COASTAL AQUACULTURE AND ENVIRONMENT IN THE PHILIPPINES

by

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CONTENTS

Abstract

The importance of fish and shellfish in the national diet and the present status and practices of coastal aquaculture in the Philippines are presented. The existence of industrial and organic pollution of the major river systems is described and its effects on inland and coastal aquaculture are analysed. The diminished availability of milkfish fry, abandonment of fish pond areas, damage to oyster beds and the increased parasitic infections transmitted to man from infected fish and shellfish are stressed. Measures taken by the National Water and Air Pollution Control Commission, in collaboration with the Fisheries Commission, to study and cope with the increasing pollution of coastal areas and the Government's financing plan for coastal aquaculture are discussed.

1 INTRODUCTION

The Philippines is a tropical archipelago of more than 7 000 islands and islets generally lying between 4° and 21°N latitude and between 118° and 127°E longitude. Temperatures average 28°C (82.4°F) and the annual rainfall is 2 500 mm (98.5 inches), although there occur pronounced dry and wet periods. For the past ninety years an average of twenty-one typhoons have passed through the country each year, easily the highest frequency in the world, causing the heavy seasonal rainfall and resulting in loss of lives and severe damage to public works, housing, crops and fish-ponds. In recent years damage to property alone has been estimated at ₱100 million annually [1/]. Unfortunately no figures for damage to fish ponds alone are available. Government assistance in the rehabilitation of damaged fishponds consists of providing fingerlings for immediate distribution as soon as dikes and other damages are repaired.

In the Philippines, fish is a basic food second only to rice. Studies of the Food and Nutrition Research Centre show that 61.1 percent or almost two-thirds of the animal protein produced in the country is supplied by fish. Moreover, about 37.6 percent of food commodities needed for human consumption comes from fish, molluscs, and crustaceans (Intengan, 1972). The annual production of fisheries amounted to almost 746 000 tons in 1967 of which commercial fishing in territorial waters accounted for 44.5 percent, municipal fishing on rivers, lakes and bays contributed 47 percent and the balance of 8.5 percent came from fishponds. Since 1958 commercial fishing catches increased by almost 300 percent due to mechanisation and use of modern deep-sea fishing methods, and municipal fishing catches by 37 percent. On the other hand, fishpond production increased by only 11 percent to a volume of 64 000 tons in 1967. Although this may represent a rather small portion, it is a significant one, especially if we consider that there was an increase of 2 900 ha of freshwater fishponds and 2 000 ha of brackishwater fishponds from 1965 to 1967 for which fairly complete data are available (Intengan, 1972). It is felt, because of difficulties in gathering accurate statistics, that even these figures are under-reported.

2 PRESENT COASTAL AQUACULTURE PRACTICES

2.1 Philippine Species Involved

Coastal aquaculture in the Philippines at present primarily involves the raising of milkfish, "bangos" (Chanos chanos), the jumbo tiger shrimp called "sugpo" (Penaeus monodon), and crabs called "alimango" (Scylla serrata) in brackishwater fishponds; the rearing of recently introduced species such as carps (Cyprinus carpio), tilapia (Tilapia mossambica), indigenous species such as snakeheads or "dalag" (Ophicephalus striatus), and catfish or "hito" (Clarias batrachus) in freshwater areas; oyster (Crassostrea spp.) farming in bays, coves and estuarine rivers; the culture of saltwater mussels known as "tahong" (Mytilus smaragdinus) which thrive well in habitats similar to those of oysters; the propagation of the window-pane shells popularly known as "kapis" (Placuna placenta) in mudchoked tidal flats; and the growing of some species of algae and seaweeds which are either consumed locally or exported [2/]. Seventeen species of oysters have been reported to thrive in the Philippine waters, but only four species are cultivated commercially [3/]. The saltwater mussel and window-pane shell might be profitably raised also in oyster areas, except that it is very susceptible to parasitic infestation by the pea crab (Pinnotheres sp.) (Blanco, 1955). The culture of algae or seaweeds in some coastal regions of the country has gained significant development in recent years due to its importance as an export item. Potential areas for growing seaweeds are now being seriously considered by both the Government and private entrepreneurs. Two species of seaweeds of economic importance now being considered for culture are Eucheuma and Gracillaria, with the former being more in demand (Trono, 1971).

1/ ₱ is the symbol for pesos : U.S.$ = 6 pesos

2/ Republic Act 3931 creating the National Water and Air Pollution Control Commission

3/ Oyster Farming. Unpublished leaflet, Philippine Fisheries Commission, 1962

2.2 Potential Fishery Areas in the Philippines

The total fishery resources of the country are distributed in about 166 million ha of marine waters (coastal and offshore), one million ha of freshwater areas (lakes, rivers, swamps, paddy fields, etc.), and about 500 000 ha of brackishwaters (estuarines and mangrove swamps) suitable for development into estuarine fishponds. In addition about 100 ha of bays, coves and estuarine rivers are potential areas for oyster farming. The Government programme of constructing new fishponds amounting to about 35 000 ha during the next four years will therefore be a small fraction of the 1.6 million ha potentially available for aquaculture.

3 EFFECTS OF POLLUTION ON AQUACULTURE

Very significant water pollution problems in the Greater Manila area, which adversely affect the fishpond and brackishwater resources of the country, are the pollution of the Pasig River system and its tributaries (San Juan and Marikina Rivers) and the Tinajeros-Tullahan River system: the Bulacan River, the Balagtas River and the San Pedro River. The capture of "bangos" fish fry on the shallow coastal areas of Manila Bay and adjacent vicinities has also reportedly diminished due to pollution effects. In addition, fishponds and fishing have also been affected in the Agno River in Pangasinan Province, the Sipalay River in Negros Occidental Province, the Jalaur River in Iliolo Province, the Bañadero River in Laguna Province, the Bais River in Negros Oriental Province, etc. (National Water and Air Pollution Control Commission, 1970, 1971).

3.1 Greater Manila Area

Pasig River is the only drainage channel of Laguna de Bay, a 90 000 ha freshwater lake, reputed to be one of the largest in Southeast Asia. It joins two major rivers downstream with a number of tributaries in Manila proper as it finally empties in Manila Bay. More than 120 industrial firms discharge wastes and organic materials into this river. The city "esteros" or small creeks and drainage waterways receive untreated or undertreated septic tank effluents and have also become dumping sites of garbage and other refuse. Makeshift slum dwellings have mushroomed along the rivers and "esteros" to a staggering number so that there is now an estimated squatter population of 70 000 along the Pasig River and all its tributaries alone. The river system is practically devoid of fish and other aquatic life of economic importance, particularly during the summer months.

Duck rearing, which produces a local delicacy, the embryonated duck egg, depends upon snails for feed. These snails, such as "tulla" (Corbicula manillensis), "susong pangpang" (Vivipara angularis) and "susong buele" (Melania lateritia) in turn are now (1972) practically absent in the upper reaches of the Pasig River where a major duck industry used to exist.

The destruction of these snails has been partially blamed on pollution although excessive snail gathering and algae blooms have also been cited as other causes (National Water and Air Pollution Control Commission, 1970, 1971).

Tinajeros River is located north of Manila separating the municipalities of Polo, Bulcan Province and Malabon, Rizal Province. It is about 20 km long, winding upstream east and north from Manila Bay. It is affected by tidal fluctuations and used as a source of replenishment water for the numerous fishponds and fish corrals around the area.

This river (from the mouth to just below the town of Novaliches) is a dead river except during floods. A survey conducted in 1967 showed that the organic pollution load coming from thirteen factories and industrial firms discharging into this river amounted to more than 24 500 kg (54 000 lb) daily. Waste water discharge from the factories was also bio-assayed and the results showed that milkfish fingerlings died within one minute and fifty seconds to nine minutes after exposure.

The fisheries in the region are located downstream from the Tinajeros Bridge to Manila Bay, a distance of about 5.4 km. Old residents of tho area claim that before and during the Second World War the Tinajeros River and its tributaries were normally populated by a number of fish species of economic value and fishing was a source of livelihood for small-scale fishermen. The numerous brackishwater fishponds along the river system had been very productive during those days. "Salambao" or giant it is important for the growth of farming organisms to safeguard food supplies through proper control of pollution.

3 THE EFFECTS OF POLLUTANTS ON FISH FARMING

The effects of pollutants could be classified as direct and indirect effects. Examples of direct effects are: poor or slow growth, spread of diseases, decrease or loss of economic value on the products, etc. These problems (except the decrease of economic value) would be related to physiological malfunctions of farming organisms, and would mostly be concerned with chronic effects of low concentrations of pollutants, except in the case of accidents. Although accidental pollution gives serious damages to the fisheries, these are not continuous and the cause of damage is, at times, easily determined and treatment methods might be established. However, the cause of chronic effects may be more difficult to determine. Thus, here also is an important field for fundamental research on physiology.

The decrease of economic value of products is one of the most serious problems facing fish farming. Several causes for such problems could be listed, but the objectionable smell by pollutants is most common. Although almost all odorous wastes may cause this trouble, the wastes from oil refineries and petrochemical factories are common and serious sources. Fish develop the offensive smell in the meat when exposed to the wastes. In this case, fish show no change of appearance, or even of physiological functions, but the economic value might be decreased and quite often the product is totally lost. In addition, the fishermen who have received complaints from consumers would subsequently be unable to sell their merchandise at a regular price, even when the fish are quite fresh and clean.

As to the indirect effects of pollutants, the effects of red tides which are caused by eutrophication of coastal waters are typical examples. The enrichment of waters with organic wastes is not always harmful, and often helps increase the productivity of water. However, if the supply of organic substances is too great, it would exceed the self-purifying capacity of the water and excessive eutrophication may occur. There are many species of red tide organisms. Some dinoflagellates secrete toxic substances which inflict serious damage on fisheries. Even when the organisms are not toxic, they consume the dissolved oxygen in water and suffocation occurs in aquatic animals. These toxic effects and suffocation are the main causes of damage to fisheries by red tide. The red tide is a new type of pollution, and it is not yet very common. However, it is likely to become a global problem in the near future.

As another type of indirect effect, the change in location of fishing grounds can be emphasized. Usually, fish have an avoidance reaction against pollutants. When the migration route is blocked by a water mass containing pollutants, fish easily change the route and consequently their location is changed. There would be no actual damage to the fisheries stocks, but no profitable result could be expected for the fishermen in cases where fish do not appear at traditional fishing grounds.

The avoidance reaction of fish is related to sensory physiology and it is notable that this is a relatively undeveloped field of research.

3.1 Accumulation of Harmful Substances

Many paralytics affecting humans and resulting from the effect of pollutants have been discovered in Japan. The wastes from a chemical factory containing mercuric compounds affected human health via fisheries products, and the symptom was named the "Minamata Disease" after a small city from where the first patients came.

The mercury contained in the waste was discharged into the sea from the factory and was dispersed in a small bay where it was concentrated by aquatic organisms. Among the people in the area, more than one hundred patients were found. Mortality was over 50 percent, and even amongst survivors, many patients became invalids. The cause of this disease was the absorption of mercury from ingested fisheries products.

liftnets, pushnets, fish corrals and oyster beds abounded along the entire course of the river system then.

At present, almost all these activities along the river, with the exception of a few remaining fishponds, have completely disappeared because fish of commercial importance could no longer be raised. Moreover, the inland fishery and oyster beds were also destroyed by pollution. Even barnacles have greatly diminished in quantity. Fish kills have been reported from time to time among the fishpond owners and even in the downstream portion of the river system. About 30 industrial firms have been identified as contributing to the overall pollution of this river.

3.2 Other Areas Affected

Other areas are also adversely affected by industrial operations of mining companies, textile mills, coconut products factories, sugar centrals, distilleries, and other industries located in certain areas of the country. It is thus evident that pollution plays a major role in the future expansion or decline of coastal aquaculture.

3.3 Parasitic Infections

Pollution may also result in the transmission to man of certain parasitic diseases from infected fish or snails. Two examples are the human intestinal fluke infestation, resulting from ingestion of half-cooked "kohol" (*Ampullaria luzonica*), and other edible molluscs and fish worms of milkfish, goby (Gobiidae), mullet (*Mugil* spp.) and mudfish (Velasquez, 1972).

4 PEST AND DISEASE CONTROL BY PESTICIDES AND OTHER CHEMICALS IN FISHPONDS

In the Philippines, experience shows that the protection and growth of desirable benthic blue-green algae and diatoms (locally known as "lab-lab") is best effected by eradication of undesirable fish species and other pests.

Two undesirable growths that must be avoided in fishpond propagation are the filamentous green algae and various free-living phytoflagellates (free-swimming phytoplankton). The former are not desirable because of their physical toughness so that juvenile milkfish are unable to feed on them unless the algae die first and are softened through putrefaction or decay. Furthermore, these noxious weeds interfere with the harvest of fish and accelerate the evaporation of pond water. Lastly, the activities of fish are hampered by these algae which occupy their living space.

Phytoflagellates are undesirable because they prevent the growth of algae in the stratum by decreasing sunlight penetration. Furthermore, the presence of tremendous numbers of these microscopic organisms, suspended in the water, reduce the grazing and schooling activities of the milkfish. At times fish kills also occur following oxygen depletion resulting from the death and subsequent decomposition of an algal bloom.

It must also be noted that chironomid larvae are insect pests since they are food competitors of milkfish. They destroy the bottom algae during the time when the salinity of pond water declines to about 20-30 per ml. These larvae can be eliminated by the application of certain selective poisons such as gamma-BHC, diazinon, and sumithion. Snails, polychaete worms and other organisms that either directly consume these algae or are indirectly harmful to their growth should be eliminated by the application of either nicotine or baylucide (a mollucide).

Tobacco waste is easily available from cigar and tobacco factories and can be used as an agent for hastening the decay of organic matter associated with the bottom mud. The released plant nutrients would then be made available for algal growth. Simultaneously, the application of this material (tobacco waste) can also eliminate insects and other pests from the ponds. The nicotine content of tobacco waste may be as much as 4 percent, and acts as a powerful pesticide. In doses of 2 ppm it is also effective in poisoning polychaete worms, undesirable snails and other nuisance organisms in the bottom soil.

To kill predatory and undesirable fish in ponds before the "bangos" fry or fingerlings are stocked, 0.25 ppm of potassium cyanide, 0.75 ppm of ethylparathion, 3 ppm of saponin, or 5 ppm of rotenone may be used. Three days after poisoning the pond bottom, additional water may be added to a depth of 20-25 cm, so that the poison will be diluted and dissipates within five days after the application. If there is an abundance of snails and polychaete worms in the pond, application of 3 ppm baylucide before the stocking of fish will help considerably (Tang, 1967).

The Philippine Fisheries Commission, from 1967 to 1969, conducted a series of four experiments using certain organic and inorganic fertilizers on a 2.5 ha fishpond to improve the existing production technique in "bangos" culture. Pesticides were used in conjunction with fertilizers. The amounts of pesticide and fertilizer used are shown in Table I. It was observed from these experiments that "bangos" production increased considerably from 637.2 kg to 1 994.8 kg per hectare cropping or an increase of nearly 300 percent (Tang, 1967).

5 RESEARCH UNDERTAKEN BY THE NATIONAL WATER AND AIR POLLUTION CONTROL COMMISSION

To cope with the increasing number of complaints and inquiries from the public, the National Water and Air Pollution Control Commission has undertaken two research projects on water quality adaptable to local conditions, namely, "The Study of the Concentration of Trace Elements and Other Substances Toxic to Fish and Aquatic Life" and "Studies on the Dissolved Oxygen Requirements of Philippine Food Fishes, Oysters and Other Marine Life". This was made possible with financial assistance from the National Science Development Board through its Special Science Fund.

Using available local edible fish species such as milkfish, carp, mudfish, tilapia, catfish, bangayngay (Ophicocara aporos), climbing perch (Annabas testudineus), mussels, and oysters, the median tolerance limits of each species at 96 hours exposure to variations of pH, chloride, and dissolved oxygen were established (see Table II).

To assess the toxic effects of locally distributed pesticides, a series of static bioassay tests were also conducted. Utilizing fingerlings of four edible fish species, namely, milkfish ("bangos", one of the more delicate species), tilapia (considered one of the sturdiest species), carp, catfish ("hito"), and mussel ("tahong") the median tolerance limits at 96 hours exposure were determined. The toxic effects of certain organic dyes and synthetic detergents on the four test fish species were also undertaken and the results are shown in Table III.

6 CONFLICTS IN THE USE OF COASTAL AREAS

The shoreline of the Greater Manila Area and its contiguous waterways have been subjected to heavy siltation and illegal disposal of garbage and domestic wastes by residents bordering the coastal areas. As a result, the river beds have become shallow and narrow. Commercial propagation of the window-pane shell declined rapidly when sedimentation and pollution set in. At present no trace of these shells can be found in the whole Bacoor Bay (a cove in Manila Bay), whereas several years ago this was their principal source (Tang, 1967). Pollution, coupled with siltation and absence of conservation and preservation practices, has been the principal cause of this disappearance. Luckily, other coastal areas in the country such as in the provinces of Bataan, Pangasinan, Bohol, Negros, Iloilo, Masbate and Sulu are still productive sources of these shells (Tang, 1967).

Table I Amount of fertilizer and pesticide applied during the experiments on improved techniques in milkfish ("bangos" culture at Dagat Dagantan Saltwater Fishery Experimental Station

Experiment Series	Fertilizer used			Pesticide used		
	Kind	Quantity (kg)	Rate of Application per hectare	Kind	Quantity (kg)	Rate of Application per hectare
FIRST						
9 May to 9 November 1967	Chicken manure NPK (16-20-0)	5 000 28 bags 1/	2 000 kg 11.2 bags	Tobacco dust	1 000	400
SECOND						
5 February to 10 July 1968	Chicken manure NPK (16-20-0)	2 954 35 bags	181.6 kg 14 bags	Tobacco dust	1 000	400

1/ Note: 1 bag of fertilizer = 45 kg

Experiment Series	Fertilizer used			Pesticide used		
	Kind	Quantity (kg)	Rate of Application per hectare	Kind	Quantity (kg)	Rate of Application per hectare
THIRD						
25 July to 28 December 1968	Chicken manure NPK (16-20-0) SPG Carabao	2 100 14 bags 7 bags	840 kg 5.6 bags 2.8 bags	none	-	-
FOURTH						
1 February to 20 June 1969	Chicken manure NPK (18-46-0)	2 835 35 bags	1 134 kg 15 bags	Fish Poison		3 ppm

Table II TLm 96 values of DO (mg/l), chloride (mg/l) and pH for some common Philippine fish, oyster and mussel (Static Bioassay)

Scientific Name	Lower limit DO (ppm)	Range of pH	Upper limit Chlorides (ppm)
Chanos chanos	3.0	4.5-9	25 000
Cyprinus carpio	2.2	5.0-8	11 000
Tilapia mossambica	2.0	5.0-8	11 000
Ophicephalus striatus	2.0	5.0-8	12 000
Clarias batrachus	2.0	5.0-9	15 000
Annabas testudineus	-	5.0-8	11 000
Synbranchus bengalensis	-	5.0-8	25 000
Ophiocara oporos	-	5.0-8	-
Ostrea iredalei	-	6.5-8	7 000
Mytilus smaragdinus	-	6.8-8	12 000

Table III TLm 96 Values (mg/l) of pesticides (Static Bioassay) for Philippine edible fish and mussel

Pesticide	*Chanos chanos*	*Cyprinus carpio*	*Tilapia mossambica*	*Clarias batrachus*	*Mytilus smaragdinus*
DDT	0.040	0.047	0.047	0.218	61
Endrin	0.00038	0.0026	0.0042	0.0018	7.5
Aldrin	0.0046	0.024	0.056	0.068	0.345
Dieldrin	0.00265	0.015	0.042	0.038	10.9
Malathion	-	-	-	0.046	-
Ethyl Parathion	-	-	-	1.35	-
Mancozeb Dithane M-45	-	-	-	1.49	-
Detergents (Tide)	76	76	76	38	-
Organic Dyes	64	68	76	760	-

Water pollution is caused principally by rapid urbanization and industrialization. Sometimes, the question to be resolved is whether it would be more economical to transform fishponds and coastal areas into real estate reclamation or housing subdivisions. Industry can and does provide jobs for people, but can it absorb all those that depend for their livelihood on fishponds or small-scale fishing when these areas become industrial areas?

As one mining industrialist argued, "Before we came into this rural locality there were less than perhaps 500 people in 100 homes with no community facilities and they utilized the stream for domestic purposes, such as water supply and fishing. But they paid at most several hundred pesos in Government taxes a year. A few years after we came in and started our mining operations, the population grew to more than 15 000, attracted by job opportunities and community facilities made available by the company; local and national governments were paid millions of pesos in taxes a year." Schools, roads, health centres, and commercial stores were put up and what was once a sleepy unpolluted rural area is now a bustling progressive one but indeed with heavily silted rivers which are used as receiving waters for the mine tailings. Which would the people and the Government rather have?

Pollution, it seems, is the penalty that has to be paid for progress, but too much pollution is undesirable since it affects the very life of certain sectors and may even affect public health. Therefore, a certain balance has to be established.

As the UN Regional Seminars on Development and Environment so clearly stated, there is basically no fundamental disagreement between economic development and environmental concern. "The environmental problem was only one aspect of the general problem of development. The ultimate objective of both environmental control and economic development was the physical, mental and social well-being of man", (UN Conference on the Human Environment, 1972). What has to be done is to develop the economy by industrialization without causing any pollution detrimental to the human environment.

7 RECENT GOVERNMENT PLANS AND FINANCE FOR COASTAL AQUACULTURE

With financing from national funds and possible UN sources, the Philippine Government, through the Philippine Fisheries Commission, has launched a fishery research and development programme. A basic strategy of the Government in the programme is the redeployment of Government resources into inland fisheries development, retaining only minimal Government activities in marine fishing. The private sector is expected to work actively in commercial deep-sea fishing. A main feature of the fish production programme is increasing the yield from fresh and brackishwater fishponds and increasing the total hectarage of new fishponds annually.

Recently, the Development Bank of the Philippines (DBP) has raised the ceiling on loans for development of medium-sized fishponds as a new policy coordinated with the fishery expansion programme. Under the special financing plan, the DBP will grant ₱1 500 per ha for fishponds with an area of 50 ha or less.

This type of loan is granted for the layout and construction of the main dike, secondary dike, main gate, nursery pond, transition pond, secondary gates, tertiary wooden gate and caretaker's quarters; purchase of fishpond equipment; purchase of fish fry; excavation of rearing pond; and advances to caretakers.

This special fishpond financing plan is different from the financing programme for fishpond areas of 50 ha or more, where the amount of loan granted is based on actual needs, but does not exceed 80 percent of the actual fund requirement for the complete development of the project. (The remaining 20 percent is provided by the borrower as his equity counterpart.)

The DBP also grants loans of ₱4 000 per ha under the special financing for milkfish ("bangos") fingerling pond operators, ₱2 000 per ha for foreshore and river fishermen, and ₱250 per ha as fishpond fertilizer loan.

Moreover, the DBP's large-scale fishpond financing programme (50 ha and above) now includes the development of freshwater fishponds. Under a recent DBP board resolution, the coverage of the large-scale financing programme was not only expanded but the development of projects financed under the programme was reduced to 25-ha units. It was explained that, under the new scheme of development, fishpond areas will be divided into units or modules of 25-ha each and each module will be developed in succession. This is a departure from the old practice of developing a 100-ha fishpond area as one unit which will require full utilization of limited resources since development will progress by stages.

In view of the celebration of the DBP's 25th anniversary, all loans amounting to ₱5 000 or less also enjoy a preferential interest rate of 9 percent per year.

The special fishpound financing loan with ceiling removed is granted to operators who have existing fishponds or who will just start the business and are willing to put up the counterpart requirements in the form of improvements.

All of these arrangements are being undertaken by the Philippine Government in order to encourage expansion and rapid development of the fishing industry, particularly fishpond and coastal aquaculture, and thereby realize the primary objective of making the country self-sufficient and eventually an exporter of fish products.

However, unforeseen calamities sometimes set back the best of government plans and intentions. As at the time of this writing, the worst floods in history hit the country and fishpond losses were estimated at ₱80 million (₱31.7 million for brackish water ponds and ₱48.2 million for freshwater ponds). Flood waters overran a total of 41 000 ha in three main fishpond provinces. In addition, about ₱19 million worth of harvestable fish were lost and ₱47 million worth of fingerling were washed away. This will set back the national effort a few years and assistance from the UN and donor countries would help a great deal.

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