MP435

Aquaculture Producer's

Quick Reference Handbook

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Introduction

A wealth of information exists concerning most aspects of aquaculture production, cultural practices and treatments. What is lacking is a small, practical, conveniently-sized quick reference guide. This booklet is intended to fill that void. In addition to channel catfish, this guide is applicable to baitfish, "feeder" fish, ornamentals, game fish, Chinese carps and other food fish species.

Before any disease treatment or chemical application is made, four important factors must be known.

(1) Know the water, including volume and water chemistry.

(2) Correctly identify the fish, plant or pest species being treated.

(3) Know how toxic the chemical is to the fish, plant or pest species being treated and know what effect the treatment has on the phytoplankton community in the pond. Especially know the label requirements, and keep a copy of the label in your records.

(4) Know the disease or targeted pest being treated. If you don't know, call your nearest diagnostic facility for assistance. Different diseases show the same symptoms and many species of aquatic vegetation look alike, which can add to the confusion.

Important Conversion Factors

Chemicals used in the aquaculture industry are based on treatment in units called parts per million (ppm). Conversion factors are the weight of a chemical that must be added to one unit volume of water to give one part per million. Important conversion factors needed for calculations are listed in Table 1.

Determining Pond Areas

Conversion factors have little meaning if the pond size or volume is unknown. For a successful treatment, the approximate area or volume of water must be known. This allows for the most efficient use of the chemical. The following formulas help in determining areas and volumes. Practical examples are also included.

Keep in mind that ponds are built based on the lay of the land. Pond shape and size are determined by the slope of the terrain, boundaries such as roads and utility right-of-ways, adjacent properties and distances from rivers or streams. With this in mind, very few ponds are perfectly shaped squares, rectangles, triangles or circles. Common area formulas may need a little correction.

Square, Rectangular and Triangular-Shaped Ponds

If a pond is a perfect square or rectangle, the following formula applies:

$A = l \times w$
Where A = Area (in square feet)
l = length in feet
w = width in feet

Example #1. Measurements show a pond to have dimensions of 660 ft by 660 ft. What is the surface area?

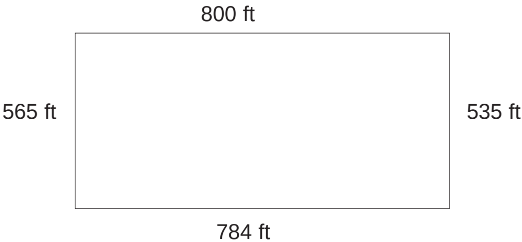
$A = l \times w$
$A = 660 \times 660$
A = 435,600 square feet

To convert square feet to acres divide by 43,560

$$\frac{435{,}600 \text{ square feet}}{43{,}560 \text{ square feet per acre}}$$

= 10 acres

To calculate areas for ponds that are not perfectly square or rectangles, adjust the formula slightly. Measure the lengths and add the distances together, then divide by two to get an average. Do the same with the widths. Refer to example #2.



Example #2. A pond has the above dimensions. What is the acreage?

$$\text{Area} = \frac{l + l}{2} \quad x \quad \frac{w + w}{2}$$

$$\text{Area} = \frac{800 + 784}{2} \quad x \quad \frac{564 + 535}{2}$$

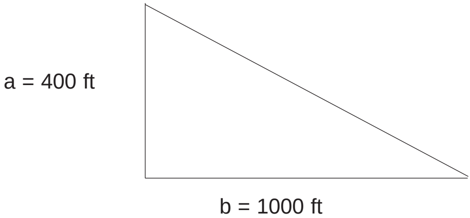
Area = 435,600 square feet

$$\frac{435{,}600 \text{ square feet}}{43{,}560 \text{ square feet per acre}}$$

Area = 10 acres

Calculating pond areas for triangular-shaped ponds containing a 90° angle is easy. Just use the following formula:

$$\text{Area} = \frac{a \quad x \quad b}{2}$$



Example #3. Calculate the area of a triangle with the dimension given above.

$$\text{Area} = \frac{a \quad x \quad b}{2}$$

$$\text{Area} = \frac{1000 \;\text{x}\; 400}{2}$$

$$\text{Area} = \frac{400{,}000}{2}$$

Area = 200,000 square feet

$$\text{Area} = \frac{200{,}000 \text{ square feet}}{43{,}560 \text{ square feet per acre}}$$

Area = 4.59 acres

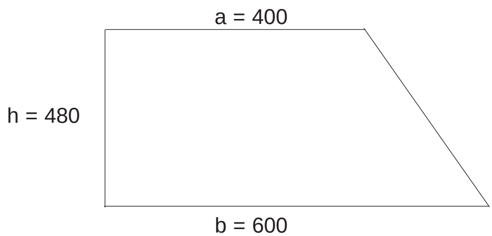
The formula used for calculating area of a triangle with a 90° angle also works well for triangles where all sides are equal (equilateral triangle) or where two sides are equal (isosceles triangle).

Calculating area for triangular-shaped ponds that have no 90° angles and uneven sides is hard to determine. A complicated formula for calculating the area exists. Contact an Extension specialist or Natural Resource Conservation Agency technician if you encounter this problem.

Trapezoid-Shaped Ponds

To calculate areas for trapezoid-shaped ponds having four sides and a 90 degree angle, use the following formula:

$$\text{Area} = \frac{(a + b) \times h}{2}$$



Example #4. Calculate the area of a trapezoid-shaped pond having the dimensions given in the figure above.

$$\text{Area} = \frac{(a + b) \times h}{2}$$

$$\text{Area} = \frac{(400 + 600) \times 480}{2}$$

$$\text{Area} = \frac{1000 \times 480}{2}$$

$$\text{Area} = 500 \times 480$$

$$\text{Area} = 240{,}000 \text{ square feet}$$

$$\text{Area} = \frac{240{,}000 \text{ square feet}}{43{,}560 \text{ square feet per acre}}$$

$$\text{Area} = 5.51 \text{ acres}$$

Irregularly-Shaped Ponds

For calculating areas for irregularly-shaped or mixed-shaped ponds, divide the pond into regular-shaped sections and calculate those areas. Then add the areas of each section to determine the total area for the pond.

Estimating Water Volumes

The importance of knowing the correct volume of water bears being repeated. Treatments are based on adding a recommended weight or concentration of chemical to the water. Not knowing the correct volume can result in an overdose, which can kill fish, while under treating is a waste of money and time.

Vats, Tanks, Troughs and Hauling Boxes

These are normally rectangular-shaped objects. To calculate the volume, inside measurements need to be known. That is the inside length, width and depth. Remember, vats are usually made of concrete blocks or poured formed cement. The walls of the vats are six to eight inches thick. Also note that vats are never filled to capacity and water depth is what counts. Be careful not to overestimate the volume of the vats.

To calculate the volume, measurements must be made and recorded in the same units. Use the following formula to calculate volume:

Volume = l x w x d
where l = length
w = width
d = depth

Example #5. What is the volume in cubic feet and gallons of a minnow vat which is 30 feet in inside length, 5 feet inside width and 2 feet deep?

Volume = l x w x d

Volume = 30 x 5 x 2

Volume = 300 cubic feet

To convert cubic feet to gallons, refer to Table 1 for conversion factors

300 cubic feet x 7.48 gallons/cubic foot (from Table 1)

Volume = 2,244 gallons

Example #6. What is the volume of a hatchery trough which has an inside length of 8 feet, an inside width of 22 inches and a depth of 10 inches?

In this instance you have mixed units. To simplify things, it would be much better to convert units to feet, so divide inches by 12 to get the units in feet.

$$\frac{22 \text{ inches}}{12 \text{ inches per ft}} = 1.83 \text{ ft} \qquad \frac{10 \text{ inches}}{12 \text{ inches per ft}} = 0.83 \text{ ft}$$

Volume = l x w x d

Volume = 8 ft x 1.83 ft x 0.83 ft

Volume = 12.15 cubic feet

To convert to gallons:

12.15 cubic feet x 7.48 gallons/cubic feet
(from Table 1)

Volume = 90.88 gallons

Example #7. What is the volume of a hauling box (transport box) which is 4.5 feet long, 8 feet wide and 4 feet deep?

Volume = l x w x d

Volume = 4.5 ft x 8 ft x 4 ft

Volume = 144 cubic feet

Volume = 144 cubic feet x 7.48 gallons/cubic feet
(from Table 1)

Volume 1,077.12 gallons

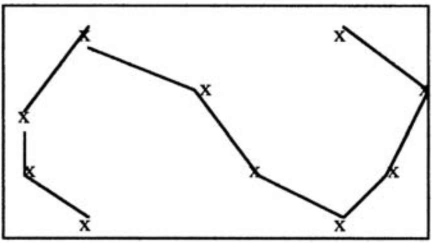
Levee or Watershed Ponds

Calculating Average Depth

Calculating the volume of ponds requires an accurate estimate of the pond's average depth. Miscalculating pond depth by as little as 6 inches can render a pond treatment useless or cause undue stress due to over treatment.

Two people are needed to calculate the depth of a pond – one to measure depth and one to record the measurements. Necessary equipment includes a boat with a motor, a sounding device to do the measurements and a pen and pad to record the measurements. A 10-feet-long length of 3/4-inch PVC pipe makes a good sounding device. The pipe's measurements should be graduated into 1-inch increments.

For ponds 5 acres or less, a minimum of ten measurements is needed. For ponds over 5 acres, a minimum of 20 measurements must be taken. Take the measurements along an S-shaped figure across the pond. Refer to the figure below:



To calculate average depth, total the measurements, and divide by the number of measurements.

Calculating Pond Volume

The preferred unit for calculating the volume of a pond is acre-feet. To calculate the volume of a pond, use the following formula:

Acre-feet of water = A x D

Where A = Acres
D = Average Depth

Example #8. What is the volume of water in a pond which is 10 acres in size, and has an average depth of 5.3 feet?

Acre-feet of water = A x D

Acre-feet of water = 5.3 x 10

Acre-feet of water = 53

Volume = 53 acre-feet

Calculating Treatments

If an individual raises fish long enough, eventually problems arise which require some type of chemical treatment. Examples of problems include fish diseases, parasites, aquatic vegetation, nuisance algae blooms and salt and fertilizer applications.

Calculating pond treatments requires the information previously discussed concerning conversion factors and volume calculations. Treatments are not as simple as adding chemical to the ponds behind an aerator and hoping for the best results. In addition to the volume of water, consideration must be given to the concentration and formulation of the chemical of choice. Not all chemical formulations are 100% in strength, and this must be accounted for when treating. Formulation types vary. Some formulations include liquids (L), wettable powder (WP) and emulsifiable concentrates (EC). The type of formulation can determine how the chemical is applied to the pond.

Read the labels carefully and follow any restrictions carefully. Make certain you keep a copy of the label in your records for all chemicals used on the farm. Restricted use pesticides require you to have taken training to be a **Certified Pesticide Applicator**. Call your county Extension office for information on training sessions.

Basic Treatment Formula

Most chemical treatments can be calculated by using the following formula:

$$\text{Amount of chemical needed} = v \times cf \times \text{ppm desired} \times \frac{100}{\%AI}$$

Where v = volume of water needing treatment

cf = conversion factor (on Table 1)

ppm = the desired concentration of chemical needed for water volume being treated

$\frac{100}{\%AI}$ = 100 divided by the percent active ingredient of the chemical to be used. Most chemicals are considered 100% AI. The percent AI is the percentage of the active ingredient of the product used and is found on the product's label.

Example #9. A pond needs to be treated with a herbicide. The pond is 11.5 acres and has an average depth of 4.6 feet. The recommended treatment is 2 ppm. The active ingredient is 100%. How many pounds of the herbicide are needed for the treatment?

Remember, ponds are treated in units called acre feet.

Volume = Area in Acres x Average Depth

Volume = A x D

Volume = 11.5 acres x 4.6 feet

Volume = 52.9 acre feet

Now, refer to Table 1, Common weight and volume conversions for aquaculture. The conversion factor needed is for acre feet, 2.72 lbs/acre feet = 1 ppm.

Amount of chemical needed =

$$52.9 \text{ acre ft} \times 2.27 \text{ lbs/acre ft} \times 2 \text{ ppm} \times \frac{100}{100\% \text{ AI}}$$

The 100s cancel out and are not needed when %AI is 100.

Amount of chemical needed = 287.78 lbs

Special Treatments

Chemicals Less Than 100% AI

Not all chemicals used in fish farming are formulated at 100% active ingredient. One such chemical is Dylox, which is used in the baitfish and ornamental industry to control gill and body flukes. This compound is not legal in states other than Arkansas and is illegal for use on food fish. Permission to use this compound is obtained from the Arkansas State Plant Board.

Example #10. How much Dylox is needed to treat a goldfish pond which is 2.5 acres and has an average depth of 3 feet. The treatment rate is 0.5 ppm active ingredient.

Remember Dylox is 80% AI. Also use the correct conversion factor.

Volume = 2.5 acres x 3 ft depth

Volume = 7.5 acre feet

Amount of chemical needed = volume x conversion factors x ppm needed x $\frac{100}{80\%\ \text{AI}}$

Amount of chemical needed = 7.5 acre ft x 2.72 ppm x 0.5 ppm x $\frac{100}{80}$

Amount of chemical needed is 12.75 pounds

Formalin Treatments in Vats

In many instances, vat treatments are more effective than are pond treatments. This is due to a much smaller volume of water being treated plus less organic material, mud and better water chemistry in vats. Formalin is a chemical used for many vat treatments. Formalin is a solution of 37% formaldehyde gas dissolved in water. Formalin is considered 100% AI.

Example #11. Catfish fingerlings in a vat need a formalin treatment. The vat holds 3,000 gallons. The treatment rate is 167 parts per million for 1 hour. How much formalin is needed for the treatment?

Amount of chemical needed = volume x conversion factor x ppm needed

Amount of chemical needed = 3,000 gallons x 0.0038 grams per gallon x 167 ppm

Amount of chemical needed = 1,904 grams

Please note that formalin is slightly heavier than water, having a specific gravity of 1.07, but for practical purposes consider formalin as equivalent in weight to water.

1,904 grams is equivalent to 1,904 cc's or = 1.904 liters

Copper Sulfate Treatment

Copper sulfate is approved as an algicide. Copper can be toxic to fish. The toxicity of copper sulfate to fish depends on the total alkalinity of the water. If the total alkalinity of the water is less than 40 parts per million, the use of copper sulfate is not recommended. If the total alkalinity is over 300 parts per million, then, treatment may be ineffective. The effective copper sulfate dosage can be calculated using the following formula:

$$\text{Maximum safe dose in parts per million} = \frac{\text{total alkalinity (ppm)}}{100}$$

Example #12. A ponds needs to be treated with copper sulfate. The pond is 10 acres and averages 4.8 feet deep. The total alkalinity of the water is 171. How much copper sulfate is needed for the treatment?

First, determine the safe dose for copper sulfate in the above situation.

$$\text{Maximum safe dose in ppm} = \frac{\text{total alkalinity}}{100} = \frac{171}{100} = 1.71 \text{ ppm}$$

Now, the calculations can be completed.

Amount of copper sulfate needed =
volume x cf x ppm desired

Amount of copper sulfate needed =
48 acre ft x 2.72 x 1.71

Amount of copper sulfate needed = 223 pounds

Use of Salt

Salt has several uses in the aquaculture industry. In the catfish industry salt is primarily used as a preventative measure against methemoglobin or "brown blood disease" and as a hauling aid. In ponds, the standard recommendation is to maintain 100 ppm chloride in catfish ponds at all times, and when nitrite is present, maintain a minimum chloride to nitrite ratio of 12 to 1. When hauling fish, a 26-ounce box of table salt is commonly added to each hauling tank.

In the baitfish industry salt is added to vats as soon as fish from the ponds are emptied into the vats. From a scientific standpoint, the salt improves the osmoregulation of the fish. It aids in the "hardening process" of the baitfish. For vats a good recommendation is to add one pound of salt to each 40 gallons of water, to achieve a salt level of 2.8 parts per thousand (ppt).

Nitrite Treatments

Salt or sodium chloride is the cheapest source of chloride for the producer. Adding 4.5 pounds of salt to one acre-foot of water increases the chloride level 1 ppm. The following examples show how to calculate the amount of salt needed to prevent "brown blood disease."

The first step is to measure the chloride level in the pond. Several common fish farm chemical kits or water test strips are available for testing chlorides. The next step is to calculate how much salt is necessary to raise the chloride level to at least 60 ppm and preferably 100 ppm.

Example #13. Water testing reveals a pond has 30 ppm chloride. The fish producer wants to raise the chloride level to 100 ppm. So the chloride level must be raised by 70 ppm. The pond is 12 acres with an average depth of 4 feet.

Remember, 4.5 pounds are needed per acre foot to raise the chloride level by one ppm

4.5 lbs salt x 70 ppm chloride needed =
315 lbs of salt/acre-foot

315 lbs salt/acre-foot x 48 acre feet =
15,120 lbs salt needed

15,120 lbs salt ÷ 2,000 lbs = 7.56 tons

Example #14. Water testing reveals a pond has 8 ppm nitrite. The chloride level is 60 ppm. The pond is 15 acres with a 4 foot average depth. How much salt must be added to the pond?

Remember, 12 to 1 is the recommended chloride to nitrite ratio to prevent the formation of "brown blood disease."

8 ppm nitrite x 12 = 96 ppm chloride needed

96 ppm chloride needed - 60 ppm chloride present =
36 ppm chloride to add

36 ppm chloride to add x 4.5 lbs salt/acre-foot =
162 lbs salt/acre-foot

162 lbs salt per acre-foot x 60 acre-feet in pond =
9,720 pounds

9,720 lbs ÷ 2,000 lbs = 4.86 tons

OR add 5 tons of salt to the pond.

Nitrite prevention is the key. Try to maintain at least 60 ppm chloride level in ponds at all times and preferable 100 ppm level. Always maintain a minimum 12 to 1 chloride to nitrite ratio.

Potassium Permanganate Treatment

Potassium permanganate is used in the aquaculture industry as an oxidizing agent. The chemical helps break down organic material in a pond. Research shows there is no evidence that potassium permanganate adds any oxygen to the water and, in fact, may actually slow a pond's recovery from an oxygen depletion by binding up the phosphorus in the water. Phosphorus is needed in the pond for bloom development.

To calculate the recommended dose of potassium permanganate needed in a pond, the permanganate demand can be tested at a diagnostic laboratory. This is a time-consuming task for the catfish producer and for the laboratory personnel.

A good field test is an initial treatment of 4 ppm (10.8 lbs of potassium permanganate per acre foot), then add the chemical in 2 ppm increments (5.4 lbs per acre foot) until the water holds a permanent pink color for a minimum of 8 hours. If the water turns a dark brown color any time during the treatment, then more chemical is needed. This procedure would need to be started in the morning hours rather than late in the afternoon. It is difficult to determine a pinkish water color by use of a spot light, which is what will happen if the treatment is started too late in the day.

Useful Tables and Charts

Table 1. Conversion Factors (C.F.) are the weight of a chemical that must be added to one unit volume of water to give one part per million (ppm).

2.72 pounds per acre-foot	1 ppm
1,233 grams per acre-foot	1 ppm
0.0283 grams per cubic foot	1 ppm
0.0000624 pounds per cubic foot	1 ppm
0.0038 grams per gallon	1 ppm
0.0584 grains per gallon	1 ppm
1 milligram per liter	1 ppm
0.001 gram per liter	1 ppm
8.34 pounds per million gallons of water	1 ppm
1 gram per cubic meter	1 ppm
1 milligram per kilogram	1 ppm
10 kilograms per hectare-meter	1 ppm

Table 2. Miscellaneous conversion factors for aquaculture use.

1 acre-foot	43,560 cubic feet
1 acre-foot	325,850 gallons
1 acre-foot of water	2,718,144 pounds
1 cubic-foot of water	62.4 pounds
1 gallon of water	8.34 pounds
1 gallon of water	3,785 grams
1 liter of water	1,000 grams
1 fluid ounce	29.57 grams
1 fluid ounce	1.043 ounces
1 grain per gallon	17.1 milligrams per liter
1 milliliter of water	1 gram
1 cubic meter of water	1 metric ton
1 quart of water	946 grams
1 teaspoon	4.9 milliliters
1 tablespoon	14.8 milliliters
1 cup	8 fluid ounces
1 acre-foot/day of water	226.3 gallons/minute
1 acre-inch/day of water	18.9 gallons/minute
1 acre-inch/hour of water	452.6 gallons/minute
1 second foot of water	448.8 gallons/minute
1 cubic foot/second of water	448.8 gallons/minute
1 foot of water	0.43 pounds/square inch
1 foot of water	0.88 inches of mercury (HG)
1 horsepower	550 foot-pounds/second
1 horsepower	745.7 watts
1 kilowatt	1,000 watts
1 kilowatt	1.34 horsepower
1 hectare	10,000 square meters
1 hectare	2.47 acres
1 acre	4,048 square meters

Table 3. Common weight and volume conversion factors for aquaculture. ***Source: Third Report to the Fish Farmer. U.S. Fish and Wildlife Service.***

1 acre equals
43,560 square feet
4,840 square yards
4,046.8 square meters

1 acre foot equals
43,560 cubic feet
325,851 gallons
2,718,144 pounds
1,233,489 liters

1 cubic foot equals
28.32 liters
28,317 ml or cc's
7.48 gallons
1,728 cubic inches
0.037 cubic yards
62.43 pounds
957.5 fluid ounces

1 cup equals
8 fluid ounces
1/2 pint

1 gallon equals
3.75 liters
3,785.4 ml or cc's
128 fluid ounces
8 pints
4 quarts
0.013 cubic feet
133.52 ounces
8.35 pounds

1 kilogram equals
2.205 pounds
35.27 ounces
1.0 liters of water

1 liter equals
33.82 fluid ounces
1.057 quarts
0.26 gallons
1 kilogram
2.205 pounds

1 ounce (weight) equals
28.35 grams
0.063 pounds
0.96 fluid ounces

1 ounce (fluid) equals
29.57 grams
29.57 ml or cc's
1.043 ounces (water)
1/8 cup
6 teaspoons
2 tablespoons

1 gram equals
0.035 ounces
1 ml or cc
1.000 milligrams

1 pint equals
473.17 ml or cc's
1/2 quart
16 fluid ounces
16.69 ounces of water
1/8 gallon
1.04 pounds of water

1 quart equals
946.34 mi or cc's
32 fluid ounces
4 cups
2 pints
1/4 gallon
2.09 pounds

1 tablespoon equals
14.79 ml or cc's
3 teaspoons
1/2 fluid ounce

1 teaspoon equals
4.93 ml or cc's
1/3 tablespoon

Table 4. Estimated pond filling time in days at various pumping rates.

	Pumping rate (gallons per minute)				
Pond size (acres)	**200**	**500**	**1,000**	**1,500**	**2,000**
1	4.5	1.8	0.9	0.6	0.5
2	9	3.6	1.8	1.2	0.9
5	23	9	4.5	3	2.3
10	45	18	9	6	4.5
12.5	56.5	22.5	11.3	7.5	5.7
15	58	27	13.5	9	6.8

Table 5. Pumping rate equivalent to gallons per day and acre feet of water per day.

Pumping rate (gallons per minute)	Gallons per day	Acre feet per day
50	72,000	0.22
100	144,000	0.44
200	288,000	0.88
500	720,000	2.21
750	1,080,000	3.31
1,000	1,440,000	4.42
1,500	2,160,000	6.63
2,000	2,880,000	8.84

Table 6. Estimated discharge rate in fish ponds for short drain pipes with low head pressure.

Pipe diameter (inches)	Estimated discharge gallons per minute)
4	125
6	350
8	600
10	1,000
12	1,600
14	2,400

Table 7. Estimated drainage time, hours/days, in fish ponds with short drain pipes and low head pressure.

Pipe diameter (inches)		Acre feet of Water				
		1	5	10	20	40
4	hrs	43.5	217.5	435	870	1740
	days	1.8	9.1	18.1	36.3	72.6
6	hrs	15.5	77.5	155	310	620
	days	.65	3.2	6.5	12.9	25.8
8	hrs	9.1	45.5	90	180	360
	days	.38	1.9	3.8	7.5	15
10	hrs	5.4	22	44	88	176
	days	.23	.92	1.8	3.7	7.3
12	hrs	3.4	17	34	68	136
	days	.14	.71	1.42	2.83	5.7
14	hrs	2.6	13	26	52	104
	days	.11	.54	1.1	2.2	4.3

Table 8. Estimated pumping rates from deep wells of various sizes.

Well size (inches)	Discharge (gallons per minute)
4	90
6	400
8	600
10	1,000
12	2,000

Table 9. Tons of salt needed to raise chloride concentrations to various levels for specified volume of water.

Volume	ppm Chloride needed				
Acre-Feet	20 ppm	40 ppm	60 ppm	80 ppm	100 ppm
5	.225	.450	.675	.90	1.125
10	.450	.90	1.35	1.80	2.25
15	.675	1.35	2.025	2.70	3.35
20	.90	1.80	2.70	3.60	4.50
25	1.125	2.25	3.375	4.50	5.625
30	1.35	2.70	4.05	5.40	6.75
35	1.575	3.15	4.725	6.30	7.875
40	1.80	3.60	5.40	7.20	9.0
45	2.025	4.05	6.075	8.10	10.125
50	2.25	4.50	6.75	9.0	11.25
55	2.475	4.95	7.425	9.90	12.375
60	2.70	5.40	8.10	10.80	13.50

Table 10. Measurement conversion tables weight in grams for spoon and cup volumes for various chemicals.

Copper sulfate (snow)

Level	1/4 tsp	=	1.6 g
“	1/2 tsp	=	3.2 g
“	1 tsp	=	6.4 g
“	1 Tbsp	=	19.2 g
“	1/4 cup	=	76.8 g
“	1/2 cup	=	154.6 g
“	1 cup	=	307.2 g

Copper sulfate (powder)

Level	1/4 tsp	=	1.0 g
“	1/2 tsp	=	2.0 g
“	1 tsp	=	4.0 g
“	1 Tbsp	=	12.0 g
“	1/4 cup	=	48.0 g
“	1/2 cup	=	96.0 g
“	1 cup	=	192.0 g

Dylox*

Level	1/4 tsp	=	0.94 g
“	1/2 tsp	=	1.88 g
“	1 tsp	=	3.75 g
“	1 Tbsp	=	11.25 g
“	1/4 cup	=	45.0 g
“	1/2 cup	=	90.0 g
“	1 cup	=	180.0 g

Formalin (37% formaldehyde)

Level	1/4 tsp	=	1.3 g
“	1/2 tsp	=	2.6 g
“	1 tsp	=	5.3 g
“	1 Tbsp	=	15.8 g
“	1/4 cup	=	63.2 g
“	1/2 cup	=	126.4 g
“	1 cup	=	252.8 g

Table 10. Measurement conversion tables weight in grams for spoon and cup volumes for various chemicals (continued).

Coarse-grain salt

Level	1/4 tsp	=	1.2 g
"	1/2 tsp	=	2.4 g
"	1 tsp	=	4.8 g
"	1 Tbsp	=	14.4 g
"	1/4 cup	=	57.6 g
"	1/2 cup	=	115.2 g
"	1 cup	=	330.4 g

Table salt

Level	1/4 tsp	=	1.6 g
"	1/2 tsp	=	3.2 g
"	1 tsp	=	6.5 g
"	1 Tbsp	=	19.5 g
"	1/4 cup	=	78.0 g
"	1/2 cup	=	156.0 g
"	1 cup	=	312.0 g

Potassium permanganate

Level	1/4 tsp	=	2.0 g
"	1/2 tsp	=	4.0 g
"	1 tsp	=	8.0 g
"	1 Tbsp	=	24.0 g
"	1/4 cup	=	96.0 g
"	1/2 cup	=	192.0 g
"	1 cup	=	384.0 g

Sodium bicarbonate

Level	1/4 tsp	=	1.1 g
"	1/2 tsp	=	2.2 g
"	1 tsp	=	4.4 g
"	1 Tbsp	=	13.2 g
"	1/4 cup	=	53.0 g
"	1/2 cup	=	106.0 g
"	1 cup	=	212.0 g

Table 11. Net mesh sizes for grading catfish.

Square mesh size in inches	Length or weight of fish held
1/4	1 - 2 inches
3/8	3 - 4 inches
1/2	4 - 5 inches
3/4	7 - 8 inches
1	8 - 10 inches (1/2 pound)
1 3/8	3/4 pound
1 5/8	1 1/2 pounds
1 7/8	2.0 pounds

Table 12. Bar grader size for channel catfish.

Bar width in 64th inch increments	Weight in lbs per 1,000
27/64	3 inches
32/64	4 inches
40/64	5 inches
48/64	6 inches
56/64	7 inches
64/64	8 inches
96/64	11 inches

Table 13. Length/weight relationship for golden shiners.

Total length inches	Weight in lbs per 1,000
2.0	3.9
2.5	5.4
3.0	8.6
3.5	13.5
4.0	19.0
4.5	32.5
5.0	44.0
5.5	60.0

Table 14. Length/weight relationship for food size catfish.

Total length (inches)	Weight (lbs per 1,000)	Total length (inches)	Weight (lbs per 1,000)
15.0	1.19	20.5	3.13
15.5	1.32	21.0	3.38
16.0	1.46	21.5	3.63
16.5	1.60	22.0	3.90
17.0	1.76	22.5	4.19
17.5	1.92	23.0	4.48
18.0	2.10	23.5	4.79
18.5	2.28	24.0	5.11
19.0	2.48	24.5	5.45
19.5	2.69	25.0	5.80
20.0	2.91		

Table 15. Catfish farmers of America fingerling length-weight chart.

Length (inches)	# per lb	Lbs per 1,000	Length (inches)	# per lb	Lbs per 1,000
1.0	1,429.6	0.7	5.1	26.8	37.3
1.1	1,250.0	0.8	5.2	25.4	39.3
1.2	1,000.0	1.0	5.3	24.1	41.5
1.3	833.3	1.2	5.4	22.9	43.7
1.4	714.3	1.4	5.5	21.7	46.0
1.5	625.0	1.6	5.6	20.7	48.4
1.6	555.6	1.8	5.7	19.6	50.9
1.7	476.2	2.1	5.8	18.7	53.4
1.8	416.7	2.4	5.9	17.8	56.1
1.9	357.1	2.8	6.0	17.0	58.6
2.0	322.6	3.1	6.1	16.2	61.6
2.1	285.7	3.5	6.2	15.5	64.5
2.2	250.0	4.0	6.3	14.8	67.5
2.3	227.3	4.4	6.4	14.2	70.6
2.4	204.1	4.9	6.5	13.6	73.7
2.5	181.8	5.5	6.6	13.0	77.0
2.6	163.9	6.1	6.7	12.4	80.4
2.7	149.3	6.7	6.8	11.9	83.8
2.8	137.0	7.3	6.9	11.4	87.4
2.9	123.5	8.1	7.0	11.0	91.0
3.0	113.6	8.8	7.1	10.5	94.8
3.1	104.2	9.6	7.2	10.1	98.6
3.2	96.2	10.4	7.3	9.7	102.6
3.3	88.5	11.3	7.4	9.4	106.7
3.4	81.3	12.3	7.5	9.0	110.8
3.5	75.2	13.3	7.6	8.7	115.1
3.6	69.0	14.3	7.7	8.4	119.5
3.7	64.9	15.4	7.8	8.1	124.0
3.8	60.2	16.6	7.9	7.8	128.6
3.9	56.2	17.8	8.0	7.5	133.6
4.0	52.4	19.1	8.1	7.2	138.2
4.1	49.0	20.4	8.2	7.0	143.1
4.2	45.9	21.8	8.3	6.7	148.2
4.3	43.1	23.2	8.4	6.5	153.4
4.4	40.3	24.8	8.5	6.3	158.7
4.5	38.0	26.3	8.6	6.1	164.1
4.6	35.7	28.0	8.7	5.9	169.7
4.7	33.7	29.7	8.8	5.7	175.4
4.8	31.7	31.5	8.9	5.5	181.2
4.9	30.0	33.3	9.0	5.3	187.4
5.0	28.3	35.3			

Table 16. Centigrade to Fahrenheit temperature conversion chart.

°C	°F	°C	°F	°C	°F
0	32.0	14	57.2	28	82.4
1	33.8	15	59.0	29	84.2
2	35.6	16	60.8	30	86.0
3	37.4	17	62.6	31	87.8
4	39.2	18	64.4	32	89.6
5	41.0	19	66.2	33	91.4
6	42.8	20	68.0	34	93.2
7	44.6	21	69.8	35	95.0
8	46.4	22	71.6	36	96.8
9	48.2	23	73.4	37	98.6
10	50.0	24	75.2	38	100.4
11	51.8	25	77.0	39	102.2
12	53.6	26	78.8	40	104.0
13	55.4	27	80.6		

Table 17. Saturation level of oxygen in parts per million (ppm) in fresh water at various temperature and at standard sea level pressure, 760 mm Hg.

Temperature °C	Temperature °F	Oxygen concentration (ppm)	Temperature °C	Temperature °F	Oxygen concentration (ppm)
0	32.0	14.6	21	69.8	9.0
1	33.8	14.2	22	71.6	8.8
2	35.6	13.8	23	73.4	8.7
3	37.4	13.5	24	75.2	8.5
4	39.2	13.1	25	77.0	8.4
5	41.0	12.8	26	78.8	8.2
6	42.8	12.5	27	80.6	8.1
7	44.6	12.2	28	82.4	7.9
8	46.4	11.9	29	84.2	7.8
9	48.2	11.6	30	86.0	7.6
10	50.0	11.3	31	87.8	7.5
11	51.8	11.1	32	89.6	7.4
12	53.6	10.8	33	91.4	7.3
13	55.4	10.6	34	93.2	7.2
14	57.2	10.4	35	95.0	7.1
15	59.0	10.2	36	96.8	7.0
16	60.8	10.0	37	98.6	6.8
17	62.6	9.7	38	100.4	6.7
18	64.4	9.5	39	102.2	6.6
19	66.2	9.4	40	104.0	6.5
20	68.0	9.2			

Table 18. Estimated pounds of purged channel catfish that can be hauled per gallon of water per hour transportation time at 65°F using liquid oxygen system.

Number fish per lb		Hours of transportation time 8	12	16
1	Lbs per gallon	6.30	5.55	4.80
2	Lbs per gallon	5.90	4.80	3.45
4	Lbs per gallon	5.00	4.10	2.95
50	Lbs per gallon	3.45	2.50	2.05
125	Lbs per gallon	2.95	2.20	1.80
250	Lbs per gallon	2.20	1.75	1.50
500	Lbs per gallon	1.75	1.65	1.25
1,000	Lbs per gallon	1.25	1.00	0.70
10,000	Lbs per gallon	0.20	0.20	0.20

Table 19. Pounds of sportfish that can be hauled per gallon of water at temperatures of 65 to 85°F.

Number of fish per pound	Total length (inches)	Number fish per gallon	Pounds fish per gallon
25	4	25	1.00
100	3	67	0.66
400	2	220	0.50
1,000	1	333	0.33

Table 20. Stages of channel catfish egg development at 78°F.

Distinctive feature	Age (days)
No internal pulsation (heart beat)	1
Pulsation visible	2
Bloody streak visible	3
Entire egg bloody in appearance	4
Eyes visible	5
Eyes prominent, embryo turns in shell	6
Embryo complete, no bloody streaks	7
Hatching begins	8

NOTE: For each increase of 2°F above 78°F, subtract one day from incubation time. For each decrease of 2°F below 78°F, add 1 day to incubation time.

Table 21. Stocking guide for channel catfish fingerling production during a 120-day growing season.

Number of fry stocked per acre	Length at harvest average length (inches)
33,000	6.1
84,000	4.9
217,000	4.6
560,000	3.7

Table 22. Fraction of toxic (un-ionized) ammonia in aqueous solution at different pH values and temperatures.

	(Temperature °C)												
pH	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**
7.0	.0013	.0016	.0018	.0022	.0025	.0029	.0034	.0034	.0039	.0046	.0052	.0069	.0080
7.2	.0021	.0025	.0029	.0034	.0040	.0046	.0054	.0062	.0072	.0083	.0096	.0100	.0126
7.4	.0034	.0040	.0046	.0054	.0063	.0073	.0085	.0098	.0114	.0131	.0150	.0173	.0198
7.6	.0053	.0063	.0073	.0086	.0100	.0116	.0134	.0155	.0179	.0206	.0236	.0271	.0310
7.8	.0084	.0099	.0116	.0135	.0157	.0182	.0211	.0244	.0281	.0322	.0370	.0423	.0482
8.0	.0133	.0156	.0182	.0212	.0247	.0286	.0330	.0381	.0438	.0502	.0574	.0654	.0743
8.2	.0210.	0245.	0286.	0332	.0385	.0445	.0514	.0590	.0676	.0772	.0880	.0998	.1129
8.4	.0328	.0383	.0445	.0517	.0597	.0688	.0790	.0904	.1031	.1171	.1326	.1495	.1678
8.6	.0510	.0593	.0688	.0795	.0914	.1048	.1197	.1361	.1541	.1737	.1950	.2178	.2422
8.8	.0785	.0909	.1048	.1204	.1376	.1566	.1773	.1988	.2241	.2500	.2774	.3062	.3362
9.0	.1190	.1368	.1565	.1782	.2018	.2273	.2546	.2836	.3140	.3456	.3783	.4116	.4453
9.2	.1763	.2008	.2273	.2558	.2861	.3180	.3512	.3855	.4204	.4557	.4909	.5258	.5599
9.4	.2533	.2847	.3180	.3526	.3884	.4249	.4618	.4985	.5348	.5702.	6045	.6373	.6685
9.6	.3496	.3868	.4249	.4633	.5016	.5394	.5762	.6117	.6456	.6777	.7078	.7358	.7617
9.8	.4600	.5000	.5394	.5778	.6147	.6499	.6831	.7140	.7428	.7692	.7933	.8153	.8351
10.0	.5745	.6131	.6498	.6844	.7166	.7463	.7735	.7983	.8207	.8408	.8588	.8749	.8892
10.2	.6815	.7152	.7406	.7746	.8003	.8234	.8441	.8625	.8788	.8933	.9060	.9173	.9271

To calculate the amount of un-ionized (toxic) ammonia present, find the fraction of ammonia that is in un-ionized form for a specific pH and temperature from the table. Multiply this fraction by the total ammonia nitrogen present in a sample to determine the ppm of un-ionized ammonia.

Table 23. Factors for calculating carbon dioxide concentrations in water with known pH, temperature and total alkalinity measurements.

pH	5/41	10/50	15/59	20/68	25/77	30/86	35/95
6.0	2.915	2.539	2.315	2.112	1.970	1.882	1.839
6.2	1.839	1.602	1.460	1.333	1.244	1.187	1.160
6.4	1.160	1.010	0.921	0.841	0.784	0.749	0.732
6.6	0.732	0.637	0.582	0.531	0.495	0.473	0.462
6.8	0.462	0.402	0.367	0.335	0.313	0.298	0.291
7.0	0.291	0.252	0.232	0.211	0.197	0.188	0.184
7.2	0.184	0.160	0.148	0.133	0.124	0.119	0.116
7.4	0.116	0.101	0.092	0.084	0.078	0.075	0.073
7.6	0.073	0.064	0.058	0.053	0.050	0.047	0.046
7.8	0.046	0.040	0.037	0.034	0.031	0.030	0.030
8.0	0.029	0.025	0.023	0.021	0.020	0.019	0.018
8.2	0.018	0.016	0.015	0.013	0.012	0.012	0.011
8.4	0.012	0.010	0.009	0.008	0.008	0.008	0.007

To calculate the carbon dioxide level (ppm), find the corresponding factor from the table and multiply that factor times the total alkalinity.

Table 24. Personnel and addresses of University of Arkansas at Pine Bluff's Fish Disease Laboratories.

Extension Fisheries Specialist
Extension Associate
Lonoke Agricultural Center
2001 Hwy 70 East
P.O. Box 357
Lonoke, AR 72086
501-676-3124
501-676-7847 (fax)

Extension Fisheries Specialist
Extension Associate
Chicot County Extension Bldg.
523 Hwy 65 & 82
Lake Village, AR 71653
870-265-8055
870-265-8060 (fax)

Associate Professor
Extension Associate
UAPB Fish Disease Laboratory
1200 North University Drive
P.O. Box 4912
Pine Bluff, AR 71601
870-543-8034
870-545-8162 (fax)

Table 25. Submitting fish and water samples for disease diagnosis.

Good Fish Samples

- 3-5 live fish showing disease or behavior signs of a disease.
- Fresh dead fish with normal eye and normal gill color.
- Be aware that live fish may have pale gills and cloudy colored eyes.
- Observe for lesions, skin breaks, sores, reddish areas, as well as erratic behavior, such as scratching, flashing, piping or swirling.
- Fish can be caught via dipnet, hand or cast net. Note numbers of dead fish.

Transporting Fish to the Laboratory

- For trips 1 hour or less, place fish in a bucket of cool water and aerate the water.
- For longer trips, place fish in a plastic bag (no water) on ice. Sample is acceptable for 24 hours.

Poor Fish Samples

- Dead fish with cloudy colored eyes.
- Dead fish with pale or white gills.
- Fish which have been dead for several hours.
- Fish caught by hook and line or baited into a net are poor samples. Randomly snagged fish are a little better for samples.

Collecting Water Samples

- Use clean bottle or jar (canning jars work well).
- Collect sample below pond's surface and screw lid on the jar below the pond's surface being careful not to trap air bubbles.
- Keep the water sample cool and out of sunlight.
- It is a good idea to place the water sample on ice.

Table 26. Suggested fertilization schedule. Use this as a starting point and modify for your pond conditions by adding more or less of the two types of fertilizer.

Organic fertilizer	+	Inorganic fertilizer	
rice bran, cotton seed meal, or alfalfa pellets		liquid 10-30-0 or similar	OR powdered 0-49-0 or similar
day*	**pounds/acre**	**gallons/acre**	**pounds/acre**
1	250	2 to 4**	16 to 32**
8	50	1 to 2	8 to 16
If needed:***			
14	50	1 to 2	8 to 16
21	50	1 to 2	8 to 16
28	50	1 to 2	8 to 16

* Day 1 is the first day the pond is being filled.

** For ponds with calcium hardness below 50 mg/l, use the lowest rate. For each additional 75 mg/l of calcium hardness, add an additional 1 gallon/acre of liquid or 8 pounds/acre of powdered fertilizer. For example, if the calcium hardness is 200 mg/l, use 4 gallons/acre liquid or 32 pounds/acre powdered. For repeat applications, use one-half of the initial rate.

*** Continue fertilization if light penetration is greater than 18 inches. Do not add more fertilizer if dissolved oxygen reading is less than 4 ppm or if light penetration is less than 9 inches. If this schedule does not produce an adequate bloom, add fertilizer more often rather than increasing the amount per application.

Table 27. Inorganic fertilizer rate chart.

		Water calcium hardness		
Fertilizer type		**Low <50 ppm**	**Medium 50 to 100 ppm**	**Hard >100 ppm**
Liquid 11-37-0	Gallons/acre	1/2-1	1-2	2-4
Powder 10-52-4	Pounds/acre	4-8	8-16	16-32
Granular 0-46-0	Pounds/acre	4-8	8-16	16-32

Table 28. Channel catfish fry preparation and fertilization schedule.

Week 1

- Fill ponds.
- Add fertilizer following Tables 26 and 27.
- Hatch fish.
- Set up aeration – minimum 1 hp per acre.

Week 2

- Add grass carp 15-25 per acre if no weeds present, add 50-100 per acre in weedy ponds.
- Add fertilizer following Tables 26 and 27.
- Stock fry following Table 21.
- Temper water slowly, stock fish in early morning.
- Feed 40-45% protein meal 3 times daily for maximum of 15 lbs/acre/day.
- Monitor oxygen and aerate as needed.

Week 3

- Add fertilize following Tables 26 and 27, if needed.
- Continue feeding, if fish feeding at surface switch to 36% crumbles 2 times daily for maximum or 20 lbs/acre/day.
- Monitor oxygen and aerate as needed.

Weeks 4-5

- Fertilize pond following Tables 26 and 27, if needed.
- Continue feeding, gradually increasing rate as fish grow.
- Continue monitoring oxygen.

Week 6 and on

- Continue feeding crumbles until fish are 2 inches long, then switch to small diameter pellet.
- Continue monitoring oxygen.

Table 29. Effect of salinity on channel catfish fingerling production.

- Growth much better at 1 part per thousand (1,000 ppm) chloride level.
- Growth the same at 0, 2 and 4 parts per thousand chloride level.
- Survival same for 0, 1 and 2 parts per thousand chloride level.
- Survival reduced at 4 parts per thousand chloride level.

Table 30. Survival of channel catfish to fingerling size.

- Alabama survey shows fry to fingerlings survival is 56%.
- Survival above 80% is considered excellent.
- To improve survival, prevent oxygen stress, handle fish as gently as possible when moving fish during summer months.

Notes

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