Water Quality & Aquaculture

Water quality and quantity vary from place to place, and are affected by ecological factors such as soil and air quality. While certain water quality is preferred over another for fish-breeding, it is impractical to regulate large body of water, especially in open environments. Therefore species selection is largely dependent on the kind of water available.

Tropical fish, for instance, are generally sensitive to poor water quality and require a higher level of water quality management skills from fish farmers; Ornamental fish, on the other hand, are kept in tanks more than food fish. Although it is easier to regulate water quality in tank conditions than open bodies of water, a large number of fish kept in a small confined space causes nitrogenous waste buildup, and hence 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

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

The acceptable range for fish culture is usually between pH 6.5 to pH 9.0. Acidic water which is less than pH 5 leeches metals from rocks and sediments and can contain a high level of metallic ions. These metals have adverse effects on fish's metabolism rates and ability to take in water through their gills. On the other hand, alkaline water with pH level above 9.0 causes a chemical change, converting ammonium to toxic ammonia, which is fatal to fish.

Alkalinity is the sum of all bases in the water, mainly carbonate and bicarbonate alkalinities. These bases are responsible for neutralizing acid in the water without changing the overall pH level. The right alkalinity level in water, usually above 20 ppm, is therefore essential for pH stability.

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)

Water hardness measures the concentration of calcium and magnesium ions in water, and is best kept at about 75 ppm.

The correct balance of 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 is essential:

- To break down waste into harmless ammonia
- As food for zooplankton – a microscopic animal which forage fish like bluegills feed on
- As a important source of dissolved oxygen through day photosysnthesis, especially 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. In the aquaculture environment, water salinity level is important for constant exchange of mineral and water between the fish and their surrounding, and therefore the survival of the fish.

Salinity control becomes even more important in the transport of fish. 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), varies with each species, and each development stage of the fish, even those within the same temperature tolerance category. In general, having the right water temperature is crucial because water temperature affects the feeding pattern and growth of fish. Fish experience stress and disease breakout when temperature is often near their maximum tolerance or fluctuates suddenly. In addition, warm water holds less dissolved oxygen than cool water. This poses as a problem because oxygen consumption, along with metabolism rate and chemical reactions, doubles with every 10°C increase in temperature.

Eutech's PCSTestr 35

Dissolved Oxygen

Dissolved oxygen is by far, the most important parameter in aquaculture. Low dissolved oxygen levels causes more fish kill than all other water quality problems combined. Oxygen consumption is directly linked to fish size, feeding rate, activity level and temperature. The amount of dissolved oxgen in water increases as temperature reduces, and decreases when salinity and altitude increases *(see Table 1)*.

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 at 5 ppm. Warm water species are more well-adapted to occasional low DO levels than cool water species. Portable waterproof DO meters, such as the Eutech CyberScan 300, should suffice for a quick DO check.

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 analysis — in this case, the right instrument can significantly ease the task of water quality monitoring. For quick, easy multiparameter measurements, lightweight pocket testers, such as the Eutech's PCSTestr 35, are available in the market for measurements of various parameters such as pH, temperature, salinity, conductivity, dissolved oxygen and total dissolved solids.

The multiparameter Eutech's PCSTestr 35 pocket tester is waterproof, easy to calibrate and allow users to measure and scan through several parameters simply by pressing a button. For more information, email Eutech at eutech@thermofisher.com or visit our website at http://www.eutechinst.com.

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Sampling Water in the Field

The QHSuc handheld water sampler from **QH SEREVIS** (Czech Republic) is designed for single water sampling in the field. The device is supplied with 12V / 12Ah carefree battery. The sample is taken by peristaltic pump from max. 7m depth. The variable speed motor is reversible and can sample at any speed up to 2,9 L per minute controlled by switch and flow control. Before and after sampling you may reverse the pump to clean (empty) the hose. One sample volume depends on how long the switch is manually held in the pumping position. The device can be carried by the handle or by the strap across your shoulder. The sampler is supplied including 5m fitting-equipped suction hose and 12V/12Ah battery. You may order NAB 920 230VAC/12V1A DC battery charger as an accessory.

Monitor and Measure Pollutants in a Heavily Populated Bay Area.

The Environmental Protection Authority in Australia is obliged by an Act of Parliament to monitor the condition of Port Phillip Bay. To achieve this, there was a need to measure the ecological consequences of wastewater outflows from Melbourne and the Bay's capacity to cope with it. The city sits on the Yarra River with three other main flows into the Bay from the Werribee Sewerage Farm, Patterson and Werribee Rivers. The Marine Sciences Laboratories were chosen to map the discharge plumes form these outflows over a 12-month period. The information the scientists needed was on temperature, salinity, acidity, dissolved oxygen, nitrates, phosphates and chlorophyll levels.

dataTaker DT85 from **Datataker** (Australia) was installed to record the mass of information generated by the sensors, greatly simplifying the collection of data during the project. The water was pumped continuously from 1.5 metres below the surface, through the array of sensors, which measured temperature, salinity (reduced salinity because of increased fresh water can lead to damage to marine life) acidity, dissolved oxygen, nitrates, phosphates and chlorophyll.

The dataTaker data logger's ability to record electric current and resistance as well as voltage was also and advantage.

The cruises took place over a four-day period quarterly for the year. Interim reports revealed there had not been serious damage to marine life, although there was plenty of evidence the city's outpourings. It was found that some of the major flows into the Bay occur only intermittently, although influences of the Yarra River were found on every sampling.

A Simple Combination of Point Level Measurement and Communication Technology

Hawk (Australia) launches Gladiator Smart Admittance Switch a state of the art probe which is immune to build-up.

The Gladiator Smart Admittance Level Switch is designed to detect the level of liquid, slurry or powder in a tank or vessel. The unit measures the capacitance or "admittance" between a probe and the wall of the container. As the level of the product rises to the level of the probe, or drops below that level, the capacitance measured at the probe changes. The Gladiator detects this change and produces an output. The Gladiator can monitor materials with a wide range of dielectric constants, so the system is applicable to a large variety of liquids, slurries and powders.

Hawk has designed the unit to operate in tough industrial environments. It is simple to set up and calibrate, and has excellent temperature stability. Several probe types are available to meet specific application requirements, and all types are resistant to product build-up.

The Gladiator communicates using Modbus, HART, or Profibus protocols. A remote amplifier can be positioned up to 500 m (1640 Ft) away from the unit. The HawkLink GSM/CDMA communication option allows a technician to commission, calibrate, test, or check the output of the unit from anywhere in the world.

Gladiator Switches are suitable for wide variety of production situations. For example, the instrument can monitor liquids applications in the petrochemical, food and beverage, and water and wastewater industries. The Gladiator can also monitor levels of dry powdered material for industries including cement, glass, pharmaceutical, mining and minerals, power generation and fertilizer.