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Public attitudes and perceptions towards the ocean as an input for public policy

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ABSTRACT

Amidst growing concerns about ocean health and the sustainability of coastal communities, understanding local perceptions and attitudes towards these issues is critical. This research addresses this gap by investigating the views of Chilean coastal communities, offering insights into their relationship with the ocean. We designed and distributed a nationwide online citizen consultation between January and May 2022, covering a range of topics from ocean health perceptions to the frequency of respondents' interaction with the ocean, from which 1221 responses were obtained from all 16 regions of Chile. The data was analyzed using factor analysis of mixed data (FAMD) and cluster analysis. Five distinct clusters were identified, enabling a more comprehensive understanding of community perspectives on ocean-related issues. Cluster 1, comprising mainly middle-aged males, associates the ocean with power, mystery, and economic benefits, emphasizing biodiversity as a crucial indicator of ocean health. In Cluster 2, predominantly retired individuals above 60, engaged in contemplative ocean interactions, prioritize ocean cleanliness and identify overexploitation as a key concern. Cluster 3, composed mostly of females aged 30–60, finds emotional connections like calmness and hope in recreational ocean activities. Young females in Cluster 4, primarily university students, perceive a healthy ocean as pristine and endless and a damaged ocean as an unclean environment. Cluster 5, consisting mostly of coastal residents below 20, predominantly high school students, engage in ocean activities through consumption and contemplation, associating a healthy ocean with cleanliness despite minimal perceived benefits. Our findings highlight the multifaceted nature of human-ocean relationships, emphasizing the need for tailored interventions informed by these diverse perspectives.

1. Introduction

Humans depend on oceans for economic, social, and health benefits (Nash et al. 2021a, 2021b). Developing countries, in particular, heavily rely on traditional ocean sectors like fishing and tourism to generate foreign exchange, income, and jobs (Organization for Economic Cooperation and Development, OECD, 2022). With the expansion of new ocean-based activities such as offshore wind energy, aquaculture, and marine biotechnologies—the so-called blue sectors—, this dependence is expected to increase (OECD 2022; United Nations, 2021). However, as demands on ocean ecosystems grow, their state deteriorates (Franke et al., 2020; Halpern 2020). Unfortunately, the lack of an equilibrated development of such increasing demands may escalate the possibility of further degradation, and it is projected that only 2% of countries will achieve Sustainable Development Goal (SDG) 14 for the oceans by 2030 (de Salas et al., 2022).

In this context, public attitudes and perceptions towards the ocean are critical in designing interventions to foster ocean conservation (Jefferson et al., 2015) and sustainability (Molony et al., 2022). Firstly, a better understanding of individual appraisals helps identify knowledge gaps and the level of society's awareness about the importance of ocean conservation (McKinley and Burdon 2020). Examining variations across

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different societal groups provides insights into how people value the ocean, its connection to their well-being, and the threats they recognize. This knowledge can motivate individuals to take action and support conservation efforts (Easman et al., 2018).

Secondly, this understanding provides a foundation for targeted interventions aimed at promoting sustainable practices. By discerning activities perceived as detrimental to the ocean, such as overfishing or pollution, as well as those seen as protective, such as marine conservation efforts, conservation initiatives can craft strategies to align behavior with ocean preservation goals. The influence of societal behavior, encompassing consumer choices and specific actions, holds great potential for alleviating pressures on the oceans (Pahl et al., 2017; Nisa et al., 2019). Policymakers can leverage this understanding to develop regulations, laws, and incentives that harmonize with societal ideals, facilitating sustainable ocean management (Bennett et al., 2021; Bennett 2022). Moreover, incorporating public input into policy-making processes ensures that regulations resonate with the needs and aspirations of communities, enhancing their effectiveness and fostering widespread acceptance (Huang and You 2013; Lotze et al., 2018).

Thirdly, positive or favorable attitudes can facilitate stakeholder engagement by identifying common ground, addressing concerns, and fostering shared responsibility for conservation efforts (Wiener et al., 2016; Tonin and Lucaroni 2017). For example, the success of marine protected areas relies on public engagement and acceptability (Voyer et al., 2012; Voyer and Gladstone 2018).

Despite being sometimes dismissed as anecdotal and lacking rigor by proponents of evidence-based conservation (Bennett, 2016), information derived from the public has gained significance in the field of marine science (McKinley and Fletcher 2012; Voyer et al., 2012; Jefferson et al., 2021). Researchers have explored various aspects such as understanding of marine ecosystems (Boxall 2014; Jefferson et al., 2021; Manson et al., 2021), awareness of environmental issues like pollution and climate change (Gelcich et al., 2014), knowledge of conservation measures (Easman et al., 2018), and attitudes (positive or negative) towards marine protected areas (McNeill et al., 2018). Yet, specific studies on aspects such as perceptions on ocean health and ocean benefits, which we include in this study, are still scarce (Schuldt et al., 2016). The field continues to evolve as new issues arise and public attitudes and perceptions change over time. Ongoing research is essential to monitor and understand societal dynamics, which can inform efforts to protect and restore our oceans (Jefferson et al., 2021).

Several theoretical frameworks have been instrumental in understanding the complexities of human perceptions and behaviors, which provide a useful context for this research. For example, the theory of the Construal Level explains that there is a relation among the psychological distance and response of people to a specific event (Liberman and Trope 1998; Liberman et al., 2007) and it has been applied to understand pro-environmental decisions (e.g. Wang et al., 2019; Sun and Sano 2023).

In turn, Petty and Cacioppo introduced the Elaboration Likelihood Model (ELM) in 1981, innovating the study of persuasion and its influence on the formation of consumer attitudes. ELM delves into the cognitive processes involved in persuasion, examining how individuals process and engage with persuasive messages, considering the variables that influence the strength and direction of attitude change (Petty and Briñol 2011; Liu et al., 2022). Thus the ELM provides a framework that delineates how various factors influence cognitive engagement and, consequently, changes in attitudes (Kitchen et al., 2014), which has been useful in understanding people's decisions regarding environmental issues (Powell et al., 2018; Nakano and Hondo 2023).

Finally, the Agenda-Setting Theory (McCombs and Shaw 1972; Kim et al., 2017; McCombs et al., 2018) highlights the power of media in shaping public priorities, indicating that media coverage can significantly influence public perception and concern. In the realm of environmental studies, this theory finds critical application by examining how environmental issues are prioritized in the public and political discourse (e.g., Goncalves and De Santo 2022). Media coverage, or the lack thereof, significantly influences which environmental concerns gain prominence among the public and decision-makers. For instance, extensive media focus on climate change has elevated it as a central issue, mobilizing public demand for policy action and sustainable practices (Keskitalo et al., 2012). Conversely, lesser-covered issues, such as biodiversity loss or soil degradation, may not receive the same level of attention or urgency (Dandy et al., 2014).

Despite their distinct focuses, these theories share several commonalities in their application to environmental issues. They point at the critical role of effective communication in bridging the gap between knowledge and action, highlight the influence of message processing and media on public perceptions and behaviors, and advocate for tailored strategies to enhance public engagement in environmental conservation.

This study explores the diverse attitudes and perceptions of coastal communities towards the ocean. Perceptions are defined here as encompassing how individuals interpret and make sense of their engagement with the ocean, including their beliefs, knowledge, and understanding of ocean health, benefits, anthropic pressures, and meanings attached to marine ecosystems (Jefferson et al., 2021). Perceptions can vary among individuals and communities based on their experiences, cultural backgrounds, and access to information, influencing their attitudes and behaviors towards the ocean (Beyerl et al., 2016; Manson et al., 2021). In turn, attitudes are defined as referring to individuals' overall evaluations, emotions, and predispositions towards the ocean and its various aspects (Albarracín and Shavitt, 2018). Attitudes can range from positive to negative and can impact people's willingness to take action to protect and conserve marine resources (Pérez Ibarra et al., 2020).

A growing number of studies is examining these components, evaluating general marine environmental conditions (e.g., Gelcich et al., 2014; Daigle et al., 2016; Lotze et al., 2018; Rock et al., 2020; Jefferson et al., 2021; Manson et al., 2021) as well as specific marine ecosystems, resources, or user groups (Trenouth and Campbell, 2013; Hamilton and Safford 2015). Yet, few studies have explicitly focused on the attitudinal and perceptual aspects considered here (e.g., Manson et al., 2021), which makes this investigation valuable in contributing to a more holistic understanding of the complex dynamics shaping coastal communities' relationship with the ocean.

For the case of Chile, the expectation is to find different groups of people who may have varying perceptions and attitudes based on several factors, such as geographic location, socioeconomic status, and age, among others. Acknowledging differentiated groups of people and their motivations, policymakers gain valuable insights into the specific needs and concerns of diverse communities (Huang and You 2013; Jefferson et al., 2015).

2. Methods and data

2.1. Study case

Chile offers a compelling case study due to: i) the significant proportion of continental coastal districts (103 over 346); ii) its diverse geography, resulting in varying ocean conditions from productive to fragile areas; iii) the distinct pressures occurring along the coast (e.g., mining, salmon farming, urban expansion), shaping marine use possibilities. Human activities have transformed the Chilean coast, causing ecosystem degradation and heightened natural threats (Aguilera 2018; Winckler et al., 2022). A recently proposed framework law aims to address these issues by embracing, among others, the principles of Integrated Coastal Zone Management, defined as a dynamic, continuous and iterative process designed to promote sustainable management of coastal zones (European Commission 1999). The proposed framework law advocates for the harmonious integration of sectoral policies to facilitate sustainable development along coastal regions and recognizes

effective social participation as essential in the decision-making processes governing coastal management (Martínez et al., 2022).

2.2. Instrument design and distribution

2.2.1. Survey design

The survey was designed by the research team and pilot tested by two of the authors in October 2021. The final instrument comprised 24 questions encompassing a range of topics including perceptions of ocean health, patterns and frequency of ocean interaction, individual conceptions of the ocean, interpretations of a healthy or impaired ocean, assessments of the benefits associated with a healthy ocean, and participant demographic profiles (Supplementary Material A). These questions varied in format, consisting of multiple-choice, Likert scale and open-ended questions. In the case of Likert scale questions, a 5-point scale was chosen primarily for its simplicity and ease of understanding for participants. Research suggests that while 7-point or 10-point scales can offer slightly higher variability, they may also introduce complexity that can confuse respondents or lead to less thoughtful responses (Dawes 2008; Finstad 2010). Additionally, a 5-point Likert scale is particularly suited for gauging emotions and behaviors along a bipolar spectrum, utilizing descriptors ranging from "strongly disagree" to "strongly agree", or "very bad" to "very good" (Dawes 2008; Joshi et al., 2015).

2.2.2. Survey distribution

The non-probabilistic internet survey distribution, led by three communication experts (one being an author), included the following steps:

Step 1 (January 2022): An illustrative depiction of ocean elements and human interactions was designed. This visual was incorporated into posters, press releases, and social media posts to captivate interest and enhance comprehension. Physical posters were placed at city bus stops in different municipalities of the country.

Step 2 (February–March 2022): A comprehensive press release clarified the survey's purpose, eligibility, and invitation. Shared with various media outlets, it resulted in 44 publications. Social media platforms (Instagram, Twitter, LinkedIn, Facebook) were also utilized. Diverse content, such as interviews, videos, and trivia, was curated. A viral-sharing text message was disseminated via WhatsApp. The survey was featured on authors' universities and research centers websites and emailed to 3650 research center subscribers.

Step 3 (February–March 2022): To expand outreach, paid promotions on Facebook and Instagram were employed. Collaboration with social media influencers and engagement with sea-related groups were pursued. Despite reaching over 128,000 people, only 78 surveys were completed through this approach.

Step 4 (April–May 2022): A strategic approach engaged educational institutions, foundations, associations, and municipalities to broaden survey reach. A tailored press release targeting schools acknowledged that students above 16 could participate. Municipalities shared the survey actively, particularly in previously underrepresented regions. A raffle announcement for 10 adorned boxes was introduced to incentivize participation.

Exclusions comprised individuals below 16 years and those lacking functional email addresses. Minors were excluded due to their susceptibility to external influences like parental, peer, and media factors. Excluding email-less participants aimed to ensure uniqueness and prevent survey re-administration.

Along these steps, each communication task was carefully designed to resonate with the intended audience, incorporating both tailored messages and direct access mechanisms to the survey. A QR code, leading directly to the survey hosted on chileoceanos.cl, was attached to every message, alongside a direct link for easy online access. For dissemination through more traditional means, such as posters, television, and radio broadcasts, the strategy was adapted to include the survey's URL with the invitation ("Visit chileoceanos.cl to participate"). Additionally, a QR code was displayed in visual media (except in radio broadcasts) to provide direct access to the survey page upon scanning.

After using these different communication strategies, the final sample was composed of 1221 responses. However, given the dissemination strategy of the instrument, the precise determination of the origin population of the these responses presents inherent challenges. It has been well documented that online instruments encounter difficulties in sampling methods and contact delivery modes (Fan and Yan 2010). Achieving representative samples and broad coverage in online surveys is complex, except when targeting a specific, well-defined group (Couper 2000). Internet accessibility, often influenced by demographic factors, further impacts the effectiveness of this approach (Ferri-García and Rueda 2022). Consequently, it is unclear whether results from internet surveys can be representative of the entire population (Grewenig et al., 2023).

2.2.3. Participants description

The proportion of interviewees living in coastal municipalities as compared to non-coastal municipalities, reached 56.6%. The mean age of participants was 36 years (mode = 31; Standard deviation = 12.9). Regarding education, 0.3% had only completed elementary school, 8.6% high school, and 7.2% held a technical degree. For the most part, the sample was composed of people holding university education (59.7%) and graduate education (23.7%). It is important to mention that in Chile, 41% of 25–34 year-olds had a tertiary qualification in 2020 compared to 47% on average across OECD countries.

Most of the respondents were employed at the time of the consultation (state worker = 16.5%; dependent worker = 52.5%; independent worker = 30.9%), whereas 4.0% was unemployed, 1.9% was retired, and 22.2% was student. Regarding the proportion of people living in the different macrozones of the country, less than 20% lived in the northern regions (Big north = 5.1%; Small north = 18.0%), 27.7% lived in central Chile, and near 50% lived in the southern regions (South = 44.0%; Extreme south = 4.7%). Finally, regarding gender, 57.4% of the respondents recognized themselves as of the female gender, 40.8% of the male gender, and 1.7% recognized themselves as of other gender.

2.3. Data analysis

Considering the research objectives, the integration of factor analysis of mixed data (FAMD) and cluster analysis was considered a fitting approach. Factor analysis can provide information about the underlying dimensions or constructs that drive perceptions and attitudes. Cluster analysis, on the other hand, allows for the characterization of different profiles or subgroups within the data (Khan and Ahmad, 2004). By using the factor scores as input variables in the cluster analysis, the analysis allows to identify groups of individuals who have similar patterns of responses on the underlying factors derived from the factor analysis. The analysis was conducted in R, version 4.0.2. Both FAMD and Hierarchical Clustering on Principal Components (HCPC) analyses used the FactoMineR package. The results were extracted and visualized using the Factoextra package (Husson et al., 2016; Kassambara and Mundt, 2017).

It is important to mention that not all questions in the survey were included in the FAMD and cluster analysis and some of them were transformed to fit the requirements of the modeling approaches (see Table 1).

2.3.1. Factor analysis of mixed data

FAMD is a statistical technique that specifically addresses the analysis of datasets encompassing both quantitative and qualitative variables (Mafata et al., 2022), which aligns with the present study. It enables the examination of similarities between individuals while considering mixed types of variables, namely quantitative (continuous or discrete numerical variables) and qualitative (categorical or ordinal

Table 1
Questions' survey and derived variables used in the FAMD and cluster analysis. The first nine variables are qualitative whereas the last two are quantitative. Variables considered as control variables are signed with an asterisk.

Question in the survey	Variable	Categories of the variable	Description
Name up to three ways in which you interact with the ocean.	INTERACTION	- Contemplation - Consumption - Recreation - Work - Other	The most common type of interaction the person has with the ocean in the place where he/she most frequently interacts with it. The variable's categories were obtained based on the coding of the open-ended survey question.
What does the ocean represent or mean to you? Use three concepts.	MEANINGS	- Power and strength - Symbol of mystery - Hope - Calmness - Endlessness	The most common representation or meaning the person gives to the ocean. The categories were obtained based on the coding of the open-ended question
What does a healthy ocean mean to you? Please explain briefly.	HEALTHY	- Biodiverse - Clean - Pristine - Sustainable	The perception of the person regarding what a healthy ocean is. The categories were obtained based on the coding of the open-ended question
What does a damaged ocean mean to you? Please explain briefly.	DAMAGE	- Dirty - Intervened - Overexploited - Little diverse	The perception of the person regarding what a damaged ocean is. The categories were obtained based on the coding of the open-ended question
What is your age?	AGE*	<20; 21–30; 31–40; 41–50; 51–60; >60	The person's age range
Which is your gender? Male; Female; Other (which?; prefer not to say)	GENDER*	Female; Male; Other	The person's gender
What is your level of formal education? Incomplete primary education; Complete primary education; Incomplete secondary education; Complete secondary education; Incomplete technical education; Complete technical education; Incomplete university education; Complete university education; Postgraduate Master's; Postgraduate Doctorate	EDUCATION*	- Elementary - High School - Technical degree - University - Graduate	The person's formal education level. The categories were obtained by regrouping the original options in the survey question
What is your main occupation? (Select one). Student; Company employee; State employee; Self-employed; Retired; Other (specify); Currently unemployed	OCCUPATION*	State worker; Dependent worker; Independent worker; Student; Unemployed; Retired; Other	The person's main occupation at the time of the consultation. The categories of the variables were obtained by regrouping the original categories in the question
Indicate the town and municipality where you currently reside.	PLACE*	Coastal; Non coastal	Indicates whether the person lives in a coastal municipality. The categories were obtained by dividing the municipalities in coastal and non-coastal
Not originally in the survey.	ZONE*	Extreme south; South; Central; Big North; Small north	The zone of the country where the person lives. This variable was created base on the PLACE variable
Do you perceive that the ocean in the locality and municipality where you usually interact with it provides you with benefits? Yes; No	BENEFITS	Yes; No	Binary answer about whether the person perceive benefits from the ocean or not
How often do you interact with the ocean? Daily; Weekly; Monthly; A few times a year; Rarely	FREQ*	1 (less; rarely)–5 (more; daily)	The original question's categories were transformed into a semi-quantitative scale indicating the frequency with which the person interacts with the ocean
How do you perceive the health status of the ocean in the locality and municipality where you usually interact with the ocean? Very bad; Bad; Average; Good; Very good; Don't know	STATE	−2; −1; 0; 1; 2	The original question's categories were transformed into a semi-quantitative scale indicating people's perception of ocean health (−2: very bad, 2: very good)

variables) variables (Bécue-Bertaut and Pagès 2008). Furthermore, it facilitates the exploration of associations among all variables, regardless of their quantitative or qualitative nature (Mafata et al., 2022). In several fields, this kind of analysis is frequently used to present groups (e.g. patients, voters, farmers) in a simplified and visual way for a large range of data.

In order to perform the analyses, the quality and completeness of the data was initially checked with regard to missing values, outliers, or any data entry errors. Data entry errors were corrected and 21 responses were eliminated because they contained blank values. Questions in the survey, particularly open-ended questions, were generally transformed to categorical variables (see Table 1). When needed, the quantitative data obtained from Likert scale questions was standardized to ensure uniformity across the chosen variables. This standardization step holds significance, as factor analysis is sensitive to variations in variable variances (Bécue-Bertaut and Pagès 2008). The standardization method employed was z-score transformation.

The adequacy of the data for FAMD was assessed using the following measures: the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity. These tests evaluated if the data had sufficient intercorrelations between variables to proceed with factor analysis. The appropriate number of factors to extract from the data was decided based on the following techniques: Kaiser's criterion (eigenvalue greater than 1), screen plot inspection, and that accumulated percentages of inertia explained was at least 60%.

2.3.2. Clustering analysis

Cluster analysis was applied to the data to identify groups of individuals who shared similar patterns or profiles in terms of their perceptions and attitudes (Perez and Nadal 2005; Beer and Theuvsen 2019). When combining factor and cluster analysis, factor scores from factor analysis are used as input variables in cluster analysis (Mafata et al., 2022), which serve as a reduced set of variables that capture the underlying factors identified in the factor analysis. The cluster analysis algorithm groups individuals based on their similarity in the values of the factor scores (Rundle-Thiele et al., 2015). This helps to capture the underlying dimensions or factors that drive similarities or differences among individuals, allowing for a more meaningful clustering of individuals based on their perceptions or attitudes (Guest and McLellan 2003).

The agglomerative hierarchical clustering method was applied to the dataset, which included the factor scores as input variables. The algorithm grouped individuals based on their similarity in the values of the factor scores. Agglomerative clustering will start with "n" clusters, where "n" is the number of observations, assuming that each of them is its own separate cluster. Then the algorithm will try to find the most similar data points and group them, so they start forming clusters. The distances used to build the clustering were calculated using the first five dimensions of the FAMD. The stability and meaningfulness of the clusters was assessed using the Elbow (compactness of clusters) and Silhouette (how close each point in one cluster is to points in the neighboring clusters) visualization techniques (Husson et al., 2016).

2.3.3. Additional qualitative analysis

Additionally, relationships between the clusters and other variables not included in previous analyses were explored. Particularly, it was considered of interest to explore differences between the clusters in relation to whom people believe are harming the ocean, which was a question in the survey not used in the previous analysis. Understanding these perceptions can shed light on public awareness and attitudes towards environmental accountability. By identifying the entities or groups that individuals associate with ocean damage—whether they are corporations, governments, or specific industries—researchers can better understand the narratives and beliefs that influence environmental advocacy and policy support (Hartley et al., 2018).

3. Results

3.1. FAMD results

Table 2 shows, for the first five components, the associated eigenvalues, the variance explained by each component from FAMD, and the most contributing variables for each component. An eigenvalue greater than 1 indicates that the associated component explains more variance than one of the data's original variables. In general, this is used as a cut-off point to show how many factors to retain in the analysis (Husson et al., 2010).

Fig. 1 shows the correlation that each variable has with components 1 and 2 of the FAMD. The variables "Place", "Zone" and "Meanings" have higher positive values on Component 1, and they contribute significantly to the variability along this dimension. These variables show a pattern of alignment with the axis representing Component 1, indicating a strong association with the underlying factor represented by this component. In turn, the variables "Education", "Occupation" and "Age", have higher positive values on Component 2 and are more strongly related to this dimension. The other variables that are closer to the center are less correlated with these two components, but they contribute to components 3, 4 and 5 (see Table 2). The variables in black (frequency and state) are quantitative variables, so their relationship with the components is observed by using a correlation circle.

Fig. 2 shows the relationship between the categories of each of the variables included in the FAMD. The coordinates associated with components 1 and 2 are used. For example, a marked separation between coastal and non-coastal zones and the different regions of Chile is found. In each quadrant, categories associated with each other are identified, with regions distinguished in colors to facilitate the interpretation of the categorical interactions. Depending on the combination of components that are visually explored, different relationships between categories can be identified.

Fig. 3 shows the relative perception of the ocean's health status (X-axis varying from −1 very negative to 1 very positive) according to their perception of benefits from the ocean, further discriminating by type of municipality and macrozone of residency. In general, the most negative perception of ocean health is observed for people living in the big north and coastal areas. A similar trend is reveled for the small north. In non-coastal areas (mostly represented by respondents from the country's capital), the perception is less negative. In the central zone and the extreme south, the perception of ocean health is positive in coastal areas and negative in non-coastal areas.

In the following section, the results of the cluster analysis are presented, where the attributes shared by the persons assigned to each group are described based on the distance matrix constructed with the values of the FAMD components.

3.2. Cluster analysis results

Fig. 4 illustrates the dendrogram resulting from the hierarchical clustering analysis applied to participant data. This analysis delineates five distinct clusters, each comprising individuals who share similar perceptions and interpretations of the ocean. The following sections provide detailed descriptions of these clusters, outlining the unique

Table 2
Results from the factor analysis of mixed data (FAMD).

Component	Eigenvalue	% of variance	Most contributive variables (Contribution>10)
1	2.41	6.17	Age, Occupation, Education
2	2.20	5.64	Place, Zone, Meanings
3	1.65	4.24	Age, Occupation, Healthy, Damage
4	1.54	3.94	Age, Education, Occupation
5	1.42	3.64	Age, Zone, Damage, Occupation, Interaction

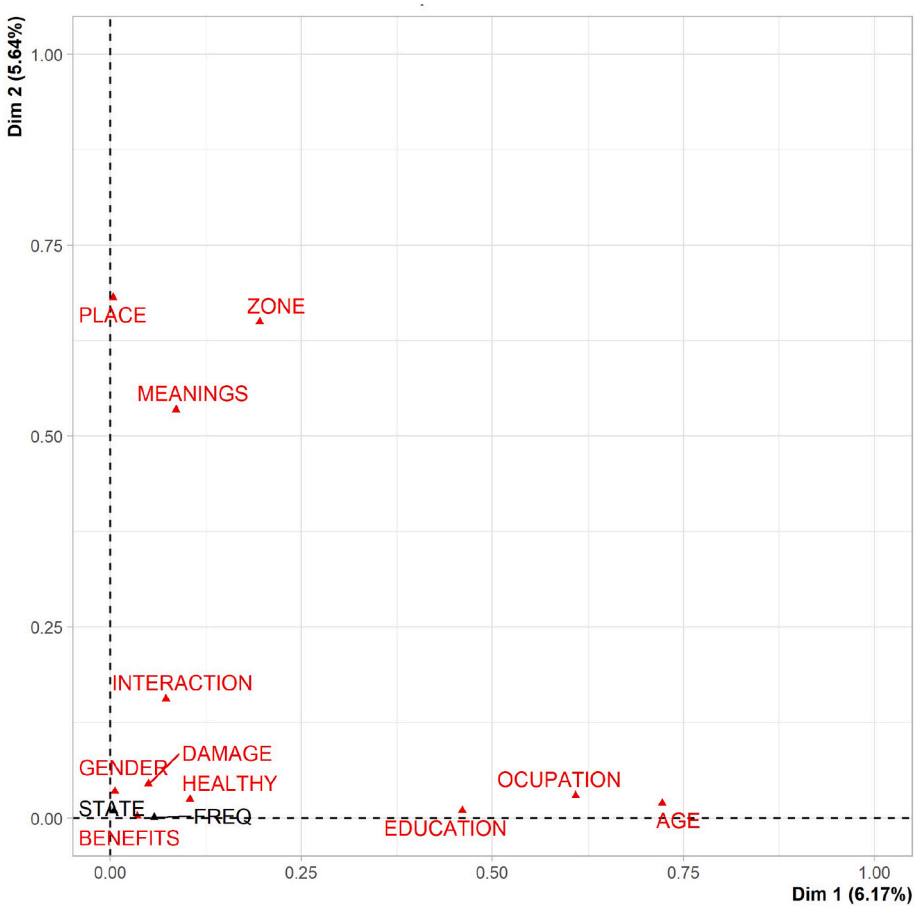

Fig. 1. Relative contribution level of each active qualitative variable (in red) of the FAMD to dimensions 1 and 2. The quantitative variables are shown in black, which are not associated with the qualitative ones.

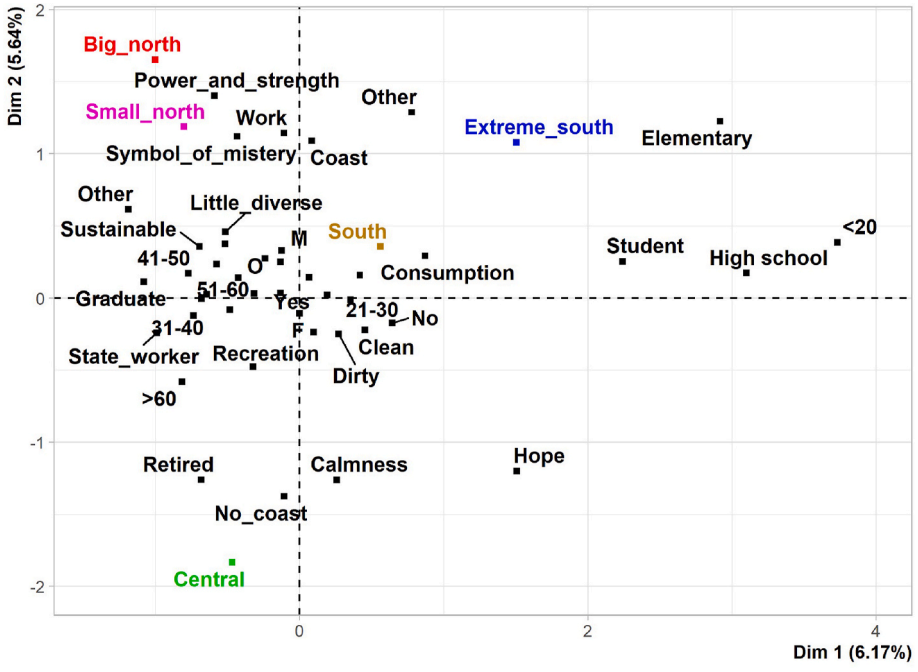

Fig. 2. Two-dimensional plan of the FAMD showing the relationship between the categories of qualitative variables based on dimension 1 and 2. The colored categories indicate the different areas where respondents live, and are included for illustrative purposes.

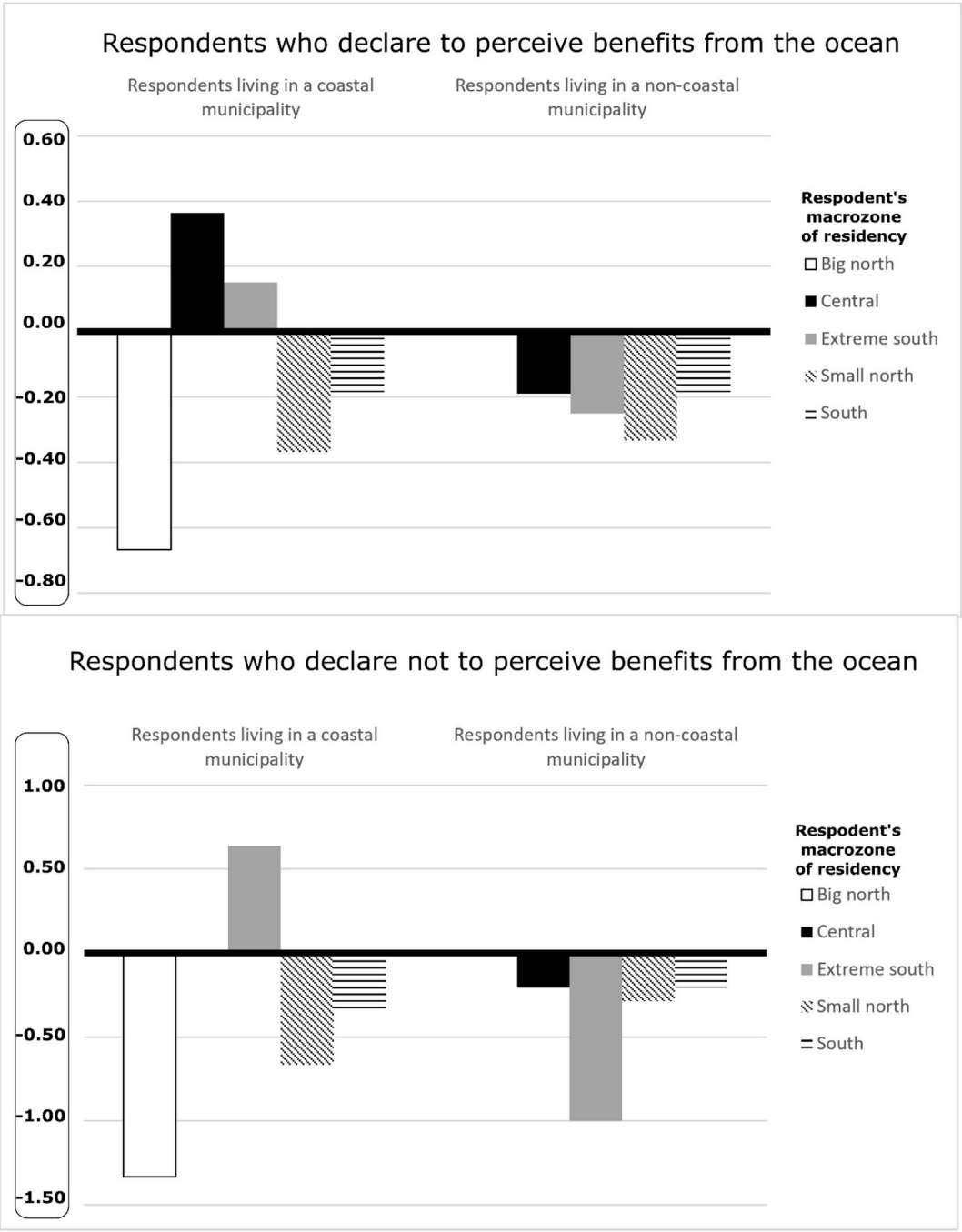

Fig. 3. Respondents' perceptions of ocean health (X-axis varying from −1 very negative to 1 very positive) based on whether they declare receiving benefits from the ocean, their affiliation with a coastal municipality, and the macrozone of the country where they reside.

characteristics defining each typology.

Fig. 5 displays the pivotal variables with v-test values exceeding two, which have played a substantial role in delineating the unique features of each cluster. These variables have significantly contributed to shaping the diverse attitudes and perceptions held by distinct groups across the country.

Cluster 1, labeled as "Pragmatic coastal dwellers", comprises individuals residing in coastal areas, particularly in the northern regions (small and big north). Mainly male and between 30 and 50 years of age, with some extending to 60 years, they engage with the ocean through work-related activities. This cluster perceives tangible benefits from the ocean and often holds university-level education, frequently working independently or under an employment arrangement. Their meanings of the ocean lean towards power and strength and mystery as they probably associate it with the uncertainty of the ocean, symbols of the unknown. Biodiversity is crucial for their perception of ocean health, where limited ecosystem diversity signals a damaged ocean.

Cluster 2, labeled the "Elderly inquisitors of the sea" is dominated by people who reside preferably in the small north and southern regions, predominantly composed of retired individuals and dependent workers. It encompasses both genders, mainly above 60 of age, who possess technical-level education. This group interacts with the ocean in ways categorized as "other activities" (mainly research, artistic creation, biodiversity observation). They associate ocean health with cleanliness, while overexploitation serves as their primary indicator of damage.

Cluster 3, "Ocean recreationists", primarily consists of individuals

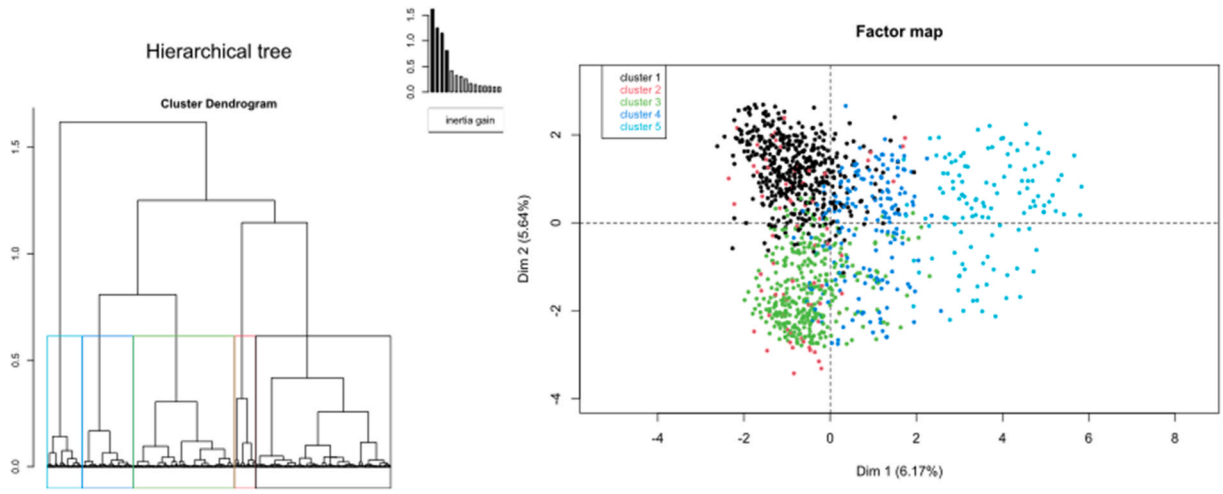

Fig. 4. A- Corresponds to the dendrogram resulting from the Hierarchical Cluster Analysis applied to the Factor Analysis Mixed Data results previously exposed. B- Biplot Link between the cluster variable and the categorical variables (chi-square test).

residing outside coastal municipalities, including respondents from the country's capital, who engage in recreational activities with the ocean, mainly in the central zone. This group is predominantly female, aged between 30 and 60, and has a higher prevalence of graduate-level education. Members of this cluster typically have independent or employment-based occupations, displaying a diverse range of professions. Their perception of the ocean centers on tranquility and hope, reflecting a unique blend of relaxation and optimism associated with their interactions with the sea.

Cluster 4, "Young adults advocates for pristine oceans", primarily consists of residents from the southern municipalities, mainly females aged 21 to 30, and often university students. Their interaction with the ocean is predominantly through contemplation, and they perceive benefits from it. In this cluster, a healthy ocean equates to pristinity, and the ocean symbolizes endlessness for them. They associate a damaged ocean to an unclean environment.

Cluster 5, labeled as "Hopeful youth for a cleaner future", is predominantly found in Chile's southern and extreme southern coastal areas. It comprises both male and female individuals below 20 years of age, with a substantial presence of high school students. Their interactions with the ocean involve consumption (e.g., fish and natural products) and contemplation, with a perception that the ocean does not provide benefits. Cleanliness defines a healthy ocean for them, and they perceive a damaged ocean as a polluted (dirty) environment. The ocean, for this cluster, symbolizes hope.

The identified groups showed significant differences in terms of the frequency with which they interact with the ocean (eta2 = 0.022, p-value<0.01) and the perception of ocean health status (eta2 = 0.0142, p-value<0.01). Cluster 1 showed a higher frequency of interaction with the ocean (v.test = 3.262) and a more negative perception of ocean health status (v.test = −2.537). Cluster 2 and 4 showed no association with these variables whereas cluster 3 showed a more positive perception of ocean health status than the others did (v.test = 3.747). Cluster 5 showed the lowest frequency of interaction with the ocean (v.test = −4.489).

3.3. Perceptions regarding who threatens ocean health

Fig. 6 illustrates the distribution of perceptions regarding the primary drivers of ocean health degradation within each identified group. Notably, no significant distinctions emerged among the groups in their attribution of these drivers. Overall, all groups predominantly identified "companies" (e.g., salmon farming, mining, pulp processing) and "people" (e.g., tourism, littering) as the principal drivers behind ocean health deterioration. This collective perspective hints at a potential gap in understanding the intricate dynamics affecting the ocean and its contributing factors.

4. Discussion

4.1. Attitudes and perceptions toward the ocean

The results provide different inputs and a structured understanding of how distinct groups of individuals relate to marine ecosystems and their perceptions regarding its benefits and significance.

Firstly, it is crucial to recognize that both the geographical location and the personal significance individuals attach to the ocean serve as relevant factors that differentiate the public. Consequently, it can be anticipated that the combination of these elements significantly molds attitudes and behaviors concerning ocean use (Jefferson et al., 2015; Manson et al., 2021). Moreover, these factors influence the perceived benefits individuals derive. Additionally, socio-demographic variables such as age, education, and occupation further differentiate these perceptions (Heck et al., 2016). Age, particularly in conjunction with educational level and occupation, acts as a moderating factor, shaping individuals' interpretations of what the ocean represents to them.

The cluster analysis confirms these initial results, discovering five distinct groups that relate to and use the ocean differently, and consequently have different attitudes regarding its value and potentially different visions about conservation measures required to keep its benefits. Cluster 1, depicting pragmatic coastal dwellers, highlights the significance of economic and utilitarian perspectives. The emphasis on the ocean as a symbol of mystery might indicate a connection to the unknown potential of marine resources. In contrast, Cluster 2 of elderly inquisitors of the sea represents a subgroup whose perceptions are shaped by less traditional interactions with the ocean. Cluster 3 depicted by ocean recreationists, predominantly marked by recreation-based interactions, portraits the influence of emotional connections on perceptions (Rogan et al., 2005; Marczak and Sorokowski 2018; Brosch 2021). Cluster 4, comprising young adults advocates of pristine oceans, underscores a generational shift (Bøhlerengen and Wiium 2022). Their emphasis on "pristinity" as a sign of a healthy ocean might reflect their aspirations for untouched environments. Finally, Cluster 5, comprising even younger people identified with a cleaner future, reflects a group potentially more disconnected from direct ocean contributions to their lives, for whom nonetheless the ocean represents hope.

Interestingly, the variables "frequency of interaction with the ocean" and "state of ocean health" not emerging as significant in clusters 2 and

Variable	Categories	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
INTERACTION	Contemplation				1	1
	Consumption					2
	Recreation			3		
	Work	3				
	Other		3			
MEANINGS	Power and strength	4				
	Symbol of mystery	5				
	Hope			1		2
	Calmness			4		
	Endlessness				1	
HEALTHY	Biodiverse	2				
	Clean		1			3
	Pristine				2	
	Sustainable	1				
DAMAGE	Dirty				2	1
	Intervened					
	Overexploited					
	Little diverse	2				
AGE	<20					5
	21-30				5	
	31-40	3		3		
	41-50	4		1		
	51-60	1		1		
	>60		5			
GENDER	Female			1	1	
	Male	2				
	Other					
EDUCATION	Elementary					
	High School					5
	Technical degree		1			
	University				4	
	Graduate	3		1		
OCCUPATION	State worker			2		
	Dependent worker	3		2		
	Independent worker			1		
	Student				4	4
	Unemployed					
	Retired		5			
	Other	1				
PLACE	Coastal	5				2
	Non coastal			5		
ZONE	Extreme south					2
	South				3	3
	Central			5		
	Big North	4				
	Small north	5	1			
BENEFITS	Yes	1			1	
	No					3

Fig. 5. Description of the five clusters showing the variables that reached a v.test value above 2. “5”: v.test >18; “4”: v.test 14–18; “3”: v.test 10–14; “2”: v.test 6–10; “1”: v.test <6. The green gradient indicates graphically the magnitude of the values.

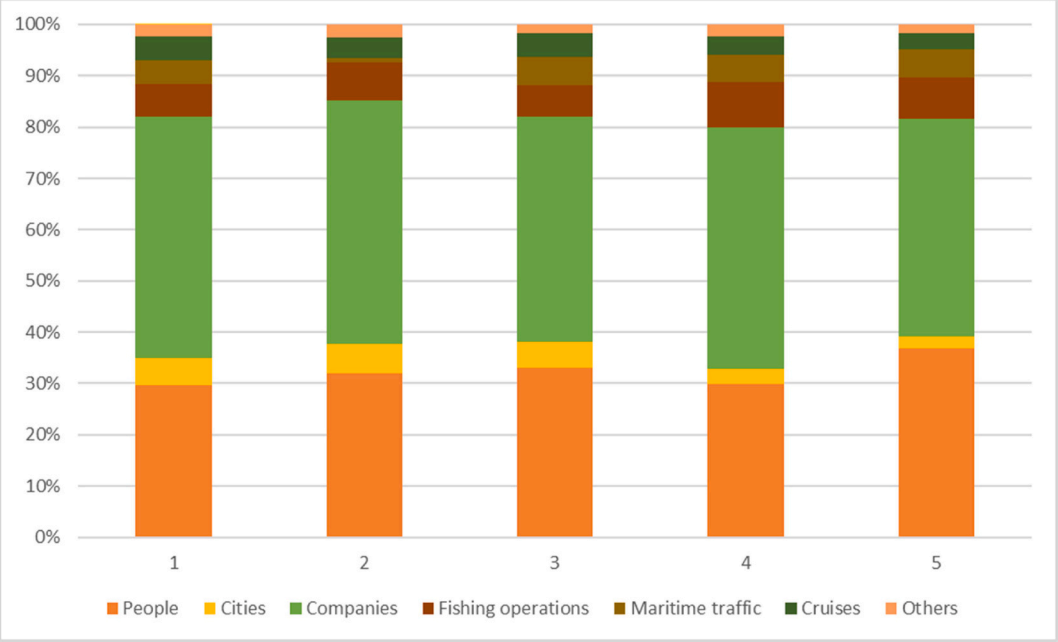

Fig. 6. The chart illustrates the varying perceptions of ocean damage drivers among individuals surveyed, categorized based on their membership in the identified clusters (1–5).

4 challenges the notion of uniform attitudes based solely on direct interactions or observable ocean conditions. This complexity, combined with the influence of diverse personal and contextual factors, highlights the necessity for tailored policy interventions to effectively engage these distinct groups towards sustainable ocean management. Additionally, certain key variables related to attitudes and perceptions, such as "who are responsible for damaging the ocean" or "the type of benefits perceived by people as being provided by the ocean (e.g., food provision, tourism and recreation, coastal protection) were initially discriminated as not relevant based on FAMD and therefore not considered in the cluster analysis.

4.2. *Implications and future actions*

First and foremost, the findings shed light on the complexity of human relationships with the ocean in line with recent literature (Borja et al., 2020; Omstedt and Gustavsson 2022; Thurstan 2022; Allison et al., 2023; Buchan et al., 2023), highlighting that a wide range of factors shapes perceptions and attitudes, rooted in distinctive characteristics. This perspective reinforces the idea that perceptions of the ocean are multifaceted and shaped by personal experiences, cultural backgrounds, and specific contexts (Omstedt and Gustavsson 2022; Allison et al., 2020). In this study, these aspects are represented, for example, by factors such as the meanings people attribute to the ocean and the ways they interact with the sea. This outcome directly aligns with the ocean sustainability challenges posed for this decade, which advocate for a deeper and more holistic understanding of people's connection to the ocean (IOC-UNESCO 2021).

Secondly, the variation in perceptions and attitudes across different groups stresses the importance of sociodemographic characteristics in shaping attitudes. The study supports previous research indicating that factors such as age, gender, education, and geographic location influence how individuals perceive the ocean (Dlamini et al., 2020). By better understanding these differences, strategies and policies can be customized to be more effective and relevant for each demographic group, in line with efforts to drive marine sustainability in Chile. For example, in the small north municipalities, where a considerable portion of the survey respondents falls in the elderly inquisitors of the sea group (Cluster 2), policy makers have the opportunity to engage in educational initiatives that emphasize the importance of conserving clean coastal environments. Understanding that this group values ocean cleanliness can lead to targeted efforts to reduce physical pollution and ensure clean beaches and waters. By involving retirees in ocean conservation efforts, local communities can actively contribute to sustainable coastal and marine environments for all. Despite the increasing participation of older people in environmental activism worldwide (e.g., https://www.eldersclimateaction.org/), their contributions and experiences remain underexplored in academic research. Future studies could explore how to effectively mobilize and engage older adults in environmental causes, the impact of digital technology on their activism, and how environmental movements can benefit from intergenerational collaboration.

In contrast, the central and southern regions, characterized by young advocates of pristine oceans (Cluster 4), have a distinct perspective. They prioritize pristinity and view a damaged ocean as one with a dirty environment. This demographic group is potentially more open to innovative and technology-driven approaches to address marine health concerns, as the literature has shown in climate action by youth (Waeterloos et al., 2021). For example, policymakers can leverage this demographics' desire for pristinity by exploring eco-friendly and sustainable fishing and aquaculture practices. By aligning policies with young people's values, there is an opportunity to promote practices that reduce environmental impact (Arnot et al., 2023). Furthermore, initiatives promoting beach clean-ups and waste recycling in coastal areas can resonate strongly with this group, fostering a sense of ownership and active participation in maintaining the pristinity they value (Hanan et al., 2018). At present not all coastal municipalities have such measures implemented.

Thirdly, the results point to the existence of a gap between perceptions and behaviors, as found in other studies (e.g., Tofighi and Jackson 2022). This is illustrated by people who perceive that the ocean does not provide benefits to them, despite having frequent interactions with the ocean. Likely, many individuals across clusters perceive ocean-related problems as remote, with limited relevance to their daily lives (Schuldt et al., 2016). This perception of distance can hinder meaningful engagement and support for policies aimed at ocean restoration for example. The unfamiliarity of ocean ecosystems to a significant portion

of the public further complicates matters. Unlike terrestrial environments, the ocean is relatively less familiar to many individuals. This lack of familiarity can create barriers to understanding and appreciating the intricacies of marine ecosystems (Stoll-Kleemann 2019; Kelly et al., 2022), such as ocean health, what a healthy ocean really means, and the benefits that it provides to people. The UN Decade of Ocean Science for Sustainable Development 2021–2030 highlights the need for a 'rigorous ocean literacy programme of activities' to increase public awareness and knowledge that can guide sustainable behaviors and inform decision-making regarding the ocean (UN, 2018). Ocean literacy has multiple aspects or dimensions: from knowledge about how the oceans work and our impact on them, to attitudes toward topics such as sustainable fisheries, and our behavior as consumers, tourists, policy makers, fishers, etc. (Brennan et al., 2019) and thus provides valuable insights to plan policy interventions regarding the ocean.

The consistent perception across clusters, that companies and people in general are the primary agents responsible for ocean damage is noteworthy (Fig. 6). However, this perception appears to absolve the individual respondent of his/her own accountability in this context. When individuals are cognizant of their contributions, they tend to adopt more responsible behaviors (Jagers and Matti 2010; Hua and Dong 2022). Consequently, aligning public perception with empirical reality could engender a collective sense of responsibility, encouraging proactive measures to mitigate the impacts on oceans.

To address the above challenges, several strategies rooted in the theories posed in the introductory section are possible:

i Reducing psychological distance:

The results suggest varying degrees of "psychological distance" among different clusters in their perceptions of the ocean. Psychological distance consists of four interconnected dimensions: spatial, social, temporal, and hypothetical (Liberman et al., 2007). In the context of this study, these principles can be applied to the clusters' perceptions of their interactions with the ocean, their understanding of its benefits in interplay with socio-demographics characteristics. For example, for pragmatic coastal dwellers (Cluster 1), emphasizing how a healthy ocean directly contributes to their economic well-being and the prosperity of their local communities can enhance their engagement and support for ocean-related policies. For ocean recreationists (Cluster 3), framing the ocean as a source of "calmness" and "hope" and highlighting how these emotional connections benefit individuals' well-being can strengthen their engagement with ocean issues. These insights illustrate the importance of tailoring communication and policy approaches to bridge the psychological distance within each demographic cluster.

ii. Increasing familiarity

One fundamental aspect of the ELM is the concept of the central and peripheral routes to persuasion. When people engage in the central route, they critically analyze information, considering it in depth. In contrast, the peripheral route involves more superficial processing, where people may rely on cues like attractiveness or credibility of the communicator. The ELM posits that individuals are more likely to engage the central route when they possess knowledge or familiarity with the topic under consideration (Petty and Cacioppo 1986). The study reveals varying levels of familiarity with marine environments across different clusters. This aligns with the principles of the ELM, as familiarity can be seen as a form of prior knowledge. The results suggest that individuals within each cluster may process information related to the ocean differently based on their existing familiarity. Drawing from the ELM, communication and policy strategies can be tailored to align with these varying levels of familiarity. People with higher familiarity ("interaction", "frequency") can be engaged through the central route, providing detailed and comprehensive information about marine ecosystems, benefits, and conservation efforts. Conversely, for clusters less familiar with marine environments, employing the peripheral route may be more effective. This involves simplifying messages, using relatable cues, and making information easily accessible.

iii. Mitigating politicized interpretations

In this study, Agenda-Setting Theory is a valuable framework for depoliticizing discussions surrounding various aspects of ocean perception, including not only variables like "healthy" and "damaged" but also the variable "meanings", which delves into the symbolic interpretations and emotional connections people have with the ocean. Agenda-Setting Theory posits that the media has significant power to shape public perception by deciding which issues are discussed and how they are framed (McCombs and Shaw 1993; Liu et al., 2010). By understanding the distinct attitudes and perceptions of different demographic clusters revealed in this research, communication approaches can be tailored to align with their unique perspectives. For instance, when engaging with pragmatic coastal inhabitants the communication message can highlight how a healthy ocean directly contributes to local economies and livelihoods. For ocean recreationists, the messages can focus on the emotional and well-being aspects of a thriving ocean. In this way, the strategies prioritize conveying impartial, evidence-based narratives tailored to the specific attitudes and perceptions within each group. By actively working to shape the media agenda to prioritize factual and scientific information over politicized rhetoric, studies such as this attempt to guide public discourse toward a more rational and consensus-driven understanding of ocean conservation. This approach ensures that discussions about ocean health and sustainability are grounded in objective, unbiased perspectives while respecting the diverse viewpoints revealed in the clusters.

4.3. *Implications for further studies*

This exploratory study, while not necessarily grounded in a specific theory, has employed theoretical frameworks to contextualize the findings on public perceptions and attitudes towards the ocean, thus highlighting the significance of the theoretical lenses applied, even as it opens the door for future studies to more precisely align their methodologies with the theories utilized. Other research endeavors could enhance this aspect by more rigorously integrating theoretical foundations from the outset, ensuring a stronger theoretical grounding in the design of their instruments and analysis. This does not diminish the value of the current study; rather, it highlights the exploratory study's role in shedding light on the importance of the theoretical frameworks that have been considered. Indeed, there exist other theories equally relevant to understanding public engagement with the ocean (e.g., Gkargkavouzi et al., 2020) suggesting a broad field for future research.

In terms of methods, the framework and analytical approaches used in this study could serve as a model for similar research across different regions. By adapting the survey instrument, the survey distribution strategy and analytical models to fit local contexts, researchers can explore public attitudes and perceptions towards the ocean in varied geographical and cultural settings.

In terms of results, while specific to the Chilean context, they likely have parallels in other countries with similar geographical, cultural, or socio-economic characteristics. For example, countries with shared environmental challenges may exhibit similar patterns of public perception towards the ocean. Alternatively, nations with significant coastal tourism or fishing industries might find comparable clusters that prioritize economic benefits over environmental considerations, or vice versa. Conversely, in countries where marine conservation and management efforts are more visible and promoted, clusters that demonstrate a high level of environmental awareness and personal responsibility for ocean health may be more prevalent. In addition, in countries with robust environmental education programs and active social media engagement, it is plausible to anticipate the formation of

youth clusters that are highly aware of and concerned about the ocean.

The insights gained from this study are particularly timely and relevant as Chile embarks on the consideration of new coastal management legislation. The Coastal Law, rooted in the principles of coastal zone management, presents a unique opportunity to integrate the study's findings into policy-making and regulatory frameworks. By aligning public perceptions and attitudes towards the ocean with the objectives of this new legislation, there exists a potential to enhance the effectiveness of coastal management efforts in Chile.

5. Conclusion

In conclusion, this study provides valuable insights into the complex web of attitudes and perceptions that coastal communities in Chile hold toward the ocean. By recognizing these differences, more targeted and effective communication strategies and interventions could be designed. Rather than adopting one-size-fits-all measures, policymakers may consider the specific needs and concerns of different demographic clusters. Yet, acknowledging some methodological limitations is essential. Primarily, using social media for survey distribution may not fully represent the population, potentially excluding non-users and introducing a selection bias towards more digitally active demographics. Although this method expands accessibility and participation, reaching segments otherwise challenging to include, it might skew the sample. Detailed demographic survey questions helped gain insights into respondents' age, gender, location, among others, yet these do not fully offset the representativeness issue but offer a foundation for interpreting results. Moreover, the survey's cross-sectional design limits causal inferences and longitudinal insights. Nonetheless, this exploratory study sheds light on varying public perceptions of ocean issues, providing a groundwork for future research to deepen understanding of ocean user dynamics, benefits, and conservation motivations.

CRediT authorship contribution statement

Laura Nahuelhual: Conceptualization, Data curation, Funding acquisition, Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing. **Jonathan von Below:** Data curation, Formal analysis, Methodology, Software, Visualization. **Alejandra Engler:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Gonzalo Campos:** Data curation, Methodology, Supervision. **Javiera Bianchi:** Data curation, Methodology, Writing – original draft.

Declaration of competing interest

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

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

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