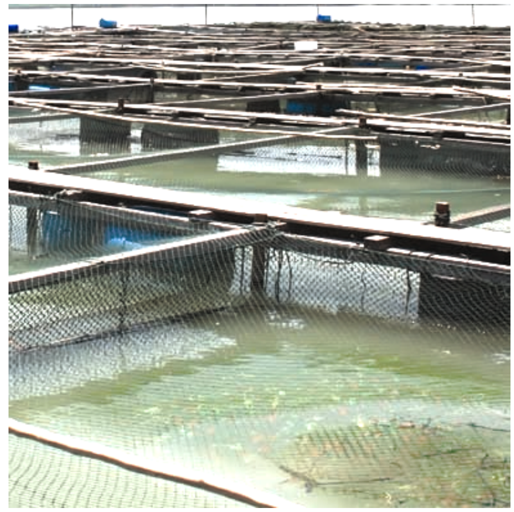
Tech Notes:

Water Quality & Aquaculture



Water quality and quantity vary from place to place, and are affected by ecological factors such as soil and air quality. On a whole, groundwater is considered more desirable for aquaculture because it has more consistent water quality than surface water, and is less likely to be contaminated by pathogens or fish.

As it may be impractical to regulate large volumes of water in open ponds or single pass flow-through culture systems, species selection is largely dependent on the kind of water available.

Tropical fish, for instance, are generally sensitive to poor water quality and therefore require fish farmers to have a higher level of water quality management skills; Ornamental fish are kept in tanks more than food fish. In tank conditions where a large number of fish is kept in a small confined space, the buildup of nitrogenous waste requires additional care and measures to maintain a healthy stock.

Regardless of the kind of water available or the species chosen, all fish depend entirely on water to live, eat, grow and perform other bodily functions. Therefore, it is no surprise that the success of a fish farming establishment lies greatly on its water quality management programme.

The following are some parameters that are considered to be the most important in aquaculture:

pH, Alkalinity & Water Hardness

The acceptable range for fish culture is usually between pH 6.5 to pH 9.0. When water is very alkaline (> pH 9), ammonium in water is converted to toxic ammonia, which can kill fish. On the other hand, acidic water (< pH 5) leeches metals from rocks and sediments. These metals have an adverse effect on the fishes' metabolism rates and ability to take in water through their gills, and can be fatal as well.

pH, alkalinity and water hardness go hand-in-hand.

Alkalinity is the sum of the carbonate and bicarbonate alkalinities, which are responsible for neutralizing acid in the water without changing the overall pH level.

Water hardness is similar to alkalinity but uses different measurements. It is a measure of mainly calcium, magnesium and other ions.

The correct pH, alkalinity and hardness are essential for a successful pond fertility programme, where fertilizers containing nitrogen, phosperous and potassium are added to encourage the growth of phytoplankton. Phytonplankton breaks down waste into harmless ammonia, and is the food of zooplankton – a microscopic animal which forage fish like bluegills feed on. Phytoplankton also produces dissolved oxygen during day photosysnthesis and is the most important source of dissolved oxygen in pond systems.

Salinity

Typically, the salt concentration in a fish is about 0.5% higher than its surrounding water. As a result, there is a constant influx of water into the fish through osmosis, diluting its body fluid. In order to maintain their salinity level, fish are constantly excreting a stream of urine. At the same time, they absorb salt from their surrounding via special cells in their gills. This constant exchange of mineral and water between the fish and their surrounding is crucial for their survival.

EUTECH INSTRUMENTS
Technology Made Easy ...
Blk 55, Ayer Rajah
Crescent, #04-16/24
Singapore 139949
+65 6778 6876
+65 67730836 fax
www.thermofisher.com

When fish are stressed, as they are when being shipped around in bags, they react by leaking bodily minerals into the water. If this condition persists for an extended period of time, the huge amount of salt lost can be fatal for the fish. The survival chances of a fish can be significantly increased by adding salt to their transport water. Since mineral leakage is directly linked to the concentration of salt between the fish and the water, increasing salinity of the water reduces salt leakage and stress build-up for the fish.

Fish that have been imported in salted water need to be gradually acclimatized back to the salinity of their original habitat, which may be as low as 100ppm. Gradual acclimatization should take place over several days via a 30% daily water change.

Temperature

Aquatic animals take on the temperature of their environment and are intolerant of rapid temperature fluctuations. This makes water an ideal living habitat for them, because water is a bad conductor of heat, allowing large amount of heat energy to be absorbed without a corresponding temperature change.

Temperature tolerances of fish are broadly categorized into cold water, cool water, warm water and tropical water. For each species, there is a minimum and maximum tolerance limit, as well as an optimal temperature range for growth. This optimal temperature range, also known as the standard environmental temperature (SET), may vary with each species, even those within the same temperature tolerance category, and with each development stage of the fish.

Water temperature affects the feeding pattern and growth of fish. Fish generally experience stress and disease breakout when temperature is chronically near their maximum tolerance or fluctuates suddenly. It is therefore important to acclimatize fish gradually when moving them from one location to another.

Warm water holds less dissolved oxygen than cool water. This is a point worth noting, since every 10°C increase in temperature doubles the rate of metabolism, chemical reaction and oxygen consumption in general.

Dissolved Oxygen

Dissolved oxygen is by far, the most important parameter in aquaculture. Low dissolved oxygen levels are responsible for more fish kills, either directly or indirectly, than all other problems combined. Oxygen consumption is directly linked to size, feeding rate, activity level and temperature, and it will surprise some that large fish consume less oxygen than their smaller counterparts which have higher metabolic rates. The amount of dissolved oxgen in water increases as temperature reduces, and decreases when salinity and altitude increases:

Variable		**Temperature °C (°F)**				
		20.0 °C (68.0 °F)	22.0 °C (71.6 °F)	26.0 °C (78.8 °F)	28.0 °C (82.4 °F)	30.0 °C (86.0 °F)
		Oxygen (ppm)				
Salinity (ppm)	0 ppm	9.2 ppm	8.8 ppm	8.2 ppm	7.9 ppm	7.6 ppm
	5,000 ppm	8.7 ppm	8.4 ppm	7.8 ppm	7.5 ppm	7.3 ppm
	10,000 ppm	8.3 ppm	8.0 ppm	7.4 ppm	7.1 ppm	6.9 ppm
Altitude (ft)	0 ft (sea level)	9.2 ppm	8.8 ppm	8.2 ppm	7.9 ppm	7.6 ppm
	1,000 ft	8.8 ppm	8.5 ppm	7.9 ppm	7.6 ppm	7.4 ppm
	2,000 ft	78.5 ppm	8.2 ppm	7.6 ppm	7.3 ppm	7.1 ppm

Table 1: Solubility of oxygen (ppm) in water at various water temperatures, salinities and altitudes (Source: LaDon Swann, http://aquanic.org)

Not only is dissolved oxygen important for fish respiration, it is also important for the survival of phytoplankton, the organism which breaks down toxic ammonia into harmless forms.

To cultivate good growth, a good rule of thumb is to maintain DO levels at saturation, or at least 5 ppm. Warm water species are more well-adapted to ocassional low DO levels than cool water species.. Portable dissolved oxygen meters, such as the Eutech EcoScan DO 6, should suffice for a quick DO check.

Thermo Fisher SCIENTIFIC

Check Your Water Quality Frequently & Regularly

Water quality is the biggest concern to an aquaculturist or fish farmer, who must become accustomed to frequent and regular water quality analyses. Lightweight pocket testers are available in the market for measurements of various parameters such as pH, temperature, salinity, conductivity, dissolved oxygen and total dissolved solids.

A multiparameter pocket tester such as Eutech's PCSTestr 35 will allow users to measure and scan through several parameters simply by pressing a button, and can prove to be very convenient in such multiparameter applications.

References

Howerton, Robert (2001) *Best Management Practices for Hawaiian Aquaculture*, Center for Tropical Aquaculture Publication No. 148

Summerfelt, Robert C. (n.d.) *Water Quality Considerations for Aquaculture*, Aquaculture Network Information Center (http://aquanics.org)

Swann, LaDon (n.d.) *A Fish Farmer's Guide to Understanding Water Quality*, Aquaculture Network Information Center (http://aquanics.org)

Watson , Craig A. and Shireman, Jerome V. (1996) *Production of Ornamental Aquarium Fish*, Department of Fisheries and Aquatic Sciences: Document FA-35