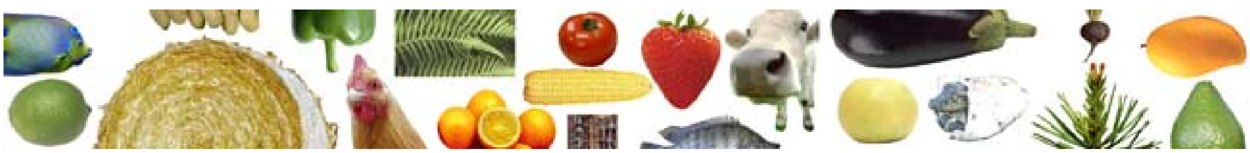
Lesson Plan

Aquaculture:

Emergency Management and Quarantine of Aquaculture Facilities

SART Training Media



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About Florida SART

SART is a multiagency coordination group consisting of governmental and private entities dedicated to all-hazard disaster preparedness, planning, response, and recovery for the animal and agriculture sectors in the state of Florida.

SART operates at the local level through county SART organizations.

SART utilizes the skills and resources of many agencies, organizations and individuals with its multiagency coordination group structure.

SART supports the county, regional, and state emergency management efforts and incident management teams.

SART Mission

Empower Floridians through training and resource coordination to enhance all-hazard disaster planning and response for animals and agriculture.

SART Goals

- Promote the active engagement of each county coordinator who is responsible for animal and agricultural issues
- Provide assistance in the development and writing of county ESF-17 plans
- Promote the establishment of a county SART to work as a multiagency coordination group to support emergency management and incident management teams
- Provide training for all SART and animal and agriculture personnel
- Identify county resources available for an emergency or disaster
- Work to comply with the National Incident Management System (NIMS) document

Subject: **Aquaculture may be Florida's least known, important commodity. This unit introduces participants to needs and procedures in helping an aquaculture facility respond to a man-made or natural disaster.**

Introduction

This lesson plan, together with a workbook and PowerPoint presentation, form a training unit entitled Emergency Management and Quarantine of Aquaculture Facilities, which is part of the SART training module for Aquaculture. This lesson plan gives the instructor direction for the educational portion of the workshop. For information on planning, organizing and publicizing the entire training event, consult the Creating a County SART Toolkit. The toolkit and other SART training materials are available on the Florida SART Web site: <www.flsart.org>.

This lesson plan is structured to identify the needs of and procedures for emergency management and quarantine of aquaculture facilities.

A PowerPoint presentation has been created to accompany the lesson. Throughout the lesson plan, symbols have been placed in the margins to indicate that a PowerPoint slide is available for that section.

Approximately 55 minutes should be allocated for this program.

Session Outline

Part 1—Beginning the Workshop	5 minutes
Part 2—Emergency Scenarios	5 minutes
Part 3—Basic Needs for Aquaculture	10 minutes
Part 4—Risk Factor Identification	10 minutes
Part 5—Facility Risk Management	10 minutes
Part 6—Highlight Key Resources	5 minutes
Part 7—Summary and Wrap-Up	10 minutes
Total	55 minutes

Learning Objectives

At the end of this unit, participants will be able to:

1. Identify natural and man-made disasters and disease-related emergencies that affect the aquaculture industry.
2. List and discuss an aquaculture operation's basic needs.
3. Identify and discuss risk factors common to an aquaculture operation.
4. List and describe effective risk management techniques as applied to an aquaculture facility.
5. Identify key resources available for more information.

Learning Environment/Aids

To complete this lesson plan, you will need:

- The PowerPoint presentation *Emergency Management and Quarantine of Aquaculture Facilities* slides
- Optional: a companion publication, *Emergency Management and Quarantine of Aquaculture Facilities: Participant Workbook*, is available. It contains copies of the PowerPoint slides and resource information

To conduct this training unit, you will need:

- A means to show the PowerPoint presentation: a computer with a projector. (Note: Master black and white copies of the slides are included at the end of this manual for use as a flipbook or, if you prefer, to make transparencies for use with an overhead projector.)
- Sufficient seating for all participants

Each participant will need:

- A pen or pencil
- Participant workbook or paper for notes

Before the Workshop

On the day of the workshop, check that all equipment needed is in place. Double-check that electronic media works on the equipment you have. Also, make certain that any materials for participants, such as paper, workbooks and pens/pencils, are available in sufficient numbers.

Part 1: Beginning the Workshop

Time: 5 minutes

Focus: Starting your training session on the right note

SLIDES 1-3

Once all participants have taken their seats and have settled down, welcome them to the Emergency Management and Quarantine of Aquaculture Facilities workshop. Thank them for attending and congratulate them on taking the time to learn about this important Florida industry. Remind them that the best way to respond to an aquaculture emergency situation is to have a foundation of knowledge on which to build.

During this introduction, you may choose to administer the Pre-Test included in this manual. Make sure to explain to the participants that the pre-test is only meant to guide them; they will not be graded. Use of pre- and post-tests can help to evaluate how much knowledge participants gain during the session.

SLIDE 4

This lesson plan can be used with agricultural and non-agricultural audiences. At the end of this training session, participants will be able to identify natural and man-made disasters and disease-related emergencies that affect the aquaculture industry, list and discuss an aquaculture operation's basic needs, identify and discuss risk factors common to an aquaculture operation, list and describe effective risk management techniques as applied to an aquaculture facility, and identify key resources available for more information. Additional aquaculture units cover general industry overview and aquatic animal diseases.

Remind attendees that the reason they are attending the workshop is because they realize the value of being prepared by having a disaster plan in place. The information they gain in this workshop will enhance their professional performance.

This introduction should not extend past five minutes. More time may be needed if the pre-test is used. This is a time when the audience is getting comfortable with the workshop they have decided to attend, the surroundings, and you, the presenter. At the same time, the presenter is getting comfortable with the audience, the material to be presented and being a presenter. Pay close attention to time; you may find yourself a bit nervous getting started. These "nerves" can make people ramble or talk faster or slower, while others may forget the time and forget to move on. Even if your audience is enjoying what they are doing, they will appreciate your discipline when the workshop ends on time.

Part 2: Emergency Scenarios

Time: 5 minutes

Focus: Describe natural and man-made disasters and disease-related emergencies that affect the aquaculture industry

SLIDES 5-7

There are three categories of emergencies that have the potential to affect aquaculture:

– natural disasters,
– man-made disasters, and
– biological disasters, such as endemic and foreign aquatic animal disease (FAAD) outbreaks.

Natural disasters like hurricanes, drought, flood and fire occur by force of nature. Some of these disasters, like hurricanes, have a time period before they strike, during which people can make last-minute preparations to secure property and life and potentially evacuate, if necessary. In order to prepare an aquaculture facility for hurricanes and floods, protective barriers should be constructed to prevent the release of nonindigenous species into the surrounding ecosystem. Depopulation of the stock may be a last resort if conditions are such that protective barriers for the facilities do not work. Depopulation may also be needed if the conditions after the natural disaster warrant it. Evacuation of broodstock and/or high-value animals may be an option if there is enough time before the disaster. If evacuation is chosen, a plan for short- and long-term contingencies for the animals is advised. Part of evacuation planning involves securing transportation, housing, water, oxygen and supportive therapy for evacuated animals. Once the time arrives for recovery, carcass disposal and euthanasia of sick and dying animals become tasks of importance. Humane euthanasia practices should be utilized. Carcass disposal should be conducted within state regulatory requirements.

The 2004 hurricane season in Florida provides a good example of how natural disasters can affect an aquaculture facility. Wind damaged buildings and equipment. Flooding contaminated facilities leading to loss of animals. Power and water outages created breaks in operations facility management.

SLIDES 8-10

[Slides 8, 9 and 10 show some of the damages seen after Hurricane Jeanne in 2004. Slide 8 shows wind damage to shelters housing aquaculture systems and also shows cages blown by the wind into earthen ponds containing fish. Flooding is of great concern to the producers using earthern ponds because as seen on Slide 9, the flooding merges the ponds. This merging can spread disease, promote interbreeding (separate colors of fish produce an unsellable multicolor offspring), mix incompatible species (one species is killed by the other) and requires an incredible amount of time and labor to separate the hundreds to thousands of fish into their respective species populations. Slide 10 is a photo simply illustrating efforts to restore power. Many audience members will undoubtedly have some memories of the 2004 hurricanes and the hurricanes' effects on their farms and lives. This is a time that one or two members may share their experience. Make sure to keep it brief as too many stories will take up all the presentation time.]

SLIDE 11

Man-made disasters include agroterrorism, nuclear fallout and chemical spills, among others. These disasters are the result of human error or human intention. Slide 11 shows a news story about a man-made disaster. Remediation of the effects of these types of disasters on aquaculture products depends on the ultimate disposition of the product. Disasters involving fish intended for human consumption should undergo intensive investigation to determine the impact of the disaster on the safety of the animal and the animal product. In many cases, these animals will be euthanized and disposed of if there is a possible threat to the human consumer. [This is a good point for the audience to work with: why should food fish not be eaten after such disasters as named above have occurred. This participation will help the audience think critically about the issues of man-made disasters. Critical thinking should be emphasized throughout this presentation.] Non-food fish, or ornamental fish, should undergo investigation as well. The ultimate result of a man-made disaster on ornamental aquaculture products is the loss of consumer confidence and economic loss.

SLIDE 12

On-farm biological disasters include fish and economic losses related to the outbreak of diseases caused by pathogens such as viruses, bacteria, fungi, parasites. Foreign Aquatic Animal Diseases (FAADs) such as Spring Viremia of Carp (SVC), White Spot disease (WSD) in shrimp and Bonamiosis in molluscs have the potential to devastate an entire farm's stock, threaten other farms, and impact trade with other countries. [Some or all of the audience may have participated in the training unit, Aquatic Animal Diseases. This would be an opportune moment to solicit answers from the audience about other emerging and endemic aquatic animal diseases. This allows participants to apply the information from a previous unit to the current one.] If an FAAD is suspected, diagnostic confirmation should be obtained as soon as possible. If tests report positive results, quarantine steps should be taken immediately to prevent further infection. State officials will typically initiate and direct a "biocontainment" effort after a confirmed diagnosis. Movement of fish onto and from the farm will most likely be restricted. Generally, stock will be depopulated in a humane manner and carcasses disposed of according to state regulations. After depopulation, disinfection of the affected areas will be necessary. There are disinfection techniques specific to the various aquaculture systems; some work for multiple systems and others are only good for a particular situation.

Part 3: Basic Needs for Aquaculture

Time: 10 minutes

Focus: List and discuss an aquaculture operation's basic needs

SLIDE 13

Every aquaculture operation, regardless of system design or product raised (for example, food fish versus non-food fish), requires suitable water, air and temperature regulation. Lack of any one of these or interruption of the ability to provide for it could have catastrophic consequences.

SLIDE 14

[Slide 14 shows a graphic that aids in the explanation of the types of aquaculture systems available. There are extensive and intensive aquaculture practices. Static systems are generally used in extensive aquaculture. Flowing systems are used in intensive aquaculture. There are two types of flowing systems, open and closed. Details of each of these types follow.]

SLIDES
15-16

The term “extensive aquaculture” is used to describe aquaculture systems that rely on few inputs from the aquaculturist. These operations are typically conducted in static water systems, like pond culture. These water systems are usually open, meaning that they are free to receive natural inputs of water. Because of the lower input levels, lower yields are associated with this practice. An example of extensive aquaculture use is catfish farming in the Mississippi River delta, where they use large ponds to raise the fish.

“Intensive aquaculture” usually relies completely on artificial inputs of food and therapeutic agents, and is generally conducted in flowing systems like raceways and net pens. These water systems are often closed, meaning that the water is reconditioned and recirculated. Because of higher water volume and higher inputs, yields are typically higher compared to extensive aquaculture practices.

Static water systems must have a reliable water source. They require input only occasionally. An example of a static system is an earthen pond.

Flowing systems require a continuous water supply. These systems can be defined as either open or closed. Examples of flowing systems include raceways, ocean net pens, and recirculating systems.

Open systems have water flowing through the system and then the water is released into a water body; no water is recycled for reuse. These systems require a suitable, reliable water source and typically have excellent water quality. High stocking densities are capable in an open system. Raceways, pens and cages are examples of open systems.

Closed systems, also known as recirculating or reuse systems, are systems in which water from the culture chamber (where the fish are) is recycled back after passing through some type of treatment, or filtration, to improve water quality. Less water is needed to operate a closed system, thus less effluent is produced. There is greater control over water quality, but limited stocking density. Increased costs of operation should be expected with a closed system as well because of the equipment required and the electricity needed to run the equipment. Ponds, aquariums and recirculation systems are examples of closed systems.

SLIDE
17

[Slide 17 shows two open systems. The top left picture is a raceway designed so that water enters one end of the system and then flows one-way down through the culture chambers, then out into a water body. It does not re-enter culture units. Designs are usually a stairstep-type. No biofilter is required on this. The bottom right picture is a net pen situated in an open body of water so that water is flowing through the net pen.]

SLIDE
18

[Slide 18 has pictures showing examples of two closed systems. The picture on the left is of standard glass aquariums connected by a common sump, bead filter, electric pump, ultraviolet light (UV) and fluidized bed column. Water is recycled from the aquariums through the filtration chambers then back to the aquariums. The picture on the right is of a larger fiberglass aquaculture tank system. These tanks are all connected by a much larger recycle filtration system.]

SLIDES
19-21

Water is by far the most important input for an aquaculture system. Poor water quality kills more fish than any disease. Water supply may come from a protected source, like a municipality or well, or from an unprotected source, like surface water or natural water bodies. The assumption of this distinction between protected and unprotected sources is that protected water sources have less risk of environmental or biological contamination. However, it is important to remember that protected water sources may not be suitable for all species being reared.

Different species have different water quality parameter requirements. For example, municipal water is chlorinated to make it safe for human consumption; however, chlorine is highly toxic to fish. Tap water must be dechlorinated prior to use in aquaculture systems. Two effective dechlorination methods are the use of vigorous aeration of the water and either sodium thiosulfate (7 mg/L for each 1 mg/L of chlorine) or commercial dechlorinators. In some areas, like Hillsborough County, Florida, the municipal water is treated with not only chlorine, but also chloramines. Activated carbon or sodium thiosulfate in combination with ammonia neutralization may be used to deactivate this chloramine treatment of municipal water. Well water may also contain contaminants which may be harmful or lethal to fish. Elevated hydrogen sulfide, iron or carbon dioxide or dissolved nitrogen gas levels may be present. To overcome some of these problems with well water sources, systems are designed to de-gas water before it goes into the tanks.

Test kits are available and recommended to monitor the water quality of the systems in use. Parameters of importance include ammonia, nitrites, dissolved oxygen, pH, hardness, turbidity, chlorine and heavy metals. Remember to check the expiration dates on any kits used. If no expiration date is listed, then replace the kits once per year. After using any part of a kit in the water, rinse well before using again. Store all testing kits in a cool place; do not keep them stored in a hot place like a truck cab or toolbox!

Filtration of the water in the system is important as well. Typically, components of an aquaculture filtration unit consist of mechanical and biological chambers. A power source is usually required to run the filtration unit. Mechanical, biological and chemical methods are available for filtration.

Mechanical filtration is effective in removing suspended solids and fouling organisms like sand, feed particles and fecal debris from the water. The water exchange rate is low to allow for the settling of solids. Many methods and mediums can be used. Some examples of mechanical filtration include gravel and sand filters and gravity and pressurized systems. All of these devices must be well maintained because they can clog easily. Mechanical filtration is usually the first component of a recirculating system.

In biological filtration, the major function is the bacterial nitrification of ammonia. The primary source of ammonia in aquaculture is its excretion from the gills of fish. Ammonia, especially in its unionized form, is toxic to fish. Tolerance of ammonia toxicity varies from species to species. For example, the no-effective level (NOEL) of unionized ammonia for catfish is 0.06 parts per million (ppm), for trout is 0.01 ppm and for tilapia is 1 ppm. The size of biofilter needed for a system is determined by the amount of ammonia in the system and the biofilter's efficiency.

SLIDES 22-23

A biofilter has several requirements for proper function. The filter must have surface area for bacterial colonization, oxygen and sufficient time. For example, *Nitrosomonas* spp. are used for the conversion of ammonia to nitrite and Nitrobacter spp. for conversion of nitrite to nitrate. The conversion of ammonia to nitrate is a one-way reaction; once the reaction takes place, the reaction products cannot revert. During the conversion of ammonia to nitrite, hydrogen ions are released into the system causing the pH to drop over time. A buffering system should be in place to counteract this. Nitrification is an oxidative process and must have oxygen. Anaerobic conditions will kill a biofilter.

A biofilter must have time to establish proper function, which can take several weeks to several months. Once a system is established with the appropriate bacteria, and as ammonia builds up, there will be a lag-time during which conversion of ammonia to nitrite will begin, followed by conversion of nitrite to nitrate. Put another way, increasing amounts of ammonia signal nitrifying bacteria to "gear up" and start the bacterial conversion process. As nitrite levels build up, another group of nitrifying bacteria become active and start the conversion of nitrite to nitrate. Nitrate is the least toxic form of nitrogen in an aquaculture system. Nitrate is primarily reduced or eliminated from a system with water exchanges as needed. [Now that you have explained the nitrogen cycle and biofilter diagrams located on Slides 22 and 23, check with the audience before moving on from this topic. Ask if there are any questions or if clarifications are needed.]

SLIDE 24

Commercial chemical products are available to bind ammonia. However, these should be used with caution and only in an emergency situation. They do not fix the problem of an inadequate biofilter.

SLIDE 25

Fish must have water with dissolved oxygen in it. The term dissolved oxygen refers to the oxygen gas that is dissolved in water. Fish have gills specialized to take oxygen out of water despite the water being 800 times denser than air and containing only three percent the amount of oxygen found in air. Generally, dissolved oxygen (DO) levels should not fall below 5 ppm, but tolerance is species-specific and environmental conditions may alter how much DO fish need. High stocking densities and feeding times are two examples of environmental conditions that result in the need for increased dissolved oxygen. Oxygen depletion may result in more fish kills than all other factors combined.

The quality of the air source being used should be ensured. Four ways to effectively provide oxygen to the system are through chemical, photosynthetic, diffusive and mechanical means. Dissolved oxygen can be provided chemically with products like oxygen tablets. Photosynthesis produces oxygen as a by-product of plant-light interaction. The amount of oxygen produced is directly related to the number of plants. However, in the absence of light, plants take up oxygen and give off carbon dioxide. The photosynthetic process slows in cooler water temperatures. Diffusion directly transfers oxygen from the environmental atmosphere to the water. This is influenced by temperature, elevation, barometric pressure and water salinity. Mechanical aeration devices and techniques work by increasing the area of contact between air and water. Water should be circulated so fish can find areas with higher oxygen concentrations; circulation reduces stratification as well. Mechanical devices should be chosen to produce the smallest bubble size. Smaller bubbles rise slower and have greater surface area for oxygen diffusion.

SLIDE 26

Dissolved oxygen is depleted by animal and plant respiration, organic decomposition and the natural diurnal cycle of dissolved oxygen. The highest levels of DO occur at dusk. The lowest levels occur at dawn after a period of high oxygen consumption by animals and plants. Tolerance of low DO is species-specific, but a good rule of thumb is to not let DO fall below 5 ppm. Clinical signs of fish affected by low DO include gulping at the surface, lethargy, loss of appetite, increased ventilatory effort and death. Larger fish tend to die first in these conditions because they have a higher metabolism.

SLIDE 27

As water temperature increases, oxygen solubility decreases and as water temperature decreases, oxygen solubility increases. As salinity increases, oxygen solubility decreases and as salinity decreases, oxygen solubility increases. As pressure increases, oxygen solubility increases and as pressure decreases, oxygen solubility decreases.

Fish are ectotherms, meaning that they use the temperature of their surroundings to control their body temperature. Temperature directly affects fish

SLIDE 28

metabolism, feeding and survival. A fish's metabolism increases rapidly as temperature increases. As temperature decreases, the demand for food and oxygen decreases. Temperature also has an effect on a fish's immune system. When proper temperature is maintained, fish are generally immuno-competent, meaning that their immune systems are working at good levels to protect them from disease. However, when water temperatures are below optimum, fish may become immuno-suppressed, and they will be more susceptible to disease.

No other physical factor affects development and growth of fish as much as temperature. Optimal temperature range is species-specific. Fish must also be protected from rapid changes in water temperature and extremes of heat and cold. Temperature changes should be done gradually. Changes greater than 5 to 10 degrees should be done over several hours to several days. Signs of temperature stress are lethargy, abnormal behavior, increased ventilation and death. To prevent temperature stress, avoid moving fish during times that may pose a temperature stress, protect from heat and cold and acclimate them to new water temperatures over time.

SLIDE 29

Based on the needs described herein, the following tools are needed for an aquatic facility emergency. Water needs must be identified and estimated so that water may be stored ahead of time or an alternate water source should be determined and made available. This could include bottled water or drinking water. Make sure that whatever alternate water source is chosen, it is treated so that it is safe for use in the aquaculture system. Avoid deionized, distilled and reverse osmosis water. Keep in mind that a power source may or may not be available to get this alternate water into the system, so this issue must be addressed when deciding on a suitable alternative.

Test kits and certain equipment should be available in a location that is easily accessible. A water test kit should have the ability to measure the ammonia, nitrite, pH and dissolved oxygen levels. A DO meter can be used to measure dissolved oxygen. A thermometer, for temperature readings, and a refractometer, for salinity levels, should be kept with the water test kit(s).

A back-up power source should be obtained prior to an emergency to keep the facility operating. The generator selected should be large enough to handle all the essential power needs of the facility. If budget allows, larger or additional generators can be added as needed to the facility to provide for additional, nonessential power. Fuel needs for the generator(s) must also be accounted for. There are several steps that can help assess a facility's fuel needs for their generator(s). First, speak with the local energy supplier, so they know the importance of power for the facility; this may not guarantee immediate return of power, but may place you higher on the must-have-power list. During this conversation, find out how soon the energy supplier estimates power being restored to facilities during various disasters. Take this estimate and use it to calculate how much fuel is needed to run the generator(s) at full output. Add a day or more cushion to this estimate; remember, it is better to have more than enough fuel than not enough. No one has ever complained that they had overplanned!

The oxygen supply to the systems must be continued during the emergency and recovery period. If the primary source of oxygen is power-generated, then an alternate source must be identified or alternative power source selected to power the primary source. Remember to calculate fuel needs for the alternative power source, too.

Supportive therapies that fish in a system already need prior to an emergency should be identified. Additional fish may need these therapies, too, before the end of an emergency time period. The means to provide these therapies should be secured. If no therapies reach fish needing them, carcass disposal and euthanasia methods become the next course of action.

In the event that a disease is suspected at the facility, an available diagnostic facility needs to be identified. Diagnostic facilities may be overloaded or shut down in emergency situations. This needs to be anticipated. A list of local, in-state and out-of-state diagnostic laboratories should be identified with various methods of contact, such as Web sites, e-mail, or emergency phone numbers.

SLIDE 30

Emergency preparation starts with understanding the functions and needs of the systems in use. The next step is identification of risk factors and risk management practices for the facility that should be incorporated into daily operation and into disaster and emergency planning. Knowing how pathogens are transmitted and how to prevent transmission is helpful whether you regularly work in an aquaculture facility or are simply responding to a facility after a disaster has struck. [This would be another good opportunity to ask audience members why they think this is true. Listen for or promote the idea that knowing basic risk management strategies is essential in animal and agriculture disaster response. This knowledge benefits responders by allowing them to not make a disaster situation worse by spreading disease, mixing up tank-specific equipment, etc.]

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Part 4: Risk Factor Identification

Time: 10 minutes

Focus: Identify and discuss risk factors common to all aquaculture operations

SLIDE 31

Biological hazards have several modes of transmission. Aerosolization of water droplets, often caused by splashing, may carry bacterial, viral, parasitic and fungal organisms. Contamination can be introduced from fish, equipment, personnel, feed and/or water. Vertical transmission is the transfer of a pathogen from adult to offspring. In fish, this is typically from the female to her eggs. Eggs may be contaminated either externally or internally. Methods are available to disinfect eggs for pathogens carried on the external surface. Horizontal transmission is the transfer of pathogens directly from fish to fish. Densely stocked culture systems are susceptible to rapid pathogen proliferation and high levels of disease incidence. Potential vectors of pathogen transfer are personnel, equipment and some parasites. Transmission of many diseases can be prevented with proper risk management.

SLIDES 32-35

There are three groups of risk factors associated with an aquaculture facility and its management: incoming materials, on-farm management and outgoing effluent and products. Incoming materials include fish, equipment, people (workers, visitors, deliveries, etc.), feed and vehicles. On-farm management consists of the fish, quarantine practices, traffic, and equipment flow. Fish and water are the effluent and outgoing products. Identification of intervention points within this workflow will enhance animal health and provide better biocontainment/biosecurity practices.

Several steps should be taken to ensure the health of the fish in the aquaculture system. Incoming fish present the risk of pathogen introduction. Incoming fish can pass pathogens on to resident fish and vice versa. Recommended intervention tactics are to purchase from low-risk, reputable fish sources and practice quarantine and/or acclimation. The health status of incoming fish should be monitored for the presence of pathogens or signs of stress which could predispose the fish to disease. Treat any fish for identified pathogens.

Environmental conditions should be monitored routinely. Filtration systems should be checked and cleared as needed. Health treatments should be performed as needed along with proper nutrition provided. Daily observation is very important to develop a sense of what is normal for the fish and when something is awry.

Water management practices include maintaining fish in separate systems and between-use cleaning and disinfection. Separate system containment is a good idea, but not always feasible. Water disinfection with ultraviolet (UV) radiation and/or ozone is an option. The equipment used to disinfect the water should be monitored for efficacy. Use appropriate dose ranges for the pathogens targeted.

Proper maintenance of feed supplies and their storage areas is important. Feed should be kept dry, protected from pests and kept in a temperature-controlled environment.

Equipment is another risk factor in aquaculture facility management. Equipment can easily spread pathogens. Intervention tactics for equipment include multiple dip buckets, restricted net sharing, separate nets for quarantine/suspect fish, and dip change protocol. Equipment used in day-to-day facility operations should have multiple disinfection stations near the areas of use to make it easier for personnel to sanitize equipment. Each time equipment is used it should be disinfected to prevent the spread of any contaminants. Equipment sharing should be limited as much as possible. Separate equipment should be utilized for acclimation and quarantine areas. A dip change protocol should be instituted to routinely change the dip solutions used.

Personnel risk pathogen introduction and dissemination by transporting the pathogen from one tank to another. Ways to prevent this include training personnel in the proper protocol, limiting access in different areas to certain personnel, and instituting a hygiene program. Traffic flow should be minimized throughout the operation. This is especially true for quarantine and acclimation areas where fish are new to the environment and under stress. Acclimation and quarantine fish should be handled last. Alternatively, specific personnel could be assigned to handle only these areas of the operation. Hygiene programs should include foot bath and hand wash stations, clean clothes, protective clothing, and awareness of the hygiene program expectations.

Part 5: Facility Risk Management

Time: 10 minutes

Focus: List and describe effective risk management techniques as applied to aquaculture facility

SLIDES
36-39

A quarantine area is an isolated space separate from resident fish with dedicated equipment and supplies, limited foot-traffic and managed personnel and traffic flow. Some goals of quarantine are to prevent bag water from entering the aquaculture system, in addition to preventing disease and pests in/on the fish from contaminating a clean population.

The bag water that fish are transported in is a potential source of pathogens. Bag water has poor quality due to wastes accumulated during transport, including high ammonia and carbon dioxide and low pH levels. It is poor management to allow bag water to be introduced into the established system.

The length of time fish should be in quarantine depends on the life cycle of the pathogen to be controlled. The recommended minimum time for quarantine is four weeks or more. It is important to remember that the goal of quarantine practices should not be to eliminate all pathogens. This would be impossible and impractical. Management practices should be targeted toward specific pathogen elimination or prevention. Monitor the health status of the fish and treat for specific pathogens as clinical signs are expressed. Some diseases' clinical signs will not be expressed unless the temperature is adjusted to its optimal range. For example, if water temperature is at 75°F (24°C), SVC probably will not express itself; the temperature must be changed to the range in which the disease expresses itself, in the case of SVC, 58 to 68°F (12 to 28°C). Using quarantine practices allows for the safe manipulation of the fish's environment.

Acclimation is defined as a method to slowly introduce fish to a new environment. For example, new fish brought into a facility need to be acclimated to the water quality conditions like pH and temperature at the new facility. During this period, it is possible to perform therapeutic treatments. The pictures on Slide 38 show an acclimation table.

Several positive and negative qualities are attributable to quarantine and acclimation. Effective quarantine protocols require a minimum of four weeks to complete whereas acclimation can be completed within hours. Fish in quarantine are isolated in separate systems with separate equipment in reduced densities according to species or origin. Fish are acclimated in groups, usually the group they arrived with. Acclimation aims for stress reduction, and quarantine aims for diagnostics and treatment of pathogens found. Acclimation allows for bath treatments as necessary if a pathogen is found or suspected. Quarantine is optimal for pathogen control and elimination, however requires more labor and money to perform. Acclimation is less than optimal for pathogen control and elimination, but can be less expensive.

SLIDES
40-41

Collecting fish samples is part of the diagnostic process for determining disease and mortality causes in aquaculture. Sampling for tests is especially important and necessary with diseases that share clinical signs like Koi Herpes Virus (KHV) and Spring Viremia of Carp (SVC). Certain steps should be taken when preparing a sample to get the most accurate diagnosis possible. First, case history information should be gathered which should include general, behavioral, physical and treatment information. A clean water sample should be taken for water quality evaluation. Take a clean transport bag and seal it beneath the water surface so tha no air is trapped in the bag. Do not use the water the fish are transported in; a separate water sample must be shipped. Collect three to five live, moribund fish and place them in an appropriate container to ship. If multiple species are affected, then collect samples of all species, bagged separately. If the fish are dead, wrap them in a moist paper towel and place in a zipper-lock bag. Refrigerate the dead fish, do not freeze them.

Call the diagnostic lab prior to shipping the fish sample, so they will expect the package. Package the live fish sample in a double-bag one-third full of water. Make sure an oxygen source has been included for live fish like compressed oxygen or oxy tabs. If necessary, add cool packs in the summer or heat packs in the winter to keep the package at the appropriate temperature during shipping. All bags should go inside a styrofoam box and then in a cardboard outer box. Make sure to package the historical information gathered in a plastic bag to prevent damage in the event that any water-filled bags leak. Label the exterior of the box “LIVE FISH.” Ship the package overnight mail or hand-deliver when and where applicable.

Euthanasia

SLIDE
42

Emergency scenarios may dictate that fish populations must be destroyed. Two examples of such scenarios are the outbreak of a foreign aquatic animal disease (FAAD) or the imminent threat of non-native species release because of facility flooding. Primary methods for euthanasia are drug overdose and carbon dioxide compressed gas with rotenone. MS-222 and benzocaine are two drugs used for euthanasia. However, these drugs may be expensive for large populations of fish. Fish euthanized with MS-222 are not suitable for human or animal consumption. Compressed carbon dioxide gas and rotenone are practical solutions for larger populations. The USDA has used both for Spring Viremia of Carp (SVC) infected/exposed fish depopulation. A secondary method of euthanasia is stunning followed by decapitation.

[The top right picture on Slide 42 shows a tank of koi euthanized with compressed carbon dioxide gas. The numbered pictures at the bottom of the same slide show the stages of anesthetic overdose when MS-222 is used. Picture 1 is of a goldfish swimming normally prior to drug addition. After a few minutes, the fish is unable to maintain orientation in the water column, shows normal or slightly increased or decreased ventilation and responds to stimuli as shown in picture 2. By picture 3, the fish is sedated/anesthetized. Ventilation is reduced or intermittent and equilibrium has been lost. Picture 4 shows the result of overdose, death.]

SLIDES 43-44

[Slides 43 and 44 provide the opportunity for the audience to evaluate the scene pictured and provide details of the biosecurity shown. Some questions to ask if the audience remains silent could be: What do you see hanging by the tank? Hanging in the background? The audience should be able to state that each tank has its own net and scrub brush, examples of good biosecurity. Once audience members have offered some guesses, continue to Slide 44. Slide 44 has the target areas circled on the photo. Make sure to ask if there are any questions before proceeding to the next section.]

Part 6: Highlight Resources

Time: 5 minutes

Focus: Identify key resources that participants can easily access for additional information

SLIDES
45-51

The following are sources of additional information about the agencies, manuals and documents mentioned in this module. Others listed, but not mentioned in this module, may be helpful resources as well. [Note that Web addresses on the PowerPoint slides are hyperlinked to allow you to visit these sites during the presentation to show the audience anything you find particularly noteworthy.]

- USDA-APHIS fact sheets for various animal diseases, aquatic included, are available on the World Wide Web. On-line at: <http://www.aphis.usda.gov/lpa/pubs/fsheet_faq_notice/fsfaqnot_animalhealth.html>
- APHIS's Center for Emerging Issues (CEI) has various worksheets available on animal health and diseases of concern. <http://www.aphis.usda.gov/vs/ceah/cei/worksheets.htm>
- Aquatext.com is a free, on-line aquaculture dictionary. <http://www.aquatext.com>
- Florida Department of Community Affairs, Division of Emergency Management. <http://www.floridadisaster.org>
- United States Department of Agriculture (USDA). <http://www.usda.gov>
- Florida Department of Agriculture and Consumer Services (FDACS). <http://www.doacs.state.fl.us>
- FDACS Division of Aquaculture. <http://www.floridaaquaculture.com>
- The Division of Aquaculture's Aquaculture Best Management Practices Manual. <http://www.floridaaquaculture.com/BAD/BMP%20Rule%20-%20Manual%206-9-04.pdf>
- Aquaculture Network Information Center. <http://aquanic.org>
- USDA Animal and Plant Health Inspection Service (USDA-APHIS). <http://www.aphis.usda.gov>

- World Organisation for Animal Health (OIE). <http://www.oie.int>

- Safety for Fish Farm Workers video on the National Ag Safety Database (NASD), English and Spanish versions available. <http://www.cdc.gov/nasd/videos/v001401-v001500/v001433.html>

- *Spawn, Spat, and Sprains,* produced by the Alaska Sea Grant College Program, describes the dangers faced by shellfish farmers and salmon hatchery workers at the aquaculture worksite. It also tells how to reduce the chance of injury. Chapters include physical and chemical hazards, proper lifting techniques, airplane and boat safety, basic first aid, electrical hazards, fire fighting, cold water survival, and coping with bears. The entire book can be downloaded from: <http://www.uaf.edu/seagrant/Pubs_Videos/pubs/AN-17.pdf>

- Dr. Kathleen Hartman, an aquaculture epidemiologist, can be consulted for any questions:

Telephone:	813-671-5230, ext. 119
E-mail:	kathleen.h.hartman@aphis.usda.gov
Address:	1408 24th Street, SE Ruskin, Florida 33570

- University of Florida Institute of Food and Agricultural Sciences Electronic Data Information Source (EDIS) fact sheets for aquaculture, aquatic diseases and facility management can be found at: <http://edis.ifas.ufl.edu/DEPARTMENT_VETERINARY_MEDICINE> and <http://edis.ifas.ufl.edu/DEPARTMENT_FISHERIES_AND_AQUATIC_SCIENCES> and <http://edis.ifas.ufl.edu/TOPIC_Fish>.

- "Aquaculture Natural Disaster Preparation and Recovery," a Clemson University Cooperative Extension Service publication is available at: <http://www.clemson.edu/psapublishing/PAGES/AFW/AFW12.PDF>.

- University of Florida IFAS Extension Disaster Handbook. <http://disaster.ifas.ufl.edu>

- Southern Regional Aquaculture Center (SRAC) fact sheets on topics ranging from tanks to tilapia are available for download at: <http://www.msstate.edu/dept/srac/fslist.htm> or <http://srac.tamu.edu>.

Part 7: Summary and Wrap-Up

Time: 10 minutes

Focus: Review the learning objectives that have been accomplished and encourage a commitment to SART

SLIDE 52

You and your audience have had a stimulating and practical session, but it is almost over. Prior to answering any audience questions or comments, provide a summary to the participants of what they just learned:

- Natural and man.made disasters and disease-related emergencies that can affect an aquaculture facility
- The basic needs for an aquaculture operation
- Risk factors common to operating a facility
- Effective risk management techniques that can be applied to prepare for an emergency or mitigate one
- Valuable resources available for more information

SLIDE 53

Thank the audience for their attention and participation. Congratulate them for their commitment to the SART endeavor and on their desire to be part of the solution.

At this point, you may elect to have the participants take the Post-Test provided in the Resources section of this manual. Remember to review the answers to the test questions after all participants complete the test.

A content-specific evaluation is provided in the Resources section of the manual. The generic evaluation available in the SART unit *Creating a County SART* can be utilized as well. Please have participants complete this item at the conclusion of the session. Encourage participants to be as honest and forthright as possible as it helps you, the presenter, make adjustments for future presentations, which in turn benefits future participants.

Notes

Participant's Evaluation of *Emergency Management and Quarantine of Aquaculture Facilities*

Please circle the number that best expresses your opinions about the following statements.

		FULLY DISAGREE	DISAGREE	NEUTRAL	AGREE	FULLY AGREE
1.	The training unit's format was appropriate.	1	2	3	4	5
2.	The information presented was useful to me.	1	2	3	4	5
3.	The time it took to complete this unit was acceptable.	1	2	3	4	5
4.	Disasters that can affect aquaculture were clearly outlined.	1	2	3	4	5
5.	The basic needs of an aquaculture operation were adequately explained.	1	2	3	4	5
6.	Risk factors associated with aquaculture facility management were clearly explained.	1	2	3	4	5
7.	Risk management techniques were clearly outlined.	1	2	3	4	5
8.	Available up-to-date resources were clearly outlined.	1	2	3	4	5

9. We welcome your comments about this program:

____

____

____

____

____

Please use the back of this sheet for any further comments.

Thank you for your time!

Emergency Management and Quarantine of Aquaculture Facilities Participant Pre-Test

This pre-test is intended to gauge the level of knowledge that you have before participating in the *Emergency Management and Quarantine of Aquaculture Facilities* training. Please answer all the following questions to the best of your ability.

1. Name four types of natural disasters. ____
____
____

2. An example of a man-made disaster is ____.

3. A ________________ water system recycles water from the culture chamber back into the system after filtration or treatment.

4. Name five water quality parameters of importance in an aquaculture system.
____
____

5. The primary function of biological water filtration is nitrification of ammonia. True or False? ________________

6. Although tolerance of low dissolved oxygen levels is species specific, a minimum level of 10ppm is acceptable. True or False? ________________

7. Name three tools or resources needed for any aquatic facility emergency. ____________
____
____

8. Intervention tactics for preventing personnel from spreading pathogens include ______________, limited access and a _____________ program.

9. Quarantine requires a minimum of two weeks. True or False? ___________

10. List three resources useful for aquatic animal facility management and emergency.
____
____
____

____

Emergency Management and Quarantine of Aquaculture Facilities Participant Post-Test

This post-test is intended to gauge the level of knowledge that you have after participating in the *Emergency Management and Quarantine of Aquaculture Facilities* training. Please answer all the following questions to the best of your ability.

1. Name four types of natural disasters. ______________________________
____
____

2. An example of a man-made disaster is ______________________________.

3. A ______________ water system recycles water from the culture chamber back into the system after filtration or treatment.

4. Name five water quality parameters of importance in an aquaculture system.
____
____

5. The primary function of biological water filtration is nitrification of ammonia. True or False? ______________

6. Although tolerance of low dissolved oxygen levels is species specific, a minimum level of 10ppm is acceptable. True or False? ______________

7. Name three tools or resources needed for any aquatic facility emergency. __________
____
____

8. Intervention tactics for preventing personnel from spreading pathogens include ____________, limited access and a ___________ program.

9. Quarantine requires a minimum of two weeks. True or False? __________

10. List three resources useful for aquatic animal facility management and emergency.
____
____
____
____

Answer Key to *Emergency Management and Quarantine of Aquaculture Facilities* Pre- and Post-Tests

1. Name four types of natural disasters. **Answers will vary: Hurricanes; drought; flood; fire; or any others that qualify.**

2. An example of a man-made disaster is **(Answers will vary) bioterrorism; agroterrorism; nuclear fallout; chemical spill; etc.**

3. A **closed** water system recycles water from the culture chamber back into the system after filtration or treatment.

4. Name five water quality parameters of importance in an aquaculture system. **Answers will vary: Ammonia; nitrites; dissolved oxygen (DO); temperature; hardness; pH; turbidity; carbon dioxide; chlorine; heavy metals; or any others that qualify.**

5. The primary function of biological water filtration is nitrification of ammonia. **True**.

6. Although tolerance of low dissolved oxygen levels is species specific, a minimum level of 10ppm is acceptable. **False**.

7. Name three tools or resources needed for any aquatic facility emergency. **Answers will vary: Alternate emergency water source; test kits; equipment; back-up power source; oxygen; supportive therapy; diagnostic resource; or any others that qualify.**

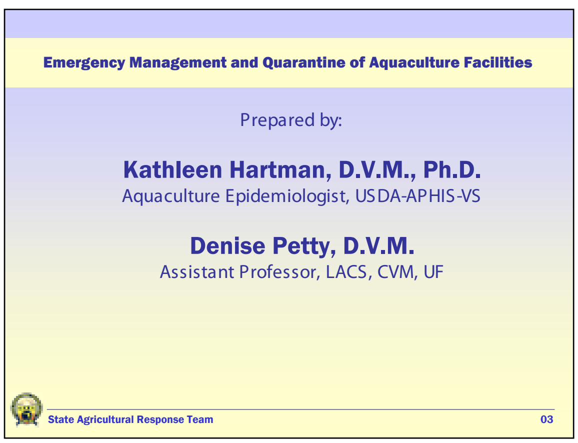
8. Intervention tactics for preventing personnel from spreading pathogens include **training**, limited access and a **hygiene** program.

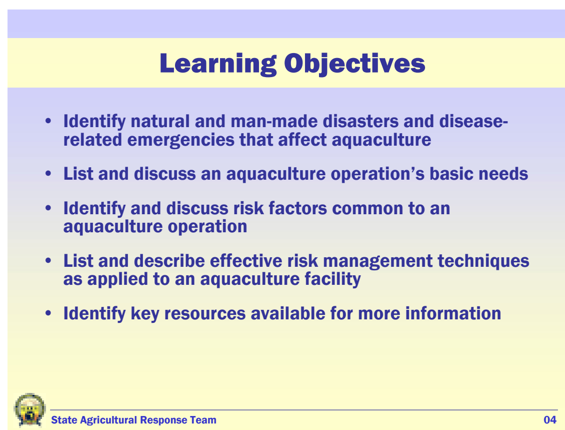
9. Quarantine requires a minimum of two weeks. **False**.

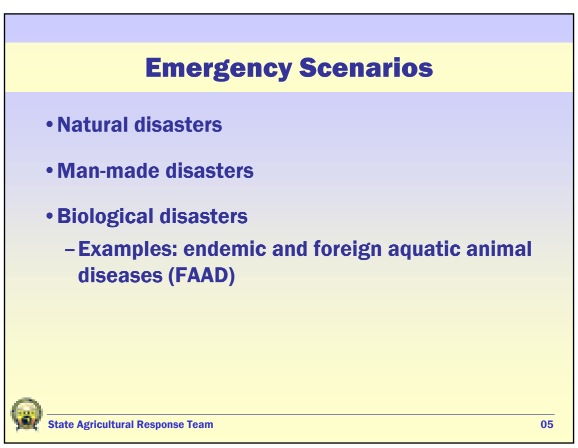
10. List three resources useful for aquatic animal facility management and emergency information. Answers will vary: **Florida Division of Emergency Management; United States Department of Agriculture; Florida Department of Agriculture and Consumer Services; Florida Division of Aquaculture; Aquaculture Best Management Practices manual; USDA-APHIS fact sheets; World Organisation for Animal Health (OIE); University of Florida Electronic Data Information Source (EDIS); UF-IFAS Disaster Handbook; or any others that qualify.**

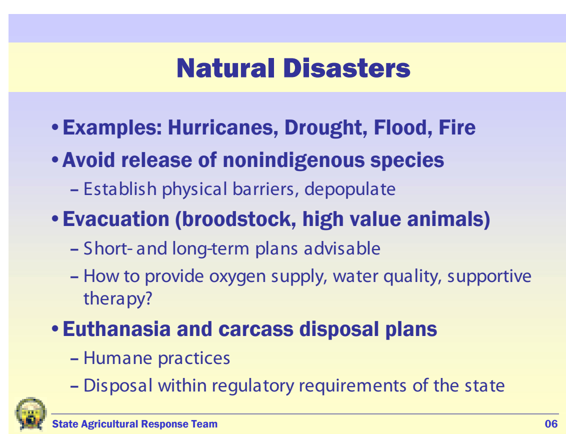
PowerPoint Slides

Slides 1-6



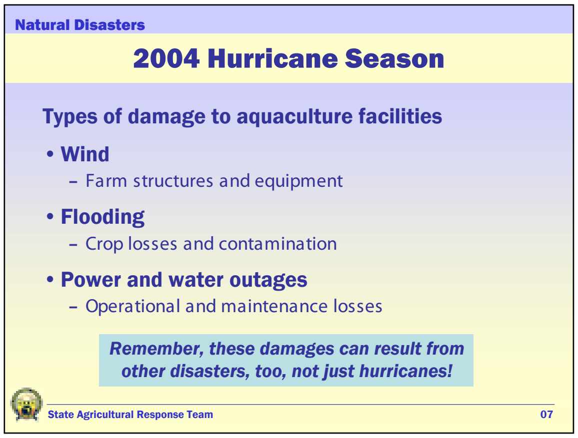


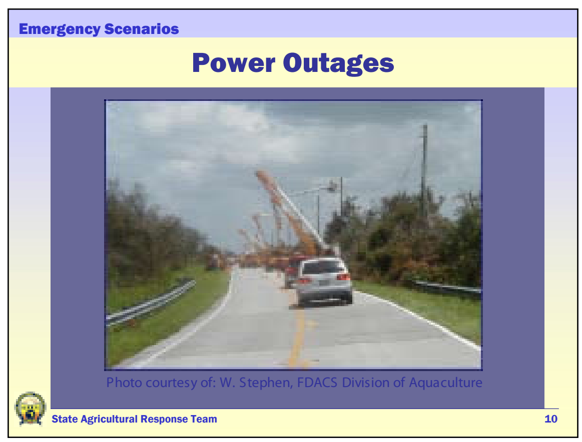


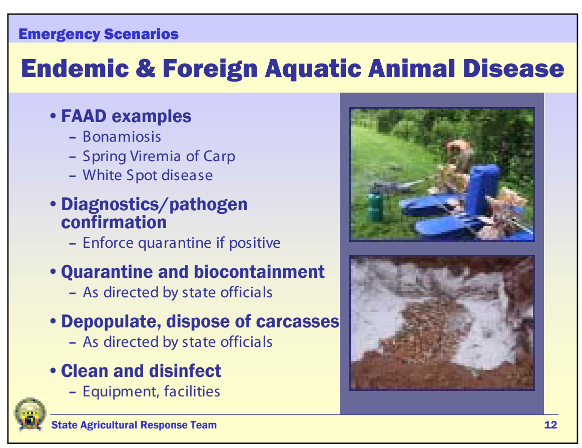


PowerPoint Slides

Slides 7-12







PowerPoint Slides

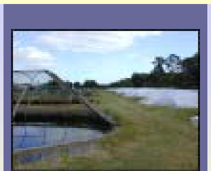
Slides 13-18

Aquaculture's Basic Needs

Water
- Suitable supply
- Quality source
- Filtration

Air
- Oxygen supply

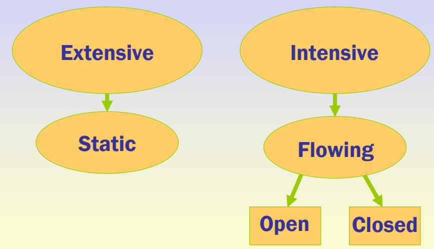
Temperature control



State Agricultural Response Team 13

Basic Needs for Aquaculture

Aquaculture Systems



State Agricultural Response Team 14

Basic Needs for Aquaculture

Aquaculture Systems

- **Defined by extensive and intensive**
  - Extensive – static water system – Lower input and lower yield
  - Intensive – flowing water system – High water volume, input higher with higher yield
- **Static water system**
  - Reliable water source, require inputs occasionally
  - Example: earthen pond
- **Flowing water system**
  - Continuous water supply
  - Defined as open or closed
  - Examples: raceways, ponds, ocean net pens, aquariums, cages, recirculating systems

State Agricultural Response Team 15

Basic Needs for Aquaculture

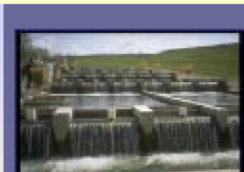
Open and Closed Aquaculture Systems

- **Open Water Systems – water flows through system and released into water body**
  - Excellent water quality
  - High stocking densities
  - Reliable, suitable water source
  - Examples: raceways, pens, cages
- **Closed Water Systems – water from culture chamber recycled back into system after filtration or treatment**
  - Less water input required
  - Less effluent
  - Control over water quality
  - Limited stocking densities
  - Increased cost
  - Examples: ponds, aquariums, recirculation systems

State Agricultural Response Team 16

Basic Needs for Aquaculture

Open Aquaculture Systems



Raceway

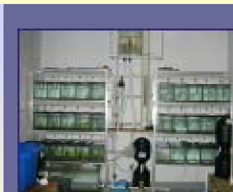
Picture courtesy aquanic.org

Net Pen

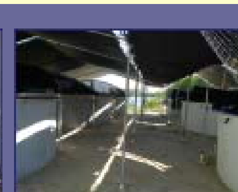
State Agricultural Response Team 17

Basic Needs for Aquaculture

Closed Aquaculture Systems



Typical glass aquariums

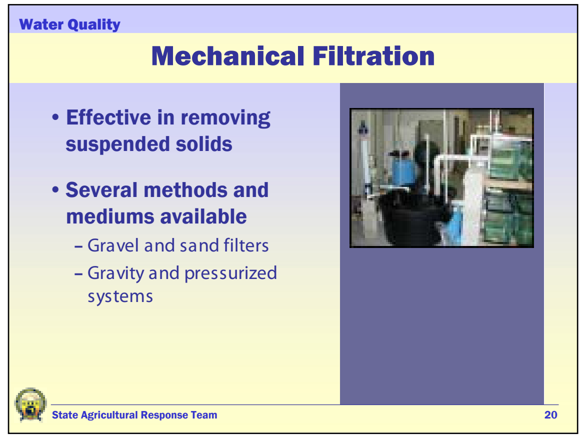


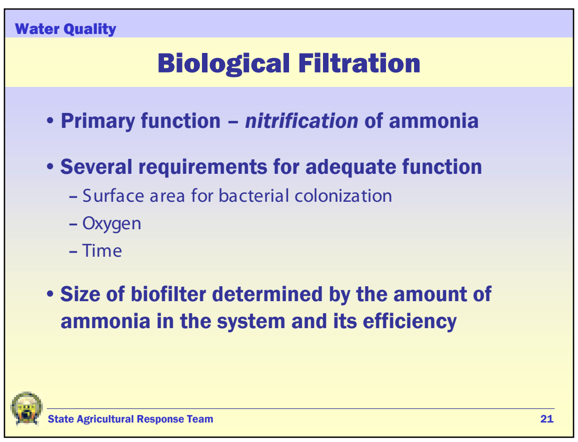
Larger fiberglass aquaculture system tanks

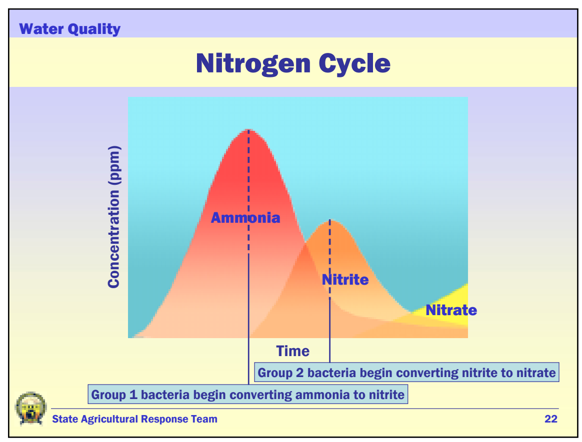
State Agricultural Response Team 18

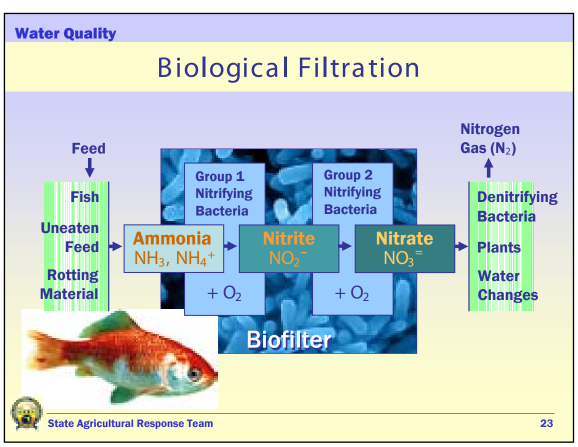
PowerPoint Slides

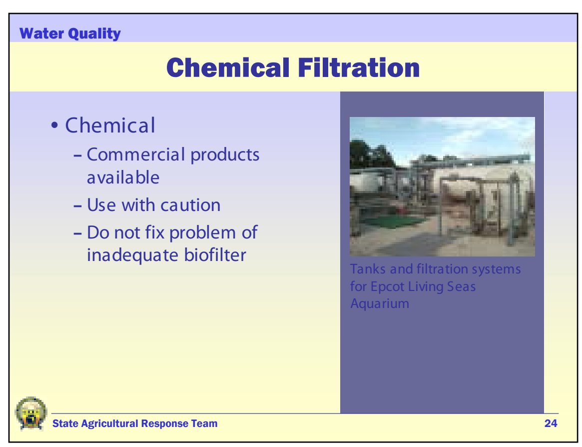
Slides 19-24





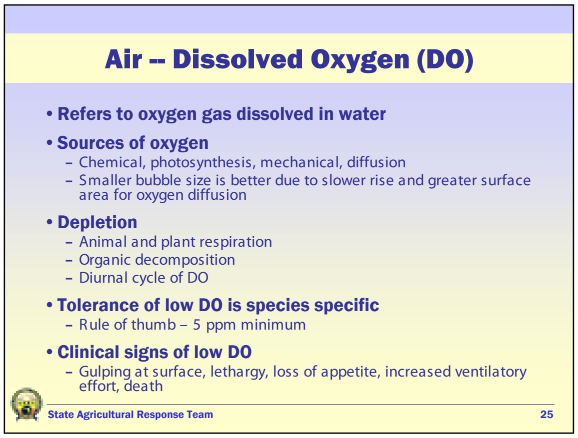


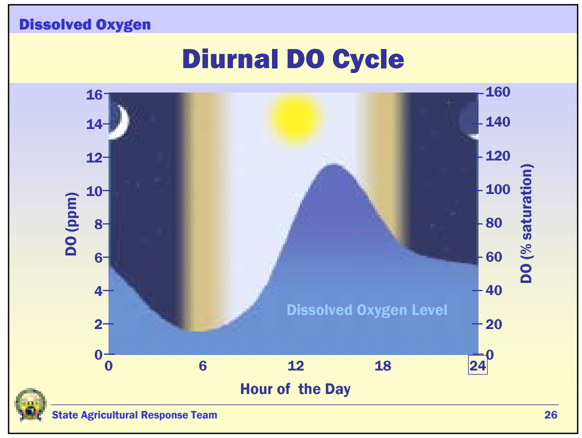


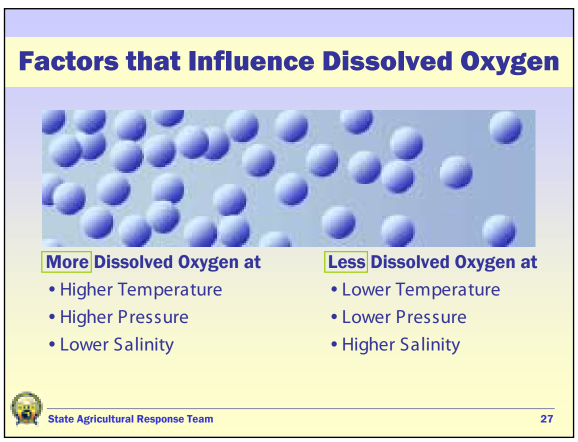


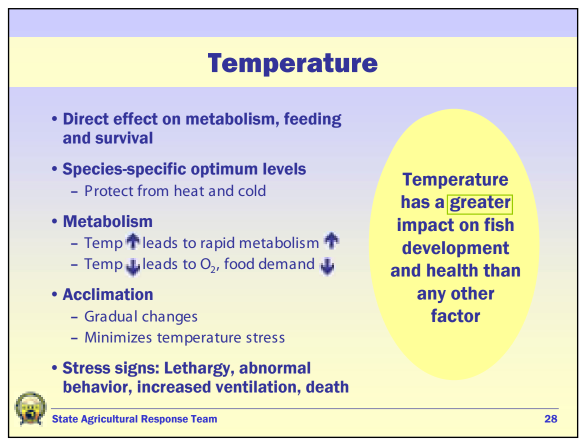
PowerPoint Slides

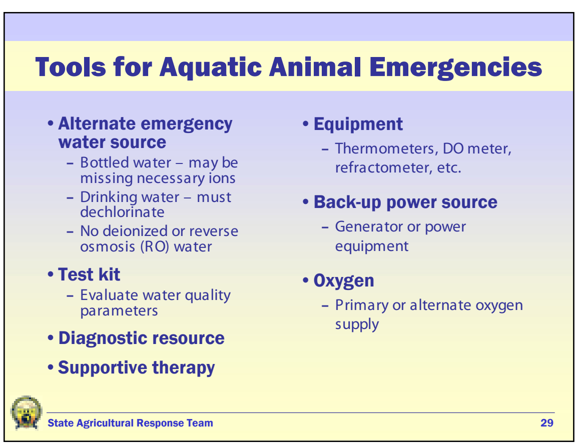
Slides 25-30

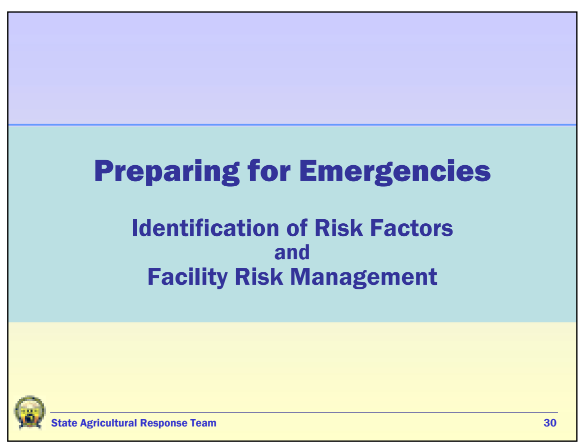












PowerPoint Slides

Slides 31-36

Risk Factor Identification

Biological Hazard Transmission

- Modes of pathogen transmission
- Aerosolization/splashing
- Contamination
  - Fish, equipment, personnel, feed, water
- Vertical and horizontal transmission
- Vectors
  - Personnel, equipment, some parasites

Argulus, Fish louse

Transmission of many hazards can be prevented with proper risk management

State Agricultural Response Team 31

Risk Factor Identification

Aquaculture Risk Factors

Identify intervention points to enhance animal health by considering three groups of risk factors

- *Incoming materials*
  - Fish, equipment, people, feed, vehicles
- *On-farm management*
  - Fish, quarantine, traffic and equipment flow
- *Outgoing effluent and products*
  - Water
  - Fish

State Agricultural Response Team 32

Risk Factor Identification

Fish Husbandry

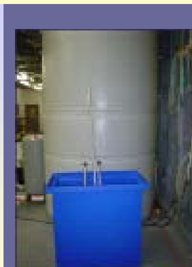
- Risk of pathogen introduction
  - Incoming fish can infect resident fish
  - Resident fish can infect incoming fish
- Intervention tactics
  - Practice quarantine and/or acclimation
  - Purchase fish from reputable source
  - Monitor environmental conditions
  - Water management
  - Feed management
  - Observe daily

State Agricultural Response Team 33

Risk Factor Identification

Equipment

- Intervention tactic
  - Multiple dip buckets/disinfection stations
  - Restrict net and equipment sharing
  - Separate nets for quarantine/suspect fish
  - Dip change protocol



State Agricultural Response Team 34

Risk Factor Identification

Personnel

- Risk of pathogen introduction and dissemination from one tank to another
- Intervention tactics
  - Training
  - Limit access
  - Hygiene program
    - Foot bath, hand wash
    - Clean clothes; protective clothing
    - Awareness

State Agricultural Response Team 35

Facility Risk Management

Quarantine

- Isolated Space
  - Separated from resident fish
  - Dedicated equipment/supplies
  - Limited visitor access
  - Managed personnel and traffic flow
- Bag water
  - Potential source of pathogens
  - Poor water quality (high ammonia, low pH, high CO_2)
  - Waste management

State Agricultural Response Team 36

PowerPoint Slides

Slides 37-42

Facility Risk Management

Quarantine

- **Length of time**
  - Pathogen life cycle dependent
    - Pathogen reproduction
    - Water temperature
  - Recommended time: = 4 weeks
- **Manipulations for pathogen expression**
- **Diagnostics/Treatments**
  - Monitor health status (non-lethal sample collection)
  - Treat for specific pathogens

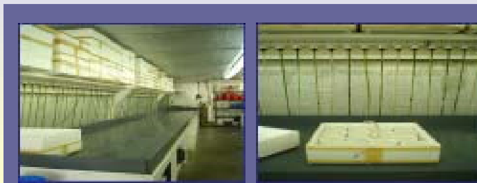
Remember, the goal is to target specific pathogen elimination and/or prevention

State Agricultural Response Team 37

Facility Risk Management

Acclimation

- Defined as a method to slowly introduce fish to a new environment
- During this period, it is possible to perform therapeutic treatments



Acclimation table

State Agricultural Response Team 38

Facility Risk Management

Quarantine vs. Acclimation

Quarantine	Acclimation
• Requires minimum of four weeks	• Complete within hours
• Isolated system and equipment	• Group acclimation
• Separate species/origin	• Stress reduction
• Reduce density	• Bath treatment possible
• Diagnostics, treatment	• Less than optimal for pathogen control/elimination
• Requires more labor and money	
• Optimal for pathogen control/elimination	

State Agricultural Response Team 39

Facility Risk Management

Collecting Fish Samples

- **Case history information**
  - General, behavioral, physical, treatments
- **Water sample**
  - Clean transport bag
  - Ship with fish
- **Collect live moribund fish**
  - 3-5; multiple species if applicable
- **If dead, wrap fish in moist paper towels and place in plastic zipper lock-type bag**
- **Do not freeze, refrigerate only**

State Agricultural Response Team 40

Facility Risk Management

Submitting Fish Samples

- **Call diagnostic lab**
- **Package live fish sample**
  - Double bag
  - 1/3 filled water
  - Oxygen source (compressed O_2, oxy tabs)
  - Heat/Cool packs if necessary
  - Styrofoam box (cardboard outer box)
  - History information (in plastic bag)
- **Ship overnight or hand-deliver**
  - Label outside box: LIVE FISH

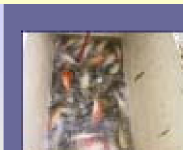
Photo source: zfin.org

State Agricultural Response Team 41

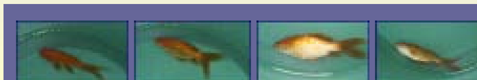
Facility Risk Management

Euthanasia of Aquatic Animals

- **Primary methods**
  - Drug overdose (MS-222, benzocaine)
    - Expensive and impractical for large populations
  - **CO_2 (compressed gas) and rotenone**
    - USDA uses for SVC depopulation
    - More practical for large populations
- **Secondary method is stunning followed by decapitation**



CO_2 euthanized koi



1 2 3 4

State Agricultural Response Team 42

PowerPoint Slides

Slides 43-48

Facility Risk Management

Sanitary Precautions

What do you notice?

State Agricultural Response Team 43

Facility Risk Management

Sanitary Precautions

What do you notice?

Every tank has its own equipment… there is no sharing between tanks

State Agricultural Response Team 44

Key Resources

- **USDA-APHIS fact sheets for various animal diseases**
  http://www.aphis.usda.gov/lpa/pubs/fsheet_faq_notice/fsfaqnot_animalhealth.html
- **APHIS's Center for Emerging Issues (CEI) worksheets on animal health and diseases of concern**
  http://www.aphis.usda.gov/vs/ceah/cei/worksheets.htm
- **Aquatext.com, a free, on-line aquaculture dictionary**
  http://www.pisces-aqua.co.uk/aquatext/dicframe.htm

State Agricultural Response Team 45

Key Resources

- **Florida Department of Community Affairs, Division of Emergency Management**
  http://www.floridadisaster.org
- **United States Department of Agriculture (USDA)**
  http://www.usda.gov
- **Florida Department of Agriculture and Consumer Services (FDACS)**
  http://www.doacs.state.fl.us

State Agricultural Response Team 46

Key Resources

- **Florida Division of Aquaculture home page**
  http://www.floridaaquaculture.com
- ***Aquaculture Best Management Practices* manual**
  http://www.floridaaquaculture.com/BAD/BMP%20Rule%20-%20Manual%206-9-04.pdf
- **Aquaculture Network Information Center**
  http://aquanic.org

State Agricultural Response Team 47

Key Resources

- **USDA Animal and Plant Health Inspection Service (APHIS)**
  http://www.aphis.usda.gov
- **World Organisation for Animal Health (OIE)**
  http://www.oie.int
- **Safety for Fish Farm Workers video on the National Ag Safety Database (NASD), English and Spanish versions** http://www.cdc.gov/nasd/videos/v001401-v001500/v001433.html

State Agricultural Response Team 48

PowerPoint Slides

Slides 49-53

Key Resources

- University of Florida Institute of Food and Agricultural Sciences Electronic Data Information Source (EDIS) fact sheets for aquaculture, including diseases
  http://edis.ifas.ufl.edu/DEPARTMENT_VETERINARY_MEDICINE
  http://edis.ifas.ufl.edu/DEPARTMENT_FISHERIES_AND_AQUATIC_SCIENCES
  http://edis.ifas.ufl.edu/TOPIC_Fish
- "Aquaculture Natural Disaster Preparation and Recovery" Clemson University Cooperative Extension
  http://www.clemson.edu/psapublishing/PAGES/AFW/AFW12.PDF

State Agricultural Response Team 49

Key Resources

- University of Florida IFAS Extension Disaster Handbook
  http://disaster.ifas.ufl.edu
- Spawn, Spat, and Sprains
  by Alaska Sea Grant College Program
  http://www.uaf.edu/seagrant/Pubs_Videos/pubs/AN-17.pdf
- Southern Regional Aquaculture Center (SRAC) fact sheets
  http://www.msstate.edu/dept/srac/fslist.htm
  http://srac.tamu.edu

State Agricultural Response Team 50

Key Resources

For any biosecurity or quarantine questions, contact:

Dr. Kathleen Hartman, Aquaculture Epidemiologist

TELEPHONE : 813-671-5230 ext. 119
E-MAIL : kathleen.h.hartman@aphis.usda.gov
ADDRESS : 1408 24th Street, SE
Ruskin, FL 33570

State Agricultural Response Team 51

Summary

- Natural and man-made disasters and disease-related emergencies that can affect an aquaculture facility
- The basic needs for an aquaculture operation
- Risk factors common to operating a facility
- Effective risk management techniques that can be applied to prepare for an emergency or mitigate one
- Valuable resources available for more information

State Agricultural Response Team 52

Thank You!

State Agricultural Response Team 53

PowerPoint Slides — Handout Pages

The *Emergency Management and Quarantine of Aquaculture Facilities* PowerPoint slides are reproduced on the following pages at reduced size with space for participant notes.

(Also included in the participant workbook for this unit, available on the SART Web site:

<www.flsart.org>

Slides 1-3

STATE AGRICULTURAL RESPONSE TEAM
S. A. R. T.
FLORIDA

Emergency Management and Quarantine of Aquaculture Facilities

Prepared by:

Kathleen Hartman, D.V.M., Ph.D.
Aquaculture Epidemiologist, USDA-APHIS-VS

Denise Petty, D.V.M.
Assistant Professor, LACS, CVM, UF

State Agricultural Response Team 03

Slides 4-6

Learning Objectives

- Identify natural and man-made disasters and disease-related emergencies that affect aquaculture
- List and discuss an aquaculture operation's basic needs
- Identify and discuss risk factors common to an aquaculture operation
- List and describe effective risk management techniques as applied to an aquaculture facility
- Identify key resources available for more information

State Agricultural Response Team 04

Emergency Scenarios

- Natural disasters
- Man-made disasters
- Biological disasters
  - Examples: endemic and foreign aquatic animal diseases (FAAD)

State Agricultural Response Team 05

Natural Disasters

- Examples: Hurricanes, Drought, Flood, Fire
- Avoid release of nonindigenous species
  - Establish physical barriers, depopulate
- Evacuation (broodstock, high value animals)
  - Short- and long-term plans advisable
  - How to provide oxygen supply, water quality, supportive therapy?
- Euthanasia and carcass disposal plans
  - Humane practices
  - Disposal within regulatory requirements of the state

State Agricultural Response Team 06

Slides 7-9

Natural Disasters

2004 Hurricane Season

Types of damage to aquaculture facilities

- **Wind**
  - Farm structures and equipment
- **Flooding**
  - Crop losses and contamination
- **Power and water outages**
  - Operational and maintenance losses

Remember, these damages can result from other disasters, too, not just hurricanes!

State Agricultural Response Team 07

Natural Disasters

Wind Damage

Photos courtesy of: W. Stephen, FDACS Division of Aquaculture

State Agricultural Response Team 08

Natural Disasters

Flooding

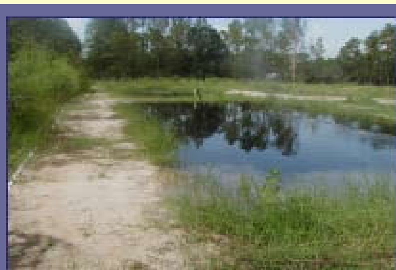
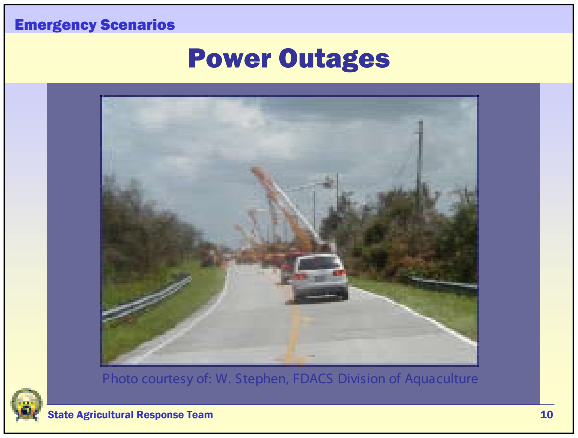
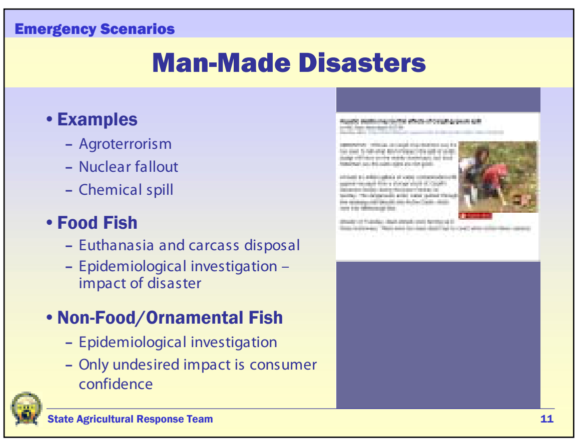


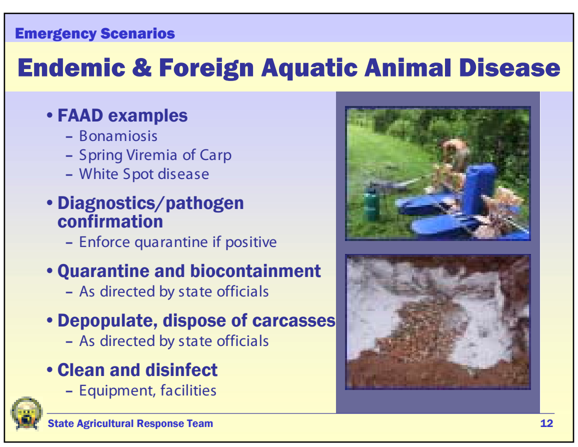
Photo courtesy of: W. Stephen, FDACS Division of Aquaculture

State Agricultural Response Team 09

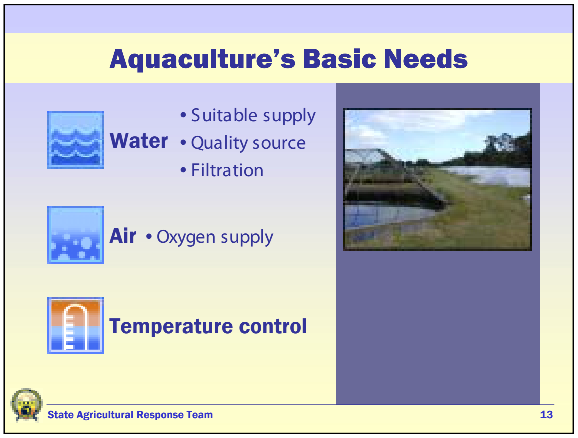
Slides 10-12

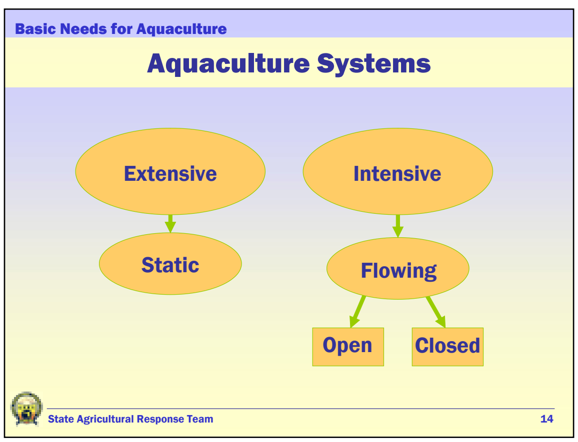

Emergency Scenarios
Power Outages
Photo courtesy of: W. Stephen, FDACS Division of Aquaculture
State Agricultural Response Team
10

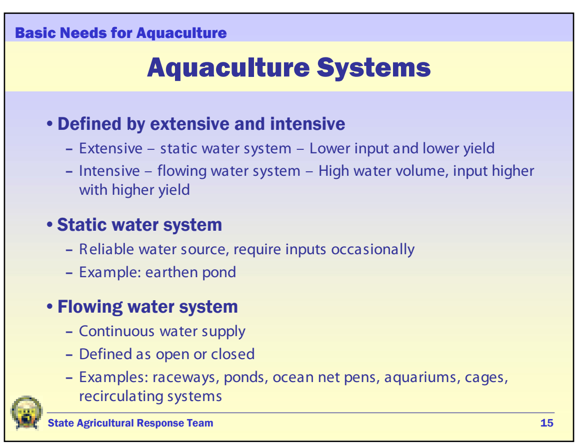

Emergency Scenarios
Man-Made Disasters
• Examples
– Agroterrorism
– Nuclear fallout
– Chemical spill
• Food Fish
– Euthanasia and carcass disposal
– Epidemiological investigation – impact of disaster
• Non-Food/Ornamental Fish
– Epidemiological investigation
– Only undesired impact is consumer confidence
State Agricultural Response Team
11


Emergency Scenarios
Endemic & Foreign Aquatic Animal Disease
• FAAD examples
– Bonamiosis
– Spring Viremia of Carp
– White Spot disease
• Diagnostics/pathogen confirmation
– Enforce quarantine if positive
• Quarantine and biocontainment
– As directed by state officials
• Depopulate, dispose of carcasses
– As directed by state officials
• Clean and disinfect
– Equipment, facilities
State Agricultural Response Team
12

Slides 13-15


Aquaculture's Basic Needs
Water
• Suitable supply
• Quality source
• Filtration
Air
• Oxygen supply
Temperature control
State Agricultural Response Team
13


Basic Needs for Aquaculture
Aquaculture Systems
Extensive
Intensive
Static
Flowing
Open
Closed
State Agricultural Response Team
14


Basic Needs for Aquaculture
Aquaculture Systems
• Defined by extensive and intensive
– Extensive – static water system – Lower input and lower yield
– Intensive – flowing water system – High water volume, input higher with higher yield
• Static water system
– Reliable water source, require inputs occasionally
– Example: earthen pond
• Flowing water system
– Continuous water supply
– Defined as open or closed
– Examples: raceways, ponds, ocean net pens, aquariums, cages, recirculating systems
State Agricultural Response Team
15

Slides 16-18

Basic Needs for Aquaculture

Open and Closed Aqaculture Systems

- **Open Water Systems – water flows through system and released into water body**
  - Excellent water quality
  - High stocking densities
  - Reliable, suitable water source
  - Examples: raceways, pens, cages
- **Closed Water Systems – water from culture chamber recycled back into system after filtration or treatment**
  - Less water input required
  - Less effluent
  - Control over water quality
  - Limited stocking densities
  - Increased cost
  - Examples: ponds, aquariums, recirculation systems

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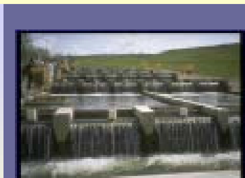
Basic Needs for Aquaculture

Open Aquaculture Systems



Raceway

Picture courtesy aquanic.org

Net Pen

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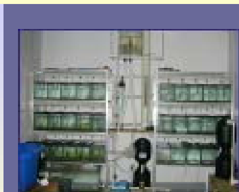
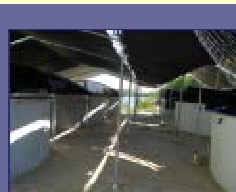
Basic Needs for Aquaculture

Closed Aquaculture Systems



Typical glass aquariums



Larger fiberglass aquaculture system tanks

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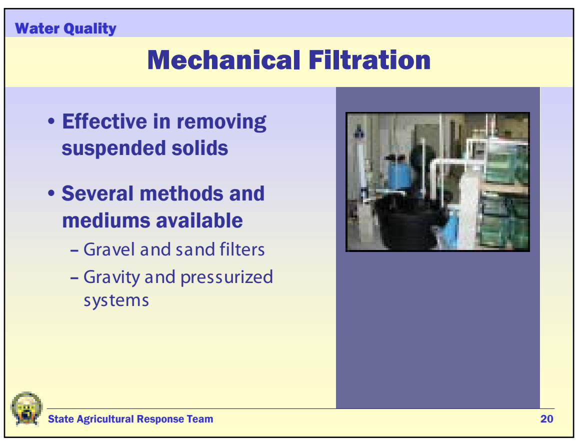
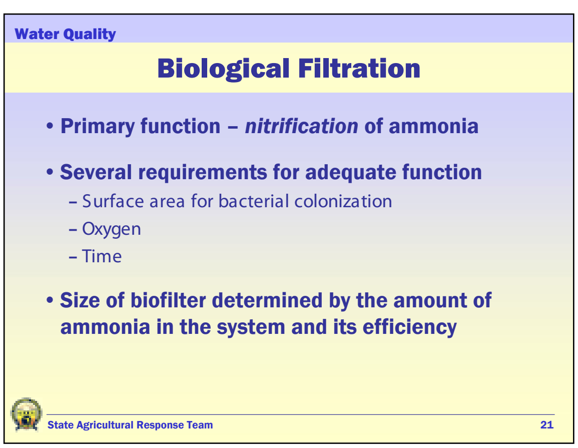
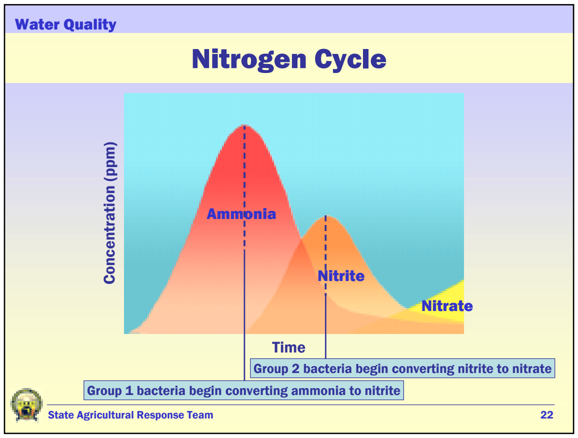
Slides 19-21

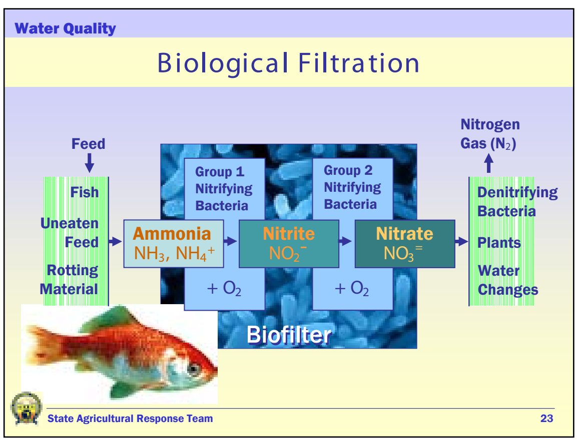

Water Quality
The *most* important production component for raising fish
• Parameters of importance:
– Ammonia, nitrites, DO, temperature, pH, hardness, CO_2, turbidity, chlorine, heavy metals
– Some fish have different tolerances
• Test kits
– Watch expiration dates
– Wash after each use and between tanks
• Reliable, safe supply source
– Protected source
– Unprotected source
Fish
Disease
Environment
State Agricultural Response Team
19

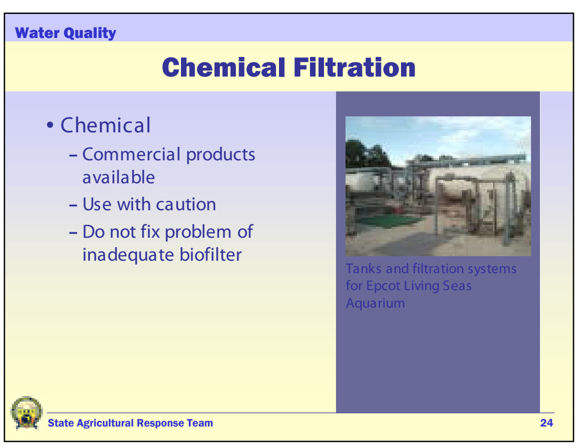

Water Quality
Mechanical Filtration
• Effective in removing suspended solids
• Several methods and mediums available
– Gravel and sand filters
– Gravity and pressurized systems
State Agricultural Response Team
20


Water Quality
Biological Filtration
• Primary function – *nitrification* of ammonia
• Several requirements for adequate function
– Surface area for bacterial colonization
– Oxygen
– Time
• Size of biofilter determined by the amount of ammonia in the system and its efficiency
State Agricultural Response Team
21

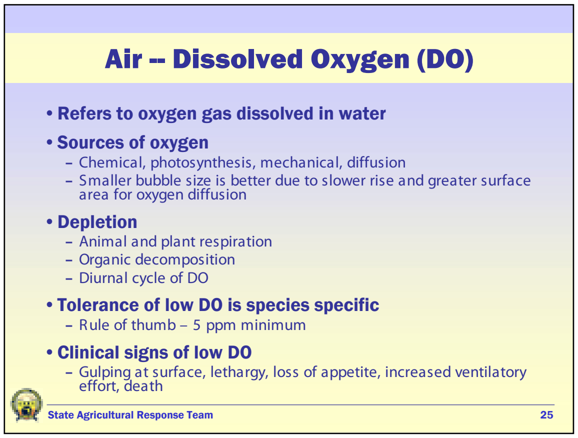
Slides 22-24

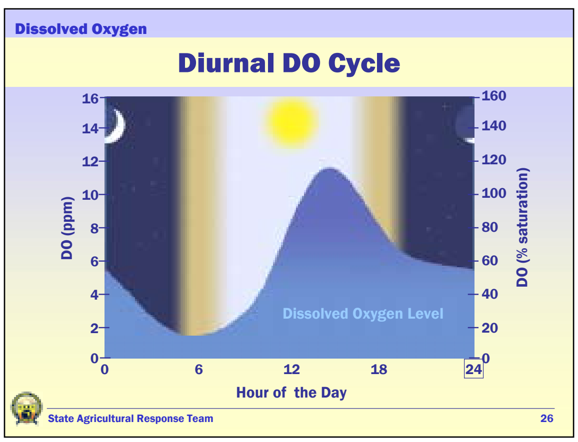

Water Quality
Nitrogen Cycle
Concentration (ppm)
Ammonia
Nitrite
Nitrate
Time
Group 2 bacteria begin converting nitrite to nitrate
Group 1 bacteria begin converting ammonia to nitrite
State Agricultural Response Team
22

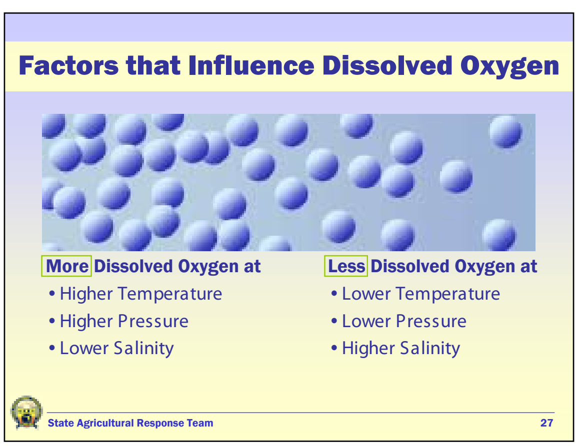

Water Quality
Biological Filtration
Feed
Fish
Uneaten Feed
Rotting Material
Group 1 Nitrifying Bacteria
Group 2 Nitrifying Bacteria
Ammonia
NH_3, NH_4^+
Nitrite
NO_2^-
Nitrate
$NO_3^=$
+ O_2
+ O_2
Biofilter
Nitrogen Gas (N_2)
Denitrifying Bacteria
Plants
Water Changes
State Agricultural Response Team
23


Water Quality
Chemical Filtration
• Chemical
– Commercial products available
– Use with caution
– Do not fix problem of inadequate biofilter
Tanks and filtration systems for Epcot Living Seas Aquarium
State Agricultural Response Team
24

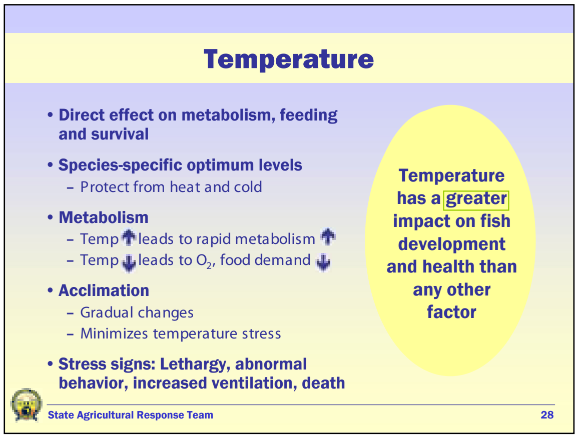
Slides 25-27

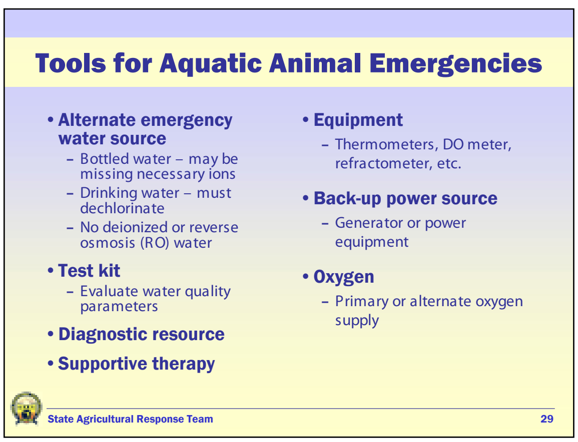

Air -- Dissolved Oxygen (DO)
• Refers to oxygen gas dissolved in water
• Sources of oxygen
– Chemical, photosynthesis, mechanical, diffusion
– Smaller bubble size is better due to slower rise and greater surface area for oxygen diffusion
• Depletion
– Animal and plant respiration
– Organic decomposition
– Diurnal cycle of DO
• Tolerance of low DO is species specific
– Rule of thumb – 5 ppm minimum
• Clinical signs of low DO
– Gulping at surface, lethargy, loss of appetite, increased ventilatory effort, death
State Agricultural Response Team
25

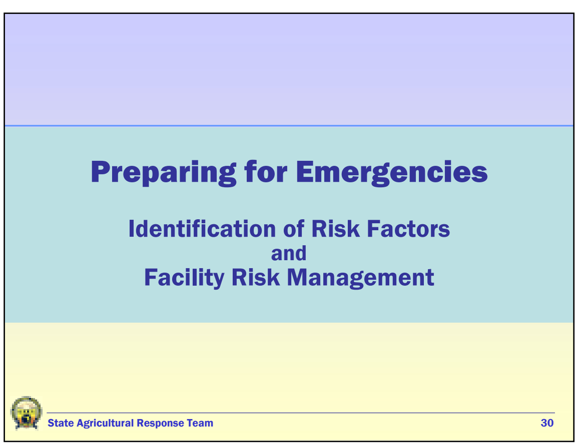

Dissolved Oxygen
Diurnal DO Cycle
DO (ppm)
16
14
12
10
8
6
4
2
0
DO (% saturation)
160
140
120
100
80
60
40
20
0
Dissolved Oxygen Level
0
6
12
18
24
Hour of the Day
State Agricultural Response Team
26


Factors that Influence Dissolved Oxygen
More Dissolved Oxygen at
• Higher Temperature
• Higher Pressure
• Lower Salinity
Less Dissolved Oxygen at
• Lower Temperature
• Lower Pressure
• Higher Salinity
State Agricultural Response Team
27

Slides 28-30


Temperature
• Direct effect on metabolism, feeding and survival
• Species-specific optimum levels
– Protect from heat and cold
• Metabolism
– Temp ↑ leads to rapid metabolism ↑
– Temp ↓ leads to O_2, food demand ↓
• Acclimation
– Gradual changes
– Minimizes temperature stress
• Stress signs: Lethargy, abnormal behavior, increased ventilation, death
Temperature has a greater impact on fish development and health than any other factor
State Agricultural Response Team
28


Tools for Aquatic Animal Emergencies
• Alternate emergency water source
– Bottled water – may be missing necessary ions
– Drinking water – must dechlorinate
– No deionized or reverse osmosis (RO) water
• Test kit
– Evaluate water quality parameters
• Diagnostic resource
• Supportive therapy
• Equipment
– Thermometers, DO meter, refractometer, etc.
• Back-up power source
– Generator or power equipment
• Oxygen
– Primary or alternate oxygen supply
State Agricultural Response Team
29

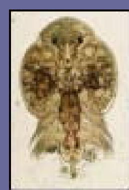

Preparing for Emergencies
Identification of Risk Factors
and
Facility Risk Management
State Agricultural Response Team
30

Slides 31-33

Risk Factor Identification

Biological Hazard Transmission

- Modes of pathogen transmission
- Aerosolization/splashing
- Contamination
  - Fish, equipment, personnel, feed, water
- Vertical and horizontal transmission
- Vectors
  - Personnel, equipment, some parasites


Argulus, Fish louse

Transmission of many hazards can be prevented with proper risk management

State Agricultural Response Team 31

Risk Factor Identification

Aquaculture Risk Factors

Identify intervention points to enhance animal health by considering three groups of risk factors

- ***Incoming materials***
  - Fish, equipment, people, feed, vehicles
- ***On-farm management***
  - Fish, quarantine, traffic and equipment flow
- ***Outgoing effluent and products***
  - Water
  - Fish

State Agricultural Response Team 32

Risk Factor Identification

Fish Husbandry

- **Risk of pathogen introduction**
  - Incoming fish can infect resident fish
  - Resident fish can infect incoming fish
- **Intervention tactics**
  - Practice quarantine and/or acclimation
  - Purchase fish from reputable source
  - Monitor environmental conditions
  - Water management
  - Feed management
  - Observe daily

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Slides 34-36

Risk Factor Identification

Equipment

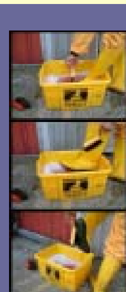
- **Intervention tactic**
  - Multiple dip buckets/disinfection stations
  - Restrict net and equipment sharing
  - Separate nets for quarantine/suspect fish
  - Dip change protocol

State Agricultural Response Team 34

Risk Factor Identification

Personnel

- **Risk of pathogen introduction and dissemination from one tank to another**
- **Intervention tactics**
  - Training
  - Limit access
  - Hygiene program
    - Foot bath, hand wash
    - Clean clothes; protective clothing
    - Awareness



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Facility Risk Management

Quarantine

- **Isolated Space**
  - Separated from resident fish
  - Dedicated equipment/supplies
  - Limited visitor access
  - Managed personnel and traffic flow
- **Bag water**
  - Potential source of pathogens
  - Poor water quality (high ammonia, low pH, high CO_2)
  - Waste management

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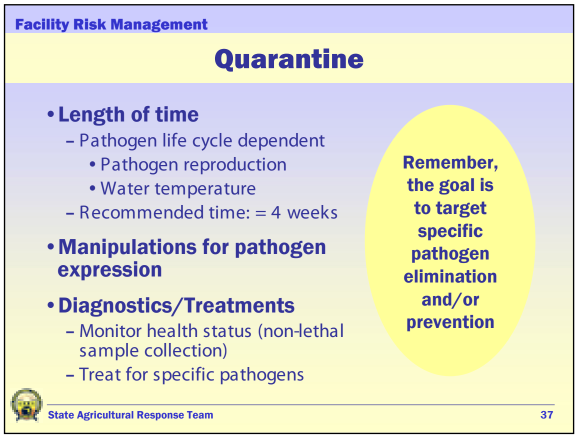
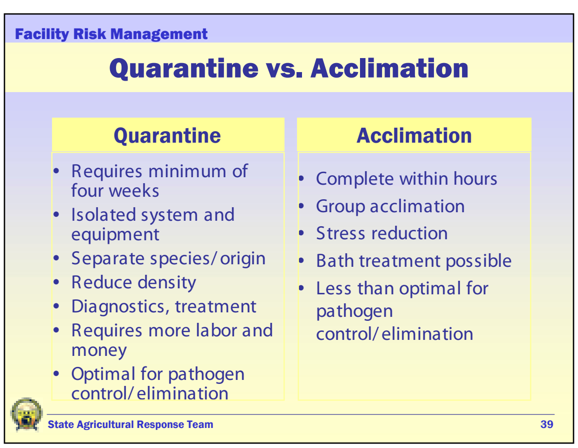
Slides 37-39


Facility Risk Management
Quarantine
• Length of time
– Pathogen life cycle dependent
• Pathogen reproduction
• Water temperature
– Recommended time: = 4 weeks
• Manipulations for pathogen expression
• Diagnostics/Treatments
– Monitor health status (non-lethal sample collection)
– Treat for specific pathogens
Remember, the goal is to target specific pathogen elimination and/or prevention
State Agricultural Response Team
37


Facility Risk Management
Acclimation
• Defined as a method to slowly introduce fish to a new environment
• During this period, it is possible to perform therapeutic treatments
Acclimation table
State Agricultural Response Team
38


Facility Risk Management
Quarantine vs. Acclimation
Quarantine
• Requires minimum of four weeks
• Isolated system and equipment
• Separate species/origin
• Reduce density
• Diagnostics, treatment
• Requires more labor and money
• Optimal for pathogen control/elimination
Acclimation
• Complete within hours
• Group acclimation
• Stress reduction
• Bath treatment possible
• Less than optimal for pathogen control/elimination
State Agricultural Response Team
39

Slides 40-42

Facility Risk Management

Collecting Fish Samples

- **Case history information**
  - General, behavioral, physical, treatments
- **Water sample**
  - Clean transport bag
  - Ship with fish
- **Collect live moribund fish**
  - 3-5; multiple species if applicable
- **If dead, wrap fish in moist paper towels and place in plastic zipper lock-type bag**
- **Do not freeze, refrigerate only**

State Agricultural Response Team 40

Facility Risk Management

Submitting Fish Samples

- **Call diagnostic lab**
- **Package live fish sample**
  - Double bag
  - 1/3 filled water
  - Oxygen source (compressed O_2, oxy tabs)
  - Heat/Cool packs if necessary
  - Styrofoam box (cardboard outer box)
  - History information (in plastic bag)
- **Ship overnight or hand-deliver**
  - Label outside box: LIVE FISH

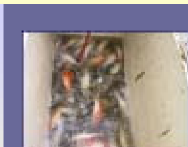
Photo source: zfin.org

State Agricultural Response Team 41

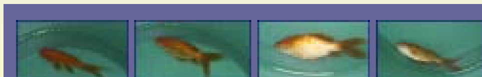
Facility Risk Management

Euthanasia of Aquatic Animals

- **Primary methods**
  - Drug overdose (MS-222, benzocaine)
    - Expensive and impractical for large populations
  - **CO_2 (compressed gas) and rotenone**
    - USDA uses for SVC depopulation
    - More practical for large populations
- **Secondary method is stunning followed by decapitation**



CO_2 euthanized koi



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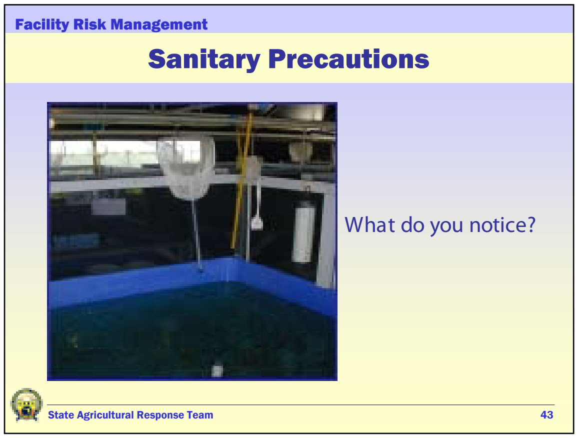
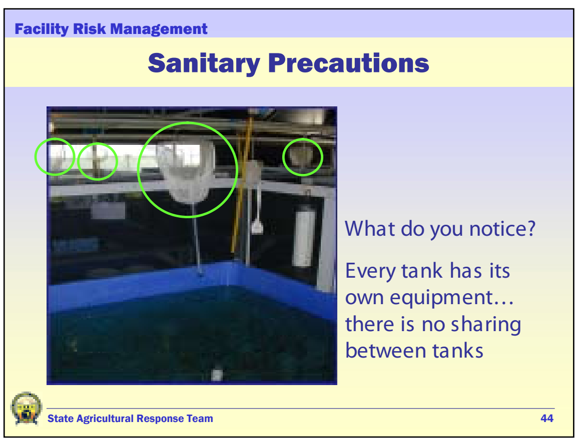
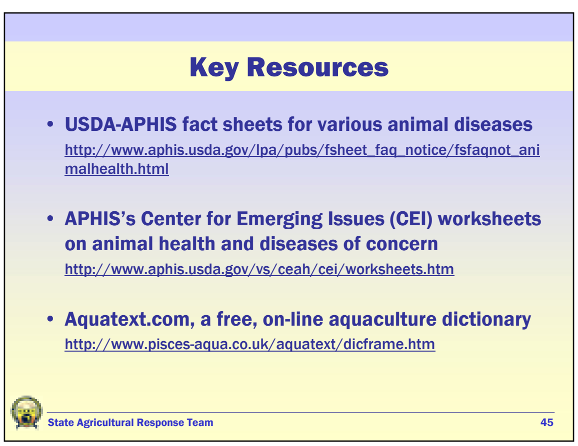
Slides 43-45


Facility Risk Management
Sanitary Precautions
What do you notice?
State Agricultural Response Team
43


Facility Risk Management
Sanitary Precautions
What do you notice?
Every tank has its own equipment… there is no sharing between tanks
State Agricultural Response Team
44


Key Resources
• USDA-APHIS fact sheets for various animal diseases
http://www.aphis.usda.gov/lpa/pubs/fsheet_faq_notice/fsfaqnot_animalhealth.html
• APHIS's Center for Emerging Issues (CEI) worksheets on animal health and diseases of concern
http://www.aphis.usda.gov/vs/ceah/cei/worksheets.htm
• Aquatext.com, a free, on-line aquaculture dictionary
http://www.pisces-aqua.co.uk/aquatext/dicframe.htm
State Agricultural Response Team
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Slides 46-48

Key Resources

- **Florida Department of Community Affairs, Division of Emergency Management**
  http://www.floridadisaster.org
- **United States Department of Agriculture (USDA)**
  http://www.usda.gov
- **Florida Department of Agriculture and Consumer Services (FDACS)**
  http://www.doacs.state.fl.us

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Key Resources

- **Florida Division of Aquaculture home page**
  http://www.floridaaquaculture.com
- ***Aquaculture Best Management Practices* manual**
  http://www.floridaaquaculture.com/BAD/BMP%20Rule%20-%20Manual%206-9-04.pdf
- **Aquaculture Network Information Center**
  http://aquanic.org

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Key Resources

- **USDA Animal and Plant Health Inspection Service (APHIS)**
  http://www.aphis.usda.gov
- **World Organisation for Animal Health (OIE)**
  http://www.oie.int
- **Safety for Fish Farm Workers video on the National Ag Safety Database (NASD), English and Spanish versions** http://www.cdc.gov/nasd/videos/v001401-v001500/v001433.html

State Agricultural Response Team 48

Slides 49-51

Key Resources

- University of Florida Institute of Food and Agricultural Sciences Electronic Data Information Source (EDIS) fact sheets for aquaculture, including diseases
  http://edis.ifas.ufl.edu/DEPARTMENT_VETERINARY_MEDICINE
  http://edis.ifas.ufl.edu/DEPARTMENT_FISHERIES_AND_AQUATIC_SCIENCES
  http://edis.ifas.ufl.edu/TOPIC_Fish
- "Aquaculture Natural Disaster Preparation and Recovery" Clemson University Cooperative Extension
  http://www.clemson.edu/psapublishing/PAGES/AFW/AFW12.PDF

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Key Resources

- University of Florida IFAS Extension Disaster Handbook
  http://disaster.ifas.ufl.edu
- Spawn, Spat, and Sprains
  by Alaska Sea Grant College Program
  http://www.uaf.edu/seagrant/Pubs_Videos/pubs/AN-17.pdf
- Southern Regional Aquaculture Center (SRAC) fact sheets
  http://www.msstate.edu/dept/srac/fslist.htm
  http://srac.tamu.edu

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Key Resources

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TELEPHONE : 813-671-5230 ext. 119

E-MAIL : kathleen.h.hartman@aphis.usda.gov

ADDRESS : 1408 24th Street, SE
Ruskin, FL 33570

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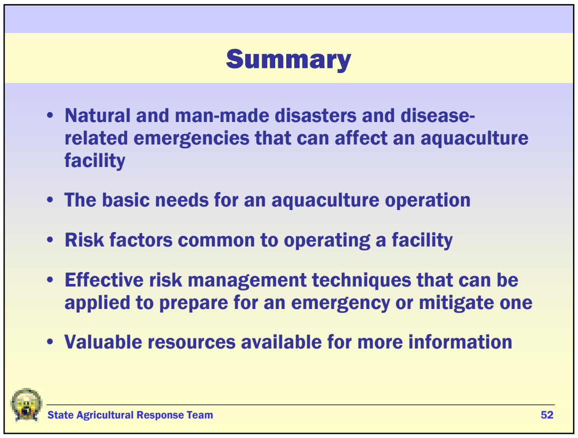
Slides 52-53


Summary
• Natural and man-made disasters and disease-related emergencies that can affect an aquaculture facility
• The basic needs for an aquaculture operation
• Risk factors common to operating a facility
• Effective risk management techniques that can be applied to prepare for an emergency or mitigate one
• Valuable resources available for more information
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Thank You!
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Notes

PowerPoint Slides

The *Aquatic Animal Diseases* PowerPoint slides are reproduced full-size on the following pages. You can use these pages as a display or photocopy them onto plastic overhead sheets for use with an overhead projector.

Color versions of these slides can be downloaded at the SART Web site:

<www.flsart.org>.

STATE AGRICULTURAL RESPONSE TEAM

S.A.R.T.

FLORIDA

Emergency Management and Quarantine of Aquaculture Facilities

Prepared by:

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Denise Petty, D.V.M.
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Learning Objectives

- Identify natural and man-made disasters and disease-related emergencies that affect aquaculture
- List and discuss an aquaculture operation's basic needs
- Identify and discuss risk factors common to an aquaculture operation
- List and describe effective risk management techniques as applied to an aquaculture facility
- Identify key resources available for more information

Emergency Scenarios

- Natural disasters
- Man-made disasters
- Biological disasters
  - Examples: endemic and foreign aquatic animal diseases (FAAD)

Natural Disasters

- **Examples: Hurricanes, Drought, Flood, Fire**
- **Avoid release of nonindigenous species**
  - Establish physical barriers, depopulate
- **Evacuation (broodstock, high value animals)**
  - Short- and long-term plans advisable
  - How to provide oxygen supply, water quality, supportive therapy?
- **Euthanasia and carcass disposal plans**
  - Humane practices
  - Disposal within regulatory requirements of the state

2004 Hurricane Season

Types of damage to aquaculture facilities

- **Wind**
  - Farm structures and equipment
- **Flooding**
  - Crop losses and contamination
- **Power and water outages**
  - Operational and maintenance losses

Remember, these damages can result from other disasters, too, not just hurricanes!

Wind Damage

Photos courtesy of: W. Stephen, FDACS Division of Aquaculture

Flooding

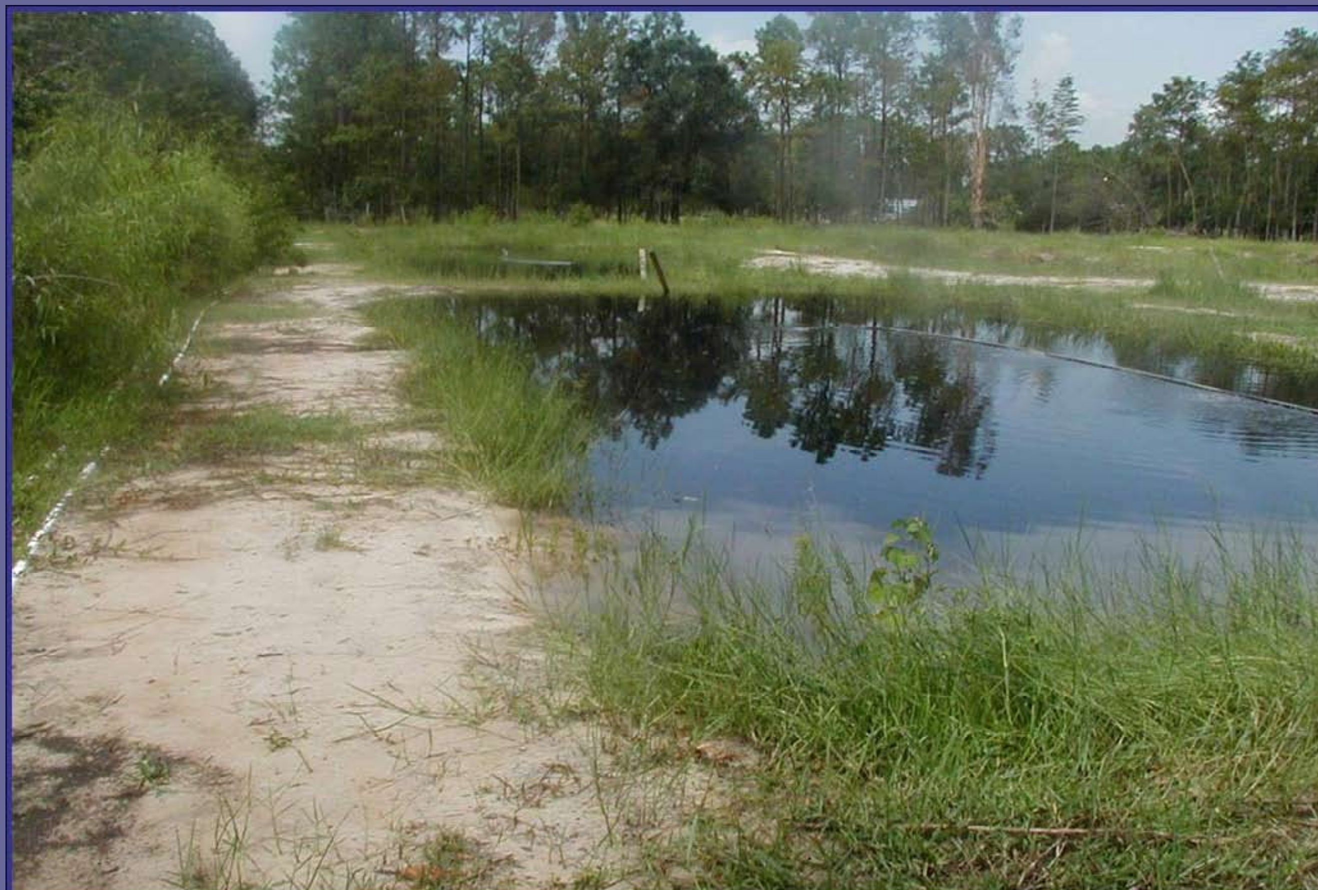


Photo courtesy of: W. Stephen, FDACS Division of Aquaculture

Power Outages

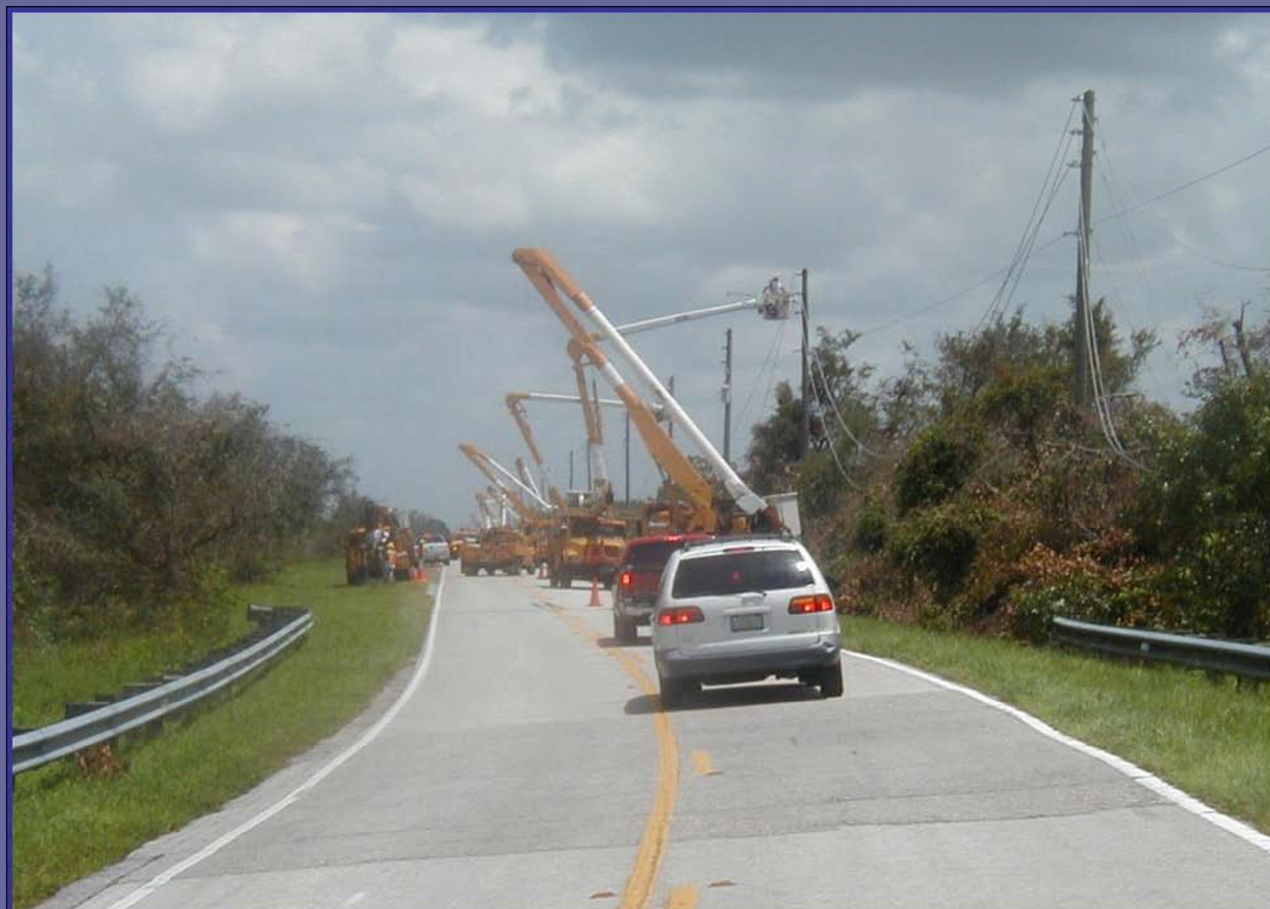


Photo courtesy of: W. Stephen, FDACS Division of Aquaculture

Man-Made Disasters

- **Examples**
  - Agroterrorism
  - Nuclear fallout
  - Chemical spill
- **Food Fish**
  - Euthanasia and carcass disposal
  - Epidemiological investigation – impact of disaster
- **Non-Food/Ornamental Fish**
  - Epidemiological investigation
  - Only undesired impact is consumer confidence

Aquatic deaths may be first effects of Cargill gypsum spill
an ABC Action News report 9/07/04
previous story: Crews dilute Gibsonton gypsum spill amidst contamination fears (9/06/04)

GIBSONTON - Officials at Cargill Crop Nutrition say it's too soon to tell what kind of impact the spill of acidic sludge will have on the nearby waterways, but local fishermen say the early signs are not good.

At least 41-million gallons of water contaminated with gypsum escaped from a storage stack at Cargill's Gibsonton facility during Hurricane Frances on Sunday. The dangerously acidic water gushed through the retaining wall directly into Archie Creek, which runs into Hillsborough Bay.

Already on Tuesday, dead animals were turning up in those waterways. There were too many dead rays to count when Action News cameras

Endemic & Foreign Aquatic Animal Disease

- **FAAD examples**
  - Bonamiosis
  - Spring Viremia of Carp
  - White Spot disease
- **Diagnostics/pathogen confirmation**
  - Enforce quarantine if positive
- **Quarantine and biocontainment**
  - As directed by state officials
- **Depopulate, dispose of carcasses**
  - As directed by state officials
- **Clean and disinfect**
  - Equipment, facilities

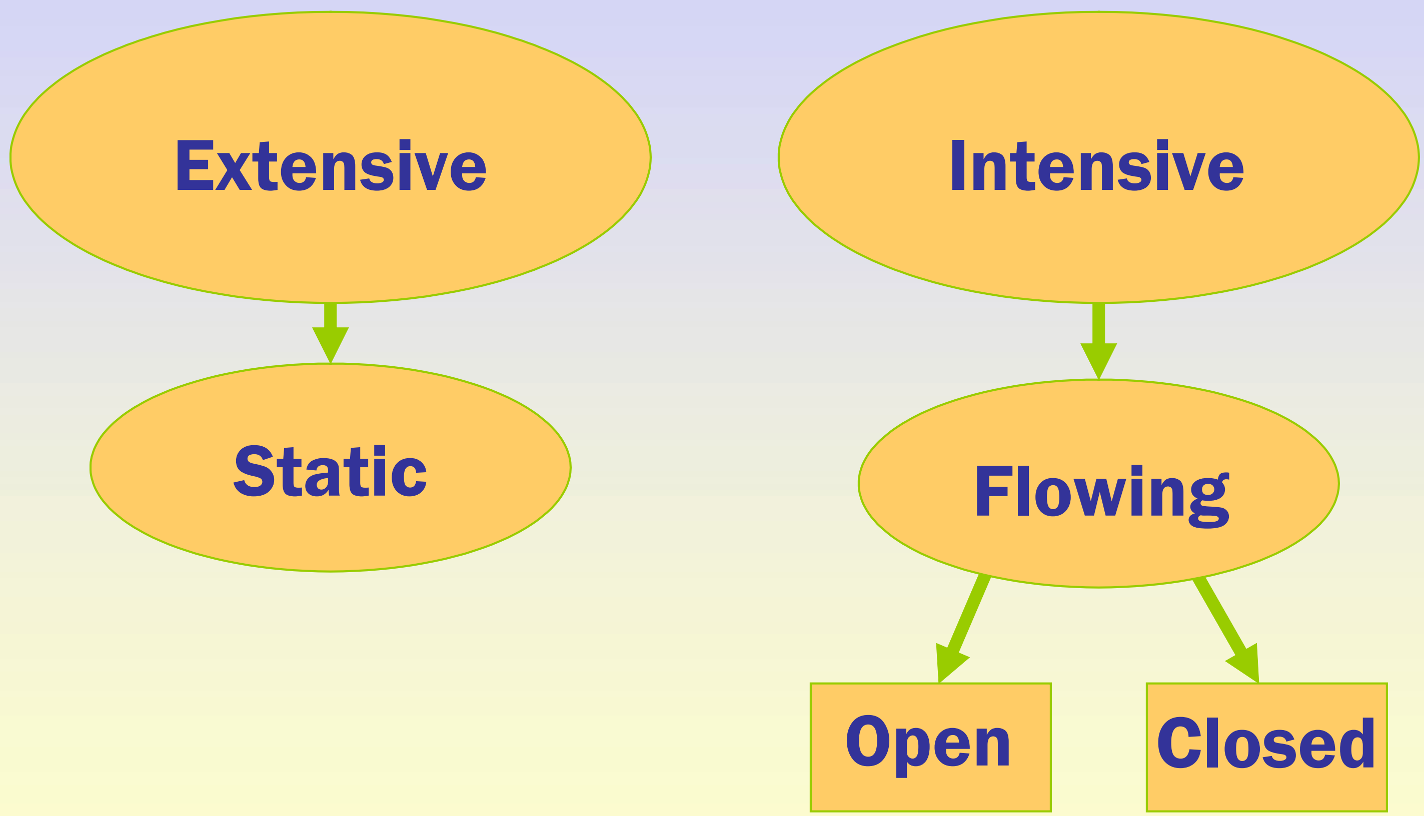
Aquaculture's Basic Needs

Water
- Suitable supply
- Quality source
- Filtration

Air
- Oxygen supply

Temperature control

Aquaculture Systems



Aquaculture Systems

- **Defined by extensive and intensive**
  - Extensive – static water system – Lower input and lower yield
  - Intensive – flowing water system – High water volume, input higher with higher yield
- **Static water system**
  - Reliable water source, require inputs occasionally
  - Example: earthen pond
- **Flowing water system**
  - Continuous water supply
  - Defined as open or closed
  - Examples: raceways, ponds, ocean net pens, aquariums, cages, recirculating systems

Open and Closed Aqauculture Systems

- **Open Water Systems – water flows through system and released into water body**
  - Excellent water quality
  - High stocking densities
  - Reliable, suitable water source
  - Examples: raceways, pens, cages
- **Closed Water Systems – water from culture chamber recycled back into system after filtration or treatment**
  - Less water input required
  - Less effluent
  - Control over water quality
  - Limited stocking densities
  - Increased cost
  - Examples: ponds, aquariums, recirculation systems

Open Aquaculture Systems

Raceway

Picture courtesy aquanic.org

Net Pen

Closed Aquaculture Systems

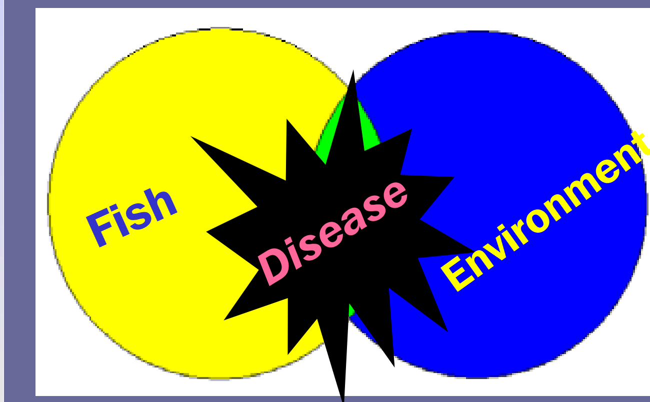
Typical glass aquariums

Larger fiberglass aquaculture system tanks

Water Quality

The *most* important production component for raising fish

- **Parameters of importance:**
  - Ammonia, nitrites, DO, temperature, pH, hardness, CO_2, turbidity, chlorine, heavy metals
  - Some fish have different tolerances
- **Test kits**
  - Watch expiration dates
  - Wash after each use and between tanks
- **Reliable, safe supply source**
  - Protected source
  - Unprotected source



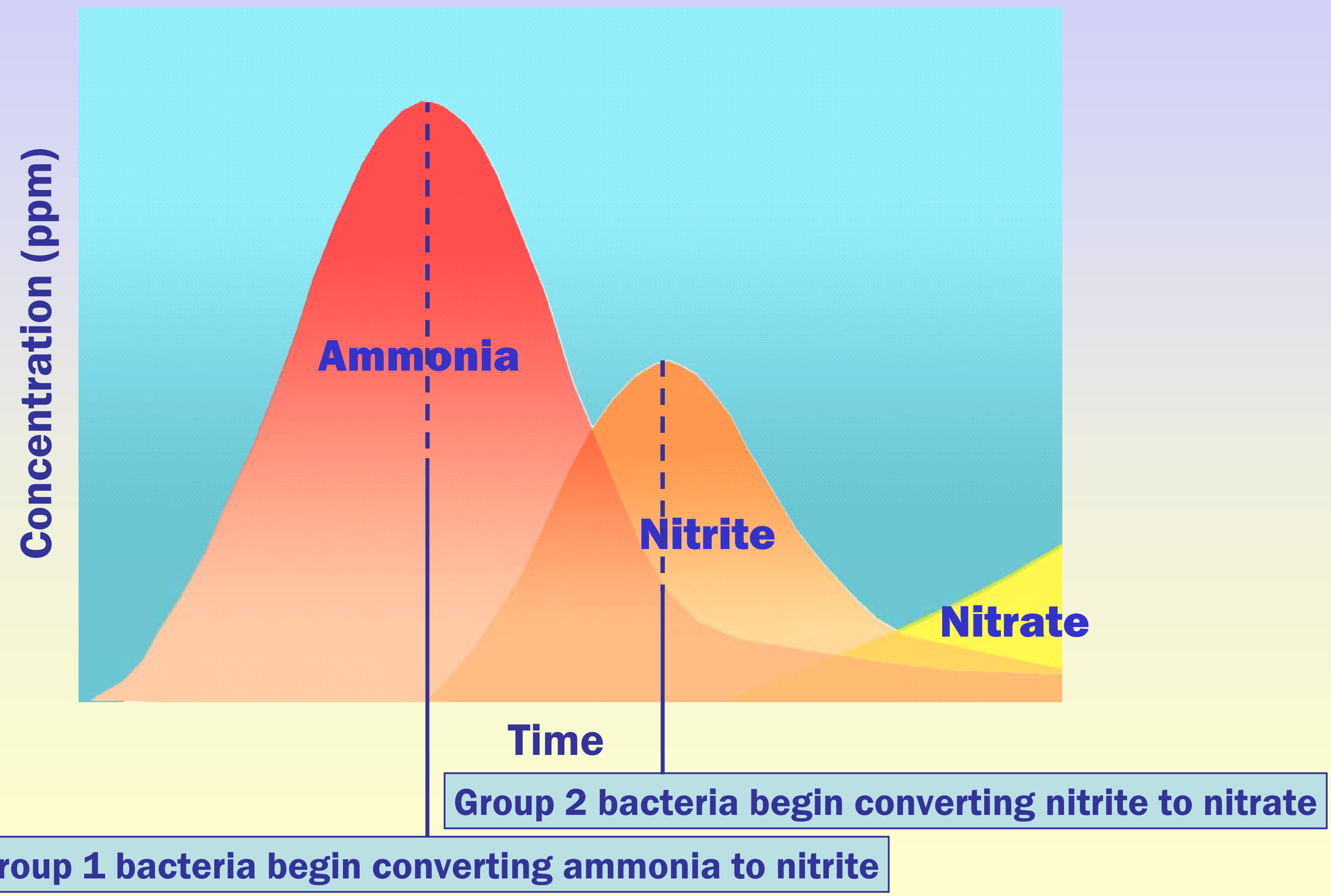
Mechanical Filtration

- **Effective in removing suspended solids**
- **Several methods and mediums available**
  - Gravel and sand filters
  - Gravity and pressurized systems

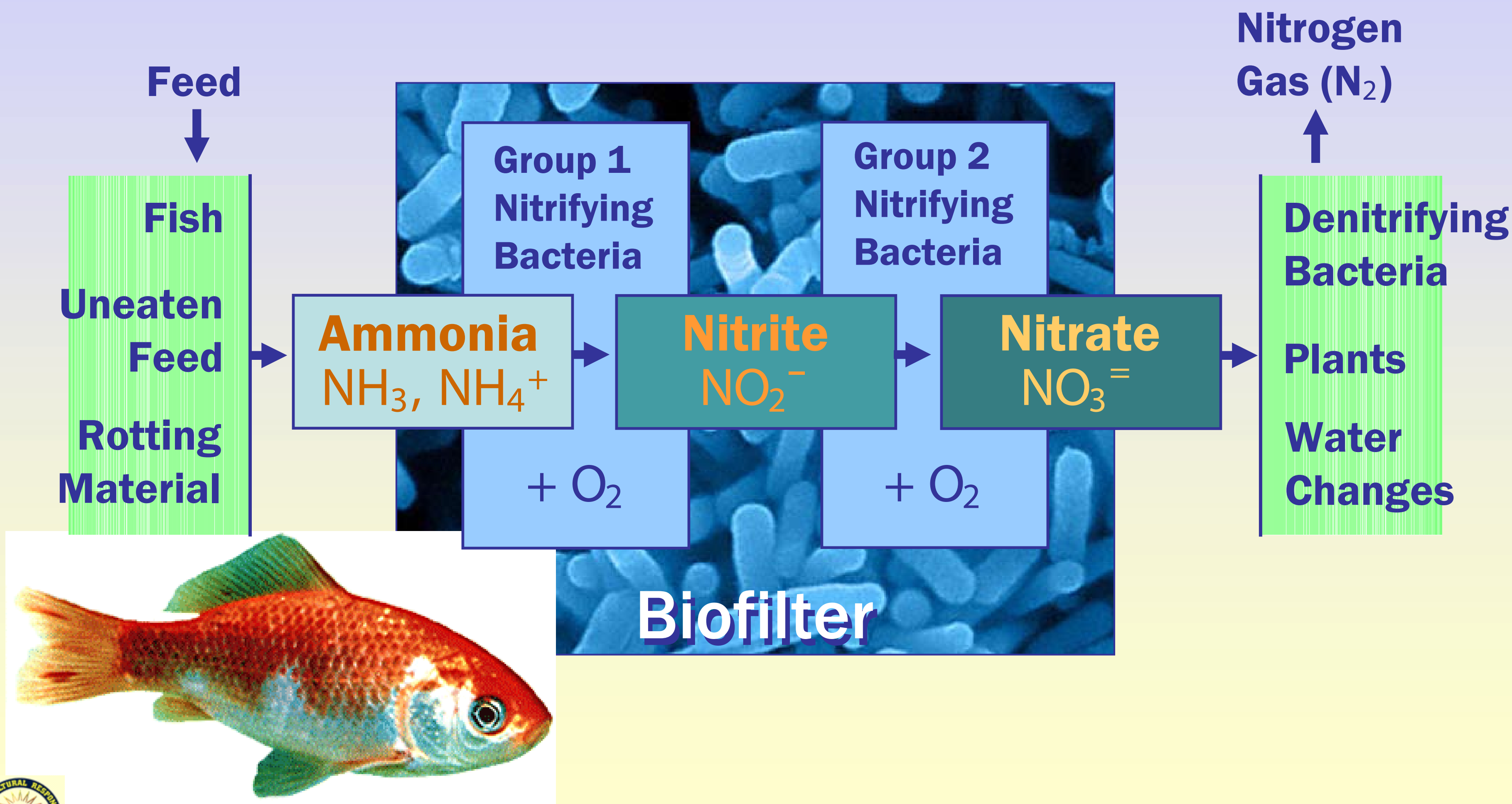
Biological Filtration

- **Primary function – *nitrification* of ammonia**
- **Several requirements for adequate function**
  - Surface area for bacterial colonization
  - Oxygen
  - Time
- **Size of biofilter determined by the amount of ammonia in the system and its efficiency**

Nitrogen Cycle



Biological Filtration



Chemical Filtration

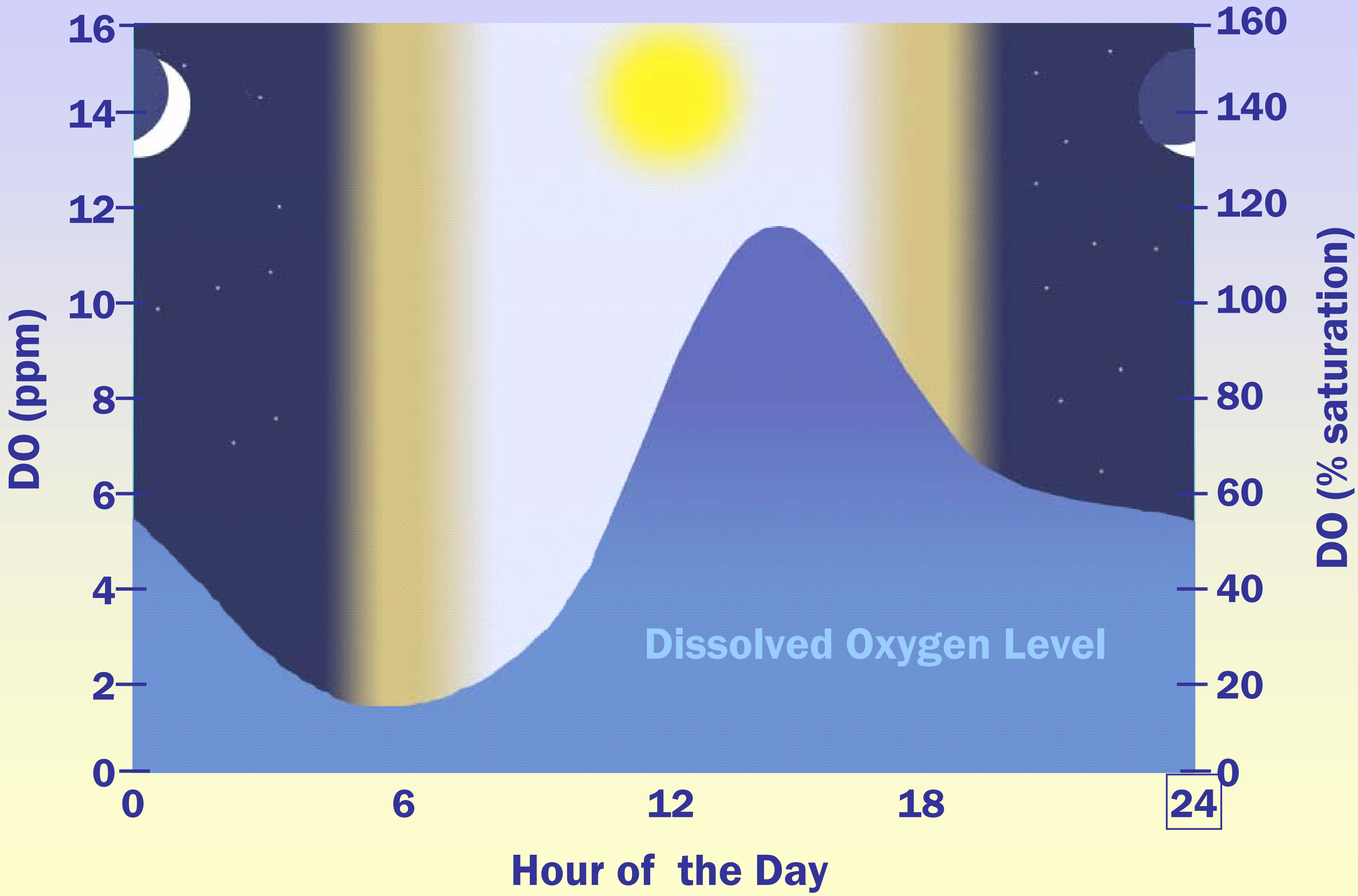
- Chemical
  - Commercial products available
  - Use with caution
  - Do not fix problem of inadequate biofilter

Tanks and filtration systems for Epcot Living Seas Aquarium

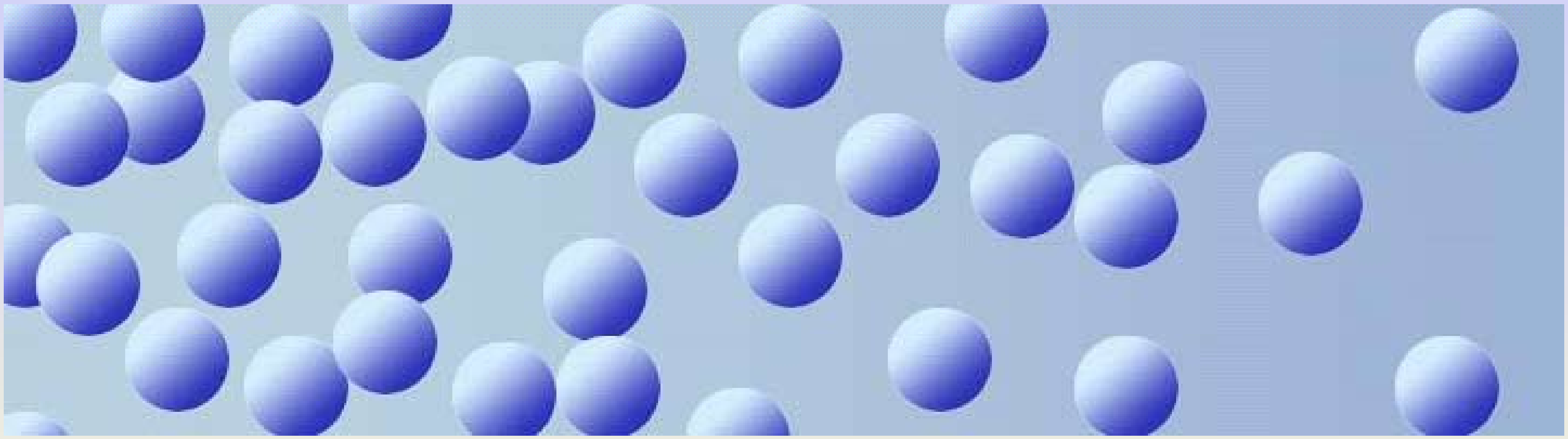
Air -- Dissolved Oxygen (DO)

- **Refers to oxygen gas dissolved in water**
- **Sources of oxygen**
  - Chemical, photosynthesis, mechanical, diffusion
  - Smaller bubble size is better due to slower rise and greater surface area for oxygen diffusion
- **Depletion**
  - Animal and plant respiration
  - Organic decomposition
  - Diurnal cycle of DO
- **Tolerance of low DO is species specific**
  - Rule of thumb – 5 ppm minimum
- **Clinical signs of low DO**
  - Gulping at surface, lethargy, loss of appetite, increased ventilatory effort, death

Diurnal DO Cycle



Factors that Influence Dissolved Oxygen



More Dissolved Oxygen at

- Higher Temperature
- Higher Pressure
- Lower Salinity

Less Dissolved Oxygen at

- Lower Temperature
- Lower Pressure
- Higher Salinity

Temperature

- **Direct effect on metabolism, feeding and survival**
- **Species-specific optimum levels**
  - Protect from heat and cold
- **Metabolism**
  - Temp ↑ leads to rapid metabolism ↑
  - Temp ↓ leads to O_2, food demand ↓
- **Acclimation**
  - Gradual changes
  - Minimizes temperature stress
- **Stress signs: Lethargy, abnormal behavior, increased ventilation, death**

Temperature has a $\boxed{\text{greater}}$ impact on fish development and health than any other factor

Tools for Aquatic Animal Emergencies

- **Alternate emergency water source**
  - Bottled water – may be missing necessary ions
  - Drinking water – must dechlorinate
  - No deionized or reverse osmosis (RO) water
- **Test kit**
  - Evaluate water quality parameters
- **Diagnostic resource**
- **Supportive therapy**
- **Equipment**
  - Thermometers, DO meter, refractometer, etc.
- **Back-up power source**
  - Generator or power equipment
- **Oxygen**
  - Primary or alternate oxygen supply

Preparing for Emergencies

Identification of Risk Factors
and
Facility Risk Management

Biological Hazard Transmission

- **Modes of pathogen transmission**
- **Aerosolization/splashing**
- **Contamination**
  - Fish, equipment, personnel, feed, water
- **Vertical and horizontal transmission**
- **Vectors**
  - Personnel, equipment, some parasites

Argulus, Fish louse

Transmission of many hazards can be prevented with proper risk management

Aquaculture Risk Factors

Identify intervention points to enhance animal health by considering three groups of risk factors

- ***Incoming materials***
  - Fish, equipment, people, feed, vehicles
- ***On-farm management***
  - Fish, quarantine, traffic and equipment flow
- ***Outgoing effluent and products***
  - Water
  - Fish

Fish Husbandry

- **Risk of pathogen introduction**
  - Incoming fish can infect resident fish
  - Resident fish can infect incoming fish
- **Intervention tactics**
  - Practice quarantine and/or acclimation
  - Purchase fish from reputable source
  - Monitor environmental conditions
  - Water management
  - Feed management
  - Observe daily

Equipment

- **Intervention tactic**
  - Multiple dip buckets/disinfection stations
  - Restrict net and equipment sharing
  - Separate nets for quarantine/suspect fish
  - Dip change protocol

Personnel

- **Risk of pathogen introduction and dissemination from one tank to another**
- **Intervention tactics**
  - Training
  - Limit access
  - Hygiene program
    - Foot bath, hand wash
    - Clean clothes; protective clothing
    - Awareness

Quarantine

- **Isolated Space**
  - Separated from resident fish
  - Dedicated equipment/supplies
  - Limited visitor access
  - Managed personnel and traffic flow
- **Bag water**
  - Potential source of pathogens
  - Poor water quality (high ammonia, low pH, high CO_2)
  - Waste management

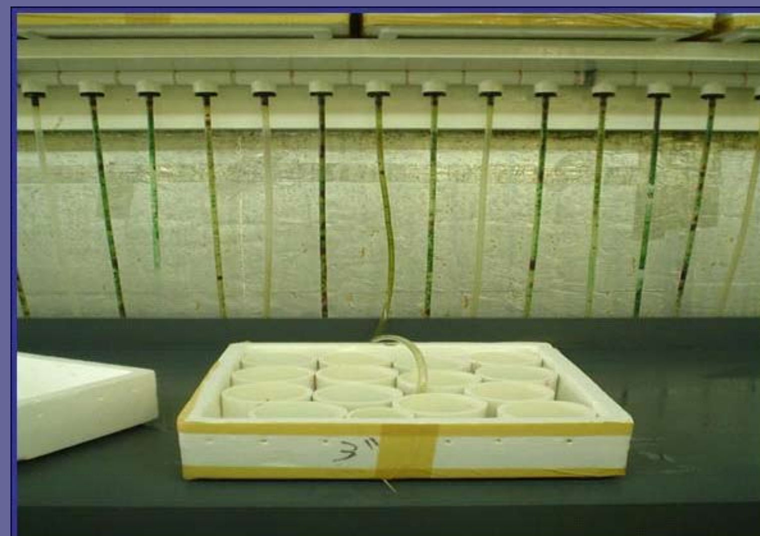
Quarantine

- **Length of time**
  - Pathogen life cycle dependent
    - Pathogen reproduction
    - Water temperature
  - Recommended time: = 4 weeks
- **Manipulations for pathogen expression**
- **Diagnostics/Treatments**
  - Monitor health status (non-lethal sample collection)
  - Treat for specific pathogens

Remember, the goal is to target specific pathogen elimination and/or prevention

Acclimation

- Defined as a method to slowly introduce fish to a new environment
- During this period, it is possible to perform therapeutic treatments



Acclimation table

Quarantine vs. Acclimation

Quarantine

- Requires minimum of four weeks
- Isolated system and equipment
- Separate species/origin
- Reduce density
- Diagnostics, treatment
- Requires more labor and money
- Optimal for pathogen control/elimination

Acclimation

- Complete within hours
- Group acclimation
- Stress reduction
- Bath treatment possible
- Less than optimal for pathogen control/elimination

Collecting Fish Samples

- **Case history information**
  - General, behavioral, physical, treatments
- **Water sample**
  - Clean transport bag
  - Ship with fish
- **Collect live moribund fish**
  - 3-5; multiple species if applicable
- **If dead, wrap fish in moist paper towels and place in plastic zipper lock-type bag**
- **Do not freeze, refrigerate only**

Submitting Fish Samples

- **Call diagnostic lab**
- **Package live fish sample**
  - Double bag
  - 1/3 filled water
  - Oxygen source (compressed O_2, oxy tabs)
  - Heat/Cool packs if necessary
  - Styrofoam box (cardboard outer box)
  - History information (in plastic bag)
- **Ship overnight or hand-deliver**
  - Label outside box: LIVE FISH

Photo source: zfin.org

Euthanasia of Aquatic Animals

- **Primary methods**
  - Drug overdose (MS-222, benzocaine)
    - Expensive and impractical for large populations
  - **CO_2 (compressed gas) and rotenone**
    - USDA uses for SVC depopulation
    - More practical for large populations
- **Secondary method is stunning followed by decapitation**

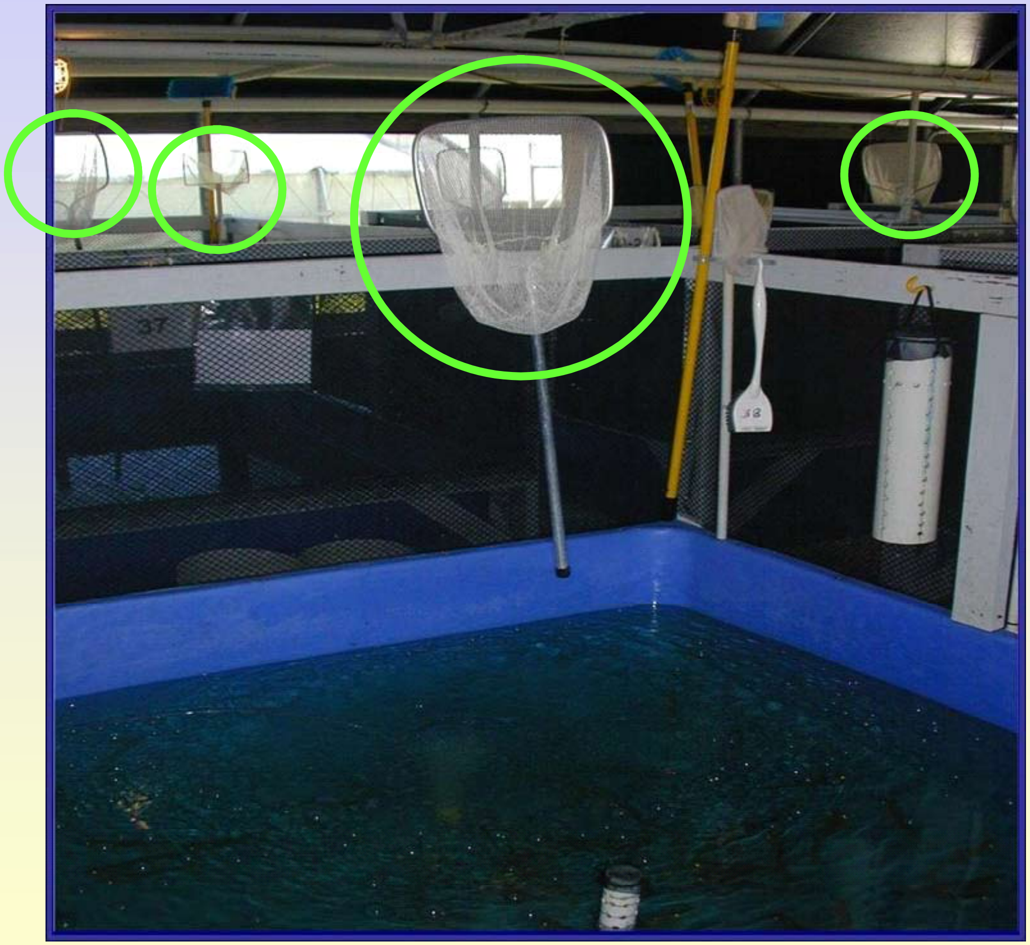
CO_2 euthanized koi

1 2 3 4

Sanitary Precautions

What do you notice?

Sanitary Precautions



What do you notice?

Every tank has its own equipment… there is no sharing between tanks

Key Resources

- **USDA-APHIS fact sheets for various animal diseases**
  http://www.aphis.usda.gov/lpa/pubs/fsheet_faq_notice/fsfaqnot_animalhealth.html

- **APHIS's Center for Emerging Issues (CEI) worksheets on animal health and diseases of concern**
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