XII

FISH GROWTH PARAMETERS AND THEIR MONITORING

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Cage aquaculture has grown rapidly during the past decades and is presently undergoing swift changes in response to increasing global demand for aquatic products. Recent studies have predicted that fish consumption in developing and developed countries will increase by 57 percent and 4 percent, respectively. Rapid population growth, increasing affluence and urbanization in developing countries are leading to major changes in supply and demand for animal protein, from both livestock and fish. The need for suitable sites has resulted in the cage aquaculture subsector accessing and expanding into new untapped open-water culture areas such as lakes, reservoirs, rivers and coastal brackish and marine offshore waters.

Growth studies are an essential instrument in the management of fisheries resources since they contribute to estimates of production, stock size, recruitment and mortality of fish populations. The study of growth means basically the determination of the body size as a function of age. Therefore all stock assessment methods work essentially with age composition data. Fish can be aged by examining scales or various bones. Hard body parts grow as the fish grows, adding annual rings similar to the rings in trees. Because the growth in the diameter of the hard body parts is proportional to the growth in length of the fish.

Fish growth and feed utilization

Growth is sensitive to environmental conditions and measurements of growth rate can often be used to provide an index of performance. Slower growth in fishes has been correlated with a variety of life history traits – from higher mortality to reduced food availability and increased age or smaller size at sexual maturity. The health and welfare of a fish can be influenced by a variety of physical factors ranging from water quality to territorial defence, unnatural habitats, stocking densities and available nutrition. Stocking density is well publicized as a factor that can influence fish health and growth rate in so far, as overstocking in a system can negatively affect water quality and food availability. Often, the stocking density alone or in combination with feeding rate is adjusted by fish farmers to obtain a particular size of fish at harvest, thus indicating that fish growth may be a function of available water space.

Specific Growth Rate (SGR)

The specific growth rate can be calculated based on the following method.

$SGR = Log_e W_2 – Log_e W_1 / D \times 100$

where, ‘W_2’ is the mean weight of the fish during the present sampling, ‘W_1’ is the mean weight of the fish during the previous sampling and ‘D’ is the number of days between the two samplings.

Average Daily Growth Rate (ADGR)

This can be calculated using the following formula.

$W_2 – W_1 / D$

where W_2 is the final body weight and W_1 is the initial body weight

Survival rate (SR)

$SR = (N_2 / N_1) \times 100$. The survival rate is always expressed in percentage, where N_2 is the number of survivors during the present sampling and N_1 is the number of survivors during the previous sampling.

Biomass

Biomass can refer to species biomass, which is the mass of one or more species, or to community biomass, which is the mass of all species in the community. The mass can be expressed as the average mass per unit area, or as the total mass in the community. How biomass is measured depends on why it is being measured.

Biomass = Mean weight x Number of fishes

Weight Gain (WG) = Initial body weight - Final body weight of fish

Protein Efficiency Ratio (PER)

PER is the measurement of the body's biological absorption of a protein from a food source to usable protein. PER is a widely used method for evaluating the quality of protein in food.

PER = Gain in body mass (g) / Protein intake (g)

Net Protein Utilization (NPU)

The net protein utilization, or NPU, is the ratio of amino acid converted to proteins to the ratio of amino acids supplied. It is profoundly affected by the level of limiting amino acids within the food stuff. As a value, NPU can range from 1 to 0, with a value of 1, indicating 100% utilization of dietary nitrogen as protein and a value of 0 an indication that none of the nitrogen supplied was converted to protein.

Feed Conversion Ratio (FCR)

FCR is calculated from the number of kilos of feed that are used to produce one kilo of whole fish. The ratio of the gain in the wet body weight of the fish to the amount of feed fed. The true F.C.R includes wasted feed and mortalities. The ratio, usually expressed as a true ratio (i.e. 1 : 1.5) is often quoted as a "rate" (1.5). Two additional terms are used by the farmer, the biological FCR and the economic FCR. Biological FCR is the net amount of feed used to produce one kg of fish, while the economic FCR takes into account all the feed used, meaning that the effects of feed losses and mortalities, for example, are included. Farms reporting a low FCR normally have good management practices in place, with no overfeeding and very low, if any, mortalities. Overfeeding or underfeeding will increase the FCR.

The basic principle in feeding is that the fish should be fed exactly to satiation. If they are fully fed, the fish are not stressed. In an efficient trout or salmon farm, the FCR will be close to 1. This is extremely low when compared with land animals. There are three reasons for this; the biology of the fish, the way the fish live and the high nutrient concentration of fish feed. Fish have a low body maintenance requirement. Fish are poikilothermic (cold-blooded) animals (their body temperature is equal to that of its environment) and thus they do not use feed to maintain body temperature as warm-blooded animals do (e.g. poultry, pigs and cows). For a fish, floating in the water consumes less energy than standing and walking on legs. The fishes are very efficient converters of feed into energy and building blocks (muscles) for growth and their feeds are also more concentrated than those for pigs or cattle, since they do not need 'filler' ingredients such as fibres. Fishes use oils and fats as their prime energy source and, therefore, this is more concentrated than the carbohydrates needed by land-living animals. Finally, land animals have a far higher feed capacity than fish and therefore they can grow well on less concentrated feed.

Feed Efficiency

A figure used to represent the efficiency of food use. The inverse of the feed conversion ratio e.g. a feed conversion ratio of 1 : 1.5 becomes a feed efficiency of 0.66 (1 / 1.5).

Feed Rate

The amount of feed given to the fish, over a specified period of time . The most common way of expressing this is as percentage of the animal body weight per day. For example a 1000 gram fish, being fed 20g of feed per day would be on a 2% feed rate [(20 / 1000) x 100)].

Energy Assimilation

The food consumption of fishes can be summarized in the following equation:-

$$C = P + R + F + U$$

where, C = food consumption in energy terms (Joules); P = energy used for tissue growth (including fat deposition, egg and sperm development); R = energy used for work (including body maintenance, digestion, activity); F and U = energy losses in faeces and urine respectively. The amount of useful energy available to the animal, or assimilation (A) as it is generally termed, can be derived from $A = C - (F + U) = P + R$. Assimilation is often quantified in terms of assimilation efficiency.

Carrying capacity

A major consideration in the site selection process should be the carrying capacity of the site which indicates the maximum level of production that a site might be expected to sustain. Intensive cage fish farming results in the production of wastes which can stimulate productivity and alter the abiotic and biotic characteristics of the water body, whilst less intensive methods can result in over cropping of algae and a fall in productivity. Hence profitability or even viability may be seriously affected. Therefore it is extremely important for all concerned with cage fish farming to have an accurate evaluation of the sustainable levels of production at a particular site before culture. The carrying capacity of a biological species in an environment is the population size of the species that the environment can sustain indefinitely, given the food, habitat, water and other necessities available in the environment. In ecological terms, the carrying capacity of an ecosystem is the size of the population that can be supported indefinitely upon the available resources and services of that ecosystem. Carrying capacity varies based on a number of factors, such as, water flow, volume, exchange rate, temperature, oxygen content, pH, size and species of fish being reared and accumulation of metabolic products. Carrying capacity is based on loading (the weight of fish per unit of water flow) and density (the weight of fish per area of water body) of the fishes in the system.

Condition Factor

An easily measured index of growth is the length-weight relationship, often referred to as condition factor (C). C is the ratio of fish weight to the length cubed. Condition factor, one of the most important feeding and growth criteria. Since 'C' may vary between species, strains, diet and feeding levels, water quality and hatchery management, it should be calculated for each hatchery. 'C' is calculated by weighing a sample of 50-100 fish together. After the average weight and the average length are measured, values are used in the formula $C=W/L^3$. A high condition factor would indicate a well-fed fish, while a low condition factor may indicate a poorly fed fish of the same length.

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