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BIOLOGICAL SCIENCES

# Economic efficiency and family income of small-scale fisheries on the north coast of São Paulo State, Brazil.

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**Abstract:** Small-scale fisheries is an important factor in the generation of income, jobs and food security. Understanding the characteristics of small-scale fisheries, and the volume of resources and food that they generate can help society recognize their value, lead to the establishment of public policies to improve working conditions and adapt the management of exploited resources for long-term conservation. The objective of this study was to estimate income, production capacity and importance of small-scale fisheries for fisher families of the municipality of Caraguatatuba, São Paulo, Brazil. Fishers were interviewed from May 2012 to June 2013 and categorized according to vessel size and the number of people on the boat and helpers. Monthly income ranged from US$ 566.78 to US$ 1,466.87. The importance of fishing to family income ranged from 50.60% (employee) to 78.25% (entrepreneur). Fishers usually dedicate themselves to this activity for 8.47 to 13.22 hours daily, with daily fish production volume ranging from 42.72 to 122.14 kg/day. Small-scale fisheries involve, either directly or indirectly, about 1,170 people in the municipality and provide a network of social protection due to their local and regional importance.

**Key words:** family income analysis, fishers, profitability small-scale fishery, professional fishers.

## INTRODUCTION

The small-scale fisheries accounts for more than 50% of all marine and freshwater fisheries in the world, and practically all of their production is for human consumption (FAO 2010). It provides about 20% of the animal protein need of about 3.2 billion people (FAO 2018) and involves 59.2 million people worldwide (FAO 2018). According to the General Register of Fishing Activity from the Ministry of Fisheries and Aquaculture – MPA (2010), there were 853,231 professional fishers in Brazil in 2010. The northeast region of Brazil has the majority of professional fishers (43.70% of the total for the country), followed by the north region (38.80%), while the state of São Paulo in the southeast region accounts for has 25,288 fishers (2.96%).

According to Fishermen´s Association (Zone 8) (unpublished data), whose coverage area corresponds to 14 coastal and inland municipalities, the municipality of Caraguatatuba on the north coast of the state of São Paulo currently has 183 fishers, among which 128 are originally from Caraguatatuba itself, while in the 1980's and 1990's there were 505 fishers registered (personal observation). The number of fishers had been increasing in Fisherman's Association until its re-registration when the number started decreasing as the fishers changed their careers or there was no proof of their occupation, or even due to death cause.

According to Schuhbauer & Sumaila (2016), to determine whether small-scale fisheries can be considered economically viable and beneficial to society, the number of jobs, the level of dependence, and the associated costs of fishing, among other attributes, must be identified.

According to Béné et al. (2010), many international development agencies believe that fishing is economically inefficient. According to these authors, there is a concept related to small-scale fishing referred as labor buffer, which recognizes the positive aspect of this activity for the reduction of poverty of fishers and its great capacity to offer employment opportunities. This role of small-scale fisheries was proposed by Jul-Larsen (2003). Accordingly, the objective of this work was to study the income generation of fishers from Caraguatatuba and evaluate whether the labor buffer concept mentioned by Béné et al. (2010) corresponds to their reality through the analysis of profitability, importance for family income and production capacity of fishing.

## MATERIALS AND METHODS

A total of 51 fishers, only from municipality of Caraguatatuba (about 40% of the total for the municipality) were interviewed from May 2012 to June 2013. Interviews were held mainly on Mondays, since this is the day that fishers check their fishing gear, supply the boat engine and set up accounts with the Association of Fishers. The Association of Fishers provides ice and maintains the marketing structure provided by Caraguatatuba City Hall, which subsidizes part of the cost of ice. Thus, this cost was not considered in the analysis. All of the respondents belonged to this association.

The interviews were conducted at the two main points of the fishermen´s businesses areas in Caraguatatuba: Camaroeiro and Porto Novo. We asked the fishermen about willingnesses to collaborate with the research after being told its purpose and that any information provided by them would remain confidential. A pre-developed questionnaire inquiring about socioeconomic and production data was used. The research project and the questionnaire had been previously evaluated and approved by the Research Ethics Committee of the Federal Institute of Science, Education and Technology of São Paulo.

According to the information provided, four different categories of fishers were identified (Table I). It should be emphasized that this work does not aim to categorize the respondents according to the species captured since fisheries in this region are multispecific and fishers commercialize the largest possible volume of fish, including by catch.

The classification of fishers prioritized the productive structure (engine power and crew size) employed in the activity, since this element is decisive in determining the production capacity and income generation. The first category represents the individual fishers who mostly work without helpers. They use small vessels, usually canoes or boats, of 10 meters in length or less, with engines of up to 22 HP. It is not uncommon to see boats with more powerful engines.

The second and third category are entrepreneurial fishers. These fishers employ motor boats with over 20 HP and hire at least one person to compose the crew. This category is divided into family entrepreneurs and the employed entrepreneurs. The family entrepreneur is characterized by hiring relatives for the crew. The employer entrepreneur usually has two boats, the most common of which are

**Table I. Categories of fishers by type of fishing practiced.**

| Types of fishers | Individual | Entrepreneur | | Employee |
|---|---|---|---|---|
| | | Family | Employer | |
| Fishing modes | alone or with a crew member | crew of one person (relatives) | at least two helpers | crew of the entrepreneur, common to work with some relative |
| Size of boat | motor up to 22HP or sometimes larger (canoes, boats, batteries) | own boats, motor above 20HP | own boats, usually two (whaling boats) | does not own a boat |
| Frequency | 23 (45.1%) | 10 (19.6%) | 10 (19.6%) | 8 (15.7%) |

whaling boats, and a crew consisting of at least two helpers.

The fourth category is the sharecroppers or employees. The main feature of these fishers is that they do not have a boat, but work as helpers of the categories. It is very common for the individuals of this category to work with a relative, such as their father, brother or cousin.

## Net available income

An income analysis was performed for each category adopting the concept of net disposable personal income: wich is the one received by households and is available for consumption or savings (Cacciamali 2011). Fishers reported their net disposable income during the interviews. In cases where there was division among a crew, the gross disposable income was inferred considering what the fishers reported for the earnings after deductions of variable costs. It should be noted that the amounts were recorded in reais (R$) and converted into US dollars at the average rate for the currency in 2013, which was R$2.16 for US$1.00.

## Profitability analysis

Profitability is the relationship between revenues and costs generated by the use of company assets during its activity (Gitman 2010). The analysis of profitability is based on a statement of income and its percentage composition, with the aid of vertical analysis (Gitman 2010). The analysis produces, among other information, the profit margin in relation to sales revenues.

The profitability analysis of the present work was carried out using information on net disposable income and operational expenses by structuring the statement of income for each interviewed fisher. For that, we used the model of Padoveze (2008) to study the balance and leverage. The operating result is the residual value of sales revenues minus variable costs, adding or subtracting other amounts until the identification of profit or loss.

Revenue from sales is the product of the volume sold at the price charged. Variable and fixed costs are subtracted from the sales revenue to find the operating result. Variable costs are proportional and directly related to the volume of productive activity (Padoveze 2008). In the present case, variable costs were determined from fuel, direct labor and gear expenses, including the constant maintenance required by gear, which generates costs for each fishery. Food costs were considered negligible, since most fishers practice near shore activity and do not spend long periods on board a vessel.

Fixed costs are those that remain constant, regardless of the volume produced, because they are linked to a period of time Padoveze (2008). In the present study, fixed costs are composed of fees and maintenance and depreciation costs for boats and engines. Fees include expenses related to the monthly association membership, social security, authorization for professional fishing and compulsory insurance of the vessel. All values reported annually were adjusted to the monthly values to match the time base of the data. For the analysis of depreciation, a rate of 5% per year was applied to the values cited in the the fishers, which was subsequently divided by 12 to establish a monthly value; the 5% rate was indicated by Appendix regarding the Normative Instruction 162 of BRASIL (Secretaria da Receita Federal 1998).

For the present study, the gross disposable income was determined from the difference between the sale value of fish and the costs of fuel and gear. It should be noted that fishers who hire a crew use a portion of the gross disposable income to pay them, providing available net income to finance fixed costs. The operating result was obtained by excluding the fixed costs from available net income. Table II presents the income statement model used to identify the formation of disposable income and operating income (profit or loss).

The vertical analysis of the operating result is an integral part of profitability analysis and allows the operating margin to be determined according to the following equation:

$$Operating\ margin = \frac{operating\ profit}{sales\ revenue} \times 100 \quad (1)$$

## Vertical analysis of operating results

After identifying the operational results for each interviewee, a vertical analysis was performed. According to Matarazzo (2010), a vertical analysis consists of calculating the percentage of each item of expenditure of the statement in relation to sales revenue. The purpose of this analysis was to identify the distribution of sales revenue, up to the formation of profit or loss. The average of these distributions per fisher category were then calculated (Table III).

## The importance of fishing income to family income

The importance of fishing to family income was defined as the percentage of participation of the available net income in the total income of the family, as informed by the fishers.

**Table II. Structure of disposable income used for estimates.**

| **Sales Revenue** |
|---|
| (-) Cost Production Variables |
| (-) Fuel |
| (-) Gear |
| (=) Gross Income Available |
| (-) Direct labor |
| (=) Net Available Income |
| (-) Fees |
| (-) Maintenance |
| (-) Depreciation |
| (=) Operational result (profit or loss) |

**Table III. Average income of fishers of the municipality of Caraguatatuba per category.**

| | Individual | Entrepreneur | | Employee |
|---|---|---|---|---|
| | | Family | Employer | |
| Average income | n = 23 (45.10%) | n = 10 (19.60%) | n = 10 (19.60%) | n = 8 (15.7%) |
| | R$ 1,478.74 (sd = 666.12) US$ 684.60 | R$ 1,954.40 (sd = 985.72) US $904.81 | R$ 3,168.44[1] (sd = 2,315.79) US$ 1,466.87 | R$ 1,224.25 (sd = 633.55) US$ 566.78 |

[1] **One fisher did not report monthly income. R$ (2013): US$ 1 = R$ 2.16.**

### Production capacity and volume

In the present study, production capacity is described as the volume of fish obtained as a function of time worked. It was calculated as the number of hours worked multiplied by the days worked per week, resulting the weekly journey. Time estimates were made using the program Oriana v. 4.02. Volume produced was described as pounds per day on average fishing day, with an average fishing day being established and explained to the fisher the one that is not the best nor the worst, according to yield. Thus, this value would be an average and, according to the fisher's knowledge, the most common. We chose this kind of question to avoid overestimated values of daily production by the fishermen. We asked fishers to describe their last week's catch because it would be easy to remember. It should be noted that the product of fishing comprises a wide variety of items of different sizes and weights, implying very different production volumes.

## RESULTS

### Net available income

The average monthly income for the individual fisher category was US$684.60 (n = 23), in a range between US$162.07 and US$1,389.20 (Table III). For the family entrepreneur category the average monthly income was US$904.81, and for the employee entrepreneur category it was US$1,466.87 (n = 09). Employee fishers had the lowest average income of US$ 566.78. Overall, the lowest income reported in the study was US$694.60 while the highest one was US$4,167.61.

One of the interviewed fishermen declared an income of US$9,259.25, of was withdrawn from the analysis since it was understood that it was likely to be a mistake or an extremely atypical value, which would invalidate the information received during the interview.

### Profitability analysis

In all cases the fishers had an operating profit, which generated positive margins. However, the observed operating margins varied widely. The employee category had the highest operating margin, since all income received immediately turned into profit (Table IV).

### Vertical analysis of operating results

For all categories, except employee, the greatest costs were fuel and manpower, while the lowest were depreciation and fees (Table V). The main types of gear reported were for trawling and holding. The employee category had no costs, except for the fee paid to the Association of Fishers, when it became associated, and the fee to authorize a professional fisher, which

is obligatory for all categories to practice the profession.

### The importance of fishing income to family income

The importance of fishing income to family income was greater, in absolute terms, for the employer entrepreneur category (78.25%), but this category is the only source of income for 25% of the respondents (Table VI). The fishing income was less important to family income for the employee category, which was the only source of income for 14.3% of the fishers.

### Production capacity and volume

The entrepreneur fishers dedicated more hours to fishing, had greater production per day and hour in absolute terms, and had a higher standard deviation. Both individual and entrepreneur fishers had similar absolute levels of income and working hours (Table VI).

One fisher reported a yield of 200 kg/day, which was removed from the analysis because it was highly discrepant regarding the rest of the data. It may also have been an atypical day of fishing, which would then fail to address the question about an average working day.

## DISCUSSION

### Net available income

The main species caught, using trawling and gillnets in the municipality of Caraguatatuba in the period between 2013 and 2017 were: *Xiphopenaeus kroyeri*, *Micropogonias furnieri*, the "mixture" (several species of low commercial value, such as *Paralonchurus brasiliensis* and *Menticirrhus americanus*), *Cynoscion leiarchus*, and *Mugil curema* (Instituto de Pesca 2018). We believe that during the period of this study the composition of landings were similar to the species caught. As previously mentioned, the fishery of the studied region comprises multispecies. Only trawling has a definite target species, where the *Xiphopenaeus kroyeri* is the most important species. However, in case they catch other species they also commercialize them, which are called "mixture".

Analyzing the four categories of fishers, the highest net disposable income in absolute terms was that of the employer entrepreneur, which can be explained by the fact that some of these fishers have two boats and more people involved. Having a more robust production structure, the employer entrepreneur is able to generate sales revenue at a level which is well above the other categories, and thus achieve

**Table IV. Observed operating margins (as percentages) for each category of fishers.**

| Category | Margin | | | |
|---|---|---|---|---|
| | Minimum | Maximum | Average | Standard deviation |
| Individual | 4.82 | 65.47 | 29.44 | 16.63 |
| Family entrepreneur | 3.46 | 62.70 | 27.16 | 17.02 |
| Employer entrepreneur | 10.92 | 40.58 | 23.40 | 12.90 |
| Employee | 95.83 | 100.00 | 98.64 | 1.47 |

**Table V. Averages for the vertical analysis (in percentage) for each category of fishers.**

| | Individual | Family entrepreneur | Entrepreneur employer | Employee |
|---|---|---|---|---|
| **Sales Revenue** | **100.00** | **100.00** | **100.00** | **100.00** |
| (-) Cost Production Variables | 24.90 | 28.50 | 33.30 | 00.00 |
| Fuel | 22.30 | 20.80 | 26.70 | 00.00 |
| Gear | 02.60 | 07.70 | 06.60 | 00.00 |
| (=) Gross Income Available | 75.10 | 71.50 | 65.90 | 100.00 |
| (-) Direct labor | 22.30 | 30.30 | 32.20 | 00.00 |
| (=) Net Available income | 52.80 | 41.20 | 33.70 | 100.00 |
| (-) Fees | 01.50 | 00.40 | 00.40 | 01.40 |
| (-) Maintenance | 17.40 | 09.60 | 07.10 | 00.00 |
| (-) Depreciation | 04.50 | 04.00 | 03.60 | 00.00 |
| (=) Operational result | 29.40 | 27.20 | 23.40 | 98.60 |

the highest available income. We believe that classifying fishers according to the various species they catch may also affect their income. However, this was not the purpose of our study.

The comparison of the monthly income of the fishers in Caraguatatuba with that of other fishers in different locations in Brazil (Table VII) revealed that the values were quite different. To adequately compare the levels of income for fishers in different regions of Brazil, we matched the characteristics of the fishers mentioned in Table VII with the categories defined in this paper, specifically: whether the fisher works alone or with a helper, whether the fisher is the owner of a vessel or not, and also the vessel size.

Peixer & Petrere (2009) found that the average monthly income of professional fishers was US$ 239.64 in Pirassununga (countryside of the state of São Paulo). The large difference between the observed income between the fishers in the country side and those on the coast side is explained by the lower daily production of the fishers in the countryside (19.9 kg/day), as well as the commercial value of the species caught in the two different regions. Shrimp is the main exploited resource in Caraguatatuba, which has a higher added value in comparison to many of the species landed in the countryside. Another aspect of inland fishing is that, in general, the fish is landed far from the points of retail trade for these products.

Alencar & Maia (2011) analyzed the database of 2008 from the General Registry of Fishing Activities (RGP) of the Ministry of Fisheries and Aquaculture and estimated the average annual income of Brazilian fishers at US$ 1,965.28/year when considering all regions of the country. They found average fisher income to be higher for the southeast region than for the other regions of the country at US$ 3,318.86/year. The data were compared considering only 10 months because many of the fishing closed periods.

The income differences between what was found by Alencar & Maia (2011) and the categories described by the present study

**Table VI. Data regarding the importance of fishing income to family income, production capacity and average production volume (kg) per day and hour for the studied categories of fishers (US$ 1.00 = R$ 2.16).**

| | Individual | Entrepreneur | | Employee |
|---|---|---|---|---|
| | n = 23 (45.10%) | Family n= 10 (19.60%) | Employer n= 10 (19.60%) | n = 8 (15.7%) |
| Importance of fishing income to family income | 71.64% (sd = 25.38%) 36.00% of total family income | 68.34% (sd = 25.45) 30.00% of total family income | 78.25% (sd = 18.02) 25.00% of total family income | 50.60% (sd = 28.77) 14.3% of total family income |
| Production capacity | 8.47 hours/day (sd = 4.40) 5.91 days a week (sd = 0.99) Weekly average = 50.08h | 8.32 hours/day (sd = 3.25) 5.40 days a week (sd = 1.34) Weekly average = 44.93h | 11.14 hours/day (sd = 3.10) 6.00 days a week (sd = 0.66) Weekly average = 66.84 | 13.22 hours/day (sd = 01.48) 5.00 days a week (sd = 0.57) Weekly average = 66.10 |
| Average production volume kg/day | 42.72 (sd = 40.40) | 44.50 (sd = 35.85) | 80.50 (sd = 29.85) | 122.14 (sd = 67.32) [1] |
| and kg/hour | 05.04 | 05.34 | 07.22 | 09.24 |

[1] **one non-response.**

may be related to the characteristics of the artisanal fishing employed in the municipality of Caraguatatuba, regarding which the fish is landed only a few hours after capture and delivered to the merchants who sell it to the products to the final consumer; in other words, it is a short supply chain. There is no transport charge because this place is located exactly at the point of fish landing and commerce.

Comparing fishers' income in Caraguatatuba with the Brazilian monthly *per capita* income for 2013, the year when the data of the present study were collected in the field, revealed that only the employer entrepreneur category had a higher average income, in absolute terms. In fact, the entrepreneur income in Caraguatatuba was a little higher than twice the national per capita income, indicating that this profession has a high financial return. According to Béné et al. (2010), the income generated by fishing is often higher than the income of rural workers, or the national average income. However, there are several risks involved with small-scale fishing compared to other types of work Béné et al. (2010), where the production variation greatly influences in the family income. Comparing the present findings to that of available literature on fisher income reveals that the income generated by fishing activities in Caraguatatuba is comparable to the regions worldwide the characteristics of the fish stocks, the seasons of each type of fishery, and the environmental and climatic conditions—which vary throughout seasons and facilitate or hinder access to different species of higher or lower sales value.

## Profitability and vertical analysis of operating results

The analysis of profitability revealed three important aspects, the first of which is positive and diversified margins. The fishers in Caraguatatuba obtain profit from the activity of fishing; the revenues pay the costs, replace the wear and tear of the productive means and generate sustenance for the families. The second is the non-homogeneous nature of the weights of costs; the types of fisheries that fishers develop are similar, but their productive structures differ, depending on the boat size variable. This difference in production structure means that production costs have different weights for each category of fisher.

Fuel and gear costs represent 24.90%, 28.50% and 33.80% of sales revenues for individual, family entrepreneur and employer entrepreneur fishers, respectively. The fuel expense incurred by the employer entrepreneur category consumes a third of the revenues from sales. This greater share is due to the use of larger boats that consume more fuel. Labor, as

**Table VII. Comparison of the monthly income of artisanal fishers from different locations in Brazil and the World.**

| | Individual | Entrepreneur | | Employee |
|---|---|---|---|---|
| | | Family | Employer | |
| **Average income**<br>US$ 1 = R$ 2.16 (2013) | R$ 1,478.74<br>US$ 684.60 | R$ 1,954.40<br>US$ 904.81 | R$ 3,168.44<br>US$ 1,466.87 | R$ 1,224.25<br>US$ 566.78 |
| **Pirassununga**<br>Peixer & Petrere (2009) | | US$ 239.64 | | |
| **Average for Brazilian fishers**<br>Alencar & Maia (2011)<br>US$ 1 = R$ 1.67 | R$ 3,282.03 (US$ 1,965.28)/year<br>Monthly value (10 months) = US$ 196.52<br>Southeast: R$ 5,542.50 (US$ 3,318.86)/year<br>Monthly value (10 months) = US$ 331.88 | | | |
| **Brazilian monthly per capita income[1]:**<br>2013: US$ 1,023.20 (US$ 1 = R$ 2.16)<br>2015: US$ 720.88 (US$ 1 = R$ 3.34) | | | | |
| **Ciés Islands (NW Spain)**<br>Cambiè et al. (2012) | | US$ 2,107.93 | | |
| **Vigo (Galicia)**<br>European Commission, DG Mare (2011) | | US$ 2,150.40 | | |

[1] **MW = minimum wage: from October 2005 until April 2006 the minimum wage was R$ 300.00 (US$ 136.55), after which it rose to R$ 350.00 (US$161.11). Information from Banco Central do Brasil (2016).**

expected, had a higher cost for the employer entrepreneur (30.40% of the sales revenue) because they have at least two helpers.

Net disposable income is 52.70% of sales revenues for individual fishers, since variable expenses are proportionally smaller in relation to the other categories of fishers in this study.

The share of fixed expenses of revenues is below 24%. Particularly, the maintenance cost for individual fishers (17.4%) is higher than the one for the other categories. Regarding the employee fishers, this cost is irrelevant since they do not own a boat or a motor.

The third is that operational margins are equivalent, but not proportional to revenue. As a result of the non-homogeneity of cost weights across categories, the operating margins diverge. The employer entrepreneur has a disposable net income, in absolute terms, about two times numerically greater than the others. However, in relative terms, it is positioned below the others; that is, even generating more income, the result is numerically lower. The employer entrepreneur reaches the net margin of 24.90%, while the family entrepreneur achieves 27.20% and the individual fisher 29.40%. This fact derives from the more robust, and therefore more costly, productive structure for the employer entrepreneur.

The fisher employee category does not have the costs that the other categories of fishers do since it always has a crew. Therefore, net disposable income becomes an operational profit, which generates high margins. However, this information is misleading because, in absolute terms, fisher employees have the lowest income of all categories.

The World Bank (2009) displays some consolidated data from several countries regarding the costs of fishing. They emphasize that the data vary greatly depending on the type and location of the activity. They present general data regarding the major cost factors as percentages of the total cost: labor (30 to 50%); fuel (10 to 25%); repair and maintenance of vessels/engines (5 to 10%); fishing gear (5 to 15%). These values are similar to those found in the present study.

Although historical cost data are not available for fishers from Caraguatatuba, the findings of this study show that it is possible to understand that fuel costs variation has a direct impact on the net income of fishers because it is the second largest cost item of the activity. Small-scale fishing in Caraguatatuba, unlike industrial fishing, has no subsidies for the purchase of fuel. The only partial subsidy these fishers have is for ice and a commercial cold storage structure (only for ice), maintained by the City Hall. We believe that the cost of ice should be considered in the case of fishermen who do not have this benefit.

In the city of Rio Grande, on the southern coast of Brazil, Rodrigues et al. (2018) estimated fuel costs to be 35-60% of sales revenue according to various fishing gear. However, it is worth mentioning that these authors analyzed industrial fleets and, in the case of the present study, we only analyzed small-scale fishing, the only type of fishing undertaken in the municipality. According to the World Bank (2012), this cost was estimated to be 43% of sales revenue in developing countries.

## The importance of fishing income to family income

In Caraguatatuba, fishing as a source of income is more important for entrepreneur fishers (78.25% of family income) and for individual fishers (71.64%), than for employees. For employees this activity is the only opportunity available and less important for family income (50.60%). However, it must be remembered that there are large standard deviations for these data; in other words, this information and this reality

vary greatly within each group of fishers. The large standard deviations can be understood in the context of natural variation in the yield of daily catches, which leads fishers to look for other activities when production is less. In Cambodia, the continental fishery is responsible for more than 50% of family income; in parts of the Zambezi Basin, fishing income is higher than livestock income; and in the mainstream Mekong River, 20% of household income comes from fishing FAO (2018).

According to the FAO & World Fish Center (2008), fishers who have fishing as their main activity are considered those who have up to 90% of their income from fishing, or who invest 90% of their time in it; partial fishers are those for which fishing income is responsible for up to 30% of their total income, have less than 90% of their livelihood coming from fishing or who invests at least 30% to 90% of their working time in this activity. Following this classification, we interpret all the categories of fishers in Caraguatatuba described in the present study as having fishing as their main activity since income from fishing is above 50% of the family income.

Diversification of economic activities is one of the characteristics of small-scale fishers. Such diversification is necessary because fishing is a high-risk activity that is exposed to fluctuations in the size and location of stocks. In addition, some exploited species have highly unpredictable occurrences (Allison & Ellis 2001). Fishers use strategies such as changing target species, changing fishing locations and diversifying the way to obtain income (Allison & Ellis 2001, Cinner et al. 2009). The last alternative, however, is limited, since the level of schooling among fishers is generally low. In this regard, the reality in Caraguatatuba is not different from that of other places in Brazil (personal observation).

**Production capacity and volume**

The fishers of Caraguatatuba work on average five or more days a week and about 10 hours a day, except for those of the employee category, who fish for more than 13 hours a day. The average weekly workload of fishers is higher than that of general workers (40 to 44 hours per week), according to Brazilian laws in force. This reveal show much time and effort are required by this activity. In the Dholi region of India, Kumar et al. (2018) recognized three categories of fishers: those who fish for 2-3 hours per day, those who fish 4-6 hours per day, and those who fish the entire day, which is the case of the majority.

Depending on the amount of time spent fishing, which varies from 44.93 to 66.84 hours per week, it is possible to conclude that all the categories of fishers of the present study expend great effort, including those of the employee category, which has the longest working day. These data seem to indicate that the part-time fisher employee, when dedicating time to this activity, exerts great effort, and likely juggles fishing activity with other sources of work depending on the time of the year and fisheries output.

The daily yield in Caraguatatuba varies from 42.72 kg/day to 122.14 kg/day, depending on fisher category, but the standard deviations reveal great variation in yield, which is expected due to the variable availability of the resource. The highest daily production for the fisher employee may be related to the greater number of fishers present in the vessel, which in some cases is more than two, which also explains the lower income due to the division of the generated profits.

Alencar & Maia (2011) provide data for the annual production for Brazil (transformed into weekly production, considering 10 months fishing per year due to the closures), with the South Region producing 65.25 kg, the southeast

region 45.75 kg, and the average for the entire country being 28.00 kg. Weekly catches in Caraguatatuba, taking into account the number of fishing days, are much larger than the production levels cited by these authors. The higher production levels may explain the higher income observed in Caraguatatuba compared to other regions of Brazil. For 100 villages surveyed in Samoa, fishers caught 13.7 kg per fishing trip of about four hours three times a week (Ministry of Agriculture and Fisheries, Apia, Samoa 2014).

According to Allison & Ellis (2001), the fact that fishers operate discontinuously and are frequently interrupted while seeking alternative sources of income makes it unlikely that stocks will be decimated, and thus they require more appropriate rules compared to orthodox management. According to these authors, the policies and type of management should be those that encourage and enable fishers to act only part of their time. Hence, fishers look for strategies to guarantee family sustenance by means of so-called "freelance" at temporary activities. This is the case mainly with employees in small-scale fisheries.

If this is indeed the case, then current Brazilian law legislation (Brasil, Law n. 11.959 of June 29, 2009) is adequate in this regard. It does not restrict professional fishing to those people who have this activity as their principal and only way of life, as was until the sanction of this law.

If exercising temporary fishing proves be a way of guaranteeing more adequate levels of exploitation and, at the same time, promoting the generation of income for families, policies for this sector should then favor those who practice it in this manner. In the case of insurance, for example, currently only fishers who exclusively carry out this activity have the right to receive monthly payments when fishing is closed. If the return for stock protection is positive, it would compensate government investment by maintaining the benefit for all fishers, including those who do not engage in the activity full-time. In this case, other criteria should be established, such as an appropriate minimum working time in the fishery to receive the benefit.

Policy makers also need to take into account that fishing is not only a necessity, it is also a choice, and must be seen in this context to understand the reasons for entering, remaining in or leaving the activity Cinner et al. (2009). According to Béné et al. (2010), instead of insisting that fishers abandon this activity, governments should guarantee other means of subsistence. In some societies in the Pacific, fishing is being re-conceptualized as a pluralistic activity, where environmental, economic, social and cultural aspects at any level of management must be taken into account Hilmi et al. (2016).

Some options to improve the income of fishers, without increasing pressure on stocks, are being studied, such as the Pescatourisme 83 project in Greece (European Regional Framework for Cooperation 2014), for example. In this case, professional fishers take tourists on their boats during their daily activities, who spend three to four hours learning the fishery techniques used by the fishermen. Such activity is an interesting possibility for Caraguatatuba because it is a tourist town and would probably experience a demand for this type of activity.

## CONCLUSIONS

According to Fishermen's Association there are about 130 fishers in Caraguatatuba. Taking into account the estimates of FAO (2010) that for each person employed in this sector other three are employed in secondary activities, there should be around 390 people directly involved in small-scale fisheries in Caraguatatuba. If we also consider that each fisher has at least

three people in their family, then there would be approximately 1,170 people who would depend on this sector in this municipality. Then, the income generated involves a large number of people. This activity can be considered a labor buffer, as mentioned by Béné et al. (2010), because all these people may not have another source of income, due to the absence of alternative jobs and because they constitute unskilled labor.

This fact corroborates the statements of these authors inasmuch as fishing provides a protection network during phases of economic down turn and personal financial crisis. This aspect of small-scale fisheries must be taken into account by those who administer the use of these natural resources.

Studies like this are relevant as they provide data to subsidize social security networks for several governmental spheres. They are also significant for decisions that aim to decrease the fishery effort, provide the maintenance due to the closed periods or even the financial compensation due to occasional polluting activities such as oil spills, which have already occurred in the northeast coast of São Paulo.

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## Author contributions

Janice Peixer: collected the data and wrote the first version of the article. Ricardo Maroni Neto: entered in a later phase of the project and made the financial / economic analysis of the data.