


## Participatory action research supporting adaptive governance of Manila clam fisheries

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### ABSTRACT

This paper reports the outcomes of the engagement between researchers, harvesters and other relevant stakeholders using participatory approaches for the purpose of the sustainable management of Manila clam fisheries in Portugal. Collaborative meetings were held between 2018 and 2023 in several coastal systems, framed by participatory action research principles. The goal was to identify problems, collect and analyse biologic and social information, and to discuss and co-construct potential solutions for the management of Manila clam fisheries, addressing the social, economic, biological and ecological dimensions. Throughout the process, a deeper understanding of the challenges facing Manila clam management was acquired, which demonstrated that success varies from system to system and “one size fits all” approach is not viable. Stakeholder meetings resulted in a functional network linking local and national actors. This collaboration influenced national and local regulatory measures, though formal mechanisms for sustaining the network were not achieved. The establishment of local organisations enabled consensus at the local level that shaped governance outcomes; regions with organized associations (Ria de Aveiro and Óbidos lagoon), achieved more effective management solutions compared to less cohesive communities (Tagus and Sado estuary). Participant perception assessments demonstrated that although they have an overall positive attitude towards the collaborative process, they are not certain about its potential to improve management. The Manila clam illegal fishing is perceived as a critical issue that undermines management solutions, that needs dedicated efforts and higher political support. This study highlights the importance of trust, social cohesion, and government support in building effective resource management systems.

### 1. Introduction

Portuguese coastal zones, lagoons, and estuaries have a high number of non-indigenous species (NIS) [7]. Most of the NIS identified in coastal systems are well-established populations, and some are considered invasive species, such as the Manila clam (*Ruditapes philippinarum*), since they are capable of fast dispersal and have caused negative impacts on locations where they have been introduced. This species has been introduced worldwide, often as a response to the overexploitation of native clam stocks [4,11]. The Manila clam is characterized by a high reproductive success, fast growth, and high tolerance to environmental variability [27], and the populations are usually highly abundant, which

explains the invasive nature of the species and its relevance for commercial exploitation.

Biologic invasions in aquatic systems represent a major threat to freshwater and marine biodiversity and cause severe negative ecological, economic and social impacts [36]. Invasive species management can be costly and yield limited success, leading to stakeholder frustration and deterring policy makers from future investments [13]. Moreover, since the ecological trajectory of invaded ecosystems is hard to predict, managers face increasing challenges to deliver informed decisions. The resist-accept-direct (RAD) framework emerged from the recognition of these uncertain consequences of management decisions [37]. Within the RAD framework it is assumed that decision-makers i)

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can actively resist (R) the ecological trajectory by restoring conditions of the invaded ecosystem, ii) can accept (A) the trajectory, allowing the ecosystem to drift into new conditions or iii) intervene in the trajectory (D) to guide the transformation of the ecosystem [37].

The Manila clam was introduced to Portugal in the 1980s and is currently distributed in several coastal systems where it represents an important resource to the bivalve fishery [35,16,43]. The exploitation of the species has been increasing in Portugal, however, it comes with undesired consequences. Overexploitation and Illegal, Unreported, and Unregulated (IUU) fishing of the Manila clam is currently a national problem that threatens ecosystems and sustainable fisheries [9], exacerbated by the management challenges that resulted from the approval of European and Portuguese legislation concerning the NIS (EU Regulation n° 1143/2014 and Portuguese Decree-Law No. 92/2019), which prohibits their release in the wild and also its detention, cultivation and trade.

The unregulated nature of Manila clam harvesting and the current legislation concerning NIS resulted in a considerable effort to achieve a management solution that balances the ecosystems conservation and the exploitation of the resource. Several research projects have been conducted since 2011 to study the Manila clam populations in Portugal, the exploitation characteristics, and the socio-economic dimensions of harvesting [23,24,43,42,28,5,9,6]. These projects set the scientific basis for the management of the resource and for the elaboration of the Manila clam Action Plan (McAP) required by the Portuguese NIS legislation. The establishment of the McAP requires multi-institutional planning efforts and must involve a wide range of key stakeholders with recognized interests in the problem, namely administration institutions with competences on nature conservation, marine resources management, enforcement authorities and local authorities, harvesters, and local associations, among others. The aim of the McAP is to define objectives, indicators, and goals that contribute to a compromise between the interests of different positions and needs of stakeholders.

The complexity of the underlying socio-ecological system in which the Manila clam fishery unfolds demands new management approaches, in which stakeholders can discuss the complexities of the issues, share information or insights, and learn collectively [14]. Stakeholders' knowledge is essential to understand the problem, as well as considering the dynamic of interactions between individuals, institutions, social organizations, and cultural norms, to accomplish a successful management [2].

To address these challenges, Participatory Action Research (PAR) [33] was used as a methodological framework to understand and improve the Manila clam fisheries governance, defined here as the design of the governing systems (which institutions and actors are involved and how they interact). The goal was to increase stakeholders participation in fisheries management, which is recognized as essential for identifying and developing optimal management solutions [38]. Therefore, stakeholders were brought together during the research-action process to address their common issues of interest, using a cyclic pattern of planning, action, evaluation, and reflection. The theoretical framework underpinning the PAR process followed the rationale of Habermas' Theory of Communicative Action [18,34]. This theory emphasizes the role of genuine dialogue, where every participant is free to express their views without fear of retribution or marginalization, i.e. free from coercion, to achieve mutual understanding and consensus. The principles of Collaborative Planning Theory were also applied, emphasizing that the legitimacy of a decision relies on the integrity of the process that produced it. Consensus is achievable when individuals actively listen to one another and adapt their perspectives based on newly gained insights [34,30].

This paper documents the outcomes of the participatory action research process to the Manila clam management and addresses two main objectives: (1) to describe the dynamics of Manila Clam harvesting in four study sites in Portugal and (2) to explore the potential for consensus-based clam management approaches. By engaging

researchers, fishers and other relevant stakeholders, this study provides insights into the adapting management of Manila clam fisheries and discusses how participatory processes can support the sustainable exploitation of the resource.

## 2. Participatory action research framework

A consensus-based clam management required an alternative research approach, method, and application, to achieve social change. The PAR framework, guided by the rationale of Habermas' Theory of Communicative Action, recognized research as a communicative act, and was used for the construction of collective knowledge, considered essential to support a Manila clam joint management solution. PAR is a collaborative process of research, education, and action [17], that emphasizes the participation and action of community members targeted by a research process. It aims to achieve social transformation [26], by fostering a collaborative understanding of the world and encouraging reflective action for effective change [33]. In a PAR process the community plays the role of co-researchers, either participating in the identification of the problems, collecting, and analysing the information, or in the identification of potential solutions [32], operating as a "community organizing and problem-solving tool" [38], pp.8).

The key aspects of PAR outlined by McTaggart [26] are: i) emphasis on participation - engage the community and promote their involvement as co-researchers, allowing them to shape research questions, experimental design, methods, and analysis; ii) collective inquiry and experimentation - emphasize collective inquiry based on experience and social history, encouraging communities to evolve and collaboratively address significant questions and issues; iii) integration of participation, action and research. Since PAR embraces a pluralistic approach, it moves beyond a single, uniform set of ideas and methods. Instead of relying on detached, passive observation, PAR focuses on creating knowledge that is grounded in real experiences and actively contributes to social change.

## 3. Methods

### 3.1. Study area characterization

The Manila clam is currently distributed in the Ria de Aveiro, Óbidos and Albufeira coastal lagoons and Tagus, Sado and Mondego estuaries [16,35,43,42], and represents an important fishery in most of these coastal systems, except in the Mondego estuary and Albufeira coastal lagoon, where it has a residual occurrence. The state of the Manila Clam exploitation in Portugal was addressed by Coelho et al. [9], showing that there are significant differences between the abundance and distribution of the resource and between the structure of the fishing communities. In Ria de Aveiro (83 km<sup>2</sup>) and Óbidos coastal lagoon (7 km<sup>2</sup>) the Manila clam is abundant but not the dominant species, and it is harvested alongside other bivalves, while in the Tagus estuary (325 km<sup>2</sup>) it is the dominant species and intensively harvested. In the Sado estuary (180 km<sup>2</sup>), although abundant, the exploitation of Manila clams has low expression [9]. In fact, Coelho et al. [9] report the Tagus estuary as the most important system for the Manila clam harvesting, with higher resource abundance and where a drastic transformation of the dynamics of the clam fishery occurred in the past ten years. Currently, in the Tagus estuary, the Manila clam is the main target species, with high number of fishers engaged in IUU fishing, while in Ria de Aveiro and Óbidos coastal lagoon most harvesters are licensed and catch also other species (cockles and European native clams). This study was conducted in the four Portuguese systems where the Manila clam fishery is relevant: the Ria de Aveiro, Óbidos coastal lagoon, and Tagus and Sado estuaries.

### 3.2. Characterization of Manila clam harvesting

#### 3.2.1. Harvester surveys

Surveys were conducted in the Ria de Aveiro, Óbidos coastal lagoon, and Tagus and Sado estuaries between 2019 and 2022 to characterize Manila clam fishers', through face-to-face interviews conducted during low tide in periods of full or new moon (spring tides), in areas previously identified for bivalve harvesting. Respondent sampling was based on a modification of the snowball sampling approach [3], to guarantee that it is representative of the fisher population. The sample used initial individuals' social network to access the group, who were randomly selected from the different fishing zones in each system. Due to the COVID pandemic, telephone surveys were also conducted using the contacts provided by local fishers associations. To cope with the pandemic limitation, an online version of the survey was also made available and disseminated through associations, local authorities, representatives of relevant stakeholders, and social media. The survey consisted of 18 questions, both quantitative and fixed choice and open-ended short-answer questions, covering the following purposes: i) characterization of harvesters (licensed and unlicensed); ii) fishing effort determination; iii) identification of fishing techniques; and iv) knowledge about harvesting regulations. Answers to the questionnaires were subject to descriptive statistics based on their relative percentages. A total of 234 surveys were carried out in the studied systems (Tagus - 134, Sado - 21, Aveiro - 36, Óbidos - 43), numbers that were proportional to the importance of the harvesting activity in each system. Face-to-face interviews were the main method to collect fishers' answers (78 %), with only 51 surveys performed online.

#### 3.2.2. Fishing effort and yield estimation

Manila clam fishing effort and yield in 2019 was estimated in the scope of the NIPOGES project, developed by the Faculty of Sciences at the University of Lisbon [6]. The project evaluated the status of the Manila clam populations, characterized the harvesting community and the resource value. Aerial (videos recorded during a gyroscope's flight) and terrestrial surveys (observations registered using binoculars) were performed in four coastal systems during NIPOGES to count the number of harvesters and estimate fishing effort. This method was combined with the answers concerning fishing effort obtained from the surveys (4.1.1), to estimate in each system the total Manila clam fishing effort (details in [6]). These results were compared with official statistics data from landings and licenses in 2019, delivered by the Portuguese General Fisheries Directorate (DGRM) of the Portuguese Government.

### 3.3. Collaborative governance - participatory action research methodology

The principles of PAR were used to develop a collaborative governance process with an effective, expanded, and active engagement of stakeholders, aiming for the development of joint solutions for Manila clam management. The process was developed through a series of collaborative meetings, which aimed to: (1) improve common understanding of the problems associated with Manila clam management; (2) establish collaborative networks for the future; (3) promote the transfer of knowledge and contribute to the individual and social learning of stakeholders; and (4) collectively support the development of proposals for the Manila clam management. The collaborative meetings were designed to increase knowledge sharing between stakeholders and researchers, and to co-build collective understanding and social capital [46]. Between 2018 and 2022 the meetings were organized in the scope of the NIPOGES project and held in three coastal systems – ria de Aveiro, Óbidos coastal lagoon and Tagus estuary – and in 2023 expanded to the Sado estuary, taking advantage of the collaborative governance process developed so far.

In practice, the process included three main phases: 1) preparation period, identification and mapping of stakeholders; 2) structure and

design of the collaborative meetings; 3) implementation of the collaborative meetings for the development of management proposals. In the preparatory phase (Phase 1), preliminary meetings were held within the NIPOGES research team and with members of the target fishing communities where stakeholder mapping started to take place. Stakeholders mapping was developed to include actors directly and indirectly affected by the Manila clam management, to guarantee the mobilization and involvement of all potentially interested and/or impacted by the process results. A set of key questions based on ISO 26000 – Guide to Social Responsibility was used to support the identification of the actors (e.g. who can positively or negatively be affected? Who are the actors most affected by the outcome? who is responsible for the management decision-making?), which were directly contacted by email and/or telephone and inviting to attend the meetings. Harvesters' surveys also provided individual contacts. The mapping was continuously updated throughout the project whenever considered necessary. Subsequently, the meetings were structured and designed to adjust to the expected outputs in each cycle of the collaborative governance process (Phase 2), and materialised into three sessions, each with specific objectives (Phase 3) (Fig. 1). Due to the COVID-19 pandemic three meetings were held online, using ZOOM conferencing software.

Following the principles of PAR, the implementation of the NIPOGES governance process resulted in a total of 9 collaborative meetings held between 2018 and 2022 (3 online), and four meetings held in the scope of the McAP, in 2023. The collaborative meetings were structured and facilitated by mediation professionals, with expertise in engagement and participation techniques. Interactive methodologies were used to favour the creation of dialogue, encourage mutual learning, and the effective involvement of all the participants [41]. Dynamics, flexibility and adaptability were ensured, to align the process with the specificities of each coastal systems (Ria de Aveiro, Óbidos coastal lagoon and Tagus estuary), and respond to the needs of each region and its stakeholders. The diversity of stakeholders and the differences between regions required adjustments in the meetings, namely in the sessions scheduling, the digital options, or to ensure the integration of illiterate participants. The results of each meeting were analysed by the NIPOGES project team through content analysis of the notes captured, which were grouped in different topics. Meeting minutes were prepared and shared with participants to ensure that all views and concerns were captured. This local and scientific knowledge was progressively integrated into the preparation of the following meetings, following Luyet et al. [22] principles for successful participation. The NIPOGES governance process ended with the development of proposals for the management of the Manila clam, which were discussed with stakeholders in 2023 in a final round of meetings. These meetings were organized to address the need to develop the McAP, as required by the legislation regarding the introduction of alien species into nature (Decree-Law No. 92/2019).

### 3.4. Assessment of stakeholder's engagement

A survey on a 5-point Likers scale [21] was developed to assess stakeholders' perception about the participatory process developed in the scope of NIPOGES project and during the development of the McAP. The survey asked respondents about their (i) perceptions concerning the participatory process, and (ii) perceptions towards fishery regulations. An online questionnaire comprising fourteen questions was sent by email and/or WhatsApp to all the participants in the meetings (n = 94). The questionnaire used in the survey was tested with two representatives of fishers, two researchers, and two administration technicians in order to: ensure reliability and validity, identify potentially confusion items, and elicit improvement suggestions. The questionnaire items were revised accordingly. Forty-four valid questionnaires were analysed to assess stakeholders' perception about the collaborative process. Answers to the questionnaires were subject to descriptive statistics based on their relative percentages.

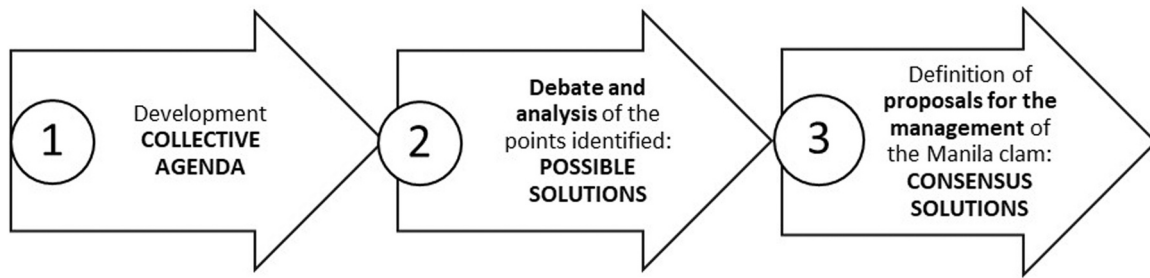


Fig. 1. The three cycles of the collaborative governance process, and correspondent objectives of the sessions.

4. Results

4.1. Characterization of Manila clam harvesting

4.1.1. Harvester surveys

The mean age of harvesters surveyed (86 % male) was 45 years (range between 14 and 76 years old, with no significant differences between systems) with more than 60 % of the harvesters younger than 50 years. The fishery targeting Manila clam greatly increased after 2010, when 75 % of the interviewed harvesters started to catch the species. Manila clam is the exclusive target to half the respondents (with differences between systems), with the other half targeting also other species (e.g other clam species, cockles, cuttlefish). Across the four studied systems, most of the harvesters have alternative professional occupations besides fishing (57 %), and no professional license (58 %) (Fig. 2), although they indicated that the catch frequency is, on average, 5–7 days a week. Half of the respondents collect clams by hand, but the fishing techniques (Table S1) are variable between systems (Fig. 2), and therefore, the average daily yield ranges between 0.5 kg and 10 kg.

The Manila clam market chain is highly variable in the four studied systems. Although personal consumption was commonly mentioned as

the final destination of Manila clams' catches, the answers may mask the illegal activity, either of the recreational fishery or of non-licensed harvesters. In the four studied systems, there are harvesters with recreational licenses that sell their catches either to intermediaries or directly to restaurants to avoid the fiscal costs of entering the formal economy. This occurred predominantly in the Tagus and the Sado estuaries. Typically, sales occur via illegal intermediaries in the Tagus estuary, where direct cash payments were observed during field interviews. Therefore, it is possible that some of the respondents have omitted the fact that the harvest is for commercial purposes and indicate personal consumption for precaution. In the Óbidos coastal lagoon and Ria de Aveiro the Manila clam first-sale occurs via registered buyers: DOCAPECA auctions, the public service organising the first sale of sea products or the shellfish industry, both representing a guarantee of the application of national and European shellfish control regulations [31].

4.1.2. Fishing effort and yield estimation

Manila clam harvesters and yield in 2019 were estimated in each studied system based on harvesters counts and survey results, showing great inconsistencies between estimates and official landings data (Fig. 3). Hand collection was the catch technique used by most fishers,

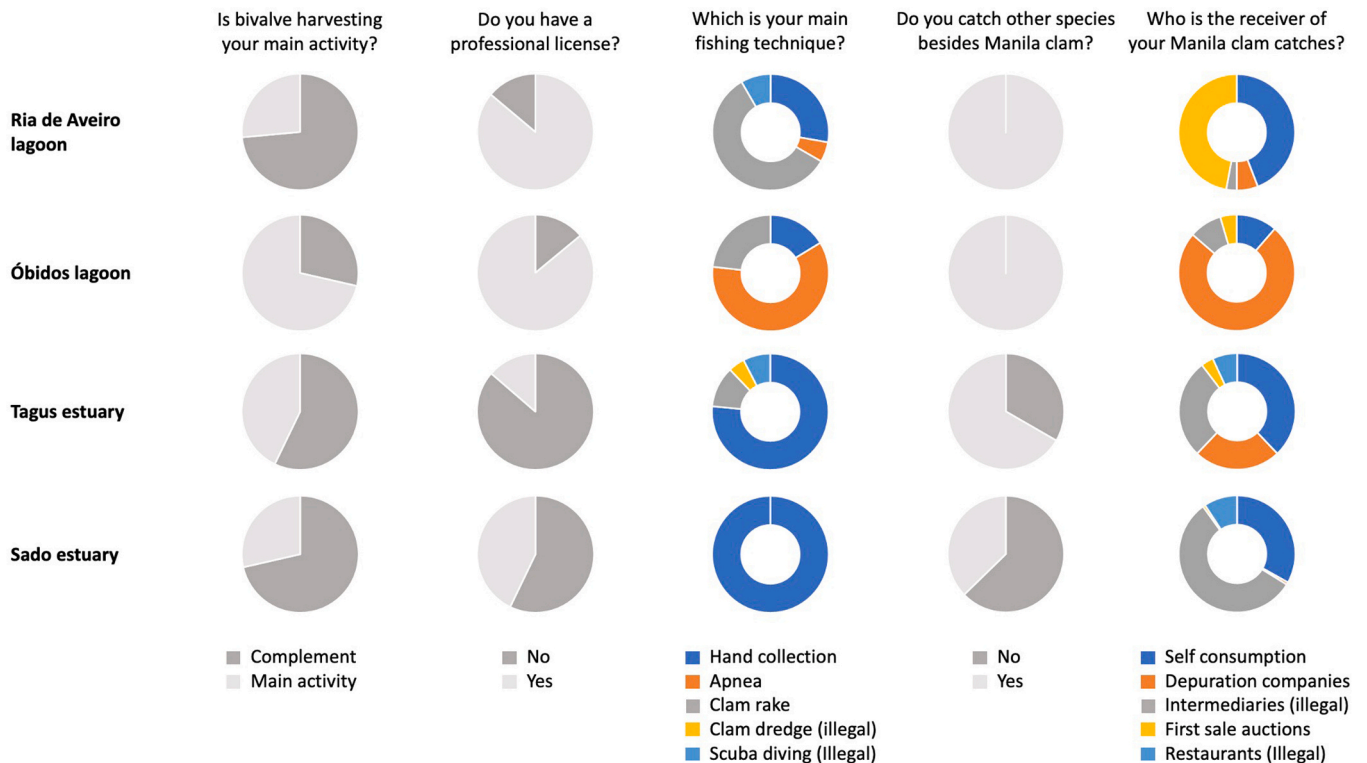


Fig. 2. Frequency of answers to the survey conducted in Ria de Aveiro, Óbidos coastal lagoon, Tagus and Sado estuary between 2019 and 2022, targeting Manila clam harvesters.

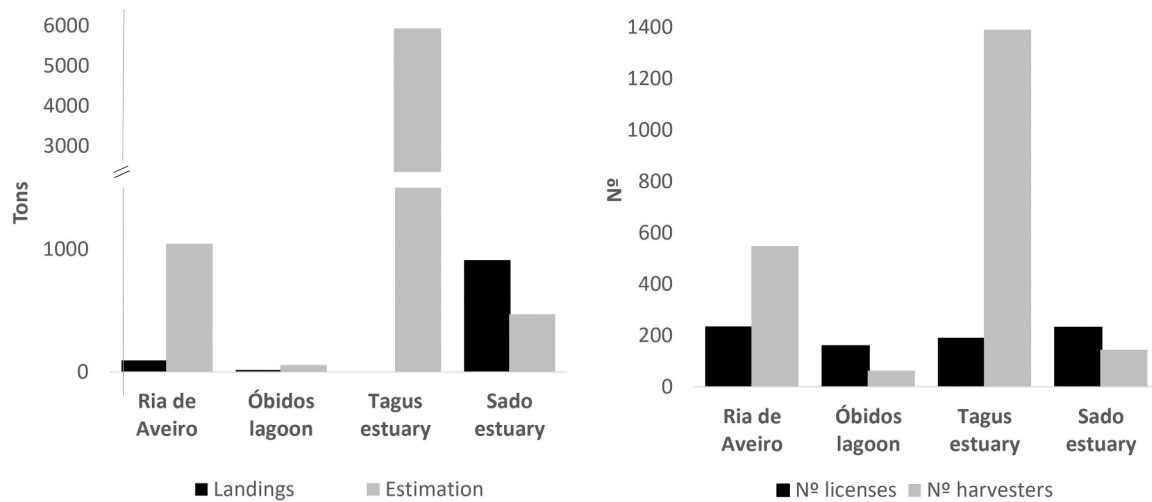


Fig. 3. Estimates (grey) and official landings data (black) of the Manila clam catch (left) and the number of harvesting licenses and number of estimated harvesters (right) in Ria de Aveiro, Óbidos lagoon, Tagus and Sado estuary in 2019.

although higher clam volumes are captured using other fishing techniques. In the Tagus estuary the number of harvesters estimates were the highest, and where inconsistencies with assigned licenses are greater. In the four studied systems the total Manila clam yield in 2019 was estimated to be 7491 tons (≈ 24 million euros at first sale), which is seven times higher than the official statistics in that year for the entire country (1024 tons). The Tagus estuary is also the system where inconsistencies between estimated values (80 % of the catch in the four systems) and official landings is higher. Manila clam first-sale is officially

concentrated in ports located in the Sado estuary (912 tons), which is the only system where yield estimates are lower than data of official landings.

4.2. Collaborative governance process through PAR

The stakeholders mapped in the Tagus and Sado estuaries, in Ria de Aveiro and in the Óbidos coastal Lagoon included harvesters (of Manila clams and other bivalve species), NGOs, local, regional and national

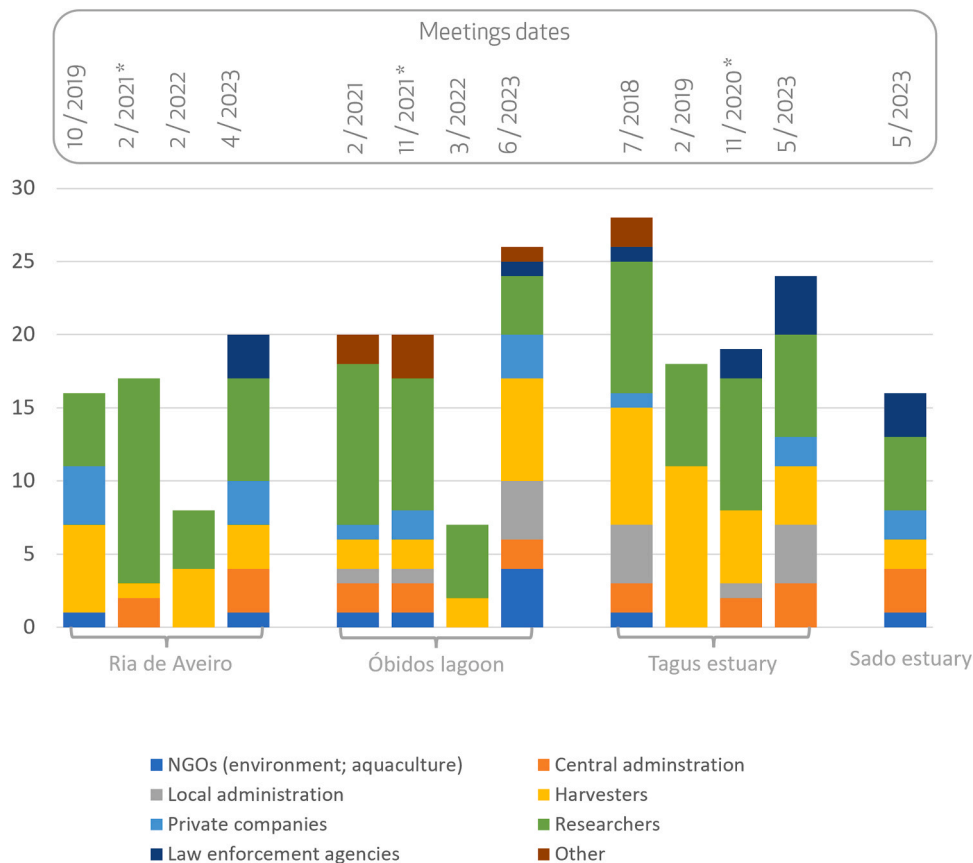


Fig. 4. Number of participants per stakeholder group present in the Manila clam regional meetings occurred between 2018 and 2023 in Ria de Aveiro, Óbidos coastal lagoon, Tagus and Sado estuaries. Meetings held online signed with an asterisk.

administration, enforcement agencies, private companies, and academics. The collaborative meetings held between 2018 and 2022 were attended by 71 stakeholders, with a significant increase in the participants numbers in 2023. This was accompanied by an increase in stakeholders' diversity, particularly with the regular participation of law enforcement agencies. In total, the thirteen meetings brought together 94 representatives of public and private institutions, regional and national administration, including the project members, guaranteeing the presence of diverse interests in the Manila clam management. Participants were relatively equally distributed among stakeholders' groups, although harvesters and researchers had higher representation and were the only groups present in all the meetings (Fig. 4).

The engagement, mobilization, and participation of stakeholders in the meetings varied across the coastal systems. Although it was in the Tagus estuary that harvesters were present at higher numbers, particularly in the February 2019 meeting (Fig. 4), the participants did not represent most of the Manila clam harvesters. Since most have no license to harvest (Fig. 3), they are not engaged in any of the three fishers' organizations that exist in the Tagus estuary, which were the ones enrolled in the process. In the Sado estuary, there is no organization that represents the Manila clam harvesters, and the participants in the meeting were involved on an individual basis. Therefore, the low levels of organization of both systems prevented adequate representativity of harvesters in the meetings held in the Tagus and Sado estuaries. This contrasts with the fishing communities in Ria de Aveiro and Óbidos coastal Lagoon, where most harvesters are engaged with the local associations, showing that a strong self-organization is present in these systems, i.e. harvesters organize themselves towards common goals. Therefore, in Ria de Aveiro and Óbidos coastal Lagoon, the local fishers association were the main mobilizers of participants and the key informants during the collaborative meetings.

To increase stakeholders' participation, particularly the harvesters, the meetings were scheduled after 5 pm in locations close to the fishing areas. However, their participation was negatively impacted by difficulties in accessing and using technology when meetings were held exclusive online, and to a lesser extent when a hybrid format (online and face to face) was adopted. The participants in the online meetings were mainly those who had been working with researchers and were aware

about the research projects on the Manila clam for a longer time.

There was a fruitful exchange of views on topics related to Manila clam management during the collaborative meetings, with an emphasis on fishery regulations and surveillance (Fig. 5). Stakeholders widely agreed that illegal fishing is a major problem for the fisheries sustainability and several infringements were identified: illegal fishing gear, non-licensed harvesters, unreported catches, and misleading catch origin. Illegal activity also occurs in the commercialization chain and therefore this topic was also frequently discussed in all the meetings. However, throughout the collaborative governance processes, it was possible to identify topics and concerns that were specific to a particular system. For instance, the conflict between harvesting and aquaculture activities is highly relevant only in Ria de Aveiro, the area-based management concern emerged frequently in the Óbidos coastal lagoon meetings, and the degradation of the social system is a major concern specific of the Tagus estuary, where undocumented immigrant labour and human trafficking networks connect directly with the local Manila clam harvesting (Fig. 5).

The implementation of the collaborative meetings and the identification of the various themes and concerns made it possible to incorporate local knowledge into the decision-making process and to co-construct a total of 39 proposals/recommendations for the management of Manila clam (Tagus Estuary - 17; Sado estuary - 4, Ria de Aveiro - 11 and Óbidos coastal Lagoon - 7) (details in [9]). These proposals were a substantial support base for the consolidation of the governance model adapted to each system, and framed the McAP meetings that took place in 2023, when the Sado estuary was added to the collaborative process. In the Sado meeting the harvesters recognized the importance of collective action and regretted the fact that there is no local organization to represent their interests.

#### 4.3. Assessment of stakeholder's engagement

The response rate of the perception survey was 47 % (11 responses from Ria de Aveiro, 13 from Óbidos lagoon, 14 from Tagus estuary, 6 from Sado estuary), with the representativeness of respondents highly balanced: 9 % NGOs, 21 % Central administration, 11 % Local administration, 18 % Harvesters, 14 % Private companies, 9 % Researchers,

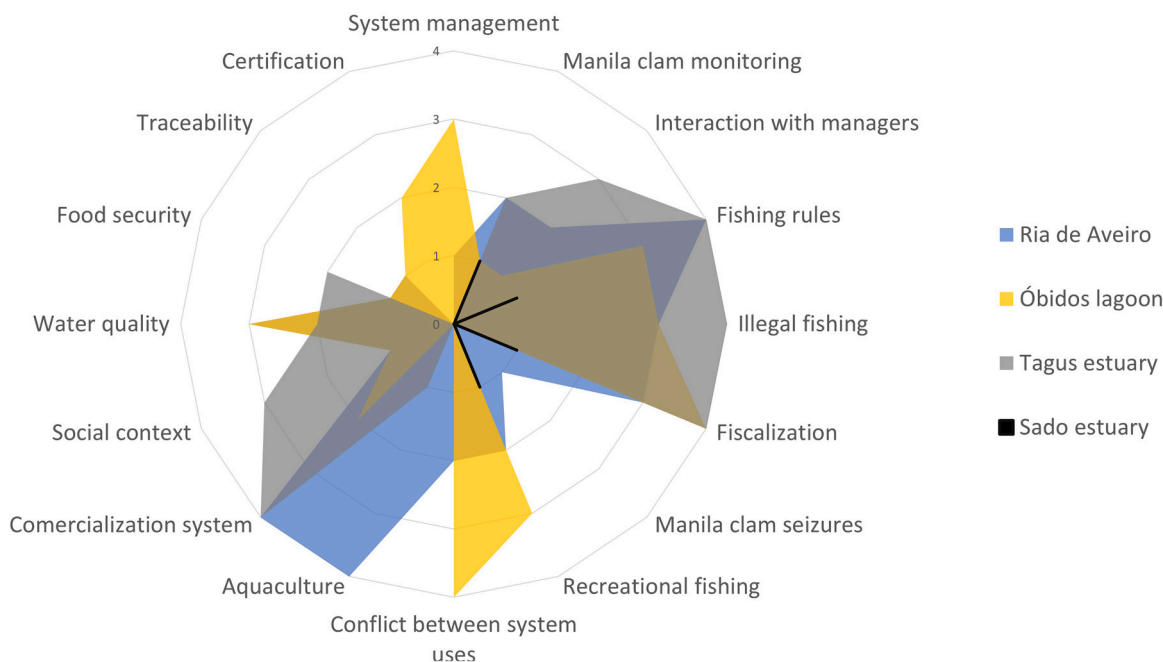


Fig. 5. Topics and concerns covered in the Manila clam regional meetings that occurred between 2018 and 2023 in Ria de Aveiro, Óbidos lagoon, Tagus and Sado estuary. The values on the axis indicate the number meetings in which the topic/concern was mentioned.

16 % Law enforcement agencies, 2 % Other participants. The differences in the response rate between systems and/or stakeholders' groups is highly related with the rate of participation, except in the case of researchers and harvesters, which had a low rate of response compared with the numbers of participants in the meetings.

Most stakeholders showed a positive perception regarding the participation in the meetings and considered that the relevant interests concerning the Manila clam fisheries were present in the discussion (Table 1). Administration (central and local) and law enforcement agencies were the stakeholders that mostly disagreed with the representativeness of all relevant actors, particularly in the Tagus estuary. Respondents felt they had the opportunity to voice their concerns, ask questions, and discuss management strategies, however, perceptions regarding regulation changes were neutral. When asked if meetings changed regulation for the better, most stakeholders did not notice significant improvements in Manila clam management, especially in the Tagus estuary, although the majority stated that the situation did not get worse. The knowledge increase (in biology, Manila clam fishery, fishing regulation and enforcement) and the opportunity to meet with different stakeholders were pointed out as the major positive aspects of the collaborative meetings, although almost 50 % of participants considered that information exchange should be improved (Table 1). Participants suggested more regular communication and feedback, since they perceive little impact of the meetings outputs on the management decisions. Therefore, perception analysis shows that stakeholders, although recognising the efforts to update Manila clam management in recent years, particularly in terms of regulating the fishing effort and the allowable catches, they are still unsatisfied with the lack of measures to reduce IUU catches. This is particularly evident in the comments collected in the perception survey: *"I would like a solution to be found for more control over harvesting"* and *"I honestly believe that the Manila clam issue needs a multidisciplinary working group, dedicated and funded by a political initiative. By this way, it can be objectively determined whether the legal norms that regulate the activity serve the interests of the rule of law and what measures should be taken to ensure effective compliance or whether, on the contrary, they should be changed/reformulated"*.

#### 4.4. Impact of participatory research in Manila clam governance

A general overview of the Manila clam exploitation in Portugal between 2009 and 2024, the research developed to assess the status of the populations, the collaborative meetings, and the regulation changes in the same period are summarized in Fig. 6.

**Table 1**

Descriptive statistics to Likert-type statements designed to quantify stakeholders' perceptions regarding the Manila clam regional meetings organized between 2018 and 2023 in Ria de Aveiro, Óbidos coastal lagoon, Tagus and Sado estuaries. Statements were measured in a five-point Likert-scale, subsequently dropped to a three-point Likert-scale: disagree (=1), neutral = neither agree nor disagree (=2), agree (=3);  $\pm$  SD - standard deviation.

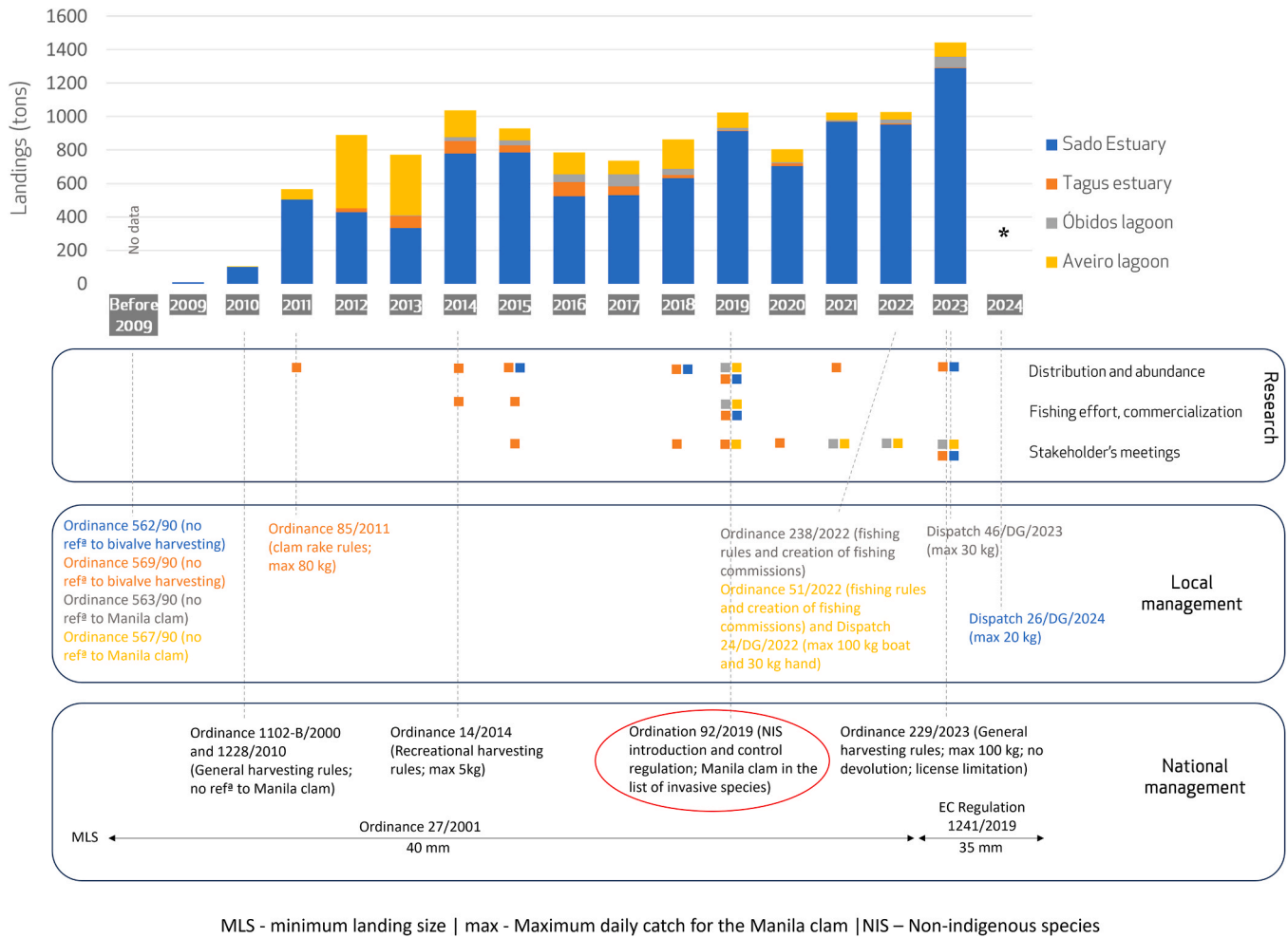
Likert-scale items	Responses			Mean ( $\pm$ SD)
	Disagree	Neutral	Agree	
<i>Participation in meetings</i>				
"The relevant stakeholders were all represented"	10	3	31	2.48 (0.84)
"Meetings promote dialogue between stakeholders"	5	2	37	2.73 (0.65)
"Stakeholders active participation was guaranteed"	4	2	38	2.78 (0.60)
"Meeting expectations were fulfilled"	4	5	35	2.71 (0.62)
<i>Outputs</i>				
"Meetings changed the regulations for the better"	11	18	15	2.10 (0.76)
"Meetings changed the regulations for the worse"	21	15	8	1.71 (0.76)

The Portuguese General Fisheries Directorate (DGRM) oversees clam fisheries management. It has legal authority over coastal waters and jurisdiction over activities related to the capture of shellfish. The recorded regulation of bivalve fisheries in the studied systems dates to the 1990's, when Manila clam populations were not yet established in Portugal. Therefore, when the fishery started to increase in 2009, there were no specific measures to regulate the Manila clam fishery or even the knowledge to support decision-making. Research projects started to gather knowledge about the distribution, abundance, and fisheries of the species in 2011, first in the Tagus estuary, and in the following years expanded to other Portuguese coastal systems. Stakeholder meetings in the scope of those projects started in 2015, to discuss the data gathered by researchers and the harvesters' knowledge about the resource exploitation, which set up the basis for the decision-making concerning specific management measures. The engagement of researchers with the communities lasted around six years, before Manila clam specific regulations were adopted. In-depth discussions around each theme, analysis of biological, ecological and social data, and the results of questionnaires, culminated in several recommendations.

The 39 proposals/recommendations for the sustainable management of Manila clam co-construct by stakeholders (details in [9]) were discussed in the meetings held in 2022 and 2023, when there was a consensus about the need to update the system-specific regulations to include the species. The maximum daily quantities of Manila clam catch in each system, the harvesting techniques, criteria for closure periods or the need to increase the number of harvesters licenses in the Tagus estuary, were agreed between stakeholders (regional Ordinances 51/2022 and 238/2022, regional Dispatches 24/DG/2022, 46/DG/2023 and 26/DG/2024) (Fig. 6). These specific measures were based on data on Manila clam productivity and fishing effort estimations (research and local knowledge), however, the legal instruments under which the Manila clam harvesting was framed do not address the resource specificities, namely its non-indigenous and invasive nature.

Coordinated efforts between the fishery and the conservation government agencies were established following the approval of the National law listing the Manila clam as an invasive NIS of concern (Annex II of the Portuguese NIS law, Decree-Law No. 92/2019), acknowledging the need to adapt regulations and management tools. Since Article 16 introduced legal constraints to Manila clam harvesting (prohibition of holding and trade of the species included in the List of Invasive Species), inconsistencies with fishing regulations arose, and the elaboration of the McAP to ensure the control, containment, or eradication of the species, mandatory by the NIS law, emerged as an important instrument to manage the Manila clam populations and its fisheries. The dialogue between the Portuguese competent authorities resulted in the assumption that Manila clam population control should be carried out through sustainable fishing, since the current state of the populations does not allow for its eradication. Therefore, the knowledge network established between 2011 and 2022 was recognized as relevant to address Manila clam conservation concerns and motivated a new round of meetings with stakeholders in 2023, in the scope of the preparation of the McAP. In turn, these meetings strengthened the network, evidenced by participants' comments like *"These processes are very important to improve understanding and help management to make more conscious decisions"*, and by their availability to answer the online perception questionnaire.

Although the fishery regulation adaptations followed the recommendations that emerged from the participatory action research process, the specific models proposed to manage this fishery in the Óbidos lagoon (co-management) and in the Tagus estuary (concession areas and free-access areas) (details in [9]), were questioned, mainly by harvesters. In the Óbidos lagoon it was argued that an area-based co-management model would be more suitable to address the interconnected nature of the fishery problems, and in the Tagus estuary stakeholders stated that the illegal fishing dissemination in this system could compromise the concession model.



**Fig. 6.** Schematic representation of Manila clam history in Portugal since 2009 through landing statistics (top plot), research topics and related actions (box 1), and management framework at regional (box 2) and national level (box 3). Colours represent actions in respective systems: ■ Sado estuary, ■ Tagus estuary, ■ Óbidos lagoon, ■ Ria de Aveiro. Regulations in the management framework boxes shows in parenthesis, when appropriate, the related measures for the Manila clam fisheries: fishing gear, minimum landing size and maximum daily catch. Red oval signs legislation concerning the non-indigenous species. Non-available data signed with an asterisk.

**5. Discussion**

The establishment of the Manila clam in Portuguese estuaries and coastal lagoons introduced significant socio-ecological changes in the systems that require adaptations in the natural resources management. The significant increase in abundance of Manila clams, particularly in the upstream areas of the Tagus estuary after the strong reduction of the native congeneric species *Ruditapes decussatus* in downstream areas [8], caused relevant changes in the commercial harvesting of bivalves, and triggered intense Illegal, Unreported and Unregulated (IUU) fishing activities.

The participatory action research (PAR) framework implemented in this study provided key knowledge to understand how the Manila clam fishery, the institutions and the actors respond to, and learn from, this driver of change. Collective reasoning and collective management proposals were constructed during the Manila clam governance process, based on the dialogue between stakeholders and on the integration of scientific and local knowledge, known to be a valuable tool for effective management [39,15,1]. Through this process, the social and economic importance of the Manila clam was ascertained and consequently used to design policies that contribute to the resilience of fishing communities.

The fact that Manila clam is on the list of invasive species in the scope

of the Portuguese NIS regulation, introduced additional challenges to the species governance process. Since the current state of the populations in the studied aquatic systems does not allow eradication, and the new benthic communities are significantly altered in relation to the state before introduction, the decision to adopt a management strategy towards sustainable fishing was consensual between the stakeholders. It is in line with the Direct option under the RAD paradigm for managing ecological transformations [37] and with the fisheries certification standards concerning NIS, advocated by the Marine Stewardship Council [25]. Managing invasive species through fishing is an accept-type strategy, which recognizes that the commercial value of the species might be a practical and cost-efficient complementary solution for population control [13]. The option to promote sustainable fishing is a trade-off between maintaining Manila clam populations at levels that minimises negative impacts on native species, and reducing the impacts caused by IUU fishing.

The diversity of issues and concerns identified during the collaborative meetings highlight the diversity in the socio-ecological systems engaged in Manila clam management, although there are problems that cut across systems and require similar solutions. Therefore, the process was conceived knowing that meetings in which stakeholder participation is inclusive, creative and based on genuine dialogue [40,44], are crucial to the development of consensual solutions [10]. The resulting

network of stakeholders included the relevant local and national actors, provided the necessary linkage between levels of action, and influenced the harvesting measures approved in 2023 at national level (Ordinance 229/2023). This achievement is highly relevant in the Manila clam fishery governance and demonstrates that a functional network with capacity to influence political decisions was built through the collaborative process. However, formal mechanisms to maintain structured or frequent interactions among stakeholders were not created, and the sustainability of the network is uncertain.

The history of local cooperation, expressed through harvesters self-organisation, had a strong impact on the fishery governance outcomes. In the Ria de Aveiro and Óbidos coastal lagoon, where strong fisher's associations exist, regional Ordinances (51/2022 and 238/2022) to regulate the Manila clam harvesting in each system were approved in 2022, while at Sado estuary specific management measures were delayed (Sado estuary Dispatch 26/DG/2024 was released only in August 2024) and in the Tagus estuary management measures date back to 2011. Those approved regulations were discussed during the governance process and achieved a consensus between stakeholders (namely the national administration and the local fishers organisations), demonstrating the importance of well-functioning communities to the resources management. According to Jentoft [19] and Jentoft et al. [20] trust and social cohesion in fishing communities are key factors for effective management systems. Moreover, government agencies that support the economic and social sustainability of communities contribute to the effectiveness and efficiency of the fisheries' governance systems. In the Ria de Aveiro and Óbidos coastal lagoon, direct contact between national agencies and local associations has strengthened the sense of community and bolstered collective action, while in the Tagus and Sado estuaries the capacity for collective action is significantly weakened, and consequently, the Manila clam fishery still lacks a specific regulation in the Tagus estuary. In fact, harvesters in the Sado estuary have acknowledged that more organised communities have greater opportunities to participate in fisheries management, thereby contributing to the development of more effective management solutions.

The response rate of the online survey to access perception about the participatory process (47 %) is in line with average response rates in other fields of research [45]. Although harvesters and researchers showed lower response rate, considering the higher number of these actors in the participatory process, this balanced the responses between stakeholders' group, avoiding response bias towards a specific interest group. The researchers did not respond as their participation in the study could have presented a conflict of interest. The harvesters, on the other hand, might have face difficulties in answering due to their internet proficiency. Future planning of surveys targeting Manila clam harvesters should keep in mind that alternative modes to the online should be considered.

The stakeholders' positive feedback about the collaborative meetings was not followed by satisfaction about its impacts on the management of Manila clam. Although participants expressed some level of dissatisfaction on both the process (i.e. allocated time and continuity) and the outputs (i.e. management measures changes, information exchange), the incapacity of the governance process to address the illegal activities in the Manila clam fisheries was pointed out as the major problem. Several stakeholders highlighted how illegal fishing and organised crime undermines fishing regulatory efforts to promote sustainable management in Manila clam fisheries. Therefore, if stakeholders do not perceive their participation as meaningful to find a solution to the fishery core problems, they might get frustrated with the cooperative management efforts and decrease their trust in future initiatives [12]. Since illegal fishing compromises the success of the participatory processes [29], confronting its detrimental impact on the sustainable management of Manila clam fisheries is key for the collaborative governance. To address this problem, one suggestion was the formation of a dedicated multidisciplinary group supported by a political initiative, to combat illegal

activities and reinforce the integrity of collaborative governance.

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## CRedit authorship contribution statement

**Correia Maria:** Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Chainho Paula:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization. **Goulding Thomas:** Writing – review & editing, Methodology, Investigation. **Carvalho Frederico:** Writing – review & editing, Methodology, Investigation. **Cabral Sara:** Writing – review & editing, Methodology, Investigation. **Ferreira Filipa:** Writing – original draft, Methodology, Investigation. **Vasconcelos Lia:** Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization.

## Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.marpol.2025.106605](https://doi.org/10.1016/j.marpol.2025.106605).

## Data availability

Data will be made available on request.

## References

- [1] S. Aswani, A. Lemahieu, W.H. Sauer, Global trends of local ecological knowledge and future implications, *PLoS One* 13 (4) (2018) e0195440.
- [2] N.C. Ban, M. Mills, J. Tam, C.C. Hicks, S. Klain, N. Stoeckl, M.C. Bottrill, J. Levine, R.L. Pressey, T. Satterfield, K.M. Chan, A social-ecological approach to conservation planning: embedding social considerations, *Front. Ecol. Environ.* 11 (4) (2013) 194–202, <https://doi.org/10.1890/110205>.
- [3] H.R. Bernard. *Research Methods in Anthropology: Qualitative and Quantitative Approaches*, 4<sup>th</sup> ed, AltaMira Press, Oxford, 2006, p. 803.
- [4] A. Bodoy, T. Maitre-Allain, A. Riva, Croissance comparée de la palourde européenne (*Ruditapes decussatus*) et de la palourde japonaise (*Ruditapes philippinarum*) dans un écosystème artificiel méditerranéen, *Vie Mar.* 2 (1981) 39–51.
- [5] S. Cabral, F. Carvalho, M. Gaspar, J. Ramajal, E. Sá, C. Santos, G. Silva, A. Sousa, J. L. Costa, P. Chainho, Non-indigenous species in soft-sediments: are some estuaries more invaded than others? *Ecol. Indic.* 110 (2020) 105640 <https://doi.org/10.1016/j.ecolind.2019.105640>.
- [6] Chainho, P., Costa, J.L., Brito, A.C., Amorim, A., Melo, R., Guerreiro, J., Pinto, B., Catalão, J., Carvalho, F., Correia, M.J., Santos, M., Cabral, S., Goulding, T., Santos, C. et al. (2022). Relatório do projeto "NIPOGES - Estado atual das populações de Amêijoja-japonesa da ria de Aveiro, lagoa de Óbidos e estuários do Tejo e Sado – bases científicas para uma gestão sustentável do recurso". MARE-UL, IDL, IPMA, MARE-UNOVA, MARE-UEVORA, Universidade Évora, CESAM-UAVEIRO, SPL, APARA. 169pp.
- [7] P. Chainho, A. Fernandes, A. Amorim, S.P. Ávila, J. Canning-Clode, J.J. Castro, A. C. Costa, J.L. Costa, T. Cruz, S. Gollasch, C. Grazziotin-Soares, R. Melo, J. Micalé, M.I. Parente, J. Semedo, T. Silva, D. Sobral, M. Sousa, P. Torres, V. Veloso, M. J. Costa, Non-indigenous species in Portuguese coastal areas, coastal lagoons, estuaries and islands, *Estuar., Coast. Shelf Sci.* 167 (2015) 199–211, <https://doi.org/10.1016/j.ecss.2015.06.019>.
- [8] Chainho, P., 2014. Portuguese report. In: Report of the Working Group on Introduction and Transfers of Marine Organisms (WGITMO), 19–21 March, 2014, Palanga, Lithuania. ICES CM 2014/ACOM: 32, 259 pp.
- [9] P. Coelho, F. Carvalho, T. Goulding, P. Chainho, J. Guerreiro, Management models of the Manila clam (*Ruditapes philippinarum*) fisheries in invaded European coastal systems, *Front. Mar. Sci.* 8 (2021) 685307.

- [10] Public participation and better environmental decisions, in: F.H.J.M. Coenen (Ed.), *The promise and limits of participatory processes for the quality of environmentally related decision-making*, Springer Netherlands, Dordrecht, 2009, <https://doi.org/10.1007/978-1-4020-9325-8>.
- [11] D. Cordero, M. Delgado, B. Liu, J. Ruesink, C. Saavedra, Population genetics of the Manila clam (*Ruditapes philippinarum*) introduced in North America and Europe, *Sci. Rep.* 7 (1) (2017) 39745, <https://doi.org/10.1038/srep39745>.
- [12] C.A. Crandall, M. Monroe, J. Dutka-Gianelli, K. Lorenzen, Meaningful action gives satisfaction: Stakeholder perspectives on participation in the management of marine recreational fisheries, *Ocean Coast. Manag.* 179 (2019) 104872.
- [13] de Carvalho-Souza, M. Kourantidou, M. Kourantidou, I. Laiz, M.A. Nuñez, E. González-Ortegón, How to deal with invasive species that have high economic value? *Biol. Conserv.* 292 (2024) 110548.
- [14] T. Dietz, E. Ostrom, P.C. Stern, The struggle to govern the commons, *Science* 302 (5652) (2003) 1907–1912, <https://doi.org/10.1126/science.1091015>.
- [15] D.J. Fraser, T. Coon, M.R. Prince, R. Dion, L. Bernatchez, Integrating traditional and evolutionary knowledge in biodiversity conservation: a population level case study, *Ecol. Soc.* 11 (2) (2006).
- [16] Gaspar, M.B. (2010). Distribuição, Abundância e Estrutura Demográfica da Amêijoia-Japonesa (*Ruditapes Philippinarum*) no Rio Tejo. Relatório Técnico do IPIMAR, 6. Available online at: (<https://www.researchgate.net/publication/285740837>).
- [17] S. Hall, Notes on Deconstructing “the Popular” [1981], in: D. Morley (Ed.), *Essential Essays, Volume 1: Foundations of Cultural Studies*, Duke University Press, 2019, pp. 347–361, <https://doi.org/10.2307/j.ctv11cw7c7.20>.
- [18] A. Honneth, H. Joas (Eds.), *Communicative action: essays on Jürgen Habermas’s The theory of communicative action*, MIT Press, 1991.
- [19] S. Jentoft, The community: a missing link of fisheries management, *Mar. Policy* 24 (1) (2000) 53–60.
- [20] S. Jentoft, M. Bavinck, E. Alonso-Población, A. Child, A. Diegues, D. Kalikoski, J. Kurien, P. McConney, P. Onyango, S. Siar, V.S. Rivera, Working together in small-scale fisheries: harnessing collective action for poverty eradication, *Marit. Stud.* 17 (2018) 1–12.
- [21] R. Likert, A Technique for the Measurement of Attitudes, *Arch. Psychol.* 140 (1932) 1–55.
- [22] V. Luyet, R. Schlaepfer, M.B. Parlange, A. Buttler, A framework to implement stakeholder participation in environmental projects, *J. Environ. Manag.* 111 (2012) 213–219, <https://doi.org/10.1016/j.jenvman.2012.06.026>.
- [23] Maia, F., Barroso, C., & Gaspar, M., (2014, September 12-14). Reproductive cycle and condition index of the Manila clam *Ruditapes philippinarum* (Adams & Reeve, 1850) in Ria de Aveiro lagoon (NW Portugal) [Poster presentation]. XVIII SIEBM, Gijón, Spain. DOI: [10.13140/RG.2.2.25726.74562](https://doi.org/10.13140/RG.2.2.25726.74562).
- [24] Maia, F. & Gaspar, M. (2014). Case Study: Clam Harvesting in the Ria de Aveiro. Biology and Management of Bivalve Harvesting in Ria de Aveiro. Gepeto Project Technical Report. The Portuguese Institute for Sea and Atmosphere (IPMA), Lisbon. 67pp.
- [25] Marine Stewardship Council (MSC) (2024). MSC Fisheries Standard v3.1. Available online: <https://www.msc.org/standards-and-certification/fisheries-standard/vers-ion-3> (accessed on 29 October 2024).
- [26] R. McTaggart (Ed.), *Participatory Action Research: International Contexts and Consequences*, State University of New York Press, State University Plaza, Albany NY, 1997, p. 12246. ISBN-0-7914-3533-4.
- [27] P.A.C.O. Melià, G.A. De Leo, M. Gatto, Density and temperature-dependence of vital rates in the Manila clam *Tapes philippinarum*: a stochastic demographic model, *Mar. Ecol. Prog. Ser.* 272 (2004) 153–164, <https://doi.org/10.3354/meps272153>.
- [28] P. Moura, P. Vasconcelos, F. Pereira, P. Chainho, J.L. Costa, M.B. Gaspar, Reproductive cycle of the Manila clam (*Ruditapes philippinarum*): an intensively harvested invasive species in the Tagus Estuary (Portugal), *J. Mar. Biol. Assoc. U. Kingd.* 98 (7) (2018) 1645–1657, <https://doi.org/10.1017/S0025315417001382>.
- [29] F. Nunan, D. Cepić, E. Yongo, M. Salehe, B. Mbilingi, K. Odongkara, P. Onyango, E. Mlahagwa, M. Owili, Compliance, corruption and co-management: how corruption fuels illegalities and undermines the legitimacy of fisheries co-management, *Int. J. Commons* 12 (2) (2018) 58–79.
- [30] A. Oels, Evaluating stakeholder participation in the transition to sustainable development, *Methodology, Case Studies, Policy Implications*, LIT Verslag, Münster, 2003.
- [31] E.H. Pinn, L. Le Vay, Interpretation of the European legal framework for the microbiological classification of bivalve mollusc production areas, *Mar. Policy* 148 (2023) 105479, <https://doi.org/10.1016/j.marpol.2023.105479>.
- [32] H. Purnomo, D. Puspitaloka, B. Okarda, A. Andriato, N. Qomar, S. Sutikno, A. Muhammad, I. Basuki, A. Jalil, Yesi, P. Prasetyo, Zulkardi Tarsono, S. Kusumadewi, H. Komarudin, A. Dermawan, M. Brady, Community-base fire prevention and peatland restoration in Indonesia: a participatory action research approach, *Environ. Dev.* 50 (2024) 100971, <https://doi.org/10.1016/j.envdev.2024.100971>.
- [33] P. Reason, H. Bradbury (Eds.), *The Sage Handbook of Action Research: Participative Inquiry and Practice*, 2nd ed, SAGE, Los Angeles, Calif., 2008. ISBN 978-1-4129-2029-2.
- [34] O. Renn, Participatory processes for designing environmental policies, *Land Use Policy* 23 (2006) 34–43, <https://doi.org/10.1016/j.landusepol.2004.08.005>.
- [35] Ruano, F. & Sobral, D.V. (2000). Marine non-indigenous species – current situation in Portugal. In: Rodrigues, L., Reino, L., Godinho, L.O., Freitas, H. (Eds.), *Proceedings of the 1st Symposium on Non-Indigenous Species: Introduction, Causes and Consequences*. Liga para a Protecção da Natureza, Lisboa, Portugal, pp. 58–63.
- [36] G.M. Ruiz, J.T. Carlton, E.D. Grosholz, A.H. Hines, Global invasions of marine and estuarine habitats by non-indigenous species: mechanisms, extent, and consequences, *Am. Zool.* 37 (6) (1997) 621–632, <https://doi.org/10.1093/icb/37.6.621>.
- [37] G.W. Schuurman, D.N. Cole, A.E. Cravens, S. Covington, S.D. Crausbay, C. H. Hoffman, D.J. Lawrence, D.R. Magness, J.M. Morton, E.A. Nelson, R. O’Malley, Navigating ecological transformation: Resist–accept–direct as a path to a new resource management paradigm, *BioScience* 72 (1) (2022) 16–29.
- [38] D. Selener. *Participatory Action Research and Social Change*, 2nd. ed., Global Action Publications, Cornell University Press, 1997. ISBN 9978-95-130-X.
- [39] R.A. Silvano, J. Valbo-Jørgensen, Beyond fishermen’s tales: contributions of fishers’ local ecological knowledge to fish ecology and fisheries management, *Environ., Dev. Sustain.* 10 (2008) 657–675.
- [40] Vasconcelos, L. (2007). Participatory governance in complex projects. Reservoir and River Basin Management: Exchange of Experiences from Brazil, Portugal and Germany, Gunkel, Günter & Sobral, Maria. 114-124.
- [41] Vasconcelos, L., Marques, M.J., & Martinho, G. (2005). Public Participation in waste Management—overcoming ingrained myths. In X International Waste Management and Landfill Symposium, Sardinia, Italy.
- [42] C. Velez, E. Figueira, A. Soares, R. Freitas, Spatial distribution and bioaccumulation patterns in three clam populations from a low contaminated ecosystem, *Estuar. Coast. Shelf Sci.* 155 (2015) 114–125, <https://doi.org/10.1016/j.ecss.2015.01.004>.
- [43] C. Velez, P. Galvão, R. Longo, O. Malm, A.M. Soares, E. Figueira, R. Freitas, *Ruditapes philippinarum* and *Ruditapes decussatus* under Hg environmental contamination, *Environ. Sci. Pollut. Res.* 22 (2015) 11890–11904, <https://doi.org/10.1007/s11356-015-4397-7>.
- [44] N. Videira, P. Antunes, R. Santos, G. Lobo, Public and stakeholder participation in European water policy: a critical review of project evaluation processes, *Eur. Environ.* 16 (1) (2006) 19–31, <https://doi.org/10.1002/eet.401>.
- [45] M.J. Wu, K. Zhao, F. Fils-Aime, Response rates of online surveys in published research: A meta-analysis, *Comput. Hum. Behav. Rep.* 7 (2022) 100206, <https://doi.org/10.1016/j.chbr.2022.100206>.
- [46] Y. Yu, J.X. Hao, X.Y. Dong, M. Khalifa, A multilevel model for effects of social capital and knowledge sharing in knowledge-intensive work teams, *Int. J. Inf. Manag.* 33 (5) (2013) 780–790, <https://doi.org/10.1016/j.ijinfomgt.2013.05.005>.