research management
findings
Number 9 • March 1988

FALL USE OF ROTENONE AT LOW CONCENTRATIONS TO ERADICATE FISH POPULATIONS

by Jeff Roth and Vern Hacker

Emulsified rotenone has been used for many years to eradicate unbalanced fish populations to improve sport fishing. Until recently, rotenone was mainly applied during the warmer periods of the year. However, rotenone detoxifies rapidly in warm, sunlit waters, especially in turbid or alkaline conditions. Applying rotenone in summer, then, particularly when turbidity levels are high, results in detoxication so rapid that resistant species survive the treatment.

Treatment immediately before freeze-up results in a prolonged period of low-level toxicity. At that time, the feeding actions of species such as carp and bullheads are greatly slowed, and turbidity resulting from suspended bottom materials is at the annual minimum. Also, light levels are declining as ice and snow cover develop.

Over the past several years, fish managers of the Wisconsin Department of Natural Resources (WDNR) have been experimentally treating lakes with reduced levels of rotenone in the week before freeze-up with good results. This article documents the methods and results of initial studies conducted in northwest Wisconsin on Perch and Lund lakes.

Description of the Lakes

Perch Lake (70 acres) and Lund Lake (22 acres) are located approximately 6 miles north of Drummond in Bayfield County. Both are landlocked, seepage lakes surrounded by 60% mixed upland hardwoods and 40% lowland marsh with total volumes of 1,304 acre ft and 257 acre ft, respectively. Bottom substrate in both lakes includes sand, gravel, and muck, and aquatic vegetation is common. The waters are similarly soft, clear and slightly acidic.

Before treatment the fish population in Perch and Lund lakes included muskellunge (*Esox masquinongy*), largemouth bass (*Micropterus salmoides*), and black crappie (*Pomoxis nigromaculatus*). In addition, Perch Lake had pumpkinseed (*Lepomis gibbosus*) and central mudminnow (*Umbra limi*) while Lund Lake had white sucker (*Catostomus commersoni*). The fish populations of both lakes were unbalanced with below average growth rates and few harvestable-size fish.

Studies Before and After Treatment

Oxygen/temperature profiles were collected immediately prior to treatment and twice during the detoxification period. Zooplankton samples were taken in August prior to treatment, twice in 1980, and once in 1981. A No. 20 mesh plankton net and cup were towed vertically (20 ft bottom to surface) and horizontally (5-10 ft depth) in various locations throughout each lake to document the species present. Samples were preserved in the field and later analyzed at the University of Wisconsin-Stevens Point.

Post treatment bioassays were initiated the week of treatment and continued monthly until detoxification occurred. Three wire mesh cages containing tempered white suckers and rainbow trout were set immediately below ice cover, at mid-depth, and at bottom levels at various locations in each lake. Cages were inspected periodically each day and condition of test fish recorded. Dissolved oxygen readings were taken on-site. Fyke net and boom shocker surveys were conducted in April 1980 to determine the status of the fish population after treatment.

Treatment

Perch Lake was treated on 6 November 1979 at 10:00 a.m. with 317 gallons of 0.75 mg/l synergized rotenone. Application was complete by 1:15 p.m. The lake was divided into 4 treatment zones and each zone was treated with a calculated amount of rotenone (Fig. 1).

The diluted mixture (lake water and rotenone) was sprayed over the entire lake surface and pumped into the deepest portion. We used a specially designed sprayer boat with adjustable intakes and perforated sprayer booms constructed from 2-inch pipe. A small portable water pump was used to mix the water/rotenone solution in-line. By adjusting a series of valves we varied the dispersal of rotenone within each treatment zone, which assisted in an even application. In shallow bays a conventional flat bottom boat equipped with two 50-gal

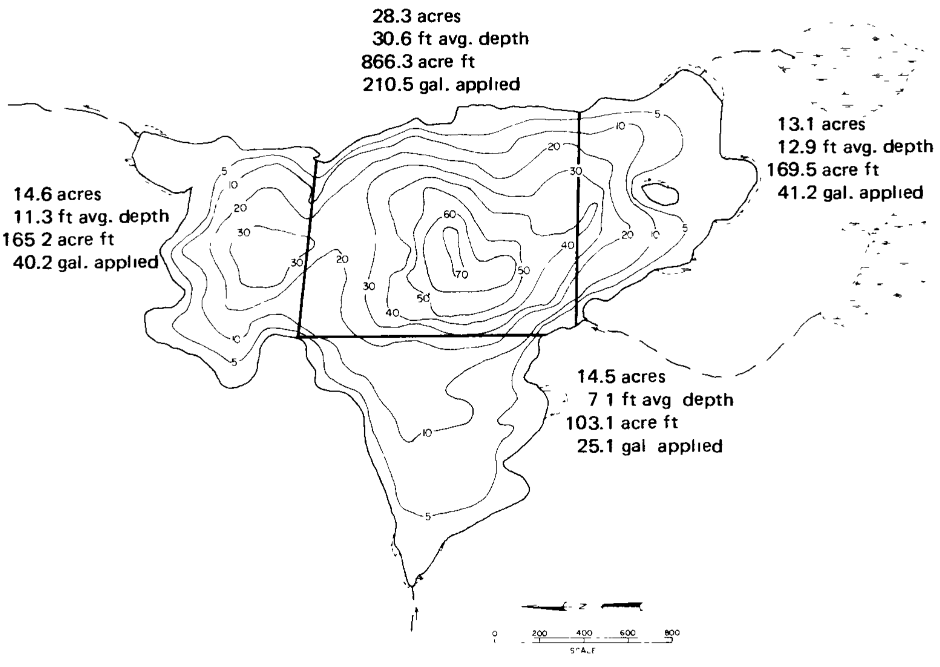

FIGURE 1. Map of Perch Lake showing the 4 treatment zones and the amount of rotenone used in each zone.

drums, a Homelite water pump, and a 6 ft by 1/2 inch pipe was employed instead of the heavier equipment to reduce turbidity. Lund Lake was treated in much the same way, with 42 gallons of rotenone applied at a concentration of 0.50 mg/l.

Results and Discussion

Based on fall and winter bioassay results on Perch Lake, the exposure period required to kill fish lengthened from the 3-6 hours on the day of treatment to 36 hours in February (Table 1). Rates in Lund Lake were similar although slightly longer exposure periods were required at any given time to secure a complete kill of the test species. Detoxification did not occur until approximately 4 months after treatment. That conclusion was reached after test species remained alive during 336 hours of exposure in mid-March. Death rates of caged fish were consistently the same at all depths in both Lund and Perch lakes. We believe, however, that the detoxification rate was greatly increased by a late February thaw and the resulting dilution effects.

Electrofishing and fyke net surveys in April 1980 indicated complete eradication of the fish populations in both lakes. Zooplankton species composition and abundance were similar before and after treatment. Although benthic populations were not studied, the literature suggests that benthic invertebrates are very resistant to rotenone when the organisms are residing on natural substrates.

Follow-up Study

Detailed bioassays were conducted on a comparable lake, Patterson Lake, Price County, treated on 8 November 1982. Bioassays were run at concentrations of 0.0 (control), 0.25, 0.50, 0.75, and 1.0 mg/l on white sucker, pumpkinseed, bluegill, and central mudminnow. The first signs of stress occurred in the 1.0 mg/l and 0.75 mg/l tanks after 2.5 hours. Water temperatures remained relatively constant throughout the study period with the lake at 4.4 C and test barrels at 1.6 C. After 5.5 hours of exposure, mortalities were observed in the 0.50, 0.75, and 1.0 mg/l test tanks, with all species affected.

Exposure time for an 80% kill of test fish (all species combined) at various concentrations is listed in Table 2. A complete kill was achieved in 19.25 hours in all but the 0.25 mg/l tank. All fish remained alive and unstressed in the control tank. The 0.25 mg/l bioassay contained live fish after 24.25 hours although fish were "slightly gilling." A projected

TABLE 1. Bioassay results from Perch and Lund lakes using rainbow trout and white sucker submerged in wire mesh cages on 5 dates.

Date of Bioassay	Time Required to Kill Test Fish (hours) Perch Lake	Lund Lake
7 Nov 1979	3-6	3-6
10 Dec 1979	8	8
7-8 Jan 1980	26	29
25-26 Feb 1980	36	48
12-26 Mar 1980	alive after 336	

TABLE 2. Bioassay results (80% kill) from a follow-up study in Patterson Lake on 8 November 1982 using white sucker, central mudminnow, pumpkinseed, and bluegill at 4 concentrations.

Time (hours)	Rotenone Concentration (mg/l) 0.25	0.50	0.75	1.00
5- 6				X
9-10			X	X
17-18		X	X	X
25-30*	X	X	X	X

*Projected time.

exposure period of 25-30 hours would be required at this concentration and water temperature to cause fish death. White suckers were least tolerant while central mudminnows were most resistant to the rotenone.

Conclusions and Management Implications

Applying rotenone at low concentrations just prior to freeze-up has some distinct advantages. The low concentrations used can cut the cost of toxicant in half. Clean-up and odor problems are eliminated since fish are left to decompose under the ice. Detoxification time, though long, is not as long as documented for winter treatment and doesn't present the logistical problems with restocking in the spring that winter treatment does. However, effects on more tolerant fish species, not tested in this study, are unknown. Dilution from any source appears to be a critical factor in maintaining the exposure period. Thus, seepage lakes are most suitable.

If you are considering chemical treatment at low concentrations:

1. Treat as close to "ice-up" as possible. Perch and Lund lakes had an ice fringe approximately 20 feet from shore the day of treatment.

2. Make certain even dispersal of rotenone occurs. Ideally, high wind action would occur immediately after application followed by total ice cover the next day.

3. Avoid creating turbidity, which assists detoxification. At low concentrations of rotenone, turbidity could determine whether or not a complete kill is achieved.

4. Use a rotenone concentration of at least 0.50 mg/l (assuming water chemistry similar to our study).

5. Consider climate of the treatment site when planning your project. Climate will determine how soon dilution occurs. In-lake bioassay results (see Table 1) will vary within Wisconsin.

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