The First 15 Years of Mariculture Parks in the Philippines: Challenges and the Way Forward

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Front cover photo: Cage culture caretakers are tightening the nets of the fish cage in a mariculture site in Sto. Tomas, La Union, Philippines. Photo by Benedict Mark M. Carmelita

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EXECUTIVE SUMMARY

Mariculture plays a crucial role in national and local economies, and its sustainable development is important. This study was conducted to assess the development, current status, and potential of mariculture parks after 15 years of the Mariculture Park Program of the Philippines. Six mariculture parks in six municipalities in five provinces and three regions of the country were taken as case studies: (1) Balingasag, Misamis Oriental, and (2) Lopez Jaena, Misamis Occidental in Region 10 (Northern Mindanao); (3) Calape and (4) Talibon, Bohol, in Region 7 (Central Visayas); and (5) Sto. Tomas, La Union, and (6) Sual, Pangasinan, in Region 1 (Ilocos Region). The data for this paper was drawn from a larger data set collected using focus group discussions, a household survey, key informant interviews, secondary data collection, and observations conducted from November 2014 to August 2015.

Mariculture parks have the potential to provide benefits to society, but these benefits have not been fully realized so far. The Mariculture Park Program is beset by a threefold concern of low uptake, low participation of fishers, and low diversity of species being farmed. There are several factors that explain these outcomes. These include the (1) high cost of investment and operation, particulary for the physical structures (cages and support structures); (2) high cost (and sometimes limited availability) of juveniles/fingerlings and feed; (3) high vulnerability of the cages to changes in climate such as strong typhoons; (4) diseases and fish kills; and (5) other issues of theft and poor siting of the mariculture park.

It is therefore recommended that (1) hatcheries for the frys/fingerlings be set up to support operators, (2) operators be linked to different companies selling feed to encourage competition, (3) companies or universities be encouraged to formulate cost-effective feed, (4) research be supported to address technical challenges related to cage farming operations, and (5) the reported negative environmental impacts of mariculture operations should also be addressed through regulatory measures or the imposition of taxes for such impacts.

1.0 INTRODUCTION

The decline in capture fish production in the country has highlighted the importance of aquaculture as a source of food and employment for the present and the future. Over the period 2002–2010, capture fisheries grew slowly from 2.0 million metric tons in 2002 to 2.6 million metric tons in 2010 (DA-BFAR 2012; DA-BFAR 2015); it declined thereafter to 2.3 million metric tons in 2014. Aquaculture, on the other hand, has been contributing considerably to fisheries output, both in volume and value terms. Since 2005, aquaculture has been contributing half (46%–52%) to total fish production or more than one-third (34%–39%) to total production value (DA-BFAR 2015).

Among the aquaculture sectors, mariculture (fish pens and cages and mariculture of oyster, mussel, and seaweed) contributes to about 80% of aquaculture production, with seaweed farming sharing about 67% of aquaculture production (DA-BFAR 2015). At present, fish pens and cages in brackish, fresh, and marine waters contribute 10%–12% to total aquaculture production, but the potential for increase is high. In 2010, for instance, only 0.54% of the 50,150 ha of the 62 mariculture parks in the country was developed by 2,199 investors and the Bureau of Fisheries and Aquatic Resources (BFAR) (Salayo et al. 2012).

Mariculture is the managed cultivation or production of aquatic (fish and other marine) organisms in brackish and saline water (Troell 2009). Simply put, it is aquaculture in (shallow or deep) coastal waters (Lopez 2006). It usually uses cages or pens for fin fishes, and it can be a monoculture or polyculture system. Mariculture has been practiced in the Philippines for a long time. However, mariculture development has been difficult to monitor and is largely unregulated in terms of stocking and feeding practices. Fish farmers used to install cages of any number and size simply anywhere. The situation inevitably led, in some areas, to mass fish kills in cages and other environmental problems (Escobar et al. 2013; Rosario 2008; San Diego-McGlone et al. 2008; Sumalde, Francisco and Peñales 2002).

In the early years of the 2000s, the Philippine government, through the BFAR, introduced the Mariculture Park Program in order to promote food and job security and income improvement to drive local development. This program was expected to achieve the following (Rosario 2008):

1. contribute to employment generation and poverty alleviation in the countryside;
2. promote marine fish culture as an alternative source of livelihood for marginalized and sustenance fisherfolk;
3. develop an area with appropriate equipment and infrastructure that will allow fishers, fish farmers, and investors to operate cost effectively and securely;
4. develop skilled and technically capable fisherfolk to support the mariculture industry; and
5. promote the use of environmentally friendly inputs and farm management practices.

With mariculture parks as a centerpiece program, the BFAR has been infusing money in its development in many areas in the country. The BFAR has established demonstration cages to showcase fish farming technologies and attract investors. It plays a major role in the management of mariculture parks under co-management schemes with local government units (LGUs). It also provides the following:

1. technical assistance and financial support in the development of the mariculture parks;
2. leads mariculture park research (e.g., on how to develop new mariculture-related technologies, such as better mooring systems against strong wind and wave actions, and cage design standardization); and
3. provides capacity building (e.g., training fisherfolk involved in mariculture so that they are better skilled in managing mariculture facilities), among others.

Moreover, a number of guidelines were issued on the implementation and maintenance of mariculture parks, selection of locators[1] in a mariculture park, and the accreditation of input suppliers, among others.

[1] "Locator" is the term used in the Mariculture Park Program documents. Locators are mariculture operators, who can be individuals, groups of individuals, organizations, or firms.

Mariculture has the potential to increase food production and income, which will in turn spur local development in the country. Between 2010 and 2014, the annual production from fish cages and pens ranged between 255,000 and 305,306 metric tons (DA-BFAR 2015). However, mariculture, if not properly managed, can negatively impact the host community and the environment, which may outweigh any positive impacts.

Given the potential role of mariculture in the national and local economy, its sustainable development is important. After 15 years or so of the Mariculture Park Program, this study was conducted to assess the development, current status, and potential of mariculture parks. The aim is to increase understanding of the Mariculture Park Program and to identify the factors that are key to its effective implementation. Effective implementation of the mariculture program requires continuous feedback of information, which would help in adjusting strategies and planned activities toward the achievement of the objectives on job generation and food security. Accordingly, six mariculture parks in the country were taken as case studies. These mariculture parks are in six municipalities in five provinces and three regions in the Philippines.

The method of data collection is described in the next section. This is followed by sections on the mariculture park program, and the evolution of mariculture in the six study sites including a description of what they have become through the years. The issues in the mariculture park program and the challenges in the current state of mariculture are presented before the conclusions and the way forward.

2.0 METHODOLOGY

The data in this paper was drawn from a larger data set using multiple field data collection methods employed from November 2014 to August 2015 in the six study sites: (1) Balingasag, Misamis Oriental, and (2) Lopez Jaena, Misamis Occidental in Region 10 (Northern Mindanao); (3) Calape and (4) Talibon, Bohol, in Region 7 (Central Visayas); (5) Sto. Tomas, La Union, and (6) Sual, Pangasinan in Region 1 (Ilocos Region) (Figure 1). These methods included focus group discussions (FGDs), a household survey, key informant interviews (KIIs), secondary data collection, and field observation.

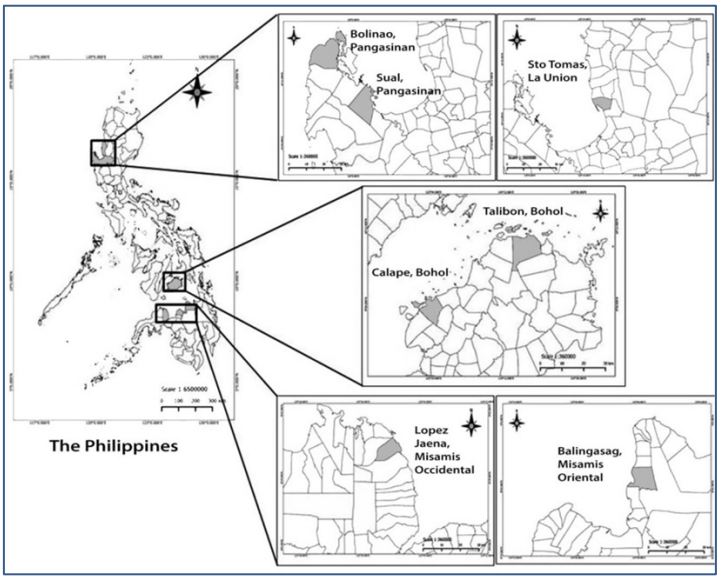

Figure 1. Location of the study sites

The data in this study was mostly taken from KIIs, secondary data collection, FGDs, and observations. A total of 124 key informants were interviewed on mariculture establishment and operation. These comprised stakeholder representatives involved in the different stages of mariculture operation, i.e., input (suppliers of feed and fingerlings, and cage and net fabricators); grow-out (operators and caretakers/watchmen/laborers); and marketing (traders and processors). The key informants of the study also included development agents, namely, the local mariculture area managers and aquaculture experts from the local governments and the BFAR.

Data from the FGDs supplemented the data collected from the other sources. The 48 FGDs conducted in 23 barangays in the six sites involved a total of 274 participants. Separate discussions were held with men and women in the 19 barangays selected in the study as mariculture barangays or non-maricuture barangays, while a mixed group of men and women were engaged in the FGDs in four barangays. The participants were selected based on two criteria: (1) they must have been residents of the barangay years before the establishment of the mariculture park/zone, and (2) they had knowledge of mariculture in the area.

Relevant secondary data were also collected from the BFAR central and regional offices and their official websites, the local governments of the study sites, and the official websites of other agencies. Observations were conducted by visiting the designated mariculture parks/zones and observing major activities, such as the transportation of fingerlings and feed from the shore to mariculture areas, installation/repair of cages feeding, change of nets, cage fabrication, harvesting, postharvest activities, and trading.

3.0 MARICULTURE IN THE PHILIPPINES

3.1 Beginnings

Although aquaculture in the Philippines has been practiced for more than 600 years, it was not until 1965 when fish cages were first introduced in the country for the culture of the common carp in Laguna de Bay, followed in the early 1970s with milkfish culture in fish pens (Yap 1999). In the early 1990s, milkfish culture in fish pens spread to Lingayen Gulf, and fish cages spread to Taal Lake. The technologies caught on very fast, particularly when higher production was demonstrated. In 1996, Norwegian cages were introduced for salmon culture in Sual Bay, Pangasinan.

The development of mariculture was accompanied by a new set of environmental problems caused mainly by unregulated fish farming practices, namely, the installation of cages and pens anywhere in any size. Mass fish kill in cages and other environmental problems were experienced (Escobar et al. 2013; Rosario 2008; San Diego-McGlone et al. 2008; Sumalde, Francisco, and Peñales 2002). The 2001 massive fish kill experienced in Bolinao focused public attention on mariculture and generated public outcry calling for the dismantling of fish cages and pens.

In the early 2000s, the BFAR introduced the Mariculture Park Program as a new approach in fish farming. The main aim of the program was to provide the infrastructure for cost-effective, secure, and regulated mariculture operations while promoting employment, contributing to poverty reduction in the coastal areas, providing alternative livelihoods to marginalized fisherfolk, developing the technical capacity of a pool of fisherfolk to support mariculture, and promoting the use of environment-friendly inputs and farm management practices (Rosario 2008). It was designed to be participatory, with the BFAR working with LGUs, relevant national government agencies, NGOs, and fisherfolk (Adora 2011).

The legal mandates for the establishment of mariculture parks can be found in the 1998 Fisheries Code (RA 8550) as amended by RA 10654,[2] in a Department of Agriculture-Department of Environment and Natural Resources (DA-DENR) Joint Memorandum Order No. 01 (Series of 2000), and in municipal ordinances (Rosario 2008). The Fisheries Code of 1998 requires that aquaculture areas be designated by the local governments in the case of municipal waters, or by the DA for waters located outside municipal waters (Yap 1999). Furthermore, the appropriate government unit is also required to regulate the stocking density and feeding based on the carrying capacity of a respective area. Moreover, it was thought that the development of mariculture parks would make it easier for the government to monitor and regulate the cages that had been installed in accordance with market forces with no regard for sustainability (Rosario 2008; Yap 1999). The idea was that the government could regulate the numbers and sizes of cages (and thus stocking and feeding), and the distances between the cages; however, this has generally not been achieved.

The bases for the establishment of mariculture parks in the country include (1) the Fisheries Office Order (FOO) 317, Series of 2006 (Implementing Guidelines and Procedures in the Establishment and Management of Mariculture Zone/Parks) and (2) the FOO No. 74, Series 2009. The idea was to create an industrial estate in the sea—the mariculture park—where the whole area would be subdivided into aquaculture farm plots for mariculture activities, which would then be leased to investors (BFAR 2014; Adora 2011).

To attract investors, the government would provide the necessary infrastructure (mooring systems, navigation lanes, and docking areas); utilities (support facilities); and technical services. It was designed to be participatory, involving the LGUs, fisherfolk organizations, and NGOs. It embraced a holistic approach covering infrastructure, capacity building, production, marketing, environmental monitoring, and other ancillary industries (feed suppliers, cage/raft and net suppliers, fingerling suppliers, and other supplies and materials). The mariculture park would promote and attract tourists and scuba divers, serve as fish breeding stations, and preserve and protect rare aquatic species.

Moreover, the Mariculture Park Program was designed to be fisherfolk-focused (Adora 2011). The mariculture parks were envisioned to benefit the fisherfolk in the communities where they were situated. According to Cruz (2000, p. 50), the "modern cage-farming facilities were designed to provide fishermen an opportunity to start a livelihood in aquaculture." The mariculture parks were meant to teach the local residents about more profitable use of high-value species (e.g., groupers, snappers, and lobsters) by selling them live. Similarly, the *Philippine Star* (31 October, 2004) quoted BFAR Assistant Director Gil Adora in saying that, "The mariculture zone project envisions the socioeconomic transformation of marginal fisherfolk and fishing communities into empowered and productive organizations through a thriving mariculture industry and the ancillary industries that accompany it. It is also a boost to efforts to ensure our food security, and can develop the skills of our fisherfolk in supporting mariculture."

To attract investors, the BFAR financially supports the implementation of mariculture parks, subsidizing grow-out operators[3] in their initial investment, particularly the fishers displaced from their usual fishing areas and those who want to shift to mariculture.

[2] An Act to prevent, deter, and eliminate illegal, unreported, and unregulated fishing, amending the Republic Act 8550, otherwise known as the "The Fisheries Code of 1998," and for other purposes.

[3] Grow-out operators refer to individuals, groups, or firms who grow fish in pens, cages, or other enclosures to marketable size.

3.2 Establishment of the Mariculture Park Program

The rationale behind the conceptualization of the Mariculture Park Program was to address the pressing issues of the declining productivity and resource depletion of capture fisheries, and the persistent poverty of coastal communities (Adora 2011). The yields from capture fisheries have been declining due to the unabated problems of overfishing, destructive fishing methods, pollution, and loss of marine habitats (BFAR 2014). The objectives of the mariculture park are the following ((BFAR 2014; Adora 2011):

1. to generate employment and alleviate poverty in the countryside,
2. to promote marine fish culture as an alternative source of livelihood for marginalized and sustenance fisherfolk,
3. to develop an area with appropriate equipment and infrastructure that will allow fisher-farmers and investors to operate cost effectively and securely. and
4. to promote the use of environment-friendly inputs and farm management practices.

Mariculture parks were envisioned to be implemented at the village level, where local government participation would be needed to designate a parcel of at least 100 ha of coastal municipal waters to be declared as a mariculture reserve. The plan was to utilize modern floating cages designed to tolerate up to two- to three-meter waves and to last at least five years with little maintenance. A component of the park is the establishment of a grid-type "community" storm mooring system and cluster of marine sea cages to be managed/operated by the local fisherfolk association. The LGU shall pay rental for the cage modules as user fees. Aside from these, mariculture parks are designed to provide security from encroachment, entanglement of moorings, and navigational hazards.

A major support facility is a floating sea base composed of landing ports and a multipurpose workboat (for hauling supplies and harvests, and for the maintenance of moorings). Other major support services are cold storage facilities, transport and market access, feed processors, and hatcheries/nurseries, which are component facilities of the project.

The first mariculture park was launched on 10 August, 2001 at the Island Garden City of Samal in Davao del Norte with a total budget of PHP 15 million (BFAR 2014). In 2004, there were three operational mariculture parks in the country. The number has grown through the years: 29 in 2008 (BFAR 2008), 50 in 2010 (BFAR 2010), 65 in 2012 (BFAR 2012), and 67 in 2013 (BFAR 2013).

3.3 Management of the Mariculture Parks

The process to be observed in the establishment of the mariculture park is as follows: (1) site selection and prioritization, (2) pre-assessment of site suitability; (3) public hearing/consultations, (4) municipal resolutions, (5) municipal ordinance, (6) development plan, (7) Rapid Risk Analysis/Environmental Risk Assessment, (8) organization of the Executive Management Council (EMC), (9) detailed survey/Environmental Compliance Certificate (ECC) issuance, (10) subdivision plan, (11) installation layout (mooring/cages), (12) training/IEC, (13) lease/permit issuance, (14) operation and management, and (15) regular monitoring (physico-chemical) (Rosario 2008).

The BFAR plays a major role in the management of mariculture parks under co-management schemes with the LGUs. The EMC, which governs the implementation of the mariculture parks, is chaired by the local government executive or the municipal/city mayor and co-chaired by the DA-BFAR regional director. The members of the EMC include the municipal

agricultural officer, city/municipal council chairman on agriculture, barangay chairperson of all barangays covered by the mariculture park, a representative from the Department of Environment and Natural Resources Office, a representative from the City/Municipal Fisheries and Aquatic Resources Management Council, DA-BFAR staff, and representatives from the locators association. The Secretariat is composed of members from the local government and the BFAR. The EMC assumes the general functions of planning, directing/implementing, evaluation, monitoring, and approving the Project Management Unit. In 2010, the BFAR created the BFAR National Mariculture Parks Development and Management Committee composed of the BFAR national and regional staff. The committee was created to provide leadership and direction in the implementation of the National Mariculture Park Development and Management Program. It was envisioned that this management structure would guarantee that the operation of the park would be regulated, prevent ecological disasters, and contribute to the promotion of social equity along with food security, providing livelihood, and alleviating poverty in the country.

4.0 MARICULTURE PARK OPERATION IN THE SIX STUDY SITES

4.1 Typology of the Six Mariculture Parks in the Study

The mariculture sites covered by the study were grouped based on the information on their current management, which involve the private sector, the LGU, and the BFAR. These categories were (1) LGU and BFAR-led; (2) private sector and LGU-led; and (3) private sector and BFAR-led (Table 1).

Table 1. Categories of mariculture parks in the study

LGU and BFAR-led	
Mariculture park in the municipality of Balingasag, Misamis Oriental province (Region 10) Mariculture zone in the municipality of Lopez Jaena, Misamis Occidental province (Region 10)	The areas are officially declared as mariculture parks/zones with an active Executive Management Council chaired by the local chief executive and co-chaired by the BFAR regional director.
Private sector and LGU-led	
Mariculture park in the municipality of Sual, Pangasinan province (Region 1)	The LGU has a presence in the management of the operation of privately owned fish cages and pens in the identified mariculture zone. The area had mariculture operations before being designated as a mariculture park. The BFAR supports the organization of the cages.
Private sector and BFAR-led	
Mariculture zone in the municipality of Calape, Bohol province (Region 7) Mariculture zone in the municipality of Talibon, Bohol province (Region 7) Mariculture zone in the municipality of Sto. Tomas, La Union province (Region 1)	These are officially declared mariculture areas, but most of the privately owned fish cages and pens are found outside the declared mariculture zones, and their operations are unregulated. The BFAR has demonstration cages in the area, which can be found inside or outside the designated mariculture zones.

4.2 Establishmentof Mariculture Operations in the Study Sites

The start and development of mariculture operations in each site is different (Table 2). Among the six mariculture parks, the earliest to be declared was the one in Sto. Tomas, and the latest was the park in Sual. Mariculture, however, was already practiced in Sual by the private sector from the middle of the 1990s, while it was declared a mariculture park only in 2009.[4] Similarly, in Sto. Tomas, the BFAR initiated a mariculture park as a demonstration research site in the 1990s, but its designation as a mariculture zone happened only in 2002. The operation of mariculture parks in Balingasag, Lopez Jaena, Calape, and Talibon started upon their official designation as such. All mariculture parks were created through the passage of a municipal ordinance or resolution (in the case of Sto. Tomas). All were in marine waters—a bay, sea, or cove. The details of the establishment of each mariculture park are discussed in succeeding sections.

4.2.1 LGU and BFAR-led mariculture areas

(a) Mariculture park in the municipality of Balingasag, Misamis Oriental province, (Region 10)[5]

The BFAR declared an area in Macajalar Bay within the territorial waters of the municipality of Balingasag as feasible for mariculture park operation after conducting a site evaluation in 2006. The proposal for the establishment of the mariculture park gained the support of the local government and of the fisherfolk after consultations with them. The park was seen as an employment opportunity. In 2007, the municipal ordinance for the creation of the Balingasag Mariculture Park was passed. The ordinance declared a 195.7 ha for mariculture, with 19.5 ha for fish cages. The mariculture area is about 1 km away from the coastline of Barangay Waterfall and Barangay 6. The two initial operators were the BFAR with one demonstration cage and a private investor. A training course for caretakers, which is a requirement in mariculture operation, was first conducted in the same year. Other training batches followed in the two succeeding years.

In 2010, the municipal councilor who partnered with the BFAR director in 2006 in promoting mariculture in the area became the President of the Balingasag Mariculture Park Investors Association, with 87 investor-members. Milkfish was also declared as the local commodity for the One-Town, One Product program of the local government during the first 2010 Harvest Festival. This coincided with the establishment of a milkfish processing plant in the area. The following year, the Balingasag Processing Association was formed. More cages were established; thus, by January 2014, there were 63 operators of more than 200 fish cages. In December 2014, a strong typhoon hit the area and destroyed almost half of the number of bamboo fish cages in the mariculture park.[6]

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[4] Based on the BFAR Main Office records as of July 2014, although other documents and KIIs point to 2013 as the year mariculture park was launched in Sual.

[5] Narrative assembled from KIIs in January 2015 with the Vice Mayor [identified to be one of the pillars of mariculture in the area], President of the Balingasag Fisherfolks Association, caretaker of the cages, President of the Balingasag Fish Processing Association, and online news articles: (i) *Mariculture park planned for Balingasag (The FishSite, April 2007),* retrieved from: http://www.thefishsite.com/fishnews/4078/mariculture-park-planned-for-balingasag-misamis-oriental*;* (ii) *7thLambangus Festival kicks off"(Imam, May 2015),* retrieved from: http://www.mb.com.ph/7th-lambangus-festival-kicks-off*/;* and (iii) *Celebrating the Lami-ang Bangus of Balingasag, Misamis Oriental" (Banos, Dec 2011),* retrieved from: http://www.kagay-an.com/celebrating-the-lami-ang-bangus-of-balingasag-misamis-oriental.

[6] Data collection was from January to February 2015. The municipality proposed a rehabilitation plan in 2015, in which the BFAR committed PHP 11.9 million counterpart, while the local investors had to raise PHP 34.4 million.

Table 2. Location and establishment of the mariculture parks in the study sites

Attribute	LGU and BFAR-Led		Private Sector and LGU- Led	Private Sector and BFAR-Led		
	Balingasag	Lopez Jaena	Sual	Calape	Talibon	Sto. Tomas
Specific location	Macajalar Bay	Iligan Bay	Cabalitian Bay	Calape Bay	Danajon Bank, Bohol Sea	Sto. Tomas Cove
Initiator of mariculture in the area	BFAR	BFAR	Private sector	BFAR	BFAR	BFAR
Year of establishment as mariculture park/ launched as MP	2007 (March)	2011 (February)	2009 (October) but mariculture operations started as early as mid-1990s[3]	2008 (October)	2008	2002 (October) but started mariculture as demo site in the 1990s
With legal instrument for the creation	Municipal Ordinance No. 06-2006	Municipal Ordinance No. 01-2011[2]	Municipal Ordinance No. 05-2014[4]	Municipal Ordinance No. 2008-08[5]	Municipal Ordinance No. 2008-30[6]	* Memorandum of Agreement [7] * ABC Resolution No. 3, 2002[8] * SB Resolution No. 41 S. 2001[9]

Sources:
(1) Municipal Ordinance No. 06-2006.
(2)Municipal Ordinance No. 01-2011A: An Ordinance Establishing the MariCulture Zone within the Municipal Waters of Lopez Jaena and Creating the Lopez Jaena Mariculture Executive Management Council and for other purposes
(3) Based on Salayo et al. (2012) and the BFAR mariculture park records as of July 2014 (unpublished). KIIs identified 2013 as the year of launching of the mariculture park in Sual, given that it was affected by strong typhoon in 2009.
(4) Municipal Ordinance No. 05-2014: Sual Fisheries Code for the Sustainable Management, Development, Conservation, and Protection of the Municipal Waters
(5) Municipal Ordinance No. 2008-08: An Ordinance Declaring and/or Establishing an Area within the Calape Bay or Municipal Waters as the Calape Mariculture Zone
(6) Municipal Ordinance No. 2008-30: An Ordinance Providing Guidelines on the Operation of the Talibon Mariculture Zone
(7) Memorandum of Agreement (17 October, 2002) BFAR, LGU, DENR on 17 October, 2002
(8) ABC Resolution No. 3, 2002: Joint resolution of the barangay councils of the coastal barangays approving the development of a mariculture zone at Santo Tomas Cove, Santo Tomas, La Union (March 4, 2002)
(9) SB Resolution No. 41 S. 2001: Committing Support and Cooperation to the Development of a Mariculture Park at Santo Tomas Cove, Santo Tomas, La Union (September 10, 2001)

Note: BFAR = Bureau of Fisheries and Aquatic Resources, MP = mariculture park, SB = Sangguniang Bayan (municipal council), ABC = Association of Barangay Captains

(b) Mariculture park in the municipality of Lopez Jaena, Misamis Occidental province, (Region 10) [7]

The BFAR initiated the establishment of a mariculture zone in Iligan Bay within the territorial waters of the municipality of Lopez Jaena in 2009. In 2010, with the support of the local government, public consultations were conducted with the nine barangays covered by the proposed mariculture area of 313.26 ha (31.2 ha for fish cages). In February 2011, the mariculture park was formally launched with the passage of Municipal Ordinance No. 01-2011. The first batch of livelihood cages[8] was constructed and released in the same year. In 2012, the second batch of livelihood cages was constructed and released in 2013. Similarly, the third batch was constructed in 2013 and released in 2014. The grow-out cages were about 1.5 km away from the nearest coastline belonging to Barangays Biasong and Eastern Poblacion.

Training courses related to mariculture operation (e.g., feeding management, cage construction, and fish processing) were provided by the BFAR. In 2012, a training program in fish processing was provided to the Women's Association, which led to the formation of the Lopez Jaena Fish Processors Association with 28 initial members. In 2013, a training course on "Bangus Fingerlings/Garungan Production and Handling Techniques" was conducted. In 2014, training on "Cost-Efficient Feeding Management in Bangus Production" was given. In the same year, a consultative meeting/forum on "Sustainable Development of Existing Mariculture Parks" was also conducted.

4.2.2 Private sector and LGU-led mariculture areas

(a) Mariculture zone in the municipality of Sual, Pangasinan province (Region 1) [9]

The first fish cages in Sual were established in Cabalitian Bay by two corporations in 1996. In the succeeding years, more private investors (individuals and corporations) built more fish cages. In 2002, cage operations were scattered in the waters of Barangay Baquioen. Around 2003, the BFAR conducted an ecological assessment to determine the feasibility of Sual waters to accommodate the fish cages that were displaced in Bolinao and Anda due to fish kill. Sual was chosen over the municipality of Dasul (also in Pangasinan province) because it was a cove. Despite the losses incurred after strong typhoons hit the area, particularly in 1999 (typhoon Gading), 2008 (typhoon Cosme), and 2009 (typhoon Emong), more individuals and corporations continued to install fish cages in the area. In 2010, a significant increase in the number of cages was observed. In 2013, fish cage operations were seen as a threat to the power plant in Cabalitian Bay as more and more cages were built near it. To the operators, the growth of milkfish was better if it was nearer to the plant during the cold months. The warm water that the plant releases balances the temperature of the cold water outside. As a result, a minimum 250-meter perimeter distance from the shoreline was set for the cages.

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[7] Narrative assembled from KIIs in March 2015 with the EMC-Project Executive Director, Barangay Captain of Eastern Poblacion, Vice-President of the Investors Association, a member of the Laborers Association, and members of the Fish Processors' Association; and secondary sources (Lopez Jaena Coastal and Fisheries Profile CY 2014, photocopy), and FGDs with fisherfolk in Lopez Jaena.

[8] Livelihood cages are cages under the Livelihood Support Program of the BFAR for small mariculture operators. The cages are called livelihood cages or livelihood support cages.

[9] Narrative assembled from KIIs in May 2015 with the Sual Municipal Agricultural Office; field manager of one fish cage operator; *Bantay Dagat* (Sea Watch) chief; area supervisor of two fish cage operators in the area; BFAR Region 1 mariculture program coordinator; and a news article "*Fish cages seen threat to Sual coal power plant," Philippine Daily Inquirer News* online, September 2013, retrieved on January 10, 2016 from http://newsinfo.inquirer.net/491107/fish-cages-seen-threat-to-sual-coal-power-plant.

In 2013,[10] the Sual Mariculture Park was launched, nearly two decades from when the first fish cages were built in the area. As a mariculture park, an ECC was required to operate fish cages. The purpose of establishing the Sual Mariculture Park was to organize the operation of the fish cages and assign a specific area for their operation. The BFAR started to assist in organizing the operation of the fish cages and in assigning a specific area for operations. It adopted the "subdivision" layout of the fish cages (entailing the relocation of some fish cages to near Barangay Cabalitan). In 2014, Municipal Ordinance No. 05-2014 or the Sual Fisheries Code was passed. The Ordinance set guidelines on the management of coastal aquaculture (Article VIII). It had sections dealing with the qualifications of applicants to construct and operate aquaculture activities; definition of the mariculture zone (208 ha); mariculture operations (number of fish cages, stocking density, feeding, etc.); applications; permits; and annual fees.

4.2.3 Private sector and BFAR-led mariculture areas

(a) Mariculture in the municipality of Calape, Bohol province (Region 7)[11]

The mariculture zone in Calape Bay within the territorial waters of the municipality of Calape was initiated by the BFAR, with support from the local government. Calape is host to two BFAR facilities: the Central Visayas Regional Fisheries Research and Development Center, and the BFAR Central Bangus and Abalone Hatchery. The mariculture zone was formally established in October 2008 with the passage of Municipal Ordinance No. 2008-08 declaring and/or establishing an area within the Calape Bay or Municipal Waters as the Calape Mariculture Zone. The designated area is 220 ha, of which 22 ha are allocated for fish cages.

In 2009, the BFAR started mariculture operations with demonstration cages to grow grouper, seabass, red snapper, pompano, and tilapia. The demonstration lasted only a year, with the cages being destroyed from wear and tear. The BFAR then provided rent-to-own cages in collaboration with the local government. The local government provided the labor and the BFAR provided the materials for the construction of eight cages with a dimension of 10 x 10 x 7 m. The agreement was for the LGU to collect the rent and place it in a mariculture trust fund. The EMC selected the beneficiaries (or the "renters"), but not one of them went into cage culture operation within the one-year period that they were given to start operations.

The rent-to-own cages were then offered to other private investors. Private investors came in trickles: one in 2010, two in 2011, one in 2012, four in 2013, and two in 2014. However, the number of operators did not increase given that most cage culture operations lasted only a year. Moreover, the private operators did not locate their operations in the designated mariculture zone, but in areas nearer to the shoreline. In 2015, only four of the eight rent-to-own cages were still operating. The BFAR returned to demonstration cage operations in February 2015. However, the cages were not returned to the designated mariculture area, but were located nearer to the shoreline. The distance of the cages to the causeway was about 300 m.

[10] A KII candidate informed the research team that the mariculture park was launched in December 2013. In the BFAR records, however, the Sual Mariculture Park is reported as launched in 2009.

[11] Narrative assembled from KIIs in March 2015 with the Calape Coastal Resource Management (CRM) officer, and Calape BFAR-Demo Cage aquaculture technician; and secondary sources (*Municipal Ordinance No. 2008-08: An Ordinance Declaring and/or Establishing an Area within the Calape Bay or Municipal Waters as the Calape Mariculture Zone, soft copy; Calape Mariculture Park Locators Record prepared by aquaculture technician, and Calape BFAR Demo Cage records*).

(b) Mariculture in the municipality of Talibon, Bohol province (Region 7) [12]

Mariculture operations were formally launched in Talibon, close to Danajon Bank, in 2008 with the passage of Municipal Ordinance No. 2008-30 *(An Ordinance Providing Guidelines on the Operation of the Talibon Mariculture Zone)*. Section 4 of the Ordinance stipulates that the mariculture zone of about 250.8 ha is located between Mahanay Island and Barangay San Francisco. In 2009, the BFAR started with demonstration cage operations. In 2010, the first fish cages were established by three operators, who also served as legislative members in the municipality. Two of them were also fishpond operators and one was a fish trader. Others soon followed. By 2011, there were 19 local operators (mostly fishpond operators and fish traders) of 79 cages. A large-scale operator who was not a local resident of Talibon started establishing fish cages in Barangay Tanghaligue. In 2013, the Bohol earthquake and typhoon Haiyan devastated mariculture operations in Talibon. Only seven operators (four fish pen operators and three fish cage operators) remained operational. In late 2014, another strong typhoon hit the area and left only three operators, with two operators (one fish pen and one fish cage operator) located in Barangay San Francisco, and the large-scale operator in Barangay Tanghaligue (who expanded his area of operation, encroaching into the seaweed farms of other operators). The fish cages and pens were 500–800 meters away from the shoreline of Barangays San Francisco and Tanghaligue.

(c) Mariculture in the municipality of Sto. Tomas, La Union province (Region 1)[13]

Before the mariculture area in Sto. Tomas Cove was established in the municipality of Sto. Tomas in 2002, the BFAR conducted research in the area on fish pen culture from 1989 to 1990. From three trials of seabass culture in floating cages in 1989, the demonstration research showcased the culture of grouper in fish pens in 1990. Groupers were cultured to become breeders that lasted until 2001. Another study was conducted in 1991 comparing the culture of milkfish with seeds from the wild and from the hatchery.

In 2001, the local legislative body of Sto. Tomas passed a resolution (No. 41, Series of 2001; September) committing support and cooperation to the development of a mariculture park in Sto. Tomas. In 2002, the Association of the Barangay Councils passed a resolution (No. 3, Series of 2002; March) approving the development of a mariculture zone in Sto. Tomas. In the same year, an agreement between the BFAR, the LGU, and the DENR was signed, stipulating the obligations of the parties in the implementation of the mariculture park in Sto. Tomas. The 10-hectare mariculture area is inside the Agoo-Damortis Protected Landscapes and Seascapes; thus, it is under the management of the DENR-Protected Area Management Board.

The mariculture zone was formally launched in October 2002. In 2003, there were 8 operators (9 cages) in the mariculture zone; 9 in 2004 (8 individuals, 1 corporation with 11 cages); and 13 in 2005 (11 individuals and 2 corporations with 27 cages). In 2006, livelihood cages by the member-barangays of the people's organization (Barangays Narvacan, Cabaruan, Raois, Ubagan, Cupang, Casantaan, Namonitan, and Tubod) became operational, together with three individual

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[12] Narrative assembled from KIIs in March 2015 with fish pen operator, Talibon BFAR-Demo Cage aquaculture technician, and fish cage operators; and secondary sources (*Municipal Ordinance No. 2008-30: An Ordinance Providing Guidelines on the Operation of the Talibon Mariculture Zone, photocopy; Municipality of Talibon, Individual Program of Works: Establishment of Executive Management Council Office [DA-BFAR] at Carlos P. Garcia Multi-purpose Center, photocopy; Talibon Mariculture Zone Locator Status Report 2011, photocopy; Talibon Mariculture Zone Locator Status Report as of November 14, 2013, photocopy);* FGDs with fisherfolk in Barangay Tanghaligue, and personal communication with the provincial agriculturist to Talibon LGU on Feb 23, 2015, in Talibon.

[13] Narrative assembled from KIIs in May 2015 with the BFAR-RMATDEC (Regional Mariculture Technology Demonstration Center) aquaculture technician, and administrator of Small Fishermen Association of Casantaan), and secondary sources (Sto. Tomas MZP Operation, records provided by BFAR-RMATDEC technician), and FGDs in June 2015 with operators outside the Sto Tomas MZP (Barangay Narvacan).

investors, and two corporations, for a total of 20 cages. A strong typhoon in 2006 destroyed all the cages; in 2007, there were no operations in the mariculture park. In 2008, one corporation from a nearby province became the sole operator with five cages, but only for a year. In 2009, there were no operations again in the mariculture park. In 2010, another corporation started operations in the park with three cages, and these increased to 15 in 2011, but reduced to 13 in 2012, 11 in 2013, and 5 in 2014. In 2015, a feed corporation (which used to be a supplier of the corporation that started mariculture operations in 2010) commenced mariculture operations with four cages. In 2013, another livelihood cage from the BFAR was awarded to the fishers' association for the culture of the green grouper. The operations of this association remain to this day.

Meanwhile, fish cages and other mariculture operations outside the mariculture park had started earlier than those in the park. The strong earthquake in July 1990 destroyed the fishponds in the area. Two former fishpond operators turned to growing milkfish in fish pens two to three years after the earthquake. Bamboo fish pens had been built in former fishpond areas before the earthquake and were flooded. In 2006, after their fish cages in the mariculture park had been destroyed by the typhoon, three individual members of the peoples' organization of Sto. Tomas turned to bamboo fish cage operations to grow groupers. Many followed by borrowing money to finance the high investment costs. In other barangays, fish pens to raise grouper were built. Although the typhoon in 2008 paralyzed the operation of cages in the mariculture park, the cages outside the park suffered less. Soon, stronger fish cages and pens for raising groupers were built. In 2015, about 40 fish cages (under 40 operators) were located outside of the mariculture zone. These fish cages and pens were built near the homes of their owners, about 10–40 meters away from the shoreline.

From historical accounts of the establishment and development of the six mariculture parks, there are lessons to be learned:

1. The BFAR needs the support of the LGUs to establish mariculture parks, particularly in passing local ordinances that legalize them. The municipal waters where mariculture operations are located are under the jurisdiction of the local government.
2. Even if mariculture parks are established, the investors come in trickles, providing evidence that mariculture parks are not as attractive as envisioned, even if the BFAR provides demonstration sites or livelihood support. From among those who invested in mariculture operations in the mariculture parks, some left soon.
3. The uncertainty is high. One strong typhoon is enough to wipe out investments, and small operators using bamboo cages are highly vulnerable. There is also uncertainty in the sourcing of juveniles. This is the main reason why mariculture operations, specially by small-scale operators, can be shortlived. In the case of Sual where large-scale operations using high-density polyethylene (HDPE) cages is the norm, mariculture operations have shown resilience to typhoons.
4. When the location of the mariculture park is far from the shoreline, it is not attractive to investors because of the costs incurred in transporting the inputs (fingerlings, feeds, etc.) and the physical danger to the operations. If not monitored and regulated, then investors will locate outside of the designated sites.
5. Existing sites for mariculture operations can be converted into mariculture parks such as the case of Sual. Mariculture operations led by the private sector had already been established two decades before the area was designated as a mariculture park.

4.3 Management and Operation of the Six Mariculture Parks

All mariculture parks are supposed to be managed by the EMC. Among the six mariculture parks, the EMCs were active only in the two LGU and BFAR-led sites (Table 3). In the four other sites, the EMCs were not active or established, and the private sector operators were left to themselves or were managed by the LGUs. Operational practices were highly varied and poorly regulated, which gave rise to a number of issues and challenges in mariculture operation in the study sites.

The smallest mariculture zone was in Sto. Tomas (10 ha, all for fish cages), while the biggest was in Lopez Jaena (313 ha with 31 ha for fish cages). The other mariculture areas were also big, near or more than 200 ha, in which about 10%–100% were allocated for fish cages/pens.

Table 3 provides information on the current operations of the mariculture areas in the study sites. The numbers of operators and cages are based on the latest data shared by the local government or the BFAR regional office. It shows that many of the mariculture operators, particularly the medium and big ones, were from outside of the LGU where the mariculture operation was located. They used cages (square or round; fixed or floating) and pens made of bamboo, galvanized iron pipes, or high-density polyethylene.[14] Milkfish was the main species farmed, with a little of other species such as pompano and siganids. Grouper was popular in the Sto. Tomas and Region 1 mariculture sites.

Currently, the local government of Sual manages its mariculture area through the municipal agriculture office. The BFAR assists in improving the layout of fish cages from the clustering method to the current subdivision method. As of May 2015, Sual had 21 operators (mostly corporations and individuals from outside the municipality) with 750 cages. Most of the cages were circular, floating HDPE ones, and there were also a number of square and circular steel cages. The species raised included milkfish, red snapper, green grouper, pompano, and siganid ("Malaga").

In Calape, Talibon, and Sto. Tomas, the fish cages and pens of private operators were built outside of the respective mariculture zones. The main reason identified was the far distance of the designated mariculture areas from the shore. In Calape, even the BFAR demonstration cages were located outside the designated mariculture zone.

The mariculture park in Balingasag was hit by a strong typhoon in December 2014, which drastically reduced the number of active operators and cages by January 2015. As of January 2014, it had 63 active operators and 203 cages. The big and medium operators were from outside the municipality, specifically from Cagayan de Oro. By January 2015, it was estimated that the number of cages left that could still support operations was fewer than 113 belonging to 38 operators. Most of the fish cages were square bamboo cages and a relatively few round HDPE cages. Most of the cages destroyed during the typhoon were made of bamboo. Milkfish was the most common species grown with lesser quantities of siganid and pompano.

[14] Pens are fixed, while cages can be floating or fixed.

Table 3. Operators, cages, and species grown in the mariculture areas in the study sites

Attribute	LGU and BFAR-Led		Private Sector and LGU-Led	Private Sector and BFAR-Led		
	Balingasag	Lopez Jaena	Sual	Calape	Talibon	Sto. Tomas
Current management	EMC	EMC	Private sector with LGU	EMC not active; private sector left to themselves	EMC not active; private sector left to themselves	Private sector left to themselves in non-MPA; BFAR in MPA
Total area (hectares)	195.7	313.26	208	220	250.28	10
Area for fish cage (hectares)	19.5[1]	31.2[2]	208	22	25.28	10
No. of operators	*(as of Jan 2014)* *Total:* 63 Small = 28 Medium = 24 Big = 11	*(As of December 2014)* *Total:* 79 Small = 0 Medium = 23 Big = 10 Livelihood = 36 Conditioning = 10	*(as of May 2015)* *Total:* 21	(*as of Feb 2015)* *Total:* 6 (inclusive of BFAR)	*(as of Nov 2013)* *Total:* 7 Fish cage = 3 Fish pen = 4	*(as of May 2015)* *Total:* 74 Inside MZ = 3 (inclusive of BFAR demo cage) Outside MZ = 71
No. of cages or pens	*(as of Jan 2014)* *Total:* 203 Small = 15 Medium = 44 Big = 144	*(as of Dec 2014)* *Total:* 177 Small = 0 Medium = 41 Big = 44 Livelihood = 36 Conditioning = 48 LGU/BFAR = 2 R&D = 6	*(as of May 2015)* *Total:* 750	*(as of Feb 2015)* *Total:* 17 (inclusive of BFAR demo cage)	*(as of Nov 2013)* *Total:* 65 Fish cage = 36 Fish pen = 29	*(as of May 2015)* *Total:* 79 Inside MZ = 8 (inclusive of BFAR demo cage) Outside MZ = 71

Table 3 continued

Attribute	LGU and BFAR-Led		Private Sector and LGU-Led	Private Sector and BFAR-Led		
	Balingasag	Lopez Jaena	Sual	Calape	Talibon	Sto. Tomas
Residence of the operators	Big & medium: Outside of LGU Small: Within LGU	Big & Medium: Almost all are from LGU Livelihood: Within LGU	Almost all are outside of the LGU	Outside of the LGU	Almost all are from within LGU	Outside MZ: All within LGU Inside MZ: Outside and within LGU
Kinds of fish cages	Square bamboo cages Circular HDPE cages	Circular HDPE cages Square bamboo cages	Square GI pipe cages Circular HDPE cages	Floating square bamboo cages	Bamboo fish pen Square bamboo cages	Outside MZ: Floating bamboo and fish pen Inside MZ: Circular HDPE cages, square rope-framed cages
Species cultured	Milkfish, siganid, pompano	Milkfish, siganid, pompano	Milkfish, red snapper, green grouper, pompano, siganid	Milkfish	Milkfish	BFAR Demo: Pompano, mangrove snapper, malaga Inside MZ: Milkfish, green grouper Outside MZ: Grouper, milkfish, malaga

Notes: (1) Data were assembled from a number of KIIs and secondary sources. (2) [1]Areas utilized were 9.363 ha and [2]7.833 ha, based on the data (Powerpoint presentation) shared during the Mariculture Summit on 30 October, 2014, by Mr. Narciso Minguito, MP Program Coordinator for Region 10. (3) Conditioning cages are where fry/fingerlings/seeds are conditioned first (to adjust to water temperature) before being transferred to grow-out cages. (4) EMC = Executive Management Council, HDPE = high-density polyethylene, MPA = marine protected area, MZ = mariculture zone

In 2014, in the Lopez Jaena Mariculture Zone, there were 79 active operators operating 177 cages, of which 36 were livelihood cages, 41 were medium cages, 44 were big cages, 48 were conditioning cages, 2 were demonstration cages of the BFAR and the LGU, and 6 were research and development cages by the Mindanao State University-Naawan. Most of the grow-out cages were floating circular HDPE cages while there were relatively fewer square bamboo cages. Milkfish was also the most common species raised, with relatively less pompano and siganid. Most of the operators were local residents.

In terms of number of cages, Calape had six operators (from outside of Calape) with 17 cages, including one BFAR demonstration cage. In Talibon, the most recent number of operators (mostly local residents) available was as of November 2013: three fish cage operators had 36 cages and four fish pen operators had 29 fish pens. The fish cages and fish pens were made of bamboo.

In Sto. Tomas, the mariculture zone had only three operators (BFAR, a corporation from outside Sual, and an individual from Sual) and eight HDPE or rope-framed cages (including the BFAR demonstration cages) as of May 2015. Outside of the mariculture area, however, there were 71 operators (all local residents) with 71 floating cages and fish pens. The BFAR was raising pompano, mangrove snapper, and siganid (Malaga) in their demonstration cages. The other two cages inside the mariculture zone grew milkfish and green grouper. The fish pens outside the mariculture area were rearing grouper, milkfish, and siganid.

4.3.1 Permits and fees in mariculture operation

The requirements in terms of permits and fees to be paid in mariculture operation differed by site (Table 4). There were common requirements like having to get a business or mayor's permit, but amounts to be paid varied, ranging from PHP 500 per year (medium player) in Balingasag to PHP 12,000 per operator per year in Sual. Annual space rental fees ranged from PHP 250 per cage per year (small player) in Lopez Jaena to PHP 2,000 per cage per year (medium to big players) in Lopez Jaena and Balingasag. Calape also had a rental of PHP 500 per cropping per year for livelihood cages. The equivalent in Sto. Tomas was the resource user's fee of PHP 5/m^3 per year. Reservation and application fees were also required in Balingasag (same fee of PHP 1,000 per operator) and Lopez Jaena (PHP 200 per operator), which varies by level of player. In Sto. Tomas, the filing/application fee was low at PHP 20 per operator. Only in Sual did an ECC application cost PHP 50,000. Also in Sto. Tomas, the operators had to pay PHP 1/m^3 per year. It can be noted that only in Sual where the ECC is individually filed by operators, while in other sites, it is the BFAR who files the ECC for the mariculture park.

4.3.2 Support from BFAR

The BFAR provides technical support to officially designated mariculture parks. Table 5 shows the support from the BFAR, as identified from various KIIs and secondary data sources. The support from the BFAR for each mariculture park was highly varied. It ranged from capacity building (various training courses on value addition and for the caretakers); support activities (layout of cages, water quality assessment); and provision of production inputs (cages) to infrastructure support (auction markets, fish ports, EMC building, processing plant, hatchery).

Table 4. Permits and fees in mariculture operation

Mariculture Site	LGU and BFAR-Led		Private Sector and LGU-Led	Private Sector and BFAR-Led		
	Balingasag	Lopez Jaena	Sual	Calape	Talibon	Sto. Tomas
Business permit/ Mayor's permit (per year)	PHP 500[1] (medium player) PHP 1,500[1] (big player)	Small = PHP 250 Medium = PHP 1,000 Big = PHP 1,500[2]	PHP 12,000 per operator[12]	PHP 1,000 per operator	PHP 3,000 per operator	PHP 4,000 per cage
Barangay permit/ clearance				PHP 30 per operator	PHP 50 per operator	
Space rental (per year)	PHP 2,000[1] (medium and big players)	Small = PHP 250 per cage Medium = PHP 2,000 per cage Big = PHP 2,000 per cage		Livelihood cages = PHP 500 per cropping [4]		
Reservation Fee	P1,000 per operator	Small = PHP 500 Medium = PHP 1,000 Big = PHP 1,500[2]				
Application/ Filing fee	HP 200 per operator	Small = PHP 250 Medium = PHP 500 Big = PHP 750[2]				PHP 20 per investor[5]
Auxiliary invoice			PHP 5 for every 25 kg banyera (fish tub) 10–20 kg ice box, plastic bags of fingerlings or other fishery products in live form[3]			
Resource/User's fee						PHP 5/m^3 per year[5]
Permit fee (DENR/PAMB)						PHP 1/m^2 per year[5]
ECC			PHP 50,000 per operator			

Sources: (1) BMP powerpoint presentation prepared by the A.T. Fisheries (Balingasag Municipal Agriculture Office), soft copy (2) Draft primer on Mariculture Park Policies and Guidelines (Lopez Jaena Mariculture Park) prepared by the Municipal Agriculture Office, booklet; (3) Municipal Ordinance No. 05-2014: Sual Fisheries Code, photocopy (4) KII with Calape CRM Officer, March 2015 (5) Sto. Tomas Mariculture Zones in Region 1-Sto. Tomas MZP Model, brochure

Note: DENR = Department of Environment and Natural Resources, ECC = Environmental Compliance Certificate, PAMB = Protected Area Management Board

Table 5. Support from the BFAR

LGU and BFAR-Led		Private Sector and LGU-Led	Private Sector and BFAR-Led		
Balingasag	Lopez Jaena	Sual	Calape	Talibon	Sto. Tomas
1. Floating guard house 2. Floating cottage 3. Fish landing 4. Auction market 5. Multi-species processing plant 6. Lying-in community-based hatchery 7. Livelihood cages 8. Skills training and seminar for fisherfolk and women's association 9. Patrol boat engine for law enforcement[1] 10. Waste disposal system 11. Conduct of EMC meetings 12. Water quality assessment, 13. Application of ECC for mariculture park, 14. Assistance for typhoon damages	1. Hands-on training on Bangus fingerlings/ garungan (local name for fingerlings) production and handling techniques 2. Hands-on training on Bangus deboning and value-added product/fish processing 3. Sea cage caretakers' training 4. Hands-on training on garungan production (Module II) 5. Livelihood cages 6. Consultative meeting/forum on sustainable development of existing MPs 7. Conduct of EMC meetings 8. Water quality assessment 9. Application of ECC for mariculture zone	1. Sual fish port 2. Water quality assessment 3. Organizing the layout of the cages 4. Training on fish processing 5. Assistance in the application of ECC by operators	1. EMC building 2. Livelihood cages, 3. BFAR demo cage 4. BFAR hatchery 5. Central Visayas multi-species nursery demonstration 6. Training for caretakers/operators on fish cage culture	1. EMC Building (now Coastal Resource Management Office 2. Training for caretakers/operators on fish cage culture. 3. Assistance for damages of typhoon/earthquake (HDPE fish cages) 4. BFAR demo cage (but destroyed by typhoon).	1. BFAR-RMATDEC 2. Damortisfish port 3. Training for caretakers/operators on fish cage culture 4. Training on fish processing 5. BFAR demo cage 6. Livelihood cages for fishers' association (with DOLE) 7. Water quality assessment 8. Application of ECC for mariculture zone

Note: Data assembled from secondary sources and KIIs

5.0 ISSUES IN MARICULTURE PARK OPERATION

The three main issues in the Mariculture Park Program are (1) low uptake, (2) low participation of the small-scale fishers/fisherfolk, and (3) lack of diversity in species farmed. These three issues are the main reasons why mariculture parks have not fully attained their goal of increasing employment and reducing poverty in the areas where they are located.

6.1 Low Uptake

In general, the number of operators in the six study sites did not significantly increase through the years (Table 6). This is particularly clear in the case of Calape, Talibon, Sto. Tomas, and Sual. At the time of the launching of the mariculture zone in Calape, the number of operators was below five and reached six only after seven years. Similarly, the mariculture park in Talibon started with the BFAR operating demonstration cages. It reached 19 operators in 2011, and only three in 2015. In Sto. Tomas, the available data (2003–2006) showed an increasing number of the mariculture park operators, with 14 in 2006 as the highest; thereafter, only one operator from 2007 to 2015. In Sual, with data available only for 2010, 2014, and 2015, the number of operators did not go beyond 25. In Sual, most of the operators were big companies, while some were feed companies. In other sites, the operators were individuals/families or cooperatives, a few small companies, and the BFAR operating its demonstration cages.

The LGU and BFAR-led mariculture sites attracted relatively more operators, but the numbers have also been changing. In Balingasag, the number of operators started with two, reached 94 in 2010, and declined thereafter to fewer than 38 by February 2015. Only in Lopez Jaena did the number of operators steadily increase in its five years of operation.

The number of cages in operation followed the trend of the number of operators, although one operator could have a number of cages. In Balingasag, the 94 operators in 2010 had 276 cages, while the 63 operators in 2014 had 203 cages. In Lopez Jaena, the mariculture park started in 2011 with two BFAR demonstration cages, increased to 146 cages in two years with 55 operators, and reached 177 cages in 2014 and 2015. In Sual, the number of operators in 2014 and 2015 declined by two, but the number of cages declined by 28. In Calape, the highest number of cages was 17 in 2015 with six operators. In Talibon, the number of cages in 2011 reached 79, run by 19 operators, a dramatic increase from 15 cages by six operators in 2010. In 2015, the number of cages went down to three by three operators.

The same trend is reflected in the national data. In June 2010, almost a decade since the BFAR has introduced the Mariculture Park Program, there were 62 mariculture parks with a combined area of 50,150 ha with only 273 ha (0.54%) developed by 2,199 locators/investors and the BFAR (Salayo et al. 2012). Based on the records of the BFAR Main Office in 2015, as of June 2014, there were 67 mariculture parks with a total planned area of 34,183 ha—a decline of 32% from the 2010 designated area. In terms of developed area in 2014, the total area was 13,047.15 ha or 38% of the planned area. However, 12,550 ha (96% of the developed area) was from the Autonomous Region of Muslim Mindanao (ARMM). If the ARMM is not included, then the total planned mariculture area in 2014 was only 19,783 ha and the developed area was 496.15 ha or 2.51% of the planned area. Unfortunately, the total number of locators was not available in the 2014 data, but the total number of cages was 2,963 with 342 BFAR/LGU livelihood assistance, 68 BFAR techno demo, 101 LGU cages, and 2,452 private sector cages.

Table 6. Number operators and cages in the six mariculture sites (2003–2015)

Year	LGU and BFAR-Led				Private Sector and LGU-Led		Private Sector and BFAR-Led					
	Balingasag		Lopez Jaena [5]		Sual		Calape [6]		Talibon		Sto Tomas [9]	
	Operators	**Cages**	**Operators**	**Cages**	**Operators**	**Cages**	**Operators**	**Cages**	**Operators**	**Cages/ pens**	**Operators**	**Cages/ pens**
2003											8	9
2004											9	11
2005											13	27
2006											14	27
2007	2[1]	2[1]									nd	nd
2008	nd	nd					1[1]	1[1]	1[1]	1[1]	1	5
2009	nd	nd					nd	nd	nd	nd	nd	nd
2010	94[2]	276[2]			12[2]	343[2]	2	Nd	6[2]	15[2]	1	3
2011	nd	nd	1	2	nd	nd	3	3	19[7]	79[7]	1	15
2012	nd	nd	13	2	nd	nd	3	4	nd	nd	1	13
2013	nd	nd	55	146	nd	nd	4	7	7[8]	65[8]	1	11
2014	63[4]	203[3]	79	177	23[10]	778	3	16	nd	nd	1	5
2015	<38[4]	<113[4]	79	177	21[11]	750[11]	6	17	3[12]	3[12]	1	4

Sources:
(1) Key informant interviews
(2) Salayo, Francisco and Peñales (2012)
(3) BMP powerpoint presentation prepared by the AT-Fisheries (Balingasag Municipal Agriculture Office), soft copy
(4) Researchers'estimate from available records in February 2015 after typhoon Ruby devastated the mariculture operation in December 2014
(5) Lopez Jaena Coastal and Fisheries Profile CY 2014, photocopy
(6) As of February 2015, Calape Mariculture Park Locators record prepared by the aquaculture technician, and the Calape BFAR Demo Cage records
(7) Talibon Mariculture Zone Locator Status Report (2011), photocopy
(8) As of 14 November, 2013, Talibon Mariculture Zone Locator Status Report, photocopy
(9) Sto. Tomas MZP Operation records provided by the BFAR-RMATDEC technician
(10) BFAR Central Office, as of July 2014, unpublished
(11) Fish cage layout provided by Sual Municipal Agricultural Office to the researcher on 1 June, 2015
(12) Based on site visit during data collection in the area in March 2015

Note: nd = no data

In 2013, the BFAR conducted an assessment to identify sites for permanent removal and intensive promotion (BFAR 2014). This indicates that some mariculture parks were not functioning as expected. Out of the 67 mariculture park areas (as of June 2014), only three (i.e., Balingasag MP in Misamis Oriental [Region 10]; Panabo MP in Davao del Norte [Region 11]; and Pantukan MP in Compostela Valley [Region 11]) were identified for intensive promotion. The rest had the following distribution: 21 were "non-performing" (31%), 23 were "LGU-managed" (34%), 11 were BFAR-managed (16%), 4 were found to have "other potential areas for intensive culture," 2 were for permanent delisting, 1 was for assessment, 1 had "6 clusters with no stock," and 1 had "no Memorandum of Agreement with the LGU."

5.2 Low Participation of Small-Scale Fishers

Among the critical issues is the low participation of fisherfolk in mariculture. According to Adora (2011), the Mariculture Park Program was designed to be fisherfolk-focused. The mariculture parks were envisioned to benefit the fisherfolk in the communities where they were situated. Albeit late, the BFAR, in 2009, came up with the guidelines on the implementation of a cage-for-rent project to address the problem of none-to-low participation of small fishers in mariculture parks due to the high investment costs. Despite this, there is still lower-than-expected investment level in mariculture among the fisherfolk. Based on the records of the BFAR Central Office (as of July 2014), the number of livelihood assistance beneficiaries (small-scale fishers, small-scale operators, small-scale fishers cooperatives, and local fisherfolk organizations) was 17 (33%) in Balingasag, 20 (27%) in Lopez Jaena, and 10 (100%) in Calape, with none in Sual, Talibon, and Sto. Tomas (Table 7).

Table 7. Participation of small fishers in mariculture in the six mariculture sites

Attribute	LGU and BFAR-Led		Private Sector and LGU-Led	Private Sector and BFAR-Led		
	Balingasag	Lopez Jaena	Sual	Calape	Talibon	Sto. Tomas
Total no. of operators	52	74	23 private sector	10 livelihood beneficiaries	14 private sector	BFAR, 1 private sector
Total no. of cages	257	136	778	10	48	24[2]
No. of livelihood assistance beneficiaries, (% to total operators)	17 (33%)	20[1] (27%)	0	10 (100%)	0	0
No. of livelihood assistance beneficiaries, (% to total no. of cages)	17 (7%)	20 (15%)	0	10 (100%)	0	0

Source: BFAR (2014)
Notes: (1) No. of cooperatives (2) 3 BFAR-Techno and 21 private investors

At the national level, only 342 out of the 2,963 cages were BFAR/LGU livelihood cages. The *Minda News* (7 June, 2012) reported that out of the 300 cages of local investors in Panabo City Mariculture Park, only 20 were operated by local fisherfolk families.

Meanwhile, there are issues of displacement of fishers from traditional fishing grounds now occupied by fish cages and gleaning areas being replaced by mooring areas. Fishing is not allowed in areas surrounding the mariculture park. For instance, it is about 100 m in Balingasag and Lopez Jaena. According to the fishers in all six mariculture sites, fish are abundant around the mariculture area because of the feeds that escape to the surrounding waters. In effect, the mariculture area also serves as a protected area for fish.

5.3 Lack of Diversity in Species Farmed

As described by the DA-BFAR (2009), mariculture parks differ from traditional fish farming in some areas in the country because they entail cultivating high-value fin fishes and other commercially important marine species such as milkfish, siganids, groupers, and red snappers in enclosures (pens or cages) in open waters. Also included are aquasilviculture, mussel and oyster culture, sea ranching of lobsters and seahorses in coral reefs, and seagrass farming areas in large enclosures in the open sea in municipal waters. Based on the report of *The Philippine Daily Inquirer* (2 January, 2012), the DA claims that fish farmed using cages or pens in open waters have higher quality than those farmed in fish tanks or ponds.

In the case of the mariculture parks in the six study sites, however, there was no diversity in the species farmed (Table 3). Milkfish was the primary species farmed in all the six sites. Milkfish is suited to the exposed conditions, but its price is low and has small international market. There were pompano and siganid bred in Balingasag and Lopez Jaena, but in small numbers.

Grouper farming was only found in Sto. Tomas. The production was low, but the price was six times higher than that of milkfish. Grouper farming catered to the live-fish restaurant trade. This result supports earlier studies on grouper culture that found it to be highly profitable (Baliao et al. 1998; Baliao et al. 2000; Pomeroy et al. 2004). However, if farm management is poor, then the survival rate is low, which results in losses. This happened to the green grouper farms inside the mariculture zone in Sto. Tomas.

6.0 CHALLENGES IN MARICULTURE OPERATION

The mariculture park program is beset by a number of challenges that can explain the low uptake of the private sector, the low participation of fisherfolk, and the lack of diversity in the species farmed. Table 8 shows the challenges, as identified by the key informants who included operators, supervisors/managers, local fishery managers assigned to mariculture operations, and the FGD participants. Most of the challenges were production inputs-related (low supply and high cost); production practices-related (diseases, high mortality, fish kill); vulnerability to changes in climate (natural calamities such as typhoons, jelly fish boom, red tide); and others such as theft and poor site conditions.

Table 8. Issues and challenges in mariculture operations in the six sites

Issues	Balingasag	Lopez Jaena	Calape	Talibon	Sto Tomas	Sual
Production inputs-related						
High investment cost/construction materials	x	x	x	x	x	x
High cost of operation	x	x	x	x	x	x
High cost of feeds/ increasing price of feeds	x	x	x	x	x	x
High price of fingerlings	x	x		x	x	x
Low supply of fingerlings	x	x			x	x
Low supply of feeds	x				x	
Production practices-related						
Diseases	x		x	x	x	x
High fish mortality	x	x	x			x
Fish kill		x			x	x
High vulnerability to changes in climate						
Natural calamities	x	x	x	x	x	
Strong/destructive typhoons	x	x		x	x	x
Theft				x	x	x
Poor site conditions			x	x	x	

Sources: Various KIIs and FGDs

6.1 High Investment and Operational Costs

There has been much optimism about what mariculture parks can bring. For instance, there is much expectation on the "moneymaking power of mariculture" (PIA 2009). It was expected that the yield per cropping of one cage could equal the yield of a 2-hectare fishpond. According to Rosario (2008), the estimated benefits of mariculture parks to the local government are

1. *Mayor's/business permits*. PHP 1,500 per mooring space per year x 30 spaces per hectare, PHP 45,000;
2. *EMC rentals*. PHP 5,000 per mooring space per year x 30 spacer per hectare, PHP 150,000;
3. *Employment benefits*
   Direct: caretaker (60), security (2), maintenance (5)
   Indirect: cage fabricators (360), mooring development (15), fry producers (133), transport and handling (5,346);
4. *Other business operations* such as value-addition (milkfish deboning), cage suppliers, feed suppliers, fish dealers, warehouse, ice plant and cold storage, milkfish hatchery operations, and milkfish nursery operations.

Only those with the capacity to invest can afford to do so because the investment costs are very high. The bigger the scale of operation, the more the investment items, and the higher the costs. Based on the case of the six mariculture parks, cages of different materials, dimensions, and nets are the major initial investment items in mariculture operation. For instance, in the LGU and BFAR-led mariculture parks in Balingasag and Lopez Jaena, the total investment cost (sans the livelihood operators) ranged from PHP 153,000 (medium operator using bamboo cages of 10x10x8 m to grow milkfish) to PHP 10 million (big operator using floating circular HDPE cages 20 m [diameter] x 6 m [height] to grow milkfish).

The cages accounted for the highest share (60%–80%) of the total investment cost. In Sual, the total investment cost ranged from PHP 38 million to PHP 97 million. In the private sector and BFAR-led mariculture parks in Calape and Talibon, the total investment cost ranged between PHP 145, 000 and PHP 2.2 million. Only in Sto. Tomas was the total investment cost low, ranging between PHP 23,000 and PHP 55,000 for single cages to farm groupers, but outside the mariculture park.

About 15 years ago, Yap (1999) already cited that the biggest problem in promoting sea cages as a technology option for the poor was the cost of the cages and that of their installation. Imported fish cages with a 19-meter diameter cost more than PHP 1.4 million (approximately USD 36,800) including installation, with 50% of the cost apparently going into the mooring system. A locally manufactured circular cage with a 15-meter diameter reportedly cost about PHP 600,000 (USD 15,789) with installation. Smaller cages for less exposed sites were available at about PHP 100,000 (USD 2,632) per four-cage module, with each cage measuring 5x5 m, without the mooring.

Similarly, operational costs are very high. For instance, the annual operating cost per cage for a small and big player in Balingasag was around PHP 360,000 and PHP 3.2 million, respectively. In Lopez Jaena, the annual operation cost per cage ranged between PHP 443,000 and PHP 1.7 million. In Sual, the cost range was PHP 1.7 million to PHP 2.5 million. In Calape, it was PHP 112,000, and in Talibon, it ranged from PHP 744,000 to PHP 987,000. In Sto. Tomas, it was PHP 25,000 for a small bamboo cage to grow groupers outside the mariculture park, and PHP 2.2 million for an HDPE cage to grow milkfish inside the mariculture park.

As discussed, the fisherfolk who are supposed to be the main players are largely missing as operators. Unless given support by the BFAR, such as the case in Balingasag and Lopez Jaena, these fishers cannot participate as operators in mariculture. Only through the assistance of the BFAR, through the rent-to-own scheme (livelihood assistance program), can the small-scale fishers operate cage culture. The initial outlay for mariculture operation is beyond the capacity of fisherfolk. Also, the small cages with bamboo frames that small fishers use are not suitable in typhoon-prone areas. Moreover, the major production inputs in mariculture operation (fingerlings and feed) are also major constraints. During the FGDs, the amount estimated by the participants to start mariculture operations was between PHP 250,000 and PHP 500,000, which is near to the actual data of initial investment costs in the mariculture parks in the study sites.

9.2 Expensive Feed

In general, fish feed was found to be the most expensive operational input, sharing 51%– 88% of the total operational cost. There are only a few feed companies (e.g., Tateh, Santeh, and BMEG) in the country, and they were present in all the study sites. Their limited numbers and the inelastic demand for feeds likely contribute to the high price of feed. The feed companies delivers directly to the fish farmers (such in Balingasag and Lopez Jaena), or they have a local distributor (such as in Calape and Talibon). Sual was different because many of the investors were also feed companies or bought the feed from their co-operators. In Sto. Tomas, the groupers were fed with trash fish, which created a market for juvenile fish for grouper fish farmers.

Feeds delivered are usually payable within a month or two or during harvest time. The feed is stored in storage houses. The cost of a bag of feed ranged between PHP 500 and PHP 810 depending on the brand, with most suppliers buying feed costing PHP 700 per bag (BFAR Region 10 2015). The commercial pellet feed is the most expensive operational input for the mariculture production of milkfish.

The different study sites had different feeding practices: Balingasag and Lopez Jaena had scheduled feedings five to six times a day; in Sual, feeding was continuous between 6.00 a.m. and 6.00 p.m. or until the fish appeared to stop eating; in Calape and Talibon, feeding was three to five times a day; and in Sto. Tomas, it was two to three times a day. For grouper, the feeding schedule was dependent on the availability of trash fish. The small-scale fishers did not have access to the financial resources necessary to invest in the purchase of pellet feed, and thus their participation as operators in mariculture was low.

Aside from price, the total annual feed expenses were found to be influenced by the scale of operation, feeding practices, and the available budget of the operator. In Balingasag, the cost ranged between PHP 280,000 (1 unit, bamboo, floating, square, 5x5x8 m, milkfish culture) and PHP 11.8 million (24 units, bamboo, floating, square, 10x10x8 m, milkfish culture). In Lopez Jaena, the estimated annual cost of feed was PHP 386,000 (1 floating bamboo cage 10x10x 4 m, milkfish culture) and PHP 26 million (30 units of floating bamboo cages, 10x10x6 m, milkfish culture). In Sual, the cost was estimated at PHP 23.4 million (18 units, galvanized iron pipes, floating, square, 19x19x16 m, milkfish culture) and PHP 123.8 million (55 units, HDPE, floating, circular, 18 m diameter x 8 m height, milkfish culture). In Calape, it was PHP 330,000 (4 units, bamboo, floating, square, 8x8x8 m, milkfish culture). In Talibon, it was PHP 710,400 (1 unit, bamboo, floating, square, 6x6x5 m, milkfish culture) and PHP 1,126,400 (2 units, bamboo, fixed, square, 20x20x5 m, milkfish culture). In Sto. Tomas, the cost was between PHP 16,200 (1 unit, bamboo, floating, square, 10x10x2 m, grouper culture) and PHP 7.8 million (4 units, HDPE, floating, circular, 16 m diameter x 8 m height, milkfish culture).

There are not many feeding companies in the mariculture sites that otherwise would encourage competition and lower prices. Also, the distribution channels for pelleted feed are not widely available in rural areas, which limits access to it. These two factors increase the cost of feed. The lack of affordable and accessible pelleted feed is a major constraint in grouper mariculture production. Groupers are fed on trash/low value fish. The availability of trash fish thus affects grouper farming operations. The use of trash fish has ecological and localized environmental impacts like pollution and requires long hours of feeding. The dependence on trash fish should be reduced.

6.3 Scarcity of Fingerlings/Juveniles

The poor availability of fingerlings/juvelines is another major constraint. There was sourcing from hatcheries, and heavy reliance on the capture of wild fry/fingerlings/sub-adults for stocking milkfish, grouper, or other species. The seed from wild fishery sources is dwindling or getting more expensive to obtain. The scarcity of fingerlings drives the price up. This problem had been reported even before mariculture parks were promoted by the BFAR. For instance, mariculture development in Lingayen Gulf was found to be constrained by the supply of wild fry, among other factors (Palma, Legasto, and Paw 1989). Table 9 shows the estimated annual need for 10.2 million fingerlings in the three mariculture parks in Region 10, including that in Balingasag and Lopez Jaena mariculture parks.

The cost of fingerlings varied by study site. The fingerlings in Balingasag and Lopez Jaena (PHP 5.50–8.50 per piece) were three to four times more expensive than those in Sual (in Luzon; PHP 1.50–3.00 per piece) and also in Calape and Talibon (in the Visayas; PHP 2.50–3.00 per piece). This can be explained by the scarcity of fingerlings in the Mindanao area. The fingerlings of the grouper were relatively cheaper than milkfish fingerlings in Mindanao, but comparable to the price of fingerlings in the Luzon and Visayas study sites.

Table 9. Annual fingerlings requirement for the three mariculture parks in Region 10 (Northern Mindanao)

Type of Cage	No. of Cages	Stocking Density (pcs)	Total Fingerlings Needed (pcs)
For Balingasag MP			
Norwegian Cage (15 m diameter)	28	40,000	2,240,000
Bamboo (10x10 m)	105	15,000	3,150,000
Bamboo (5x5 m)	15	5,000	150,000
		Total	5,540,000
For Lopez Jaena MP			
Norwegian Cage (15 m diameter)	13	40,000	1,040,000
Norwegian Cage (10 m diameter)	2	18,000	72,000
Bamboo (10x10 m)	106	15,000	3,180,000
		Total	4,292,000
For Sultan Naga Dimaporo MP			
Norwegian Cage (15 m diameter)	2	40,000	160,000
Bamboo (10x10 m)	6	15,000	180,000
Bamboo (5x5 m)	3	5,000	30,000
		Total	370,000
		TOTAL	**10,202,000**

Source: Based on the powerpoint presentation shared during the Mariculture Summit on 30 October, 2014, by Mr. Narciso Minguito, MP Program Coordinator for Region 10

The total cost incurred by the operators depended on their scale of operation, stocking rate used, and available budget. In Balingasag, the annual estimated cost of fingerlings ranged between PHP 420,000 (2 units of floating bamboo cage, 10x10x6 m, milkfish culture) and PHP 5.4 million (for 30 units of floating bamboo cage, 10x10x6 m, milkfish culture). In Sual, the estimated annual cost ranged between PHP 2.7 million (18 units, galvanized iron pipes, floating, square, 19x19x16 m, milkfish culture) and PHP 9 million (75 units, HDPE, floating, circular, 20 m diameter x 8 m height, milkfish culture). In Calape, the estimated cost was PHP 80,000 (4 units, bamboo, floating, square, 8x8x8 m, milkfish culture). In Talibon, it was between PHP 162,000 (1 unit, bamboo, floating, square, 6x6x5 m, milkfish culture) and PHP 280,000 (2 units, bamboo, fixed, square, 20x20x5 m, milkfish culture). In Sto. Tomas, the cost ranged between PHP 8,750 (1 unit, bamboo, floating, square, 10x10x2 m, grouper culture, outside of MZ) and PHP 768,000 (4 units, HDPE, floating, circular, 16 m diameter x 8 m height, milkfish culture).

Mostly, the fish cage operators secured their supply from other provinces or from local private owners of conditioning ponds and fishpond owners. The main sources were from the wild or hatcheries. In Balingasag, the BFAR had a list of accredited fingerling suppliers.[15] In this list, four were also fish cage operators (two big and two medium). Only one of them was from Balingasag; the rest were in other municipalities in Misamis Oriental, Cagayan de Oro City, and Davao ("not accredited"). Recently, there has been a conversion of brackish water ponds to nurseries for fingerlings for the Balingasag mariculture park.

In Lopez Jaena, most of the fingerlings came from the nearest city of Dapitan in another province. In Sual, the fingerlings were sourced from neighboring municipalities. In Calape, the main source was the BFAR milkfish hatchery located in the municipality. In Talibon, the operators bought from local fishpond operators. In Sto. Tomas, the fingerlings for grouper and milkfish were bought from a local source or from the nearby city of Dagupan in another province.

[15] The list is available at http://mariculture.bfar.da.gov.ph/mz_locator_inputsuppliers_reg10.htm.

6.4 Diseases and Fish Kills

Diseases and fish kill have plagued mariculture operations and can easily wipe out production. Juveniles are sensitive to handling and changes in water temperature. During the KIIs, the caretakers and managers explained why they needed to avoid noise or any disturbance that will stupefy the fish, causing them to swim toward the nets or in any direction that may damage their scales. Such damaged parts will be entry points for pathogens, which cause diseases that can spread easily.

Diseases are influenced by production practices, the number of pens and cages in a particular area, and unregulated mariculture operations. The environmental integrity of the resource can be compromised by pollution resulting from intensive fish culture. Consequently, recreational activities are affected. A case in point is the Bolinao (Pangasinan) mariculture, which was established in 1995. The uncontrolled proliferation of fish pens and cages to more than double the allowable limit of 554 units has degraded the sea in the area. In just over 10 years, the water has become eutrophic, with ammonia increasing by 56%, nitrite by 35%, nitrate by 90%, and phosphate by 67% (CRTR 2010).

Among the six study sites, fish kill came out as a concern in Lopez Jaena, Sual, and Sto. Tomas. In Sual, it was reported to be a frequent occurrence, and the FGD participants cited it as a concern because fish were being found buried in plastic bags by the shoreline. In the summer months, when the water temperature is high or rapidly fluctuating, fish kill is observed. In Sto. Tomas, this concern was aired by grouper farmers with cages and pens outside the declared mariculture zone.

6.5 High Vulnerability to Changes in Climate

Strong typhoons are becoming the new normal and have become a major threat to matriculture operations located in typhoon paths. This was demonstrated recently by typhoon Seniang, which severely damaged the Balingasag mariculture park on 29 December, 2014. The summary of damage caused is shown in Table 10.

Other natural calamities experienced included the earthquake in Calape and Talibon, which destroyed the cages resulting in losses. Also the red tide and jelly fish bloom in Balingasag, Lopez Jaena, and Talibon killed farmed fish.

6.6 Theft

One of the main reasons why caretakers and guards are stationed in the cage and pen areas is to ensure security of the fish or juveniles. According to the KIIs, the reasons the fishers were not allowed to fish near the cages was because of the incidence of theft, on top of avoiding disturbance to the fish. Thieves damage nets by slashing them, and they let the fish out of the cages. In Lopez Jaena, Calape, and Sual, the municipal *Bantay Dagat* (Sea Watch) patrol team augments the security in the mariculture parks by conducting sea patrols.

Table 10. Summary of damage to Balingasag Mariculture Park by typhoon Seniang

Attribute	All	Small	Medium	Big
Number of investors affected	31 = 5 small, 17 medium, 9 big	5	17	9
Number of cages damaged	105 totally damaged bamboo fish cages and 4 partially damaged Norwegian cages (3 by big investors and 1 by medium investor) Organic aqua cages: 2 bamboo	5 bamboo	39 (38 bamboo, 1 Norwegian)	63 (60 bamboo, 3 Norwegian)
Percentage damage to structure	46%			
Total amount damaged (PHP)	53,128,860 with the breakdown: Cage structure = 8,566,000 (16%), Feeds = 21,065,136.82 (40%) , Fingerlings = 17,372,524 (33%), Broodstocks = 4,288,500 (8%), Labor & maintenance = 1,466,700 (3%) Other floating structures = 370,000 (0.7%) BFAR floating kubo (house) and organic aqua cages = 310,000 (0.58%)	1,261,472 (2.37%)	14,842,893 (27.94%)	36,714,495.82 (69.10%)
Total number of fingerlings lost (pieces)	1,867,124 (100%)	37,600 (2.01%)	639,156 (34.23%)	1,190,368 (63.75%)
Production losses[1] (in kg)	858,877.04	17,296.00	294,011.76	547,569.28
Value of production loss (PHP 95/kg)	81,593,318.80	1,643,120.00	27,931,117.20	52,019,081.60
No. of watchmen affected	27 persons (176 daily wage)			
No. of caretakers affected	55 persons (276 daily wage)			

Source of raw data: BFAR Region 10 (Northern Mindanao) (2015). Damage Report of Balingasag Mariculture Park after the onset of typhoon Seniang on 29 December, 2014 (dated 9 January, 2015) as submitted to the BFAR Central Office

Note: (1) Production losses were computed based on the following formula: No. of fingerlings x 400 grams per piece per 1,000 g

6.7 Poor Site Conditions

In areas declared as mariculture parks or zones, site selection is done by the BFAR. However, three sites (i.e, Calape, Talibon, and Sto. Tomas) had few cages in the designated areas, but more in nearby areas. It was reported that the sites were too far, had strong currents that bamboo cages could not withstand for a long time, or the water depth was too shallow.

The bamboo cages are relatively cheap structures and not built to withstand heavy seas. But the relatively lower start-up capital and cost of operations, compared to the more durable offshore cages, makes the system affordable to small, cooperative/family-run and medium-scale enterprises. However, going far out to sea makes the security of the cages a major concern and requires living facilities to be built into the system. The same problem constrains operators from moving out to open waters. If they do so, a more complicated logistical arrangement would have to be devised.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Mariculture parks have the potential to provide benefits, but these have been limited so far. They are beset by a three-fold problem of low uptake, low participation of fishers, and low diversity of species being farmed. The factors that constrain the development of mariculture parks include the following:

1. high cost of investment and operation, particulary for the physical structures (cages and support structures);
2. scarcity and high cost of operational inputs, particularly of juveniles/fingerlings and feed;
3. high vulnerability to changes in climate such as strong typhoons;
4. diseases and fish kills; and
5. other concerns of theft and poor site conditions.

Solutions to the contraints to mariculture development must be found. With the scarcity of seed and dwindling stocks, hatcheries must be the norm. Successful partnerships between hatcheries and backyard nurseries and grow-out farmers should be encouraged. There is an urgent need to focus research and development efforts on the development and standardization of commercially viable seed production technologies. The seed production of the species for which technology is available (milkfish) is presently done mostly by the BFAR, and consistent and adequate seed availability is a major constraint for prospective cage farmers.

The development of hatcheries will increase the availability of fingerlings. This will encourage competition among hatcheries and drive the price of seed down. As seed is a major component of production, lower fingerling costs will reduce grow-out production costs. These two factors will likely increase mariculture production.

There is also a need to establish a price ceiling for feed and to encourage more feeding companies or distributors. Furthermore, it is necessary to ensure the adoption of “best or better management practices’, including efficient feed formulation and feeding techniques. Wrong feeding practices can result in considerable wastage.

Stocking densities and cage numbers should be within the carrying capacity of the local environment. Mariculture parks should be properly sited, ensuring adequate water depth below the cages and sufficient water movement to disperse waste. Except for the big operators, most operators in the study sites did not have appropriate storage facilities for feed. This can result in degradation of the pellets, particularly the vitamin content, resulting in poor growth and disease in the fed fish.

Appropriate cost-effective pelleted feed should be formulated and commercial feed production is needed to expand grouper cage farming. The grouper fish farmers did not have access to refrigeration, finding it easier to collect trash fish themselves, or in small amounts as and when financial or trash fish resources were available.

There is a need to review the suitability of some areas or the site selection protocol. The mariculture areas should not be near enough so as to destroy key fishery habitats or far enough to become expensive to establish cages. If the sites are far, then the bamboo cages will not be able to withstand strong water currents for an extended period of time. There is also a need for proper layout of fish cages and pens.

New on-farm studies are needed to address the technological challenges involved. There is a need for standardization of many techniques in relation to cage farming operations. The major aspects include: stocking, feeding, farm management (to deal with bio-fouling[16] of net cages, regulation of fish growth and production, grading, health management, water quality, and pollution control); and carrying capacity assessments of the farm sites. Currently, there are no uniform leasing policies or regulatory measures for cage sites or farming. Leasing policies have to be formulated for the development and expansion of cage farming. Regulatory measures are also needed to prevent the use of available inshore sites beyond their carrying capacities. There is also the absence of a uniform definition of small, medium, and large operations. Each site had its own definition. Uniform compensation for laborers hired was also absent.

More interventions by the government and fishery developmental agencies in financing the sector are needed to enhance the popularization and establishment of cage farming in the country. A vital aspect is to develop market chains, especially domestic ones, and vertically integrate the different sectors to bring about more efficacy and cost effectiveness.

[16] Biological fouling is the accumulation of microorganisms, barnacles, and algae on submerged structures like nets and parts of fish pens or cages.

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