HATCHERY MANUAL

FISH FARMING AT HOME FOR FUN AND PROFIT

By

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Introduction

Outside of the United States and in many areas of this country malnutrition is a way of life. In most cases this malnutrition is due to the unavailability of low cost proteins such as lysine and others. Home fish farming offers a solution to the availability of an affordable source of fish.

Part of this solution requires knowledge of how to grow, harvest, purge, process, prepare and cook fish, and preserve fish. The farmed fish will be healthy and acceptable in many forms to those who would like to include more fish in their diets.

Fish are very high in lysine and very small amounts of fish in the diet can go a long way toward creating longer, healthier and more enjoyable lives by supplying the body's protein needs.

This book is written to help you understand the major factors that affect success in growing tilapia on a small scale.

Tilapia – An Ideal Fish for Aquaculture

The name tilapia is a taxonomic name (genus) given to a group of fish that belong to the cichlid family of fishes. The cichlids populate many of the tropical and semi-tropical areas of the world and have many things in common with each other, but there are major differences between most of them and the tilapias.

The Tilapias are one of the major groups of food fishes around the world, especially in the tropical and semi-tropical areas, and have been cultivated for thousands of years. Pictures or carvings appear on artifacts and monoliths in Egyptian tombs as far back as 2,000 BC, but only in the last 50 years have we began to focus on developing them as an alternative to harvesting wild fish.

The tilapias have a number of **special capabilities**. Some of these capabilities occur in one fish or another, but seldom occur within the same fish. The fact that all of these characteristics occur within the same fish is what makes tilapia a very good fish for home aquaculture.

These capabilities include:

FILTER FEEDING: The tilapia have tiny combs located on their gills, called gill rakers, that allow them to remove organisms from water passing through their gills. Tilapia can filter organisms as tiny as 3 microns, which is about the size of human blood cells. This filtering is so efficient that it can be compared with the best swimming pool filters in removing microbes from the water.

EFFICIENT DIGESTION: The acid content in the tilapia stomach is one of the strongest known and allows them to efficiently digest a wide range of microbes, including diatoms, bacteria, fungi and other organisms, by simply dissolving their cell walls. Tilapia feed on dead leaves and organic debris that fall to the bottom of a pond. Tilapia have been shown to be able to digest up to 70% of the “mud” as it passes through their gut.

STRONG IMMUNE SYSTEM: When well fed and kept in warm water, tilapia are resistant to diseases. This means that for the beginner and the experienced fish farmer, we a least do not have to worry about losses of fish due to strange diseases, such as those found in catfish, trout, and most other fish.

FREQUENT BREEDING AND MOUTH BROODING: At temperatures of 85 degrees F, they can produce baby tilapia (fry) almost every week year round. The mouth brooding and maternal protection of the fry helps to create a high survival rate. This combination of continuous production and high survival rate, allows the tilapia farmer to have a constant supply of fingerlings to replace those that get big enough to eat.

REASONS FOR GROWING FISH AT HOME
The reasons for growing tilapia at home are many and include some of the following:

(1) **<u>Family Diet Improvement-Nutrition</u>** Since the tilapia provide a high quality meat source that is high in protein and very low in fat,

they provide an ideal meal in terms of a balanced amino acids and protein intake.

(2) **<u>Extra Income</u>** Since it is so easy to learn to produce tilapia at home it is possible to produce more than the needs of the family in a small space. These extra tilapia can be sold as fry, fingerlings or eating fish when there are more than needed.

(3) **<u>Lower Food Cost for Family</u>** Waste from the tilapia growing tank can be used to grow organic vegetables and the kitchen waste can be ground and fed back to the tilapia. This recycling of energy and nutrients allows you to create a sustainable production system.

A. **Recycling food & vegetable waste** lower the cost of the feed needed to raise the fish. The recycled waste provides much more food per pound when fed to the fish than when used to make compost.

B. **Feeding the fish cost** less than buying fish. Even when supplemental fish foods are purchased from feed suppliers, the cost of the feed required to produce one pound of tilapia is far less than to buy the same amount of fish in the grocery store.

(4) **<u>Lower Cost for Animal Food</u>** The tilapia by product, such as the scales, bones, and stomach contents make excellent feed supplements for other farm animals such as chickens or hogs, at a much lower cost than buying the feeds for them.

(5) **<u>Education</u>** Working and playing with the tilapia breeding system, water systems, air systems, feeding programs and many other activities provide many opportunities for learning the basics in science and social fields.

For instance the breeding and maternal care, and the aggression and territorial behavior provide opportunities to understand the basics of the establishment of animal social systems. The measurement of water quality parameters provides opportunities to understand basic water chemistry. The physical dissolving of the oxygen in the water provides an opportunity to understand the mechanics of air compression, expansion, water air interfaces and what it means to dissolve a gas into water.

The processing of the waste water provides an opportunity to learn about suspended solids, dissolved solids and the role of bacteria and other aquatic organisms in keeping the water clean and suitable for growing fish.

(6) **Entertainment** Watching the fish in the breeding and growing tanks allows for countless hours of enjoyment as they perform their mating and territorial rituals. This is one reason I recommend that each new breeder setup be put indoors in a suitable place where it will be viewed often during the day and evening so that the fish can be enjoyed while learning from them.

Tilapia Hybrids Offer Superior Growth

In the last 25 years, we have concentrated on developing better gene lines in pure species of *T. mossambica*, *T. hornorum*, *T. nilotica* and *T. aurea*. These pure tilapia gene lines can then be crossed to create F1 hybrids with improved characteristics and also with hybrid vigor and evenness of growth rate.

These new varieties of hybrids, such as the Pennyfish™, offer improvements in cost of production that promise to reduce the cost of producing fish for food to match that of chicken, and to do it in a fraction of the space of other animal crops. All in all, these tilapia may prove to be the cheapest source of low cost, high quality protein on Earth.

Sources of Tilapia

Fish Farming Stages

The process for farming tilapia includes the following stages:

Breeding → Fry Sizing → Fingerling production → Grow-out to market size → Purging → Harvesting → Processing → Packaging → Marketing → Cooking → Eating

Before fish can be farmed we must first have a source of fry or fingerling fish, so the first section of this book and of this course will be devoted to methods of getting growable fish.

Wild Capture

The advantages of wild capture of tilapia are:

1. Larger fish can be captured and moved to a properly designed growing environment so that the amount of time and food required to get the fish to edible sizes is less (saves time and money on feeding). Sometimes 4 to 5 ounce fish can be captured in outside areas in climates which support year round growth, and these wild recruits can then be sexed to select all males for placing into the growing environment.

2. Larger fish gain weight faster and so the weight gain per day in the growing environment is greater.

3. Tilapias are easily available in Florida and many countries because they are in many rivers and lakes and can be captured easily by either cast netting or seine fishing.

The disadvantages of collecting wild fish are:

1. The possibility of introducing parasites or diseases into your growing tanks, and then having then to deal with cleaning up the problem.

2. There can be questions as to the food quality of wild or locally captured tilapia due to the fact that you may not know what chemicals or pollutants may be in the water from where they came.

3. Another disadvantage is that it may require special knowledge and time to find the tilapia and capture them. Transporting tilapia alive requires some special skills and knowledge and so the number being moved that remain alive may be low due to mishandling.

4. The availability of wild caught tilapia can vary widely throughout the year depending on outside conditions and water temperature and so fish may not be available when wanted for restocking.

Purchasing Tilapia

The advantages of purchasing tilapia are:

1. Purchasing tilapia allows you to concentrate on learning how to set up and operate a growing system. You can focus on learning one skill at a time. If the tilapia are available on a reliable and regular basis this can be a good choice.

2. If you can find someone who is producing a high yielding fast growing fingerling, then you can get a head start on the production cycle and this will allow you to grow more fish per year in the space you provide.

3. Another advantage of purchasing fingerlings is that survival should be good when the fingerlings are purchased from a reliable dealer with experience in the live shipping and transport of fingerlings.

The disadvantages of purchasing fingerlings:

1. The cost per fingerling of purchased fingerlings over homegrown is often more expensive.

2. Another disadvantage of purchasing the fingerlings is that even reliable producers do not always have them when you need them. This can make it difficult to even out your production schedule.

3. If you produce your own fingerlings and have excess, the extra fingerlings may be sold for additional income.

Breeding Tilapia

The advantages of breeding your own fry and raising them to fingerlings for stocking are:

1. A small number of well-kept breeders can produce a continuous supply of fry and fingerlings so that a known number of replacements are always available for the tilapia reaching usable size in your growing system.

2. Extra fingerlings may be sold for extra income.

3. Breeding tilapia is fun.

4. Bred fingerlings are less expensive and are of known quality because you know what they have been eating and <u>most importantly</u> who their parents were.

Breeding Tilapia at Home

We have examined the reasons for growing tilapia at home and the possibilities for getting started. We can now discuss the biology and behavior of tilapia and the possibilities of getting started breeding them at home.

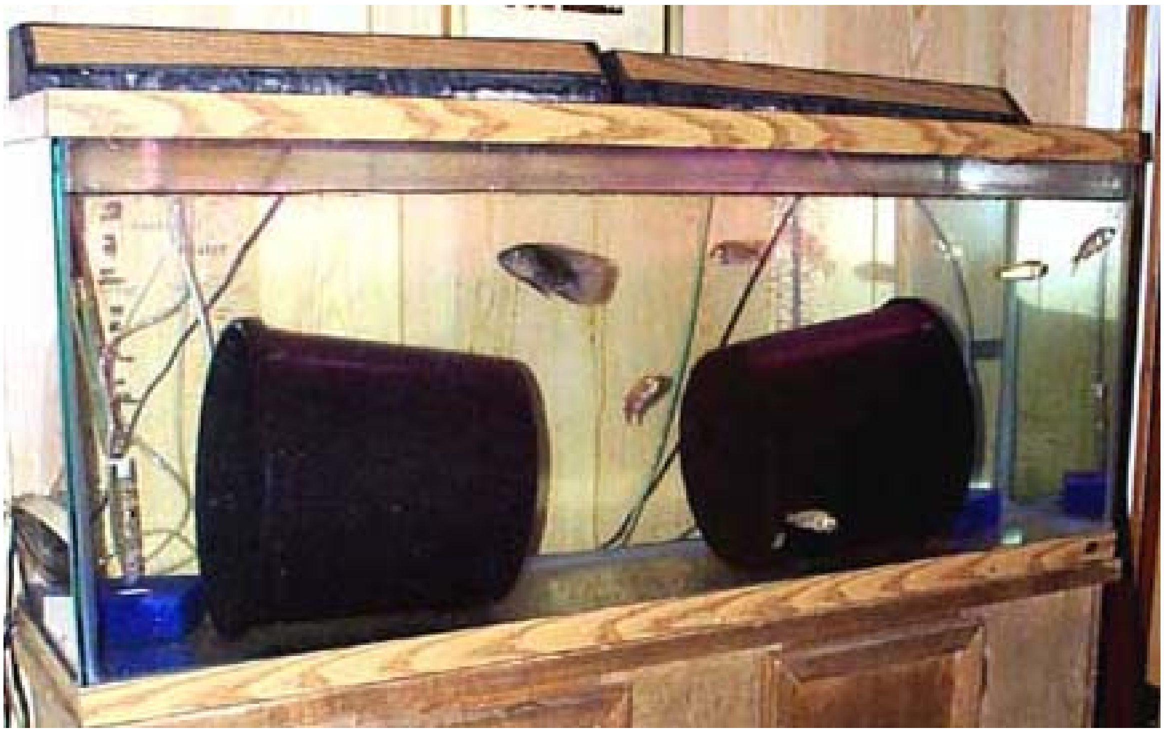


Figure 1. Breeders in 55-gallon Aquarium

The breeders in this 55-gallon aquarium can provide twenty five thousand fry to grow to fingerlings for stocking growing systems in one year. This makes it possible for a very modest investment to grow over 2,000 pounds of live Supermale Pennyfish (tm) to market size each year.

This section discusses some of the advantages of using Pennyfish breeders in a home production system.

Figure 2. Two females with eggs in mouth

First, you need to concentrate on is the production of a suitable fingerling. The fingerlings I most seriously recommend right now are the Pennyfish™ which are the result of crossing the Male *T. hornorum* with the female Orange *T. mossambica*. Both gene lines are special gene lines that I have created here on my farm in Palmetto, Florida.

The *T. hornorum* gene line has more than 100 generations of selection for body form while maintaining its purity as a pure gene line.

The body form improvement allows the farmer to get about 9% more fillets out of a 1.25 pound or 600-gram fish. This is about 54 more grams more than the normal *T. hornorum* ancestor formerly provided. The total yield is around 252 grams of fillet from a 600-gram hybrid, or 126 grams per fillet instead of 90 grams per fillet from a normal body form.

In addition the fingerlings can grow at just above **5.5 grams per day** average so that from a ten-gram fingerling you can get a 600-gram fingerling in around 110 days (5.5 grams times 110 days = 605 grams).

Because Pennyfish are a true unmixed hybrid they all grow at around the same rate of speed so that less than 7% are below 600 grams at the 110-day mark while approximately the same number are above it. Also because they are an F1 hybrid and the father is a **natural SUPERMALE**, having both chromosomes for maleness when crossed with a pure natural XX female like *T. mossambica* or *T. nilotica* the only chromosome combination possible is the ZX chromosome, and since the Z chromosome is dominant in 99.9% of the offspring you get virtually 100% males. This means that in an outdoor mud pond you can stock a known number such as 6,000 per acre and with proper fertilization and feeding harvest 6,000 1.25-pound fish in around 120 days.

Figure 3. Pennyfish™

Figure 4. Chocolate Hybrid

The Chocolate Hybrid shown in Figure 4 is displayed on a 16-inch by 8-inch grid and actually overlaps the grid. This fish was produce along with 600 other Chocolate Hybrids in a cage. They were stocked at 100 grams on March 15, 1998 and weighted out at an average of just over 3 pounds or 1,362 grams on September 15, 1998.

The Chocolate Hybrid is produced by breeding the Supermale *T. hornorum* male with the *T. nilotica* female. Since the male has a sex chromosome complement of ZZ and the female has one of XY the only thing the fry or fingerlings can be is XZ or ZX either way they are 100% males. This fingerling has both the hybrid vigor imparted by being an F1 hybrid of two species and the extra growth of being all males.

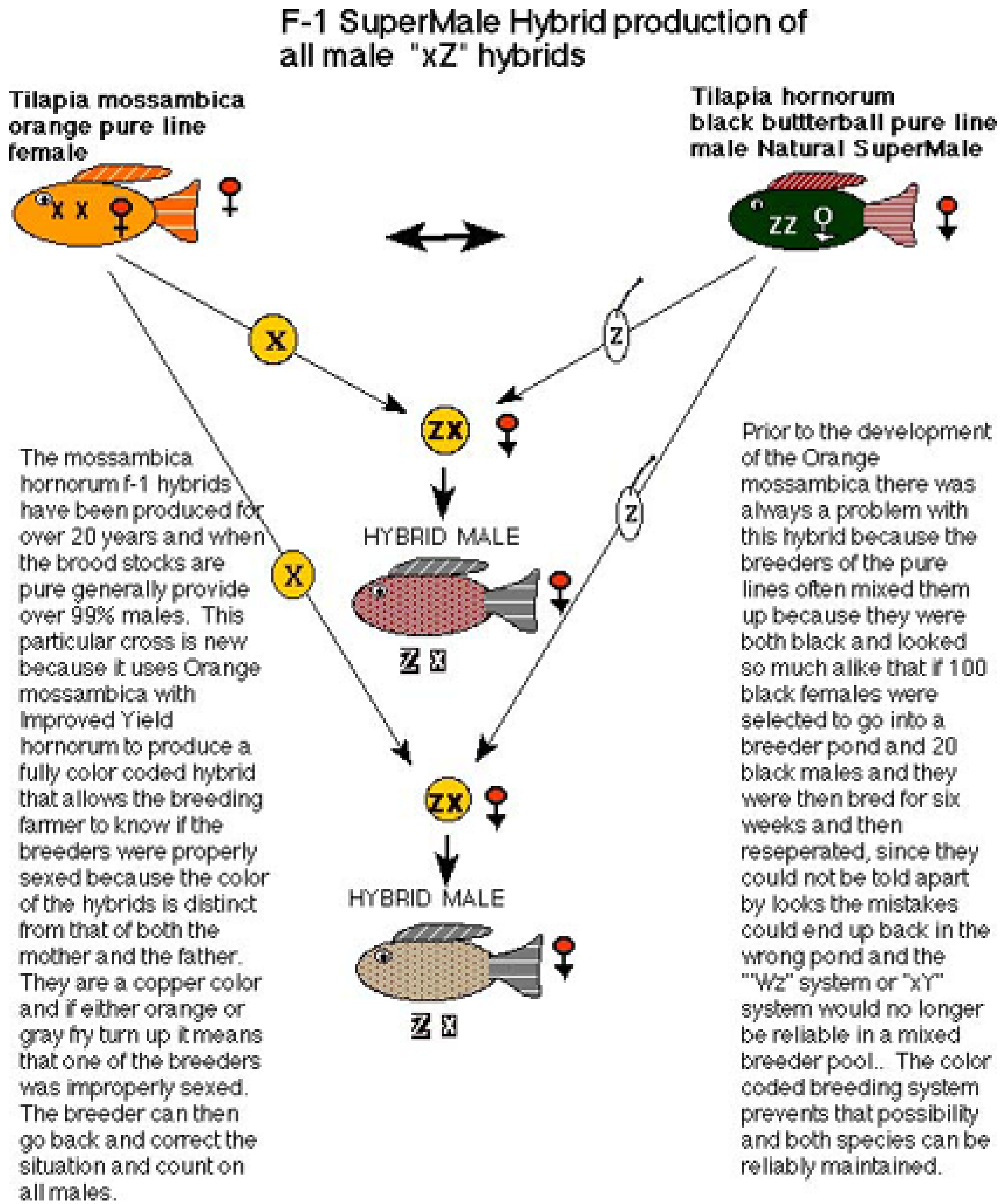


Figure 5. F1 Supermale Hybrid Production

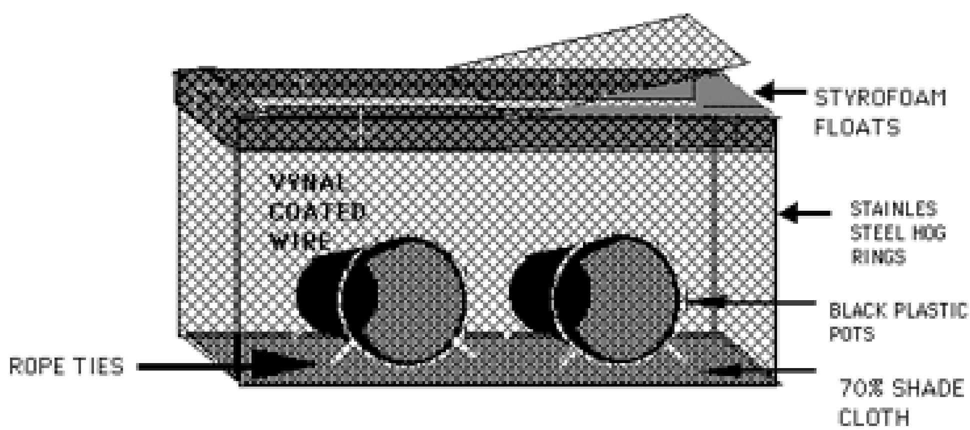
One advantage of using our Orange *mossambica* brood stock is that the parents are different and it is virtually impossible to set up breeding colonies that will not produce 99.9% males (see Figure 5). It seems that one fish out of a thousand just has to be female due to the differences inherent in the individual chromosomes coming from both the male and the female.

The cost for the breeding and selection program that results in the ability to produce such fast growing fish is very high. To produce both the male and female breeders of the pure line *T. hornorum* and *T. mossambica* parent stocks, will cost you around $2,000,000 US.

However if you leave the breeding and selection process to us, and just buy male *T. hornorum* and female *T. mossambica* at the price of $50 each for small numbers the total cost per fingerling is dramatically lower.

Since each male can breed in a natural environment with up to ten females or more, the male can be responsible for as many as 50,000 fingerlings per year.

The female and male brood stock for *T. mossambica* is also available for $10,000 in the orange and we will ship you up to 2,000 fry for that price which should result in around 1,000 or more females that will be breedable females on the first breeding and unlimited numbers by later breedings.



The cage material can also be plastic and can be square mesh one inch and solid enough to take the handling the cage will have.

Figure 6. Tilapia breeder cage

Once your breeders are in cages like the ones shown in Figure 6 and breeding you will be moving the cages once a week to a new pond or fresh tank. If the breeders are in a pond, you should ensure that they have clean water rich with algae and no other animals for the fry to compete with, such as dragonfly larvae.

The size of pond for breeding 20,000 fry per week should be around 2,700 square feet (90 feet by 30 feet). The depth should be around 5 feet in the middle sloping gradually to the banks.

With 200 females you should have 40 cages and the cages should be about 2 feet by 2 feet by 4 feet. You should use either plastic or vinyl coated galvanized steel wire for the cages. This many breeders kept at 85 degree F temperature in ponds like this will produce 20,000 fry per week, or **one million per year**.

The bottom panel should have a layer of window screen or other fine weave mesh attached to it with stainless steel hog rings about every 1.5 inches around the perimeter of the 2 X 4 foot panel.

Then you should attach 2 (two gallon) plastic pots, which are ordinarily used for planting plants in. You should attach them so the open end of the pot faces one of the long sides and is about 10 inches from the end of the panel where it starts and around 20 inches where it ends, and the other pot attached the same way from the other end. When you are finished with the bottom of the cage you will have the fine mesh material secured every 1.5 inches and the two pots facing the same way toward where the side panel will be when you attach it.

Then the four side panels should be attached first by using the 3/8-inch stainless steel hog rings every one inch along the bottom, and when you have all four side panels attached, two (2-foot by 2-foot), and 2 (2-foot by 4-foot), then you fold the side panels up and clip them together every one inch until you reach the top. When you are done you will have a box made from cage material that contains two plastic pots facing one side of the cage about 10 inches from that side. The back of the pots will be around 5 or so inches from the other side panel.

Then you cut two pieces of cage material so they are two foot by two foot, and you attach one of them around the top of the cage on three sides at 2-inch intervals with the stainless steel hog rings. The other piece of 2 foot by 2-foot material you will just attach to the edge of the first piece that runs across the top, so it will swing open when you need to tend to the fish.

You then attach 8 pieces of No. 8 vinyl coated electrical wire, 4 inches long each, around the perimeter of the other three edges at one foot intervals, so that 2 inches of the wire are attached to the cage material and the other 2 inches stick up in the air above the edge of the cage.

You will use these to bend down over the edge of the cage to hold the top of the cage shut.

The next job is to supply flotation to the cage, which we do here by cutting 4 inch by 4-inch Styrofoam logs, 8 foot in length so that each log is 4 foot long. Then two of the logs are tied with the same electrical wire mentioned earlier, at one-foot intervals along the cage. The Styrofoam logs should be attached inside of the cages.

When you put the Styrofoam logs in, through the top, you will have to secure them at the end where you have placed the top of the cage by having someone hold the log while you slip the wire under it and fish it out of the top of the cage. You will now have two logs of Styrofoam running the length of the cage.

Now you hold another piece of Styrofoam up against the edge of the cage and measure so that when you cut it there is about 1 inch extra to go between the two long pieces inside the cage. Then when it is cut you will need to force it in to fit.

Then you tie each piece twice with the same wire. The Styrofoam has now become an integral part of the structure of the cage so that when you go to move the cage you will be using that structure to hold the shape of the cage.

Now you are ready to put the cage in the water. You leave the door to the cage open and put the breeders you have in a net deep enough to hold them in a sort of bag with one hand while you place them into the cage, you do this up on the bank so if one of them jumps you can recover it before it gets into the water. Place the net into the cage and turn it so the exit is down, and let go of the net so the fish can swim into the water. As soon as all of the breeders are in the cage you fold down the lid and bend over the tie holds you previously installed.

You then string a rope across the pond, which you will use to tie each cage of breeders so that it will be within about a yard (meter) of the bank. You can place the rope so that it will go across the middle of the cage with the end that opens toward the bank and then use 2 clothespins to attach the rope to the center of the cages. Space the cages about 2 feet apart.

Now you feed the fish twice a day with a good trout chow, placed inside of the cage from the top so the Styrofoam will keep it from floating out. One bag of trout chow should last about a month for the breeders, as you will only have four cages and you only use about 1.2 cup for each cage twice a day.

In about 8 to 10 days you will see fry swimming around the pond, and so you start counting for seven days when you see this which will bring you to the 15th or the 17th day after placement of the breeders. Meanwhile you pump out or otherwise drain the pond next to the pond your breeders are in and rotenone the bottom or use some chemical to sterilize it that will go away in 7 days. Then you refill the pond a couple of days before you want to move the breeders, and then test the water with a couple of live fry by removing a bucket of water about half full and placing the fry in the bucket where they cannot accidentally fall into the pond.

Once you move the cages, the fry will then continue to grow with no difficulty for about 30 days or so until you need the pond again. Then you can use some fish traps which we can send to you or the Cooperative we work with can, to trap out the fingerlings to stock in the grow out ponds which by that time you should have the first 1/2 acre pond ready. It is important that nothing else be in the ponds. You should also fertilize the pond with 100 pounds of triple super phosphate which is suspended in about 5 bags of 20 pounds each and tied with a string to a flotation device in the pond.

The process should be repeated if the green algae begins to clear up so that you can see your fingers when your elbow is at the water.

Lesson 1: Behavior and Biology of Breeding Tilapia

Hatchery Lessons

The male tilapia's goal in life once he reaches breeding age is to establish a territory that he can defend and to attract into his territory as many females as possible. The male tilapia seeks females who are ready to drop eggs for him to fertilize and to keep out of this territory any tilapia or other fish that is not ready to breed with him.

The female tilapia's biological goal is to reach breeding maturity. She then searches for a suitable male who is able to keep other fish out of his breeding territory while they are breeding.

In natural ponds, lakes or rivers the male generally chooses a site to establish his territory up against a barrier of some sort such as the edge of the pond bank, a tree stump, an outcropping a large rock or anything that allows him to restrict the area which he will need to defend while undergoing the breeding ritual.

When he finds a suitable territory, the male will start by chasing out any other fish and then he will attempt to dig a shallow bowl shaped hole in the mud, sand, gravel or other substrate where he has chosen his territory. The size of the territory he will usually choose to defend is generally 2 to 4 times his body length in diameter in a circle or semicircle if he is successful in establishing his territory against a natural barrier. The actual size depends also on visibility.

The pit he digs is formed by scooping out a mouthful of the substrate and spitting it out over the top edge of what is to be his spawning site until he has created a pit with a diameter of about 1.5 times his body length. The size of his territory and of the pit in its center is important to understand because we are trying to create in our breeding tanks acceptable substitutes for these areas.

The breeding follows a very precise pattern with the male first establishing a territory, which in the case of controlled breeding we help to establish by placing a flowerpot in the breeding. Then, when a female is ready to breed, she will swim into the “arena” the male is defending, and they will do a shake rattle and roll sort of dance while circling each other.

When she is properly courted, the female will lay 3 to 5 eggs at a time in the center of the males territory, usually in the flower pot, then she will swim a little distance away. The male will swim over the eggs and fertilize them, then she will return and pick them up in her mouth and repeat the dance with the male while they circle each other head to tail wriggling and vibrating the whole time. She will often on this occasion suck at the area of the sperm tube as if to draw extra sperm to insure fertilization of the eggs. When they have done this for a minute or so she will return to the center of the pit and lay more eggs, and so on until she has a full mouth of fertilized eggs.

The number of eggs the female produces is related to several factors. The most important is her size in grams and her condition in terms of being well fed. The female *mossambica* for instance start breeding at 20 to 30 grams and continue up to and over 1,000 grams.
A well-fed healthy female can lay one to two eggs per breeding for each gram of weight she has attained. This means that even a small one-ounce female can produce as many as 50 or more eggs per breeding and up to 2,000 or more when she is fully-grown.
The male and female continue their spawning until the female has a full mouth and this can take from 3-0 or 40 minutes to 2 or 3 hours for a large female.

Once she has these eggs in her mouth she will leave the breeding area and join the other females in an area of the pond or tank where she is out of sight of the male. She must be able to do this, as he will continue to harass her as long as she remains in the breeding arena. Once she has left the arena she will continue to hold the eggs for 7 to 10 days depending on how warm the water is. The warmer the water the shorter the incubation time.

During the incubation process she slowly and continuously rolls the eggs gently to keep them well oxygenated and clean. The female tilapia is capable of telling sick or dead eggs from healthy live eggs and swallows any that are not right.

The fertilized eggs begin development almost immediately after the female picks them up in her mouth and within 48 hours at 85 degrees F, the beginnings of eyes and tails can be seen on the eggs.

By the fourth day the fry begin to resemble small fish attached to little yellow balls, which are the egg sacks. These are called appropriately egg sac fry, and usually by this stage if separated from the mother are easy to keep alive.

By the fifth day the fry can swim and navigate well enough to be released by the mother for brief excursions out into the world. At first she lets them out for a brief swim and sucks them back in within a few minutes.

By the sixth day she allows them to browse on bacteria, algal, and fungal growths on the surface of plants or walls. While the fry are out the mother tilapia keeps a sharp eye out for any intruders such as other fish and will aggressively chase them away if they approach the area where the fry are feeding.

If she perceives any danger she will signal the fry by a sideways wiggle of her body and an open mouth at which signal the fry will immediately swim towards and into her mouth. When this is viewed it looks like a film in slow motion reverse where she just spit out a mouthful of tiny pebbles.

The older the fry get, the longer the time the mother allows them to spend outside and by the tenth day she will often no longer tend them or allow them oral sanctuary.

It is also the true that the older the fry are when the mother is disturbed, the more likely she is to spit them out to fend for themselves if she feels her life is in danger.

When we substitute our own breeding areas for the natural ones the tilapia use for breeding there are a number of containers we can choose to use.

Some possible containers include:

aquariums
tanks
cages
pens in tanks
pens with cages
ponds
ponds with cages
ponds with pens with cages

In this manual we will just consider aquarium breeding because that is something anyone can get into for a small amount of money. However if you have a tank or pond we can also advise on a way of setting up breeding in your situation. In the next lesson we will look at a simple aquarium system for breeding a small number of tilapia.

One other important consideration in this lesson however is the kind of tilapia to choose to breed, their size and the reasons for these choices.

The beginner can find tilapia from many sources and can achieve good results in breeding the tilapia. Producing fry in aquariums with almost any tilapias of the right size is possible as long as the tilapia are healthy and the system is set up correctly.

Fry are of course the first stage of the small fish following the egg stage and are from 1/8 to 1/4 of an inch in length.

The fry are easy to produce, but after that the choice of breeding stock begins to affect each growth stage from fry to fingerling and from fingerling to edible size fish.

There are several important factors to understand.

1. Try to know the identity of the breeding stock, which includes the species of tilapia and from what strain including whether it is a pure gene line. If the breeder is not a pure line, then try to find out the mixture of its parents. If you cannot find information about the parental lineage, then you may have a poor start for

your breeding program.

2. Understand that a pure line tilapia gene line is always inbred and has many multiple weak genes that show up on the opposite chromosomes on many different character determining gene sites. This means that a high percentage of the fry will have highly variable growth rates.

3. The male fry will grow faster than the female fry on the average, but some females will grow faster than some males, and in most good growing systems it is better to have all males if possible to grow for food fish.

4. The only way at present to get all male fry from a pure gene line is to use a sex reversal feed that contains male hormones or buy your fry from someone who has already put them through the reversal process.

5. Hybrid tilapia that are produced by crossing a male tilapia from a pure gene line of a different species with a female tilapia from a pure line of a different species will be free of almost all of the built in defects from a pure gene line and both the males and the females will grow on the average faster than the sex reversed fingerlings from the pure gene line. These are called F1 hybrids and are by far the best breeding stock to use because for the life of the breeders you will have good quality growing stock.

6. F1 hybrids do not all turn out male, but they too can be sex reversed and when this is done they produce an even better growing stock for food fish production.

7. There are also F1 hybrid breeding stocks available, for instance the Pennyfish* which will produce only male offspring. When you can afford to get breeders of this type, then optimal results will occur because all of the fish will be stronger than the average pure line reversed sex tilapia and all will reach market size in the shortest possible time.

8. It is not a requirement of this course to buy your breeders from any special place. However, it is important for you to know that the breeders you use will determine the type of problems you will need to be solving as you go to the next stages of learning to grow tilapia at home for food.

In summary the breeding behavior of the tilapias makes it possible to set up small indoor breeding areas that can produce adequate supplies of fry to grow in a production system for food.

The selection of which breeding stock will have a profound effect on the total growth rate of our fry and fingerlings and on the time and space it takes to get them to edible size, however for the purpose of learning the breeding process itself almost any tilapia males and females will do.

If you prefer to skip the breeding portion in this manual and simply find someone else who can supply you with fry or fingerlings, you may of course do this. Some of you may also wish to share the expense of the breeders with each other, especially if the tilapia breeders or fingerling sources are close to each other.

I can supply tilapia breeders or fingerlings to any of you who wish to contact me for that purpose.

Mike Sipe
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Palmetto, Florida 34221 USA

Phone (941) 729-2012
E-mail mikesipe@aol.com

Lesson 2: Aquarium Breeding Tilapia

This method is the simplest to set up but requires daily attention and individual handling of each breeder female each time they breed. The tilapia may be bred in twenty or fifty-gallon aquariums provided certain precautions are taken.

The aquariums need to be set up with the following requirements:

1. An aquarium pump and air stone to supply oxygen.

2. A filter to remove excess waste and solids from the water. This filter can be an inexpensive corner filter such as sold in aquarium shops.

3. A plastic pot or clay pot (a common flower pot can be used) that can be placed in a good position in the tank to help define the male's territory.

4. Good strong light over the tank, which can be either florescent with two bulbs, or incandescent, which provides beneficial light, enhancing vitamin D synthesis and controlling the day length.

5. A mesh cover to prevent the fish from jumping out.

6. A small fine mesh net about 8 inches by 8 inches for handling the breeders.

Breeder Selection from Wild or Available Stocks

Note: If you have purchased tilapia breeders, you can skip this topic.

The next thing we will need is a group of unsexed breeder size tilapia from which to choose our breeders.

We will need between 25 and thirty for each ten breeder females and two males we wish to set up breeding with.

The size should be about 3 inches to 6 inches and the weight per breeder should be between 40 grams (2 ounces) and 120 grams (6 ounces).

Fish Sexing and Breeder

The next step is to determine which fish are male and which fish are female.

This is done by checking the reproductive organs on the underside of the fish.

The fish has two to three exit areas depending on whether it is a male or a female.

The first hole is the anus through which waste material produced in the digestive system is voided. The anus is located just to the rear of the belly on the bottom of the fish and is called the anus. The second organ just to the rear of that is called an anal papilla and is shaped like a small cone. This organ serves as both the urinary opening and as the channel for sperm to be ejected during fertilization.

The male only has the cone shaped papilla, where the female has an additional opening near the middle of the papilla to allow eggs to be ejected during mating.

The tilapia are able to breed as soon as 60 days after hatching from eggs and as small as 1 to 3 inches in length and one/half ounce in weight. The problem is at that size it is still difficult to see the difference between the sexes even with magnification.

The size I recommend though is large enough for the difference to be easier to see. If tilapia sex identification is a problem, then it is possible to make the ovarian opening more visible with a dye such as gentian violet.

A cue tip is dipped in the violet colored liquid and drawn quickly and lightly over the papilla from front to back. The dye tends to concentrate in any crevices or openings thus outlining them for better visibility.

A twenty-gallon aquarium can successfully breed up to five small females with one male.

Sexing the Tilapia

As you identify the sex of each tilapia, separate the females from the males into two containers. The containers should have air stones bubbling air into them to keep the water oxygenated.

When all of the breeders have been sexed we then count 5 females into each 10-gallon aquarium.

The aquarium is first filled with clean water that is chlorine free (city water often has chlorine) and air is bubbled through it with the sponge filter, which is placed in the back corner of the aquarium. This is done for a half hour or so to insure that the chlorine is bubbled out.

It is best to use the same water the fish are being held in to start the aquarium. This can be done by first bubbling the water in the container that will be used to hold the sexed fish or by taking this water from the container the original group of tilapia have been kept in.

Territory Definition

The flowerpot is then placed into the aquarium facing the open end of the flowerpot toward one end of the aquarium, and within about 8 inches of that end. This will encourage the male to make his territory between the open end of the pot and the end of the aquarium. This allows females who are on the other side of the flowerpot to be out of site when he is in his territory.

Once we have the five females and a pot in each tank we are ready to get the males into the tanks.

We then take each male and a sharp pair of scissors and cut the upper lip off of the male.

Pulling the upper lip out will reveal the articulation between the edge of the lip and the front area of the tilapia.

Then take the scissors while holding the male firmly (with a towel or wash cloth if possible, then cut a line across the hinge of the upper lip through the thin membrane and the center cartilage over to the opposite hinge, making a clean cut.

This cut heals quickly and the male is breeding within a few minutes of being placed with the females.

The reason for trimming his lip is that the male is very aggressive with any fish that is within the area that he claims as his territory. The male tilapia claims a territory usually 2.5 times his body length in all directions that he can see from the center of his arena.

If you have the fish in a small 10 gallon aquarium, that territory includes all of the space within the aquarium which leave the females no where to get away from his breeding efforts.

The flowerpot helps to visually block off part of the aquarium, but it does not completely prevent the male tilapia from continuously chasing the females even if they are not ready to breed. He bites at them with his scraping teeth and very soon scrapes a lot of skin and scales off of them.

Removing the male tilapia’s upper lip prevents him from causing injury to other fish and does not interfere with his ability to breed with the females that are ready.

Before we learned of this procedure we often found half the females dead the next day. Now we usually do not find any dead from the male’s constant harassment if we trim his lip.

Once the male is trimmed he is placed in the aquarium with the five females and allowed to begin his mating in a gentler manner.

Lesson 3: Daily Breeding Management

Equipment Checks

Once the breeders are set up in the aquariums we need to set up the automatic controls that keep the conditions right for breeding.

1. Lighting

The lights over the aquariums need to be plugged into a timer and the timer set to come on at 6 am. and go off at 12 pm

2. Heating

Then we need to plug in an aquarium heater with a thermostat and set the thermostat for 85 or 88 degrees F.

3. Oxygenation

Next, we need to plug in the air pump and attach a line to the corner filter and the air stones, which are then placed into the opposite corner of the aquarium from where the flowerpot is placed.

Once these three things are set up we will be ready to watch the fish and take care of the daily and weekly chores associated with breeding tilapia.

Feeding

The type of feed needed for good breeding is different from that used to grow or maintain tilapia. The feed requires a higher concentration of protein and vitamins to meet the needs of the breeders for producing healthy eggs and sperm. The feed needs a high utilization rate to reduce the amount of waste so that cleaning up after the breeders is not a constant chore.

I usually use either a good quality salmon or trout breeder chow booster or tuna Tender Vittles cat food from Purina.

The amount needed per week is **about 4 to 5 ounces** per aquarium.

Feeding Process

Feeding should be done two or three times a day and no more than a teaspoon of feed should be fed to all of the fish in an aquarium at one time.

A thermometer should be used to check the temperature of the aquarium water once a day to be certain that the heater is working properly.

The breeders should be kept between 85 and 92 degrees F to achieve good breeding.

Lighting Timer Checks

Once a week the timer should be checked to see that the lights are coming on at the right time and going off at the right time.

If you are in a closed room rather than an open greenhouse the lights should come on at 6 am in the morning and go off at 12 midnight. If you place the aquarium in a greenhouse or a brightly lit window, then the lights should come on at 6 pm and go off at 12 pm.

Air Pump Check

Once a day the air pump should be checked to make sure the bubbles are being delivered out of the top of each filter and air stone connected to it. If the oxygen level is low the tilapia will usually warn you in advance by rising to the surface and skittering.

Filter Cleaning

The filter should be taken out of the tank about every 3 days and washed out under running water and then put back into the tank and hooked up to the air.

Figure 7 This beautiful male *T. mossambica* is an exceptional example of the red strain. It is the best of the best after 77 generations of selection for the red color.

Lesson 4: Breeder Management

Each day after the breeders are set up in the tanks we need to observe each of the females and the male to be sure that they are healthy and active.

One thing we need to watch for is damage to the skin and fins of the females from the male's constant harassment. If the females show signs of sluggishness or there are obvious sores or skin lesions and the male is chasing them to distraction sometimes they need to be separated until the females are healthy and ready for breeding.

Another possibility is to place into the aquarium rocks with holes in them or pieces of plastic pipe with openings big enough for the females but too small for the males. This will give the females a place to hide if they need it.

Breeder Clues

If the male begins dancing around a female and she joins in the dance there is a good chance they will breed soon. Once they have bred, the female will have a mouth full of eggs and will not show much interest in eating.

When a female is observed in that state a note should be made and then in three or four days time she should be gently removed from the aquarium and placed in another aquarium until her eggs have developed into free-swimming fry.

The best way to do this is to take two 6-inch by 6-inch nets and very slowly herd her into one. Then, gently hold the net against the side of the aquarium and bring it up over the side and transfer her immediately into a bucket with water from the aquarium. Quickly transport the female and pour her and the water into the waiting aquarium.

The nursery aquarium should have water at the same temperature and from the same source as the breeding aquarium.

Lesson 5: Post Breeding Behavior

Tilapia males in general are very aggressive and territorial. To a certain extent, mother tilapia also becomes territorial for a period of time after breeding.

Besides the obvious full mouth, the female develops a dark marking on her forehead and often darker vertical stripes on her body when brooding eggs. She also becomes more sensitive to many things and can be upset rather easily.

Unbred females also have personalities which appear to border on jealousy in that they often will swim forcefully into a pregnant mother and make her spill some of her eggs. They will then often eat the eggs. Whether this is just a way to get a free meal or a sort of jealous attack to insure lower survival of the other female's eggs is difficult to analyze. The males can also cause a bred female more difficulty by chasing her aggressively after she is finished breeding.

The unbred females do not always bother the bred females. The males may in some cases actually share the brooding behavior with the female by taking some of the eggs into their mouth and rolling them as the female does until the fry are free swimming.

Females in the tank that also have bred may, if the female drops some eggs, actually pick them up and adopt them with her own brood. Many times in large group breeding tanks I have found both eggs and fry in the mouth of the same female.

I have also witnessed a single male breeding simultaneously with four different females. As each female dropped her eggs in his nest site, the male fertilizes them and then each of the females would move in and pick up some of the eggs.

Understanding which type of behavior a female will practice is not always easy. Under one set of circumstances the same fish may exhibit entirely different behavior than under another set.

In any case, leaving a female in the tank after she has bred may result in fewer eggs reaching the hatching stage. If the eggs left in the breeding tank until they are free-swimming fry, many will be eaten by the unbred female adults.

Figure 8. Red Butterball Female Holding Eggs

Lesson 6: Nursery Tank Management

When a female is caught in the nursery tank she may get overly excited and try to escape. This may cause her to spit all or part of her eggs out.

The best thing of course is to move very slowly and gently. When moving her eggs from the tank, catch the female, preferably with two nets. However, if she spits out eggs, you can pick them up with the net or a piece of air tubing that is rigged to create a siphon. You can just siphon the eggs into a bucket or other container on the floor.

Once the female breeder is moved, you can then drop any eggs she has spit into the new tank and she will usually pick them up within a little time and continue incubation. Waiting to move the eggs is also considerably helpful because then even if the female does spit the embryos, they will be far enough along to leave on the bottom of the tank. The eggs will probably develop normally as long as they have eyes and a tail.

Sometimes, especially with young females, the male does not properly fertilize the first brood and the female will then not swallow them because she instinctively knows that they are not developing properly.

Each female incubates her eggs by slowly and continuously rolling them gently in her mouth. She can tell whether each egg is sick or dead and separate those eggs from healthy live eggs while swallowing any that are not right.

The eggs begin development almost immediately after the female picks them up in her mouth and within 48 hours the beginnings of eyes and tails can be seen on the eggs. By the fourth day the fry begin to resemble small fish attached to little yellow balls, which are the egg sacks.

Motherly Behavior

The mother tilapia changes in behavior as the young eggs develop into fry or baby fish. During the first two or three days she simply swims around in a group with the rest of the females and young males but by the fourth or fifth day she begins to look for a place where she can set up housekeeping.

At this time she turns a darker shade of color on the front of her head and sometimes develops darker bands running vertically sort of like a zebra. This darker forehead appears to be a signal to any other tilapia or fish to stay away, because if they make the mistake of coming too near her she will dart at them and bite them if she can. By the fifth to ninth day the fry can swim and navigate well enough to be released by the mother for brief excursions out into the world.

At first she lets them out for a brief swim and sucks them back in within a few minutes, but by the sixth day she allows them to browse on zooplankton, bacteria, algae, and fungal growths on the surface of plants, rocks, or aquarium walls. While the fry are free swimming, the mother tilapia keeps a sharp eye out for any intruders such as other fish and will aggressively chase them away if they approach the area where the fry are feeding.

If the mother perceives any danger to the fry that she cannot chase away, she will signal the fry by a sideways wriggle of her body and an open mouth. The fry will immediately swim towards and into her mouth. When this is viewed it looks like a film in slow motion reverse where she just spit out a mouthful of tiny pebbles.

The older the fry get the more time the mother allows them to spend outside and by the tenth day she will no longer tend them or allow them oral sanctuary. It is also true that the older the fry are when the mother is disturbed, the more likely she is to spit them out to fend for themselves if she feels her life is in danger.

Figure 9. Female with fry

Lesson 7: Fry to Fingerlings

Once the mother tilapia begins to allow the fry out to browse on microscopic plankton, the mother can be caught and put back into the breeder tank to breed again.

It is best to catch her with a net with at least 1/4-inch holes in it so as to allow any fry to escape.

When you pick up the mother tilapia you should hold her gently but firmly with a wet towel or a cloth glove. It is best to place your fingertip on her lower lip and pull downward to open her mouth to look into it to see if she is holding any fry in her mouth.

If she is holding fry, you should continue holding her mouth open and place her back into the aquarium or into a large shallow pan with water from the aquarium and swish her forward and backward until all of the fry are washed out. You may then place her back into the breeding aquarium and then get back to the fry.

The fry are now frantically searching for a hole or nook that looks like mom's mouth, but they will cease this behavior in a few hours.
The fry now need to be fed about three times a day.

Fry Food

The food for fry needs to be either live food like zooplankton, brine shrimp or high protein powder of flake food such as is used for trout or salmon fry. We now use a diet from the local cooperative, which is very good for these fish, and seldom do we lose any when this is used.

The best food I have used so far is a mixture of dried spirulina and artificial zooplankton. I get if from the local tropical fish cooperative. If none of these are available there are a number of ways to solve the problem of feeding the young tilapia fry.

One of the best feeding methods is to take a quart of the same food that you use for the larger tilapia, and soften it in water, add two eggs, and then blend it till it is like a soup and mix it with two cups of water that has just been boiled and in which you have mixed one ounce of knox gelatin.

You then place the mixture into a bucket, pan or bowl and refrigerate it until needed.

When you feed it to the fry you just take a half-teaspoon and drop it into the tank for the first feeding and watch to see if they eat it. They may not eat the first day or two especially if the yolk sac egg is still showing in their own stomachs.

Any feed that is not eaten by the second feeding should be taken out of the tank and disposed of.

By the second or third day the fry will swarm around the feed like starving animals, which from their point of view they are.

Once the fry begin to eat the food, you can feed them as much as they will eat within a fifteen-minute period. This sometimes can be a large amount, especially when they grow so fast.

Once you know about how much they eat on an individual feeding, try to give them that much for the next two feedings that day. Each day they will eat a little more as long as the oxygen levels and temperature in the water are good.

Moving the Fry

When the fry reach about one inch in length or more you should consider moving them into a larger growing area, either a pond, a tank or a cage.

The size of area you decide to put them into now depends on a number of things. One is how many are there and what type of conditions you have. If you have a pond with nothing in it and it is more than 10 feet by 10 feet and 3 feet deep you can put four or five hundred young fingerlings into it to grow up to 3 to 4 inches or one-ounce stocker fingerlings.

Lesson 8: Fingerling Growing Resources

Prior to reaching this point you need to look around you and see what you have that can be an asset to your fish-growing project.

1. Do you have any outdoor yard space?
2. Do you have a pond or creek?
3. Do you live on a canal?

If you have a yard with about 10 feet by 10 feet area available to put a fish tank and you do not have a pond or live on a canal, then tank culture is your only current choice.

If you have any yard space or a pond or a canal that you can put a cage in then you can begin the decision of what is the best way to proceed.

If you have some yard space you can then opt for a pool or tank. Whichever container you choose you need to consider how easy it will be to change the water, drain it, clean it and harvest the fish out of it.

If however you want to use the pond or a canal or creek then you can proceed to decide on how to house the fish to be grown in the water you have chosen.

All of these possibilities can be good and productive and as far as the management of the safety of the fish each one has advantages over the other for different safety reasons.

For instance if you have a creek or canal where the water is in motion you will have very little need to worry about losing your fish to low oxygen conditions, but you may have the threat of toxic materials or wild animals to contend with.

If you have a pond you will have some need to worry about losing the fish to low oxygen conditions in the pond, but the bigger the pond and the less fish you have in your cage the less you have to worry about oxygen, but you may still have to worry about animals and if you do not own the whole pond about other people.

If you decide on a tank you then can have more protection from what has access to your fish, but you will have to be very careful to set things up so as to not have accidents that can cause the loss of the fish during power outages or equipment failures.

Naturally there are a lot of options at this point, but lets just say that you make a choice and then we can proceed without knowing exactly what you have chosen, but can analyze what to do next on the basis of the amount of water the tank contains.

Lesson 9: Deciding on a Production Goal

The next question you need to ask is: How many pounds of fish do you want to have each week?

The amount of tank space you can provide for growing fish can then be designed to produce the amount of fish that you wish to have to eat each week.

The production per week in a tank is usually figured by the cubic foot of growing space, because that tells us how many fish we can house.

In a tank with just water and no water exchange the weight of fish that can be maintained is very small or around one to two ounces of whole fish per cubic foot. Even this amount can be precarious though because as we look at the amount of oxygen that is in a tank, we realize that it is only a fraction of a gram per cubic foot, and so very little feed can be added per cubic foot without upsetting this balance.

If a small aeration device is added you can add two or three times that weight of fish per cubic foot or around one half pound per cubic foot. This additional biomass of fish can then be fed enough feed with the continuous air supply to replace oxygen as it is used up by the consumption of the feed.

If in addition to the aeration you can also exchange water, that is bring in new water, you can then add more ounces per cubic foot of fish that can be held in each cubic foot of water.

A tank 10 feet by 10 feet with 3 feet of depth is 300 cubic feet. If the tank can only hold 1 ounce per cubic foot we will only be able to house 300 total ounces of fish in our tank at any one time.

If you figure that the fish will gain weight at the rate of 2% per day, 2% of 300 ounces is 6 ounces a day, so even a relatively simple tank that can hold 300 ounces of live fish can produce 6 ounces a day of weight gain on a good day.

If we then either have a continuous supply of new water or a continuous supply of air bubbling into the water to exchange oxygen, we can then multiply the total amount of biomass of fish that can be grown in the tank.

This amount is directly related to the oxygen supply and indirectly related to getting rid of the waste products of fish metabolism. These waste products include CO2, ammonia, nitrates, nitrites, solids and other such.

In a well-designed system, water exchange is an effective means of eliminating most of these waste products. However, proper handling of the wastewater may pose an additional problem.

In Lesson 10 we will delve a little deeper into the oxygen topic and in a later lesson, we will delve into the alternatives to water exchange for reduction of waste products in a growing tank.

Lesson 10: Understanding Weight Gain and Measurement

A standing crop is the total weight of all of the fish in a tank or pond at any chosen moment of time. This number is usually expressed in *pounds per cubic foot* so that the amount of growth that is possible in a tank or pond can be calculated.

A one acre pond for instance with an average depth of 5 foot will have five acre-feet of water. Each acre is about 44,000 square feet, which means that a one-acre pond like the one above will have about 220,000 cubic feet of water.

The oxygen required per cubic foot, and the feed required per cubic foot will be the same for the pond as it will be for the small tank we described earlier.

The amount of feed that can be fed to a tank or pond over a 24 hour period is easy to calculate because it is equal to the amount of oxygen in the water as dissolved oxygen.

Water will hold at any given moment in time up to 40 parts per million dissolved oxygen. Water typically holds is 8 parts per million or less dissolved oxygen, depending on the temperature of water. Warmer water holds less than colder water. Cold water will hold about 8.5 parts per million and warm water just under 8 parts per million.

A cubic meter of water is one million grams of water and it is approximately the same as a cubic yard for our purposes: 27 cubic feet versus 33 cubic feet.

Most of the numbers we need to use in our calculations do not need to be exact because the way we arrive at our original estimates of volume in a pond are far from accurate. If we know that a pond is approximately one acre or one hectare (one hectare = 2.2 acres) and one kilogram is 2.2 pounds then any estimates we make as to the amount of oxygen in a pond will be the same number whether we say pounds per acre or kilograms per hectare.

Since one cubic meter is one million grams and contains about 8 grams of oxygen under the best of normal conditions, all we need to do to estimate the amount of oxygen available in a lake or pond is to come up with the approximate square footage and depth and convert that to cubic meters, a number we can comprehend, and multiply by the oxygen reading in ppm and we will have our total grams per pond. A pond that is for instance 200 feet by 300 feet is then 60,000 square feet and since an acre has almost 44,000 square feet then the pond is about one and a half acres.

A hectare of water is 100 meters by 100 meters and if it is one meter deep it will have 10,000 cubic meters of water and if for each cubic meter of water it has 8 grams of oxygen then a fully saturated hectare of water has 80,000 grams of oxygen available for fish to draw from to metabolize the feed they eat.

Eighty kilograms of oxygen is the same as 176 pounds of oxygen per hectare, or 80 pounds of oxygen per acre.

Remember,
1 hectare = 2.2 acres
1 kilogram = 2.2 pounds

So if a hectare is divided by 2.2 you have one acre and if a kilogram is divided by 2.2 you have one pound, so pounds per acre = kilograms per hectare.

An acre then contains in a normal situation with good oxygen saturation about 80 pounds of dissolved oxygen and if we have a pond that is 1% of an acre it will contain not quite a pound of oxygen. A pond 20 feet by 20 feet and one yard deep will be about 1% of an acre and will contain about one pound of oxygen.

Now once you understand this you will be able to easily figure how much feed you can put in the water at one time. But first you need to understand that we do not want to bring the oxygen down to zero with our feeding program because even with tilapia that will result in severe stress on the fish and will not help our growing operation. With most fish it will simply kill them.

But, if we cannot match the oxygen in the water with the same weight of feed then how much can we add?

It turns out that we can usually get away with putting in feed that weighs about half the weight of the total dissolved oxygen in a pond with no continuous aeration. As a guideline, we only feed in excess of 4 ppm. That is, if the number is 7ppm, we only feed 3 ppm of feed, by weight.

So, in our 1% of an acre pond we can put about 7 ounces by weight of feed without causing too much difficulty.

A twenty foot by twenty foot tank that is three feet deep, with no new water coming in to it and no mechanical aeration of the water can then be fed up to 7 ounces of feed a day and not reduce the oxygen below what is safe.

Now how many pounds of fish can we grow in that tank per year if we can feed it 7 ounces a day (we will assume that the oxygen will magically reappear once a day in the water)?

The answer is derived by multiplying the daily feed amount by 365, or we can grow about 159 pounds of fish a year in our 1% of an acre. Now that equals about 15,000 pounds a year for an acre, which is just about 2,000 more than we can find proof of for tilapia in the literature.

But, that is all right, because we will just put in 6 ounces per day to be sure. We are not overfeeding our fish and the proper oxygen level is maintained.

Lesson 11: Growing Strategies

The next question then is how we pick our strategy so that we get our 167 pounds of tilapia a year out of the tank, because the growth takes place day by day and ounce by ounce and bigger fish need more to grow on than smaller fish.

There is no good answer to what is the best system. But, we have tried several strategies that seem to work well for us.

One is to divide the tank into a series of smaller tanks with the smallest fish in the smallest tanks and the largest fish in the largest tanks, and keep moving them as they grow to the next larger size group.

This is the strategy used by trout farmers and salmon farmers especially with fish that will eat each other readily, but this system require upwards of 6 or 8 moves to bring a fish to harvest weight. This is a lot of labor one way or another.

Another method is to divide the tank into 4 growing areas, each of which is twice as big as the first one.

However when you do this you find the first two sections to be equal and so the division looks like this those illustrated in the drawings for this chapter.

If we then divide the area into separate tanks we will have two small tanks a slightly larger tank, another larger tank and a final tank. Each tank will then receive an amount of feed appropriate to its area and volume per day and we will always know about how much to feed the fish in this plain and simple system.

Fry may be supplied to this system from an indoor aquarium breeding setup, or from fry purchased or supplied by a friend. We can put up to 10 breeders in the small tank division and move the breeders after each breeding cycle. We can then breed the fish in the other side of the divided tank

And move them again when there are more fry in the tank. Of course we will have lights over the tank and a timer to insure at least a 16-hour day, the same as we would in the aquarium set up.

Some of the fry will tend to grow faster than the others and may begin eating their smaller brothers and sisters. We need to plan to prevent this situation by moving the bigger fry on to the next larger tank fairly frequently.

The more often they are fed the less they will prey on each other, but I still believe it is best to separate out the bigger ones every 3 to 4 days for the best survival.

The number of fry that survive to edible size is called the survival rate. In the wild the survival rate is seldom more than 1%, but because we protect our fish and take good care of them we expect a higher rate and can usually achieve 75% or better once we know how.

To collect the fish from each tank it is necessary to build a frame with netting of the correct size to collect all of the fry and fingerlings or to have one for each size we want to collect.

A fine mesh that fits each size tank is easier and we can then sort the sizes of fish by having a grader system ready to sort the fish.
The grader system can be made up from a few different sizes of plastic or nylon netting and can be nested from large to small to make the job of sorting easier, or a frame may be made for each tank which is one mesh size for each larger division of the tank with the largest mesh being the size of the mesh for harvest size fish.

The grader materials shown are square mesh as this is what I prefer, but hexagonal or diamond-shaped netting may be used as long as you go through the process of finding out which size of fingerling is separated out by each mesh size. Nylon netting may also be used, but you should be careful to use only knotless nylon so as to reduce the risk of damaging the gills of the fingerlings.

When each group of fingerlings is separated out by size, the larger sizes can be then moved on to tanks with fish of similar size and the smaller ones left behind to continue growing to stocking size.
This can of course continue until the final sizing which produces the market size separation.

Lesson 12: Cage Culture Strategies for Tilapia

Cage Culture Strategies for Tilapia

The cage growing methods have some obvious advantages over tank methods and some disadvantages.

The primary advantages are:

1. **Low oxygen cost**. In most cases the oxygen requirements are met by a much larger body of water in which the cages are suspended. Often the pond volume may be at least 100 times or more the cage volume. So we do not have to pay for the power to produce this oxygen we need because we are borrowing it from the other 99% or more of the pond that does not have cages.

2. **Low start up cost**. Capital requirements are low because the cost of cages to house large numbers of fish are low per fish. For instance, a $200 cage can easily house up to 1000 pounds of fish.

3. **Less risk**. Cages can contain large numbers of fish while we feed them all the feed they can eat and still not expose the fish to high risk of oxygen depletion.

4. **Sex reversal is not required**. The sex of the fish in properly designed and floated cages is not as important as it is in tanks or in ponds because the tilapia can not breed without a solid surface for the females to lay their eggs while the male fertilizes them. This allows the tilapia to grow faster because mating is prevented.

Some disadvantages are that:

1. **Less control**. We do not have control of what happens in the larger body of water. For instance, the temperature of the

water, the water quality and the effects of storms. If we do not own the entire body of water and it is not in our back yard we take the risk of having other people or animals gain access to our fish or we have to provide protection to prevent such access.

2. **Higher feed cost**. We usually must depend on a high quality of feed to grow fish in cages.

3. **Escape risk**. There is always some risk of escape even in the best-designed cage.

The design of a cage system for producing tilapia then is not constrained or limited by the amount of power needed to produce oxygen to enable the feeding of the tilapia.

We can safely stock up to 3 pounds of tilapia per cubic foot of cage safely and grow them to 7 or 8 pounds per cubic foot without having to worry about overcrowding.

The size of each cage can be calculated based on how many pounds of tilapia we wish to harvest each week. For instance if we want to have 20 pounds per week we can stock 400 fish in a cage and grow them to one and a quarter pounds each and we will have 500 pounds of tilapia to harvest. A 4-foot by 4-foot by 4-foot cage has 64 cubic feet of space and, at 8 pounds per cubic foot growth capacity, 500 tilapia require about 62 cubic feet so we can stock up to five hundred tilapia and grow them to harvest size in one cage.

Lesson 13: Feed & Growth Requirements for Tilapia

All fish growth and weight maintenance requires similar amounts of vitamins, minerals, proteins and calories.

The total amount of food required for growth depends on how much of these nutrients are available in the food for a specified amount of energy needed to digest the food.

Some foods may supply one or more nutrients, but may lack others. Unless the other nutrients are available from another source, the fish will not grow as well as if when fed a more balanced feed.

In general, the clearer the water and more restricted the fish are, such as in tanks or cages, the more balanced the feed needs to be.

For instance trout, tilapia, or catfish grown in raceways with very clean water need nearly the same amount of feed and nearly the same formulas to get the same amount of growth from a pound of feed.

However these same three kinds of fish can have drastically different protein requirements when grown in more natural circumstances.

Trout are obligate predators and they need the 36% or more protein feeds with lots of vitamins and high oils.

A catfish which is both a scavenger and a predator can get by with a lower protein diet and less vitamins in the feed, and still give good conversions if it is loose in a pond.

A tilapia in a natural pond can filter feed microorganisms including algae, which is high in vitamins. This natural food source can result in astounding tilapia growth conversions. Under rich nutrient conditions in the water, tilapia can be fed low protein diets like those used with catfish. However, tilapia have a lower tolerance for animal fats and tend to get arteriosclerosis and fatty livers on too much catfish feed.

It takes 1.5-1.6 pounds of a floating trout chow (Purina Trout Chow), with 36% protein, to get one pound of weight gain from any of these three fish in a clean water situation, but in a natural pond setting the catfish can get the same yield on a 26% protein feed and the tilapia can get 1 to 1 or better with the extras it picks up from the filter feeding.

Tilapia can even be raised in very high densities and continue to get good growth on low cost feed. However, the more biomass in a body of water the lower the conversion rates go until at a certain point we are back to the clean water requirements for the feed and back to the same conversion rates as trout on that feed.

With tilapia this number seems to be reached at a stocking density of about 50,000 pounds or more per acre.

Lesson 14: Space versus Power Requirements for Tilapia

Space requirements for back yard fish farming varies according to the availability or usable feeds. This availability depends on both cost and nearness of good feed sources.

What feeds may be used depends on both the quality and volume of food available. For instance if all of the household kitchen food waste were ground and mixed evenly and an analysis made or the resulting mix we would find various amounts of proteins, vitamins, fats, and carbohydrates, depending on both the household food budget and the time of year and culture of the household.

The analysis could tell us how balanced the feed was, but not how well the fish will convert it.

For instance most household kitchen waste would require 3 - 5 pounds to get one pound of weight gain from Tilapia without balancing.

This however is not bad news since the cost of processed kitchen waste is very low, and must be disposed of anyway. Large amounts of feed however must be matched with comparable portions of oxygen to be digested by tilapia and their waste must also be disposed of.

More food volume means more oxygen, more waste and more water volume per pound of fish in the tank.

Densities

1 oz. to 10-pounds/cubic foot of water. Better food, more oxygen delivery, and cleaner water or better sewerage treatment, means more fish per cubic foot of growing space.

All successful aquaculture operations have in common the need to provide large numbers of juveniles for cultivation.
The most important of the current types of fish that are now feasible to cultivate is tilapia. This course is designed to teach individuals interested in the large-scale intensive production of Tilapia how to produce enough fingerlings to stock these systems so that the industry will be able to develop.

Hatchery Operations

As a student of hatchery operations, the bulk of your time will be spent working in and learning about the hatchery techniques. In order to start a viable enterprise of your own, it is essential that you learn to produce your own fingerlings because it would be expensive and risky to import all your fry.

This hatchery here on this site consists of six concrete tanks, which are 21 x 10 feet deep and thirty-two inches high. The water is kept at twenty-six inches. It is important that the dimensions of each of the tanks are exactly uniform so that the net frames and other equipment can be designed to work or fit all of the tanks.

The heart of the hatchery operation is the individual cage breeding colonies. Each cage has two sets of colonies.

We will go into detail on the need to construct the cages just right from a practical and operational standpoint.

Cage Construction

Each breeding cage is made of three pieces of 24” x 48” inch wire and four pieces of 24” x 24” inch wire. The wire is made from 18-gauge steel, it is one inch x one inch and is double dipped galvanized wire that is vinyl coated. The vinyl coating serves two purposes, one is that it is gentle on the fish when they are in contact with the wire and the second is the cages can be expected to last ten years if properly constructed.

The wire cage panels are fastened together by stainless steel hog rings. Ordinary galvanized hog rings will disintegrate within one year. A plastic mesh such as 70% shade cloth is attached to one wire panel that is to be the bottom of the cage. This is to keep the fish eggs from falling through the bottom of the cage to the floor of the tank when the fish choose to breed outside the plastic buckets.

Two black plastic buckets, nine inches high and ten inches in diameter are fastened to the cage seven inches from the back, by a rope. These buckets serve as the breeding arena where the males entice the females into mating. The buckets are also very important in allowing the males to establish their own territory and in preventing the males from attacking the females that are not ready to breed. The design for these cages is a result of over twenty years of laboratory research combined with seven years of cage testing.

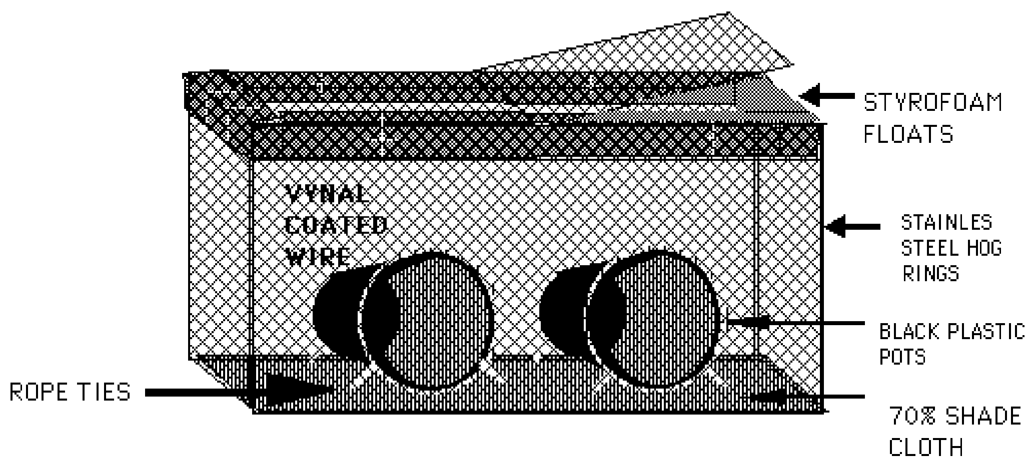


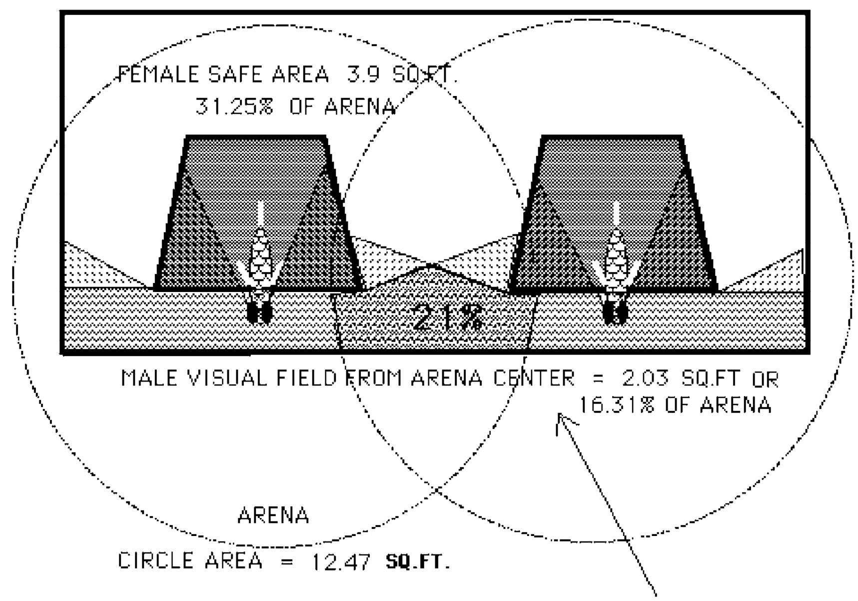
Figure 10. Tilapia Culture Cage

These cages take advantage of the fact that the male Tilapia perceives his territory visually and is inclined to ignore what he cannot see.

THE ARENA CAGE

THIS VIEW IS FROM THE TOP LOOKING DOWN INTO THE CAGE AND SHOWS THE IMAGINARY CIRCLE PROSCRIBED FROM THE VISUAL CENTER OF THE AREA CHOSEN BY EACH MALE AS HIS BREEDING TERRITOR.

TOTAL CAGE AREA 8 SQ.FT.



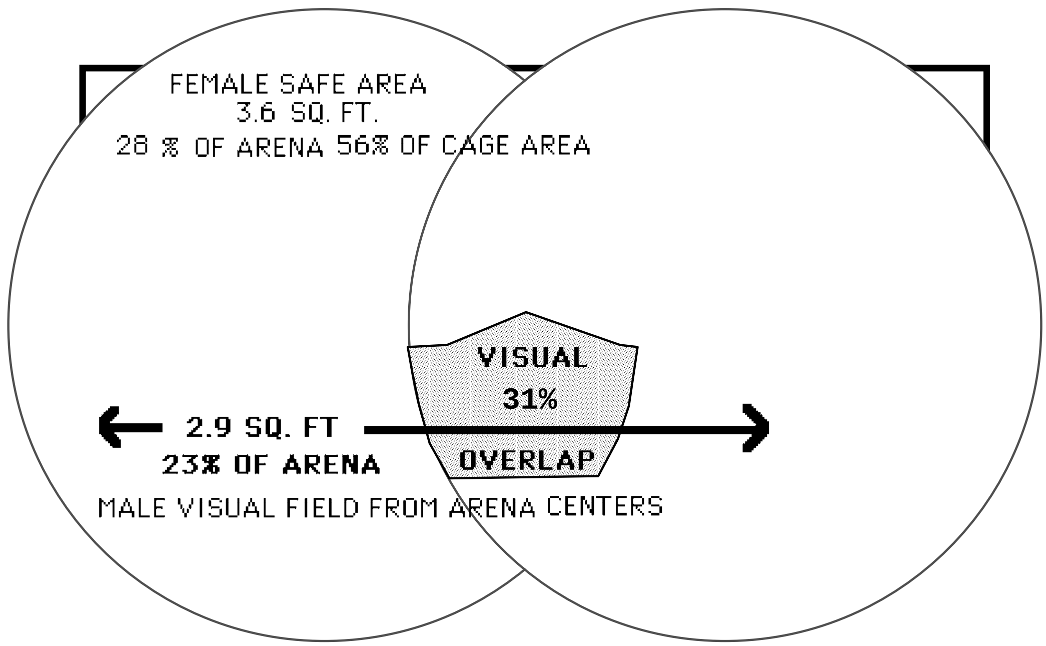
21% OF MALE VISUAL AREAS OVERLAP EQUALS ONLY 3% OF TOTAL ARENA CIRCLE A FOR EACH MALE AS A COMBAT ZONE

EACH MALE CHOOSES AN AREA EQUAL TO A CIRCLE WITH A RADIUS OF TWO AND ONE HALF TIMES HIS BODY LENGTH, AS HIS BREEDING ARENA AND PROCEEDS TO CLEAN IT OUT AND DRIVE AWAY ANY FISH THAT IS NOT A FEMALE THAT IS READY TO BREED. IF THE INTRUDING FISH CAN NOT LEAVE THE TERRITORY HE WILL CONTINUE TO ATTACK UNTIL THE OTHER FISH IS DEAD EVEN IF THE FISH IS A FEMALE. IF THE MALE CAN NOT ACTUALLY SEE THE OTHER FISH, EVEN IF IT IS WITHIN THE IMAGINARY CIRCLE OF HIS ARENA, HE WILL NOT CONTINUE THE ATTACK IF HE DOES NOT SEE THE FISH FROM THE ARENA CENTER. A PROPERLY DESIGNED CAGE THEN REDUCES THE AREAS THE MALE CAN SEE FROM THE CENTER OF HIS ARENA TO THE AREA IMMEDIATLY IN FRONT OF THE POT.

Figure 11. Arena Cage

ARENA CAGE

THIS CAGE IS SHOWN WITH THE POTS PLACED FURTHER TOWARD THE REAR OF THE CAGE AND THE SAFE AREAS FOR THE FEMALES ARE SHOWN TO BE REDUCED AS WELL AS THE VISUAL OVERLAP OF THE BREEDER MALES IS SHOWN TO BE INCREASED WITHIN THE AREAS OF THE ARENAS FALLING INSIDE THE CAGE.



IN THIS SECOND EXAMPLE THE SAFE AREA OF THE TOTAL CAGE FOR THE FEMALES IS SHOWN TO BE 56% AGAINST 62.5% OF THE FIRST CAGE. IF HOWEVER THE SAFE AREAS IN CAGE ONE ARE COMPARED AGAINST THE UNSAFE AREAS IN THE SAME CAGE AS A RATIO, WE FIND THAT THE RATIO OF SAFE TO UNSAFE AREAS IS 1.92 AS COMPARED WITH A RATIO OF 1.25 IN THIS EXAMPLE.

THE AMOUNT OF VISUAL OVERLAP FROM THE CENTER OF EACH MALE'S ARENA IS ALSO INCREASED AND AS A RESULT THE MALES WILL ENGAGE IN TERRITORIAL CONTEST MORE OFTEN THAN IN CAGE ONE.

Figure 12. Arena Cage (Pot Further Toward the Rear)

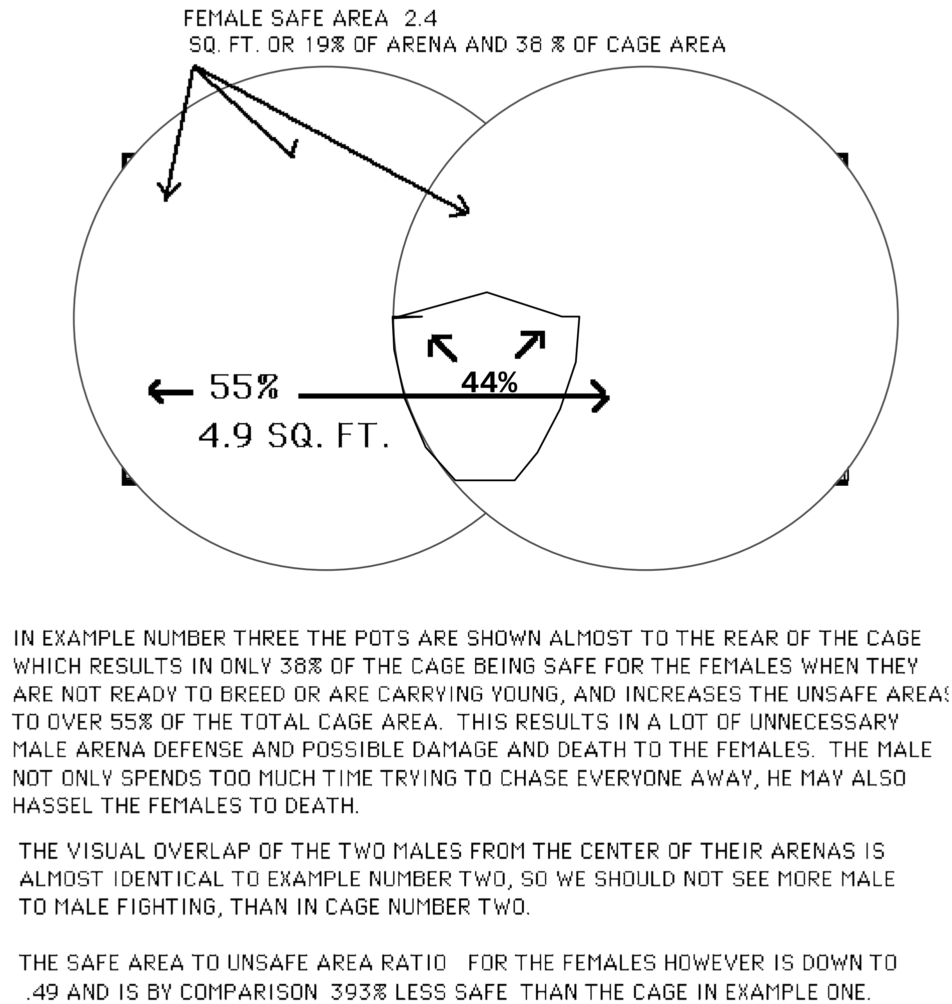


Figure 13. Female Safe Area

When the pots are placed properly in the cage, as illustrated below, each of the males has very little of his breeding arena overlapping that of the other male and very little of his imaginary territory is visible from his position within the center of the front of the pot.

This is very important as the females that are not ready to breed or which have already bred, need to be able to be out of sight of the male when the male is in his territory. If she is not out of sight he will harass her constantly. If he cannot see her though, he does not perceive that she is within the imaginary circle. Without the visible barrier of the pot, she would always be in the territory of one of the two males.

The placement of the plastic flower pots allows the male to establish his territory within the open part of the pot which is placed close enough to the front of the cage so that when he is inside he cannot see more than about 20% of the total volume of the cage. This allows the females that are not ready to breed plenty of room to stay out of what he perceives as his territory. Any female caught within his territory had better be ready to breed.

In addition to the increased area for the females to stay out of the visible areas of sexual aggression, a second advantage of this placement of the pots means the males also have a reduced area of confrontation where their territories overlap. This overall reduction in size of visible areas that produce either sexual confrontation or territorial defense means that more time can be spent in reproducing and less in useless fighting.

A third advantage to the position of the pot in the first illustration (Figure 11), is that the females that have bred and have babies or eggs can find a place behind a pot and establish a small territory of their own. This allows them to defend against any other fish entering while her fry are being allowed out for foraging during the period when she is guarding them.

If as shown in Figures 12 and 13, the pots are moved toward the rear of the cage, less room is left in the cage where the females can be out of sight of the male when he is positioned at the center of his breeding arena. The breeding area is delimited by an imaginary circle with a radius approximately two and one half times his body length.

The following is a breakdown in both square feet of area and percentage of arenas that each area of the breeding arena occupies in the three examples of cages presented.

SQUARE %/ARENA FEET		
ARENA CIRCLE AREAS	12.48	100.00%
TOTAL CAGE AREA	8.00	

Safe area in square feet for females in cage

FEMALE SAFE AREA	#1	3.90	31.25%
FEMALE SAFE AREA	#2	3.60	28.85%
FEMALE SAFE AREA	#3	2.40	19.23%
MALE VISUAL FIELD FROM ARENA CENTERS	#1	2.04	16.31%
MALE VISUAL FIELD FROM ARENA CENTERS	#2	2.89	23.16%
MALE VISUAL FIELD FROM ARENA CENTERS	#3	4.92	39.46%
MALE VISUAL OVERLAP WITHIN ARENAS	#1	0.74	21.00%
MALE VISUAL OVERLAP WITHIN ARENAS	#2	1.74	31.00%
MALE VISUAL OVERLAP WITHIN ARENAS	#3	1.64	44.00%
MALE VISUAL OVERLAP WITHIN TOTAL ARENAS	#1	0.74	5.89%
MALE VISUAL OVERLAP WITHIN TOTAL ARENAS	#2	1.74	13.94%
MALE VISUAL OVERLAP WITHIN TOTAL ARENAS	#3	1.64	13.14%

SAFE AREA TO UNSAFE AREA RATIOS

CAGE DESIGN	#1	1.92
CAGE DESIGN	#2	1.25
CAGE DESIGN	#3	0.49

CAGE DESIGN # 1 IS SAFER THAN DESIGN #3 BY 393.19%
CAGE DESIGN # 1 IS SAFER THAN DESIGN #2 BY 255.57%

Without the plastic buckets, the males will chew the females to death. When the cages are finished and ready to set up breeders, it is necessary to choose the breeders carefully.

Here is an alternative breeder cage solution that is also proving to be quite successful. This system provides space for multiple breeder colonies and here on my farm are allowing up to 50 females and five males to a cage with the tubular PVC habitats. They are really cranking out the fry.

The major difference in the PVC habitat cage is that more females and males can be given privacy space, which helps to get more breeders into a smaller area by reducing the overall square feet required per 30 gram female. A female can find an empty tube when she needs it for breeding. The larger tubes allow space along with the open areas of the cage for the males to set up their domains.

The top of the cage is Styrofoam cut to fit inside the cage and held in place by cable ties. When the Styrofoam is cut so that the pieces fit together tight, the Styrofoam gives stability to the cage and prevents it from sinking below the water level.

Figure 14. Tilapia Breeder Cage (Alternative Design)

The breeding area consists of the following layers:

Top layer: Seven pieces of 2-inch PVC with holes drilled in the end of each piece and held together by cable ties.

Second Layer: Four pieces of 4-inch PVC, also drilled and held together by cable ties.

Bottom Layer: Corrugated plastic cut so that it is 14-inches wide and 20-inches long, laid on the bottom of the cage.

Figure 15. Tilapia Breeder Cage immersed underwater showing breeding area

Material can be purchased from Tuff Stuff Products.

http://www.tufftubs.com/htdocs/order.htm

Breeder Selection

Once a tilapia is about sixty days old and about four inches in length, it is ready to sex and be set up to breed. At this age and size two black *T. hornorum* improved form males and ten orange color *T. mossambica* (5 to 1 ratio) are put in each cage. Once placed in a cage these breeders can produce an average of 1,000 red F1 hybrids per week for up to two years.

The number of cages of breeders required is a function of the number of juvenile red F1 hybrids needed for production. If the number of fingerlings needed is one million, forty cages are needed to produce those million fingerlings per year over the two-year period.
We choose the breeders very carefully according to color in the *T. mossambica* and body form in the *T. hornorum* and ship them ready to stock in the cages.

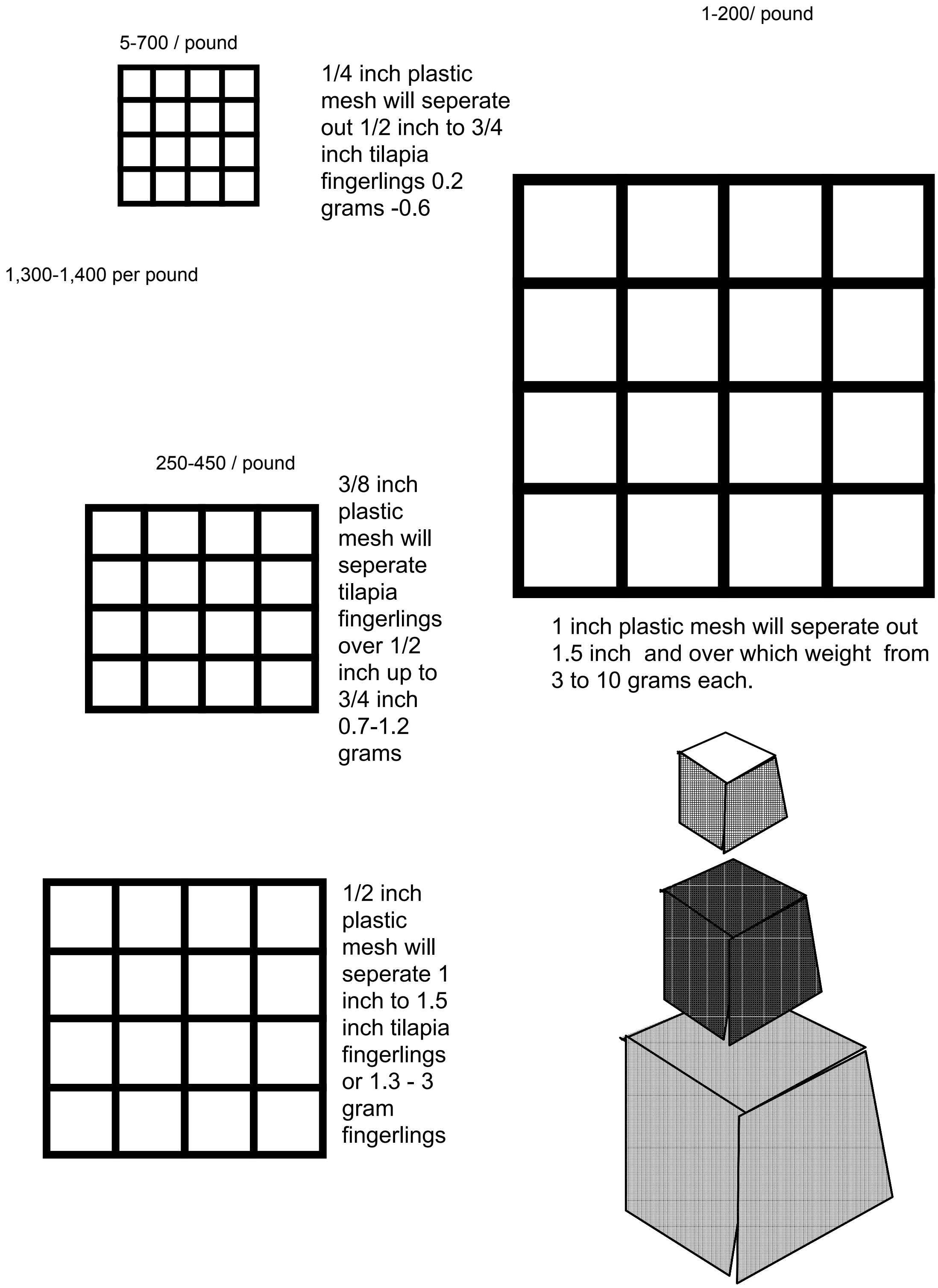


Figure 16. Mesh for Grading Fingerlings

Tank Set Up

Each set of twenty cages requires at least 2 tanks and up to 8 tanks for the whole breeding cycle. The cages are allowed to stay in one tank for one week. At the end of each week one or two people then lift each cage out of the water very slowly then quickly and smoothly set it back down in the water of the new tank.

The temperature of these tanks should be controlled to between 88 and 90 degrees F at all times.

At the end of each week breeding cycle, two people smoothly and slowly lift each cage from the water, preferably. As the cage is lifted the portion of the cage to the rear of the back of the breeding pots is lifted from the water first to allow all the water to exit the cage, carrying any small fry which may happen to be in the cage out, with the departing water.

As soon as the cage clears the water, it is quickly moved over the wall to the waiting clean breeder tank and smoothly allowed to settle into the tank. If this whole moving process is done smoothly and in less than ten seconds, few of the females holding eggs will spit the developing eggs.

Each cage is moved over the breeder wall from the previous weeks breeding tank to the clean breeding tank in the same manner, and when all of the cages have been moved, they are arranged as shown in the illustration. Each cage should be separated from the next cage by at least eight inches of water. This space is designed to give the tiny fry room to maneuver away from the breeders.

Each cage should also be at least twelve inches away from the concrete walls of the breeder tank. This distance can be maintained either by the placement of one or several strings or ropes stretched from one end of the tank to the other.

The moving of the cages is done so that most or all of the babies in each of the tanks will fall within seven days of the same age. The F1 hybrids grow so rapidly, that if the oldest fry are 8 to 11 days older than the youngest fry, they can be 20 to 30 times bigger. As it is, when they are within seven days of the same age the largest fry will be over an inch long and weigh up to 1 gram while the smallest will be only 1/4th inch and weigh only 1/15th of a gram.

The tilapia in general is known historically and on a worldwide basis to be omnivorous herbivores. That is, everyone believes them to be placid non-meat eaters. Unfortunately while this is true for most of their lives, this is not true during the first three to four weeks of life and if the breeder does not recognize this fact and keep moving the newly released fry out of danger from their older brothers and sisters (by moving the cages with their mothers in them), most of the production will be lost to cannibalism.

The very young tilapia are so voracious for meat that they will ignore high protein floating feed in favor of swallowing down a tiny helpless younger sibling. Fry within the one to five gram ranges are literally growing so fast that their demand for protein is at the highest it will ever be during their life cycle and this intense demand for protein turns them into hungry little cannibals that eat their younger brothers and sisters.

The moving-cage-method of breeding the F1 hybrids can result in up to 5,000 babies per female breeder per year, but the previous methods of producing the same kind of F1 hybrids resulted in only 50 babies per female per year. So it is very important to keep the movement of the breeders within the 7 day cycle as each day past that point the breeder is loosing more than 95% of each days production to cannibalism.

Incubation

The female tilapias we are working with incubate the developing eggs in her mouth. She slowly and continuously rolls them gently while they are incubating and is capable of telling sick or dead eggs from healthy live eggs and swallows any that are not right.

The eggs begin development almost immediately after the female picks them up in her mouth and within 48 hours the beginnings of eyes and tails can be seen on the eggs. By the fourth day the fry

begin to resemble small fish attached to little yellow balls, which are the egg sacks. By the fifth day the fry can swim and navigate well enough to be released by the mother for brief excursions out into the world. At first she lets them out for a brief swim and sucks them back in within a few minutes, but by the sixth day she allows them to browse on bacteria, algal, and fungal growths on the surface of plants or walls. While the fry are out the mother tilapia keeps a sharp eye out for any intruders such as other fish and will aggressively chase them away if they approach the area where the fry are feeding.
If she perceives any danger she will signal the fry by a sidewise wriggle of her body and an open mouth at which the fry will immediately swim towards and into her mouth. When this is viewed it looks like a film in slow motion reverse where she just spit out a mouthful of tiny pebbles.

The older the fry get the more time the mother allows them to spend outside and by the tenth day she will no longer tend them or allow them oral sanctuary. It is also the true that the older the fry are when the mother is disturbed, the more likely she is to spit them out to fend for themselves if she feels her life is in danger.

It is this maternal behavior that is being called on when the cages are lifted out of the tank gently and moved smoothly to the next tank in less than ten seconds. The mothers that are holding eggs will not generally spit them out if the movement is done gently while the mothers holding older fry will spit them and so most of them will remain behind as a part of that weeks fry production. Some of the fry will of course go over to the new tank with the mother, but that is expected and as long as the cages are moved again with seven days they will not be large enough to eat the new fry.

The breeder manager will first notice fry around the 10th to 15th day after the breeders are first set up in the cages. The first movement of the cages should take place the seventh day following the first fry swimming in the breeder tanks.

Some Tilapia breeders will milk the eggs and fry from each mother each week by holding her body firmly in one hand and using the forefinger of the other to push down her lower jaw while swishing the mothers mouth back and fourth in a bucket of water or other container. When this is done, all of the eggs, partially developed fry and developed fry will go into the container and can be separated out later.

The undeveloped eggs are then separated from the fry that can swim and are put in special incubators that are designed to imitate the gentle rolling and cleansing action of the mothers mouth as she sucks water in through her mouth and expels it out through her gills while allowing the eggs to gently tumble in her buccal cavity.

This milking of the mothers is very labor intensive however and comparisons of the number of fry produced per female per year do not indicate any production advantage for this method. The cost in time per fry produced is vastly greater (100 to 1) which makes the cage system the most economical method.

Each cage that is two feet wide by two feet tall by four feet long will house ten female *T. hornorum* and two red male *T. mossambica*. Each of the females will breed once every six to eight weeks and will produce an average of five hundred babies per brood. The average production of each cage then comes out to about one thousand red F1 hybrid fry per week.

It is therefore possible to set up one cage of pure line hybrid parent stock breeders for each 500 fry needed each week. It will then take two tanks that are a minimum of 24 feet long by 10 feet wide by 30 inches in depth to produce an average of 10,000 fry per week, which is just over one HALF million fry per year. The cages are spaced about twelve inches apart in the tank and two cages are floated end to end in rows from the front to the back of the tank.

Figure 17. Tilapia Cage

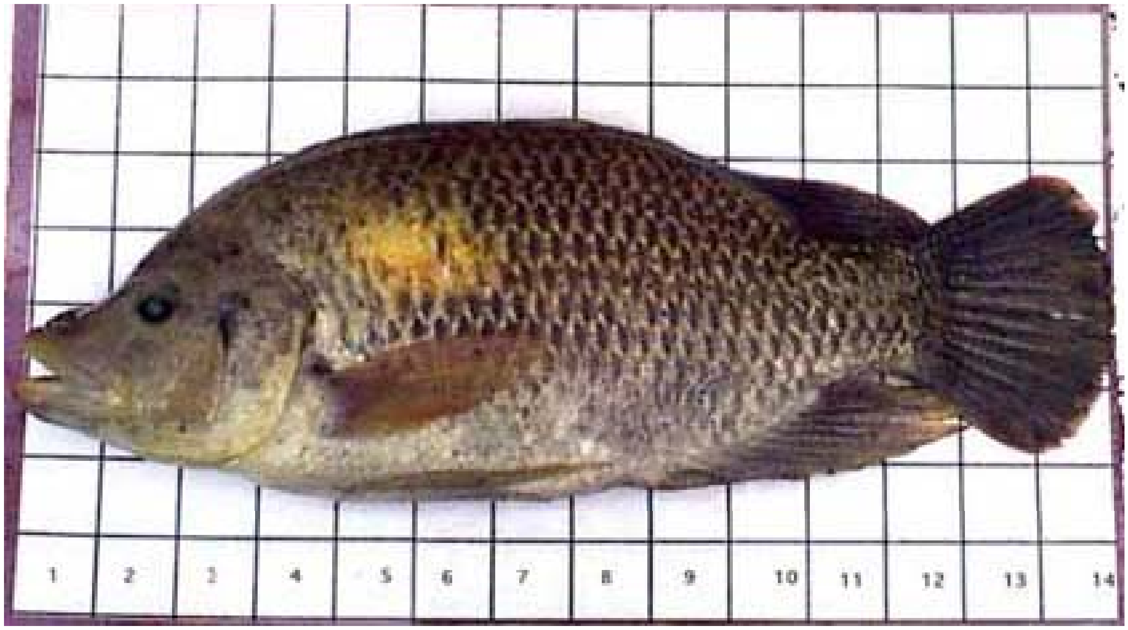


Figure 18. One Kilogram Pennyfish Grown by George Hale in a 5-Acre Pond between Mar 15 and Sept. 15, 1998.

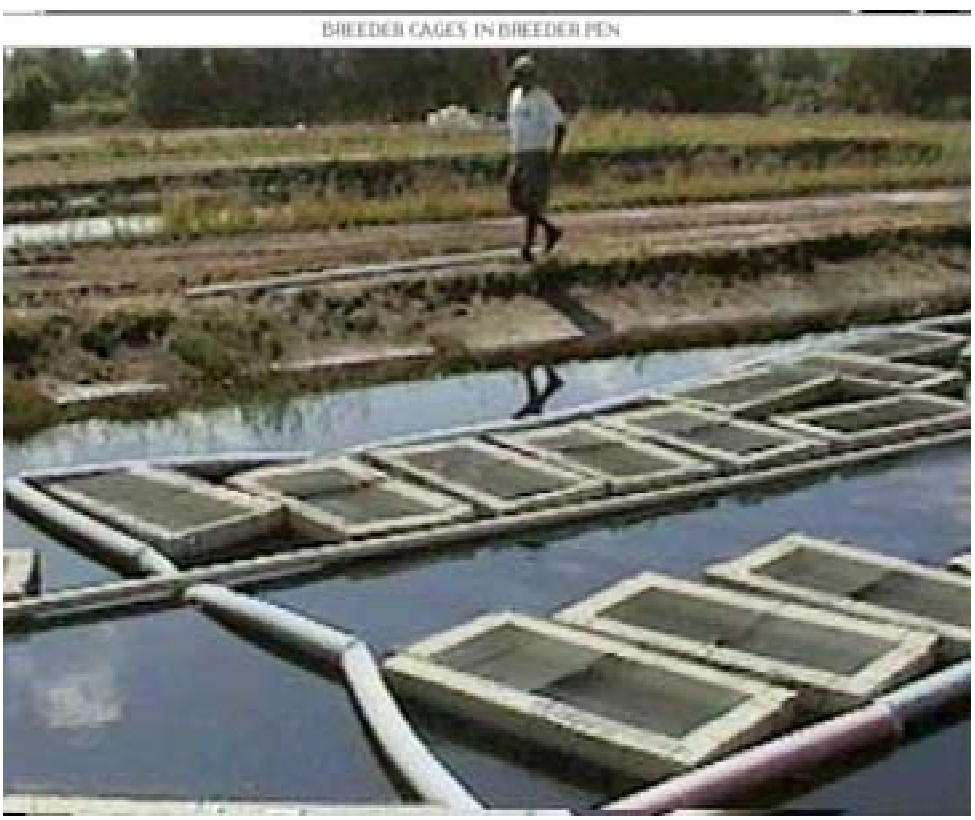


Figure 19. Breeder pen with cages inside it.

The cages were moved within the pen once a week, and the pen was rolled by a roller bar that was made from 2- foot long 4-inch PVC with end caps, it floats in the water and is pulled from one end, under the pen forcing all of the cages to one end and then the cages are moved to the free area and the process continued until all of the fry are on one side of the bar and all the cages with breeders are on the other side.

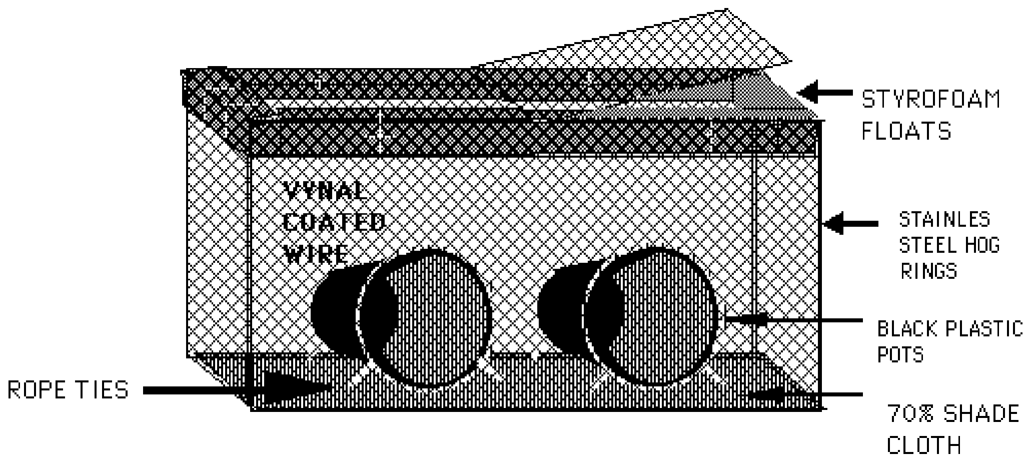


Figure 20. Breeder Cage with Description of Materials

An air pump or 1 horsepower blower attached to approximately 24 (8 inch) air stones is used to maintain a good level of oxygen in these two tanks. It is also recommended that a recirculation pump of approximately 3/4 horsepower with a built in heater of 3000 watts controlled by an in line thermostat be used to keep the temperature in the proper range for breeding. This range is between 88 and 92 degrees.

Operations with less cages can size down the blower and tubing required to maintain oxygen levels as well as the water heater and recirculation equipment, but it is important to control both oxygen levels and temperature for good results.

Moving The Fry

After the moving of the breeders from the previous weeks breeder tank, the fry may be moved at any time prior to the breeders being put back into the tank the next week.
A frame should be built that spans the tank from side to side leaving about one inch on each side for easy movement from the back to the front of the tank. The depth of the frame should be about 40 inches and the width 9 feet 10 inches. It can be constructed easily from 3/4 inch PVC pipe, but do not glue it together until the net is made. The frame should then be fitted with a piece of window screen or plastic or nylon netting that is fine enough to hold the smallest fry. We find that 20/20 mesh is a good size; this means that there are 20 strands per inch each way. The fitting of the screen should allow a bag to form at least 24 inches below the frame when the frame is held horizontal to the tank at the end of the run.

When the frame is complete two people will be able to carry it to the rear of the tank and slide it down the back wall while shaking the frame gently. By the way, you should by this time have glued the four elbows to the four pieces of PVC so that when you wiggle and slide the frame it won't fall apart on you in the water.

This shaking motion results in all of the fry moving away from the frame well in advance of its arrival at each spot as it is moved through the tank. This is because at this stage the fry are highly visual and the frame will precede the netting in all cases and since we use dark colored or charcoal netting the fish do not see the material of the net that is following the frame.

When the fry are all collected up at the end of the run through the tank, the belly of the net will hang down into the water so that when the frame is placed at the end of the tank the fry will have plenty of water to swim in. As was mentioned earlier, the fry at this stage are highly visual and can easily be herded into small nets of about ten inches by ten inches, which can be obtained from tropical fish supply houses. The mesh in these should be about 1/32 of an inch. Remember to herd the fish by letting them see your other hand, much like a dog herds sheep by moving around the edge of a group. Try not to chase them down with sudden lunges, as this can damage and kill the fry when the net catches them between the net frame and the window screen of the collector frame.

As each group of fry is collected from the breeder tank collection frame, they should be counted into a box or bucket or a waiting sizing tank that has been filled with water from the breeder tank before starting the collection process. This is important as sudden water changes can damage the young fry and if water is moved from the large breeder tank to the tank or container where the fry are to be counted prior to collecting the fry, it will then be identical in all aspects.

When the fry are moved to the waiting container or tank, the net should be gently lifted from the water in the collection frame and moved smoothly and gently to the container where the fry are to be counted. The net should then be lowered at least half-way into the water so all of the fry can resume swimming, and then one corner of the front edge should be lowered to allow the fry to swim out of the net.

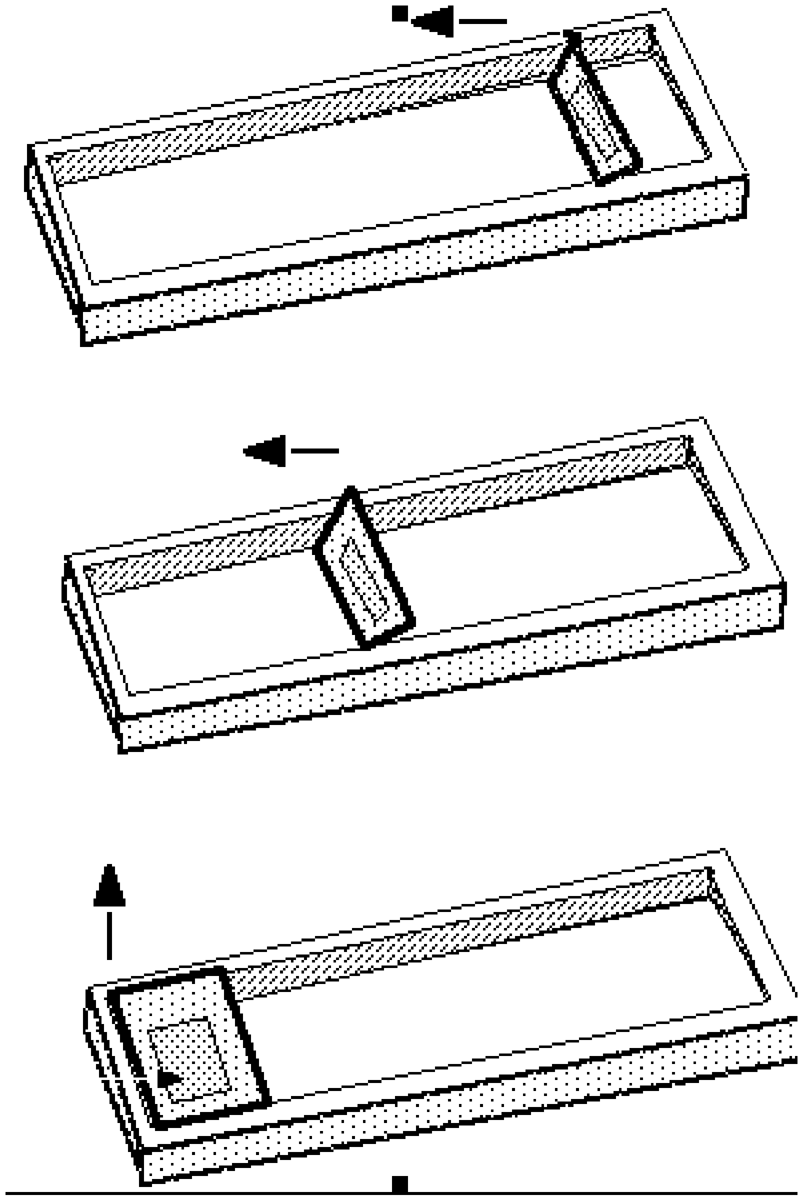


Figure 21. Moving fry

When the frame has been moved from the back of the tank slowly to the front of the tank the front edge is brought carefully up the front wall and out of the water and then hung on the walls at the front of the tank so that the net or screen is still below the surface where all of the fry have been collected.

Sizing Tanks

After the fry are counted, they are placed in one of the six sizing tanks where they will be fed until they are large enough to be put in the ranching tanks with the rest of the larger fish being grown for market.

Each sizing tank should be 6' X 6' by 36" and should have good water circulation and oxygen control. In general the water temperature in these tanks should be maintained between 80 degrees F. and 95 degrees F.

There should be six of these sizing tanks so that each group of fry can be allowed six weeks to reach two inches or more when it is safe to mix them with the larger fish in the ranching tank.

The feed for these fry should start out with a high protein ration such as Purina Trout Fry feed or tropical fish starter feed and be changed by the second or third week to Catfish starter floating fortified feed. The fish in the sizing tanks can be fed by an automatic feeder that is monitored closely so as not to under feed or over feed, or the Hatchery Manager should assign someone to feed at least four to six times per day all of the feed the fish will consume within 15 minutes of each feeding.

Correct feeding methods are important at this stage as they can make all the difference in having a high survival from the fry to the fingerling stage and thus in the cost of running a hatchery. Underfeeding can result in starvation and additional predation of some of the fingerlings and overfeeding can result in poor water quality and possible killing of whole tanks of fish.

The second group of tanks is for free breeding of the tilapia and requires handling of each breeder each week. Sizing tanks are not shown, but are the same as in the first drawings. Example of a smaller breeder set up using precast concrete tanks

F1 Hybrid Breeder Ponds

Ponds of these dimensions can produce between 10,000 and 80,000 fry per week depending on the size of the breeders and the quality of their feeding and care, as well as the number of cages and breeders in each pond.

The more fingerlings and fry that are produced each week the more care and oxygen that must be provided to maintain good growth and get them to reach the largest size before moving to a growing tank or growing pond

The F1 hybrid tilapias produced from the supermale breeders can easily perform at these rates of growth and better.

The more ponds up to around 10 that are used to move the breeder cages the larger will be the fingerlings when it is time to move them to make room for the cages to be moved in that pond on the next week.

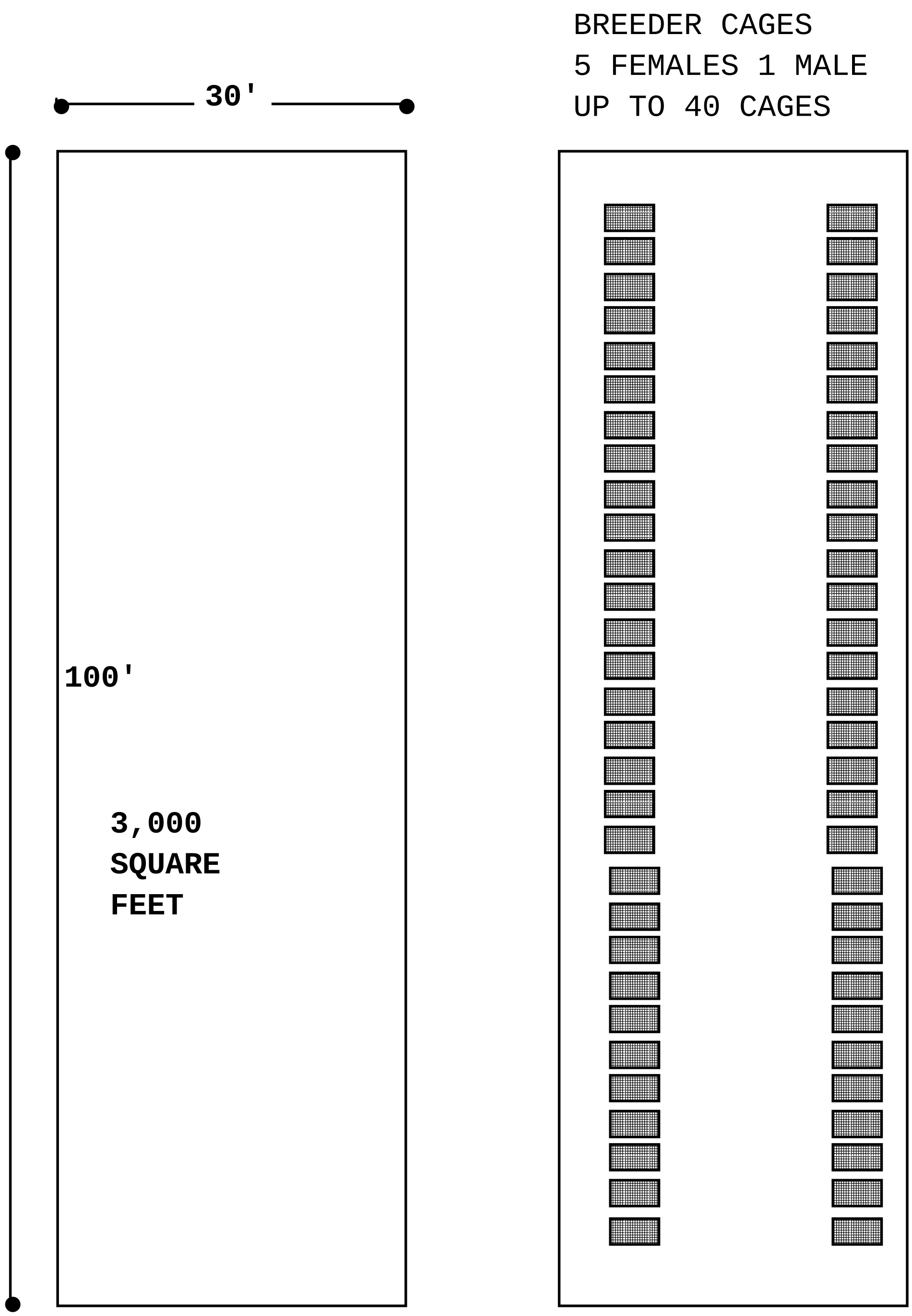


Figure 22. Breeder Cages

WEEK 1

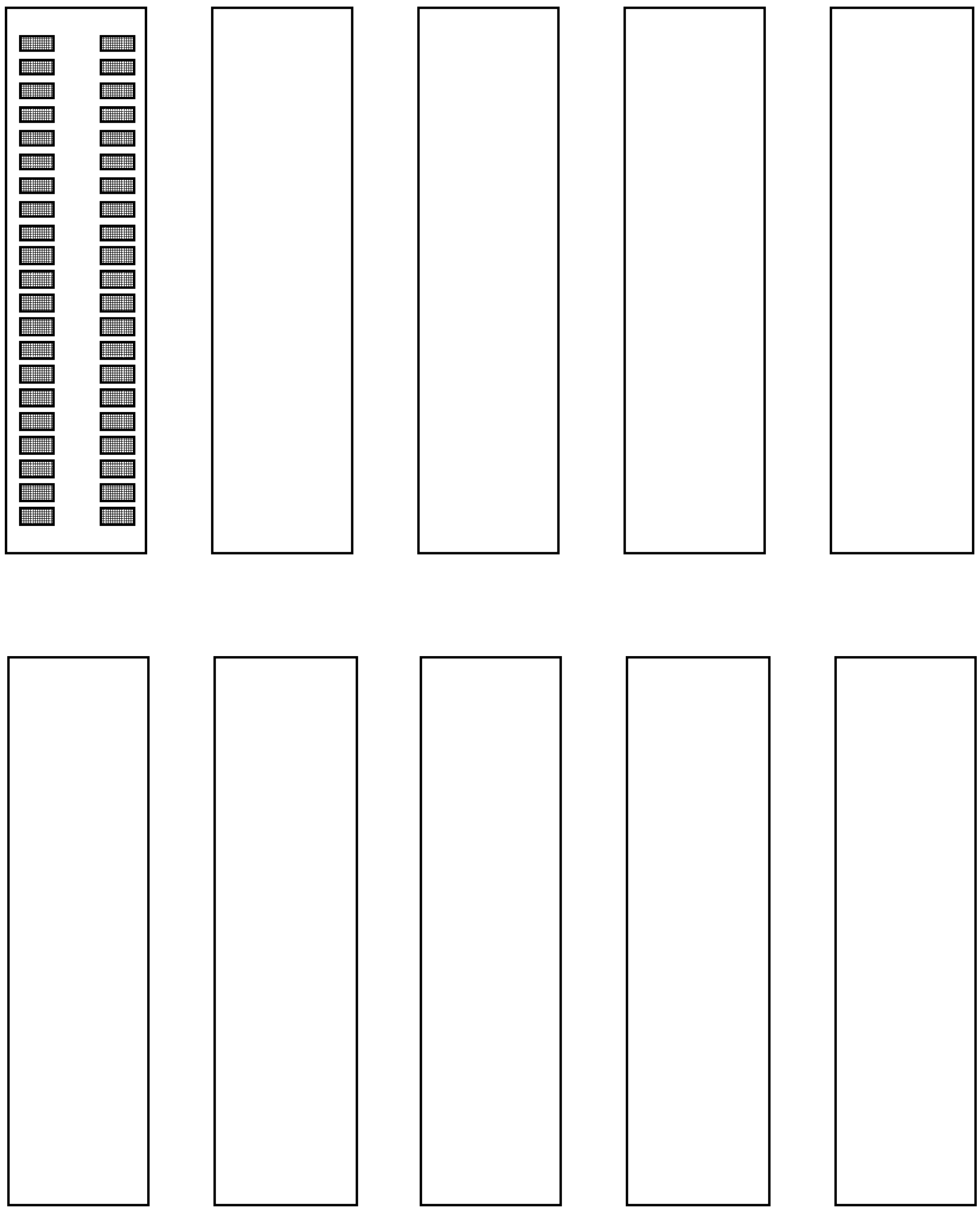


Figure 23. Cage Configuration - Week 1

WEEK 2

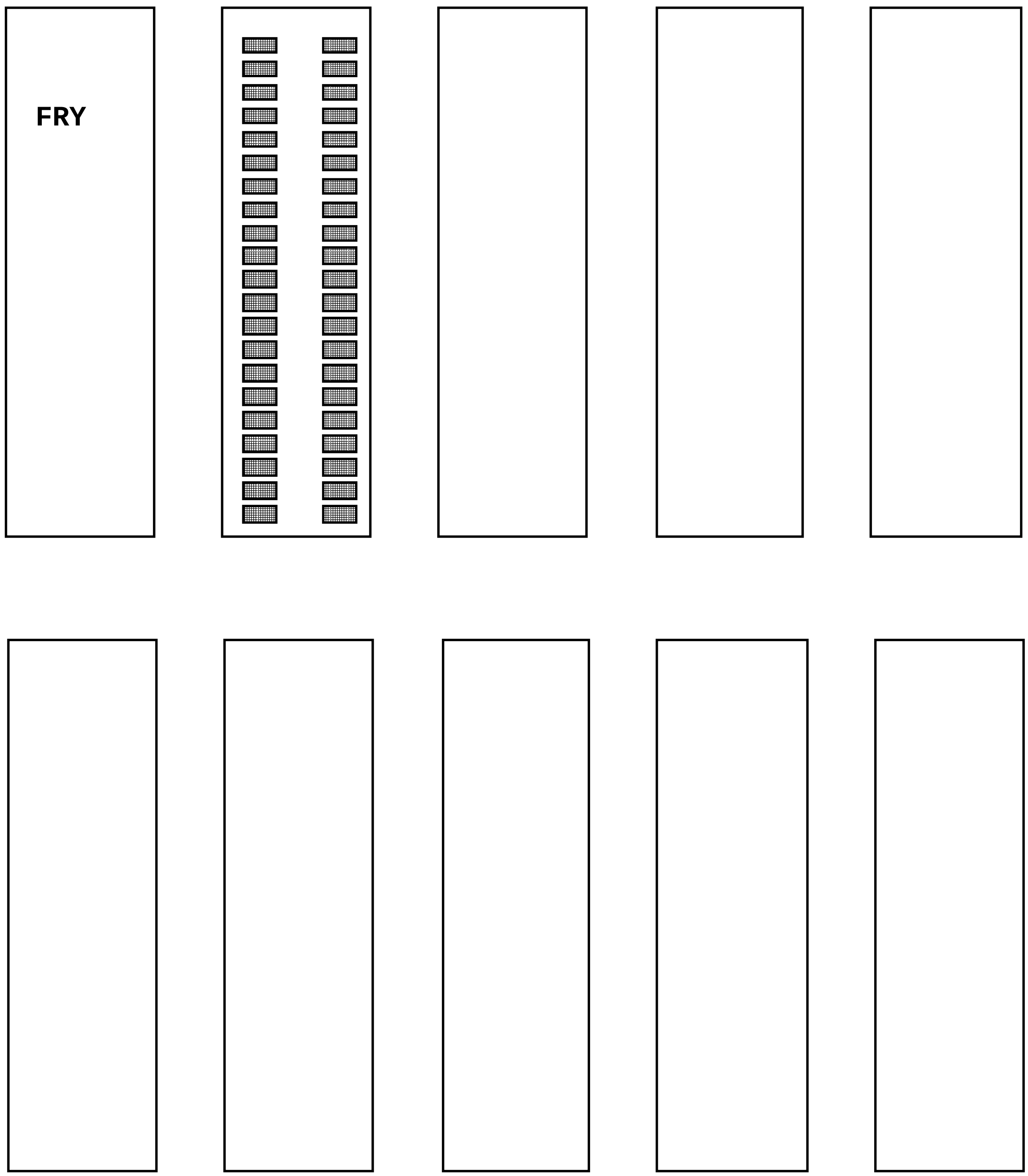


Figure 24. Cage Configuration - Week 2

WEEK 3

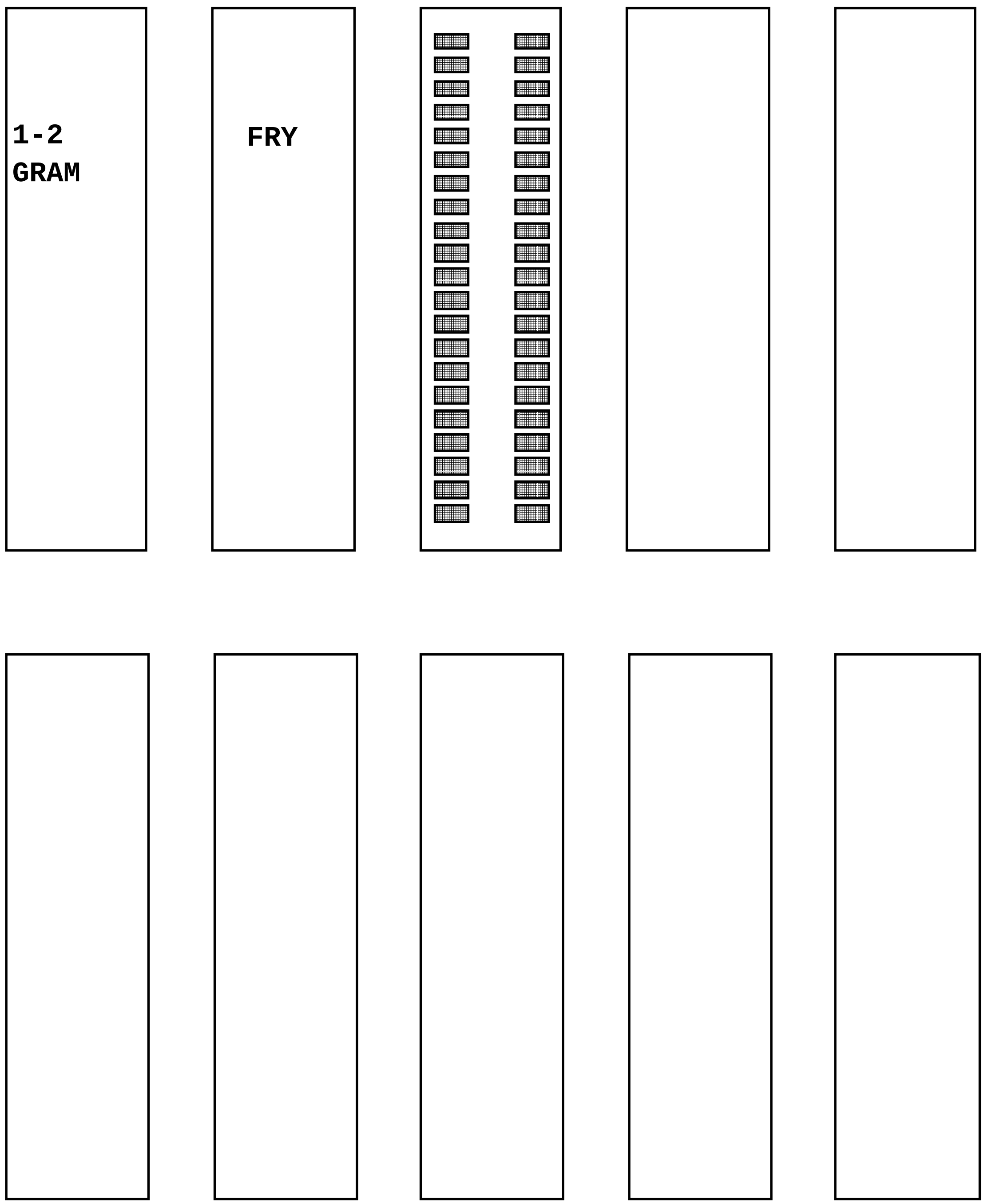


Figure 25. Cage Configuration - Week 3

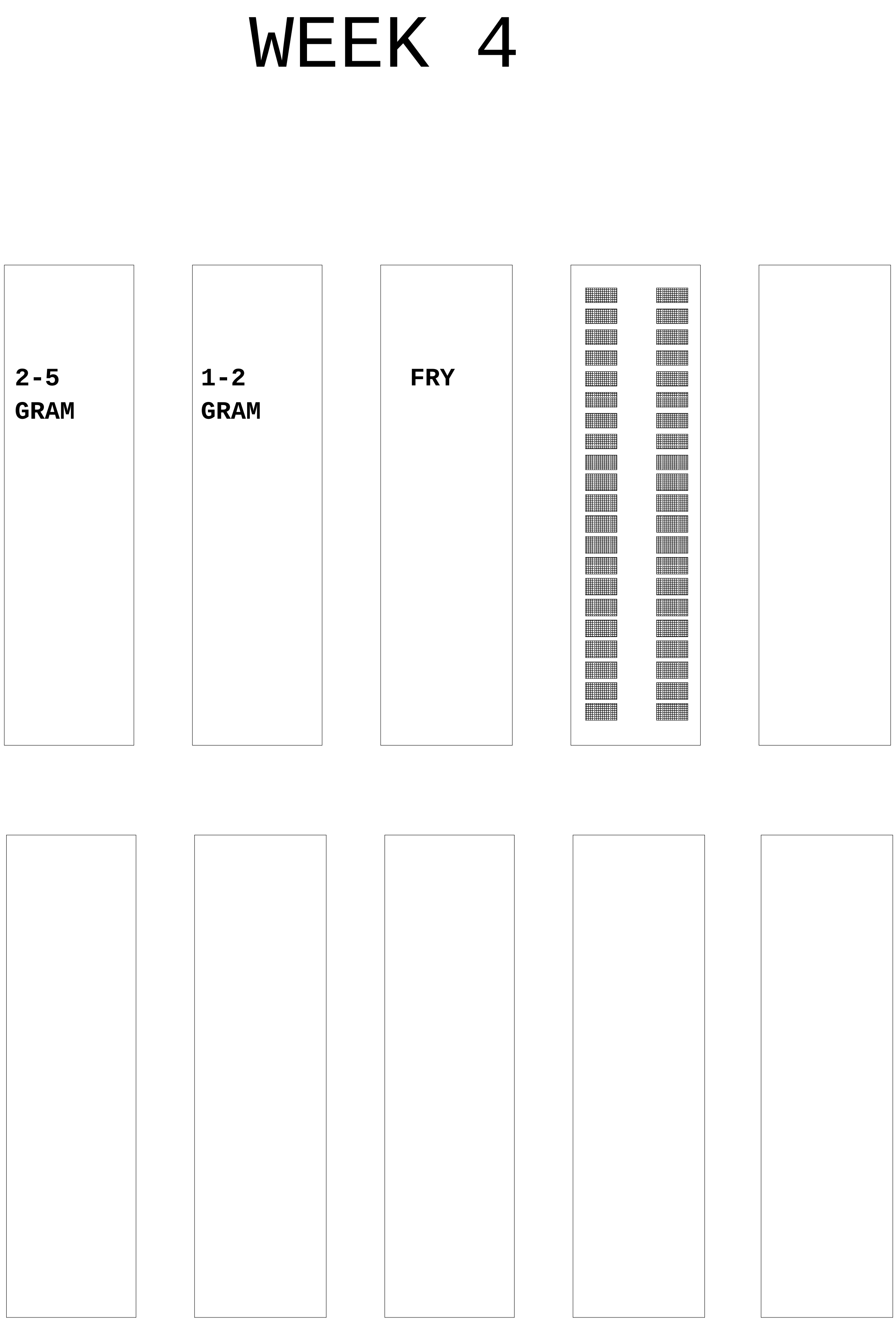


Figure 26. Cage Configuration - Week 4

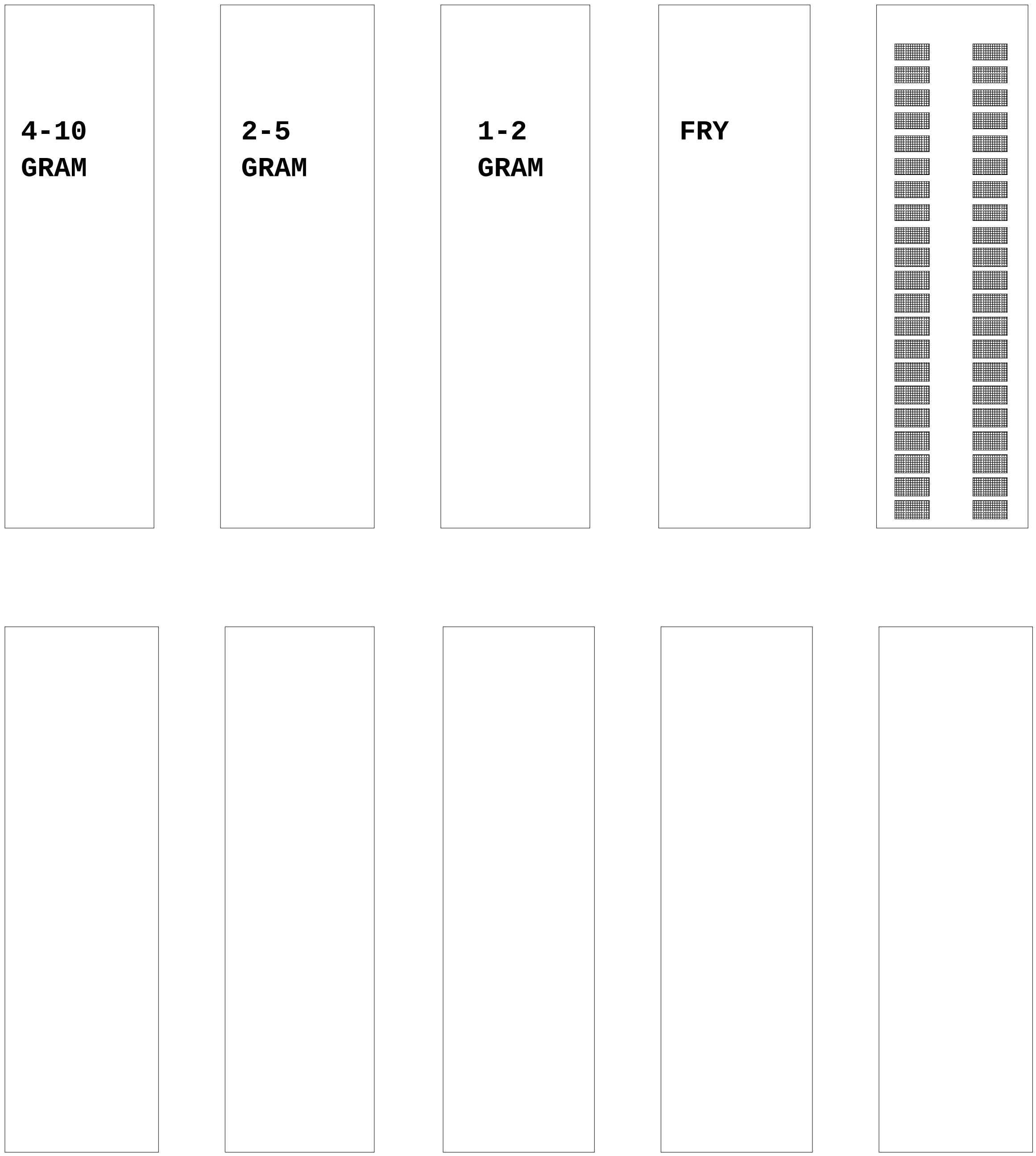


Figure 27. Cage Configuration - Week 5

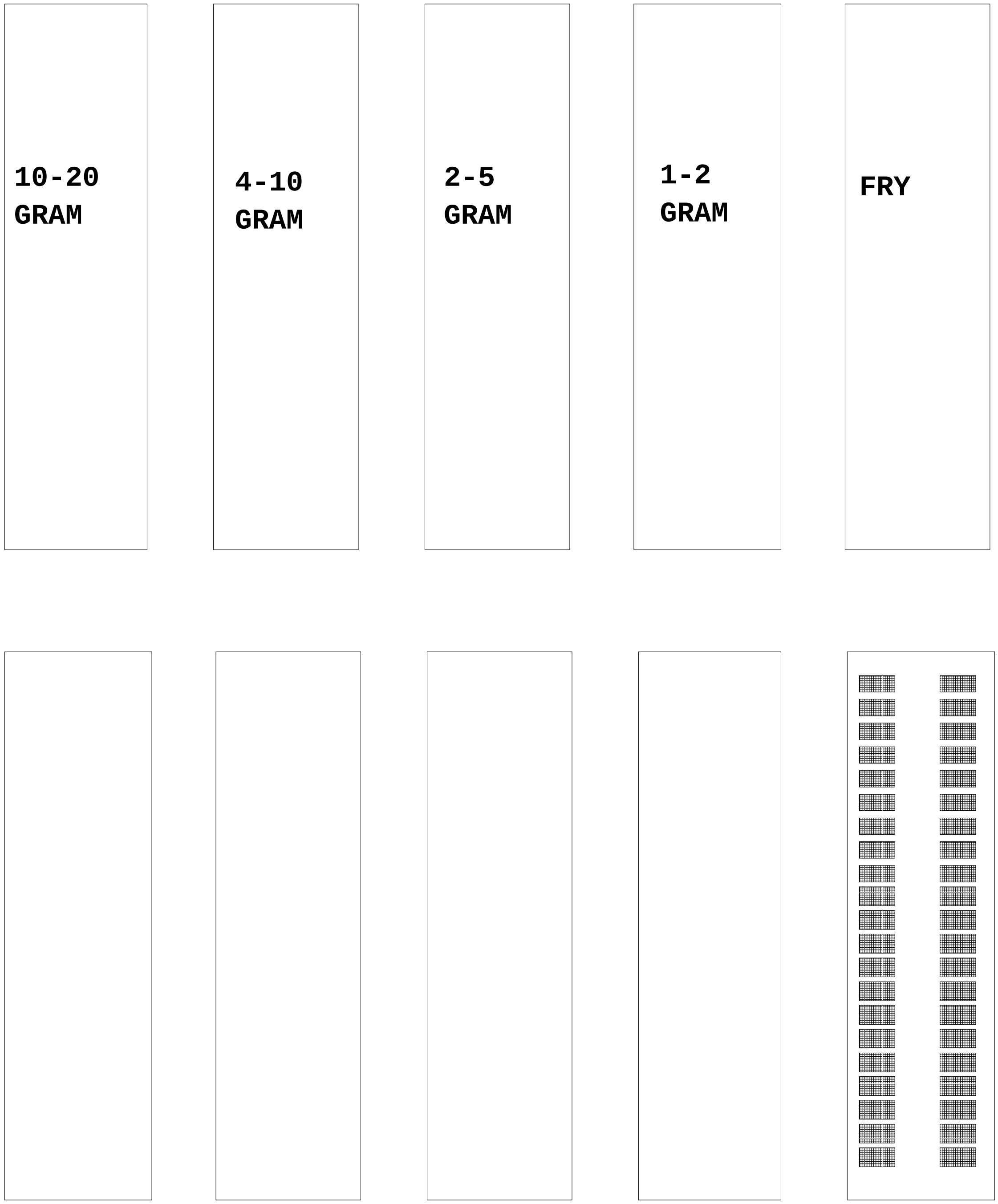


Figure 28. Cage Configuration - Week 6

WEEK 7

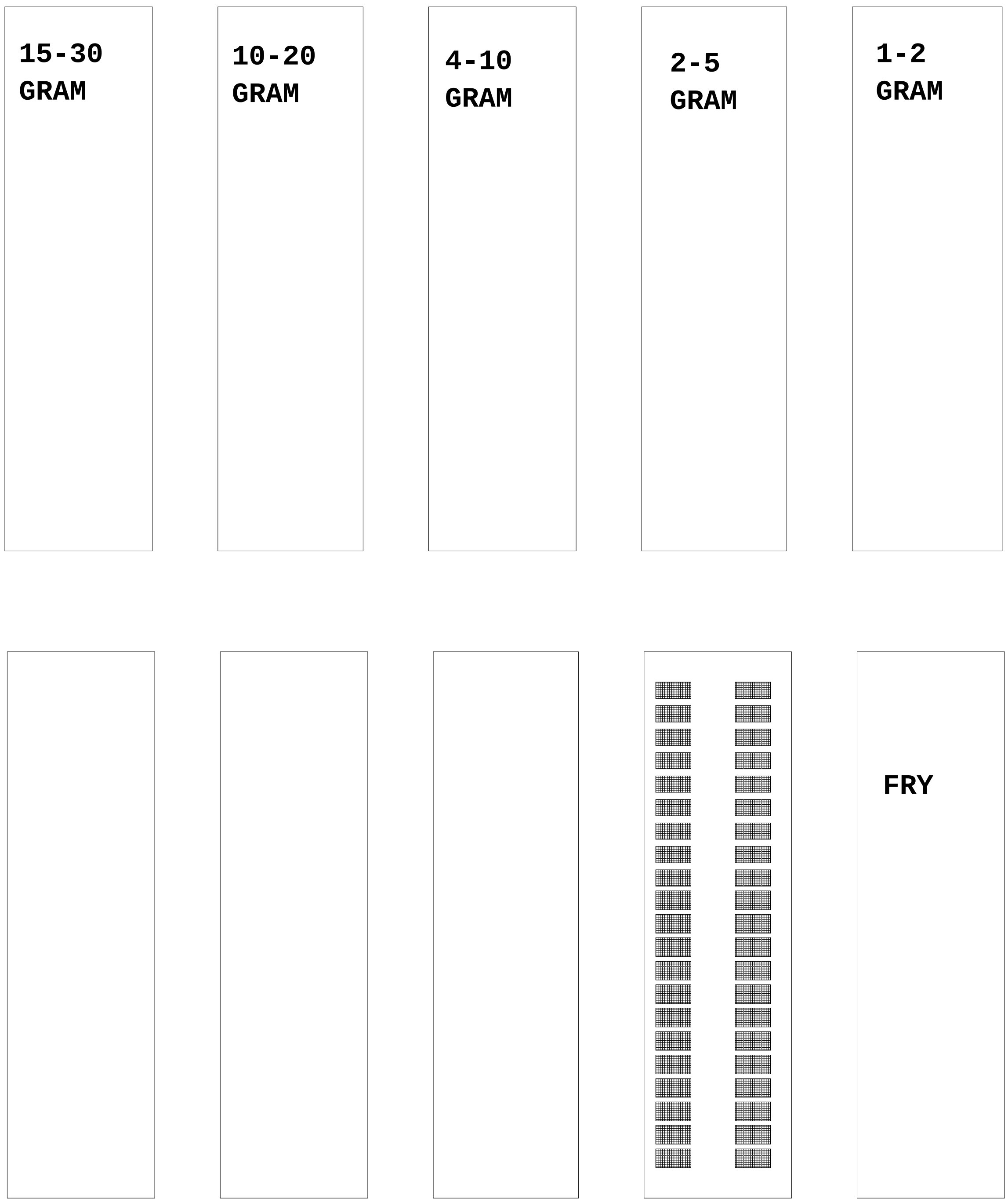


Figure 29. Cage Configuration - Week 7

WEEK 8

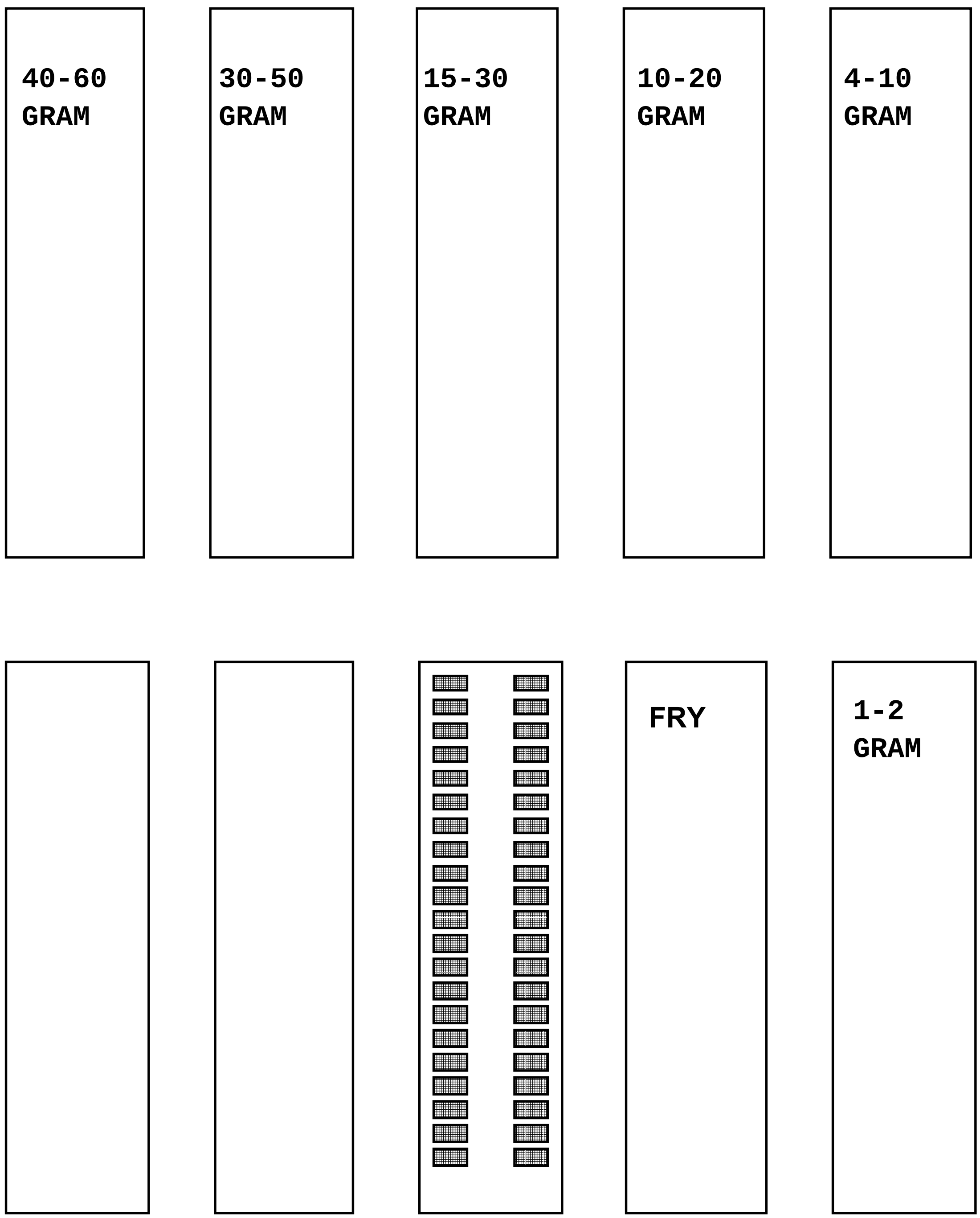


Figure 30. Cage Configuration - Week 8

WEEK 9

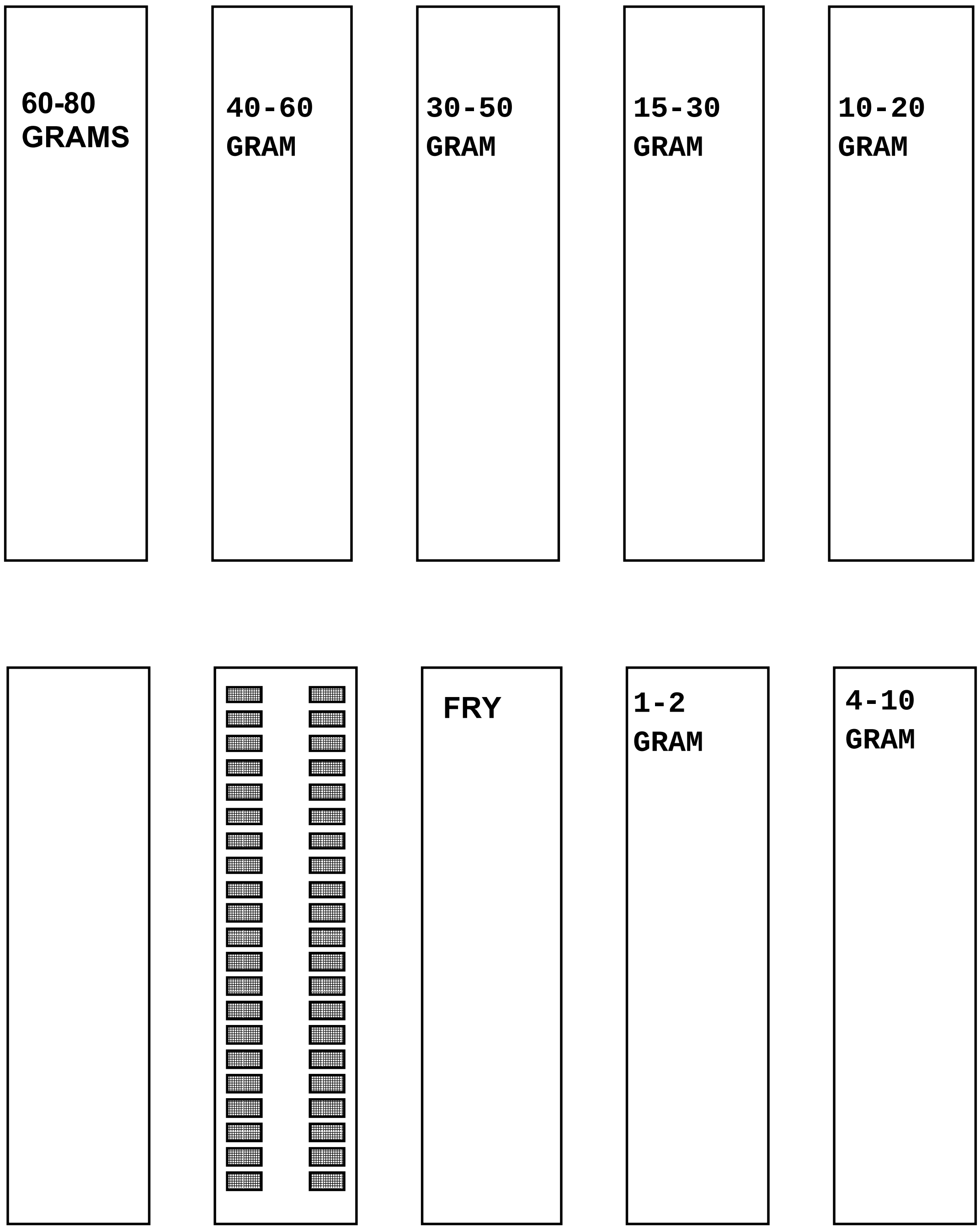


Figure 31. Cage Configuration - Week 9

WEEK 10

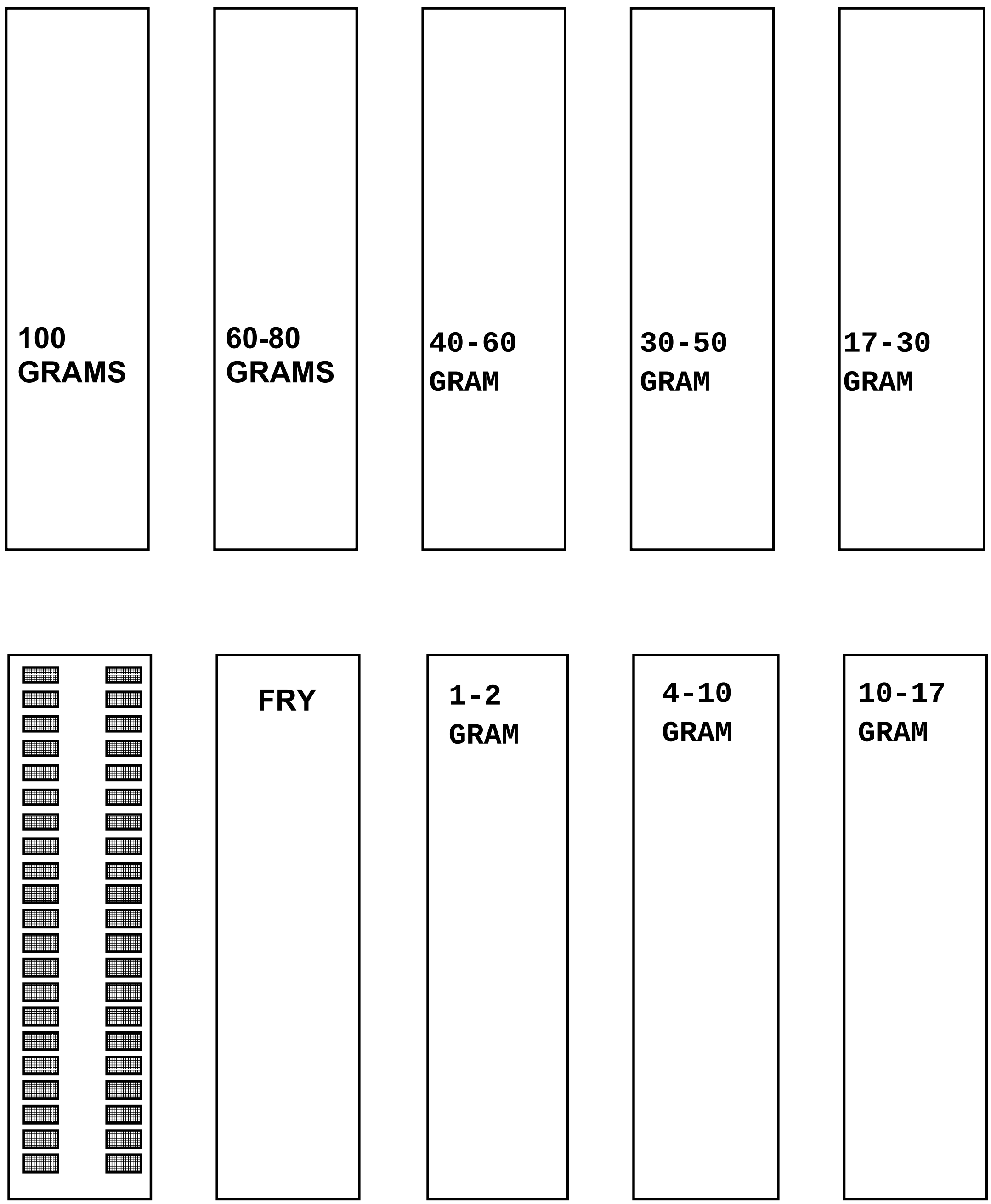


Figure 32. Cage Configuration - Week 10

By the10th week the breeder cages have been moved nine times and the number of fry that have been bred is 400,000.

You will have an average 40,000 all male hybrids each week, thereafter, that will be ready to be moved into a growing situation.

You can at this point start harvesting fingerlings that are in the number one pond and either selling them or stocking them. You will have seven days to capture the fingerlings (preferably in traps) or by pumping the pond down and seining them.

Biography

MIKE SIPE is an Aquaculture consultant and has been in the Tilapia production and genetic improvement and breeding business for over 25 years. He created the first red Tilapia from black ones and now maintains and distributes 10 specially bred Tilapia gene lines used to produce faster growing tilapias to clients and dealerships worldwide.

Mike has traveled to many other countries including Saudi Arabia, Kenya, Peru, Mexico, Honduras, Panama and has helped set up many tilapia farms. He has developed new methods of growing tilapias intensively using pure oxygen. He distributes the parent stocks to produce such fish as Pennyfish* Chocolate Hybrids* and Happyfish* all of which are all male hybrids that grow 2 to 4 times faster than tilapias available elsewhere.

He has trained hundreds of Aquaculture professionals in the production and breeding of Tilapia and has assisted in the start-up of dozens of Tilapia aquaculture businesses in the U.S. and in over 30 other countries. Learn more about Mike and his latest book: Cherry Snapper: the true story at his web site: cherrysnapper.com You can reach Mike at MIKESIPE@aol.com