Comanagement for aquaculture: Suggestions from a comparative study between two major production areas of milkfish in the Philippines

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\textbf{ABSTRACT}

This study examined if, and how, comanagement is effective in controlling aquaculture industry in the municipalities of Anda and Bolinao in the province of Pangasinan, in the Philippines, the locations of two major production areas of milkfish (\textit{Chanos chanos}) in the country. Institutional and community analyses conducted in these study sites revealed a unique hierarchy of resource users, as well as unique social and economic problems in aquaculture, distinct from those of capture fishery. It was also indicated that comanagement is seen as a solution for essential practices to be enforced practically and sustainably for the management of this industry. To improve aquaculture governance, it is desired that the comanagement scheme shall include not only the governments and fishers but also business operators who often have large capital and a high degree of power.

\textbf{KEYWORDS}

Aquaculture governance; fishing community; mariculture; fish kill

\section*{Introduction}

The increase in human population has created greater demand for food fish (Jacquet and Pauly 2007; Pauly et al. 2002). Aquaculture is one of the fastest growing industries, providing nearly half of the global supply of food fish, and it is anticipated to grow further (FAO 2010). Aquaculture therefore has been contributing to poverty alleviation, food security, and income generation (FAO 2002). In spite of its increased growth and contribution to the global society, aquaculture has also resulted in negative impacts on marine biodiversity and coastal health (Campbell and Pauly 2013) and on social fairness in coastal communities (Huong and Berkes 2011; Lebel et al. 2014; Nayak and Berkes 2010). However, there are a very

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limited number of studies conducted on the aquaculture management systems in the Philippines and the rest of the world, which include those by Salayo et al. (2012) and Chen and Qiu (2014). This is in contrast with the numerous management studies reported for capture fishery (Andalecio 2011; Espectato et al. 2012; Maliao et al. 2009; Pomeroy and Berkes 1997; Pomeroy and Pido 1995). Efforts for tackling aquaculture-related problems seem to have predominantly emphasized technical approaches (Galappaththi and Berkes 2015). It is generally agreed that community-based approaches and comanagement initiatives, in which authority and responsibility for fisheries management is shared (Pomeroy and Williams 1994), will be useful (Berkes 2009; Pomeroy and Berkes 1997), especially in the Philippines, where alternative methods of resource management have been necessary because of the shifting of historical and political paradigms (Alcala and Russ 2006). In this country, the Local Governmental Code (LGC) of 1991 has provided an optimal institutional setting for fisheries comanagement (Sunderlin and Gorospe 1997). The LGC promotes partnership or alliance-building initiatives. Nevertheless, very little work has empirically examined if, and how, such approaches can be effective for the management of aquaculture; as Galappaththi and Berkes (2015) pointed out, scholars might consider aquaculture not to be part of the main area of common or collective action approaches. However, given the considerable effects of aquaculture industry on both coastal ecosystems and communities as well as the limited capacity of governments, it is important to investigate the effectiveness of such approaches for aquaculture management as well.

For a very long time, finfish aquaculture in the Philippines was virtually synonymous with milkfish production, which has been supporting the population growth of the country as one of the most popular food fish (FAO 2014). However, in the surrounding areas of Pangasinan, problems have arisen from milkfish aquaculture involving feeding practices. In the early 1990s, milkfish aquaculture in fish pens began in shallow marine bays and estuaries, particularly in the Lingayen Gulf area, where Bolinao and Anda are located (FAO 2014). This expansion in aquaculture has resulted in environmental issues such as algal blooms, water-quality degradation, and fish mortalities in the areas (Azanza et al. 2005; Escobar et al. 2013; Holmer et al. 2003; San Diego-McGlone et al. 2008). Hence there is a need to manage this industry (David et al. 2014). This could be achieved through the assessment of the factors affecting enforcement and the determination of what is needed to achieve successful management for the industry, by investigating the current enforcement status of regulations related to milkfish culture, as well as the impact of the industry on the fishing communities. This study, therefore, aimed at investigating if and how comanagement can be effective in regulating the aquaculture industry.
by comparing two major production areas of cultured milkfish (Chanos chanos) in the Philippines, the municipalities of Anda and Bolinao in the province of Pangasinan, the northwestern part of Luzon island.

**Methods**

This study was carried out through both original fieldwork and literature review on the topic. This research focused on institution and community to understand if, and how, comanagement can be effective in regulating the aquaculture industry. The institutional analysis component of this study investigated current status and limitations of aquaculture management, and participation of resource users with focus on regulation of aquaculture facilities and multisectorial monitoring systems, based on the recommendations by David et al. (2014). According to David et al., there are two recommendations for proper management of aquaculture in Anda and Bolinao in order to help prevent fish mortalities and algal blooms. The first recommendation is to reduce the density of aquaculture facilities (fish pens and cages) by 35% from the 2010 number, while the second recommendation is to develop and deploy a multisectoral monitoring system that is not solely reliant on the government but also involves the aquaculture operators and affected communities themselves. Based on the first recommendation, this article focuses on calculation of carrying capacity of aquaculture facilities, tagging of the facilities, and regular meetings of aquaculture operators/owners. Based on the second recommendation, this article focuses on multisectoral water-quality monitoring in each municipality.

The community analysis component of this study looked into the economic/social impacts of aquaculture on the fishing communities of Anda and Bolinao and how resource users are participating in decision making for the industry. Fieldwork was carried out as a component of the Coastal Ecosystem Conservation and Adaptive Management under Local and Global Environmental Impacts in the Philippines (CECAM) project under the JST-JICA, Science and Technology Research Partnership for Sustainable Development (SATREPS). Field data were collected through semistructured interviews of Local Government Unit (LGU) officers, People’s Organization (PO) representatives, and local fishers in both Anda and Bolinao (see the questionnaire in the online supplemental information). There were 233 fishers (74 in Anda and 159 in Bolinao) who participated in the survey via house visit interviews and four focused group discussions, which were organized with the assistance of the LGUs. Data for institutional analysis was collected through semistructured interviews of LGU officers and official documents offered by LGUs and UPMSI (University of the Philippines Marine Science Institute). LGU officers of Bolinao and Anda provided guidance during the
surveys and assisted with the translation from English to local language (mainly Tagalog). Fieldwork was carried out for 38 days from April to November, 2014.

Results

Overview of the study sites and the aquaculture-related problems

Bolinao has a population of 69,568 citizens, and Anda has 39,414 inhabitants (Table 1). Bolinao is a municipality that is 2–3 times bigger than Anda in terms of population, land area, and local government budget allocation for the Municipal Agricultural Office (MAO), under which aquaculture industry is assigned. On the other hand, Anda is more dependent on coastal resources given that it has more coastal barangays (villages), higher coastal population, and more municipal fishers (Table 1). Aquaculture of milkfish in Bolinao started in 1995 (Verceles et al. 2000) and in 1998 for Anda (MAO, Anda). Since then the industry has expanded, resulting in environmental problems such as fish mortalities and algal blooms. The massive fish mortality in Bolinao in 2002 incurred a total reported loss of US$9.72 million (San Diego-McGlone et al. 2008). This fish mortality coincided with a bloom of *Prorocentrum minimum*, the first reported bloom occurrence in the country and probably in the whole Southeast Asia region (Azanza et al. 2005).

In the Philippines, regulations such as the Philippine Environment Code (1988), Philippine Fisheries Code (1998), Agriculture and Fisheries

| Table 1. Comparison of basic statistics between Anda and Bolinao, in the Philippines. |
|---------------------------------|--------|--------|
|                                | Anda    | Bolinao |
| Latest issue of LGU profile    | 2013    | 2014    |
| Municipal class                | 3rd     | 1st     |
| Population                     | 39,414 (2011) | 69,568 |
| Total land area                | 8,379 ha (2011) | 23,320 ha |
| Agricultural land area         | 5,155.73 ha | 7,961.5 ha |
| Forest                         | 298 ha | 4745.06 ha |
| Number of Barangays (villages) | 18      | 30      |
| Number of coastal Barangays (villages) | 17 | 23 |
| Number of coastal population   | 37,548  | 57,391  |
| Number of households           | 8,855 (2011) | 13,539 |
| Budget of MAO                  | 2,090,882 php (2014) | 6,133,000 php (2014) |
| Number of municipal fishermen  | N/A     | 4,209   |
| Number of registered fisherfolk| 3,000 (2009) | 3,277 |
| Number of mariculture facilities| 389 (2014) | 383 (2012) |
| Number of fishing boats        | 1103 (2009) | 4,300 |
| ~ Motorized                    | 718 (2009) | 2,500 |
| ~ Nonmotorized                 | 385 (2009) | 1,800 |
| Annual fish catch (MT)         | 2,995 (2009) | 6360 (2011) |
| Annual production by mariculture (MT) | N/A | 15770 (2011) |
| CRM Office                     | No      | Yes     |
| CRM officer                    | 1 (part-time) | 2 (+2 admin officer) |

Source: Municipality profiles of Anda (2013) and Bolinao (2014).
Modernization Act (1997), and the Reorganization Act of the Department of Environment and Natural Resources (1987) listed by National Aquaculture Legislation Overview (FAO 2014) have provisions on aquaculture. According to the Philippines Fisheries Code of 1998, the Bureau of Fisheries and Aquatic Resources (BFAR) under the Department of Agriculture (DA) is the national government agency responsible for the development, conservation, management, protection, and utilization of fisheries resources. The BFAR operates regional offices throughout the country. Both the Local Government Code of 1991 and Fisheries Code of 1998 transferred government supervision and licensing of all types of aquaculture to the LGUs. The only licensing function left with BFAR for aquaculture has to do with granting of Fishpond Lease Agreements for public land (FAO 2014). Hence, government function to manage aquaculture and other coastal resources has been devolved to the LGUs. Also, the government has increasingly engaged nongovernment organizations and POs on fisheries comanagement (FAO 2014).

**Institutional analysis**

The current status of the essential practices for proper management of aquaculture recommended by David et al. (2014) is assessed and shown in Table 2. In brief, they have been basically implemented in Bolinao but not in Anda.

**Calculation of carrying capacity**

Figure 1 shows the trend in the number of aquaculture facilities in Bolinao from 1995 to 2011. After the massive fish kill (mortality) in 2002, Bolinao was able to maintain the number of facilities to less than 544 units, which is the prescribed carrying capacity. Carrying capacity was estimated with technical assistance from UPMSI in Bolinao; however, it has not been calculated in Anda.

**Tagging of facilities**

Registration of aquaculture facilities at the LGU is institutionalized, facilitating management of the industry; fees should be paid annually,

| Table 2. Current status of aquaculture governance in Anda and Bolinao, in the Philippines. |
|------------------------------------------------------------------------------------------------|
| **Anda**                                                                                   | **Bolinao** |
| Calculation of carrying capacity                                                           | Not yet     | Done (with assistance by UP) |
| Registration of facilities (tagging)                                                       | Insufficient| Sufficient (with assistance by PO) |
| Organizing operators’ association                                                          | Not yet     | Done |
| Regular water-quality monitoring                                                           | Limited (only 1 person have continued) | Sufficient (with assistance by PO) |
| Last fish kill incident                                                                    | June, 2014 (still several times per year) | 2011 |
and only municipal residents can be given permits (Municipality of Bolinao, Fishery Ordinance No. 1 Series of 1999). Survey results, however, found that registration has not been completely enforced by the LGUs. As seen in Table 3, 43% of the facilities are owned by foreign operators in Anda, and 1% are owned by foreign operators in Bolinao. Registration in Bolinao is done with assistance from POs based in the area.

**Regular meetings of the aquaculture operators/owners**

Having an association of owners/operators where they can regularly meet and discuss matters enables necessary actions to be taken, such as transfer or removal of fish facilities to avoid the risk of fish mortalities or water-quality degradation. Nonetheless, the interviews of LGU officers revealed that such an association exists in Bolinao but not in Anda, where they perceived that the consensus building has been difficult.

![Figure 1. Trend over time of the number of aquaculture facilities in Bolinao municipality in the Philippines. Source: Aruelo et al. (2012).](image)

**Table 3.** Composition of fishery and aquaculture communities in Anda and Bolinao, in the Philippines.

|                                | Anda       | Bolinao   |
|--------------------------------|------------|-----------|
| Number of municipal fishermen  | 3,000      | 4,209     |
| Number of aquaculture facilities | 389      | 383       |
| Number of aquaculture owners   | 60         | 84        |
| Number of “big owners” who have more than 10 facilities | 11       | 8         |
| Number of facilities that are owned by “big owners” | 209      | 232       |
| Percentage of facilities owned by “big owners” | 53.7%   | 60.6%     |

*Source: Municipal fisheries profile of Bolinao (2011) and municipal coastal database of Anda (2011).*

1The Fishery Ordinance document was not provided by Municipality of Anda; however, interview results for MAO Anda showed that similar documents exist in Anda as well.
Regular water-quality monitoring

Regular monitoring requires manpower, technical skills, and funds for equipment and supplies. To meet this demand, a previous project, the Sagip Lingayen Gulf Project (2003–2007), supported the water-quality monitoring teams (WQMT) being formed, trained, and equipped to monitor water quality in neighboring municipalities including Anda and Bolinao (Solibaga et al. 2008). After the project, regular water-quality monitoring was institutionalized in Bolinao with collaboration between the LGU and PO. Additionally annual funds became available from the LGU for this activity. In the case of Anda, only one person has been contracted to continue monitoring by joining the monitoring of BFAR.

Community analysis

From the community analysis, it was found that there are two types of fishers within the community, the capture fishers and the caretakers who feed and guard the cultured fish in the facilities. In Bolinao, there are 4,209 fishers including 383 caretakers;\(^2\) while in Anda, there are 3,000 fishers including 389 caretakers.\(^3\) There are 383 aquaculture facilities in Bolinao with 61% owned by only 8 “big owners,”\(^4\) and in Anda 389 facilities, with 54% owned by 11 “big owners” (Table 3).

Since the initial cost to establish a facility (300,000 php per fish pen, 3,000,000 php per fish cage\(^5\)) is too high for local fishers, who only earn around 50,000 php per year (Table 4), only wealthier residents can venture into aquaculture. From the survey, as much as 43% of the facilities in Anda are found to be owned by foreigners such as Taiwanese (Table 5). Additionally, according to the survey, caretakers have no say in the operations such as stocking, feeding, and harvesting. This means that owners are the decision makers in aquaculture operations. This is different from the experience of capture fishers, who make decisions based on their fishing and selling of catch. Thus, there is a unique hierarchy for decision making and resource use in aquaculture, which is different from that found in capture fishery.

Community surveys about the impact of aquaculture on the livelihood of local fishers were conducted in nine barangays (villages) and aquaculture zone between the two municipalities (Table 6). There is a strong perception by the capture fishers in Awag, a barangay along the Anda aquaculture zone (Tables 7 and 8), that there has been a decline in fish catching rates. From 24 respondents, which is equivalent to 95% of the 25 respondents, this is attributed to the

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\(^2\)Calculation is based on the assumption that each facility has one caretaker.

\(^3\)Calculation is based on the assumption that each facility has one caretaker.

\(^4\)In this article, “big owners” are persons who own more than 10 facilities.

\(^5\)According to the interview for aquaculture owners.
### Table 4. Average annual income of fishers in Anda and Bolinao (PHP), in the Philippines.

| Barangay          | Total income: capture fisher | Total income: caretaker |
|-------------------|------------------------------|------------------------|
|                   | Anda                         | Bolinao                |
| Salud, Culang, pirah, Lucientell, Luna Balingasay | – | 47,825 |
| Culang Dewey Estanza Luna Balingasay | 44,172 | – |
| Lucero Luciente II Poblacion Malong Awag  | 33,920 | 55,265 |
| Average           | 28246 | 121,993 |
|                   | Anda                         | Bolinao                |
|                   | 27,024 | 50,394 |
|                   | 50,394 | 50,394 |

### Table 5. Number of facilities and the composition of their owners in Anda and Bolinao.

|                | Total number of facilities | Facilities owned by foreigners | Percentage of facilities owned by foreigners |
|----------------|---------------------------|-------------------------------|---------------------------------------------|
| Anda           | 389                       | 168                           | 43.2%                                       |
| Bolinao        | 383                       | 1                             | 0.3%                                        |

Source: Structure survey results by Anda LGU (2014) and Bolinao LGU (2012).
aquaculture operation that has occupied a large part of the municipal waters used for fishing. This suggests that the aquaculture industry, even if it brings income to the municipality, does not fully benefit the local fishers. As a matter of fact, many of them in Awag perceived themselves as having become more marginalized than before, as a consequence of excessive aquaculture operation and privatization of municipal water. Thus an exploitative situation was perceived by local fishers in Anda.

### Discussion

**Importance of aquaculture comanagement schemes**

The results of the two analyses in this study show that there has been efforts toward proper management of aquaculture in Bolinao with assistance from the academe and POs, while this has been weak in Anda, where collaboration among stakeholders is limited; and that 24 respondents perceive an exploitative situation caused by excessive aquaculture operation in Barangay Awag, Anda aquaculture zone.

It can be suggested that comanagement, defined here as the sharing of responsibility and authority (Pomeroy and Williams 1994) among LGUs, POs, and academe, is important for proper aquaculture governance in the study areas. An attempt toward this was already made by drafting the fishery comanagement

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Aquaculture owners prohibit fishers catching fish not only inside the facilities but also around those since they have sometimes experienced the fish stolen from the facilities.
Table 7. Results of a survey regarding the perception of changes in fish catch (the numbers of respondents who perceived some extent of changes in fish catch) in Anda and Bolinao, in the Philippines.

| Poblacion (capture fisher) | Awag (capture fisher) | Awag (caretaker) | Malong (capture fisher) | Malong (caretaker) | Luciente II, Luna (capture fisher) | Luciente II, Luna (caretaker) | Balingasay (capture fisher) | Balingasay (caretaker) | Culang (capture fisher) | Culang (caretaker) | Dewey (capture fisher) | Estanza (capture fisher) | Lucero (capture fisher) | Lucero (caretaker) | Luciente II (capture fisher) | Luciente II (caretaker) | Total |
|----------------------------|----------------------|------------------|-------------------------|-------------------|-----------------------------------|-------------------------------|---------------------------|------------------------|----------------------|----------------------|----------------------|-----------------------|-------------------|-----------------|----------------------|----------------------|--------|
| Increase                   |                      |                  |                         |                   |                                   |                               |                           |                        |                      |                      |                      |                       |                   |                 |                      |                      |         |
| Same                       |                      |                  |                         |                   |                                   |                               |                           |                        |                      |                      |                      |                       |                   |                 |                      |                      |         |
| Decrease                   |                      |                  |                         |                   |                                   |                               |                           |                        |                      |                      |                      |                       |                   |                 |                      |                      |         |
| 0-27%                      | 0                    | 0                | 0                       | 0                  | 9                                 | 0                             | 0                         | 0                      | 0                    | 0                    | 0                    | 2                     | 4                 | 19              |                      |                      |         |
| 30-49%                     | 6                    | 0                | 0                       | 0                  | 2                                 | 2                             | 11                        | 1                      | 0                    | 29                   | 0                    | 19                   | 0                 | 0               | 70                    |                      |         |
| 50-79%                     | 5                    | 0                | 0                       | 1                  | 0                                 | 0                             | 5                         | 3                      | 1                    | 0                    | 3                    | 0                    | 7                 | 0               | 25                    |                      |         |
| 80-100%                    | 8                    | 0                | 0                       | 2                  | 0                                 | 0                            | 12                        | 0                      | 0                    | 0                    | 1                    | 0                    | 6                 | 0               | 29                    |                      |         |
| without percentage        | 0                    | 24               | 0                       | 1                  | 1                                 | 0                             | 0                         | 0                      | 0                    | 0                    | 0                    | 0                    | 0                 | 0               | 26                    |                      |         |
| n/a                        | 2                    | 0                | 1                       | 3                  | 1                                 | 1                             | 8                         | 0                      | 1                    | 0                    | 0                    | 5                    | 0                 | 15              | 37                    |                      |         |
| Sub total                  | 26                   | 25               | 11                      | 8                  | 4                                 | 14                            | 38                        | 4                      | 3                    | 29                   | 5                    | 25                   | 5                 | 17              | 233                   |                      |         |
platform by the neighboring municipalities of Anda, Bolinao, Bani, and Alaminos, which have experienced common problems associated with aquaculture development (Pomeroy et al. 2010). Water-quality monitoring teams were also formed, trained, and equipped by the Sagip Lingayen Gulf Project in the four neighboring municipalities (Solibaga et al. 2008). After the project, the LGUs of Bolinao, Alaminos, and Bani continued the regular monitoring. In Anda, the Bantay dagat (local patrolling body for CRM) continued monitoring for a while, but after the change in local leadership, the Anda LGU stopped funding for related activities.

### Success factor of aquaculture comanagement in Bolinao and its effectiveness

When one considers the factors that enable the present status of aquaculture comanagement in Bolinao, the existence of a PO named “KAISAKA” (KAIIsahan ng mga Samahan Alay sa KAlikasan, or “union of organizations for the environment” in English) based in Bolinao plays an important role. It is a federation established in 1997 that consists of Bolinao barangay POs. It was initiated by three organizations: Haribon Foundation, UPMSI, and UPSWCD (University of the Philippines College of Social Work and Community Development) for capacity development of the community. Also, after that project, KAISAKA gained several project opportunities, which developed the capacity of the organization.

During the Sagip project, KAISAKA was trained for the WQM just like other POs in neighboring municipalities. However, for KAISAKA, funding support was obtained from the LGU of Bolinao and the Philippines Tropical

| Barangay                        | Number of respondents | Percentage |
|---------------------------------|-----------------------|------------|
| Población (capture fisher)      | 0/26                  | 0%         |
| Awag (capture fisher)           | 24/25                 | 96.0%      |
| Awag (caretaker)                | 0/11                  | 0%         |
| Malong (capture fisher)         | 1/8                   | 12.5%      |
| Malong (caretaker)              | 1/4                   | 25%        |
| Bolinao mariculture area (caretaker) | 0/14               | 0%         |
| Balingasay (capture fisher)     | 0/38                  | 0%         |
| Culang (capture fisher)         | 0/4                   | 0%         |
| Culang (caretaker)              | 0/3                   | 0%         |
| Dewey (capture fisher)          | 0/29                  | 0%         |
| Estanza (capture fisher)        | 0/5                   | 0%         |
| Lucero (capture fisher)         | 0/25                  | 0%         |
| Lucero (caretaker)              | 0/5                   | 0%         |
| Luciente II (capture fisher)    | 0/17                  | 0%         |
| Luciente II (caretaker)         | 0/19                  | 0%         |
Forest Conservation Foundation just after the project termination in 2007 to continue the WQM, unlike the other POs. And the following year, two leaders of KAISAKA were assigned by Bolinao as contract officers of the CRM Office. This was also the time when the Bolinao CRM Office was established next to the MAO, and they succeeded gathering the continuous (annual) fund for WQM and other related activities from Bolinao LGU, which is still granted today.

Thus, a major reason why Bolinao was able to establish an aquaculture comanagement scheme is the existence of a mechanism to sustain the activity and to ensure that it will not be affected by changes in leadership of the local politics. This mechanism is based on two important factors, the participation of a resource user organization (KAISAKA) that can continue with the management activities, and the availability of regular/mandated funds from the LGU for them to continue the activities.

As seen in Table 1, there is difference in capacity between Anda and Bolinao. Human resources at the CRM office in Anda is comprised of a single individual who is a part-time contractual staff member and also the fishery technician. On the other hand, Bolinao has two full-time contractual staff members and two full-time administrative staff members. Additionally, there are many PO members who are willing to assist the CRM office of Bolinao. This is not the case for Anda, thus making it difficult for them to implement aquaculture management with the limited funding and human resources. Hence, the collaboration between LGU and the resource user organization is effective for aquaculture governance to ensure sustainability. In addition, such collaboration can empower the resource user organization to address aquaculture-related concerns. The members of KAISAKA are actively patrolling the municipal waters to monitor the illegal facilities and to check water-quality parameters. For facilities constructed without permits, the leaders of KAISAKA are able to remove them with the authorization by the LGU.

**Implication for the improvement of aquaculture governance**

As previously mentioned, the community analysis indicated a unique hierarchy for operational decision making and resource use in aquaculture, which is different from capture fishery. Even if both caretakers and capture fishers are living and engaged in fishing in the same community, they can have different livelihood situations. Increasing marginalization and privatization might lead to increasing social injustice, as some fishers have already mentioned during the survey. In order to develop comanagement, an institutionalized arrangement for intensive user participation in decision making is needed (Berkes 2009). Hence it is important to get the local fishers more involved in the decision-making process for aquaculture.
Furthermore, to improve aquaculture governance, it would be important that the comanagement scheme include not only the governments and fishers but also business operators who often have large capital and a high degree of power. The inclusion of business operators may, however, be more difficult to achieve than the participation of local fishers since some of the business operators do not even live in the area and only finance the business. Even in this situation, successful aquaculture comanagement cannot efficiently be achieved without the participation of these business operators. This is an issue to be investigated in future studies and practical projects aiming at aquaculture development and management. Aquaculture governance could be improved by promoting the participation of local fishers, governments, and business operators in comanagement platforms.

**Summary and concluding remarks**

This study investigated if, and how, comanagement can be effective in regulating the aquaculture industry. To avoid environmental, social, and economic problems related to aquaculture, it can be said that governmental regulations are essential as a first step, in order to control wealthy and powerful operators. The case of Bolinao municipality shows the effectiveness of comanagement as an essential tool to be enforced practically and sustainably for the management of aquaculture industry and to enable the resource users to gain the power shared with LGU (Figure 2).

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*Figure 2. Functions and factors affecting the success of comanagement for aquaculture.*

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*Robinson and Pascal (2009) reported a good practice of a village-based aquaculture program that has been carried out with local people, NGOs, academe, and private companies.*
This study is one of the first steps toward achieving proper governance of the aquaculture industry in the Philippines and other regions as well. Further studies on this topic are needed in order to make sure that aquaculture grows in a sustainable manner.

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