Methodological proposal

Methodology for Assessing the Performance of the Fisheries Management Plan

CONTENIDOS

Acronyms

Acronym	Full Term	Description
TEK	Traditional Ecological Knowledge	Knowledge, practices, and beliefs accumulated and culturally transmitted by communities, valuable for contextualized fisheries management.
CPK	Co-Production of Knowledge	Collaborative process in which scientists, managers, and fishers jointly generate knowledge and management objectives.
MC	Management Committee	Advisory body that includes public and private representatives, responsible for creating management strategies through Management Plans (MPs).
MP	Management Plan	Strategic plan developed to ensure the sustainability of fishing activities, usually formulated by Management Committees.
SERNAPESCA	National Fisheries Service	Chile's governmental body responsible for fisheries regulation and oversight.
MINECOM	Ministry of Economy, Development, and Tourism	Oversees fisheries through Management Committees and coordinates regulatory measures for sustainable fishing practices.

1. Introduction

The incorporation of fishers' knowledge in all phases of fisheries decision-making is essential to address the complex challenges associated with sustainability. Overfishing remains a direct driver of marine biodiversity loss (Díaz et al., 2015), impacting the ocean's ability to provide essential services such as food provision, water quality, and resilience to disturbances (Worm et al., 2006). In light of this issue, there is a need to adopt management strategies that consider the local and traditional knowledge of fishers, so that extraction rates can be adjusted not only to the ecological limits of exploited populations but also to the specific socioeconomic contexts of each fishing community (Neubauer et al., 2013).

As an initial approach to understanding the willingness to adopt a particular management measure, it is necessary to explore Traditional Ecological Knowledge (TEK). TEK encompasses the perceptions and experiences that communities have accumulated regarding their natural environment (Huntington, 2000), including knowledge, practices, and beliefs that evolve through adaptive processes and are passed down from generation to generation through cultural transmission (Berkes et al., 2000). This knowledge represents an invaluable resource that can be integrated into modern conservation programs (Drew, 2005), contributing to a more contextualized and effective management. TEK can provide essential data and tools to support management decisions, not only through the information it provides but also in its practical application, thus bridging the gap between knowledge and action (Beier et al., 2017; Cooke et al., 2021).

Decision-making processes in fisheries management are multidimensional, spanning various scales and levels of interaction, and involving actors with divergent needs and interests. These actors are affected by political, social, and administrative uncertainty, which complicates the implementation of sustainable strategies. In this context, co-management structures that enable the co-production of knowledge (CPK) among scientists, managers, and fishers have been proposed as a viable solution to problems that cannot be solved exclusively from the scientific or political domains (Cash et al., 2006). CPK facilitates active participation of fishers in data generation and the definition of management objectives, thereby increasing the legitimacy and feasibility of adopted decisions.

A example of joint administration is the creation of Management Committees (MC), which act as advisory councils composed of public and private representatives, including a representative from the Undersecretariat of Fisheries, one from the National Fisheries Service, another from the Maritime Territory and Merchant Marine Directorate, a representative of processing plants, and seven representatives of artisanal fisheries (MINECOM, 2013). These committees aim to develop management alternatives that ensure the sustainability of fishing activities through the design of Management Plans (MP), moving towards the concept of advised co-management, where stakeholders collaborate in generating management recommendations supported by the government (Mcconney et al., 2003). MCs have significant potential to integrate local knowledge, facilitate socio-ecological feedback mechanisms, and develop multi-level interactions, key aspects for achieving a polycentric governance system where different decision-making levels are respected and complement each other (Estévez et al., 2020; Gelcich, 2014).

However, decisions made in these spaces are not always fully supported by the majority of fishers. This reveals the persistence of a top-down approach, where scientific knowledge predominates, while other sources of knowledge, such as Traditional Ecological Knowledge (TEK), receive less consideration. To improve this governance framework, it is essential to actively incorporate TEK and the direct input of fishers in the establishment and evaluation of management rules and decisions. Including this information not only strengthens the representativeness of the decisions but also increases their applicability and acceptance at the local level, facilitating the transition toward a more inclusive and sustainable fisheries management.

2. Context

The evaluation of fisheries management plans requires an approach that considers multiple perspectives, including practical and traditional knowledge that complements scientific knowledge. In particular, the Traditional Ecological Knowledge (TEK) of artisanal fishers provides a deep and adaptive understanding of the ecosystem, valuable for fisheries management. This knowledge, accumulated and culturally transmitted, enables the design and adjustment of management measures that respond not only to biological criteria but also to local socioeconomic dynamics (Huntington, 2000; Berkes et al., 2000; Drew, 2005).

In Chile, Management Committees (MCs) have been established as joint management spaces, bringing together public and private representatives along with artisanal fishers to develop sustainable management alternatives through specific management plans (MINECOM, 2013; Mcconney et al., 2003). However, the challenge lies in ensuring that these plans are truly effective on the ground and have the acceptance of the fishing communities involved. In this context, the present methodological proposal aims to offer a simple and effective tool to evaluate the performance of management plans both before their implementation and during their execution.

The proposed methodology focuses on facilitating discussion and feedback spaces within the MCs, based on the direct collection of fishers' opinions through surveys and dissemination processes of management decisions. This tool not only assesses the impact of each measure on the fishing community but also identifies early improvement opportunities that can be discussed and, if necessary, integrated into the management plan.

Initially designed for the southern octopus management plan, this methodology is adaptable to other fisheries, providing a flexible and transferable structure. Through this proposal, the aim is to enrich the evaluation process of management plans within MCs, promoting fisheries governance that fully leverages TEK and encourages active collaboration among all parties. This methodology has been made available for use by the Undersecretariat for Fisheries and Aquaculture to strengthen its work within the MCs. In this context, a pilot application of the tool has been conducted to measure the performance of the management plan proposal recently developed by

the MC of the artisanal fisheries of the Juan Fernández Archipelago and Desventuradas Islands, the results of which are presented in this document.

3. Methodology

3.1 Dissemination of Management Rules Proposed by the Management Committee

The first stage of the methodology for evaluating the performance of fisheries management plans focuses on the dissemination of the rules proposed by the Management Committee. This campaign combines digital and in-person strategies to ensure that fishers and other involved stakeholders understand and actively participate in the fisheries management process, adapting to different contexts and fishing communities. The dissemination includes both informational videos and printed materials to maximize the reach and effectiveness of communication.

To achieve broad dissemination, several short videos are produced and adapted for distribution through instant messaging platforms like WhatsApp, which is widely used in many fishing communities. Each video presents a key aspect of the management plan, covering everything from the structure and function of the Management Committee to the goals and strategies of the plan, along with specific measures for the conservation of priority species and sustainable practices. These videos are designed to be visually engaging and easy to understand, encouraging fishers to share them within their social networks and discuss the content. To further extend the campaign's reach, partnerships are established with local authorities and community media outlets, such as radio stations and other regional channels, ensuring that the messages also reach fishers who prefer traditional media or who do not regularly use digital platforms.

In addition to videos, a direct dissemination campaign is conducted at fishers' gathering and work points through the distribution of infographics. These infographics are designed to visually and simply present the management rules, with specific details about the rules and recommended practices for resource conservation. This printed material provides a clear and easily accessible

visual reference, allowing fishers to consult it at their workplace and understand the measures in the context of their daily work. The infographics are distributed at fishers' meeting points and are managed by MC representatives and community leaders, who are available to answer questions and gather initial impressions and comments from fishers on the proposed management rules. This direct interaction approach not only reinforces understanding of the measures but also fosters constructive dialogue on management decisions.

The overall objective of this dissemination campaign is to ensure a clear and thorough understanding of the management rules, promote active participation among fishers, and open a continuous feedback channel between the MC and the fishing community. This two-way communication strategy not only conveys the key information effectively but also helps build an environment of trust and transparency, essential elements for achieving inclusive and sustainable fisheries management. Thus, the methodology is proposed as a versatile and adaptable tool for different fishing contexts, helping to strengthen collaboration between management committees and fishing communities in any fishery where these practices are implemented.

Finally, to consolidate the dissemination process and ensure broader participation, open workshops are held where artisanal fishers' representatives publicly present the proposed management strategies. These workshops provide a space where anyone interested, whether a member of the fishing community or other sectors, has the right to express their observations and comments on the presented measures. This workshop format promotes inclusive dialogue and allows for gathering a variety of perspectives, contributing to a more precise and legitimate adjustment of management strategies. The feedback obtained in these meetings is integrated into the evaluation process, ensuring that the final decisions of the management plan result from a participatory and transparent discussion.

3.2 Instrument for Evaluating the Level of Acceptance and Impact of the Measures

This section details the survey instrument designed to gather the level of acceptance and perceived impact of the management measures among fishers and other community members

involved in fishing. The survey has been developed to collect key information that reflects the perceptions and degree of alignment within the fishing community regarding the decisions proposed in the management plan. This tool not only facilitates the evaluation of the effectiveness and acceptance of management measures but also provides a solid database for making informed and adaptive adjustments during the implementation process.

3.2.1 Instrument Design

The survey was developed in digital format, using accessible platforms such as Google Forms to allow greater accessibility and ease of response among participants. The questionnaire is structured in sections aimed at capturing both the level of acceptance and the impact of the management measures in ecological, social, and economic areas. Below is a description of each section of the questionnaire and its purpose within the overall evaluation.

- **Participant Identification Section**: This first section collects basic demographic and contextual information about the participants, such as their role within the fishing activity (fisher, processing plant member, trader, etc.), their tenure in the sector, and their place of residence. This information is essential for analyzing the results based on the specific characteristics of each stakeholder group and adjusting the analysis according to demographic variations.
- **Level of Acceptance of the Measures**: This section presents specific questions to assess the degree of acceptance of the proposed measures. Participants are asked to indicate their level of agreement with each of the management rules using a Likert scale ranging from "Strongly Disagree" to "Strongly Agree." This structure allows for quantifying the overall support for each measure and observing patterns of acceptance or resistance among different stakeholder groups. The questions are designed to measure both the approval of individual measures and the general willingness to comply with the new rules.
- **Perceived Impact of the Measures**: Here, the perceived impact of the measures on ecological, social, and economic dimensions is explored. This section gathers information

on how fishers and community members anticipate that the measures will affect the sustainability of fishery resources, their economic activity, and the overall well-being of the community. The questions include statements about the expected effects of the measures on the conservation of key species, the stability of fishers' incomes, and the social balance within the community. Participants rate the impact as "High," "Moderate," or "Low," thus providing a detailed assessment of each measure's implications.

- **Open Comments Section**: Finally, the survey provides a space for open comments where participants can freely express their opinions and concerns. This qualitative section is essential for capturing nuances that cannot be reflected through structured questions, allowing fishers and community members to offer specific observations, improvement suggestions, or concerns about the implementation of the measures.

3.2.2 Instrument Implementation

The survey is distributed both digitally and in printed format, depending on the preferences and accessibility of each stakeholder group. Members of the Management Committee and community leaders collaborate in distributing and collecting responses, facilitating access to the questionnaire in small fishing ports and fishermen's gathering points. This process maximizes participation and ensures that the responses reflect a diverse and representative view of the fishing community.

3.2.3 Results Analysis

The collected data are analyzed quantitatively to evaluate general levels of acceptance and perceived impact. Responses from the Likert scale allow for calculating averages and acceptance percentages for each measure, while impact ratings help identify which dimensions (ecological, social, or economic) require greater attention or adjustments. The open-ended comment section is analyzed qualitatively, identifying recurring themes, suggestions, and concerns that provide

valuable context for interpreting numerical results and adapting management measures in line with community feedback.

In conclusion, this survey instrument allows for a precise and detailed evaluation of the acceptance and perceived impact of the proposed management measures, offering an effective mechanism to integrate the perspectives and needs of fishermen and other stakeholders involved in fishing activities.

4. Case Study: Artisanal Fisheries of the Juan Fernández Archipelago

4.1 Background of the Artisanal Fisheries of the Juan Fernández Archipelago

The Juan Fernández Archipelago, comprising the islands of Robinson Crusoe, Santa Clara, and Alejandro Selkirk, is located approximately 360 nautical miles off the Chilean coast (Arana, 1987) (Figure 1). This oceanic ecosystem is renowned for its high level of endemism and unique characteristics (Pequeño & Sáez, 2000; Rozbaczylo & Castilla, 1987), which led to its designation as a National Park in 1935 and a UNESCO World Biosphere Reserve in 1977. Along with the Desventuradas Islands Archipelago, located further north, these areas benefit from environmental protection due to their distinctive biodiversity, with endemism rates reaching up to 72% in the Desventuradas Islands (Bahamonde, 1987).

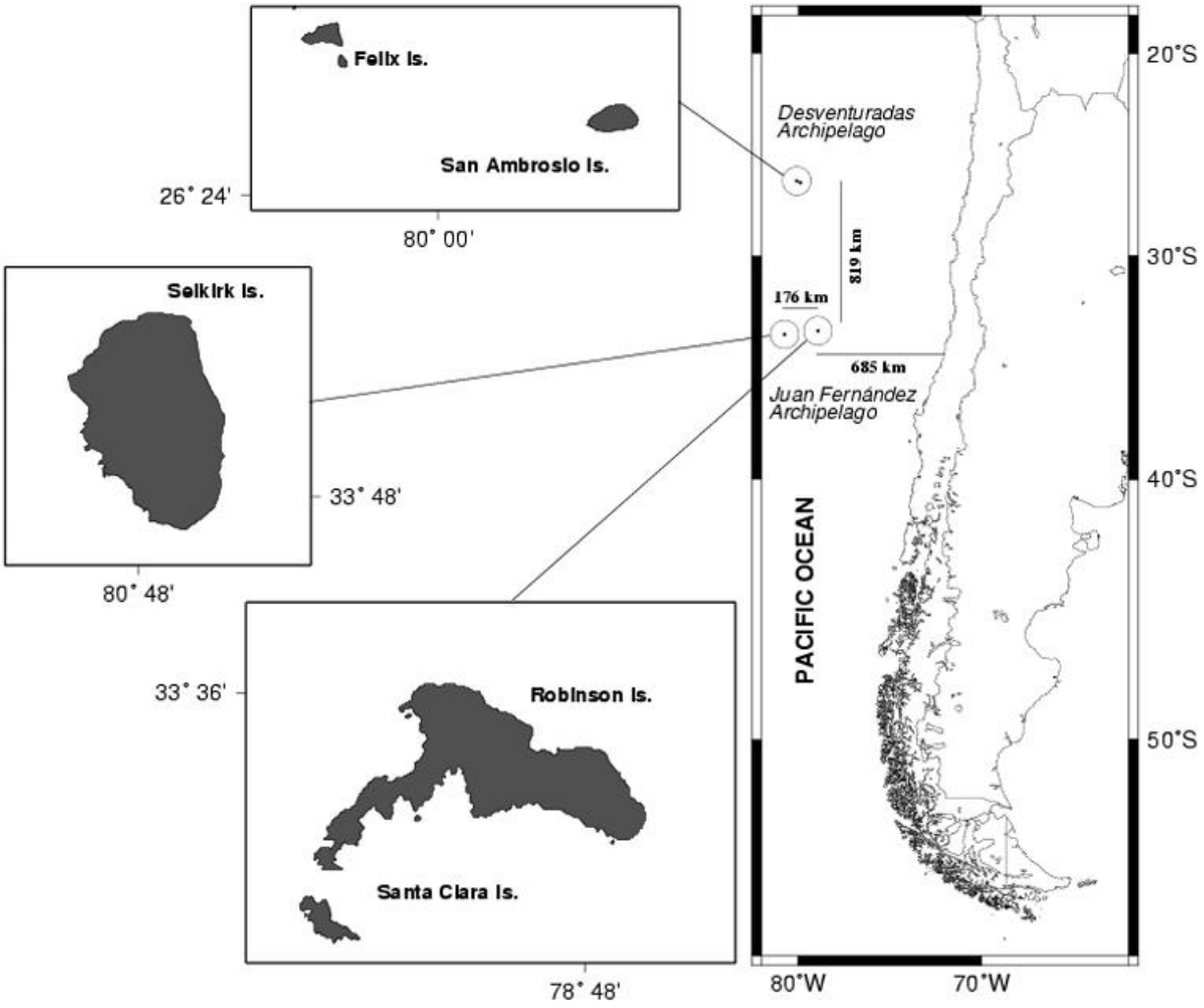

Figure 1. Geographic location of the Juan Fernández and Desventuradas Archipelagos.

The fishing community, known as the "fernandezianos," resides primarily in the village of San Juan Bautista on Robinson Crusoe Island, with a population of 926 inhabitants (2017 Census). The local economy largely depends on artisanal fishing activities, especially the harvesting of the Juan Fernández lobster (*Jasus frontalis*), the most important fishing resource in the archipelago (Pladeco, 2009). In recent years, the golden crab (*Chaceon chilensis*) has emerged as an alternative to diversify fishing activities (Pladeco, 2015), and other species, such as the Gay's morwong, yellowtail, and Juan Fernández cod, are also captured for direct consumption or as bait.

4.1.1 Lobster Fishery

The lobster fishery is one of the oldest in Chile, with capture records dating back to the 1930s (Yáñez et al., 1985). The fleet consists of approximately 37 to 45 vessels that operate across different subsystems: Robinson Crusoe-Santa Clara, Alejandro Selkirk, and occasionally the Desventuradas Islands (Ernst et al., 2015). Each fisher owns "marcas" or specific fishing sites that are transferred through inheritance or sale. This traditional system ensures an orderly and controlled exploitation (Ernst et al., 2010, 2013). Lobsters are captured exclusively using traps, whose design has evolved slightly in recent decades (Ernst et al., 2013).

4.1.2 Golden Crab Fishery

The extraction of golden crab began in the 1990s and is primarily limited to 4-6 vessels operating near Robinson Crusoe. This resource is found in deeper zones, requiring traps similar to those used for lobster (Arana, 2000a, 2000b). The fishery is characterized by a predominance of males in landings and has been regulated to establish a minimum shell width of 130 mm for captured individuals, promoting sustainable extraction (Arana et al., 2006).

4.1.3 Gay's Morwong and Other Fish Species Fishery

The fishing of Gay's morwong (*Nemadactylus gayi*) and other species, such as yellowtail amberjack and cod, is mainly conducted as a complementary activity to crustacean capture. These species are important both for direct consumption and as bait. Gay's morwong sustains fishing activity during the lobster closed season (Ernst et al., 2010).

4.1.4 Management Committee

With the creation of the Management Committee for crustacean fisheries in the Juan Fernández Archipelago and Desventuradas Islands, a formal management structure was established, involving representatives from fishers, processing plants, and national entities such as the Undersecretariat of Fisheries, SERNAPESCA, and the Navy. This committee plays a crucial role in decision-making, providing a forum for planning sustainable strategies that integrate both the local knowledge of fishers and the technical support from national institutions (MINECOM, 2013).

This fishery management system, which combines formal and informal regulations, aims to balance economic exploitation with marine resource conservation, promoting both species sustainability and the local economy.

4.2 Description of Management Measures Proposed by the Management Committee

4.2.1 Lobster (*Jasus frontalis*)

The conservation measures for the lobster aim to ensure the long-term sustainability of the species. The following measures have been agreed upon:

- **Effort Limit – Vessels**: A maximum of 67 vessels is allowed across the areas of Robinson Crusoe – Santa Clara, Alejandro Selkirk, and the Desventuradas Islands. Additionally, vessel limits are set by subsystem: 53 vessels may operate in Robinson Crusoe – Santa Clara, up to 17 vessels in Alejandro Selkirk, and a maximum of 10 vessels in the Desventuradas Islands.
- **Effort Limit – Traps**: Effort is also limited by the number of traps each vessel can carry. This is set at 50 traps in Robinson Crusoe and Santa Clara, and 60 in other subsystems. Each vessel may carry an additional 10 traps if a third crew member is included.
- **Maximum Capture Size (Existing Measure)**: To maintain reproductive potential, lobsters larger than 140 mm in carapace length must be released, allowing them to reproduce before being recaptured.
- **Biological Closed Season (Existing Measure)**: Lobster fishing is closed from May to September in the Juan Fernández Archipelago and from June to September in the Desventuradas Islands to protect reproductive periods.
- **Release of Egg-Bearing Females (Existing Measure)**: There is an indefinite ban on the capture of egg-bearing females, ensuring their contribution to the recruitment of new generations.

4.2.2 Golden Crab (*Chaceon chilensis*)

The golden crab fishery is an emerging fishery with low capture pressure. According to the Management Committee, no more than two vessels are consistently dedicated to the extraction of this resource. Nevertheless, the decision was made to implement basic conservation measures aimed at ensuring the long-term sustainability of the species. The following measures have been agreed upon:

- **Capture Size Regulation**: A minimum carapace width of 120 mm has been established to ensure that crabs have the opportunity to reproduce before being captured.

- **Release of Egg-Bearing Females**: All egg-bearing females must be returned to the sea, thus protecting the reproductive capacity of the population.
- **Selective Capture Traps**: The use of traps with spacing between bars is encouraged, adjusted to allow crabs smaller than 120 mm to escape, thereby reducing the incidental capture of juveniles.

4.2.3 Gay's Morwong (*Nemadactylus gayi*)

The strategy for Gay's Morwong focuses on protecting juvenile specimens and ensuring sustainable extraction:

- **Minimum Hook Size**: Only hooks sized No. 8 or larger are permitted to prevent the capture of individuals below the first maturity size (286 mm fork length).
- **Voluntary Release of Juveniles**: The release of live Gay's Morwong smaller than 286 mm is encouraged to preserve individuals that have not yet reached reproductive maturity, thus promoting population sustainability.

4.2.4 Eel (*Gymnothorax porphyreus*)

The measures for eels aim to reduce their use as bait and preserve their availability:

- **Use of Smaller Traps**: Traps used to capture eels must be one-third smaller than lobster traps, minimizing excessive capture.
- **Release of Extreme-Sized Specimens**: The release of eels under 30 cm or over 100 cm is encouraged to protect both juveniles and large adults, helping to maintain a well-structured population.

4.3 Survey Implementation

The survey conducted in the Juan Fernández Archipelago and the Desventuradas Islands included 46 participants, who provided responses regarding their level of agreement and perceived impact concerning the management strategies for various species. Additionally, data were collected on the respondents' relationship to the fishing activity and the subsystem to which they belong, allowing for the contextualization of their perceptions and an understanding of the differences in their responses based on their roles and areas of operation.

4.3.1 Respondent Distribution by Subsystem

As shown in the left panel (Figure 2), the majority of respondents (60.9%) belong to the Robinson Crusoe-Santa Clara (RC-SC) subsystem, the main inhabited area and the central hub for fishing operations in the archipelago. This high percentage reflects the importance of this subsystem in the fishing activity of the area. It is followed by the Alejandro Selkirk (AS) subsystem with 28.3% of respondents, representing a significant part of operations in more remote areas. Finally, the Desventuradas Islands (ID) subsystem accounts for 10.9% of respondents, indicating a lower level of fishing activity in this area due to its remoteness and restrictive access conditions.

This distribution shows that the survey captured a representative sample of the three subsystems, with a predominance of the RC-SC area, consistent with the concentration of fishing activities in this sector. The variation in the percentage of respondents by subsystem suggests that any management policy should consider the specificities and priorities of each area to achieve effective implementation tailored to local needs.

4.3.2 Respondents' Relationship with Fishing Activity

In the right panel (Figure 2), we observe the distribution of respondents' roles within the fishing activity. The results show that the primary roles of participants are "Owner" (32.6%) and "Crewman" (26.1%), who play crucial roles in daily fishing operations. This group provides a comprehensive perspective of those who directly rely on fishing resources for their income, making their perception of management measures essential for the acceptance and effectiveness of these policies.

An equal percentage of respondents (26.1%) identified as "Captain," typically holding leadership roles on vessels and offering a strategic viewpoint on resource management. Additionally, 10.9% of respondents are "Scientific Observers," who provide technical and monitoring insights, fundamental for assessing the impact of management measures from a scientific perspective. Finally, 4.3% of participants indicated "Other" as their relationship with fishing activity, which includes support roles onshore or in complementary activities.

4.3.3 Implications of the Results

The composition of the 46 respondents, both in terms of subsystem and roles in fishing activity, reflects a broad and diverse representation of those involved in the archipelago's fisheries. The predominance of roles directly linked to extraction and fishing operations ensures that the perceptions collected in the survey come from individuals deeply integrated in the activity, which enhances the validity of results on perceived impact and agreement levels with management strategies.

These results underscore the importance of adapting management measures according to the characteristics of each subsystem and the needs of different roles within the fishing activity. The high participation of "Owners" and "Crewmen" highlights the relevance of considering Traditional Ecological Knowledge (TEK) in policy design, as these groups typically possess a deep understanding of the local ecosystem. Furthermore, the inclusion of "Scientific Observers" in the

survey allows for a complementary approach that combines empirical experience with scientific data, facilitating a more robust co-management model aligned with sustainability principles.

In conclusion, the structure of the 46 respondents provides a solid basis for interpreting results on the acceptance and perceived impact of management measures, which is essential for developing effective and socially accepted policies. Understanding the characteristics and concerns of the various stakeholders within the artisanal fishing sector of the Juan Fernández Archipelago is critical to enhancing the sustainability of marine resources and promoting the resilience of fishing communities.

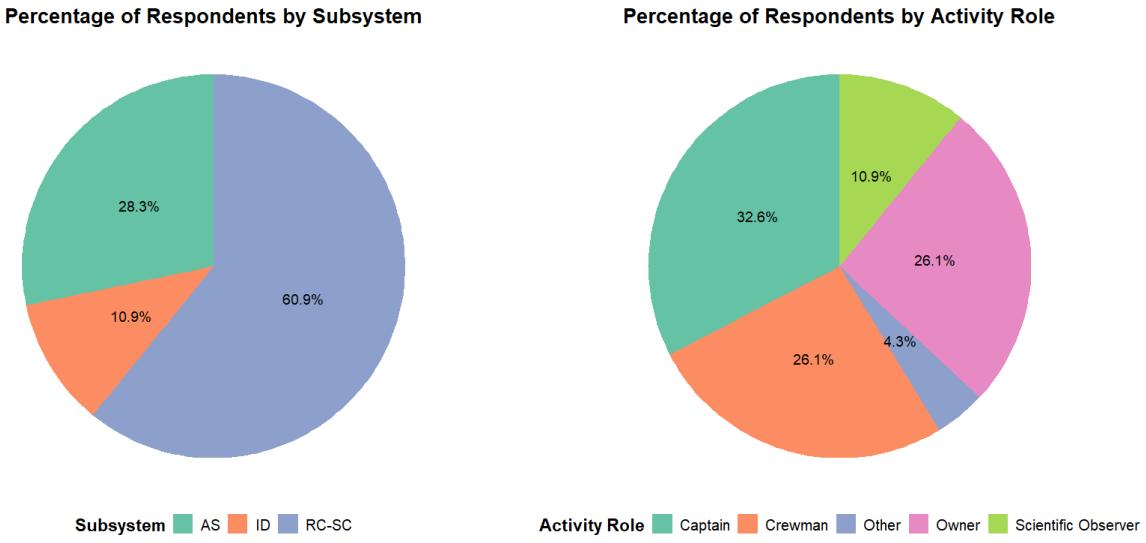

Figure 2. Percentage of respondents by subsystem (left) and by their role in fishing activity (right).

4.4 Survey Results

4.4.1 Analysis of the Perceived Impact Level

The left panel of the chart (Figure 3) shows the perceived impact level for the management strategies applied to each species, classified into three categories: "High," "Moderate," and "Low."

- **Lobster**: Lobster is perceived with "High" and "Moderate" impact, with high impact prevailing. Fishers emphasize its economic relevance and fear that restrictive management might affect the income of their communities, which depend on the sale of this species. Additionally, some expressed concern over possible restrictions in capture seasons or extraction sizes, which could alter the dynamics of this fishery.
- **Golden crab**: The perceived impact for golden crab is predominantly "Moderate." Although it is not the main target of artisanal fishing, changes in its management could influence the overall availability of benthic resources in the area. Some respondents noted that, given its limited market, restrictions on its extraction would not significantly affect their income, but they do consider the sustainability of the resource to be relevant.
- **Gay's Morwong**: The perceived impact for this species is mostly "Moderate," though a significant proportion also rates it as "High." Participants mention that, due to the presence of Gay's Morwong in coastal areas and its role in the diet of several communities, its management could affect both the local ecosystem and community economies. Although it is not of high commercial value, its ecological and social importance explains the perception of a considerable impact.
- **Eel**: Most respondents consider the impact of management measures on eel to be "High." In their justifications, many fishers highlight that eel is a key species in artisanal fishing, mainly used as bait. More restrictive management could indirectly affect other fisheries that rely on it, which represents a significant change in traditional practices. Some even warn that this could impact operational costs and the effectiveness of captures for other species.

4.4.2 Analysis of the Agreement Level

The right panel of the chart (Figure 3) reflects the participants' level of agreement with each management measure on a scale of "Agree," "Neutral," and "Disagree."

- **Lobster**: Lobster shows the highest level of agreement, with a significant majority in the "Agree" category. Fishers believe the restrictions are necessary to prevent population depletion and ensure its sustainability. This support is due to the species' perceived vulnerability and its economic value.
- **Goldencrab**: There is also a high level of agreement for this species, though slightly lower than for lobster. Participants highlight its ecological importance, although some in the "Neutral" category feel that regulations are not as urgent due to its lower economic impact.
- **Gay's Morwong**: Most respondents are positioned at a "Neutral" level, showing ambivalence about the need for management measures for this species. Some participants believe that Gay's Morwong management should be adaptable, especially if the species does not show signs of overexploitation.
- **Eel**: Eel shows the highest level of disagreement, with a notable proportion in the "Disagree" category. Fishers argue that regulating eel could complicate access to essential bait for other fisheries, suggesting alternatives that allow for its traditional use without affecting its role in artisanal fishing.

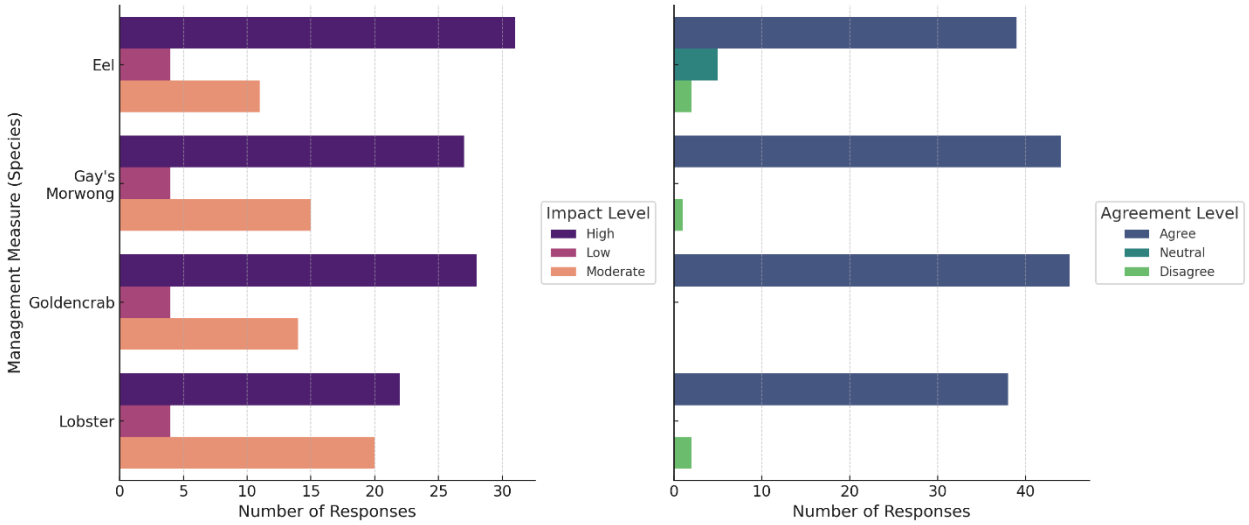

Figure 3. Nivel de impacto (panel izquierdo) y nivel de acuerdo (panel derecho) con las medidas de manejo propuestas por el Comité de Manejo de las pesquerías artesanales del Archipiélago de Juan Fernández e Islas Desventuradas.

4.4.3 Critical Perceptions

Below are some critical perceptions which, though infrequent, were expressed with determination:

- **Doubt about the effectiveness of measures**: Some fishers expressed skepticism regarding the real effectiveness of the measures, arguing that issues of overexploitation and population decline cannot be resolved solely through local regulations without considering external factors such as climate change and pollution.
- **Perception of external interference**: A small group stated that the regulations seem to respond more to external pressures or international standards than to local needs. These fishers believe that incorporating Traditional Ecological Knowledge (TEK) has not been entirely effective and that decisions reflect a "top-down" approach.
- **Impact on the local economy**: Some participants criticized restrictions on key species such as lobster, arguing that these could reduce their income and benefit intermediaries or external markets. They suggest that management strategies should include financial support or training to offset the economic impact.

- **Lack of flexibility in implementation**: In the case of eel, some fishers suggest that strict regulation ignores the cultural value and tradition of its use as bait. They believe an adaptable policy, allowing for exceptions or incorporating traditional uses, could be more acceptable and effective.

These critical perceptions underscore the need for a more inclusive and adaptable fisheries management approach that considers not only ecological knowledge but also the specific socio-economic and cultural contexts of each community. Incorporating these critical voices could enrich decision-making processes, facilitating a more balanced and contextualized management approach that increases both the acceptance and effectiveness of conservation policies in the long term.

4.4.1 General Analysis of Results

The chart (Figure 3) shows a clear variation in the perceived impact and level of agreement toward management measures by species. Lobster stands out as a species for which regulation is widely accepted and viewed as high-impact, reflecting its economic value and the need for conservation. In contrast, eel regulation faces resistance due to its essential role as bait, suggesting that a uniform policy may not be suitable for all species.

This analysis emphasizes that local perceptions and Traditional Ecological Knowledge (TEK) should be central components in developing and implementing fisheries management policies, as traditional experiences and knowledge provide valuable context that can enhance the effectiveness and acceptance of management measures.

5. Conclusions and Recommendations

Applying a methodological approach that integrates Traditional Ecological Knowledge (TEK) in evaluating fisheries management plans has proven an effective tool for addressing sustainability challenges in fishing communities. The experience in the Juan Fernández Archipelago and the Desventuradas Islands demonstrates how the active participation of fishers and consideration of their perceptions regarding the impact and acceptance of management measures can enhance the legitimacy and effectiveness of implemented strategies.

Based on the results obtained in the pilot application, several general conclusions are drawn:

- **Relevance of Local Knowledge**: The study results highlight the importance of incorporating TEK in all decision-making phases. Local fishers have a deep understanding of ecosystems and the dynamics of exploited species, allowing management strategies to be adjusted to local ecological and socio-economic realities. This knowledge is essential for anticipating and mitigating potential negative impacts of regulations on fishing communities.

- **Variable Acceptance by Species**: The analysis of agreement levels and perceived impact reveals significant differences among species. Lobster, a high-value species, showed high acceptance and is perceived as having great impact, indicating a favorable disposition towards its regulation to ensure sustainability. In contrast, eel, primarily used as bait, generated high levels of disagreement, indicating that fishers perceive a risk in its regulation, as it would affect other fishing activities. This finding underscores the need to adopt differentiated policies according to each species' role and importance in the ecosystem and local economy.

- **Limitations of the Top-Down Approach**: Resistance from some fishers to certain management measures reveals that decisions imposed without adequately integrating TEK can generate friction and reduce acceptance on the ground. The lack of flexibility in some regulations was perceived as external interference that does not always meet local needs. This shows that, while Management Committees (MCs) represent progress toward co-

management, it is necessary to strengthen their capacity to effectively integrate fishers' opinions and knowledge in the decision-making process.

- **Need for Flexibility in Implementation**: The critical perception of some fishers regarding the lack of adaptability in regulations reflects the importance of adopting a more flexible approach in designing management policies. This is particularly relevant for species with cultural or functional value in artisanal fishing, such as eel. Adaptive regulation that allows for exceptions or incorporates traditional uses could improve the acceptance and effectiveness of the measures.

Based on the results, recommendations are proposed to improve governance in fisheries management systems:

- **Strengthen Fisher Participation in Policy Design**: It is recommended that MCs continue to promote more active participation by fishers, not only in the implementation phase of management plans but also in their design and evaluation. To improve decision legitimacy, it is crucial that fishers have a decisive role in formulating strategies and that their contributions are explicitly integrated into the regulatory framework.

- **Adopt an Adaptive Methodology to Evaluate Performance**: The survey methodology used in this study provides a practical tool for assessing the impact and acceptance of management measures. It is recommended that this methodology be applied periodically, allowing adjustments based on feedback from fishers and other stakeholders. This adaptive approach facilitates fisheries management that responds to changing ecosystem conditions and community needs.

- **Develop Species-Specific Policies**: The results suggest that a uniform management approach may not be appropriate for all species. It is recommended to implement resource-specific policies, adapted to each species' ecological, economic, and cultural importance. This will contribute to more precise and accepted management, avoiding negative impacts on the economy and traditional practices of fishing communities.

- **Integrate Economic Support and Training Programs**: Given the economic impact that certain regulations may have on fishers, it is recommended that management plans include economic support and training programs. These programs can help mitigate the

negative effects of restrictions, facilitating the transition to sustainable practices. Additionally, training in conservation and management techniques can strengthen fishers' ability to adapt to changes and contribute actively to resource sustainability.

- **Promote Continuous Research and Monitoring**: To improve the effectiveness of management decisions, it is essential to have continuous monitoring and updated scientific data on population status and the impact of management measures. Collaboration between scientists and fishers in these monitoring programs can strengthen the data foundation for management and increase fishers' confidence in the information used for decision-making.

- **Strengthen Communication and Feedback**: Effective dissemination of management rules, through videos, infographics, and workshops, has been key to achieving a broad understanding of measures among fishers. It is recommended to continue and expand these communication efforts to ensure that all stakeholders understand and support decisions. Additionally, it is essential to keep feedback channels open to gather opinions and suggestions that may inform future management plan revisions.

The general conclusion from the application of this approach for evaluating fisheries management plans' performance has demonstrated its effectiveness in incorporating TEK and the direct perceptions of fishers into the decision-making process. This participatory evaluation model contributes to improving the acceptance and sustainability of management measures, facilitating a transition toward more inclusive and adaptive fisheries governance. Replicating this approach in other fisheries will help develop policies that address both the ecological needs of marine ecosystems and the socio-economic contexts of the communities that depend on them. Continuous collaboration between fishers, scientists, and managers will be essential to ensure this model's success and strengthen fisheries sustainability in the long term.

6. References

Arana, P. (1987). *Perspectiva histórica y proyecciones de la actividad pesquera realizada en el archipiélago de Juan Fernández. Islas Oceánicas Chilenas: Nuestro Conocimiento y Necesidades Futuras* (J. Castilla, Ed.). Tinker Foundation, USA y P. Universidad Católica de Chile. .

Arana, P. (2000a). Estimación de abundancia y biomasa del cangrejo dorado (Chaceon chilensis), en el archipiélago Juan Fernández, Chile. *Investigaciones Marinas*, *28*, 53–68.

Arana, P. (2000b). Pesca exploratoria con trampas alrededor de las islas Robinson Crusoe y Santa Clara, archipiélago Juan Fernández, Chile. . *Investigaciones Marinas*, *28*, 39–52.

Arana, P., Ahumada, M., Guerrero, A., Espejo, V., Yáñez, E., Silva, C., Ernst, B., & Orensanz, J. M. (2006). *Evaluación de stock y distribución de la langosta y el cangrejo dorado en el Archipiélago Juan Fernández (Proyecto FIP 2005-21). Informe final.* .

Bahamonde, N. (1987). San Félix y San Ambrosio, las islas llamadas Desventuradas. In Castilla JC (Ed.), *Islas Oceánicas Chilenas: Conocimiento científico y necesidades de Investigaciones. Santiago: Ediciones Universidad Católica de Chile.* (pp. 85-99 p.).

Beier, P., Hansen, L. J., Helbrecht, L., & Behar, D. (2017). A How-to Guide for Coproduction of Actionable Science. In *Conservation Letters* (Vol. 10, Issue 3, pp. 288–296). Wiley-Blackwell. https://doi.org/10.1111/conl.12300

Berkes, F., Colding, J., & Folke, C. (2000). Rediscovery of Traditional Ecological Knowledge as Adaptive Management. In *Source: Ecological Applications* (Vol. 10, Issue 5).

Cash, D. W., Adger, W. N., Berkes, F., Garden, P., Lebel, L., Olsson, P., Pritchard, L., & Young, O. (2006). Scale and Cross-Scale Dynamics: Governance and Information in a Multilevel World. *Ecology and Society*, *11*(2). https://doi.org/10.5751/es-01759-110208

Cooke, S. J., Nguyen, V. M., Chapman, J. M., Reid, A. J., Landsman, S. J., Young, N., Hinch, S. G., Schott, S., Mandrak, N. E., & Semeniuk, C. A. D. (2021). Knowledge co-production: A pathway to effective fisheries management, conservation, and governance. *Fisheries*, *46*(2), 89–97. https://doi.org/10.1002/fsh.10512

Díaz, S., Demissew, S., Carabias, J., Joly, C., Lonsdale, M., Ash, N., Larigauderie, A., Adhikari, J. R., Arico, S., Báldi, A., Bartuska, A., Baste, I. A., Bilgin, A., Brondizio, E., Chan, K. M. A., Figueroa, V. E., Duraiappah, A., Fischer, M., Hill, R., … Zlatanova, D. (2015). The IPBES Conceptual Framework - connecting nature and people. *Current Opinion in Environmental Sustainability*, *14*, 1–16. https://doi.org/10.1016/j.cosust.2014.11.002

Drew, J. A. (2005). Use of traditional ecological knowledge in marine conservation. *Conservation Biology*, *19*(4), 1286–1293. https://doi.org/10.1111/j.1523-1739.2005.00158.x

Ernst, B., Chamorro, J., Manríquez, P., Orensanz, J. M. L., Parma, A. M., Porobic, J., & Román, C. (2013). Sustainability of the Juan Fernández lobster fishery (Chile) and the perils of generic science-based prescriptions. *Global Environmental Change*, *23*(6), 1381–1392. https://doi.org/10.1016/j.gloenvcha.2013.08.002

Ernst, B., Manríquez, P., Orensanz, J. M., Roa, R., Chamorro, J., & Parada, C. (2010). Strengthening of a traditional territorial tenure system through protagonism in monitoring activities by lobster fishermen from Juan Fernandez Islands (Chile). *Bulletin of Marine Science*, *86*, 315–338.

Ernst, B., Pino, J., Chamorro, J., Manríquez, P., Rivara, P., & Porobic, J. (2015). *Programa de Seguimiento de las Principales Pesquerías Nacionales, año 2014. Pesquerías de Crustáceos del archipiélago Juan Fernández"*.

Estévez, R. A., Veloso, C., Jerez, G., & Gelcich, S. (2020). A participatory decision making framework for artisanal fisheries collaborative governance: Insights from management committees in Chile. *Natural Resources Forum*, *44*(2), 144–160. https://doi.org/10.1111/1477-8947.12200

Gelcich, S. (2014). Towards polycentric governance of small-scale fisheries: Insights from the new "Management Plans" policy in Chile. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *24*(5), 575–581. https://doi.org/10.1002/aqc.2506

Huntington, H. P. (2000). USING TRADITIONAL ECOLOGICAL KNOWLEDGE IN SCIENCE: METHODS AND APPLICATIONS. In *1270 INVITED FEATURE Ecological Applications* (Vol. 10, Issue 5).

Mcconney, P., Pomeroy, R., & Mahon, R. (2003). Guidelines for coastal resource co-management in the Caribbean: Communicating the concepts and conditions that favour success. *Caribbean Conservation Association*, 56pp.

MINECOM. (2013). *Modifica en el ámbito de la sustentabilidad de recursos Hidrobiológicos, acceso a la actividad pesquera industrial y Artesanal y regulaciones para la investigación y fiscalización, la Ley general de pesca y acuicultura contenida en la ley n°18.892 y Sus m* (p. 71).

Neubauer, P., Jensen, O. P., Hutchings, J. A., & Baum, J. K. (2013). Resilience and recovery of overexploited marine populations. *Science*, *340*(6130), 347–349. https://doi.org/10.1126/science.1230441

Pequeño, G., & Sáez, S. (2000). Los peces litorales del Archipiélago Juan Fernández (Chile): endemismo y relaciones ictiogeográficas. . *Investigaciones Marinas.,* , *28*, 27-37.

Pladeco. (2009). *Plan de desarrollo Comunal. Obtenido desde la página web http://www.munivalpo.cl/transparencia/archivos/plan_desarrollo_comunal/PLADECO.pdf*.

Pladeco. (2015). *Actualizacion del plan de desarrollo comunal 2015-2020. Ilustre Municipalidad de Juan Fernández, año 2015.* .

Rozbaczylo, N., & Castilla, J. (1987). *Invertebrados marinos del Archipiélago Juan Fernández. In: Castilla J.C. (ed) Islas Oceánicas Chilenas: Conocimiento Científico y Necesidades de Investigaciones.* . Ediciones Universidad Católica de Chile. .

Worm, B., Barbier, E. B., Beaumont, N., Duffy, J. E., Folke, C., Halpern, B. S., Jackson, J. B. C., Lotze, H. K., Micheli, F., Palumbi, S. R., Sala, E., Selkoe, K. A., Stachowicz, J. J., & Watson, R. (2006). Impacts of biodiversity loss on ocean ecosystem services. *Science*, *314*(5800), 787–790. https://doi.org/10.1126/science.1132294

Yáñez, E., Pizarro, L., Barbieri, M. A., & Barra, O. (1985). Dinámica del stock de langosta (Jasus frontalis H. Milne Edwards, 1837) explotado en el archipiélago Juan Fernández (33°40'S-80°W). En: "Investigaciones Marinas en el Archipiélago Juan Fernández." In Arana (Ed.), *Investigaciones Marinas en el Archipiélago Juan Fernández* (pp. 251-271 pp.). Escuela de Ciencias del Mar, UCV.