Production performance of seabass (*Lates calcarifer*) between cage and pond culture system

A Thesis

By

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Declaration

The results submitted in this thesis are entirely of the candidate's own investigations and no part of the results has been accepted for any degree, nor is it being concurrently submitted for any degree.

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Dedicated to

My Beloved Parents

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Abstract

The present study was carried out to compare the production performance of sea bass in cages and pond culture system from July to August, 2014. The study area was located near the Panguchi River and its adjacent area at Morrelgang Upazilla of Bagerhat District. For the research work, square and rectangular cages with size was 3 m, 3m and 1 m, thus it was 9 m^3 in volume were taken. The experimental ponds were rectangular in shape with size ranging from 2000 m^2 to 2 hectares and depth of 1.2 to 1.5 meters. The fries were collected from Koyra Upazilla of Khulna District and transported to the experimental area in an oxygenated tank by track. The seabass fry were stocked in cages at the rate of 20 m^{-2}. The ponds were stocked at the rate of 2 m^{-2}. Water quality was also monitored throughout the experimental period. The trash fish were given as feed four to two times in a day at the rate of 20-10 % of the body weight. Sampling was done every week for weight and length measurement. For each sampling 20 pieces of fish was taken. The study revealed that both cage and pond culture is favourable in our country. Again, statistical analysis of my research also showed that, cage farming of seabass gave us better growth performance in short time with great survivality than ponds. Best growth was in the cage 1 with mean value being obtained at 116.67 g. The lowest value at the last sampling was found to be 37.15g for the cage 4. From the result, it can be assumed that cage culture of seabass is more profitable over pond culture of seabass with the same treatment. This study might help to become cage farming more popular among local people of Bangladesh.

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CHAPTER 1

INTRODUCTION

Introduction

Bangladesh has vast water bodies with a lot of fishery potentials; such as rivers, beels, haors, baors, ponds, dighis, lakes and estuaries. Fisheries resources of Bangladesh have been playing an important role in the socio-economic development, supplying about 63 % animal protein to our meal and earning a lot of foreign currency(DoF, 2010-2011). However, because of overexploitation and negligence in the past years fish production from these waters has declined and nowadays fish has become scarce. As a matter of fact, most of the production used to come from the natural waters and there has been little advance in aquaculture. At present urgent need has arisen to increase fish production through different methods of culture and management.

Among the fisheries products, seabass (*Lates calcarifer*) is one of the valuable and important products from the coastal waters. Asian sea bass (*Lates calcarifer)* is a very tasty and nutrient rich fish. It has good market demand to the consumer in Bangladesh as well as in the other countries of the globe.*Lates calcarifer* (Bloch), commonly called the giant sea perch or seabass, is an economically important food fish in the tropical and subtropical regions of Asia and the Pacific. It is commercially cultivated in Thailand, .Malaysia, Singapore, Indonesia, Hong Kong and Taiwan, in both brackish water and freshwater ponds, as well as in cages in coastal waters. Throughout the coastal areas of Bangladesh and in the marine environment seabass are found considerably. The supply of the product in the local as well as in the national market is totally depends on the capture fishery or as the by catch of shrimp farms. But the consumer demand is increasing day by day. However, until now no hatchery has been developed to supply available seed for seabass culture. For that, commercial culture has not been developed. Because of its high market value, it has become an attractive commodity of both large to small-scale aquaculture enterprises. However, the major constraint to rapid expansion of seabass culture has been the inconsistent supply of fry collected from the wild. It fluctuates widely from year to year, making forward planning for production difficult. But amount of this fish is decreasing day by day. Decreasing is occurring due to heavy pollution of water and this fish has lost its habitats and food. It lives mainly in coastal region of sunderbans reserved forest. So the destruction of this mangrove forest, it has lost its suitable environment to survive. Seabass has been fairly extensively cultivated in ponds and cages in many Southeast Asian countries. Although cage culture technology of this species is being developed in Hong Kong, Singapore, Malaysia and Thailand, grow-out culture techniques in ponds have not yet been standardized. The method is simple and highly profitable compared to pond culture. Thus, the cage culture of seabass has expanded very rapidly in the last five years in Bangladesh.

Globally, marine fish cage farming has proved to be a promising productive sector of industrial economy. Cage farming of marine finfish is an alternative to meet increasing demand for food fish. The raising of fish in pens and cages is a new method and system of aquaculture in Bangladesh. But it is no doubt that the potential for fish pen and cage culture in Bangladesh is high because of the presence of vast inland water resources which could be tapped for fish production. Besides this, the culture of seabass in pond environment is also introduced in Bangladesh. A pond is a body of open and standing water with aquatic plants, having shallow depth, occupying a basin and lacking continuity with sea and it does not stratify thermally. The production rate of seabass in pond culture system is also satisfactory in our country. But cage farming will give us better growth performance in short time with great survivality. So, cage farming would have become more popular among the local people. Development, therefore, of the haors, boars and lakes for sea bass aquaculture will most likely ensure a steady supply of fish to meet the local needs of the majority of the population and likewise to improve income capacities of the fishermen and fish farmers which in the long run might be liberated from poverty.

The Food and Agriculture Organization (FAO) has identified sea farming, especially sea bass culture as one of the areas to develop the aquaculture industry, and has expressed its desire to fund a major thrust in this area. Since sea bass fetches a high price, it is very attractive for commercial- or small-scale culture operations meant to increase the income of small-scale farmers or fishermen. FAO's role has been to conduct and coordinate research and disseminate information to industry to enhance development of commercial sea bass culture. Many other research projects (including those of the Network of Aquaculture Centers in Asia. (NACA), are involved in sea bass culture development. Also. A training course on sea bass spawning and larval rearing was organized by the Department of Fisheries of Thailand

and FAO/UNDP South China Sea Fisheries Development Program (SCSP) in Thailand in 1982.

In India, culture of marine finfish in open sea net cages is being promoted on a large scale due to increasing demand for quality fish and diminished production from capture fisheries. Cage culture is preferred over ponds for rearing Asian seabass (Boonyaratpalin and Williams, 2002). While nursery rearing of cultivable finfish like Asian seabass hasbeen perfected in India (Philipose et al., 2011), research is now being focused on economically viable cage design and improved mooring systems.

It is thus obvious that culture of seabass population would be economically advantageous. Very recent this culture practice of seabass will significantly contribute higher production in local community of Bagerhat district. So, this study is taking up a challenge to develop sustainable seabass aquaculture that might also helps to approach for its hatchery technology in Bangladesh. This study will significantly contribute to higher production of seabass in Bangladesh as well as farmer's income. To achieve this broad goal of seabass aquaculture, efforts were given to select some suitable researchable ponds for the experimental work at the proper of Morrelgang Upazilla of Bagerhat District. The research team communicated with some marginal farmers who were engaged with the research work for culturing seabass and also with fishermen, fish fry distributors, suppliers as well as other stakeholders. The seabass fries were collected from different river stretches of coastal districts namely Bagerhat, Khulna and Satkhira. Other experimental unit, iron cages, was constructed and wrapped with nylon and plastic net for sustainable aquaculture practice of seabass and compare the growth performance in cages and ponds. The seeds were available at the middle month of June,2014 and the research continued with the proper experimental design. The farmers were motivated for adaptive research trial of seabass and after a short culture period a good result was revealed on the growth performance and captive culture of seabass in the dynamic coastal waters. During the research period local peoples showed their interest in seabass culture and realized that the fish species is a very good aquaculture item in the research area as well as the coastal districts of Bangladesh.

In this study, the production performance of seabass was compared between cage and pond culture system, with an objective to understand the feasibility, growth rate, feeding rate, costbenefit analysis and economic viability of this two culture system. In Bangladesh *Lates calcarifer*found abundantly in the Bay of Bangle and coastal areas. So, it is ideal for seabass cage culture without affecting traditional fishing operations. The economics of cage farming was also be worked out. The need to standardize stocking densities and feeding rate had been emphasized. This study might help to become cage farming more popular among local people.

1.2 Objective of the study

- To evaluate the production performance of seabass in cage and pond culture system.

CHAPTER 2

REVIEW OF LITERATURE

Review of Literature

2.1 Present status of seabass fisheries and aquaculture

World fisheries production of seabass in 1983 was reported by FAO (1985) to be 14895 tonnes, of which 11456 tonnes (77 %) was contributed by South-East Asia, with Indonesia producing 11010 tonnes (from both inland waters and marine) and Malaysia 446 tonnes. In the same year, farmed seabass production in South-East Asia was 2416 tonnes, the producing countries being Indonesia (1105 or 46 %), Thailand (1084 or 45%), and Malaysia (227 or 9 %) (SEAFDEC, 1985). Singapore's production of farmed seabass was 100 tonnes in 1983, rising to derived from by-catch from brackishwater culture of milkfish.

2.2 Biology of seabass:

2.2.1 Nomenclature and Taxonomy

Phylum	Chordata
Sub-phylum	Vertebrata
Class	Pisces
Sub-class	Teleostomi
Order	Percomorphi
Family	Centropomidae
Genus	*Lates*
Species	*Lates calcarifer* (Bloch)

(Bhatia and Kungvankij 1971)

The above is an accepted taxonomic classification of seabass or giant perch. Seabass has been placed under several families by various authors in the past (e.g. the grouper family, Serranidae and family Latidae, etc.) However, Centropomidae is the commonly accepted familya name of this species, and the recognized generic name is *Lates*. Other names such as Perca,Pseudolates,Holocantrus,Coins, Plectropoma, Latris, and Pleotopomus were also given by various authors who collected the fish specimens from different areas. Bloch (Schneider

1801) stated that *Lates calcarifer* occured in Japan Sea but named it as Holocentrus calcarifer.

The common local names of this species are listed below:

Common English name	: Giant perch, white seabass, silver seaperch, giant perch, palmer, cock-up seabass
India	: Begti, betki, dangara, voliji, fitadar, todah
East Bengal	: Kora, baor
Sri Lanka	: Modha koliya, keduwa
Thailand	: Pla kapong kao, pla kapong
Malaysia	: Saikap, kakap
North Borneo	: Ikan, salung-sung
Vietnam	: Ca-chem, cavuot
Kampuchea	: Tvey spong
Philippines	: Kakap, apahap, bulgan, salongsong, katuyot, matang pusa
Indonesia	: Kakap, pelak, petcham, telap
Australia and Papua New Guinea	: Barramundi

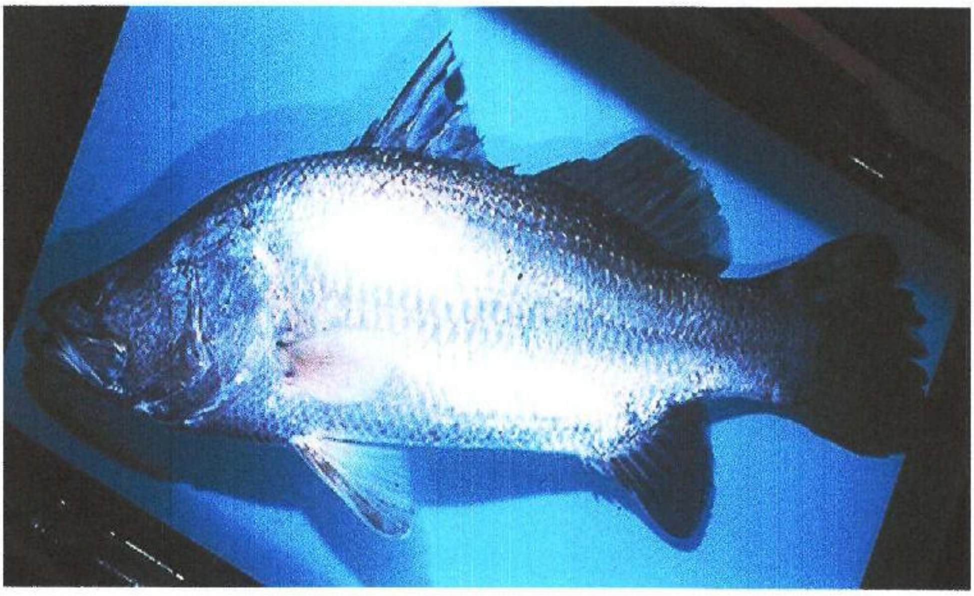


Figure 1. *Lates calcarifer*

2.2.2 Habit and habitat

Seabass are demersal,inhabiting coastal waters, estuaries, lagoons and rivers. They are foundin clear to turbid water, usually within a temperature range of 26-30^{0}c.This species does not undertake extensive migrations within or between river systems, which has presumably influenced establishment of genetically distinct stocks.Seabass feeds on crustaceans, mollusks and smaller fish (includingits own species).Juveniles feed on zooplankton. The seabass is euryhaline but stenothermal. It inhabits rivers and descends to estuaries andtidal flats to spawn. In areas remote from fresh water, purely marine populations may become established(Kungvankij 1971).

2.2.3 Distribution

2.2.3.1 Geographic distribution

Seabass is widely distributed in tropical and sub-tropical areas of the Western Pacific and Indian Ocean, between longitude 50°E - 160°W latitude 24°N – 25°S **(Fig. 2).** It occurs throughout the northern part of Asia, southward to Queensland (Australia), westward to East Africa (FAO 1974).

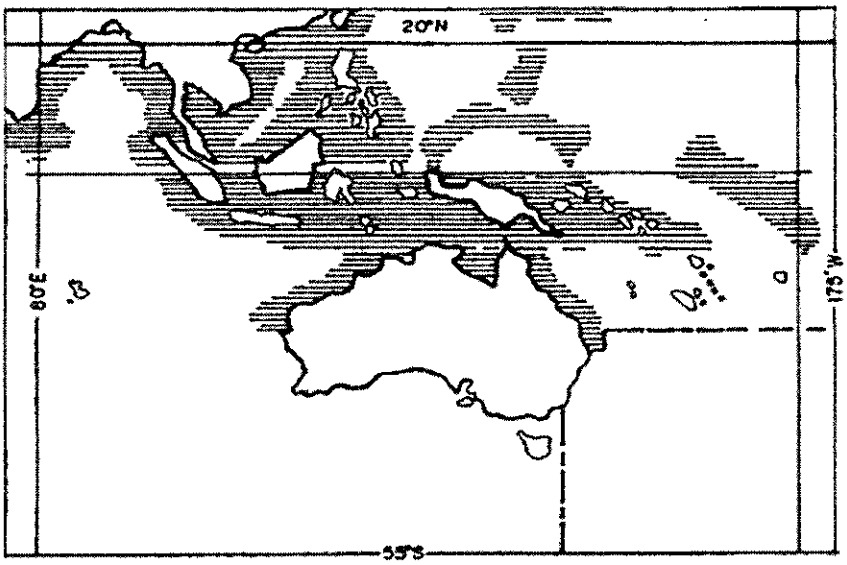


Figure 2 . Geographic distribution of *Lates calcarifer*. (After FAO 1974)

2.2.3.2 Ecological distribution

Seabass is a euryhaline and catadromous species. Sexually mature fish are found in the river mouths, lakes (e.g. Songkhla lake) or lagoons where the salinity and depth range between 30–32 ppt and 10–15m, respectively. The newly-hatched larvae (15–20 days old or 0.4–0.7cm) are distributed along the coastline of brackish water estuaries while the 1-cm size larvae can be found in freshwater bodies e.g. rice fields, lakes, etc. (Bhatia and Kungvankij 1971). Under natural condition, seabass grows in freshwater and migrates to more saline water for spawning. In Bangladesh *Lates calcarifer* found abundantly in the Bay of Bangle and coastal areas.(FAO 1974).

2.2.4 Food and feeding habit

Although the adult seabass is regarded as a voracious carnivore, juveniles are omnivores. Analysis of stomach content of wild specimens (1–10 cm) show that about 20% consists plankton, primarily diatom and algae and the rest are made up to small shrimp, fish, etc. (Kungvankij 1971). Fish of more than 20 cm, the stomach content consists of 100% animal prey: 70% crustaceans (such as shrimp and small crab) and 30% small fishes. The fish species found in the guts at this stage are mainly slipmouths or pony fish (*Leiognatus sp.*) and mullets (*Mugil sp*).

2.2.5 Reproduction and life cycle

Life history

Seabass spends most of its growing period (2–3 years) in freshwater bodies such as rivers and lakes which are connected to the sea. It has a rapid growth rate, often attaining a size of 3–5 kg within 2–3 years. Adult fish (3–4 years) migrate towards the mouth of the river from inland waters into the sea where the salinity ranges between 30–32 ppt for gonadal maturation and subsequent spawning. The fish spawns according to the lunar cycle (usually at the onset of the new moon or the full moon) during late evening (1800–2000 hours) usually in synchrony with the incoming tide(Kungvankij 1984). This allows the eggs and the hatchlings to drift into estuaries. The larval development takes place after which they migrate further upstream to grow. At present, it is not known whether the spent fish migrates upstream or spends the rest of its life in the marine environment **(Figure 3).**

Smith (1965) noted that some fish spend their whole life in freshwater environment where they grow to a length of 65 cm and 19.8 kg body weight. The gonads of such fish are usually undeveloped. In the marine environment, seabass attaining a length of 1.7 m have been recorded in the Indo-Australian region (Weber and Beaufort 1936).

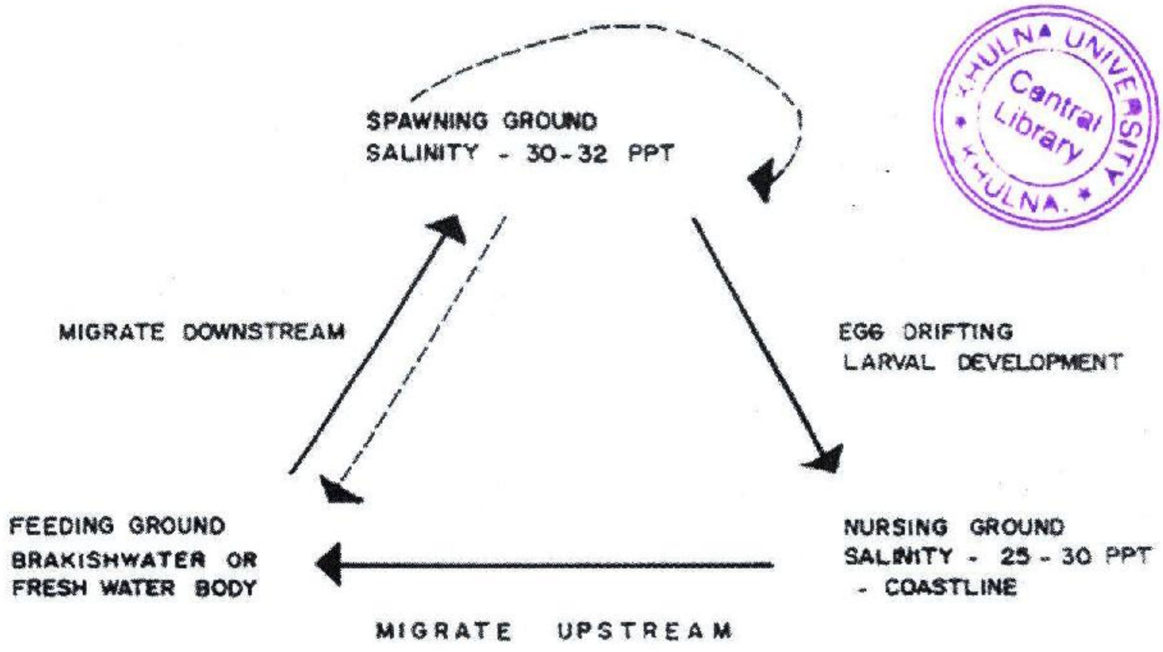


Figure 3. Migration pattern of *Lates calcarifer* Bloch

Sex determination

Identification of the sexes is difficult except during the spawning season. There are some dimorphic characters that are indicative of sex **(Figure 4).**

- Snout of the make fish can be slightly curved while that of the female is atraight.
- The male has a more slender body than the female.
- Weight of the female is heavier than males of the same size.
- The scales near the cloaca of the males are thickers than the female during the spawning season.

- During the spawning season, abdomen of the female is relatively more bulging than the males.

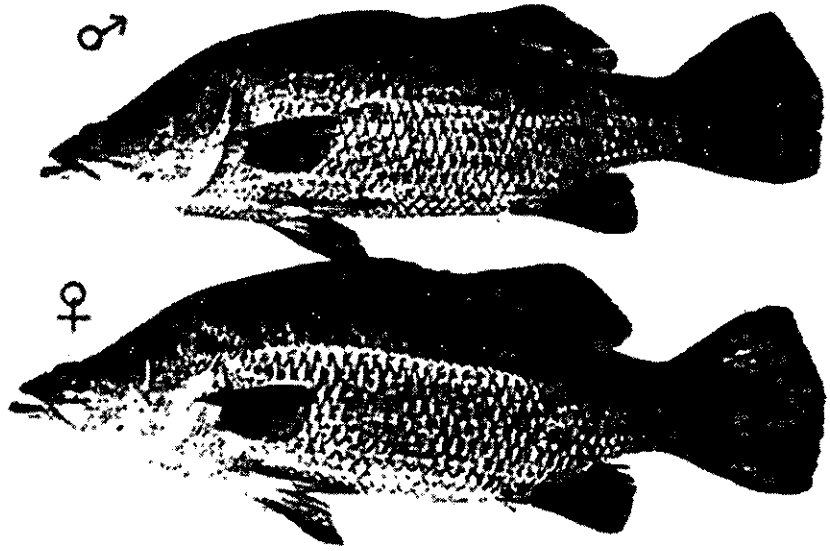


Figure 4. Photograph of adult male and female seabass

Sexual maturity

In the early life stages (1.5–2.5 kg body weight) majority of the seabass appear to be male but when they attain a body weight of 4–6 kg majority become female. After culture period of 3–4 years, however, in the same age group of seabass both sexes can be found and identified as mentioned above. In a fully mature female, the diameter of the oocysts usually range from 0.4 ro 0.5 mm(Bhatia and Kungvankij 1971).

Fecundity and spawning

The fecundity of seabass is related to the size and weight of the fish. Observations by the Australian Department of Agriculture (Anon. 1975) showed that a 12 kg fish had 7.5 million eggs; a 19 kg fish 8.5 million and a 22 kg. fish, 17 million.Seabass spawn all year round

(Kungvankij 1984) with the peak season occurring during April-August and large number of fry (1 cm in size) can be collected during May to August (Bhatia and Kungvankij 1971).

In spawning activity of seabass that has undertaken in tank conditions, mature male and female fish separate from the school and cease feeding about a week prior to spawning. As the female attains full maturity, there is an increase in play activity with the male. The ripe male and female then swim together more frequently near the water surface as spawning time approaches. The fish spawns repeatedly in batches for 7 days. Spawning occurs during late evening (1800–2200 hours)(Kungvankij 1984).

2.3 Market prospect of seabass

2.3.1 Favourable demand in the domestic market

Seabass has good demand in domestic market. Demand is particularly high in the institutional market (hotels and restaurants). Demand for household consumption is low. It is very popular food item in tourist zones of Coz's bazar and Kuakata. The taste of seabass as marine fish is different from other freshwater fishes and it has almost boneless biomass which makes it attractive as a gourmet food(Alam and salauddin 2012). The larger fishes are considered tastier. In urban markets, especially in Chittagong the demand is comparatively higher than other divisional centers. Tourist locations in Coz's bazaar Chittagong in the South-East and Kuakata in the south-West, are mainly served by the captured sea-bass. It is estimated that approximately 2500 MT of sea-bass is traded each year in 3 major fish hubs in the southern region which are Satkhira-Khulna-Bagerhat, Madaripur-Faridpur-Magura and Patuakhali-Barisal-Borguna per year.(Alam and salauddin, 2012) Percentage distribution of cultured and captured sea-bass is unknown. The traders in the regional bazaars and arots expressed that they are able to sell whatever volume of seabass is supplied in the market.

2.3.2 Higher market price

The price of seabass is higher in comparison to other brackish water fish species. The farmers sell sea-bass in the local arots. Clearly the price is much higher for larger seabass. Arots makes a profit of Tk 50-100/kg when they sell to the Beparis and depots. The margin fluctuates by 10 %-15 % depending on size. The Beparis distribute the sea-bass to the larger whole-sale markets in the country like Karwan bazaar and in other tourist zones(Alam and salauddin 2012).

2.4 Suitable ecosystem for seabass production in South-Eastern region

South-Eastern Coastal region of Bangladesh has suitable ecosystem for seabass production. Seabass is a marine species, which comes to the estuaries in times of breeding where saline water from sea unites with fresh water from river. Natural fries are abundant in the estuaries after breeding season. Districts located in this region (Potuakhali, Barguna, pirojpur, Kuakata, Bagerhat) has availability of wild fries. Another key factor which makes South-eastern coastal region suitable for their availability in the inland due to presence of mildly saline water. Salinity level of ~15ppt is suitable for better growth of seabass.(Alam and salauddin 2012) Also, in far Southern region like Satkhira, marine seabass fries and juveniles are available.

2.5 Current practices for seabass culture

Sea bass is an euryhaline fish and for this reason, it is important for marine and brackish water fish farming. Sea bass is an economically important cultured fish species and So, it is ideal for seabass cage culture without affecting traditional fishing operations.The newly developed cage farming of seabass is an alternative ecofriendly technology in the brackish water aquaculture in Bangladesh. Seabass has been commercially cultivated in brackish water and freshwater ponds and marine cages in many Southeast Asian countries. While the cage culture technology is now established, grow-out techniques in pond are still in the developmental stages. Although considerable progress has been made over the past ten years, many problems remained unsolved.

Cage culture of seabass

Cage culture is the preferred culture method of barramundi in Thailand, Hong Kong, Malaysia, Singapore and Indonesia. In South-East Asia, cage culture is usually simpler and more profitable than pond culture. Traditional Asian cage farming uses either simple fixed or floating cages. Fixed cage are made by fastening a cage net to four wooden poles or stakes installed at its four corners. Fixed cages are usually set in shallow bays with narrow tidal

Pond culture of seabass

Although methods of pond culture of sea bass havebeen practiced for over 20 years in Southeast Asia and Australia, not much has been done on the commercial scale (SCFP 1982). At present, culture of sea bass in brackish water ponds has been identified in some countries as having tremendous market potential and high profitability. These, however, can be achieved if conditions are met such as adequate fry supply,availability of suitable sites and properly designed fishfarms, Supply of fry from the wild is very limited. As with cage culture. it is one of the constraints in theintensification of sea bass culture in ponds.(Alam and salauddin 2012)

There are two culture systems employed in pondculture of sea bass. The monoculturesystem has aserious disadvantage, since it is entirely dependent onsupplementary feeding. The use of supplementary feed reduces profit to a minimum, especially where thesupply of fresh fish is limited and expensive. Poly-culture shows great promise in reducingthe priceif nottotally eliminating the farmers' dependence on trash fish as food source. Seabass has a fast growth ratewhich makes itsuitable for poly-culture.Besides this, the culture of seabass in pond environment is also introduced in Bangladesh. A pond is a body of open and standing water with aquatic plants, having shallow depth, occupying a basin and lacking continuity with sea and it does not stratify thermally. The production rate of seabass in pond culture system is also satisfactory in our country.

Imelda J. *et al.,* (2007) , conducted A pilot study on culture of Asian seabass *Lates calcarifer* (Bloch) in open sea cage in India.. In this study, he introduced the idea of mariculture through cage farming to the local fishermen of Cochin coast to have an alternate livelihood option.

Abdalla, A.& El-Shebly *et al.*, (2009) observed in a study on Aquaculture Potential of Sea Bass *(Dicentrarchus Labrax)* in Brackish Water Fish Farms in Egypt. In this paper he discussed the semi-intensive culture of sea bass (*Dicentrarchus labrax*) reared in brackish water fish farms. The results of the work indicated the validity and importance of sea bass culture where the average final length and weight of cultured sea bass during the first year are higher than that recorded by for the first and second year lengths and weights of sea bass at the open water.

Gammanpil, M & Singappuli MS*et al.*, (2009) conducted a syudy on Economic viability of Asian sea bass (*Lates calcarifer)* and Tilapia (*Oreochromis niloticus*) small scale aquaculture systems in Sri Lanka. the purpose of the study was to assess production cost and profitability (economic viability) of semi intensive monoculture of Asian sea bass (*Lates calcarifer*) and GIFT Tilapia (*Oreochromis niloticus*) produced in net cages in SriLanka. The results found that Tilapia cage culture had the highest return on investment (40.7%) and required 353.1 kg of the total production to reach the break-even point compared to sea bass.

Jocelyn M. et al.,(2012).has established a research paper from Southeast Asian Fisheries Development Center Aquaculture Department Tigbauan, Iloilo, Philippines. This paper showed the recent technique of using net cages installed inside a deeper pond to nurse early juveniles has improved survival and growth rates and produced uniformly sized-juveniles. Cage-rearing facilitates size sorting so sibling cannibalism is reduced and allows ease in feeding and handling of the fish.

Solanki H. G. *et al.(2013).* The study was conducted in Danti Farm of Navsari Agricultural University, Gujarat, India for a period of eight months (225 days). Comparison of length-weight regression coefficient '*b*' of *L. calcarifer* from the wild and from different culture systems. The result of the study showed that the LWR of seabass reared in pond culture system with formulated feed is comparable to the LWR of natural population.

Kandan S. *et al.*,(2015). In India, a technology has been developed and perfected for culturing of seabass in cages in ponds by RGCA, an R & D, and the arm of the Marine products Export Development Authority. In this method, the pond cages have the dimension of 2m.2m.1.3m (approx. 5.0cu.m) using PVC pipe frames of 40 nm (floating frame), 32mm (sinver) and 25 mm (top lid). The cages are fastened to the bamboo or wooden poles of the catwalks fixed in the ponds.

Cheong, L.*et al*(2010). has done a researchonStatus of knowledge on farming of Seabass *(Lates calcarifer)* in South East Asia.This paper highlighted on the various techniques of farming seabass (Lates calcarifer) in South-East Asia, namely, Thailand, Malaysia, Philippines, Indonesia and Singapore. The management and husbandry aspects are discussed, and the potential of farming this fish under highly intensive conditions is mentioned.

Monwar,M*et al.*,(2013) has published a research paper on Polyculture of seabass with tilapia for the utilization of brown fields in the coastal areas of Cox's Bazar ,Bangladesh. This paper found that polyculture of tilapia and seabass has the potential to be successful in Bangladesh because coastal areas of Cox's Bazar have seasonal fluctuation of salinity (5 to 15 ppt). So this polyculture system would be effective as tilapia utilize plankton in the culture ponds, while seabass consume tilapia fry as a live feed.

Philiopse K..K,& Sharma S.R *et al (*2011)., has done a research work on Culture of Asian seabass (*Lates calcarifer*, Bloch) in open sea floating net cages off Karwar, south India. This paper reported that the Culture of Asian seabass in open sea floating net cages made of either HDPE or GI pipes, has been successfully demonstrated off Karwar, south India. Various growth parameters like average daily growth rate (ADGR), survival rate (SR), specific growth rate (SGR) and biomass index (BI) were estimated. Mean weight and length at the end of the 150 days experimental period was 1.02 kg and 412.05 mm respectively with a SR of 68.8%.

Shubha and Kathiresan *et al.*,(2014). published a research article on Barcoding of Asian seabass across its geographic range provides evidence for its bifurcation into two distinct species.

Danakusumah *et al.*,(1986). In Australia, they observed in a study named, Cultureof Sea Bass *(Lates calcarifer)* in Earthen Brackishwater Ponds.It is found from the study that Average individual daily growth was 1.50, 1.33, 3,58, and 2,65 g for those cultured in A-I, A-2, B-1 and B-2. Respectively .During the experiment, survival rates were 76.5, 72.2. 79.2 and *85A%* for those cultured in A-I, A-2, B-1 and B-2, respectively. Sea bass are piscivorous, so mortality is possibly caused by their cannibalism.

Khamis and Hanafi *et al.,* observed in a experiment in Malaysia. The results of the experiment After a culture period of about 7.5 months, found that the average body weight of fish which were stocked at 3000 pieces/ha is 365.9 g compared to 225.5 g at 4500 picces/ha stocking. The survival rate (76.4%) for the trial with stocking density at 3000 pieces/ha is much higher than that with stocking density at 4500 pieces/ha, which is only 30.4%.

Sakaras *et al.*, (1987) observed in a experiment named Optimum stocking density of sea bass *(Lates calcarifer)* cultured in cages. He found the results After 2 JO days, fish production per cage increased steadily with increase in stocking density. Fish production from various stocking densities was 53.60, 83.17, 109.50, 125.23 and 148.70 kg/cage, respectively from stocking density of 100, 150, 200, 250 and 300 fish/cage.

Kungvankij *et al.,(1984)*Cage Culture of Sea Bass *(Lates calcarifer)* in Indonesia showed Stocking density in cages is usually between 40-50 fish/m'. Two to three months thereafter. when the fish have grown to between 150 and 200 g, the stocking density should be reduced to 10-20 fish/m'.

Tookwinas S. and B. Charearnrid, *et al.*,(1988). Have found in a study about Training manual on Sea bass *(Laces calcarifer)* culture in Thailand. Here, they observed the production performance of seabass in cages and pond culture system.

CHAPTER 3

MATERIALS AND METHODOLOGY

Materials and Methodology

3.1 Desktop Studies and Baseline survey

Desktop studies were conducted for secondary materials, books, journals, literature review and internet search relevant to the research theme. Beside literature review baseline surveys were arranged at Morrelganj Upazilla of Bagerhat Districtnear the panguchi river to select the suitable site for the experiment and also in the Barisal, Khulna and Satkhira District for good source of seeds. Field trips were made at MorrelgangUpazilla to see the facilities of ponds and also for the selection of dedicated farmers.

3.2 Site Selection and study period

The location was selected for the research work in Panguchi River and its adjacent area at Morrelgang Upazilla of Bagerhat District (Map in appendix). Skill labors were also selected for preparation of cage and also for cage wrapping with net. The study was conducted july-august,2014.

3.3Cage preparation

In general, square and rectangular cages with size varying from 20 to 100 m^3 are preferable because they are easy to construct, manage and maintain. Seabass cages usually are made of polyethelene netting with the mesh size ranging from 2 to 8 cm. The choice of mesh size depends on the size of the fish. In this experiment, Four iron framed cages were prepared from a well experienced worker from Gollamari of Khulna city. The measurement of the cage was 3 m, 3m and 1 m, thus it was 9 m^3 in volume.

3.4 Cage setting and pond repairing

Initially all the cages were set at the adjacent Panguchi River of theMorrelgang Upazilla of Bagerhat District. Bamboo pole and plastic drums were used to hold and float the cages with the tidal fluctuation of the river. Hence, during the strong tides the current was very strong and two of the cages were damaged. So, later on it was repaired and shifted to ponds which had water exchange facility. Seabass ponds are generally rectangular in shape with size ranging from 2000 m^2 to 2 hectares and depth of 1.2 to 1.5 meters. Each pond has separate inlet and outlet gate to facilitate water exchange. The pond bottom was entirely flat levelling toward the drainage gate. All the ponds were prepared before stocking with special reference to dike renovation and fencing.

3.5 Transportation of fry

The fries were collected from Koyra Upazilla of Khulna District and transported to the experimental area in an oxygenated tank by track. A little amount of fries also collected from Bagerhat and Satkhira districts.

3.6 Stocking

Immediately before collecting the seeds all the cages were set and the cages was stocked with seabass fry at the rate of 20 m^{-2}. The ponds were stocked at the rate of 2 m^{-2}. Due to limited time the culture was stopped after approximately 2 month.

3.7Post stocking management

Post stocking management is important for the better survival and growth of fry. After stocking fry in the ponds and cages, adequate feeding management was maintained to ensure proper feed supply to the fry. Water quality was also monitored throughout the experimental period.

3.8 Feeding

After ensuring enough primary production, fries were stocked in the ponds and cages. They were reared for about 8 weeks, due to the limitation of time. Feed is the major constraint confronting the seabass culture industry. At present, trash fish is the only known feed stuff used in seabass culture. The feed were given four to two times in a day at the rate of 20-10 % of the body weight. Trash fishes collected from the rivers were used as feed staff in this study.

3.9 Sampling

Sampling was done every week for growth measurement in weight and length. For each sampling 20 pieces of fish was taken. Very small mesh size net was drawn in the pond to collect the fry. An electric balance with p to 0.1 mg denomination and a centimeter scale up to 1mm graduation were used for weight and length measurement respectively.

Fig7 : sampling fish from experimental pond. Fig 8: Sampling fish from cages.

3.10 Statistical analysis

Data were analyzed with the help of computer software Excel and SPSS.

CHAPTER 4

RESULTS

Results

4.1 Growth performance in weight

The study revealed that the best growth was in the cage 1 with mean value being obtained at 116.67 g. The lowest value at the last sampling was found to be 37.15g for the cage 4. Cage 3 also showed better performance than all the ponds with the mean value 64.51g. But cage 2 and 4 showed lower growth performance than all the ponds. Among all the ponds pond 3 had the better growth rate at the last sampling with the mean weight of 54.3 g .Here, the standard deviation of mean value were given (Table 1).

Table 1. Growth performance of *Lates calcarifer* based on weight in cages and ponds

Date	Cage1 (gm)	Cage2 (gm)	Cage3 (gm)	Cage4 (gm)	Pond1 (gm)	Pond2 (gm)	Pond3 (gm)	Pond4 (gm)
05/07/2014	19.01±13.05	11.99±2.91	12.51±3.48	12.35±1.38	11.09±2.29	10.12±1.80	13.82±10.12	11.04±2.3
12/07/2014	39.15±34.45	15.93±1.82	17.57±3.40	12.85±2.62	16.12±3.18	13.02±2.99	15.02±5.11	16.35±2.4
19/07/2014	48.71±42.86	19.36±2.89	18.16±4.57	14.04±4.98	24.23±6.82	14.74±5.06	25.46±15.84	21.47±4.3
26/07/2014	64.64±36.14	22.19±4.33	20.1±2.68	18.81±6.68	21.38±10.99	23.23±7.44	27.98±6.18	23.87±4.8
04/08/2014	74.89±44.22	28.12±9.29	29.65±13.67	26.63±8.06	23.85±7.72	22.96±8.01	29.83±8.04	28.6±5.83
11/08/2014	68.38±38.31	33.12±9.01	32.27±10.99	34.53±8.07	35.18±12.30	32.11±9.43	36.45±10.79	23.07±5.8
15/08/2014	116.67±43.80	38.05±11.43	64.51±38.48	37.15±6.88	49.37±21.54	40.35±15.53	54.3±21.97	47.35±22.0

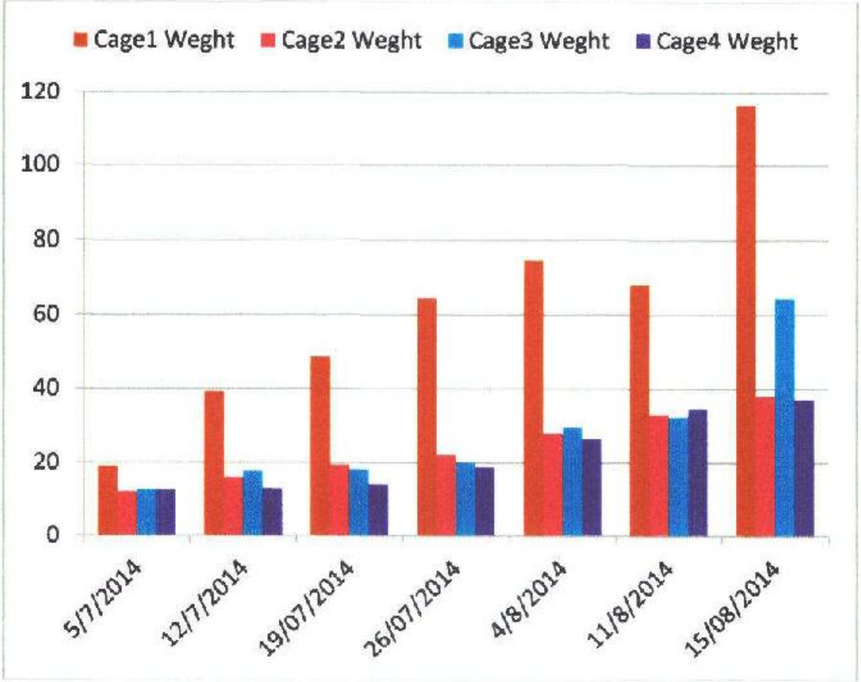


Figure 9. Growth performance of seabass in different cages based on weight

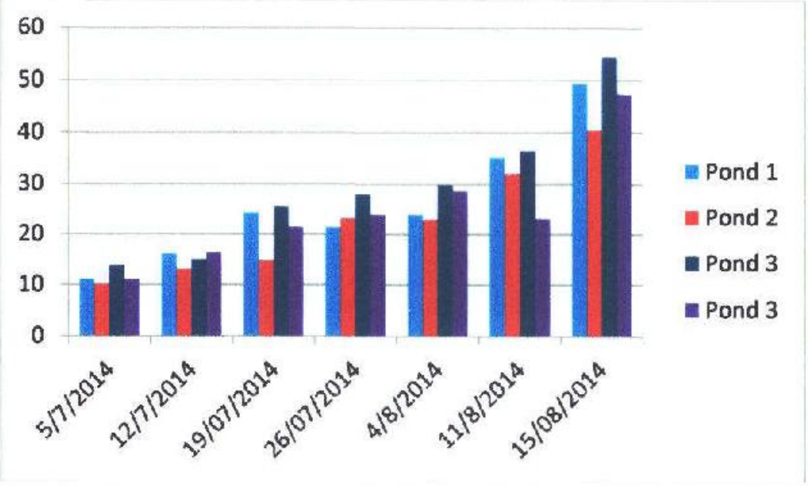


Figure 10. Growth performance of seabass in different ponds based on weight

4.2 Growth performance in length

4.2 Growth performance in length

The result of the study showed that the best growth of seabass based on length was in the cage 1 with the mean value of being obtained 21.68 cm. The lowest length at the last sampling was found to be 15.09 cm for the cage 4. Pond 3 showed better performance among all the ponds with the mean value 17.79 cm. But cage 2 and 4 showed lower growth performance than all the ponds (Table 2). Here, the standard deviation of all mean value were given. Figure 3 and 4 are also representing the growth comparison of seabass cultured in cages and ponds.

Table 2. Growth performance of *Lates calcarifer* based on length in cages and ponds

Sampling date	Cage1(cm)	Cage2(cm)	Cage3(cm)	Cage4(cm)	Pond1 (cm)	Pond2 (cm)	Pond3 (cm)	Pond (cm)
05/07/2014	11.67±2.39	10.07±1.10	10.7±0.97	10.41±1	9.33±0.94	8.68±1.21	10.13±1.89	9.15±1
12/07/2014	15.05±2.92	12.66±1.24	13±3.40	10.35±1.70	13±1.92	11±2.10	11.75±2.40	13.15±1
19/07/2014	15.35±3.93	13.93±1.14	12.3±0.88	11.55±1.51	12.45±1.44	10.86±1.44	13.6±2.59	14.07+
26/07/2014	16.89±3.28	13.32±1.60	11.91±0.85	11.65±1.44	12.01±2.83	12.86±1.86	14.12±1.51	13.15±
04/08/2014	17.29±3.96	14.27±1.91	13.9±3.57	13.39±1.33	13.8±1.76	13.3±2.38	15.35±2.18	15.02±1
11/08/2014	17.49±2.85	15.19±1.84	14.94±1.40	14.65±1.16	17.91±8.60	14.93±2.21	15.78±2.00	13.22±1
15/08/2014	21.68±3.49	15.22±1.49	16.55±2.37	15.09±0.73	16.83±2.74	15.54±2.51	17.79±2.23	16.36±

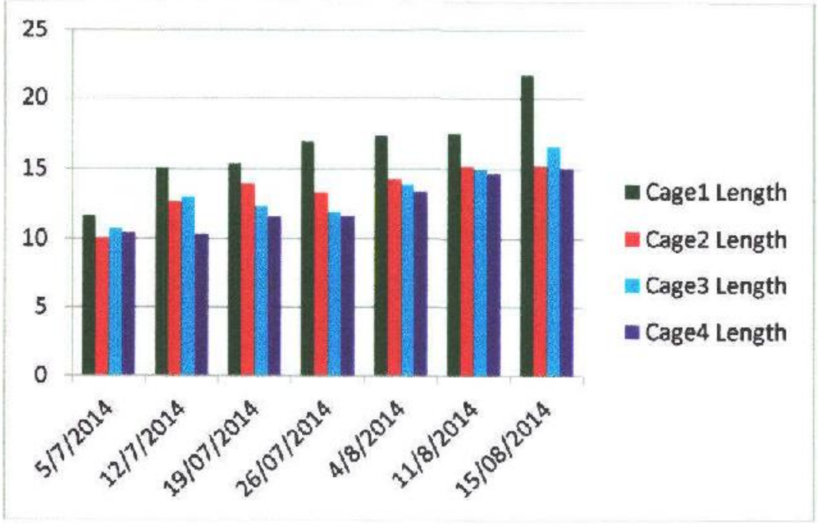


Figure 11. Growth performance of seabass in different cages based on length

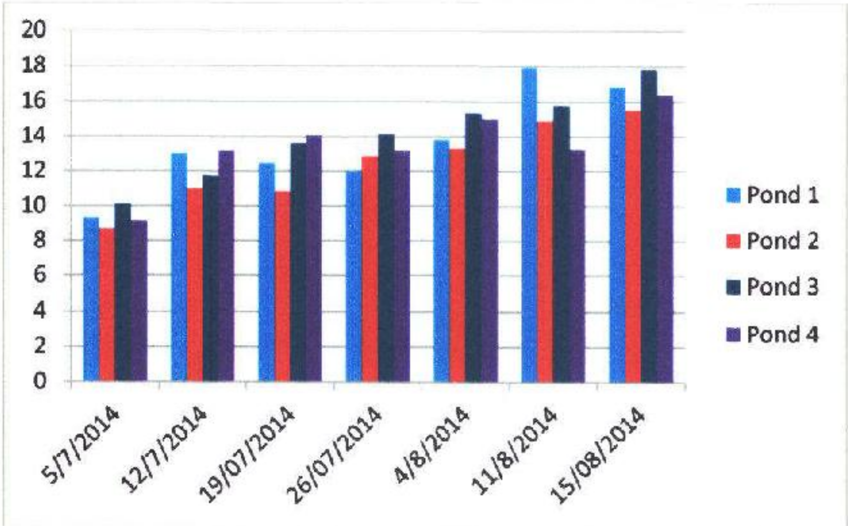
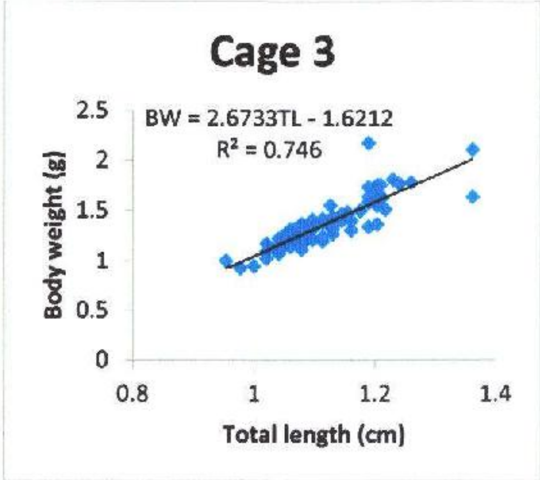


Figure 12. Growth performance of seabass in different ponds based on length



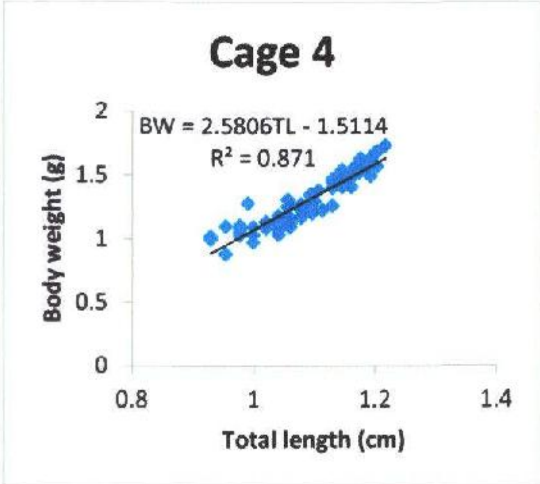


Figure 13. Growth patterns of seabass at different cages

4.3.2 Growth patterns and length-weight relationship of samples of ponds

In Figure 14, the relationship of body weight with total length of *Lates calcarifer* from four ponds. The figure showed that in all the ponds body weight is positively allometric with total length with the regression equation for pond 1, BW= 1.5389TL - 0.3715, 0.5588; for pond 2, BW= 2.1115TL - 1.0006, 0.8854; for pond 3, BW = 2.3301TL - 1.2566, 0.885 and for pond 4 the regression equation is BW = 1.9131TL - 0.8012, 0.7484. As the growth patterns are not compatible with the environment, feeding and other factors, so we should have to be concerned about the sustainable culture of seabass.

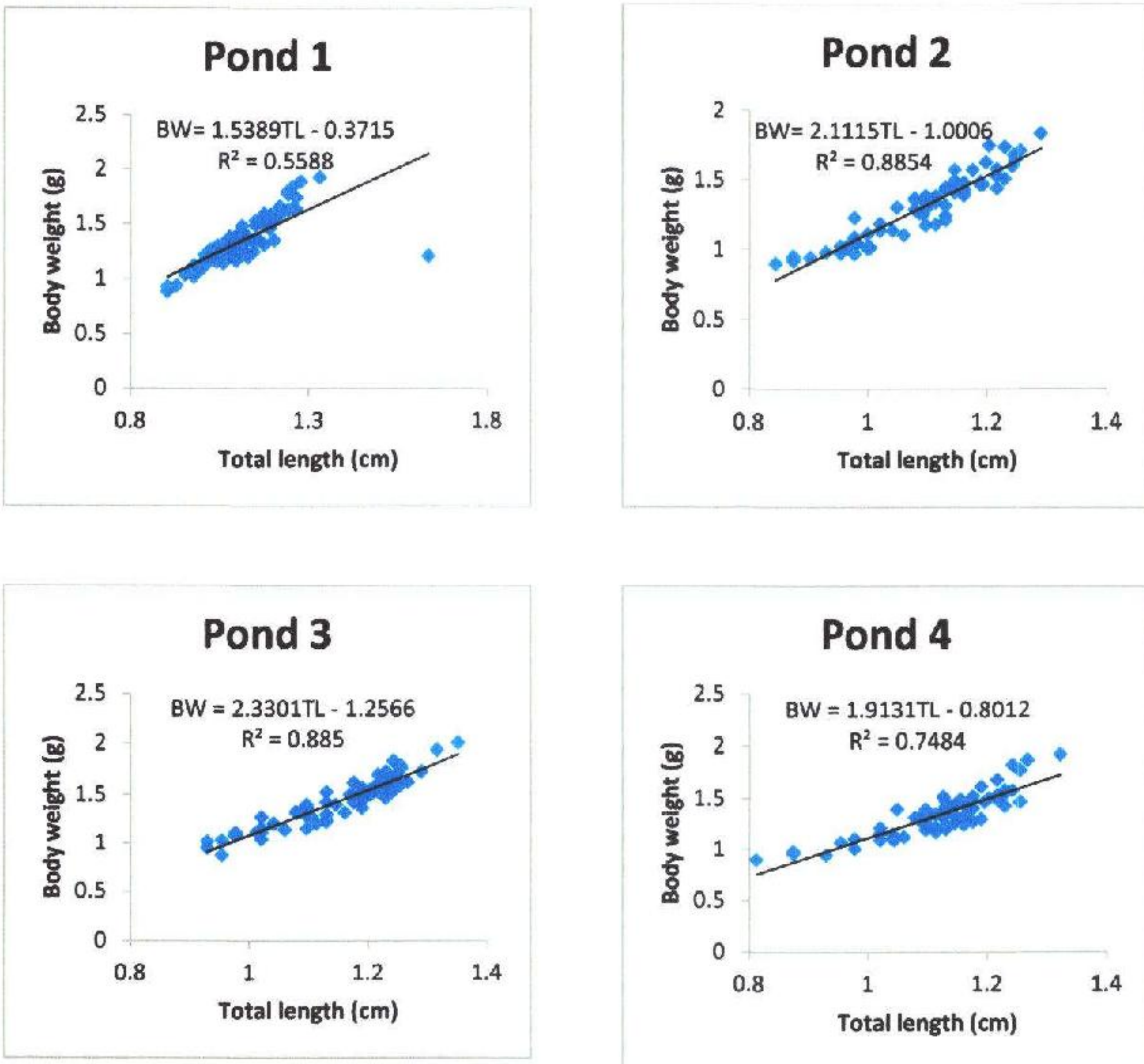


Figure 14. Growth patterns of seabass at different Ponds

4.4 Water quality parameters

Water quality of a pond is an important factor. To ensure good water quality of a pond at least 30% the water of high tide in every full moon and sun should change water of the pond. Beside this, to keep in observation the salinity, ph, temperature of the water, any exception happens, the necessary steps should be taken at once. Aquatic weeds should be clean regularly.

The study revealed that all the water quality parameters were within the range of acceptable limit. The most important water parameters temperature and ammonia were found to be good for aquaculture (Table 3). In this experiment dissolved oxygen (DO) content was found to be favorable for aquaculture (Table 3). In this study the pH values of water was ranged from 7.1-7.5, which is also good for grow-out culture of fish. It is better to mention here, that slightly lower pH is good for aquaculture which helps to keep lower the NH_3-N in aquaculture systems.

During the culture period ammonia nitrogen was found to be ranged from 0.33 -0.35 mg/L Maintenance of NH_3-N level is very essential to avoid toxicity in aquatic environment. The maintenance of good productivity nitrate-nitrogen is very essential. The range of nitrate-nitrogen value recorded in the present study was 2.23- 3.86 mg/L.

The average value of water transparency was found to be almost similar at all sampling dates and it ranged from 16 cm to 24 cm of different treatments. Average alkalinity values ranges from 150 mg/L to 200 mg/L.

Cage/Pond no.	Temp. (°c)	pH	DO(mg/L)	Sechi Depth (cm)	Alkalinity (mg/L)	NO_3-N (mg/L)	NH_3-N (mg/L)
Cage 1	32.3	7.0	5.25	16	150	2.25	0.33
Cage 2	35.2	7.1	5.25	16	150	2.30	0.34
Cage 3	34.2	7.3	5.25	16	150	2.34	0.35
Cage 4	32.1	7.2	5.25	16	150	2.23	0.33
Pond 1	35.2	7.2	5.68	24	160	3.72	0.35
Pond 2	35.4	7.1	5.22	22	150	3.86	0.34
Pond 3	35.3	7.2	5.76	20	200	3.46	0.35
Pond 4	35.5	7.3	5.56	21	200	2.99	0.34

Table 3 : Water quality parameters of cages and ponds during culture period of seabass

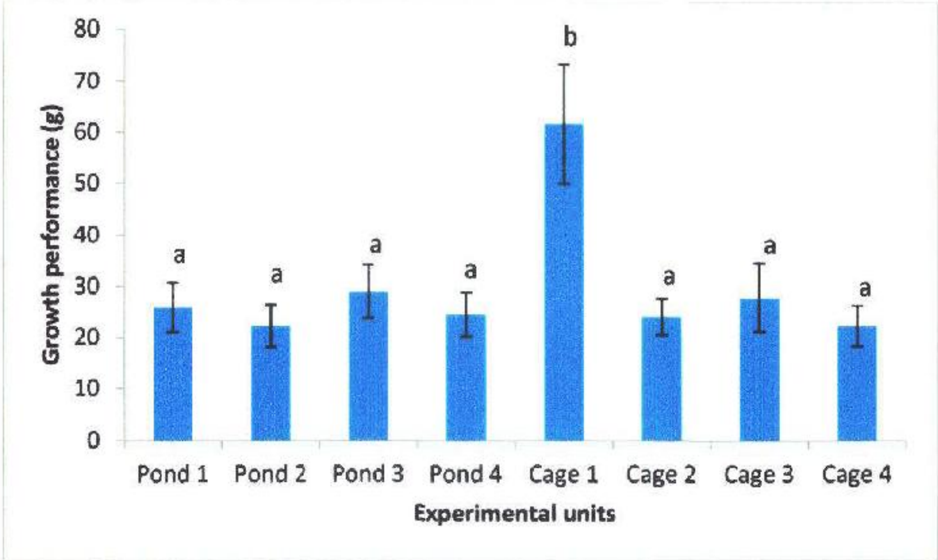
CHAPTER 5

DISCUSSION

Discussion

The study showed the results that growth performance of *Lates calcarifer* based on weight in cages and ponds, the best growth was in the cage1 with mean value being obtained at 116.67 g. Cage 3 also showed better performance than all the ponds with the mean value 64.51g.Philipose and Sharma, 2011 has been successfully demonstrated the Culture of Asian seabass in floating net cages, at Karwar, south India. Mean weight and length at the end of the 150 days experimental period was 1.02 kg and 412.05 mm respectively. Among all the ponds, pond 3 had the better growth rate at the last sampling with the mean weight of 54.3 g (Table 1) of my study. So, it is clear from the results that the cages showed better growth performance based on weight between cage and pond culture system. Again, the result of the study showed that the best growth of seabass based on length was in the cage 1 with the mean value of being obtained 21.68 cm. Pond 3 showed better performance among all the ponds with the mean value 17.79 cm (Table 2).Danakusumah,(1986) observed in a study named, Culture of Sea Bass *(Lates calcarifer)* in Earthen Brackish water Ponds. It was found from the result that Average individual daily growth was 1.50, 1.33, 3,58, and 2,65 g . So, here also proved the better growth performance based on length found in cages than ponds. In Figure 13, the relationship of body weight with total length of *Lates calcarifer* from four cages. Growth patterns and length-weight relationship of samples of cages showed that in the cage 1 body weight is positively correlated with total length with the regression equation of BW = 3.1026TL - 2.0772, 0.963;here,R=correlated co-efficient and R^2=coefficient determinate. So, here the value of R^2=0.963 that means growth performance of cage 1based on body weight and length is favorable and other cages body weight is negatively correlated with the total length with the regression equations for cage 2, BW = 2.2929TL - 1.2336, 0.794; for cage 3, BW = 2.6733TL - 1.6212, 0.746 and for cage 4, BW = 2.5806TL - 1.5114, 0.871. In Figure 14, the relationship of body weight with total length of *Lates calcarifer* from four ponds. Growth patterns and length-weight relationship of samples of ponds showed that in all the ponds body weight is negatively algometric with total length with the regression equation for pond 1, BW= 1.5389TL - 0.3715, 0.5588; for pond 2, BW= 2.1115TL - 1.0006, 0.8854; for pond 3, BW = 2.3301TL - 1.2566, 0.885 and for pond 4 the regression equation is BW = 1.9131TL - 0.8012, 0.7484.In spite of all those, cage 1 showed better growth patterns.

Solanki,(2013) observed in a study that was for a period of eight months (225 days) and the result of the study showed that the LWR of seabass reared in pond culture system with formulated feed is comparable to the LWR of natural population. As the growth patterns are not compatible with the environment, feeding and other factors, so we should have to be concerned about the cage culture of seabass.



From the above statistical analysis, it can be clearly understood that cage 1 has significant differences that contain b value which indicates the highest growth pattern. The other cages and ponds have no significant differences that's why except cage 1 all the cages and ponds contain value a. So, cage 1 have the highest production than all the cages and ponds.

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In my study, the results showed that the natural environment and the water quality parameter both were an important factor for ensuring a better production rate in cages and ponds. First, the temperature of water in cages was found to be favorable that is good for seabass production. On the other hand, the temperature in ponds water fluctuated and the production rate is not so much satisfactory. Then, the sechi depth of cages were maintained in a steady condition during the culture periods. But the sechi depth of ponds were fluctuated from each other. So, ultimately it enhanced the production of cages and hampered the production of ponds. Again, the dissolved oxygen (DO) and ammonia content were found to be favorable for seabass production in cages and the amount of dissolved oxygen (DO) and ammonia were in a high content in ponds (Table 3). In this study the pH values of water was ranged from 7.1-7.5, which is also good for grow-out culture of fish. It is better to mention here, that slightly lower pH is good for seabass production, which helps to keep lower the NH_3-N in a production system. During the culture period ammonia nitrogen was found to be ranged from 0.33 -0.35 mg, maintenance of NH_3-N level is very essential to avoid toxicity in aquatic environment. The maintenance of good productivity nitrate-nitrogen is very essential. The result revealed that cages support this statement. The range of nitrate-nitrogen value recorded in the present study was 2.23- 3.86 mg/L. The average value of water transparency was found to be almost similar at all sampling dates and it ranged from 16 cm to 24 cm of different treatments. Average alkalinity values ranges from 150 mg/L to 200 mg/L. In cages, the content was in a steady condition that is favorable for better production.

At last, it can be said from this experimental work the growth performance of seabass between cage and pond is not far differences. But cages showed somehow better growth rate than all the ponds. This results from my experimental work and it supports the results of Solanki, (2013) perhaps some experimental units were different. We should be taken it as a commercial purpose with proper management strategy then we can be able to ensure better production of seabass among the countries. In South-East Asia, cage culture is usually simpler and more profitable than pond culture Glenn Ship, (2007). The success of cage culture of seabass and its economic viability have contributed significantly to large scale development of this aquaculture system and also the local people have benefitted from it.

Problems and Constraints of my study

Unlike in freshwater fish culture, floating net cage culture for marine finfish is not common in Bangladesh. Sea bass itself is also a new cultured species introduced to the farmers despite its popularity in the country. In promoting the culture of this species, problems and constraints encountered are:

(a) **Availability of seedused/or culture**. No marine finfish hatchery has yet been established and therefore fry/fingerlings have to be obtained from the wild. Since the collection of sea bass fry fingerlings from the wild is unfamiliar to the fishermen, the availability of seed is uncertain and unpredictable. As well, the fishing gear used to collect the fish tends to cause high mortality;

(b) **Availability and price of feed**. The feed used in sea bass culture,natural and formulated will depend on the trash fish available. Trash fish is also eaten by the local population, so it can also be too expensive for use as feed;

(c) **Marketing of the products**. The high cost of trash fish as the main source of feed undoubtedly leads to an increase in the cost of production and consequently will reduce the market for sea bass sold almost entirely as iced fish.

CHAPTER 6

CONCLUSION

Conclusion

The results from the experimental work showed that cage culture of seabass is more profitable over pond culture of seabass with the same treatment. Statistical analysis of my research also showed that, cage farming of seabass gave us better growth performance in short time with great survivality than ponds. So, cage farming would have become more popular among the local people one day. The implications of this research are to bring back the fertility of the coastal land, utilization of vast unutilized or underutilized derelict coastal areas, low cost but profitable and quick return on the investment, easy tech and risk-covered, eco-friendly affordable environmentally sustainable technology and employment opportunity for the marginal farmers. To meet the increasing demand of animal protein as well as to raise the economic progress of the country, the policy makers among government, non-government and other related organizations should take immediate steps to extend the cage farming of seabass for the increase of fish production especially in the coastal areas. Development, therefore, of the haors, boars and lakes for cage culture of seabass will most likely ensure a steady supply of fish to meet the local needs of the majority of the population and likewise to improve income capacities of the fishermen and fish farmers which in the long run might be liberated from poverty.

CHAPTER 7

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APPENDICES

Photo gallery

Fig 1: One of the experimental sites

Fig 2: Project office rented during experiment

Fig 3: One of the experimental sites

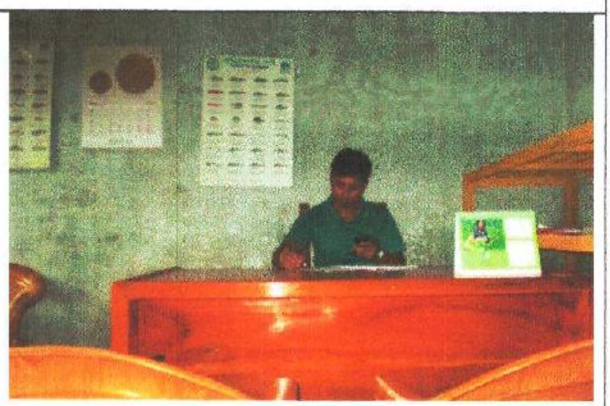


Fig 4: PI cheching the project work

Fig 5: One of the experimental sites of cages

Fig 6: One of the experimental sites of cages

Fig 7: One of the cages was damaged due to high tide and strong current

Fig 8: One of the experimental ponds selected for project work

Fig 9: One of the experimental ponds selected for project work

Fig 10: Strong current created problem of cage culture

Fig 11: Strong current created problem of cage culture

Fig 12: Turbidity was also a problem in coastel areas

Fig 13: Sampling fish from ponds

Fig 14: Sampling fish from ponds

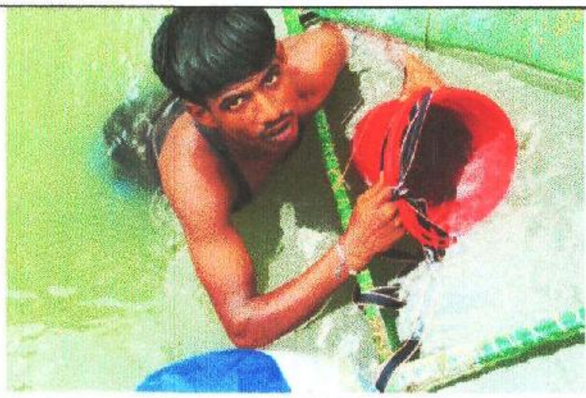


Fig 15: Sampling fish from cages

Fig 16: Sampling fish from cages

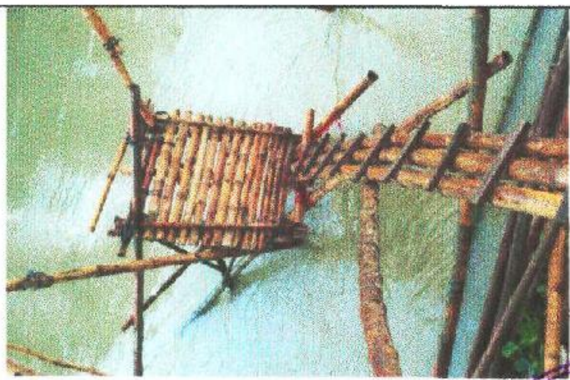


Fig 17: One of the cages was damaged by strong current

Fig 18: One of the experimental unit was damaged by strong current

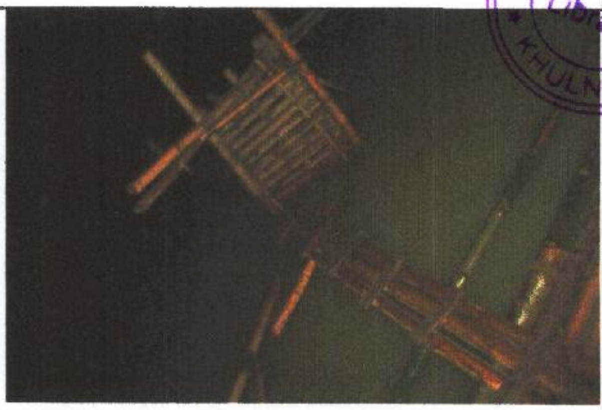


Fig 19: Tide and current increased at night

Fig 20: One of the experimental unit was damaged by strong current

Fig 21: High tide flooded experimental areas

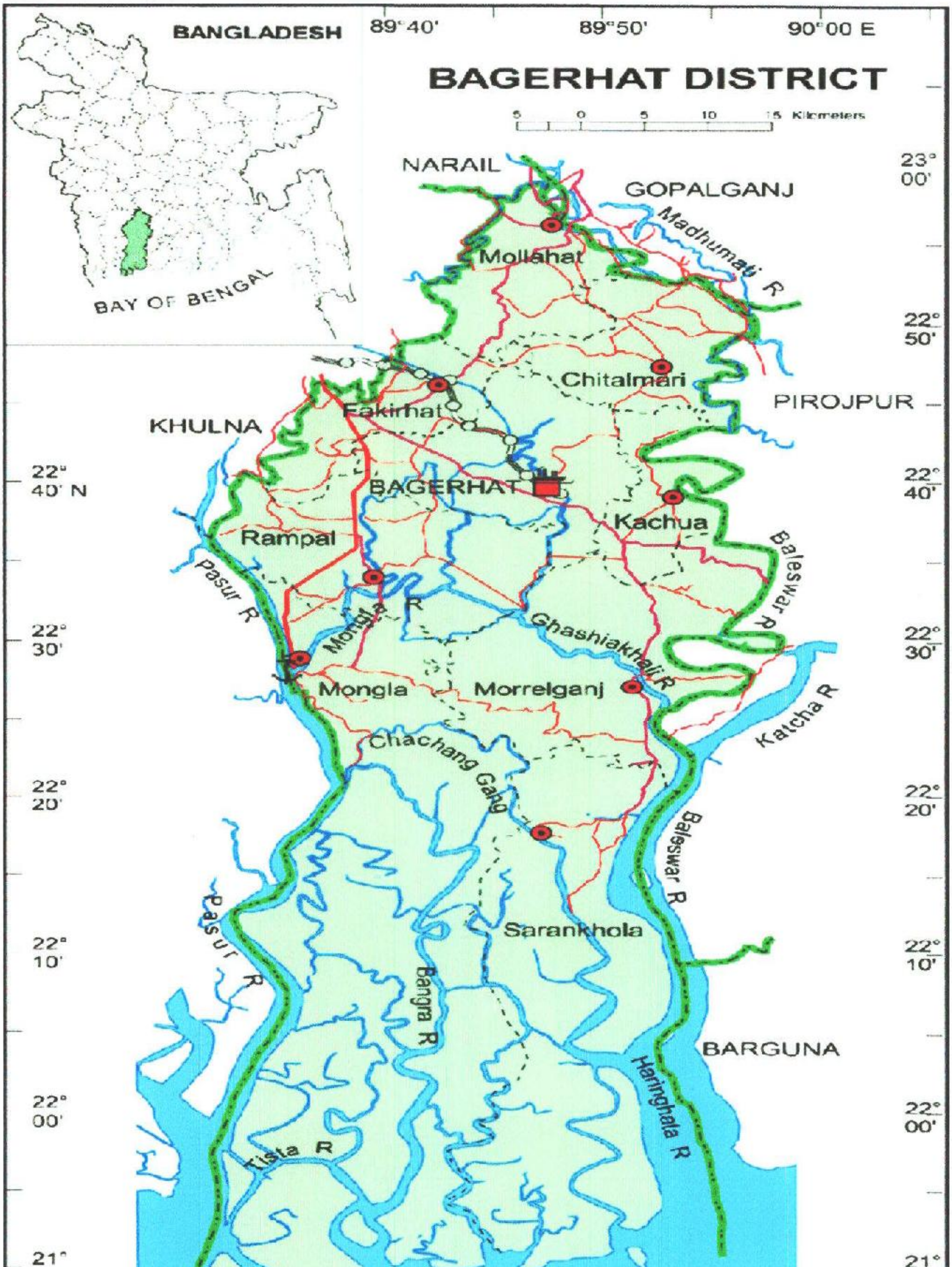
Fig 22: Sampling during experiment

Fig 23: Sampling during experiment

Fig 24: Sampling during experiment

Fig 25: Cages were shifted from river to a pond

Fig 26: Final sampling at the end of the experiment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Mollahat
Chitalmari
PIROJPUR
Fakirhat
KHULNA
BAGERHAT
Kachua
Rampal
Baleswar R
Pasur R
Mongla R
Ghashiakhali R
Mongla
Morrelganj
Katcha R
Chachang Gang
Baleswar R
Sarankhola
Pasur R
Bangra R
BARGUNA
Haringhata R
Tista R
BAY OF BENGAL