

# Rotenone Use in North America (1988–2002)

## Introduction

The American Fisheries Society (AFS) Fish Management Chemicals Subcommittee (FMCS) conducted surveys of governmental agencies in North America in 1998 and 2001 to determine use patterns and issues (McClay 2000, 2002). Here I report on a follow-up survey covering 2001 and 2002 and on 15 years (1988–2002) of data from the three surveys.

## Methods

In the current survey, 95 questionnaires were sent to 83 jurisdictions in 69 agencies representing all 50 states, 2 U.S. territories, 11 Canadian provinces and territories, 4 federal agencies, and 1 Native American tribe. Information was requested on the quantity of rotenone used, treatment objectives, and issues. I also queried the interest for a proposed training program on the use of fish management chemicals and a new liquid formulation that has significantly less petroleum-hydrocarbon solvent.

Multiple responses from the same agency were consolidated into one response (e.g., responses for five U.S. Fish and Wildlife Service [USFWS] regions were consolidated). Quantities of rotenone are reported as kg of active ingredient (AI). One gallon of liquid rotenone (2.5% synergized or 5%) contained 0.1909 kg of AI for applications made through the year 2001 and 0.175 kg of AI for applications made in 2002. One pound of 5% powdered rotenone contained 0.0227 kg AI, although some lots of “5%” powder may actually contain up to 7.5% rotenone. One pound of Carp Management Bait<sup>®</sup> contained 0.0273 kg AI for all years.

## Results and Discussion

### Response

Seventy-six responses (80%) were received from 64 agencies (93%) representing 49 states, 2 U.S. territories, 10 Canadian provinces and territories, USFWS, U.S. Department of Agriculture Forest Service (USFS), and National Park Service (NPS). The response rate in the current survey (80%) was slightly below the 82% and 87% obtained in the previous surveys (McClay 2000, 2002). Sixteen surveys were sent to the 7 regional offices of the USFWS and 9 surveys were sent to the regional offices of the USFS. Eight responses (50%) were received from 3 USFWS regions and 4 responses (44%) were received from 4 USFS regions. One state (Tennessee) and 1 Canadian province (Newfoundland) did not respond.

### Scope of use

Rotenone was used by 29 states, 2 Canadian provinces (Alberta and New Brunswick), and 2 federal

agencies (NPS and USFWS) during 2001–2002. During the 15-year survey period, a total of 38 states and 5 provinces used rotenone and it was used annually in at least 26 states and 1 Canadian province. Rotenone has been used by governmental agencies in at least 35 states for more than 50 years (McClay 2000). Twelve states have not used rotenone in the past 15 years (1988–2002): Arizona, Connecticut, Hawaii, Massachusetts, New Hampshire, New Jersey, New Mexico, Ohio, Oklahoma, Pennsylvania, Rhode Island, and Vermont. Seven Canadian provinces have not used rotenone in the past 15 years (1988–2002): Manitoba, Newfoundland, Nova Scotia, Northwest Territories, Ontario, Prince Edward Island, and Saskatchewan. Carp Management Bait<sup>®</sup> was used in only 4 states (Iowa, Idaho, Illinois, and Louisiana) in 1998, 1999, and 2001.

### Quantities used and water treated

A total of 4,261 kg of rotenone were used by governmental agencies during 2001–2002, with a total of 112,124 kg used for the 15-yr period (Table 1). The quantities used during 2001 and 2002 were the lowest in the last 15 years (Figure 1). The reasons for the low use could not be determined from the survey responses but are likely related to stressed governmental budgets. Overall, there has been a general decrease in the volume of standing water treated, but an increase in the length of flowing water treated; in 2002, 44 hm<sup>3</sup> and 257 km were treated compared to a yearly average of 109 hm<sup>3</sup> and 168 km treated during the period 1988–1997.

The total amount of rotenone used annually (all formulations) was highly variable during 1988–2002 (Figure 1), likely a function of sporadic use by several high consumption states. Eleven states and 1 Canadian province accounted for 89% of the rotenone used during the period 1988–2002 (Table 2). In 1988, 2 states (California and Minnesota) used 56% (1,958 kg and 2,265 kg, respectively) of the total (7,573 kg). In 1989, Wisconsin used 61% (9,701 kg) of the total (15,964 kg). In 1990, Utah used 79% (20,764 kg) of the total (26,139 kg), all on 1 project (Strawberry Reservoir). In 1991, 2 states (California and Utah) used 60% (2,865 kg and 3,225 kg, respectively) of the total (10,162 kg). And in 1997, California used 42% (4,519 kg) of the total (10,683 kg).

There were no obvious trends in the quantities of liquid or powder used during the 15-year period

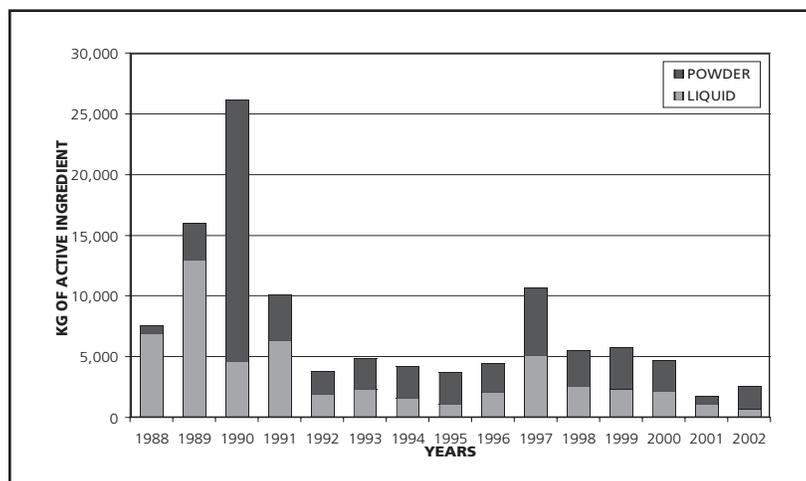
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**Table 1.** Amount of rotenone used (kg AI) in the United States and Canada by water type and formulation from 1988–2002. Actual kg of powder used may be slightly more than reported because some lots of powder contain up to 7.5% rotenone.

Water type	Total use (kg)			
	Powder	Liquid	Carp bait	All formulas
Standing	58,226	50,733	7	108,966
Flowing	207	2,951	0	3,158
<b>Total</b>	<b>58,433</b>	<b>53,684</b>	<b>7</b>	<b>112,124</b>

**Figure 1.** Amount of rotenone used (liquid, powder, and carp bait) in North America (1988–2002).



1988–2002 (Figure 1). Most of the rotenone used (97%) was applied to standing waters (Table 1). In standing waters, the use of powder rotenone only slightly exceeded the use of liquid rotenone (53% vs. 47%). Use of Carp Management Bait<sup>®</sup> was negligible as only 4 states used almost 7 kg (Louisiana in 1998, 2.7 kg; Illinois and Louisiana in 1999, 3.3 kg; and Iowa, Idaho, and Illinois in 2001; 0.7 kg).

### Uses of Rotenone

The principal reasons for the use of rotenone in 2001 and 2002 remained unchanged from the 1988–1997 (McClay 2000) and the 1998–2000 survey (McClay 2002). These were quantification of fish populations (34% of the waters treated), manipulation of fish populations to maintain sport fisheries (27%), and treatment of rearing ponds (17%). Rotenone also played an important role in the eradication of exotic species (10% of the waters treated) and in the restoration of threatened and endangered species (7%), although the quantity used was not large.

The average number of waters treated annually for all purposes decreased 12% for the period 1998–2002 compared to 1988–1997 (483 vs. 423). For these periods, the average number of waters treated annually to manipulate fish populations for maintenance of sport fisheries declined the most, from 42% of the total (1988–1997) to 27% (1998–2002). The average number of rearing facilities treated annually (for these periods) increased (from 14% to 22%), as did treatments to remove exotic fish (from 3% to 10%). The average number of waters treated annually to quantify populations remained essentially unchanged (31% vs. 30%) during these periods. The reasons for the changes could not be determined from the survey responses.

### Rotenone Treatment Procedures

Agencies were asked if they used specific treatment procedures. The results indicated that for the 5-year period 1998–2002 (compared with the period 1988–1997), more agencies performed environmental assessments (54% vs. 47%), monitored treatments with bioassays (51% vs. 44%), and monitored treat-

ments with water samples for chemical analysis (33% vs. 27%). However, fewer agencies neutralized with potassium permanganate (56% vs. 74%).

### Issues facing users of rotenone

Data from this and the two previous surveys (McClay 2000, 2002) show that an increasing proportion of U.S. and Canadian agencies are addressing a variety of issues when using rotenone (Table 3). Further, these agencies have been required to address more of those issues and the issues had greater significance than reported in previous surveys. However, two of the most significant issues continue to be (1) public notification and education and (2) public health.

### Training

Sixty-seven percent of the respondents to the 2001–2002 survey indicated they felt that training for the application of rotenone would be beneficial. Sixty-five percent indicated that they would participate in such training if it were available through AFS or USFWS. In response to that interest level, the FMCS and USFWS developed a 5-day training program in cooperation with the National Conservation Training Center

**Table 2.** Largest users of rotenone from 1988–2002 (quantities are in kg of active ingredient).

State/Province	15 year total use (kg)	% of total use	Cumulative %	Average annual use (kg)
Utah	26,705	23.8%	23.8%	1,780
Washington	17,528	15.6%	39.4%	1,169
Wisconsin	12,411	11.1%	50.5%	827
Minnesota	12,142	10.8%	61.3%	809
California	9,464	8.4%	69.7%	631
Michigan	4,272	3.8%	73.5%	285
Quebec	3,630	3.2%	76.7%	242
Illinois	3,517	3.1%	79.9%	234
North Dakota	2,883	2.6%	82.5%	192
Nebraska	2,754	2.5%	85.0%	184
Iowa	2,567	2.3%	87.3%	171
Arkansas	2,283	2.0%	89.3%	152
Other	11,968	10.7%	100.0%	798
<b>Total</b>	<b>112,124</b>			

**Table 3.** Proportion of fish and wildlife agencies that have addressed specific issues during three survey periods and the relative significance scores (0=Not Significant; 5=Most Significant) for the two most recent surveys.

Issue	% of Agencies (Significance)		
	1988-1997	1998-2000	2001-2002
Public notification and education	32%	64% (2.4)	64% (2.2)
Liability or property damage	15%	33% (0.7)	52% (1.2)
Public health	43%	58% (1.5)	57% (1.9)
Surface or ground water quality	32%	52% (1.2)	59% (1.6)
Air quality	9%	24% (0.4)	30% (0.6)
Residue in fish	22%	33% (0.5)	46% (1.1)
Animal welfare—fish	32%	36% (0.6)	54% (1.2)
Animal welfare—wildlife	30%	36% (0.6)	55% (1.3)
Animal welfare—reptiles and amphibians	NA	42% (0.9)	55% (1.3)
Animal welfare—invertebrates	28%	42% (0.7)	50% (1.1)
Collection and disposal of dead fish	48%	70% (1.2)	59% (1.5)
Public opposition	NA	NA	55% (1.5)
Regulations	NA	NA	61% (1.8)

(NCTC) in Shepherdstown, West Virginia. The first class was held in fall 2003 with a subsequent class held in spring 2004. For a description of the class and schedule, contact the NCTC (<http://training.fws.gov/>) and request information on "Rotenone and Antimycin Use in Fish Management" (Course Code FIS2132).

### **New liquid formulation**

Eighty-five percent of the respondents indicated they would consider using a formulation (currently registered in the United States as CFT Legumine®) that contains significantly less petroleum-hydrocarbon solvents and 17% indicated they thought their use might increase.

### **Conclusions**

Rotenone remains an important fishery management tool. In the last 15 years (1988–2002) it has been used by a total of 38 states and 5 Canadian provinces, continuing a trend of use by at least 35 states for more than 50 years (McClay 2000). Eleven states and 1 Canadian province accounted for 89% of rotenone use.

Although an earlier survey (McClay 2000) pointed to a decline in use over the 10-year period 1988–1997, trends in the total quantity of rotenone used over time are less evident with the addition of another 5 years of data. Wide fluctuations in annual use and the amount of different types of waters treated (standing or flowing) each year make it difficult to identify trends.

Most rotenone use (>93% annually) occurs in standing water. Overall, the volume of standing water treated generally has decreased, but the length of flowing water treated has increased.

More agencies are addressing public health and environmental issues in their planning and execution of projects. Agencies appar-

ently are responding to these issues by performing more environmental assessments and monitoring more treatments with bioassays and water samples for chemical analysis. The majority of responders felt that training for the use of rotenone would be beneficial and 65% indicated that they would participate in such training.

Many of the issues faced by North American fisheries managers using rotenone have to do with public health, air and water quality, residues in fish, and animal welfare. One contributing factor is that the liquid formulations currently available contain significant quantities of petroleum-hydrocarbons. A liquid formulation used in Europe contains significantly less hydrocarbon compounds. This formulation is currently registered in the United States under the trade name CFT Legumine® (available through Prentiss Incorporated) and is undergoing field-testing in the United States. It is likely that, depending on cost, many agencies would switch to the new liquid formulation to minimize the public issues they face when proposing fisheries management projects involving the use of rotenone. 

### **Acknowledgments**

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