EIA and monitoring for clusters of small-scale cage farms in Bolinao Bay: a case study

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White, P.G. 2009. EIA and monitoring for clusters of small-scale cage farms in Bolinao Bay: a case study. In FAO. Environmental impact assessment and monitoring of aquaculture. *FAO Fisheries and Aquaculture Technical Paper.* No. 527. Rome, FAO. pp. 537–552.

ABSTRACT

The development of programmatic EIAs and monitoring programmes for clusters of small-scale cage farmers was promoted in Bolinao Bay, the Philippines. The aim of the study was to develop a methodology for the estimation of safe aquaculture carrying capacity, optimal site selection, zoning of aquaculture parks for sustainable aquaculture development for small-scale farmers.

Aquaculture in the Philippines is an important part of rural development, poverty alleviation and source of livelihood in rural areas. However aquaculture activities are not well-planned, managed, monitored nor regulated, leading to “hot spots” of over-development. Consequently, this led to environmental degradation and lots of fish kill incidents.

The local government units (LGUs) which have jurisdiction over aquaculture management in their own designated areas have not yet realized the importance of ecosystem-based co-management of a shared waterbody. At the moment, the government is encouraging the development of aquaculture parks where zones are identified and allocated for aquaculture development.

The Environmental Management Bureau (EMB) of the Department of Environment and Natural Resources (DENR) enforces the environmental regulations for aquaculture development. The Environmental Impact Statements are only required for aquaculture developments greater than 25 hectares for inland aquaculture and more than 100 hectares for marine aquaculture (total water

FIGURE 1
Fish pen development in Daupan, Pangasinan

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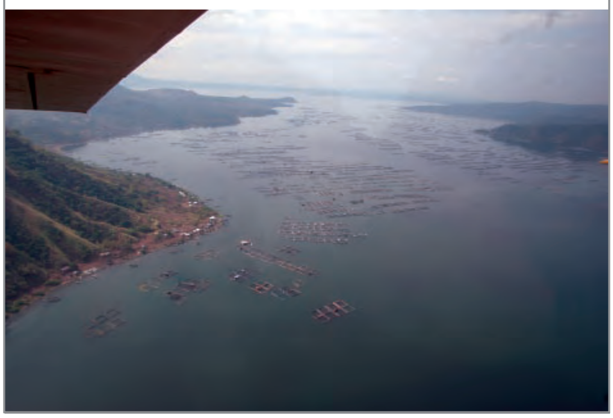
FIGURE 2
Fish cage development in Taal Lake



COURTESY OF G. CHRISIANSEN

spread area that will be utilized regardless of how many cages and their sizes). This means that all small-scale aquaculture is exempt from the process.

The government is encouraging the development of mariculture parks which are designated areas where clusters of small-scale farmers are encouraged to relocate to. Mariculture parks greater in area than that mentioned above are subject to so-called programmatic environmental regulations. Significant requirements include:

- **Programmatic Environmental Impact Statement (PEIS) –** an environmental baseline study and an assessment of the carrying capacity of an area to absorb impacts from co-located projects such as those of clustered fish farms (mariculture park or aquaculture park).
- **Programmatic Environmental Performance Report and Management Plan (PEPRMP**) – documentation of actual cumulative environmental impacts of co-located projects describing the effectiveness of current environmental mitigation measures and plans for performance improvement.

TABLE 1

Environmental Management Bureau (EMB) requirements for aquaculture

Category	Applied to	Required documents
A-1: New	Co-located projects	Programmatic Environmental Impact Statement (PEIS)
	Single projects	Environmental Impact Statement (EIS)
A-2: existing and to be expanded	Co-located projects	Programmatic Environmental Performance Report and Management Plan (PEPRMP)
A3: operating without Environmental Compliance Certificate (ECC)	Single projects	Environmental Performance Report and Management Plan (EPRMP)

This case study is a summary of work undertaken by the Norad funded EMMA project (Environmental Monitoring and Modelling of Aquaculture impact in risk areas of the Philippines) and the EU FP6 funded PHILMINAQ project (Mitigating impact from aquaculture in the Philippines (www.philminaq.eu).

CASE STUDY AREA – BOLINAO BAY, PANGASINAN

The investigations in the Norad funded EMMA study focussed in three hot-spot areas of Taal Lake (freshwater), Dagupan estuary (brackish water) and Bolinao Bay (marine). Bolinao Bay is located in the North West of Luzon Island between the northeast mainland of Cape Bolinao, Santiago Island and Cabarruyan Island (Figures 3-5). The bay has three inlets/outlets. The two up in the northern part of the bay are connected straight out to open water. However, the southern entrance is connected to Tambac Bay which also has a lot of aquaculture activity. The Tambac Bay was also affected by fish kill episodes. The studied bay is relatively shallow and the average depth in most of the area is less than 6 meters deep.

The main cultured species is milkfish (*Chanos chanos*) grown in fish pens and fish cages and oysters (*Crassostrea iredalei)* on stakes. A fish pen is built in shallow waters and is made up of bamboo poles surrounded by a fish net. A fish cage is located in deeper waters and uses either fiberglass or steel and nets held up by floaters.

Permits are issued by the two local government units (Bolinao and Anda) but numbers of structures (cages, pens and oyster farms) counted were way above the number of permits issued indicating the existence of illegally constructed structures. Overstocking and excessive feeding practices were claimed to cause deterioration in water quality that affects both the aquaculture industry and the non-cultured species.

FIGURE 3
Location of Bolinao Bay

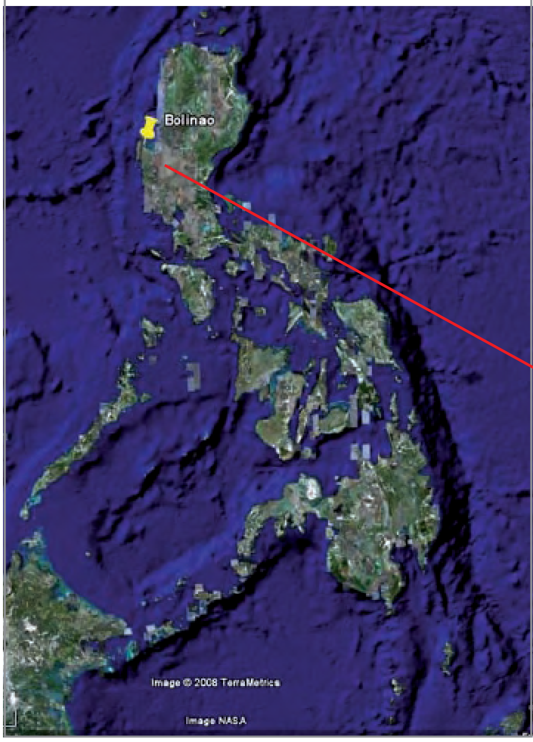


FIGURE 4
Satellite image of the Bolinao Bay

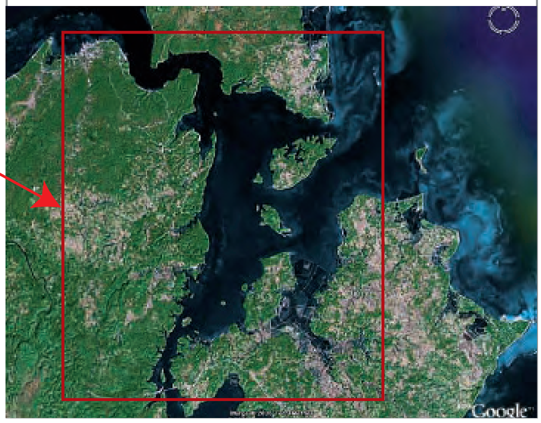


FIGURE 5
A digitalised map of the area. Area included in this study is within the red square

REGISTRATION OF FISH FARM STRUCTURES IN BOLINAO

A full registration of cages, pens and oyster farms was made recording the position of each with a GGIS reading and noting if it was operational or not. Interviews were undertaken with a sample of producers to determine the range and average productivity.

Fish cages

The main areas for fish cages are in the deeper channels and close to the entrances of the bay and especially in the northwest entrance (Figures 6 and 7).

In April 2005 there were 460 fish cages of which 322 were operational (70 percent) and 138 were not operational (30 percent). The average fish cage is square (12 m x 12 m) or circular with a diameter of 12 m and had a volume of 1 155 m^3, stocked with milkfish and holding a biomass of 11.5 tonnes. Fry were stocked at 2 g size and grown to a market size of 433 grams in 6.8 months. The fish were fed at 2.8 percent per day using 320 kg of feed per day per cage. The feed conversion rate was 2.8:1. The total feed fed per day was 103 tonnes of feed and the total production per year from cage culture was 8 867 tonnes.

FIGURE 6
Example of a typical fish cage

FIGURE 8
Example of a typical fish pen

FIGURE 7
Map illustrating the location of fish cages

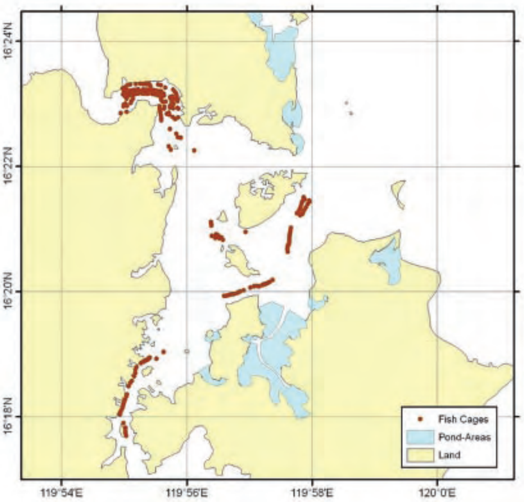
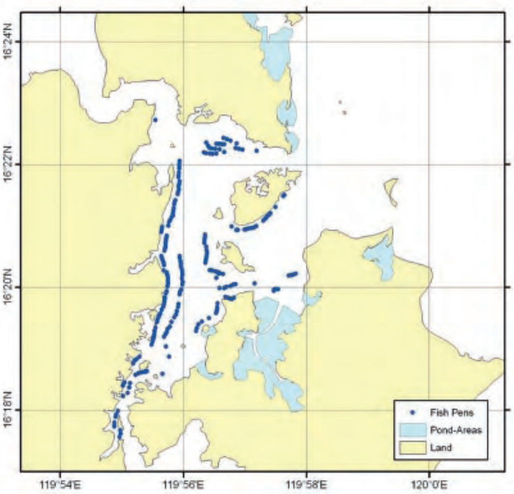


FIGURE 9
Map illustrating the location of fish pens



Fish pens

The main areas for fish cages are in shallow areas close to the coastline especially the western side of the bay and to Santiago Island and Cabarruyan Island (Figures 8 and 9).

In April 2005 there were 266 fish pens of which 217 were operational and 49 were not operational. The average fish pen is 120 m x 120m and has a volume of 14 037 m^3 and stocked with milkfish. It is stocked with fry at 2g size and is grown to a market size of 466 grams in 4.17 months. The average pen has a biomass of 15.2 tonnes and a stocking density of 1.04 kg/m^3. The fish were fed an average of 3.5 percent per day using 540 kg of feed per day per pen and a total of 117 180 kg of feed per day. The average food conversion rate was 2.2:1. The total production per year from pen culture was 14 467 tonnes.

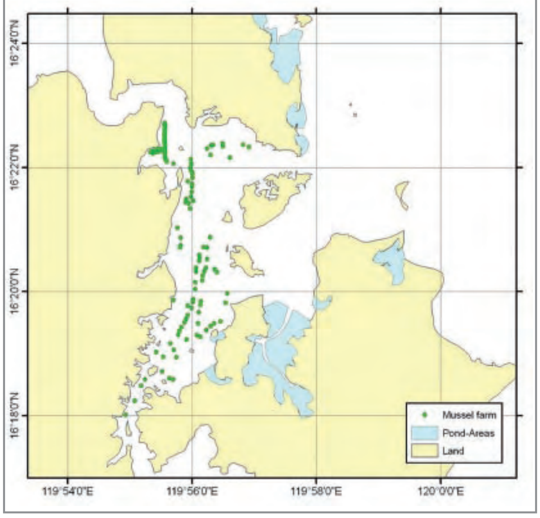
Oysters

Interviews were undertaken with producers to determine the range and average productivity. The main oysters farm activity was spread out in the whole bay but the most intensive areas are in the mid and southern part of the bay (Figures 10 and 11).

There were 254 oysters farms of which 253 were operational and one was not. The average oysters farm had 1 000 poles with an average length of 3.25 meters per pole. Oysters are grown to a market size of 5 centimeters and there are 2 crops per year. The average pole of 3.5 meters gave a crop of 6.5 kg of oysters. The total production from all the oysters farms was 1 638 tonnes.

FIGURE 10
Example of a typical oyster stakes

FIGURE 11
Location of oyster farms

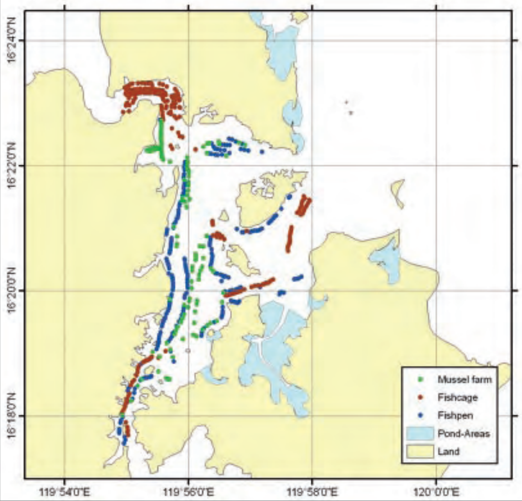


Total structures

There were 322 operational fish cages out of a total of 460 fish cages. There were 217 operational fish pens out of 266 fish pens. There were 253 operational oysters farms out of 254 giving a total of 792 operational structures out of a total of 980 structures (Figure 12).

The sea surface area in Bolinao is 28 882 031.86 m^2 (not including the islands) i.e. 2 888 hectares. In 2005, the total annual production for fish pens and cages was 23 334 tonnes and there was an annual production of 1 638 tonnes of oysters (extractive species). The total production was therefore 8.07 tonnes of fish and 0.56 tonnes of oysters per hectare of the bay.

FIGURE12
Map illustrating all the aquaculture activity in Bolinao Bay. Green dots indicate oysters farms, red dot indicates fish cages and blue dots indicate fish pens.
Light blue colorations indicate areas with fish ponds



ENVIRONMENTAL MONITORING AND MODELLING

Environmental monitoring was undertaken to investigate the environmental impact of the fish and mollusc production. Modelling was undertaken to estimate carrying capacity. Hydrographic modelling was also undertaken to assess residence time and predictive modelling to estimate impact on the sediments and identify the optimal areas for siting zones and distances between zones.

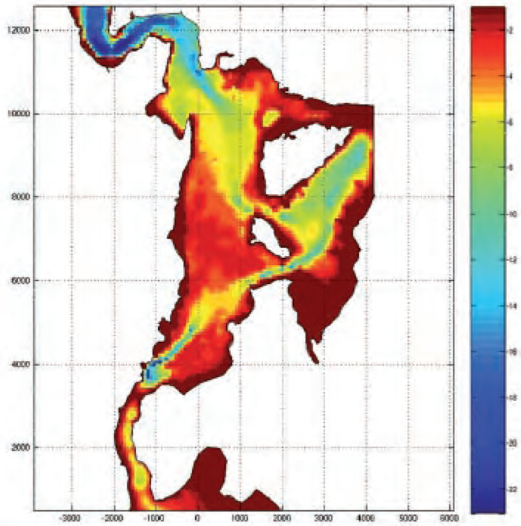
The data needed for environmental monitoring is different for physical, chemical and biological parameters. In most cases there is a need for field trips to collect new data. However historical data are also really useful information both for the modelling but also the environmental monitoring. When historical data and new data were collected these were used to do the modelling work. It is important to remember that the better the background data, the more precise the output of the modelling will be.

The most important parameters for environmental monitoring and modelling are:

- Bathymetry (depth recordings) of the area
- Tidal range and current speed, direction and dispersion
- Physical parameters including temperature, turbidity, salinity, oxygen, profile through the water column

- Water quality – chlorophyll, phosphorous, nitrite, ammonia
- Sediment analysis (biological and chemical)
- Weather data - wind direction, speed, temperature.

FIGURE 13
Bathymetry with depth in meters. The depths are colour coded between 2 m (red) and 22 m (blue)



Bathymetry

Detailed knowledge about the bathymetry in an area is vital information for being able to model the water exchange in an area. Sea maps exist with depth recording for the Bolinao Bay but the resolution (number of recordings) was not good enough for the modelling. Therefore, depth measurements were taken of the whole bay including detailed measurements in the entrance channels. To do this, a Garmin echo-sounder which contains a GPS and a chart plotter (GPSmap 178C Sounder) was set up on a boat so that depth readings could be collected. This setup measured depth with an echosounder and a GPS stored the tracks automatically tagged with the date and time of creation, as well as water temperature and depth (Figure 13).

FIGURE 14
Secchi-disk readings in Bolinao Bay 2005

Turbidity sampling (Secchi-depth)

The use of a Secchi-disk is a very well known method for measuring the water-transparency and the colour of the water (Figure 14). These data gives information about the amount of particles in the water. The particles are either related to production in the water column (phytoplankton) or particles which come from the drainage area or sediments (sand, dust).

The Secchi-depth varied from less than one meter to more than 7 meters (Figure 15). The Secchi-depth was generally lower in the area close to the southern entrance. The reason for this, even though the area has a good water exchange is that the water coming in through the southern channel has its origin from Tambac Bay were the Secchi-depth also is low. The Secchi-depth in the outer part of the northwest and northeast entrance is markedly better due to water with little particles coming in from the open sea.

Sediment sampling (Benthic stations)

Sediments are often used as indicators for evaluating the environmental status of an area. It takes much longer time to change the condition of the sediments compared to the water quality parameters. Water quality parameters give a snap shot of the conditions while sediments tell you how the conditions have developed over a longer