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Research Article

Economic diversification and vulnerability in fishing communities of the Baja California Peninsula, Mexico

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ABSTRACT. Where timely information and governance schemes were incorporated, fishery resources were more responsibly used. However, the situation in fisheries remains critical, and new challenges include climate change, pandemic effects, and social conflicts. Planning instruments for productive activities encourage the relevant role of diversification as a mechanism to generate balances between sectors to generate sustainable economic alternatives that contribute to reducing vulnerability in fishing communities and the biological sustainability of resource populations in use. This research analyzes local knowledge and socioeconomic indicators to determine the levels of income dependence on fishing activities and alternative options, such as whale, and bird watching, and sport fishing, according to their potential resources. The selected methods included a primary study through surveys of a representative sample of fishers to understand aspects of their well-being and diversification indices in two selected locations of the Baja California Peninsula. Significant differences in income levels and aspects of social cohesion were found. The locations studied also showed a high concentration rate of fishing activity measured by the Herfindahl-Hirschmann index for economic diversity. This low diversification increases vulnerability and occurs mainly in locations with lower incomes and lacking infrastructure, which shows the need to promote joint work between policymakers, communities, and academies so that they include other productive, feasible, and sustainable activities such as tourist packages, food processing, aquaculture, among others that improve income, as well as fishing that provides them with food security.

Keywords: diversification; management; well-being; vulnerability; economic alternatives; socioeconomic condition

INTRODUCTION

Fishing as an economic activity is important in developing coastal regions and communities world-wide, culture and tradition, jobs, and food provision. The international organization that governs the policy of fisheries and aquaculture, the Food and Agriculture Organization (FAO), recommends that new approaches should be adopted for their management, which includes conservation, a balance between ecological, social, and economic aspects to promote fisheries sustainability (FAO 2020). In this context, among developing countries, Mexico is one of the main promoters, guiding organizational efforts toward the goal of sustainable fisheries within the framework of the guide for their certification (Ponte 2012).

At a global level, experts agree that many fisheries are in crisis. For over 20 years, processes of over-fishing, environmental deterioration, social pressure, illegal, unreported, and unregulated fishing (IUUF), and pollution have occurred. This has been worsened because of phenomena such as climate change, ocean acidification, and eutrophication that compromise the sustainability of fishing and the well-being of thousands

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of vulnerable communities with a high dependence on fishing resources (Morzaria-Luna et al. 2014, Colburn et al. 2016, FAO 2020, Amadu et al. 2021, Armenta-Cisneros et al. 2021, EDF 2021, Prosperi et al. 2022).

Concerning the fishing sector challenges the fishers act to adapt, where income diversification is considered a strategy that allows the improvement of workers' living conditions in this sector and other vulnerable workers such as agriculture and livestock, mainly those who live in poverty (Chambers 1981, Chirau et al. 2014). Several authors agree that fisher's economic diversification is a process on evolution (Brugère et al. 2008, Prosperi et al. 2019, Armenta-Cisneros et al. 2022). Kronen et al. (2010) suggest that communities explore and develop alternative economic activities to diversify income sources. Still, diversification can only occur if these activities are feasible with or without using their capital assets and without abandoning the fishing. The alternatives are incorporated into the fisher's portfolios, seeking to expand income and active working periods during the year and to reduce their economic vulnerability (Sethi et al. 2014, Finkbeiner 2015, Salifu 2019, Armenta-Cisneros et al. 2021, Gónzalez-Mon et al. 2022).

Vulnerability is often described as a function of exposure to a stressor and the ability to respond; it has social and ecological dimensions due to changes in ecological systems affecting fishing communities and vice versa (Cinner et al. 2013). In this sense, diversification also generates employment alternatives to meet social demands and strategic programs to reduce social vulnerability and raise the well-being of fishers and their communities. In Baja California Sur, it has been found that the population living in fishing communities, particularly those located in places with difficult access and far from the main population centers, are most vulnerable. Also, localities with higher earnings have incorporated the benefits of sustainable fisheries management through diversification, and recent studies have included indexes such as Herfindahl or Simpson for measuring their diversification (Sievanen 2014, Marín-Monroy & Ojeda-Ruiz 2016, Roy & Basu 2020).

Mexico's fishing production has a relevant contribution to the world amount, ranking 16th among the 25 main producing countries and 4th within the American continent (FAO 2016a, 2018). It is estimated that small-scale fishing in Mexico generates between 250,000 and 300,000 direct jobs and contributes 23% of the national production (around 800,000 t of marine products), which provides for the economic development of numerous families and coastal communities (Inteligencia Pública 2019). However, this sector faces challenges related to the effects of climate change, such as the variability and reduction in catches, mainly in northwestern Mexico, which includes the peninsula of Baja California (EDF 2021).

Today, through the National Strategic Programs in Mexico (PRONACES, by its Spanish acronym), which articulate scientific and technical capacities with other social actors from the public and private sectors, it is recognized as a priority to generate research on socio-environmental systems and sustainability, particularly aspects of conservation of coastal and marine ecosystems with sustainable management and production (DOF 2021). On the other hand, in the Baja California Sur public sector, the government recognizes a principle of respect for the environment, where diversification is an integrated part of sustainability. Some activities have been promoted, such as sport-recreational fishing in key regions and better marketing strategies for fishery and aquaculture products (Gobierno del Estado de Baja California Sur 2018).

Based on the above information, this study identified the socioeconomic, organizational, and perception aspects of alternative activities in use by fishers in two fishing communities of the Baja California Peninsula. An index to identify the current level of diversification was estimated, thus establishing a baseline for the policymaking strategies that improve the well-being of workers in the fishing sector through economic alternatives for livelihoods. The findings of this research will be useful in understanding and improving social and economic processes taking place in many fishing communities around the world.

Ellis & Allison (2004) also point out that diversification is essential to the rural population's struggle to improve their living conditions. However, the process challenges conventional ideas about poverty reduction in rural areas, and this diversification process should also be oriented towards activities that utilize natural resources on a sustainable basis. Several authors consider this is possible because fisheries-based livelihoods are generally exposed to different risks and uncertainties compared to agricultural livelihoods, providing greater incentives for collective action and cooperation strategies to use common resources (Perry 1995, Ferrol-Schulte et al. 2013, McCay et al. 2014, Kadfak 2020).

In the Baja California Peninsula, the region with the highest fishing productivity is Magdalena-Almejas Bay, which is considered a unique socio-ecological system. Nevertheless, the social aspects have been minimally studied, and although some economic

diversification activities of the fishers have been identified, there are still challenges in measuring their impacts.

Under this context, identifying social aspects and determinants of economic diversification is necessary for designing and implementing ordering and management plans, including economic promotion. Particularly in Magdalena-Almejas Bay, whale watching, sport fishing, and seafood restaurants have been consolidated as relevant economic diversification alternatives for small-scale fishers (Marín-Monroy & Ojeda-Ruiz 2016, Ojeda-Ruiz et al. 2018). Studies of fishing in Loreto indicate that the predisposition of economic diversification of fishers is high since 39% of them incorporate alternative activities in their yearly portfolio (Armenta-Cisneros 2019).

The importance of fishing is also valued in the international political sphere. According to the United Nations (UN), more than three billion people depend on marine and coastal biodiversity for their livelihoods. Recently, the 2030 sustainable development agenda establishes new challenges for fishing and points out the need to work oriented toward increasing the contribution to the sustainable development goals (SDG), among which are no poverty, zero hunger, responsible production and consumption, decent work and economic growth, and life below water (UN 2016, 2017).

From the perspective of experts in the development of rural and urban coastal areas, diversification in fisheries can be a strategy to strengthen the ability to face current challenges such as changes in fish catch volumes, overexploitation of resources, changes in abundance and availability caused by climatic effects that will increase in the coming years and even the potential collapse of some fisheries (Ellis & Alison 2004, Worm et al. 2009, Garcia et al. 2014, Finkbeiner & Basurto 2015, FAO 2016b, Ojeda-Ruiz et al. 2018, Roy & Basu 2020).

Studies in Baja California Sur, affirm that a significant proportion of fishers are resorting to economic diversification, both in fishing activities and in other viable and profitable non-fishing alternatives in other sectors of the economy. These last alternatives primarily include low-impact tourism activities when, for reasons such as resource seasons, bans, and fishing seasonal restrictions, they cannot carry out fishing operations. On the other hand, some studies assume that stopping fishing for a while may positively impact the recovery of exploited populations. Besides, fishers have opportunities for complementary income through alternative economic activities.

It is important to note that it is assumed in the literature, without yet having developed studies to measure the impacts, that if the fishers have additional economic alternatives, the pressure on the fisheries decreases and that in some alternative activities that require less investment of time, their income could duplicate and improve their quality of life (Ramírez-Arce 2017, Armenta-Cisneros et al. 2021). These strategies, increasingly common in coastal fishers worldwide, contribute to reaching the SDGs and domestic or local goals (UN 2015, Gobierno del Estado de Baja California Sur 2018, Said & Chuenpagdee 2019).

MATERIALS AND METHODS

Study area

Two localities with high dependence on fishing activities were selected to evaluate adoption and encourage the generation of alternative activities, and both are located along the Baja California Peninsula. The first is Isla de Cedros (Cedros Island) (28°10′58″N, 115°13′04″W) in the state of Baja California. It is an insular territory located in the middle part of the Baja California Peninsula. Its demographic expansion began in 1922, due to the abundance of resources and fisheries such as abalone, lobster, sardine, and sargassum; there was even influence from Japan since they also exploited these resources and generated a transfer of knowledge to the locals. However, in 1990, with the fall in fishing activity, most of the population emigrated, and the island went from 5000 to around 2000 inhabitants. According to Baxin-Martínez (2020), despite its historical and economic relevance, it has become a forgotten space, and its revaluation is important. The island possesses a terrestrial pine ecosystem, terrestrial and marine endemism in plant and macro-algae, relevant to support the sardine fishery and nursery of some species of sharks (CONANP 2005, Martínez-Porchas 2009, Taburin et al. 2019). The economy is supported by fishing, services, and commerce, besides the employment of government and education institutions.

The second locality is Puerto Chale (Chale Port) (24°25′21″N, 111°33′12″W), located north of the municipality of La Paz in Baja California Sur; it is a small town where mainly fishing activities are carried out, and its population has remained with little growth (Table 1). Since 2009, community members of Chale Port have participated in a collaborative science program led by civil society organizations to understand the link between their fisheries and natural

Table 1. Population in Chale Port Baja California Sur, and Cedros Island, Baja California (2010-2020). Source: author's elaboration with data from "Census of Population and Housing" from the National Institute of Statistics and Information (INEGI 2010, 2020).

Year/Total population	Chale Port	Cedros Island
2010	373	1339
2020	393	1233
% Growth	5.36	-7.9

resources, which include the spatio-temporal component (Jimenez-Esquivel et al. 2018). It has very dense mangrove areas that embellish the region, and the terrestrial and marine richness of Isla Margarita serves as a refuge and procreation for several marines and terrestrial species such as bald eagles, sea eagles, frigate birds, gray whales, seals, and dolphins (CONANP 2005, Valdez-Guerrero et al. 2022). The community population is mainly dedicated to fishing and trade (Jiménez-Esquivel et al. 2018).

The selection of the localities is justified because the Chale Port has a history of greater lag in well-being indicators (Marín-Monroy & Ojeda-Ruiz 2016, Jiménez-Esquivel et al. 2018), while Cedros Island, due to its geographical condition, has a high dependence on fishing, therefore demonstrating the importance of identifying and analyzing undergoing options that complement the means of subsistence in these localities.

Methods

A local knowledge study was carried out using a questionnaire with structured questions (Méndez-Espinoza et al. 2020) to obtain information on the socioeconomic, organizational, and perception aspects of alternative fisher's activities. The questionnaire included 47 questions in two main categories: socioeconomic indicators and local knowledge about alternative economic activities in use. The first category includes their home's characteristics, access to services, social security, personal and demographic conditions, and income distribution. The second includes questions related to organization and impacts of alternative economic activities in use and social cohesion, following recommendations from previous studies (Boyd et al. 2007, Marín-Monroy 2013).

The surveys were conducted face-to-face with fishers, the target population, in the selected localities from June to September 2021. As both localities are relatively small and low populated and due to COVID-19 pandemic restrictions, the interviewer was visiting houses randomly to find fishers. A representative sample was calculated for a finite population with a 90% confidence level and a 7% margin of error in a total of 72 fishers from 176 registered (DOF 1992, Daniel 2007).

Furthermore, a protocol was followed in the research design, where all the interviewees agreed to participate or not in the study by putting a cross on the front page of the survey. Also, the participants were advised of the academic use of the collected information. Finally, the interviewer was trained to conduct the interview, including trials with key informants/fishers (the questionnaire used is provided in Suppl. Material 1).

With the survey's results, descriptive statistical analysis was performed in STATA IC 16 software. We used an index to characterize economic activity to calculate the level of diversification in these localities. If there is a greater number of economic sectors, it represents a lower market concentration and greater diversification, which also makes them more competitive (Scherer 1980). The methods commonly used to measure concentration/diversification are the Ogive index, entropy index, Gini coefficient, and the Herfindahl-Hirschmann index (HHI) (UN 2016). The last index was selected considering its use in previous studies of the fishing sector, and it is the most used in agriculture (Agnarsson et al. 2016, Haas et al. 2016, Holland & Kasperski 2016, Pandit et al. 2019, Salifu 2019). It is expressed as follows:

$$Herfindahl - Hirschmann\ index = \sum_{i=1}^{n} S_i^2$$

S_i is the share of economic activity in sector *i* in the total economy, and *n* is the number of sectors in the economy (for example, the share of exports from sector *i* in total exports or the share of employment in sector *i* in total employment). The range of this index is 0 to 1; a country with a perfectly diversified economy will have an index close to 0. While a value close to 1 indicates more concentration or a high specialization. The HHI can be used to measure concentration in the fishing sector and farmers in coastal communities and to measure income diversification (also used as Simpson index in biological sciences); this index is a measure of dominance where larger values represent specialization, and smaller values represent diversification (Finkbeiner 2015, Roy & Basu 2020).

Finally, using the questionnaire responses, we presented the activities that the inhabitants mentioned. We showed a greater interest in adopting and promo-

ting alternatives to diversify the sources of income, also considering infrastructure limitations to reduce social vulnerability.

RESULTS

Socioeconomic aspects of the productive organization and alternative means of economic diversification

Knowing the living conditions of the fishing communities is a priority task because fishers generally live in exposed areas due to the nature of the activity they carry out. Below is a summary of the main characteristics of the dwellings in the studied localities (Table 2).

Concerning Table 2, although in the two communities, most of the inhabitants own or rent a house with appropriate characteristics, built with resistant materials and equipped with basic services such as water, electricity, and drainage (INEGI 2020), in Cedros Island, most of the houses have wooden roofs but are connected to the drainage and electricity networks. On the other hand, during the field visit, less infrastructure of public services was observed in Chale Port houses and the community in general.

Questions were included in the survey's instrument that involved the integral well-being of the inhabitants (Marín-Monroy & Ojeda-Ruiz 2016) to identify the socioeconomic aspects and characterize each community. In addition to income, questions were asked about activities or jobs they liked the most, access to health services, schooling, if they suffered from chronic diseases and the leisure/recreation time they had, among the most important. The main results are shown in Table 3.

It was confirmed that the form of legal organization preferred for working in the fishing sector is the cooperative production society, a widely dominant figure, and a positive correlation was found between being a cooperative member and better living and income conditions. Additionally, in both localities, a high specialization is observed, related to the average experience as fishers, with 12 and 16.4 years, being slightly higher in Cedros Island.

Regarding the need for diversification in income options in Cedros Island, 89.8% answered that it is necessary, 8.2% said they do not know, and only 2% answered that it is unnecessary. However, in practice, few showed openness to carry out a different activity since the three jobs or activities that they most liked to do were fishing (73.5%), food preparation and sale (10.2%), and tourism service provider (8.2%). In addition to these activities, they would also like to be part of companies dedicated to commercializing fishery products (23.4%) and processing marine products (12.7%).

Two hypothetical questions were included to learn about social cohesion in Cedros Island, one related to trust in childcare and the other about participation in actions for the benefit of the community; 59.2% of those interviewed say they feel very safe when they need to leave their children in the care of someone, 26.5% said feel safe, 8.2% partially safe. In contrast, the remaining 6.1% said they feel unsafe. Regarding community participation, 26.5% are very likely to participate, 34.7% say it is likely, 18.4% are unlikely, and 20.4% do not participate. These questions are also linked to participation in religious activities since the community identifies as catholic in 83.7% and christian in the remaining 16.3%.

In the case of the town of Chale Port, the average monthly income declared was MXN$ 2476 (US$ 123.8), in terms of the sector in which 95.6% of those interviewed work in the fishing sector, in addition to the percentage of other households' members who work in fishing is 52.2%, therefore economic diversification is practically nil, confirming a high dependence on fishing activity. However, a low economic income that persists compared to other fishing locations is much lower than the reported average income from Cedros Island.

In this community, fishers are also interested in tourism as an alternative activity since it is the main area of interest for future training. The time they do not work, that is, the leisure time that they have left, is dedicated to what they described as "other /doing nothing or resting" by 47.8% of the interviewees; 17.4% to recreational activities; 13% to sports or physical activity, 13% are retired, and 8.7% did not answer. When asked if they consider that employment options must be diversified, 91.3% of those surveyed answered yes, and the remaining 8.7% did not know.

The same two hypothetical questions were included to learn about social cohesion in the Chale Port community; 69.6% of those interviewed said they feel very safe when they need to leave their children in the care of someone, 21.7% said feel safe, 4.3% said feel unsafe, and another 4.3% did not answer. In the question about community participation, 13% are very likely to participate, 47.8% say it is likely, 30.4% that it is unlikely, 4.3% do not participate, and the remaining 4.3% did not answer. In addition, the community identifies itself as catholic 91.3%, only 34.8% actively participate, and has contributed some amount to the church or tithe.

Table 2. Characteristics of fisher's house. Source: surveys' results.

Main characteristic	Cedros Island	Chale Port
Population that owns a house	49%	65.2%
The main wall material is brick or block	87.8%	78.3%
The main roofing material is concrete or cement	18.4%	69.6%
The water in your home is obtained from:	81.6% (Tubing water)	87% (Water provided by truck)
Your home drainage will:	87.8% (The public drainage network)	91.3% (Septic tank)
The electric light is obtained from:	100% (The public company CFE)	82.6% (Solar panel)

Table 3. Questions about the socioeconomic characteristics of the population. Source: surveys' results. IMSS: Mexican Institute of Health Services, INSABI: Institute of Health for Well-being. *Test of means with a significant difference.

ID Question	Cedros Island	Chale Port
¿What is your average monthly income in Mexican pesos? (*)	$10,506	$2,476
How many years have you been working?	16.4	12
Do you belong to a cooperative production society?	Yes: 91.8% No: 8.2%	Yes: 56.5% No: 43.5%
What is your highest level of schooling completed?	High School: 49% Secondary: 38.8% Primary: 12.2% Without education: 0	High School: 21.7% Secondary: 65.2% Primary: 8.7% Without education:4.4%
Do you have access to health services?	INSABI: 6.1% IMSS: 87.8% No: 4%	INSABI: 73.9% IMSS: 8.7% No: 13%
Do you suffer from any chronic disease?	Yes: 6.1% No: 93.9%	Yes: 13% No: 82.6% Did not answer: 4.4%
How many hours of recreation do you spend a week?	5.9 h	7.5 h
What is the job that you like to do the most?	Fisher 73.5%	Fisher: 39.1%

Complementary activities and their limitations

In the case of Chale Port, few complementary activities were identified, and the diversification index HHI was 0.69. In this case, of the total income generated by the inhabitants of this community, 81% comes from the fishing sector (primary). Another income source detected was government transfers since some residents receive pension or disability assistance (19%). However, the community identifies the activity of providing tourist services as potential (Ibáñez-Pérez 2014), mainly oriented to observing flora and fauna during the winter season. This income activity new in some fishers' portfolios must resolve some limitations. In this regard, during our field visit, it was observed that the infrastructure was inappropriate for developing and competing in the short term with other regions that provided ecotourism services. The main limitations to solve are related to existing infrastructure and include scarcity of water, limited access to electricity (since they use solar panels), public toilets not working, and only a few shops to supply food and essential supplies to visitors.

In Cedros Island, the diversification index HHI of the fishing sector was 0.58, where income from fishing represented 69.7% of the total, and the rest of activities from the tertiary sector had participation of 30.3%. The alternative income to the fishing activity mainly comes from activities related to trade or services and partners of the fishers, who work in activities related to services (education and the salt export company). The fishing community identifies some alternative activities, mainly related to fishing, such as preparing and selling seafood with a 10.2% preference and providing tourist services with an 8.2% acceptance. It is even observed that some are engaged in this type of activity, providing support services to tourists who come to the island to

do sport-recreational fishing. In this case, the infrastructure on the island does not represent a factor in limiting recreational fishing.

DISCUSSION

Economic diversification of fishers

Livelihood diversification is an adaptive mechanism used by fishers to cope with low catches during banning seasons; it is successful in reducing fishers' vulnerability and fishing pressure through the reduction of fishing effort but may not necessarily stop fishers from fishing completely, but eventually may influence their exit decision from the fishing sector. It also happens under income subsidy programs from the government-oriented to reduce effort or support fishers' exit from specific fisheries (Maullil et al. 2011, Finkbeiner 2015, Armenta-Cisneros 2022).

Income diversification is a form of risk reduction and income stabilization that ensures consistent consumption patterns and engenders improved quality of life, wealth accumulation, and food security for rural households from agriculture and fishing (Salifu 2019). Additionally, sustainable income diversification involves the efficient utilization of capital inputs by householders to generate desirable levels of income and well-being from a composite number of income sources; thus, rural householders pursue it as it tends to lower their risk exposure and vulnerability in areas predisposed to environmental degradation or excessive use of natural resources (Salifu 2019, Armenta-Cisneros 2022). Finally, some studies about the demand for labor have shown that diversification in shrimp and salmon farming options has improved income distribution (Cárdenas-Retamal et al. 2021, Ray et al. 2021).

Economic diversification in non-fishing activities occurs at low levels in Cedros Island and is practically imperceptible yet in Chale Port. In other regions of the peninsula such as Adolfo Lopéz Mateos Port, San Carlos Port, and Loreto, the incidence of fishers in tourist and alternative activities is increasing, with relevant impacts on income, highlighting activities such as whale and bird watching, sport fishing, diving, ecotourism tours among the most important (Marín-Monroy & Ojeda-Ruiz 2016, Armenta-Cisneros et al. 2021).

Chale Port was included in the study because of the importance of its fishing activity and a place with tourist potential. This location was included in a report from Ibañez-Peréz (2014) as one of the small towns with opportunities in the tourism sector due to its environmental characteristics, mainly its attractive landscapes and ecosystem cultural services that include endemic fauna and flora, for recreational and touristic services. Besides, there are species for recreative-sport fishing (Milcu et al. 2013).

Despite the above, no studies indicate efforts to encourage fishers' participation in these activities. Conversely, it was found that in a nearby town, Santa Margarita Island, in the neighboring municipality of Comondú, the community participated in a study that analyzed the potential of a Cooperative Society of Tourist Services as an alternative for sustainable development, where 93% of those surveyed agree on the idea that tourist activity represents an opportunity for the diversification of economic activities on the island (actually mainly supported for fishing) since it would promote work for the entire community. It is a less risky activity (Murillo-Alvarado 2017).

The diversification index HHI is the most common and familiar tool in use (Salifu 2019). Our results showed greater economic diversification in Cedros Island, and this result shows the same pattern for communities with higher cooperative fishers members (Finkbeiner 2015); however, we found a high dependence on fishing in Chale Port, which paradoxically has a natural, environmental and historical heritage that can be used. Considering national and international experiences, the higher the dependence of small-scale fishers on fishing, the more important the need to promote diversification and the management of programs and public policies from local governments, including governance aspects (Alom et al. 2020, Muringai et al. 2020, Pedroza-Gutierrez et al. 2021).

In the case of Chale Port, in addition to the challenges it will have to face related to the effects of climate change on resources and extractive activity, it will have to overcome the deficient electrical and public services infrastructure. Tourist alternatives can only be offered properly with adequate infrastructure, which limits other economic options. Additionally, it is recommended to guide the reconversion processes with support and training programs with the assistance of academic and research institutions (Trina et al. 2015, Pandit et al. 2019, Muringai et al. 2020).

According to Salifu (2019), these reconversion processes will require further examination of the political economy for income diversification, poverty reduction, and sustainable economic alternatives; previous experiences showed that these measures have failed mainly to identify the root causes of poverty. However, it is a tool that positively influences

policymaking and could be a real option for building rural livelihoods.

The efforts of the Philippine government through the Fisheries Sector Program (FSP) and the Fisheries Resource Management Project (FRMP) should also be considered to implement income diversification projects with mediocre results due to the introduction of alternatives that were beyond the skills and competencies of fishers, such as maintaining small businesses. These programs required more than start-up capital and appropriate market connections (Maullil et al. 2011).

For the above arguments, the participation of communities, governments, financial agencies, and academies is necessary to address key aspects accompanying the diversification processes. Among the most important are spatial intersectoral planning schemes, adjustments in regulations, particularly those that ensure sustainable development and establish clear rules for the participants, support to facilitate agreements between fishers and strengthen local governance, and the generation of flexible monitoring, evaluation, and decision-making schemes on progress, proposing convenient indicators and metrics to assess the effect on resources, ecosystems and promoting sustainability (Schultz-Zehden et al. 2019, Kyvelou et al. 2020, Pham 2020, Miller 2022, Prosperi et al. 2022).

In this study, because of the government structure in Mexico, it is important to underline that municipal government, the closest to people's needs, has a major responsibility in these processes. The support for economic development in rural areas is a priority. Besides, there has been a specific interest in Chale Port development in the last two municipal administrations. Still, there needs to be more continuity and efficiency in actions and public investments implemented. This document's socioeconomic indicators and infrastructure challenges prove the need to enforce programs and policies oriented to these goals (Guerrero et al. 2022).

Socioeconomics and organization aspects

The identification of the form of organization and aspects of socioeconomic and perception about alternative activities for fishers are key elements for accompanying strategies that reduce vulnerability and improve the well-being of those who work in primary sector activities, particularly in fishing (Ramírez-Arce 2017, Pandit et al. 2019, Said & Chuenpagdee 2019, Murungai et al. 2020, Armenta-Cisneros et al. 2021).

The results of the housing conditions of the fishers show some important differences between the studied communities. Although the percentage of those with their own house is high in both cases, homes are built using resistant materials, and providing basic services to the houses are covered somehow, the situation in both localities is very different. Specifically, better coverage of basic services and infrastructure by the government on water supply, drainage, and electrical energy provision in Cedros Island was found, while in Chale Port, the water supply is mainly through trucks, with low coverage of the drainage network, so septic tanks are used. Electrical energy comes basically from solar cells. Studies carried out in India, Bangladesh, and Zimbabwe show lower rates of home ownership but, above all, lags in the coverage of basic services, with an average shortage of energy of 35%, drinking water at 15%, and sanitation services at 30% of households (Trina et al. 2015, Alom et al. 2020, Muringai et al. 2020).

The average monthly income for fishers in Isla de Cedros was estimated they earned MXN$ 10,506 (US$ 525). This value shows they are above the poverty line for income per person of MXN$ 2673.6, estimated by the National Council for the Evaluation of Social Development Policy for rural areas (CONEVAL 2021). It is shown that, in general terms, the households have no income deficiencies. However, 24% of fishers' homes were below the poverty line, and in Mexico, fishers' localities have shown higher vulnerability (Morzaria-Luna et al. 2014)

In the case of Chale Port, the economically active population (EAP) is 201 inhabitants, of which 70.6% (142 people) is a male population that dedicates a greater proportion to activities related to fishing, with an average income four times lower than that declared in Cedros Island. Despite this, both localities report monthly income like other fishers in the state, such as Loreto, and higher than Chiapas and Oaxaca, which are other regions of Mexico; many even report an income above the average of Filipinas, Bangladesh, and Zimbabwe areas (Maullil et al. 2011, Marín-Monroy & Ojeda Ruiz 2016, Alom et al. 2020, Muringai et al. 2020, Armenta-Cisneros et al. 2021).

It is important to mention that despite not having specific social assistance policies, Isla de Cedros has very low marginalization indicators. Most of its population has piped water and electricity services, and it also has only 1.26% of the illiterate population and 13.88% of the population over 15 years of age without completing primary school. These values are higher than the averages in Mexico, these means better positioned (CONAPO 2010). In this sense, it is important to point out the support of companies such as Exportadora de Sal and the SCPP Pescadores

Nacionales de Abulón (fishing cooperative) in the integral development of the community by providing key infrastructure elements such as public works to supply water and energy, paving streets and maritime port infrastructure, but even more important, because they have had a positive impact on the sense of belonging and cohesion among fishers, being also a success factor for the adequate management of common goods (McCay et al. 2014).

How the community has organized itself for productive fishing activities has been predominantly in the form of fisher's associations, also known as "cooperative production societies". They arose from the General Law of Cooperative Societies promulgated in 1938 in Mexico. In addition, years later, laws and decrees were also unified to protect cooperative fishing societies in a General Fisheries Law in which seven marine species were dedicated to their exclusive capture by these organizations (Muñiz-Díaz & Alanís-Tavira 2020) was the reason the fishing sector cooperative societies were established with the priority objective of promoting work and a living way among their members. In the case of Isla de Cedros, they have had property rights for the sustainable use of some fishing resources (such as abalone and lobster), which has favored their ability to evolve into organizations that make up the entire production chain from capture, processing, and marketing (Méndez-Sánchez 2012).

In Cedros Island, the "SCPP Productores Nacionales de Abulón," which is one of the most important fishing cooperatives in Baja California, has exclusive long-term federal concessions for the capture of lobster, abalone, snails, seaweed, sea cucumber, and urchin, in addition to commercial exploitation permits of fishery resources such as crabs, clams, octopus, finfishes, sharks, tuna, sardines, and anchovy. The lobster fishery in this place is the oldest in Baja California. The company is made up of 156 partners that cover catching, processing, and marketing activities (Palma 2010).

In Chale Port, a representative fishing production cooperative society with history, scope, or social influence still needs to be identified, as in Cedros Island. Those that exist are in the process of organizational consolidation in times with extremely complex availability of resources. Previous studies also point out that this community has the lowest social security cover in Bahía Magdalena-Almejas (BCS) and is a highly marginalized population; thus, special attention by the government is needed for this locality (Marín-Monroy & Ojeda-Ruiz 2016).

CONCLUSIONS

By disaggregated indicators, this study analyzed the socioeconomic conditions of fishers from two localities with the potential to diversify economic activities and reduce dependence on fishing and, thus, the vulnerability of those who depend on it. The town with the greatest dependence was Chale Port, which also showed lower income and greater lag in basic services. Paradoxically, it is the community that requires greater diversification, and there is an area of opportunity in ecotourism services for the observation of birds and marine mammals; however, it requires public investment to consolidate a basic infrastructure for this type of activities, integrate tourist packages with the community, train guides/providers of ecotourism services following official Mexican standards. In addition, this locality has a population with a few years of residence; the social links must be worked on, and community cohesion must be promoted.

In the case of Cedros Island, there is less interest in diversification activities due to the roots of the community and the sense of belonging to the cooperative, and in general, the income is sufficient, so diversification is recognized as desirable, but not considered as a necessary alternative in the short term. In this sense, the community has started activities related to providing tourist services, mainly to tourists from the USA, such as nature tourism and sport fishing. Compared to Chale Port, it has greater economic diversification, confirmed by the concentration indices obtained.

The main recommendations from this study are: 1) the need to focus on support and diversification strategies in the most marginalized communities since the localities with better income levels, at least in the case study, tend to diversify and find other income options. Surely, in the following years, as an effect of the exploitation of the fisheries resources and the announced potential impacts of climate change, the relevance of diversification will increase, making it necessary to include in the government plans and strategic sectors public investments of Baja California Sur, to improve well-being and reduce the vulnerability of fishers, and others primary workers. 2) The social component, human capital, and their relationships are essential for developing these processes, especially governance and social cohesion since community agreements and principles of the economy for the common good are required to care for resources, environment, and heritage. Therefore, more in-depth

studies on this subject are required. 3) In this process, the academy accompaniment will be important by providing academic/research information about the resources that attract visitors such as birds, marine mammals, marine turtles, and sharks, among the more charismatic species; integrating touristic packages using participative science with the community; and training to fishers and their family to accomplish the tourism guide certification required in Mexico (Ibañez-Peréz 2014, Jiménez-Esquivel et al. 2018, Guerrero et al. 2022).

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