Good Aquaculture Practices Series 3

Environmental Management of Pond Fish Culture

Aquaculture Fisheries Division

Agriculture, Fisheries and Conservation Department

INTRODUCTION

Maintaining a good pond fish culture environment is crucial for growing healthy fish, reducing morbidities and deaths, achieving satisfactory production and improving culture efficiency. It can also lower the cost of water quality conditioning and culture environment improvement measures (such as removal of pond sediment). It is imperative for fish farmers to have a thorough understanding of various human and natural factors which may affect the environment and fish stock during the course of pond fish culture so that good management measures, including adequate precautions, monitoring and contingency response, can be put in place.

1 Why is it necessary to maintain a good pond fish culture environment?

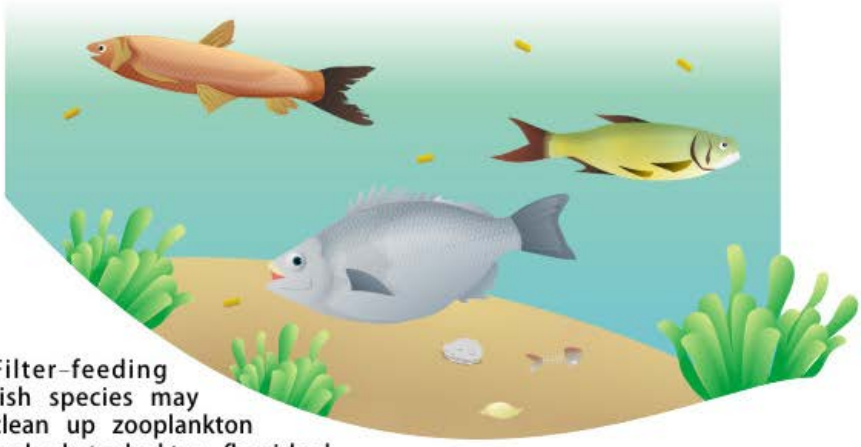
Freshwater pond fish culture has a long history. Traditional species under culture are cyprinids like grass carp, big head carp, silver carp, edible goldfish and common carp. These fishes have varied feeding habits and live in different water depths. For example:

Big head carps, found in middle to upper waters, filter feed on zooplankton and organic debris.

Silver carps, occuring in middle to upper waters, mainly filter feed on phytoplankton.

Grass carps, found in middle waters, feed on aquatic plants.

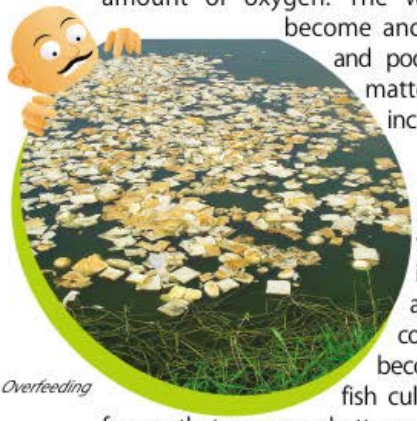
The omnivorous common carps and edible goldfish live in lower waters on pond beds and feed on organic debris, crustaceans and aquatic insects.



Filter-feeding fish species may clean up zooplankton and phytoplankton flourished by nutrients released from fertilisers, excessive fish feed and fish waste, whereas omnivorous species can consume organic matters like feed debris, dead fish and benthic organisms. Polyculture of these species in fish ponds ensures full utilisation of water space and effective use of fish feed and organic matters. Ecological balance in the water bodies is maintained as a result.

In addition to traditional pond fish culture species stated above, it is common for fish farmers in Hong Kong to stock other species like grey mullet and tilapia.

To enhance culture effectiveness, fish are fed with rice bran, flour, peanut cake or pellet feed. Poor fishpond management, such as over-stocking, over-feeding or improper disposal of dead fish, gives rise to large amount of organic matters in the water body environment. When filter-feeding or omnivorous fish and other benthic organisms in the pond fail to consume all these organic matters, they accumulate on the pond bed. Decomposition of organic matters by bacteria consumes a large amount of oxygen. The water body may become anoxic, resulting in fish deaths, reduced growth and poor resistance to diseases. Moreover, organic matters support propagation of bacteria which can increase the risk of morbidity and death.



Overfeeding

Since the fishpond is an enclosed water body, fish farmers can regulate water quality should it become unsatisfactory. However, this involves additional cost. If the culture environment continues to deteriorate, water quality may become so poor that it is no longer suitable for fish culture, and the pond has to be dredged more frequently to remove bottom sediment. Not only is it a costly exercise but operation of the fishpond will also be affected. To ensure sustainable and effective use of the fishpond, fish farmers should implement good management measures to mitigate pollution caused by fish culture activities.

2 Basic requirements of a good fishpond

To achieve good pond fish culture results, a fishpond should meet the following requirements:

2.1. Area A fishpond should not be smaller than 2,000 square metres (about 3 d.c.*). The actual size should be decided with reference to the species to be stocked so that water quality and stocking density can be well controlled. Cost effectiveness can also be achieved. *d.c. = dau chung, 1 d.c. = 674m²

2.2. Water depth Water should be 1.2 to 1.8 metres (4 to 6 feet) deep. Adequate water depth can reduce water temperature fluctuation and water quality can be easily maintained. If the pond is too deep, the lower waters may become anoxic and overturning is likely to occur.

2.3. Location It is best to position the fishpond in a place sheltered from wind. The advantage is to slow down temperature drop when there is strong wind during winter. Water temperature of a sheltered pond may remain one to two degrees higher than that of an exposed fishpond.

2.4. Drainage system

A fishpond (especially one located in lowland) must have a good drainage system to reduce the chance of flooding or river backflow during the rainy season.

2.5. Pond bottom

To minimise water loss, the pond bottom should be made up of a layer of clay with good water retention power. A sandy bottom is incapable of holding water. Water leaking out from the bottom of the pond makes frequent replenishment necessary.

2.6. Pond bunds

Pond bunds must be strong enough to prevent bund collapse due to rain, erosion or tidal force.

2.7. Soil pH

Acid soil makes pond water acidic. This is unsuitable for the growth of most algae and other organisms. As water turns acidic, balance of the pond's natural eco-system is upset. It is impossible for fish to grow healthily in such an adverse environment.

2.8. Water source

Pond fish culture requires a good and adequate water supply. Fishponds in Hong Kong mainly rely on the following water sources:

Rain

Rain is slightly acidic because of the dissolved carbon dioxide in the air. pH of rain water is generally about 5.6. When using rain as a water source for fishpond, it is important to adjust the pH balance as required.

As rain water supply varies with weather conditions, adequate reserve is essential. Reserve water supply must be in place to cater for droughts or when pond water quality turns bad. It is also vital to identify a backup water source, such as a stream or a well, in advance as an emergency measure.

Stream Check the quality of stream water. It should be clear and odourless. Never pump water from a waterway that is overgrown with algae or contaminated by domestic, livestock or industrial sewage.

Well Well water is usually lower in temperature and dissolved oxygen content. This condition easily results in deaths of fish from anoxia. It is important to measure the temperature and dissolved oxygen content before pumping the well water to a pond. After filling the pond with water, it may be necessary to use an aerator to bring up the dissolved oxygen level and balance the water temperature.

Seawater

It is common for coastal fishponds to pump seawater to culture brackish water fish species. Fish farmers should take seawater at high tide when water quality is better, and avoid taking water that is turbid or contaminated by oil or red tide. If necessary, use a settlement tank or simple filtering system to purify seawater before pumping it into the pond.

Rainfall or stream flow may change the salinity of coastal seawater. To avoid filling the pond with seawater that is significantly different in salinity, it is advisable to measure the salinity of both the seawater and pond water beforehand. As a general rule, **overall change in salinity of pond water should not exceed 5 per thousand after seawater is introduced.**

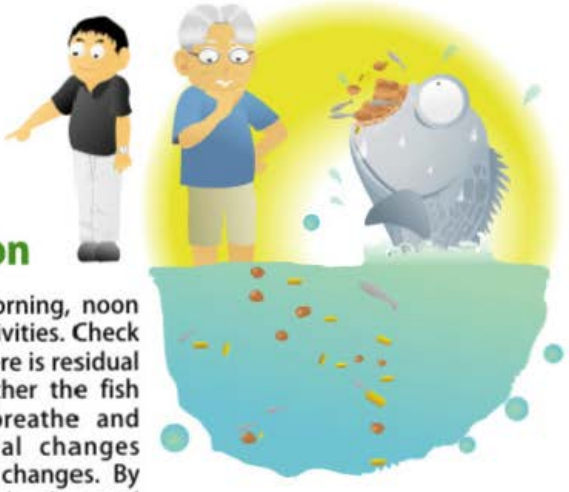
Fishpond water

Sometimes water sources are not readily available and it may be necessary to pump water from one fishpond to another for water change or replenishment. Under such circumstances, one must ensure the water from the source pond is of good quality. If water quality has deteriorated, or sick or dead fish are found, do not pump water from that pond.

3 Good pond fish culture practices

There are ten good pond fish culture practices. Their importance and related management measures are explained below :

- **Regular inspection**
- **Strengthened water quality management**
- **Good feeding management measures**
- **Proper disposal of dead fish and garbage**
- **Proper use of feed additives and drugs**
- **Regular disinfection of culture gear**
- **Quarantine for newly stocked fish/fry**
- **Isolation/proper treatment of sick fish**
- **Regular monitoring of water quality and fish health**
- **Maintenance of farm management records**



3.1 Regular inspection

Conduct inspection every morning, noon and evening to check fish activities. Check the fish appetite, whether there is residual fish feed in the pond, whether the fish come to the surface to breathe and whether there are unusual changes caused by sudden weather changes. By keeping watch, problems can be detected early and prompt remedial actions can be taken.

3.2 Strengthened water quality management

Water quality has a direct impact on the survival, growth and yield of pond fish. In an overstocking environment, organic matters such as residual fish feed, fish waste and algae often affect water quality. It is therefore necessary to monitor pond water quality closely, take appropriate measures to prevent water quality deterioration and solve any problems promptly.

The following are some important factors affecting water quality and their mitigation measures:

Colour

- Under normal circumstances, a fishpond should be light green (pea green) in colour.
- Large amounts of organic matters like residual fish feed and fish waste will turn into nutrients and support proliferation of algae, turning the water into dark green, bright green or rust colour. Pond water colour change is an indication of deteriorating water quality.
- Blue-green algae will add a muddy taste to the fish stock apart from turning pond water into a bright green or rust colour.

Mitigation measures

If water colour is too dark, reduce the quantity of feed, change water and remove the algae from the pond.

Transparency

- Transparency is about 30 cm (1 ft).
- A very transparent pond indicates water quality abnormalities, e.g. low nutrient level or high acidity, making algae unable to survive.
- Without algae to produce oxygen, the dissolved oxygen level of the pond will drop.

Mitigation measures

Apply an appropriate amount of fertiliser or use lime to neutralise acidity.

Suspended solids

- Suspended solids should be less than 50mg/L.
- When flooding occurs after heavy rain, fishpond may be affected by backflow of muddy stream water.
- If the pump inlet is placed too close to the stream bed or stream water is loaded with sand and silt, it is likely to take in turbid stream water to the pond.

- If water is visually turbid or muddy yellow in colour, observe the fish behaviour.
- A high concentration of suspended solids prevents the fish from breathing normally and reduces sunlight penetration. It also affects algal photosynthesis resulting in a lower dissolved oxygen level in water.

Mitigation measures

- Stop pumping water from the stream, change the pond water and apply fish feed sparingly.

pH

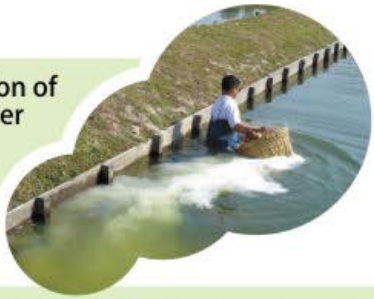
- pH level of fishpond water should be between 6 and 8.5.
- Use a litmus paper or pH meter (pH tester) to measure.

Acidic pond water

- Inherent soil acidity may turn the pond water acidic.
- Rain itself is slightly acidic. Pond water will become more acidic after heavy rain.
- The decomposition process of organic matters like residual fish feed, fish waste and algae makes the water acidic.
- Metabolism of fish slows down in acidic water (below pH 6). They appear sluggish. Their feeding and digestive ability are weakened and their growth is inhibited.
- Acidic water lowers fish blood's pH value and oxygen carrying capacity. When pH value drops to 4 or below, deaths may occur.

Sprinkling lime

- Acidity in soil or water or accumulation of organic matters may make pond water acidic. Use lime as a neutraliser.



- After draining and sun drying the fishpond, sprinkle an adequate amount of lime on the edges before filling water. If necessary, put lime directly into the pond and then measure the water pH. Make appropriate adjustment to avoid excessively high acidity or alkalinity.

High alkalinity

- Large quantities of algae will be proliferated, pond water will be over-saturated with oxygen and alkalinity will go up accordingly.
- Newly-built cement fishponds or excessive use of lime in pond after removal of bottom sediment will increase water alkalinity.
- Alkaline water (over pH 8.5) can corrode gill tissues of fish.
- Highly alkaline water will transform non-toxic ammonium salt in the water into toxic ammonia which is harmful to fish.
- Fish die at pH 10 or above.

Mitigation measures

- Stop feeding and use lime to neutralise water.

Dissolved oxygen level

- For good water quality, maintain the dissolved oxygen level at above 4mg/L.
- Measure dissolved oxygen level with a dissolved oxygen meter or reagent test kit.
- When stocking density is too high, the dissolved oxygen may not be sufficient to provide for all the fish. Anoxia is likely to occur.
- When it is cloudy or sunlight is weak, the process of photosynthesis is jeopardised and oxygen production is reduced.
- Excessive organic matters are converted into nutrients. They enable proliferation of algae which consume oxygen in the water during the night or when they die in massive quantities.
- When there is a sudden drop in temperature or when cold rain water falls into the fishpond, surface water will sink to the bottom as its gravity increases. This causes rapid convection of upper and lower waters. When anoxic lower waters move up, the whole water body will become anoxic. This condition is known as "overturning".
- When water is seriously anoxic, fish will come to the surface to breathe with their mouths. In severe cases, fish will die.
- Fish feeding activity will drop when dissolved oxygen of water is low. With a low assimilation rate, fish growth will slow down accordingly.

Mitigation measures

- Closely monitor the weather conditions and record dissolved oxygen levels. Apply aeration, stop feeding and reduce stocking density. Change the water and remove sediment from the pond bottom.
- After sunset, the algae stop their photosynthetic process and compete with cultured fish for oxygen. An aerator should be operated from noon to bring oxygen rich waters to the bottom. The aerator should run until sunrise the next day.
- Measure dissolved oxygen levels in the morning and evening every day.
- If water quality appears to have changed or when there is sudden weather change or extended cloudy weather, measure the dissolved oxygen of pond water immediately.

Sprinkle aerator

Wheel aerator

Ammonia NH_3

- Ammonia level should be lower than 0.1mg/L. Reagent test kit can be used to test the content of ammonia in pond water.

NH_3 test kit

- Organic matters generate AMMONIUM SALT, NITRITE and NITRATE when they decompose. In highly alkaline water, non-toxic ammonium will turn into ammonia which is toxic to fish.
- High level of ammonia will cause intoxication of fish. The intoxicated fish appear sluggish. Fish appetite and physiological functions are adversely affected. In serious cases, the fish will die.

Mitigation measures

Apply aeration, stop feeding and reduce stocking density. Change the water and remove sediment from the pond bottom.

Nitrite NO_2

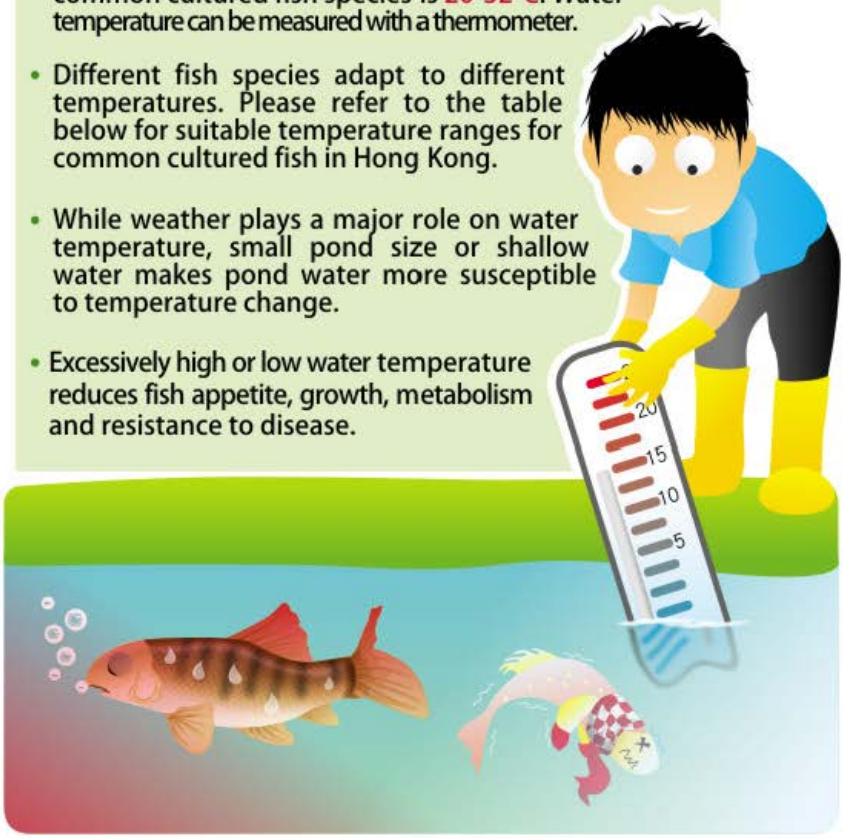
- The nitrite content should be lower than 0.2mg/L. Reagent test kit can be used to test the nitrite content in pond water.
- Organic matters generate ammonium salt, NO_2 and NO_3 when they decompose. Amongst these, nitrite will cause poisoning to fish.
- High nitrite content will cause intoxication of fish. The intoxicated fish appear sluggish. Fish appetite and physiological functions are adversely affected. In serious cases, the fish will die.

Mitigation measures

Apply aeration, stop feeding and reduce stocking density. Change the water and remove sediment from the pond bottom.

Water temperature

- The suitable water temperature range for Hong Kong's common cultured fish species is 20-32°C. Water temperature can be measured with a thermometer.
- Different fish species adapt to different temperatures. Please refer to the table below for suitable temperature ranges for common cultured fish in Hong Kong.
- While weather plays a major role on water temperature, small pond size or shallow water makes pond water more susceptible to temperature change.
- Excessively high or low water temperature reduces fish appetite, growth, metabolism and resistance to disease.



Mitigation measures

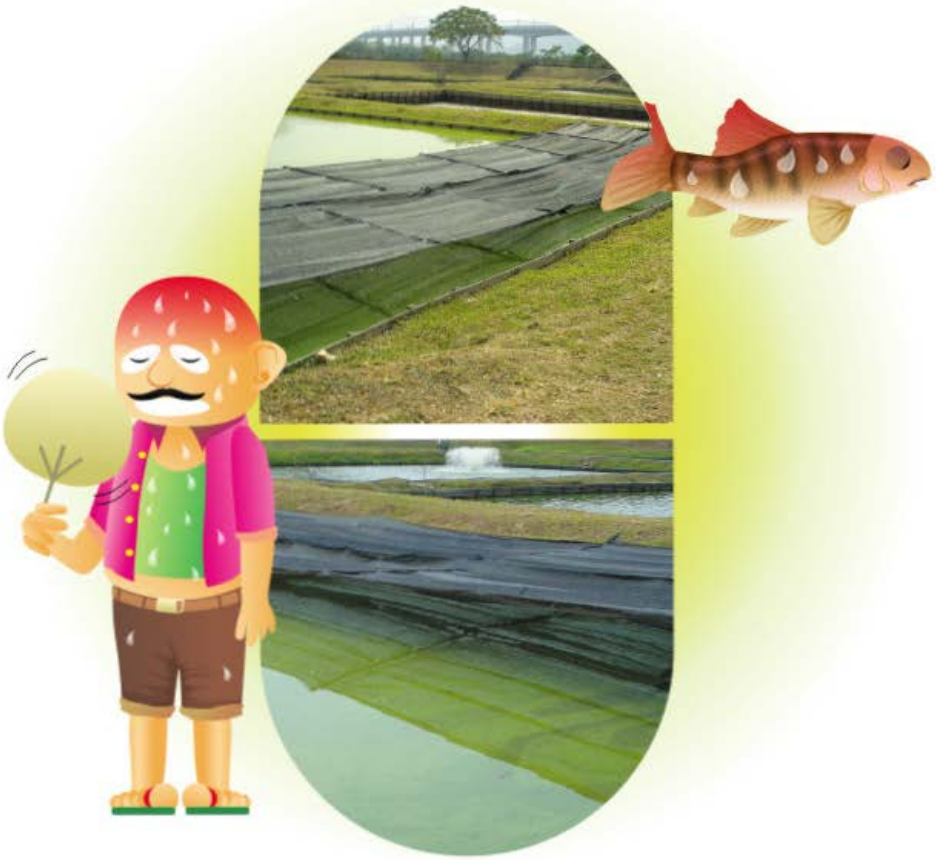
Feed sparingly, add sun screens to reduce direct sunlight and select fish species which can adapt to the local climate. When water temperature is too low, move the fish less frequently and avoid fish transferring or drug bathing. Depending on the temperature tolerance of fish species being cultured, harvest before winter or before water temperature drops whenever possible.

Suitable temperature ranges for cultured pond fish in Hong Kong

	Species	Temperature for growth Lowest(°C)	Highest(°C)
	Big head carp	22	28
	Grass carp	25	32
	Common carp	15	30
	Edible gold fish	16	25
	Tilapia	18	35
	Grey mullet	15	24
	Sea bass	20	27
	Catfish	20	30
	Spotted snakehead	16	32
	Red drum	12	30
	Large mouth bass	20	30
	Scat	20	28
	Giant grouper	20	30
	Jade Perch	22	28

Sun screen - Device against high water temperature

In summer months when temperature is high and sunlight is strong, erect a lightweight nylon screen above the fishpond to reduce exposure to sunlight. This measure can reduce the fishpond temperature by one to two degrees and prevent proliferation of algae.



Wind shelter - Device against low water temperature

It is best to position the fishpond in a place sheltered from wind. This can slow down the dropping of water temperature when there is strong wind during winter.

If the fishpond is exposed to wind, erect a sturdy wind shelter along the wind facing side to shield off strong wind blowing directly across the pond. This measure can reduce heat loss from pond water and make the water temperature one/two degrees higher than that of a fishpond exposed to wind.

Aging fishponds

- One or two years after the fish culture activities, fishponds begin to age and water quality may deterioate. Organic matters such as fish waste and residual fish feed will be deposited in the pond bottom, producing harmful substances including hydrogen sulphide and ammonia as well as harmful microbes and pathogens.

- Excessive organic matters are also converted into algal nutrients that promote algal growth. These algae consume oxygen in the water during the night and when they die in mass quantities. Fish are deprived of oxygen as a result.

Mitigation measures

- Drain the pond after harvest to remove bottom sediment and organic matters. After sun drying, sprinkle lime to neutralise soil acidity and eliminate pathogens.

Pond bulldozer

- This machine can level the pond bottom quickly, remove sediment, repair and reinforce the pond bunds. Fishponds are usually drained and cleared in winter when rain is scarce and fish growth is insignificant. The bulldozers are also used for cleaning the pond after fish stocks are sold or transferred to another pond.

3.3 Good feeding management measures

Proper feeding can prevent the presence of excessive organic matters in the water body and in turn mitigate problems like low dissolved oxygen level and bacterial growth.

Management measures

- Use dry pellet feed to reduce the content of organic matters in water.
- Apply feed in phases and in appropriate quantities. If fish are not eating, stop feeding to avoid water pollution by residual fish feed.
- Read the "Good Aquaculture Practices Series 1 Fish Feed Management" booklet to learn more about dry pellet feed and fish feed management measures.

3.4 Proper disposal of dead fish and garbage

To protect the pond from excessive organic matters and pathogens, it is important to dispose of fish carcasses and rubbish properly. It will also mitigate problems like low dissolved oxygen level and bacterial growth.

Management measures

- To avoid water contamination and spreading of germs, remove all rubbish, residual feed and fish carcasses on the water surface and put them in a rubbish bin with lid.

- Dead fish should be collected immediately and put in a garbage bag for delivery to the nearest refuse collection point.

- In the event of massive fish kill, seek assistance from the Agriculture, Fisheries and Conservation Department (AFCD).

3.5 Regular disinfection of culture gear

Culture gear which has come into contact with sick fish or new fry may be contaminated by pathogens. Regular disinfection of gear can keep the pathogens from entering the water body and prevent cross-infection of fish under culture.

Management measures

- Disinfect gear thoroughly and regularly by bleaching, steaming and drying them under strong sunlight.

- Read the "Good Aquaculture Practices Series 4 Prevention and Treatment of Fish Diseases" booklet to learn more about disinfection methods and solutions for minimising pathogens in water bodies.

3.6 Quarantine for newly stocked fish/fry

Introducing new adult fish or fry to a new environment may result in pathogenic contamination. It is essential to quarantine these fish to avoid large scale disease outbreak.

Management measures

- New adult fish and fry should be isolated for a few days to observe their health condition. If abnormal behaviour or infection symptoms are detected, isolate and disinfect immediately.

- Read the "Good Aquaculture Practices Series 4 Prevention and Treatment of Fish Diseases" and "Good Aquaculture Practices Series 5 Fry Health Management" booklets to learn more about isolation and quarantine.

3.7 Isolation/proper treatment of sick fish

To avoid spread of disease, fish affected by disease should be isolated promptly for proper treatment.

Management measures

- Any fish found infected must be isolated immediately for proper treatment.

- Use fish drugs prescribed by the AFCD or a registered veterinarian.

- Read the "Good Aquaculture Practices Series 4 Prevention and Treatment of Fish Diseases" and "Good Aquaculture Practices Series 5 Fry Health Management" booklets to learn more about isolation and quarantine.

3.8 Proper use of feed additives and drugs

Excessive use of feed additives or drugs will lead to problems like increasing organic matters in water, excessive fish drug residues, drug resistance in bacteria, and wastage. It has adverse impacts on both the environment and the health of fish.

Management measures

- Apply feed additives and drugs as instructed by the veterinarian.

- Read the "Good Aquaculture Practices Series 4 Prevention and Treatment of Fish Diseases" booklet to learn more about correct application of fish drugs and additives.

3.9 Regular monitoring of water quality and fish health

As precautionary measures, water quality and fish health monitoring help to detect disease at an early stage and reveal the cause of heavy mortalities so that appropriate treatment can be given. By monitoring fish health, fish farmers can determine whether a disease is caused by pathogens. Water quality monitoring, on the other hand, helps understand if the fish disease is related to any human factors or changes in the natural environment.

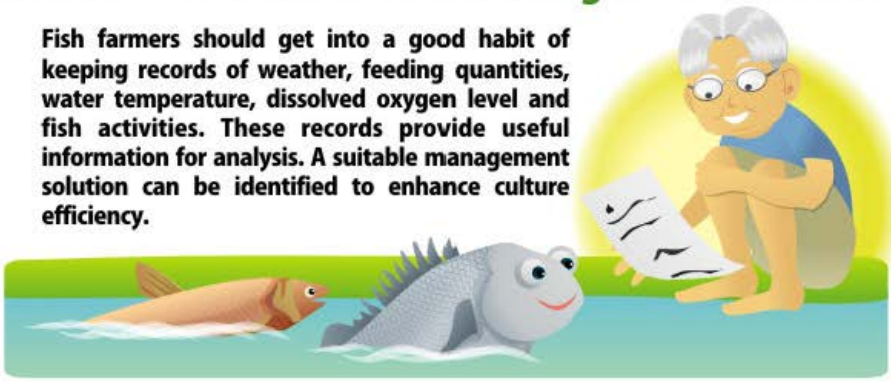
Monitoring fish health

- Carry out a simple health check on the fish every day. See if the fish are reducing feed intake or showing abnormal swimming habits. Check the body surface, fins and gills for parasites or disease symptoms.

- Read the "Good Aquaculture Practices Series 4 Prevention and Treatment of Fish Diseases" booklet to learn more about health checks.

3.10 Maintenance of farm management records

Fish farmers should get into a good habit of keeping records of weather, feeding quantities, water temperature, dissolved oxygen level and fish activities. These records provide useful information for analysis. A suitable management solution can be identified to enhance culture efficiency.



3.11 The AFCD Accredited Fish Farm Scheme and good aquaculture practices

The AFCD's ongoing Accredited Fish Farm Scheme is aimed at helping local fish farmers to improve fish farm management and production. The goal is to satisfy public demand and expand the market for the local aquaculture industry by offering quality aquaculture products that meet food safety standards. The scheme also helps fish farmers to achieve greater economic rewards. Any fish farm meeting the management criteria can apply for the status of an "accredited fish farm". For details please call our Aquaculture Fisheries Division.

4 Conclusion

How to mitigate impacts of changes in culture environment on fish activities:

- Avoid over-stocking.
- Inspect fishpond regularly to observe fish behaviour.
- Use dry pellets. Avoid feeding too much and too fast. Observe how the fish feed and stop feeding when required.
- Floating fish carcasses and rubbish should be removed immediately and placed in plastic bags for proper disposal.
- Use feed additives and drugs properly as prescribed by the registered veterinarian.
- Disinfect and dry culture gear under sunlight regularly.
- Quarantine newly acquired adult fish and fry. Isolate the fish stock for observation.
- Isolate fish affected by disease and give suitable treatment, such as drug bath.
- Observe fish behaviour. Fish with abnormal behaviour or suspected disease should be isolated from healthy stocks as soon as possible and given suitable treatments.

- Monitor and record dissolved oxygen level, water temperature, etc. daily with devices like dissolved oxygen meters, pH meters and thermometers.
- Observe weather conditions and turn on the aerator promptly if required.
- Observe changes in water temperature and weather as these may cause disease or fish kill.

When all measures fail, seek assistance from the AFCD promptly **(Pond Fish : 2471 9142)**

Technical Support

Fish farmers are welcome to telephone the AFCD for free information and technical advice:

General Aquaculture Information : 2471 9142 (pond fish) / 2150 7083 (marine fish)
Fish Health and Disease : 2471 9142 (pond fish) / 2150 7083 (marine fish)
Red Tide and Water Quality : 2150 7124

For further details of environment management of pond fish culture, contact the Aquaculture Fisheries Division of AFCD on 2471 9142 or email us at mailbox@afcd.gov.hk

June 2009