FISH CULTURE IN BRACKISH WATER

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Introduction

Brackish water is a mixture of fresh and salty water which usually occurs in estuaries, and has a salinity usually of between 15 and 30 per thousand, depending on rainfall and freshwater run-off.

Some fish species like mullets are able to survive in this environment. Most of the *Mugilidae* shoal swim in or near the surface of the water and may be seen jumping repeatedly in estuaries usually in the evenings. *M. cephalus* and *Liza aurata* are potential species for culture. These species occur in vast numbers and have very firm flesh of excellent flavour. They spawn in the tropics mostly from September to October. During this period they migrate away from estuaries.

Their normal feed is plankton and minute algae and even survive in areas where other fish would die. The fry feed mainly on diatom and epiphytic cyanophycae while the adult feed on algal debris, detritus and decayed plants in ponds—by nibbling and sucking out edible portion and rejecting the hard residual part.

Experiments to determine the adaptability of young *Liza aurata* have shown that no mortality occurred with decreasing salinity from 100% sea water to 100% fresh water. Even with a gradual change in salinity from 10% seawater to 100% freshwater no mortalities were recorded. The fry have succeeded in growing in salty ponds but very little information is available on their growth in brackish water and salty ponds. Mullets in general and, especially *Mugil cephalus* have been widely cultivated in countries like Japan, Hong Kong, China, Philippines, Korea, India, Egypt, Israel, Italy, the USA and Hawaii as primary and secondary or experimental crop and has salinity tolerance of up to 50 per thousand. They are generally cultivated in brackish water and occasionally in freshwater as in India. *Mugilidae* is widely distributed in coastal waters and estuaries conditions of tropical and subtropical zones of Atlantic, Pacific and Indian oceans.

Pond construction

Erosion is responsible for pond construction. Fertile soils carried by run-off water from inland areas is deposited in estuaries immediately it mixes with salty sea water causing the mud to gradually rise to form mud flats that support a vegetation of mangroves. The very loose initial structure of the mud changes as moisture is diminished by evaporation and transpiration. The process of drying out results in the shrinking of the soil until it attains the proper physical character of pond barrier. Even though ponds very close to the shore are filled with undiluted sea water the great amount of rainwater trapped in the ponds during the monsoons, makes it not possible for salinity values equal or higher than those of seawater to occur in the ponds at any time other than during prolonged periods of drought.

Aquaculture

The stocking rate of fish depends on the availability of the following factors: oxygen, food, the physiological and behavioural characteristics of the fish, the depth and area of the pond and the nature of the pond bottom, the desired size of fish at harvest and the length of time for the growth of the fish. All these factors are interrelated. Depletion of oxygen in the pond can cause mass fish mortality. This will happen if at the bottom of the pond there is accumulation of organic matter which when disturbed becomes oxidised and in the process reduces the oxygen level. The feeding habits of the fish, the nature and amount of food available and temperature may also affect oxygen level. The labour input in aquaculture varies a great deal depending on the culture operation. A limited study in southeast Asia has shown that most operations are highly labour-intensive. Specific areas of fish culture must be detailed and surveyed. Properly sited and cleared place which should propably include the construction of a number of ponds in series of that buffer zones of mangrove and untouched areas can be left to maintain the natural populations that will contribute to the richness of the environment. Wholesome clearance of mangrove swamps and unplanned development of coastal areas without necessary thought and planning will do irreparable damage. The productivity of the brackish water region contributes significantly to the development of the offshore fisheries, a factor that should be carefully taken into consideration.

For the purpose of developing coastal aquaculture in Kenya, a detailed survey of the concerned estuarine areas, brackish water lagoons and backwater with their marsh and mud flats should be conducted.

When such a survey is being conducted, the following should be used as guidelines.

Type of area

It is important to know and classify the area as either swampy, marshy or mangrove swamp and to know the distance from the sea, the approximate area available and whether enclosed or open. The amount of inflow of fresh water and rate of exchange with coastal tidal waters should be noted. Since organic detritus influence all major activities in estuarine communities, general characteristics of detritus in the area and information on sand and mud in collodial form should be known. The rainfall and freshwater discharge within the area can be obtained from the Meteorological Department and the National Irrigation Board of the Ministry of Agriculture.

Land regulation rights

It is important to gather information from forest authorities and land department officials on any legal procedures in the acquisition of land.

Tidal fluctuations

Soil elevation and tidal fluctuations are important factors in determining the suitability of an area for fish pond culture. If the area is not far from a port, tidal table for the port can be used for the area, and information received should be used to determine the extent to which the site under survey will get flooded by the tide during the year. Brackish-water ponds need to be filled to a minimum of 40 cm of water, but an ideal condition requires 90 cm to 120 cm of water depth.

Water characteristics

Characteristics of water, such as ranges of temperatures, turbidity, alkalinity, dissolved oxygen, nitrates, pH etc. need to be known as they directly or indirectly affect the fish.

Plantkton, vegetation and fish fauna

It is important to make quantitative study of major plants occuring in the area. This helps us know what to clear and what to leave. Fish fauna including prawns and crabs should be noted. It has been observed in the Philippines that some crabs make holes in dykes of fish farms. Fish like mullets feed on plankton, therefore, relative plankton abundance should be known in advance.

Collection of brackish water fish seed

On the basis of available information, stretches of the estuary under survey may be demarcated. The rivers and the canals in the neighbourhood of the site under survey should invariably be prospected for fish seed. In the stretches selected, a few collection centres are to be tried taking into consideration the accessibility during differential tidal phases, topography, transport facilities of the fry to the ponds, nature of the banks facilitating the operation of different nets. Tributaries and creeks harbour some of the most important brackish water fish seed. All brackish water fish species and prawns are not known to breed in confined waters, except *Etrophus suratensis*. Collection of fish seed from estuarine areas, which are under influence of strong tides is beset with many practical difficulties. For example, during flood tides, the collection may have to be restricted under conditions of sudden rise in water level and strong currents. In such a situation better results may be available during ebb currents. The operation should be made with nets after visual observations have been made to assess if collection is possible or not.

Materials and methods of collection

Many types of nets have been developed for collection of fry, but in this paper four types are described which are thought easy to operate.

Fyke net

The fyke net is recommended as the best for mullet frys. It is for shallow water and can be used in brackish water, narrow creeks and canals having moderate current.

Measurements:	Length	3.5 metres
	Diameter 1st ring	0.90 metres
	Diameter 2nd ring	0.70 metres
	Diameter 3rd ring	0.50 metres

Enclosure net

The enclosure net is made of cotton or nylon with 6.0 mm mesh, and when stretched total length should be from 1.5 to 2.0 metres or closely set bamboo splinters of 1.5 to 2.0 metres interwoven with string. This net is generally operated in places having large tidal amplitudes in undulating slopes and mud flats of the estuarine system at high tides and completely exposing the same areas at the receding phase of the tide. The length of the net vary according to the area to be enclosed. During the highest of the

high tides the net is fixed in position; first, vertical poles are fixed and the net or bamboo is attached to form a screen. During the low tide phase, water will gradually recede from the enclosure leaving the fry and fingerlings trapped to be collected by hand from the mud where they are stuck. When the water is receding a small meshed dragnet can be used because the fry are extremely sensitive to any slight physical damage.

Shooting net

The shooting net is a funnel-shaped woven netting which has a tail made of cloth at the end. This net is used in shallow margins of estuaries, creeks and cannals with the mouth facing the tidal current. It is advisable to use synthetic cloth or net for the tail into which fry collect because crabs will destroy the net in their effort to get the fry. The net is checked at intervals of 10 minutes.

Measurements:	Length	3.0 m
	Width of mouth	2.5 m
	Height of mouth	0.5 m
	Ring diameter	0.2 m

Dip net

Small dip nets of circular or triangular shape are successful in shallow waters. The net used should measure about 1 mm^2. A rectangular and circular net may be 40 cm by 80 cm, and have a diameter of 50 cm. This net can be operated at a frequence of 30 to 60 minutes during each tidal phase. The obtained fry and fingerlings are transported to the fish ponds for cultivation.

Economic feasibility of fish culture

In considering the feasibility of fish culture in the selected areas, all the information regarding location of the area, transport facilities, demand of brackish water fish in local and nearby major markets, biological data on fish fauna, fish seed etc., have to be considered during the planning of the brackish fish culture. The following factors need to be given serious consideration.

Capital expenditure

1. Coast of land/lease value/compensation etc.;
2. Forest/shrub clearing expenditure;
3. Coast of earthwork;
4. Coast of structures like sluices, sheds etc.;
5. Cost of preliminary investigations, contour, survey etc.;
6. Miscellaneous.

It has been estimated that about US$500 per hectare is required to clear an average swamp and US$2,000 per hectare of tidal land.

Recurring expenditure

1. Stocking;
2. Manuring;
3. Wages of staff;
4. Maintenances and upkeep;
5. Transport charges;
6. Miscellaneous.

Income

1. Sale of fish;
2. Sale of subsidiary crops.

The socio-economic situation of the region has to be looked at and the following factors among others should be considered:

1. Employment position of the local population;
2. Economic and social position of the fisherman in the community;
3. Number of labourers that could be made available for earthwork;
4. Possible effects that could be expected if the area under survey is converted into brackish water fish farm.

Fish seed supply is the main limiting factor in the progress of any country's marine fish pond industry. Great effort is required to provide necessary seeds for the industry. Fry collected throughout the coastline would most likely not be of adequate supply. Some other substitutes have to fill the gap, e.g., induced spawning could possibly succeed provided all necessary facilities are available. Experts in the field should be requested to collaborate in its establishment until the major objective is achieved. Unfortunately, hatchery techniques are not as developed as those for Pacific Salmon operated in the USA.

Aquaculture cannot be increased by merely starting new territories. It has one stumbling block for both the commercial developer and the subsistence farmer, the lack of sufficient fry. For example, to conserve the yellow tail, the Japanese government limited the number of juveniles taken from the sea to farms to 31 million a year; commercial shrimp and flat fish require 200 million post larvae and 25 million juvenile per year respectively to be economical. The existing milk–fish seed-collecting industry throughout southeast Asia involves the distribution of hundreds of fry each year.

In spite of difficulties encountered in this work, good yields have been obtained in various countries where fish culture is carried out. In the Indo-Pacific

region encouraging results of 450 to 500 kg/ha of milk-fish has been obtained. In China, this has been doubled by merely improving the design of the pond, controlling density of the stock and limiting competitions. In Taiwan carp and mullets were grown as secondary crop with eel as the primary crop. Production was very encouraging giving 8,000 kg/ha, while in Israel a mixture of carp, tilapia and grey mullet gave a yield of over 2,500 kg/ha. These results have shown that polyculture gives a better yield than monoculture.