

Fish Health Management for  
Intensive Fish Farming

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INTRODUCTION

During the past three decades, the raising of fish for human consumption has been increasing dramatically, especially in the sociologically and industrially developed countries of North America and Europe. The increased production has come about largely as a result of consumer awareness that fish and shellfish are nutritionally beneficial to health. Unfortunately, the production increase in some countries has been so great that the supply of propagated food fish has exceeded the demand in the marketplace.

Attendant to the increased production of food fish under intensive culture conditions has been the increased loss of production potential through infectious and noninfectious disease processes. In many cases the episodes have been so severe that 45-55% of the numbers of fish at the beginning of the rearing process have died before they became ready for market (Table 1). However, the loss of production potential has not been reflected as dead fish only. Perhaps the greatest impact has been reduced vitality which has been recorded as reduced growth rate and increased feed conversion. The costs incurred from this have been, in the opinions of many, quite significant.

Table 1. Average loss data in the freshwater food fish industry

Food Fish Production		
	Loss	Number
Green Eggs		1,000,000
	7%	
Eyed Eggs		930,000
	5%	
Hatch-out		883,500
	6%	
Swim-up		848,160
	1%	
Grow-out		839,678
	25%	
Processing		629,759
	5%	
Distribution		598,271

The economics of food fish production have not been documented with precision and perhaps there is no way to do so because of the diversity of the food fish raising community. However, a generalized picture of the costs incurred in food fish production can be presented (Table 2). These data suggest quite convincingly that the greatest portion of the costs in producing a pound of fish under intensive culture systems is feed. Thus, it would seem quite logical to assume that to pay considerable attention to that component would - or could - reduce loss of production potential. For example, weight gain in a group of fish at a feed conversion of 1.9 kg feed per kg gain is 26.6% more expensive in terms of feed costs than is the same group of fish at a feed conversion of 1.5 kg feed per kg gain. In this regard, it is beyond the comprehension of many that several fish farmers are apparently content with a 1.9:1 feed conversion when the commercially available diets all can yield a 1.3:1 conversion with very little effort.

Two of the prime factors in reduced feed conversion are subclinical respiratory (gill) diseases and asymptomatic infections of bacteria and viruses. In this regard, perhaps the most significant impediment to reducing the mortality rate and to increasing the feed conversion is due to having more concern for disease rather than health. The poultry and livestock (sheep, cattle, and swine) industries have learned that herd health management through application of the principles of preventive medicine is economically sound. In other words, these industries start with healthy animals and strive to keep them in that state through monitoring growth rates, behavior, production (milk, eggs, etc.), and environmental conditions. This could be termed preventive medicine.

Table 2. An economic overview of the freshwater food fish industry

Economics	% of gross \$
Egg Cost	3.21
Feed Cost	57.05
Labor Cost	11.11
Disease Treatment	4.70
Mortality	6.41
Overhead	<u>17.52</u>
	100.00

The foregoing is not a new concept or revelation to the majority of people in the aquaculture community. All have attempted at one time or another, in some fashion, to implement these ideas. But the enormity of the task is often mind-boggling for an individual person. The adopting of the term "fish health" as opposed to "fish disease" in our professional jargon has helped a great deal. Then wherein lies the problem?

I think the problem of our collective inabilities to do much more than "put out the brush fires" stems from the absence of a good or adequate base of knowledge of health and its change into subclinical and then clinical disease. The term "health" as it applies to an individual or a population of fish, either free-living or confined, should denote that the animal is able to conduct all its physiological activities without impediments. Its oxygen demand is met, its nutritional energy demand is met, its reproductive capacity is realized, its behavioral needs are met, and so forth; i.e., it is "normal" (a term I despise but use too frequently!!). It is my opinion that when any one of the physiological functions of a fish are comprised for whatever reasons - extrinsic or intrinsic - a state of disease ensues. This disease state may be subclinical; i.e., not noticed by the observer, or it may be clinical; i.e., quite apparent to the observer.

In the preceding paragraph I used the terms "extrinsic" and "intrinsic." These are epidemiological terms to categorize identifiable factors involved in the disease process which originate in the environment; i.e., extrinsic and those which originate within the animal; i.e., intrinsic.

## EXTRINSIC FACTORS AFFECTING FISH HEALTH

The extrinsic or environmental factors which are known to compromise the health status of fish individually or collectively can be grouped into the following categories according to their location within the system: (1) water-associated; (2) pond-associated; (3) nutrition-associated; (4) management-associated. To some, this classification scheme may seem somewhat simplistic and/or conceptual. Nonetheless, the process of investigating the nature of a disease episode has been enhanced by identifying and quantifying the associated factors. The quantitative evaluation of the prime factors has permitted the raising of fish with a minimum of problems.

(1) Water-associated factors: Among water-related factors identified as affecting the productivity of aquaculture systems, water temperature and dissolved oxygen content have the most significant insidious effects on fish health. They are inherent in all water supplies and are subject to fluctuations to which the fish in the system must adapt. The physiological effects of the fluctuations are very broad, ranging from a change in metabolic rate to altering the susceptibility to pathogens. In this regard, the documentation of environmental changes and the occurrences of infectious and noninfectious disease processes could be an invaluable aid in predicting the likelihood of a subsequent disease episode. Examples of this are legion but not sufficient to be a widespread practice.

(2) Pond-associated factors: The primary effect here is requiring a particular fish to live in a pond configuration which does not meet its behavioral requirements.

(3) Nutrition-associated factors: One would think that in this day and age of high quality commercial diets, nutritional problems would not occur, but they do, all too frequently. Our studies over the past 4-5 years on production forecasting have shown the health of fish can be compromised when the fish are fed at a rate permitting less than 80% of the Allowable Growth Rate. We have found growth rate to be a very reliable indicator of the health of the population. Deviations of as little as 1% from the expected growth rate can be measured quite accurately and evaluated with a high degree of statistical validity.

Overfeeding a population is another health-compromising situation. In this case there are frequently abnormal amounts of abdominal fat and hepatic glycogen deposits. The effects are not often seen immediately, but can be implicated in the milieu of casual factors of an unhealthy state.

(4) Management-associated factors: The primary health-threatening factors in this category emanate from exceeding one or more of the pond carrying capacities, from inadequate housekeeping practices, from inadequate record-keeping practices, and from undue physical stressors.

## INTRINSIC FACTORS AFFECTING FISH HEALTH

The intrinsic or somatic factors originate within the fish itself. They are largely governed by the genetic make-up which by and large dictates the physiological and psychological responses of the fish to the extrinsic factors.

Perhaps the major intrinsic factor which fish health managers have some control over is the generation of endogenous ammonia ( $\text{NH}_4^+$ ). We all know that free ammonia ( $\text{NH}_3$ ) in the system is deleterious to the health of fish when specified limits are exceeded. The main impact, as we now understand it, is on the gill lamellae in the form of epithelial hypertrophy and hyperplasia which reduce the oxygen uptake by the fish, thus impacting the physiological well-being of the fish. The control of this process is to reduce the dietary protein, or to decrease the retention time of ammonia in the pond by increasing the water flow, or to reduce the population of fish in the pond, or to reduce the water temperature, or to decrease the pH of the system. Any one of the foregoing will serve to preserve the health of fish, within limits.

A second intrinsic factor over which we can exercise some control is the healthy or chronic asymptomatic carrier of infectious agents. It is apparent from our studies with Renibacterium salmoninarum and Aeromonas salmonicida carriers that the presence of these bacteria within the fish negatively impact their growth potential and represent a measurable threat to the uninfected portion of the population.

## SUMMARY AND CONCLUSIONS

Up to this point, this presentation has been rather gloomy, in my opinion. But, we must face reality - we could do better with preserving the health of our fish if we only would. To that end, I would offer the following as food for thought, and, hopefully, subsequent action by both the fish farming community and the fish health management profession, collectively.

1. Practice preventive medicine through detection and elimination of the carrier states of bacterial and viral pathogens, through mass immunization of fish against pathogens, through implementation and maintenance of health-preserving management practices, and through implementation and enforcement of live fish transportation regulations.
2. Apply the principles of epidemiology to investigations of disease occurrences.
3. Maintain open lines of communication among all facets of the aquaculture community.

4. Encourage the provision of continuing education opportunities.
5. Encourage increased applied research in fish health management.