INVESTIGATIONS IN FISH CONTROL

71. Field Tests of Isobornyl Thiocyanoacetate (Thanite) for Live Collection of Fishes

United States Department of the Interior

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INVESTIGATIONS IN FISH CONTROL

71. Field Tests of Isobornyl Thiocyanoacetate (Thanite) for Live Collection of Fishes

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FIELD TESTS OF ISOBORNYL THIOCYANOACETATE (THANITE) FOR LIVE COLLECTION OF FISHES

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Abstract

Eight ponds containing a total of 28 species of fish were treated with isobornyl thiocyanoacetate (Thanite) to test its efficacy for the live collection of fish. Twenty-six species were collected alive after 1- to 4-μl/l applications of Thanite. Most scalefishes except carp *(Cyprinus carpio)* were relatively easy to collect, and catfishes (Ictaluridae) were generally the most resistant to effects of the chemical. With the exception of northern pike *(Esox lucius)*, most fish recovered quickly after being placed in fresh water. Most fish collected within 1.5 h after treatment survived, but survival rates decreased with time of exposure. The concentrations effective for collection of live fish did not routinely eliminate all fish; small numbers of at least eight species of fish survived treatments of 1.5 μ l/l or more. The high percentages of fish (of most species) collected alive demonstrated that Thanite is effective for the intended purpose.

Introduction

The development of a safe, efficacious, and relatively inexpensive chemical that would permit the live collection of desirable fishes from a body of water would be of distinct benefit to fishery management programs. The availability of a chemical that facilitated live collection would make it possible to harvest predator fish at comparatively low cost. Sport fishing could benefit in yet another way: desirable fishes that are otherwise lost when ponds and lakes are renovated or when flood waters dry up could be salvaged for stocking in public fishing areas.

Various investigators have tested many compounds to determine their advantages and limitations as collecting aids: cresol (Embody 1940; Wilkins 1955; Howland 1969); sodium sulfite (Westman and Hunter 1956); sodium sulfite catalyzed with cobalt chloride (Vanderhorst and Lewis 1969); sodium cyanide (Lewis and Tarrant 1960; Tatum 1969); fresh walnut hull extracts (Westfall et al. 1961); LSD-25 (Loeb 1962); derivatives of d-lysergic acid (Loeb et al. 1965); rotenone (Tate et al. 1965); rotenone followed by immediate immersion of treated fish in a solution of methylene blue (Bouck and Ball 1965); Aqualin (Louder and McCoy 1965); eight anesthetics, including Anileridine, Tribromoethanol, Ethinamaie, and RO 40403 (Blanchard 1966); and isobornyl thiocyanoacetate, or Thanite (Lewis 1968; Buckner and Perkins 1975; Burress and Bass 1975). Factors that must be considered in evaluating the potential usefulness of such compounds include efficacy, cost, availability, effects on target and nontarget organisms, rate of degradation, and hazards to users.

Thanite (82% isobornyl thiocyanoacetate and 18% other active terpenes) is an insecticide with low mammalian toxicity (Hercules Powder Company 1962). It has been widely used for some 30 years to control common household pests and external human parasites. Lewis (1968), who was the first to use Thanite for the live collection of fishes, reported excellent results in collecting largemouth bass *(Micropterus salmoides)* from two ponds in southern Illinois. In 1968, Buckner and Perkins (1975) began

using Thanite in the management of ponds in southwestern Georgia. They collected and moved 2,000 to 4,000 largemouth bass annually and made live collections of at least 14 other species of fish. Burress and Bass (1975) collected largemouth bass and 12 other species alive from two ponds in Florida and reported that Thanite was relatively safe and inexpensive.

The field trials reported here were conducted primarily to document the efficacy of Thanite as an aid in the live collection of fish and to facilitate the process of registering the compound with the U.S. Environmental Protection Agency (EPA) for that use. These efficacy tests were conducted in four states, in eight ponds with different physical, chemical, and biological characteristics (Table 1).

Materials and Methods

The general methods and procedures described by Burress and Bass (1975) were used in mixing and applying Thanite solutions; collecting, holding, and measuring (total length) live fish; collecting and counting fish killed by the Thanite treatment; and later treating the waters with a fish toxicant. The formulation used in six of the eight ponds consisted of Thanite, kerosene, and the emulsifier Atlox 1045A mixed in a ratio of 70:20:10 parts by volume. The other formulations used consisted of an 80:20 mixture of Thanite and Atlox 1045A in Ebert Pond, and an 80:20 mixture of Thanite and Atlox 3408F in West Sunken Camp Lake. Additional information on minor variations in methodology, descriptions of the ponds, and environmental or other factors that influenced test results is included with the results to facilitate discernment of possible cause and effect relationships. The species of fish present in the various ponds are listed in Table 2. During the treatment and collection periods, we also tried to observe the effects of Thanite on macroscopic nontarget organisms.

Results

Fish that were exposed to effective concentrations of Thanite tended to surface in distress and swim about in a disoriented manner. About 20% of them reacted by jumping or briefly skittering across the pond surface. As sedation deepened, many fish moved toward shore. Some sought cover while others floated listlessly at the surface or settled to the bottom. In general, small fish were affected first and died sooner than large ones. Occasionally, a large fish in noticeably poor physical condition surfaced before healthy young fish were sedated. Low temperatures slowed responses and delayed the onset of mortality, enabling pickup crews to cover larger areas more effectively. Fish that were collected in early stages of sedation recovered quickly after being placed in fresh water, but recovery times and mortality rates increased as exposures lengthened.

Additional observations in each of the eight ponds are detailed in the following sections.

McGraw Pond, Dundee, Illinois

This pond, on property of the Max McGraw Wildlife Foundation, was the only pond not of conventional construction. It was C-shaped, contained three islands, and had been dug with bulldozers. The bottom was covered with deposits of soft muck overlying a substrate of coarse gravel that contained a mixture of rocks 15 to 20 cm in diameter. Parrot feather (*Myriophyllum* sp.) was distributed along most of the shoreline to a depth of 1.2 m. Before treatment, the water level was lowered about 35 cm to prevent overflow of the treated water. At this lowered level, the pond had a surface area of 2.83 ha. We treated a 0.61-ha section at the deeper end, which was blocked off with a net (1.3-cm mesh, stretched measure).

We made three applications in a period of 2 h to observe the response of six species of fish (Table 2) to increasing concentrations of Thanite. The cumulative concentrations produced by successive applications were 0.8, 1.2, and 1.6 μl/l. Differences between the methods followed in this test and those described by Burress and Bass (1975) included the use of a pump to apply Thanite to the pond surface; a search of the pond bottom by divers for both living and dead fish on the second day after treatment; retention of captured fish in live cages in an adjacent pond for 24 h to evaluate their survival; and the use of antimycin to eradicate the fish remaining in the pond. Four boats operated by two-man crews were used to collect fish as they surfaced during the 3.5 h after the first application. The average area covered by each crew was 0.15 ha.

The first application of Thanite (0.8 μl/l) was too light to be effective, but the second (0.4 μl/l applied below the surface in deep water) quickly facilitated collection of numerous sunfish and intermediate-sized bass. A third application (0.4 μl/l, at the surface) was needed, however, before adult sunfish and large bass were affected. Many sunfish were captured along the block net, and numerous small white crappies were gilled in it. Wind-induced currents carried Thanite beyond the net, and distressed crappies were seen 6 m beyond the treated area. No fish were killed in the untreated area, however, suggesting that Thanite can safely be used to collect fish from selected areas of larger bodies of water.

Table 1.—*Physical and chemical characteristics of ponds treated with Thanite.*

Pond, and month and year of treatment	Surface area (ha)	Depth (m)		Volume (m^3)	Temperature (°C)		Secchi disk transparency (cm)	pH at surface	Total alkalinity ($\mu g/l$)	Conductance (mhos)
		Average	Maximum		Surface	Bottom				
McGraw Pond (10/72)	0.61	1.52	2.13	9,251	16.0	13.9	53.3	8.2	287	1,683
Barnes Pond (1/74)	0.47	1.07	1.82	5,033	13.9	10.0	10.2	7.0	25	82
Watkins Pond (1/74)	0.32	0.98	1.82	3,121	15.0	13.0	10.2	8.0	—[a]	130
Scott Pond A (2/74)	0.30	0.67	1.59	2,072	13.5	13.0	15.2	9.3	—[a]	20
Scott Pond B (2/74)	1.30	1.24	2.58	16,302	13.5	12.7	30.4	9.3	—[a]	20
Reeves Pond (2/74)	0.49	1.58	3.04	7,907	8.5	8.5	3.8	6.9	11	3
Ebert Pond (10/74)	0.81	1.25	2.75	10,135	15.0	12.0	67.0	7.5	174	496
West Sunken Camp Lake (6/75)	1.21	2.52	4.87	30,837	20.0	16.5	256.5	6.4	7	—[a]

[a] Not measured.

Table 2.—*Species of fish present in ponds treated with Thanite, 1972-75*[a].

Species	McGraw Pond	Barnes Pond	Watkins Pond	Scott Pond A	Scott Pond B	Reeves Pond	Ebert Pond	West Sunken[b] Camp Lake
Centrarchidae								
Largemouth bass *(Micropterus salmoides)*	X	X	X	X	X	X	S	S
Bluegill *(Lepomis macrochirus)*	X	X	X	X	X	X	X	S
Redear sunfish *(Lepomis microlophus)*		X	X			X		
Pumpkinseed *(Lepomis gibbosus)*								S
Green sunfish *(Lepomis cyanellus)*	X		X					
Rock bass *(Ambloplites rupestris)*								S
White crappie *(Pomoxis annularis)*	X							
Black crappie *(Pomoxis nigromaculatus)*								S
Warmouth *(Lepomis gulosus)*		X						
Dollar sunfish *(Lepomis marginatus)*		X						
Ictaluridae								
Channel catfish *(Ictalurus punctatus)*		X	X			X	S	
Brown bullhead *(Ictalurus nebulosus)*		X	S			X		
Yellow bullhead *(Ictalurus natalis)*		X						
Black bullhead *(Ictalurus melas)*							X	
Cyprinidae								
Golden shiner *(Notemigonus crysoleucas)*		X		X	X			X
Carp *(Cyprinus carpio)*	X							
Percidae								
Walleye *(Stizostedion vitreum vitreum)*								S
Yellow perch *(Perca flavescens)*	X							X
Esocidae								
Northern pike *(Esox lucius)*								S

Table 2.—*Species of fish present in ponds treated with Thanite, 1972-75*[a]. *(Continued)*

Species	McGraw Pond	Barnes Pond	Watkins Pond	Scott Pond A	Scott Pond B	Reeves Pond	Ebert Pond	West Sunken Camp Lake[b]
Chain pickerel *(Esox niger)*		X						
Redfin pickerel *(Esox americanus americanus)*		X						
Catostomidae								
White sucker *(Catostomus commersoni)*								X
Redhorse *(Moxostoma* sp.*)*								S
Lake chubsucker *(Erimyzon sucetta)*		X						
Clupeidae								
Gizzard shad *(Dorosoma cepedianum)*					X			
Poecilliidae								
Mosquitofish *(Gambusia affinis)*		X						
Salmonidae								
Chinook salmon *(Oncorhynchus tshawytscha)*							S	

[a] S= stocked within 2 to 6 weeks before treatment; X= long-term residents of the waters treated.

[b] Two bullheads of undetermined species and one longnose sucker *(Catostomus catostomus)* stocked in West Sunken Lake are not included in the test or tables. The bullheads were found dead after treatment; the longnose sucker was not recovered.

The primary objective of the pickup crews was to collect every largemouth bass that could be captured; they collected 89% of the total population (Table 3). Forty-four of 50 largemouth bass and 2 of 3 white crappies considered to be large enough for table use (more than 20 cm long) were collected alive. Of the total of 62 bass collected, 60 survived for 24 h.

The Thanite treatment killed all uncollected centrarchids, yellow perch, and some carp up to about 30 cm long. (No attempt was made to collect sedated or dead carp.) A 5-μg/l antimycin treatment applied 3 days later killed the remaining carp, but no other fish were found.

Barnes Pond, Merrillville, Georgia

Thirteen species of fish were found in this highly fertile pond. The bottom was soft mud, and wading cows had roiled the water. Aquatic macrophytes were virtually absent, but the pond surface was covered by a distinct bloom of blue-green algae. The first Thanite application of 1 μl/l was used to facilitate collection of the more susceptible scalefishes. Two additional 1-μl/l treatments were made within 3 h in an effort to collect brown bullheads, yellow bullheads, and channel catfish. Intermittent showers and winds occurred during the treatment but the pond did not overflow. Three pickup crews, each covering about 0.16 ha, collected fish for 4.5 h.

The combination of excessive turbidity (Secchi disk transparency about 10 cm), intermittent rain, and wind greatly hampered visibility and markedly reduced success in capturing fish (Table 4). The following percentages of bass and sunfish longer than 12.7 cm were collected: largemouth bass, 56; bluegill, 62; redear sunfish, 52; and warmouth, 43. Nearly all were collected after the first treatment (1 μl/l). Percentage mortalities of the fish within 3 h after collection were as follows: bass, 0; bluegill, 4; redear sunfish, 2; and warmouth, 6. We captured two

Table 3.—*Numbers and percentages of fish*[a] *collected alive or recovered dead in a 0.61-ha section of McGraw Pond after a 1.6-μl/l treatment with Thanite*[b] *on 16 October 1972.*

Species	Length range (cm)	Fish captured alive		Number recovered dead
		Number	Percent	
Largemouth bass	7-60	62	89	8
White crappie	7-40	540	68	260
Bluegill	3-20	275	75	91
Green sunfish	3-20	46	82	10
Yellow perch	10-20	3	100	0
Total		926	72	369

[a] Carp were killed by Thanite and antimycin treatments, but were not collected.

[b] Three applications of Thanite (0.8, 0.4, and 0.4 μl/l) were made during a period of 2 h.

Table 4.—*Numbers and percentages of fish collected alive or recovered dead in Barnes Pond after a 3.0-μl/l treatment with Thanite*[a] *on 7 January 1974.*

Species	Length range (cm)	Fish captured alive		Number recovered dead
		Number	Percent	
Largemouth bass	7-40	5	50	5
Bluegill	3-20	810	28	2,053
Redear sunfish	3-20	480	56	374
Warmouth	3-20	2,139	33	4,398
Dollar sunfish	3-12	10	23	34
Chain pickerel	15-20	0	0	6
Redfin pickerel	10-30	2	100	0
Lake chubsucker	20-30	111	68	53
Golden shiner	5-15	640	15	3,659
Mosquitofish	3- 5	205	29	512
Channel catfish	40-60	0	0	3
Brown bullhead	10-25	7	3	225
Yellow bullhead	10-20	2	100	0
Total		4,411	28	11,323

[a] Three 1-μl/l applications of Thanite made during a period of 3 h killed the entire fish population.

redfin pickerel, the only ones present, but six small chain pickerel were not collected alive. Dollar sunfish, lake chubsucker, golden shiner, and mosquitofish also were collected alive after the first application. Additional golden shiners, lake chubsuckers, and some small bullheads (both yellow and brown) were collected after the second treatment (1 μl/l) was applied. The third treatment (1 μl/l) brought up additional golden shiners and brown bullheads, but no live channel catfish were observed. However, the Thanite treatment killed the entire fish population, as shown by the negative results of a 2-μl/l treatment of rotenone several days later.

Watkins Pond, Morganville, Alabama

Five species of fish were present in this pond, and we stocked brown bullheads before the test. The pond was highly turbid and lacked aquatic plants. Again, we applied 1 μl/l at the beginning of the study and a 2-μl/l treatment 2.5 h later, in an effort to collect the catfish. Rain and gusty winds struck before the second treatment was applied. Fish were collected by two pickup crews (0.16 ha per crew) over a period of 4.5 h.

Although difficulties with turbidity, wind, and rain were much the same as those encountered during the treatment of Barnes Pond, substantially higher percentages of the scalefishes longer than 20 cm were collected (Table 5). The improvement in success was largely due to the smaller total number of fish in the pond. Of the "catchable" sized fish, 82% of the bass, 89% of the bluegills, 100% of the redear sunfish, and 64% of the channel catfish were captured alive. Nearly all of the scalefishes and about 3% of the brown bullheads were captured after the initial treatment with 1 μl/l of Thanite. About an equal number of bullheads were collected alive after the 2-μl/l treatment and an additional 27.6% were killed by the Thanite. Later treatment with 2 μl/l of rotenone killed no additional scalefish, but killed the remaining 135 brown bullheads.

Scott Ponds A and B, Montgomery, Alabama

The water level in Scott Pond had been lowered by about 1.2 m several months before our trial. The reduction in water level created two isolated ponds identified here as Pond A and Pond B. Both had mud bottoms and lacked aquatic vegetation. Pond A contained only largemouth bass, bluegills, and golden shiners; Pond B contained these species and a few gizzard shad. A 1-μl/l Thanite treatment was applied in Pond A at noon, and a similar treatment was added 2 h later to aid in the collection of large golden shiners. Three crews (0.10 ha per crew) collected fish for about 3.5 h. A single 1-μl/l treatment was applied in Pond B and four crews (0.33 ha per crew) collected fish for about 2.5 h.

Excellent results were achieved in Scott Pond A, where 99.6% of the total fish population was collected alive (Table 6). The weather was almost ideal—clear, calm, and relatively cool. Furthermore, each pickup crew had to cover an area of only 0.10 ha, the total fish population was low, and the response of the fish was optimal for live collection; many of them swam slowly at the surface or quietly nosed up to the bank as sedation deepened. Most fish were collected alive after the first treatment (1 μl/l), but a few of the largest bluegills and golden shiners were captured after the second 1-μl/l application. Mortality of the fish in the holding tank was negligible during the 6 h

Table 5.—*Numbers and percentages of fish collected alive or recorded dead in Watkins Pond after a 3.0-μl/l treatment with Thanite*[a] *on 28 January 1974.*

Species	Length range (cm)	Fish captured alive		Number recovered dead
		Number	Percent	
Largemouth bass	30-40	9	82	2
Bluegill	3-20	449	21	1,701
Redear sunfish	3-20	63	100	0
Green sunfish	7-15	3	100	0
Channel catfish	20-50	9	64	1[b]
Brown bullhead	12-20	12	6	56[b]
Total		545	22	1,760

[a] Two applications of Thanite (1.0 and 2.0 μl/l) were made during a period of 3 h.

[b] Number of dead fish does not include 4 channel catfish and 135 brown bullheads killed with rotenone after treatment with Thanite.

Table 6.—*Numbers and percentages of fish collected alive or recovered dead in Scott Pond A after a 2-μl/l treatment with Thanite*[a] *on 4 February 1974.*

Species	Length range (cm)	Fish captured alive		Number recovered dead
		Number	Percent	
Largemouth bass	40-50	1	100	0
Bluegill	3-20	969	100	0
Golden shiner	5-15	44	92	0[b]
Total		1,014	>99	0

[a] Two 1-μl/l applications of Thanite were made during a period of 2 h.

[b] Number of dead fish does not include four golden shiners that were killed by rotenone after treatment with Thanite.

after collection. No dead fish were found in the pond after the Thanite application, and a 2-μl/l rotenone treatment several days later killed only four adult golden shiners.

The reaction of fish to the 1-μl/l treatment in Scott Pond B appeared to be nearly optimal, but a combination of unfavorable circumstances resulted in live collection of only 43% of the total fish population (Table 7). The numerous shoal areas hampered free movement of the boats, each pickup crew had to cover about 0.33 ha, and collection efforts had to be terminated prematurely because of darkness. We captured 44% of the catchable sized bass. Six of nine bass not collected alive were large fish, not adequately sedated by the 1-μl/l dose. Of the bluegills longer than 20 cm, 43% were collected alive and the rest were killed by the treatment. Fewer than 1% of the golden shiners were collected alive; those that were left apparently were not harmed, as none were found dead until after the rotenone treatment. The entire population of gizzard shad (30 fish) was collected alive, and all survived a 2-h confinement in a heavily loaded recovery tank. Recovery of other fishes in the holding tank was excellent and mortalities were negligible during the 2 h after collection. Later application of a 2-μl/l treatment of rotenone killed the following percentages of each species originally present: largemouth bass, 37.5; bluegills, 0.5; and golden shiners, 90.9.

Reeves Pond, Greenville, Georgia

We treated this pond primarily to determine what effect extreme turbidity might have on the efficacy of Thanite. Silt washed into the pond by heavy rains had reduced Secchi disk transparency to less than 4 cm. A trickle of water flowed through the pond throughout the field trial. The pond contained no aquatic plants. The first treatment was limited to a 1-μl/l concentration, and 2.5 h later a 3-μl/l treatment was applied to facilitate the collection of catfish. Three crews (0.16 ha per crew) collected fish for 4 h. Conditions for collecting fish were less than ideal; extreme turbidity and glare greatly hampered visibility.

Table 7.—*Numbers and percentages of fish collected alive or recorded dead in Scott Pond B after a 1-μl/l treatment with Thanite on 4 February 1974.*

Species	Length range (cm)	Fish captured alive		Number recovered dead
		Number	Percent	
Largemouth bass	30-50	7	44	3[a]
Bluegill	3-20	2,814	43	3,748
Golden shiner	5-15	3	<1	0[a]
Gizzard shad	10-45	30	100	0
Total		2,854	43	3,751

[a] Number of dead fish does not include 6 largemouth bass, 30 bluegills, and 327 golden shiners that were killed by rotenone after treatment with Thanite.

The live collection of fish longer than 20 cm was regarded as successful despite the turbidity; 69% of the bass, 100% of the bluegills, and 50% of the redear sunfish were captured after the application of the 1-μl/l treatment (Table 8). A few small brown bullheads (100-125 mm) also were taken. The addition of a 3-μl/l treatment 3 h after the first resulted in collection of a 1.8-kg channel catfish, but no other fish were observed. Mortality of fish during a 3-h period in the recovery tank was negligible. The Thanite treatment killed all fish in the pond except seven brown bullheads, which were killed when 2 μ l/l of rotenone was applied later. These fish apparently survived in a small flow of spring water at the extreme upper end of the pond. On the day after treatment, a hatch of small mayflies was observed, but many died before they could leave the water.

Ebert Pond, West Salem, Wisconsin

Ebert Pond was chosen to evaluate the activity of Thanite in hard, fertile water against northern strains of fish. Dense, marginal stands of sago pondweed *(Potamogeton pectinatus)* occurred in shallow water, which included about 25% of the total pond area. Moderate amounts of duckweed *(Lemna minor)* and unidentified filamentous algae were interspersed throughout the vegetated area. The pond initially contained a population of black bullheads and bluegills; in addition, 100 chinook salmon, 15 channel catfish, and 109 largemouth bass were stocked 6 weeks before treatment. The pond was treated once with an 80:20 mixture of Thanite and Atlox 1045A surfactant to give a concentration of 1.5 μ l/l of Thanite. The chemical was applied to the deeper open water with a pump and weighted hose and to the weedy perimeter with backpack pumps.

Although the application required only a half hour, chinook salmon, bluegills, and largemouth bass were surfacing by the time the application was completed. Bullheads and channel catfish were not seen until 5 h later and none were captured. Salmon and centrarchids were easily captured with dip nets. We did not attempt to capture all of the bluegills because of the large number present, but collected 90 kg (35% of the total weight), of which 51 kg were placed in fresh water for recovery. This amount severely overloaded the two 378-liter recovery tanks and caused significant stress. Data on collection, recovery, and mortality of fish are given in Table 9. The failure of some fish to recover was probably due to oxygen deficiency in the tanks caused by overloading. The high percentage of stocked fish not accounted for indicated that many of them died between stocking and the time of treatment.

After the fish had recovered their equilibrium in the recovery tanks, representative samples of salmon, bluegills, and bass were loaded in an aerated tank and hauled 16 km to the laboratory. This trip required 25 min. Survival of these fish 5 days later was 100% for 6 salmon and 11 bass and 69% for 584 bluegills. The trial in Ebert Pond demonstrated the need for adequate recovery tanks to handle unexpectedly large numbers of fish.

The time required for the 1.5-μl/l concentration of Thanite to degrade was determined by conducting on-site toxicity tests with caged bluegill fingerlings. On the 10th day after the treatment, 10 fingerling bluegills were placed in a live cage in the pond; 7 died by day 12. A second lot of 10 bluegills was placed in the pond on day 12 and a third lot on day 13. Two fish of the second lot, but none of the third, died by day 16. Thus, the Thanite had degraded to a nontoxic level by the 13th day after application.

Table 8.—*Numbers and percentages of fish collected alive or recovered dead from Reeves Pond after a 4-μl/l treatment with Thanite*[a] *on 12 February 1974.*

Species	Length range (cm)	Fish captured alive		Number recovered dead
		Number	Percent	
Largemouth bass	10-50	39	83	8
Bluegill	3-20	137	1	10,087
Redear sunfish	3-20	208	47	237
Channel catfish	40-50	1	50	1
Brown bullhead	10-20	5	6	67[b]
Total		390	4	10,400

[a] Two applications of Thanite (1.0 and 3.0 μ l/l) were made during a period of 3 h.

[b] Number of dead fish does not include seven brown bullheads that were killed by rotenone after treatment with Thanite.

Table 9.—*Sizes and numbers of fish collected alive and recovered dead in Ebert Pond after a 1.5-μl/l treatment with Thanite on 30 October 1974, and survival of fish transported to a laboratory raceway after recovery.*

Species	Length (cm) of fish captured alive		Number of fish in treated pond				Fish hauled to laboratory raceway after recovery	
	Average	Range	Stocked	Collected alive	Recovered dead	Unaccounted for	Number	Survival after 5 days (%)
Chinook salmon	20.2	18.0-23.0	100	12	2	86	6	100
Bluegill	10.1	7.0-14.0	0[a]	4,914	13,925	—[b]	584	69
Largemouth bass	16.5	13.5-21.0	109	19	23	67	11	100
Channel catfish	Not measured		15	0	2	13	0	—
Black bullhead	Not measured		0[a]	0	25	—[b]	0	—

[a]Existing population in pond.

[b]Not known.

The pond was treated with rotenone (3.1 μ l/l of 5% formulation) 1 year after the Thanite treatment. This treatment was delayed to accommodate studies on recovery of invertebrate populations. The toxicant killed 363 kg of bullheads 5 to 36 cm long and 1.8 kg of bluegills 3 to 12 cm long, indicating that the 1.5-μl/l Thanite treatment killed less than 1% of the bullheads, but about 99% of the bluegills.

West Sunken Camp Lake, Ashland, Wisconsin

We treated this small lake to assess the efficacy of Thanite for collecting northern species of fish in very soft, acid water. The water was much clearer than other waters studied (Table 1); the bottom was devoid of vegetation. The lake was connected to East Sunken Camp Lake by a narrow neck of shallow water, which was closed with a plastic barrier before treatment to prevent circulation of water. Large numbers of golden shiners (7-12 cm long), yellow perch (8-16 cm), and white suckers (14-20 cm) were resident in the lake. The lake was stocked with the following species, of various sizes (Table 10), by the Wisconsin Department of Natural Resources about 2 weeks before the trial: redhorse, northern pike, bullhead, rock bass, pumpkinseed, bluegill, largemouth bass, black crappie, and walleye. Fish collected during the trial were placed in live cages in the untreated section to assess their survival for 24 h after collection.

A single 1.5-μl/l Thanite treatment was applied, but the chemical formulation and the application procedure were somewhat different from those previously used. The Thanite stock solution consisted of an 80:20 mixture by volume of Thanite and Atlox 3408F, a surfactant used to replace the Atlox 1045A previously employed in making stock solutions. The

Table 10.—*Numbers, sizes, and percentages of stocked fish collected alive and recovered dead in West Sunken Camp Lake after a 1.5-μl/l treatment with Thanite on 10 June 1975.*

Species	Length range (cm)	Number stocked	Captured alive			Recovered dead[b]	
			Number	Percent[a]	Weight (kg)	Number	Weight (kg)
Redhorse	22-24	4	2	50	0.1	2	1.2
Northern pike	22-100	15	9	64	3.8	5	3.6
Rock bass	14-26	54	31	72	3.5	12	1.9
Pumpkinseed	10-15	63	49	83	3.5	10	0.5
Bluegill	10-22	120	89	81	6.7	21	1.1
Largemouth bass	12-40	49	46	95	8.8	2	0.5
Black crappie	13-30	13	7	54	0.7	6	1.4
Walleye	16-71	17	13	81	11.8	3	0.5

[a]Percent of the total number recovered, both living and dead.

[b]Preceding application of antimycin.

stock solution was diluted about 5:1 with water, and was divided into three 115-liter portions. The first was applied in a crisscross pattern at a depth of about 30 to 60 cm; the second was applied to the deeper part of the lake with a weighted hose which distributed the material at depths of 3.0 to 3.7 m; and the third was divided between deep and shallow water. The distribution unit consisted of a small boat, a small outboard engine, a submersible pump with control valve in the chemical container, and a weighted hose that hung over the stern of the boat. Fish were collected by three or four men wading in shallow water and by two two-man crews in boats in the deeper water. The fish were placed in tubs of fresh water and delivered to the recovery cages within 20 min after capture. Fish were placed in four cages, according to the time elapsed after completion of the treatment. The time periods were the first, second, and third half-hours, and from 1.5 to 3.0 h post-treatment. Major effort was devoted to capturing game fish, but large numbers of other fishes were also taken. Weather (clear and calm) and water conditions were ideal for capturing fish.

Application of the Thanite required 1 h, and the first yellow perch were captured within 10 min after completion of the treatment. Shortly thereafter, sunfishes and walleyes were netted, but the more resistant golden shiners, white suckers, and northern pike showed no signs of sedation for nearly 1.5 h. Captures increased with time after treatment; more than twice as many fish were collected during the second 1.5-h period of netting as in the first 1.5 h. All game fishes taken alive were collected within 3 h after treatment. All of 408 fish (except 1 bluegill) collected in the first 1.5 h survived. After that, survival appeared to decrease with increasing length of exposure. Survival rates of most game species were excellent, ranging from 76% for walleyes to 93% for largemouth bass (Table 11). Northern pike were an exception in that none of nine survived, even though they were collected alive.

Sunfishes, largemouth bass, and walleyes were especially susceptible to capture; the percentages collected ranged from 74 to 94 (Table 10). The range of sensitivity between individuals appeared to be wider in certain other species such as rock bass and black crappie (collection rates near 50%); some were quickly affected and easily netted, whereas others were not seen until they were found dead in shallow water the day after treatment. Some white suckers and golden shiners were still alive in the lake 21 h after treatment, and a number of suckers were seen thrashing about at the surface. However, there was no sign of live fish 24 h after treatment. Except for about a 90% mortality of 1-cm frog tadpoles in the shallow water near the barrier, no mortality of nontarget organisms was noted.

The lake was treated with a 7.5 μg/l application of antimycin about 4 weeks later. Fish killed by the antimycin included 221 golden shiners, 15 white suckers, 1 bluegill, and 11 yellow perch.

Discussion

Application of 1.0- to 1.6-μl/l treatments of Thanite proved to be efficacious for collecting many sizes of several species of sport fish under a wide variety of

Table 11.—*Fish captured alive at selected time intervals after treatment of West Sunken Camp Lake with Thanite, and percentage survival 24 h after capture.*

	Time after treatment (h)								
	0–0.5		0.5–1.0		1.0–1.5		1.5–3.0		Total survival (%)
Species	Number collected	Survival (%)	Number collected	Survival (%)	Number collected	Survival (%)	Number collected	Survival (%)	
Golden shiner	0	—	0	—	5	100	293	61	61
White sucker	0	—	0	—	6	100	113	83	89
Redhorse	1	100	0	—	1	100	0	—	100
Northern pike	0	—	0	—	1	0	8	0	0
Rock bass	4	100	4	100	7	100	16	81	90
Pumpkinseed	11	100	6	100	8	100	24	71	86
Bluegill	5	80	13	100	25	100	46	80	88
Largemouth bass	2	100	9	100	13	100	22	86	93
Black crappie	2	100	1	100	3	100	1	0	85
Yellow perch	35	100	91	100	45	100	188	47	72
Walleye	3	100	6	100	1	100	3	0	76

conditions. Bluegills, white crappies, dollar sunfish, and yellow perch were the most sensitive to Thanite. Redear sunfish, warmouths, green sunfish, largemouth bass, gizzard shad, lake chubsuckers, and walleyes were somewhat less sensitive. Golden shiners, mosquitofish, carp, chain pickerel, and redfin pickerel were moderately resistant, and catfishes were the most resistant. Channel catfish were less resistant than brown or yellow bullheads; yellow bullheads were the most resistant species tested.

Northern pike were observed in only one test, but their reaction was unique. Of 15 fish stocked in West Sunken Camp Lake, only 9 were captured alive and none survived for 24 h after being transferred to fresh water. Apparently the fish absorbed a lethal dose of chemical before they became sufficiently sedated to be vulnerable to netting.

One recommendation regarding the use of Thanite should be added to the general guidelines suggested by Burress and Bass (1975). If, for example, largemouth bass of widely varying sizes are collected, the application of a 1-μl/l treatement followed by a second application of 0.5 μl/l could apparently be expected to give good results. In our trials, the first treatment was strong enough to produce good sedation and still permit rapid recovery of small fish; the later boost in concentration usually affected the more resistant large fish within a short time. If only large fish are sought, a single application of 1.5 to 2.0 μl/l should suffice.

Channel catfish can be collected alive with high concentrations of Thanite. However, additional research will be required to determine the concentrations needed under different environmental conditions. Bullheads appear to be so resistant to Thanite that their live collection is not economically feasible.

We believe that Thanite has many advantages as an aid in the live collection of fish. It is safe and convenient to handle and apply. Concentrations of 2 μl/l or less are required to effect prompt response of numerous species of fish, and degradation of the compound to nontoxic levels occurred within about 2 weeks in Ebert Pond (the only water in which such test was conducted). Variations in pH, temperature, hardness, conductivity, and turbidity appeared to have little effect on efficacy. However, treatment at low temperatures tended to reduce mortality. Survival of fish (other than northern pike) that were collected and placed in fresh, well aerated water within 2 h after treatment was excellent. Although Thanite was clearly effective for collecting several species of fish, its efficacy for collecting largemouth bass was especially noteworthy: even though weather and water conditions were adverse in four of eight tests, we collected more than 83% of a total of 226 bass (7-60 cm long) alive.

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