

Aquaculture



Fish Health Considerations for Recirculating Aquaculture

Fish health is critical to aquaculture production. Health impacts the ability to complete the production cycle in a predictable manner, market a high-quality product, and ultimately generate the greatest possible revenue. Sick and stressed fish do not eat to their full capacity, which means they do not grow at their optimal rate. When this occurs, the fish may have an appearance that is not acceptable to consumers, such as skin lesions. Fish that do not grow cost the farmer time and money in labor, feed, and other resources. The farmer must provide the optimal environmental conditions for the fish to grow so that they remain healthy and achieve their full potential. This publication will cover concepts that affect fish health such as how to identify and prevent diseases, how to treat issues as they arise, and the regulatory aspects of treating and transporting fish.

STRESS

Stress is the biological and physical response of a fish to deviations from their optimal growth conditions. Fast and drastic changes in environmental conditions as well as rough handling or overcrowding can be stressful to fish. During the stress response, fish channel energy that was once used for growth, reproduction, or immune



Fish health screening

response into basic functions vital for survival, such as swimming, respiration, and pumping blood. Stress events can be acute (high level, short duration – e.g., temperatures shock), which typically lead to mortality; or chronic (low level, long duration – e.g., transport issues), which lead to decreased growth rates, reduced reproduction, and increased disease. Stress reduction and prevention is critical to keeping fish healthy and growing fast. **These stress events often result in diseases 10 to 14 days after the cause event.**

DISEASES

Different aquaculture species have variable susceptibility to specific diseases. Some viral and bacterial infections only affect certain species or groups. For example, viral issues that affect marine shrimp are not likely to affect freshwater finfish or mollusks like oysters. However, ubiquitous diseases like *Aeromonas spp.* tend to affect a wide range of species and may even transfer to humans.

Some species, such as catfish and trout, have specific disease issues that are particularly harmful to their health.



Aeromonas bacteria on a catfish

Because of their commercial importance, these species are extensively researched and disease testing strategies have been established. Fish health certifications are required when shipping live fish between facilities for certain species, particularly when traveling across state lines. Other species are not subject to this testing regimen for transport within the boundaries of Iowa. Information on fish health certifications in Iowa can be found at the Iowa Department of Natural Resources website, www.iowadnr.gov/Fishing/FishingLicensesLaws/LicenseApplications.aspx.

Virus – Viruses may be untreatable after an infection begins. Some must run their course. Providing the highest possible water quality during this disease outbreak is critical to saving the remaining crop. Vaccines are sometimes used to create immunity in fish at the beginning of the grow-out cycle. These vaccines are often expensive and may require highly trained technicians to administer.

Additionally, because viruses can be host-specific, vaccines are often not available. That is why it is important to import only healthy stock and to quarantine the fish for at least two to four weeks before bringing them into the grow-out facility so that diseases are not introduced.

Bacteria – Bacteria are single-celled organisms. They are found attached to fish, hard surfaces, or free-floating in the water. Many bacteria are completely inert in the system, while others are actually beneficial, including those that process wastes generated from aquaculture. Some, however, are pathogenic and can cause serious problems for fish. Many of these pathogenic bacteria are ubiquitous, or naturally found in all water sources. These bacteria are not normally a problem unless their numbers become too great or the fish become stressed and susceptible to disease. Treatment options for these diseases include preventative measures such as quarantine of new organisms,

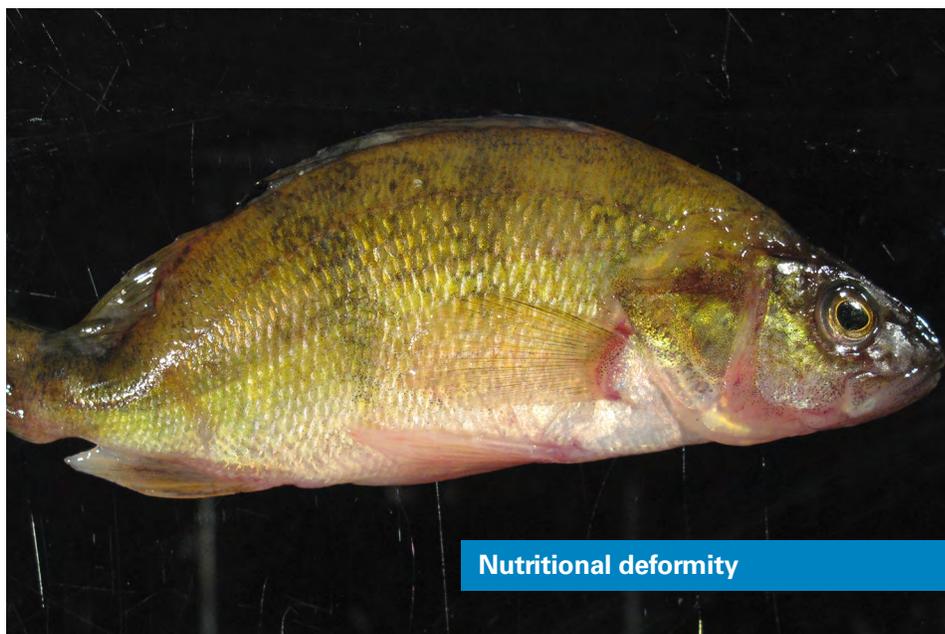
which is the best treatment method. Other preventative actions include improving solids and organics removal and sterilizing water using ultraviolet radiation or ozone treatment. Treating fish using therapeutants or drugs should only be the last resort for disease management.

Fungus – Many waterborne fungi can be pathogens to fish through a variety of pathways. Fungi tend to feed on organic matter in the system, and they may therefore be reduced by keeping the levels of organics to a minimum. Under normal circumstances, the mucus layer of the fish is sufficient to prevent the establishment of fungal infections. Under stressful conditions or around external lesions, fish are susceptible to infection, especially in cool water conditions. Optimal environmental conditions and animal husbandry practices will greatly reduce the risk of fungal outbreaks.



Parasites – Parasites of fish range from trematodes, nematodes, cestodes, and many others. They affect the internal organs, flesh, gills, skin or other parts of the fish. Parasites are uncommon in recirculating aquaculture because their lifecycles are difficult to complete in an artificial environment. Prevention of parasite introduction into the aquaculture facility is key, which often occurs when fish are brought from outdoor ponds to an indoor system. The best preventative measure for parasites is to obtain fish stock from a biosecure facility that is free of these organisms.

Environmental Toxins – Poor water quality is stressful to fish. The most critical water conditions are low levels of dissolved oxygen and high levels of unionized ammonia and nitrite. These toxins can cause reduced growth rates, decreased immune response, and even mortality. Nitrite specifically causes



Nutritional deformity

brown blood disease, which limits the fish's ability to get oxygen to its organs. Ammonia and nitrite toxicity tend to occur when the biofilter is compromised. Water quality should be measured daily to help prevent mortalities.

Feed Toxins – Feed that is stored in a humid environment is likely to be colonized by different types of molds that release mycotoxins like aflatoxin. These toxins can be particularly stressful to fish because they overwhelm the filtering capabilities of the liver, leading to reduced growth and mortality. Issues with aflatoxin may be manifested as jaundice or yellowing of the fins and other parts of the fish. Fish should not be fed moldy feeds.

Inadequate Nutrition – Deficiencies in certain vitamins, nutrients, minerals, proteins, lipids, and carbohydrates can lead to a number of disorders in fish. For example, a vitamin C deficiency can cause distortions in the bone structures of juvenile fish, leading to scoliosis. Actual diet formulations can also be problematic.

For instance, feed pellets can be too hard to break down in the gut, feeds that contain too many fines are hard to feed, and feeds with indigestible components are useless to the fish. It is important to use a species-specific “complete” feed from a reputable manufacturer to ensure that all of the nutritional requirements have been met. This may be difficult for some of the newer aquaculture species as specific diets may not have been created yet. In this case, choose a diet that is adequate for a fish that has a similar life cycle and feeding habits (i.e., carnivorous vs. omnivorous; freshwater vs. saltwater; warmwater vs. coldwater).

DISEASE CONTROL

Preventing Disease – Disease prevention is the best and least expensive practice for preserving fish health. Providing optimal water quality and preventing excessive handling will prevent stress and maximize health. Additionally, providing a biosecure facility with biosecurity practices that prevent the introduction of diseases reduces the risk of disease outbreaks.



Continual monitoring of the fish with minimal handling will help farmers recognize potential and early stage disease issues so they can be dealt with before they become detrimental to the operation.

Equipment such as ultraviolet sterilizers, ozone generators, and other water decontamination methods may be used on a continual basis to reduce the pathogen population in the water. Each piece of equipment has its associated cost in terms of purchase price and effects on water quality and other equipment. Installation and use of this equipment should be carefully considered and managed according to the specific aquaculture operation size and goals.

Recognizing Disease Behavior –

Successful aquaculturists know exactly what the health status of their fish is at all times, both because the managers grow accustomed to the behavior patterns of the fish, and because the

fish populations are regularly screened for disease issues. Abnormal behavior like lethargic or erratic swimming, sideways or upside-down swimming, scraping along the hard surfaces in the tank (flashing), gulping air from the water’s surface (piping), and diminished feeding response are indicators of fish health. It takes a trained eye to recognize these issues, and a professional to diagnose and treat them.

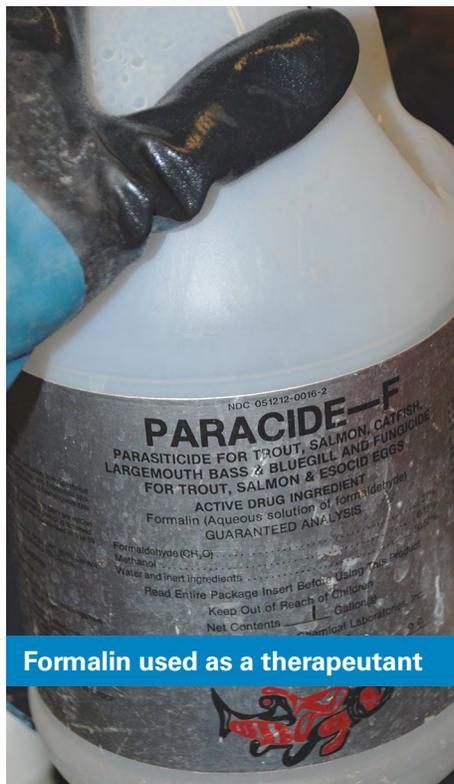
Therapeutants – Therapeutants are chemicals that can be applied to the culture water or fish feed to reduce disease issues. These can be anything from salt that is added to reduce stress to external treatments like hydrogen peroxide or formalin. Once disease issues are recognized, the least-invasive yet effective control method should be used to stop its spread. Each therapeutant will require a specific dosage rate, which is dependent on the situation. A dip is a short immersion treatment that is usually at a very high dosage rate compared to

a bath, which may last for 20 minutes (dip) to several hours (bath). Generally these therapeutants should not be used unless prescribed by an aquatic veterinarian, although some treatments like salt do not require prior approval to obtain. Even salt should be calculated to the correct dosage rate before application so as not to harm the biofilter or fish.

Aquaculture Drugs – Aquaculture drugs are targeted treatments for specific diseases. Because they are regulated, aquaculture drugs must be prescribed by an aquatic veterinarian. These drugs may be administered as fish immersion or as an additive in the feed. Common aquaculture drugs include florfenicol, sulfadimethoxine, and oxytetracycline. A list of approved aquaculture drugs from the U.S. Food and Drug Administration can be accessed on their website, www.fda.gov/AnimalVeterinary/DevelopmentApprovalProcess/Aquaculture/ucm132954.htm.



Sodium chloride salt used as a therapeutant



Formalin used as a therapeutant



Ammonia and bleach used for sterilization of equipment

FISH HEALTH SAMPLING

Collecting and Preparing Fish Samples

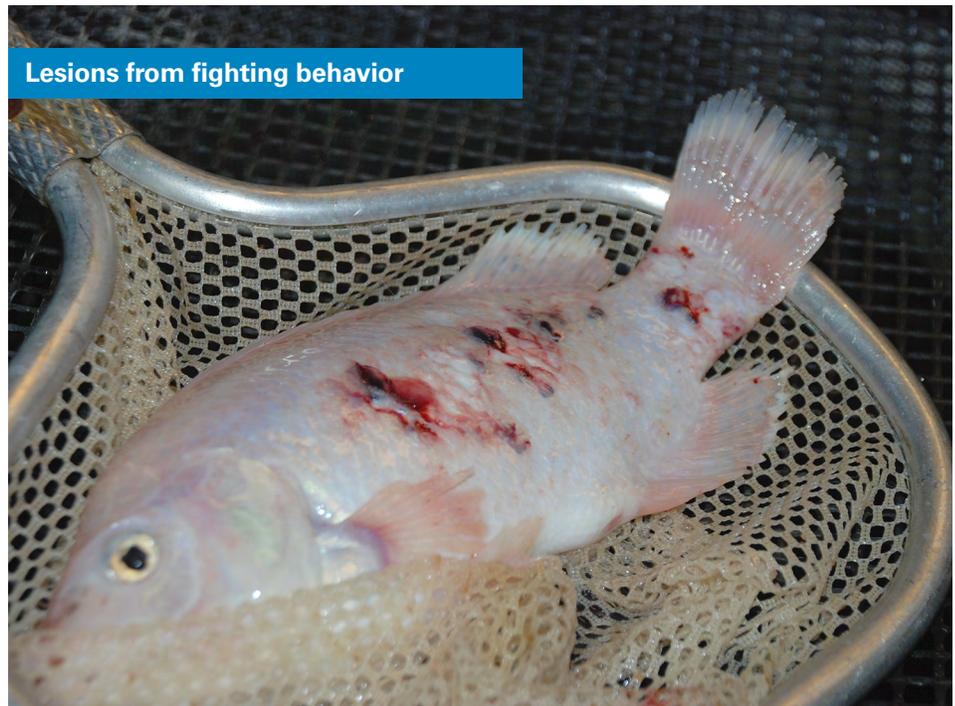
– There is an established set of procedures for collecting and shipping fish samples so that the fish health lab staff will have the greatest ability to identify and diagnose diseases and prescribe treatments.

Which Fish to Collect – Healthy fish will not yield the necessary results to diagnose disease issues, and dead and decayed fish will give a false impression of the disease problem. Only sick fish that are either alive or freshly dead should be collected for disease diagnosis by a pathology lab. Choose live fish that exhibit clinical signs of disease such as erratic swimming, flashing, piping, lesions, hemorrhages, fungal growths, fin rot, popeye, brown or eroded gills, or other abnormal symptoms.

Shipping Protocols – The packing and shipping method are very important to helping the fish health diagnostic lab staff evaluate diseases. Live, sick fish generally must be killed using an approved, humane method. The fish are then placed in a plastic bag. The bag is sealed with identification information and put on ice in a cooler for transport to the fish health diagnostic lab. It is either sent overnight or directly transported to the diagnostic lab. The time between death and diagnosis should not be more than several hours because fish will begin to decompose and the disease will not be identifiable. Below are some resources for collecting and shipping protocols:

University of Arkansas at Pine Bluff Shipping Protocols

<http://aqfi.uaex.edu/extension/fishhealth/shipping/>



Lesions from fighting behavior



Edwardsiella tarda, hybrid striped bass

United States Fish and Wildlife Service Sampling Protocol

www.fws.gov/policy/aquatichandbook/volume_2/chapter2sampcollect.pdf

Auburn University Collecting and Shipping Protocols

www.ag.auburn.edu/fish/guidelines-for-collecting-and-shipping-diseased-fish/



Where to Ship Samples – There are fish health diagnostic labs around the United States that can test for a variety of diseases. Samples should be sent to a reputable lab that has some specialty in diagnosing diseases specific to the culture organism of interest. For example, freshwater finfish samples should not be sent to diagnostic labs that specialize in only marine fish health. Following are reputable resources for finding the correct fish health diagnostic lab:

United States Department of Agriculture Approved Fish Health Diagnostics Labs
www.aphis.usda.gov/animal_health/lab_info_services/downloads/ApprovedLabs_Aquaculture.pdf

Aquatic Veterinarians
www.aquavetmed.info/

American Fisheries Society Certified Fish Pathologists
<https://afs-fhs.org/certification/afs-certified-fish-pathologists.php>

REGULATORY ISSUES

Regulatory issues may occur because of different aquaculture laws in each state. Some laws do not allow the possession of live fish if they are not on the state's approved species list. These fish can only enter the state if they are dead. If the fish are an approved species in that state, then live fish will generally need to have health permits to be transferred across state lines.

If fish are to be transferred live between facilities, especially across state lines, it is likely that a survey or screening of a random sample of fish will be needed to determine the health status of the fish and whether or not they are suitable to transport. This testing must be done by a certified fish health specialist, which can be found at the following website:

American Fisheries Society Certified Fish Pathologists
<http://afs-fhs.org/certification/afs-certified-fish-pathologists.php>

For facilities that ship on a continuous basis across state lines, it is possible to have an annual or semi-annual fish health screening of all the species in the facility to reduce the cost and frequency of testing. Facilities that only harvest annually or less than annually may fare better by conducting disease testing as needed. Please note that this testing frequency is the minimum required for interstate transport; any serious aquaculture operation should be testing at least quarterly for diseases to reduce the risk of catastrophic loss due to disease outbreaks.

The following website can guide fish farmers in determining potential issues with importation in the North Central United States:

North Central Region State Import Regulations
www.ncrac.org/node/378



Hybrid striped bass with bulged eyes (popeye)

RESOURCES

American Fisheries Society. 2014. Fish Health Section; "FHS Blue Book - 2014 edition: suggested procedures for the detection and identification of certain finfish and shellfish pathogens."; Useful Links. Accessed Jan. 21, 2015.

<http://afs-fhs.org>.

Aquatic Animal Drug Approval Partnership Program (website). Accessed Jan. 21, 2015.

www.fws.gov/fisheries/aadap/home.htm.

Cagauan, A. G., R. H. Tayaban, R.M. Bartolome, and J. R. Somga. 2003. "Effect of Aflatoxin-contaminated feeds in Nile Tilapia *Oreochromis niloticus* L." Accessed Jan. 21, 2015.

<https://ag.arizona.edu/azaqua/ista/ista6/ista6web/presentation/p172.pdf>.

Kelly, A. M. October 2013. "Medicated Feed for Food Fish." Southern Regional Aquaculture Center Publication No. 473. Accessed Jan. 21, 2015.

<https://srac.tamu.edu/index.cfm/event/getFactSheet/whichfactsheet/120/>

Manning, B. B. May 2010. "Mycotoxins in Aquaculture Feeds." Southern Regional Aquaculture Center Publication No. 5002. Accessed Jan. 21, 2015.

<https://srac.tamu.edu/index.cfm/getFactSheet/whichfactsheet/221/>.

Masser, M. P., and J. W. Jensen. 1991. "Calculating Treatments for Ponds and Tanks." Southern Regional Aquaculture Center Publication No. 410. Accessed Jan. 21, 2015.

<https://srac.tamu.edu/index.cfm/getFactSheet/whichfactsheet/83/>.

U. S. Fish and Wildlife Service. 2014. "Quick Desk Reference Guide to: Approved Drugs for Use in Aquaculture," First Edition: April 2011. Accessed Jan. 21, 2015.

www.fws.gov/fisheries/aadap/PDF/Flip-Book_FINAL_for_web_23may2011.pdf.

U. S. Food and Drug Administration. October 2014. Approved Drugs for Aquaculture. Accessed Jan. 21, 2015.

www.fda.gov/AnimalVeterinary/DevelopmentApprovalProcess/Aquaculture/ucm132954.htm.

University of Wisconsin – Stevens Point IACUC SOP #5. 2011. "Standard Operating Procedure for Fish Used in Teaching and Research." Accessed Jan. 21, 2015.

www.uwsp.edu.



AUTHOR

Prepared by D. Allen Pattillo
Extension aquaculture specialist, Iowa State University Extension and Outreach
(515) 294-8616
pattillo@iastate.edu
www.extension.iastate.edu/fisheries

PHOTO CREDITS

D. Allen Pattillo, Iowa State University Extension and Outreach,
Pages 1, 2 (top), 3, 4, 5 (top),
6 (bottom), and 7.
Nic Phelps, University of Minnesota,
Pages 3 (top), 5 (bottom), and 6 (top).
Dave Cline, Auburn University,
Pages 2 (bottom) and 3 (bottom).

...and justice for all

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at 202-720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue SW, Washington, DC 20250-9410, or call 800-795-3272 (voice) or 202-720-6382 (TDD). USDA is an equal opportunity provider and employer.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Cathann A. Kress, director, Cooperative Extension Service, Iowa State University of Science and Technology, Ames, Iowa.