extent your organization / working group agrees or disagrees with these measures. Please note that these measures could also have additional effects (e.g., less comfort, higher costs, protected natural areas would not be used for other purposes such as industry or housing). Please remember to answer the questions from the perspective of the organization you work at.			
Variable name	**Variable type**	**Item**	**Response options**
Measures can be directed at industries. For instance, governments can give subsidies or tax incentives to help industries transition to eco-friendly practices. Governments can also penalize and monitor industries when they manufacture materials contributing environmental pollution.			
Policy1_industry_pull	Likert	Subsidies and tax incentives for industries should be implemented to counter environmental pollution.	Strongly disagree (1) – strongly agree (7)
Policy2_industry_pull	Likert	Penalties and monitoring for industries should be implemented to counter environmental pollution.	Strongly disagree (1) – strongly agree (7)
Other measures can be directed at consumers. For instance, consumers can be informed about the impact of products they are buying (e.g., through labels). Consumers can also be requested to pay an environmental tax for products that contribute to environmental pollution (e.g., single-use plastic bags).			
Policy3_consumer_push	Likert	A certification system that labels products as "environment-friendly" should be established to inform consumers about their environmental impact.	Strongly disagree (1) – strongly agree (7)
Policy4_consumer_push	Likert	A certification system that labels products as "environment-friendly" should be established to inform consumers about their environmental impact.	Strongly disagree (1) – strongly agree (7)
Lastly, governmental and non-governmental action plans can also be implemented to help reduce environmental pollution.			
Policy5_govern_restore	Likert	The restoration of coastal habitats (e.g., salt marshes, seagrass beds), which act as natural carbon sinks and help mitigate pollution should be supported by the EU government.	Strongly disagree (1) – strongly agree (7)
Policy6_govern_protect	Likert	Stronger restrictions to protect endangered and threatened plant and animal species from habitat destruction should be implemented.	Strongly disagree (1) – strongly agree (7)
Policy7_govern_fair	Likert	Countries should not be allowed to export their waste to other countries (e.g., typically richer countries export some	Strongly disagree (1) – strongly agree (7)

		of their waste to less rich countries that may not have the means of dealing with the waste in an environmentally friendly manner).	
Policy8_govern_tech	Likert	Governments should support research and innovation in developing sustainable technologies and materials for the future.	Strongly disagree (1) – strongly agree (7)

Trust			
IntroTrust Mitigation of environmental pollution can come from a variety of involved groups. We are interested in your organisation's / working group's views on the government, industry, research and consumer efforts to mitigate environmental pollution.			
Variable name	**Variable type**	**Item**	**Response options**
Trust_governments	Likert	My organisation / working group trusts the EU government to lead an effective environmental pollution mitigation strategy.	Strongly disagree (1) – strongly agree (6)
Trust_governments_local	Likert	My organisation / working group trusts the local government to lead an effective environmental pollution mitigation strategy.	Strongly disagree (1) – strongly agree (6)
Trust_industries	Likert	My organisation / working group trusts the authenticity of labels indicating sustainable production.	Strongly disagree (1) – strongly agree (6)
Trust_industries_green	Likert	My organisation / working group believes that industry efforts are often "greenwashing". (Greenwashing is when a company falsely claims to be environmentally friendly to attract customers while not taking meaningful steps to protect the environment.)	Strongly disagree (1) – strongly agree (6)
Trust_research	Likert	My organisation / working group trusts independent researchers to provide reliable information about environmental pollution.	Strongly disagree (1) – strongly agree (6)
Trust_NGO	Likert	My organisation / working group trusts non-governmental organisations to lead an effective environmental pollution mitigation strategy.	Strongly disagree (1) – strongly agree (6)
Trust_own	Likert	My organisation / working group is a trustworthy contributor to solving environmental problems	Strongly disagree (1) – strongly agree (6)

In the last part of the survey, we would like to ask you more specific questions related to mitigating the issue of PFAS. First, carefully read the text describing PFAS or "forever chemicals" pollution. Then, please share the extent to which your organisation / working group agrees or disagrees with different measures.

PFAS or “forever chemicals”			
Mitigation strategies: policies for industries, consumers, governmental protection programs			
PFAS or “forever chemicals” are used in a variety of different products (non-stick cookware, water resistant clothing, hygiene products, etc.). The issue with PFAS chemicals is that they do not break down easily and can accumulate in natural environments as well as in humans and animals. High levels of PFAS in human bodies are related to numerous health issues. PFAS pollution demands both immediate actions to mitigate ongoing contamination and long-term strategies to prevent further environmental and health risks. To what extent do you agree or disagree with the following measures? Please note that these measures could have additional effects (e.g., higher costs, change in product performance). **We would like to know to what extent your organisation / working group agrees or disagrees with these measures. Please note that these measures could have additional effects (e.g., higher costs, change in product performance).**			
Variable name	**Variable type**	**Item**	**Response options**
PFAS_policy1_push	Likert	Governments should hold industries accountable for the responsible production, use, and disposal of PFAS chemicals through penalties.	Strongly disagree (1) – strongly agree (7)
PFAS_policy2_pull	Likert	User items (clothing, wax for cars and skis, post-it papers) should be labeled for containing PFAS.	Strongly disagree (1) – strongly agree (7)
PFAS_policy3_push	Likert	Manufacturing of PFAS for the purpose of consumer goods should be banned in the EU.	Strongly disagree (1) – strongly agree (7)
PFAS_policy4_pull	Likert	Manufacturing of PFAS for the purpose of essential products (e.g., medical equipment) should continue to be allowed in the EU.	Strongly disagree (1) – strongly agree (7)

Variable name	Variable type	Short description / item	Response options	Reference
Country	Categorical	Please select your country of residence.	Netherlands, Germany, Greece, Bulgaria, Ireland, Other (enter)	
Gender	Categorical	Please select your gender identity.	Woman, man, transgender, non-binary, other, prefer not to say	
Age	Numeric	Please enter your age.	18 and higher	
Sector	Categorical	Which of the options below best describes the sector you work in?	University, independent research institute, Industry (production, supplier, distribution, retail),	

			Governmental organisation, Non-governmental organisation, Other (enter)
Scope	Categorical	Organisation scope What is the scope of the organisation at which you work? Select all that apply.	Local, EU, Global
Size	Categorical (ordered)	How many employees are in the organisation where you currently work?	1 to 10 employees, 11 to 50 employees, 51 to 250 employees, more than 250 employees
Experience	Categorical (ordered)	How long have you been working in this sector?	Less than 1 year, 2 to 5 years, more than 5 years
Responsibility	Categorical (ordered)	Do you have managerial responsibility?	I am an employee without managerial responsibilities, I myself have managerial tasks, the employees below me have no management tasks, there are other managers above and below me, I am a part of the top management
Sustainability	Likert	To what extent does your organisation have an environmental or sustainability agenda (e.g. renewable energy consumption, strong environmental attitude)?	No sustainability agenda at all (1) – Sustainability is the main priority (7)
Other_org	Open	Do you know of any other organisations, experts or industry representatives who might be able to take part in our survey? Please feel free to provide us with a few names of such organisations.	
Other_poll	Categorical	You have answered all the questions about PFAS. Thank you very much! We really appreciate your effort. Is your work perhaps related to other environmental pollutants such as microplastics, eutrophication or underwater noise? If so, please consider responding to 8 more questions about one of these pollutants.	I will answer 8 more questions about microplastics, I will answer 8 more questions about PFAS, I will answer 8 more questions about eutrophication, I will answer 8 more questions about underwater noise, take me to the end of the survey

Thank you very much for participating in this survey!

If you want to finish the survey, please proceed to the next page. If you are interested in learning more about our research questions and the topic of environmental pollution, please read on.

Environmental contamination and pollution are a direct result of human activities on both land and in the marine environment. Instances of environmental pollution require urgent attention as a healthy and clean nature and seas provide numerous ecosystem services (e.g. food, oxygen production, climate regulation), which are critical for our survival and well-being.

The purpose of this study is to better understand human perceptions of microplastics, PFAS, excess of nutrients (eutrophication), and underwater noise. Our focus is on risk perception for human health and the environment. Moreover, we aim to explore the types of measures that receive public support and to understand how other factors (values and trust in institutions) can illuminate the relationship between risk perception and support for measures.
If you would like to learn more about the Source to Seas – Zero Pollution 2030 project, please visit our web page: https://soszeropol2030.eu/

Furthermore, if you would like to learn more about the four pollutants, you can visit the following pages:
- Microplastics: https://oceanservice.noaa.gov/facts/microplastics.html and https://www.nhm.ac.uk/discover/what-are-microplastics.html
- PFAS: https://www.oecd.org/chemicalsafety/portal-perfluorinated-chemicals/
- Eutrophication (Excess of nutrients): https://education.nationalgeographic.org/resource/dead-zone/ and https://www.unwater.org/news/water-pollution-agriculture-global-review
- Underwater noise: https://clearseas.org/en/underwater-noise/

If you have any questions about this research, please contact:
the study lead Dr. Nina Vaupotič (nina.vaupotic@univie.ac.at)

the project lead Prof. Dr. Sabine Pahl (sabine.pahl@univie.ac.at)
You can ask for removal of your data up to 48 hours after completing the survey referring to your “participant ID” = ${e://Field/Random%20ID}.

We would like to thank you once again for your valuable contribution to this study. Your participation is greatly appreciated!