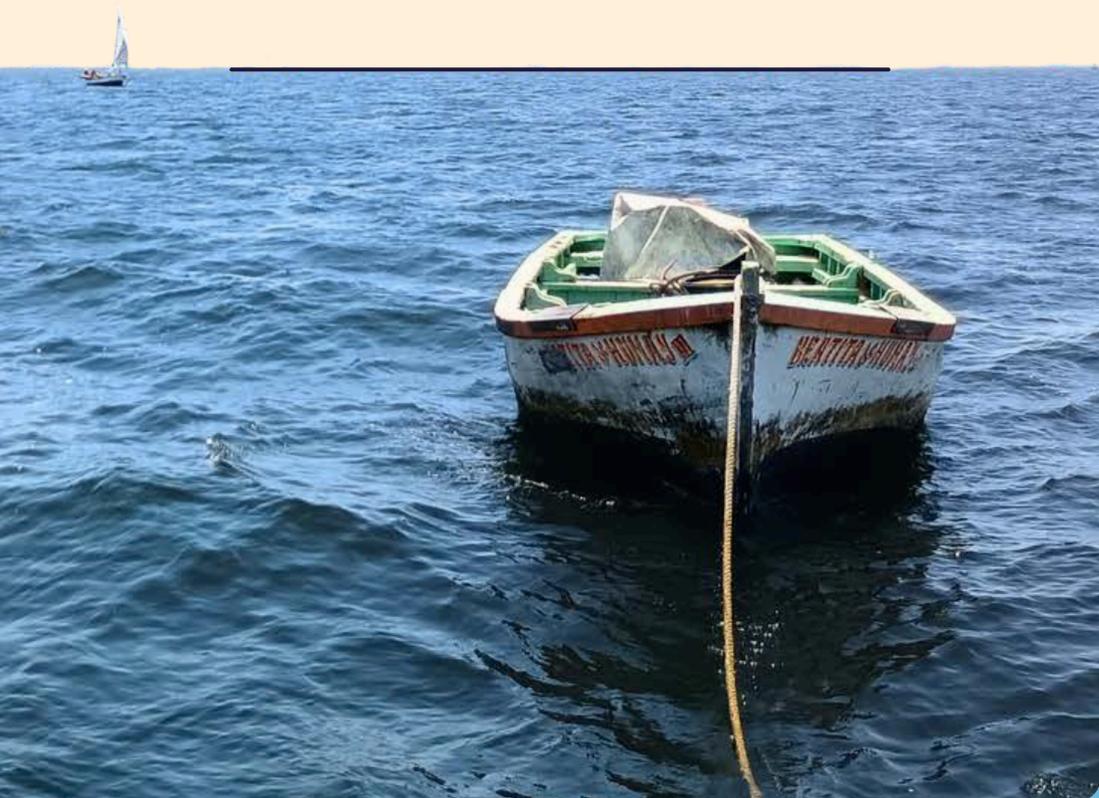


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# POLICY BRIEF:

## FROM MENTAL MODELS TO LEVERAGE POINTS IN THE SECHURA MARINE RESOURCE SYSTEM

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## ABOUT THE PROJECT AND THE RESEARCH TEAM

The authors and the research that developed this document are associated with the Humboldt Tipping project, funded by the German Federal Ministry for Research, Technology and Space (BMFTR; 01LC2323D).

Humboldt Tipping (2019–2026) is a transdisciplinary research initiative that brings together Peruvian and German research institutions. Its objective is to analyze the risks of global change in the coastal upwelling of the Humboldt Current, through studies that explore the relationships between the ecological, social, and economic dynamics of this system. The project aims to develop evidence-based adaptation strategies for fisheries, aquaculture, and coastal communities, thereby contributing to food security, poverty reduction, and sustainability.

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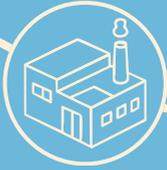
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# GENERAL SUMMARY

This document presents the results of a **participatory research process** aimed at identifying **priority actions** to inform **transformation towards sustainability** in the **Sechura Bay, Peru marine resource system**.

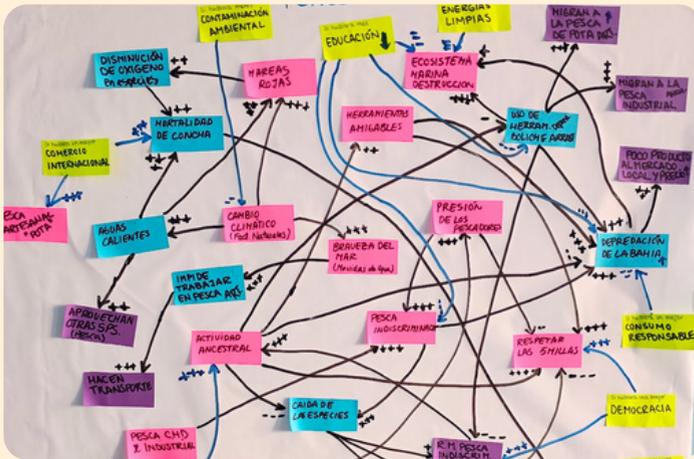
In 2024-2025, **participatory modeling workshops** were held with **45 informants** from the Sechura marine resource sector, including fishers, mariculturists, divers, processing companies, and government representatives. The workshops involved mapping and discussing their “**mental models**,” or beliefs about how the system works, using a tool called **fuzzy cognitive mapping (FCM)**.

The analysis of the FCMs aimed to:

1. **Develop comprehensive models of the system dynamics shaping sustainability challenges in Sechura**, based on the collective knowledge of 45 informant mental models
2. **Identify key “leverage points” for intervening in the Sechura marine resource system**: those areas where changes could generate the greatest transformative impacts on the rest of the system.

This document summarizes **six key leverage points** based on the FCM analysis, along with a **set of priority actions to address** them refined through a final workshop series with study informants.

# METHODS AND APPROACH:



## MENTAL MODELS

Mental models reflect people's beliefs about how the world works, influencing their decisions and actions. We use a method called fuzzy cognitive mapping (FCM) to map, compare, and aggregated “shared mental models” of consensus belief. In contexts with multiple interests, understanding mental models is essential for collective decision-making: it is easier to reach agreements when there is a shared understanding of the causes of problems.

In complex natural resource systems, characterized by a lack of information and uncertainty, aggregating the mental models of different stakeholders further helps to better understand the system's key dynamics, based on their combined collective intelligence.

## LEVERAGE POINTS

The leverage points approach, derived from complex systems research, uses systems models like FCM to identify specific points where actions predict the most transformative desired changes within the system.

This is important because many traditional policies and scientific recommendations focus on mitigating the symptoms of problems without addressing their underlying causes and goals of the system. Leverage points encourage deeper questioning of how and why a system is designed and functions in a certain way.

# APPLICATION IN SECHURA

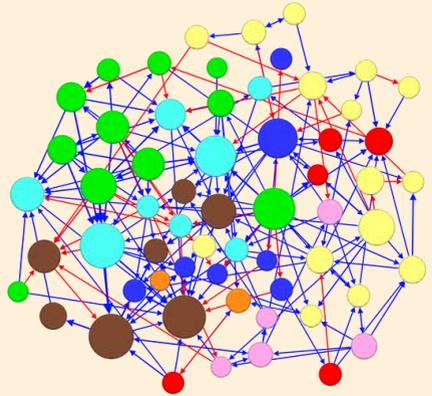
## 1. MAPPING MENTAL MODELS

In 2024, we conducted **participatory modeling workshops** with **Fuzzy Cognitive Mapping (FCM)**, where 45 informants mapped their **mental models** of the Sechura marine resource system. FCM represents mental models in terms of **key social and ecological variables** shaping sector outcomes, **causal relationships**, and the **relative strength** of these relationships.



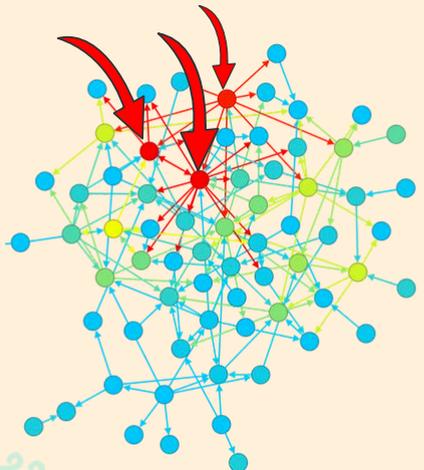
## 2. AGGREGATED MODELS AND POTENTIAL FUTURE SCENARIOS

The individual FCMs were combined into **collective “wisdom of crowds” models** capturing shared understandings of key problem arenas in Sechura. Using these models, we simulated **future “what-if” scenarios**, including climate impacts and policy changes. Results supported participatory discussions on both **predicted and desired futures** for Sechura.



## 3. IDENTIFYING LEVERAGE POINTS

To inform insights into transforming Sechura to a more desirable state, we applied **network analysis** to identify the **most influential variables** across hundreds of FCM concepts. These are **leverage points**, where targeted interventions could produce the **largest system-wide impacts**. Findings were discussed in a final workshop series, resulting in **priority intervention options** for each leverage point.



# SIX KEY LEVERAGE POINTS

## LEVERAGE POINTS 1-3: "SHALLOW" INTERVENTIONS

**1** IMPROVE FINANCIAL  
RESILIENCE TO  
CLIMATE IMPACTS

**2** REDUCE POLLUTION  
AND REVERSE  
ECOSYSTEM  
DEGRADATION

**3** MITIGATE ILLEGAL  
AND OVEREXTRACTIVE  
INDISCRIMINATE  
FISHING

The mental model analysis identified **six key leverage points**: areas where changes can have the **greatest impact** on **transforming the Sechura marine resource system** toward sustainability.

The leverage points are **not independent**: they relate to **highly interconnected social-ecological problems** in Sechura and **must be addressed together**.

The **first three leverage points (1-3)** correspond mostly to "**shallower**" **interventions** aimed at addressing **direct challenges to marine resources**, including climate impacts, pollution, and overfishing.

The immediate resource challenges (1-3) are **amplified** by **deeper systemic conditions**, such as corruption, widespread informality, and inequities in public policy. **Addressing** these **root causes** requires "**deeper**" **interventions** (leverage points 4-6) aimed at **transforming the design, underlying logic, and fundamental goals** of the Sechura marine resource governance system.

Taking action on these deep issues is **essential** for achieving **desired long-term, sustainable transformation** and effectively resolving the more visible challenges of points 1-3.

## LEVERAGE POINTS 4-6: "DEEP" INTERVENTIONS

**4** COMBAT WIDESPREAD CORRUPTION

**5** STREAMLINE AND SUPPORT ACCESS TO FORMALIZATION

**6** ADDRESS SOCIAL INEQUALITIES AND SMALL-SCALE EXCLUSION

The following pages summarize the **recommended priority actions** to drive change at **each leverage point**. These insights were informed by the **FCM analysis** and refined through a final series of **informant workshops**.

# LEVERAGE POINT 1:

## IMPROVE FINANCING OPTIONS

Mariculturists operate in an environment of productive and financial instability closely linked to climatic factors, especially events such as red tides or phenomena like El Niño. The recent financing granted by FONDEPES in 2025 was considered a step forward, although its accessibility was concentrated among large producers, and in some cases, the credit was used without actually stimulating production. Furthermore, the historical lack of public capital has forced many producers to rent or sell their land, generating processes of exclusion and concentration that have been exploited by the private sector.

→ **Manage a revolving fund that provides credit to small producers, initially fueled by strictly managed state capital, would allow mariculturists to cope with the inherent risks of shellfish production and become less dependent on external investors.**

## INSURANCE FOR CLIMATE RISK MANAGEMENT

The lack of insurance tailored to the sector prevents producers from protecting themselves against events such as red tides or ocean warming anomalies, discouraging planting or leading to the sale and lease of concessions under unfavorable conditions. This lack of risk management instruments reflects fragmented governance that fails to incorporate ecological rhythms or the specific production characteristics of the territory.

→ **Promote the creation of a sector-specific climate insurance mechanism, managed transparently and sustainably, that redistributes risk and contributes to the economic and social stability of mariculturists in the face of the impacts of climate change.**

# IMPROVE FINANCIAL RESILIENCE TO CLIMATE IMPACTS

## HATCHERIES AND SEED LABORATORY DEVELOPMENT

Dependence on natural seed sources, such as Isla Lobos de Tierra, creates productive vulnerability to environmental fluctuations and regulatory closures lacking ecological and operational criteria. Currently, there are some private shellfish seed laboratories, which still limits supply and drives up prices.

→ **Strengthen the development of local hatcheries would allow for diversification of supply and stabilization of seed prices. This measure, in addition to reducing pressure on natural seed banks, would contribute to ecological sustainability. Furthermore, it is necessary to ensure certified standards of homogeneous quality for laboratory-produced seed.**

## PRODUCTIVE DIVERSIFICATION AND REGULATORY FLEXIBILITY

Species diversification (octopus, rockfish, scallop, razor clam, shrimp) is recognized as a key strategy to reduce vulnerability to climate and market shocks. However, regulatory barriers, fishing bans disconnected from ecological cycles, and limited infrastructure restrict its implementation. More flexible regulations are needed to allow the cultivation of species adapted to local conditions and comparable in health to the scallop. Simultaneously, inter-institutional coordination, investment in infrastructure, and technical support are required to facilitate their responsible marketing.

→ **Review and adapt the regulatory framework to favor sustainable productive diversification, promoting innovation, traceability, and the responsible use of local species within the Sechura environmental governance system. Promoting joint programs between local producers and technical specialists would contribute to the diversification and innovation process.**

# LEVERAGE POINT 2:

## ECONOMIC ALTERNATIVES FOR WASTE UTILIZATION

The management of marine waste, particularly that from shellfish harvesting, remains a challenge. The transfer of jurisdiction over the Chulliyachi shellfish dump to OEFA (Environmental Assessment and Enforcement Agency) has not resolved the environmental problems, highlighting the need to define responsibilities and promote sustainable economic valorization alternatives. Previous experiments failed to achieve economic viability, underscoring the importance of promoting applied research and targeted subsidies that encourage environmentally responsible solutions. At the same time, the improper disposal of organic waste by some fishing vessels and processing plants, along with the lack of sanitation infrastructure, exacerbates marine pollution.

→ **The creation of incentives and transparent control mechanisms, accompanied by environmental education and effective oversight, are essential steps toward a circular economy for the bay.**

## PROMOTE SUSTAINABLE TOURISM AND TERRITORIAL GOVERNANCE

Ecotourism, which could complement fishing in Sechura Bay, has significant potential, particularly linked to the gastronomy associated with the supply chain of various seafood products and beach circuits. However, its development faces structural governance barriers. For example, the use of fishing vessels for whale or sea lion watching and the adaptation of piers to promote tourism.

→ **Strengthen inter-institutional and community coordination mechanisms, promote sustainable tourism plans that integrate ecological corridors with road infrastructure, and guarantee legal certainty regarding land use for economic activities compatible with conservation.**

# REDUCE POLLUTION AND REVERSE ECOSYSTEM DEGRADATION

## INSTITUTIONAL STRENGTHENING AND ENFORCEMENT OF REGULATIONS TO ADDRESS POLLUTION

Weak environmental oversight and persistent corrupt practices within public administration limit the effective enforcement of regulations. The lack of basic infrastructure at fishing ports, such as sanitation systems or waste reception facilities, is directly linked to the degradation of the marine ecosystem. Cases like the failed Parachique water and sewage project illustrate institutional fragility and the disconnect between supply chains and the public health system.

→ **It is urgent to strengthen the technical capacities of institutions, ensure transparency in the execution of public projects, and establish effective sanctioning mechanisms that promote shared environmental responsibility among the State, fishers, and the private sector through regulations.**

## STRENGTHEN ENVIRONMENTAL GOVERNANCE IN THE BAY TO ADDRESS SOCIO-ENVIRONMENTAL CONFLICTS

The coexistence of fishing/mariculture and hydrocarbon extraction activities is a growing source of socio-environmental conflict in the bay. There is a widespread perception that oil projects and extractive industries driven by foreign companies threaten the sustainability of marine ecosystems and the livelihoods of local fishing communities. Likewise, projects in watersheds can endanger the bay through the discharge of polluted water. The lack of transparency regarding tax benefits and limited local participation in decision-making deepen distrust of the State.

→ **Strengthen environmental governance through participatory, transparent, and evidence-based processes that prioritize the conservation of hydrobiological resources over short-term extractive interests. An integrated governance framework could help prevent conflicts, guarantee environmental justice, and ensure the sustainability of the bay's socio-ecological system.**

# LEVERAGE POINT 3:

## STRICT MONITORING AND ENFORCEMENT OF CURRENT 5-MILE ZONE LAW REGULATIONS

Effective compliance with the 5-mile zone law is a key framework for the sustainability of marine resources and the coexistence of different types of fishing. This coastal strip protects the breeding grounds of marine species and guarantees the natural regeneration of the ecosystem. However, the lack of operational regulations and enforcement mechanisms has allowed for recurring non-compliance, generating tensions among traditional, artisanal, industrial, and subsistence fishers. The absence of formal/operational recognition of traditional fishers exacerbates this situation, limiting their access to the resource.

→ **Integrating traditional ecological knowledge into monitoring systems, strengthening participatory monitoring, and ensuring strict enforcement of the law would reduce pressure on coastal ecosystems and consolidate more equitable and environmentally sustainable fisheries governance in the bay.**

## REASSESS FISHERIES LAWS

The regulatory analysis reveals inconsistencies in the application of fisheries laws and inequalities among different fisheries. The quota law allowed for greater control over species, but it also generated inequities in quota allocation that affected small producers. The law on flagrant offenses, although aimed at punishing overfishing, has been perceived as a disproportionate punitive tool, as it does not distinguish between serious crimes and minor offenses, generating uncertainty among fishers. Furthermore, the reduction of minimum sizes constitutes a direct and constant risk to the conservation of juvenile populations.

→ **Regulation of illegal fishing should incorporate a legal system of graduated and proportionate sanctions, aligned with ecological and equity criteria, so as to promote the sustainability of resources without criminalizing artisanal/traditional fishing, thereby strengthening the legitimacy of public fisheries policies.**

# MITIGATE ILLEGAL AND OVEREXTRACTIVE INDISCRIMINATE FISHING

## UPDATE SCIENTIFIC ASSESSMENTS

Research demonstrates a persistent disconnect between government scientific projections and the empirical observations of fishers. Cases such as the lack of studies on the density and availability of species like grouper or mullet, which nevertheless occasionally result in fishing bans, reflect the need for science that is more closely linked to the local area and geared towards adaptive and continuous management. Limited coordination and access to information between institutions like IMARPE and fishing organizations have hindered access to data and the interpretation of timely diagnoses for both parties.

→ **Strengthening joint assessments through participatory research and integrated monitoring would allow for the incorporation of traditional knowledge into scientific management, improve the accuracy of management policies, and anticipate the effects of climate change on the bay's marine ecosystems.**

## DECENTRALIZED TECHNICAL TRAINING ON SUSTAINABLE FISHING METHODS AND THE USE OF FISHING GEAR

Gaps in technical fisheries training continue to be a structural factor that fuels illegal and indiscriminate fishing. The lack of targeted and effective training programs on minimum sizes, sustainable fishing gear, and current regulations limits the adoption of responsible practices. The lack of institutional coordination and technological resources restricts access to information and technical assistance, while existing programs still fail to link training with professional certification or formal education.

→ **Decentralizing training, incentivizing it, mapping areas without training coverage, and integrating sustainability content into educational and licensing programs would strengthen the productive and environmental capacities of fishing communities. Furthermore, investing in technical and environmental education would consolidate a culture of responsible and resilient fishing, key elements for the economic and ecological sustainability of the bay.**

# LEVERAGE POINT 4:

## OVERSIGHT OF SOCIO-ENVIRONMENTAL CONFLICTS AND GOVERNANCE IRREGULARITIES IN THE FACE OF EXTRACTIVE INDUSTRIES

The absence of transparent and proportionate mechanisms to balance the extractive interests of hydrocarbons and mining with the protection of marine ecosystems and fishing livelihoods is notable. Project approval processes are often carried out without effective prior consultation or the participation of local stakeholders, generating distrust and perceptions of institutional irregularity. The lack of coordination between technical-scientific studies and participatory fishing processes weakens the legitimacy of decisions.

→ **Establishing a legal mechanism for independent oversight, with representation from fishers and civil society, would allow for the validation of impact studies and ensure that the exploration and exploitation of hydrocarbons and minerals are subject to principles of transparency, accountability, and sustainability.**

## IMPLEMENT COMMUNITY CO-MONITORING AND SURVEILLANCE COMMITTEES WITH THE COAST GUARD, COMMUNICATION NETWORKS, AND REPORTING CHANNELS.

Effective control of fishing and aquaculture activities faces serious limitations due to a lack of funding, clear legal frameworks, and institutional coordination. Although formal reporting channels exist through the Ministry of Production (PRODUCE), their use is limited due to the absence of legal support and protection for whistleblowers. Local experiences, such as existing surveillance committee initiatives organized by fishing associations and authorities (COREVIPA), demonstrate that community surveillance can be an effective tool for preventing corruption and illegal fishing, provided it is institutionalized under co-governance schemes.

→ **Implementing surveillance committees with legal backing and a state budget, integrating the coast guard and local stakeholders, would consolidate permanent communication networks and guarantee protected reporting mechanisms. This approach would strengthen the governance of the bay, fostering social co-responsibility in the protection of resources and the sea as a common good.**

# COMBAT WIDESPREAD CORRUPTION

## MONITORING AND ENFORCEMENT OF REGULATIONS FOR THE PROTECTION OF LOBOS DE TIERRA ISLAND AND THE FIVE-MILE ZONE LAW

A progressive deterioration of the protection mechanisms for restricted areas within the five-mile zone and on Lobos de Tierra Island is evident, exacerbated by a lack of institutional protection and the absence of environmental oversight. Large-scale projects, such as the potential construction of an industrial port, jeopardize the island's status as a national reserve and open the door to economic interests that displace conservation. This scenario reflects gaps in inter-institutional coordination and weak implementation of the existing legal framework.

→ **Strengthening environmental oversight through an autonomous authority or co-governance mechanisms (State-civil society), along with the strict enforcement of the five-mile zone law and the island protection law, is fundamental to preventing the capture of strategic marine areas and ensuring the conservation and long-term sustainability of coastal ecosystems and the socio-economic inclusion of diverse fishing practices.**

## ESTABLISH INDEPENDENT OVERSIGHT TO MONITOR THE ALLOCATION OF PERMITS, CONCESSIONS, AND QUOTAS

The system for allocating permits, quotas, and restocking areas exhibits high levels of discretion, fostering corrupt practices and concentrating rights in the hands of a few legal entities or private actors. Regulatory changes during the period 2015-2018 have allowed non-fishing actors to access concessions and benefits designed for artisanal producers, weakening the principles of equity and sustainability. The manipulation of certificates of origin, harvest volumes, and vessel documents, as well as product laundering, reflect structural flaws in traceability and public control.

→ **Developing an independent, public or mixed-ownership body to oversee permit allocation, quota management, and certification processes would restore institutional transparency, reduce opportunities for corruption, and strengthen the credibility of the fisheries system at the regional, national, and international levels.**

# LEVERAGE POINT 5:

## INSTITUTIONAL STRENGTHENING AND INCLUSIVE FORMALIZATION OF MARICULTURE AND DIVERS

Current formalization pathways are characterized by excessive, fragmented, and costly bureaucracy that excludes actors with fewer resources, perpetuates irregular practices, and fosters dependence on private intermediaries, concentrating the benefits in groups with greater economic capacity. This situation, coupled with the low response of divers and mariculturists to formalization campaigns, reflects weak institutional coordination, impacting both governance and job security. The lack of technical assistance and training programs in safety and first aid exacerbates informality and the vulnerability of maritime workers.

→ **Establish a comprehensive formalization support office, funded with public funds or revenue from shellfish exports and coordinated among authorities, trade associations, and training centers. This initiative would simplify and digitize procedures, as well as offer technical and legal guidance. Mandatory certification and diving safety, promoting equitable, efficient, and sustainable formalization, would be essential.**

## PROVIDING TRAINING ON FINANCE, BUSINESS MANAGEMENT, LAW, AND ACCOUNTING

Regulatory changes in the Bay have limited the economic autonomy of small-scale mariculturists without access to concessions, who lack the financial, legal, and administrative tools to compete. However, the regulatory change has also boosted medium and large companies, which have managed to establish a sustained presence in the market.

→ **In this context, it is proposed to implement inclusive, comprehensive training programs in business management, finance, and fisheries law for grassroots organizations, accompanied by the creation of guarantee funds and community infrastructure that strengthen productive resilience and participatory governance.**

# STREAMLINE AND SUPPORT ACCESS TO FORMALIZATION

## CLEAR REGULATIONS TO REDUCE THE MARGIN OF INTERPRETATION, PROMOTE SECTOR INCLUSION, AND FACILITATE THE STRATEGIC USE OF RESOURCES.

Inconsistencies in traceability regulations, sanitary provisions, and seed extraction zones create ambiguities that affect marketing and promote informality. For example, in the past, the closure of production areas without sustainable alternatives forced mariculturists to relocate to unauthorized areas, increasing informality and health, environmental, and economic risks. Furthermore, the lack of coordination and coherence between SANIPES (National Fisheries Health Agency), the Port Authority, and regional governments hinders the implementation of sustainable resource management policies. Additionally, while the sanitary treatment of other species is addressed through monitoring, the government has not promoted their access to markets, thus limiting local producers.

→ **Implement sanitary and production regulations under a territorial and participatory approach, strengthening equitable co-management mechanisms among fisheries, the government, and the private sector. This institutional integration would allow for more efficient and socially responsible traceability, as well as a strategic and adaptive use of marine-coastal resources, consolidating an inclusive and sustainable governance model for the bay.**

# LEVERAGE POINT 6:

## PUBLIC CONSULTATIONS WITH ALL AFFECTED GROUPS ON IMPORTANT AND BINDING CHANGES

Fishing and aquaculture regulations have been enacted, in many cases, without an effective consultation process with the actors directly involved. Technical working groups or hearings lack binding force, which weakens the legitimacy of policies and accentuates distrust of institutions. Fishers and mariculturists, especially small-scale ones, face barriers to accessing legal and digital information that exclude them from deliberative processes.

→ **Establishing binding public consultation mechanisms and direct representation in ministerial bodies of the sector would allow regulations to be adapted to local production realities and reduce social conflicts arising from regulatory exclusion.**

## FORMULATE FEDERATIONS WITH STATE SUPPORT AND RECOGNITION

Trade associations can strengthen the sector's negotiating capacity and economic sustainability, provided there is institutional backing. The lack of legitimate recognition and institutional support for federations weakens their representativeness and fragments the sector between industrial and artisanal interests.

→ **It is essential that the State promote the institutionalization of federations and working groups through transparent and participatory regulatory frameworks, guaranteeing their autonomy and representativeness vis-à-vis all fishing groups and private actors.**

## REVIEW FISHING COMPLIANCE REGULATIONS REGARDING GRADUATED AND PROPORTIONAL SANCTIONS

The uniform application of sanctions has criminalized subsistence fishing practices, while more serious infractions remain unpunished. The lack of coordination among the competent entities creates operational gaps and weakens the control of regulatory compliance.

→ **Review the sanctions framework to include proportional scales of penalties according to the magnitude of the infraction, strengthening inter-institutional coordination and training authorities in the differentiated identification of each type of fishery.**

# ADDRESS SOCIAL INEQUALITIES AND SMALL-SCALE EXCLUSION

## PRIORITIZING EQUITY AND SOCIAL SUSTAINABILITY OVER ECONOMIC EXPANSION

Overexploitation and competition between industrial and artisanal fleets have increased resource depletion and inequality within the sector. The loss of species and indiscriminate access to traditional fishing grounds affect both the ecological sustainability and food security of coastal communities.

→ **It is urgent to review the criteria for granting permits, clearly differentiating vessel categories and areas of operation, and to implement a control system that penalizes industrial fishing in artisanal areas protected by law. Legal recognition of traditional fishing grounds and the rigorous application of laws against bottom trawling are essential steps to preserve ecosystems and guarantee equity among different types of fisheries.**

## REDUCING THE ASYMMETRIC DEPENDENCE OF SMALL PRODUCERS ON FISH FARMS AND PROCESSING PLANTS

There is a structural dependence of producers on large aggregating companies, which reduces their autonomy and puts downward pressure on prices. Limited access to financing and the limited financial literacy of fishers hinder the implementation of cooperative projects and diversification. Furthermore, state support mechanisms fail to encompass the diversity of fisheries or adapt to the economic differences between fishing gear.

→ **Implement programs, such as state-run collection centers, public subsidies, and technical assistance, prioritizing hatcheries and processing plants so that primary producers can avoid problems accessing key resources at strategic times for their activity. And promote diversified and formalized aquaculture projects with financial and production training, enabling associations to market directly to national and international markets.**

# ACKNOWLEDGEMENTS

These policy recommendations are based on the results of a participatory research project conducted with 45 key informants connected to the Sechura Bay coastal marine system. Participants included: mariculturists (AMYGE, AMYPE, and independent), traditional, artisanal, and industrial fishers (deep-sea, trawl, purse seine, and industrial), fisheries engineers, processing company owners, representatives of associations and guilds, and local and regional government authorities (including the municipality, DIREPRO, DICAPI, and SERNANP).

We also thank the following informants who responded to the final call for feedback on these policy recommendations in October and November 2025, and who agreed to be mentioned here by name:

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