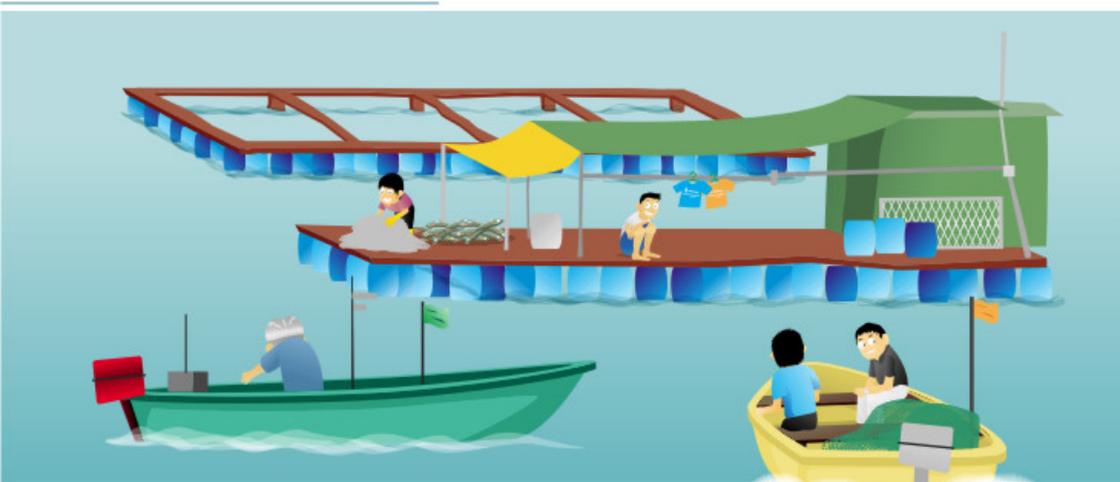




# Environmental Management of Mariculture





## INTRODUCTION

Maintaining a good mariculture environment is the key to ensuring sustainable utilisation of fish culture zones and successful rearing of healthy and high quality adult fish. Marine fish farmers must therefore thoroughly understand the impacts of fish culture activities and natural factors on the culture environment and fish stock. They must also put in place good management measures to reduce diseases and kills, and to mitigate pollution of the aquaculture environment.

Good mariculture practices include adequate precautions, monitoring and contingency response. The prime objective is to regulate disadvantageous conditions like increasing organic matters, low dissolved oxygen level and high bacterial content in the water body.

# 1

## Why is it important to maintain a good mariculture environment?

**Maintaining a good mariculture environment is the key to ensuring sustainable use of fish culture zones and successful rearing of healthy and high quality adult fish. Marine fish farmers must therefore thoroughly understand the impacts of fish culture activities and natural factors on the culture environment and fish stock. The following example shows the consequences of poor culture environment management :**

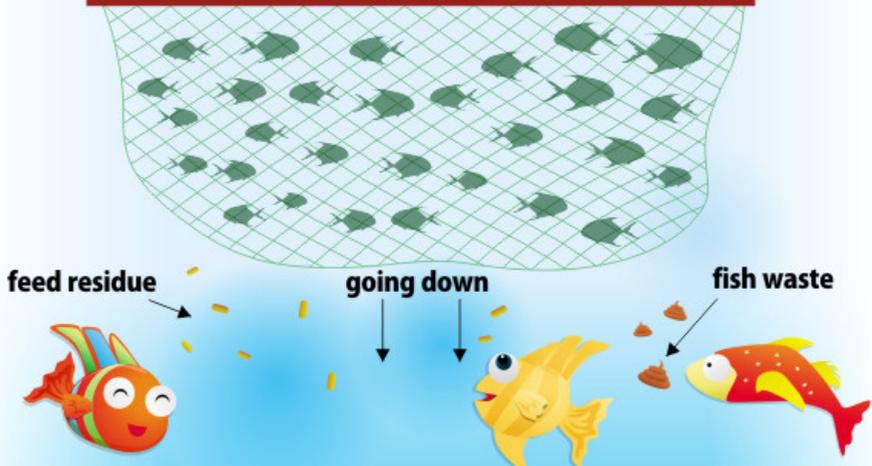
A healthy seabed is an effective buffer zone which is crucial in keeping satisfactory water quality. Fish culturing activities produce organic waste like residual fish feed, fish waste and fish carcasses.

Under normal conditions, feed coming out from fish rafts is largely consumed by wild fish, while any remaining residual feed and organic waste are either consumed by benthic species like crabs, snails, polychaete annelids or slowly decomposed by bacteria when they reach the seabed. A negligible amount of organic matters will flow out of the culture zones with tides and currents.



## Balanced Condition

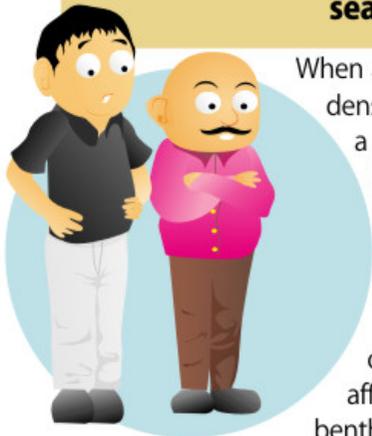
### fish raft



### layer of organic matters

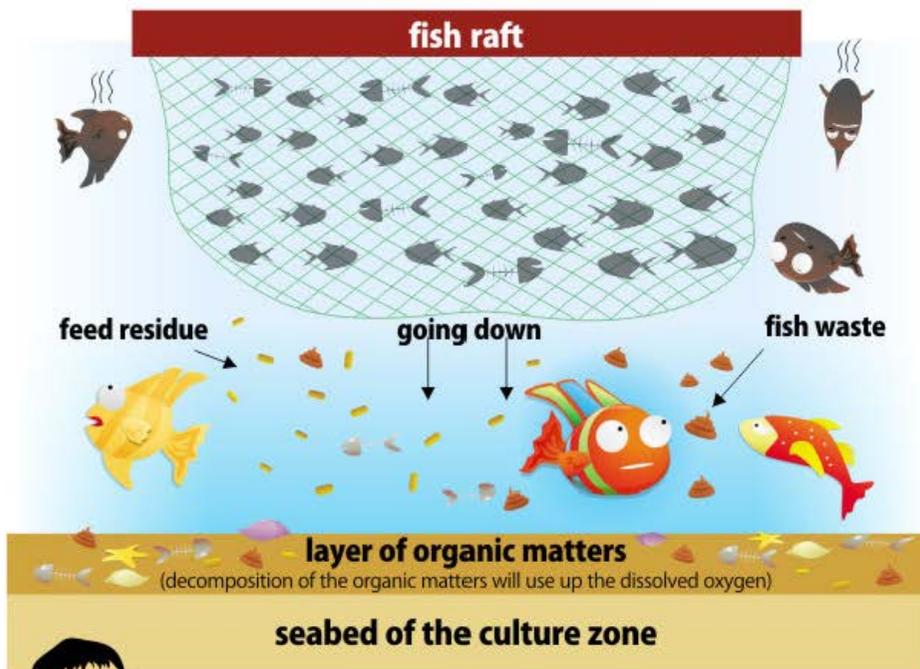
(decomposition of the organic matters will use up the dissolved oxygen)

### seabed of the culture zone



When a marine fish farm is poorly managed - such as over-density, over-feeding or improper disposal of dead fish - a significant amount of organic matters would be introduced to the water body. Given that excessive organic matters are not completely consumed by other marine organisms, and the natural decomposition process is slow, they begin to settle on the seabed of the fish culture zone. As the load of organic matters increases, the water body may be affected by problems like turbidity, anoxia, death of benthic species and bacterial growth. Risks of fish disease and kill are heightened.

## Imbalanced Condition



We can see from the above example that poor environmental management can ultimately affect a marine fish farmer's harvest, while continued deterioration of the culture environment can ultimately make the water quality of a fish culture zone unsuitable for culture, thus destroying his livelihood. Therefore it pays to carry out good practices to reduce potential environmental impacts on fish culture activities and ensure sustainable utilisation of fish culture zones. Good culture practices should be three-thronged, covering prevention, monitoring and contingency response. The prime objective is to regulate any material changes of water environment (i.e. increasing organic matters, low dissolved oxygen level and high bacterial content) caused by fish culture activities.

## 2

## Good mariculture practices

**There are ten good mariculture practices. Their importance and related management measures are explained below :**

- **Maintain appropriate stocking density**
- **Remove fouling organisms on the fish cages regularly**
- **Good feeding management measures**
- **Proper disposal of dead fish and garbage**
- **Regular disinfection of culture gear**
- **Quarantine for newly stocked fish/fry**
- **Isolation/proper treatment of sick fish**
- **Proper use of feed additives and drugs**
- **Regular monitoring of water quality and fish health**
- **Maintenance of farm management records**



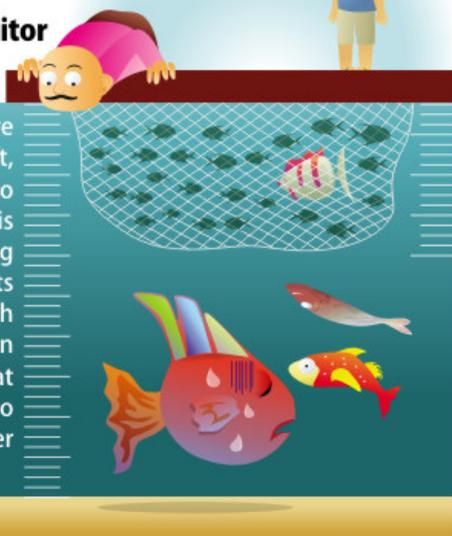
## 2.1 Maintain appropriate culture density

As fish grow, they need more space for movement. Since the space in a net cage is limited, it is necessary to make adjustment according to the size or weight of fish stock. Failing this will weaken the immunity of fish and result in higher risk of injury caused by fish knocking against each other as well as bacterial, viral or parasitic infection. Another risk associated with high stocking density is that dissolved oxygen may be insufficient to sustain the entire stock. This is particularly common when water level is too low and water current is poorly exchanged or stagnant. The fish stock may suffer from anoxia. Moreover, fish waste may also encourage growth of bacteria.



### Why is it necessary to monitor the water level?

Sea water levels in fish culture zones vary from 10 ft to 50 ft, and most fish nets are set 8 ft to 15 ft deep. If your culture zone is in a shallow area, avoid setting net cages of marine fish rafts too deep or they would touch the seabed. Dissolved oxygen level is comparatively lower at sea bottom. Fish cultured too close to the seabed may suffer from anoxia.



### Why is it necessary to monitor tidal movements?

Exchange of currents/water bodies in fish culture zones is mostly supported by the natural ebb and flow of tides. Tides in Hong Kong are mixed and mainly semi-diurnal. For most part of a month, there are two high tides and two low tides per day. The tide range is particularly large during the new moon or the full moon. This period is called spring tide, which represents the best dissolved oxygen exchange. In the first and last quarters of a month, the tide range is very small. This period is known as neap tide, during which there may be only one high tide and one low tide daily with dissolved oxygen exchange of seawater being relatively slow.



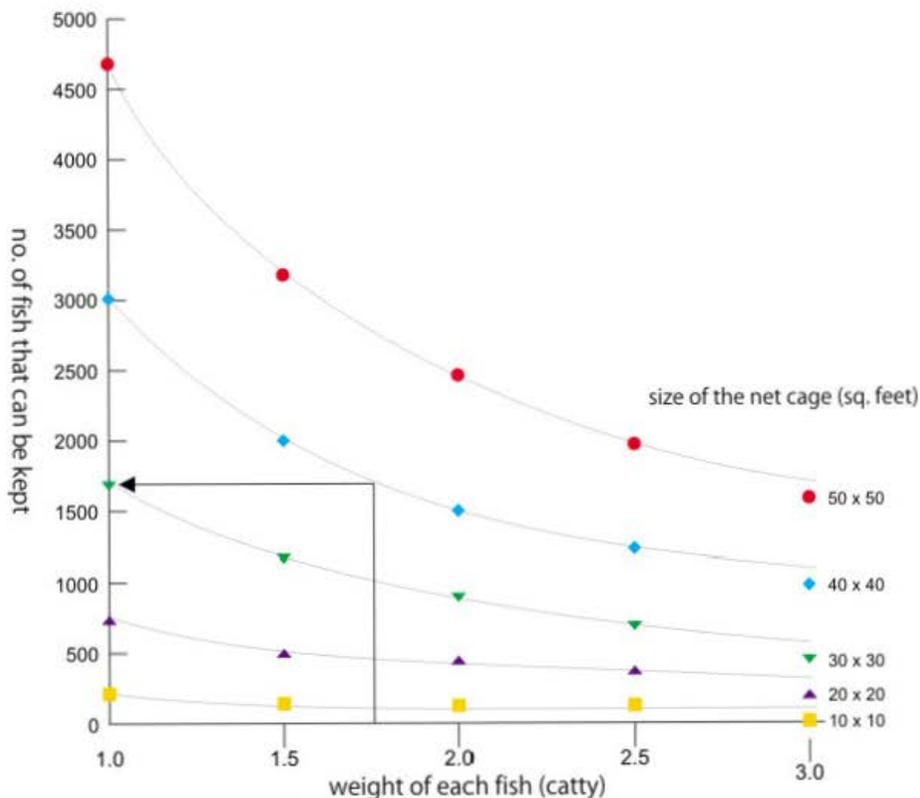
## Management measures :

- Check the growth rate of fish. Sort them out into different cages according to their size to reduce stocking density.



- As some species grow more rapidly, it is advisable to sort fish by size. This can protect smaller fish from being preyed on by bigger ones.
- Use the “Appropriate culture density chart” to estimate the appropriate density.

## Appropriate stocking density chart



### How to use the chart :

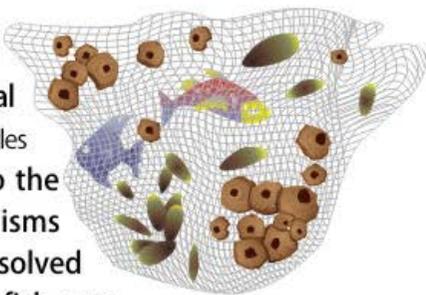
How to use the chart :

1. Estimate the weight of each fish (catty).
2. Measure the dimension of the net cage (generally ranging from 10 ft x 10 ft to 50 ft x 50 ft)
3. With a ruler, draw a line from the bottom of the chart (i.e. horizontal axis) up to the curve of the known net cage dimension.
4. At the intersecting point, draw a horizontal line from right to left to meet the vertical axis. This tells you the approximate number of fish you can keep.

Example : If the average weight of a fish is 1.7 catties, you can keep approximately 1,700 to 1,800 fish in a 40 ft x 40 ft cage.

## 2.2 Remove fouling organisms on the fish cages regularly

Fish culture activities enrich the sea with nutrients. This, coupled with warm water temperature, is an ideal habitat for fouling organisms (e.g. barnacles and mussels) that attach themselves to the fish nets. Proliferating fouling organisms not only consume a great deal of dissolved oxygen, but also block the meshes of fish nets and impede effective replenishment of dissolved oxygen in seawater inside the nets. Fouling organisms may also add weight to fish nets and cause damage or tear.



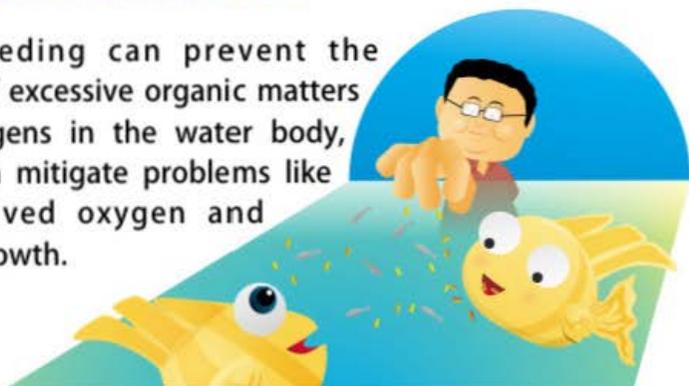
### Management measures :

- Clean the fish nets regularly to prevent deposit of fouling organisms which will affect sea current exchange.
- Inspect the fish nets regularly and repair any torn or damaged parts.



## 2.3 Good feeding management measures

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



### Management measures :

- Use dry pellet feed instead of trash fish 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.

## 2.4 Proper disposal of dead fish and garbage



To protect the water body from excessive organic matters and pathogens, it is important to dispose of waste 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.



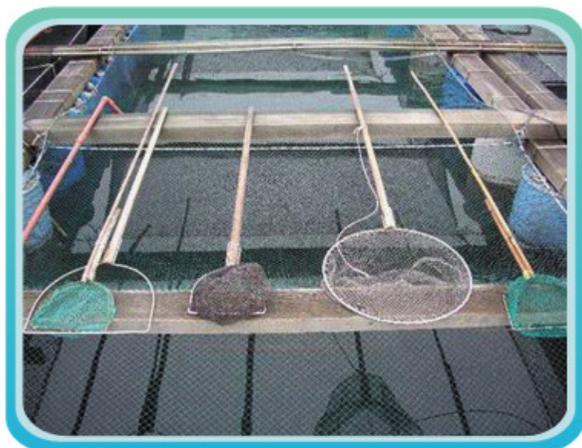
- Dead fish should be collected immediately and put in a garbage bag for delivery to the nearest refuse collection point.



- In the event of fish kill in great numbers, seek assistance from the Agriculture, Fisheries and Conservation Department (AFCD) or the Marine Department.

## 2.5 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.

## 2.6 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.

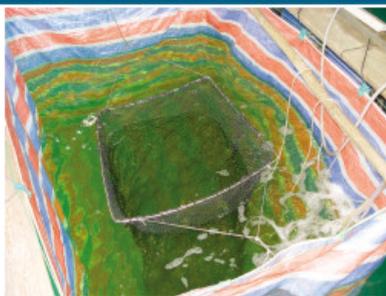
## 2.7 Isolation/proper treatment of sick fish

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 or destroyed.



- 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.

## 2.8 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 registered 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.

## 2.9 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 high mortality 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.

## Monitoring water quality

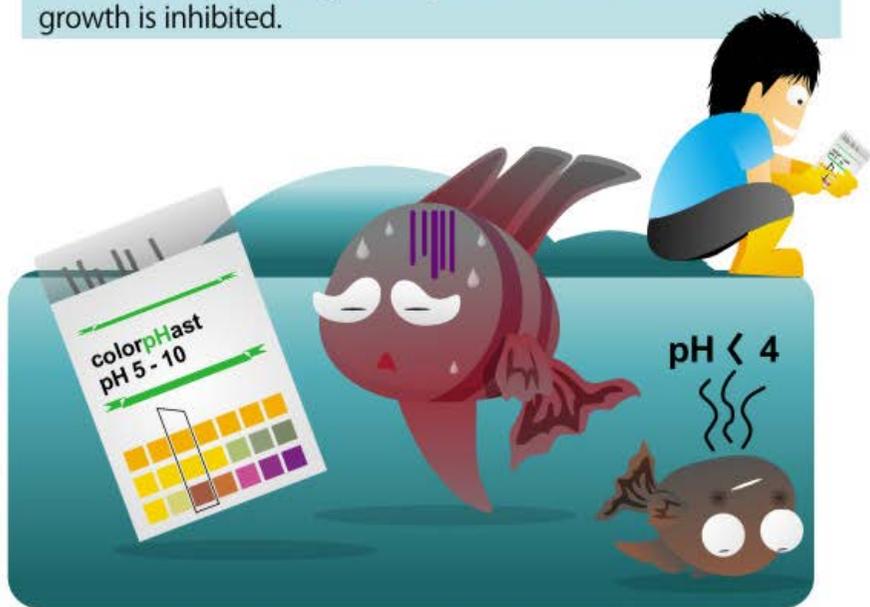
- Measure water quality parameters at specified times every day. These parameters vary in different seasons across waters where marine fish culture zones are situated. Unless in special conditions (e.g. stagnation or cold current), water quality parameters of fish culture zones should generally remain within the following ranges most of the time :

Water quality parameters	General range	Testing tool
Dissolved oxygen	4-8 mg/L	 <p>Dissolved oxygen meter</p>
Water temperature	18-28°C	 <p>Thermometer</p>
pH	7.9 - 8.3	 <p>pH meter / litmus paper</p>
Salinity	25 - 34 ppt	 <p>Salinity refractometer</p>

The following are the key factors that affect water quality and their management measures :

## pH

The decomposition process of organic matters turns the water acidic. Acidic water lowers the blood oxygen carrying capacity of fish and slows down metabolism. Fish appear sluggish and feed intake drops. Digestive power is also weakened and growth is inhibited.



### Management measures :

- Appropriate feeding can prevent seawater from turning acidic.
- When seawater pH value is low, stop feeding.

### Dissolved oxygen level

Dissolved oxygen level may drop due to several reasons, including the increase in organic matters, over-feeding, high culture density and natural phenomena like stagnation, upwelling current, rising water temperature and red tide. Fish living in a low dissolved oxygen environment for extended periods may show poor appetite, decelerated growth rate, poor resistance to disease and high morbidity. When seawater is seriously anoxic, fish will surface to breathe with their mouths. Kill may occur suddenly within a few hours.





## Dissolved oxygen level in seawater may drop due to several natural phenomena :

### Stagnation :

When high and low tide ranges are small and water flow is slow, exchange with dissolved oxygen enriched seawater is less effective.

### Upwelling current :

Water with low dissolved oxygen at the bottom of the fish culture zone is brought up to the surface by coastal wind, rapid current or upward and downward tidal movements.

### Water temperature :

In hot weather and relatively high water temperature, airborne oxygen dissolves in water at a slower pace.

### Red tide :

Red tide algae respire at night and consume dissolved oxygen in the water.

## Management measures :



➤ Monitor dissolved oxygen levels more closely if you suspect any changes or when there are sudden weather changes or extended cloudy periods.

➤ Refer to special markers on the mariculture calendar for anoxic days and keep close watch of fish stock during such periods. If necessary, stop feeding, reduce the stocking density and turn on an aerator or jet water along the borders of rafts with a blast pump to boost dissolved oxygen.



## Water temperature

Climate is a major influence on water temperature changes. Excessively high or low water temperature affects appetite of fish. It also reduces growth, metabolism and resistance to disease. Sometimes it leads to disease or death.



## Management measures :



➤ Select species that can adapt to the local climate.



➤ Feed sparingly and add sun screens to reduce direct sunlight.

- When water temperature is too low, move the fish less frequently.
- Depending on the temperature tolerance range of fish species under culture, harvest before the onset of winter or before water temperature drops whenever possible.
- Stay alert to water temperature changes. If it falls below 18°C, monitor fish activities closely. If necessary, sell the fish stock.
- Highly nutritious feed must be given to prepare fish for winter. Add vitamins C and E appropriately to boost immunity and cold tolerance.



## 2.10 Maintenance of farm management records

Marine 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 thus be identified to enhance culture efficiency.



## 2.11 The AFCD Accredited Fish Farm Scheme and good aquaculture practices

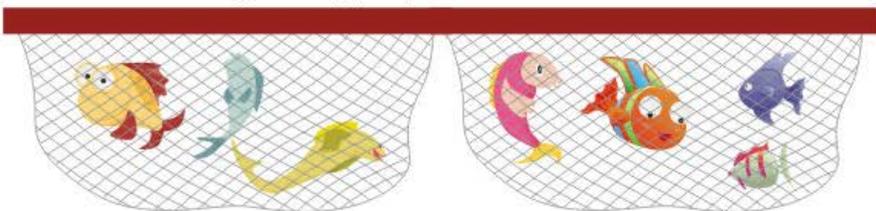


The AFCD's ongoing **Accredited Fish Farm Scheme** is aimed at helping local fish farmers to improve fish farm management and production. The goal is to satisfy public demand and expand the market for the local aquaculture industry by offering quality aquaculture products that meet food safety standards. 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.

### 3 Conclusion

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

- Avoid over-stocking. Monitor growth rate and sub-divide fish in different cages as appropriate.



- Use dry pellets. Avoid feeding too much and too fast. Observe how the fish feed and stop feeding when required.
- Clean and repair cages regularly.
- 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.

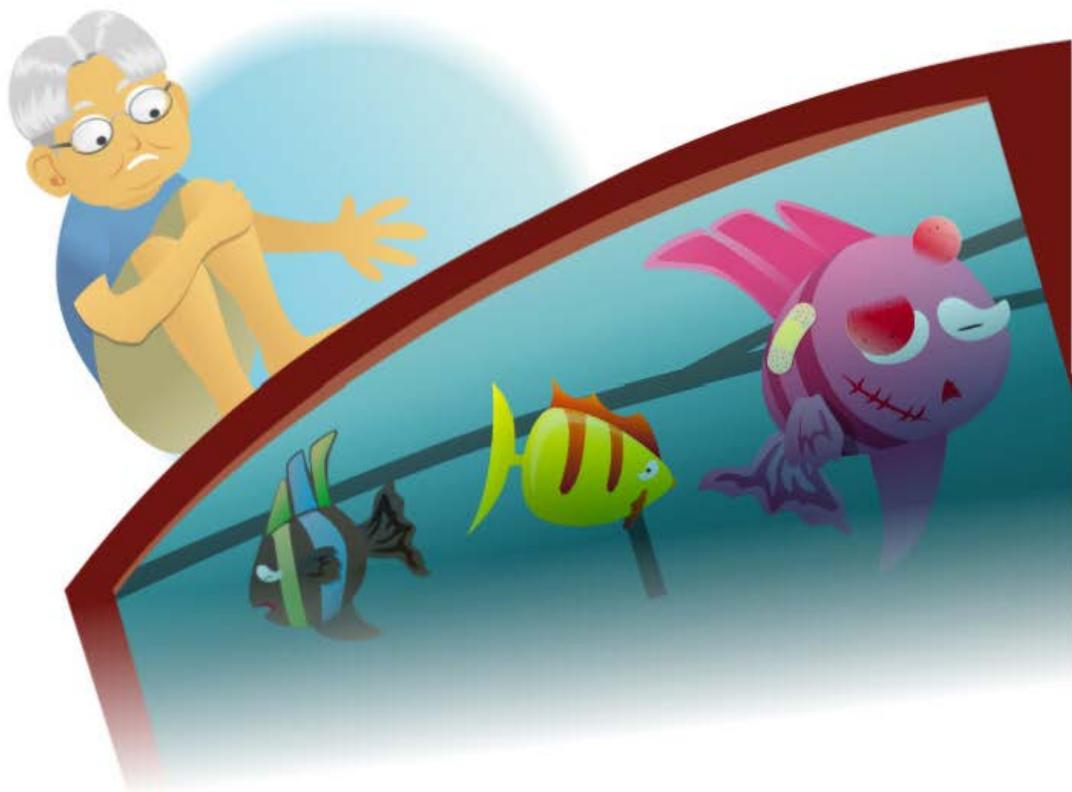


- Monitor and record dissolved oxygen level, pH value, water temperature, etc. daily with devices like dissolved oxygen meters, pH meters and thermometers.



- Observe changes in seawater level, the ebb and flow of tides and any emergence of red tide. Turn on the aerator promptly if required.

- Observe fish behaviour. Fish with abnormal behaviour or suspected disease should be isolated from healthy stocks as soon as possible and given suitable treatments.



- 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  
**(Mariculture : 2150 7083)**



## 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 environmental management of mariculture, contact the Aquaculture Fisheries Division of AFCD on 2150 7083 or email us at [mailbox@afcd.gov.hk](mailto:mailbox@afcd.gov.hk)