

FL 576

UNITED STATES DEPARTMENT OF THE INTERIOR, STEWART L. UDALL, SECRETARY
Frank P. Briggs, Assistant Secretary for Fish and Wildlife
Fish and Wildlife Service, Clarence F. Pautzke, Commissioner
Bureau of Sport Fisheries and Wildlife, John S. Gottschalk, Director
Washington, D.C. 20240 · Leaflet FL-576 · January 1965
(Supersedes FL-350, August 1949)

ROTENONE IN FISH POND MANAGEMENT

by

Edward C. Kinney
Staff Specialist
Division of Fishery Management Services

ROTENONE is a chemical compound extracted from roots of many species of plants of the bean family. In some areas it may be called derris or cube. It is a modern ingredient in some insecticides, but has been used for centuries by natives to capture food fish.

Rotenone, used in fish management in the United States since 1934, is lethal to fish but not particularly toxic to mammals. Swine are more sensitive to the chemical than other mammals tested.

CAUTION: Rotenone in powder form will cause respiratory irritation if inhaled. A mask or damp cloth over the face during mixing is recommended. Liquid rotenone spray should not be allowed to drift onto personnel.

The laws of all States prohibit use of fish toxicants, including rotenone, in public waters except by authorized personnel, and many States restrict application of poisons in any waters. Do not use rotenone or other fish toxicants without approval of the appropriate State agency, usually the fish and game or conservation department.

Some common uses of rotenone in fish management are:

1. To obtain a complete kill of fishes in a pond, lake, reservoir or stream. Purposes are to eliminate competitive or undesirable species so stocked fish will be more successfully established, to remove overabundance of stunted fish or coarse fish, to remove disease carriers in hatchery water supplies, and to prevent clogging of intake screens by fish at pumping stations.

2. To obtain a partial fish kill. Purposes are to thin populations of stunted fish to provide more space and food for the remaining fish, and, in investigative work, to sample for species, numbers, sizes and condition of fishes.

3. To obtain a selective fish kill. Careful application of rotenone can kill large numbers of gizzard shad, a nuisance fish, with minimum loss of game fishes. Successful selective kills also have been made on threadfin shad and freshwater drum.

Commercial rotenone formulations are available in liquid and powder form. The active ingredient content varies from less than 1 percent to 20 percent. Liquids containing 5 percent active ingredients are commonly used. Information concerning sources of rotenone, including special formulations used in fish control, may be obtained from dealers in farm supplies and agricultural chemicals or from fishery biologists.

Several types of rotenone products are available for special uses. Some liquid preparations are more effective than powders in cold water. Some are for use in warm surface waters while others are made to penetrate into cooler, deeper waters. For water supply reservoirs, formulations are available which have little effect on water taste and odor.

Cost for rotenone to treat a 1-acre pond having an average depth of 3 feet is \$5 to \$15, depending on the type and concentration used.

Although some lakes have been treated successfully at water temperatures as low as 44° F., best results may be expected when water is 60° or above. Some manufacturers recommend application when surface waters are 70° or higher.

The concentration to use depends on purpose, kinds of fish, and water temperature and quality. The following table is a general guide:

<u>Type of Use</u>	<u>Parts Per Million</u>	
	<u>5% Rotenone or Equivalent Mixture</u>	<u>Active Rotenone or Equivalent</u>
Selective treatment	0.10 - 0.13	0.005 - 0.007
Normal pond use	0.5 - 1.0	0.025 - 0.050
Remove bullheads or carp	1.0 - 2.0	0.050 - 0.100
Remove bullheads or carp in rich organic ponds	2.0 - 4.0	0.100 - 0.200
Preimpoundment treatment above dam	3.0 - 5.0	0.150 - 0.250

(Note: Most literature on the subject, and most manufacturers' data are based on amounts of 5 percent rotenone.)

Accurate determination of the volume of water to be treated is essential for calculating the amount of rotenone to apply. Volume usually is figured in acre-feet; one acre-foot is the unit of volume having an area of 1 acre and a depth of 1 foot; it contains 43,560 cubic feet, 326,000 gallons, or 2,718,000 pounds.

Average depth may be found by sounding a pond along several transects with a weighted line or a pole marked off in feet and inches, adding all measurements and dividing by the number of soundings.

EXAMPLE: Surface area of a pond is 35,700 square feet or 0.82 acre (43,560 square feet in an acre). Average depth from 25 soundings is 32 inches or 2.67 feet. Area times depth in feet gives 2.19 acre-feet.

Commercial rotenone preparations intended for fishery use contain instructions on the labels on amounts to use. Amounts to use of 5 percent liquids, which weigh about the same as water (8.3 pounds per gallon), are usually given as follows:

<u>Amount</u>	<u>Acre-feet</u>	<u>Approximate Parts Per Million of Mixture</u>
1 gallon	6	0.5
1 gallon	3	1.0
1 gallon	1½	2.0

For 5 percent powdered rotenone 2.7 pounds equals one part per million of the mixture per acre-foot of water. The pounds to use may be obtained by multiplying the acre-feet to be treated times the parts per million of the rotenone mixture recommended times 2.7.

For powdered rotenone other than 5 percent the following formula may be applied to determine the amount to use:

$$\frac{\text{Acre-feet} \times \text{ppm active rotenone recommended} \times 2.7}{\text{Percent rotenone in product to be used}} = \text{Pounds to apply}$$

EXAMPLE: A concentration of 0.1 ppm rotenone (not mixture) is recommended for a total kill. The rotenone mixture available contains 2 percent rotenone.

$$\frac{2.19 \times 0.1 \times 2.7}{0.02 (2\%)} = 29.6 \text{ pounds of 2 percent rotenone}$$

It is very important that rotenone be applied to obtain a uniform distribution throughout the water treated. Some of the common methods used to apply rotenone in ponds and small lakes are by garden sprayers, backpack pumps, boat bailers, garden-hose syphon, gasoline-powered pumps, and by hand. In using pumps or boat bailers, the rotenone should be mixed with water before application rather than applying it at full strength. A wash tub or garbage can makes a convenient container for mixing. Liquid rotenone mixes readily with water.

Powdered rotenone must be thoroughly stirred so that all lumps are dissolved. An oar or boat paddle provides a good stirring device. The amount of water to use depends upon the strength of the rotenone mixture and the application method. It is better to add enough water to cover the entire area and have a few gallons left than to run out before complete coverage is obtained.

EXAMPLE: A 1-acre pond having a maximum depth of 9 feet is to be treated with 1 gallon of 5 percent rotenone. The equipment to be used includes a small boat (12-15 ft.) with motor having a reverse or complete traverse, a venturi type boat bailer with 5 to 6 feet of suction hose, a 5-gallon hand pump or sprayer, a 14 to 18 gallon wash tub, a bucket, a pint or quart can, one or more dip nets (long handled preferred) and normal boat-safety equipment. Use one of the following methods to assure adequate coverage:

a. On the basis of volume, place or locate markers along the shore so that the pond will be divided into three sections each with about the same amount of water. About half of the pond area will be in the upper, shallower section and about one-third of the area will be in the center section. Put a quart of rotenone in the tub and almost fill the tub with pond water. Apply by using the boat with bailer in operation to cover one of the end sections. Repeat the process for the other two sections. Place a pint of rotenone in the hand pump and fill tank with water. Spray the shoreline paying careful attention to muskrat and crayfish holes, vegetated areas and any puddles in the watershed which might contain fish. The remaining pint should be mixed with water and applied to any areas which were overlooked. What is left should be distributed in the deeper waters. The boat is then run around the pond several times at maximum safe speed to insure mixing.

b. Mix one quart of rotenone as in previous instructions. Circle the shoreline by boat making the paths about 6 feet apart at the shallow end and 3 feet apart at the deeper end. Cover about one-third of the pond per tub of mixture. Use the remaining quart of rotenone as in previous instructions.

The application can be carried out by one man in about 30 minutes. Two men, one in the boat and one along the shore can cover the area in 10 to 15 minutes. An extra man in the boat can act as a lookout for snags, help keep the boat on course and pick up fish. An extra man on shore can assist in picking up fish. The operation can be carried out using only hand pumps but unless the pond is narrow at least a rowboat is required.

Some types of rotenone do not penetrate the deeper parts of a pond (20 to 25 feet or more) when applied on or at the surface. The deeper parts are usually treated by pumping the mixture through a weighted garden hose with nozzle, or through a section of perforated hose or lawn sprinkler type perforated hose. If powdered rotenone is used, it may be towed in a porous bag at various depths. If powdered rotenone

is used in a pump, it should be thoroughly mixed to prevent clogging of the hose nozzle or perforations. Excellent distribution can be obtained by using a gasoline-powered pump using a short section of garden hose with nozzle for shallow areas and a 25-foot section of perforated sprinkler hose for deeper areas. If powdered rotenone is used, the perforations should be enlarged by piercing a few of the openings with an ice pick. A one-fourth to one-half pound weight should be tied on the end of the tubing so that the deepest water can be covered to the bottom without the boat's being in motion. By adjusting the speed of the boat the weight can be kept close to the bottom. At the end of the operation, the pump and hoses can be easily cleaned by pumping pond water until the discharge is clear. The weight should be removed from the perforated hose before cleaning.

The boat, tubs and other equipment should be washed before leaving the area to prevent contamination of other waters.

Within 10 to 15 minutes after treatment starts, fish will surface and dart about as though having lost their sense of balance. There may also be some gasping and gulping of air. The fish do not remain on the surface for long. During hot weather it is handy to have a cooler chest containing ice available for temporary storage of fish intended for table use. Other fish should be buried to prevent odor and fly problems. After death, most fish sink to the bottom until bloating causes them to rise to the surface again. A complete kill will usually be obtained in from 24 to 36 hours.

It has been reported that rotenoned fish will recover if rescued from the treated water at the first signs of distress and placed in untreated water. Most fish, however, are collected too late for revival.

Waters which have been treated with rotenone will usually detoxify within a few days to a month, but some colder waters may remain toxic for a month and a half. Rapid detoxification is favored by the use of lower concentrations. Other factors which favor rapid detoxification are high water temperatures, high alkalinity and abundant light and aeration.

Potassium permanganate has been used successfully to oxidize rotenone in treated waters (Lawrence, 1955). It may be applied to neutralize the effects of the rotenone so as to protect downstream fishes in event that the pond overflows. It is also used in conjunction with partial treatment of lakes and ponds to reduce the damage to the non-target species such as bass. It can be used to detoxify a pond under special conditions following application of rotenone. Potassium permanganate is also toxic to fish and should be used with care. Lawrence (op.cit.) found that at 81° F., potassium permanganate killed bluegills at 3 p.p.m.; largemouth bass at 4 p.p.m.; and fathead minnows at 5 p.p.m. At 58° F.,

bass and bluegill were killed at approximately 5 p.p.m. Concentrations of potassium permanganate equal to the parts per million of rotenone used will usually detoxify most of the rotenone. Various devices have been developed to distribute large amounts of potassium permanganate. For pond use, the towing of a burlap bag containing the crystals behind the boat is satisfactory.

Before the rotenone treated water is stocked, the water should be tested to make certain that it is not toxic. There is a chemical test for rotenone (Post, 1955) which is fairly accurate. A simple test for toxicity may be made by placing live-boxes, usually minnow buckets, containing test fish in a few areas in the pond. Since there is danger of the test fish escaping, only species which are intended for stocking should be used. Since the deeper, cooler water is likely to remain toxic over a longer period of time, one live-box should be placed on the bottom in the deeper section. Testing deeper water is complicated by the fact that the bottom waters may not contain sufficient oxygen to support fish. Thus, if the test fish survive in all live-boxes except the one in the deep water, the cause of mortality could be residual rotenone or low oxygen or both. Testing for oxygen requires special water sampling equipment and chemicals. (Ellis et al., 1948)

In conclusion the following points are stressed:

1. Before rotenone is applied, the need for its use should be determined by a fishery biologist.
2. Before rotenone is applied, permission should be obtained from the proper State authorities.
3. An accurate determination should be made of the amount of water to be treated.
4. The amount of rotenone to be used should be the minimum recommended for the type of treatment required.
5. Rotenone should be distributed uniformly throughout the volume of water treated.
6. Waters should be tested for toxicity before fish are stocked.
7. Approved State and Federal stocking recommendations as to kinds and numbers of fishes and times of stocking should be followed.
8. Steps should be taken to keep species of fish, other than those stocked, out of the pond. This may include bank and spillway modification to prevent fish access from other waters and the prohibition of the use of certain bait fishes.

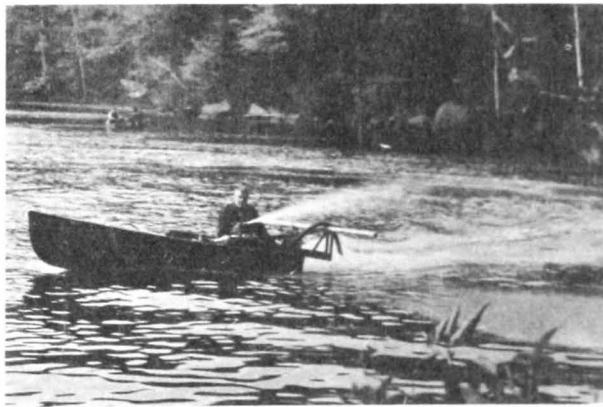
Additional information concerning the use of rotenone in fish ponds and technical assistance available may be obtained in some States from the local representative of the State fish and game department. This is usually either the county fish and game law enforcement officer or the State district fishery biologist. In some States, the Soil Conservation Service assists cooperators in pond management.

References

- Ellis, M. M., B. A. Westfall and M. D. Ellis. 1948. Determination of water quality. U. S. Fish and Wildlife Service, Research Report 9, 122 p.
- Lawrence, J. M. 1955. Preliminary results on the use of potassium permanganate to counteract the effects of rotenone on fish. Proceedings Southeastern Association of Game and Fish Commissioners, p. 87-92.
- Post, George. 1955. A simple chemical test for rotenone in water. U. S. Fish and Wildlife Service, Progressive Fish-Culturist, vol. 17, no. 4, p. 190-191.
- Sowards, Charles L. 1961. Safety as related to the use of chemicals and electricity in fishery management. Bureau of Sport Fisheries and Wildlife, Washington, D. C. 33 p.
- Welch, Paul S. 1948. Limnological methods. McGraw-Hill Book Co., 381 p.



Application of rotenone by hand pump.



Application of rotenone by gasoline-operated pump.

The Department of the Interior, created in 1849, is concerned with management, conservation, and development of water, wildlife, fish, mineral, forest, and park and recreational resources. It also has major responsibilities for Indian and Territorial affairs.

As America's principal conservation agency, the Department works to assure that nonrenewable resources are developed and used wisely, that park and recreational resources are conserved for the future, and that renewable resources make their full contribution to the progress, prosperity, and security of the United States, now and in the future.

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
BUREAU OF SPORT FISHERIES AND WILDLIFE
WASHINGTON, D.C. 20240

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF THE INTERIOR