PROMOTING POLICIES IN RESEARCH, DEVELOPMENT AND INNOVATION FOR FISHERIES AND AQUACULTURE IN BRAZIL

Felipe Morais Santos

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ABSTRACT

Brazilian Federal Government has been seeking to organize, promote and develop fisheries and aquaculture activities through a sustainable way in order to provide income, job creation, social inclusion and economic growth. The establishment of this model of sustainable development will be feasible from an intense appreciation and encouragement of research and innovation environment in teaching and research institutions, as well as the productive sector.

Considering the importance of consolidating a research, development and innovation structure to allow support such sustainable development of the fisheries and aquaculture sectors, the present work aims to create subsidies for the elaboration of a sound and effective policy as well as to recommend ways of enhancing the Brazilian governance in this specific area. In order to meet this objective have been taken into account the National Strategy for Science, Technology and Innovation (2016-2022), the United Nations Convention on the Law of the Sea and the Sustainable Development Goals of the Agenda 2030 as well as other legal instruments at international level and the national policies directly related to the proposed theme.

The scientific knowledge of the oceans, coastal areas, and inland waters is a prerequisite for the proper management, protection and sustainable use of its resources, in addition to serving in aid in the decision-making process of topics related to fisheries and aquaculture, among others. Integrated to this, the Ministry of Science, Technology, Innovation and Communications plans to establish the National Institute for Oceanic Research and Waterways, which will have the challenging task of increasing the production of scientific and technological knowledge acquired over the oceans, including fisheries and aquaculture, among others judged essential for the country to advance in the national economic development.

Despite the progress made in promoting and implementing research, development and innovation activities related to fisheries and aquaculture, there are still significant challenges to be overcome. In this way, some actions were proposed to achieve this purpose, such as training and capacity building of human resources; transfer of marine technology; definition of the research lines focus; cooperation and integration among the governmental, academic and productive sectors, as well as the creation of research networks and; international cooperation, in order to carry out exchange activities and training of human resources, development of research and transfer of marine technology.

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LIST OF ACRONYMS

ABC - Brazilian Cooperation Agency

ANA - National Water Agency

AQUIPESCA - Aquaculture and Fisheries Action

BNDO - National Oceanographic Data Bank

CAPES - Coordination for the Improvement of Higher Education Personnel

CBD - Convention on Biological Diversity

CBPA - Brazilian Consortium for Research, Development and Transfer of Technology in Fisheries and Aquaculture

CCAMLR - Commission for the Conservation of Antarctic Marine Living Resources

CGEE - Center for Strategic Studies and Management in Science, Technology and Innovation

CGTMT - Criteria and Guidelines on the Transfer of Marine Technology

CIRM - Inter-Ministerial Commission for Marine Resources

CNPASA - National Research Center for Fisheries and Aquaculture

CNPq - National Council for Scientific and Technological Development

COFI - Committee on Fisheries

CONAMA - National Environmental Council

CONAPE - National Aquaculture and Fisheries Council

COPESCAALC - Commission for Inland Fisheries and Aquaculture of Latin America and the Caribbean

CPG - Permanent Committee of Management and Sustainable Use of Fisheries Resources

CTGP - Technical Committee on Shared Management of Fisheries Resources

CTPA - Interministerial Technical Commission on Science, Technology and Innovation for Fisheries and Aquaculture

DGP - Directory of Research Groups

DOALOS - Division for Ocean Affairs and Law of the Sea

EstatPESCA - Statistical Monitoring Program

EEZ - Exclusive Economic Zone

EMBRAPA - Brazilian Company of Agricultural Research

ENCTI - National Strategy for Science, Technology and Innovation

FAO - Food and Agriculture Organization

FINEP - Studies and Projects Financier

FNDCT - National Fund for Scientific and Technological Development

IBAMA - Brazilian Institute for the Environment and Renewable Natural Resources

IBGE - Brazilian Institute of Geography and Statistics

ICCAT - International Commission for the Conservation of Atlantic Tunas

INCT - National Institutes of Science and Technology

INPI - National Institute of Industrial Property

INPOH - National Institute for Oceanic Research and Waterways

IOC - Intergovernmental Oceanographic Commission

MAPA - Ministry of Agriculture, Livestock and Food Supply

MCTIC - Ministry of Science, Technology, Innovation and Communications

MDIC - Ministry of Industry, Foreign Trade and Services

MEC - Ministry of Education

MMA - Ministry of Environment

MPA - Ministry of Fisheries and Aquaculture

MPDG - Ministry of Planning, Development and Management

MRE - Ministry of Foreign Affairs

NGO - Non-Governmental Organization

OEI - Organization of Ibero-American States for Education, Culture, Science and Technology

PETROBRAS - Brazilian Petroleum S.A.

PMN - National Maritime Policy

PNDSAP - National Policy for the Sustainable Development of Aquaculture and Fisheries

PNMA - National Policy of Environment

PNRM - National Policy for Marine Resources

PPG-Mar - Human Resources Capacitation in Marine Sciences

PREPS - National Program for the Tracking of Fishing Vessels by Satellite

PSRM - Sectorial Plan for the Sea Resources

PROANTAR - Brazilian Antarctic Program

PROBORDO - National Fishing Fleet Observer Program

PROFROTA - National Program for Financing the Expansion and Modernization of the National Fishing Fleet

RD&I - Research, Development and Innovation

REVIMAR - Evaluation, Monitoring and Conservation of Marine Biodiversity Action

RFMO - Regional Fisheries Management Organization

RGP - General Record of the Fishing Activity

SAP - Secretariat of Aquaculture and Fisheries

SBPC - Brazilian Society for the Advancement of Science

SDG - Sustainable Development Goal

SEAP - Special Secretariat of Aquaculture and Fisheries

SecCTM - Secretariat of Science, Technology and Innovation of Brazilian Navy

SEP - Special Secretariat of Ports

SEPED - Secretariat of Policies and Programs for Research and Development

SINPESQ - National Fisheries and Aquaculture Information System

ST&I - Science, Technology and Innovation

SUDEPE - Superintendence of Fisheries Development

TPP - Public Fishing Terminals

UNCLOS - United Nations Convention on the Law of the Sea

UNESCO - United Nations Educational, Scientific, and Cultural Organization

UNGA - United Nations General Assembly

WECAFC - Western Central Atlantic Fishery Commission

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INTRODUCTION

1. Background

Food production in the context of sustainable development will be one of the greatest challenges for humanity in the coming years. In this sense, assuring food security in terms of economically efficient food production and distribution, while avoiding unsustainable environmental impacts, make it urgent to develop integrated policies that ensure environmental conservation (BARROSO *et al.*, 2007).

For fisheries and aquaculture, sustainable development must consider, among other factors, the exploitation of fisheries resources together with environmental conservation, the maintenance of stocks, fisheries management, sustainable management of aquaculture, proper disposal of processing waste, the use of best practice management and appreciation of fishermen and aquaculture producers, as well as the need to develop research, innovation and new technologies that support those factors (VALENTI, 2002).

Internationally agreed goals and targets are increasingly accepted as having a significant political and instrumental value, insofar as they provide a globally shared normative framework that complements international conventions and other tools of international law by catalyzing action, mobilizing stakeholders and fostering collaboration between the members of the international community (SDSN, 2015). Seventeen Sustainable Development Goals (SDGs) and 169 targets were integrated into the 2030 Sustainable Development Agenda (Agenda 2030), intended as a driver for realizing and mainstreaming sustainability throughout the United Nation system as a whole.

The SDGs "aim to cover the whole sustainable development universe, which includes basically all areas of the human enterprise on Earth" (LE BLANC, 2015). This is particularly evident in the fact that environmental sustainability, rather than being relegated into one goal, now spans across several SDGs that are explicitly targeting major global environmental issues, including SDG 6 - clean water and sanitation, SDG 13 - climate action, SDG 14 - life below water, and SDG 15 - life on land (NTONA & MORGERA, 2017).

Taking into account the relevance of the SDGs for the sustainable development of ST&I in marine fisheries and aquaculture, it is worth to highlight the SDG 14 which aims to conserve

and sustainably use the oceans, seas and marine resources for sustainable development, considering the following targets[1]:

- 14.4. By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices and implement science-based management plans, in order to restore fish stocks in the shortest time feasible, at least to levels that can produce maximum sustainable yield as determined by their biological characteristics;
- 14.A. Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission (IOC) Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries.

In Brazil, the Ministry of Science, Technology, Innovation and Communications (MCTIC - *Ministério da Ciência, Tecnologia, Inovações e Comunicações*) is preparing to align its actions with the Agenda 2030 established by the United Nations; and this adaptation began with the Secretariat of Policies and Programs for Research and Development (SEPED - *Secretaria de Políticas e Programas de Pesquisa e Desenvolvimento*). The SEPED mission is to establish a relationship between internal and external actions of MCTIC with the SDGs. This work began with the elaboration of the National Strategy for Science, Technology and Innovation (ENCTI 2016-2022 - *Estratégia Nacional de Ciência, Tecnologia e Inovação*). The principal objective of this strategy is to promote science, technology and innovation for the economic, social and environmental development of Brazil. It therefore has a direct relationship with most of the principles of the Agenda 2030, which were proposed to guide national policies and cooperation activities, with the expectation that governments would establish national frameworks for the achievement of the seventeen Goals.

Facing this reality, the Brazilian Federal Government has begun to organize, promote and develop the fisheries and aquaculture activities in a sustainable way to provide income, job creation, social inclusion and economic growth. The Brazilian government understands that to establish this developmental model, strong support for and encouragement of research and

[1] SDG 14: sustainabledevelopment.un.org/sdg14

innovation is needed in educational and research institutions as well as within the productive sector (ROUTLEDGE *et al*., 2011).

Considering the importance of consolidating a research, development and innovation (RD&I) structure to support the sustainable development of fisheries and aquaculture in Brazil, the present work takes into account the SDG 14 as well as the ENCTI, which aims to guide actions that contribute to national development through initiatives that enhance the advancement of knowledge and innovation. ENCTI is the medium-term strategic orientation document for the implementation of public policies in the field of science, technology and innovation (ST&I) in Brazil, and also serves as a framework for the formulation of other policies of interest.

ENCTI articulates eleven Strategic Themes, and describes the main issues related to each of these themes, and how these issues should be treated in order to build integrative proposals that produce the desired results. For each of the eleven Strategic Themes, ENCTI defines strategies to prioritize the actions to be taken by the actors in the sector. As a strategy to strengthen the national ST&I planning system, specific plans of action were prepared for each of the themes, detailing the initiatives and resources that should be mobilized in each area.

Although there is a cross-cutting relationship with other Strategic Themes, such as "Food", "Biomes" and "Bio-economics", in the context of the present work, greater emphasis shall be given to the Strategic Theme "Water". This Strategic Theme aims to increase the RD&I national capacity on strategic issues related to water, including ocean science, to help Brazil face the great national challenges related to food security, fisheries and aquaculture, sustainable use of natural resources and development of innovative technologies, among others. Scientific knowledge of the oceans, coastal zones and inland waters is a prerequisite for adequate management, protection and sustainable use of its living and non-living resources, as well as assisting the decision-making process on issues related to fisheries and aquaculture.

Promoting the improvement of RD&I activities related to coastal and oceanic environments is an essential factor for the effective management of the Brazilian marine territorial space as well as for the advancement of the knowledge on these environments, which also means guaranteeing the availability of financial resources specifically geared towards supporting the increase and maintenance of research infrastructure, such as research vessels and internationally certified laboratories. In this sense, MCTIC plans to establish a National Institute for Oceanic Research and Waterways (INPOH - *Instituto Nacional de Pesquisas Oceânicas e Hidroviárias*) with the challenging task of increase the production of scientific and technological

knowledge from the oceans. MCTIC has already acquired the Hydro-oceanographic Research Vessel "*Vital de Oliveira*", one of the world's top five ocean research vessels, through a public-private partnership with the Ministry of Defense/Navy of Brazil, Petróleo Brasileiro S.A. (PETROBRAS) and Vale S.A.

Therefore, the present work should take into account the following associated strategies related to the Strategic Theme Water[2]:

- Preparation of an "Action Plan on ST&I for the Oceans" to promote RD&I in order to produce and apply scientific and technological knowledge to promote social, economic and environmental benefits by filling essential knowledge gaps, encouraging innovation and providing the necessary infrastructure for the advancement of ocean research;
- Promotion of RD&I in the areas of marine biotechnology, sustainable use of resources and potential exploitation of fisheries and aquaculture;
- Implementation of the INPOH, aimed at promoting scientific and technological development in the areas of its competence.

Besides that the present work will take into account international and national legal frameworks to serve as a guide in proposing measures to promote RD&I and the sustainable development of fisheries and aquaculture. In that sense, the legal frameworks listed and described below were selected due to their relevance and pertinence to the theme, highlighting the aspects related to RD&I, including transfer of technology, promotion of cooperation and development of capacity building.

2. International Legal Framework

a) 1982 United Nations Convention on the Law of the Sea[3]

The United Nations Convention on the Law of the Sea (UNCLOS) is the most comprehensive international legal system for the oceans and seas of the world, establishing rules governing much of the uses of the oceans as well as the exploration and exploitation of their

[2] ENCTI 2016-2022: portal.insa.gov.br/images/documentos-oficiais/ENCTI-MCTIC-2016-2022.pdf

[3] United Nations Division for Ocean Affairs and Law of the Sea. United Nations Convention on the Law of the Sea of 10 December 1982. Overview and full text. www.un.org/depts/los/convention_agreements/convention_overview_convention.htm.

living and non-living resources. In addition, it provides the framework for international cooperation on delimitation of ocean space, environmental control, marine scientific research, economic and commercial activities, transfer of technology, and the settlement of disputes relating to ocean matters.

For the purpose of the present work, it should be noted that in the Exclusive Economic Zone (EEZ) defined by UNCLOS, the coastal State has sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources, and jurisdiction with regard to marine scientific research. Beyond the EEZ, under the principle of freedom of the high seas, UNCLOS grants all nations *inter alia*: the freedom of fishing and the freedom of scientific research.

The conduct of marine scientific research is a right for all States and competent international organizations, which are called on to promote and facilitate the development of research activities in accordance with UNCLOS and with the principle of respect for sovereignty and jurisdiction, on the basis of mutual benefit, and for peaceful purposes. Besides that, States, directly or through competent international organizations, are called on to cooperate in accordance with their capabilities to promote actively the development and transfer of marine science and marine technology on fair and reasonable terms and conditions.

b) 1992 Convention on Biological Diversity[4]

The objectives of the Convention on Biological Diversity (CBD) are the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding.

The principle of CBD is that States have the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction. As far as possible and as appropriate, States are called on to cooperate directly or through competent international organizations in

[4] Convention on Biological Diversity. Text of the Convention. www.cbd.int/convention/text/

respect of areas beyond national jurisdiction and on other matters of mutual interest, for the conservation and sustainable use of biological diversity.

States shall establish and maintain programs for scientific and technical education and training in measures for the identification, conservation and sustainable use of biological diversity and its components, and provide support for such education and training for the specific needs of developing countries; promote and encourage research which contributes to the conservation and sustainable use of biological diversity; and promote and cooperate in the use of scientific advances in biological diversity research in developing methods for conservation and sustainable use of biological resources.

States undertakes to provide and/or facilitate access for and transfer of technologies that are relevant to the conservation and sustainable use of biological diversity or make use of genetic resources and do not cause significant damage to the environment. Besides that, Sates shall promote international technical and scientific cooperation in the field of conservation and sustainable use of biological diversity, where necessary, through the appropriate international and national institutions.

c) 1995 United Nations Fish Stocks Agreement[5]

The Agreement for the Implementation of the Provisions of the UNCLOS Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks sets out principles for the conservation and management of those fish stocks based on the precautionary approach and the best available scientific information, and elaborates on the fundamental principle, established in UNCLOS, that States should cooperate to ensure conservation and promote the objective of the optimum utilization of fisheries resources both within and beyond the EEZ.

States shall collect and exchange scientific, technical and statistical data with respect to those fish stocks; ensure that data are collected in sufficient detail to facilitate effective stock assessment; and take appropriate measures to verify the accuracy of such data. Consistent with

[5] United Nations Division for Ocean Affairs and Law of the Sea. The United Nations Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (in force as from 11 December 2001) Overview. www.un.org/depts/los/convention_agreements/convention_overview_fish_stocks.htm.

Part XIII of UNCLOS, States shall cooperate to strengthen scientific research capacity in the field of fisheries and promote scientific research related to the conservation and management of those fish stocks for the benefit of all. Further, States are called on to actively promote the publication and dissemination to any interested States of the results of that research and information relating to its objectives and methods and, to the extent practicable, shall facilitate the participation of scientists from those States in such research.

d) 1995 Code of Conduct for Responsible Fisheries[6]

The Food and Agriculture Organization (FAO) Code of Conduct for Responsible Fisheries is voluntary; however, certain parts of it are based on relevant rules of international law, including UNCLOS, and contain provisions that may be or have already been given binding effect by means of other obligatory legal instruments amongst the Parties, such as the 1993 Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas.

Global in scope, the Code of Conduct is directed toward members and non-members of FAO, fishing entities, sub regional, regional and global organizations, whether governmental or non-governmental, and all persons concerned with the conservation of fisheries resources and management and development of fisheries, such as fishermen, those engaged in processing and marketing of fish and fisheries products and other users of the aquatic environment in relation to fisheries. The Code provides principles and standards applicable to the conservation, management and development of all fisheries. It also covers the capture, processing and trade of fish and fisheries products, fishing operations, aquaculture, fisheries research and the integration of fisheries into coastal area management.

Among its objectives are to facilitate and promote technical, financial and other cooperation in conservation of fisheries resources and fisheries management and development, and promote research on fisheries and associated ecosystems and relevant environmental factors. In that sense, States should recognize that responsible fisheries require the availability of a sound scientific basis to assist fisheries managers and other interested parties in making decisions. Therefore, States should ensure that appropriate research is conducted into all aspects of fisheries

[6] Food and Agriculture Organization of the United Nations. Implementation of the 1995 FAO Code of Conduct for Responsible Fisheries. In: *FAO Fisheries and Aquaculture Department*. www.fao.org/fishery/code/en

including biology, ecology, technology, environmental science, economics, social science, aquaculture and nutritional science. States should ensure the availability of research facilities and provide appropriate training, staffing and institution building to conduct the research, taking into account the special needs of developing countries.

3. National Legal Framework

a) Law No. 6.938 of 31 August, 1981[7]

The National Policy of Environment (PNMA - *Política Nacional de Meio Ambiente*) aims to preserve, improve and restore the environmental quality of Brazil, in order to ensure conditions for socio-economic development, the interests of national security, and the protection of the dignity of human life, while promoting research and development of technologies for the rational use and protection of environmental resources.

PNMA aims, among others, to develop research activities and technologies aimed at the rational use of environmental resources and the diffusion of environmental management technologies. Under this policy, the governmental organizations, entities, and programs intended to promote scientific and technological research will consider, among their priority goals, the support of projects that aim to acquire and develop applicable basic knowledge in the environmental and ecological areas.

b) Decree No. 96.000 of 2 August, 1988[8]

Provides for the conduct of research and scientific research on the Continental Shelf and in waters under Brazilian jurisdiction, and on foreign research vessels and aircraft visiting Brazilian ports or airports during transit of Brazilian jurisdictional waters or in overlying airspace.

The activities covered by this decree, restricted to the Continental Shelf and to the waters under Brazilian jurisdiction, may not contradict the provisions of the National Maritime Policy (PMN - *Política Marítima Nacional*), the National Policy for Marine Resources (PNRM - *Política Nacional para os Recursos do Mar*) and the PNMA as in the Sectoral Plans arising

[7] www.planalto.gov.br/ccivil_03/leis/L6938.htm

[8] www.planalto.gov.br/ccivil_03/decreto/1980-1989/D96000.htm

from these policies. Research and scientific research on the continental shelf and waters under Brazilian jurisdiction may only be carried out for exclusively peaceful purposes, and in accordance with the provisions of Brazilian law, and in international acts to which Brazil is bound.

c) Decree No. 99.165 of 12 March, 1990[9]

Promulgates the UNCLOS in Brazil. Considering that Brazil has ratified the 1982 UNCLOS Convention, the decree posits that UNCLOS shall be executed and fulfilled in full under Brazilian law.

d) Law No. 8.617 of 4 January, 1993[10]

Provides for the Territorial Sea, the Contiguous Zone, the EEZ and the Continental Shelf in Brazilian waters. In the EEZ and the Continental Shelf, Brazil, in the exercise of its jurisdiction, has the exclusive right to regulate marine scientific research, the protection and preservation of the marine environment, as well as the construction, operation and use of all types of artificial islands, and structures. Marine scientific research in the EEZ and Continental Shelf may only be conducted by other States with the prior consent of the Brazilian government, in accordance with the legislation in force that regulates the matter.

e) Decree No. 1.265 of 11 October, 1994[11]

The purpose of the PMN is to guide the development of the country's maritime activities, in an integrated and harmonious manner, aiming at the effective, rational and full use of the seas and our inland waterways, in accordance with national interests. Its objectives include the research and development of national technology in the field of maritime activities and the research, exploration and rational exploitation of living and non-living resources in the water column, bed and subsoil of the seas and our rivers and navigable lakes.

PMN supports universities, research centers, associations, congresses and entities responsible for technical publications, which contribute to the development of national

[9] www.planalto.gov.br/ccivil_03/decreto/1990-1994/D99165impressao.htm

[10] www.planalto.gov.br/ccivil_03/leis/L8617.htm

[11] www.planalto.gov.br/ccivil_03/decreto/1990-1994/D1265.htm

technology in the field of maritime activities; encourages the establishment or development of research institutions in the field of maritime activities; and aims to maintain, in an integrated way, databases of monitoring the capture, production and marketing of fish and its derivatives.

f) Decree No. 2.519 of 16 March, 1998[12]

Promulgates the CBD. Considering that the CBD was signed by the Brazilian Government in Rio de Janeiro on 5 June, 1992 decrees the CBD, attached to a copy of this Decree, shall be executed in full under Brazilian law.

g) Decree 5.377 of 23 February, 2005[13]

The PNRM is intended to guide the development of activities aimed at the effective use, exploration and exploitation of the living, mineral and energy resources of the Territorial Sea, the EEZ and the Continental Shelf, in accordance with national interests, in a rational and sustainable development for the country's socioeconomic development, generating employment and income and contributing to social integration. PNRM establishes principles and objectives for the preparation of government plans, programs and actions in the field of human resources training activities; in the development of research, marine science and technology; and in the exploration and sustainable exploitation of the marine resources.

h) Law No. 11.959 of 29 June, 2009[14]

The National Policy for the Sustainable Development of Aquaculture and Fisheries (PNDSAP - *Política Nacional de Desenvolvimento Sustentável da Aquicultura e da Pesca*) was formulated, coordinated and implemented in order to promote sustainable development of fisheries and aquaculture, in harmony with the preservation and conservation of the environment and biodiversity; the planning, promotion and monitoring of fishing activities; the preservation, conservation and recovery of fisheries resources and aquatic ecosystems and; socioeconomic, cultural and professional development to people engaged in fisheries and aquacultures activities as well as their communities.

[12] www.planalto.gov.br/ccivil_03/decreto/d2519.htm

[13] www.planalto.gov.br/ccivil_03/_Ato2004-2006/2005/Decreto/D5377.htm

[14] www.planalto.gov.br/ccivil_03/_ato2007-2010/2009/lei/l11959.htm

According to PNDSAP, fisheries research will be conducted to obtain and provide, on a permanent basis, information and scientific data that allow the sustainable development of the fishing activity. Aquaculture activity is classified as scientific or demonstrative when practiced solely for the purpose of research, studies or demonstration by an entity legally qualified for these purposes.

i) Law No. 13.123 of 20 May, 2015[15]

The Law of Biodiversity regulates Article 1, Article 8 (line j), Article 10 (line c), Article 15 and Article 16 (lines 3 and 4) of CBD; provides for access to genetic heritage, protection of and access to associated traditional knowledge, and sharing of benefits for the conservation and sustainable use of biodiversity. This Law provides for goods, rights and obligations relating to, among others, access to technology and transfer of technology for the conservation and use of biological diversity.

OBJECTIVES

General Objective

Contribute to the creation of subsidies for the elaboration of a sound and effective policy as well as to recommend ways of enhancing the Brazilian governance in RD&I for the sustainable development of fisheries and aquaculture taking into account international and national legal frameworks, the SDG of the Agenda 2030 as well as the strategic themes of the ENCTI.

Specific Objectives

- Present a general overview of the legal and institutional framework in science, technology and innovation in Brazil with regard to the marine sciences, fisheries and aquaculture;
- Analyze the current state of fisheries and aquaculture in Brazil, with regard to its management, development, human resources and scientific research;

[15] www.planalto.gov.br/ccivil_03/_Ato2015-2018/2015/Lei/L13123.htm

- Elaborate guidelines for the promotion of RD&I in fisheries and aquaculture, with regard to the development of infrastructure, scientific agenda, human resources and cooperation.

PART ONE – THE STATE OF FISHERIES AND AQUACULTURE IN BRAZIL

CHAPTER 1 – MANAGEMENT AND DEVELOPMENT

Section A – Management of Fisheries and Aquaculture

Paragraph 1 – International Management

Adequate fisheries and aquaculture governance is necessary to guarantee the sustainability of these activities and overall ocean health (GELCICH *et al.*, 2010; JACKSON *et al.*, 2001; WORM *et al.*, 2006). The United Nations system plays an important role in the management of fisheries and aquaculture, through the implementation of international conventions, agreements and codes, while the Regional Fisheries Management Organizations (RFMOs) play a unique role in facilitating international cooperation for the conservation and management of fish stocks. In that sense, the roles of the main international bodies related to fisheries and aquaculture management to which Brazil is a member, will be identified and described below.

a) Food and Agriculture Organization[16]

FAO is a specialized agency of the United Nations that leads international efforts to defeat hunger. Its goal is to achieve food security for all and make sure that people have regular access to enough high-quality food to lead active, healthy lives. FAO assistance in Brazil[17] is centered on four priority areas: food security, including the right to adequate and healthy food for all people at all times; South-South cooperation, including the creation of a multifaceted cooperation platform addressing food security, agriculture, forestry and fisheries as well as family farming and adaptation to climate change; overcoming extreme poverty, with a focus on family farming and family aquaculture; sustainable management of natural resources, climate

[16] FAO: www.fao.org/home/en/

[17] www.fao.org/countryprofiles/index/en/?iso3=BRA

change and desertification, including the introduction of an agro-ecological production matrix for social and environmental sustainability.

Moreover, it's the global institution dealing with fisheries and aquaculture issues. As part of its mandate, it fosters global, regional and national sustainable development initiatives to secure responsible fisheries worldwide. FAO is the only intergovernmental organization formally mandated by its constitution to undertake the worldwide collection, compilation, analysis and diffusion of data and information in fisheries and aquaculture. Since its inception, the FAO Fisheries and Aquaculture Department has built up statistical databases that are publicly accessible.

The FAO Fisheries and Aquaculture Department[18] functions are to:

- make available technical information, guidelines and standards and provide technical advice and assistance to FAO members in enhancing fisheries and aquaculture development at the national, regional and global levels;
- facilitate the role of the FAO in providing a neutral forum for States and other stakeholders to discuss global fisheries and aquaculture issues, taking into consideration the views and interests of civil society organizations and the private sector;
- contribute to the implementation of relevant United Nations General Assembly (UNGA) resolutions and reporting obligations on oceans and the law of the sea, sustainable fisheries and any other special and periodic reports requested by UNGA; and
- provide assistance in the administration of global development assistance schemes, e.g. the Fish Stocks Agreement, and the Agreement on Port State Measures.

The FAO Committee on Fisheries (COFI) [19], a subsidiary body of the FAO Council, presently constitutes the only global inter-governmental forum where major international fisheries and aquaculture problems and issues are examined and recommendations addressed to governments, regional fishery bodies, non-governmental organizations, fish-workers, FAO, and the international community, periodically on a world-wide basis. COFI has also been used as a forum in which global agreements and non-binding instruments were negotiated. The COFI Sub-

[18] Food and Agriculture Organization of the United Nations. The FAO Fisheries and Aquaculture Department and the UN agenda. In: *FAO Fisheries and Aquaculture Department*. www.fao.org/fishery/topic/16001/en

[19] Food and Agriculture Organization of the United Nations. Fisheries and Aquaculture Department. Committee on Fisheries (COFI) - Fisheries and Aquaculture Department. In: *FAO Fisheries and Aquaculture Department*. www.fao.org/fishery/about/cofi/en

Committee on Fish Trade[20] provides a forum for consultations on technical and economic aspects of international trade in fish and fisheries products, including pertinent aspects of production and consumption. The COFI Subcommittee on Aquaculture[21] provides a forum for consultation and discussion on aquaculture, and advises COFI on technical and policy matters related to aquaculture and on the work to be performed by FAO on aquaculture.

b) International Commission for the Conservation of Atlantic Tunas[22]

The International Commission for the Conservation of Atlantic Tunas (ICCAT) is responsible for the conservation of tunas and tuna-like species in the Atlantic Ocean and adjacent seas, and is the only fisheries organization that can undertake the range of work required for the study and management of tunas and tuna-like fishes in the Atlantic. Such studies include research on biometry, ecology, and oceanography, with a principal focus on the effects of fishing on stock abundance. The organization was established at a Conference of Plenipotentiaries, which prepared and adopted the International Convention for the Conservation of Atlantic Tunas.

ICCAT has no regulatory powers, but makes regulatory binding recommendations and resolutions to be implemented by contracting parties (catch quotas, minimum weight of fish, limitation of incidental catches and illegal, unreported and unregulated fishing) on the basis of scientific evidence provided by Standing Committee on Research and Statistics and of other relevant information, aimed at maintaining the populations of ICCAT species at levels which will permit maximum sustainable catch.

In a simplified way, ICCAT works as follows: each year the Standing Committee on Research and Statistics meets and defines the sustainable catch limits of the various exploited species. Subsequently, ICCAT decides how the maximum allowable catch will be allocated among the various member countries. A key point in this context is that the vast majority, if not all, of the species of tunas and the tuna-like are already being captured at levels close to their maximum sustainable capacity, i.e. there is no concrete way of extending the catch tuna in the

[20] Food and Agriculture Organization of the United Nations. Fisheries and Aquaculture Department. COFI Sub-Committee on Fish Trade. In: *FAO Fisheries and Aquaculture Department.* www.fao.org/fishery/about/cofi/trade/en

[21] Food and Agriculture Organization of the United Nations. Fisheries and Aquaculture Department. COFI Sub-Committee on Aquaculture. Text by Rohana Subasinghe. In: *FAO Fisheries and Aquaculture Department*. www.fao.org/fishery/about/cofi/aquaculture/en

[22] International Commission for the Conservation of Atlantic Tunas. Introduction. www.iccat.int/en/introduction.htm.

Atlantic Ocean without compromising the sustainability of stocks (HAZIN & TRAVASSOS, 2007).

Due to the interest in tuna fishing, Brazil has been a member of ICCAT since its inception and has actively participated in its work, with a prominent role in the negotiations involving quotas to capture the main stocks exploited in Brazilian fisheries (LIMA, 2001). In this sense, the position of the Brazilian government has always been to defend strict respect for sustainable maximum catch limits, with the same emphasis that it has defended the country's right to develop its oceanic fisheries.

c) Commission for Inland Fisheries and Aquaculture of Latin America and the Caribbean[23]

The objective of the Commission for Inland Fisheries and Aquaculture of Latin America and the Caribbean (COPESCAALC - *Comisión de Pesca Continental y Acuicultura para América Latina y el Caribe*) is to promote the sustainable development and management of inland fisheries and aquaculture, according to the rules and principles of the FAO Code of Conduct for Responsible Fisheries.

Amongst its functions is supporting the formulation of national and regional development and management plans of inland fisheries and aquaculture; promoting and coordinating research at national and regional levels, aimed at the sustainable development and management of inland fisheries and aquaculture; incentivizing the application of better management practices and sustainable technologies in inland fisheries and aquaculture; contributing to the creation of institutional capacity and to the formation of human resources, through training, extension services and technology transfer, in collaboration with national and regional institutions; contributing to data collection, analysis and the exchange of inland fisheries and aquaculture statistics; and stimulating collaboration among Member States and between them and international organizations.

Brazil is among the 15 main world producers of inland fisheries, contributing with 49% of the continental water production in Latin America and the Caribbean. In the last 10 years, catches stabilized at approximately 243 thousand tons (FAO, 2016). Despite the fact that inland

[23] Food and Agriculture Organization of the United Nations. Regional Fishery Bodies summary descriptions. Commission for Inland Fisheries and Aquaculture of Latin America and the Caribbean (COPESCAALC). Fishery Governance Fact Sheets. In: *FAO Fisheries and Aquaculture Department*. www.fao.org/fishery/rfb/copescal/en

fisheries production is lower than maritime fishing, its importance lies in the fact that it is an important and relatively more significant source of employment than in marine fisheries and aquaculture. The regional inland aquaculture production is in continuous growth, having reached during the year 2014, the historical figure of 1,140,555 tons. The main aquaculture producing countries of the region, which in turn are members of COPESCAALC in 2014 were Chile, Brazil, Ecuador and Mexico contributing with approximately 80% of the aquaculture production of Latin America and the Caribbean (FAO, 2016).

d) Western Central Atlantic Fishery Commission[24]

The general objective of the Western Central Atlantic Fishery Commission (WECAFC) is to promote the effective conservation, management and development of the living marine resources of the area of competence of the Commission, in accordance with the FAO Code of Conduct for Responsible Fisheries, and to address common problems of fisheries management and development faced by members of the Commission.

The work of WECAFC is guided by the following three principles: promote the application of the provisions of the FAO Code of Conduct on Responsible Fisheries and its related instruments, including the precautionary approach and the ecosystem approach to fisheries management; ensure adequate attention to small-scale, artisanal and subsistence fisheries; and coordinate and cooperate closely with other relevant international organizations on matters of common interest.

Inside its structure is the Scientific Advisory Group which is constituted of five scientists with suitable scientific qualifications and experience in fisheries who serve in their personal capacity, providing scientific advice to WECAFC and its *ad hoc* working groups, and assessing and reporting on the status of stocks in the area covered by the Commission, and accessing the situation, trends and prospects of fisheries in the region.

Brazil has a very limited participation in WECAFC since only a small part of the Brazilian coast (northern coastal region) is covered by this Commission. Most WECAFC members have endorsed the Caribbean and North Brazil Shelf Large Marine Ecosystem Strategic

[24] Food and Agriculture Organization of the United Nations. Regional Fishery Bodies summary descriptions. Western Central Atlantic Fishery Commission (WECAFC). Fishery Governance Fact Sheets. In: *FAO Fisheries and Aquaculture Department*. www.fao.org/fishery/rfb/wecafc/en

Action Programme. Under its strategies are the recommendation to implement ecosystem-based management/ecosystem approach to fisheries of the Guianas-Brazil continental shelf with special reference to the spiny lobster fisheries, the four-wing flyingfish fisheries and the shrimp and groundfish fishery by strengthening the sub-regional arrangements for the management of the aforementioned fisheries, and establish a decision-making capacity for policy formulation and management, as well as the inclusion of dedicated financing to support the implementation of the aforementioned strategy (WECAFC, 2016).

e) Commission for the Conservation of Antarctic Marine Living Resources[25]

The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) was established with the objective of conserving Antarctic marine life and practices an ecosystem-based management approach. This does not exclude harvesting as long as such harvesting is carried out in a sustainable manner and takes account of the effects of fishing on other components of the ecosystem. The fisheries are managed using the ecosystem-based and precautionary approach and management objectives which balance conservation and rational use of living resources and maintain existing ecological relationships.

The status and management of the fisheries is reviewed annually by the Scientific Committee and its specialist working groups using the best available science and information, including detailed data from the fisheries and fishery surveys, and the CCAMLR Scheme of International Scientific Observation. The main route for scientific advice in CCAMLR is through the Scientific Committee and its subsidiary groups. The Convention requires the Commission to take full account of the recommendations and advice of the Scientific Committee.

Brazil joined the Antarctic Treaty in 1975 and the Brazilian Antarctic Program (PROANTAR – *Programa Antártico Brasileiro*) was created in 1982 when the first Brazilian expedition to the continent was made. Brazil became an Advisory Member of the Treaty in 1983, and the Antarctic Station "*Comandante Ferraz*" was inaugurated in 1984. PROANTAR establishes and organizes national support for scientific research in various areas of knowledge about the Antarctic region, in order to support the status of Brazil as an Advisory Member of the

[25] Commission for the Conservation of Antarctic Marine Living Resources. About CCAMLR: Conserving Antarctic marine life and Ecosystem-based management. www.ccamlr.org/en/organisation/about-ccamlr; Science. www.ccamlr.org/en/science/science; Fisheries. www.ccamlr.org/en/fisheries/fisheries.

Antarctic Treaty and, therefore, to ensure Brazilian participation in the processes the future of this continent (CIRM, 2011).

Brazil joined the CCAMLR in 1985. Currently the Brazilian fishing vessel fleet has not been carrying out any activity on the Antarctic continent, and only in 2000 Brazil officially announced to CCAMLR its intention to conduct an exploratory fishing program, but this program was not implemented. In this way the Brazilian participation in the CCAMLR is mainly restricted to issues related to the conservation of the Antarctic living resources, such as the creation of Marine Protected Areas under the Convention.

Paragraph 2 – Brazilian Management

The effective management and conservation of the living aquatic resources used by fisheries and aquaculture are necessary to ensure their contribution to sustainable development, poverty eradication and food security. The effectiveness and performance of conservation and management measures is conditioned by given social, economic, institutional and political circumstances. The sectoral governance of fisheries and aquaculture encompasses complex social, institutional and political processes, has international, national and local dimensions and clearly requires legal, social, environmental, economic and political considerations, as well as interactions between the government and civil society (including in particular fishers, aquaculture producers, industry and private sector in general, as well as other stakeholder groups) for allocation of resources and power[26]. The following sections describe the role of the main national organizations responsible for the management of fisheries and aquaculture in Brazil.

a) National Environmental Council

The National Environmental Council (CONAMA - *Conselho Nacional do Meio Ambiente*) [27], instituted by PNMA, is the consultative and deliberative body of the Environment National System. Although this Council does not have the competence to deal directly with

[26] Food and Agriculture Organization of the United Nations. Management and conservation of aquatic resources: Background to Department's activities. Fishery Governance Fact Sheets. In: *FAO Fisheries and Aquaculture Department*. www.fao.org/fishery/topic/16032/en

[27] MMA/CONAMA. www.mma.gov.br/port/conama/

fisheries and aquaculture activities, the CONAMA Resolutions have the competence to establish standards and criteria for the environmental licensing of potentially polluting activities, and to establish rules, criteria and standards related to the control and maintenance of the quality of the environment, to the rational use of environmental resources, especially water resources.

The CONAMA Resolutions are acts that deal with deliberation linked to guidelines and technical rules, criteria and standards related to environmental protection and to the sustainable use of environmental resources. The following CONAMA Resolutions have direct relationship with aquaculture activities: No. 312 of 10 October, 2002[28] which provides for licensing of shrimp farms in the coastal zone; No. 357, of 17 March, 2005[29] which deals with the classification of water bodies and environmental guidelines for their classification, as well as establishing the conditions and standards for the discharge of effluents and; No. 413 of 26 July, 2009[30] which provides for the environmental licensing of aquaculture.

All aquaculture enterprises must have their environmental licensing issued by governmental environmental control agencies, be they municipal, state or federal (according to their size and location), which must follow the standards and criteria established by the Resolutions above.

b) National Aquaculture and Fisheries Council

The Decree No. 5.069 of 5 May, 2004[31] provides for the composition, structure, competencies and functioning of the National Aquaculture and Fisheries Council (CONAPE - *Conselho Nacional de Aquicultura e Pesca*). CONAPE is an advisory body, and is part of the basic structure of the Ministry of Agriculture, Livestock and Food Supply (MAPA - *Ministério da Agricultura, Pecuária e Abastecimento*)[32]. Among its functions are the following:

- support the formulation of the national policy for fisheries and aquaculture;
- propose guidelines for the development and promotion of fisheries and aquaculture production;

[28] www.mma.gov.br/port/conama/legiabre.cfm?codlegi=334

[29] www.mma.gov.br/port/conama/legiabre.cfm?codlegi=459

[30] www.mma.gov.br/port/conama/legiabre.cfm?codlegi=608

[31] www.planalto.gov.br/ccivil_03/_ato2004-2006/2004/decreto/d5069.htm

[32] MAPA: www.agricultura.gov.br/

- consider the guidelines for the development of the plan of action for fisheries and aquaculture;
- propose measures to ensure the sustainability of fishing and aquaculture.

CONAPE is a consultative and deliberative body composed of 54 councilors represented by governmental and non-governmental entities (civil society) with a two-year mandate. CONAPE was holding four ordinary meetings per year, in addition to occasional extraordinary meetings, but with the end of the Ministry of Fisheries and Aquaculture (MPA - *Ministério da Pesca e Aquicultura*), it resulted in the containment of the necessary expenses for the travel and lodging of the councilors, and the activities of this Council are temporarily paralyzed.

b) Technical Committee on Shared Management of Fisheries Resources

The Decree No. 6.981 of October 13, 2009[33] provides for joint action by the MAPA and the Ministry of Environment (MMA - *Ministério do Meio Ambiente*)[34] on aspects related to the sustainable use of fishery resources and establishes the Technical Committee on Shared Management of Fisheries Resources (CTGP - *Comissão Técnica da Gestão Compartilhada dos Recursos Pesqueiros*)[35], an advisory body and coordinator of the activities of the shared management system, with the purpose of examining and proposing measures and actions inherent in the joint competences referred to in this Decree.

Even with the end of the MPA, the competences for the shared management system of fishing resources continued to be divided between MMA and MAPA, without prejudice to the continuation of the meetings of this Technical Committee.

c) Permanent Committees of Management and Sustainable Use of Fisheries Resources

The CTGP may set up the Permanent Committees of Management and Sustainable Use of Fisheries Resources (CPGs - *Comitês Permanentes de Gestão para o Uso Sustentável de*

[33] www.planalto.gov.br/ccivil_03/_Ato2007-2010/2009/Decreto/D6981.htm

[34] MMA: www.mma.gov.br/

[35] MMA/CTGP: www.mma.gov.br/biodiversidade/biodiversidade-aquatica/recursos-pesqueiros/comiss%C3%A3o-t%C3%A9cnica-de-gest%C3%A3o-compartilhada-dos-recursos-pesqueiros-ctgp

Recursos Pesqueiros)[36], regulated by Inter-ministerial Order MPA/MMA No. 05 of 1 September, 2015[37].

The CPGs are composed of representatives of the government and civil society, in a joint manner, and assisted by scientific subcommittees composed of researchers, technicians and practitioners with well-known expertise in the related field. The CPGs are to serve as advisory bodies on measures for the sustainable management and use of fishery resources, based on the best available scientific and technical data, as well as traditional knowledge.

However, since 2010, CPGs have been experiencing problems for their effective implementation, with the exception of CPG of Tunas and Related Species, mainly because Brazil as a member of ICCAT is obliged to send data and reports to maintain their quotas of capture. Due to the same problems mentioned previously for CONAPE, with the end of the MPA the CPGs meetings have suffered discontinuity and are temporarily paralyzed.

d) Inter-ministerial Commission for Marine Resources

The Inter-ministerial Commission for Marine Resources (CIRM - *Comissão Interministerial para os Recursos do Mar*)[38] has the purpose of coordinating matters related to the achievement of the PNRM. The PNRM is consolidated by multiyear and annual plans and programs, designed by the CIRM, that unfold themselves in specific projects, and make up the basic working documents. These projects are approved by the CIRM and the resources needed are transferred from the different agencies, based on partnerships, to the executing institutions (universities, research institutions and government organizations related to resources of the sea), upon development of the different stages.

Within the CIRM, there are two Executive Committees dealing directly with matters related to aquaculture and fisheries, as follows:

- Aquaculture and Fisheries Executive Committee

[36] MMA/CPG: www.mma.gov.br/biodiversidade/biodiversidade-aquatica/recursos-pesqueiros/comit%C3%AAs-permanentes-de-gest%C3%A3o-cpg

[37]www.icmbio.gov.br/cepsul/images/stories/legislacao/Portaria/2015/p_mpa_mma_05_2015_sistema_gest%C3%A3o_pesca_compartilhada.pdf

[38] CIRM: www.mar.mil.br/secirm/ingles/principal.html

The Aquaculture and Fisheries Executive Committee (AQUIPESCA – *Comitê Executivo para Aquicultura e Pesca*)[39] was coordinated by MPA. Its purpose is to foster, in a cooperative environment among ministries, the implementation of priority actions of the PNDSAP, in order to qualify manpower resources in fishing activities, adjust fishing effort and encourage mariculture.

The strategic need to promote sovereign exploitation of the country's fishery resources, based on an effective policy for the occupation of the EEZ, aims, first and foremost, at the development and promotion of Brazilian fish and aquaculture production, in a sustainable manner. To achieve the goals set forth by the MPA, it is essential to establish a cooperative environment among the ministries, to contribute to the formulation and implementation of public policies for fisheries and aquaculture. Within the CIRM, this environment is the AQUIPESCA.
Under AQUIPESCA lie the Aquaculture and the Fisheries Subcommittees, which discuss operational strategies for the development of fisheries and aquaculture, based on the planned proposals, and those presented by the MPA for each sector. These strategies are examined in advance by the Fisheries and the Aquaculture Subcommittees, respectively, before being submitted for consideration and approval by the Executive Committee.

Due to the end of the MPA, which was the coordinator of the AQUIPESCA, the meetings have suffered discontinuity and are temporarily paralyzed.

- Evaluation, Monitoring and Conservation of Marine Biodiversity Executive Committee

The Evaluation, Monitoring and Conservation of Marine Biodiversity Executive Committee (REVIMAR - Comitê Executivo para *Avaliação, Monitoramento e Conservação da Biodiversidade Marinha*)[40] is coordinated by the MMA and aims to evaluate, monitor and promote the conservation of marine biodiversity, with an ecosystem approach, aiming to establish scientific bases and integrated actions to support conservation policies and actions, and promote shared management strategies for the sustainable use of living resources.

The creation of this Executive Committee results from the need to proceed with the evaluation of the sustainable potential of the living resources of the EEZ, initiated by the Evaluation of the Sustainable Potential of Living Resources in the Exclusive Economic Zone

[39] CIRM/AQUIPESCA: www.mar.mil.br/secirm/ingles/aquipesca.html

[40] CIRM/REVIMAR: www.mar.mil.br/secirm/ingles/revimar.html

Program, with a view to implementing more efficient management systems that ensure the conservation and use of fishery resources in a sustainable manner; the urgent need to implement a permanent action to monitor the main fish stocks in order to allow the continuous generation of information essential for the conservation and rational use of fish stocks; and ensure the conservation and monitoring of existing ecosystems in coastal and marine areas.

The operational strategy is based on management units, corresponding to stocks, multi-species fisheries and other categories appropriate to fisheries management. The management units may be national, regional or local. Scientific Subcommittees are organized according to the selected management units, and focus on assessing the status of the underlying stocks, monitoring them and issuing recommendations to managers. The basic data for the activities conducted by the Scientific Subcommittees (catch, fishing effort, frequency distribution of lengths and prices of first marketing) are provided by fisheries statistical systems, implemented by the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA - *Instituto Brasileiro de Meio Ambiente e dos Recursos Naturais Renováveis*)[41]/MMA, MAPA and partners.

Considering that MMA is the coordination of REVIMAR, even with the end of the MPA there were no problems for the continuity of the activities and the meetings developed by this Executive Committee.

Section B – Status of Fisheries and Aquaculture Development

Paragraph 1 – Brazilian Governance

a) Brief Institutional Overview of Fisheries and Aquaculture in Brazil

According to MARRUL FILHO (2001) until the mid-1960s, the national fishing industry was characterized by the low investment and underutilization of natural resources and by the fragility or near-absence of state regulations on the use of fisheries resources. In 1962, the Superintendence of Fisheries Development (SUDEPE - *Superintendência do Desenvolvimento da Pesca*) was created, an autarchy linked to the MAPA, with a clear developmental bias.

[41] IBAMA: www.ibama.gov.br/

SUDEPE had, under its jurisdiction, all the main instruments of administration of fishing activity and administration of use of aquatic biodiversity. Between 1962 and 1989, SUDEPE was dedicated to promoting the industrialization of the sector, through fiscal incentives, among other strategies aimed at the intense exploitation of naturally occurring fish stocks (DIAS NETO, 2010).

IBAMA was created 1989, bringing together the responsibilities of SUDEPE, which was extinguished. The policy undertaken by IBAMA, from 1989 to 1998, focused on concrete and strong actions aimed at recovering fishery resources in situations of overfishing or threatened with exhaustion. This line of action also contemplated the recovery of the economics of its fisheries. Thus, IBAMA, after negotiations with the fishing industry, defined management measures that favored a significant recovery of stocks and, consequently, the production of these resources. As a result of the position of adopting strong measures, it was able, after the second year, to reverse the downward trend in total production and then recover it (DIAS NETO, 2010).

Between 1998 and 2002, the functions of development and promotion of fishing resources were transferred again to MAPA, where a Department of Fisheries and Aquaculture (DPA - *Departamento de Aquicultura e Pesca*) operated, introducing significant changes in competencies, among which stands out the division of competences on the management of the use of fishing resources between the MMA and MAPA; organization and maintenance of the General Record of the Fishing Activity (RGP - *Registro Geral da Atividade Pesqueira*); leasing of foreign fishing vessels by companies or national ship-owners and; promotion and stimulation of aquaculture (DIAS NETO, 2010).

Between 2003 and 2009, the management and development of fisheries and aquaculture passed to the Special Secretariat of Aquaculture and Fisheries (SEAP - *Secretaria Especial de Aquicultura e Pesca*), linked to the Presidency of the Republic. In 2009 occurred the transformation of the SEAP into MPA which was the main institution responsible for fisheries and aquaculture management and development until 2015. The recognition of the importance of the fisheries and aquaculture sector for the country's development was gradually implemented through an institutional strengthening policy. The creation of the MPA, the enactment of the Fisheries Law (PNDSAP), and the holding of the three National Aquaculture and Fisheries Conferences were fundamental milestones in this political and institutional movement.

However, by 2015 MPA was extinguished and MAPA incorporated its competences again through the creation of the Secretariat of Aquaculture and Fisheries (SAP - *Secretaria de*

Aquicultura e Pesca), as the main institution responsible for fisheries and aquaculture management and development in Brazil.

b) Ministerial Competencies Related to Fisheries and Aquaculture Development

SAP/MAPA exercises the following competencies, in accordance with Decree No. 8.701 of 31 March, 2016[42]:

- formulate the guidelines for governmental action for the national fisheries and aquaculture policy, covering production, transportation, processing, marketing, supply and storage;
- promotion of fisheries and aquaculture production;
- implementation of infrastructure to support the production, processing and marketing of fish and promotion of fisheries and aquaculture;
- organization and maintenance of RGP;
- standardization and inspection of aquaculture and fisheries activities;
- the granting of licenses, permits and authorizations for the practice of aquaculture and fishing modalities in the national territory;
- authorization of the leasing of foreign fishing vessels and their operation, observing the limits of sustainability established jointly with the MMA;
- operationalization of the concession of the economic subsidy to the price of diesel oil;
- to promote, within the scope of its competence:
  i. the preparation, implementation, monitoring and evaluation of plans, programs and actions;
  ii. the intra-sectoral and inter-sectoral articulation necessary for the execution of aquaculture and fisheries activities;
  iii. aquaculture and fisheries research;
  iv. the modernization and implementation of infrastructure to support the production, processing and marketing of fish, and the promotion of fisheries and aquaculture, including the dissemination of technology, aquaculture extension and training;

[42] www.planalto.gov.br/ccivil_03/_ato2015-2018/2016/decreto/D8701.htm

v. the direct or indirect administration of the Public Fishing Terminals (TPP - *Terminais Pesqueiros Públicos*);

- supply to the MMA of the data of the RGP related to the licenses, permits and authorizations granted for fisheries and aquaculture, for the automatic registration of the beneficiaries in the Federal Technical Register of Potentially Polluting Activities and Users of Environmental Resources;
- plan, coordinate, implement and evaluate activities, programs and actions of infrastructure and logistics to support fisheries and aquaculture;
- express its views on actions developed and to be developed by the MAPA in the field of fisheries and aquaculture sanitation.

c) Joint Competence for the Sustainable Use of Fisheries Resources

As mentioned earlier, the Decree No. 6.981 of October 13, 2009 regulates the joint competence of MPA (now MAPA) and MMA, and based on the best scientific and existing data, to establish rules, criteria, standards and measures for the sustainable use of fisheries resources, under different forms of exploitation including commercial, amateur and subsistence fishing. This shared management system of sustainable use of fisheries resources is intended to support the development and implementation of management measures for sustainable use of fisheries resources. The provisions of this Decree do not apply to the standardization of aquaculture activities.

The rules, criteria, standards and management measures, in accordance with the peculiarities of each management unit, should include the following: the access regimes; the total allowable catch; sustainable fishing effort; the periods of closure; fishing seasons; capture sizes; prohibited areas or reservations; the gear, apparatus, methods and systems of fishing and; the protection of individuals in the process of breeding or restoring stocks. In the absence or insufficiency of scientific data, the precautionary principle should be applied for the definition of criteria and standards of use.

The resulting rules, criteria, standards and measures for the management of the sustainable use of fisheries resources are established jointly by MAPA and MMA, based on the information based on technical and scientific data. Moreover, all information from the surveys conducted by MAPA and MMA and its specialized agencies on the sustainable use of fisheries resources will be shared among the agencies involved.

However, the participatory management process does not occur automatically, and a motivation/mobilization was necessary to create it. In this way, MPA, together with the MMA, elaborated the model of fisheries management and defined the organization and operation of the shared management system based on the state of the stocks, combined with the main demands of the national fishing sector. This model describes the legal basis and guidelines and identifies possible management committees (CPGs), which are joint, consultative and advisory bodies, involving the user in the management process, decision-making, implementation and enforcement (RUFFINO, 2010).

d) Governance for Scientific Development on Fisheries and Aquaculture

Since MPA was extinguished and its structure incorporated into MAPA, there is a gap of effective government support for RD&I in fisheries and aquaculture; from 2003 to 2015, SEAP and MPA were the main institutions designated to promote and strengthen RD&I aimed at developing the fisheries and aquaculture sectors in Brazil. Some of these actions were possible through the partnership established in 2003 between the SEAP, MCTIC and its agencies such as the National Council for Scientific and Technological Development (CNPq - *Conselho Nacional de Desenvolvimento Científico e Tecnológico*)[43] and the Studies and Projects Financier (FINEP - *Financiadora de Estudos e Projetos*)[44], and the National Fund for Scientific and Technological Development (FNDCT - *Fundo Nacional de Desenvolvimento Científico e Tecnológico*)[45], which was regulated trough the Interministerial Order MCTIC/MPA No. 35, of 16 January, 2013[46] creating the Interministerial Technical Commission on Science, Technology and Innovation in Fisheries and Aquaculture (CTPA - *Comissão Técnica Interministerial de Ciência, Tecnologia e Inovação em Pesca e Aquicultura*), with the purpose of establishing technical and scientific cooperation for the formulation of policies to support scientific and technological development and innovation in the fisheries and aquaculture sectors. CTPA were composed by MPA, SEPED/MCTIC, CNPq and FINEP.

[43] CNPq: cnpq.br/

[44] FINEP: www.finep.gov.br/

[45] FNDCT/MCTIC: fndct.mcti.gov.br/

[46]www.icmbio.gov.br/cepsul/images/stories/legislacao/Portaria/2013/p_inter_mcti_mpa_35_2013_comissatecnica_interm_de_ciencia_tecnologia_inovacao_pescaeaquicultura.pdf

Among the purposes of CTPA was to support the implementation of the Brazilian Consortium for Research, Development and Transfer of Technology in Fisheries and Aquaculture (CBPA - *Consórcio Brasileiro de Pesquisa, Desenvolvimento e Transferência de Tecnologia em Pesca e Aquicultura*) in Fisheries and Aquaculture, aiming to contribute to the definition, through a participatory form, of national policies and guidelines for the promotion of research and technology transfer in the areas of fisheries and aquaculture. CBPA was a Cooperation Agreement established in 2010 between MPA and the Brazilian Company of Agricultural Research (EMBRAPA - *Empresa Brasileira de Pesquisa Agropecuária*)[47], which is linked to MAPA, considering that EMBRAPA has created in 2009 the National Research Center for Fisheries and Aquaculture[48].

The purposes of CBPA are to propose policies and strategic guidelines for research and development (R&D) and transfer of technology (TT) in fisheries and aquaculture; set priorities for a consolidated national program of R&D and TT in fisheries and aquaculture; define funding strategies and allocation of resources for the financing of programming and the necessary infrastructure; define institutional integration strategies for the financing and implementation of R&D and TT programming in fisheries and aquaculture; and propose training policies for human resources in the fisheries and aquaculture sector.

Perhaps one of the great challenges is to seek the development of environmental sustainability mechanisms that, in order to be successful, will have to promote the sustainable development of productive chains, introduce new technologies and face structural growth bottlenecks, especially in the research area.

Paragraph 2 – Policies and Programs

The main policies and programs related to the development of fisheries and aquaculture carried out in Brazil in the last years are identified and described below, considering the model of governance by the ministries responsible for fisheries and aquaculture management and development being divided into two final thematic lines (fisheries and aquaculture) and four other cross-cutting thematic lines (monitoring and control, and infrastructure and foment).

[47] EMBRAPA: www.embrapa.br/

[48] EMBRAPA Fisheries and Aquaculture: www.embrapa.br/pesca-e-aquicultura

a) Fisheries Program

Program of Economic Subsidy to the Price of Diesel for Fishing Vessels

The economic subsidy to the price of diesel has the objective of promoting the equalization of the price of diesel for the national fleet at the price effectively practiced in the sale to the foreign vessels, thus enabling the increase of the competitiveness of Brazilian fish in the international market and consequent increase in the profitability of those workers involved in the fishing activity. The subsidy was created by Law No. 9.445 of 14 March, 1997[49] and is currently regulated by Decree No. 7.077 of 26 January, 2010[50].

The subsidy consists of:

- Full exemption of the Tax on the Circulation of Goods and Services provided by the States of the Federation at the moment of the acquisition of the diesel in the fuel retailers, authorized by MAPA Ordinance;
- Payment of monetary assistance of up to 25% provided by the Federal Government of the difference in the price paid for diesel to equalize at international levels after analysis of the application and of the beneficiary.

The SAP/MAPA is responsible for coordinating the diesel subsidy in Brazil and for federal subsidy payments, and establishes annual quota of diesel, quantified in liters per vessel, based on the engine power of the vessel, amount of annual hours and the consumption of engine power.

b) Aquaculture Program

Federal Dominion Water Aquaculture Development Program

The Decree No. 4.895 of 25 November, 2003[51] provides for the authorization for the use of physical spaces of water of federal domain for aquaculture purposes. The physical spaces in federal water may have their authorized uses for the purpose of aquaculture, observing criteria of ordination, location and preference, with a view to sustainable development, the increase of Brazilian fish production, social inclusion and food security.

[49] www.planalto.gov.br/ccivil_03/leis/L9445.htm

[50] www.planalto.gov.br/ccivil_03/_Ato2007-2010/2010/Decreto/D7077.htm

[51] www.planalto.gov.br/ccivil_03/decreto/2003/d4895.htm

For the purposes of the aquaculture practice dealt with in this Decree, the following are considered to be federal waters:

- inland waters, Territorial Sea, EEZ, the Continental Shelf and the public federal waters;
- lakes, rivers and any watercourses on land in the federal domain, or which flood more than one Federation Unit, serve as a boundary with other countries, or extend to or from a foreign territory; and
- deposits of water from federal works, dams, reservoirs and canals, including those under the administration of the hydroelectric companies.

The authorization for use in Federal waters for aquaculture is for both the marine or continental environment for the private/business or social sector. The two main modalities are:

- aquaculture Area: they are destined to aquaculture projects, individual or collective.
- aquaculture Park: is a set of aquaculture areas, delimited by MAPA, with previous study.

MAPA will delimit the location of the water parks and areas of preference with prior approval of the MMA, the Maritime Authority, the Ministry of Planning, Development and Management (MPDG - *Ministério do Planejamento, Desenvolvimento e Gestão*)[52] and the National Water Agency (ANA - *Agência Nacional de Águas*)[53], within the scope of their respective competencies.

c) Monitoring and Control Programs

General Record of the Fishing Activity

RGP, established by PNDSAP is an instrument of the Federal Government that aims to contribute to the management and sustainable development of the fishing activity, as well as allowing the interested party to carry out fishing and aquaculture activities throughout their production chain. RGP is an instrument that allows legalization of the respective users for the exercise of the fishing activity, with the accreditation of fisherman or fishing companies and also of the vessels to carry out these activities, comprising information from all those who deal directly with the fishing activity, incorporating, so far, the following categories: fishing apprentice; professional fisherman in artisanal and industrial fishing; fishing vessel; fishing

[52] MPDG: www.planejamento.gov.br/

[53] ANA: www2.ana.gov.br/Paginas/default.aspx

industry; amateur or sports fisherman; organizer of amateur or sport fishing competition; aquaculture producers and; merchant of living aquatic organisms.

It is incumbent upon MAPA to organize and maintain the RGP and therefore to grant licenses and permits for the practice of commercial, artisanal or amateur fishing and aquaculture for the capture of highly migratory species, underexploited or unexploited species and overexploited or endangered species for the holding of amateur fishing competitions, as well as authorize the leasing and operation of foreign fishing vessels where the law permits.

National Program for the Tracking of Fishing Vessels by Satellite

The National Program for the Tracking of Fishing Vessels by Satellite (PREPS - *Programa Nacional de Rastreamento de Embarcações Pesqueiras por Satélite*)[54] was established and regulated through Inter-ministerial Normative Instruction MPA/MMA/Brazilian Navy No. 2 of 4 September, 2006[55].

This Program has the purpose of monitoring, management and control of the operations of the fishing fleet authorized by MAPA, in addition to the potential to improve the safety of the fishermen embarked.

Its objectives are:

- contribute to safety actions of navigation and safeguard of human life at sea, facilitating the location of the vessel in cases of accidents at sea;
- to allow the owners or renters of fisheries vessels to monitor in real time the fishing cruises of the vessels under their responsibility;
- subsidize fishing masters with information about their operations. In addition, it allows visualizing with greater efficiency the geographical restrictions to the fisheries activity established in the legislation;
- to allow the coordinating bodies of the Program to verify the use of the issued Fisheries Authorizations, as well as the control over the use of federal fisheries subsidies, such as diesel;

[54] PREPS: sinpesq.mpa.gov.br/preps_cms/

[55] www.icmbio.gov.br/cepsul/images/stories/legislacao/Instrucao_normativa/2006/in_seap_mma_md_02_2006_preps.pdf

- provide support to the monitoring of fisheries activity and minimize conflicts between industrial and artisanal fisheries activities;
- to allow an evaluation of the effectiveness of the fisheries management measures, promoting their critical revision, based on a better understanding of the strategies of occupation of the fishing areas and effort on the resources.

National Fishing Fleet Observer Program

The National Fishing Fleet Observer Program (PROBORDO - *Programa Nacional de Observadores de Bordo da Frota Pesqueira*)[56], established by Joint Normative Instruction SEAP-MMA No. 1 of 26 September, 2006[57] was created in Brazil to meet the need to monitor foreign vessels leased to Brazilian companies from the Policy on the Leasing of Foreign Fishing Vessels, whose objective was to occupy the Brazilian EEZ and adjacent waters.

The objective of the program is to carry out the scientific technical survey of fishing operations, including biological data on the resources, characterization of the environment (fishing zones) and the technologies used in the vessels.

Through this monitoring, necessary data are being generated to scale the sustainable fishing effort for new fisheries and the establishment of mechanisms for the recovery and sustainable control of traditional resources exploited by commercial fishing.

Participation of the following vessels is mandatory:

- all foreign fishing vessels under valid lease authorization, enrolled in the RGP and allowed to operate in waters under Brazilian jurisdiction, including fishing cruises in international waters;
- Brazilian fishing vessels, enrolled in RGP and allowed to operate in waters under Brazilian jurisdiction and subject to the system of control of compliance with limits for the capture of deep demersal resources, established by a specific normative act;
- Brazilian or foreign vessels under lease, enrolled in RGP and allowed to operate in the capture of fishing resources in the Antarctic Sea, administered under CCAMLR;

[56] PROBORDO: sinpesq.mpa.gov.br/cob_cms/index.php?option=com_content&view=article&id=1:probordo

[57] www.icmbio.gov.br/cepsul/images/stories/legislacao/Instrucao_normativa/2006/in_seap_mma_01_2006_probordo.pdf

- other vessels, enrolled in RGP and duly granted, which will be defined in a specific normative act.

Statistical Bulletin of Fisheries and Aquaculture

Between 2000 and 2007, the information used for the consolidation of national fisheries and aquaculture statistics was collected and published by IBAMA, through the Statistical Monitoring Program (EstatPESCA). With the inclusion of MPA in the consolidation of the national fisheries statistics, the EstatPESCA Program was gradually replaced by a new monitoring methodology based on the National Fisheries and Aquaculture Information System (SINPESQ - *Sistema Nacional de Informações da Pesca e Aquicultura*)[58] model. In this way, SEAP and MPA carried out the consolidation of the national fisheries statistics between the years 2008 and 2011, this being the last year with the publication of official statistical data on fishing in Brazil.

With regard to Brazilian aquaculture, MPA and MAPA, in partnership with the Brazilian Institute of Geography and Statistics (IBGE - *Instituto Brasileiro de Geografia e Estatística*)[59], carried out the collection, analysis and publication of statistical data through the Municipal Livestock Research between 2013 and 2015.

d) Infrastructure and Foment Program

Public Fishing Terminals

Decree No. 5.231 of 6 October, 2004[60] provides for the principles to be observed by the federal public administration in the creation, organization and operation of TPP, which is the physical structure built and equipped to meet the needs of the activities of handling and storage of fish and merchandise related to fishing, which may be provided with warehouse structures for the sale and processing of fish as well as structure to support fishing vessels navigation.

In the area of TPP, only the following activities can be carried out: unloading, transportation, handling, classification and weighing of fish; processing, marketing, statistics and storage of fish; manufacture and storage of ice; commercialization of food, fuel, equipment, electricity, water and ice for the supply of fishing vessels; industrial use of waste and tailings from the

[58] SINPESQ: sinpesq.mpa.gov.br/

[59] IBGE: www.ibge.gov.br/home/

[60] www.planalto.gov.br/ccivil_03/_ato2004-2006/2004/decreto/d5231.htm

handling and processing of fish; repairs and maintenance of fishing vessels; training and qualification of personnel for the performance of the fishing activity and support to the fishing activity; banking, communications, food and outpatient services designed to serve TPP users; inspection of the fishing activity and labor, sanitary, customs, agricultural, environmental and maritime matters carried out by the competent bodies, as well as other activities defined as of interest to the fisheries sector.

National Program for Financing the Expansion and Modernization of the National Fishing Fleet

The Law No. 10.849 of 23 March, 2004[61] creates the National Program for Financing the Expansion and Modernization of the National Fishing Fleet (PROFROTA - *Programa Nacional de Financiamento da Ampliação e Modernização da Frota Pesqueira Nacional*). PROFROTA includes financing for the acquisition, construction, conversion, modernization, replacement, adaptation and equipping of fishing vessels with the aim of reducing catch pressure on over-exploited stocks, providing efficiency and sustainability of the coastal and inland fishing fleet, promote the maximum utilization of catches, increase national fish production, use fish stocks in the Brazilian EEZ and in international waters, consolidate the national ocean fishing fleet and improve the quality of fish produced in Brazil.

Its beneficiaries are the individuals and legal entities, including cooperatives and associations, duly registered in the RGP in the categories of fishing-owner, professional fisherman, industry or fishing company, classified by size, according to criteria to be defined in regulation.

CHAPTER 2 – SCIENTIFIC RESEARCH

Section A – Development of Human Resources

Paragraph 1 – Graduate Programs

The Ministry of Education (MEC - *Ministério da Educação*)[62] is the main body responsible for implementing the current National Education Plan 2014-2024 being applied to all the modalities

[61] www.planalto.gov.br/ccivil_03/_ato2004-2006/2004/lei/l10.849.htm

[62] MEC: www.mec.gov.br/

of teaching developed in the country, among which stands out the professional, scientific and technological education and university higher education, both at graduate and postgraduate level, as well as university research and extension.

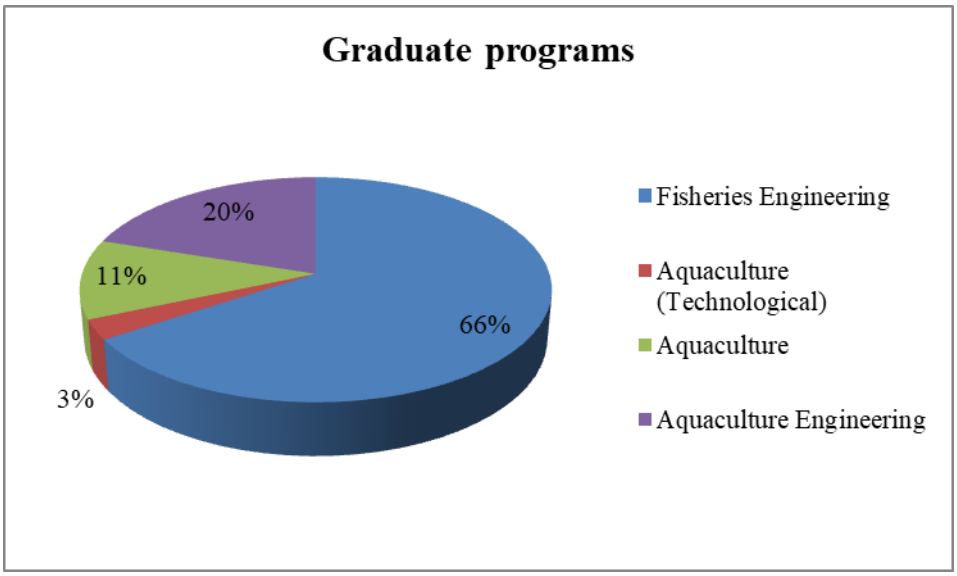
KRUG (2012) carried out a survey, in which it was verified that 40 graduate programs focusing on the Marine Sciences area were active in Brazil. Of these, 17 were on Fisheries Engineering, 13 on Oceanography, 7 on Biological Sciences (focusing on Marine Sciences), two on Aquaculture Engineering and one on Geophysics (focusing on Marine Sciences). Therefore, it is interesting to note that fisheries and aquaculture represented around 50% of all marine science undergraduate programs in Brazil, which indicates an important contribution in the training of human resources in this area, especially considering that Oceanography and Marine Biology programs also train professionals focused on fishing and aquaculture. When analyzing only the universe of fisheries and aquaculture, there were a total of 20 programs in these areas, since that one program was not counted in this study because its exclusive focus on inland aquaculture.

As a way of analyzing the current scenario of fisheries and aquaculture research in Brazil, a mapping of graduate programs focusing specifically on fisheries and aquaculture was carried out, as well as the description and qualification of the training of human resources in these areas. In this sense, for the survey of the graduation programs in fisheries and aquaculture was used the e-MEC Register of Institutions and Courses of Higher Education[63], this being the only official data base, containing information about the Institutions of Higher Education and respective undergraduate programs of the federal education system.

Although in Brazil there are several graduate programs that may present an interface in the training of human resources in the areas of fisheries and aquaculture, such as Oceanography/Oceanology, Biology/Biological Sciences, Agronomy/Agronomic Engineering, Zootechny and Veterinary Medicine, among others, these graduate programs will not be considered in the present analysis due to the existence of a high number of courses, both in public universities and in private universities, but not necessarily representing a significant number of trained professionals which work or will work in the areas of fisheries and aquaculture. In that sense, for the current analysis was chosen to focus only on graduate programs that have a direct relationship with fisheries and aquaculture, such as Fisheries Engineering, Aquaculture and Aquaculture Engineering.

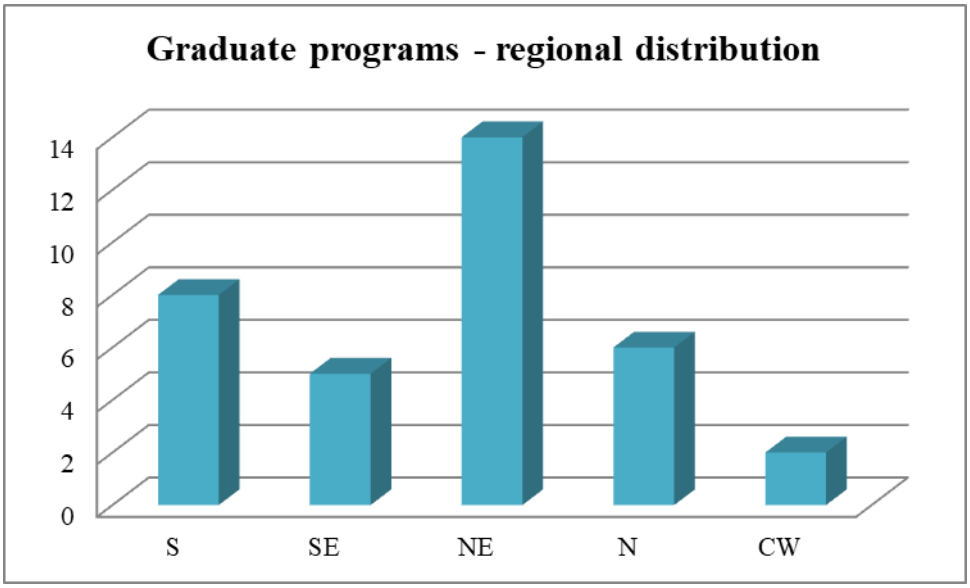
[63] e-MEC: emec.mec.gov.br/

Through the access to the e-MEC portal, a textual search was carried out, using the following terms: "Fisheries Engineering"; "Aquaculture" and "Aquaculture Engineering". As a result, 35 graduate programs were located, including 23 programs in Fisheries Engineering, one technological course in Aquaculture, four programs in Aquaculture and seven programs in Aquaculture Engineering (Graphic 1). It can be noted that there was a 75% increase in the total number of graduate programs in fisheries and aquaculture when comparing the information of KRUG (2012) with the data presented in the present study, where a total of 35 undergraduate programs were verified.



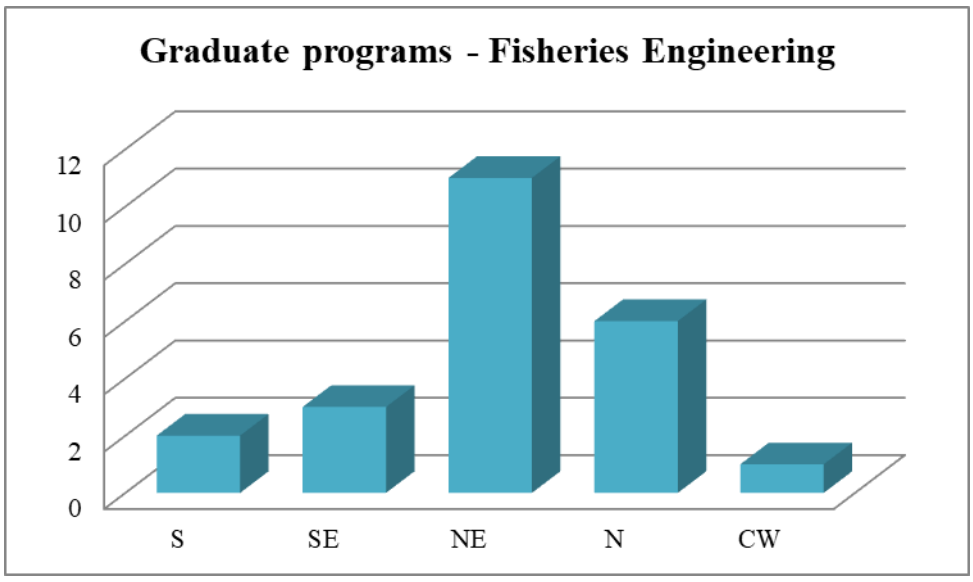
Graphic 1: Graduate programs directly related to fisheries and aquaculture in Brazil.

These graduate programs are distributed in 19 states of the federation of the five geographic regions in which Brazil is divided (Graphic 2), being 8 programs located in the southern region (S), 5 in the southeast region (SE), 14 in the northeast (NE), 6 in the northern region (N) and 2 in the center-west region (CW).



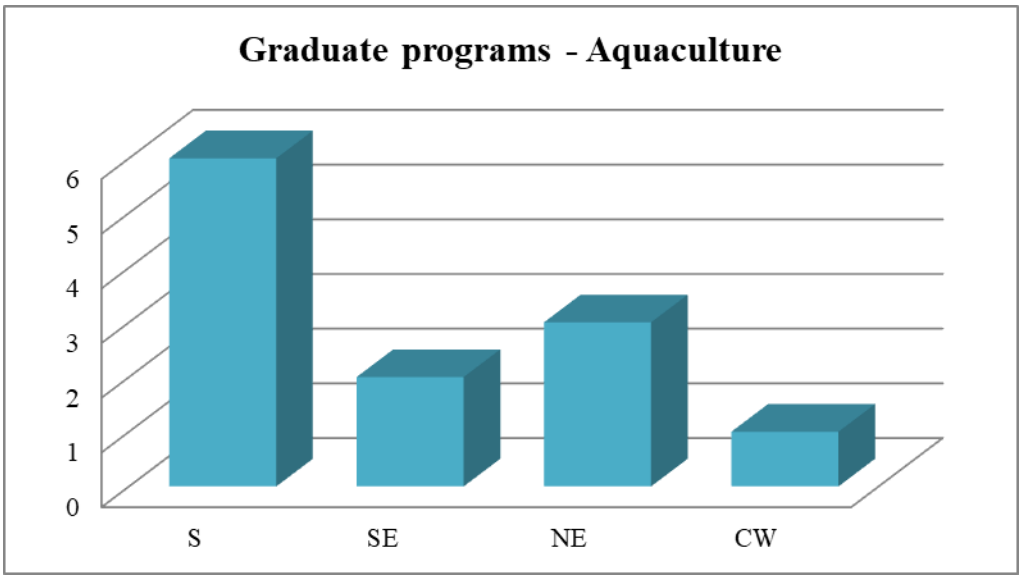
Graphic 2: Regional distribution of the graduate programs directly related to fisheries and aquaculture in Brazil.

When analyzed separately, it can be observed that the graduate programs in Fisheries Engineering are present in the five geographic regions of Brazil, being noted a significantly higher concentration in the northeast region (Graphic 3). This situation probably reflects the historical importance of this region in the creation and dissemination of these programs, considering that in 1970 the first undergraduate program of Fisheries Engineering in Brazil was created at the Federal Rural University of Pernambuco.



Graphic 3: Regional distribution of the Fisheries Engineering graduate programs in Brazil.

Regarding the Aquaculture and Aquaculture Engineering, 12 graduate programs were identified, which are distributed in four regions of the country, and it is noted that the northern region is the only one that does not have any graduate program in this subject (Graphic 4).

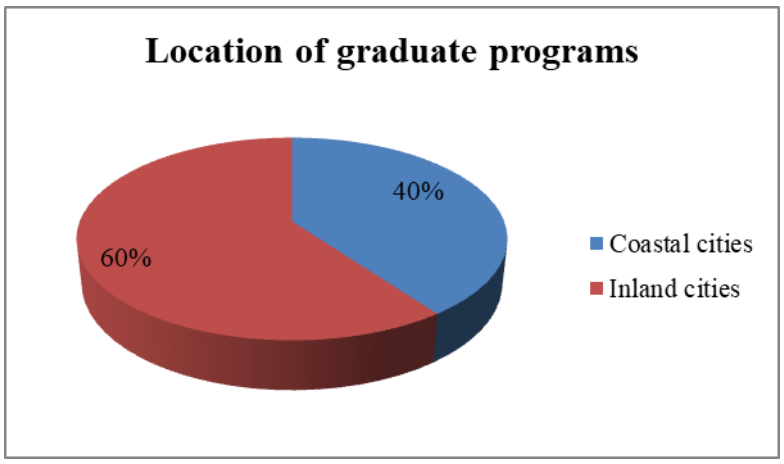


Graphic 4: Regional distribution of the Aquaculture graduate programs in Brazil.

In the same way, it can be inferred that the southern region leads the number of graduate programs in the Aquaculture area, since in 1998 the first Aquaculture Engineering course of Brazil was created, based at the Federal University of Santa Catarina.

Considering that these graduate programs covers all fisheries and/or aquaculture education, it is not possible to classify them as regards the training of human resources with a focus on marine and/or inland water science. However, when the cities in which these graduation programs are located, it is possible to observe that 21 of the 35 host cities are located at inland region of the country, while only 14 are based in the coastal region (Graphic 5).

Despite this significant increase, in a time span of 6 years, when analyzing the geographical location of the courses, it is possible to verify that the courses based at inland areas of the country have tripled. In 2011, there were seven courses, currently 21. The courses based in coastal areas were 13, with only one being created in this period. In this sense, considering the historical importance of undergraduate courses in fisheries and aquaculture for the training of human resources in the marine sciences, it becomes fundamental a greater incentive in training these professionals with a focus on marine environments.



Graphic 5: Location of the graduate programs in fisheries and aquaculture in Brazil.

In addition, although all 35 graduate programs are potential trainers of human resources in fisheries and aquaculture whose approaches may be geared to both the marine and inland water environment, from the situation identified above, it can be inferred that there is a tendency of graduate programs based at inland cities to form a greater number of professionals focused on

the fishing and aquaculture of inland waters, resulting, consequently, a lower formation of human resources with focus on marine environments.

Although graduate programs are widespread in the training of professionals working in fisheries and aquaculture in marine or inland water environments, it should be emphasized that their focus is not exclusively on the production or exploitation of fisheries resources but also on other links in the productive chain, such as fishing gear and farming techniques, reproductive biology, production of young forms and live food, nutrition, transportation, storage, marketing, slaughter and processing, health aspects, among others.

Notwithstanding that the number of graduate programs in Fisheries Engineering is significantly higher than those of Aquaculture, not necessarily a greater training of professionals dedicated to fisheries, to the detriment of aquaculture, since fisheries and aquaculture have equivalent workload into the Fisheries Engineering programs. On the other hand, the opposite does not apply to the workload of Aquaculture programs, which are exclusively directed to this area;

Even though it is not necessarily information that reflects a greater training of human resources on freshwater fisheries and aquaculture, 60% of the graduate programs may be considered at inland areas of the country, which may show some fragility training focused on marine environments. Moreover, it is possible to observe a greater tendency towards the training of human resources in aquaculture, geared mainly to freshwater environments.

Paragraph 2 – Postgraduate Programs

In this paragraph will be made a survey of the universities and Postgraduate Programs (Master and PhD) aimed at scientific training resources in fisheries and aquaculture and its geographic distribution in Brazil, as well as the main programs that have interface with these areas. In this context the potentialities and weaknesses related to the scientific training of human resources in these areas of knowledge will be identified and evaluated.

In Brazil, the organism responsible for recommending and recognizing postgraduate courses, including the professional master's degree, academic master's degree and doctorate, is the Coordination for the Improvement of Higher Education Personnel (CAPES - *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior*)[64]. CAPES is a foundation linked to MEC and

[64] CAPES: www.capes.gov.br/

plays a fundamental role in the expansion and consolidation of the *stricto sensu* postgraduate programs in the country. Among its competences, besides the evaluation of postgraduate programs, are the access and dissemination of scientific production in Brazil, through the portal "*Periódicos*"[65]; promotion of international scientific cooperation; and fostering the training of human resources in Brazil and abroad.

The postgraduate programs recommended by CAPES are available for consultation, through the Sucupira Platform[66], where it is possible to carry out searches by area of evaluation, grade and geographic region. According to KRUG (2012), are considered postgraduate programs in marine sciences the ones whose research or production lines (dissertations and theses) fall in the majority (more than 50% of the total) in the definition of Marine Sciences adopted by the CIRM's Human Resources Capacitation in Marine Sciences Action (PPG-Mar - *Formação de Recursos Humanos em Ciências do Mar*)[67], defined as "the area of knowledge that is dedicated to the production and dissemination of knowledge about the components, processes and resources of the marine environment and transition zones". In the survey carried out in 2011, the aforementioned authors identified 28 postgraduate programs pertaining to the Marine Sciences, being 28 of master's and 21 of doctorate.

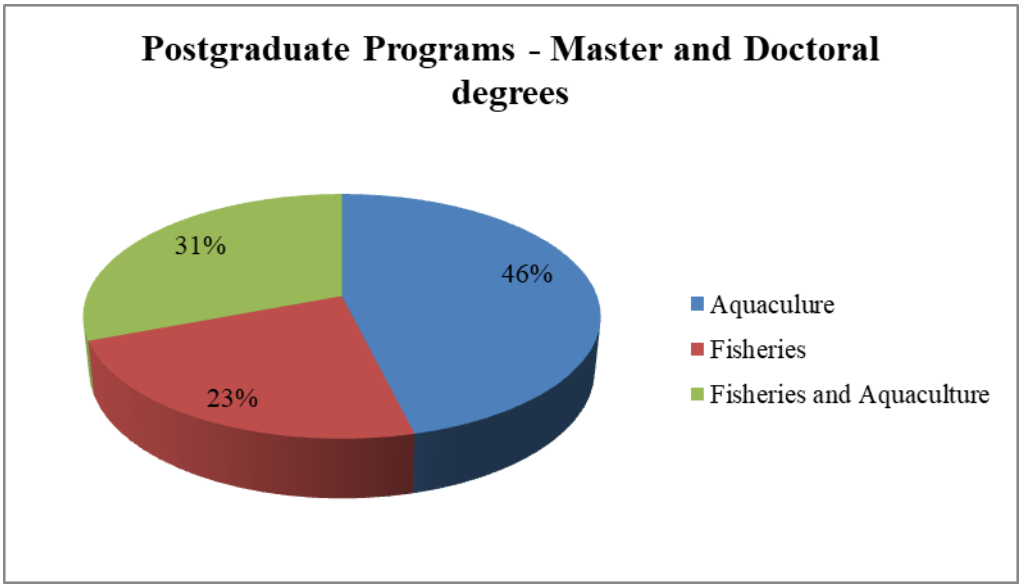
For the elaboration of this study, a search was made for the "Zootechnics/Fisheries Resources" evaluation area, focusing on the sub-area "Fisheries Resources and Fisheries Engineering". From this search, a total of 13 postgraduate programs were identified, and these programs are made up of 13 master's degree courses and 9 doctoral courses.

By means of a brief analysis, 6 of the 13 programs have as their main theme aquaculture, 4 of them work both fisheries and aquaculture, and 3 have an exclusive focus on fisheries (Graphic 6).

[65] www.periodicos.capes.gov.br/

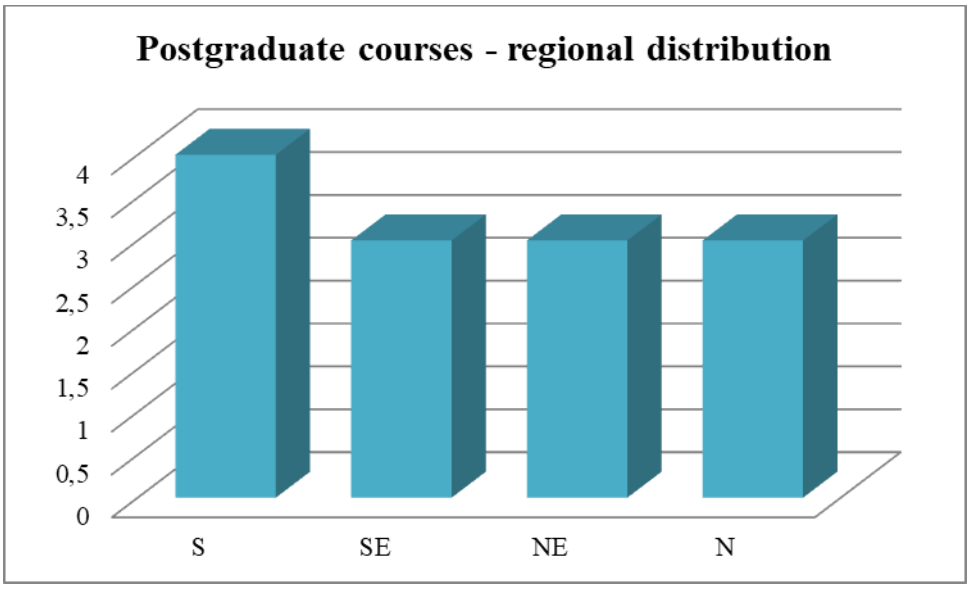
[66] sucupira.capes.gov.br/sucupira/

[67] CIRM/PPG-Mar: www.mar.mil.br/secirm/ingles/ppgmar.html



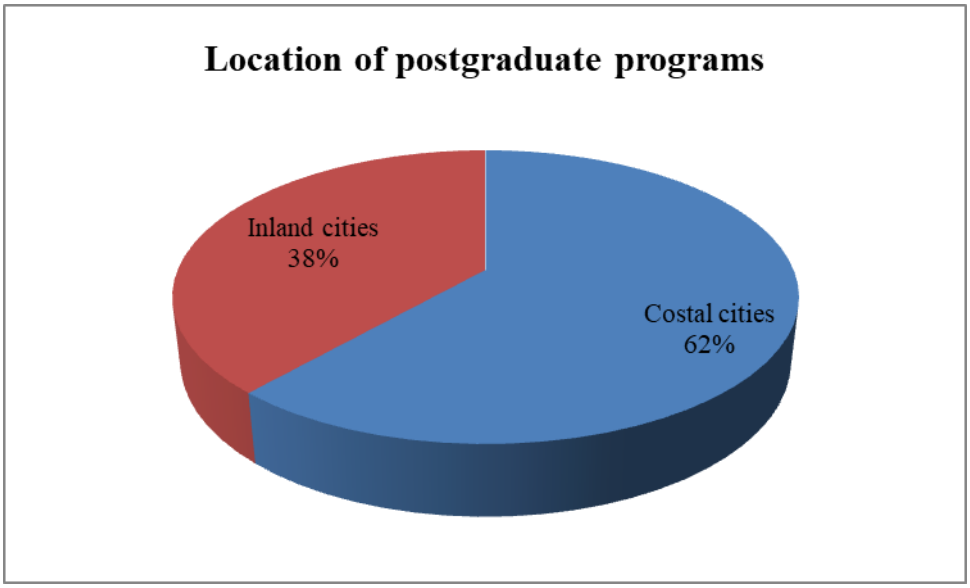
Graphic 6: Main focus of the fisheries and aquaculture postgraduate programs in Brazil.

When analyzing the geographical distribution of postgraduate programs, the absence of programs in the central-western region of Brazil is observed. The southern region presents the highest number of courses recommended/recognized by CAPES, with 4 programs, followed by the southeast, northeast and northern regions, at the same level with 3 programs in each (Graphic 7).



Graphic 7: Regional distribution of the postgraduate programs on fisheries and aquaculture in Brazil.

As opposite to the observed for graduate programs, when we analyze the location of the host cities of the postgraduate programs, it is possible to observe a preponderance of the programs located in coastal regions. Thus, of the 13 identified programs, 8 of them are located in coastal regions and the other 5 are located at inland areas of Brazil. This result suggests that 62% of the graduate programs present a greater focus of qualification of the human resources directly related to marine, coastal and/or oceanic environments.

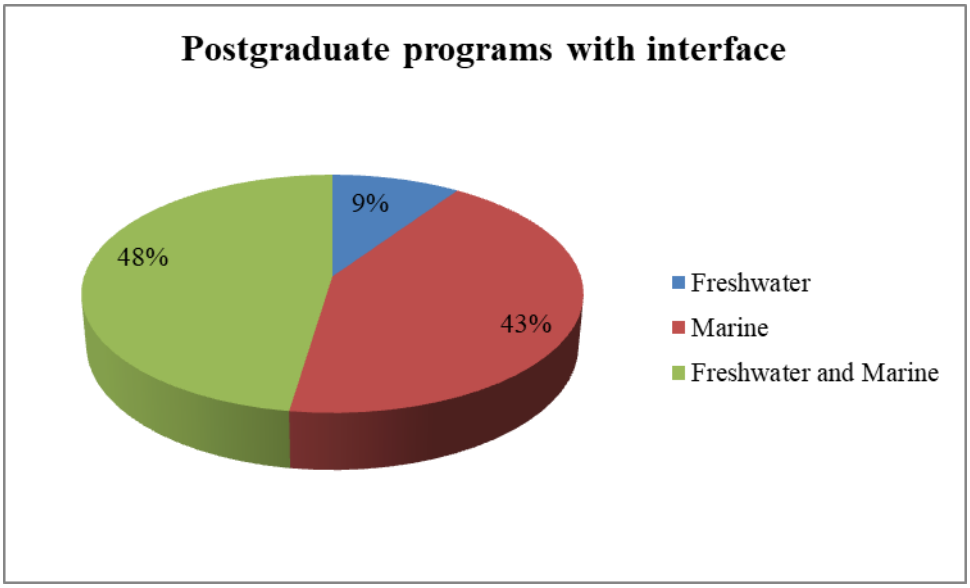


Graphic 8: Location of the postgraduate programs in fisheries and aquaculture in Brazil.

In addition to postgraduate programs with a direct focus on fisheries and aquaculture, it is known that these themes are crosscutting to other areas of training, which contribute greatly to the qualification of human resources in fisheries and aquaculture. Moreover, such programs in related areas also have researchers/professors with significant activity in the areas of fisheries and aquaculture, even if this is not their main focus.

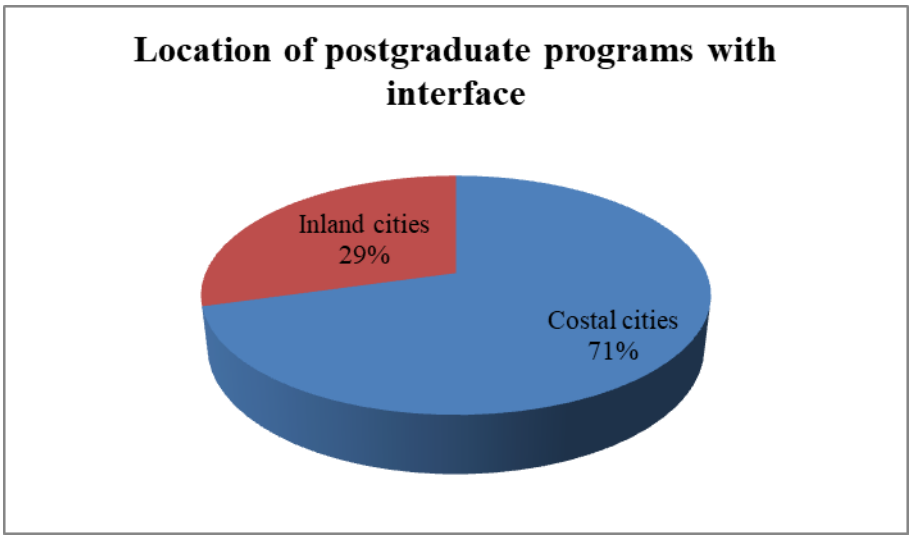
In that sense, a survey of postgraduate programs in Brazil was carried out in 2013, in which fisheries and aquaculture were not characterized as the main focus in professional qualification, but where there was research development in these areas. These programs received the nomenclature of “postgraduate programs with interface in fisheries and aquaculture" and were located, based on the analysis of the curricula of the researchers, contemplated with productivity grants, conceived by CNPq (OEI, 2013).

In this context, 21 programs were identified with interface in fisheries and aquaculture distributed in the large areas of Agrarian Sciences, Biological Sciences and Exact and Earth Sciences. Of these 21 courses, 10 are active in both marine and inland waters, 9 are prominent in research in marine environments and only 2 of them are focusing only at inland waters (Graphic 9).



Graphic 9: Main environment focus of the postgraduate programs with interface in fisheries and aquaculture in Brazil.

In this sense, was observed an important focus in marine environments, in the postgraduate programs with interface in fisheries and aquaculture, suggesting a greater qualification of human resources in this area. Corroborating this situation, it is possible to observe a higher prevalence of programs located in coastal regions, since 12 of them are located on the coast, while only five are located at inland regions of Brazil (Graphic 10).



Graphic 10: Location of the postgraduate programs with interface in fisheries and aquaculture in Brazil.

From the diagnosis presented above it was observed a prevalence of postgraduate programs focusing exclusively on aquaculture, showing a certain weakness in the training and qualification of human resources in fisheries. Regarding the location, unlike the scenario presented for graduate programs, there are a higher number of postgraduate programs located in coastal regions, both of the courses with direct focus on fisheries and aquaculture, and those with an interface in these areas, which suggests a possible greater training/qualification of human resources in the marine environment.

Finally, when conducting a brief analysis of postgraduate programs in Brazil, one can affirm that this is a recent activity, its beginning dating from the 60's. However, it was from the end of the 80's, that such postgraduate programs began to be noted and characterized as important centers of research and training of researchers (FERREIRA, 1998).

Postgraduate programs in Brazil play a fundamental role both in the training of human resources and in the generation of quality science. Corroborating this view, SEVERINO (2006) stated that besides being the source of future great researchers, postgraduate programs contribute to the institutionalization of scientific and research practice in the country. In addition, it can be said that international cooperation agreements, promoting the exchange of researchers, have greatly influenced this pattern of high research efficiency, currently present in Brazilian postgraduate studies (SANTOS & AZEVEDO, 2009).

However, even though it is of such importance for the development of science in the country, could be noted only a few postgraduate programs focusing on fisheries and aquaculture, despite the continental dimensions of Brazil, with its huge potential at inland water resources and its 8,000-kilometer-long coastline. In this sense, could be inferred that the training of human resources in the areas of fisheries and aquaculture falls short of the needs and potential of the country.

Section B – Promotion of Scientific Research

Paragraph 1 – Research Groups

In recent years, Brazil has invested in the expansion of the university system and in the modernization of public research institutes. These investments were fundamental for the formation of a contingent of scientists and research groups of international level, increasing the impact of science produced in Brazil in frontier areas of knowledge. One of the policies adopted is the promotion of research networks, through the integration of the best groups in frontier areas of knowledge and strategic for sustainable development. In this context, we highlight the National Institutes of Science and Technology Program (INCT – *Institutos Nacionais de Ciência e Tecnologia*)[68], which mobilizes and aggregates researchers, encouraging a higher scientific productivity, reducing regional disparities and stimulating the development of leading research to promote innovation and entrepreneurship, in close coordination with companies Innovative.

The survey of research groups active in fisheries and aquaculture in Brazil was carried out through a research in the Directory of Research Groups (DGP - *Diretório de Grupos de Pesquisa*)[69], available at the Lattes Platform[70], which represents the experience of CNPq in the integration of researcher's resumes, Research Groups and Research and Higher Education Institutions in a single information system.

In this context, the DGP is the inventory of the groups of scientific and technological research in activity in the country, which basically has three purposes: to promote the exchange of

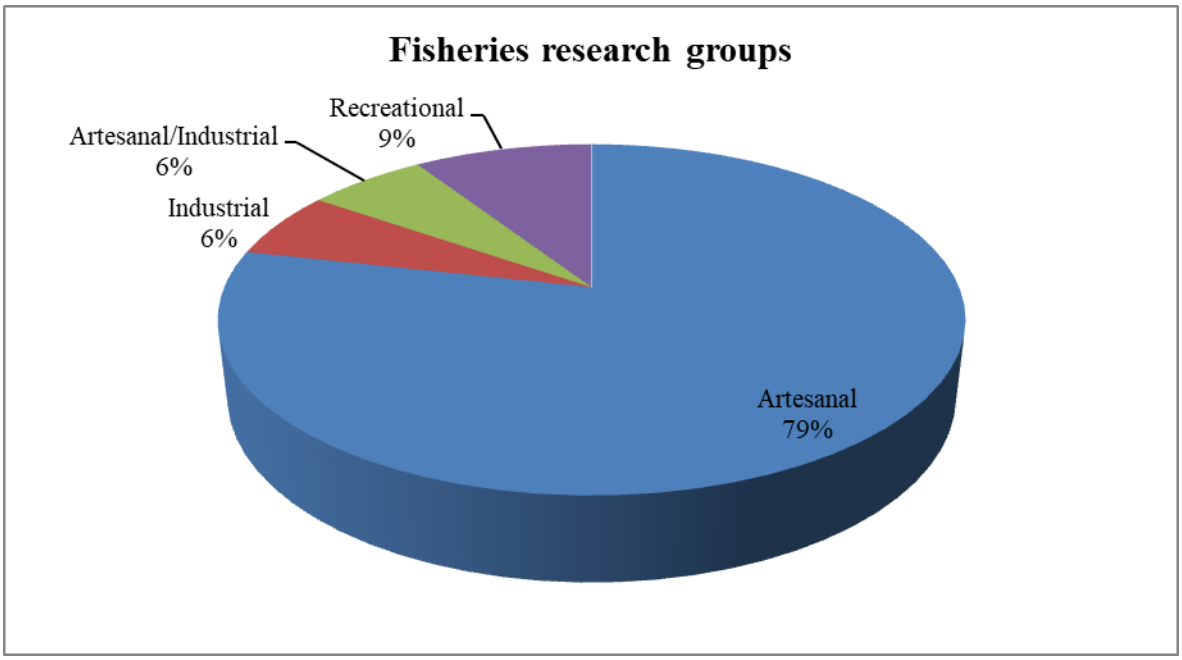
[68] INCT: inct.cnpq.br/home/

[69] DGP: lattes.cnpq.br/web/dgp

[70] Lattes Platform: lattes.cnpq.br/

information; be an important tool in the planning and management of science and technology activities; and serve as a memory of scientific-technological activity in Brazil.

Thus, when accessing the DGP page, a parameterized consultation was carried out on the current basis, with terms related to fisheries and aquaculture. In the first stage of the search, the following terms were inserted: “artisanal fisheries”, “industrial fisheries”, “marine fisheries”, “continental fisheries”, “amateur fisheries” and “sport fisheries”. All queries were performed per group and the terms applied to the "group name", "search line", and "search line keyword" fields. In order to avoid multiple counts, a cross-check of all groups was performed to ensure that they were counted only once. Thus, a total of 65 research groups were registered with some activity involving fisheries. Of these, 51 specified their activities in artisanal fisheries, 4 in industrial fisheries, 4 declared to conduct research in both artisanal and industrial fisheries, and finally 6 groups were obtained from the searches with the terms "amateur fisheries" and "sport fisheries", being jointly classified as recreational fisheries (Graphic 11).



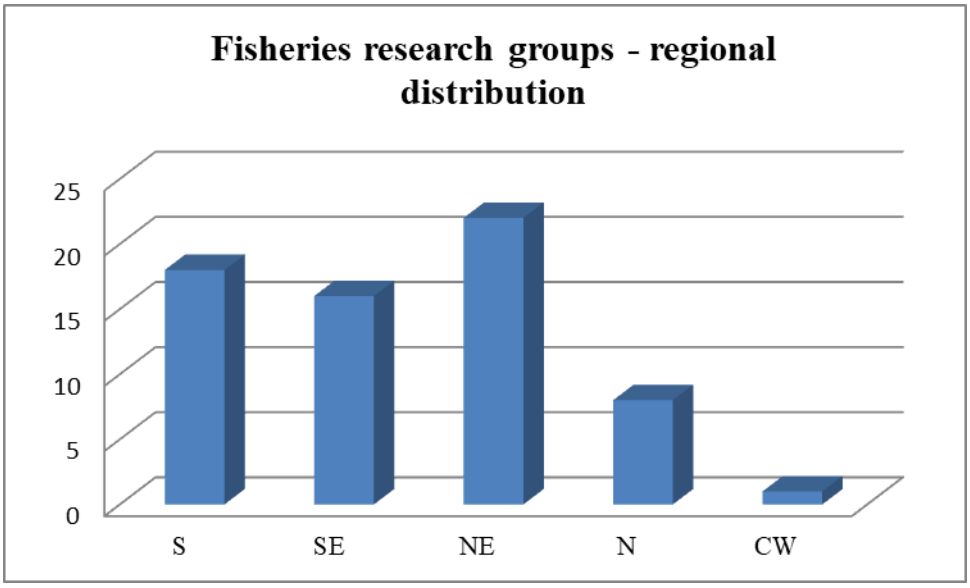
Graphic 11: Focus of activity of the research groups directly related to fisheries in Brazil.

It is worth noting that when the term “fisheries" alone was inserted in the DGP search field, the platform did not return complete results, which impaired the survey of research groups in this

category. It is believed that the system presented some error, which persisted during the two weeks of research, to elaborate this content.

When applying the terms “marine fisheries” and “inland fisheries”, it was noted that there is not an expressive specification of the research groups regarding the type of environment in which their activities are focused. Thus, when using the term "marine fisheries", only four groups were listed, all of them already counted in the previous searches, three of them in artisanal fisheries and one in industrial fisheries. Regarding the search using the term "continental fisheries", only two groups were listed, both counted as being of the artisanal fisheries, considering that is inexistent the inland industrial fisheries in Brazil.

When analyzing the geographical distribution of the research groups with activities involving fisheries, there is a scenario of great contrast. Of the 65 groups, 22 are located in the northeast region, 18 in the southern region, 16 in the southeast region, 8 in the northern region and only 1 group is located in the central west region (Graphic 12). This situation corroborates with those already described for undergraduate and postgraduate programs, which demonstrate the great lack of human resources and infrastructure for research in fisheries and aquaculture in the northern and central-western regions of Brazil.

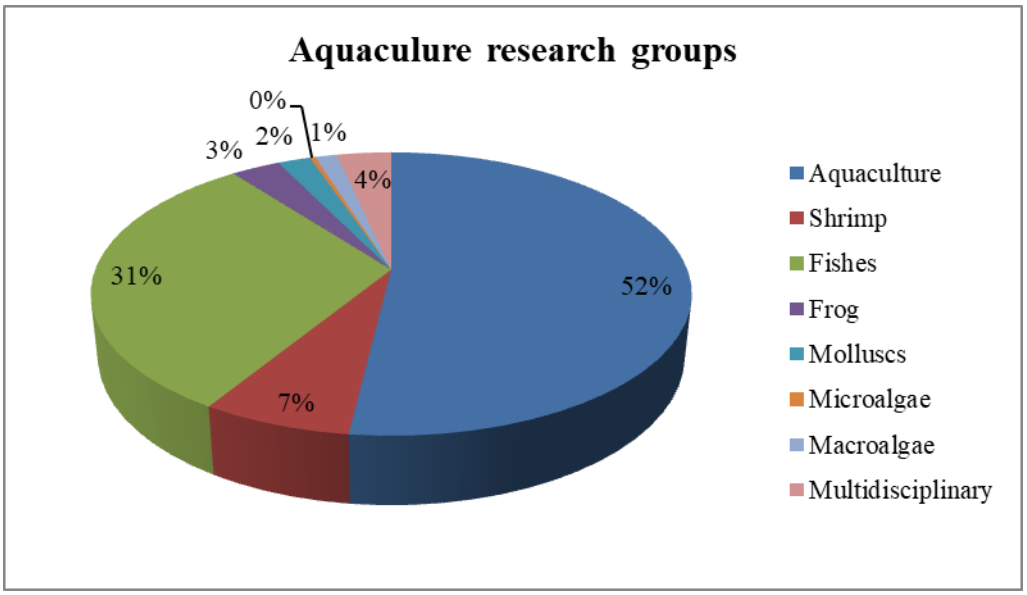


Graphic 12: Regional distribution of the fisheries research groups in Brazil.

For the second part of DGP searches, the following terms were inserted: "aquaculture", "fish farming", "shrimp farming", "mollusk farming", "frog farming", "micro-algae farming” and

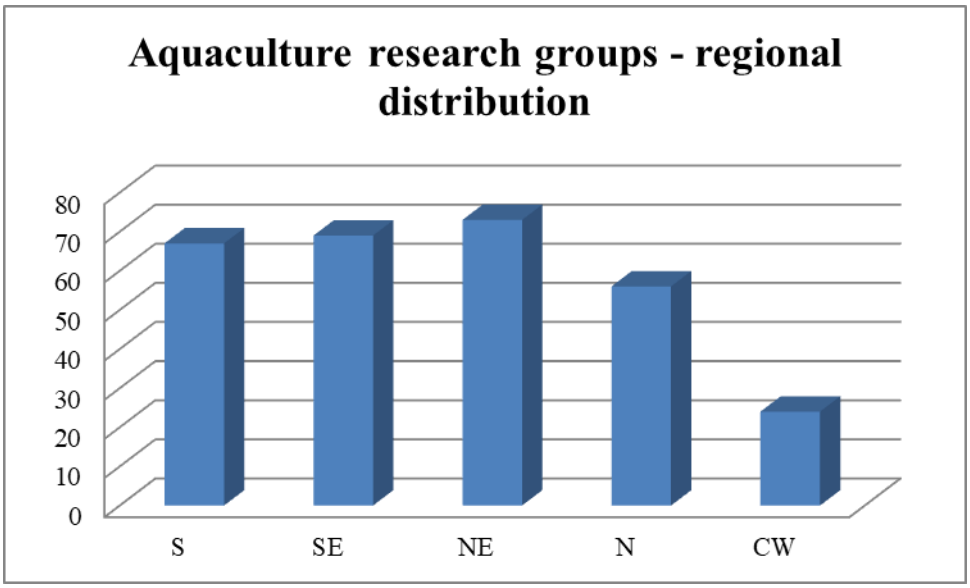
“macro-algae farming". In the same way as for the fisheries groups, the information obtained in these searches was cross-checked so that the research groups were counted only once. In this way, all the groups that appeared in the search with the term "aquaculture" and in at least one of the other terms were counted in the specific area of aquaculture that they dedicate, since the research group specified in which of the aquaculture areas they concentrates its performance.

Thus, in the universe of 289 groups, located from the search using the previously highlighted terms, 150 were declared only as research groups in aquaculture, without detailed description of which of the aquaculture areas this research group dedicates its activities. Among the research groups that specified their areas of activity, 89 were classified with a focus on fish farming, 20 in shrimp farming, nine in frog farming, six in mollusk farming, four in macro-algae farming and only one in micro-algae farming. In addition, 10 groups were considered multidisciplinary, since they worked with more than one group of species (Graphic 13).



Graphic 13: Focus of activity of the research groups directly related to aquaculture in Brazil.

When analyzing the geographic distribution of the research groups in aquaculture, it is possible to observe that these are well distributed among the north, northeast, southeast and south regions, with absolute numbers in the northeast region. On the other hand, the central-west region stands out due to the low number of research groups, in absolute terms, when compared to the other regions (Graphic 14).



Graphic 14: Regional distribution of the aquaculture research groups in Brazil.

A similar survey was conducted by KRUG (2012), in order to identify the research groups registered at DGP that had a role in marine sciences. Considering the data from the summary published in 2010, a total of 27,523 groups were found, of which 587 groups were identified acting in marine sciences, being 322 active in the field of marine sciences, while 265 other groups were classified as correlates, since their research lines were not predominant with the marine sciences.

OEI (2011) identified 281 research groups in fisheries and aquaculture, but their analysis considered only 211 groups, after applying a methodology which classified them as active and occasional. The other 70 groups disregarded in their analysis were classified as non-active, having demonstrated rare or no action in fisheries and aquaculture. Among the research groups considered in their analysis, about 60% of them were engaged in aquaculture, while about 40% were engaged in fisheries. The present analysis shows a considerable increase in this difference, where about 82% of the groups work in aquaculture, against only 18% in fisheries of a total of 354 research groups with some activity in fisheries and aquaculture.

Considering the data published by CNPq in the statistical summary of 2016[71], only 159 groups were classified and considered in the area "Fishery Resources and Fisheries Engineering", which represents 0.4%, in the universe of 37,640 research groups registered in the Directory.

In this context, it is observed a lack of expressiveness of the fisheries and aquaculture research groups when compared to all the groups registered on the CNPq platform. This situation reinforces the need to encourage and promote the engagement between researchers and students, in order to form collaborative research networks, which can consequently increase the number of groups, as well as the amount of applied research, reducing the pulverization of research and the duplicity of isolated experiments. This situation is aligned with the proposed in the paragraph on national cooperation, which presents possible models of research networks that would boost fisheries and aquaculture in general.

The present study focused only on the quantitative analysis of the groups, not considering the qualitative analysis of the information or the intensity of the groups' performance. However, the data presented by OEI (2011) indicated that in aquaculture, the groups operating at inland waters environment were more numerous, especially those of inland fish farming. Regarding fisheries, the marine area was more expressive.

According to the scenario described, there are a significantly larger number of aquaculture research groups compared to fisheries. A large deficiency of fisheries and aquaculture research groups is observed in the northern and central-western regions of Brazil, similar to the one observed previously in relation to undergraduate and postgraduate programs, as well as by OEI (2011), what may be explained by the there lack of installed capacity, research and human resources.

Paragraph 2 – Financial Support

In Brazil, there are three main research funding agencies, linked to the Federal Government: CAPES, CNPq and FINEP. As already mentioned, CAPES, a foundation linked to the MEC, plays an important role in the expansion and consolidation of the *stricto sensu* postgraduate course, in the evaluation of courses, in the access and dissemination of scientific production and in the promotion of human resources training, while CNPq and FINEP, autarchy and public

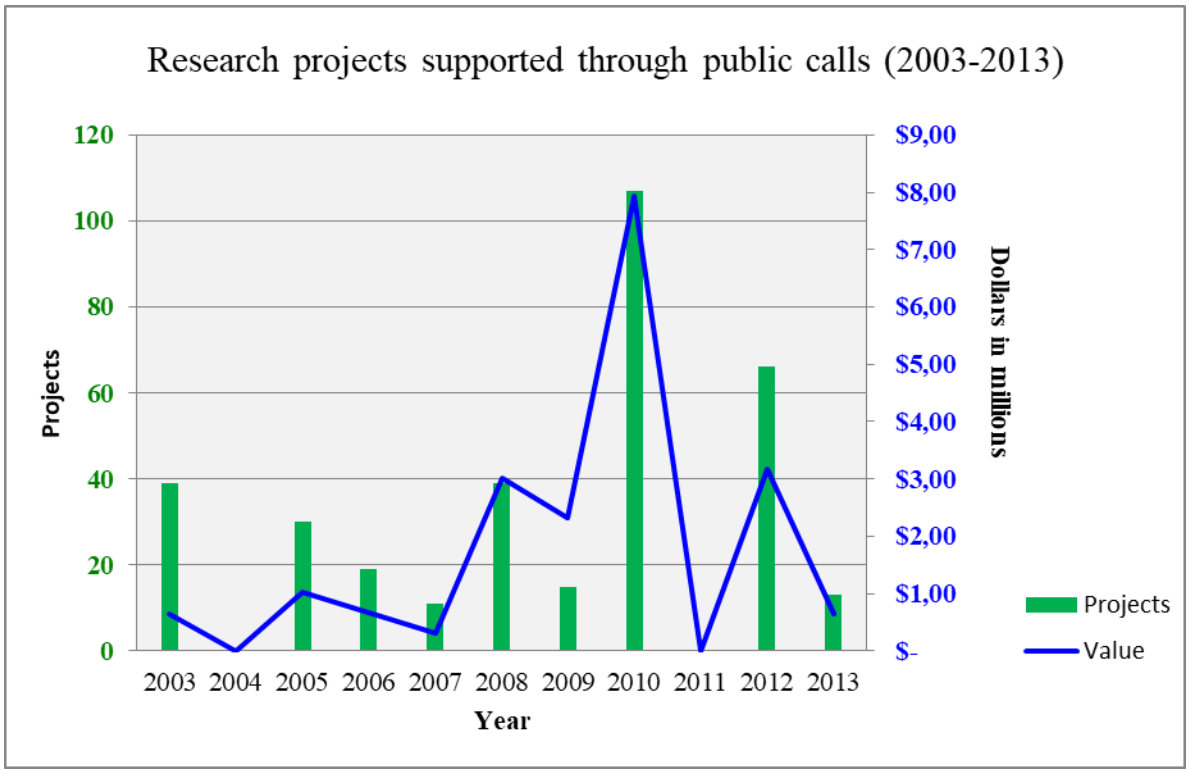
[71] DGP: lattes.cnpq.br/web/dgp/por-area1

company, respectively, are linked to MCTIC. The first aims to foster ST&I and act in the formulation of its policies, contributing to the advancement of knowledge frontiers, sustainable development and national sovereignty. In turn, FINEP aims to promote the economic and social development of Brazil through the public promotion of ST&I in companies, universities, technological institutes and other public or private institutions.

However, it is worth mentioning that such institutions are responsible for the promotion of ST&I in all areas of knowledge, without presenting an exclusive team and/or resources to promote scientific research in fisheries and aquaculture. On the other hand, these areas obtained significant investments in the period from 2003 to 2015, resulting from the efforts of SEAP and MPA, which, in turn, had as one of its objectives the promotion of fisheries and aquaculture research.

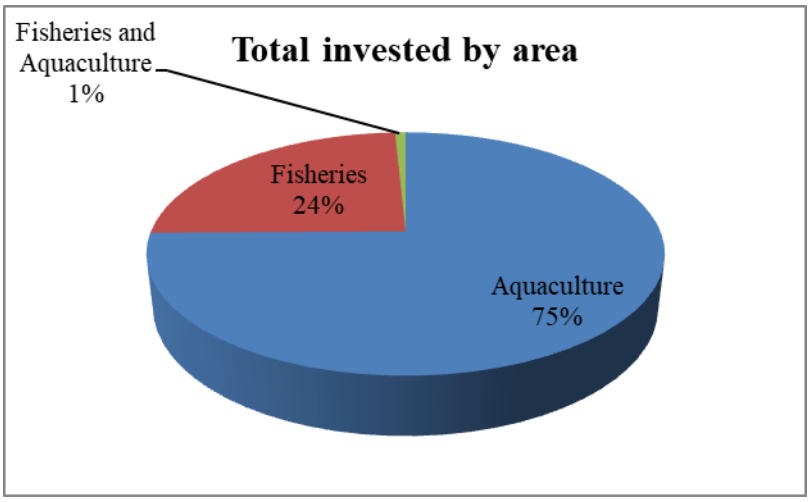
As a way to meet the numerous demands for research, SEAP and MPA carried out several actions to foment RD&I, aiming at the development of the fisheries and aquaculture sectors in Brazil. A large part of these actions were made possible through partnerships with the above-mentioned agencies, with special emphasis on CNPq, FINEP and FNDCT. These partnerships have had significant importance in the diffusion of the thematic and in the capture of financial resources, resulting in the launch of several public calls, which are characterized as the main tool used in the promotion of RD&I in fisheries and aquaculture by those institutions.

Between 2003 and 2015, 13 public calls were launched, which resulted in the financing of 334 research projects in fisheries and aquaculture, with a financial contribution of approximately US$ 20 million (Graphic 15). When analyzing the annual investment, it is worth to be highlighted the year of 2010, where approximately US$ 8 million were invested, distributed in three public calls, which supported 107 projects. Such an investment may be related to the consolidation of the then newly created MPA.



Graphic 15: Number of projects and their values invested to the promotion of research projects in fisheries and aquaculture in Brazil between 2003 and 2013.

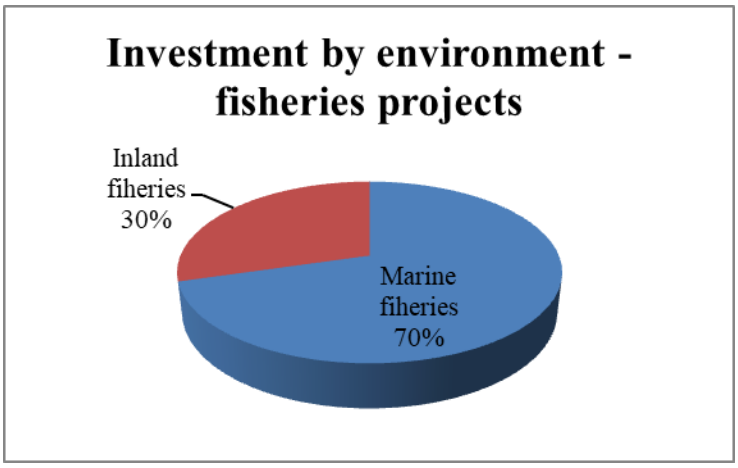
When analyzing the areas of fisheries and aquaculture, a significant difference can be observed, both with regard to the quantitative of projects and the financial resources invested. Throughout the 10 years of investment, aquaculture was supported with approximately 254 research projects, totaling an investment of around US$ 15 million. In contrast, fisheries had only 77 projects supported, with a total investment of around US$ 5 million (Graphic 16).



Graphic 16: Quantitative of projects and the financial resources invested in fisheries and in aquaculture research projects.

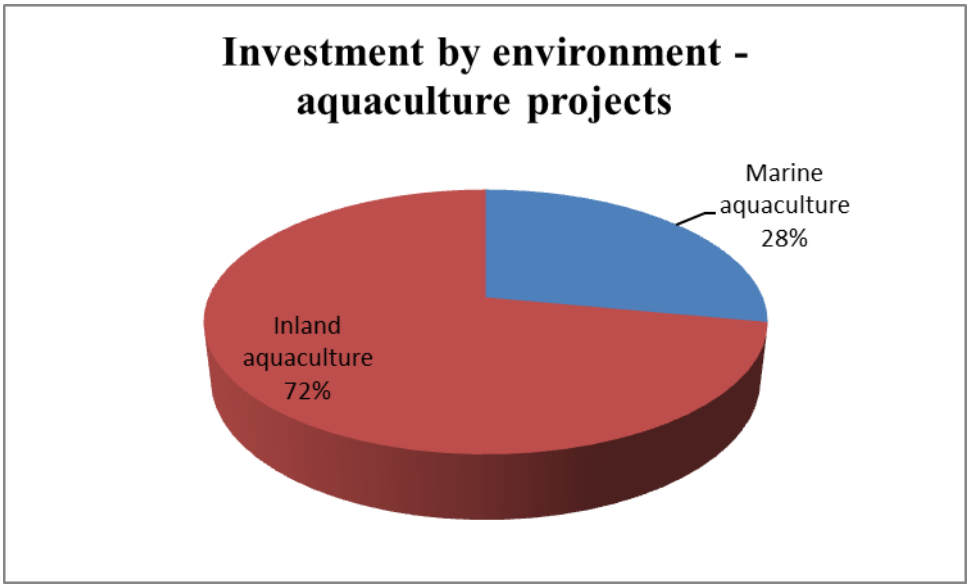
This situation corroborates with those described for graduate and postgraduate programs, as well as for the research groups analyzed in this study. Similarly, ROUTLEDGE *et al.* (2011) reported this difference in investment between areas and correlated it with the fact that a greater number of public calls have been directed to aquaculture. This is due to the great difficulty of internalizing the fisheries theme with the different sectoral fund management committees, the main co-financiers of the calls.

By carrying out a separate analysis of both areas, and starting with the projects supported in fisheries, it was possible to note a greater investment in projects with a focus on the marine environment, where 57 projects were supported by US$ 3.5 million. On the other hand, inland fisheries were contemplated with 20 projects and approximately US$ 1.5 million (Graphic 17). This situation can be justified by the greater presence of important research institutions in the coastal regions of Brazil, as well as by the high development of the fleet operating in the marine environment, in detriment of the presented to inland waters, where fisheries represents a subsistence activity.



Graphic 17: Relation of the investment in fisheries research projects with focus in marine and inland environment.

In the case of aquaculture, when the investment by culture environment is analyzed, there is a situation opposite to that of fisheries. In marine aquaculture, 78 projects were supported, with a contribution of about US$ 4 million; 176 freshwater aquaculture projects were supported, totaling an investment of US$ 11 million (Graphic 18). This situation may be related to the history of aquaculture in Brazil, which had its beginning with the freshwater fish culture. In the 1930s, records of the first freshwater fish cultures with national prominence were used to survey public dams in the northeast region of the country (OSTRENSKY *et al.*, 2007). This, in turn, may have attracted a larger number of researchers and institutions at the time, and this framework has been repeated over the years (ROUTLEDGE *et al.*, 2011) or because of the representativeness of freshwater fish farming, with a better structuring of the productive chain, which corresponds for 70% of national aquaculture production (IBGE, 2015).



Graphic 18: Relation of the investment in aquaculture research projects with focus in marine and inland water.

With the extinction of the MPA, the fisheries and aquaculture sectors lost an important organism that was active in supporting and promoting research in these areas. However, with the incorporation of SAP by MAPA, it is important to highlight the existence of EMBRAPA in the structure of this ministry, which has a decentralized research unit, created since 2009, whose main focus are fisheries and aquaculture.

In this sense, CNPASA has the national mission of generating knowledge and technologies for fishing and aquaculture. In aquaculture, its focus is on productive chains of native freshwater fish species. For this purpose, it has a multidisciplinary team, with expertise in the areas of nutrition, genetics, sanitation, fish processing, economics, production systems, and breeding and conservation resources. When compared to aquaculture, there is a significantly lower quantity of human resources engaged in fishing, crowded in the unit, indicating the need for the composition of this framework by the company.

Considering the period of analysis of this work, which covered the years 2003 to 2015, it was possible to observe the lack of constancy and continuity of investments in RD&I in fishing and aquaculture. Note that in the years 2004, 2011, 2014 and 2015 there were no public calls. This situation does not necessarily reflect the absence of investment in those years, considering that the extinguished Ministry had other mechanisms to support research, however, it reflects a very small investment compared to the years whose calls were the main support tools.

When analyzing the investments made by area, separately, it is observed that aquaculture prevailed both in volume of resources and in number of projects, in about 75% compared to fisheries, reiterating the difficulties already described for fisheries research. Regarding the investments, most of the resources were destined to marine fisheries, perhaps because of the size of the active fleet on certain fishery resources, while inland aquaculture has shown greater investments, which can be attributed to the history of the activity in the country.

PART TWO – SCIENCE, TECHNOLOGY AND INNOVATION FOR FISHERIES AND AQUACULTURE

CHAPTER 1 – INFRASTRUCTURE AND SCIENTIFIC AGENDA

Section A – National Institute for Oceanic and Waterways Research

Paragraph 1 – Centre for Marine Research in Fisheries and Aquaculture

Analyzing the information listed in Part One above, it is possible to note a strong tendency for the promotion and strengthening of RD&I on new technologies for the productive activities of fisheries and aquaculture, mainly by the international laws and soft-laws as well as by the international organizations dealing with this subject. Thus, based on this review of the legal and institutional framework, whose main focus was the aspects related to fisheries and aquaculture RD&I, it is highly recommended the consideration of such issues by the Brazilian stakeholders when planning and promoting their actions and strategic programs in this way.

The importance attached to marine scientific research is such that UNCLOS itself devotes its Parts XIII and XIV to deal exclusively with this matter by proposing actions and measures that promote the marine scientific research as well as the development and transfer of marine technology. Thus, Article 239 indicates that “States and competent international organizations shall promote and facilitate the development and conduct of marine scientific research in accordance with this Convention”. In addition, Article 275 indicates that “States shall to promote, directly or through appropriate international organizations, the establishment, in particular in the coastal developing States, of national centers for marine scientific and technological research and the strengthening of existing national centers in order to stimulate and

advance the conduct of research marine science by developing coastal States and to increase their national capacity to utilize and preserve their marine resources for their own economic benefit".

Likewise, it is worth to note that CBD also dedicates some of its Articles to the promotion and development of scientific research, among which are Article 12 (Research and Training), Article 16 (Access and Transfer of Technology), Article 17 (Exchange of Information) and Article 18 (Technical and Scientific Cooperation). In addition to these Conventions, the Fish Stocks Agreement, in its Item 3 of Article 14, states that "Consistent with Part XIII of the Convention, States shall cooperate, either directly or through competent international organizations, to strengthen scientific research capacity in the field of fisheries and promote scientific research related to the conservation and management of straddling fish stocks and highly migratory fish stocks for the benefit of all". While the Code of Conduct for Responsible Fisheries dedicates its Article 12 exclusively to fisheries research, being worth to highlight its item 2, which indicates that "States should establish an appropriate institutional framework to determine the applied research which is required and its proper use".

When we take into account Brazilian legislation, with particular emphasis on PNMA, PMN, PNRM and PNDSAP, it can be noted that these also recognize the value of research and technological development, as can be seen in specific articles.

The PNMA in its Article 2 indicates among its guiding principles "incentives for the study and research of technologies oriented towards the rational use and protection of environmental resources".

The PMN proposes a series of actions to be carried out in the field of scientific and technological research and development, so that the following should be highlighted: encouraging research that contributes to the attainment or development of national technology; support universities and research centers that contribute to the development of national technology in the field of maritime activities; encourage the establishment or development of research institutions in the field of marine activities.

The PNRM is essentially aimed at "establishing principles and objectives for the preparation of government plans, programs and actions in the field of human resources training activities; in the development of research, marine science and technology; and the exploration and sustainable exploitation of the marine resources".

The PNDSAP, in its Article 7, indicates that the fisheries activity includes, among others, the research of fisheries resources, as well as that the sustainable development of the fisheries

activity will be achieved through, among others the research of the resources, techniques and methods pertinent to the fisheries activity.

In this way, the MCTIC seeking to work in accordance with the recommendations established by the international legislation, as well as adapting to the national policies now in force in Brazil and, also, based on recommendations of the Brazilian scientific community through the 62nd Meeting of the Brazilian Society for the Advancement of Science (SBPC - *Sociedade Brasileira para o Progresso da Ciência*), started in 2010 the constitution process of INPOH. This result was articulated between MCTIC, Secretariat of Science and Technology of the Brazilian Navy (SecCTM - *Secretaria de Ciência e Tecnologia da Marinha do Brasil*), MPA and the Special Secretariat of Ports (SEP - *Secretaria Especial de Portos*). Since its creation was officially established in 2013, its main objectives include the promotion of scientific and technological development in the areas of physical, chemical, biological and geological oceanography; ocean-atmosphere interaction; marine fisheries and aquaculture; river and port hydraulic; port studies; coastal and underwater engineering; underwater instrumentation; marine and coastal biodiversity and; energy from the oceans.

The idea was conceived for the Institute to function as a Social Organization and to coordinate activities for the country's scientific and technological development as well as to expand the knowledge base on the oceans and their sustainable use, with an emphasis on the South and Tropical Atlantic Ocean. The option of adopting the Social Organization model was due to the fact that this type of institution brings more flexibility to manage the resources, that would come in part from the ministries interested in the Institute, with a management contract that allows the use of such resources trough a most effective and dynamic way, being this type of organization regulated through Law No. 9.637 of 15 May, 1998 which provides for the qualification of entities such as social organizations.

The association that gave rise to INPOH had the expressive participation of the scientific community in the area of Marine Sciences, as well as companies and non-profit organizations representing civil society. The governance structure was built considering all public partners and stakeholders involved. It’s worth to be noted that initially the idea was to create the Institute with a central administration and four research centers, namely: South Atlantic Oceanography Center; Tropical Atlantic Oceanography Center; Center of Ports and Waterways; and the Center for Marine Research in Fisheries and Aquaculture.

The creation of the Institute have already completed the phases of the constitution of and association, the registration in the competent public departments, the convocation of the Board of Directors and the election of the Executive Board, while lasts pending the phases of qualification as a Social Organization, through a presidential decree, as well as the signing of the Management Agreement. Due to bureaucratic, institutional and financial problems that have occurred in recent years, the process of qualifying the Institute as a Social Organization has been going on for much longer than expected and there is currently no definition of when this phase can be achieved.

Among the main problems identified as responsible for not implementing INPOH is the extinction of the MPA and the SEP, which have been incorporated into other ministries that have not yet given equal importance to the effective implementation of the Institute. As a result, the budgets that MPA and SEP would provide to support INPOH are no longer available. In addition, considering that there has been a reduction of four partner institutions to only two currently, it will be necessary to proceed with a review of the current Statute of INPOH, which will consequently result in a change in the Board of Directors.

Actually, the mission to carry forward the Brazilian scientific community wish for the creation and implementation of a national institute focused on marine and oceanic scientific research considering the current reality is exclusively the responsibility of MCTIC and SecCTM. Thus, the creation of the four research centers is temporarily suspended, mainly due to the problems resulting from the reduction of the available budget. A suggestion for the current reality of INPOH would be to consider the formalization of partnerships with Associated Laboratories (linked to research centers of Brazilian universities) through the publication and launch of public calls and other forms of selection of these partners.

In spite of the problems listed here, the present work has among its objectives the construction of a scenario in which public policies for scientific and technological development aimed at the promotion of the sustainable development of fisheries and aquaculture, and the proposal to create the Center for Marine Research in Fisheries and Aquaculture of INPOH become a reality in Brazil.

According to MCTIC/UNESCO (2013a), INPOH's Center for Marine Research in Fisheries and Aquaculture may represent an opportunity to materialize the Brazilian commitment to the development of fisheries and aquaculture from a responsible perspective. The Center should act as a driving force for improvements in the national marine fisheries and aquaculture scenario, giving priority to and implementing actions, programs and projects that are strictly in line with

the aspirations of the Code of Conduct for Responsible Fisheries. The explicit incorporation of this vocation into the Mission of the Center would not only contribute to making the Center the driving force, but would also:

a. strengthen its neutrality *vis-à-vis* the difficult institutional framework described above;
b. give the necessary north to its own scientific initiatives;
c. project INPOH at national and international levels, facilitating partnerships and leveraging additional funding.

In order to contribute to the implementation of a policy in which materializes the desire of the Brazilian scientific community for the creation and implementation of the Center for Marine Research in Fisheries and Aquaculture, the Chapter One of Part Two of this study will present relevant aspects and conditions that can be considered essential for the achievement of the Center's work. Therefore, the implementation plan and the scientific agenda, including the research priorities for the fisheries and aquaculture areas, will be proposed below.

Chapter Two of Part Two has the purpose of complementing the scientific actions from the implementation of the Center, considering the strengthening of human resources, through the promotion of capacity building and the transfer of technology, as well as strengthening the Center itself and INPOH through institutional cooperation with other research centers and public and private institutions at national and international level.

Paragraph 2 – Implementation Plan

The present Implementation Plan for the Center for Marine Research in Fisheries and Aquaculture was built based on information obtained from technical products prepared by Ad hoc consultants, within the scope of Project 914BRZ2018 (MCTIC/UNESCO) contracted with Brazilian researchers of notorious knowledge in the areas of fisheries and aquaculture. These consultancy products were contracted and elaborated in 2013 and had as objective to provide the essential elements to the formulation of the Scientific Agenda and the Implementation Plan of INPOH, in what refers to its operation in marine fisheries and aquaculture research.

Through a proposal for the purpose of systematization, the Center was grouped into four Thematic Units. According to the proposal presented, the Units would comprise seven national and multi-institutional programs to be articulated and managed by the Center, as well as three priority areas of scientific action of the Institute itself, which will be described as follows:

a) Unit of Management for Induced Programs and Projects

The objectives of this Unit are to provide assistance to the management of the programs and projects to be developed by the Center and to articulate, foster and manage the induced scientific programs and projects, which may require national and/or international multi-institutional participation (as will be explained in Paragraphs 1 and 2 of Section B) and a greater degree of infrastructure. The assumption was that this Unit would only serve the Center for Marine Research in Fisheries and Aquaculture; however it could be considered the implementation of a central Project Office for INPOH as a whole.

b) Unit of Structural Programs

The objective of this Unit is to maintain and manage programs for obtaining, processing, storing and disseminating environmental, and marine fisheries and aquaculture data and information in order to provide the necessary support for the work of universities and research centers already in existence in Brazil, the future research centers of INPOH, the governmental institutions, as well as to society in general. Therefore, the following programs should be articulated and managed by this Unit:

- National Statistical Program for Marine Fisheries and Aquaculture

This program has the objective of articulating and maintaining a permanent system of collecting, processing, storing and disseminating fisheries information (e.g. catch, fishing effort, fishing areas, basic biological data and means of production, among others) and aquaculture (production by groups of species, cultivated area, among others) throughout all the estuarine and marine national domain. Therefore, the following basic actions should be considered:

a. the program structured in accordance with SINPESQ;
b. articulate a national network of institutions that can act as partners in the development, maintenance and operationalization of the Program;
c. make it viable, by own means, to cover sites where there are no available partners;
d. define with IBGE, MAPA and other institutions, the standards and instruments of collection, processing, storage and dissemination of data;
e. host and manage the biological, fisheries and aquaculture database and manage access to data and information;

f. prepare consolidated annual reports on fisheries and aquaculture production in the country's marine and estuarine areas.

- National Board Observer Program - PROBORDO

The objective of PROBORDO is to organize and maintain a scientific observation network on board of commercial vessels in order to obtain *in situ* data on technological, operational aspects, qualitative and quantitative composition of the catches used and discarded, fishing effort, fisheries areas and biological data, among others. Therefore, the following basic actions were proposed:

a. articulate with MAPA and MMA the restructuring of the PROBORDO legal framework;
b. perform the executive management of the Program;
c. articulate a network of partner institutions and/or contractors in strategic coastal locations to act as logistical/operational centers of the Program;
d. define, together with the government, research institutions, and the productive sector, observation goals and protocols;
e. format and conduct, in conjunction with government and partner institutions, specific courses to train observers;
f. to host and manage the biological and fisheries database and manage access to data and information.

- Scientific Observation Program for Fishing Vessels by Satellite

The objective of this Program is to make possible the scientific application of the information coming from the satellite tracking of the national fishing fleet. Therefore, this Program should consider the basic actions described below:

a. articulate with the Management Committee of PREPS the release of access to the data and information of the Program for INPOH;
b. to promote their integration with the other fisheries and environmental data/information systems managed by the Institute;
c. to enable its application for national oceanographic and fisheries research.

- Monitoring Program for Oceanographic Data Associated with Fisheries and Aquaculture

The objectives of this Program are: to expand national oceanographic monitoring through the use of commercial fishing vessels such as mobile stations as well as the aquaculture parks as fixed estuary and ocean observation stations; to enable the investigation of the relationship between oceanographic variables and fisheries and aquaculture resources. Therefore, the following basic actions should be considered:

a. articulate partnerships with the productive and scientific sectors to form an observation network;
b. define, together with the partners, the set of oceanographic data to be monitored;
c. define sensors and instruments to be adopted;
d. adapt, install, calibrate and maintain the sensors/instruments with the support of the partners;
e. to manage the collection and measurement of data quality;
f. to host and manage the database and the access to data and information.

- National Management Program for Fisheries and Aquaculture Research Vessels

Its objective is to enable the provision and coordinated use of vessels to meet the demands of national fisheries and aquaculture research through the following basic actions:

a. to manage future fishing research vessels linked to the Institute;
b. to enable the use of third-party research vessels and/or the contracting of commercial fishing vessels to conduct direct evaluations of fish stocks under the Fish Stock Assessment Program (below) or to meet other demands related to the projects and programs managed or supported by the Institute.

c) Unit of Marine Fisheries and Aquaculture Evaluation, Diagnosis and Planning

This Unit has the objectives of providing Brazil with periodic reviews and evaluations on fisheries and aquaculture activities, on fish resources and national aquaculture as well as on the associated environment, in addition to producing and maintaining an up-to-date scientific knowledge base, with a view to subsidize public policies and to point out the Brazilian research priorities in marine fisheries and aquaculture. Therefore, the following Programs are associated with this Unit:

- Fish Stock Assessment Program

This program aims to implement a routine of periodic evaluation of abundance as well as a diagnosis of the exploitation state of the national fish stocks through the following basic actions:

a. organize and maintain a multi-institutional network of researchers (including the Institute itself) to conduct periodic assessments and assessments of fisheries resources;
b. jointly with the government and partner institutions, define the stocks to be evaluated, the applicable methods (e.g. direct evaluations, structured models, etc.) in each case;
c. establish, manage and execute, together with the partners, a calendar of evaluation and diagnosis of the selected resources;
d. promote the continuous training of Brazilian researchers in the subject;
e. provide advice on planning and execution of evaluations of emerging or not yet evaluated fisheries resources for national researchers.

- Fisheries and Aquaculture Evaluation, Diagnosis and Planning Program

Its objective is to produce and disseminate an updated scientific knowledge base on the structural, functional and strategic aspects of marine fisheries and aquaculture at the national level, in order to identify RD&I priorities and guide the public sector policies. In this way, the preparation of studies and periodicals on relevant topics in marine fisheries and aquaculture, including at least:

a. qualitative and quantitative assessments and forecasts of the threats and vulnerabilities of marine fisheries and aquaculture to the various pressure and impact agents, whether current or future;
b. characterization of the state of the art of knowledge and gaps in national research in marine fisheries and aquaculture;
c. characterization of the structure and dynamics of the national marine fisheries and aquaculture;
d. diagnosis of the state of national fish stocks;
e. proposals for priority programs and projects for the sustainable development of marine fisheries and aquaculture.

d) Research Unit on Responsible Marine Fisheries and Aquaculture

This Unit aims to develop research focused on filling important gaps in national fisheries and aquaculture science, contributing to the development of these activities in the country in

accordance with the principles of the Code of Conduct for Responsible Fisheries. Therefore, it is recommended to implement three main research areas:

- Fisheries and Aquaculture Technology

The priority research lines proposed for this Unit are: description of the fishing gear and the technology used in the country; development of technological and operational alternatives that will mitigate the negative effects of fishing on target species, associated fauna, other components of the marine ecosystem, atmosphere and profitability of fisheries; development of rational materials, equipment and cultivation techniques in environmental, energetic, operational, economic and social aspects, including technologies that are not widely available or dominated in the country, such as surface and/or submersible net cages, and protocols for the aquaculture structures settlement in shallow and deep water areas.

- Sustainable Development of Marine Aquaculture

The following priority research lines were proposed for this research unit: development of polycultures of native species; aquaculture and bioremediation; diagnosis and strategies to reduce the environmental and social impacts of aquaculture; organic and/or low input aquaculture.

- Stock Assessment, Economics and Ecosystem Management

The following priority research lines were proposed for this research unit: assessment of fish stocks by direct and indirect methods; fisheries and aquaculture economy; ecosystem management of marine fisheries and aquaculture at local, regional, national and international scales.

In addition to the suggested research lines for the units mentioned above, in the paragraphs of the following Scientific Agenda section, will be presented and discussed suggested priority research lines for the fisheries and aquaculture areas, in order to complement the above information.

Section B – Scientific Agenda

Paragraph 1 – Priorities in Fisheries Research

Considering the importance of environmental, social and economic sustainability of fisheries in Brazil, it is necessary to adopt adaptation measures that cover the main links of the fisheries productive chain. These measures aim at conditioning the exploitation of these resources to biologically sustainable levels, providing the recovery of the main fish stocks, as well as optimizing these chains, both with measures of management as well as better use of the fish and the aggregation of value to its products. Parallel to these actions, it is necessary to stimulate the development of new productive chains in an orderly way, making fishing effort compatible with the potential for renewal of stocks and, consequently, sustainable harvest yields.

The scientific agenda proposed here aims to guide the development of research and technological innovation, seeking to solve some of the bottlenecks of fisheries production chain, as a way of subsidizing fisheries management in a manner compatible with sustainable development. From the elaboration of a structured scientific agenda and with constant financial and structural investments, it becomes possible to increase the competitiveness of the national fish production, obeying the sustainable limits of exploitation of the fisheries resources, besides promoting the inclusion and socioeconomic development as well as food and nutrition security.

To this end, this scientific agenda was built based on information obtained from technical products prepared by *Ad hoc* consultants, within the scope of Project 914BRZ2018 (MCTIC/ UNESCO). In addition, other types of information were also collected through documents obtained from MPA, which were elaborated and discussed as a way of collaborating with the development of a scientific agenda for the Center for Marine Research in Fisheries and Aquaculture of INPOH. These documents describe the main bottlenecks and lines of action necessary for the development of fisheries, discussed trough participatory exercises, along with the various segments involved with the fisheries activity in Brazil.

In this sense, it is necessary to induce RD&I activities in the different areas of fisheries science, in order to generate knowledge, methods and techniques to support the orderly and sustainable development of fisheries in Brazil, with minimization and mitigation of impacts and, improving the competitiveness of the productive sector. Therefore, taking into account the proposals indicated by MCTIC/UNESCO (2013b) to seek the modernization of fisheries activity in Brazil, it is suggested to prioritize the areas of research described below:

a. Studies that contribute to the maintenance, management and sustainability of national fisheries, reconciling the maximum sustainable yield from exploitation and production, without endangering fish stocks, the environment and associated ecosystems;

b. Development of methods and technologies for the modernization of the main Brazilian fisheries, allowing, among other things, better selectivity of fish caught, reduction of incidental fisheries and accompanying fauna and reduction of high levels of waste and loss of fish quality in the processes storage, handling, landing and marketing.

Thus, the research demands were organized into five topics, which summarize the main areas that make up the fisheries production chain, with specific action lines for each area highlighted.

- Fisheries Biology

Although it is a basic area of knowledge for an effective fisheries management which still presents a large part of the current investments in research, it is considered that it is still urgent to concentrate more efforts in studies focused on the fisheries biology of several commercially exploited species. Information on the biology of the main species, focusing on genetics as a tool for population characterization, as well as breeding, feeding, age, growth, recruitment periods, distribution and relative abundance are essential for the construction of sustainable fisheries management.

In addition to fisheries monitoring data, such as catch and effort, the development of research capable of providing biological information on the main exploited species is crucial to allow the application of more reliable inventory evaluation methods.

- Environmental Interactions

Another important area to be studied are the effects of the environment on fish stocks. The study of the interference of environmental phenomena, such as climatic variability and oceanographic changes, relative abundance of stocks, distribution and catch levels, could better portray the behavior and habitat use of some stocks, as for migratory fish.

For this type of study, the use of pop-up electronic tags and acoustic telemetry, as well as the enrichment phenomena associated with banks and oceanic islands, become essential tools. In this context, research with an ecosystem approach should receive special attention, including the relationships between the main species caught, their habitat and the fishing equipment used to capture them, including the influence of fishing in the food chain.

According to CGEE (2007), some important topics to be considered in this area of knowledge include:

a. the mapping of submarine relief and types of funds, and their association with fish resources;
b. the dynamics of surface currents and effects on larval distribution;
c. the dynamics of the thermo-haline structure of the water column and sea surface temperature;
d. studies aimed at the application of remote sensing in fishing;
e. selectivity studies of fishing apparatus;
f. assessment of the productivity of the ecosystems used in fisheries, in particular as regards the spatial and temporal distribution of chlorophyll;
g. recruitment studies, based on oceanographic monitoring and abundance of eggs and larvae.

- Fisheries Technology

Within the scope of this topic the development and diffusion of new technologies for the fisheries activity should be treated. In this context, the development of equipment for the prospection and capture of new stocks, as well as the improvement of the fishing gear, is aimed at reducing catches of accompanying fauna, increasing the efficiency of catches of target species and the consequent minimization of negative impacts on the environment.

- Fish Technology

Within the topic of fish technology, the development of new technologies for the handling, conservation and processing of fish on board and on land is emphasized, leading to better quality, reduction of losses and, consequently, value added. In this sense, it can be affirmed that the improvement of fish handling, conservation and processing techniques can therefore significantly increase the value of the fish caught, thus increasing fishery yield without the need to increase fishing effort.

Another focus should be on the development of new fish-based products, both in terms of diversification in their presentation and in the development of industrial products. These products have high added value and have strong demand from the industrial sector, both from the food industry and from the pharmaceutical and biotechnological industries.

Finally, in the same way, it is important to develop a line of research for the use of fishing waste, also called by-products. Through this initiative, in addition to adding value to what would

previously be discarded, there is also the resolution of an environmental liability, resulting from the fish processing.

- Socioeconomics

Despite its importance, this is one of the least known and studied aspects of the national fisheries activity. Studies of this nature should serve as a basis for the development of new models of fisheries management. Such models should include elements directly linked to the conservation of target stocks (catch quotas, fisheries effort limitation, minimum catch size, etc.), elements of the marine ecosystem (impact on accompanying and incidentally caught species of fauna, degradation of habitats) and alternative management strategies (implementation of marine reserves as a tool for fisheries management, areas of fishing exclusion, shared management, etc.). In addition, this area should focus on discussions and constructions about the management process, associativism, cooperativism, production relations, occupational safety, among other aspects, with the productive sector, being it industrial or artisanal fisheries. Knowing the profile of fisheries professionals is fundamental to propose techniques for improving the activity, since the workforce must also undergo a transformation process.

Once the strategic areas for the development of research have been defined, it is necessary to define for which species the efforts will be focused as a priority. Therefore, due to the huge biological diversity in Brazil, there is, historically, great difficulty in defining which species or groups of species should receive greater focus, in this way the following table 1 presents a list of species proposed as priorities for the research in marine fisheries.

Table 01: Priority species to focus on marine fisheries research in Brazil, as well as their respective geographic regions in which the studies must be developed (*Common names obtained from the Fishbase[72] database).

Groups of Species*	Scientific Name	Geographical Regions
Tunas and Related Species (Atuns e afins)	*Xiphias gladius*, *Thunnus albacares*, *Thunnus alalunga*, *Thunnus obesus*, *Coryphaena hippurus* *Katsuwonus pelamis*	N / NE / SE / S

[72] FishBase: www.fishbase.org/

Shrimps (Camarões)	*Xiphopenaeus kroyeri, Farfantepenaeus brasiliensis, Farfantepenaeus paulensis, Farfantepenaeus subtilis, Litopenaues schmitti*	N / NE / SE / S
Laulao Catfish (Piramutaba)	*Branchyplatystoma vaillant*	N
Mangrove Crab (Caranguejo-uçá)	*Ucides cordatus*	N / NE
Octopus (Polvo)	*Octopus genus*	N / NE
Southern Red Snapper (Pargo)	*Lutjanus purpureus*	N / NE
Croakers (Corvinas, Pescadas)	*Menticirrhus americanus, Menticirrhus littoralis, Micropogonias furnieri*	N / NE / SE / S
Sardine (Sardinha)	*Sardinella brasilienses*	SE / S
Mullets (Tainhas)	*Mugil* spp.	SE / S
Blackfin Goosefish (Peixe-sapo)	*Lophius gastrophysus*	SE / S
Deep-Sea Crab (Caranguejo de profundidade)	*Chaceon ramosae Chaceon notialis*	SE / S
Rough Scad (Xixarro)	*Trachurus lathami*	SE / S
Argentine Shortfin Squid (Calamar Argentino)	*Illex argeninus*	S
Argentine Anchovy (Anchoíta)	*Engraulis anchoita*	S

Paragraph 2 – Priorities in Aquaculture Research

The scientific agenda proposed aims to guide the development of research and technological innovation, in order to solve the bottlenecks of aquaculture production chains. In this way, it is intended to stimulate and leverage the production of national marine aquaculture, based on sustainable development models. Through a solid scientific agenda that meets the needs of the productive sector, it becomes possible to increase the competitiveness of the national aquaculture production, within safe limits for environmental, economic and social sustainability.

Following the same methodology used for the construction of the scientific agenda for fisheries, this agenda was built on the basis of technical products prepared by Ad hoc consultants, within

the scope of Project 914BRZ2018 (MCTIC/UNESCO). In addition, other types of information were also collected through documents obtained from MPA, which were elaborated and discussed as a way of collaborating with the development of a scientific agenda for the Center for Marine Research in Fisheries and Aquaculture of INPOH. These documents describes the main lines of research needed to develop different production chains, discussed through participatory exercises, along with the various segments involved with Brazilian aquaculture.

In this way, the following priority research lines will be described for each marine aquaculture production chain in Brazil. These research lines were organized in 12 topics, which represent the main species to be developed, emphasizing that in addition there will be a need to contemplate market research, as well as the development of marine aquaculture parks. Such stratification was due to the different levels of development in which the productive chains meet, requiring specific investments and in the most varied intensities, in order to promote their full development.

- Pacific White Shrimp (*Litopenaeus vannamei*)

The Pacific white shrimp production chain is one of the most consolidated in Brazilian aquaculture. The first production records date back to the 1980s, when the national shrimp production sector began to focus on this species, based on the success of the production farms already installed in countries like Ecuador and Panama, which demonstrated a good capacity of adaptation of the different ecosystems (ROCHA, 2011). Thus, considering the current stage of development of shrimp farming, the main lines of research aim at the development of production models in low salinity waters, including studies on osmoregulation, administration of mineral supplements via fertilizers and via feed, as well as sensorial analyzes.

Despite the already advanced stage of development of this production chain, Brazilian shrimp farming has still suffered from pathologies. In this area, the studies should be related to the development and use of probiotics and immunostimulants, as well as the quantification and qualification of micro-algae and their control, as well as the investment in studies with genetic improvement, aiming at a higher resistance of the farmed animals.

- Mussel (*Perna perna*)

The cultivation of the mussels *P. perna* together with the oysters *Crassostrea* sp. represents the main species of mollusks grown by Brazilian marine aquaculture. Regarding geographic distribution, mussels cultivations are concentrated in the coastal areas of the southeastern and

southern regions of Brazil, however, the productive chain of this species has been showing great variability in the volumes produced annually. This variation is justified in large part due to the difficulties in the process of seed harvesting. Therefore, it is necessary greater investments in research focused on solving the bottlenecks related to this seed collection in natural banks at different seasons, considering the necessary structures, locations and extracts of the water column, in order to guarantee constancy in the seed supply. Another line of research should be related to studies with new farming technologies, both in coastal areas and in off-shore areas, as well as mechanization of the productive process. The processing is another line that deserves to be highlighted, as a way of adding value and reducing losses. In sanity the focus should be given to the detection and control of the main diseases that affect these animals in the cultivation system.

- Oysters (*Crassostrea* sp.)

As previously mentioned, the oyster species of the genus *Crassostrea* are of great importance in the Brazilian marine aquaculture scenario. As with mussels, much of the commercial production is concentrated in the coastal areas of the southeastern and southern regions, although there are also smaller production records in the northern and northeastern regions (MANZONI, 2005). For these groups, the research should focus on reproduction, being related to the development of laboratory protocols that provide an increase in the production of larvae and seeds. In addition, it is necessary to develop research to determine the carrying capacity of natural seed capture systems in the natural environment, in the case of species occurring in Brazilian waters. In the area related to production management, the research lines should be focused on the use of new production systems, the density used in the production structures and the periodicity of management in the different production systems already used in Brazil. In relation to the pathology, it should cover the detection and control of the main diseases that affect larvae, juveniles, adults and breeding animals.

- Scallops (*Nodipecten nodosus*)

Scallops belong to the group of Pectinidae, which are currently among the mollusks with the highest commercial value in the world, whose demand is much higher than the offer. In Brazil, scallop cultivation is characterized as a recent activity, with its first studies dating back to the early 1990s (RUPP, 2001). Considering that Brazil does not have natural stocks that sustain an

extractive activity, it is expected that the production of scallops should be exclusively originated from aquaculture. Therefore, studies aimed at larval production, remote settlement and mechanization of production systems are considered the most necessary for this species.

- Cobia (*Rachycentron canadum*)

Currently, Cobia is the only marine fish species commercially produced in the country, with the first cultivation initiatives recorded between 2005 and 2006. However, its production has not yet been consolidated, requiring studies in different areas[73]. Thus, research should focus on the improvement of larviculture as well as nutrition, developing balanced diets, including evaluating the viability of the reuse of artisanal fishing tailings, as well as the use of probiotics and immunostimulants. In the area of sanity, it is necessary to use efforts in the detection of pathologies and their control in larvae, juveniles, adults and reproductive individuals.

- Grouper (Family Serranidae)

Grouper have been farmed in Southeast Asia for more than 20 years, but despite their potential market it is noted that there are few initiatives to cultivate these species in America, with only a few studies done with this group of species focused exclusively on their biology. In a natural environment, Serranids present a slow growth rate, however they can reach higher growth rates when bred in captivity, which has justified the investment in research in this group (SANCHES *et al*., 2007). Therefore, it is believed that the greatest focus should be given in the area of larviculture, in addition to nutrition, with a focus on the use of commercial diets and fishery tailings. Another important line of research should focus on the definition of the growth curve of the species in the different productive systems. In the area of management, it is necessary to develop the main techniques of classification by size.

- Mullet (*Mugil* sp.)

Mullet is an important fishing resource in Brazil, having great historical and social importance, mainly in the southern region of the country. However, as a large part of extractive fisheries resources, stocks are overfished (OCEANA, 2016), with aquaculture being an important tool to

[73] Aquaculture Brasil. O Bijupirá é salvação da piscicultura marinha no Brasil? www.aquaculturebrasil.com/2016/08/26/bijupira-e-salvacao-da-piscicultura-marinha-no-brasil/

meet market demands, avoiding increased efforts on wild stocks. In Brazil, mullet cultivation is still an incipient activity requiring further studies for its improvement. Therefore, the research lines should focus on reproduction, developing protocols for natural and induced spawning as well as the larviculture and nursery protocols. Another important area is the nutrition of these species, where low-cost diets and studies to define the growth curve of captive animals must be developed.

- Seahorses (*Hippocampus reidi*, *Hippocampus erectus*)

Besides ornamental importance, which represents a market of thousands of dollars per year, seahorses present different medicinal uses in several traditional communities in Brazil and in the world (CARLOS *et al*. 2009). Therefore, it is necessary to focus on the development and/or improvement of cultivation protocols, which contemplate reproduction, nutrition, prospecting, production, as well as conservation of live food. In addition, studies should consider non-invasive and destructive methods of traceability of animals grown and extracted from the natural environment, in order to certify the production, as well as to allow the formation of breeding stock.

In addition to the productive chains listed above, it is essential to expand the studies on the areas destined to the demarcation and the implantation of the marine aquaculture parks, in order to meet all the requirements defined in the environmental licensing processes, seeking to minimize the possible negative impacts that the activity can generate. Thus, this scientific agenda should contemplate:

- Survey of potentially usable areas for marine aquaculture;
- Studies of support capacity, bathymetry and hydrodynamic modeling of the areas destined and/or to be destined to marine aquaculture parks;
- Development of techniques to prevent/reduce the escape of cultivated species to the natural environment;
- Proposition of risk-based surveillance systems and dispersion modeling of infectious diseases of aquatic animals, in the environment and in production systems.

CHAPTER 2 – HUMAN RESOURCES AND COOPERATION

Section A – Capacity Building and Transfer of Technology

Paragraph 1 – Capacity Building

Capacity building is becoming a recurring theme in the institutional literature as well as in the agenda programming of public administrations, international agencies, and governmental and NGOs. However, despite its growing importance from the point of view of dialogue and the activities of organizations, there is no single definition of the concept of "capacity building"[74].

When considering the strictly institutional meaning, capacity building refers to the process of optimizing the competences of individuals and the institutional support of one or more organizations. Thus, capacity building can be defined as the process whose objective is to facilitate, together with the stakeholders, the consolidation of their capacities at the individual, organizational and sectorial levels to allow them to evolve and adapt to the new contextual requirements and fulfill its role within a governance structure.

The instruments and tools for capacity building are significantly varied and comprise, among others: training, access to and dissemination of information, exchange fora, facilitation and guidance, consultative support, tutoring and twinning systems, inter organizational collaboration and networking, feedback and capitalization of experiences, tested institutional approaches, among others.

The Chapter 37 of the Agenda 21 has as theme the National Mechanisms and International Cooperation for Capacity-Building in Developing Countries. From this document it can be inferred that the ability of a country to follow sustainable development paths is determined to a large extent by the capacity of its people and its institutions as well as by its ecological and geographical conditions. Specifically, capacity-building encompasses the country's human, scientific, technological, organizational, institutional and resource capabilities. A fundamental goal of capacity building is to enhance the ability to evaluate and address the crucial questions related to policy choices and modes of implementation among development options, based on an understanding of environmental potentials and limits as well as of needs as perceived by the people of the country concerned. As a result, the need to strengthen national capacities is shared by all countries.

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[74] Civil Society Homepage. Capacity Building: webgate.ec.europa.eu/fpfis/mwikis/aidco/index.php/9EDF:_Capacity_building

The SDG 17.9 of the 2030 Agenda for Sustainable Development[75] is the dedicated target to capacity building and aims to "enhance international support for implementing effective and targeted capacity-building in developing countries to support national plans to implement all the sustainable development goals, including through North-South, South-South and triangular cooperation".

In considering the specific case of international legislation for the sustainable development of fisheries, the Article 25 of the Fish Stocks Agreement, whose central theme is related to the forms of cooperation with developing States, indicates that they should cooperate, either directly or through sub regional, regional or global organizations in order to promote the provision of assistance related to the development of human resources and to technical assistance directed specifically towards training and capacity building at the local level. Such assistance shall be provided to developing States in order to build capacity in the field of conservation and management of living marine resources.

The FAO Fisheries and Aquaculture Department[76] is an example of an international organization that seeks to conduct capacity building activities for marine and inland fisheries as well as aquaculture. This capacity building program includes training courses within Technical Cooperation Projects, preparation of training materials (e.g. simple methods in aquaculture series, disease diagnosis guides, surveillance methods, extension and technical manuals, among others), and awareness rising through training/workshops, financial and technical support to existing training programs conducted by partner institutions and customized training courses on specific topics.

The FAO capacity building program is developed through the use of methodologies to enable participants to work independently on fisheries and aquaculture management issues and to actively participate in the formulation of management plans in the region where they work.

Through Technical Cooperation Programs and unilaterally or multilaterally funded field projects, the Department provides technical information, advice and training to interested parties and government managers of member countries as well as to the RFMOs. The products resulting

[75] Sustainable Development Knowledge Platform: sustainabledevelopment.un.org/sdg17

[76] Food and Agriculture Organization of the United Nations. Capacity building and training. In: *FAO Fisheries and Aquaculture Department*. www.fao.org/fishery/topic/16033/en

from such training have the main purpose of being passed on and used by fishermen and fish farmers, resource managers and policy makers to improve production, conservation and policy making in the fisheries and aquaculture sector. As a result, such training helps improve food supply and rural livelihoods through responsible production, better management practices, and improved environmental sustainability.

In this sense, the capacity building model being developed by the FAO Fisheries and Aquaculture Department could be promoted and replicated at the national level for the purpose of the improvement of the fisheries and aquaculture management and development. A common vision on the development of an ecologically sustainable and economically viable fisheries and aquaculture sector in Brazil is desirable, being identified the following components as priorities: an ecosystem-based approach to aquaculture and fisheries management; an effective fisheries (co) management system; an improved international market access by producing good quality, high value species; an increased cooperation between government departments; an increased cooperation between public and private sector.

According to the World Bank-funded Study of Good Management Practice in Sustainable Fisheries[77], the institutions can be considered extremely important and play a key role in the management of fisheries, as well as in aquaculture. The quest for success in fisheries and aquaculture management requires that many factors be considered, but the underlying role of appropriate institutions must be considered as central to this process. In the absence of strong institutions and capable of developing their role, management of the fisheries and aquaculture sectors will not succeed. Although institutional capacity building is relevant to all fisheries and aquaculture activities, there is a strong need, both in Brazil and in many developing countries, to institutionally strengthen, in a substantial improvement in issues related to the management of the sector.

Although there is an emphasis on scientific and technical approaches to fisheries and aquaculture management in many parts of the world, there is a growing need to expand such perspectives and to include multidisciplinary information and analysis in the development of future management plans for fisheries and aquaculture. In this context, the role of institutions for success in fisheries and aquaculture management is important because institutions are key to better understand how activities in the fisheries and aquaculture sector operate. But institutions and stakeholders

[77] Institutional capacity-building for success in fisheries management. www.issuelab.org/resources/17818/17818.pdf

involved in fisheries and aquaculture management often need to be better developed and strengthened so they can play an effective role and promote successful management of these sectors.

The Sectoral Plan for the Marine Resources (PSRM – *Plano Setorial para os Recursos do Mar*) is one of the PNRM developments, with the objective of knowing and evaluating the potential of the sea, as well as monitoring the living and non-living resources and the oceanographic and climatological phenomena of marine areas under jurisdiction and national interest, aiming at the management, sustainable use of these resources and the fair and equitable distribution of the benefits derived from such use.

Considering that Brazil presents about 8,500 km of coastal zone, concentrating approximately 23% of its population, there is a need to promote the formation and the capacity building of professionals capable of contributing to the research, conservation and sustainable exploitation of coastal and marine resources, such as is the case of fisheries and aquaculture. In this way, it is increasingly necessary to promote studies aimed at identifying, monitoring, proposing as well as applying mitigation and adaptation measures to the environmental impacts resulting from the exploration and exploitation of marine resources.

The VI PSRM (2004 to 2007) advocated that educational institutions, postgraduate programs and research groups studying the sea in Brazil fell short of national needs to promote integrated knowledge of the EEZ and of the Brazilian Legal Continental Platform. Thus, to coordinate the actions aimed at strengthening the capacity building and training of human resources for the study of the sea was instituted the PPG-Mar. The VIII PSRM (2012-2015) expanded the scope of human resources capacity building and training, which acquired the status of a cross-cutting theme. The IX PSRM (2016-2019) is currently in force, which focuses on the following topics of interest, among others: the promotion of scientific research and technological development; the monitoring of living marine resources and their sustainable conservation, exploration and exploitation and; the continuing training of human resources in marine sciences.

Composed of representatives of the academic sector and government ministries and government agencies related to the theme, PPG-Mar elaborated a definition for the expression Marine Sciences, which since then has come to be understood as “the area of knowledge that is dedicated to the production and dissemination knowledge of the components, processes and resources of the marine environment and transition zones”. This is a preliminary definition, which is not meant to exhaust the debate but serves as a starting point in the search for

consensus. PPG-Mar has been a positive action to give unity to teaching and research in the area of Marine Sciences. The adoption of an objective definition for marine sciences had the merit of allowing the identification of which graduate and postgraduate programs have this theme as their main interest.

In this sense, PPG-Mar develops initiatives that aim to strengthen the habilitation and maximize the use of Human Resources in Marine Sciences in Brazil, in the fields of Oceanography, Fisheries Engineering, Aquaculture, Ocean Engineering, Marine Biology, and Marine Geology among other areas related to teaching and research of the marine environment.

In this way, PPG-Mar is an example of a program dedicated to the training and capacity building of students and researchers, and it is imperative that this program continues to be maintained and even expanded to give continuity to its attributions. It is worth noting that, from 2017, four new research vessels will be delivered as floating teaching laboratory, increasing the experience on research vessels for students, as well as the execution of studies and research related to the Marine Sciences, in the four regions of Brazil with financial resources coming from the MEC. The construction of these vessels is the result of a study carried out within PPG-Mar which identified the lack of floating means to enable students of the various courses in Marine Sciences in the operation of equipment, collection and processing of samples in the sea.

The activities developed by PPG-Mar have been recognized in the Brazilian academic environment in marine science, whether teaching or knowledge generation. Thus, PPG-Mar is an indispensable piece to stimulate the capacity building and formation of human resources in this domain of knowledge, essential for the exploration and exploitation of the wealth existing in the Territorial Sea, in the EEZ, and in the Continental Platform of Brazil.

Paragraph 2 – Transfer of Technology

Transfer of technology can be defined as the transfer of technical or scientific knowledge, such as the results of scientific research and research in combination with factors of production. It can be understood as the process of making available to individuals, companies or governments skills, knowledge, technologies, manufacturing methods, types of manufacturing and other facilities. This process aims to ensure that scientific and technological development is accessible to a wider range of users who can develop and exploit technology in new products, processes applications, materials and services.

It is worth noting that this perception of marine technology transfer is reflected in several major international soft-law instruments, including the Chapter 17 of the Agenda 21 which is dedicated to the protection of the oceans, all kinds of seas, including semi-enclosed seas, and coastal areas and the protection, rational use and development of their living resources. In this case, special attention must be due to the program area dedicated to the sustainable use and conservation of marine living resources under national jurisdiction which indicates that "States, with the support of relevant intergovernmental organizations, as appropriate, should provide for the transfer of environmentally sound technologies to develop fisheries, aquaculture and mariculture, particularly to developing countries, among other scientific and technological means of implementation". This goes in the same direction as the one established in the Article 25 of the Fish Stocks Agreement which is dedicated to the forms of cooperation with developing States, indicating that "cooperation with developing States for the purposes set out in this article shall include the provision of assistance relating to human resources development, technical assistance, transfer of technology, including through joint venture arrangements, and advisory and consultative services".

In addition, reference to that subject can also be found in the outcome document of the Rio+20 Conference, which reaffirms "the importance of building the capacity of developing countries to be able to benefit from the conservation and sustainable use of the oceans and seas and their resources". In this regard, the outcome document specifically emphasizes the need for marine technology transfer, taking into account the IOC Criteria and Guidelines on the Transfer of Marine Technology (CGTMT).

It is also worth mentioning that the relevance of the CGTMT was recently recognized by the UN 2030 Agenda for Sustainable Development. The Target 14.A of the SDG 14 seeks to "increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries".

According to the CGTMT, marine technology refers to the "instruments, equipment, vessels, processes and methodologies required to produce and use knowledge to improve the study and understanding of the nature and resources of the ocean and coastal areas". In this sense, marine technology includes information and data on marine sciences and related marine operations and

services in a user-friendly format: manuals, guidelines, criteria, standards and reference materials; sampling and methodology equipment; observation facilities and equipment; equipment for *in situ* and laboratory observations, analysis and experimentation; computer and computer software, including models and modeling techniques; expertise, knowledge, skills, technical/scientific/legal know-how and analytical methods related to marine scientific research and observation.

The CGTMT aim at applying the provision of the Part XIV of the UNCLOS, providing a critical tool to promote the development and transfer of marine science and technology, as well as capacity building, in ocean and coastal related matters trough international cooperation on fair and reasonable terms and conditions, especially with regard to developing States, either directly or through competent international organizations. These guidelines are thus expected to enable all parties concerned to benefit from developments in marine science-related activities, and in particular those activities that aim at stimulating the social and economic contexts in developing States, on an equitable basis.

Besides that, CGTMT focus on the development of special financial and scientific schemes to facilitate marine technology transfer at the national, regional or sub-regional levels; the transfer of marine technology free of charge or at a reduced rate for the benefit of the recipient state; the taking into account of the needs and interests of developing and land-locked States as well as of other legitimate interests, including the interests of holders, suppliers and recipients of marine technology; the importance of the transfer of environmentally sound technologies; and the need to utilize cooperation schemes, including joint ventures and partnerships among Member States, appropriate international organizations, governmental and NGOs and/or private entities.

In addition, guidelines for the implementation of the CGTMT include establishing a clearing house mechanism which should provide member states with direct and rapid access to relevant sources of information and practical knowledge in the transfer of marine technology. This mechanism should also seek to facilitate technical, scientific and financial cooperation effectively; the inclusion in national strategic plans of specific components of marine technology transfer; the establishment of focal points, be they regional or sub regional for the transfer of marine technology; and the organization of conferences in the context of the IOC Assembly or meetings of the various IOC sub-structures.

The implementation of UNCLOS Part XIV is subject to difficulties inherent to all international technology transfer regimes[78]. These difficulties result from the limited economic and regulatory incentives for marine technology holders to transfer technology, as well as from problems linked to monitoring State compliance. One of the major implementation issues arising from UNCLOS Part XIV is thus linked to the interests of marine technology holders. The only assurances provided by the Article 267 of the UNCLOS to this effect are to require States to have due regard for the rights and duties of holders, suppliers and recipients of marine technology.

With regard to the transfer of technology to be developed at the national level through Brazilian institutions, it is again important to emphasize the Interministerial Order MCTIC/MPA No. 35, of 16 January, 2013 creating the CTPA, with the purpose of establishing technical and scientific cooperation for the formulation of policies to support scientific and technological development and innovation in the fisheries and aquaculture sectors.

Among the purposes of CTPA are to recommend actions and solutions for the sustainability of fisheries and aquaculture, by supporting the generation, adaptation and transfer of knowledge and technologies that benefit the various segments of Brazilian society and; to support the implementation of the CBPA, aiming to contribute to the definition, through a participatory form, of national policies and guidelines for the promotion of research and technology transfer in the areas of fisheries and aquaculture. CBPA was a Cooperation Agreement established in 2010 between MPA and EMBRAPA, which created in 2009 the CNPASA.

As previously mentioned, the purposes of CBPA are to propose policies and strategic guidelines for R&D and transfer of technology in fisheries and aquaculture; set priorities for a consolidated national programming on a R&D and transfer of technology agenda in fisheries and aquaculture; define funding strategies and allocation of resources for the financing of programming and the necessary infrastructure; define institutional integration strategies for the financing and implementation of R&D and transfer of technology programming in fisheries and aquaculture; propose training policies for human resources in the fisheries and aquaculture sector.

In Brazil, industrial and commercial technology transfer contracts must be evaluated and recorded by the National Institute of Industrial Property (INPI - I*nstituto Nacional da Propriedade Industrial*), an institution linked to the Ministry of Industry, Foreign Trade and

[78] The transfer of marine technology as benefit-sharing: www.benelexblog.law.ed.ac.uk/2015/11/04/the-transfer-of - marine-technology-as-benefit-sharing /

Services (MDIC - *Ministério da Industria, Comércio Exterior e Serviços*), so that a technological contract has certain economic effects. The INPI defines the technology transfer contract as the commitment between the parties involved, formalized in a document that explains the economic conditions of the transaction and the technical aspects. By legal provision must be registered by the INPI all contracts that imply transfer of technology, either between national companies, or between national companies and headquartered or domiciled abroad, so understood as the rights license (exploitation of patents and industrial design and use of brands), acquisition of technological know-how (provision of technology and provision of technical and scientific assistance services) and franchise agreements. Considering that the economic development of the commercial productive activities of fisheries and aquaculture must undergo a process of industrialization of these sectors, it is clear the importance that the INPI can represent in the collaboration of the formalization of contracts of transfer of technology to be received or passed on by companies Brazilians.

The latest legislation regulating technology transfer is established through Law No. 13.243 of 11 January, 2016 which provides for stimuli to scientific development, research, scientific and technological training and innovation and amends Law No. 10.973 of 2 December, 2004, which provides incentives for innovation and scientific and technological research in the productive environment and provides other measures. This Law establishes measures to encourage innovation and scientific and technological research in the productive environment, with a view to technological training, to the reach of technological autonomy and to the development of the national and regional productive system of the Country, under the terms of the Federal Constitution.

Such measures should observe some principles, among which the following should be highlighted: the promotion of scientific and technological activities as strategic for economic and social development; promotion of cooperation and interaction between public organizations, between the public and private sectors and between companies; stimulation of innovation activity in the scientific, technological and innovation institutions and in companies, including the attraction, constitution and installation of research, development and innovation centers and of technological parks and poles in the country; promotion of business competitiveness in national and international markets; encouraging the creation of favorable environments for innovation and technology transfer activities; promotion and continuity of scientific and technological

training and qualification processes; simplification of procedures for project management of ST&I and adoption of control by results in its evaluation.

Section B – Institutional Cooperation

Paragraph 1 – National Cooperation

The main objective of this paragraph is to propose mechanisms to strengthen national cooperation between government, researchers, producers and other stakeholders in the fisheries and aquaculture production sector. Thus, it is necessary that national cooperation should be characterized by collaborative works, which seek to minimize duplication of efforts and, consequently, to enhance research and its practical results. In this way, the proposal presented is a way of seeking solutions to bottlenecks currently identified in the RD&I sector in fisheries and aquaculture, in order to promote the sustainable development of these activities in Brazil.

Taking into account that institutional cooperation at the national level can be considered as a group of stakeholders, working together in the search for solutions to common obstacles within the country, it can be inferred that such national cooperation in RD&I also can be considered as a research network. In this context, research networks can be defined[79] as a way of articulating knowledge, which goes beyond scientific institutions and their physical boundaries, and produces knowledge according to guidelines considered strategic for a given area, both nationally and internationally. For CNPq[80], the research networks aim at the knowledge and the process of innovation, through joint efforts, the exchange of information and skills, in the pursuit of common goals, with or without sharing of facilities.

ADAMS (2012) stressing the importance of research networks, states that today's research as well as those of the future will be done in networks. While SHIN *et al*. (2013) emphasize the importance of this format in the investigation processes. In this sense, taking into account the current situation in Brazil, where it has been observed that many of the scientific research is

[79] dlm.fflch.usp.br/sites/dlm.fflch.usp.br/files/Solange%20Gallo.pdf

[80] DGP. Redes de Pesquisa: lattes.cnpq.br/web/dgp/glossario?p_p_id=54_INSTANCE_QoMcDQ9EVoSc&_54_INSTANCE_QoMcDQ9EVoSc_struts_action=%2Fwiki_display%2Fview&_54_INSTANCE_QoMcDQ9EVoSc_nodeName=Main&_54_INSTANCE_QoMcDQ9EVoSc_title=Redes+de+Pesquisa.

being carried out in isolation, it is necessary to reinforce the need to organize research networks that involves, besides researchers from universities and research centers, other institutions related to the public and private sectors that seek and/or promote the scientific and technological development of Brazilian fisheries and aquaculture. In this sense, two forms of research networks will be proposed, the first represented by the National Institutes of Science and Technology (INCT - *Institutos Nacionais de Ciência e Tecnologia*), while the second is based on the formation of a Consortium for Research and Development of New Technologies in Fisheries and Aquaculture.

The INCT Program has ambitious and comprehensive goals in national terms, highlighting:

a. to mobilize and aggregate, in an articulated way with networks, the best research groups in frontier areas of science and in strategic areas for the sustainable development of the country, as defined in PACTI;
b. to promote basic and fundamentally competitive scientific research internationally;
c. to develop advanced scientific and technological research associated to applications, promoting innovation and the entrepreneurial spirit, in close articulation with innovative companies, in the areas of the Brazilian System of Technology;
d. to promote the advancement of the national competence in its area of activity, creating attractive and stimulating environments for talented students of different levels, from high school to postgraduate, and taking direct responsibility for the training of young researchers. The INCTs should also establish programs that contribute to the improvement of science education and the diffusion of science to the common citizen;
e. Support the installation and operation of laboratories in educational and research institutions and companies, in frontier areas of science and technology, promoting the country's international competitiveness, the best national distribution of scientific and technological research, and the qualification of the country in priority areas for regional and national development.

Each Institute should have a clearly defined theme or area of action. These should be backed by a well-structured program of scientific or technological research that allows for substantial scientific advances or innovative technological development, not only in a research project or a set of research projects, even if they are linked. Each Institute is made up of a headquarters entity and a network of research groups organized either regionally or nationally. The host entity must

demonstrate that it already has the capacity to leverage resources from other sources and have physical space and infrastructure that enable a visible characterization of the National Institute.

The marine sciences are included in some of the current INCTs, among which we can highlight: INCT Tropical Marine Environments; INCT Aquatic Toxicology; INCT Marine Sciences for the Study of Integrated Oceanographic Processes from Platform to Slope; INCT Integrated Oceanography and Multiple Uses of the Continental Shelf and Adjacent Ocean; INCT Transfer of Continent-Ocean Materials. However, it should be noted that none of these INCTs have their activities focused on the development of national fisheries and aquaculture, so it is highly recommended that these areas be included in the next INCT national calls.

The second proposal is to carry out a plan initially proposed by MPA and the Center for Research in Fisheries and Aquaculture of EMBRAPA, that is, the creation of a National Consortium for Research and Development of New Technologies in Fisheries and Aquaculture, as established in the Term of Cooperation concluded between these institutions in the year 2010.

This Consortium would be characterized as a strategic research network, with the following attributions:

a. propose policies and strategic guidelines for RD&I and transfer of technology in fisheries and aquaculture;
b. define priorities for a consolidated national programming in a RD&I and transfer of technology agenda in fisheries and aquaculture;
c. define strategies for funding and allocation of resources to finance the programming and the necessary infrastructure;
d. define institutional integration strategies for the financing and execution of the programming of RD&I and transfer of technology in fisheries and aquaculture;
e. propose human resources training policies in the fisheries and aquaculture sector.

Thus, considering the new Brazilian institutional reality regarding the management and development of fisheries and aquaculture as well as its strategic importance and the need to create a research network whose objective is the scientific and technological development of fisheries and aquaculture activities, it is recommended that the composition of this Consortium should include the following entities:

- MCTIC, for being the highest organization for ST&I in Brazil and, also, its main agencies to promote research, i.e. CNPq and FINEP, and INPOH, as the research center for marine sciences;

- MEC, responsible for the national education policy and for the Brazilian universities, as well as CAPES, whose main function is to incentive the formation and professional qualification;
- MAPA, as it is currently responsible for the management, planning and development of fisheries and aquaculture in Brazil, as well as EMBRAPA, a public company linked to it dedicated to the development and transfer of technology;
- MMA, responsible for environmental policies and also for the shared management of the fishery resources together with the MAPA. In this case, the participation of IBAMA, responsible for inspection, licensing and environmental control activities should be included.
- State Governments: mainly through its foundations to support research, as well as its research and rural extension companies;
- Universities: where the Brazilian critical mass is concentrated, being the main institutions generating scientific knowledge in the country;
- Non-governmental organizations: these institutions are able to complement the work of the state, through partnerships, as well as its history of pursuing activities that seek sustainable development through its concentration of actions for environmental and social purposes;
- Private Sector: since they have a great interest in the fact that the results of the research are practical and applicable in the optimization of the productive processes, within standards that seek for the environmental, economic and social sustainability;
- Other public and/or private institutions of RD&I.

It should be noted that these are considered central institutions to the formation and development of a research network in fisheries and aquaculture. However, it is not an unquestionable model, and it is possible to include new institutions identified as important partners in this process or even that their involvement is like collaborating institutions.

From this structure, it is believed in the establishment of a new reality for national scientific and technological development in fisheries and aquaculture. Where there would be the maximization of efforts, with the involvement of researchers, and the creation of an environment conducive to the discussion of subjects that permeate both the scientific methodologies, as well as the planning and management of the actions to be performed. All this gear is being run by

contributions from the government, the scientific community, the productive sector and all other institutions that are consortium and/or collaborators.

For the better operation of this network, it would also be necessary to develop an online platform, which would be characterized as the main instrument for planning, monitoring and operationalization of activities. Such a platform should systematize and integrate the communication and negotiation processes of all consortium members and collaborators.

Thus, based on this collaborative institutional arrangement, organized with the main institutions related to fisheries and aquaculture at the national level, it is expected to propose and execute applied research in order to meet the demands, both environmental and technological. In this way, it will be possible to solve the bottlenecks and obstacles that impede the growth of this important Brazilian sector, on a sustainable basis.

Paragraph 2 – International Cooperation

International Cooperation is the mechanism by which a country or an institution promotes the exchange of successful experiences and technical, scientific, technological and cultural knowledge, through the implementation of programs and projects with other countries or international organizations, being this a very used tool for the promotion of foreign policies, with socio-economic development as the focus. The results generated in this process allow the scientific and technological exchange, as well as the transfer of technologies that culminate in the strengthening of the institutions and organisms involved and in the closer relations between countries.

The development of concrete actions that make feasible the execution of international cooperation is indispensable for Brazilian research institutions and companies to be able to become competitive in the globalized world. In this sense, cooperation with international reference countries and institutions of research and technology should be considered strategic for the exchange of information in RD&I in modalities as technological, scientific, academic and human resources interchange as well as the development of training programs and technical assistance for specialists, technicians and professionals working in the sector.

Technical cooperation is an important instrument of development for countries and institutions, considering that through transfers of knowledge, successful experiences, technology and equipment, this also contributes to the training of human resources and to the strengthening of

institutions involved in projects. This type of cooperation takes into account the potential for changes and advances that the knowledge, experiences and technologies can cause in the long term, with the positive and relevant results of a project or activity carried out by the participating institutions.

According to the Brazilian Cooperation Agency (ABC – *Agência Brasileira de Cooperação*)[81], an institution linked to Ministry of Foreign Affairs (MRE – *Ministério de Relações Exteriores*)[82], international technical cooperation in Brazil is guided by the concept of "partnership for development", that is, the idea that the cooperation relationship entails for partners, efforts, benefits, commitments and results. In addition, cooperation must always be in line with the country's foreign policy guidelines, which reflects, for example, the definition of the priority international partners with which cooperation activities and projects will be developed. In this sense, international technical cooperation has the following guidelines:

- emphasis on programs of national, regional and local impact, in that order;
- concentration of efforts in projects that allow the creation of multiplier effects and sustainability of the expected results, avoiding the dispersion of efforts;
- emphasis on projects that enable the training of national institutions, through the transfer and absorption of priority knowledge, with a view to internalizing this knowledge and establishing the conditions for future innovation;
- emphasis on projects that integrate the basic components of international technical cooperation, namely: consultancy, training of human resources and eventual acquisition of equipment necessary for its development;
- preference to projects where the counterpart of resources mobilized by the partner country is clearly defined;
- preference for projects that cause a deepening of relations and open good prospects for political, commercial and economic cooperation between Brazil and developed or developing countries. At the multilateral level, projects are approved based on the basic concepts of multilateralism, universality and neutrality.

Scientific cooperation actions are usually carried out with the involvement of MCTIC and its development agencies (CNPq and FINEP), as well as through MEC with the involvement of

[81] ABC: www.abc.gov.br/

[82] MRE: www.itamaraty.gov.br/

CAPES, while in the scope of foreign policy these actions are coordinated by the Department of Science and Technology of MRE.

In view of this scenario, international cooperation in the areas of RD&I is essential for the development of fisheries and aquaculture in Brazil. Its wide application will allow a great transfer of technologies and capacity building in strategic areas and will contribute to the resolution of the bottlenecks of the productive sector, which should be consulted in some way to be able to endorse strategies to stimulate innovation in industry.

In the fisheries and aquaculture areas, international cooperation actions are also strategic to create conditions in which the potential of developing the activity in Brazil is promoted. In this way, the implementation of a continuous program of cooperation in fisheries and aquaculture could present the following strategic advantages:

- strengthen ties with countries and research institutions that aim to promote the development of marine sciences, with emphasis on fisheries and aquaculture;
- stimulate the development of strategic areas for the growth of fish production and its quality;
- subsidize solutions focused on problems in the fisheries and aquaculture industry;
- generate and transfer knowledge and technology;
- promote the capacity building of human resources to act in the various links of the fisheries and aquaculture production chains;
- strengthen Brazilian research institutions and postgraduate programs as well as their international insertion;

However, for intentions of cooperation to be implemented, intensive negotiation and articulation among all stakeholders is necessary, so that the main demands and the format of operationalization are defined. In this sense, it is necessary to define some aspects to enable such execution, such as:

- definition of priority areas for RD&I that should be included in the international cooperation actions;
- definition of the national and foreign institutions profiles that focus on the participation of international cooperation actions;
- survey of funding sources for international cooperation actions;
- definition of forms, modalities and deadlines for international cooperation.

It is extremely complex to plan the format and characteristics of international cooperation in fisheries and aquaculture, and one of the major difficulties faced in this regard is the lack of information and dialogue on the demands and main needs of academia and of the productive sector. In this sense, this approach is necessary to build a policy that meets these needs and is directed toward solving the bottlenecks of the activity as a whole. Nevertheless, it is certainly possible to define some of the cooperation modalities that are to be promoted, whose actions are listed below:

- support to research projects in the areas of fisheries and aquaculture in conjunction with foreign institutions;
- transfer of technology in the areas of fisheries and aquaculture;
- exchange and training (capacity building) of researchers, teachers and technicians in priority research areas;
- support for postgraduate (master's, doctorate and post-doctorate) training for Brazilian students abroad.

In view of these cooperation modalities, another major challenge concerns the ways in which these actions are implemented and executed, so it is suggested to launch national or international calls for proposals, in conjunction with the RD&I development agencies such as CNPq, FINEP and CAPES. This modality allows taking advantage of the structure and the expertise of institutions that already have experience in fomenting and managing international cooperation in RD&I. Similarly, public calls of proposals stimulate wide competition among research institutions and transparency in the selection process, as well as increasing the financial contribution of the actions.

Before developing any actions to foster international cooperation, it is extremely important to conduct a broad discussion to detail the areas of research that will be prioritized to be developed, since the detailing of the priorities should be carried out in a participatory manner in conjunction with the Brazilian and foreign research institutions, as well as taking into account the needs inherent to the national productive sector.

In this sense, an agenda that brings together stakeholders, including the government, is crucial to define the focus that will be assigned to future international cooperation actions. In the same way, this meeting will allow the direction of research in a way that meets the demands and needs of the activity as a whole. The participation of foreign institutions is essential for them to present the main research areas in which they have the expertise and interest to develop cooperation.

Therefore, it is suggested initially the elaboration of public notice composed of two calls. The first call would have the objective of financing workshops, seminars, among other forms of meeting with all interested parties to discuss and define in detail the main areas and lines of research that will be prioritized in future cooperation actions. The second call would be used to finance cooperation activities focused on the displacement of researchers, postgraduate students and Brazilian teachers to carry out RD&I activities abroad, such as training, courses and short-term internships. It is recommended, in this case, to prioritize proposals linked to research projects approved or already underway, financed by public governmental institutions. These activities would be carried out in cutting-edge technological areas, where Brazil or the proponent team present gaps and knowledge needs for the development of research, transfer of technology and human resources capacity building.

In addition, the funding of postgraduate scholarships abroad is highly strategic for training and specialization of Brazilian human resources. Thus, it is also recommended to prepare a public notice with the specific objective of financing research projects and postgraduate scholarships abroad for researchers working in marine sciences with emphasis on fisheries and aquaculture. The development of the call for proposals would be made up of two phases: the first phase destined to the financing of postgraduate scholarships, in the form of full doctorate or sandwich modality and postdoctoral prioritizing countries and institutions with a high degree of development in these areas; the second phase would be aimed at supporting the development of joint scientific, technological and innovation research projects by financing international cooperation activities.

CONCLUSIONS

The 2015 United Nations Sustainable Development Summit adopted the 2030 Agenda for Sustainable Development, which includes a set of 17 SDGs. The 2030 Agenda defines global sustainable development priorities and aspirations for 2030 and seeks to mobilize global efforts to benefit people, planet, prosperity, peace and partnership. The SDGs aim, by 2030, *inter alia*, to: end poverty and hunger; further develop agriculture; support economic development and employment; restore and sustainably manage natural resources and biodiversity; fight inequality and injustice; and tackle climate change. It commits stakeholders to work together to promote sustained and inclusive economic growth, social development and environmental protection.

According to FAO (2016), several SDGs are relevant for fisheries and aquaculture and for the sustainable development of the sector, but SDG 14 (Conserve and Sustainably Use the Oceans, Seas and Marine Resources for Sustainable Development) is of particular relevance. The SDG 14 focuses expressly on oceans, underlining the importance of the conservation and sustainable use of oceans and seas and their resources for sustainable development, including through their contributions to poverty eradication, sustained economic growth, food security and the creation of livelihoods and decent work.

Taking into account the ENCTI 2016-2022, a document validated by the National Council for Science and Technology, should be noted that it lists 12 priority themes, which are closely related to the SDG, considering that ENCTI advocates that ST&I should act for the economic and social development of the country in a sustainable way. Thus, the essence of ECTI is completely involved with the essence of the SDG, as the ST&I component is the bridge to the fulfillment of the 17 purposes established by the United Nations until 2030.

The ENCTI 2016-2022 contains the medium-term strategic orientation for the implementation of the ST&I public policies, as well as it is a suitable basis for the formulation of other public policies of national interest. In this context, when taking into account the Strategic Theme Water of ENCTI 2016-2022, it is worth to be noted that this document plays an essential role in the achievement of this work. Among the main approaches that have been attributed to this theme, it is highlighted the exploitation of the potential of national fisheries and aquaculture in continental and marine waters, activities that contribute to employment and income generation and to food security.

LEGAL FRAMEWORKS

As observed in the International Legal Frameworks, the importance of oceans, seas and coasts, including their resources and ecosystems as utilized by fisheries and aquaculture, is now widely recognized by the international community. This statement can be verified by noting that this wide range of mandatory and voluntary instruments to regulate the use of oceans, seas and their resources in order to comply with the precepts of sustainable development. Considering that scientific research and the transfer of technology are components present in all of these instruments, they should necessarily be observed when proposing public policies related to the promotion of RD&I in fisheries and aquaculture for the purpose of the sustainable development.

UNCLOS defines the rights and responsibilities of nations with respect to the world's oceans, establishing guidelines for, among others, the conservation and use of the marine living resources, marine scientific research and development and transfer of marine technology. The Chapter 17 of Agenda 21 sets forth rights and obligations of States and provides the international basis upon which to pursue the protection and sustainable development of the marine and coastal environment and its resources. The CBD is an international legally-binding treaty with three main goals: conservation of biodiversity; sustainable use of biodiversity and; fair and equitable sharing of the benefits arising from the use of genetic resources.

The Fish Stocks Agreement marked a major step forward in the development of a comprehensive legal regime for the long-term conservation and sustainable use of straddling and highly migratory fish stocks. Finally, in relation to the Code of Conduct for Responsible Fisheries it is necessary to ensure that all people working in fisheries and aquaculture commit themselves to its principles and goals and take practical measures to implement them. Governments, in cooperation with their industries, fish farmers and fishing communities, have the responsibility to implement the Code, which will be most effectively achieved when governments are able to incorporate its principles and goals into national fishery policies and legislation.

Therefore, Brazil as a Member State of the United Nations and a signatory of these international instruments aforementioned has been seeking to align its national policies to follow the precepts of sustainable development advocated by the international community. Observing the Brazilian national policies dedicated to the conservation and sustainable use of marine resources, as well as with regard to the fisheries and aquaculture activities, it is generally noted that RD&I is a present component, as observed in international instruments above.

POLEJACK (2010) stated that PMN and PNRM are the main Brazilian national policies that deal specifically with the marine sciences, having been elaborated simultaneously with the international discussions on UNCLOS. Considering the marine sciences as an important tool in providing information on how to better approach the marine environment, these national policies take advantage of this field of knowledge to guide the exploitation of the marine resources and also as developers of new maritime technologies.

The sustainable growth of fish production is a challenge, whose importance is evident in the face of the continuous increase in demand, both domestic and worldwide. In this sense, fishing and aquaculture legislation assumes a fundamental role in defining policies to encourage these activities; social policies in support of fishermen and aquaculture; and management, surveillance

and control measures (BRASIL, 2015). PNDSAP became the main legal instrument to be established on fisheries and aquaculture in Brazil, aiming to ensure the sustainable use of fishery resources and optimize the resulting economic benefits, in harmony with the protection of the environment and biodiversity; to promote the development, promotion and monitoring of fishing activity, the preservation, conservation and recovery of fishery resources and aquatic ecosystems; and to stimulate the socioeconomic, cultural and professional development of those who carry out the fishing activity.

MANAGEMENT AND DEVELOPMENT

The institutional framework for fisheries and aquaculture governance consists of the sets of principles rules, conditions, agreements, processes, mechanisms and organizations used for the development and management of these activities. Its functioning and outcome are influenced by the set of ideas, values, beliefs and assumptions under which the people concerned operate[83].

At global level, the UNGA and the United Nations Informal Consultative Process on the Law of the Sea, both being advised by DOALOS and in conformity with UNCLOS, address global fisheries and aquaculture issues among other responsibilities. Moreover, FAO is the United Nations specialized agency with a global mandate for fisheries and aquaculture policies through the Fisheries and Aquaculture Department and COFI as well as its Subcommittee on Fish Trade and Subcommittee on Aquaculture.

At regional level, the RFMOs are international organizations made up of countries with interests in fishing in a given region. Some manage all stocks in a specific region; others focus on highly migratory species, such as tuna, covering large geographic areas. Although some RFMOs have a merely advisory role, most have management powers which allow them to set catch and effort limits and technical measures as well as control obligations. however, it is noted that the Brazilian participation in these RFMOs has been active and significant only in relation to ICAAT and CCAMLR, but in the latter case there are no records of fishing activities by Brazilian boat fleets in the Antarctic region.

[83] Food and Agriculture Organization of the United Nations. Fisheries and Aquaculture topics. Institutions in fisheries governance. Text by Peter Manning. In: FAO Fisheries and Aquaculture Department. www.fao.org/fishery/governance/institutions/en

At national level, the last years were marked by a major change in the arrangement of the institutions responsible for the governance of fisheries and aquaculture in Brazil, as it was explained it the paragraph 'Brazilian Governance' above. Considering fisheries activities, the Shared Management System for the sustainable use of fishery resources established a joint mechanism between MPA (now MAPA) and MMA. However, one of the major shortcomings identified in the current shared management system lies in a certain imbalance of forces between the governmental institutions responsible for the management of fishery resources. In this way, perhaps the solution will reside in another arrangement separating extractive fishing and aquaculture production entirely, bringing the exclusive management of extractive fishing back into the environmental area of government (MMA and IBAMA), while the management of aquaculture production would be competent exclusive of MAPA.

The case of aquaculture is somewhat less complex than that of fisheries, since there is no shared management system, its management has being of exclusively responsibility of MAPA, and advisory bodies such as CONAPE and CIRM's AQUIPESCA Action, being in charge of MMA regulate only the environmental licensing standards through CONAMA. However, for ROUTLEDGE *et al*. (2011) in the field of research and innovation, a challenge to be highlighted is the difficulty of combining the focus of RD&I activities to the real needs of the productive sectors, through survey research lines and the definition of priority species, from the involvement of the productive, governmental and academic sectors. On the part of the federal government, it is necessary the development of public policies that encourage the formation of an innovation environment and the approximation of the academia with the productive sector.

VIANA (2013) analyzed an audit report made, which among other subjects included a case study focused on the management of the sustainable use of fishery resources in the country and highlighted structural problems affecting the success of the sustainable management in the country, as the lack of use of available technical and scientific knowledge to support decision making, the weakening of governmental research centers of fishery resources and the absence of a government policy aimed at the continued generation of scientific data and information on the marine ecosystem and its resources.

HAZIN & TRAVASSOS (2006) states that the consolidation of Brazil as an important actor in the South Atlantic oceanic fisheries can only be achieved if the entire fishing development effort is adequately grounded in conducting scientific research and technical information capable of contributing to the competitiveness and efficiency of the national fleet.

SCIENTIFIC RESEARCH

Despite the progress made in the promotion and implementation of actions in RD&I in the last years, there are significant challenges related to the research in fisheries and aquaculture that needs to be evaluated and reworked, such as the lack of trained human resources; need to define the focus of the research lines; lack of integration between academic and the productive sectors; need for networking and; define a suitable methodology for evaluating the results of RD&I projects in order to allow the correction of directions and technology transfer to the productive sector.

Taking into account the graduate programs, it is possible to observe a greater tendency towards the training of human resources dedicated to aquaculture than in fisheries, even though it is observed that there are a significantly higher number of programs in Fisheries Engineering than those of Aquaculture. In addition, it is also observed that most of these professionals are geared to inland water environments as 60% of these graduate programs are located at inland areas of the country. Such situation can be justified by the great potential of Brazil to develop aquaculture, including the great diversity of freshwater fish with aquaculture potential, the high availability of freshwater and the predominantly favorable climate for activity.

When conducting an analysis of the postgraduate programs in Brazil, the same tendency was observed with the prevalence of programs focusing exclusively on aquaculture, showing a certain weakness in the training and qualification of human resources in fisheries. Regarding the location, it was possible to observe that 62% of the postgraduate programs are located in coastal regions, suggesting a higher training and qualification of professionals with a scientific bias in the marine environment. Even though it is so important for the development of science in the country, a small number of postgraduate programs focusing on fisheries and aquaculture have been observed. In this sense, the training of human resources in these areas may not be addressing the needs of the country's potential for research and innovation development.

Considering the research groups, the present study focused only on the quantitative analysis of the groups, not considering the qualitative analysis of the information or the intensity of the groups' performance. Thus, there are a significantly larger number of aquaculture research groups compared to fisheries groups, since 289 aquaculture groups and only 65 fisheries groups were observed. According to data presented by OEI (2011) it was noted that in aquaculture, the groups operating at inland waters were more numerous, especially those of freshwater fish

farming. Regarding fisheries, the marine area was more expressive. Regarding their location, a higher deficiency of fisheries and aquaculture research groups, as well as for the graduate and postgraduate programs, were observed in the northern and central-western regions of Brazil, where there is a lack of installed capacity, research and human resources.

Finally, regarding the financial support considerations it was possible to observe the lack of constancy and continuity of investments in RD&I in fisheries and aquaculture. Nevertheless, when analyzing the investments made separately, it was observed that aquaculture was more expressive than fisheries, both in terms of volume of resources and number of projects, in about 75%. Regarding fisheries, most of the resources were destined to marine fisheries, probably because of the greater representability of marine fisheries over the freshwater. Inland aquaculture presented higher investments, which can be attributed to the representability of the inland aquaculture to the national fish production.

Higher investments in marine fisheries are justified due to their greater representativeness in total national production of extractive fisheries, accounting for 69% (553,670.0 t) of catches, while freshwater fisheries accounted for 31% (249,600.2 t) of total production (MPA, 2011). Relative to the Brazilian aquaculture, freshwater fish is the main category, receiving most of the investments. According to IBGE (2015) it corresponds to 84% of the aquaculture production in the country, while marine aquaculture accounts for only 16% of total production, which includes crustacean farming (12%) and the production of oysters, scallops and mussels (4%). Besides that, the arrival of new companies, fast professionalization and technological intensification have been some of the factors observed in Brazilian aquaculture, which presented a growth of 123% between 2005 and 2015, a leap from 257,000 to 574,000 tons of fish in the period (EMBRAPA, 2016[84])

INFRASTRUCTURE AND SCIENTIFIC AGENDA

Since 2010, MCTIC has been dealing with the idea of implementing INPOH which is currently a Civil Association now in the process of qualification as Social Organization. However, the subject is being handled with low priority in the higher levels of the Federal Government, and still depends on regulation of the Social Organization model associated to the Legal Framework

[84] EMBRAPA. Brazilian aquaculture grows 123% in ten years. www.embrapa.br/en/busca-de-noticias/-/noticia/18797150/aquicultura-brasileira-cresce-123-em-dez-anos

of Science, Technology and Innovation. This qualification will allow the Institute to sign a management contract with other entities. In addition, the implementation of an institute such as INPOH would open a modernization perspective for the National Oceanographic Data Bank (BNDO - *Banco Nacional de Dados Oceanográficos*) currently maintained by the Brazilian Navy Hydrography Center, which would allow a consolidation of information related to oceanography and marine sciences in general, taking into account the broad spectrum that INPOH intends to address.

The Institute's consolidation rests on the promotion of scientific programs for coastal zones, ports and waterways, large-scale ocean circulation, ocean-atmosphere interaction and climate variability, marine biodiversity and renewable natural resources, deep ocean and underwater acoustics, as well as technology and innovation related to instruments of observation and monitoring of the oceans, among others.

In addition, another field of activity of INPOH refers to the logistics and operational management of the 'days of sea' to meet the demands of oceanographic research by the national fleet of research vessels, as this role is currently being shared between the Brazilian Navy and MCTIC. Therefore, the Brazilian scientific community hopes to have an active Institute that seeks to fill in key knowledge gaps, fostering innovation and providing the necessary infrastructure to advance sustainable national development, as well as contributing to the promotion of social, economic and environmental benefits.

Its worth to be noted that initially the idea was to create the Institute with a central administration and four research centers, among which will be highlighted the Center for Marine Research in Fisheries and Aquaculture. According to the report of MCTIC/UNESCO (2013a), a new research institute focused on fisheries and aquaculture science, with a national scope and vision, based on a structure and legal status distinct from those conventionally involved in the area, focused on excellence, endowed with a permanent and qualified technical and scientific body not contaminated by polarization which affects the main bodies responsible for national fisheries and aquaculture governance, would meet the potential needed to address some of the barriers that affect RD&I in fisheries and aquaculture in Brazil. It is even possible to argue that for certain situations, such as the difficulty of articulation and proper operationalization of national fishery and aquaculture statistics, it is likely that it represents the only possible alternative for overcoming.

In this sense, the Center for Marine Research in Fisheries and Aquaculture of INPOH would represent an opportunity to materialize commitment of Brazil to the development of fisheries and aquaculture under the perspective of international instruments of which the country is a signatory, such as UNCLOS, Agenda 21, Fish Stocks Agreement and the Code of Conduct to Responsible Fisheries, as well as to meet the target 14.A of SDG 14, which aims to "increase scientific knowledge, develop research capacity and transfer marine technology".

Effective programs specially designed to meet the specific demands of the fisheries and aquaculture sectors, such as a RD&I program, may contribute to the achievement of significant improvements, including effective development, environmental sustainability, economic profitability and social responsibility. These improvements focus on ways to reduce threats to biodiversity and ecosystem productivity through better governance and more integrated planning and management practices. In the face of food insecurity, global climate change and increasing population pressures, it is imperative that RD&I programs help maintain the resilience of ecosystems and the multiple goods and services ecosystems provide (USAID, 2013).

HUMAN RESOURCES AND COOPERATION

SDG Target 17.9 of the 2030 Agenda for Sustainable Development is dedicated to capacity-building, aiming to enhance international support for implementing effective and targeted capacity-building in developing countries to support national plans to implement all the sustainable development goals. Furthermore, the 2030 Agenda deals with the means required for implementation of the Goals and targets, including the mobilization of financial resources as well as capacity-building and the transfer of environmentally sound technologies to developing countries. Member States also commit to strengthen their national institutions to complement capacity-building and to ensure the inclusion of capacity-building and institution-strengthening in all cooperation frameworks and partnerships.

The perception that educational institutions, graduate and postgraduate programs as well as the research groups studying the marine environment in Brazil are below the real needs of the country justify the adoption of actions aimed at strengthening the formation of human resources and capacity building in marine sciences. In this way, the PPG-Mar Action has been developed within the scope of the CIRM, as established in the PSRM. Thus, the continuous training of human resources in Marine Sciences in order to the enhancement of technical and scientific body with a solid theoretical and practical basis, must be considered a priority to the development of

scientific and technological research, promote the sustainable use of resources in national and international waters, ensure the conservation of coastal and marine environments and expand ocean monitoring, among other goals.

UNCLOS contains a number of provisions dealing with marine scientific research and transfer of marine technology. In particular, it calls for all States to cooperate in accordance with their capabilities to promote actively the development and transfer of marine science and marine technology on fair and reasonable terms and conditions in order to help developing countries to access the benefits of oceans and seas. Through the CGTMT, IOC pretends to inspire national actions, legislation, projects, and programs, as the concept of Transfer of Marine Technology represents a true opportunity in international cooperation under the IOC umbrella[85].

In Brazil, the transfer of technology in fisheries and aquaculture, in general, had previously been regulated through the legal mechanism that created CTPA, whose purpose was, among other, to recommend actions and solutions for the sustainability of fisheries and aquaculture, by supporting the generation, adaptation and transfer of knowledge and technologies and encourage the formation of research groups and networks and technical cooperation with emphasis on fisheries and aquaculture. However with the extinction of MPA this mechanism has become outdated since MAPA did not put into practice its attribution to promote and encourage the research and generation of new technology in fisheries and aquaculture at national level.

Another purpose of the CTPA was to support the implementation of CBPA in order to contribute to the participatory definition of national policies and guidelines for the promotion of research and technology transfer in the areas of fisheries and aquaculture. The creation of this Consortium also became outdated after the extinction of MPA. The EMBRAPA's CNPASA has been developing actions of generation and technology transfer for fisheries and aquaculture. However, this institution has a highly targeted scientific bias towards freshwater aquaculture, while actions in fisheries and marine aquaculture are practically null. In this way, it is clear the importance and the need to implement INPOH as well as the establishment of its Center for Marine Research in Fisheries and Aquaculture, since in addition to acting as a national reference center in the generation and transfer of technology in marine fisheries and aquaculture, it would also assume a role of coordinate the actions of research groups in the country.

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[85] UNESCO/IOC. Transfer of Marine Technology. Knowledge Sharing and Capacity Development for Sustainable Ocean and Coastal Management. unesdoc.unesco.org/images/0023/002325/232586e.pdf

Considering that capacity building and transfer of technology actions can be included in cooperation agreements and programs, considering the national institutions or through international cooperation programs, some mechanisms have been proposed seeking to promote the strengthening of the scientific and technological development of fisheries and aquaculture.

Considering the cooperation among Brazilian institutions, it was pointed out two different ways for the institutionalization of research networks in fisheries and aquaculture. The first proposal refers to the INCTs, a cooperative model of research networks coordinated and managed by MCTIC and CNPq, whose goals include the possibility of mobilizing and aggregating the best research groups for the country's sustainable development and stimulate scientific research to be competitive internationally. Although this model is already in place and operational, it has been noted that none of the INCTs currently in activity are focused fisheries and aquaculture, although some of them are focused on oceanic and coastal marine environments.

The second proposal was based on the creation of a National Consortium for Research and Development of New Technologies in Fisheries and Aquaculture, in the same model of CBPA, initially proposed through the term of cooperation between MPA and EMBRAPA. This consortium would have among its attributions to propose policies and strategic guidelines, as well as the priorities to compose an agenda for RD&I and technology transfer in fisheries and aquaculture; fundraising and allocation of resources for research and infrastructure; institutional integration for financing and execution of research and technology transfer programs; promote the capacity building of human resources.

International cooperation in RD&I is essential for the development of fisheries and aquaculture in Brazil. The strengthening of actions in this direction would contribute to the transfer of technologies and capacity building in strategic areas besides collaborating to solve the bottlenecks of the productive sector.

Considering the complexity of planning the format and characteristics of international cooperation in fisheries and aquaculture, one of the difficulties faced is the lack of information on the demands of academia and the productive sector. In this sense, this approach will be necessary to construct a policy that meets those needs and is directed toward to solve the bottlenecks of the activity as a whole. Therefore, the following actions must be taken in consideration when considering the promotion of international cooperation programs: support to research projects together with foreign institutions; transfer of technology and; exchange and capacity building in priority research areas.

Considering the cooperation modalities listed, it was suggested to launch international calls for proposals, in conjunction with RD&I development agencies such as CNPq, FINEP and CAPES. This modality allows to take advantage of the structure and the experience of these institutions in the foment and management of the international cooperation, in addition the public invitations of proposals stimulate the ample competition between researchers and the transparency in the selection process, as well as increase the financial contribution of the actions taking into account that the other partner institutions will also contribute financial contributions in support of the selected projects.

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