FISH FARM™

The Mini Fish Farm™ Operation Manual

(Part No. FF50-3)

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PENTAIR

AQUATIC ECO-SYSTEMS™

Pentair Aquatic Eco-Systems, Inc. *• Phone: 407-886-3939 • Email: PAES.General@Pentair.com • Web: PentairAES.com*

The Mini Fish Farm™ Operation Manual

Contents

Introduction

The Mini Fish Farm™ can grow fresh, unpolluted fish throughout the year. Fish are one of the best sources of protein in the animal kingdom, low in both calories and saturated fats. Aquaculture is a fascinating hobby and the Mini Fish Farm™ will provide enjoyment for many years.

This guide describes how to grow up to 100 pounds of fish every six months. The Mini Fish Farm™ recirculating aquaculture system is designed for both low energy and low water usage. It is a simple, economical system, especially designed for the beginner in aquaculture.

Until now, food fish culture has been limited to commercial facilities requiring large quantities of water and expertise. But as natural water supplies are depleted or polluted, commercial operations are using more complex and expensive bioengineering designs. This modern technology has opened the door for a new approach to fish culture that is as practical as home gardening for the combined benefits of relaxation, education
and food production.

Description of the Mini Fish Farm™

The Mini Fish Farm™ is a growing system for fish (as well as other aquatic animals and plants) that uses unique biofiltration and clarification devices to make the reuse—or recirculation—of water possible. This recirculation system allows the feeding of up to 5 lbs (2.26 kg) of fish food per day without water replacement! The Mini Fish Farm™ contains approximately 500 gallons (1,890 liters) of water in its 5-foot diameter polyethylene tank. In addition to fish food, the only inputs required for normal operation are 10 gallons (38 liters) of water and 2.1 kWh of electricity per day. See Biofiltration and Clarification (p. 5) for further descriptions.

Small-Scale Fish Culture

The Mini Fish Farm™ has been designed to operate with a minimum of technical knowledge. However, just as it is necessary to understand the fundamentals of gardening before attempting to grow your own food, there are fundamentals of fish culture which must be understood before proceeding. This manual will guide you every step of the way.

For fish to remain healthy and grow at a favorable rate, they must be provided with a suitable environment. The environment is water, and water quality is something with which the beginner in aquaculture should be familiar. Here are some guidelines that will help to make your first attempt at raising fish successful:

Operating Guidelines

1. Keep electricity and power cords away from the water. Wear safety glasses and gloves when pouring or handling strong chemicals. Keep chemicals out of children's reach.
2. Keep foreign chemicals away from the Mini Fish Farm™. Insecticides, soaps, oil and grease, cleaning agents and bactericides can either kill fish directly or inhibit the operation of the system to the point that the fish could suffer.
3. Start the Mini Fish Farm™ by following the start-up procedures described in this manual under Biofilter Acclimation (p. 8).
4. Never overfeed the fish. Give them only what they will eat in one feeding. Uneaten food will place an undue burden on the water cleaning systems, degrade the water quality, promote diseases and odors and discolor the water.
5. Make certain that water is always flowing through the clarifier and biofilter (besides cleaning).
6. Clean the clarifier and filter pad every day. The clarifier removes "settleable solids" (which are heavier than water). If they are not removed daily, they will begin to float in the water (as a result of gas formation during decomposition), and will then pass through the clarifier, contaminating the water.
7. If ammonia gets too high, reduce it by either exchanging water or using zeolite. See Water Exchange and Zeolite (p. 5).
8. If nitrite gets too high, reduce it by exchanging water. If fish are already stressed, add 1/3 lb of salt (noniodized) to the water to reduce the toxicity of nitrite. Stop feeding until nitrites are at a safe level. See Nitrite (p. 4).
9. Monitor and chart water quality daily (see Evaluation of Water Quality (p. 2)). By charting, you will be able to foresee and thereby avoid problems. Example and blank charts are found in Appendix A.
10. If you can't find an answer to a problem in this manual, call Pentair Aquatic Eco-Systems for guidance.

Chapter 1

Water Quality

Evaluation of Water Quality

Fish farmers should have some means of evaluating water quality in order to be aware of the health of the fish culture system. Water quality analysis kits are popular for this purpose because they are relatively inexpensive. Also, they provide cookbook-like directions, so little knowledge of chemistry is required. Test kits provide an adequate level of accuracy and reliability for most fish culture.

Because it is necessary to replace the reagents in these kits as they are used, it may be more economical to purchase a meter when a large quantity of measurements are to be taken. Initially, meters are more expensive, but they are fast and convenient.

Water Quality Parameters

Temperature

One of the primary factors affecting fish growth is the temperature of the water in which they are cultured. For each species of fish, there is a wide temperature range which they tolerate and a smaller temperature range for their optimum growth. In order to achieve the fastest and most efficient conversion of fish food to fish weight, the water temperature must be kept as close to this optimum value as possible (see Chapter 3, p. 12).

Commercial aquaculture operations, because they use large quantities of water, must restrict their species choice to fish which will grow well at the temperature naturally occurring in their location. For instance, only operations with an abundant source of cool water grow trout. Catfish farmers (using outdoor ponds) are confined to geographic areas where the water remains warm enough for an adequate season of growth.

With recirculating tank culture (as in the Mini Fish Farm™), temperature control is much more plausible. Recirculating culture systems reduce the quantity of heat (or cold) needed, as the heat can be conserved with insulation and very little new water is needed. We recommend that the system be placed indoors where water temperature can be maintained more easily. Outdoors, season length is determined by the geographic location and the use of a cover. Solar energy can be collected to extend warm-water culture. A water chiller may be used to cool the water.

Oxygen

Oxygen is as necessary to fish as it is to us. However, oxygen is not as abundant in water as it is in air. The air we breathe is about 20 percent oxygen. The air in the water that fish breathe is only about .0001 percent oxygen. Very often, oxygen availability is one of the limiting factors to fish growth and survival. Dissolved oxygen (D.O.) enters the water in various ways, depending on the body of water involved. In natural systems such as lakes and rivers, oxygen is provided mostly by absorption of oxygen from the air. Oxygen can also be added in significant amounts by plants and algae through photosynthesis. During nighttime hours, however, algae and plants will consume oxygen.

As the total weight of the fish increases, so does the amount of oxygen needed to sustain them. Without continual replenishment, the D.O. level becomes depleted, possibly causing a high degree of stress or even asphyxiation of the fish. Some species have greater tolerance to low D.O. levels than others, but continued low levels stress the fish, resulting in less efficient food conversion and greater susceptibility to diseases. Frequent monitoring of D.O. is usually not as necessary in the Mini Fish Farm™ as it would be in pond culture, because continuous aeration is provided by an energy-efficient linear compressor. Compressed air is delivered to air diffusers, which produce small bubbles that add oxygen and remove carbon dioxide while circulating the water. If the oxygen level becomes low, stop feeding until it comes back up. See the Water Quality Tolerance Chart in Appendix C (p. 19).

Chlorine

Chlorine kills fish and must be eliminated from water before adding fish. When filling the tank initially, add 11 grams of sodium thiosulfate (included) to the water. This will neutralize the chlorine. Spraying the water in will help with degassing, whether filling the tank or filling the clarifier. See Appendix F (Sodium Thiosulfate, p. 21).

Algae

Crystal clear water does not necessarily constitute good water quality. Some species prefer and may even require water green with algae. Trout production systems require clear water, but most outdoor fish culture systems are more likely to contain green water. Algae can have both positive and negative effects, but when properly managed a healthy algae population can offer some advantages. The Mini Fish Farm™ will operate equally as well with both clear water and green water.

On a sunny day, algae is capable of producing a large quantity of oxygen (through photosynthesis) while consuming carbon dioxide ammonia. Algae consumes both ammonia and nitrate as food, so algae growth improves the water quality for the fish. When algae is eaten by fish (such as tilapia), these waste products become fish food. If not managed, however, algae can be dangerous. With high levels of nutrients in a recirculating system, the algae population can become very thick (sometimes called an algae bloom). A "die-off" of such a large population of algae is where the problem comes in. Dead algae are fed upon by bacteria, which consume large quantities of oxygen while producing ammonia. This additional ammonia can overload the biofilter, as it had been acclimated to low ammonia levels when the algae were alive.

The Mini Fish Farm™ provides good control of the algal community through mixing, aeration and clarification. As fish production levels increase during the early part of the season, the green algae become more abundant. The natural life/death cycle for algae is evenly spaced, and only a partial die-off takes place at any one time. Dead or unhealthy algae cells clump together and, if not removed in some way, they settle to the bottom of the tank and begin to decompose. The Mini Fish Farm™ sediment pick-up and clarifier system removes these clumps of dead cells, leaving the healthy, small algae to move through the system.

Nitrogenous Compounds

Nitrogen occurs in several forms in recirculating fish culture systems. Two of these, ammonia (NH_3) and Nitrite (NO_2-) are toxic to fish and must be carefully monitored and controlled. This is especially important during start-up of the biofilter; during periods of maximum stocking densities; and in the event of some disruption of the system, such as disease, overfeeding or after a mechanical breakdown of the system. The third form of nitrogen, nitrate, is not toxic to fish. The Mini Fish Farm™ biofilter is designed to convert the ammonia produced by the fish into harmless nitrate.

Ammonia

Ammonia is probably the most important water quality parameter that needs to be monitored in the Mini Fish Farm™ (see Biofilter Acclimation on p. 8). Ammonia builds up in a fish culture system as a byproduct of fish metabolism. The protein in the fish food is converted to both fish flesh and ammonia. In most aquaculture facilities, metabolites are controlled by varying the stocking and feeding rates or by adjusting the amount of water exchange. In a natural body of water, such as a pond, ammonia produced by the relatively small fish population is diluted by the water and is ultimately consumed by algae and other plants.

In the more densely populated situation of a recirculating system, ammonia can be partially removed by the algal population (in well-lighted situations), but high production levels require a biological filter (see Appendix C on p. 19 for safe levels of ammonia for each species).

Even though pH is not as critical as some other factors, it is extremely important to measure and take it into consideration when determining the toxicity of ammonia. The higher the pH, the more toxic the ammonia. Ammonia in water occurs in two states: ionized (NH_4+) and un-ionized (NH_3). It is un-ionized ammonia that is toxic to fish. The proportion of un-ionized ammonia in water is directly related to the pH and the temperature of the water. The higher the pH, the higher the proportion of toxic NH_3. The following chart illustrates the relationship of the ammonia equilibrium as a function of pH and temperature. Most water quality tests for ammonia-nitrogen provide a value for the total ammonia (NH_3 + NH_4+) present. If the pH and temperature of the water are known, this chart will give the actual percentage of toxic (un-ionized) ammonia. The Water Quality Tolerance Chart in Appendix C uses un-ionized ammonia, so always reference this chart when testing for ammonia. To determine toxic levels, measure total ammonia, pH and temperature of the fish culture water. Find the percentage of toxic ammonia at the measured pH and temperature from the chart. Move the decimal of the percentage two places to the left and multiply this value by the value measured for total ammonia.

Example:

Mini Fish Farm™ water is measured at pH 8.0 and temperature 86°F. The chart indicates that 8 percent of the total ammonia levels is the toxic NH_3. If total ammonia levels are measured at 1.8 ppm, then the un-ionized portion is 1.8 x .08 = .14 ppm. If the toxicity of the un-ionized ammonia (NH_3) is considered detrimental at levels above .03 ppm (for your species) then .14 should not be dangerous to the fish. The biofilter produces acid as it removes the ammonia, so the pH of your culture water should drop throughout the production cycle. When the pH drops below the desired level, add sodium bicarbonate to return the pH to the desired level.

Percentage of Un-Ionized Ammonia in Water at Different pH Levels & Temperatures

Temp	Temp	pH							
(°F)	(°C)	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5
50	10	0.02	0.1	0.2	0.6	2	6	16	37
59	15	0.03	0.1	0.3	0.9	3	8	22	46
68	20	0.04	0.2	0.4	1	4	11	28	56
77	25	0.06	0.2	0.6	2	5	15	36	64
86	30	0.1	0.3	0.8	3	8	20	45	72

Example:

The ammonia test kit has indicated that the ammonia level is 1 ppm. The pH kit measures 7.0 and the water temperature is 68°F. Multiply the ammonia measures (1 ppm in this example) by the percentage shown on the chart (.4 percent in this example) 1 x .004 = .004 ppm un-ionized ammonia. Remember that the bold numbers on the chart are percentages, so the decimal must be moved two places to the left in all calculations.

Nitrite

Nitrite could be the second most important parameter to monitor, especially while acclimating the biofilter. Nitrite (NO_2) is the intermediate product of biological nitrification resulting from the oxidation of ammonia by *Nitrosomonas* bacteria. Nitrite may sometimes reach toxic levels during the early stages of filter acclimation or following overfeeding. Nitrites are absorbed through the fish gills and interfere with their ability to absorb oxygen. Fish affected by high nitrite levels appear to suffer from oxygen depletion. The toxicity of nitrite can be reduced by adding 1/3 pound of noniodized salt (included) to the Fish Farm™ water.

In a properly functioning system, nitrite should not be present at toxic levels. The nitrite is oxidized by *Nitrobacter* bacteria, also growing on the biofilter, and changed to nitrate (NO_3-) which is not toxic to fish. If potentially toxic nitrite levels do not start coming down after two days, begin water exchange and/or add salt as described above.

Nitrate

Since nitrate is not toxic to fish even in high concentrations, it is a relatively safe end product of nitrification and can be allowed to accumulate in the water. When the Fish Farm™ is located where it receives sunlight, nitrate becomes a nutrient source for the algal population. In combination with algae-eating fish, this provides for an efficient recycling of nitrogen, with the original waste from the fish converted into a food source.

pH

Technically, the pH of water is a measure of its hydrogen ion (H+) concentration. In general, water with a pH less than 7 is called acidic and with a pH greater than 7 is basic. A pH of 7 is neutral. Fish can tolerate a fairly wide range of pH, but optimum values are usually from 7.0 to 7.6 (see Appendix C). Raise pH using sodium bicarbonate (50 lbs included). It can be lowered by the addition of hydrochloric acid (also known as muriatic acid), but the water may need to be buffered by the addition of sodium bicarbonate first, if the alkalinity is too low. Change pH levels slowly. Do not change more than 0.2 pH units per hour, or more than 1.0 unit in 24 hours. See Appendix C (p. 19) and Appendix E (p. 20).

Alkalinity

Alkalinity is a measure of the quantity of compounds which shift the pH to the alkaline (above 7) side of neutrality. This measure is mostly influenced by bicarbonates, carbonates and hydroxides, and less frequently by borate, silicate and phosphates. Alkalinity is important to the fish farmer because it buffers (slows rate of reaction) pH changes that occur naturally during photosynthetic cycles and pH changes that are caused by other factors, such as the addition of acid. For most fish species, total alkalinity should range between 50–200 ppm $CaCO_3$. Alkalinity can be increased by the addition of Sodium Bicarbonate. See Sodium Bicarbonate in Appendix E.

Hardness

Hardness is a measure of dissolved metallic ions and is commonly measured in mg/l (ppm) or grains per gallon (multiply grains per gallon x 14.2 to get ppm). Typically, calcium and magnesium dominate the ion concentration but iron, strontium and manganese ions can also be found. Since bicarbonates generally are measured as alkalinity, the hardness (carbonate hardness) usually is considered equal to the alkalinity; therefore, hardness should also range between 50–200 ppm $CaCO_3$. Hardness and alkalinity can be used interchangeably in some cases; however, in other situations they are not at all the same, so be aware of the difference when doing chemical analysis.

Clarification

As control of ammonia and nitrite is achieved, fish production increases. However, this in turn leads to increased feeding levels and increased solid waste material within the system. The control of these suspended (particles that do not sink) and settleable (particles that sink given time) organic waste materials is as important to the health of the fish as the control of the parameters discussed previously. It has been demonstrated that in small-scale recirculating systems without a means of effectively removing suspended organic material, production capacity is severely limited.

The solids in a fish culture system are comprised of fecal wastes, uneaten food, fines (dust material from the food too small to be eaten) and, in outdoor systems, dead algae. Their concentration, both in the water and on the tank bottom, can affect the health of the fish carrying capacity of the system. Through bacterial decomposition of this organic material, oxygen levels decrease and secondary ammonia levels increase. Increased turbidity reduces light penetration and, in a system with algae, decreases the oxygen made available through photosynthesis. The suspended solids in the water can also directly affect the fish through gill damage and by reducing their ability to locate food.

The Mini Fish Farm™ uses a unique clarifier designed for its effectiveness, ease of maintenance and low energy requirements. This system provides stable water quality conditions and good dissolved oxygen levels and helps maintain the health of the fish. The Mini Fish Farm™ clarifier and filter pad should be cleaned daily.

Biofiltration

A recirculating aquaculture system is very dependant on its water cleansing systems. In the Mini Fish Farm™ solid waste (particulates) is removed by sedimentation and filtration which takes place in the clarifier. The liquid waste (dissolved) is removed by bacteria growing on the surfaces of the biofilter packing (Siporax®), as well as all other submerged surfaces.

Plants and algae may be present if the Mini Fish Farm™ is in a well-lighted location. Plants and algae will also remove liquid waste (and possibly allow the Fish Farm™ to carry more than 100 pounds of fish).

Biofiltration is a natural, 2-step process that changes ammonia first to nitrites and then to harmless nitrates. The process is performed by nitrifying bacteria (*Nitrosomonas* and *Nitrobacter*) which are found naturally in the soil, air and water. These bacteria attach themselves to solid surfaces, forming what feels like a slime.

In the Mini Fish Farm™, ammonia builds up more quickly than it can be removed by the algal population. More of the nitrifying bacteria are needed to remove ammonia than are naturally supported on the surface areas of the tank. The biofiltering system provides greatly increased surface area to support a large, active population of bacteria.

Water Exchange

The Mini Fish Farm™ was designed to operate on only 10 gallons per day of water exchange. Reasons for exchanging water may include ammonia and nitrite reduction, temperature adjustments, tank cleaning and water clarification.

Either drain out several inches of tank water (by opening the clarifier drain valve) and then refill the tank, or drain water while adding new water (this is not as effective as the first method).

When replacing water, spray and/or splash the incoming water. This will add oxygen (aerate), degas chlorine (if chlorine is present) and degas nitrogen.

Water can be easily drained by attaching a garden hose and adapter to the clarifier drain valve and allowing it to gravity flow wherever desired. Water may also be siphoned out using the bottom cleaning wand or the optional submersible water pump. Remember that the electric submersible water pump will add a small amount of heat to the tank when operating—this may or may not be desirable.

Zeolite

Ammonia can also be removed from water through the use of zeolite, also known as clinoptilolite. Like activated carbon, zeolite can also remove color and organic matter.

Some recirculating fish culture systems have been built using zeolite in place of a biological filter but, commonly, zeolite is used to augment the biofilter during periods of acclimation, recovery and overload. Keep some on hand as an alternate to a water exchange for ammonia reduction.

To expand the Mini Fish Farm™ growing capacity well beyond the capacity of the biofilter, use zeolite to control ammonia levels and/or exchange water.

Zeolite traps ammonia in its pores. When all pores are filled, it must be replaced or recharged. One gram of zeolite will trap up to 3 mg of ammonia (total ammonia). To remove one mg/l (ppm) of ammonia from the Mini Fish Farm™, a minimum of one kilogram (2.2 pounds) of zeolite is needed (10 lbs included).

Zeolite may be used in conjunction with chloramines neutralizer (PAES part no. **CL128**) to eliminate ammonia after it is freed from its bond with chlorine.

The amount of zeolite to use (and its frequency) will be determined by the brand of zeolite, the particle size and the number of times it has been recharged.

Circulation of water through the zeolite is required for the ammonia to come in contact with the microscopic trapping pores. We recommend that mesh bags of zeolite be hung from the tank walls.

Recharge the zeolite by submerging it in a salt solution, 45 ppt or greater (one gallon of water with 1/2 lb salt works well), for about 8 hours. Rinse with fresh water, then reuse. Be careful not to pour waste salt water on intolerant plants. Another recharge method is air-drying for several days, preferably in a warm, dry climate. The effectiveness of recharging diminishes approximately 10 percent per recharge cycle.

Summary

While all of the information provided in this introductory chapter may seem overwhelming for beginners, the actual management of the Mini Fish Farm™ is relatively simple. For instance, by correctly following the procedures outlined in Chapter 2, water quality remains acceptable throughout the season. A careful feeding schedule results in rapid and efficient fish growth. Choosing the correct species of fish provides the least expensive and most productive harvest possible.

While experience is the best teacher for making these management decisions, the following step-by-step instructions provide a safe and effective method for obtaining a profitable harvest from the very first year.

Chapter 2

Operation and Maintenance

As described in the first chapter, the Mini Fish Farm™ represents a complex living system. As with any living system with interacting physical, chemical, and biological variables, no matter how carefully monitored and controlled, it is always possible to have unforeseen problems occur. The management requirements for the Mini Fish Farm™ have been greatly reduced through its almost foolproof design.

Mini Fish Farm™ Components

The Fish Culture Tank

The polyethylene tank holds sufficient water to grow a population of fish whose total weight is as high as 100 pounds. It is adapted for integration with other system components to provide for necessary water quality control. The polyethylene tank can be placed on almost any flat, level surface capable of holding the weight of 4,800 lbs (2,182 kg) of water.

The Biological Filter

The biofilter is pre-built for ease of installation. It provides the necessary surface area for growth of nitrifying bacteria. These bacteria work more effectively at temperatures above 55°F. Once in position, start the air compressor and the filter will begin to flow with water. However, before it can function properly, the filter must go through a period of acclimation. This means that bacterial population must grow to a sufficient size on the filter media (initially it is a slimy film, eventually building to a thick brown slime). After proper acclimation, it will be possible to follow the filtration process using water quality tests for ammonia, nitrites, and nitrates. It may take up to 8 weeks to establish a healthy bacteria population. In this chapter, we describe how to pre-acclimate your filter so that it is actively working even before fish are added to the system.

The Clarifier

The clarifier will remove settleable wastes from the water and pass clarified water down through the biofilter chamber, which then is returned to the tank by an airlift. The water returns free of the settleable solids and lower in dissolved nutrients. The clarifier is cleaned daily to remove the settled wasted. A filter pad is used to "magnetically" attract and remove other non-settleable particles before they pass into the biofilter.

The Aeration System

Because of its innovative design, the Mini Fish Farm™ can utilize a very low-energy air compressor (17¢ a day) to provide the plumbing, biofilter and aeration functions of the system. By using an airlift from the external biofilter, water flow is established between these components. This flow is directed into the tank to provide a counterclockwise water rotation. The air diffusers that are suspended from the side of the tank also assist in water circulation, which "spins" heavier-than-water particles toward the tank center, where they can be absorbed by the siphon assembly. Air from the compressor is also directed through a series of air diffusers, which break the air up into very small bubbles. As these bubbles rise though the water, oxygen from the air dissolves into the water, providing for the needs of the fish.

Management of the Mini Fish Farm™

The Mini Fish Farm™ is designed to maintain water quality for the production of up to 100 pounds of fish. The limiting factor in achieving this production level is the time given to the fish, optimal temperatures for their growth and management of the input of feed to the fish.

The most important defense against mishap—and the greatest assurance for the fast and efficient growth of the fish—is careful management of water quality within the system. This requires a thorough understanding of the system and its everyday health. How are the fish eating? Is there a healthy algal bloom? Are the filter and clarifier working properly? Most importantly, is fish feed being added in the proper amounts?

This chapter provides the guidelines for daily, weekly and seasonal management practices. As increased levels of fish are produced, the culturist must accommodate new pressures on the system by changing feed rates, checking on oxygen levels at different times of the day and carefully monitoring the system for ammonia and nitrite levels.

Testing the Water Source

The first step in preparation for fish culture is determining the suitability of available water sources. Surface waters such as streams, ponds or lakes should be avoided, since they can introduce disease organisms. However, it is possible to use such water sources if they are known to be free of pathogens and environmental contaminants.

On the other hand, because so little water is replaced in the system, any potable water (drinking water) source is usable. It is possible to pre-condition even chlorinated city water in a separate container by aeration or by adding sodium thiosulfate (included) to rid the water of chlorine. By aerating water for 24 hours, chlorine is removed and temperatures are brought up to the ambient levels in the tank. It is important to remember that aeration alone will not rid the chloramines from the water and the sodium thiosulfate should be used as prescribed in Appendix F (p. 21).

The pH of the water should be between 6.5 and 8.5. Take the pH reading after aerating the water, as it may change. The action of the biofilter will tend to bring the pH down over the course of the production cycle. To acclimate the biofilter initially, when the pH is too high, use pH Down liquid (part no. **DN-16**), or muriatic acid poured slowly into the airlift side of the clarifier. Be very careful when pouring acid. Always use eye protection against splashing. If any acid splashes on skin or clothing, rinse immediately with water.

Levels of oxygen may be very low in the water put into the tank, the Mini Fish Farm™ aeration system will quickly raise it up to the required levels.

If the Mini Fish Farm™ is filled from a good source of water, there should not be any PCBs, heavy metals, herbicides, pesticides or other contaminants in the water used for fish culture. Insecticides (bug spray, etc.) can be very toxic to fish even in very low levels.

Biofilter Acclimation

The biofilter must be acclimated with the necessary bacteria before it will function properly. A clean, new filter, or one that has been dry for any length of time, will not remove ammonia from the water. A population of nitrifying bacteria must be cultured before the fish can be cultured.

One way to acclimate the filter is to stock low densities of fish, and feed them small amounts of feed. The little ammonia that is produced acclimates to the biofilter slowly without harming the fish. After the filter is seen to be changing the ammonia to nitrates, increasingly more fish and/or feed can be added.

The bacteria (*Nitrosomonas* and *Nitrobacter*) that accumulate on the filter are present naturally in the air and in the water of the culture system. However, in order to acclimate the filter quickly, the bacteria should be introduced from sources where they are found in higher concentrations. This is called "seeding" the biofilter.

A concentrated population of the nitrifying bacteria (ProLine™) is included with the Mini Fish Farm™ and will ensure that the bacteria are present for acclimation of the biofilter. Also, previously acclimated filters (such as aquarium filters), or the soil or sediments from a shallow pond area, are good sources of *Nitrosomonas* and *Nitrobacter*. If soil is used, it should be removed from a clean, well-oxygenated pond. The substrate is then placed into a fine-mesh cloth sack and hung in the fish culture tank.

In order for the seeded bacteria to multiply and colonize the biofilter, they must be supplied with ammonia. If the tank is not to be partially stocked at this time, small quantities of household ammonia (non-detergent) can be added to the water in the culture system. This creates a situation similar to that caused by feeding a small population of fish. When total ammonia concentrations rise above 2 ppm, the *Nitrosomonas* population will increase.

Periodic checks with an ammonia test kit show that simple aeration and evaporation dilute the ammonia concentration over time. Add ammonia to keep concentration above 2 ppm.

As *Nitrosomonas* bacteria grow on the filter, they change some of the ammonia (NH_3) into nitrites (NO_2). This can be observed with a nitrite test kit. As the concentration of nitrites begins to increase, the filter is halfway acclimated. The presence of nitrites stimulates the reproduction and build-up of *Nitrobacter* on the filter plates.

Nitrites are changed into nitrates (NO_3) by the Nitrobacter bacteria. Watch the nitrite levels carefully. When the nitrites are removed as fast as they are produced and concentrations have dropped to less than .5 ppm, the filter is acclimated and fish can be stocked safely. If ammonia is added at this time, it should very quickly disappear from the culture water, with nitrates as the end result.

As nitrates accumulate in the system in outdoor situations, the water in the tank may begin to turn green with algae. This is a good sign that signals the readiness of the tank to accommodate fish. Heavier concentrations of algae may not appear until the fish population is stocked and growing.

Aeration

The compressor will provide the necessary flow of air, directed to the diffusers, which are placed in position on the tank wall near the bottom of the tank. Depending upon the pH of the water, it is possible that the diffusers will need cleaning every six months. This can be done by soaking them in muriatic acid for a couple of hours. Always use caution when using acid and wash hands thoroughly when finished.

Clarifier

It is very important to correctly establish the siphoning and airlift pumping systems, to provide for the flow of water into the clarifier and back to the culture tank. If the clarifier is not cleaned every 24 hours the waste will start to break down and could float over the weir and into the biofilter, which will have an adverse effect on the water quality.

Fish Transfer

Note:

If ammonia is used to acclimate the biofilter, fish should not be added to the Mini Fish Farm™ until the ammonia and nitrites have been reduced to safe levels by the biofilter.

The fish may be delivered in oxygen-charged bags of water. Problems can arise during the fish acclimation procedure when the fish are released from the bags too quickly. Usually this is due to thermal shock from differing temperatures. If the temperature difference is more than 10°F, it is best to float the bags in the water for an hour, allowing the temperatures to equalize. Open the bags and add small amounts of the Mini Fish Farm™ water to the bagged fish over a period of about 10 minutes. This will slowly condition the fish to the varying chemical conditions (especially the pH) of their new environment. The fish can then be released into the tank. They should quickly become comfortable in the tank and begin to take food within 24 hours.

Feeding

Fish Food

Feed costs are the single greatest expense in raising fish. When possible, this expenditure should be reduced by using species of fish whose nutritional requirements are easily met; i.e., they feed low on the food chain. These may include such examples as carp (an omnivorous fish that efficiently converts many forms of feeds) and tilapia (an herbivorous fish which eats algae and several forms of vegetation). However, in most situations at least some commercial feed is necessary for optimum feed conversion. The proportion of food needed to produce a corresponding fish weight is usually expressed as a ratio, such as 1.2:1 (1.2 pounds of food are required to raise the weight of fish by one pound.)

Many years of nutritional research to determine the requirements of trout, salmon, and catfish have resulted in the development of commercially available feeds. These rations provide the necessary proportions of protein, carbohydrates, fat, mineral and vitamin levels for that species of fish. Other fish species may accept these foods, but their nutritional requirements may not be met completely. Therefore, try to use the best feeds available for your species.

Feeding Techniques

An accurate determination of the amount of food to add to a closed culture system is critical. Underfeeding results in poor growth, and overfeeding can have devastating results on water quality.

To estimate the proper amount of feed to offer, several parameters must be considered. Most important is an accurate estimate of the "standing crop," which is the weight of live fish present in the culture system. Depending upon the nutritional quality of the feed, the amount to add can be determined by taking a percentage of this standing crop. Under proper conditions of temperature and good water quality, fish consume at least 3% of their body weight daily.

Some species feed best at a certain time of day or night. Research the habitats of the species being raised.

Example:

The standing crop has been determined to be a total of 10 lbs (4.5 kg) of fish that need to be fed six times daily:

1. The proper feeding rate has been determined to be 5 percent of body weight per day (5% of 10 lbs is .5 lbs (227 g).
2. Divide the .5 lbs (227 g) of food into six portions. Feed all six portions in 24 hours, trying to feed at those times of the day that feeding is most active.
3. After finding the best feeding times, use an automatic feeder set to dispense the proper amounts at the proper times. Note that a demand feeder (one that allows the fish to feed themselves) may not be a good choice with the Mini Fish Farm™, because fish often "play" with it, resulting in overfeeding, wasting feed or polluting the water.
4. At least once a day, observe the fish while they feed. If they become sick, it will show up as a reduction in feeding activity. Reduce the amount of feed whenever they are not eating it.
5. Larger and more aggressive fish will outcompete the smaller and more timid fish for food. See that all the fish get an opportunity to eat.

When the fish are stocked, their weight can be obtained directly. This can be done by placing all or some of the fish in a bucket of water, whose weight was predetermined. The additional weight of the fish is obtained by subtracting the weight of the water without the fish. Once the weight is known, feeding should commence at a level of 3% daily. With fingerlings, levels as high as 6% can be given if the biofilter is properly acclimated. This is determined by frequent testing of the water for ammonia and nitrite in the first few weeks of feeding.

Since the fish are constantly growing, a reestimate of the fish and new feed weights must be made weekly. Sampling the population could provide an accurate idea of the growth of the fish, but this can be stressful and may put the fish off feed for a period of time.

A theoretical determination of the growth can be made by assuming that the fish are converting the fish food into fish weight at a particular rate. This "feed conversion" value is usually estimated to average around 1.5:1. This means that 1.5 pounds of feed will result in the growth of one pound of fish. Many fish, especially tilapia, will do better than this, but it is better to underestimate growth than to overfeed the system. One or
two samples over the growth cycle will serve to provide a correction for any variation of growth due to estimations.

Formula for Determination of Feed Conversion:

$$S = \frac{\text{Feed added (lbs)}}{\text{Net fish production (lbs)}}$$

By using the following formulas, it will be possible to readjust the feed weights on a weekly basis:

Fish weight x 3% (.03) = Feed weight
Feed weight x Feeding days per week = Weekly feed weight
Weekly feed weight/1.5 = Net fish production
Net fish production + Previous week's fish weight = New fish weight

Feed Management

By observing the feeding behavior, it can be decided whether the correct amount of feed is being provided by the above method. Floating feed pellets can be a great management tool by clearly demonstrating the feeding levels of the fish. The feed should be added to the tank several times a day if possible, so that the fish can eat it over the entire light cycle. If this is not possible, it is even more important to use a floating feed that will not be removed by the clarifier siphon.

If there is feed floating at the end of the day, the fish are being fed too much, and the amount should be reduced. If the fish are consuming all the rations within minutes of it being added, we recommend providing more feed while carefully watching that the water quality is remaining good.

As the standing crop of fish increases to levels near the holding capacity of the system (100 lbs) or if the water quality conditions deteriorate (high or low temperatures, high ammonia or low oxygen levels), it may be better to reduce feed and continue culturing rather than harvest the fish. Or, if any differential growth occurred, there may be fish of harvestable size to remove, allowing for continued growth of the remaining stocks.

The normal feeding routine involves a 3% feeding for 6 or 7 days each week. A day without feed, especially when the starting crop is large, is often very helpful to the overall health of the system. There may be a "slingshot effect" if feeding is resumed at higher levels than the previous week after giving the system a day or more without feed. Ammonia levels could shoot up for a day or two before the filter reacclimates at the higher feeding levels. In these cases, it is often helpful to either use a lower daily feed percentage or gradually increase the feed percentage throughout the week. For instance, after not feeding on Sunday, feed 1% on Monday, 2% on Tuesday and 3 or 4% for the remainder of the week.

With such alternative feeding regimes, as food weight increases to very high daily levels, ammonia production should increase more steadily, rather than erratically. By this time the fish are quite large and should be receiving a lower daily percentage of feed. Through proper management of the feed level and feeding methods, it will be possible to maximize the growth of the fish and use as much of the system capacity as possible.

Maintenance and Cleaning

Feeding

The most obvious daily maintenance requirement of the Fish Farm™ is the feeding of the fish. The feed weight for the week should be computed and the ration weighed out. When the fish are small, they may receive up to 6% of their body weight; when they reach 1/4 to 1/3 lb, this should be reduced to 2 to 3% per day.

The daily feed weight should be added in 2 or 3 feedings to increase the growth rates of the fish and to provide for more efficient water quality maintenance by the biofilter, clarifier and aeration systems.

Water Quality

Initially, it is necessary to watch ammonia and nitrite levels very carefully. If the filter is properly acclimated, the levels should remain low as feeding commences. If the levels rise above those shown in Appendix C (p. 19), feeding should be discontinued until they come back down. Temperature and oxygen levels should be noted frequently in the first two or three weeks of growth as well. As the fish, the system and management techniques become harmonized, these parameters need only be checked 1 or 2 times a week until production levels are much higher. As feeding levels increase to over 12 oz (340 g) per day, the frequency of water quality checks should be increased. D.O. levels, in particular, provide an accurate determination of the success of your feed management techniques and the pressure being exerted on all of the system components. Usually, unless acute problems occur that require immediate measures to save the fish, an adjustment of feed weights will rectify any problem that is occurring with water quality.

We suggest that a thorough record of feeding, temperature, oxygen, ammonia, pH and nitrite levels be kept. It is usually possible to see problems beginning to occur well before they become threatening to the fish. An example log is provided in Appendix A (p. 16) of this manual. You can make your own log book or make copies of this one.

Clarifier Cleaning

It may become necessary to increase the frequency of the cleaning process as feed levels increase, or as algal blooms tend to increase or die off. In general, the clarifier and its filter pad should be cleaned at least every 24 hours.

Harvesting

As long as the water temperature within the Mini Fish Farm™ remains within the optimal levels for the growth of the fish species being raised and the capacity of the system has not been reached, feeding and growth of the fish can continue. After temperatures drop below optimal, feed will be wasted if continually added, since the fish will convert it less and less efficiently.

As temperatures drop, the filter does not function well and the algal population is less healthy. During the later portion of the growing season in temperate climates, the temperature will fluctuate unless some form of covering is applied to the tank.

After the feed levels are at their maximum for daily input without causing water quality problems, it is possible to continue for a period without increasing these levels. The fish will continue for a period without increasing these levels. The fish will continue to grow and possibly exceed the system capacity. Once the feeding is discontinued, harvest operations can proceed.

There may be some concern about off-flavor from such intensive culture of fish. This can arise from the existence of some blue-green algae species, as well as a certain species of bacteria that can grow on the walls of the tank. If this occurs, it is best to hold the fish in clear water for a few days. This will remove the off-flavor, and the fish will be ready to eat. Because of this possibility, it is imperative to understand the importance of keeping the system as clean as possible at all times. Keeping the system very clean is important not only for controlling the off-flavor problem, but also so that the fish are not allowed to deteriorate. If emphasis is given to periodically scrubbing the liner and keeping the pipes and clarifier clean, no such problems should occur.

In some cases, all the fish will be removed at one time for processing and possibly freezing. Holding facilities and ice should be on hand and processing should occur immediately following the harvest.

If fish are to be kept alive, a secondary holding tank is handy. The Mini Fish Farm™ can be used after harvest to continue to hold fish, even at sub-optimal temperatures, so that fresh harvests can be made. If temperatures remain above 55°F, or if the system is inside, it is possible to continue to remove the fish until the system is restocked. As they are removed, it is possible to resume feeding (even at reduced levels) to minimize weight loss.

Chapter 3
Fish Species

Fish Species Used in Small-Scale Systems

Species Selection

A choice must be made concerning the type, size and number of fish to be stocked in the Mini Fish Farm™. The different species of fingerlings available at start-up is likely to influence the decision. Do not acquire the fingerling fish before the system is ready. *Aquaculture Magazine's* annual *Buyer's Guide and Industry Directory* lists distributors for several varieties of fish. Appendix J (p. 25) lists some suppliers, and Appendix I (p. 23) lists local and state aquaculture extension agents who should be able to provide a local source of fingerlings.

In order to determine the number of fish needed to start, decide how many pounds of fish you want to harvest at the end of the season. For example, assuming each fish grows to about 1 lb, it may be advisable to stock only 100 the first season. This will result in something less than 100 lbs of production (assuming a few will die or be eaten by the others) and will provide an opportunity to learn management techniques with a wider margin for error.

We recommend using fingerlings 2–3" in length. This size fingerling can reach harvestable size in 6 months. But everyone's situation is different. Sometimes smaller, less expensive fry can be obtained. The shipping cost would be reduced, but it will take up to 2 more months of growth to produce fish large enough to harvest. If the warm water season is short, the fish may be too small to harvest at the end. Larger fingerlings may be more expensive initially (and more difficult to ship) but the increased harvest size could more than pay for the added expense and inconvenience.

The environmental characteristics of the aquaculture system determine the type of fish to be raised. The most important consideration is water temperature. Temperature may be most easily controlled indoors, since climate through the growing season must be considered for outside systems. In addition, the tolerance of the fish to stress and water quality is important to consider.

Many of the warmwater fish species have the greatest potential for recirculating systems. These fish are capable of more efficient food conversion and may accept less expensive supplementary or substitute feeds, such as algae, detritus or aquatic vegetation.

The following describes a few of the species which may be considered in this category and some of their qualities.

Tilapia

The earliest record of man harvesting a cultured fish exists as a frieze on an Egyptian tomb dated 2500 B.C. The fish depicted is a tilapia. Since that time, species of this family of fish have become the most widely cultured in the world. From its origins in the Near East and Africa, tilapia have been introduced into Asia, Japan, Russia, India, Europe, Latin America, South America and the United States. Because they are easy to breed and tolerate a wide range of water quality conditions, they can make a home in practically any body of water, from drainage ditches to brackish ponds.

The more than two dozen separate species of tilapia fill various niches in the food chain. This has made them popular in subsistence aquaculture, where high quality commercial foods are not available. Some species have adapted to feed on plankton, while others prefer larger aquatic vegetation.

Tilapia have varying degrees of temperature tolerance, but none survive below 50°F for long periods of time. This has limited their natural range to tropical and subtropical areas. In temperate regions, this may be an advantage to small-scale aquaculture interests, since there is no danger of escaped tilapia surviving the winter and displacing the native fish species. In parts of southern Florida, Louisiana, Texas and California, populations of tilapia have established themselves. Since they have excellent culinary characteristics of taste and texture, they should be seriously considered for culture in the Mini Fish Farm™.

As small-scale or backyard culture species, the many tilapia varieties provide several advantages. In addition to those already mentioned, they are forgiving fish that tolerate low oxygen, high ammonia and the generally eutrophic conditions that are lethal to many other cultured species. There is a distinct advantage in using fish that survive poor waste water quality when you are a novice in aquaculture.

As tilapia become more widely cultured in both research and commercial situations, their availability is increasing. The purchase of fry and the requirements for their transport from the hatchery may be cost-effective for most people. The excellent reproductive ability of this extraordinary fish should be take advantage of and breeding your own fish for restocking is not unreasonable.

Oxygen: Tilapia survive with oxygen levels as low as .5 ppm, partly because of their unique ability to breathe oxygen from the surface layers of water.

Temperature: Tilapia live in water from 64° to 94°F, but the best growth rate is around 75° to 85°F. From 61° to 50°F they can survive, but they are lethargic, do not feed and become more susceptible to disease. They die at temperatures below 50°F.

Ammonia: Tilapia tolerate high levels, surviving in ponds with large amounts of organic matter.

Hardness: Tilapia are highly resistant to both disease and parasites and thrive even with poor water quality.

Feeds: Some tilapia (*T. zillii*) prefer larger aquatic plants (or even garden wastes or grass clippings), while others, like blue tilapia (*T. aurea*) are adapted to feed on plankton. Java tilapia feed mainly on plankton, but also eat all kinds of plants and vegetable feeds such as soybean or grain meal. For fastest growth, pelleted feeds are readily accepted, with natural feeds available for supplementation.

Stocking: Java and Nile tilapia can be raised successfully with channel catfish or carp. Since carp and catfish have different feed requirements than tilapia, polycultures (two or more species in the same body of water) using these species provide increased growth.

Growth Rates: This varies with stocking densities, available food and water quality. Under proper conditions, the tilapia can grow extremely fast, reaching harvest size from 1" (2 cm) fingerlings in one season (6 months).

Availability: Tilapia are most commonly raised by commercial dealers in Alabama, Arkansas, California, Idaho, Oklahoma and Florida. They are easily spawned and kept indoors through winter. Aquarium dealers often obtain tilapia species that are then spawned by the culturists to provide the required number for stocking. Since it is illegal to culture tilapia in some states, check with your state fish commission before purchasing.

Options for Acquiring Tilapia

Even though tilapia may be more difficult to obtain initially, they have favorable qualifications for backyard fish culture. Once an initial population is established, the fish provide the fry necessary to stock the Mini Fish Farm™ year after year.

From Distributors

It may be possible to buy fingerlings from dealers in Florida or in other southern states and have them shipped by air in containers with oxygen. This means bigger fish can be obtained that will reach a harvestable size easily. Cost usually runs from 10 to 20¢ per fish, plus shipping.

Spawning Tilapia

Several large specimens (3" or more) of tilapia can often be obtained from an aquarium store. These fish should spawn and provide enough fish to stock the entire system. This method of stocking is the least expensive but requires more patience and an understanding of the reproductive techniques of the fish. In areas with a long growth season, the broodstock (a few spawning individuals) can be allowed to reproduce in open ponds (if permitted by state laws). The fry will appear in a school on the surface and can be removed to a separate grow-out tank or allowed to grow within the pond. At this time, the larger fingerlings will begin to consume smaller fry that continue to be spawned unless they are removed.

It may be possible, with a long enough growing season, to bring these newly hatched fry to table size the first summer. If they are too small for harvest, over-wintering them inside provides large fish for stocking the following year. In this way, a two-year season yields a very productive harvest.

Aquarium Spawning

If a small pond is not available, or if temperate region temperatures are too low most of the year (tilapia spawn at 80°F), tilapia may be spawned in an aquarium over the winter.

The aquarium can be as small as 30 gallons, but spawning occurs more easily in a larger tank. Fine gravel on the bottom of the aquarium stimulates spawning activity and a small box filter will maintain water quality. The temperature should be kept between 78° to 82°F with an aquarium heater. Also, sufficient light should be provided for 12 to 18 hours daily. With this setup, successful tilapia spawning can occur continually throughout the year.

Large numbers of fry can be produced by two methods. In the first method, a male tilapia and 4 or 5 females (brood stock of about 1/4 to 1/3 lbs are the easiest to use) are introduced into the aquarium. When spawning is initiated by two individuals (usually marked by the building of a nest), remove all fish except for the pair. When eggs are observed in the female's mouth, the male should be removed and the female allowed to brood the eggs and fry. When the fry begin swimming in a school, the female is removed to protect the growing fry from being eaten.

The second method encourages a more continuous production of juvenile tilapia. A "family" of tilapia is established in a larger aquarium or tank. As free swimming fry appear, they should be removed. This method works best in larger aquariums or tanks (over 100 gallons), because the spawning pair must constantly defend the nest from other individuals that wish to spawn.

Aquarium-spawned fry can be raised indoors in aquariums and small tanks over winter. By raising twice the number of fry required, enough fish for stocking is virtually assured; however, fry should be sorted according to age groups to prevent cannibalism. Newly hatched fry are the most vulnerable. The fry should be fed a fine, protein-rich meal which can be obtained by pulverizing pelleted feed or buying aquarium fish food. Algae growing in the aquarium will provide additional food and increased growth.

Catfish

The channel catfish is a prime candidate for small-scale fish farming due to its qualities as a warmwater, domestic, farm-raised fish and the vast amount of research which has been carried out on it. Its nutritional requirements have been exactingly determined and can be provided by pelleted commercial feeds. Catfish has fast growth and exceptional quality as a food fish, and it can tolerate a lower temperature than tilapia.

Channel Catfish (*Ictalurus punctatus*)
Brown Bullhead Catfish (*I. nebulosus*)
Black Bullhead Catfish (*I. melas*)
Yellow Bullhead Catfish (*I. natalis*)

Oxygen: Catfish grow well with more than 4 ppm of oxygen. At less than that, they eat less and become less resistant to disease and parasites.

Temperature: They grow most efficiently between 80° and 85°F. Below 60°F, growth stops, but the fish are not particularly stressed.

Ammonia: Keep un-ionized ammonia below 1 ppm.

Nitrite: Keep nitrite below .5 ppm.

Hardness: Catfish can contract bacterial infections, viruses or parasitic diseases if oxygen, ammonia and temperature levels are not maintained. Under controlled conditions, the catfish is very hardy and resistant to disease and parasite problems.

Feeds: Their natural diet includes aquatic insects, crayfish, bluegills and other small fish, frogs and some filamentous algae. For rapid growth in a culture system, commercial pelleted fish feeds are necessary.

Feed Utilization: In intensive culture, catfish may convert feed as efficiently as 1 1/2 lbs of feed to 1 lb of fish.

Growth Rate: Catfish fingerlings (3" to 6") can reach harvestable size in 6 months under optimal culture conditions.

Availability: Unless a pond is available to breed your own fingerlings, catfish have to be acquired from a commercial dealer each year. They are generally more available than tilapia and can often be purchased through local fish farmers. The state fish commission can provide a list of dealers in your area. Catfish can be purchased in most states in the South and several in the North, generally in the spring of the year. The dealer usually bags the fish for transport if the fingerlings are small and only 100 to 200 are ordered. A transport tank may be necessary for larger fingerlings.
In both cases, the supplier makes sure there is enough water and oxygen to transport the fish. It is also possible to have small fingerlings shipped by air from greater distances.

Other Species

Species such as trout, hybrid striped bass, yellow perch and carp can also be grown in the Mini Fish Farm™. It is important to learn as much as possible about the fish you want to raise and to determine whether the necessary water quality required can be provided for a season long enough to assure their growth to harvestable size.

To be considered for aquaculture, a fish species must be available as a fry or fingerlings and must be trained to take commercial feeds. If these requirements are met, it is only necessary to provide whatever additional water quality and management needs are demanded by that fish.

Fresh water prawns (*Macrobracium rosenbergii*) can be raised along with warmwater fish such as tilapia. Polyculture is a more advanced culture exercise, as feeding, predation and harvesting become more difficult.

Afterword

As you enter into this backyard fish farming venture, you can anticipate the enjoyment that will come with growing a tank full of fresh, healthy fish. With the Mini Fish Farm™ and the enclosed information, you should be able to make aquaculture as useful as gardening for providing food for your table. You will add a measure of self-sufficiency to your life and enjoyment and satisfaction to your leisure time.

Just as home gardening has become one of the world's most practiced hobbies, small-scale fish farming can make a significant contribution to your family's food requirements. You will have the satisfaction of knowing that the fish you are eating is the freshest and purest available. Good luck and happy harvests!

Pentair Aquatic Eco-Systems, Inc.

This manual was prepared with the cooperation of Steven Van Gorder for Pentair Aquatic Eco-Systems, Inc., and incorporates years of scientific research as well as practical experience in the art and science of small-scale fish production.

Maintenance

There are three main areas of maintenance:

1. Clarifier. The clarifier must be cleaned daily. If the fish waste is not removed every day, it will begin to decompose and float to the surface of the water. Cleaning the clarifier is a simple procedure and shouldn't take more than 5 to 10 minutes.

a. Remove siphon tube from clarifier, allowing air to enter.
b. Remove the velocity reducer, allowing the water to drain.
c. Place a bucket under the waste drain valve.
d. Open the waste drain valve. Note that the clarifier holds approximately 10 gallons. If using a 5-gallon bucket, make sure the bucket doesn't overflow.
e. Use the squeegee provided to push waste out of the clarifier and out through the waste drain valve.
f. Remove and rinse weir filter pad free of any debris.
g. Use a hose to rinse out any additional waste and close the waste drain valve.
h. Refill the clarifier with clean water so that water level is just above the weir.
i. Restart the siphon assembly.

2. Siphon Assembly. As feeding rates increase, a bacterial growth will occur inside the siphon assembly and reduced flow-through will result. A high water level in the fish tank could be used to compensate, but could cause an overflow if a power failure occurs. To clean the siphon assembly, take it apart at the valve (the joints above the water line are glued to prevent air leaks) and brush it or hose it with high pressure water.

3. Air Diffusers. Air diffusers will build up a growth of bacteria (feels like slime) and calcium carbonate. Clean by first removing them from the fish tank, then brushing, rinsing and, if necessary, immersing them in hydrochloric (muriatic) acid.

a. Safety first. Have water available to rinse skin, clothing and other materials in the event that acid is spilled or splashed.

b. Wear glassed to prevent eye injury.

c. Use acid in a well-ventilated area only.

d. Follow all safety precautions on the acid label.

e. To reduce the amount of acid used, select a tall acid-compatible container which is slightly larger than the diffusers being cleaned. Pour in sufficient acid so the diffusers will be covered.

f. Connect at least 2' of air line to the air diffuser, blow out the water held in the diffuser pores and immerse the diffuser in the acid. Acid will enter the diffuser and flow into the air line, backwashing the diffuser. Foam and gases will be given off as the acid reacts with the diffuser fouling materials. Note that cleaning should not be left unattended because of the possibility of acid back-siphoning out of the container due to foam production.

g. Leave the diffusers in the acid for a few minutes (acid will not damage them even if left for hours), lift them above the acid level to allow the acid to drain and either pour water into the tubing or use air to force out the acid.

h. Rinse and put the diffusers back into service for "like new" performance.

Appendix A

Daily Water Quality Data (sample form)							
Date	**Air Temperature**	**Water Temperature**	**pH**	**Total Ammonia**	**Un-Ionized Ammonia***	**Feed Fed**	**Standing Crop**
5/24	78	72	8	7	.35	1.5	50
5/25	80	74	8	7.5	.37	1.52	50.75
5/26	85	78	7.4	5.5	.072	1.54	51.51
5/27	83	76	7.4	6.0	.078	1.57	52.28
5/28	85	76	7.6	6.0	0.78	1.59	53.06
5/29	90	79	7.6	3.0	.062	1.61	53.86
5/30	87	79	7.6	1.0	<.02	1.64	54.67
5/31	90	76	8.0	<1	0	1.66	55.49
6/1	95	79	7.6	<1	0	1.69	56.32
6/2	95	79	7.6	<1	0	1.71	57.16
6/3	91	80	7.6	<1	0	1.74	58.02
6/4	88	79	7.6	<1	0	1.77	58.89
6/5	88	79	7.8	<1	0	1.79	59.77
6/6	90	80	7.8	<1	0	1.82	60.66
6/7	92	81	7.8	<1	0	1.85	61.57
6/8	92	81	8.0	<1	0	1.87	62.49
6/9	88	80	8.0	<1	0	1.90	63.43
6/10	90	81	7.9	<1	0	1.93	64.38
6/11	90	81	7.9	<1	0	1.96	65.34
6/12	91	81	7.8	<1	0	1.99	66.32

*To be calculated using un-ionized ammonia chart in Appendix B (p. 18).

Worksheet designed by Annandale Fisheries & Manufacturing Co., St. Paul, MN.

Daily Water Quality Data							
Date	Air Temperature	Water Temperature	pH	Total Ammonia	Un-Ionized Ammonia*	Feed Fed	Standing Crop

*To be calculated using un-ionized ammonia chart in Appendix B (p. 18).

Worksheet designed by Annandale Fisheries & Manufacturing Co., St. Paul, MN.

Appendix B
Un-Ionized Ammonia Measurement

Materials needed: pH test kit
Total ammonia test kit
Thermometer
Percent un-ionized ammonia chart

Method:

1) Measure and record the pH and temperature.
2) Sample and determine "total ammonia" levels (using test kit).
3) Using data from steps 1 and 2, refer to the "Percentage of un-ionized ammonia" chart below and determine the percentage of un-ionized ammonia for a particular pH and temperature.
4) Use the following equation to determine the concentration (ppm) of un-ionized ammonia.

$$\text{ppm unionized ammonia} = \frac{\text{(ppm total ammonia) x (percent un-ionized ammonia)}}{100}$$

Example: pH = 8
Temp = 15°C
Total ammonia measurement = 1 ppm
Percent un-ionized ammonia (from chart) = 3

$$\text{ppm un-ionized ammonia} = \frac{10 \text{ x } 3}{100} = .03 \text{ ppm}$$

Percentage of un-ionized ammonia in water
at different pH levels and temperatures

Temp (°F)	Temp (°C)	pH 6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5
50	10	.02	.1	02	.6	2	6	16	37
59	15	.03	.1	.3	.9	3	8	22	46
68	20	.04	.2	.4	1	4	11	28	56
77	25	.06	.2	.6	2	5	15	36	64
86	30	.1	.3	.8	3	8	20	45	72

Appendix C

Water Quality Tolerance Chart

By keeping water quality within the ranges shown, the fish should remain free of stress, eat well and grow at a good rate.

	Temp °F	D.O. mg/l	pH Units	Alkalinity mg/l	CO_2 mg/l	*Ammonia %	Nitrite mg/l	Hardness mg/l	Chloride mg/l	Salinity ppt
Trout/Salmon	45–68	5–12	6–8	50–250	0–20	0–.03	0–.6	50–350	0–1,500	0–3
Walleye/Perch	50–65	5–10	6–8	50–250	0–25	0–.03	0–.6	50–350	0–2,500	0–5
Sunfishes	60–80	4–10	6–8	50–250	0–25	0–.03	0–.6	50–350	0–2,000	0–4
Hybrid Striped Bass	70–85	4–10	6.8	50–250	0–25	0–.03	0–.6	50–350	0–1,500	0–3
Tilapia	75–94	3–10	6–8	50–250	0–30	0–.03	0–.7	50–350	0–5,000	0–10
Catfish/Carp	65–80	3–10	6–8	50–250	0–25	0–.03	0–.7	50–350	0–4,000	0–8
Goldfish/Koi	65–75	4–10	6–8	50–250	0–25	0–.03	0–.6	50–350	0–2,000	0–4
Minnows/Shiners	60–75	4–10	6–8	50–250	0–25	0–.03	0–.6	50–350	0–2,500	0–5
Shrimp (Freshwater)	68–80	4–10	6.5–9	60–100	0–20	0–.05	0–.9	60–250	0–1,500	0–3
Shrimp (Saltwater)	60–75	4–10	6–8	50–250	0–15	0–.01	0–.1	50–350	13,000–18,000	25–35
Mussels (Freshwater)	40–50	4–10	6–8	50–250	0–20	0–.02	0–.3	50–350	0–500	0–1
Sturgeon	50–70	4–10	6–8	50–250	0–25	0–.03	0–.6	50–350	0–2,000	0–4
Tropical Fish	68–84	4–10	6–8	50–250	0–20	0–.03	0–.5	50–350	0–2,500	0–5
Snails	60–80	3–8	6–8	50–250	0–20	0–.02	0–.6	50–350	0–2,000	0–4
Fresh H_2O	60–65	3–6	6–7	25–150	---	0–2	0–.5	25–150	0–50	0–.5

Un-ionized Ammonia—See page 18 for the method of calculation.

To convert to °C use the following formula: $\frac{5(°F-32)}{9} = °C.$

Appendix D

Troubleshooting Guide

Careful management of the Mini Fish Farm™ can result in trouble-free production, but good management depends on the ability to recognize potential problems as they develop and respond quickly with the proper course of action. The following chart describes possible problems that may occur and the management techniques necessary to rectify them.

Problem	***Possible Cause***
Compressor stops running.	No power to compressor.
Reduced diffuser flow.	Kink in air line. Diffusers need cleaning.
Reduced water flow through airlift return.	Fish tank water low. Siphon is not working. Siphon assembly tubes need cleaning. Clarifier filter pad needs cleaning. Check air lines. Biofilter clogged.
Fish not feeding.	Check water quality.

Appendix E

Sodium Bicarbonate

Adjusting pH and Alkalinity Using Sodium Bicarbonate

Sodium bicarbonate (baking soda) can be used to buffer against sudden pH changes and increase total alkalinity in a fish culture system. Typically, recirculating systems require weekly or biweekly dosages. We advise maintaining a pH between 6.5 and 8.5 depending on the species and a total alkalinity between 50 and 200 mg/l. If pH and alkalinity are lower than the suggested range, they may be corrected by the addition of sodium bicarbonate. To accurately calculate the minimum amount needed for a given change, test a sample of the water to be adjusted by following the following steps:

1. Collect 5 gallons of sample water to be adjusted.
2. Test pH and total alkalinity.
3. Dissolve 1/4 teaspoon of sodium bicarbonate into the sample.
4. Retest pH and alkalinity.* If desired results are achieved, the dosage rate is set at 1/4 teaspoon of sodium bicarbonate per every 5 gallons of water in the system.
5. If desired results are not achieved, dissolve another 1/4 teaspoon sodium bicarbonate into the sample and retest to determine change. Continue to add sodium bicarbonate in 1/4 teaspoon increments, testing each sample after sodium bicarbonate has completely dissolved, until desired results are achieved.

   *Note: pH should not be adjusted more than 1 unit every 24 hours. Alkalinity should not be adjusted more than 50 mg/l every 24 hours.

Example: After 1/4 teaspoon of sodium bicarbonate is dissolved into a 5-gallon sample of water collected from a 780-gallon system, the pH increases .5 units. If this is a desired result (it could be, as it keeps with the rule of limiting change in pH to less than one unit in a 24-hour period), then the dosage has been determined to be 1/4 teaspoon sodium bicarbonate per 5 gallons of water in the system. The rest is simple arithmetic: Divide 780 gallons by 5 to yield the number of 1/4 teaspoon dosages, which is 156. Then multiply 156 by .25 teaspoons, which equals 39 teaspoons (1 cup = 48 teaspoons).

Note: It is better to add small amounts of sodium bicarbonate daily rather than a large amount once a week.

Appendix F

Sodium Thiosulfate

Removing Chlorine Using Sodium Thiosulfate

Sodium thiosulfate is the main compound in most chlorine/chloramine removers. When municipal water is used for aquaculture, use sodium thiosulfate for instant neutralization of chlorine. Dosage rates vary with the pH of the water; however, rates between 1.6 to 2.6 parts sodium thiosulfate per one part chlorine should be adequate. To calculate the minimum amount needed for a given change, test a sample of the water to be adjusted.

1. Collect 5 gallons of water to be adjusted.
2. Test chlorine levels.
3. Dissolve 1/4 teaspoon sodium thiosulfate into sample.
4. Retest total chlorine levels. If chlorine is not detected, your dosage rate is 1/4 teaspoon sodium thiosulfate per 5 gallons of water in system.
5. If desired results are not achieved, dissolve another 1/4 teaspoon of sodium thiosulfate and retest to determine change. Continue to add sodium thiosulfate in 1/4 teaspoon increments, testing sample after sodium thiosulfate is completely dissolved, until desired results are achieved.

Example: After 1/4 teaspoon sodium thiosulfate is dissolved into a 5-gallon sample of water collected from a 780-gallon system, the chlorine level drops to 0 ppm. The dosage has been determined to be 1/4 teaspoon sodium thiosulfate per 5 gallons of water in the system. The rest is simple arithmetic: Divide 780 gallons by 5 to yield the number of 1/4 teaspoon dosages, which is 156. Then multiply 156 by .25 teaspoons, which equals 39 teaspoons (1 cup = 48 teaspoons).

Remember: pH will affect dosage rates, so adjust the pH of subsequent treatments to match the pH of the past treatment from which the dosage was derived, or retest using the above procedures. Excess sodium thiosulfate up to 100 ppm will not harm fish.

Appendix G

NaCl (Noniodized Salt)

Salt is used as a nitrite stress reducer that inhibits the occurrence of "brown blood" disease in catfish. We recommend using 1/3 lb of salt in the system to raise chloride levels. It is chlorides in the salt (60 percent) that help the fish to maintain oxygen levels in their blood. See Nitrite (p. 4).

Zeolite (Clinoptolite)

Zeolite is a naturally occurring clay-type product that is used to absorb ammonia. It can be recharged overnight using a saltwater bath. This will recharge it to 85% of its original capacity. Zeolite can only be used in fresh water. To remove one ppm of ammonia from the Mini Fish Farm™, 5.6 lbs of Zeolite should be put in a mesh bag and placed in the tank. This is usually used as a backup if the biofilter crashes and/or ammonia rises to unacceptable levels.

Appendix H

Calcium Chloride

Adjusting Hardness Using Calcium Chloride

Depending upon water's buffering capacity, calcium chloride may raise or lower the pH. Normal calcium hardness levels in recirculating aquaculture systems should be maintained between 100 to 250 mg/l, depending upon the species. Fast dissolving pellets are 1/8" to 1/4" in size.

Caution: Avoid contact with eyes, skin, or clothing. Avoid breathing dust or mist. Use good personal hygiene and housekeeping.

Disposal: Dissolve in water; however, use care as solution can get very hot. Flush to sewer with plenty of water only if permitted by applicable disposal regulations. If the calcium hardness is lower than the suggested range of 100 to 250 mg/l depending upon species, it may be corrected with the addition of calcium chloride. To calculate the minimum amount needed for a given change, test sample of the water to be adjusted.

1. Collect 12 gallons of water to be adjusted.
2. Test pH, total alkalinity and calcium hardness. Calcium chloride will change pH and alkalinity. Note that pH should not be adjusted more than one unit every 24 hours. Alkalinity should not be adjusted more than 50 mg/l every 25 hours in water containing fish.
3. Dissolve 6 grams (about one teaspoon) of calcium chloride into the sample.
4. Retest sample for hardness, pH and alkalinity. If desired results are achieved, the dosage rate is determined to be 6 grams calcium chloride per 12 gallons of water in the system.
5. If desired results are not achieved, dissolve another 6 grams calcium chloride into sample and retest to determine change. Continue to add calcium chloride in 6-gram increments testing sample after calcium chloride has totally dissolved, until desired results are achieved.

Example: After one teaspoon calcium chloride is dissolved in a 12-gallon sample of water collected from a 780-gallon system, the hardness increases to 150 ppm. If this is the desired result, the dosage has been determined to be one teaspoon calcium chloride per 12 gallons of water in the system. The rest is simple arithmetic: Divide 780 gallons by 12 to yield the number of one-teaspoon dosages, which is 65 (1 cup = 48 teaspoons).

Note: Dissolve determined amount of calcium chloride in a bucket of water before adding to system. Caution: Mixture will become very hot. Add slurry to system slowly. Test system to verify that desired results are achieved.

Aquaculture Extension Contacts

Appendix I

This list and more national aquaculture information available on the NASAC website (nasac.net)

Alabama
Rusty Wright
Auburn University
Extension Specialist
Fisheries & Allied Aquacultures
203B Swingle Hall
Auburn University, AL 36849-5628
334-844-9311
334-844-9208 (Fax)
wright2@auburn.edu

Claude Reeves
Alabama A&M and Auburn Universities
Extension Aquaculturist
Alabama Cooperative Extension System
Wiregrass Regional Research & Ext. Ctr.
P.O. Box 217
Headland, AL 36345
334-693-2010
334-693-2957 (Fax)
creeves@aces.edu

Alaska
Raymond RaLonde
University of Alaska
Aquaculture Specialist
Marine Advisory Program
1007 West Third Avenue, Ste100
2221 E. Northern Lights Blvd.
Anchorage, AK 99501
907-274-9691
907-277-5242 (Fax)
afrlr@uaa.alaska.edu

Arizona
Dr. Kevin Fitzsimmons
University of Arizona
Environmental Research Laboratory
Dept. of Soil, Water & Environmental Science
2601 East Airport Drive
Tucson, AZ 85706
520-626-3324
520-573-0852 (Fax)
kevfitz@ag.arizona.edu
http://ag.arizona.edu/azaqua

Arkansas
Dr. Nathan Stone
University of Arkansas at Pine Bluff
Extension Fisheries Specialist
Mail Slot 4912
Pine Bluff, AR 71601
870-575-8138
870-575-4638 (Fax)
nstone@uaex.edu

California
Dr. Fred S. Conte
University of California-Davis
Department of Animal Science
1 Shields Avenue
Davis, CA 95616-852
530-752-7689
530-752-7817 (Fax)
fsconte@ucdavis.edu
http://aqua.ucdavis.edu

Connecticut
Tessa Getchis
University of Connecticut
Cooperative Extension System
1080 Shennecossett Road
Groton, CT 06360
860-405-9104
860-405-9109 (Fax)
tessa.getchis@uconn.edu

Delaware
John W. Ewart
University of Delaware
Delaware Aquaculture Resource Center
Sea Grant Marine Advisory Service
Graduate College of Marine and Earth Studies
700 Pilottown Road
Lewes, DE 19958-1298
302-645-4060
302-645-4213 (Fax)
ewart@udel.edu
http://darc.cms.udel.edu

District of Columbia
Dr. Gloria Wyche-Moore
University of the District of Columbia
Assoc. Dean of Research & Advanced Study
Agricultural Experiment Station
4200 Connecticut Avenue, NW
Building 52, Room 416E
Washington, DC 20008
202-274-7124
202-274-7119 (Fax)
gwychemo@udc.edu

Florida
Dr. Michael S. Spranger
University of Florida/IFAS
Asst. Director, FL Sea Grant Extension &
Asst. Dean, Environmental & Natural
Resources Programs
P.O. Box 110405
Gainesville, FL 32611-0405
352-392-1837
352-392-5113 (Fax)
spranger@ufl.edu

Georgia
Dr. Randal L. Walker
University of Georgia
Director, Marine Extension Service
Room 1030–Chicopee Bldg #1
Athens, GA 30602-3636
706-542-8849
706-542-8838 (Fax)
walker@uga.edu, www.marex.uga.edu

Hawaii
Clyde Tamaru
University of Hawaii
Aquaculture Specialist
Sea Grant College Program
2525 Correa Road, HIG 205
Honolulu, HI 96822
808-956-2869
808-342-1063 (Cell)
808-956-2858 (Fax)
ctamaru@hawaii.edu

Idaho
Gary Fornshell
University of Idaho
Aquaculture Extension Educator
Twin Falls County Extension Office
246 Third Avenue East
Twin Falls, ID 83301
208-734-9590
208-733-9645 (Fax)
gafornsh@uidaho.edu

Iowa
Richard Clayton
Iowa State University
Fisheries/Aquaculture Extension Associate
339 Science II
Ames, IA 50011-3221
515-294-8616
515-294-7874 (Fax)
rclayton@iastate.edu
www.public.iastate.edu/~rclayton

Kansas
Charles Lee
Kansas State University
Department of Animal Sciences & Industry
Call Hall, Room 131
Manhattan, KS 66506
785-532-5734
785-532-5681 (Fax)

Kentucky
Dr. Robert M. Durborow
Kentucky State University
State Extension Specialist
Aquaculture Program
Aquaculture Research Center
103 Athletic Drive
Frankfort, KY 40601
502-597-6581
502-597-8118 (Fax)
robert.durborow@kysu.edu

Louisiana
Dr. Greg Lutz
Louisiana State University
Agricultural Center
Aquaculture Research Station
Louisiana Cooperative Extension Service
2410 Ben Hur Road
Baton Rouge, LA 70802
225-765-2848
225-765-2877 (Fax)
glutz@agctr.lsu.edu

Maine
James Weber
University of Maine
Dept of Animal & Veterinary Sciences
Cooperative Extension
5735 Hitchner Hall, Room 130
Orono, ME 04469-5735
207-581-2768
207-581-2729 (Fax)
jweber@umext.maine.edu

Maryland
Don Webster
University of Maryland
Extension Aquaculture Specialist
Wye Research & Education Center
P.O. Box 169
Queenstown, MD 21658
410-827-8056
410-827-9039 (Fax)
dwebster@umd.edu

Michigan
Dr. Donald Garling
Michigan State University
Aquaculture Specialist
Extension Services
220A Natural Resources Building
East Lansing, MI 48824
517-353-1989
517-432-1699 (Fax)
garlingd@msu.edu

Ronald Kinnunen
Michigan State University
District Sea Grant Agent
MSU Sea Grant Extension
710 Chippewa Square, #202
Marquette, MI 49855-4821
906-226-3687
906-226-3687 (Fax)
kinnune1@msu.edu

Micronesia, Federated States of
Dr. Singeru Singeo
College of Micronesia
Cooperative Extension Service
Agriculture Research Station
P.O. Box 1179
Kolonia, Pohnpei, FSM 96941
011-691-320-2728/2462
011-691-320-2726 (Fax)
ssingeo@mail.fm

Minnesota
Jeff Gunderson
University of Minnesota
Sea Grant Program
2305 E. Fifth Street
Duluth, MN 55812
218-726-8715
218-726-6556 (Fax)
jgunder1@umn.edu

Mississippi
Dr. Jimmy Avery
Mississippi State University
National Warmwater Aquaculture Center
Box 197
Stoneville, MS 38776
662-686-3273
662-686-3320 (Fax)
javery@drec.msstate.edu

Missouri
Robert A. Pierce, II
University of Missouri
Fish & Wildlife Specialist
School of Natural Resources
302 Anheuser Busch Natural Resources Bldg.
Columbia, MO 65211
573-882-4337
573-884-5070 (Fax)
piercer@missouri.edu

Montana
Martin Frick
Montana State University
Agricultural Education
106 Linfield Hall
Bozeman, MT 59717-0374
406-994-5773
406-994-6696 (Fax)
uadmf@montana.edu

Nebraska
Dr. Kyle Hoagland
University of Nebraska – Lincoln
Director, Water Center
Limnologist, School of Natural Resources
103 Natural Resources Hall
Lincoln, NE 68583-0844
402-472-3305
402-472-3574 (Fax)
khoagland@unl.edu

Nevada
Rich Haskins
Nevada Department of Wildlife
Chief of Fisheries
1100 Valley Road
Reno, NV 89512
775-688-1569
775-688-1595 (Fax)
rhaskins@ndow.org

New Hampshire
Roland Barnaby
University of New Hampshire
Extension Educator, Cooperative Extension
Sea Grant & Marine Resources
113 North Road
Brentwood, NH 03824-6623
603-679-5616
603-679-8070 (Fax)
rollie.barnaby@unh.edu

New Jersey
Gef Flimlin
Rutgers University
Cooperative Extension
Ocean County Extension Center
1623 Whitesville Road
Toms River, NJ 08755
732-349-1152
732-505-8941 (Fax)
flimlin@aesop.rutgers.edu

New Mexico
Jon Boren, Ph.D.
New Mexico State University
Extension Wildlife Specialists
P.O. Box 30003, MSC-3AE
Las Cruces, NM 88003-8003
Boren: 505-646-1164
Hurd: 505-646-2053
505-646-1281 (Fax)
jboren@nmsu.edu
brhurd@nmsu.edu

New York
Dr. Joe M. Regenstein
Cornell University
Professor of Food Science
Stocking Hall
Ithaca, NY 14853-7201
607-255-8041
607-254-4868 (Fax)
jmr9@cornell.edu

North Carolina
Dr. Tom Losordo
North Carolina State University
Biological & Agricultural Engineering
Campus Box 7625
Raleigh, NC 27695-7625
919-515-6784
919-515-6772 (Fax)
tlosordo@ncsu.edu

North Dakota
Mark E. Clark
North Dakota State University
Assistant Professor
Biological Sciences
Stevens Hall, Room 119
Fargo, ND 58105
701-231-8246
701-231-7149 (Fax)
m.e.clark@ndsu.nodak.edu

Ohio
Laura G. Tiu
Ohio State University
Aquaculture Specialist
South Centers @ Piketon
1864 Shyville Road
Piketon, OH 45661-9749
740-289-2071 ext. 121
740-289-4591 (Fax)
tiu.2@osu.edu

Oklahoma
Conrad Kleinholz
Langston University
Aquaculture Program Director
P.O. Box 1730
Langston, OK 73050
405-466-6127
405-466-6177 (Fax)
cklein@luresext.edu

Pennsylvania
Charles Conklin
PA Aquaculture Association
c/o Big Brown Fish Hatchery Inc.
P.O. Box 584
Effort, PA 18330
570-629-0427
570-619-6584 (Fax)
charlieconklin@verizon.net

Puerto Rico
Saul Wiscovich
University of Puerto Rico-RUM
Natural Resources & Aquaculture
Edo.C Oficina 107
P.O. Box 9031
Mayaguez, PR 00681-9031
787-832-4040
787-265-4130 (Fax)
s_wiscovich@seam.uprm.edu

Rhode Island
Dr. David A. Bengtson
University of Rhode Island
Professor and Chair
Dept. of Fisheries, Animals & Veterinary Science
Kingston, RI 02881
401-874-2668
401-789-8930 (Fax)
bengtson@uri.edu

Dr. Dale Leavitt
Assistant Professor/Regional
Aquaculture Extension Specialist
Roger Williams University
401-254-3047
dleavitt@rwu.edu

South Carolina
Jack M. Whetstone
Clemson University
Associate Professor - Aquaculture
Extension Aquaculture Specialist
Cooperative Extension Service
SC Marine Extension Program
P.O. Box 596
Georgetown, SC 29442
843-546-6321
843-546-6296 (Fax)
jwhtstn@clemson.edu

Tennessee
Rob Beets
Tennessee Department of Agriculture
Market Development Division
P.O. Box 40627
Nashville, TN 37204
615-837-5517
615-837-5194 (Fax)
Robert.beets@state.tn.us

Texas
Michael P. Masser, Ph.D.
Texas A&M University
Associate Dept. Head and Program Leader
Dept. of Wildlife & Fisheries Sciences
111B Nagle Hall - 2258 TAMU
College Station, TX 77843-2258
979-845-7473
979-845-7103 (Fax)
m-masser@tamu.edu

Utah
Dr. Terry Messmer
Utah State University
Extension Specialist
The Dept. of Wildland Resources
Logan, UT 84322-5230
435-797-3975
435-797-3796 (Fax)
terrym@ext.usu.edu

Vermont
Jurij Homziak, Ph.D.
University of Vermont
Lake Champlain Sea Grant Program
School of Natural Resources
317 Aiken Center
Burlington , VT 05405-0088
802-656-0682
802-656-8683 (Fax)
jhomziak@uvm.edu

Virgin Islands
Dr. James Rakocy
University of the Virgin Islands
Research Professor of Aquaculture
Director, Agricultural Experiment Station
RR1, Box 10,000
Kingshill, USVI 00850
340-692-4031
340-692-4035 (Fax)
jrakocy@uvi.edu
http://rps.uvi.edu/AES/Aquaculture/aqua.html

Virginia
Dr. Michael H. Schwarz
Virginia Polytechnic Institute & State Univ.
Dept. of Fisheries & Wildlife Sciences
156 Cheatham Hall
Blacksburg, VA 24061
540-231-4625
540-231-7580 (Fax)
mschwarz.vt.edu

Dr. Brian Nerrie
Virginia State University
Aquaculture Specialist
Cooperative Extension
P.O. Box 9081
Petersburg, VA 23806
804-524-5903
804-524-5245 (Fax)
bnerrie@vsu.edu

Washington
Steve Harbell, County Director
Washington State University
Pacific County Cooperative Extension
P.O. Box 88
1216 W. Robert Bush Drive
South Bend, WA 98586-0088
360-875-9331
360-875-9304 (Fax)
harbell@wsu.edu

West Virginia
Kenneth J. Semmens, Ph.D.
West Virginia University
Extension Specialist, Aquaculture
1052 Agricultural Sciences Building
P.O. Box 6108
Morgantown, WV 26506-6108
304-293-6131, Ext. 4211
304-293-6954 (Fax)
ken.semmens@mail.wvu.edu
www.wvu.edu/~agexten/aquaculture

Wisconsin
Fred P. Binkowski, Senior Scientist
University of Wisconsin
Director, Aquaculture Institute
Great Lakes Water Institute
600 E. Greenfield Avenue
Milwaukee, WI 53204
414-382-1723
414-382-1705 (Fax)
sturgeon@csd.uwm.edu

Wyoming
Glen Whipple
University of Wyoming
Director, Cooperative Extension Service
College of Agriculture, Dept 3354
1000 East University Avenue
Laramie, WY 82071
307-766-5124
307-766-3998 (Fax)
glen@uwyo.edu

Appendix J

US Fingerling Suppliers

The following list of US Fingerling Producers was compiled by Pentair Aquatic Eco-Systems, Inc., using the results of a customer mail-in survey. The list is intended solely for the use as a reference, and by no means does Pentair Aquatic Eco-Systems wish to imply that it is complete. To add your company to the US Fingerling Producers list or update any of the information below, contact Pentair Aquatic Eco-Systems at 2395 Apopka Blvd, Apopka, FL 32703. Phone: 407-886-3939.

Aquaculture of Texas Inc
4141 Fort Worth Hwy
Weatherford, TX 76087-8610
PH: 817-594-4872 FX: 817-732-8248
Craig Upstrom
Ships small quantities by air
Prefers to ship by air, UPS, & live haul truck
Macobrachium rosenbergii

Carolina Classics Catfish Inc
PO Box 10
Ayden, NC 28513
PH: 919-746-2818 FX: 919-746-3947
Tom Blevins
Does not ship small quantities by air
Prefers to ship by truck
Channel Catfish

Carolina Fisheries
2207 Idalia Rd
Aurora, NC 27806
PH: 919-322-7117 FX: 919-322-4687
Lee Brothers
Ships small quantities by air
Prefers to ship by company live haul truck
Hybrid bass, Striped bass, White bass

Casta Line Trout Farms
Rt 1, Box 151
Goshen, VA 24439
PH: 540-997-5461 FX: none
Bryan Plemmons
Does not ship small quantities by air
Prefers to ship by company truck
Rainbow trout, Brook trout, Golden trout

Crystal Fisheries
PO Box 103, Main Street
Wilnot, AR 71676
PH: 501-473-5254 FX: none
Greg Lipscomb
Ships small quantities by air
No preferred method of shipment
Hybrid striped bass, Grass carp, Largemouth Bass, Big Head carp, Tilapia (4 species)

Curryville Fisheries
Rt 1, Box 107A
Curryville, MO 63339
PH: 314-324-2285 FX: 314-324-2286
Ted Werenski
Ships small quantities by air
No preferred method of shipment
Catfish, Bluegill, Hybrid sunfish, Largemouth Bass, Fathead minnows, Walleye/Northern Pike, Redear sunfish, Yellow perch, Mosquito fish

Dunn's Fish Farm
PO Box 85
Fittstown, OK 74842-0085
PH: 800-433-2950, 405-777-2202
FX: 405-777-2899
David Dunn, Lisa Phillips
Does not ship small quantities by air
No preferred method of shipment
Florida largemouth, Florida bass, Black crappie, Largemouth bass, Fathead minnows, Channel catfish, Hybrid bluegill, Triploid grass carp

Easterling Fish Hatchery
Rt 1, Box 576
Clio, AL 36017
PH: 334-397-4437 FX: none
William B. Easterling
Ships small quantities by air
Prefers customer pick-up
Channel catfish, Bluegill, Shellcracker, Koi, Grass carp/White amur, Largemouth bass

Flowers Fish Farm
13965 County Road 442
Dexter, MO 63841
PH: 314-568-2962 FX: 314-624-5592
Kevin Flowers
Does not ship small quantities by air
Prefers to ship by truck
Channel catfish, Hybrid bluegill, Diploid grass carp, Big Head carp

Fountain Bluff Fish Farm
112 White Lane
Gorham, IL 62940
PH: 618-763-4387 FX: same
Larry or Joan Brown
Does not ship small quantities by air
Prefers customer pick-up or to ship by truck
Channel catfish, Hybrid sunfish, Bluegill, Redear, Crappie, Largemouth bass
Grass carp

Freshwater Farms of Ohio
2624 North Rt 68
Urbana, OH 43078
PH: 937-652-3701 FX: 937-652-3481
Dr. David A. Smith, Ph.D.
Ships small quantities by air
Prefers customer pick-up
Rainbow trout, Yellow perch, Hybrid Bluegill, Channel catfish, White amur
Fathead minnows, Rosy Red minnows
Largemouth bass

Hickling's Fish Farm
Rt #1, Box 201A1
Edmeston, NY 13335
PH: 607-965-8488 FX: 607-965-2328
Vincent or Linda Hickling
Does not ship small quantities by air
Prefers to ship by truck
Largemouth bass, Smallmouth bass
Walleye

Kloubec Fish Farms
1375 Baxter Ave
Amana, IA 52203
PH: 319-846-2077 FX: 319-846-8099
Myron
Ships small quantities by air
No preferred method of shipment
Hybrid striped bass, Largemouth bass, Tilapia, Channel catfish, Walleye, Saugeye, White amur, Hybrid bluegill, Fathead minnows, Koi

Molakai Sea Farms
Palaau Road, Box 560
Kaunakakai, HI 96748
PH: 808-553-3547 FX: same
Steve Chaikin
Ships small quantities by air
Prefers to ship by air
Litopenaeus vannamei, Clarius fucus

Robert Mutter Fisheries
272 Pine Ridge Road
Glasgow, KY 42141
PH: 502-646-2106 FX: none
Mr. or Mrs. Robert Mutter
Does not ship small quantities by air
Prefers to ship by truck
Catfish, Bluegill, Bass, Crappie, Bait minnows

Northeastern Biologists Inc
1 Kerr Road
Rhinebeck, NY 12572
PH: 914-876-3983 FX: 914-876-6462
John Clark
Ships small quantities by air
Prefers to ship by FedX or UPS 1-Day
Largemouth bass, Smallmouth bass, Bluegill sunfish, Pumpkinseed sunfish, Golden shiner, Fathead minnow, Crayfish

Opel's Fish Hatchery
PO Box 323
Worden, IL 62097
PH: 618-459-3287 FX: none
Gary Opel
Does not ship small quantities by air
Prefers to ship by truck in large quantities only
Channel catfish, Hybrid bluegill, Redear Sunfish, Black crappie, Largemouth bass, Fl/IL Largemouth bass, Hybrid stripers Walleye, Northern pike, Flathead catfish Blue catfish, Triploid grass carp Muskies, Fathead minnows, Crayfish

Owen & Williams Fish Farm
Rt 4, Box 750
Hawkinsville, GA 31036
PH: 912-892-3144 FX: 912-783-3144
Wendy Gordon
Ships small quantities by air
Prefers to ship by air
Grass carp, Channel catfish, Bluegill Bream, Shellcracker bream, Redbreast Bream, Largemouth bass, Hybrid striped Bass, Crappie, Mirror carp, Tilapia

Perry Minnow Farm Inc
13510 Windsor Blvd
Windsor, VA 23487
PH: 804-539-1709 FX: none
Susan Perry
Does not ship small quantities by air
Prefers customer pick-up
Largemouth bass, Bluegill bream, Channel catfish, Crappie, Redear sunfish, Israeli carp, Hybrid bluegill

Pond View Koi
RD 3, Box 281-1
Unadilla, NY 13849
PH: 607-369-4060 FX: none
Maria & Charles Wagner
Ships small quantities by air
Prefers to ship by truck
Koi

Price's Fish Farm
Rt 1, Box 309-2
Red Level, AL 36474
PH: 334-222-8087 FX: same
Dirk Price
Ships small quantities by air
Prefers to ship by air freight or FedX
Koi, Butterfly Koi, Shubunkin golfish, Comet goldfish, Largemouth bass, Bluegill, Shellcracker

Robinson Wholesale Inc
603 Freeman Street
Genoa City, WI 53128
PH: 414-279-6888 FX: 414-279-2331
Robert Borst
Ships small quantities by air
Prefers customer pick-up or ship by truck
Perch, walleye, Hybrid bluegill, Largemouth bass, Smallmouth bass, Channel catfish, Fathead minnows

Rocky Mountain White Tilapia
PO Box 1052
Alamosa, CO 81101-1052
PH: 719-589-3032 FX: same
Erwin Young
Ships small quantities by air
Prefers to ship by air freight or truck
Rocky Mountain white tilapia, Mosquito fish, Soft shell turtles, Hard shell turtles

Shadow Lake Ranch
20966 Old Aturas Road
Redding, CA 96003
PH: 916-549-3988 FX: none
Steve Boyer
Does not ship small quantities by air
Prefers customer pick-up
Catfish, Largemouth Florida bass

Southern Fish Culturists Inc
PO Box 490251
Leesburg, FL 34749-0251
PH: 352-787-1360 FX: none
John F. Dequine
Ships small quantities by air
Prefers shipments by air, bus, FedX, or Express Mail
Tilapia aurea, Bluegill sinfish, Channel catfish, Crayfish, Largemouth bass, Redear sunfish, Mosquito fish

Southland Fisheries
600 Old Bluff Road
Hopkins, SC 29061
PH: 803-776-4923 FX: 803-776-4975
Jesse or Clay Chappell, David Burnside
Ships small quantities by air
Prefers customer pick-up or ship by air or truck
Hybrid striped bass, Hybrid bluegill, Coppernose bluegill, Florida largemouth bass, Sterile grass carp, Red drum, Redbreast bream, Shellcracker, Koi, Channel catfish

Spruce Creek Fish Hatchery
PO Box 145
Miltona, MN 56354-0145
PH: 800-972-7648 or 218-943-1800
FX: 218-943-5155
Troy Drews
Ships small quantities by air
Prefers shipment by truck
Walley, Hybrid bluegill, Largemouth bass, Muskie, Black crappie, Yellow perch

Sweetwater Aquaculture Inc
Route 1, Box 184A
Lapwai, ID 83540
PH: 208-843-2929 FX: none
Greg Dillon
Ships small quantities by air
Prefers shipment by FedX
Rainbow trout, Channel catfish, Largemouth bass, Bluegill sunfish, Pumpkinseed sunfish, Goldfish, Koi

Tyler Fish Farm
Route 3, Box 3286
Ben Wheeler, TX 75754
PH: 903-849-2081 FX: same
Bob Waldrop
Does not ship small quantities by air
Prefers customer pick-up or ship by truck
Florida bass, Coppernose bluegill, Threadfin shad, Channel catfish, Hybrid striped bass, Fathead minnows, Black crappie, Cuban bass

Van Winkle's Fish Hatchery
507 State Road 145
Birdseye, IN 47513
PH: 812-389-2343 FX: none
Tom Van Winkle
Does not ship small quantities by air
Prefers customer pick-up
Triploid grass carp

Whispering Pines Fish Farm
11829 Matteson Road
Holland, NY 14080
PH: 716-496-7440 FX: none
Steve Welk
No preferred method of shipment
Trout, Perch, Minnows, Bass

Wyoming Trout Ranch
4727 Powell Highway
Cody, WY 82414
PH: 307-527-7446 FX: same
Bill Nye
Does not ship small quantities by air
Prefers shipment by truck
Rainbow trout, Cutthroat (Yellowstone) trout, Cutthroat (Snake River) trout, Eastern brook trout, Brown trout, German trout

American Pond & Lake Management
1994 South 600 West
Russiaville, IN 46979
PH: 765-883-5718 FX: none
Abe Rayl
Does not ship small quantities by air
Prefers shipment by truck
Channel catfish, Bluegill, Triploid grass carp, Redear sunfish, Hybrid bluegill, Largemouth bass

Appendix K
Setting Up the Mini Fish Farm™

Note: Reading the directions and/or watching the video before assembling will make the assembly faster and easier.

Instructions

Tools needed: Nutdriver (included)

1. The Mini Fish Farm™ will arrive on one pallet with all components packed inside tank.
2. Select the tank location by keeping the sun, shade, water supply and water drain in mind. A minimum area of 7'4" x 9' is needed. We recommend that the system be located inside where climate conditions can be maintained and controlled. For warmwater fish, the tank may be located near a window that takes advantage of the sun, yet is still insulated against the cold. Be sure to consider the weight of the tank when full of water (4,800 lbs/2,182 kg). If placed outside, some consideration should be given as to placement near trees, which could result in large amounts of leaves in the water, predators including neighborhood pets and water runoff from roofs.
3. Prepare the site. It is best to select level ground. If the ground is uneven (more than 1" from one side to the other), place a 2" bed of sand, level it and place the tank on top. It is important that the system be level to ensure good water flow dynamics when in production. Do not use shims to level the tank as the weight of the tank will cause it (tank) to bend around the shims.
4. **Set-Up:** Unpack and lay out each component. Become familiar with each piece, as it will make installation easier.
   A. **Tank**: The tank comes as a one-piece unit with no assembly required. Place in a preselected and prepared spot (see #2 above). If the tank has a window (optional), position the tank for optimal view.
   B. **Clarifier Stand**: The stand comes preassembled. Position the long side 4" from tank (Fig. 1) and level. Stand can be placed anywhere along side the tank. Try to place it so that draining of the clarifier is done with ease (Fig. 2).
   C. **Clarifier**: The clarifier should be placed on its stand with the weir to the right side of the stand and the deep end with the drain valve to the left (Fig. 2). The filter pad included should be placed in the chamber after the weir (Fig. 2).
   D. **Biofilter**: The majority of the biofilter comes preassembled. Connect the biofilter to the clarifier by screwing in the true union (A on Fig. 3) which is already assembled to the biofilter tank and the 90° elbow (B) coming off of the clarifier. This will position the biofilter so that the discharge (C) from the biofilter will be facing tank at a right angle, as airlift will be attached to it.

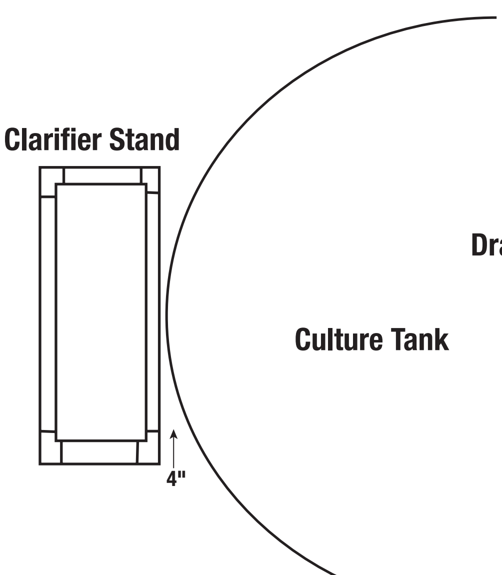

Fig. 1 (Top View)

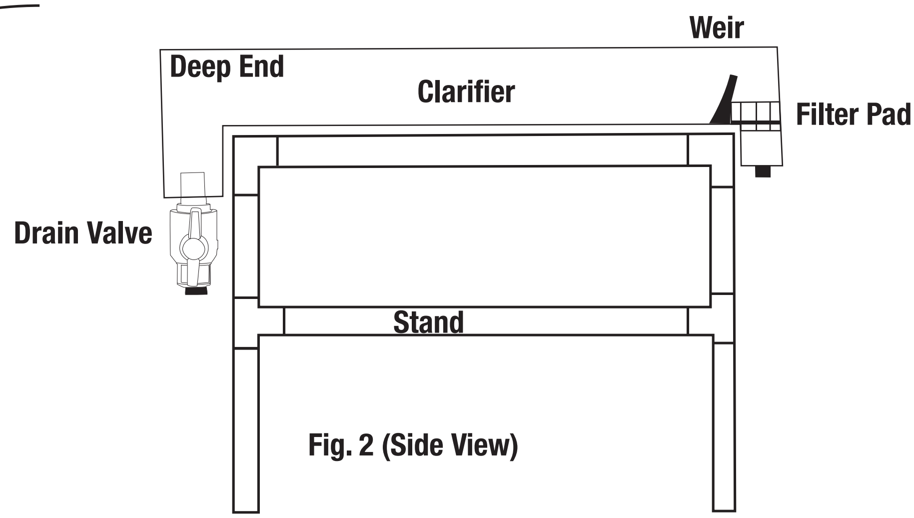

Fig. 2 (Side View)

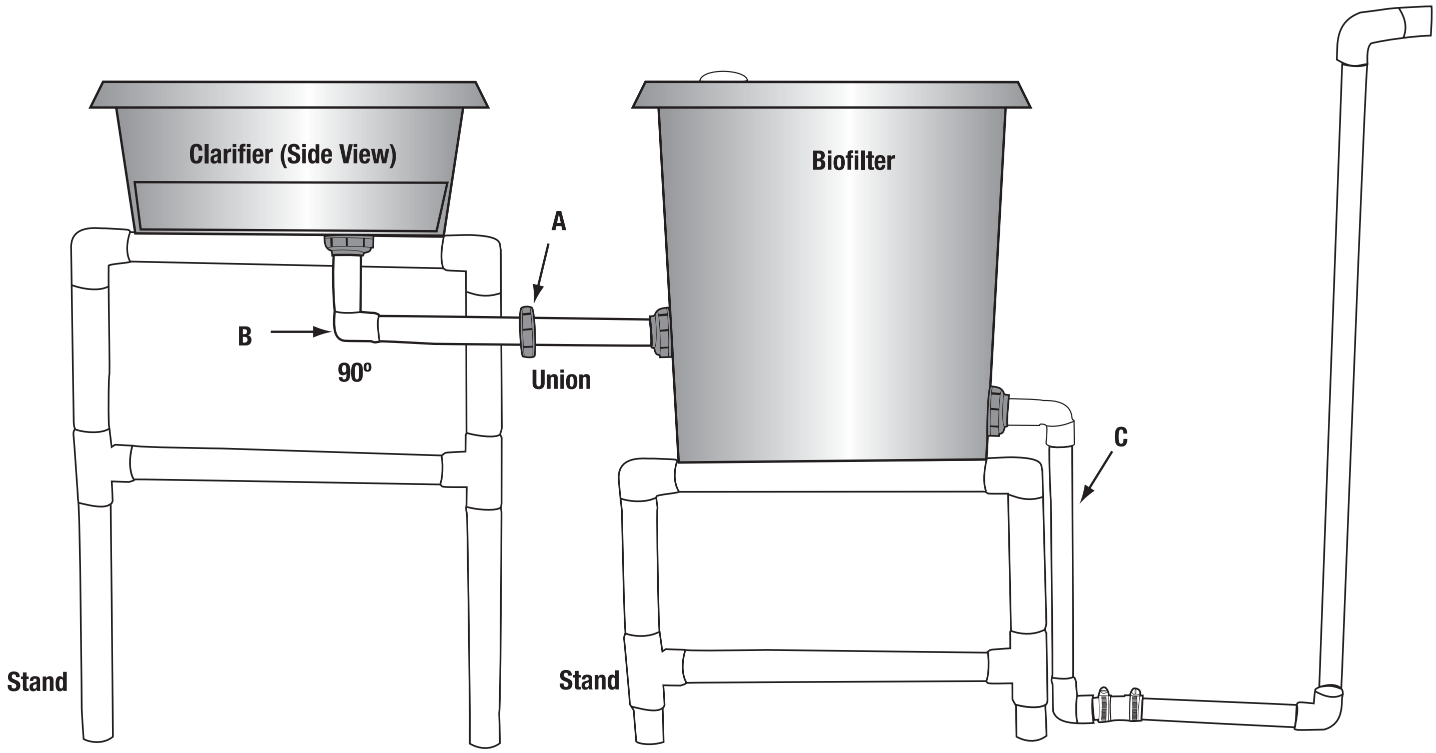

Fig. 3

E. **Airlift**: Attach airlift pipe (A of Fig. 4) to the outflow of biofilter (B) using vinyl tubing and clamps provided. Be sure tubing covers both pipes evenly and clamps are tight. Use only water as lubrication—any other substance could foul water.

F. **Siphon Assembly**: Comes assembled. Install as shown in Fig. 5 with the velocity reducer on the left (deeper) end of the clarifier with elbows facing left. Water intake assembly should be centered and flat on the bottom of the tank. The velocity reducer goes in the deeper end of the clarifier with elbows facing away from the clarifier.

G. **Boil Baffle/Diffuser Assembly**: Using attached clips, this assembly hangs on the) inside of the tank wall near the mid-line of the clarifier (Fig. 6) with air diffusers suspended off the bottom. Be sure to remove cardboard from diffusers before installation.

H. **Air Compressor**: For safety reasons, we recommend that the air compressor be placed higher than—and away from—the Fish Farm™. Installation above water level will prevent water from back siphoning into pump in the event of a power outage. The hose assembly should be connected. The 3/8-inch reinforced hose should be attached to the Boil Baffle Assembly (A of Fig. 8), and put the other end into its respective nipple on the manifold. The smaller clear hose should be connected to the airlift (B). Match the other end to attach to the corresponding nipple on the 3-way air manifold. The other clear hose (1/4") connects to the 3" x 3" square diffuser, which is to be placed in the bottom center of the biofilter tank, and the other end into its nipple on the manifold (C).

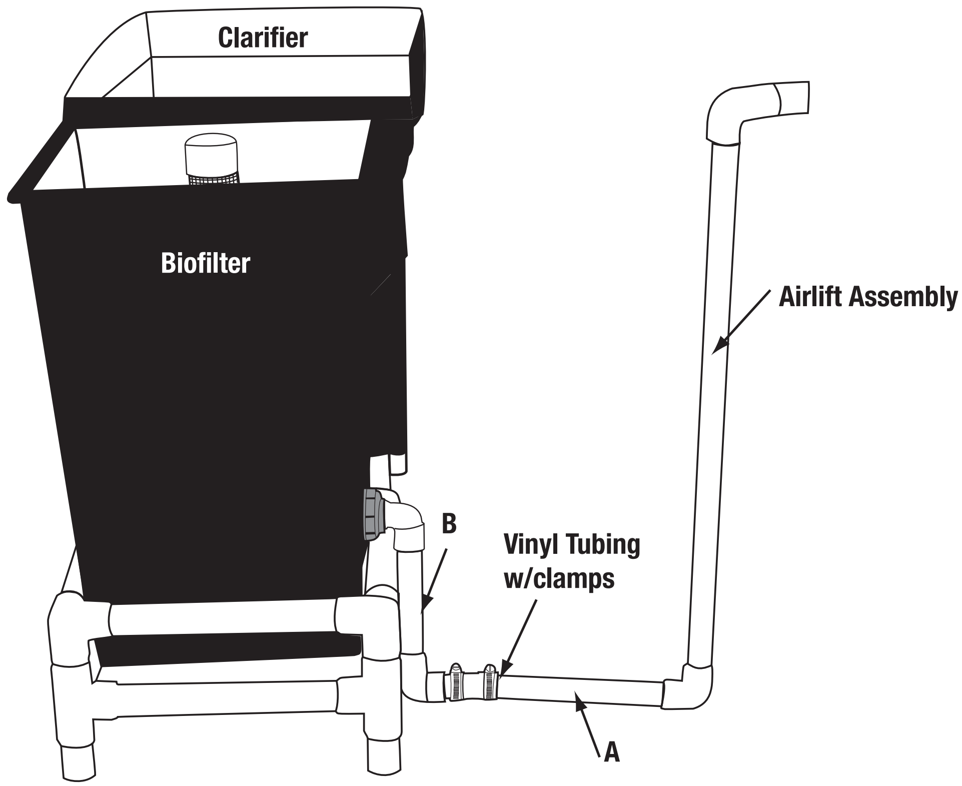
Clarifier
Biofilter
Airlift Assembly
B
Vinyl Tubing
w/clamps
A

Fig. 4

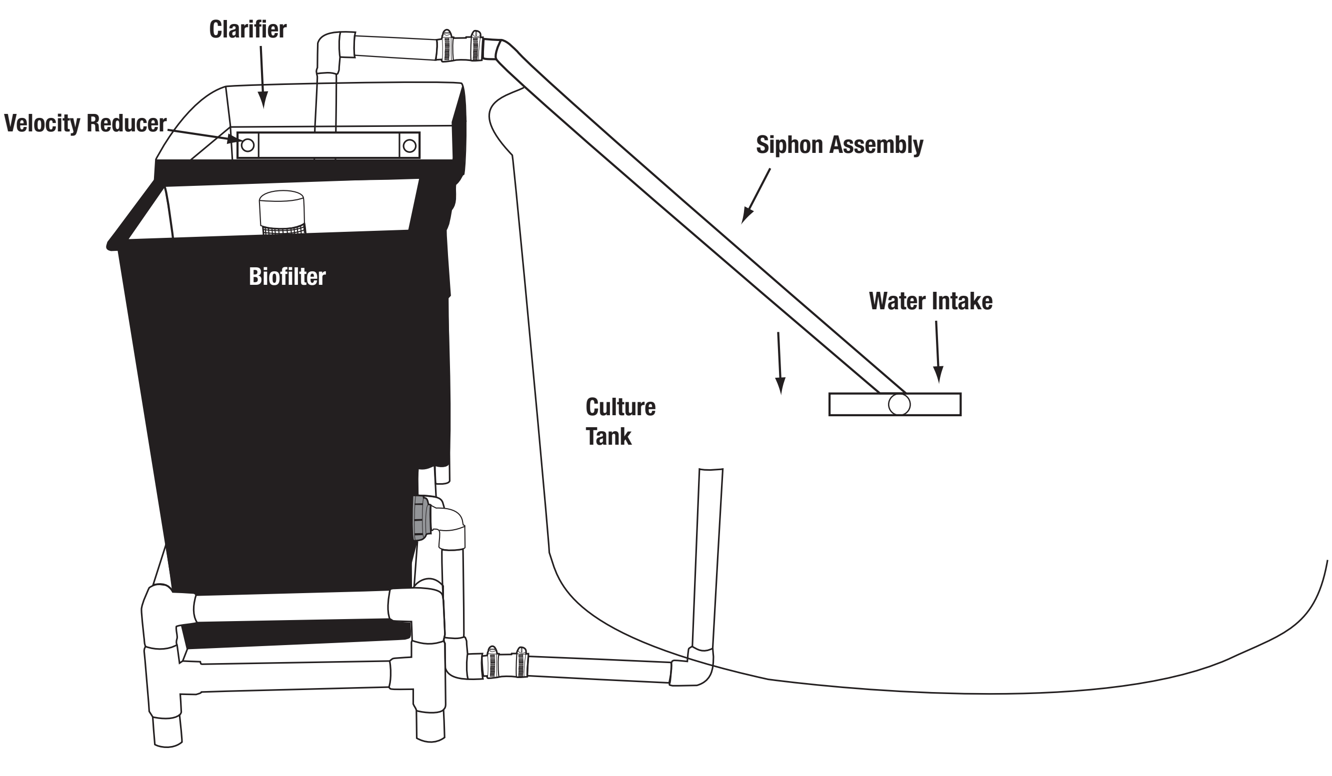
Clarifier
Velocity Reducer
Siphon Assembly
Biofilter
Water Intake
Culture
Tank

Fig. 5

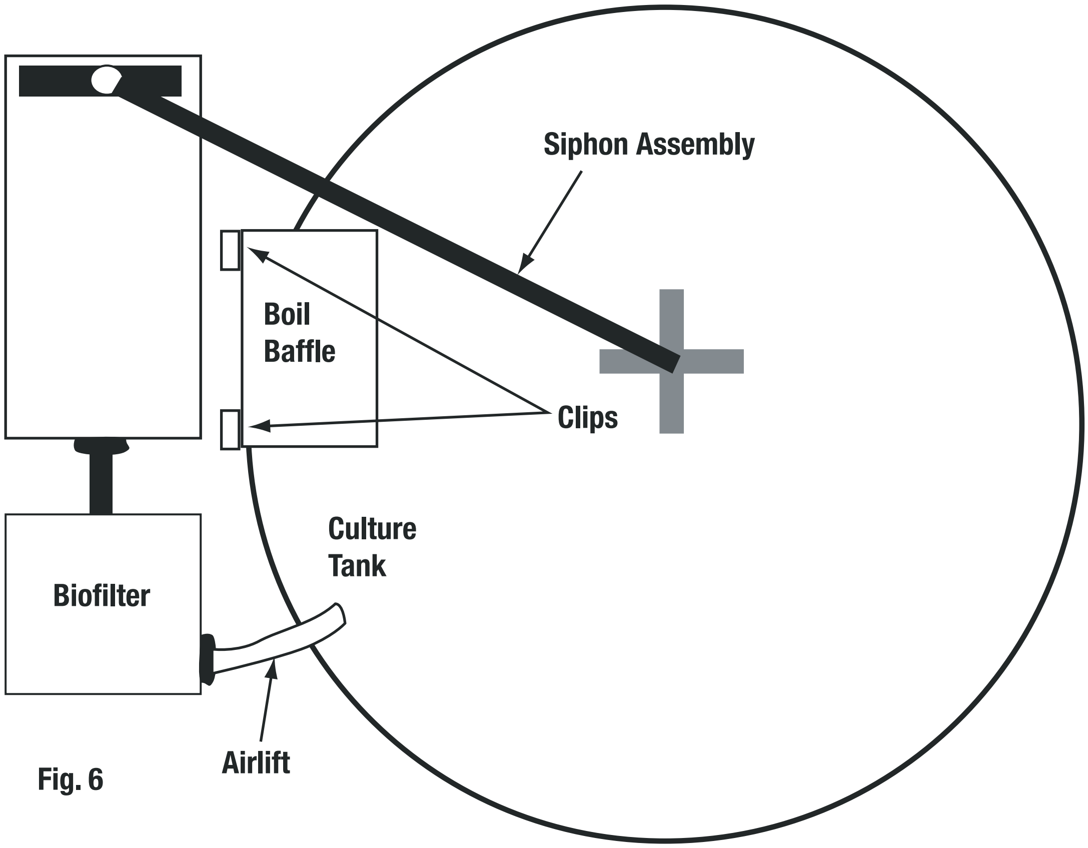
Siphon Assembly
Boil
Baffle
Clips
Culture
Tank
Biofilter
Airlift

Fig. 6

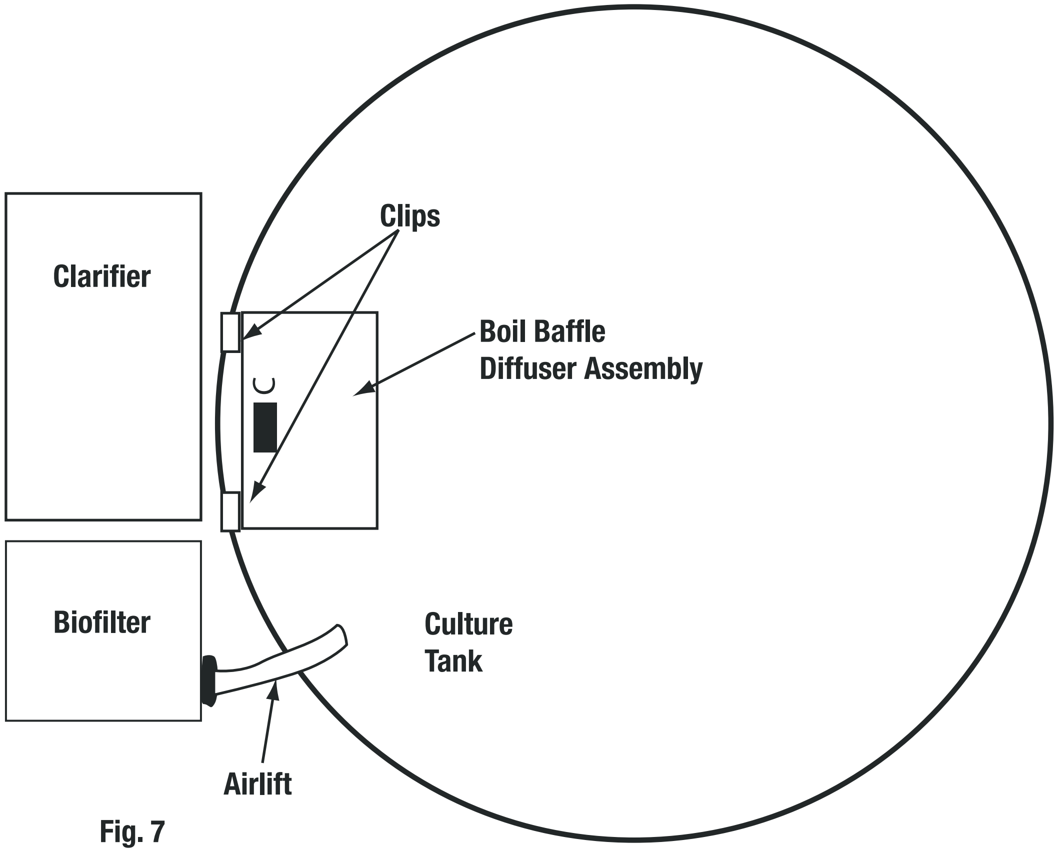

Fig. 7

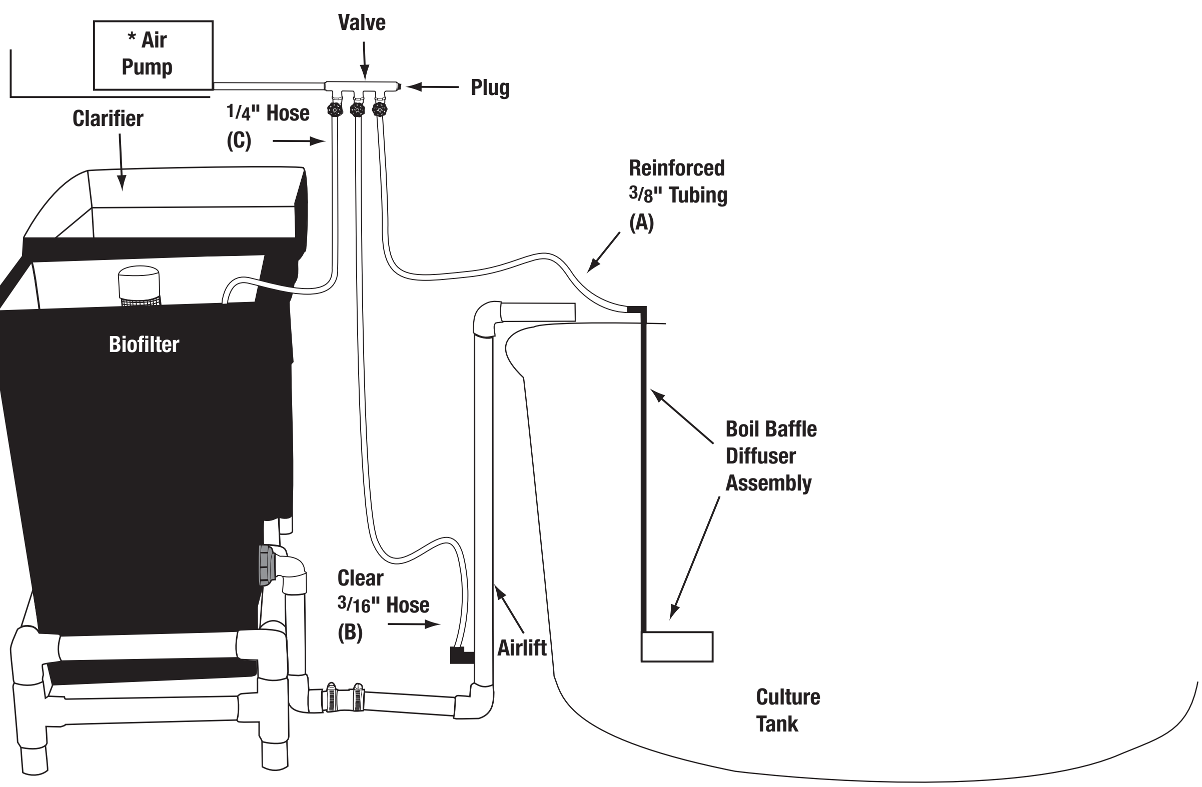

Fig. 8

* Note: Locate higher than and away from system.

Notes

Notes

Notes

Pentair Aquatic Eco-Systems, Inc. *• Phone: 407-886-3939 • Email: PAES.General@Pentair.com • Web: PentairAES.com*