CHAPTER 10

FISH MANAGEMENT

In a given water body, it may become necessary to manage populations of certain fish; bottom-rooting fish, such as carp, which increase turbidity; fish that compete with more desirable game fishes for space and food; and stunted sunfish (including many species in the Centrarchidae family: bluegill, redear, pumpkinseed, green sunfish, panfish, etc.) found in overpopulated conditions may detract from overall lake or pond quality. Fish management is a continuous process that requires frequent monitoring.

Under certain conditions, fish management may entail use of special pesticides called **piscicides**, more commonly called fish toxicants. Fish management requires in-depth training and experience working with complex aquatic ecosystems. Commercial use of piscicides is a regulated activity classified under pesticide applicator Commercial use of piscicides is a regulated activity classified under pesticide applicator certification category 5, aquatic pest management according to Regulation 636 of the Natural Resources and Environmental Protection Act 451. The Michigan Department of Environmental Quality also regulates the applications of piscicides by issuing permits for such treatments to waters of the state under the Water Resources Commission Act (P.A. 245 of 1929 as amended).

This chapter is intended to provide you with a basic knowledge of how and when to apply piscicides. These activities should be performed only by trained professional fisheries biologists with appropriate pesticide applicator credentials. All details and site-specific decisions required for a comprehensive and successful fish management program are not covered in this chapter. *"Managing Michigan Ponds for Sport Fishing," Second Edition,* Extension bulletin E-1554, produced by MSU Extension in cooperation with other agencies, is a useful manual for learning more about all the considerations required for successful pond management for fishing. Additional references are listed in Appendix A. For more information contact the MDEQ, a fisheries and wildlife specialist at MSU or a private fisheries consultant.

Stunted Fish

Stunted sunfish is a common problem in Michigan's inland ponds and lakes, though other fish may also be prone to stunting, such as bullheads, perch and crappie. To determine if sunfish are stunted, sample several and observe their length and/or the ages from scale samples and compare age to total length.

Determining Fish Age

Scales can be used to determine fish age for most species. A typical scale from a bluegill is shown in Figure 10-1. About 10 to 20 scales are removed with the blunt edge of a knife from the upper side of the fish, just under the front edge of the dorsal fin.

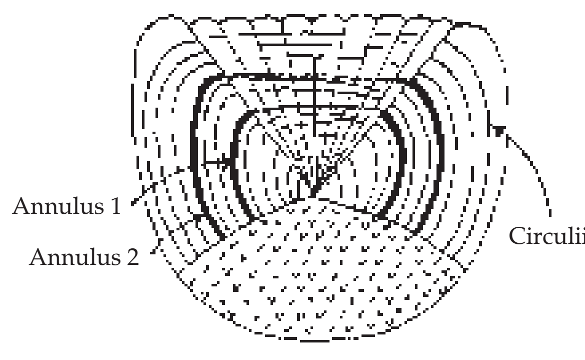

Figure 10-1. Fish scale showing annuli.

Place scales from individual fish in envelopes like those used by coin collectors. Record important information on the outside of the envelope, including the collector's name, the species of fish, the locality and method of capture, the date and time of capture, and the total length and weight of the fish. To obtain meaningful samples, you should sample at least 10 fish per inch group (i.e., ten 2- to 3-inch fish, ten 3- to 4-inch fish, ten 4- to 5-inch fish, etc), collected over a short period of time. Take samples to a trained fisheries biologist for evaluation.

The scales are generally aged on a microfiche reader. The scales are slightly moistened, placed on the microfiche reader and read directly off the screen. **The age of the fish is determined by counting the number of wide transparent growth rings, called annuli**. The bluegill in Figure 10-1 is 2 years old. Aging fish is similar to aging a tree by counting the number of growth rings.

Bony structures such as spines, vertebrae or otoliths (ear bones) can be used to age scaleless fish, such as catfish, or fish with very small scales, such as lake trout. These are cut into thin sections so the annuli on these structures can be read. This process should be done only by experienced fisheries biologists. Table 10-1 provides some information about various fish and approximate sizes at different ages.

If the bluegills are significantly smaller than the size listed for the appropriate age group in Table 10-2, they are stunted. If bluegill are stunted, their maximum size at any age would be 4.5 to 5.7 inches.

Stunting in bluegills or other sunfish types has two probable causes: either large predators are unavailable, or the sunfish are able to hide from the large predators in dense stands of weeds. Both allow the survival of large numbers of young sunfish that would normally be eaten by predators. Bass, the typical sunfish predators, are sight feeders. If the sunfish have dense weeds to hide in, it is very difficult for the bass to locate and capture them. Therefore, fisheries management includes aquatic vegetation management. Once the number of small sunfish increases dramatically, their growth rate slows as their food supply diminishes. They will reduce the number of young bass by raiding nests and eating the bass eggs and larvae. The result is fewer adult bass to prey on the sunfish, and increased stunting. If sunfish numbers are reduced, bass can quickly replenish themselves. Mature female bass can produce 10,000 to 20,000 eggs a year.

The stunted fish problem is a function of the carrying capacity of a lake or pond. A lake supports around 200 to 400 pounds per surface acre in southern Michigan. It doesn't matter if that is 200 one-pound fish or thousands of sunfish that weigh only a few ounces each. The more fish you have, the smaller the portion of the total food supply that each gets. Additional food is not a solution — it adds more nutrients to the system which promotes more weed growth.

Table 10-1. Summer length ranges at various ages for fishes in Michigan ponds. These are rough statewide values. Growth may be somewhat greater where fish are not crowded and temperature and food supply are ideal. Growth can be much slower, especially where ponds are overpopulated. (D.L. Garling and Keith Ashley, 1984, MSU Extension bullein E-1774, "Determining the Age of Fish.")

Length in Inches							
Kind of fish	First summer **(Age 0)***	Second summer **(Yearling)**	Third summer **(2-yr-old)**	Fourth summer **(3-yr-old)**	Fifth summer **(4-yr-old)**	Sixth summer **(5-yr-old)**	Life expectancy
Rainbow trout**	4-6	9-14	14-171	5-19	***	***	5-7
Brook trout	2-4	6-8	8-12	9-14	11-16	***	5-7
Largemouth bass	1-4	6-8	8-10	10-12	12-14	13-17	14-15
Smallmouth bass	1-4	4-7	7-10	10-12	12-14	13-17	12-14
Channel catfish	1-4	5-7	8-10	11-13	13-15	15-17	10-14
Bluegill	.5-2	3-4	4-5	5-6	6-7	6.5-7.5	10-11

* Fingerling.
** From fall-spawning stock in hatcheries.
*** Very few survive to this age, and growth at this age is extremely variable.

Table 10-2. The mean sizes of bluegills in our region (from MSU Extension bulletin E-1776).

Age (years)	1	2	3	4	5	6	7	8
Size (inches)	1.8	3.4	4.5	5.7	6.5	7.0	7.5	8.0

As with aquatic weed control, understanding a lake's ecosystem is crucial. A fish biologist must select the correct fish species suitable for a given water body and recommend physical alterations to improve the conditions. Pond depth and surface area, water supply, water quality and water temperature must be determined when managing fish. The stunted fish problem requires a drastic reduction (about 90 to 95 percent) in the number of stunted sunfish. The conditions that led to the development of the stunted population must also be identified and corrected or the problem will reoccur.

Fish Population Management Tactics

There are a variety of reasons to reduce the fish population in a water body. It may have become contaminated with undesirable fish, such as carp, suckers or bullheads. A trout pond may contain unwanted warmwater fishes that are competing for food and reducing trout growth and survival. It may have suffered a winter-kill of one kind of fish but not others that disrupted the predator-prey balance. Or perhaps panfish are overabundant and stunted. Various methods to alter fish populations are described below.

1. Intensive angling

It is often thought that sunfish overabundance can be remedied by intensive fishing. Angling for reduction of sunfish, however, is rarely effective.

2. Predator stocking

It is often thought that stocking northern pike, muskellunge or walleye (predators) should result in sunfish control. Such attempts have been numerous but not successful. The stunted sunfish are too large to be consumed by predators in the sizes normally stocked. In addition, these predators would rather eat torpedo-shaped prey, such as small bass, than fish shaped like a sunfish.

Each northern pike or walleye requires 5 to 10 acres of lake area to support its feeding requirements. Pike and walleye should never be stocked in ponds or small lakes. Having northern pike in bass-bluegill ponds often results in more predation on bass than on bluegills.

3. Spawning bed destruction

Attempts have been made to control sunfish by destroying their eggs, by raking or trampling the nests. For this to be effective, however, almost every nest has to be destroyed. Sunfish spawn over such a long period, hatch in so few days and hatch so many fry (young fish) in each nest that such control measures are a long, hard task with a high failure rate.

4. Cover reduction

Sunfish can overpopulate a pond when plant cover is abundant. The weeds must be reduced or the problem will continue. Scattered stands with moderate plant density (about 80 stems per square yard or meter) promote a better balance between predator and prey fishes. Weeds can be reduced by physical, chemical, mechanical or biological means.

5. Water level drawdown

Some fish populations can be controlled by manipulating water level. When deciding if a drawdown should occur, consider the impacts it will have on all other components of that ecosystem. Review the "Nonchemical Aquatic Vegetation Management Techniques" (chapter 6) in this manual and consult with a lake vegetation manager to determine the impact on both the desirable and the undesirable plant species found in that water body. An Act 346 permit is required to drawdown the water body.

Water discharged from a water body must not damage downstream waters or properties by flooding, erosion or sedimentation. The owner is responsible for releasing the water in a cautious and reasonable manner.

Fish present in the pond may not be released into public waters without a permit from the MDNR Fisheries Division. Unauthorized introductions of fish can disrupt natural fish populations to the detriment of public interest.

Total drawdown is used to eliminate all fish from a pond. Do not overlook fish in residual puddles. Spot applications of fish toxicants may help in attaining complete kill. Desirable fish, such as large bass, can usually be salvaged and kept alive for restocking if other water for holding them is available.

Partial drawdown can be used to concentrate fish so the predators such as bass can feed more efficiently. This tactic depends on having enough predators to consume a large portion of the unwanted fish. When the pond refills, the survivors may be able to make better use of the existing food supply, if overabundant aquatic plants have been controlled.

Predatory reduction of small fishes will be most effective if the partial drawdown is done for a month or more in July or August. Carefully consider whether the danger of oxygen depletion and mass fish die-off will increase during partial drawdown.

6. Seining

Seining is often the most effective method for reducing numbers of unwanted fish in small ponds. Seining is usually done by two people, each holding a wooden upright that supports an end of the net. See figure 10-2. Floats keep the seine top at the water surface, and weights hold the bottom edge on the pond bed (See figure 10-3). For best results, the seine must be deeper than the deepest part of the pond so that it will "belly" without being pulled away from the pond bed as it is drawn along. The seine must stay tight along the pond bed or fish will escape underneath. Seines of 50 to 200 feet (15 to 60 meters) can be built to fit various ponds.

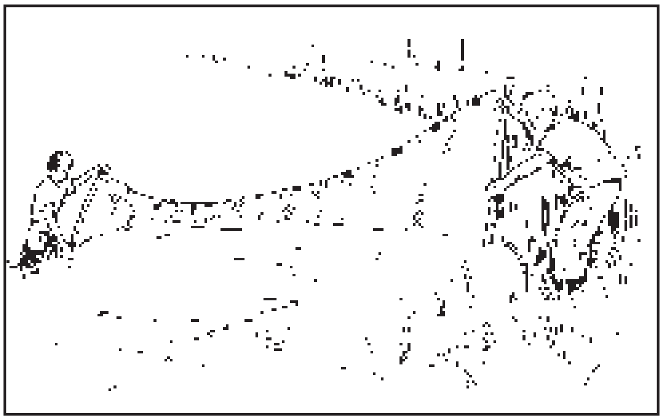

Figure 10-2. Seining a pond.

Small minnow seines of 15 to 40 feet (5 to 12 meters), available at sporting goods shops, can be used along shorelines to remove panfish fry (recently hatched fishes) and fingerlings (small fish up to one year in age). Small seines may be especially useful on panfish during spawning periods.

Nylon netting is most rip resistant and needs little maintenance. For removing small panfish, use netting with mesh of from 1/4 to 1/2 inch (1/2 to 1 cm).

The pond bottom should be smooth and free of snags such as rocks, logs and brush. Dense weed beds also impede seining. Water-level drawdown can aid in seining by drawing water away from weed beds and other shore-zone obstructions, as well as decreasing the area and depth to be seined.

Draw the seine so that the bottom edge stays ahead of the upper edge. Many fish escape if a seine rolls up at the bottom as it is pulled along.

To recover bass, large panfish or minnows and return them to the pond uninjured, pocket the seine in shallow water at the end of the haul rather than dragging it ashore. Rolling or folding the net can greatly harm fish by bruising them and by removing their slimy covering and scales, thus increasing the

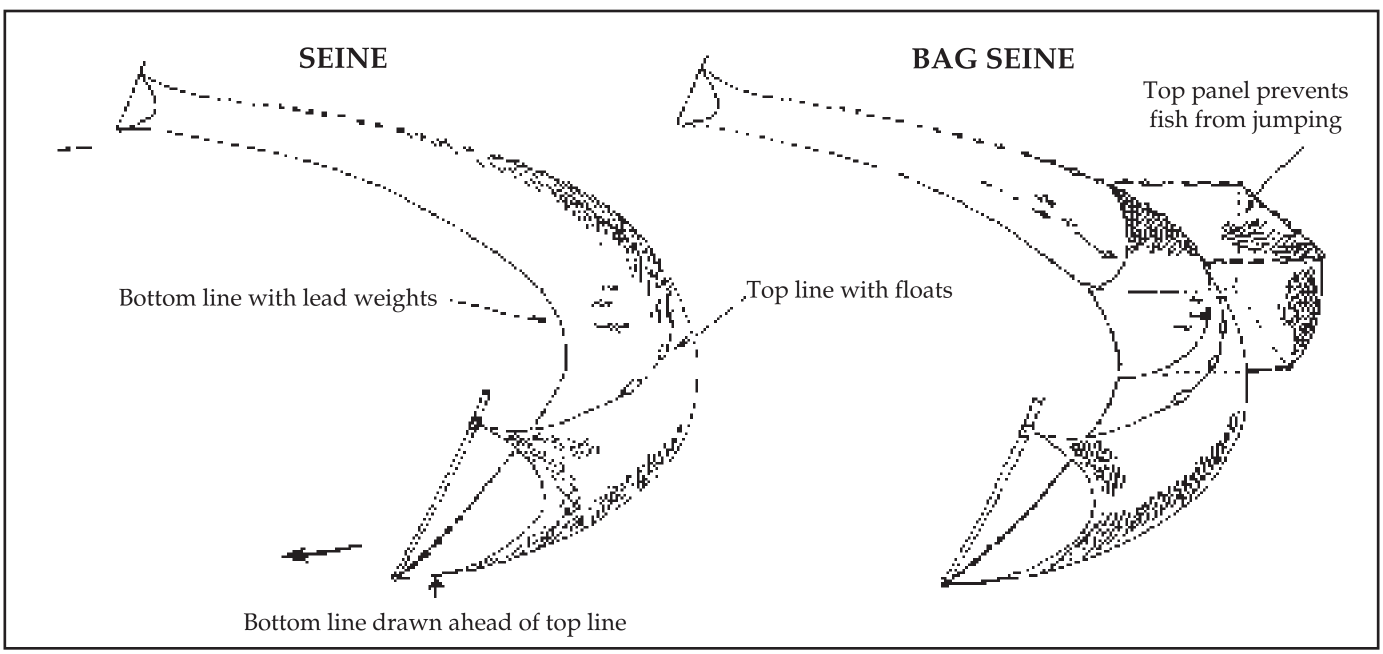

Figure 10-3. A seine and a bag seine.

risk of infection and disease. Minnows are very prone to such injury, especially in hot weather.

To thin out populations of bluegills and other sunfish, seine frequently in the warm season when continual hatching of sunfish occurs. Remove panfish that are less than 6 inches (15 cm) long, and return those over 6 inches plus any bass or channel catfish (not bullheads!). This amounts to selective breeding for the trait of fast growth, while making room for that growth to occur.

Continue seining until about 80 percent of the pond's estimated summer poundage of panfish has been removed. Estimating the total weight of panfish in a pond is difficult, and it is best to consult a professionally trained biologist in your area.

Seining can provide useful information about the fish population but can also give misleading impressions. Bass and carp, especially the older ones, are skillful at avoiding nets. When you seine up only small bass or carp, don't conclude that the big ones aren't there.

7. Live Trapping

Fish traps may be useful for reducing populations where obstacles to seining are present. An effective trap can be made of 1/2-inch (1-cm) hardware cloth on wooden framing. Figure 10-4 illustrates three types of fish trap construction.

Use traps with or without "wings," which are like fences extending outward from the mouth of the trap. They guide fish toward the opening.

Place traps in water that is just deep enough to cover them, parallel or at right angles to the shore, off peninsulas or in shallow bays where small fish gather. Support traps with poles or iron reinforcing rods driven into the bed. Up to 10 traps per acre (25 per hectare) may be needed.

For panfish thinning, remove the same amounts and sizes of fish as described in the section on seining. Take fish out of traps daily. Otherwise, turtles may be attracted and eat the desirable fish.

Gauze bags of bait, such as bread, oatmeal, soybean cake or cottage cheese can be hung in traps to increase catch, but they aren't necessary.

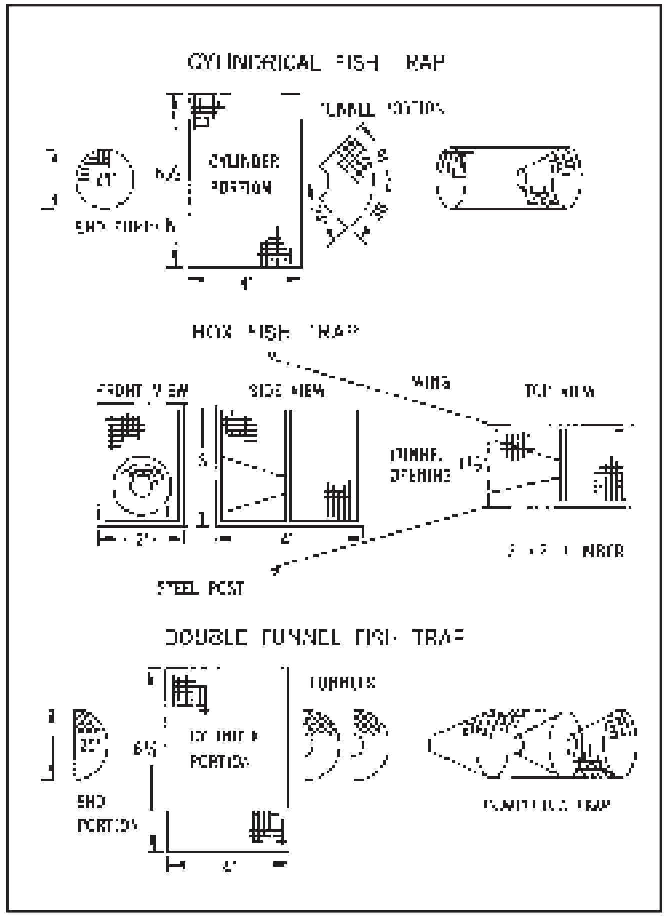

Figure 10-4. Fish trap construction.

Fish Management Using Piscicides

Mechanical techniques to remove fish, such as seining and trapping, can be effective but have limitations. Piscicides have become important in fish management because they may overcome some of these limitations. Before attempting any piscicide application, consult an MDEQ or MSU Extension specialist who has experience working with these compounds. A DEQ permit is required under Water Resources Protection, Act 451, part 31 of 1994, which requires permits to regulate the discharge or storage of any substance which may affect the water quality of the State.

Preparing for a Piscicide Treatment

Only two piscicides are registered for fishery use by the U.S. Environmental Protection Agency.

Be familiar with label directions and Material Safety Data Sheets (MSDS) for each product. Follow all product label directions. Have copies of the labels and MSDSs for the products available for reference as follows:

— When products are handled and transported.

— Where products are stored.

— Where products are used.

Use all safety equipment as defined on the label when handling piscicides, oxidizers and dyes.

Follow all storage guidelines as discussed in the core manual, E-2195, chapter 6, "Pesticide Handling, Storage and Disposal." To avoid storage complications, purchase products at the time of need and purchase only the quantity to be used for each treatment. Some formulations may separate when subjected to freezing temperatures, so mix well before applying. Some piscicides lose solvents (the carrier or liquid that dissolves a pesticide to form a solution), even in unopened containers. The contents may dry to a crystalline substance if stored for an extended period of time.

When preparing for a treatment, comply with Part 83, Pesticide Control, of Act 451; with Act 368, the Aquatic Nuisance Control Act; with Act 346, the Inland Lakes and Streams Act; and with Act 245 of 1929 as amended, the Water Resources Commission Act. Obtain all necessary certifications and permits. (See the chapter on laws and regulations in this manual.) Plan for the containment and neutralization (pesticide degradation) strategies that accompany your treatment. Contain treated water until it is neutralized whenever possible. If containment is not possible:

— The area required for neutralization should be accounted for in the treatment plans.

— Neutralization is to be completed in a manner so that no fish are killed outside the described project area.

A piscicide applied to water can be neutralized by natural degradation, dilution and/or detoxification. When considering the rate of neutralization of treated waters, consider the following factors:

— Volume of inflow to the treatment zone.

— Tributaries.

— Volume of outflow.

— Temperature.

— Turbidity.

— Chemical and biochemical oxygen demand.

— Species composition.

— Profile of water velocities across a stream channel.

— Dilution.

Toxic effects of piscicides can be eliminated almost immediately with potassium permanganate ($KMnO_4$), a strong oxidizing agent with biocidal properties. $KMnO_4$ is used to control fish diseases, eliminate taste problems in fish, reduce algal blooms and detoxify fish toxicants. Piscicide applicators may use $KMnO_4$ to set up borders in a lake, for example, where no toxicant is wanted. A cold or muddy stream or lake will require more $KMnO_4$ to neutralize a toxicant. Cold water will slow the rate of reaction, and muddy water has more organic matter that will bind with the $KMnO_4$ and make it less available. Contact the MDNR Fisheries Division or the MDEQ for assistance in planning for and determining detoxification procedures and rates.

If $KMnO_4$ is used to detoxify water, the piscicide solvents and emulsifiers (chemical that allows petroleum-based pesticides to mix with water) may be removed by other chemical agents. Activated carbon filtration can remove the solvents, emulsifiers and any odor caused by the piscicide.

Potassium permanganate is toxic to some fish, and concentrations of 3 to 4 milligrams per liter are hazardous to apply. Use nose, throat, and eye protection when handling or working with $KMnO_4$. If the compound is accidentally taken internally, give the person lemon juice or orange juice, milk or a sugar solution to drink. If none of those are available, give large quantities of water. See chapter 6, "Pesticides and Human Health" in the core manual, E-2195, for more information on pesticide exposure.

When treating water bodies with an outlet and water control structure (e.g., valve or stoplogs):

— Lower the water level as much as possible before treatment.

— Shut off the outflow to the extent possible during treatment.

— Contain treated water within the project area until it is neutralized or detoxified.

When treating water bodies with outlets but no water control structure:

— Determine containment or neutralization measures on an individual basis.

— Neutralize treated water (see above) before it leaves the project area.

Methods of Application

Uniform distribution of a fish toxicant in a body of water is essential. Depending on circumstances, various methods can be used.

Backpack sprayers may be useful for treating small ponds. They can also be used to cover marshy areas and shorelines with thick vegetation. Failure

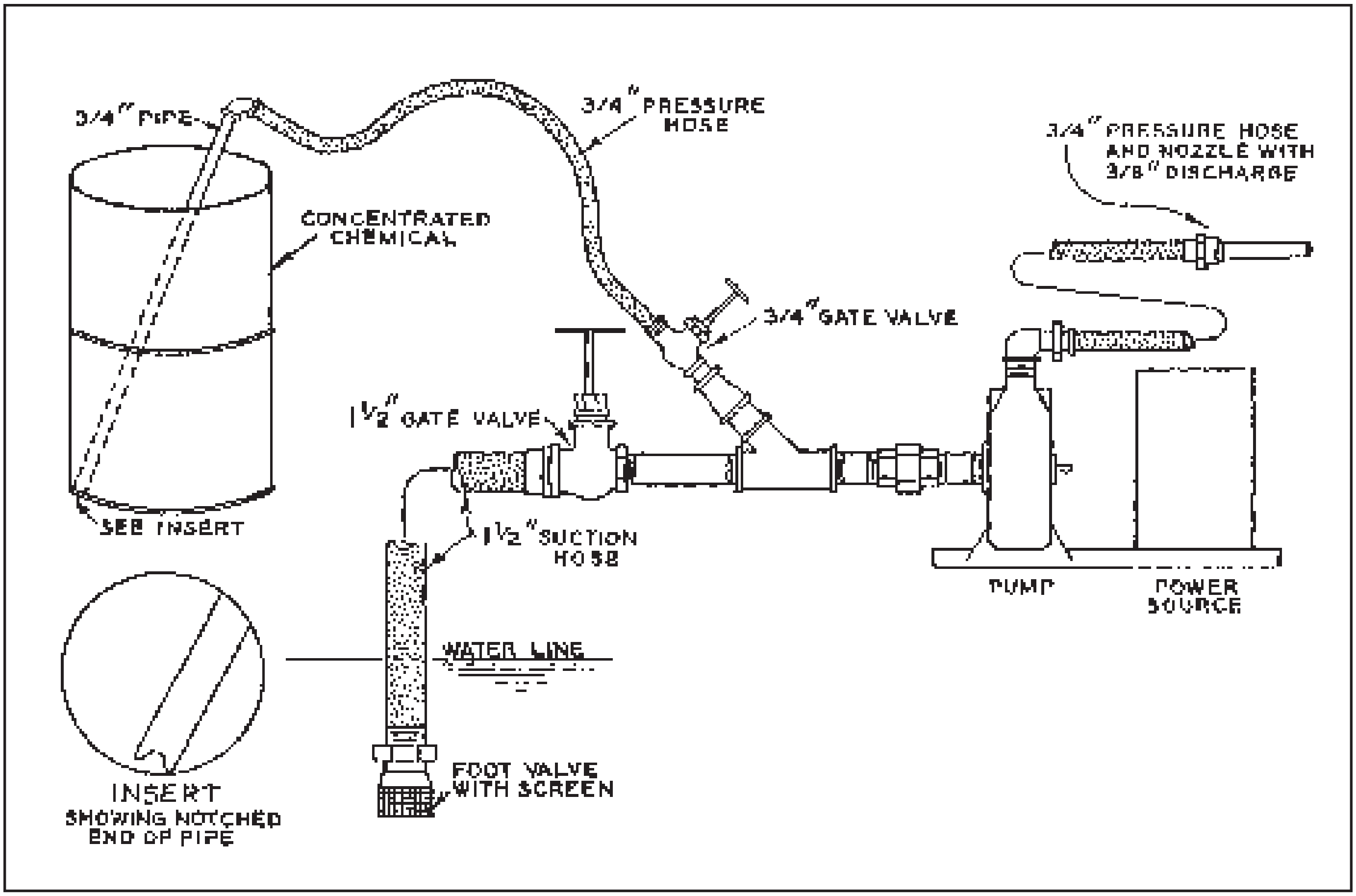

Figure 10-5. Equipment for chemical treatment of lakes. Modified from drawing furnished to the MDNR by Wisconsin Committee on Water Pollution .

to cover these areas adequately may cause the entire project to fail.

Motor-driven boats are used for large ponds and lakes. Spray the surface and along the edges with a centrifugal pump with enough pressure to throw a stream of water 30 to 40 feet. Dilute the piscicide according to the manufacturer's directions before spraying it on water. This dilution prevents waste or excessive application of material. To dilute the chemical, connect the pump intake to a 45 degree wye (shape of a "Y"). A hose from one arm of the wye draws chemical from a reservoir in the boat, while the other arm of the wye is connected to a hose through which diluting water is drawn from the lake. Valves on these two lines control the proportions of dilution water and chemical. See Figure 10-5.

For deep-water treatments in large lakes, a venturi rig is effective in dispersing the chemical. A boat bailer can be attached to the lower unit of an outboard motor and to a 30- to 55-gallon graduated tank in the boat by a length of hose. With this rig, chemical is siphoned from the tank at an even rate if the boat speed is constant. A faucet attached between the hose and the tank regulates the dispersion of toxicant. (See Figure 10-6.) Review the "Pesticide Application Equipment and Techniques" chapter in this manual.

Chemicals can be dispersed into water below the thermocline (the division between the layer of warmer water above the cooler water below) by attaching a heavy metal pipe or weights to the discharge hose. Even at slow running speeds, a 20- to 30-pound weight may need to be attached to the pipe. You can check the depth of the pipe while running by towing it toward shore until it strikes the bottom and taking a depth sounding at this point. This gives the approximate depth at which the chemical is being distributed at a given running speed.

To get even distribution of chemical over the surface of a large lake, subdivide the lake into sections and apply a quantity of chemical that is proportional to the volume of each section. Mark these sections in advance with shore markers and buoys. Because the quantity of chemical to be applied to a given area must be proportional to its volume, deeper areas are usually traversed with venturi rigs more than once, while shallow shore zones are sprayed once. An orderly pattern for applying the chemical is necessary.

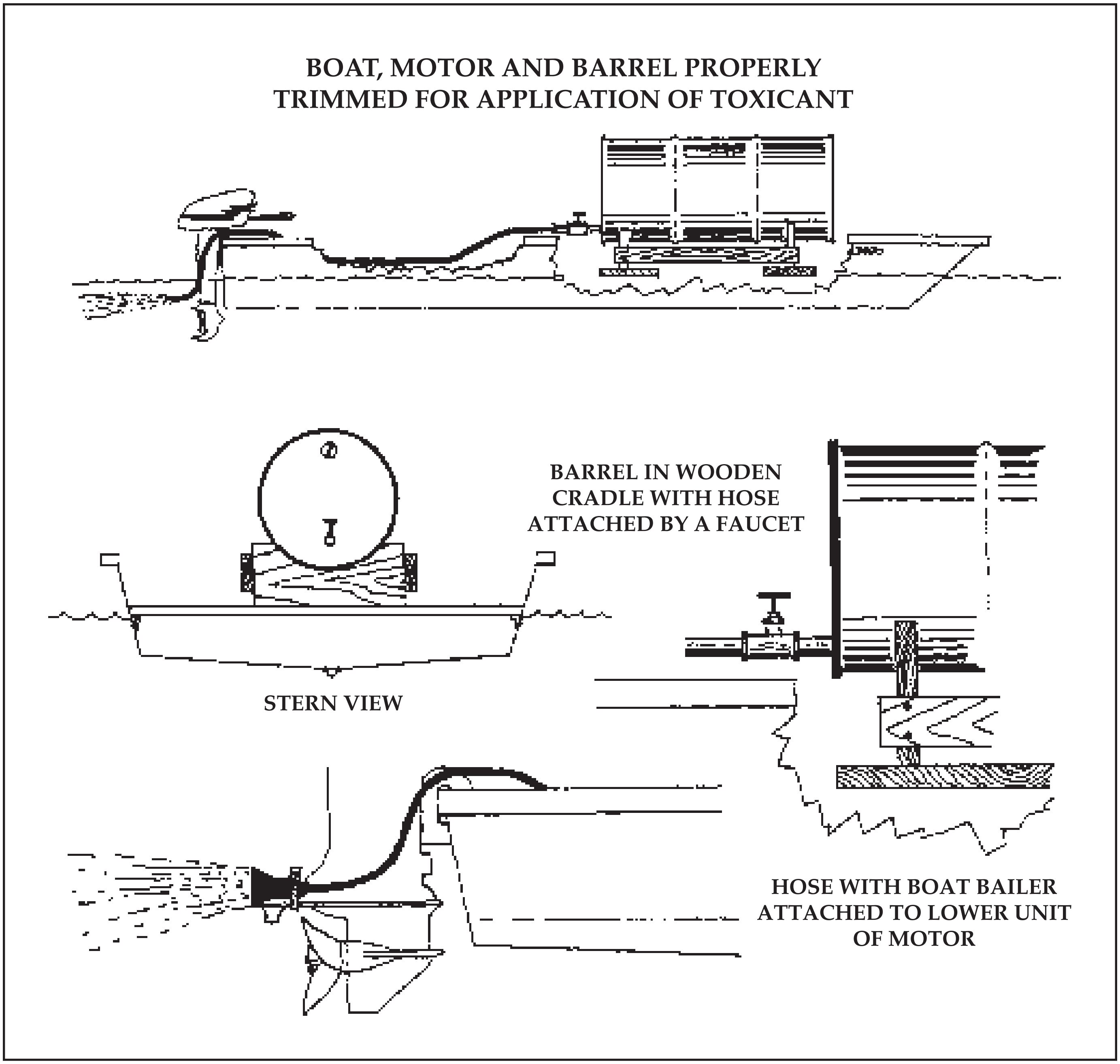

Figure 10-6. "Venturi rig" for applying liquid fish toxicants.

For small lakes, a spiral treatment pattern with a venturi rig may be the most efficient. Treatments start from shore and proceed toward the center in a spiral pattern. The distance between successive whorls should not exceed 30 feet. This is necessary for thorough coverage because wind and wave action does not carry chemical effectively to all water areas.

Because of the complex nature of flowing waters, applications to streams, irrigation ditches or other flowing water require professional planning and implementation.

Flowing waters may require continuous introduction of toxicant from one or more stations for a period of time. Effective treatment of flowing water systems depends on several factors, including:

— Chemical concentration (calculate volume of area being treated to determine dose).

— Contact time (determine flow rate in cubic feet per second).

— Type of target fish.

— Water temperature (colder water temperatures may reduce effectiveness of piscicides).

— Water turbidity and pH.

— Weather conditions.

Piscicides

Piscicides work by interfering with fish cellular respiration. Piscicides are generally nontoxic to most mammals and birds at the concentrations used to kill fish, but swine may be adversely affected. Some piscicides leave a detectable taste or odor for up to a month after water is treated. Taste and odor can be removed immediately by treating the water with activated charcoal at a rate of 300 parts per million for each 1 part per million piscicide remaining.

Piscicide toxicity is influenced by species, size of fish, water temperature, pH and oxygen concentration, the presence of suspended matter in the water, sunlight, and metabolic activity of aquatic organisms.

Concentrations of piscicides lethal to fish will not harm submersed or emergent aquatic vegetation. The presence of aquatic plants can interfere with application, however, and reduce the efficacy of fish toxicants. If masses of floating plants are present, the toxicant should be distributed under the floating masses. To avoid this placement problem due to the presence of aquatic plants, treat in the fall after plants have died back. Be aware that piscicides can last longer in the cool water that's typical of fall or spring conditions.

Silt can adsorb toxicants, thereby reducing their effective concentration.

In thermally stratified lakes, some toxicant solutions do not penetrate the thermocline. This can be an advantage if the intent is to remove the warm-water species and cold-water species remain in the lower, colder depths where the piscicide may not penetrate. This separation of zones based on temperature cannot be relied on completely to protect nontarget species because some cold-water species forage in the upper zones where they are exposed to piscicides. Also, some cold-water species are diurnal and move into the upper zones at night. Warm-water species can also move out of the treated area by moving into lower, colder zones, thereby avoiding lethal concentrations.

Piscicides are photochemically degraded, so if sunny weather is predicted, applications should be made early in the morning or late in the day to allow time for a reaction.

Fish Sensitivity to Piscicides

Through research experiments and observation, biologists have divided fish species into three groups with high, moderate and low sensitivity to piscicides. In general, scaled fish are more sensi-

Table 10-3. Relative Resistance of Fishes to Piscicides (Adapted from Illinois Pesticide Applicator Training Manual 39-6, Aquatics, 1989).

Least resistant (Most susceptible)	Moderately resistant (Moderately susceptible)	Most resistant (Least susceptible)
Gizzard shad	Bigmouth buffalo	Black bullhead
Minnows	Black crappie	Bowfin
Trout	Bluegill	Channel catfish
Walleye	Brook stickleback	Flathead catfish
Yellow perch	Carp	Goldfish
	Fathead minnow	Shortnose gar
	Freshwater drum	White catfish
	Largemouth bass	
	Northern pike	
	Northern redbelly dace	
	Quillback	
	Smallmouth bass	
	Spotted sucker	
	Sunfish	
	White crappie	
	White sucker	

Listing within groups is in alphabetical order.

tive than bullheads or other catfish, sunfish are moderately sensitive, and species such as yellow perch and trout are highly sensitive to piscicides.

The duration of fish exposure to a lethal dose of piscicide — contact time — is a critical factor. In streams a chemical can move past the fish, and in standing bodies of water rapid dilution or degradation is likely. Fish must receive a lethal dose before the fish or the toxicant moves from the treated area.

If the water body has outlets, it is important that the application method does not repel the fish. Understand the properties of the product you select. One piscicide currently registered by EPA repels fish. If you use this product, close off all known outlets so the fish do not escape before receiving a lethal dose. An alternative is to use a different product. If these outlets are creeks or streams, treatment effects may be short-term because fish will be able to reenter the area. Treatments should not be attempted without proper authorization and experienced applicators. Develop an acceptable plan for disposing of the dead fish before making a treatment. Digging pits and burying them deep enough so that raccoons and other fish-eating animals cannot get to them may be an option. Burying the fish lessens the stench that accompanies fish decay. Use of approved landfills in the area of your treatment is most likely required to dispose of dead fish. The MDNR is exploring a method for composting dead fish. Check with local authorities for proper disposal procedures.

Lampreys (Primitive Vertebrates): a Problem to Great Lakes Fish

Four native lamprey species occur in Michigan, along with one species, the sea lamprey, that is not indigenous. Sea lampreys are considered pests in Michigan waters. Sea lampreys are native to the Atlantic Ocean. They were introduced to the Great Lakes beginning in the late 1880s with the completion of the Erie and Welland canals. Food supplies were abundant and stream conditions ideal for reproduction and survival. By 1938, sea lampreys were present in all five of the Great Lakes.

The sea lamprey is considered a pest because, in its lifetime, a single sea lamprey can kill 40 or more pounds of fish by attaching to the fish with its sucking disk and horny teeth and using its sharp tongue to rasp through scales and skin to feed on fish body fluids. To kill large fish such as salmon and lake trout usually takes more than one attack by a sea lamprey. Several attacks will weaken the fish and ultimately kill it.

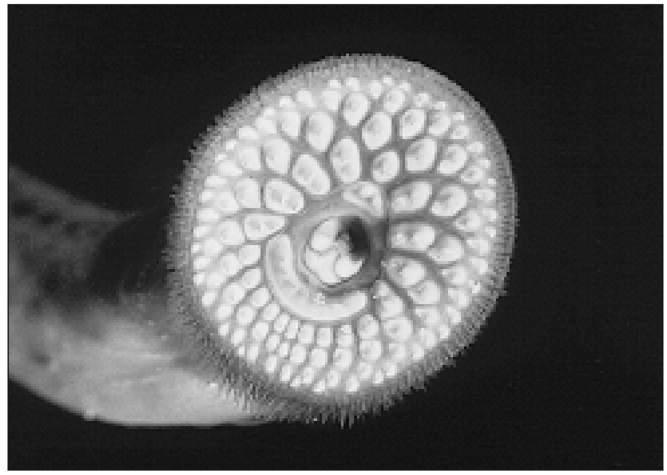

Figure 10-7. "Sea lampreys' horny teeth." Credit: Michigan Sea Grant Program.

The sea lamprey was a major cause of the severe reduction in populations of lake trout, whitefish and other desirable and commercially valuable fish in the Great Lakes during the 1940s and 1950s. Today fish populations are abundant and

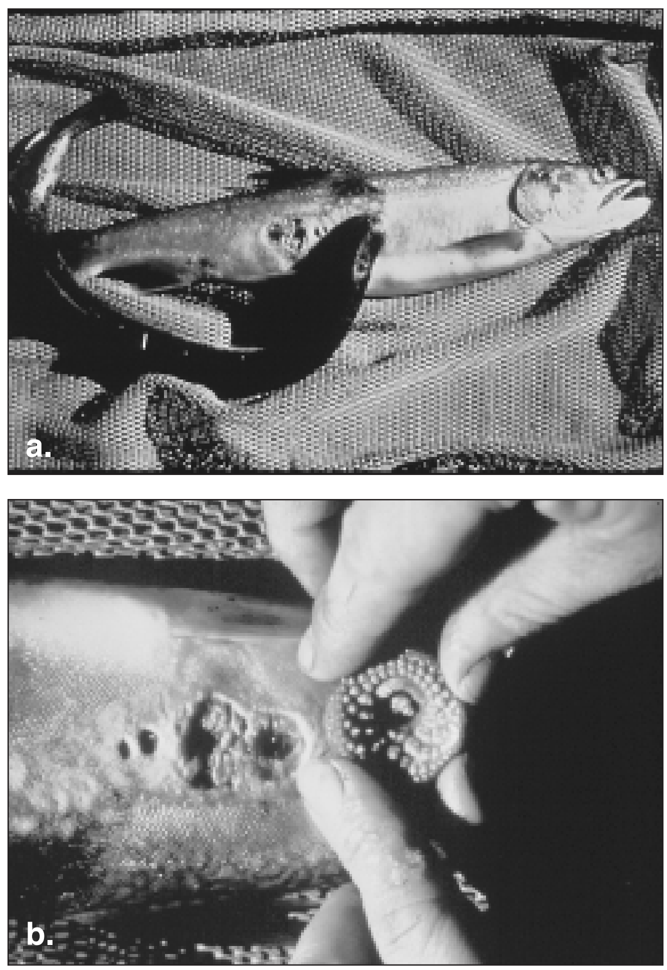

Figure 10-8 a & b. "Injury to sport fish caused by sea lamprey attack." Credit: Michigan Sea Grant Program.

the Great Lakes again rank high as a source of recreational and commercial fisheries. This revival can be directly attributed to the international sea lamprey management program.

Figure 10-9. "Sea lamprey attached to a desirable Great Lakes fish." Credit: Michigan Sea Grant Program.

Aquatic pest managers are not involved in sea lamprey management because control programs are administered only by governmental agencies. The Great Lakes Fishery Commission funds the Sea Lamprey Control Program for American waters. The cooperating agencies in Canada include the Department of Fisheries and Oceans and the Ontario Ministry of Natural Resources. The U.S. Fish and Wildlife Service contracts with the Great Lakes Fishery Commission and implements the control procedures for the United States.

If you encounter a lamprey population or receive inquiries, contact the U.S. Fish and Wildlife Service sea lamprey control unit.

Piscicide Calculations

Work through the following equations to familiarize yourself with calculating appropriate rates for treatments associated with fish management. Calculations for piscicide applications to flowing water and standing water follow. You will not be responsible for knowing the constants and how they are derived, but you do need to have a working knowledge of the equations.

Standing Water Example: Piscicide Application

1. Obtain all appropriate permits and certification.
2. After identifying the species that needs to be eradicated, determine the amount of piscicide needed to apply to standing water when the recommended label rate is 3 ppm, the effective contact time (ECT) is 10 minutes (determined by species susceptibility to the piscicide) and the pond is 100 feet by 75 feet by 4 feet average depth.

> Constants (conversion factors) needed for this equation:
>
> - 43,560 cubic feet/acre foot
> - 0.326 gallons of piscicide/acre foot/ppm
> - 3,785 ml per gallon

Determine the volume of the pond in acre feet:

$$= \frac{\text{length x width x average depth}}{\text{43,560 cubic feet/acre foot}}$$

$$= \frac{\text{100 ft. x 75 ft. x 4 ft.}}{\text{43,560 cubic feet/acre foot}}$$

= 0.689 acre feet

Determine the gallons of piscicide needed for a 3 ppm application:

= Acre feet to be treated x 0.326 gallons piscicide/acre foot/ppm x desired ppm

= 0.689 acre feet x 0.326 gallons piscicide/acre foot/ppm x 3 ppm

= 0.674 gallon

Determine the milliliters of piscicide to add to sprayer (convert gallons to ml):

= 0.674 gal. x 3,785 ml/gal.

= 2,551.09 ml

3. Determine the pumping rate of your sprayer in gallons per minute (GPM).

   Use 0.22 GPM for this example.

4. Determine the output of the spray tank when making this 10 minute (10 ECT) application.

   = Duration of treatment (ECT) x pumping rate (GPM)

   = 10 ECT (min) x 0.22 GPM

   = 2.2 gallons of output

Convert gallons of solution to ml:

= 2.2 gallons x 3,785 ml/gallon

= 8,327 ml solution

Determine the amount of water to be added to the spray tank:

= Total solution in sprayer – Amount of piscicide

= 8,327 ml of total solution – 2,551.09 ml piscicide

= 5,776 ml water

Potassium Permanganate ($KMnO_4$)

If you need to apply $KMnO_4$ to detoxify a piscicide application, use the following calculations:

Constants needed:
- 453.5 grams per pound
- 16 ounces per pound
- grams = milliliters

1. Determine clarity and water temperature values.

Clarity values		Water temperature values		
Clear	1.00	Hot	(> 30°C)	1.00
Turbid	1.25	Warm	(24° to 29°)	1.25
Muddy	1.50	Cold	(18° to 23°)	1.50

2. Determine the multiplier value if you are applying $KMnO_4$ to turbid, hot water.

$$\text{Multiplier value} = \text{(clarity value)} + \text{(temperature value)}$$

$$= 1.25 + 1.00$$

$$= 2.25$$

3. Determine pounds of $KMnO_4$ needed to detoxify the 2551.09 ml of piscicide you added in the standing water example.

$$\text{Grams of } KMnO_4 = \frac{2551.09 \text{ ml}}{29.573 \text{ ml/ounce}} \times 2.25$$

$$= 86.26 \text{ ounces} \times 2.25$$

$$= 194 \text{ ounces} \times 1\text{lb}/16 \text{ ounce}$$

$$= 12.13 \text{ lbs.}$$

As a general rule, the MDNR finds that 5 ppm of $KMnO_4$ detoxifies 3 ppm of the piscicide rotenone.

Marker Dye

Often a marker dye is used to determine where the piscicide has been added in flowing water. The dye, sprayed before the piscicide application, enables the applicator to know where to apply the detoxicant, if needed.

Flowing Water Example: Piscicide Application

1. Obtain all appropriate permits and certification.

2. Determine the estimated discharge rate of the stream in cubic feet per second (CFS). Refer to Chapter 8, "Pesticide Application Equipment and Techniques" in this manual.

   Set barrier nets above and at the end of the treatment section and mixing section of the stream being treated.

Constants (conversion factors) needed for this calculation:
1.7 ml/min/CFS/ppm of piscicide product
3,785 ml/gallon

3. Determine the amount of piscicide needed to apply per minute to the flowing water when the recommended rate of product is 4 parts per million (ppm) for 10 minutes ECT, and the discharge rate is 26.49 cubic feet per second (CFS).

   ml product/minute

   = discharge rate x 1.7 ml/min/CFS/ppm x rate of application

   = 26.49 CFS x 1.7.ml/min/CFS/ppm x 4 ppm

   = 180.13 ml/min.

   Total ml product = ml product/min x min ECT

   = 180.13 ml/min x 10 min ECT

   = 1801.3 ml piscicide

4. Determine the pumping rate of your sprayer in gallons per minute (GPM). Use 0.22 GPM for this example.

5. Determine the output of the spray tank when making this 10 minute (10 ECT) application.

   = Duration of treatment (ECT) x pumping rate (GPM)

   = 10 ECT (min) x 0.22 GPM

   = 2.2 gallons output.

   Convert gallons of solution to ml:

   = 2.2 gallons x 3,785 ml/gallon

   = 8,327 ml of solution.

Determine the amount of water to be added to the spray tank:

= Total solution (ml) in sprayer – Amount of piscicide (ml)

= 8,327 ml – 1801.3 ml piscicide

= 6525.7 ml water to add to tank.

Detoxification with $KMnO_4$

Calculate the amount of potassium permanganate ($KMnO_4$) needed to detoxify the piscicide application. Starting at the end of the treatment zone on the stream, the MDNR generally detoxifies for a period of time before and after the application time. In the above flowing water example, calculate for 10 minutes before, during and 10 minutes after the treatment has reached and passed through the mixing zone (the end of the treated area).

As a general rule, the MDNR finds that 5 ppm of $KMnO_4$ detoxifies 3 ppm of the piscicide rotenone.

Then 4 ppm rotenone is detoxified with 6.67 ppm $KMnO_4$.

Conversion factor = 1.7 g/minute/CFS/ppm product

Note: gram = cc = ml water

Determine application rate of $KMnO_4$ g/min:

= Discharge rate (CFS) x 1.7g/min/CFS/ppm x Desired ppm

= 26.49 CFS x 1.7 g/min/CFS/ppm x 6.67 ppm

= 300.37 g/min

Determine total grams of $KMnO_4$ needed for duration of application:

= Application rate g/min x (10 min before + 10 min during + 10 min after)

= 300.37 g/min x (10 min + 10 min + 10 min)

= 9,011.1 g

Drip System Piscicide Calculation, Calibration and Worksheet

The following can be used as a standard step-by-step procedure for setting up picicide drip systems along a flowing stream to ensure sufficient contact time at the specific labeled rates.

For this example we will use the following data:

County drain length
to be treated = 2 miles = 10,560 ft.

Average width = 10 ft.

Average depth = 4 ft.

Flow rate = 20 cfs (cubic feet per second)

60 seconds x 60 minutes = 3600 seconds per hour

Label Dose Rate = 1.7 ml/cfs/min

Step 1 – Calculate county drain volume.

Calculate stream volume in cubic feet based on water levels at the time of treatment by using the following formula:

County drain length (ft) x Avg. width (ft) x Avg. depth (ft) = cubic feet of water.

10,560 ft. x 10 ft. x 4 ft. = 422,400 cubic ft.

Step 2 – Calculate turnover time.

Calculate the amount of time it takes for the water in the stream to be replaced by new water, based on water flow rate at the time of treatment using the following formula:

$$\frac{\text{County drain volume (cubic feet)} \div \text{Flow rate (CFS)}}{3{,}600\ \text{sec/hr}} = \text{Turnover time in hours}$$

$$\frac{422{,}400\ \text{cubic feet} \div 20\ \text{CFS}}{3{,}600\ \text{sec/hr}} = 5.8\ \text{hrs}$$

Step 3 – Calculate total piscicide requirements.

Determine the amount of piscicide required to achieve a 1 ppm level with the volume of the stream.

First, convert the label dosage rate from (ml/cfs/min) to (ml/cfs/hour) since the turnover time of the flowing water is in hours:

= Label dosage rate (ml/CFS/min) x 60 min/hour

= 1.7 ml/CFS/min x 60 min/hour

= 102 ml/CFS/hour

Now, determine the total amount of piscicide required for treating this flowing water:

= Label dosage rate (ml/cfs/hr) x Flow rate (CFS) x Turnover time

= 102 ml/CFS/hour x 20 (CFS) x 5.8 hrs

= 11,832 ml piscicide.

To convert ml of piscicide into gallons of piscicide:

= ml piscicide ÷ 3,785 ml/gallons

= 11,832 ml ÷ 3,785 ml/gallons

= 3.1 gallons.

Step 4 – Number and distance between drip sites.

Determine the number of drip sites required based on the turnover time (hrs) by using the chart below:

Turnover time (hrs)	Number of drip sites
Less than 4.5	1
4.6 – 7.5	2
7.6 – 10.5	3
10.6 – 13.5	4
13.6 – 16.5	5
etc.	

Based on a turnover time of 5.8 hours, calculated in step 3, the chart indicates that two drip systems are required.

Therefore:

$\frac{10{,}560 \text{ ft.}}{2}$ = 5,280 ft. between drip systems (place one system at the head of the county drain & measure 5,280 ft. downstream)

Step 5 – Calculate piscicide required for each drip site.

Calculate as follows:

$$\frac{\text{Total piscicide required (gal)}}{\text{No. of drip sites}} = \text{piscicide product required at each site (gallons)}$$

$$\frac{3.1 \text{ gal}}{2 \text{ sites}} = 1.55 \text{ gal/site}$$

Step 6 – Drip duration per site.

Based on the labeled dosage rate of 1.7 ml of pesticide per cfs per minute, determine the amount of drip time required for application at each site using the following formula:

$$\frac{\text{Piscicide required per site (gal)} \times 3785 \text{ ml/gal}}{\text{Label rate ml/cfs/min} \times 60 \text{ min/hr} \times \text{flow rate (cfs)}} = \text{Drip duration (hrs) per site}$$

$$\frac{1.55 \text{ gal X } 3785 \text{ ml/gal}}{1.7 \text{ ml/cfs/min x } 60 \text{ min/hr x } 20 \text{ cfs}} = \frac{5{,}866.75 \text{ ml}}{2{,}040 \text{ ml/hr}} = 2.87 \text{ hr}$$

Step 7 – Drip rate conversion and calibration.

To determine the drip rate in ml per minute, use the following formula:

Flow Rate (cfs) x Drip rate (ml/cfs/min) = Drip rate in ml/min

20 cfs x 1.7 ml/cfs/min = 34.0 ml/min

Conclusion and Explanation

Based on the example used, this county drain would be treated with two drip systems 5,280 feet (1 mile) apart. Each would be supplied with 1.55 gallons of product to be applied simultaneously at a rate of 34 ml/min. Treatment would take 2.86 hours. Suitable contact time is ensured but piscicide levels within any section of the drain would not exceed 1 ppm.

Similar calculations would be required for detoxification of the product and for use of marker dye.

Always read and follow all directions and precautions on the product label.

Chapter 10 – Fish Management Review Questions

Write the answers to the following questions, and then check your answers with those in the back of this manual.

1. Pesticides used for the purpose of killing fish are called ________________________________.

2. The age of a catfish can be determined by counting the number of annuli — thick growth rings— on their scales. True or False?

3. What are the two probable causes of stunting of bluegills or other sunfish?
   1.
   2.

4. Which statement concerning seining is incorrect?
   a. Nylon netting from 1/4 to 1/2 inch is best for removing small panfish.
   b. The pond bottom should be smooth and free of snags and dense weeds.
   c. Seining should be done frequently in the warm season to be effective.
   d. Both a and c.
   e. None of the above.

5. Fish traps may be useful for reducing populations in ponds that have obstacles to seining. True or False?

6. List the three occasions when you should have available copies of the labels and MSDS for the pesticides being used.
   1.
   2.
   3.

7. A piscicide applied to water can be neutralized by:
   a. Dilution.
   b. Natural degradation.
   c. Detoxification.
   d. Both b and c.
   e. All of the above.

8. List six of the nine factors that must be taken into account when considering the rate of neutralization.
   1.
   2.
   3.
   4.
   5.
   6.

9. For a large pond, the surface and the edges can be sprayed with a centrifugal pump having enough pressure to throw a stream of water 30 to 40 feet. True or False?

10. Effective treatment of flowing water systems is dependent upon several factors including:
    1.
    2.
    3.
    4.
    5.
    6.

11. The fish least susceptible to piscicides is:
    a. Black crappie.
    b. Trout.
    c. Black bullhead.
    d. White sucker.

12. Black bullhead need to be removed from a pond that is 200 feet long, 80 feet wide and has an average depth of 5 feet. A piscicide concentration of 3 ppm for 15 minutes (ECT) is required for an effective treatment of bullhead.
    a. Determine the volume of the pond in acre feet of water and how much piscicide product is required to obtain a 3 ppm concentration. There are 43,560 cubic feet per acre foot of water.
    b. Next, determine how much water should be added to the spray tank if the sprayer has a pumping rate of .25 GPM when making this 15-minute application..

13. Use the following data to solve the following questions.

Canal to be treated = 1.5 miles = 7,920 feet

Average width = 15 feet

Average depth = 5 feet

Flow rate = 20 cfs (cubic feet per second)

60 seconds x 60 minutes = 3,600 seconds per hour

Label dose rate = 1.5 ml/cfs/min

Step 1 – Calculate the volume of the canal as cubic feet of water.

length x avg. width x avg. depth = volume (cubic feet)

Step 2 – Calculate the canal turnover time.

$$\frac{\text{Vol. of canal (cu ft.)} \div \text{Flow rate (cfs)}}{\text{3,600 seconds/hour}} = \text{Time (hrs)}$$

Step 3 – Determine the amount of piscicide required to achieve a 1 ppm concentration in the canal. First, convert the label dosage rate from (ml/cfs/min) to (ml/cfs/hour) since the turnover time of the flowing water is in hours:

Label dosage rate (ml/CFS/min) x 60 min/hour.

Next, determine the total amount of piscicide required for treating this flowing water:

= Label dosage rate (ml/cfs/hr) x Flow rate (cfs) x Turnover time

Convert ml of pisicide to gallons of piscicide:
= ml piscicide ÷ 3,785 ml/gallon

Step 4 – Determine the number of drip sites and the distance between the drip sites.

Turnover time (hrs)	Number of drip sites
Less than 4.5	1
4.6 – 7.5	2
7.6 – 10.5	3
10.6 – 13.5	4
13.6 – 16.5	5
etc.	

$$\frac{\text{Length of canal}}{\text{\# of drip sites}} =$$

Step 5 – Calculate the amount of piscicide required for each drip site.

$$\frac{\text{Total piscicide required (gal)}}{\text{No. of drip sites}} = \text{piscicide product required at each site (gal)}$$

Step 6 – Determine the duration of the drip application at each site.

$$\frac{\text{Piscicide required per site (gal)} \times \text{3785 ml/gal}}{\text{Label rate ml/cfs/min} \times \text{60 min/hr} \times \text{flow rate (cfs)}} = \text{Drip duration (hrs) per site}$$

Step 7 – Determine the drip rate in ml per minute using the following formula:

Flow Rate (cfs) x Drip rate (ml/cfs/min)

= Drip rate in ml/min