S&G JOURNAL
ISSN: 1980-5160

INNOVATIONS FOR ARTISANAL FISHING: SUPPORT FOR THE DEVELOPMENT OF THE ACTIVITY IN THE STATE OF CEARÁ

Rochelle Cruz de Araujo Bezerra Vidigal
rochelle.cruz@cedepesca.net
Cearense Foundation for the Support of Scientific and Technological Development - FUNCAP, Fortaleza, CE, Brazil.

Halana Rodrigues Freire Eloy
halanarodrigues@gmail.com
Cearense Foundation for the Support of Scientific and Technological Development - FUNCAP, Fortaleza, CE, Brazil.

Karla Maria Catter
kmcatter@yahoo.com.br
Cearense Foundation for the Support of Scientific and Technological Development - FUNCAP, Fortaleza, CE, Brazil.

Rossi Lelis Muniz Souza
rossilelis@gmail.com
Cearense Foundation for the Support of Scientific and Technological Development - FUNCAP, Fortaleza, CE, Brazil.

Viviana Lisboa
viviana.lisboa.lisboa@gmail.com
Cearense Foundation for the Support of Scientific and Technological Development - FUNCAP, Fortaleza, CE, Brazil.

João Felipe Nogueira Matias
jfn.matias@gmail.com
Cearense Foundation for the Support of Scientific and Technological Development - FUNCAP, Fortaleza, CE, Brazil.

Adylla Maia Cruz
adyllamaia@hotmail.com
Cearense Foundation for the Support of Scientific and Technological Development - FUNCAP, Fortaleza, CE, Brazil.

ABSTRACT

Fishing in Ceará, even with its high socioeconomic importance, presents major problems. Among them is the absence of a data collection program. This deficiency affects the lack of decision making and support to the development of public policies. In order to support the development of fisheries in the state of Ceará, this article presents innovations used in other fisheries in the world and in Brazil that may be appropriate for the state. Aim: to modernize artisanal fishing and improve the quality of life of fishermen. Based on a systematic literature review related to innovations for small-scale fisheries and listing some of the problems faced by artisanal fisheries, co-management and the use of applications for monitoring and fair trade were defined as innovations to foster positive changes in the fishing communities of the state. The results indicate that shared management between government and users, through participatory management, is a favorable measure in the management of artisanal fisheries, and the use of applications for monitoring fisheries can make up for the lack of information. Meanwhile, the development of fair trade will create market opportunities that take into consideration social, economic, and environmental aspects.

Keywords: Artisanal Fishing; Innovation; Co-management; Monitoring; Fair Trade.

PROPPI / DOT
DOI: 10.20985/1980-5160.2021.v16n3.1650

S&G Journal
Volume 16, Number 3, 2021, pp. 229-241
DOI: 10.20985/1980-5160.2021.v16n3.1650

1. INTRODUCTION

Since the early 1980s, the importance of adopting innovations has been increasingly discussed, gaining prominence for its ability to dynamize and drive economic development (Santos and Bastos, 2009).

The Oslo Manual (OECD, 2005), prepared by the Organization for Economic Cooperation and Development, states that innovation is the implementation of a new or improved product (good or service), a process, a marketing method, or a new organizational method. The development of technological innovations for fishing favors the sustainability of food, keeping the supply of fish and fish products constant (Fujii *et al.,* 2017). Process innovations do not necessarily require a technology innovation (Menezes *et al*., 2011) and can generate a favorable environment for fisheries sustainability and improve local development.

In Brazil, fishing activity is regulated by Law No. 11,959 of June 29, 2009, which provides for the National Policy for Sustainable Development of Aquaculture and Fishing. For the purposes of this law, artisanal commercial fishing is "that which is directly practiced by professional fishermen, autonomously or under a family economy regime, and may use small vessels" (Brazil, 2009, p. 4). For FAO (2017), small-scale fishing functions as an economic and social engine that, in addition to providing for the local economy food security, employment, and various other multiplier effects, supports the livelihoods of riparian communities.

Despite the large extension of the Brazilian coast and the continental potential for fish capture, fishing is stabilized, with most fisheries resources of economic interest threatened due to human interference. In addition, the activity is historically lagging behind with regard to technologies and policies best suited to the interests of users, who still suffer from being little considered in decision-making processes (Silva, 2014).

Seeking to modernize artisanal fishing and improve the quality of life of artisanal fishermen, this article aims to present innovations already used in other fisheries worldwide and in Brazil, which can be adapted to artisanal fishing in the state of Ceará.

2. METHODOLOGY

In view of the above, the work was developed through a systematic bibliographic review carried out over a period of six (6) months, using scientific papers, dissertations, theses, among others.

Initially, a research was carried out on fishing production in the world and a search for general data available on fishing in Brazil and its problems, using keywords such as "fishing production", "fishing in Brazil", and "artisanal fishing".

After this first stage, and with the problems described, another bibliographic survey was carried out seeking innovations used for artisanal fishing worldwide and in Brazil, through the use of the terms: "artisanal fishing innovations", "lack of data", and "community organization", that besides supplying the gaps previously identified, could be implemented for the development of fishing in Ceará.

3. RESULTS

Fishing in the World

According to FAO (2018), world fisheries production in 2016 (including fish, crustaceans, mollusks, and other aquatic animals), was 170.9 million tons. Of this, aquaculture accounted for 47% (80 million tons) and capture fisheries accounted for 53% of it (90.9 million). Statistics indicate that 40.3 million people participated in the primary sector of capture fisheries and that women accounted for around 14%. There was a 15% decrease in people engaged in fishing between the years 1990 to 2016. Production by fisheries showed a small decrease compared to the last two years, going from 91.2 million in 2014 to 90.9 in 2016. Unlike aquaculture which continued to grow (**Table 1**). In continental waters, 11.6 million tons of fish were caught worldwide, representing 12.8% of the total catch. This shows an increase of 2.0% compared to 2015 and 10.5% compared to the average from 2005 to 2014. However, part of the increase may be related to the improvement in the collection and evaluation of data nationally. Most producing countries show an increase in catches in recent years. Brazil, which is the main producer in South America, has not submitted official catch data to FAO since 2014.

Table 1. World fisheries and aquaculture production

Category	2011	2012	2013	2014	2015	2016
Production in millions of tons						
Capture fisheries						
Continental	10.7	11.2	11.2	11.3	11.4	11.6
Marine	81.5	78.4	79.4	79.9	81.2	79.3
Total	92.2	89.5	90.6	91.2	92.7	90.9
Aquaculture						
Continental	38.6	42.0	44.8	46.9	48.6	51.4
Marine	23.2	24.4	25.4	26.8	27.5	28.7
Total	61.8	66.4	70.2	73.7	76.1	80.0
Total fisheries and aquaculture worldwide	154.0	156.0	160.7	164.9	168.7	170.9

Source: Elaborated from FAO (2018)

In 2016, total global marine catches showed a decrease of almost 2 million tons compared to those recorded in 2015. The anchoveta (Engraulis ringens) fisheries in Peru and Chile accounted for 1.1 million tons of this decrease. Important species in other countries, such as cephalopods, also experienced a reduction in catches between 2015 and 2016. Meanwhile, China, the world's largest producer, remained stable. The valuable species groups, with significant production of lobsters, crabs, gastropods, and shrimp, recorded historic maximum catches in 2016 (FAO 2018). According to Silva (2014), the main reason for the reduction in catch volumes over the years was the over-exploitation of fish stocks. While the industry focuses on the present without regard to long-term human needs, managers try to maintain the status quo in an unstable environment (Pontecorvo, 2008).

Also according to FAO (2018), the percentage of marine fish populations exploited at biologically unsustainable levels has increased from 10% in 1974 to 33.1% in 2015, with the largest increase recorded in the late 1970s and 1980s, bringing great concern. The United Nations Sustainable Development Goals (SDGs) include target 14.4 aimed at effectively regulating catch and ending illegal, unreported, and unregulated overfishing and destructive fishing practices by 2020, and implementing science-based management plans to restore fish populations in the shortest possible time to at least levels that can produce the maximum sustainable yield, as determined by their biological characteristics (ONU, 2020). However, it seems unlikely that the world's fisheries can restore the 33.1% of the populations that are currently overfished, as it requires time and usually two to three times the life cycle of the species (FAO, 2018).

According to SAPOPEMA (2019a), one of the major fishing problems in Brazil is the lack of structure for the main links in the production chain. This results in the weakening of the activity, especially between the landing and distribution of fish, because it does not generate information about the use of the resource and its entry into the formal production chain, leading consumers to acquire a product of unknown origin and quality.

Statistical data is increasingly indispensable for the information system of a democratic society, serving the different spheres of government, private enterprise, and the population at large (MPA, 2012). However, Vasconcellos et al. (2007) state that the precariousness of artisanal fishing statistics is recognized worldwide. It is no different in Brazil, where artisanal fishing suffers from a lack of biological and socioeconomic information. This insufficiency is caused both by the dispersion of fishing communities, making a collection system difficult, and the little importance and visibility given by government agencies, which prioritized industrial fishing. In addition, artisanal fishing was historically divided by environment (marine and continental), with different methodologies for data collection and analysis, where the states adopted their own monitoring structures, making it difficult to standardize the information (Silva, 2014).

For many years, the information used to consolidate national marine fisheries statistics was collected by IBAMA, through the ESTATPESCA monitoring program. With the insertion of the MPA, the program was gradually replaced with the goal of making fish production data collection more robust and effective (MPA, 2012). However, conflicts between government institutions and segregation of responsibilities have hindered the development of a policy for monitoring and statistics (Silva, 2014). In Brazil, since 2008 there has been no data collection program, the Ministry of Fisheries and Aquaculture published statistical data until 2011.

The fish production in Brazil for the year 2011, according to the MPA (2013a), was 1,431,974.5 t. The main source of national fish production is marine extractive fishing, accounting for 553,670.0 t (38.7% of total fish), followed by continental aquaculture (544,490.0 t; 38.0%), continental extractive fishing (249,600.2 t; 17.4%), and marine aquaculture (84,214.3 t; ~6%). Extractive fishing totals 803,270 t. (**Table 2**). The number of fishermen registered by the MPA in 2012 was 1 million forty-one thousand, with: 47.02% in the Northeast region, 36.83% in the North, 8.20% in the Southeast, 6.16% in the South, and 1.79% in the Midwest. The states with the largest number of fishermen are Pará (253,084), Maranhão (175,166), Bahia (125,827), and Amazonas (85,129). Of the total, 1,033,124 fishermen work in the artisanal way, and 8,843 work in the industrial way (MPA, 2013b).

The Northeast region records the highest production of fish from extractive fishing in the country, with 248,531.9 t, accounting for 30.9% of the national production. The North, South, Southeast, and Midwest regions registered, respectively, 231,409.8 t (28.8%), 163,987.5 t (20.4%), 163,987.5 t (15.8%), and 13,836.6 t (6.2%). Assuming that industrial fishing occurs more intensively in the South and Southeast regions (37.8% of total production), it can be concluded that artisanal fishing is responsible for the great majority of fish consumed in Brazil.

The state of Ceará presents great importance in the northeastern and Brazilian context as a major producer (Fonseca, 2019). According to the MPA (2013b), the state occupied, in 2011, the seventh position in marine extractive fishing, with a production of 21,788.0 t and the sixth position in continental extractive fishing, producing 11,370.1 t of fish. A total of 29,970 fishermen were

S&G Journal
Volume 16, Number 3, 2021, pp. 229-241
DOI: 10.20985/1980-5160.2021.v16n3.1650

Table 2. National fish production in the year 2011

Regions	2011				
	Extractive fishing		Aquaculture		Total (t)
	Marine	Continental	Marine	Continental	
Brazil	553,670.00	249,600.20	84,214.30	544,490.00	1,431,974.50
North	94,265.30	137,144.50	94,265.30	137,144.50	231,409.80
Northeast	186,012.00	68,700.90	186,012.00	68,700.90	248,531.90
Southeast	114,877.30	24,446.00	114,877.30	24,446.00	139,323.30
South	158,515.40	5,472.20	158,515.40	5,472.20	163,987.50
Midwest	0.00	13,836.60	0.00	13,836.60	13,836.60

Source: Elaborated from MPA (2013a)

registered in 2012, representing 2.88% of the number of fishermen in Brazil, in the Sistema do Registro Geral da Atividade Pesqueira (SISRGP). Thus, it is not possible to obtain more up-to-date information, since there is no monitoring program in place in the state.

In the period from January to November 2019, Ceará set a record in fish exports, maintaining its leadership in Brazil. The Ministry of Economy, through the Secretariat of Foreign Trade (Comex Stat), disclosed that the State of Ceará exported 8.7 thousand tons of fish, among fish, crustaceans, and mollusks, surpassing all other states, reaching a turnover of US$ 75.3 million. In second place, appears the state of Pará that exported 7 thousand tons, followed by Santa Catarina, with 6.5 thousand tons (Government of the state of Ceará, 2019).

Co-management as a process to manage fisheries

Sen and Nielsen (1996) define co-management (or participatory management, community management, etc.) as the sharing of responsibilities between government and user groups in resource management, forming an adaptive co-management structure, which can solve the uncertainty and complexity of fisheries (Hai, 2018), as a solution to the growing problems of overexploitation.

According to Gutiérrez et al. (2011), encouraging responsible fishing, improving management through the use of local knowledge, collective ownership of users in decision making, better monitoring and control, and sensitivity to local socioeconomic and ecological constraints are some advantages of co-management. In different fisheries systems around the world, shared management between government and local users has shown to be a promising measure in the management of artisanal fisheries (Vieira *et al.,* 2015). Besides the positive points, decentralized systems present challenges, because co-management requires information (socioeconomic and institutional), which must be available to both local users and managers (Vasconcellos *et al*., 2007).

Under an ideal co-management regime, user groups should participate in all stages (planning, implementation or evaluation), which involve the management process. However, Oviedo and Bursztyn (2017) dissertate that the interorganizational relationships of local natural resource management, when evaluated in detail, often lack representative authorities and sufficient powers, leading to non-participation in the entire process, reaffirming that for effective decentralization to occur, the participative management of local institutions has to be improved, with their organizational structures strengthened.

The co-management carried out by artisanal fishermen and the government in the Patos Lagoon in Rio Grande do Sul resulted in the determination of fishing areas (Kalikoski *et al.,* 2002). In the Amazon, community management was used as a solution to the problem of over-exploitation of the pirarucu (Arapaima gigas), with the participation of fishermen in the evaluation of stocks, determination of catch quotas, and enforcement of management rules (Viana *et al.,* 2007).

Participatory management models can be found all over the country. Kalikoski et al. (2009), elucidate that, in Brazil, participatory management processes are found in fully protected units, in sustainable use units, and outside protected units, referring to fishing agreements and community management in the Amazon, Fishing Forums in the South region, and other processes in inland and coastal waters in Brazil. The authors identify the North as the region with the most initiatives and the Northeast as the region where there is the greatest occurrence of processes in the coastal area, especially in the conservation units. These same authors, conducting a bibliographic review of community management experiences in Brazil, identified the following as the main opportunities: (*i*) support for community organizations; (*ii*) informal agreements aimed

at moderate exploitation of the resource; (*iii*) creation of alternative sources of income; (*iv*) provision of information and courses for the local population; and (*v*) community leadership development. The main challenges are: (*i*) inter-scale conflicts; (*ii*) overexploitation of resources; (*iii*) delegation of little power to the population; (*iv*) failure of responsible institutions to act; and (*v*) lack of unity and/or local organization.

The Lower Amazon region is an example in the development of fishing co-management policies in Brazil, with a System of Regional Fishing Councils responsible for the elaboration and implementation of inter-community Fishing Agreements, involving more than 130 communities and 35 thousand people. Several Agro-Extractivist Settlement Projects (PAE's) have been created and Utilization Plans (UP) have been elaborated, incorporating the Fishing Agreements that are already recognized in Normative Instructions. This PAE has great potential to be the main co-management policy unit. Also according to SAPOPEMA (2019a), the Plan for the Sustainable Development of Fishing and Fish Farming in the Lower Amazon presents itself as one of the Strategic Axes for a fisheries co-management policy, and, in this way, goals are elaborated in order to obtain a system that allows communities to manage fishing resources in a sustainable way, recovering overexploited stocks and enabling effective monitoring that generates data on the impacts of the measures adopted in the fishery.

Analyzing the benefits brought by the co-management system in the Lower Amazon, in terms of productivity and conservation, Almeida et al. (2006) identified that there was an increase in productivity (CPUE) and conservation for the managed lakes when compared to unmanaged lakes.

Gutiérrez et al. (2011) conducted a study to identify quantitative and qualitative evidence of the positive impacts of co-management in fisheries worldwide. Of the 218 systems found in 44 countries, the authors analyzed a total of 130, 69% of which were artisanal fisheries. The case studies were divided by continent: Asia (26%), Europe (21%), Africa (15%), South America (14%), North America and the Caribbean (17%), and Oceania (7%), and of the 18 cases in South America, 8 are from Brazil. Weighing that for successful fisheries management through co-management, the most important attributes are the presence of community leadership, community or individual quotas, social cohesion, and community-based protected areas.

Moura *et al.* (2009) agree that co-management in artisanal fisheries has enormous potential as a process of participation, empowerment, power sharing, dialogue, conflict management, and knowledge generation. And, despite several positive co-management results in world fisheries, Castello (2008) considers that participation and fisheries management issues in Brazil still receive little attention when compared to biological and ecological issues of fish stocks.

Monitoring fishing with the use of applications

Artisanal fisheries are complex to collect information and monitor activities due to their characteristics. It requires an expenditure of financial resources that few countries have to start and maintain a continuous data collection system (Vasconcellos *et al.,* 2007). In addition, the precariousness of information makes the sector invisible and unimportant to managers, and the private sector without the necessary information to evaluate possible SAPOPEMA investments (2019a).

According to Doria *et al.* (2019a), although the use of mobile apps is quite favorable in small-scale fisheries, it is still scarce, especially in Brazil. Due to the constant challenge of conducting research on migratory fish in the Amazon River Basin, a network of scientists and fishing communities have bet on a new approach to facilitate data collection: use of mobile app for monitoring. Led by the Wildlife Conservation Society (WCS), the Citizen Science for the Amazon project prioritizes the 20 most abundant migratory fish species on the fishing landing record, which ensure food security and are sources of income for riverside and urban fishermen. These species circulate in the Amazon and its tributaries in five countries: Brazil, Bolivia, Colombia, Ecuador, and Peru. In partnership with universities, governments, NGOs, riverbank dwellers, and indigenous people, the fishing of douradas (*Brachyplatystoma flavicans*), jaús (*Paulicea luetkeni*), surubins (*Brachyplatystoma juruensi*), piramutabas (*Brachyplathystoma vaillantii*), tambaqui (*Colossoma macropomum*), curimatãs (*Prochilodus nigricans*), jaraquis (*Semaprochilodus teanurus*), and matrinxãs (*Brycon cephalus*) are being monitored using a participatory approach and innovative, low-cost technologies (InfoAmazonia, 2018).

The discussions to formulate the Citizen Science Project proposal started in 2015 and, as of March 2018, presentations and articulations began with the participating groups that chose to be part of the pilot stage, getting to know and using the tools made available by the project. Between May and June 2018 the first tests took place and in July of the same year, the application was launched. By February 2019, 2,344 records were made along 41 watersheds (Doria *et al*., 2019a).

The Cornell University Ornithology Laboratory (USA) in collaboration with Wildlife Conservation has developed a

S&G Journal
Volume 16, Number 3, 2021, pp. 229-241
DOI: 10.20985/1980-5160.2021.v16n3.1650

free application for mobile devices called Ictio to obtain information for the conservation of the Amazon, drastically reducing the cost of collecting this information and empowering citizens as guardians of aquatic ecosystems (Ciencia Ciudadana para la Amazonía, 2019). The digital tool registers, with the collaboration of local populations, individual fishermen and fishermen organized into associations, management groups, sport fishermen, scientists, indigenous people, and any citizen who wants to register observations of fish caught in the Amazon Basin (Doria *et al*., 2019b).

Ciencia Ciudadana para la Amazonía (2018) further states that the Ictio application will result in an open database that will also compile historical records of local monitoring from existing datasets or from the use of other tools such as tokens and questionnaires. In addition, all this information will be used to further the understanding of migration patterns of priority fish in the Amazon, with the aim of contributing to sustainable fisheries management and conservation of aquatic ecosystems. In the application, users have two options: choose if they are going fishing, allowing them to georeference the entire route traveled and feed in their catches while fishing, or register fish that have already been caught. In both options the fisherman can include photos, helping the data analysis team to confirm if it really is the indicated species (InfoAmazonia, 2018). In summary, Ictio allows you to record the number of individuals caught, weight (kg)/total weight, location of capture, sale price, date, and photographs. On the other hand, users can view and share their data, keeping track of the species they catch over time.

The information generated can be used by the scientific community to increase knowledge on the ecology of fish and aquatic systems in the Amazon, by civil society organizations for conservation actions, and local populations will have access to information to monitor their fishing activities and improve ecosystem management. Similarly, the information can be used by the government to improve policies on fishery resources, water quality, and watershed management (Ciencia Ciudadana para la Amazonía, 2018). To understand which environmental factors influence fish migration, a monitoring of physical-chemical water parameters and meteorological data complements the fieldwork. FieldKit, developed by Conservify, is a solar-powered platform consisting of a modular system of level sensors for collecting, storing, visualizing, and sharing research data (InfoAmazonia, 2018).

In the regions of Mid and Upper Solimões, state of Amazonas, there were more than 30 trainings and meetings to get to know the Ictio. The Mamirauá Institute, one of the project partners has held, since July 2018, training in the municipalities of Tefé, Alvarães, Uarini, Fonte Boa, Jutaí, Santo Antônio do Içá, and Maraã (Mamirauá, 2018). In April 2019, after a year of working with communities using the Ictio application, the Citizen Science Meeting was held in Tefé (AM). On the occasion, the following themes were discussed: appreciation of fishing work, involvement of more users and communities in the project, improvements in the available technologies, the importance of working together within the fishing communities, use and insertion of the tools in people's day-to-day lives, and the involvement of young people in fish monitoring (Mamirauá, 2019).

Researcher Ronaldo Barthem, an Amazon fish expert, during an interview granted to InfoAmazonia in February 2019 ponders that the Citizen Science system is an excellent contribution to produce qualitative data, and the Ictio application is an environmental education tool that causes an interaction among people who work with fisheries. He emphasizes the importance of spreading these applications to official bodies that work with fisheries management, generating more reliable and consistent data for fisheries management (InfoAmazonia, 2019).

In the Madeira River Basin (Rondônia), the app was tested by the ECOPORÉ team and the Ichthyology and Fisheries Laboratory of the Federal University of Rondônia Foundation (UNIR) for one year - from July 2018 to July 2019. The monitoring aimed to answer questions from the communities about the situation of the fish. When asked, 97% of the fishermen who participated in the project said that the information generated is important to prove their profession, to have a balance of the fisheries, and to promote the monitoring of the ichthyofauna. Of all the interviewees, 80% showed interest in using Ictio. Some difficulties were reported, such as downloading the application and the concern of being denounced for continuing to carry out fishing activity during the closed season (SAPOPEMA, 2019b). With the monitoring, it was possible to register 19 of the 20 priority species of the Citizen Science project and identify the species that appeared most frequently during the year of the project's development (Doria *et al*., 2019a).

Another application for cell phones, called Fisheye, was created by the initiative of a group formed by UNESP, Instituto Meros do Brasil, Fish Tv, Capão da Imbuia Natural History Museum, Instituto Comar, and the Boticário Group Foundation for Nature Protection. According to biologist Lawrence Ikeda, who represents Fish Tv in the project, these applications are important tools for managing the activity and encourage amateur and sport fishermen to participate by recording their catches and releases. The project encourages the insertion of citizens as collaborators, and the data generated contribute to assess the status of stocks and propose management measures (Mota, 2019).

In the municipality of Feijó (Acre), 366 km from the capital, Rio Branco, fishermen began, in 2015, to use the cell phone application to monitor nine lakes in the municipality. The initiative is part of WWF's Sustainable Fishing project in partnership with the National Bank for Economic and Social Development (BNDES), and aims to contribute to the creation of a formal data collection system for pirarucu and fishing production in the region. WWF-Brazil's fisheries specialist, Antônio Oviedo, explains that applications are currently computerizing what was previously done only on paper (Fulgêncio, 2015).

According to WWF (2015), three apps have been developed that work in offline mode for fishermen to collect socioeconomic data of the local population, information on fishing production, illegal practices, and damage to the ecosystem. The first application is "Comunidade" (Community) and makes a socioeconomic mapping of everyone who lives from fishing in the locality. With the "Observatory" it is possible to collect data on illegal fishing practices, fish mortality, and damage to the ecosystem, among others. The last and most specific application is Pesca+ ("Fishing+"), which tracks fishing production, includes fishermen's personal data, number of lake users, types of boats, fishing gear used, and size and weight of fish caught. All this information is sent to a database and once a month there is a meeting at the headquarters of the Feijó Fishermen and Aquaculture Colony to analyze the records made. Through the monitoring, it was possible to establish capture quotas, fishing gear and periods allowed for the activity, and the number of vessels authorized to be fishing simultaneously in the lakes, ensuring the sustainability of the pirarucu and other species.

For Doria et al. (2019b), the use of applications for data collection has proven to be a useful tool capable of generating information on small-scale fisheries, also allowing greater participation of fishermen in networking and the search for alternatives for fisheries management. In this context, the use of technology brings innovative conservation methods and streamlines the monitoring process (WWF, 2015).

Fair trade as an opportunity for artisanal fishermen

Initiated during the 1960s in some European countries through the action of organizations, fair trade has the objective of helping to reduce the difficulties encountered by producers and to overcome commercial inequalities, creating a fairer and more equitable commercial model. By generating opportunities for market access, the organizations started to debate and organize commercial alternatives for small producers (Hillesheim, 2012).

Martinsí et al. (2013) dissertate that fair trade is a mode of international trade and social movement that results in fairer systems and remuneration by establishing fair prices and less social disparity in production chains and entails better conditions for small workers in developing countries. The program empowers farmers, fishers, and workers to fight poverty in ways that improve lives and protect the environment. Instead of creating dependency on aid, it harnesses the power of markets to help producers, businesses, and consumers invest in a better world (FTUSA, 2017).

The initial milestone of Fair Trade in Brazil was an experimental project of the Fairtrade Labelling Organization (FLO) with the experience of Fair Juice, involving orange producers from Paranavaí/PR (Martins and Unterstell, 2009). The project, which consists in making possible the commercialization of orange juice to Germany, Austria, and Switzerland, has the partnership of the municipal government and is monitored by a consulting company that makes the link between producers and the consumer market. Besides providing a quality product, the Fair Juice has enabled social improvements and regularization of the producers' work, which is one of the requirements to obtain the seal granted by FLO. Coffee is also highlighted in Brazil, with Associations in Rondônia and Espírito Santo already in the market through FLO (Schweickert, 2004).

Costa (2017) reports that despite being little known in Brazil, Fairtrade certification works as a differential to increase competitiveness and guide consumers' choices. The research complements that in the country there are 75 certified organizations, all associations and cooperatives of products that sell with the Fairtrade seal from fresh fruits to coffee. Nevertheless, there are still no fisheries in Brazil with Fairtrade certification. Fair trade is recognized in Brazil by the National System of Fair and Supportive Trade (SNCJS), through Decree No. 7.358, of November 17, 2010 (Brazil, 2010). The SNCJS is a document that mixes mechanisms of regulation and promotion; however, it is intended to be consolidated as public policy through a law that institutionalizes it (Farias *et al.,* 2016).

According to Oliveira et al. (2014), when a consumer purchases a product resulting from fair trade, he is contributing to the provision of some benefits that ensure better living conditions in communities and that the product is not derived from unfair labor. Toledo (2018) adds that fair trade emerges as a way to "reward" small producers who adopt sustainable practices, taking into account social, economic, and environmental issues, known as the sustainability tripod. Thus, by generating opportunities for small producers who are disadvantaged by the conventional trading system, fair trade reduces the

S&G Journal
Volume 16, Number 3, 2021, pp. 229-241
DOI: 10.20985/1980-5160.2021.v16n3.1650

inequalities that characterize the global market (Stelzer and Silva, 2019).

The Fair Trade model requires that certified fisheries make a contribution from the sale of their products to a Community Development Fund, which goes back to the fishermen to be managed collectively. According to FTUSA (2020), the Fairtrade Premium cannot be used for running costs, such as paying for electricity, paying salaries, or paying for certification. It should be used to improve the quality of life of the fisherman and the whole community through social, economic, and environmental projects.

Schweickert (2004) argues that for a fair and ethical trade, the collective construction of a system is necessary, with a transparent regulation that includes the excluded, adequate public policies, independent certifications, planning that aims at commercial relations, environmental preservation, and social capital, thus contributing to sustainable development through better conditions for the workers.

Fair Trade Certified USA (FTUSA) is a non-profit organization that provides industry and consumers with fish and seafood caught in natural environments, considering social, economic, and environmental criteria. The Fisheries Program was launched in 2014, primarily for small-scale fisheries in developing countries, with the development of the Capture Fisheries Standard (CFS) based on the organization's core principles: (*i*) Empowerment: CFS helps fishers develop the skills needed to effectively trade their product; (*ii*) Economic Development: It aims at improving the stability of fishermen's income, ensuring a transparent business relationship with their buyers and requiring the payment of a Fair Trade Premium on all sales of Fair Trade Certified™ products; (*iii*) Social responsibility: protecting the human rights of those involved in fishing. Health and safety measures are established to prevent work-related injuries; (*iv*) Environmental management: registered fishermen shall adopt responsible fishing practices and work to protect fish resources and biodiversity, including data collection and monitoring to provide better information on fish stocks (FTUSA, 2017).

According to FTUSA (2018), the CFS is organized into six pillars (**Figure 1**) that address different aspects of fisheries management, processing and facilities, and group administration. The certification covers small- and medium-scale fleets, landing sites, and processing plants prior to export, involving fishermen, processors, buyers, and consumers. Compliance with the standards is verified annually during on-site audits, and certification is also subject to product traceability, from catch to final consumer (FTUSA, 2020).

As per FTUSA (2020), the first certified fishery in 2014 was Yellowfin Tuna in Indonesia. In 2016, the Mexican Pacific Shrimp supply chain in Sinaloa was certified, and then the program expanded to include Yellowfin Tuna from the Maldives. The following year, in 2017, Skipjack Tuna in the Maldives, Atlantic Sea Scallop in the US, and Alaskan Salmon were also certified. Other fisheries such as Yellowfin Tuna and Skipjack Tuna (Solomon Islands), Yellowfin Tuna, Bigeye Tuna, Mahi Mahi and Swordfish (Mozambique), Chilean Balone (Chile), American Lobster (USA), Ocean Whitefish, Barred Sand Bass, and Vermillion Rock Fish (Mexico) were certified in the years 2018, 2019, and 2020. Currently, there are 11 Fair Trade USA certified catch systems and 1 aquaculture system (**Figure 2**).

FTUSA (2018) listed some benefits gained against four pillars of fair trade with certified fisheries in the period from 2014 to 2018:

- **Empowerment**: fishermen have been organized in more than 40 Fair Trade cooperatives or associations (in all certified fisheries). This organization improves the negotiating power between fishermen and traders or middlemen, and defends their rights. The creation of Fair Trade Committees, a requirement of certification, allowed for greater consensus on decisions such as the use of the Fair Trade Premium and helped in problem solving. Directly, a total of 2,354 fishermen and 1,179 processing workers in eight supply chains have benefited.

- **Economic Development: Fishing Communities**. The Fair Trade Premium received by certified producers during the period from 2014 to 2018 totals $1.25 million. The Award has been used in the communities for safety training at sea, education (teacher qualification and better facilities), investments in post-harvest projects, landing site improvements, waste management, and long-term investments such as savings accounts for children and health insurance. Other economic benefits have a wider aid to the community, such as expanded local processing in the Maldives (skipjack tuna), and improved quality of life and income for individuals (Maldivian yellowfin tuna, Maldivian skipjack tuna, Mexican Pacific shrimp, and Alaskan salmon).

- **Economic Development: Supply Chain**. Certification has also improved market access and increased demand through the supply chain, as markets recognize the benefit of the Fair Trade label.

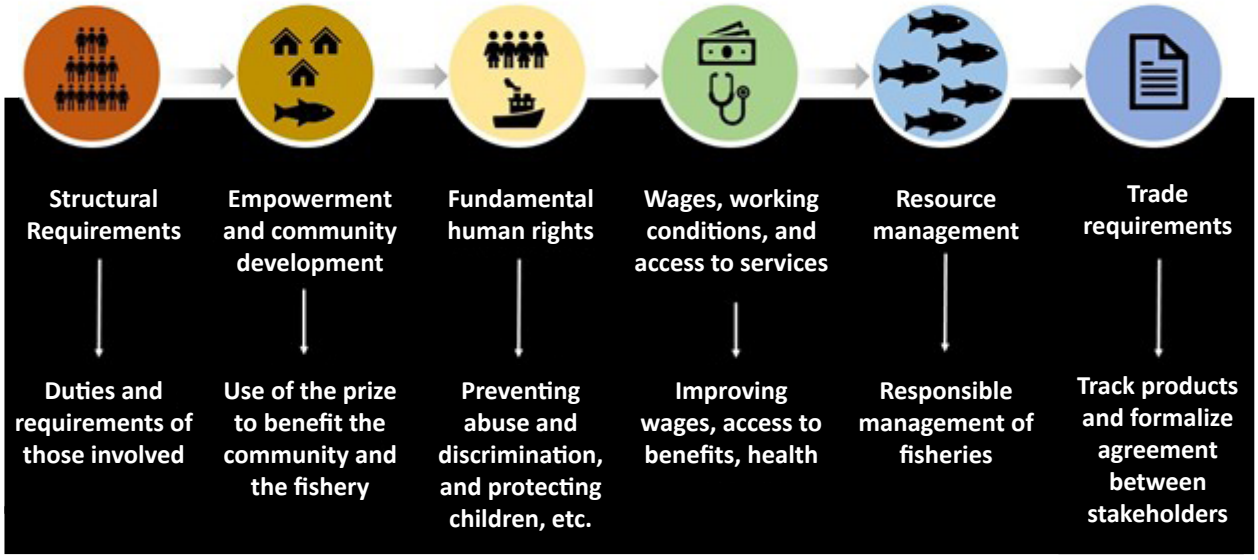

Figure 1. Capture Fisheries Standard for a Fair Trade USA certification
Source: Elaborated from FTUSA (2020)

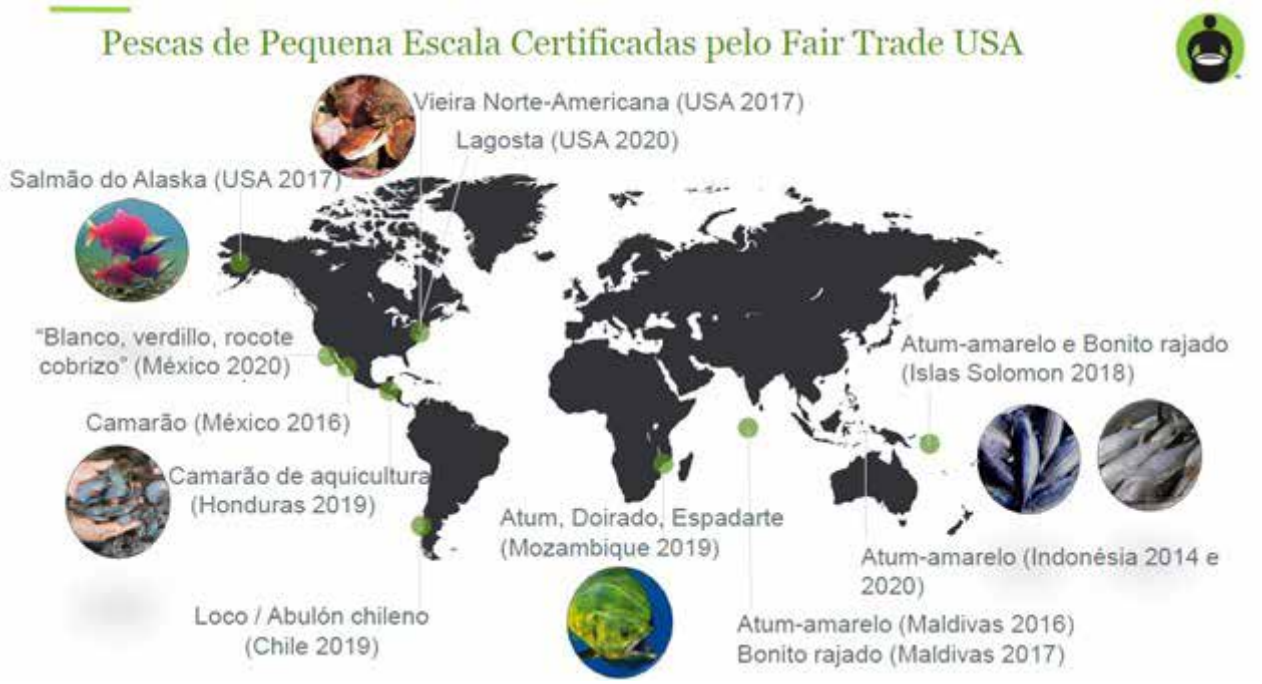

Figure 2. Fair Trade USA certified fisheries
Source: FTUSA, 2020

S&G Journal
Volume 16, Number 3, 2021, pp. 229-241
DOI: 10.20985/1980-5160.2021.v16n3.1650

- **Social Responsibility:** Fair Trade certification immediately affects the lives of the workers who participate in the program, whether at sea or in onshore processing. Audits of the fisheries show that there is no forced labor or labor abuse, providing assurance to the socially responsible supply chain. When non-conformities are identified, corrective actions are taken to improve the social and working conditions of fishermen and workers. The audits also ensure that labor, health, and safety issues that are not being met according to the norm are corrected. For example, in Indonesia, all registered fishermen received life jackets as part of the program, and a percentage received training in safety at sea.

- **Environmental Management:** In all certified fisheries, according to the Capture Fisheries Standard (CFS), 30% of the Premium must be used in environmental projects. They include monitoring, control and surveillance, improved data collection, and environmental education. In the Maldives, for example, fair trade companies supported the waste management project on the islands. The environmental requirements have also led to improvements in fishery management, increased numbers of fishermen are using logbooks, boats are equipped with VMS systems, and there has been a reduction in waste.

4. CONCLUSION

Due to the great economic and social importance of artisanal fishing in Ceará, and considering that many stocks are overfished, there is an urgent need to seek innovations and implement sustainable strategies that will boost the development of the entire sector.

The absence of a continuous program of fisheries statistics in Brazil leads to a lack of information, thus hindering the advancement of research and proposals for the formulation of public policies. The former Ministry of Fisheries and Aquaculture (MPA) published statistical data until 2011, and currently there are few initiatives that are punctual and do not become effective policies.

Shared management between government and users, through the organization of fishing communities for co-management, encourages responsible fishing and results in improvements in management through local knowledge. On the other hand, the implementation of a fisheries monitoring plan with the use of applications, an innovative and low cost technology, generates data that can be used as support for decision making, and can fill the information gaps. These two innovations, added to the development of fair trade, which creates market opportunities considering social, economic, and environmental issues, bringing a fair remuneration to the fishermen, show themselves as effective instruments that can be applied in the communities of Ceará State to improve the quality of life of the artisanal fishermen.

REFERENCES

Almeida, O., Lorenzen, K., McGrath, D. (2006). "Pescadores rurais de pequena escala e o co-manejo no Baixo Amazonas", in Almeida, O.T. (org.). *Manejo de pesca na Amazônia brasileira,* Peirópolis, São Paulo, pp. 51-72.

Brasil (2009). "Lei n° 11.959, de 29 de junho de 2009. Dispõe sobre a Política Nacional de Desenvolvimento Sustentável da Aquicultura e da Pesca, regula as atividades pesqueiras, revoga a Lei n° 7.679, de 23 de novembro de 1988, e dispositivos do Decreto-Lei n° 221, de 28 de fevereiro de 1967, e dá outras providências", publicada no *Diário Oficial da União* de 30 de junho de 2009, Seção 1, pp. 1-3.

Brasil (2010). "Decreto n° 7.358, de 17 de novembro de 2010. Institui o Sistema Nacional de Comércio Justo e Solidário – SCJS, cria sua Comissão Gestora Nacional e dá outras providências" publicado no *Diário Oficial da União* de 18 de novembro de 2010, Seção 1, pp. 2.

Castello, L. (2008). "Re-pensando o estudo e o manejo da pesca no Brasil", *Pan-American Journal of Aquatic Sciences* 3, 1, pp. 17-22.

Ciencia Ciudadana para la Amazonia. (2018). Manual ICTIO- La aplicación para registrar observaciones de peces em la cuenta amazónica, versión 2.0, 23 p.https://www.amazoniacienciaciudadana.org/espa%C3%B1ol/recursos--beta/descargas/

Ciencia Ciudadana para la Amazonia. (2019). Registrando observaciones de peces em la Amazonía. https://www.amazoniacienciaciudadana.org/espa%C3%B1ol/soluciones/ictio/

Costa, D. (2017). "Saiba quais produtores brasileiros têm selo que atesta inexistência de trabalho escravo", 27 de out. https://oglobo.globo.com/economia/saiba-quais--produtores-brasileiros-tem-selo-que-atesta-inexistencia-de-trabalho-escravo-22000696

Doria, C.R.C., Wanderley, T.V., Pinto, D.M., Souza, S.T.B. de, Sant'anna, I.R.A. (2019a), "Análise do uso do aplicativo de celular como uma ferramenta para resolver as la-

cunas de dados na pesca de pequena escala na Bacia do Madeira (RO)", in Meneguetti, N.F.S.P; Souza, M.P. (Org.), *Gestão, Inovação e Sustentabilidade em Organizações na Amazônia,* 1ed, Stricto Sensu Editora, Rio Branco, Acre, pp. 224-243.

Doria, C.R.C., Sant'anna, I.R.A., Wanderley, T.V., Pinto, D.M, Fonseca. K.A., Catâneo, D.T.B.S. (2019b). Encontro dos Pescadores do Madeira, Projeto Ciência Cidadã para Amazônia, Ecoporé/LIP/UNIR, Porto Velho, pp. 35. http://ecopore.org.br/wp-content/uploads/2019/07/RELATO-Encontro-pescadores-2019-final.pdf

Fair Trade Certified USA (FTUSA). (2017). Capture Fisheries Standard, version 1.1.0, 106 p. https://www.Fairtradecertified.org/sites/default/files/filemanager/documents/CFS/FTUSA_STD_CFS_EN_1.1.0.pdf.

Fair Trade Certified USA (FTUSA). (2018). Learnings and Best Practice of the Fair Trade Seafood Program- Impact of the Fair Trade Seafood Program (2014-2018), 8 p. https://www.Fairtradecertified.org/sites/default/files/filemanager/documents/Seafood/SEA_SeafoodProgram_5YearsofImpact_181228.pdf

Fair Trade Certified USA (FTUSA). (2020). Folheto informativo, 39 p.

Farias, B.A., Martins, C.M., Souza, P.S. (2016). "*Certificação Fair Trade e Desenvolvimento Sustentável: Estudo sobre a Cooperativa Agroextrativista Veneza do Marajó (COPAVEM)",* VII CODS- A Gestão das Organizações em Tempos de Transição, Belém, pp. 19-20 de out.

Fonseca, E.M. (2019). "Diagnosis of artisanal fishing in the area of influence of Porto do Mucuripe, Fortaleza (CE): support to regional fisheries management", Sistemas & Gestão 14, No. 3, pp. 279-290. http://www.revistasg.uff.br/index.php/sg/article/view/1586

Food and Agriculture Organization of the United Nations (FAO). (2017). "Diretrizes Voluntárias para Garantir a Pesca de Pequena Escala Sustentável no Contexto da Segurança Alimentar e da Erradicação da Pobreza", Roma. http://www.fao.org/3/i4356pt/I4356PT.pdf

Food and Agriculture Organization of the United Nations (FAO). (2018). "El estado mundial de la pesca y la acuicultura 2018- Cumplir los objetivos de desarrollo sostenible", Roma. http://www.fao.org/3/I9540ES/i9540es.pdf

Fujii, H., Sakakura Y., Hagiwara, A., Bostock J., Soyano K., Matsushita Y. (2017). "Research and development strategy for fishery technology innovation for sustainable fishery resource management in north-east Asia", *Sustainability (Switzerland)* 10, 1, pp. 59, disponível em: https://www.mdpi.com/2071-1050/10/1/59

Fulgêncio, C. (2015). Pescadores monitoram lagos com aplicativos de celular no interior do AC. http://g1.globo.com/ac/acre/noticia/2015/06/pescadores-monitoram-lagos-com-aplicativos-de-celular-no-interior-do-ac.html

Governo do Estado do Ceará. (2019). Ceará continua líder na exportação de pescado, https://www.ceara.gov.br/2019/12/04/ceara-continua-lider-na-exportacao-de-pescado/

Gutiérrez, N.L., Hilborn, R., Defeo, O. (2011). "Leadership, social capital and incentives promote successful fisheries", *Nature* 470, pp. 55. http://www.monitoringmatters.org/articles/Gutierrez.pdf

Hai, V.D. (2018), "*Fisheries Planning and Management in Vietnam: an explanation of ineffectiveness"*, Dissertation of Doctor of Philosophy in Fisheries Management, Aalborg Universitet, Denmark, Copenhagen. https://vbn.aau.dk/ws/portalfiles/portal/281675101/PHD_Vu_Duyen_Hai_E_pdf.pdf

Hillesheim, M. (2012). "P5 - Documento sistematizado contendo informações sobre certificação orgânica e comércio justo. Como obter o serviço de inspeção federal e do código de barras", *Loja da Sustentabilidade,* Brasília, DF, 30 p. https://www.bb.com.br/docs/pub/inst/dwn/_Fairtrade_.pdf

InfoAmazonia. (2019). "Brasil não sabe quanto está pescando na Amazônia", 8 ago, https://infoamazonia.org/pt/2019/08/portugues-brasil-nao-sabe-quanto-esta-pescando-na-amazonia/#!/story=post-20046

InfoAmazonia. (2018). Cientistas se unem a comunidade em rede de pesquisa colaborativa, 7 mai. https://infoamazonia.org/pt/2018/05/portugues-cientistas-se-unem-a-comunidades-em-rede-de-pesquisa-colaborativa/#!/story=post-18004

Instituto de Desenvolvimento Sustentável (MAMIRAUÁ). (2018). Aplicativo "Ictio" permite registrar e compartilhar informações sobre peixes migratórios na Amazônia. https://www.mamiraua.org.br/noticias/aplicativo-ictio-permite-registrar-e-compartilhar-informacoes-sobre-peixes-migratorios-na-amazonia

Instituto de Desenvolvimento Sustentável (MAMIRAUÁ). (2019). Um encontro de cientistas cidadãos. https://www.mamiraua.org.br/noticias/encontro-ciencia-cidada-2019

Kalikoski, D.C., Seixas, C.S., Almudi, T. (2009). "Gestão compartilhada e comunitária da pesca no Brasil: avanços e desafios", *Ambiente e Sociedade* 12, pp. 151-172.

S&G Journal
Volume 16, Number 3, 2021, pp. 229-241
DOI: 10.20985/1980-5160.2021.v16n3.1650

Kalikoski, D.C., Vasconcellos, M., Lavkulich, M.L. (2002). "Fitting institutions and ecosystems: the case of artisanal fisheries management in the Patos lagoon", *Marine Policy*, 26, 03, pp. 179-196.

Martins, R.D.A., Unterstell, N. (2009). "Comércio justo, saberes locais e articulação de atores: lições do projeto arte Baniwa no Brasil", *Administração Pública & Governança Social* 1, 4, pp. 44-64.

Martinsí, D.S., Fontes, J.R.M., Fornazier, M.J. (2013). "Produção certificada: cultivo do mamoeiro", *Informe Agropecuário*, Belo Horizonte, 34, 275, pp. 89-95.

Menezes, E.C. de O., Sperb, M.P., Tonet, R.S. (2011). "Elementos de la economía social en las comunidades de pescadores litoraleños (caiçaras): estudio de los municipios del Delta del Río Itajaí, SC, Brasil, trabalho apresentado no Congresso de Economía Social, 3, Valladolid, Espanha, Abril 2011.

Ministério da Pesca e Aquicultura (MPA). (2012). "Boletim estatístico de pesca e aquicultura –Brasil 2010", Brasília: MPA, 128pp.

Ministério da Pesca e Aquicultura (MPA). (2013a). "Boletim estatístico de pesca e aquicultura – Brasil 2011", Brasília: MPA, 60pp.

Ministério da Pesca e Aquicultura (MPA). (2013b). "Boletim do registro geral da atividade pesqueira –RGP 2012". Brasília: MPA, 50pp.

Mota, A. (2019). Aplicativos para registro e monitoramento de peixes é lançado, 16 ago. 2019. https://www.fishtv.com/noticias/geral/aplicativo-para-registro-e-monitoramento-de-peixes-e-lancado

Moura, R.L. de, Minte-Vera, C.V., Curado, I.B., Francini-Filho, R.B, Rodrigues, H. de C.L., Dutra, G.F., Alves, D.C., Souto, F.J.B. (2019). "Challenges and Prospects of Fisheries Co-Management under a Marine Extractive Reserve Framework in Northeastern Brazil", *Coastal Management* 37, 6, pp. 617-632.

Organização para Cooperação e Desenvolvimento Econômico (OECD). (2005). *Manual de Oslo-Proposta de Diretrizes para Coleta e Interpretação de Dado sobre Inovação Tecnológica*, Paris, 136 p.

Oliveira, E.C., Verdu, F.C., Reinerte, M. (2014). "Sustentabilidade por meio do comércio justo: o caso de uma cooperativa que produz artesanato em seda", *Organizações e Sustentabilidade*, Londrina 2, 2, jul./dez, pp. 114-149.

Organização das Nações Unidas. (ONU). Objetivo de Desenvolvimento Sustentável (ODS) 14 - Conservação e Uso Sustentável dos oceanos, dos mares e dos recursos marinhos para o desenvolvimento sustentável https://nacoesunidas.org/pos2015/ods14/

Oviedo, A.F.P., Bursztyn, M. (2017). "Decentralization and Fisheries Management in The Brazilian Amazon: Resource Rights and Accountability, Ambient. Soc. 20, 4, São Paulo, Oct./Dec., pp. 169-190.https://www.scielo.br/scielo.php?pid=S1414-753X2017000400169&script=sci_abstract&tlng=pt

Pontecorvo, G. (2008). "A note on ''overfishing'", *Marine Policy* 32, 6, pp. 1050-1052.

Santos, J.N.A., Bastos, A.P.V. (2009). "Inovação e mudanças na realidade amazônica: o caso da pesca no município paraense de Vigia de Nazaré", Novos Cadernos NAE 10, 2, disponível em: http://repositorio.ufpa.br/jspui/bitstream/2011/3232/1/Artigo_InovacaoMudancasRealidade.pdf

Sociedade para a Pesquisa e Proteção do Meio Ambiente (SAPOPEMA) (2019a),"Plano de desenvolvimento sustentável da pesca e piscicultura do Baixo Amazonas", Santarém, PA, 53 p. https://static1.squarespace.com/static/56e99f6f04426272fccd78c7/t/5d680f69cdd

58a00011dc6a7/1567100798465/Plano+de+Desenvolvimento+Sustent%C3%A1vel+da+Pesca+e+Psicultura+do+Baixo+Amazonas.pdf

Sociedade para a Pesquisa e Proteção do Meio Ambiente (SAPOPEMA). (2019b). "Uso do aplicativo para monitoramento da pesca na Bacia do Rio Madeira, 1 fev. 2019. http://www.sapopema.org/noticias/2019/2/2/uso-do-aplicativo-para-monitoramento-da-pesca-na-bacia-do-rio-madeira

Schweickert, V. (2004). O comércio justo como alternativa para melhorar as relações comerciais e como meio de desenvolvimento sustentável e solidário, Monografia do Departamento de Ciências Econômicas, Florianópolis, SC.

Sen, S., Nielsen, J.R. (1996). "Fisheries co-management: a comparative analysis", *Marine Policy* 20, 5, pp. 405-418.

Silva, A.P. (2014). Pesca artesanal Brasileira, Aspectos conceituais, históricos, institucionais e prospectivos, Embrapa Pesca e Aquicultura, Palmas.

Stelzer, J.; Silva, L.M. (2019). O comércio justo como garantia de sobrevivência econômica dos pequenos produtores no mercado global", *Destaques Acadêmicos*, Lajeado 11, 2, pp. 137-154.

Toledo, V.G. (2018). Ganhos percebidos pelos pequenos produtores rurais da cooperativa COACIPAR a partir da

certificação Fairtrade, Dissertação de Mestrado Profissional em Governança e Sustentabilidade, ISAE-Instituto Superior de Administração e Economia, Curitiba, PR.

Vasconcellos, M., Diegues A.C.S.A., Sales, R. R. (2007). Limites e possibilidades na gestão da pesca artesanal costeira, in Costa, A.L. (Org.). *Nas Redes da Pesca Artesanal*, Brasília, IBAMA - MMA, pp. 15-83.

Vieira, M.A.R.M., Santos, C.R., Seixas, C.S. (2015). "Oportunidades na legislação brasileira para sistemas de gestão compartilhada da pesca costeira", Boletim do Instituto de Pesca 41, 4, pp. 995-1012.

WWF – Brasil. (2015). Pescadores usam smartphones para monitorar lagos do Acre. https://www.wwf.org.br/?46442/Pescadores-usam-smartphones-para-monitorar-lagos-do-Acre

Received: June 12, 2021

Approved: October 28, 2021

DOI: 10.20985/1980-5160.2021.v16n3.1650

How to cite: Vidigal, R.C.A.B., Eloy, H.R.F., Catter, K.M., Souza, R.L.M., Lisboa, V., Matias, J.F.N., Cruz, A.M. (2021). Innovations for artisanal fishing: support for the development of the activity in the state of Ceará. Revista S&G 16, 3. https://revistasg.emnuvens.com.br/sg/article/view/1650