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Livelihoods Characterization of a Small- Scale Fishing Community in the Colombian Caribbean

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Abstract

Coastal communities that depend on small-scale fisheries (SSFs) are poorly understood. Designing policies to address their vulnerabilities requires an understanding of the socioeconomic context in which SSFs operate. Unfortunately, that type of information is usually incomplete and dispersed in developing countries. This study seeks to close this gap by comprehensively examining the socio-demographics, assets, livelihood strategies, food security, and poverty levels of a fishing village in the Colombian Caribbean, including both fishing and non-fishing households. We collected information in the village of Barú (Cartagena) through monthly surveys from July 2018 to September 2019. The analysis follows the sustainable livelihoods approach (SLA) to understand the households' livelihoods. Our results show that: (i) SSFs play a double role in fishing households: self-consumption and income generation. (ii) SSFs play an essential role in food security for both fishing and non-fishing households. (iii) Livelihood diversification, including multispecies fishing and activities by household members in addition to the head, is key for diversifying risk and smoothing consumption. (iv) Fishing communities face significant restrictions in access to financial markets. (v) Although fishing households are better off than non-fishing ones in terms of income, they exhibit much lower education and literacy. (vi) The whole community lacks access to essential services such as health services and water or sewage.

Keywords: sustainable livelihoods approach; small-scale fisheries; assets; poverty; education gap; food security; Colombia

JEL Codes: D13, I21, I22, J46, Q22, Q56

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1. INTRODUCTION

Fishing is a key component in the livelihoods of millions of people (Asiedu, 2011). Approximately 90 percent of the 38 million people that the Food and Agricultural Organization (FAO) register globally as fishers are classified as small-scale, and 95% of them are located in Africa, Asia, and Latin America (FAO, 2004).

However, there is limited information about the livelihoods of small-scale fishing (SSF) communities in developing countries (Cinner et al., 2010; Bailey & Jentoft, 1990). Collecting reliable data is difficult (Pita et al., 2019) and the sector lacks quantitative studies on socioeconomic variables (FAO & World Fish Center, 2008). Research on fisheries has emphasized biological issues (Béné, 2003). A review of 202 articles concluded that fisheries' role in poverty alleviation is unclear because good conceptual models are lacking (Bené et al., 2016). There is little rigorous data estimating the poverty level of fishing households (Willmann, 2004). In some cases, fishers' poverty has been inferred rather than proven (Thorpe et al., 2007). Moreover, the estimation of poverty indexes and the measurement of vulnerability depend on reliable longitudinal data (Béné, 2009), which has not been available. Pita et al. (2019) coordinated an entire special issue (*Marine Policy*, vol. 101, March 2019) dealing with the challenges of managing small-scale fisheries under scenarios of poor data.

Despite this lack of detailed information, there exist multiple proposals and interventions to improve the well-being of these communities and the sustainability of fishing resources. As Cinner et al. (2009) argue, successful interventions to reduce fishing efforts in overexploited fisheries require understanding the socioeconomic context in which fishers operate.

Research on livelihoods in SSF communities has increased recently. For example, Thorpe et al. (2007) describe some literature in which authors estimated and compared SSFs' income levels within and among developing countries such as Ghana (Asiedu, 2011), Malaysia (Teh & Sumaila, 2007; Tietze et al., 2000), Malawi, Uganda, Kenya (Allison, 2005), and the Philippines, Bangladesh, India, Senegal and Tanzania (Tietze et al., 2000). Findings are ambiguous. Fishers are not always the poorest of the poor. Income levels among fishing households are country-specific, and context matters. The generalization about greater poverty levels in SSFs, relative to non-fishing households, could be misleading in some cases.

However, as Thorpe et al. (2007) assert, poverty cannot be captured only in monetary terms; literacy, education, health, clean water, and other factors are dimensions of well-being. Landownership, debt, financial capital, and marginalization from political decision-making affect income and well-being in SSFs (Bené & Friend, 2011; Nayak et al., 2014). Others have highlighted the importance of SSF interventions to strengthen tenure and community governance, cover upfront opportunity costs, reduce vulnerability to market shocks by supporting a broader livelihood portfolio, and relax credit constraints (Barr et al., 2019).

In the framework of socio-ecological systems, some researchers have proposed indexes of vulnerability (Béné, 2009) or adaptive capacity (Moreno-Sanchez & Maldonado, 2013; Maldonado & Moreno-Sánchez, 2014; McClanahan et al., 2008; McClanahan et al., 2009; Cinner et al., 2012) for SSF communities. These indexes have included income, occupational diversification, poverty, material assets, wealth, dependence on natural resources, and social capital.

Income diversification is a livelihood strategy for fishing households (Thorpe et al., 2007; Béné, 2009; Ellis & Allison, 2004). Fishing is generally a part-time activity that is complemented with other sources of income. But fishing is also an essential component of food security, not only for fishing households but for their communities. SSF goes beyond being a last-resort activity for the poorest of the poor; it is relevant to other socioeconomic groups (Garaway, 2005). For example, Kawarazuka (2010) analyzes the role of SSFs in the food and nutrition security of poor rural households in developing countries, particularly in Africa, Asia, and Oceania. The author shows that fish captured in common-pool resources are used for self-consumption and traded in local markets and highlights how those fisheries can compensate for the shortage of food in poor households. He also finds that SSFs provide other income-generation opportunities such as processing and trading, and that – among those better-off – fishing income is used to purchase non-staple foods and to invest in agriculture. Kawarazuka (2010) also describes the importance of fish in rural poor communities for the consumption of high-quality nutrients. Confirming these findings, Kawarazuka and Béné (2010) identify two pathways between small-scale fisheries and household nutritional security: (i) the direct nutritional contribution from fish consumption and (ii) the increased purchasing power through the sale of fish. While some members of SSF households fish as their primary source of income, and some households engage in economic

activities not related to fishing at all, fishing shapes the livelihoods and food security of all households in these communities.

In general, studies confirm the heterogeneity within and among fishing communities and the relevance of social, economic, and institutional context in understanding poverty levels and vulnerability of fishing households. In the same way, recent literature confirms the role of fishing in the food security of fishing households and their communities.

In Latin America, however, socioeconomic studies of SSFs are limited, and Colombia is not the exception. According to the OECD (2016), there are no reliable statistics about Colombia's SSF activities and communities. Some cross-sectional surveys have characterized fishing households in terms of age, education, complementary activities, asset ownership, etc. (Viloria et al., 2014; Moreno-Sánchez & Maldonado, 2013; Agudelo et al., 2011; García, 2010). Others have collected information about fishing gear, types of boats, captured species, level of effort, etc. (Viloria et al., 2014; Rueda et al., 2011). However, little is known about the dynamics of the fishing household economy. Notably, there is scarce literature on the variability of income throughout the year.

Our objective is to describe the demographics, assets, livelihood strategies, food security, poverty level, and sustainability of a fishing village in the Colombian Caribbean (Barú-Cartagena). We hypothesize that fishing and non-fishing households differ with respect to characteristics such as education, access to financial capital, income level and diversification, and food security. We collected information from fishing and non-fishing households in the village of Barú, administering monthly socioeconomic surveys from July 2018 to September 2019. The data collection started with a baseline and was followed by monthly surveys administered to each participating household. The sample included around 100 fishing households and 150 non-fishing households. To analyze the data, we organize the information following the sustainable livelihoods approach (SLA).

Our contribution is a comprehensive description and analysis of a fishing community's livelihood that involves: (i) the characterization of fishing and non-fishing households in terms of capital (human, financial, and social), livelihood strategies (diversification of sources of income, access, use of financial services, and the role of social capital), and livelihood outcomes (monetary poverty and food security), and (ii) a longitudinal study that collects monthly panel-data information at a household level for a year.

This document is organized as follows. After this introduction, we present the methods used in this study. The third section presents the research results: descriptive statistics showing household assets, livelihood strategies, and associated outcomes. Finally, the fourth section includes a discussion of the results and the conclusions of the research.

2. METHODS

2.1 CONCEPTUAL FRAMEWORK

We follow the conceptual framework of the sustainable livelihood approach (DFID, 1999; Chambers & Conway, 1992). The SLA assumes that household well-being depends on consumption and production decisions (including livelihood strategies) in light of its endowment of assets (human, social, natural, physical, and financial) in a specific institutional and geographical framework, and the interactions of these factors (Allison & Ellis, 2001).

The assets we consider are as follows. (1) Human capital: education and employment. (2) Social capital: participation in organizations and supporting networks. (3) Physical capital: housing, appliances, vehicles, livestock, and fishing assets. (4) Financial capital: savings, credit. The livelihood strategies considered are labor and non-labor strategies, fishing, use of financial services, allocation of expenditures for household consumption, and food security strategies. Finally, outcomes include household income, expenditures, food security, poverty, and inequality.

2.2 STUDY SITE

The Barú peninsula is part of the rural area of the Tourist and Cultural District of Cartagena de Indias in the department of Bolívar (Colombia). It covers approximately 7,117 hectares and consists of three villages: Ararca, Santa Ana, and Barú. This research project was implemented in Barú village (Figure 1). The number of residents in Barú village averages 2,700-2,800 inhabitants in the populated center, mostly ancestral Afro-descendants (Lizarazo & López, 2007; Mendoza & Moreno-Sánchez, 2014; Márquez, 2014).

Figure 1 Location of Barú Peninsula adjacent to the marine protected area *Corales del Rosario and San Bernardo National Park*



Source: authors based on Google Maps and SIGOT

Barú is a major tourist destination, which exposes it to pressure that demands different ecosystem services such as seafood and recreation. Barú is located in the area of influence of the National Natural Park *Corales del Rosario and San Bernardo* (MADS, 2012), where commercial fishing is prohibited. However, subsistence fishing is allowed; in the most recent management plan, the park authorities recognized small-scale fishery activities as traditional and ancestral practices (PNN, 2020). In practice, longline and diving are the most frequent fishing arts. The management plan also identifies some species that currently are being harvested and are under some level of threat. There are two zones within the park clearly defined and managed as non-take zones. These characteristics imply that this fishery runs under a semi-open access regime. At the time of the survey, there was no official record of fishers.

In terms of infrastructure, Barú village lacks an adequate aqueduct and sewer service, and rainwater is the primary source of water supply for most households. Drinking water comes from Cartagena by boats that are adapted to transport water – known as *bongoductos* (Rodríguez-Sánchez et al., 2016; Pineda et al., 2006). There is a health post in the village that offers first aid, primary care, and vaccination campaigns (Villamil et al., 2015; MADS, 2012); a health center is currently under construction and is expected to provide more services and better equipment.

2.3 TARGET AND SAMPLE POPULATION

The population of Barú village in July of 2018 accounted for 801 households: 158 fishing households (F-hh) and 643 non-fishing households (non-F-hh). We randomly selected a stratified sample of 255 households (97 F-hh, and 158 non-F-hh) to carry out the surveys. The size of the sample included oversampling of 10%, to cope with attrition during the information gathering process. The sample anticipates a margin of error of 5% and a confidence level of 95%. The baseline survey was conducted between July and October 2018; follow-up surveys were administered monthly from October 2018 to October 2019.

2.4 COLLECTION INSTRUMENTS

We ran a *Baseline Survey* to (i) register the participating households, (ii) gather general information assumed to remain constant throughout the study period, and (iii) initiate the collection of socioeconomic information. The baseline survey consisted of seven sections: (i) Household characteristics and economic activities, (ii) Household expenditures, (iii) Household assets and income, (iv) Finances, (v) Fishing, (vi) Food security, and (vii) Land tenure.

The *Follow-Up Surveys* were conducted once a month for each household for the following 11 months and had the same structure as the baseline except for the sections on household characteristics and land tenure. During the follow-up survey, new household members were recorded, as well as any who left.

Two members of the Barú community were trained to apply the survey and became interviewers and co-researchers for the project. This made it easier for the community to accept the researchers and thus be collaborative in offering information. The interviewers were trained in topics related to ethics, survey administration, and the objectives of the project.

3. RESULTS

3.1 HOUSEHOLDS' ENDOWMENTS

3.1.1 Human capital

On average, Barú households are composed of four persons. Barú has a predominantly young population, with about 71% of the population aged under 40; the median age is 26 years.

Although the gender distribution is even (52.7% men and 48.3% women), 24.8% of non-F-hh are headed by women, while among F-hh this percentage is only 4.9%.

Households show important differences in literacy rate and schooling. The percentage of people (15 years and older) who can read and write is higher for non-F-hh than for fishing ones (Table 1). This difference is greater when heads of household are considered: 95% of household heads in non-F-hh can read and write, whereas 78% of those in F-hh can do so. Both differences are statistically significant.

Table 1 Summary of human capital indicators in Barú (Baseline survey)

		F-hh	Non-F-hh	Colombia
Dependency ratio ^a		0.52	0.51	0.64 (a)
Literacy rate (>14 years old)	Total	85.9%***	92.8%	Total: 95% (a)
	Household head	77.5%***	94.8%	
Schooling (Years of attending, older than 24 years)	Women	6.2**	7.1	8.4
	Men	4.6***	6.7	8.6
	Total	5.4***	6.9	8.5 (b)
	Household head	4.7***	6.3	
Complete high school education (>18 years old)	Women	26%**	38%	21.9%
	Men	11%***	29%	22.2%
	Total	18%***	34%	22.1% (b)
	Household head	7.1%***	19.6%	
% NEET (18-28 years)	Women	72.3	71.43	37
	Men	28.3	36.8	14.8
	Total	49	55.9	26.1

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ (a) World Bank (2020) (b) Barro & Lee (2013)

^a The age dependency ratio is: “the ratio of dependents--people younger than 15 or older than 64--to the working-age population--those ages 15-64”. <https://data.worldbank.org/indicator/SP.POP.DPND>.

Educational achievement by household members older than 24 years in non-F-hh is significantly higher than that of F-hh (7.7 vs 6.1 years). When considering only the heads of household, the difference in education level is accentuated. Non-F-hh heads are more educated (6.3 years) than those from F-hh (4.7 years).

Twenty-seven percent of the population over 18 years of age completed secondary education (34% in non-F-hh and 18% in F-hh). In both types of households, the percentage of women who have completed secondary education is higher than that of men (Table 1). Regarding school attendance rates among 5- to 18-year-old household members, there are no significant differences: 75% and 80%, for non-fishing and fishing households, respectively.

Finally, 53% of individuals aged between 18 and 28 are considered NEET (*Not in Education, Employment or Training*). For women, this rate rises to 72%; i.e., 7 out of 10 women in this age range are neither working nor studying. We believe this is related to childbearing and child-rearing by women in this age group, as well as limited job opportunities for both men and women. For men, this rate is 28%. When comparing types of households, the NEET rate is higher for non-F-hh than for F-hh, although this difference is not significant. The estimated rate for Barú is double that reported at the national level.

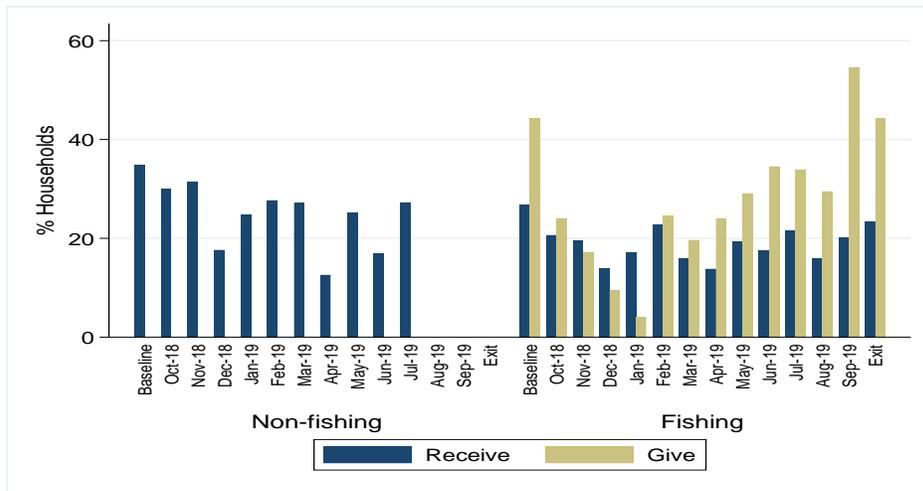
3.1.2 Social capital

The participation of Barú's households in community fisheries organizations is part of their structural social capital. The village has four formally constituted fishing organizations. The organizations' main objectives are to stabilize their members' income and to promote marketing and fishing control practices. According to the baseline survey, 5% of non-F-hh and 39% of F-hh are linked to one of these organizations.

Structural capital also includes receiving fish as a gift and receiving support when a household needs a loan or is experiencing food shortages; these examples show the existence of support networks. In the baseline survey, 35% of non-F-hh and 27% of F-hh reported having received fish as a gift; these percentages were significantly lower during the follow-up survey, averaging 24% and 19%, respectively (Figure 2).

It should be noted that the practice of gifting fish can also be related to cognitive capital, as it expresses values of solidarity. Figure 2 shows that, on average, about 28% of F-hh reported giving away part of their catch to other households. Note that, in the month of September, both at the baseline and in the follow-up survey, the percentage of F-hh that gifted fish to others was as high as nearly 50%.

Figure 2 Proportion of households who received and gave fish as a gift



In terms of sources of support in case of food shortage, 22% and 12% of non-fishing and fishing households, respectively, turned to their families; 5.4% of non-F-hh and 2.4% of F-hh went to their friends. These differences are not statistically significant.

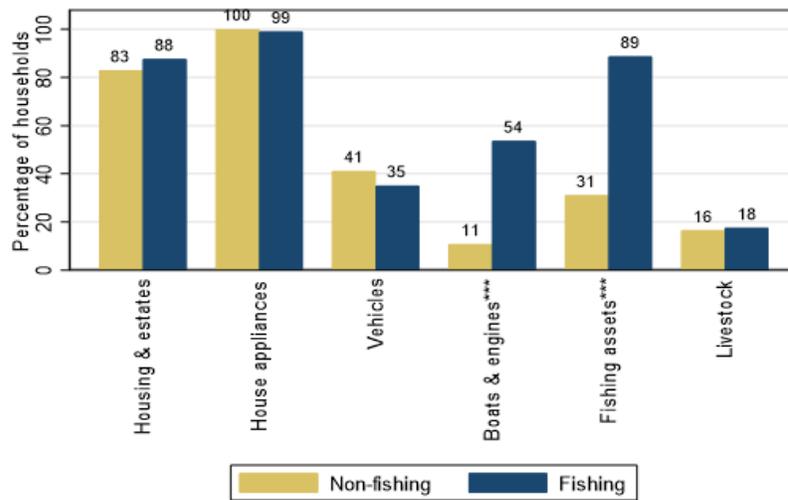
3.1.3 Physical capital

Five categories of physical assets were examined in Barú households: housing and other real estate (farms and lots), household appliances, vehicles, livestock, and fishing assets. Figure 3 shows the proportion of fishing and non-fishing households that own assets in these categories. As shown, households in Barú exhibit a high level of ownership of housing and household appliances. For instance, the percentage of households that own their residence is 70% and 81% for non-fishing and fishing households, respectively. However, the ownership of other properties such as lots and parcels is low; only 19% report owning lots and 1% rural parcels.

We found no differences in terms of vehicle ownership (mainly motorbikes) or livestock. As expected, F-hh report greater ownership of boats, boat engines, and productive assets for fishing, such as nets, handlines, fish traps, and coolers.

Among fishing assets, handlines and free-diving equipment are the most common gear among F-hh. Likewise, of these households, 43% own boats or canoes, 35% boat engines, and 36% refrigerators or coolers. Almost a quarter of non-F-hh have freezers, and around 10% own fishing gear such as handlines and trolling equipment.

Figure 3 Percentage of non-fishing and fishing households which own physical assets



* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The estimated value of household assets, expressed in dollars adjusted by the purchasing power parity of 2018 (USD-PPP), is presented in Table 2. On average, the total value of the assets is almost the same for both types of households. However, when classified in categories, there are some differences, mainly related to the value of fishing assets that, as expected, is higher for F-hh. There are other differences in the value of boats and of housing, but they are not statistically significant.

The distribution of the value of assets by quintiles shows that assets are relatively evenly distributed across the population. However, in F-hh, inequality is a little more marked, as the first two quintiles of this group account for only 27% of the value of assets. Ownership of fishing-related assets is distributed evenly among the quintiles, although this is not the case for boats and engines, which are more statistically frequent among households in the highest quintiles (4 and 5).

Table 2 Physical assets owned by fishing and non-fishing households (values in US dollars and proportions)

Variable	Non-fishing		Fishing		Difference
	Obs.	Mean (SD)	Obs.	Mean (SD)	
Housing and real estate	158	49,142 (95,759)	97	48,288 (80,353)	854
Appliances and electronics	158	1,462 (3,083)	97	1,410 (1,786)	53
Vehicles	158	365 (991)	97	248 (476)	117
Boats and boat engines	158	1,162 (5442)	97	1,607 (3349)	-445

Variable	Non-fishing		Fishing		Difference
	Obs.	Mean (SD)	Obs.	Mean (SD)	
Fishing assets	158	150 (610)	97	756 (1358)	-603***
Livestock	158	131 (869)	97	107 (540)	23
Total physical assets	158	52,412 (96,228)	97	52,412 (81,952)	0
Proportion of households with fishing assets	158	0.31 (0.46)	97	0.89 (0.32)	-0.58***
Proportion of households with boats or boat engines	158	0.11 (0.31)	97	0.54 (0.50)	-0.43***

* p<0.10, ** p<0.05, *** p<0.01

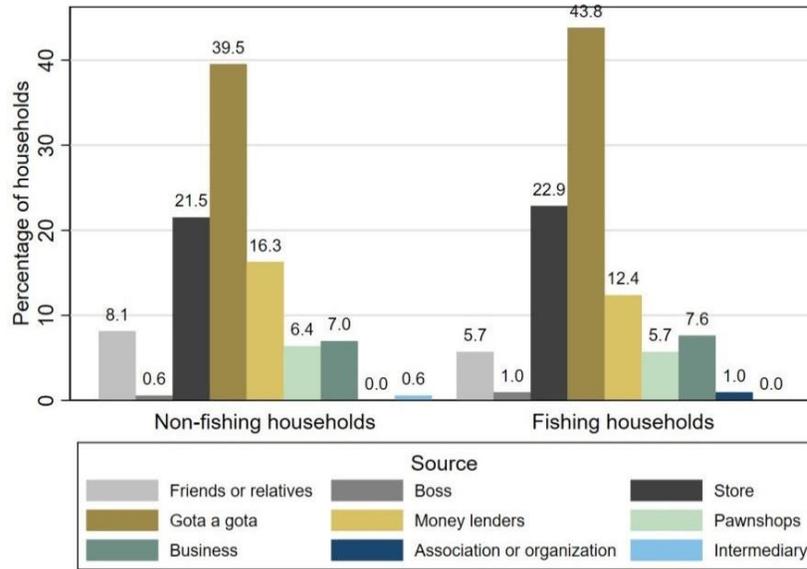
3.1.4 Financial capital

During the period of analysis, 93% of F-hh on average reported having informal savings, while this proportion was only 28% for non-F-hh. Non-F-hh save informally, mostly through piggy banks (29%), building materials (17%), and animals (21%). F-hh do so mainly through piggy banks (34%), animals (22%), and cash (15%).

In the baseline survey and throughout the follow-up surveys, on average, 10% of households reported having formal savings, from which 81% of the non-fishing and 60% of fishing households reported depositing these savings in banks. The main reasons for not saving formally are lack of money (69%), unwillingness (14%), high transaction costs or low returns (5%), not knowing how to access formal services (4%), not trusting financial institutions (3%), financial offices are too far away (2%), or having other types of savings (0.4%).

During the period of analysis, on average, 24% of non-F-hh and 26% of F-hh received informal loans. Loan sharking – known in Colombia as *gota a gota* or *pagadiario* – is the most representative source of informal loans for both types of households (39.5% for non-F-hh and 43.8% for F-hh). Food and supplies bought on credit (21.5% and 22.9%) and loans from lenders other than usury (16.3% and 12.4%) are also noteworthy (Figure 4).

Figure 4 Sources of informal household loans



Traditionally, access to formal credit has been scarce in this community. During the period of analysis, only 0.5% of non-F-hh and 1.9% of F-hh requested loans from the formal sector.

The level of total indebtedness averaged \$613 USD-PPP for non-F-hh and \$523 USD-PPP for F-hh, the difference being statistically significant.

F-hh present a lower level of indebtedness, a higher level of savings, and greater receipt of formal loans.

3.2 LIVELIHOOD STRATEGIES

This section presents strategies undertaken by households to secure their livelihoods: i) labor strategies, describing participation in the labor market and income diversification; ii) non-labor strategies, specifically considering the sources of non-labor income; iii) strategies for the use of financial capital; iv) expenditure distribution strategies; and v) food security strategies.

3.2.1 Labor strategies

On average, the economically active population is 40 years old with 6.8 years of education. Labor force participation, estimated as the number of people aged 15 and over who are working, out of the total population in this age range, reaches 52.4% in Barú, which is lower than the national figure for the same year (68.4%) (World Bank, 2020). However, employment in the village is seasonal and can therefore fluctuate over time. In non-F-hh, labor force participation is 49.5%,

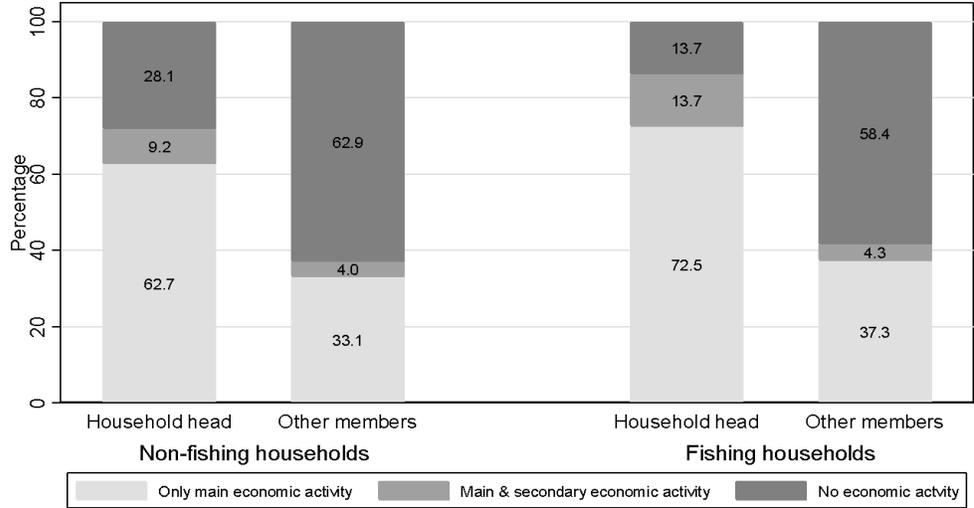
while in F-hh it is significantly higher at 56.3%. In other words, F-hh tend to have more people working than do non-F-hh: an average of 1.75 economically active people per household versus 1.37, respectively. F-hh have higher labor participation in the younger strata (15-19 years) and in the older population (60-79 years and above). More than half (56%) of adults over 60 in F-hh continue to provide income to the household, while only a third of this population participates in some economic activity in non-F-hh.

There are more men than women working in both types of households: of the total number of people who are working, 34.4% are women. The labor participation of women in non-F-hh is higher than in F-hh: 38.2% versus 33.6%. Labor participation of the heads of households in both groups reaches 51%.

The ratio between the theoretically inactive or dependent population (under 15 years and over 65 years) and the labor force (15-65 years) in Barú is 52% in non-F-hh and 51% in F-hh. In other words, for every two persons of potential working age, there is one economically dependent person, in both fishing and non-fishing households.

Figure 5 presents the distribution of people older than 15 according to the number of economic activities, showing that 12% of this population reported having a second economic activity.

Figure 5 Percentage of household heads and other members (15 years old and older) working in zero, one, or two economic activities (for all survey months)

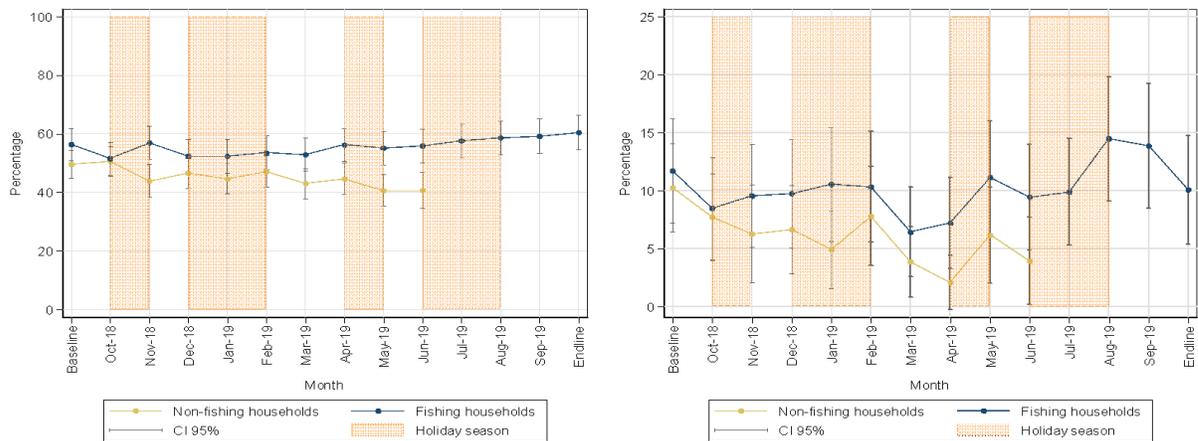


Note: 8% of this population is studying, of whom 90% only study, while the remaining percentage works and studies at the same time.

Workers who reported carrying out only one economic activity allocate between 40 (F-hh) and 47 (non-F-hh) hours per week to that activity. When workers carry out two income-generating activities, they spend up to 52 hours per week, but reduce the average hours engaged in the primary activity.

Figure 6 shows the labor dynamics of households. The share of F-hh which have an activity is significantly higher when compared to that in non-F-hh. Having a second occupation seems to be related to the tourism seasons in the case of F-hh.

Figure 6 Percentage of the population (15 years and older) with primary economic activity (left) and secondary economic activity (right)



The main activities among heads of non-F-hh are tourism, the production and sale of handicrafts, construction, and sale of food. For heads of F-hh, these activities include fishing, transport, watch keeping (security), and fishing-related activities (consisting mainly of trading fish and rental of fishing equipment). The most frequent secondary economic activities for the heads of non-F-hh are food sales and handicrafts, while for F-hh they are fishing, construction, and food sales.

When analyzing working members other than the household head, for both types of households, the most important sectors are food sales and tourism, with tourism being the most important in non-F-hh and food sales predominating in F-hh. In addition, in F-hh, about 8% of non-head, working household members are engaged in fishing as their main activity. In terms of secondary activities, the predominant economic sector in both types of households is food sales, followed by mixed and other activities for non-F-hh and fishing and construction for F-hh.

Participation in the formal labor market, under contract and with social benefits, included only 1.5% of workers, with no significant differences between non-fishing and fishing households. This implies that 98.5% of the workers in Barú are in the informal sector. People with formal jobs report significantly higher incomes than those with informal jobs: \$862 versus \$631 USD-PPP per month per worker.

Relative to income diversification, we found that households carry out on average 1.4 different activities from which they derive income, and F-hh diversify significantly more than non-F-hh: 1.71 versus 1.16 economic activities.

The right panel of Figure 7 shows the percentage of households by the number of different economic activities that they carry out. The figure highlights that about 72% of non-F-hh have one activity at most, while about 58% of F-hh have two or more activities. The left panel of Figure 7 presents the dynamics of the number of different economic activities in which households are engaged.

Figure 7 Number of economic activities by type of household during the study period (left), and distribution of households by number of economic activities (right)

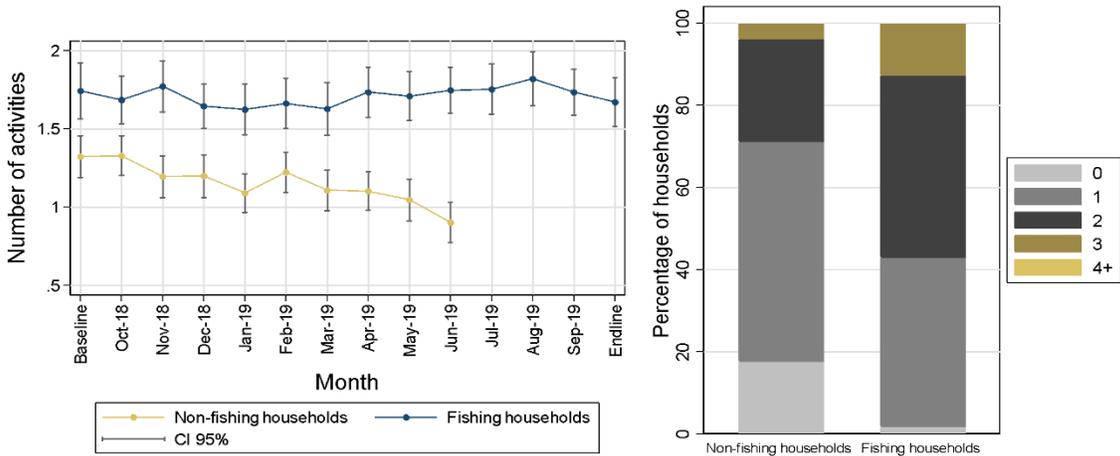


Table 3 presents some statistics about how labor diversification differs between households. The proportion of labor income derived from the primary economic activity for all households and for households with more than one economic activity is higher for non-F-hh who, on average, derive 90% of their labor income from the main activity, while F-hh derive 78% of their labor income from this activity.

Using the Simpson Diversity Index (Etea et al., 2019), we estimate the relevance of labor diversification in income generation. According to this approach, if a household has only one activity, the index will be zero. To the extent that the household participates in more activities and the income it receives from these activities is similar, the index tends to one. Therefore, the greater the diversification of activities and the distribution of income derived from them, the greater the SDI. Results for SDI are presented in Table 3 for the main activity of all household members and for household members with more than one economic activity. In both cases, F-hh diversify their income significantly more than non-F-hh. Households do not exhibit large diversity of income in the main economic activity; however, secondary economic activity tends to be more diverse within households.

Table 3 Labor income diversity measures by type of household

Variables	Non-fishing Mean (SD)	Fishing Mean (SD)	Means difference
Number of economic activities	1.160 (0.021)	1.709 (0.022)	-0.549 (***)
Proportion of income from the main activity	0.899 (0.005)	0.783 (0.006)	0.115 (***)
Proportion of income from the main activity when household has more than one activity	0.714 (0.009)	0.627 (0.005)	0.088 (***)
Simpson Diversity Index (for the main activity of household members)	0.131 (0.007)	0.267 (0.007)	-0.136 (***)
Simpson Diversity Index (for household members with more than one economic activity)	0.370 (0.009)	0.459 (0.005)	-0.089 (***)

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3.2.2 Fishing activity

One hundred percent of the respondents who fish are men, with an average age of 45.6 years and an average of 4.28 years of education. Of the heads of F-hh, 58.3% are engaged in fishing. Fishing is the primary economic activity for 31% of the people working in F-hh, while 4% engage in it as a secondary activity.

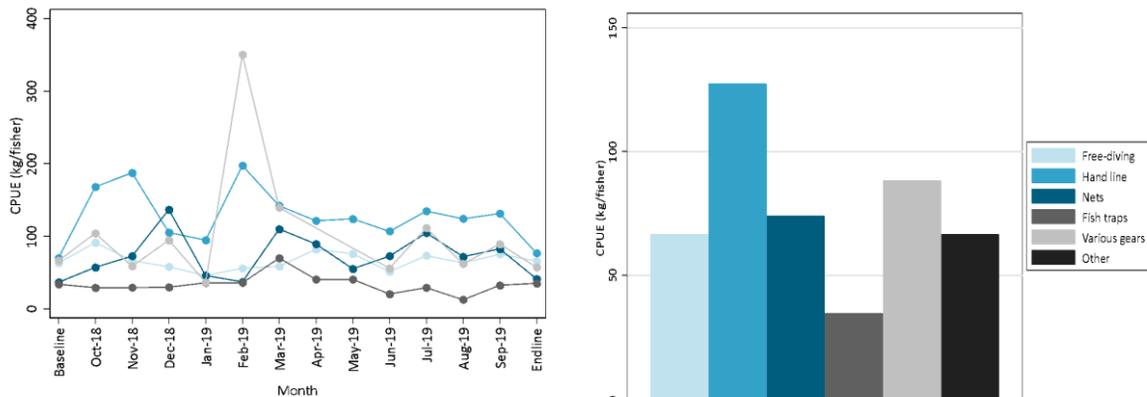
Fishing households allocate their catch to three uses: sale (85%), self-consumption (13%), or giving it as a gift to other households (2%). The latter two categories are part of the households' non-monetary income derived from fishing activity.

For the households surveyed, the total catch of fish resources averaged 9,000 kg of fish per month. February and July 2019 were the months with the highest catch, and January and June the lowest – the latter coinciding with important holiday seasons. This catch is around 97 kg per month per household, which is equivalent to around 23 kg per week. The monthly catch per fisherman is around 88 kg, while the catch per day averages 4.8 kg.

When fishing is the main activity, the most popular techniques are handlining (44%) and diving (38%). When fishing is considered a secondary activity, diving is the preferred fishing technique (76% versus 13% of handlining). During the period of study, we did not find variation in the use of fishing gear. On average, for the whole period of the survey, only 4% of F-hh diversify their gear, combining handlining with diving, nets, pots, throw nets, or longlines.

Figure 8 shows that handlining is the gear with the highest catch per unit of effort (CPUE) during most of the period analyzed (131 kg/fisherman/month), while fish traps are the lowest (32 kg/fisherman/month).

Figure 8 Catch per unit of effort (kg/fisherman/month) and total average by type of fishing gear



3.2.3 Non-labor strategies

Non-labor strategies include the receipt of income from remittances and transfers from the state. On average, 7.8% of non-F-hh and 14.8% of F-hh receive subsidies. For these households, and respectively for non-fishing and fishing households, the receipt of these subsidies is associated with the conditional cash transfer program *Familias en Acción* (42.2% and 24.8%), third-age

subsidies (45.8% and 75.9%), and compensation funds (15.7% and 3.8%). On the other hand, on average, 17.8% of F-hh and 7.8% of non-F-hh receive income from remittances.

3.2.4 Strategies for the use of financial capital

The main use of informal and formal savings in the past, for both types of households, was to deal with unexpected or unforeseen events. Other uses are related to home improvements, education, property purchase, payments for boats or engines, and businesses, which account for 57% and 60% of the uses reported by non-F-hh and F-hh, respectively. Other reported uses include covering household expenses for food and health, general expenses, and debt repayment. Thirty-six percent of households (38% non-fishing and 33% fishing) reported having no savings in the past.

In terms of use of savings during the study, on average, 18% of non-F-hh and 49% of F-hh reported using savings (formal and informal) in the month prior to the visit. The most common uses, for both types of households, were buying food and debt repayment.

About 95% of households would like to allocate their savings to future investments such as education, home improvements, house purchasing, boats and vehicles acquisition, and independent business. On the other hand, the use of savings to cover contingencies is also considered important by 32% of non-F-hh and 39% of F-hh.

Formal loans acquired in the past were mainly used for home improvements, business investment, and contingencies. Informal loans were used in the year prior to the survey by non-fishing and fishing households to cover immediate needs such as food (28% and 26%), payment of debts (25% and 15%), and contingencies (18% and 22%). Informal loans are also used to invest in businesses (12% and 6%), to purchase household items (7% and 9%) or to make home improvements (7% and 6%). During the period of the study, households continued asking for informal loans, used mainly to buy food (33% in non-F-hh and 45% in F-hh), pay other debts (30% in non-F-hh and 15% in F-hh) and cope with extraordinary events (13 and 7% for non-F-hh and F-hh).

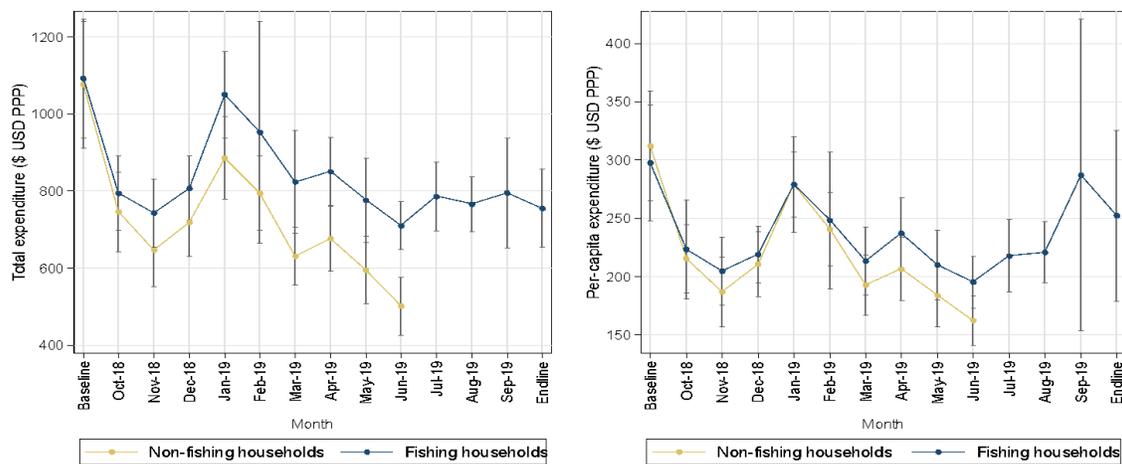
3.2.5 Allocation of consumption expenditures

The monthly monetary expenditure of households in Barú is \$785 USD-PPP per month and is significantly higher for F-hh (\$836) than for non-F-hh (\$738). When the expenditure is calculated

in per capita terms, this difference is no longer significant (\$236 vs \$222). When household size is scaled by the square root of number of members, the expenditure per capita is \$430 for F-hh and \$393 for non-F-hh.

The dynamics of average household spending are shown in Figure 9. As expected, there are some months in which expenses change. This pattern is similar for F-hh and non-F-hh. Particularly, in January the expenditures increased significantly, probably due to the start of the school season and/or indebtedness during the holiday season and its associated expenses.

Figure 9 Household total and per capita monetary monthly expenses



In terms of expenses composition, on average, 60% of household expenditure is allocated to food, including water, which represents 8.2% of total expenditure. Leisure and entertainment accounts for about 15-20% of expenses.

With regard to animal protein consumption, about 40% of expenses are used for white meat such as chicken and fish. However, for F-hh, most of these expenses are aimed at chicken. The low figure related to the expenses on fish by F-hh does not mean that they consume less fish than non-fishing households, as self-consumption plays an important role in terms of consumption. F-hh also consume more milk than non-F-hh.

Table 4 shows that the frequency of consumption by type of animal protein (fish, seafood, chicken, beef, pork, or canned protein) is significantly higher in F-hh than in non-F-hh, although the proportion of monetary expenditure on protein is relatively equal for both types of households. On average, F-hh consume animal protein 10.3 times a week, while non-F-hh

consume it 7.6 times a week. This difference is statistically significant and is mainly defined by the higher consumption of fish and other seafood by F-hh.

In a community such as Barú, households obtain fish for consumption not only from the market but also by catching it or receiving it as a gift. This consumption does not need a monetary exchange. The value of non-monetary consumption by non-F-hh – estimated at market prices – is similar to the value of fish they bought. For F-hh, the value of non-monetary consumption is up to eight to ten times the value of fish they bought.

Table 4 Frequency of weekly animal protein consumption

Type of protein	Non-F-hh		F-hh		Difference (t-test)
	Obs	Mean (SD)	Obs	Mean (SD)	
Fish	1,454	2.47 (3.06)	1,307	4.38 (2.67)	-1.91***
Other Seafood	1,454	0.09 (0.46)	1,307	0.22 (0.50)	-0.13***
Chicken	1,454	2.29 (2.12)	1,307	3.17 (1.91)	-0.88***
Beef	1,454	1.26 (1.52)	1,307	0.95 (0.95)	0.31***
Pork	1,454	1.32 (1.60)	1,307	1.31 (1.07)	0.01
Canned protein	1,454	0.18 (0.56)	1,307	0.26 (0.54)	-0.08***
Total protein	1,454	7.63 (0.10)	1,307	10.30 (0.06)	-2.67***

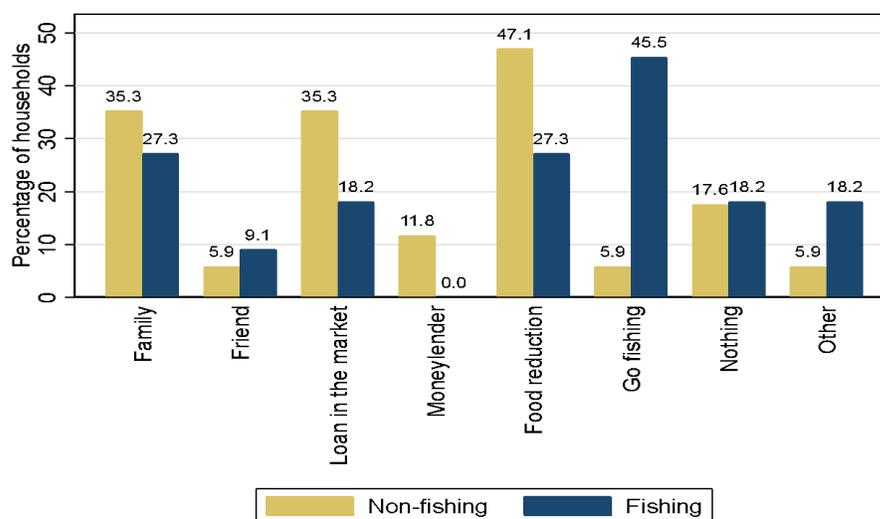
* p<0.10, ** p<0.05, *** p<0.01

3.2.6 Food security strategies

Figure 10 provides an in-depth analysis of the various sources of assistance that households in Barú resort to if they are food insecure. The strategies used by F-hh include going fishing (45.5%), followed by asking family members for help, and reducing food consumption (27.3%). In the case of non-F-hh, the predominant strategies are reducing food consumption (47.1%), asking relatives for help (35.3%), or informal loans in shops (35.3%).

These results indicate that fishing can be considered a “safety net” that allows F-hh to meet their immediate food needs (Béné et al., 2007; Béné et al., 2016). However, 27% of F-hh and 47% of non-F-hh facing a food shortage reported having to reduce the food of at least one member of the household; this difference between households is significant. Note that non-F-hh are the only ones that turn to moneylenders to solve food crises.

Figure 10 Household strategies to tackle food scarcity



When some members of the household must reduce their food intake, in non-F-hh, it is either mainly women who do so, or all members of the household equally, and, to a lesser extent, the head of the household. It is remarkable that in F-hh the main strategy is to reduce food for all members of the household equally, followed by the heads of household. In general, in the event of shocks affecting the availability of food, the most vulnerable groups in the household, i.e., children, are protected.

3.3 LIVELIHOOD OUTCOMES

3.3.1 Household income and expenditure

Monthly monetary income, including labor and non-labor sources of F-hh is higher (\$1,095 USD-PPP) and relatively more stable over time, compared to that of non-F-hh (\$833 USD-PPP). Non-monetary income – estimated as the value of fish self-consumed at market prices – amounts to \$50.47 USD-PPP for F-hh, and \$0.68 USD-PPP for non-F-hh (Table 5).

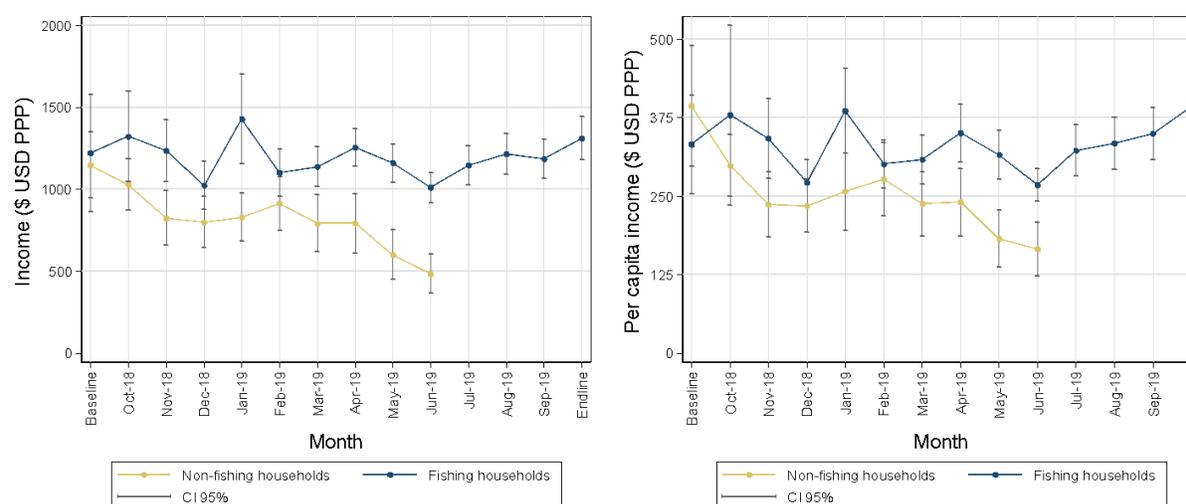
Figure 11 **Error! Reference source not found.** shows total monthly income – including non-labor and labor, monetary and non-monetary – at household level and per capita. On average, F-hh are better off than non-F-hh: \$1,145 vs. \$834 USD-PPP. Per-capita monthly income corresponds to \$333 for F-hh and \$255 for non-F-hh. When household size is scaled by the square root of total number of members, the monthly per capita income is \$612 and \$447 for fishing and non-fishing households, respectively.

Table 5 Monthly income sources of households in Barú

Household monthly income	Fishing households	Non-fishing households
From fishing	374.75	0.97
Labor different from fishing	679.12	807.82
Labor monetary income	1053.87	808.79
Non-labor monetary income	40.79	24.04
<i>Total monetary income</i>	<i>1094.66</i>	<i>832.83</i>
Non-monetary income from fishing	50.47	0.68
Monetary and non-monetary total income	1145.13	833.51

For F-hh, 37% of the income corresponds to income from fishing (monetary and non-monetary). Fish trade and gear rental generates an additional 6% of income for F-hh. For non-F-hh, fishing-related activities contribute about 4% of income. The fishing sector contributes to about 20% of Barú’s economy. However, this does not include the contribution of fishing activity to other activities such as the sale of food for tourism.

Figure 11 Total monthly household income (left) and total monthly per capita income (right)



The non-labor monetary income represents approximately 3.2% of the income of both households, without significant differences by type of household.

The average monthly income of a worker in Barú is \$678 USD-PPP, with significant statistical differences between fishing and non-fishing households. On average, heads of households earn the highest labor income of any member of the household, averaging \$745 USD-PPP.

Figure 12 shows the dynamics of income per worker during the study, highlighting the importance of the holiday seasons (December-January and June-August), particularly for F-hh, whose income increases at these times.

Figure 12 Labor income by worker per month (USD-PPP)

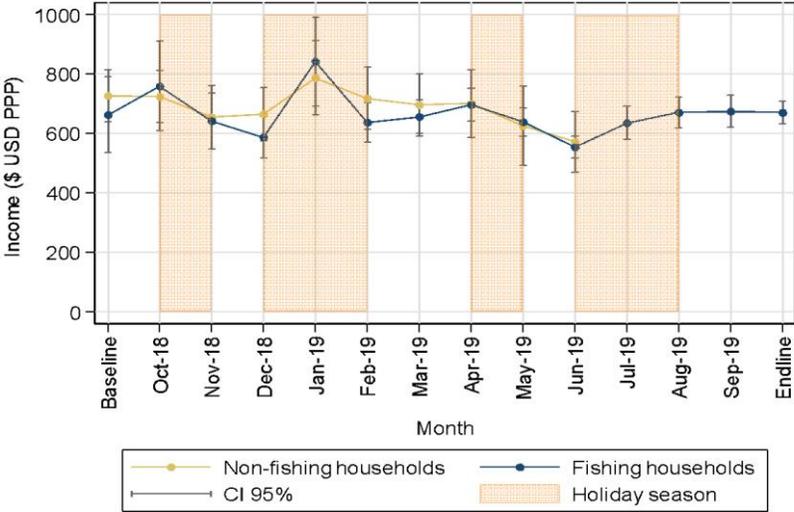


Figure 13 shows income from fishing and other activities in F-hh. Holiday seasons (December-January and June-August) increase income from non-fishing activities. A correlation analysis between the two series of income from fishing and income from other seasons shows a significant value of -0.2655, which suggests a substitution effect between fishing and non-fishing sources of income.

Figure 13 Fishing-related and other-source monthly income (USD-PPP) for F-hh

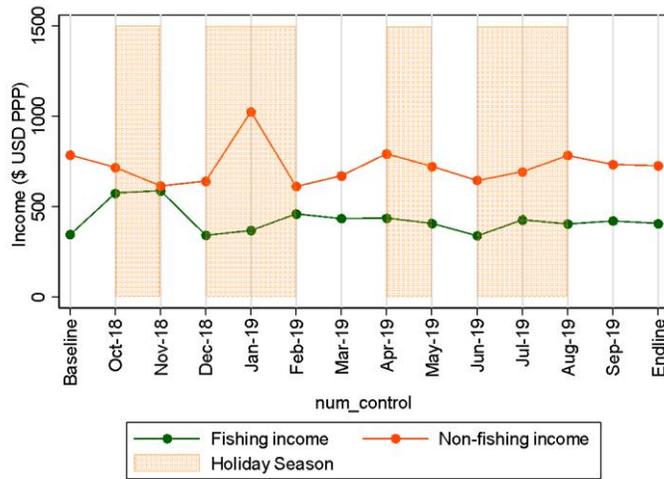
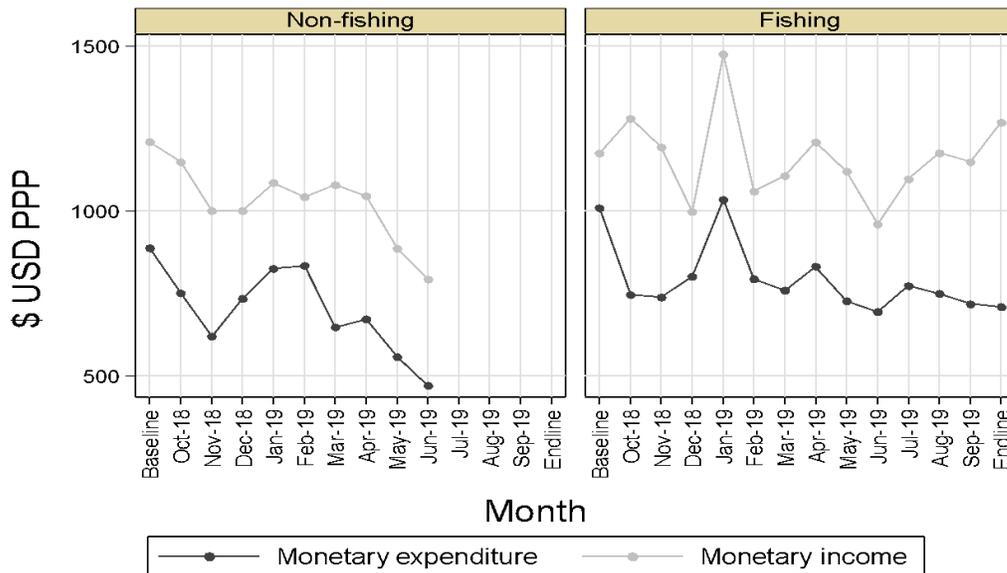


Figure 14 shows the behavior of expenditure and monetary income throughout the study. Expenditure and income trends exhibit a similar tendency: when income increases (decreases), expenditure also increases (decreases). This suggests that households may have had a surplus that allowed them to save. However, the costs associated with productive inputs are not included in this analysis for either fishing households or non-fishing ones.

Figure 14 Total monthly income and total monthly expenditure by type of household



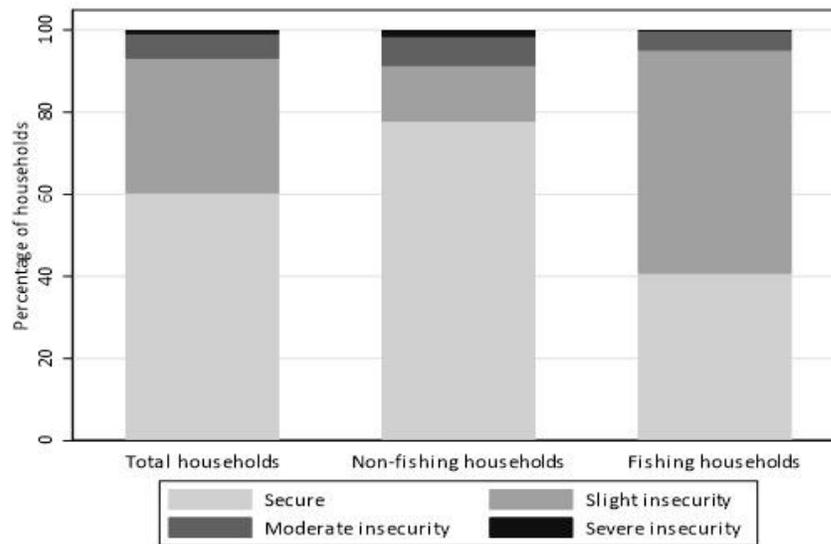
3.3.2 Food security

The indicator for food security is calculated using an adaptation of the ELCSA (FAO, 2012). Insecurity levels are estimated using the answers to the following questions, with reference to the week previous to the survey:

- Did you want to vary the household nutrition and could not?
- Did you have to reduce the food portion of a household member?
- Did someone in this household go to bed hungry?
- Did someone in this household have to skip breakfast, lunch, or dinner due to lack of food?

If the answer to all four questions is yes, the household is considered in severe insecurity. If the answer is yes to two or three questions, the household is in moderate insecurity, and if the answer is yes to one of the questions the household is in slight insecurity. Finally, if the answer to all questions is no, the household is considered to have food security. According to this classification, 60% of households can be classified as food secure, and only a small fraction of households can be considered in moderate or severe food insecurity (Figure 15).

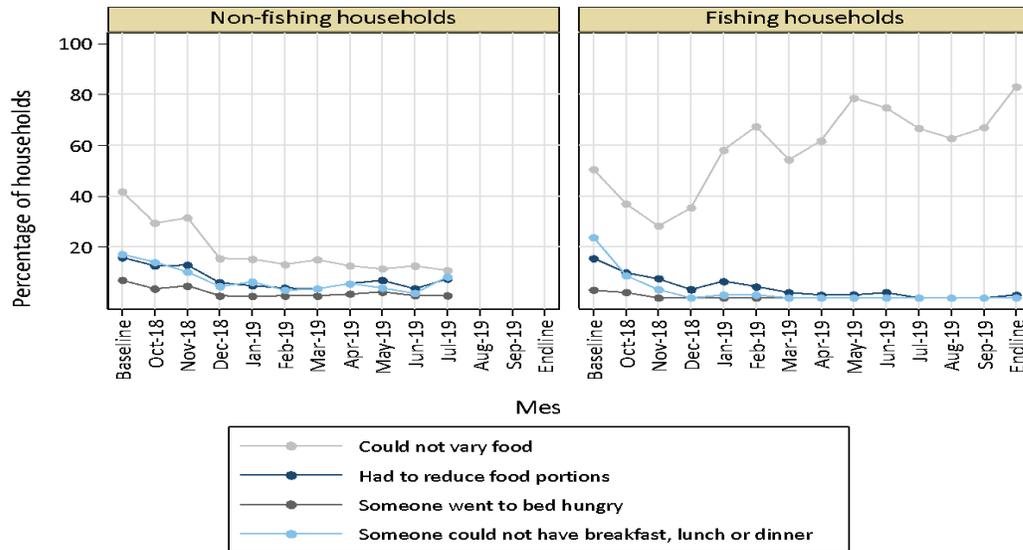
Figure 15 Annual average of types of food insecurity



None of the F-hh are in severe insecurity and there are fewer F-hh than non-F-hh in moderate insecurity. However, the slight food insecurity is much greater in F-hh. Given that they have access to fish for solving their food needs, this result does not seem intuitive. Figure 16 shows

that the main source of slight insecurity in F-hh is related to the variation in diet, while the other sources of insecurity decreased over time.

Figure 16 Types of food insecurity



To explore the relationship between fish that has been gifted and household food insecurity, a correlation analysis shows that the higher the level of food insecurity, the greater the probability of receiving gifted fish. These results show that fishers are able to focus gift efforts on the population that is most in need, playing an important role in solving extreme food insecurity (Table 6).

Table 6 Correlation between food insecurity level and receiving fish as a gift

Food insecurity	Correlation with receiving gifted fish
Food secure	-0.0687***
Slight insecurity	0.0216
Moderate insecurity	0.0781***
Severe insecurity	0.0497***

* p<0.10, ** p<0.05, *** p<0.01

3.3.3 Poverty

According to the national poverty lines, a household is considered in poverty if its income is lower than 180 USD-PPP and under extreme poverty if it is lower than 82 USD-PPP (DANE, 2018). The headcount poverty index for Barú is similar to that of the department where it is

located and higher than the national level (**Error! Reference source not found.**). However, in terms of monetary poverty, F-hh are much better off than non-F-hh, and these differences are statistically significant. Extreme poverty of non-F-hh is much higher than the national level, while that for F-hh is lower than the department and the national levels.

Table 7 Headcount monetary poverty index by household, total, local, and national (Indicators for Barú are from the average of all survey months)

	Non-fishing households	Fishing households	Total households	Bolívar department	Colombia
Poverty line	51.2	27.1	38.3	36.2	27.0
Extreme poverty line	29.4	4.5	16.1	7.0	7.2

3.3.4 Inequality

To measure the inequality of income distribution and household expenditure in the Barú village, we estimated the Gini coefficient for labor income, non-labor income, total income, household per capita income, and total expenditure. Results, presented in Table 8, show that, for all the dimensions studied, non-F-hh exhibit higher measures of inequality than F-hh. The Gini index for Barú's total income was 0.423, which is lower than that reported for the Bolívar department (0.472) and for the country (0.517).

Labor income presents the highest levels of inequality in non-F-hh, while in F-hh the source of greatest inequality is non-labor income (subsidies, remittances, and interest payments). For the total sample, the coefficients show that non-labor income is also the source of greatest inequality.

Table 8 Gini coefficient for household income and expenditure

Gini measures	Non-F-hh	F-hh	Total households
Labor income	0.560	0.258	0.421
Non-labor income	0.524	0.511	0.516
Total income	0.513	0.308	0.406
Per capita income	0.532	0.322	0.423
Expenditure	0.327	0.270	0.333

3.3.5 Potential effects of fishing activity on sustainable use

In this study, we approach the potential effects of fishing on the ecological system by analyzing the degree to which fishing gear affects the ecosystem, and the conservation status of the main species caught.

To analyze the effect of the fishing gear used on natural systems, we used the approach proposed by Bjordal (2005), which considers seven categories of effects on coastal marine ecosystems: size selection, species selection, incidental mortality, ghost fishing, habitat effects, energy efficiency, and catch quality. A score of favorability (unfavorable=1 to favorable=10) of the gear with respect to the ecosystem is assigned to each of these categories, which are then averaged arithmetically, resulting in an overall index of the average effect of each gear on the ecosystem.

Weighted scores are calculated for the average use of each gear type, measured as the percentage of fishers who used each gear type in each month during the survey period. Figure 17 shows the share of gear types used in Barú that are used to estimate the index of pressure on the ecosystem.

Figure 17 Percentage of fishers using each type of fishing gear

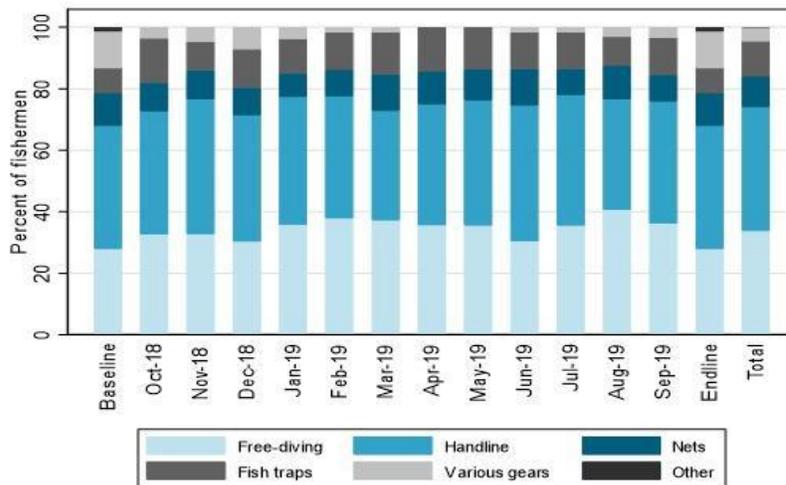


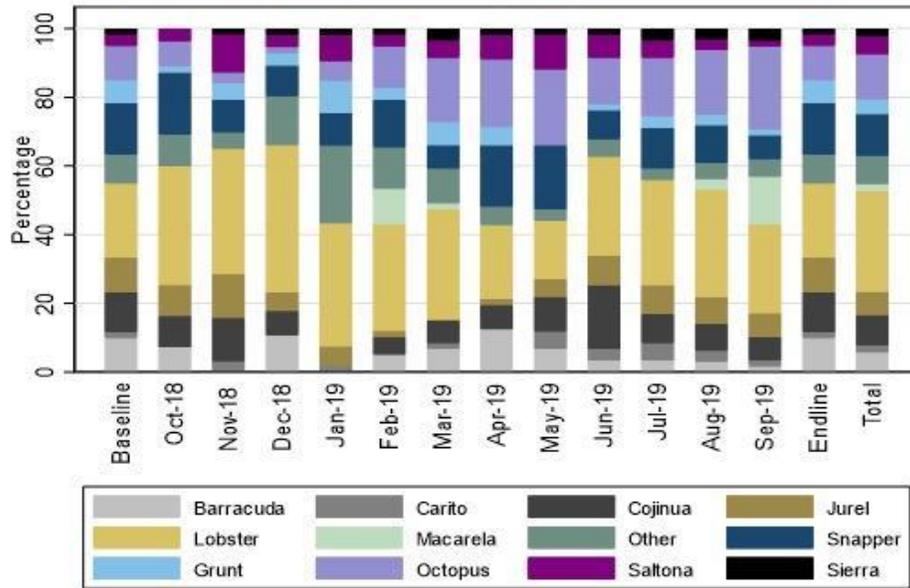
Table 9 shows the absolute and the weighted values (in parentheses) for each category and gear type. The fishing gear used in Barú has a moderate to low effect on the ecosystem. The most harmful effects are associated with size selection, species selection, and incidental mortality. However, the fishing gear in general has high energy efficiency, low generation of ghost fishing, high catch quality (no agglomeration or decomposition that damages the catch), and few effects on the species' habitats.

Table 9 Estimation of the effects of the different fishing methods on the marine ecosystem of Barú

	Size selection	Species selection	Incidental mortality	Ghost fishing	Effects on the habitat	Energy efficiency	Catch quality	Ecosystem Effect Index
Hook fishing or handlining, longline, spinel, rope	5 (2.3)	4.5 (2.0)	6 (2.7)	9.5 (4.3)	8.5 (3.8)	8.5 (3.8)	8.5 (3.8)	7.2 (3.3)
Diving	8 (2.7)	9 (3.1)	5 (1.7)	10 (3.4)	10 (3.4)	8 (2.7)	9 (3.1)	8.4 (2.9)
Fishing net	2 (0.2)	3 (0.3)	5 (0.5)	3 (0.3)	7 (0.7)	8 (0.8)	5 (0.5)	4.7 (0.5)
Pot fishing (traps)	7 (0.7)	7 (0.7)	9 (1.0)	3 (0.3)	8 (0.9)	8 (0.9)	9 (1.0)	7.3 (0.8)
Total	5.5 (5.9)	5.9 (6.2)	6.3 (5.9)	6.4 (8.3)	8.4 (8.8)	8.1 (8.2)	7.9 (8.4)	6.9 (7.4)

The survey inquired about the perceived most relevant species. Figure 18 shows the distribution of these species, indicating that most fishers reported lobster as the most important species caught, followed by octopus and snapper. These species are associated with the coral-reef ecosystem, one of the most important ecosystems for fishing in Barú, as well as with the predominant fishing gear types among the F-hh, which are handlining and diving.

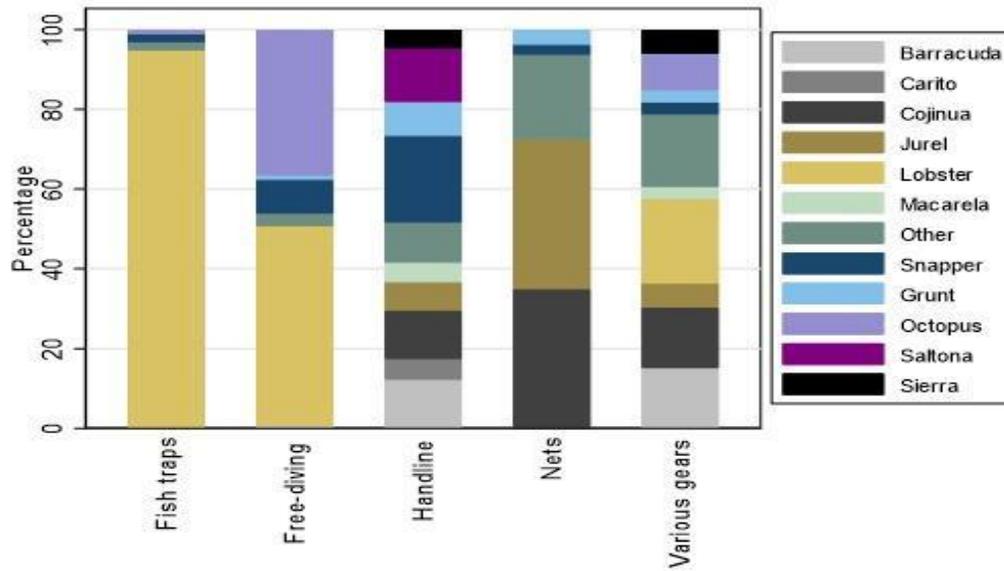
Figure 18 Main catch fish species reported by F-bb



Others: Garfish, Anchovy, Atlantic cod, grey triggerfish, Long spine squirrelfish, Mullet, Sardine.

Figure 19 shows the most frequent species caught by type of fishing gear. Three aspects to highlight: (i) fish traps and free-diving are fishing gear that target lobster; (ii) a great diversity of species is captured with handlining, notably snapper (*Lutjanus*), yellowtail snapper (*Ocyurus chrysurus*), great barracuda (*Sphyraena barracuda*), and barjack (*Carangidae*); and (iii) nets are mainly used for barjack and horse-eye jack (*Caranx hipos*, *Caranx latus*).

Figure 19 Main catch fish species by fishing gear



The species more frequently exploited in Barú lack information about conservation status. Lobster, some species of snapper, and horse mackerel are classified as vulnerable (PNN, 2019; Chasqui-Velasco et al., 2017), while barracuda and garfish are catalogued as near-threatened (Fishbase [www.fishbase.de], Chasqui-Velasco et al., 2017).

4. DISCUSSION

The main purpose of this study is to characterize the livelihoods of SSF communities – in particular, assets, strategies, and livelihood outcomes of fishing and non-fishing households in a community in the Colombian Caribbean. Our results show the differentiated strategies that F-hh and non-F-hh follow to develop their livelihoods given their human, social, and financial capital endowments.

Households in this community differ in their illiteracy rate, which is about seven percentage points greater for fishing than non-fishing households, and even greater if only the heads of household are considered. Non-F-hh heads are more highly educated than those from F-hh, by about a year and a half. In general, those individuals whose main activity is fishing report significantly lower levels of education than the sample’s average employed population. These results coincide with data from the DANE household survey, which indicates that half of the people involved in fisheries and aquaculture have reached no further than basic primary education and that about one-fifth are illiterate (OECD, 2016).

Moreover, these findings could confirm the point raised by Béné et al. (2016), who argue that fishing is an activity associated with low human capital. However, fishing does require higher physical and psychological efforts given the strenuous, dangerous, and uncertain related labor journeys. F-hh that are less endowed in terms of education see fishing as the only alternative for income generation.

Our results also suggest that things are changing for new generations: (i) young people might be less interested in fishing activity than their parents, and (ii) F-hh are currently investing more in human capital. In fact, some of the households initially classified as fishing ones reported not fishing during the survey implementation.

The estimated rate of people not in education, employment, or training (NEET) is twice as high in Barú than that reported nationally, showing the scarce opportunities that young people have in rural and fishing communities. For women, this rate is even higher: 7 out of every 10 women in this age range are neither working nor studying.

Although the average household size is similar between fishing and non-fishing households, F-hh tend to have more people working. In addition, F-hh in Barú exhibit higher occupational diversity, likely because of the uncertainty associated with fishing. F-hh diversify significantly more than non-fishing households; not all members of F-hh fish, but this activity is their highest source of income.

Our findings are consistent with Béné and Friend (2011), who argue that fishing is part of a diversified matrix of livelihood activities, where fishing-related activities remain the most important source of income.

According to Ellis and Allison (2004), livelihood diversification reduces the poor's vulnerability to food insecurity, reduces dependence on natural resources, and can provide the basis for building assets that allow households to design their own exit strategies from poverty. It also improves human capital by providing skills and experience. However, the benefits of diversification are often inhibited by the local context and governance, as well as other barriers to trade and mobility (imperfect and restricted markets). For example, access to land and agriculture – as well as access to financial services – plays a significant role in livelihood diversification and household food security (Ellis & Allison, 2004). In Barú, we found strong limitations on the potential for diversification. For example, even though the vast majority of

households surveyed are part of native families, only six households in the sample report having land for farming. This is caused by the displacement brought about by tourism on the island at the natural park. In this sense, agricultural and livestock activities are exceptional. The main sources of income diversification are the provision of services, mainly related to tourism and construction. Our findings also show that financial services are imperfect and restricted for households in fishing communities. Although F-hh save informally much more than non-fishing ones, only 10% of F-hh save in a formal financial institution and more than 60% report shark loans from informal money lenders, which might lead them to path dependence: asking for a loan to cover the previous one.

In general, the community of Barú faces restrictions in terms of access to different forms of capital, such as land, education, or financial capital, which makes it difficult to participate in diversified labor markets. These restrictions seem to be more important for the fishers, who are older and have lower education levels.

For those in Barú who fish as a secondary activity, fishing is a coping strategy when faced with shocks. In that sense, given the semi open-access nature of the resource, fishing in Barú could provide a means of producing income both as a safety net, to deal with transitory or short-term poverty, and as last-resort activity, associated mostly with chronic or long-term poverty (Béné et al., 2007; Béné, 2004).

With respect to food security, SSF have been recognized as a key to improving food security in developing countries, particularly for those whose livelihoods depend on them (Kawarazuka & Béné, 2010). We found that the frequency of animal-protein consumption is significantly higher in F-hh than in non-F-hh, although the proportion of monetary expenditure on protein is relatively equal for both. However, the estimated value of fish consumption – at market prices – is almost twofold for F-hh than for non-F-hh, which reflects the importance of self-consumption. In other words, F-hh enjoy a diet with higher protein content for the same amount of monetary expenditure. Consistent with other studies, we found that fishing is a source of food security for the community (Gomna & Rana, 2007; Chamnan et al., 2009; Mujinga et al., 2009).

The proportion of fish left by households for home consumption varies among communities and depends on the fishery in which it is being managed: from 11-20% in Papua New Guinea (Friedman et al., 2008) to 74.5% in Lao PDR (Garaway, 2005). Generally, the poorest households rely more on subsistence consumption of fish, compared to better-off households

with more access to markets. However, some studies by Béné (2003), in Lake Chad, show that the poorest households consume less of their own catch and sell most of it to generate income and buy cheaper food.

In Barú, 13% of fish caught is destined for self-consumption. This strategy allows the F-hh in Barú to report fewer cases of having to reduce food portions at home, having to send someone to sleep hungry, or having to miss a meal. Chanman et al. (2009) discuss the characteristics of fish for self-consumption: (i) smaller fish that contain more nutrients, (ii) smaller fish easier to distribute among household members, (iii) species available year-round, and (iv) typically consumed whole, which improves micronutrient provision. However, F-hh in Barú face a restriction in terms of variety of food, affecting this dimension of food security.

When having to deal with income shocks that affect food security, fishing appears to be a coping strategy for F-hh to deal with food shocks. Fishing strategy is then a safety net to cover immediate food needs (Béné et al, 2016; Béné et al., 2007). As Kawurazuka and Béné (2010) argue, we found that fishing in Barú plays a double role: (1) as an income-generating activity or cash crop; (2) as a food-generating activity or food crop. Thus, fishing is not only important in terms of improving food security per se, but also as an income-generating activity that improves livelihoods, including nutrition.

We found that 2% of caught fish is given as a gift to other households. Further, nearly one-third of the fishers give fish as a gift and nearly one-third of households receive fish as a gift, particularly those in the worst conditions in terms of food security. Those findings show a support network and altruistic behavior within this community.

A growing number of studies suggest that the income of F-hh is often higher than that of non-F-hh (Thorpe et al., 2007). Other literature points out that artisanal fishers rank among the lowest income groups or below national income levels (Teh & Sumaila, 2007; Willmann, 2004; Herring & Racelis, 1992). Similarly to our results, Allison (2005), Mkenda (2000), and Tietze et al. (2000) find that income of F-hh is higher than that of non-F-hh in rural communities.

Despite studies showing higher incomes in F-hh compared to other rural households, Thorpe et al. (2007) highlight that monetary income cannot be seen as the only way to measure household poverty. This assertion is even more important in the case of isolated communities where access to education, health, or basic services is severely restricted, resulting in health,

housing, or sanitation problems (Béné, 2003). In our case, at the time of the study, the Barú community did not have access to basic services such as health, drinkable water, or sewage.

One of the most important findings of this study is that the poverty and extreme poverty levels of F-hh are lower than those of non-F-hh. Despite strong restrictions faced by F-hh in terms of access to different forms of capital (education, financial services, land), access to natural capital and higher diversification provide them with income to solve basic needs and resources to reduce food insecurity. The poverty figures for F-hh are similar to national levels, while the figures for extreme poverty are better for F-hh than they are for the national average. This shows the importance of fishing as a buffer against the vulnerability of rural poor households.

The results also suggest that restrictions on fishing for these communities, without providing income-earning alternatives or social protection programs, could result in deterioration of their living conditions. In fact, our findings show that non-labor monetary income (mainly subsidies and transfers) represents only 3.2% of the income of both types of households. Prohibitions on fishing would require, for example, non-conditional or conditional conservation cash transfers and other social protection programs that allow households to cope with the effect of not fishing on income and food security. On the other hand, as proposed by Cinner et al. (2009), “wealth generation and employment opportunities directed at the poorest fishers may help reduce fishing effort on overexploited fisheries.”

Although Barú is located next to a protected area, where it is only allowable to fish for subsistence, the currently used fishing gear suggests moderate to low impact activity. Although the fishing volumes are low compared to the world average in small fisheries, it is not possible to say anything about the sustainability of the catch from the survey data, because biological data on the abundance of fish are required.

The results of the socio-demographic characterization confirm our hypotheses and coincide with findings presented in the literature on SSF around the world. Livelihood systems in Barú are strongly linked to the extraction and use of natural capital. As highlighted by Ellis and Allison (2004) and Beck and Nesmith (2001), the landless rural poor are among the most vulnerable groups and basically depend on wage labor and the extraction of common-pool resources. In the ancestral community of Barú, residents have been dispossessed of land due to increased tourism during the last 30 years. In addition, ethnic minorities have settled in areas that are strategic for the conservation of biodiversity; these communities make use of common-pool

resources due to their lack of access to land. Hence, employment, productive, and capacity-building interventions that allow diversification of sources of income, as well as conservation strategies – and even the assignment of property rights to use resources – would promote livelihood sustainability. Ultimately, strict conservation strategies must be developed once the external constraints that lead these communities to resource extraction and overexploitation are removed.

5. REFERENCES

- Agudelo, E., Ajiaco, R.E., Álvarez, L., Agudelo, E., Ajiaco, R.E., Álvarez, L.E., Barreto, C.G., Borda, C.A., Bustamante, C.C., Caldas, J.P., De La Hoz, J., Díazgranados, M.C., Melo, G., Perucho, E., Puentes, V., Ramírez, A., Rueda, M., Salinas, J.C. & Zapa, L. A. (2011). *Protocolo De Captura De Información Pesquera, Biológica y Socioeconómica en Colombia*. Ministerio de Agricultura y Desarrollo Rural - Dirección de Pesca y Acuicultura - Subgerencia de Pesca y Acuicultura INCODER - Conservación Internacional. 80p.
- Allison, E.H. (2005). The fisheries sector, livelihoods and poverty reduction in Eastern and Southern Africa. In: Ellis, F. & Freeman, H.A., editors. *Rural Livelihoods and Poverty Reduction Policies*. Routledge, London.
- Asiedu, B. (2011). Understanding the socioeconomic characteristics and perception of poverty in artisanal fisheries of Ghana. The Case of Kpong Reservoir. Munich, GRIN Verlag, <https://www.grin.com/document/165448>.
- Bailey, C., & Jentoft, S. (1990). Hard choices in fisheries development. *Marine Policy*, 14(4): 333-344. [https://doi.org/10.1016/0308-597X\(90\)90055-V](https://doi.org/10.1016/0308-597X(90)90055-V).
- Barr, R., Bruner, A. & Edwards, S. (2019). Fisheries Improvement Projects and small-scale fisheries: The need for a modified approach. *Marine Policy*, 105, 109–115.
- Barro, R., & Lee, J. (2013). A New Data Set of Educational Attainment in the World, 1950-2010. *Journal of Development Economics*, 104(C): 184-198.
- Beck, T. & Nesmith, C. (2001). Building on Poor People's Capacities: The Case of Common Property Resources in India and West Africa. *World Development*, 29(1): 119-133.
- Béné, C. & Friend, R.M. (2011). Poverty in small-scale fisheries: Old issue, new analysis. *Progress in Development Studies*, 11(2): 119-144.
- Béné, C. (2003). When fishery rhymes with poverty: A first step beyond the old paradigm on poverty in small-scale fisheries. *World Development*, 31(6): 941–75.

- Béné, C. (2004). Contribution of small-scale fisheries to rural livelihoods in a water multi-use context – (with a particular emphasis on the role of fishery as a “last resort activity” for the poor). Background paper prepared for the Second Session of the Working Party on Small-Scale Fisheries, Bangkok, Thailand, 18-21 November 2003. Rome, FAO. 31p.
- Béné, C. (2009). Are Fishers Poor or Vulnerable? Assessing Economic Vulnerability in Small-Scale Fishing Communities. *The Journal of Development Studies*, 45(6): 911-933, DOI: 10.1080/00220380902807395.
- Béné, C., Arthur, R., Norbury, H., Allison, E. H., Beveridge, M., Bush, S., Campling, L., Leschen, W., Little, D., Squires, D., Thilsted, S., Troell, M., & Williams, M. (2016). Contribution of Fisheries and Aquaculture to Food Security and Poverty Reduction: Assessing the Current Evidence. *World Development*, 79: 177–196. <https://doi.org/10.1016/j.worlddev.2015.11.007>
- Béné, C., McFadyen, G., & Allison, E.H. (2007). Increasing the contribution of small-scale fisheries to poverty alleviation and food security. FAO Fisheries Technical Paper 481. Rome.
- Bjordal, Å. (2005). Uso de medidas técnicas en la pesca responsable: regulación de artes de pesca. In: *Guía del administrador pesquero. Medidas de ordenación y su aplicación*. FAO Fisheries Technical Paper.
- Chambers, R. & Conway, G. R. (1992). Sustainable rural livelihoods: practical concepts for the 21st century. IDS Discussion Paper, 296 (September).
- Chamnan C., Thilsted, S., Roitana, B., Sopha, L., Gerpacio, RV., Roos, N. (2009). The role of fisheries resources in rural Cambodia: combating micronutrient deficiencies in women and children. Phnom Penh: Department of fisheries post-harvest technologies and quality control, fisheries administration, ministry of agriculture, forestry and fisheries.
- Chasqui-Velasco, L., Polanco A., Acero A., Mejía-Falla, P.A., Navia, A.F., Zapata, L.A., & Caldas, J.P. (Eds.) (2017). *Libro-Rojo-Peces-Marinos-De-Colombia*. Instituto de Investigaciones Marinas y Costeras Invemar, Ministerio de Ambiente y Desarrollo Sostenible. Serie de Publicaciones Generales de INVEMAR # 93. Santa Marta, Colombia. 552 p.
- Cinner, J. E., McClanahan, T. R., & Wamukota, A. (2010). Differences in livelihoods, socioeconomic characteristics, and knowledge about the sea between fishers and non-

- fishers living near and far from marine parks on the Kenyan coast. *Marine Policy*, 34(1), 22–28. <https://doi.org/10.1016/j.marpol.2009.04.003>.
- Cinner, J.E., Daw, T., & McClanahan, T.R. (2009). Socioeconomic factors that affect artisanal fishers' readiness to exit a declining fishery. *Conservation Biol*, 23(1): 124-30.
- Cinner, J.E., McClanahan, T.R., Graham, N.A.J., Daw, T.M., Maina, J., Stead, S.M., Wamukota, A., Brown, K. & Bodin, O. (2012) Vulnerability of coastal communities to key impacts of climate change on coral reef fisheries. *Global Environmental Change*, 22(1): 12-20.
- DANE. Departamento Administrativo Nacional de Estadísticas. (2018). Boletín Técnico Pobreza Monetaria en Colombia.
- DFID. (1999). Sustainable Livelihoods Guidance Sheets Introduction: Overview. *Sustainable Livelihoods Guidance Sheets*, 10.
- Ellis, F. & Allison E. (2004) Livelihood diversification and natural resource access. LSP Working Paper 9. Food and Agriculture Organization of the United Nations. Livelihood Support Programme (LSP).
- Etea, B. G., Zhou, D., Abebe, K. A., & Sedebo, D. A. (2019). Household income diversification and food security: Evidence from rural and semi-urban areas in Ethiopia. *Sustainability (Switzerland)*. <https://doi.org/10.3390/SU11123232>
- FAO & World Fish Center. (2008). Small-scale capture fisheries: A global overview with emphasis on developing countries. In *The World Bank. Global Program on Fisheries (PROFISH)*.
- FAO. (2004). The state of world fisheries and aquaculture, 2004. Rome, FAO Fisheries Department. 153 p.
- FAO. (2012). Escala Latinoamericana y Caribeña de Seguridad Alimentaria (ISBN 978-9).
- Friedman, K., Krone, M., Pinca, S., Magron, F., Boblin, P., Pakoa, K., Awiva, R., & Chapman, L. (2008). Papua New Guinea country report: profiles and results from survey work at Andra, Tsoilaung, Sideia and Panapompom. Pacific Regional Oceanic and Coastal Fisheries Development Programme, New Caledonia.
- Garaway, C. (2005). Fish, fishing and the rural poor. A case study of the household importance of small-scale fisheries in the Lao PDR. *Aquatic Resources Culture and Development*, 1(2): 131-144.
- García, C.B. (2010). Conocimiento tradicional: Lo que los pescadores artesanales del Caribe Colombiano tienen para decirnos. *Pan-American Journal of Aquatic Sciences*, 5(1): 78-90.

- Gomna, A., & Rana, K. (2007). Inter-household and intra-household patterns of fish and meat consumption in fishing communities in two states in Nigeria. *Br J Nutr*, 97(1): 145-152.
- Herring, A. & Racelis, R. (1992). Monitoring the Coverage of Public Programs on Low-income Families: Philippines 1992. Integrated Development Planning Project, National Economic Development Authority, Manila.
- Kawarazuka, N. (2010). The contribution of fish intake, aquaculture, and small-scale fisheries to improving nutrition: A literature review. The WorldFish Center Working Paper No. 2106. The WorldFish Center, Penang, Malaysia. 44 p.
- Kawarazuka, N., & Béné, C. (2010). Linking small-scale fisheries and aquaculture to household nutritional security: an overview. *Food Security*, 2:343–357 DOI 10.1007/s12571-010-0079-y.
- Lizarazo, J.P. & López, D.C. (2007). Identificación de amenazas y vulnerabilidades para la elaboración del PNN Corales del Rosario y San Bernardo como elemento para la gestión ambiental y la gestión del riesgo para la conservación de áreas protegidas. Editorial Académica Española, 256p.
- MADS. Ministerio de Ambiente y Desarrollo Sostenible. (2012). Modelo de desarrollo sostenible para el área marina protegida de los archipiélagos de Nuestra Señora del Rosario y de San Bernardo 2013-2040.
- Maldonado, J.H. & Moreno-Sánchez, R.P. (2014). Estimating the adaptive capacity of local communities at marine protected areas in Latin America: a practical approach. *Ecology and Society*, 19(1): 16. DOI: <http://dx.doi.org/10.5751/ES-05962-190116>.
- Márquez, A. (2014). Povos dos recifes: reconfiguracoes na apropriacao social de ecossistemas marinhos e litoraneos em duas comunidades do Caribe. Tesis Doctoral. Universidade Federal do Rio de Janeiro. Rio de Janeiro, Brasil.
- McClanahan, T.R., Cinner, J.E., Graham, N.A.J., Daw, T.M., Maina, J., Stead, S.M., Wamukota, A., Brown, K., Venus, V. & Polunin, N.V.C. (2009). Identifying Reefs of Hope and Hopeful Actions: Contextualizing Environmental, Ecological, and Social Parameters to Respond Effectively to Climate Change. *Conservation Biology*, 23(3): 662–671.
- McClanahan, T.R., Cinner, J.E., Maina, J., Graham, N.A.J., Daw, T.M., Stead, S.M., Wamukota, A., Brown, K., Ateweberhan, M., Venus, V. & Polunin, N.V.C. (2008). Conservation action in a changing climate. *Conservation Letters* 1(2): 53–59.

- Mendoza, S. & Moreno-Sánchez, R. (2014). Construcción participativa de un modelo de resiliencia socio ecológica en el territorio de Barú, Bolívar, Colombia. Informe presentado a Colciencias en el marco del proyecto “Apropiación social del conocimiento ecológico con comunidades marino-costeras en áreas marinas protegidas.” Grupo de Estudios Ambientales y de los Recursos Naturales-GEMAR, Universidad de los Andes.
- Mkenda, A.F. (2000). The Relative Welfare of Artisan Fishermen in Zanzibar. Paper given at the Second International Conference on Environment and Development, the Royal Swedish Academy of Sciences, Stockholm, 6–8 September 2000. Available from: <http://www.yourk.ac.uk/depts/ceem/publish/edepdf/Confer-2000-117-v2.pdf>.
- Moreno-Sánchez, R.P. & Maldonado, J.H. (2013). Adaptive capacity of fishing communities at marine protected areas: A case study from the Colombian Pacific. *Ambio A Journal of the Human Environment*, 42(8): 985-996. <https://doi.org/10.1007/s13280-013-0454-y>.
- Mujinga, W., Lwamba, J., Mutala, S., & Husken, SMC. (2009). An inventory of fish species at the urban markets in Lubumbashi, Democratic Republic of Congo. Regional Programme Fisheries and HIV/ AIDS in Africa: Investing in Sustainable Solutions. The World- Fish Center. Project Report 1983. 30p.
- Nayak, P.K., Oliveira, L.E. & Berkes, F. (2014). Resource degradation, marginalization, and poverty in small-scale fisheries: threats to social-ecological resilience in India and Brazil. *Ecology and Society*, 19(2): 73. <http://dx.doi.org/10.5751/ES-06656-190273>.
- OECD. (2016). Pesca y acuicultura en Colombia. *Journal of Sea*, 1 (Pesca artesanal y acuicultura), 34. Retrieved from https://www.oecd.org/tad/fisheries/Fisheries_Colombia_SPA_rev.pdf.
- Pineda, I., Martínez, L.A., Bedoya, D., Caparroso, P. & Rojas, J.A. (2006). Plan de manejo del Parque Nacional Natural Corales del Rosario y San Bernardo. UAESPNN, Territorial Costa Caribe.
- Pita, C., Villasante, S. & Pascual, J. (2019). Managing small scale fisheries under data poor scenarios: lessons from around the world. *Marine Policy*, 101: 154-157.
- PNN. Parques Nacionales Naturales de Colombia. (2019). Plan de manejo Parque Nacional Natural los Corales del Rosario y de San Bernardo (2016-2021). 260 p.
- PNN. Parques Nacionales Naturales de Colombia (2020). Plan de Manejo del Parque Nacional Natural Los Corales del Rosario y de San Bernardo (2020-2025). 228 p.

- Rodríguez-Sánchez, C.A., Moreno-Sánchez, R.P., & Maldonado, J.H. (2016). Incidencia de dos medidas diferentes de pobreza en la estimación de la capacidad adaptativa de comunidades locales ubicadas en áreas marinas protegidas: el caso de la comunidad de Barú, Bolívar. *Boletín de Investigaciones Marinas y Costeras*, 45(2): 197-236. DOI: <http://dx.doi.org/10.25268/bimc.invemar.2016.45.2.683>
- Rueda, M., Doncel, O., Viloría, E., Mármol, C., García, C., Girón, A., García, L., Rico, F., Rodríguez, A., & Borda, B.C. (2011). Atlas de la pesca marino-costera de Colombia: 2010 – 2011. *Tomo pacífico. INVEMAR y ANH. Serie de publicaciones del INVEMAR. Santa Marta*.
- Teh, L., Sumaila, U.R. (2007). Malthusian overfishing in Pulau Banggi? *Marine Policy*, 31(4): 451–7.
- Thorpe, A., Neil, A., & Allison E. (2007). Fisheries and poverty reduction. *CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources* 2, No. 085.
- Tietze, U., Groenewold, G., & Marcoux, A. (2000). Demographic change in coastal fishing communities and its implications for the coastal environments. FAO Fisheries Technical Paper No. 403. FAO, Rome.
- Villamil, E., Bolaño, J., Gómez, W., Valencia, N., Geles, M., Moreno-Sánchez, R., Mendoza, S. & Maldonado, J.H. (2015). *El pescador de Barú: una aproximación a la recuperación del conocimiento asociado a la pesca*. Universidad de los Andes, Facultad de Economía, CEDE, Ediciones Uniandes.
- Viloría, H.M M., Ante, R F., Pérez, P.S., Correa, M.C., Jiménez, L.E.A., Llano, C.G., Martínez, W., Castro, A., Posada, S., Gómez, C., Bruges, E., Narváez, J.C., Viloría, E. & Anaya, C.L. (2014). Caracterización del uso y aprovechamiento de recursos hidrobiológicos en áreas protegidas de parques nacionales naturales en el caribe de Colombia. *Boletín de Investigaciones Marinas y Costeras*, 43(2), 277–306.
- Willmann, R. (2004). Poverty in coastal fisheries. In: Neiland, A.E. & Béné, C., editors. *Poverty and Small-scale Fisheries in West Africa*. Kluwer Academic Publishers, Dordrecht; p. 245–51.
- World Bank. (2020). The World Bank Data. Available on: <https://data.worldbank.org/indicator/SP.POP.DPND>.