

and damage to the physical barrier created by mucus.

#### *Scales and skin*

(1) Scales and skin are most commonly damaged by Handling Stress. Any break in the skin, or removed scale, creates an opening for invasion by pathogenic organisms.

(2) Trauma caused by fighting (Reproductive Stress or Behavioral Stress) could result in breaks in the skin or scale loss.

(3) Parasite infestations can result in damage to gills, skin, fins, and loss of scales which could create breaks in the skin for bacteria to enter. Many times, fish which are heavily parasitized actually die from bacterial infections; but the parasite problem, associated physical damage, and stress response create a situation which allow the bacteria in the water to invade the fish, causing a lethal disease.

#### *Inflammation*

(1) Any stress causes hormonal changes which decrease the effectiveness of the inflammatory response.

(2) Temperature stress, particularly cold temperatures, can completely halt the activity of "killer cells" of the immune system, thus, eliminating an important first defense against invading organisms. Excessively hot temperatures are also very detrimental to fish, although the precise impact of sudden increases in temperature on the immune system is not known.

#### *Antibody Production*

(1) Temperature stress, particularly a sharp decrease in temperature, severely impairs the fishes ability to quickly release antibodies against an invading organism. The time lapse required to mount an antibody response gives the invader time to reproduce and build up its

numbers, therefore giving it an advantage which may allow it to overwhelm the fish.

(2) Prolonged stress severely limits the effectiveness of the immune system, thereby increasing the opportunities for an invader to cause disease.

#### **Prevention of stress**

The key to prevention of stress is **GOOD MANAGEMENT**. This means maintaining good water quality, good nutrition, and sanitation.

Good water quality involves preventing accumulation of organic debris and nitrogenous wastes, maintaining appropriate pH and temperature for the species, and maintaining dissolved oxygen levels of at least 5 mg/l. Poor water quality is a common and important **STRESSOR** of cultured fish and precedes many disease outbreaks.

Feed a high quality diet that meets the nutritional requirements of the fish. Each species is unique and the nutritional requirements of different species will vary. Supplementing diets with fresh vegetables and live food is a good way to provide a balanced diet for fish which have poorly understood nutritional requirements. Fish in ponds have an advantage over fish raised indoors, because of the variety of natural foods available.

Proper sanitation implies routine removal of debris from fish tanks and disinfection of containers, nets, and other equipment between groups of fish. Organic debris which accumulates on the bottom of tanks or vats is an excellent medium for reproduction of fungal, bacterial, and protozoal agents. Prompt removal of this material from the environment will help decrease the number of agents the fish is exposed to. Disinfection of containers and equipment between groups of

fish helps minimize transmission of disease from one population to another.

#### **Prevention of disease**

Fish farm management should be designed to minimize stress on fish in order to decrease the occurrence of disease outbreaks. When disease outbreaks occur the underlying cause of mortality should be identified, as well as underlying stress factors which may be compromising the natural survival mechanisms of the fish. Correction of stressors (ie. poor water quality, excessive crowding, etc.) should precede or accompany disease treatments.

Stress compromises the fish's natural defenses so that it cannot effectively protect itself from invading pathogens. A disease treatment is an artificial way of slowing down the invading pathogen so that the fish has time to defend itself with an immune response. Any stress which adversely effects the ability of the fish to protect itself will result in an ongoing disease problem; as soon as the treatment wears off, the pathogen can build up its numbers and attack again. Rarely would a treatment result in total annihilation of an invading organism. Disease control is dependent upon the ability of the fish to overcome infection as well as the efficacy of the chemical or antibiotic used.

#### **Summary**

The keys to minimize disease outbreaks on your fish farm are maintenance of good water quality, proper nutrition and sanitation. Prevention of disease outbreaks is more rewarding and cost-effective than treatment of dying fish. Disease treatments should never be applied in a haphazard fashion. When needed, chemical or antibiotic treatment should be targeted at a specific problem. Any management