SRAC
Southern Regional Aquaculture Center

SRAC Publication No. 4101
April 2010

Removing Fish from Ponds with Rotenone

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In the southern United States, most fish culture ponds are stocked with a single species, a production method called monoculture. Unless two or more species of fish are intentionally grown in the same pond (polyculture), the presence of additional fish species may cause management problems. Undesirable fish species may:

- Prey on the cultured species
- Overpopulate the pond
- Compete with the cultured species for food and spawning habitat
- Contribute to water quality deterioration
- Interfere with seining and grading
- Make harvest more difficult because fish must be sorted
- Cause weigh-backs or dockages when fish are sold to processing plants
- Transmit disease to cultured species

It is not uncommon for aquaculture ponds to contain undesirable species of fish. Although birds and other wildlife are often blamed for introducing unwanted fish species, most of the time introductions are the result of accidental or intentional stocking by humans. Eggs, fry or small fish may be introduced when unfiltered surface water is used to fill production ponds. Unwanted fish may be mixed with fish moved from one location to stock another. For example, green sunfish may be in a pond of channel catfish fingerlings, and when those fingerlings are harvested, transported and stocked into a pond for grow-out, the sunfish also are introduced into the grow-out pond. Fish may also enter ponds over spillways and through drains from drainage ditches during heavy rains and flooding. Proper site selection and pond construction can significantly reduce the probability of such events.

There are physical methods of removing unwanted fish, such as water level draw-downs, seining and electrofishing. Lowering the water level increases predation on small fish and limits the spawning habitat of the unwanted species. Shoreline seining may also remove some small fish. Combining water level draw-down and seining may be effective, particularly in small ponds, but usually a pond must be completely drained to remove all fish. Electrofishing, which uses electricity to stun or kill fish, is not usually effective and can be dangerous when done by inexperienced operators.

Approved fish toxicants

Chlorine, rotenone and antimycin A are the only fish toxicants currently approved by the U.S. Environmental Protection Agency (EPA). Chlorine is a non-restricted, general use pesticide that is used as a fish toxicant and algaecide.

Rotenone is derived from the roots and stems of certain tropical and subtropical plants. Rotenone kills fish by inhibiting cellular respiration and the ability to use dissolved oxygen. In effect, the fish suffocate. Fish exposed to lethal rotenone concentrations move to the surface and gasp for oxygen as if the water was oxygen-depleted. However, rotenone does not reduce the amount of oxygen dissolved in the pond water. Rotenone is sold under the brand names Fish Tox®, Nox-Fish®, Prentox®, Chem Fish® and Nusyn NoxFish®).

Products containing rotenone are restricted-use pesticides. **Restricted-use pesticides may be applied only by a certified private applicator on his or her own property, or by a licensed commercial pesticide applicator.** Rotenone can be hazardous to people and the environment if not handled and applied correctly. For information about pesticide applicators' licenses con-

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tact your county Extension office or state department of agriculture. Rotenone should not be used in, or allowed to enter, public waters, except when applied by authorized personnel. A land owner or farm manager may be held liable if fish are killed in non-treated waters. Before applying rotenone, read and carefully follow the label and supplemental instructions and contact a local fisheries biologist, conservation officer, agriculture and natural resources Extension agent, or Extension fisheries specialist for assistance.

Except for swine, which are sensitive to rotenone, livestock can drink water from a treated pond. As a precaution, however, it is best to wait a few days before giving livestock and pets access to treated water. Human swimming and wading may resume 3 days after treatment. Crops should not be irrigated with treated water. The Food and Drug Administration (FDA) has not approved the use of rotenone in ponds that contain fish destined for human or livestock consumption.

Uses of rotenone

Rotenone has two main uses in aquaculture. The first is to remove unwanted fish species from ponds before restocking fry or fingerlings. Most of the unwanted fish can be removed by draining, siphoning or pumping the pond dry. Then pools left in the pond basin can be treated with rotenone to eradicate any remaining fish.

The second use of rotenone is to remove unwanted fish selectively from fish communities. To do this the treatment rate must be adjusted, because different fish species have different sensitivity to rotenone. For example, grass carp and shad are sensitive to this chemical and can be killed with a low concentration of rotenone. It should be noted, however, that using rotenone to selectively eliminate fish species can be risky; non-target fish species may be killed if water quality conditions vary, if the application rate is miscalculated, or if the product is improperly applied.

Calculating application rate

Rotenone will remove fish only if the correct concentration is applied. The first step in calculating the proper amount of chemical to apply is to determine the pond surface area and average depth. If the pond is rectangular, multiply its length (feet) by its width (feet) to calculate the surface area in square feet. Then divide the surface area in square feet by a conversion factor of 43,560 square feet to convert pond surface area in square feet to surface area in acres. For example:

Pond length 700 ft × pond width 300 ft = 210,000 ft^2

Pond surface area of 210,000 ft^2 ÷ 43,560 ft^2 per acre = 4.82 acres

The average depth of the pond must be calculated to determine its water volume in acre-feet (1 acre-foot is 1 acre of water, 1 foot deep). There are 43,560 ft^3 in 1 acre-foot, which contains 325,850 gallons of water. Take pond depth measurements in a grid pattern across the entire surface area. Then add the depth measurements and divide the total by the number of depth measurements taken to calculate average pond depth. Finally, multiply the water surface area in acres by the average pond depth to get pond volume. Using the example above:

Pond surface area of 4.82 acres × 6 ft average depth = 28.9 acre-ft of water volume in the pond

28.9 acre-ft of water × 325,850 gal per acre-ft = 9,417,065 gal of water in the pond

For more information on calculating the surface area and water volume of a pond see SRAC Publication No. 103.[1]

The application rate for rotenone is 0.1 to 5.0 mg/L for the 5% active ingredient liquid and powder formulations. A 2.5% liquid formulation containing a 2.5% synergist is also available. Concentrations of 1 to 3 mg/L are used to remove most fish populations. Higher concentrations are needed when treating a pond with less sensitive fish species such as bullhead catfish and common carp (Table 1). Higher concentrations also are required when resistant species must be removed from ponds that are rich in organic material.

Table 1. General guide to the application rates and concentrations of rotenone required to control fish in ponds and lakes.

Type of use	5% rotenone (mg/L)	Active rotenone (mg/L)	Number of acre-feet treated by 1 gallon
Selective treatment	0.10 to 0.13	0.005 to 0.007	30 to 24
Normal pond use	0.5 to 1.0	0.25 to 0.50	6.0 to 3.0
Removal of bullhead catfish or common carp	2.0 to 4.0	0.100 to 0.200	1.5 to 0.75
Removal of bullhead catfish or common carp in organic-rich ponds	3.0 to 5.0	0.150 to 0.250	1.0 to 0.60

Adapted from Kinney, Edward. 1965. Rotenone in Fish Management. USD, Washington, D.C. Leaflet FL-576.

For a 3 mg/L rotenone treatment, 1 gallon of 5% liquid emulsifiable or 7 pounds of 5% wettable powder is enough chemical to treat 1 acre-foot of water. Liquid rotenone should be diluted in water at a ratio of at least 10:1 before application. Similarly, 5 pounds of rotenone powder should be mixed with 10 gallons of water before application. Liquid rotenone may be easier to mix and apply than the wettable powder. For more information on calculating rotenone treatments see SRAC Publication No. 410.[2]

There have been some concerns recently about the environmental impact of the petroleum products used to make liquid rotenone. Rotenone should be applied only according to the label instructions. Wear the proper safety equipment listed on the product label when handling and applying this chemical, including coveralls, a long-sleeved shirt, long pants, chemical-resistant gloves and boots, socks, and a dust/mist respirator.

Application methods

Bluegill and other sunfish can be partially controlled by applying rotenone around the shoreline during the sunfish spawning season when water temperatures are approximately 75 °F (24 °C). However, complete pond renovation may be the only effective way to eliminate sunfish. Gizzard shad and grass carp are relatively sensitive to rotenone, and a complete pond treatment of 0.10 mg/L can be used to selectively kill these fish.

Rotenone is most effective when the water is cool (45 to 75 °F, 7 to 24 °C), free of aquatic plants and dense algae blooms, and has low dissolved oxygen, low turbidity and low alkalinity. Rotenone is more toxic to fish in warm water but the chemical dissipates more quickly then and may not kill all fish present. Rotenone will break down more rapidly when applied during intense sunlight. Turbid water or water with large amounts of organic matter, vegetation or algae may require higher application rates, especially if fish are resistant. The ideal application conditions are morning hours when water pH is lowest, an overcast sky, and water temperature about 60 °F (15 °C).

Because rotenone is more toxic to fish than to fish eggs, the most effective time to apply the chemical is in the fall after most fish species have completed spawning. When possible, lower the pond's water level to reduce the water volume before applying the chemical. This will reduce the cost of the treatment and lessen the chance of contaminating the environment downstream should a heavy rain cause the pond to overflow. **As with all chemical applications, the applicator is liable for damage to off-target areas.**

Lowering the water level also makes it easier to reach all areas of the pond. However, draining too much water from the pond may make it hard to maneuver a boat without stirring up sediment and organic matter from the pond bottom. Disturbed sediments and organic matter will reduce the effectiveness of the rotenone. It is important to remember that all areas with standing water, whether they are holes or simply footprints, must be treated to eliminate eggs, larvae and small fish. Rotenone should also be applied to any holes in the pond's banks and puddles in the pond's watershed.

Fish will detect rotenone in the water and try to escape exposure, so spray the chemical first around the shallow waters of the shoreline to eliminate holes and other habitat where fish can take refuge. A chemical tank and pressure sprayer work well. Use a weighted line(s) from a boat to apply the chemical to the deepest waters. The entire water column must be treated throughout the pond. When applied properly, the chemical should corral fish near the surface of the water. Then, the entire pond surface can be treated by spraying just below the surface or distributing the chemical with the prop-wash of an outboard motor. Fish may be allowed to decay in the pond or buried on land. For more information on applying aquatic chemicals see SRAC Publication No. 360.[3]

Rotenone will detoxify in 1 to 4 weeks depending on the rate of chemical application, water temperature and other environmental factors. The water can be tested for residual rotenone by placing fathead minnows in a minnow bucket suspended at the pond surface. If the minnows survive for 48 hours the pond should be ready for restocking. If there is a need to quickly detoxify rotenone, add potassium permanganate or chlorine to the water at the application rate used for rotenone. The two chemicals quickly oxidize rotenone to a non-toxic by product. After detoxifying rotenone with either potassium permanganate or chlorine, test the water with fathead minnows as described above before restocking with fish.

Summary

Physical methods (such as seining, water level drawdowns and electrofishing) are generally ineffective at removing large numbers of unwanted fish from ponds, particularly small fish. Even when ponds are completely drained it may be necessary to chemically eradicate fish that remain in standing pools, puddles and water-filled holes. Rotenone can be used to remove all the fish in a pond or selectively kill some species that are sensitive to the chemical. A higher concentration will be needed to kill resistant species. Rotenone is a restricted-use pesticide and can be applied only by a certified private applicator on his or her own property, or by a licensed commercial pesticide applicator. The applicator is liable for any off-site damages.

References

[1]Masser M.P. and J.W. Jensen 1991. Calculating Area and Volume of Ponds and Tanks. Southern Regional Aquaculture Center Publication No. 103. Mississippi State University. Mississippi State, Mississippi.

[2]Masser M.P. and J.W. Jensen 1991. Calculating Treatments for Ponds and Tanks. Southern Regional Aquaculture Center Publication No. 410. Mississippi State University. Mississippi State, Mississippi.

[3]Avery J.L. 2003. Aquatic Weed Management: Herbicide Safety, Technology, and Application Techniques. Southern Regional Aquaculture Center Publication No. 3601. Mississippi State University. Mississippi State, Mississippi.

SRAC fact sheets are reviewed annually by the Publications, Videos and Computer Software Steering Committee. Fact sheets are revised as new knowledge becomes available. Fact sheets that have not been revised are considered to reflect the current state of knowledge.

United States Department of Agriculture

National Institute of Food and Agriculture

The work reported in this publication was supported in part by the Southern Regional Aquaculture Center through Grant No. 2008-38500-19251 from the United States Department of Agriculture, National Institute of Food and Agriculture.