How to Start a Fish Hatchery

Hatching and raising fish in various capacities, and for various reasons, is rapidly growing in popularity. One reason for the rising number of hatcheries is increased demand for finned foodstuffs, as more and more people recognize the benefits of a diet with lots of fish. Based on your personal interests and intentions, you can choose to grow fish for your own enjoyment or at the commercial level for sale in various markets.[1]

Part 1 Determining the Type and Purpose of Your Hatchery

1.

1

Determine the purpose of your hatchery. There are all sorts of different types of hatcheries that raise different types of fish for different purposes. In order to move forward on your intention to start a hatchery, there are some determinations you need to know up front. Most simply, know what type of fish you will raise – and why – in order to start setting up your hatchery or writing a business plan. In particular, consider the following, and have concrete answers to each before moving forward.

- What are you going to do with all the fish? Will you raise fish destined to be food, pets, or simply pond ornaments?
- Do you intend to take the backyard approach and build a custom fishing hole for you and your friends, or are you looking to build a business empire based on the for-profit production of the finest fish on the global market?

2

Decide what specific type of fish you want to raise. The type of fish you raise will be determined in part by the type of hatchery you hope to start. While the system you hope to build may influence your decision about what fish you will raise, there are several factors to consider about your options regarding the fish themselves.[2]

- Once you're leaning towards a certain type of fish, contact hatcheries that raise that type to see about the viability of going through with stocking your hatchery.
- Recognize that the costs associated with raising different types of fish will vary widely, for all sorts of reasons – including the amount of management different species require and the cost of the food they eat.

- Also consider the climate in which you will be operating your hatchery. Certain fish need certain temperature water to live in. If possible, you may want to avoid costs associated with heating or cooling water, which can be substantial.

3

Take the easy route with Tilapia. Tilapia are some of the easiest fish to raise, and are eaten around the world. As such, they are among the most profitable types of fish to raise. They are hardy enough to tolerate different water conditions, including low oxygen and high ammonia, and are even more resistant to illness than many other fish.[3]

- Tilapia need to be raised in water as close as possible to 84 degrees Fahrenheit (29 degrees Celsius). They will survive in water from 64-90 F (18-32 C), but will die if the water drops to 50 degrees.
- While there are many different types of tilapia, Bava, Blue, and Nile tilapia are the most appropriate for backyard and commercial hatcheries.

4

Catch yourself a catfish hatchery. Catfish are increasingly popular in people's cuisine, and they're some of the tougher fish there are in terms of resistance to disease and parasites. They also grow quite quickly. Channel catfish are one of the most popular – and profitable – choices for backyard farming, and there are several types to choose from.[4]

- Recommended water temperatures for raising catfish vary based on the season and age of the fish. A such, catfish are commonly raised in outdoor ponds.
- Specifically, channel catfish fingerlings need to be stocked when water temperatures are between 65-68 degrees Fahrenheit (18-20 C). As catfish, they will grow more quickly in water between 83-86 degrees Fahrenheit (28-30 C).[5]

5

Build a bass hatchery. Bass is unique in that many people actually prefer the taste of farmed bass to wild bass. Raising bass is most feasible in larger, well-circulated systems. Bass fingerlings, however, are more sensitive than

many other young fish, and require strict nutritional supply, gentle handling, and even particular amounts of light.[6]

- Raising bass may require extra holding tanks, as different sized individuals need to be stored separately.
- Bass prefer water as close as possible to 80 degrees Fahrenheit (27 degrees Celsius), but can survive in water ranging from 65-85 F (18-29 C).

6

Consider raising trout, salmon, or perch. Trout and salmon are especially popular for human consumption, but they require more specific conditions than the other fish mentioned in this article. When raised at sustainable, well-run operations, these types of fish can be reliably profitable options. Yellow perch is popular in some markets too, though perch does not have the global

popularity of trout and salmon. All three can grow to harvestable size in only one season.[7]

- Trout and salmon can be raised together, providing some variety in your production.
- Keep water in which you're raising trout and salmon between 55 and 60 F (13-16 C).
- If you're only raising trout, water can be a bit warmer, but monitor oxygen levels more closely.
- Rainbow and brook trout are particularly popular, as are coho and Atlantic salmon.

Get the necessary permits and licensing. Before beginning construction of a hatchery of any size or type, account for the law in your area. There are lots and lots of laws about raising animals, and even more about raising animals to be consumed as food. Further, the ways in which your hatchery may effect the surrounding land or water need to be addressed before you move forward with starting a hatchery.

- Depending on the type, size, and location of your hatchery, the paperwork will vary – but count on there being a lot of it.
- If planning to operate a production hatchery, you'll need to get a business license as well. Then there's the whole other side of the law – and a whole new stack of paperwork.

Grow a niche type of pet fish. One option for a hatchery that doesn't take up a lot of space is raising an aquarium fish for the fish-as-pet-or-decoration market. Rare types of fish that are popular amongst those who keep aquariums are usually not raised on high production equipment, and can be hatched indoors in a few small tanks and with far less equipment than needed for larger hatcheries.[8]

- Angelfish, for instance, can easily be raised on equipment that you can get altogether in a ready-to-use set.
- For different types of fish, you'll need different types of specific filters, tanks, and water-treating equipment, and fish food. For small aquariums, however, most of these will be available at specialty pet stores.
- Choose a breed of fish – such as angelfish – that are already commonly sold in pet stores, so you know you'll have demand for the glittery critters as soon as they're ready to find a home of their own.

Part 2

Developing a Business Plan for a Production Fishery

1.

1

Educate yourself about fish hatcheries. If you're not familiar with the industry, you'll need to acquire some first-hand experience before starting your own hatchery. Even if you do have some experience, owning and operating a hatchery of your own will require substantial knowledge of your specific operation and of the industry in general. If you only intend to own and oversee the business side of a hatchery, you still need to know enough to make business decisions and hire competent personnel to run your business.[9]

- Work at a running hatchery that's as similar as possible to the sort of hatchery you envision opening.
- Consult online resources and print publications, many of which are specific to certain styles of hatcheries or to raising certain types of fish.

- Take courses on fishery operations at a university or trade school. This is a good idea early on, as the broad, supplemental knowledge provided by a classroom course will help you make decisions about the type of hatchery you'd like to start.

2

Make a business plan. A solid business plan will be vital to acquire any necessary investment capital. Aside from a fair amount of commercial equipment, you'll also need the capital to get the business running and to pay employees to help you keep it running. Aside from luring investors, you'll need a business plan to help meet potential business partners, and to get loans.[10]

- Include a clear and specific feasibility report in your business plan. This should include thorough calculations of your initial expenses, operating costs, and anticipated profits for the first few years of business.
- Know that the anticipated costs of starting a hatchery depends entirely on the type of hatchery you wish to start. Though small backyard setup may cost as little as a few hundred dollars, a production facility will require thousands of dollars of investment in equipment alone.

3

Focus on the financial considerations. The capital and operating costs of starting a business – especially a production business – can wind up being far more than expected. Prepare yourself fully to have accurate expectations and to acquire a sufficient amount of initial capital. Carefully weigh both general

and specific considerations, and don’t forget to consider important factors aside from the specifics of the hatchery itself.[11]

- Ensure that there is sufficient demand in the market to meet the level of sales you need to be successful financially.
- Consider whether a hatchery is the best possible use of the specific real estate and capital you intend to use.
- Reflect honestly on whether you personally have the time and financial security to start a new business.

4

Forecast operating costs by having specific numbers ready for potential investors. Be ready to quote the anticipated costs of stocking your hatchery initially, fish food, electricity and other power, labor, water treatment

chemicals, insurance, taxes, and extraneous things like maintenance and transportation. Knowing as much as possible will ensure you make accurate estimates of both initial startup costs and operating costs.[12]

- Unforeseen costs can greatly hinder a new company, and the best way to prevent them is by knowing you've thought of everything.

5

Ensure you've considered all construction and equipment expenses. Make sure you've considered potentially expensive necessities in particular. For instance, even if you already have the land, think about what needs to be done to it. Will anything need to be dug or built? Further, what will hold the fish? All costs need to be accounted for – down to the safety equipment your staff will wear.[13]

- In a large scale production you'll need a tractor, ample storage space, and maybe even trucks.
- Have you accounted for all the piping that will connect tanks and ponds and water equipment?
- What about oxygen meters and other testing supplies?

6

Develop a specific marketing strategy. Though raising fish may not seem like a business endeavor that requires advertising, a marketing plan will greatly help get your business up and running. If there is an established market, how are you going to break into it? Will demand be consistent year-round? Consider where will be ideal for focused sales efforts.[14]

7

Round out your business plan with a healthy dose of risk assessment. Though unpleasant to think about, you have to account for the potential risks inherent to your business. One classic consideration is whether you could survive if you lost an entire crop of fish. You'll need the investment necessary to be able to do so, as losing an entire crop is a realistic possibility.[15]

- Develop a plan for a backup water source if your current source drops below an allowable quality threshold.
- Assess and address the risk for contamination by pesticides, metal, or anything else at the location in mind.
- Develop and maintain contacts for advice and information, even before you need it - particularly in terms of fish health.

Part 3

Farming Fish in your Backyard

1.

1

Dig your own pond. A small pond is one of the cheapest and easiest ways to start a small fish hatchery, for either personal use or local sales. Still, it will likely cost at least a few thousand dollars to get a pond-based hatchery up and running. Further, the size of your pond and the climate where you live will determine which fish will be most viable for you to raise.[16]

- Municipal water is often okay to fill an artificial pond, though pumping water from a natural body of water near your home may be preferable.

- Make sure that you are not violating any laws or regulations by manipulating any natural bodies of water or watersheds by checking with your local fish, wildlife and environmental regulatory agencies.
- In areas where ponds may freeze, you can pump and cycle water through an artificial heater to keep the pond warm and liquid-enough for fish to survive in. Cold climates, however, will substantially increase the cost of operation and the risk involved in running your hatchery.

2

Stock the pond according to its size. When stocking your pond with fingerlings, use the capacity of your pond to determine the number of fish it can safely hold. Depending on the type of fish you choose to raise, maintain the pond at a certain size and depth.[17]

- Take extreme care not to overcrowd the pond, as water quality and fish health can rapidly deteriorate in an overcrowded body of water.

3

Balance your pond to minimize the need for management. Aquatic plants are very helpful for multiple reasons. In an immediate sense, they provide cover for your fish during the day. Furthermore, plants help keep a pond ecologically balanced and will make a small pond a fish-raising haven with very little effort on your part.[18]

- Determine the types of plants to include in your pond based on the type of fish you plan to raise, as well the types of plants that grow naturally in ponds in your area.

4

Feed your pond fish depending on several factors. Another benefit of backyard pond hatcheries is that you can likely feed your fish less often, since your fish will be able to eat plants and insects. Even for rapid growth and a quick harvest, you'll only have to feed your fish once in a while.[19]

- Be careful not to over-feed your fish, as this may contribute to illnesses, more bacteria in the water, and decreased water quality overall.
- To determine whether your fish are in need of more food, observe their behavior when you add food to the water. If the fish go into a frenzy and eat all the food extremely quickly, start to feed them slightly more regularly.

5

Farm fish via cage culturing. If there is already a body of water present on land you have access to, you can likely set up a small fish hatchery with readily available materials. For instance, a cage can be built with plastic piping and netting, and then anchored to the edge of a body of water and used to culture fish.[20]

- Make sure the water you have access to is suitable for raising fish before deciding to start a hatchery in a natural body of water.
- Stock the cage with fingerlings and simply feed them until they are large enough to harvest.
- For a small cage culture, expect to pay for only cage materials, fingerlings, and food – which may cost as little as $100 altogether.

6

Build a flow-through hatchery. Divert a continuous source of cold water, such as a natural stream or river, into corridors that can contain fish while allowing them to swim in flowing water. You will likely need less water than you think – but the flow must remain constant. In the right location, flow-through hatcheries can be a relatively simple way to raise fish.[21]

- Be aware of additional regulations involved with diverting and benefiting from the use of natural resources. Contact local conservation authorities to discuss your plans.
- This is the method used to help many government-run conservation efforts. However, this method is harder to set up than many other options, is often not allowed, and is not as commercially viable as other options.

Part 4

Starting a Commercial Hatchery

1.

1

Scale up a pond-based hatchery. For larger-scale pond-based hatcheries, you will need several ponds, a good amount of land, and a substantial amount of additional equipment. Conceptualize scaling up a pond-based hatchery as the equivalent endeavor of going from having a garden to having a commercial farm – it will require a huge amount of planning, time and investment.

2.

2

Raise fish in tanks, containers, or tubs. One of the limitations of ponds is the amount to literal space they take up. While ponds offer a great method of raising fish in limited quantities, container-based fish hatcheries can handle a higher production capacity within a relatively limited amount of space.[22]

- Municipal water supplies are usually fine to fill tanks, though the water will likely need to be treated.
- Know that aquaponics systems come with far larger start-ups costs, a greater need for supplies and equipment, and a greater knowledge of commercial fish farming.

3

Install a pump and aeration equipment. Whatever the type of hatchery you intend to run – and especially for an aquaponics production hatchery – you'll need a pump to help you ensure that your fish always have sufficient fresh water. Similarly, the water in which your fish live will likely require a steady influx of oxygen provided by aeration equipment.[23]

- Pumps are also often necessary to cycle water from holding tanks to recycling pools or equipment that can clean the water and remove impurities.
- The more fish you're trying to raise, especially in an indoor hatchery, the more water cleaning and aeration equipment you'll need.

4

Figure out how you'll capture, handle, and grade your fish. For production fisheries, you'll need lots of equipment to deal with your product. In industry terms, you're going to need a seine. Seines are used to harvest fish, or collect them from the water. As you harvest the fish, you'll need to sort them by size. You'll also need a way to handle the fish and potentially a way to transport fish to buyers.[24]

- For larger scale hatcheries, you'll need reels and other equipment that can be used to drag large nets. You'll likely need a tractor and hoists to handle nets full of fish.
- As fish are graded, they will need to be moved to different holding tanks. You can also use counting equipment to keep track of your crop.

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HATCHERY MANAGEMENT TECHNIQUES IN MARINE FISH CULTURE DEVELOPMENT

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FI:DP/CPR/81/014
Field Document 1
May 1988

PEOPLE'S REPUBLIC OF CHINA

A report prepared for the project
Development of marine culture of fish

by

Pinij Kungvankij
Consultant (Hatchery Management)

This report was prepared during the course of the project identified on the title page. The conclusions and recommendations given in the report are those considered appropriate at the time of its preparation. They may be modified in the light of further knowledge gained at subsequent stages of the project.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 1988

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1. INTRODUCTION AND TERMS OF REFERENCE

The Government of the people's Republic of China, assisted by the United Nations Development Programme and the Food and Agriculture Organization of the United Nations, is engaged in the project Development of marine culture of fish

(CPR/31/014), whose main objectives are to develop the culture techniques including seed production of marine finfish in the coastal areas of China.

As part of the project operations, FAO assigned Mr Pinij Kungvankij as hatchery management consultant from 10 to 23 January 1988 and 29 January to 12 February 1983. The original terms of reference were as follows:

- follow up and ensure the proper culture of desirable food organisms (algae, rotifers, brine shrimps, etc.) required for hatchery operations, especially for grey mullet;
- acquire and ensure that a continuing supply of pure culture of the appropriate organisms (algae) is available for the station;
- follow up the mass culture of desirable hatchery food organisms and pursue training of project counterparts.
- ensure that the operations of the grey mullet hatchery are carried out properly;
- train counterparts in the different aspects of hatchery operations;
- coordinate his work closely with the other specialized consultants, in order to attain maximum efficiency in the management of the hatchery;
- prepare a report of his assignment with emphasis on the operation of the grey mullet hatchery.

2. DEVELOPMENT OF INFRASTRUCTURE AND FACILITIES

Although the existing hatchery and the support system for live organisms in Yantain are well developed, improvement is needed for the efficient implementation of the finfish programme, especially the mass seed production of marine finfish in the future.

Recommendations for improvement are outlined below:

a) Broodstock development tank

- Modifying one 660 m outdoor concrete tank at the seafront for holding the broodstock in addition to the existing cages.
- Dividing the tank into 4 equal compartments with polyethylene netting and wooden frame.
- Installing one unit of 4-inch diameter pump at the edge of the tank to facilitate daily water changes at 50–60% per day.
- Providing the tank with 1 unit of 2-inch air blower for water circulation and aeration.

b) Hatchery and nursery complex

The existing holding tanks in the hatchery are large (20–40 m^3) and deep (2 m), and are suitable for broodstock conditioning, gonadal maturation trials and spawning tanks. Outdoor concrete tanks are suitable for live food organism production.

It is essential to develop the 150 m unused land adjoining the existing hatchery into a larvae-rearing and nursing complex, which should consist of 20 units of 1 m^3, 20 units of 2 m^3 and 10 units of 4 m^3 fibreglass tanks for larval-rearing purposes.

The layout of the hatchery is shown in Figure 1.

c) Water intake system

Since the hatchery needs a large quantity of seawater, it should have its own pumping system.

Two types of water-intake systems are recommended:

- Pumping seawater directly from the sea.
- Pumping seawater through sump pit.

d) Water supply system

Although the seawater in front of the hatchery is very clear, filtered seawater is necessary for larviculture. The layout of the water system is shown in Figure 2. Unfiltered seawater will be used for the maturation and broodstock tanks and filtered seawater for larval-rearing.

3. LARVAL FEED DEVELOPMENT

One of the key factors to ensure success in marine finfish hatchery operations is the timely supply of the necessary food organisms in sufficient quantities. Ways of assuming continuous sources and mass production techniques are discussed below:.

3.1 CRITERIA FOR LARVAL FEED SELECTION

Feeds suitable for fish larvae are characterized as follows:

a. they should be accepted by the fish.
b. the feed should be of a size which can be eaten easily by the larvae.
c. the feed should have high dietary value especially in highly unsaturated fatty acids (HUFA), essential to the growth and survival of the larvae.
d. the feed should be easy to mass-produce in large quantities.

3.2 MOLLUSC LARVAE AS PRIMARY FEED FOR FISH LARVAE

3.2.1 Mollusc larvae

The larvae of certain molluscs are attractive as a first feed for brackishwater and marine fish larvae because of their availability and small size. The most commonly used are the trocophore larvae of oysters and mussels.

Trials were conducted on induced spawning of green mussels and scallops. Both mussels and scallops were spawned after temperature shock treatment which resulted in the mass production of mollusc larvae for marine fish larvae throughout winter.

3.2.2 Phytoplankton

Many culturists engaged in the mass production of brackishwater and marine fish larvae believe that the presence of phytoplankton in the rearing tanks is beneficial to the whole rearing procedure. Apart from serving as direct feed for fish larvae and zooplankton, phytoplankton probably plays a role in stabilizing the rearing environment through the removal of metabolites or the supplementation of necessary marine vitamins or amino acids in solution. Phytoplankton apparently acts as the "conditioner" of the rearing system.

Chlorella, Tetraselmis and Isochrysis culture techniques were introduced and discussed.

3.2.3 Rotifers

The rotifer, Brachionus plicatilis, is generally used as the first food for larvae which are too small to begin feeding on brine shrimp nauplii. Brachionus plicatilis is capable of satisfying the nutritional needs of many different species primarily because it provides the developing fish larvae with a wide range of food size (approximately from 30 to 300 mm), if allowed to reproduce in the rearing tanks. Rotifers could be easily mass-produced in hundreds of millions in the hatchery using cultures of unicellular algae as food. The particular species of algae used are carefully selected to ensure the correct biochemical composition of the rotifers before they are fed to the fish larvae. The nutritional quality of rotifers fed with marine Chlorella is believed to be much better than those fed with either freshwater Chlorella or baker's yeast (Watanabe et al., 1978).

Culture methods for mass-production of phytoplankton and Brachionus culture are detailed in the "Guide to the Production of Live Food Organisms" to be issued shortly as Field Document 2 to this project; and Field Document 3 is the "Guide to Marine Finfish Hatchery Management".

4. HATCHERY MANAGEMENT

4.1 BROODSTOCK

A sufficient supply of broodfish is essential for a successful induced breeding operation or artificial propagation. There are two sources of finfish broodstock: wild stock and those from ponds or cages. The disadvantages of wild stock is the uncertainty of capturing them, while the advantage of pond or cage reared broodstock is that they are already accustomed to culture conditions and consequently easier to develop into suitable broodfish.

4.2 SELECTION OF SUITABLE BROODSTOCK

Fish selected for broodstock should be fast-growing, active, and among the largest and strongest individuals of their age group, and free of parasites and disease.

4.3 BROODSTOCK MANAGEMENT

Gonad development is affected by nutrition (food) and environmental factors indicated below:

4.3.1 Nutrition

There is paucity of information on the nutritional requirement of broodstock and suitable practical diets. Standard practices for feeding broodstock are not well documented. At present, broodstock is fed following traditional or empirical lines. The formulated feed used are generally those commercially available as feed for rearing fish to marketable size.

Data accumulated to date indicate that poor nutrition can result in poor or negative reproductive performance and that lack of a vitamin supplement can affect sperm quality. Reliance on natural food may also lead to poor or variable reproductive performance. It has been shown that fatty acids, especially in the case of ovarian lipids, tend to utilize the highly unsaturated fatty acids.

4.3.2 Environment

- Photoperiod

One of the factors considered of great importance to the inducement of sexual matuation and spawning is photoperiod. Photoperiod manipulation is now being employed to alter the normal production of a cultured fish species, for example, mullet, rabbitfish, rainbow trout, tilapia, carp and catfish. The greatest advantage of altering the spawning time of the cultured species is the availability of fry for stocking in ponds, pens and cages throughout the year.

- Temperature

Water temperature is another important factor which influences the maturation and spawning of fish. Data accumulated to date show that the functional maturity in some species of fish is directly controlled by temperature; in others, the time of spawning is regulated by the day-length cycle, and occurs at the time when temperature is optimum for survival and food supply is adequate.

- Salinity

Some species of fish, e.g., salmon, migrate from the marine to the freshwater environment in order to spawn, while others, such as eels, migrate from freshwater to the marine environment to complete their reproductive cycle. This definitely shows that salinity is related to maturation and spawning. Salinity may influence gametogenesis but probably does not function as a synchronizer for the timing of maturation.

- Other environmental factors

Aside from photoperiod, temperature and salinity, other less obvious factors may affect the maturation and spawning of broodstock, such as rainfall, stress, sex ratios, stocking density, isolation from human disturbance, dissolved oxygen, social behaviour of fish, heavy metals, pesticides, and irradiation.

4.4 SPAWNING

At present, two major techniques are employed in the mass-production of marine finfish fry in Southeast Asian countries: artificial fertilization and induced spawning.

4.4.1 Artificial fertilization

Spawners are caught in natural spawning grounds near the mouth of rivers or in saltwater lakes. The degree of maturity of the collected spawners is immediately checked.

The dry method of fertilization is normally used. The eggs are stripped directly from the female into a dry and clean container where the milt is added. A feather is used to mix the milt and eggs for about 5 minutes. Filtered seawater is added to the mixture while stirring, and it is then allowed to stand undisturbed for 5 minutes.

The fertilized eggs are then transported to the hatchery for subsequent hatching.

4.4.2 Induced spawning by hormone injection

In induced spawning, the hormones used include the following:

> SPH - acetone dried pituitary gland homogenate of coho salmon prepared by the British Columbia Research Council, Vancouver, Canada; 1 g powder contains 17.6 mg gonadotropin.
>
> HCG - human chorionic gonadotropin, manufactured by Ayerst Laboratories, New York.

Before injection, HCG is dissolved in 3 ml of its accompanying diluent. The solution is then used to homogenize the acetone dried pituitary gland of salmon to be used for induced spawning.

Fishes with eggs of an average diameter equal to or more than 0.65 mm are induced to spawn by injecting hormones intramuscularly a few centimetres below the dorsal fin. In the first injection, the fish is given a combination of 10 mg SPH/kg body weight + 1 000–10 000 IU HCG/kg body weight. In the second injection, the fish is given a combination of 10 mg SPH/kg body weight + 2 000–20 000 IU HCG/kg body weight. Injections are administered intramuscularly a few centimetres below the dorsal fin after which the fish is completely anaesthetized by immersing it in seawater containing 100 ppm 2 - phenoxyethanol. The time-interval between injections is 24 hours for wild milkfish. This interval was selected to ensure that final maturation of eggs is completed before the fish dies or before the eyes of the breeders are completely covered with a white opaque substance.

Usually, only two injections are needed to induce both captive and wild adult fish to spawn, as long as the dosage and time-interval mentioned above are respected; however, badly injured fish may need a third injection. In such cases, the dose used in the third injection is that of the second injection. When a third injection is necessary, the fertilization and hatching rates are usually very low.

4.5 FERTILIZATION AND INCUBATION

The fish that are induced to spawn by hormone injection will be ready to spawn within 9–12 hours after the final injection. The schedule of injections for subsequent spawning must be synchronized with the natural spawning time of the fish which occurs in late evening between 18.00 and 24.00 h. On the other hand, with the stripping method, it is still necessary to extract the eggs from gonads by cannulation and examine them under microscope. The fish has spawned only if at least 40% of the eggs are transparent.

Stripping is always done by gently pressing the abdomen with the thumb and forefingers, beginning to apply pressure just foreward of the genital pore. The eggs are fertilized immediately after stripping, using the dry method, the milt being hand-stripped from the hormone-treated male.

The eggs and milt are mixed gently but thoroughly using turkey feathers. After at least 3 minutes, seawater (34 ppt) is added to the mixture while stirring it. After another 3 minutes, the fertilized eggs are transferred in a scoop net (mesh size = 500 micron) and washed thoroughly with seawater isohaline in the incubation tanks. The incubators are strongly aerated to prevent the eggs from sticking together. The eggs are incubated at ambient temperature ranging from 25° to 30°C and at a salinity of 34 ppt. Six hours after the start of incubation, dead eggs are removed from time to time by stopping the aeration for about 5 minutes. Fertilized eggs float in seawater with a salinity of at least 34 ppt while unfertilized eggs sink.

4.6 LARVAL REARING

Larvae of red seabream and black seabream were used to demonstrate the larval-rearing technique at the Centre.

The rearing tanks are made in plastic in a circular shape. Volume ranges from 1 to 10 m. The tanks are usually protected from sunshine and heavy rain.

Five hours before hatching, the developing eggs are transferred to larval-rearing tanks. The tanks are gently aerated. The larvae start to hatch 16–25 hours after fertilization, depending on the temperature and species. The usual stocking density of developing eggs is 100–200 eggs/litre.

Rearing environment

Good quality seawater at 30–31 ppt is required for larval-rearing. Water temperature is also important and should range from 26° to 28°C to promote fast growth of larvae.

Larva, tanks are prepared one or two days prior to the transfer of newly-hatched larvae. Filtered seawater is added to the tanks and very mild aeration is provided. After stocking, unicellular algae (Tetraselmis sp. or Chlorella spp.) are added to the tank and maintained at a density of 8–10 × 10 or 3–4 × 10 per ml for Tetraselmis sp. and Chlorella spp. respectively. These algae serve a dual purpose: as a direct food to the larvae and other rotifers and as a water conditioner in the rearing tank.

The day following stocking, the bottom of the larvae-rearing tank should be cleaned, and every day thereafter. This is done by siphoning off unfertilized eggs, faeces, dead larvae and uneaten food accumulating on the bottom of the tank. About 20% of the tank water is changed daily for the first 25 days of the rearing period, then increased to 40–60% per day for the remaining culture period. Since seabass can also be cultured in freshwater, it is recommended to reduce the salinity of the rearing water when the larva is still in the hatchery, before it is transferred to the freshwater environment. Beginning with the twentieth day, salinity can be reduced gradually until a freshwater condition is reached on the twenty-fifth day.

5. CONCLUSIONS

The problems and prospects of programme implementation are summarized below.

The existing facilities both in Yantain and Qidong Research Station, although in need of improvement, are sufficient to implement project activities.

The main problem at Yantain is an insufficient supply of spawners. In Qidong, water supply is the major difficulty, even though the hatchery is located close to the Yellow Sea (during low tide there is about 5 km of mudflats).

Although activities on seed production of mullet are still in the experimental stage, other results have been achieved, such as establishment of fish hatchery, culture of mullet, development of a functional core staff, up-dating and modernizing the techniques through the use of new equipment.

The staff of the centre lack practical experience in commercial-scale seed-production; most of them were trained abroad but mostly at an academic level.

The implementation of the project involved many consultants all of whom visited the centres on short-term assignments. Their various suggestions and recommendations could be confusing to the local staff.

6. RECOMMENDATIONS

Although the immediate objectives of the project have been achieved, technical assistance should be extended. Much work is needed in the second phase to achieve the mass seed production of marine fish; the technology involved should be adapted to suit local conditions and disseminated to the farmers through training.

However, for the benefit of the Chinese Government, and to fully utilize the equipment and manpower, the project should include studies on induced breeding of other economically important finfish species, since the spawning seasons differ from one species to auother. The assignment of an international expert to work full time in the field with the local staff would be useful.

Existing facilities, especially the hatchery and nursery system, should be further improved in order to facilitate the Centre's mass production of marine fish fry. The 150 m^2 unused land adjoining the existing hatchery should be developed into the nursing area to accommodate the fibreglass nursery tanks which have been ordered by FAO/UNDP.

The existing hatchery facilities will be used for maturation and spawning trials.

The 660 m^2 outdoor concrete tank at the seafront should be modified to maintain the broodstock including division of the tank into four equal compartments of polyethylene netting with wooden frame. The advantage of this tank is that the fish can be reared the whole year round without risking damage by the typhoons. Broodstock of economically important species is needed to stock the tank, one species per compartment.

An inter-disciplinary and team approach should be adopted to implement the project activities instead of having one person in charge of one species. Since there are many interdependent factors, a number of parameters should be simultaneously studied, in order to obtain a valid result and to fully utilize the available facilities and manpower.

Since the project is oriented towards production, study tours and training of local staff should be emphasized only in related fields. Staff will thus become informed of the status of the industry in other countries, advances in marine finfish culture in general and marine finfish seed production in particular.

To facilitate transport a project vehicle is essential.

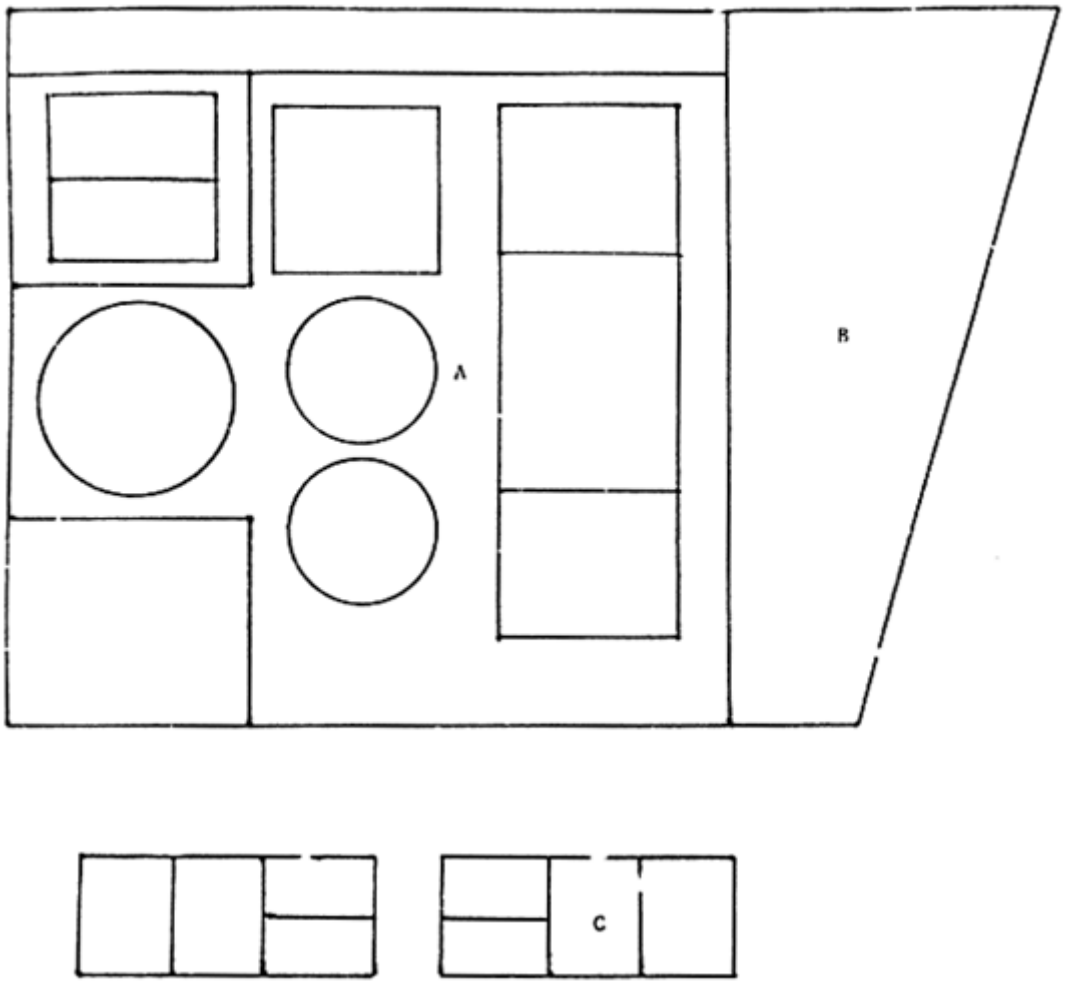

Fig. 1 Layout of hatchery

A. Existing hatchery
B. Recommended extending hatchery to accommodate the fibreglass tanks
C. Mass production of algae

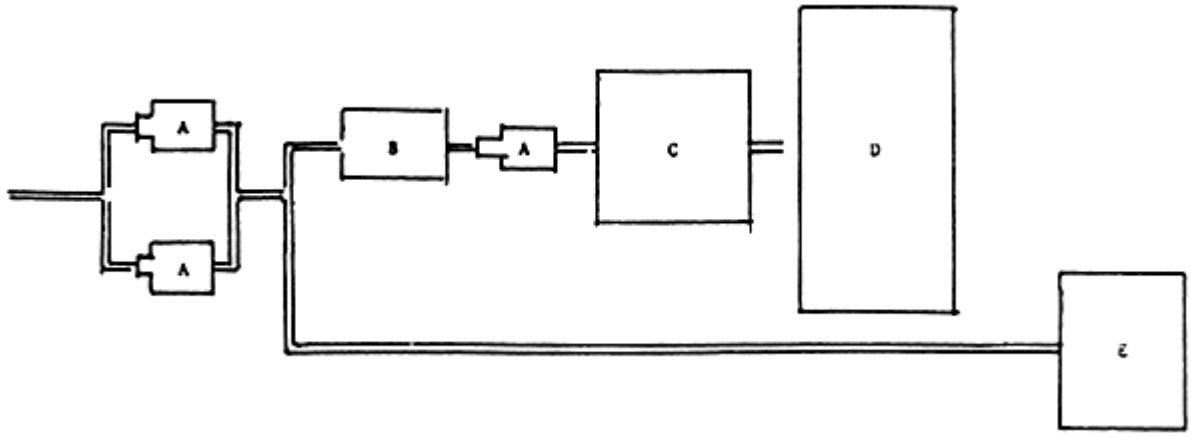

Fig. 2 Water system

A. Pump
B. Sand filter or pressure filter
C. Reservoir
D. Larvae rearing and algal culture tanks
E. Broodstock development tanks