

## A Review of Fish Control Projects

THOMAS G. MERONEK,<sup>1</sup> PATRICK M. BOUCHARD,<sup>2</sup> EDMUND R. BUCKNER,  
THOMAS M. BURRI, KAREN K. DEMMERLY, DANIEL C. HATLELI,  
ROBERT A. KLUMB, STEPHEN H. SCHMIDT, AND DANIEL W. COBLE

Wisconsin Cooperative Fishery Research Unit,<sup>3</sup> University of Wisconsin  
Stevens Point, Wisconsin 54481, USA

**Abstract.**—We searched the fisheries literature to assess the success of fish control projects. We reviewed 250 control projects from 131 papers. Usually each treated body of water was considered a project. Fish control treatments were divided into four categories: chemical applications (145), physical removal and reservoir drawdowns (70), stocking of fish (29), and any combination of chemical and physical methods (6). Success was judged by changes in standing stock, growth, proportional stock density, relative weight values, catch or harvest rates, and other benefits, such as angler satisfaction. Reduction in standing stock was the most common determinant of success. Of the 250 projects, we considered 107 (43%) to be successful, 74 (29%) to be unsuccessful, and 69 (28%) to have insufficient data to determine success. The most successful projects targeted rough fish. Total elimination was more successful (63%) than partial reduction (40%) in 221 waters. Success was not strongly related to size of water body. Success of chemical application was similar for treatment with rotenone (48%) and with antimycin (45%). Success rates for physical removal methods (nets, traps, seines, electrofishing, drawdowns, and combinations of physical treatments) ranged from 33 to 57%. Stocking certain species of fish to control others was the least successful, 7 of 29 water bodies (24%). Combined chemical and physical methods were successful in 4 of 6 projects (66%). Stocking after chemical or physical treatment may have increased success of fish control projects; 10 of 17 such projects (59%) were successful, a higher percentage than for chemical treatments, physical treatments, or stocking alone. An overall success rate of less than 50% for such a large number and wide variety of projects indicates that there is considerable room for improvement of fish control projects. The large percentage of unsuccessful projects and the complexity of factors influencing fish communities suggest that control projects should include critical evaluation of assumptions and of suspected causes of problems, explicit rationale and objectives, and pretreatment and long-term posttreatment study.

Eradication or reduction of undesirable fish species is a common management practice. Large populations of rough fish or "stunted" panfish are often considered undesirable by management agencies and are subjected to fish control projects.

Lennon et al. (1970) reviewed the status of chemical control efforts up to 1970. They identified many successful and unsuccessful projects, as well as problems frequently affecting success, but they did not address success rates. We conducted a search of the fisheries literature to determine success rates of chemical and physical fish control methods, stocking, and combinations of these

methods. We reviewed the results of 250 fish control projects reported in 131 papers from professional journals and agency publications and reports. The projects occurred on water bodies ranging from 0.2 to 55,752 ha and were located in 36 states and 3 countries.

### Methods

We searched the fisheries literature using the following keywords: antimycin, rotenone, reclamation, rehabilitation, predator stocking, fish control, poisoning, removal, and thinning. Keyword searches were made on the National Information Services Corporation Wildlife Review and Fisheries Review, 1971–February 1994 (Baltimore, Maryland); the Fish and Wildlife Reference Service, 1953–1993 (Bethesda, Maryland); and the Cumulative Subject Index to the Monthly Catalog of United States Government Publications, 1900–1971. We also searched the contents of four journals: *North American Journal of Fisheries Management*, 1983–1993; *Transactions of the American Fisheries Society*, 1923–January 1994; *Progressive*

<sup>1</sup> Present address: Georgia Department of Natural Resources, Wildlife Resources Division, Fisheries Management Section, 22814 Highway 144, Richmond Hill, Georgia 31324, USA.

<sup>2</sup> Present address: U.S. Fish and Wildlife Service, 1015 Challenger Court, Green Bay, Wisconsin 54311, USA.

<sup>3</sup> Cooperators are the National Biological Service, the Wisconsin Department of Natural Resources, and the University of Wisconsin in Stevens Point.

*Fish-Culturist*, 1935–January 1994; and *Proceedings of the Southeastern Association of Game and Fish Commissioners*, 1947–1975, and subsequently, *Proceedings of the Southeastern Association of Fish and Wildlife Agencies*, 1976–1991. We conducted a search of the General Science Index and the computerized record holdings of the University of Wisconsin in Stevens Point, and we read pertinent literature cited in various papers.

Fish species were designated as game fish, panfish, or rough fish for this review (Table 1). Chemical treatments included those with rotenone, antimycin, copper sulfate, squoxin, and toxaphene. Physical treatments included removal of fish by nets and traps, seines, electrofishing, and subjecting target species to increased predation by means of reservoir drawdown.

Each paper was critically reviewed to determine success of the project. We judged success from changes in standing stock, growth, proportional stock density (PSD; Anderson 1976), relative weight ( $W_r$ ; Wege and Anderson 1978), catch or harvest rates, other benefits (e.g., angler satisfaction), and the authors' conclusions (although we did not always agree). We drew our conclusions concerning success from evidence of the effectiveness of a control procedure that was provided in each paper. We did not use quantitative criteria for success, such as a certain percentage reduction or statistically significant change in standing stock or increase in PSD, because sufficient data were often lacking.

Sometimes authors considered a project successful when it was based on data collected for less than 1 year after treatment. We considered such short-term assessments to be successful only if the standing stock of the target species was reduced substantially. We considered reduction of standing stock a success if that was an objective of a project and evidence was provided that reduction occurred (e.g., reduction in estimates of weight per unit area or catch per effort). For the other measures of success, we required evidence of improvement obtained over a period exceeding 1 year after treatment.

### Results

We considered 43% of the 250 projects successful, 29% unsuccessful, and 28% as having insufficient data to determine success or failure (Appendix Table A.1), whereas authors considered 54% of the projects successful, 29% unsuccessful, and 17% lacked sufficient data. Usually the reason for the difference was our judgment that evidence

TABLE 1.—Species in target categories of game fish, panfish, and rough fish.

Common name	Scientific name
<b>Game fish</b>	
Channel catfish	<i>Ictalurus punctatus</i>
Flathead catfish	<i>Pylodictis olivaris</i>
Northern pike	<i>Esox lucius</i>
Muskellunge	<i>Esox masquinongy</i>
Chain pickerel	<i>Esox niger</i>
Cutthroat trout	<i>Oncorhynchus clarki</i>
Rainbow trout	<i>Oncorhynchus mykiss</i>
Brown trout	<i>Salmo trutta</i>
Brook trout	<i>Salvelinus fontinalis</i>
Striped bass	<i>Morone saxatilis</i>
Smallmouth bass	<i>Micropterus dolomieu</i>
Largemouth bass	<i>Micropterus salmoides</i>
Walleye	<i>Stizostedion vitreum</i>
<b>Panfish</b>	
Black bullhead	<i>Ameiurus melas</i>
Yellow bullhead	<i>Ameiurus natalis</i>
Brown bullhead	<i>Ameiurus nebulosus</i>
White perch	<i>Morone americana</i>
Rock bass	<i>Ambloplites rupestris</i>
Redbreast sunfish	<i>Lepomis auritus</i>
Green sunfish	<i>Lepomis cyanellus</i>
Pumpkinseed	<i>Lepomis gibbosus</i>
Warmouth	<i>Lepomis gulosus</i>
Orangespotted sunfish	<i>Lepomis humilis</i>
Bluegill	<i>Lepomis macrochirus</i>
Redear sunfish	<i>Lepomis microlophus</i>
White crappie	<i>Pomoxis amularis</i>
Black crappie	<i>Pomoxis nigromaculatus</i>
Yellow perch	<i>Perca flavescens</i>
<b>Rough fish</b>	
Paddlefish	<i>Polyodon spathula</i>
Gar	<i>Lepisosteus</i> spp.
Bowfin	<i>Amia calva</i>
Skipjack herring	<i>Alosa chrysochloris</i>
Alewife	<i>Alosa pseudoharengus</i>
Gizzard shad	<i>Dorosoma cepedianum</i>
Threadfin shad	<i>Dorosoma petenense</i>
Goldfish	<i>Carassius auratus</i>
Redside dace	<i>Clinostomus elongatus</i>
Common carp	<i>Cyprinus carpio</i>
Golden shiner	<i>Notemigonus crysoleucas</i>
Spottail shiner	<i>Notropis hudsonius</i>
Northern squawfish	<i>Ptychocheilus oregonensis</i>
River carpsucker	<i>Carpionus carpio</i>
Quillback	<i>Carpionus cyprinus</i>
Longnose sucker	<i>Catostomus catostomus</i>
White sucker	<i>Catostomus commersoni</i>
Lake chubsucker	<i>Erimyzon sucetta</i>
Northern hog sucker	<i>Hypentelium nigricans</i>
Smallmouth buffalo	<i>Ictiobus bubalus</i>
Spotted sucker	<i>Minytrema melanops</i>
Shorthead redhorse	<i>Moxostoma macrolepidotum</i>
Flathead catfish <sup>a</sup>	
Channel catfish <sup>a</sup>	
Banded killifish	<i>Fundulus diaphanus</i>
Western mosquitofish	<i>Gambusia affinis</i>
Brook stickleback	<i>Culaea inconstans</i>
Central stoneroller	<i>Campostoma anomalum</i>
Burbot	<i>Lota lota</i>
Mottled sculpin	<i>Cottus bairdi</i>
Freshwater drum	<i>Aplodinotus grunniens</i>

<sup>a</sup> Channel catfish and flathead catfish appear in the rough fish category as well as the game fish category because they were included in rough fish removal projects.

TABLE 2.—Number and percentage of criteria that we considered successful. The authors of some studies listed more than one criterion that would be used to determine success; parenthetical values are the number or percentage of projects that used a second criterion.

Criteria for success	Number of successes		Percentage
	Target species	Other species	
Reduction of:			
Standing stock	53		33
Catch or harvest	4	1	3
Other		1	1
Improvement of:			
Growth or average size	11	13	15
Standing stock	7	12 (2)	12 (10)
PSD or $W_r$ values	10 (1)	9	12 (5)
Catch or harvest	7 (2)	19 (8)	16 (53)
Other	6 (4)	8 (2)	8 (32)

from short-term assessments was insufficient to determine success.

The most common determinant of success was a reduction in standing stock of the target species, but the other criteria for success—improved growth, standing stock, PSD,  $W_r$ , catch, and harvest for both target and other species—were also important (Table 2). Usually success was based on only one of these criteria; however, in several studies success was based on changes in two of the criteria, with the most important second criterion being improved catch or harvest. In some cases the only evidence of success offered was reduction of a target species. Our assessment that such projects were successful could be considered an overestimate if there was no improvement of desired species or the sport fishery following the reduction of standing stock of the undesired species. Overestimation of success would also be caused by any tendency not to publish the results of unsuccessful fish control projects.

Panfish were the target species in 124 of the 250 treatments, rough fish in 92, and game fish in 12; 22 projects targeted more than one of these groups (Table 3). Success was greater for control of rough fish than for the other categories. Success rates were 40% for panfish, 53% for rough fish, 42% for game fish, and 23% for mixed categories. Usually game fish were reduced to benefit other species (Schmitz and Hetfeld 1965; Shetter and Alexander 1970; McHugh 1990; Goeman and Spencer 1992) or to increase their growth rate (Stephens and Beadles 1980), and in four projects brook trout were considered less desirable than other species (Klein

TABLE 3.—Numbers of fish control projects that we considered successful or unsuccessful or that had insufficient data to determine success, by category of target species. Numbers in parentheses are percentages of the total number of projects targeting that category.

Target category	Successful	Unsuccessful	Insufficient data	Total
Panfish	49 (40)	38 (31)	37 (29)	124 (50)
Rough fish	48 (53)	19 (20)	25 (27)	92 (36)
Game fish	5 (42)	7 (58)	0 (0)	12 (5)
Mixed	5 (23)	10 (45)	7 (32)	22 (9)
All	107 (43)	74 (29)	69 (28)	250 (100)

1960, 1961; Walters and Vincent 1973; Gresswell 1991).

Of 221 fish control projects in which the target species were reduced without stocking piscivores, 170 (77%) attempted partial reductions, and 51 (23%) sought total elimination (Table 4). Projects that attempted total elimination had a greater mean success rate (63%) than those attempting partial elimination (40%). Success rates were greater for rough fish than for the other categories for both total and partial eliminations.

Success with chemical or physical treatment was not strongly related to size of water body (Table 5). For 48 physical removal projects in which size of water body was specified, success appeared greatest for waters exceeding 400 ha, but no trend was evident over four smaller size categories (Table 5). For stocking projects, size was specified

TABLE 4.—Numbers of fish control projects designed to reduce or eliminate target fish without stocking piscivores and percentage of projects considered successful or unsuccessful or that had insufficient data to determine success.

Target category	Number of projects	Percentage		Insufficient data
		Successful	Unsuccessful	
Reduction of target species				
Panfish	68	35	35	30
Rough fish	80	49	21	30
Game fish	10	40	60	0
Mixed	12	8	50	42
Subtotal	170	40	31	29
Elimination of target species				
Panfish	32	63	6	31
Rough fish	11	73	18	9
Game fish	1	0	100	0
Mixed	7	57	29	14
Subtotal	51	63	14	23
Total	221	45	27	28

TABLE 5.—Numbers (percentages) of fish control projects in which chemical treatment or physical removal was considered successful and unsuccessful, by size of water body treated.

Water body surface area (ha)	Chemical (N = 55)		Physical (N = 48)	
	Successful	Unsuccessful	Successful	Unsuccessful
0.2-5	16 (94)	1 (6)	1 (11)	8 (89)
5-20	15 (75)	5 (25)	3 (43)	4 (57)
20-40	2 (40)	3 (60)	1 (20)	4 (80)
40-400	5 (63)	3 (37)	6 (43)	8 (57)
>400	4 (80)	1 (20)	12 (92)	1 (8)

for only 11 water bodies—too few to reveal a relation between success and water body size.

Chemical treatment, used in 145 (58%) projects, was the most commonly identified method of fish control, followed by physical removal or drawdown (70 projects, 28%), introduced fish species (29 projects, 12%), and a combination of treatments (6 projects, 2%). Rotenone and antimycin, used in the majority of chemical treatments, resulted in 48 and 45% success rates (Table 6). Rotenone was used more often for rough fish, and antimycin for panfish. Both chemicals generally were less effective for controlling mixed categories. A combination of two or more chemicals, usually rotenone and antimycin, was used in four projects with a success rate of 25% (Table 6). Brook trout (game fish) were successfully eliminated with rotenone from two lakes (Klein 1960), unsuccessfully reduced in a river (Klein 1961), and successfully reduced with antimycin in a stream (Gresswell 1991). Copper sulfate was used unsuccessfully to treat bluegill (panfish) nests in one project (Beyerle and Williams 1967). Squoxin successfully reduced northern squawfish (rough fish) in three projects (Lindland 1973), and toxaphene was unsuccessful for control of rough fish in a reservoir (Johnson 1966).

Of 70 projects that entailed physical removal of fish or reservoir drawdown, 43% were successful, 45% were unsuccessful, and 12% had insufficient data to determine an outcome (Table 7). Success for seines, traps, nets, and electrofishing ranged from 33 to 57%; similar success rates were calculated for drawdowns (45%) and combinations of physical treatments (36%). At a 57% success rate, nets were the most effective physical treatment used. Traps alone were used successfully in one of three projects (Wanie and Hopkins 1951; Johnson 1975; Warnick 1977), and electrofishing was also successful in one of three (Sullivan 1955; Spencer 1967; Shetter and Alexander 1970).

TABLE 6.—Numbers of fish control projects in which chemicals were used to remove target fish and percentage of projects considered successful or unsuccessful or that had insufficient data to determine success.

Target category	Number of projects	Percentage		
		Successful	Unsuccessful	Insufficient data
<b>Rotenone</b>				
Panfish	20	60	15	25
Rough fish	39	49	15	36
Game fish	3	67	33	0
Mixed	7	0	57	43
Subtotal	69	48	20	32
<b>Antimycin</b>				
Panfish	47	43	9	49
Rough fish	9	56	22	22
Game fish	1	100	0	0
Mixed	10	40	30	30
Subtotal	67	45	14	42
<b>Combination<sup>a</sup></b>				
Panfish	1	0	0	100
Rough fish	3	33	67	0
Subtotal	4	25	50	25
<b>Miscellaneous<sup>b</sup></b>				
Panfish	1	0	100	0
Rough fish	4	75	25	0
Subtotal	5	60	40	0
Total	145	46	19	35

<sup>a</sup> Usually rotenone and antimycin.

<sup>b</sup> Includes squoxin, toxaphene, and copper sulfate.

Stocking various species of fish to control others was not as successful as chemical and physical treatments. We considered 7 of 29 (24%) stocking projects to be successful and 16 (49%) unsuccessful (Table 8). Game fish (excluding ictalurids and salmonids) usually were stocked to control panfish, and 4 of 19 (21%) such projects were successful. The most common species stocked were largemouth bass (8 water bodies), northern pike (6), walleye (3), and muskellunge (3). In three projects, catfish alone (flathead, white, and blue catfish) were stocked to control bluegills, and in one project, both flathead catfish and largemouth bass were stocked (Swingle et al. 1965). We considered all four projects unsuccessful. In another project stocked flathead catfish successfully controlled black bullheads (U.S. Fish and Wildlife Service 1992). Salmonids were used successfully in two projects. In one, coho salmon were stocked to control alewives (Beeton 1969), and in the other, cutthroat trout were stocked to control brook trout (Walters and Vincent 1973).

We found six projects that used a combination of chemical treatment and physical methods (Table

TABLE 7.—Numbers of fish control projects in which various gears, drawdowns, or combinations of these treatments<sup>a</sup> were used to remove target species and percentages considered successful or unsuccessful or that had insufficient data to determine success.

Target category	Number of projects	Percentage		
		Successful	Unsuccessful	Insufficient data
<b>Seines</b>				
Panfish	1	0	100	0
Rough fish	9	56	22	22
Game fish	3	0	100	0
Subtotal	13	39	46	15
<b>Traps</b>				
Rough fish	3	33	67	0
Subtotal	3	33	67	0
<b>Nets</b>				
Panfish	9	67	33	0
Rough fish	5	60	20	20
Game fish	2	0	100	0
Subtotal	16	57	37	6
<b>Electrofishing</b>				
Panfish	1	100	0	0
Rough fish	1	0	100	0
Game fish	1	0	100	0
Subtotal	3	33	66	0
<b>Drawdown</b>				
Panfish	8	25	75	0
Rough fish	2	100	0	0
Mixed	1	100	0	0
Subtotal	11	45	55	0
<b>Combination</b>				
Panfish	9 <sup>b</sup>	22	78	0
Rough fish	13	46	15	38
Subtotal	22	36	41	23
Total	68	43	45	12

<sup>a</sup> In addition, a trawl was used unsuccessfully to remove rough fish from one water body (Otis 1988), and dynamite was used in one water body to remove gars, but insufficient data were available to determine success (Copeland 1958).

<sup>b</sup> Includes one study of effects of winterkill on panfish growth (Beckman 1950); we considered control unsuccessful.

9); four (66%) were successful (Lambou and Stern 1959; Riel 1967; Keith 1968; McHugh 1990), one (17%) was unsuccessful (Houser and Grinstead 1961), and one (17%) had insufficient data to determine the outcome (Cooper et al. 1971).

Stocking various fish species after chemical or physical treatment may have increased the success of fish control projects. In 17 projects, chemical or physical treatment was followed by supplemental stocking of certain species of fish to control other species (Table 10). Ten (59%) of these projects were successful and 7 (41%) were not. This

TABLE 8.—Numbers of fish control projects in which various fish species were introduced to control fish in target categories and percentages of projects considered successful or unsuccessful or that had insufficient data to determine success.

Target categories	Number of projects	Percentage		
		Successful	Unsuccessful	Insufficient data
<b>Introduced game fish<sup>a</sup></b>				
Panfish	19	21	42	37
Mixed	3	0	67	33
Subtotal	22	18	46	36
<b>Introduced ictalurids</b>				
Panfish	4	25	75	0
Subtotal	4	25	75	0
<b>Introduced salmonids</b>				
Rough fish	1	100	0	0
Game fish	1	100	0	0
Subtotal	2	100	0	0
<b>Mixed species<sup>b</sup></b>				
Panfish	1	0	100	0
Subtotal	1	0	100	0
Total	29	24	49	27

<sup>a</sup> Excluding ictalurids and salmonids.

<sup>b</sup> Flathead catfish and largemouth bass.

success rate exceeds that of chemical treatments alone (46%; Table 6), physical treatments alone (43%; Table 7), and stocking alone (24%; Table 8). Only combined chemical and physical treatments yielded a greater success rate (66%; Table 9); however, only six such projects were identified and evaluated. Supplemental stocking of game fish and mixed categories after chemical or physical treatments to control panfish and rough fish appeared to be the most successful procedure (Table 10). Stocking salmonids after chemical treatment for control of rough fish resulted in poor success; three out of four (75%) such projects failed.

TABLE 9.—Numbers of fish control projects in which combinations of chemical and physical treatments were employed to control fish in target categories and percentages of projects considered successful or unsuccessful or that had insufficient data to determine success.

Target category	Number of projects	Percentage		
		Successful	Unsuccessful	Insufficient data
Panfish	2	50	0	50
Rough fish	2	100	0	0
Game fish	1	100	0	0
Mixed	1	0	100	0
Total	6	66	17	17

TABLE 10.—Numbers of successful projects that entailed supplemental stocking of predaceous game fish, mixed species, or salmonids after a chemical or physical treatment. Numbers of unsuccessful stockings are in parentheses.

Target category and initial treatment	Fish stocked		
	Game fish	Mixed species	Salmonids
Panfish			
Chemical	2	1	
Physical	2		
Rough fish			
Chemical	1	3 (1)	1 (3)
Gamefish			
Physical		(1)	
Mixed			
Physical	(1)	(1)	
Total	5 (1)	4 (3)	1 (3)

### Discussion and Recommendations

This review suggests that there is considerable room for improvement of fish control projects. Control has been attempted for many species, by many methods, and by many workers, and success has been determined by various criteria. Yet less than 50% of 250 fish control projects we examined were considered successful.

The seminal reason for the failure of projects was not evident, even though authors often stated the proximate reason for failure. For example, several authors stated that a project was unsuccessful because of inadequate reduction (removal or kill) of a target species, but insufficient information was provided to determine why the level of reduction achieved was inadequate.

We believe fish control projects can be effective or ineffective for many reasons. In situations in which one species or group of species are directly and substantially detrimental to others, removal or marked reduction of the detrimental species can benefit the others. Other fish communities can have such complex interactions among species that removal of some species has little apparent effect on the remaining species (e.g., Nilsson 1967). Moreover, fish communities are profoundly influenced by habitat and water quality. If a species or group of species is "overabundant" because of deleterious environmental conditions, a fish control project can be ineffective or short-lived because it treats the symptom rather than the cause of the problem. Furthermore, exploited species can be affected by the fishery. A control program designed simply to eradicate or reduce the number of stunted panfish, for example, would not address

problems associated with high exploitation of panfish predators or the effects of a fishery that is selective for the larger panfish in the population (Coble 1988).

Because of the complexity of factors that influence fish communities, we recommend that fish control projects be preceded by critical evaluation of the assumptions involved and of the suspected causes of problems. We also recommend that fish control projects include explicit rationale, objectives, and pretreatment and long-term posttreatment study. This review would have been improved if more reports had included sufficient data to determine success. About 25% of the projects we reviewed lacked adequate information to determine success. Our assessments of success or nonsuccess are underestimated to the extent that projects of undetermined status would have contributed to either of those categories. Collection and analysis of pretreatment and posttreatment data could allow objective determination of success of fish control projects and determination of the reasons for failure of unsuccessful projects.

### Acknowledgments

This literature review was a project of the 1994 Advanced Fish Management class at the University of Wisconsin in Stevens Point. All authors except D. W. Coble, the professor, were students in that class. The starting point for the project consisted of two 20-year-old unpublished literature reviews of fish control projects compiled by previous members of the class: A. Buchanan, M. Colvin, M. Headrick, T. Joy, J. Kaster, G. Lutterbie, M. Marinac, T. Robertson, D. Sanders, T. Scullin, and B. Taubert. The manuscript was read by M. Bozek and D. Bonneau.

### References

- Anderson, R. O. 1976. Management of small warm water impoundments. *Fisheries* 1(6):5-7, 26-28.
- Avault, J. W., Jr., and G. C. Radonski. 1968. Use of antimycin as a fish toxicant with emphasis on removing trash fish from catfish ponds. *Proceedings of the Annual Conference Southeastern Association of Game and Fish Commissioners* 21(1967):472-476.
- Avery, E. L. 1978. The influence of chemical reclamation on a small brown trout stream in southwestern Wisconsin. Wisconsin Department of Natural Resources Technical Bulletin 110.
- Baumann, P. C. 1975. An evaluation of the use of antimycin A for stream reclamation in the Rock River, Wisconsin. Doctoral dissertation. University of Wisconsin, Madison.
- Beckman, W. C. 1941. Increased growth of rock bass,

- Ambloplites rupestris* (Rafinesque), following reduction in the density of the population. Transactions of the American Fisheries Society 70:143-148.
- Beckman, W. C. 1950. Changes in growth rates of fishes following reduction in population densities by winterkill. Transactions of the American Fisheries Society 78:82-90.
- Becton, A. M. 1969. Changes in the environment and biota of the Great Lakes. Pages 150-187 in Eutrophication: causes, consequences, correctives. National Academy of Sciences, Washington, D.C.
- Berry, C. R., Jr. 1982. Behavior and ecology of carp in the Bear River Migratory Bird Refuge. Utah State University, Utah Cooperative Fishery Research Unit, Final Completion Report, Logan.
- Beyerle, G. B. 1971. A study of two northern pike-bluegill populations. Transactions of the American Fisheries Society 100:69-73.
- Beyerle, G. B. 1977. Results of attempts to optimize growth and survival of bluegills in ponds by yearly population manipulation. Michigan Department of Natural Resources, Fisheries Division, Research Report 1856, Lansing.
- Beyerle, G. B., and J. E. Williams. 1967. Attempted control of bluegill reproduction in lakes by applying copper sulfate crystals to spawning nests. Progressive Fish-Culturist 29:150-155.
- Beyerle, G. B., and J. E. Williams. 1972. Survival, growth, and production by bluegills subjected to population reduction in ponds. Michigan Department of Natural Resources, Development Report 273, Lansing.
- Binns, N. A. 1967. Effects of rotenone treatment on the fauna of the Green River, Wyoming. Wyoming Game and Fish Commission Fishery Technical Bulletin 1.
- Boussu, M. F. 1955. Statewide fisheries investigations: experimental alteration of a panfish population by netting. South Dakota Department of Game, Fish and Parks, Federal Aid in Fish Restoration Project F-1-R-4, Job 1, Final Report, Pierre.
- Bowers, C. C. 1955. Selective poisoning of gizzard shad with rotenone. Progressive Fish-Culturist 17:134-135.
- Boxrucker, J. C. 1982. Pond research and management: improving Oklahoma pond management. Oklahoma Department of Wildlife Conservation, Federal Aid in Fish Restoration, Project F-40-R, Job 1, Final Report, Oklahoma City.
- Brynildson, C. 1970. Eradication of Mill Creek, Richland County. Wisconsin Department of Natural Resources, Bureau of Fish and Management, Report 37, Madison.
- Burruss, R. M. 1971. Improved method of treating ponds with antimycin A to reduce sunfish populations. Proceedings of the Annual Conference Southeastern Association of Game and Fish Commissioners 24(1970):464-473.
- Burruss, R. M., and C. W. Luhning. 1969. Use of antimycin for selecting thinning of sunfish populations in ponds. U.S. Bureau of Sport Fisheries and Wildlife Investigations in Fish Control 28:1-10.
- Cahoon, W. G. 1953. Commercial carp removal at Lake Mattamuskee. Journal of Wildlife Management 17:312-317.
- Carlander, K. D. 1958. Disturbance of the predator-prey balance as a management technique. Transactions of the American Fisheries Society 87:34-38.
- Carter, E. R. 1956. Investigations and management of the Dewey Lake fishery. Kentucky Department of Fish and Wildlife Resources, Fisheries Bulletin 19.
- Charles, J. R. 1957. Final report on population manipulation studies in three Kentucky streams. Proceedings of the Annual Conference Southeastern Association of Game and Fish Commissioners 10(1956):155-185.
- Clemens, H. P., and M. Martin. 1953. Effectiveness of rotenone in pond reclamation. Transactions of the American Fisheries Society 82:166-177.
- Clothier, W. D., and M. F. Boussu. 1953. Statewide fisheries investigations: effects of Lake Madison bullhead removal. South Dakota Department of Game, Fish and Parks, Federal Aid in Fish Restoration, Project F-1-R-3, Job 1-H, Pierre.
- Coble, D. W. 1988. Effects of angling on bluegill populations: management implications. North American Journal of Fisheries Management 8:277-283.
- Cooper, E. L., C. C. Wagner, and G. E. Krantz. 1971. Bluegills dominate production in a mixed population of fishes. Ecology 52:280-290.
- Copeland, J. B. 1958. Experimental use of explosives on the Aucilla River. Proceedings of the Annual Conference Southeastern Association of Game and Fish Commissioners 11(1957):277-280.
- Crabtree, S. E. 1967. Buffalo Lake carp control. Texas Parks and Wildlife Department, Federal Aid in Fish Restoration, Project F-14-D-10, Texas Statewide Rough Fish Control, Job 16-A-53, Austin.
- Davis, R. 1979. The use of antimycin to reduce stunted sunfish populations in hardwater lakes. Minnesota Department of Natural Resources, Section of Fisheries, Investigational Report 363.
- Dequaine, J. F. 1952. Florida's controlled seining program. Florida Game and Fresh Water Fish Commission, Fish Management Bulletin 1, Tallahassee.
- Ellis, F. S., and W. W. Thomaston. 1975. The use of antimycin (Fintrol) in farm ponds in Georgia. Proceedings of the Annual Conference Southeastern Association of Game and Fish Commissioners 28(1974):103-115.
- Engstrom-Heg, R., and H. A. Loeb. 1971. Recolonization of a rotenone treated segment of the Ten Mile River. New York Fish and Game Journal 18:135-138.
- Essbach, A. R. 1958. The Bear Pond story. New Jersey Outdoors 8(12):5-14.
- Ezell, C. R. 1962. Experimental chemical control of undesirable fish species. Texas Parks and Wildlife Department, Federal Aid in Fish Restoration, Project F-9-R-9, Work Plan E, Job 5, Austin.
- Farrell, B. 1980. Effects of winterkill and chemical

- eradication of fish on a lake ecosystem. Minnesota Department of Natural Resources, Section of Fisheries, Investigational Report 369.
- Fast, A. W. 1966. Fisheries management of El Capitan Reservoir, San Diego County, California, 1960-1962. California Department of Fish and Game, Administrative Report 66-5, Sacramento.
- Filipek, S. 1982. Survey of Arkansas' chemical rehabilitation of lakes. Proceedings of the Annual Conference Southeastern Association of Fish and Wildlife Agencies 34(1980):181-192.
- Flint, R. H. 1980. Chemical treatment of the North Fork Feather River, Butte and Plumas counties, California, 1977. California Department of Fish and Game, Inland Fisheries, Administrative Report 80-4, Sacramento.
- Foye, R. E. 1956. Reclamation of potential trout ponds in Maine. *Journal of Wildlife Management* 20:389-398.
- Gammon, J. R., and A. D. Hasler. 1965. Predation by introduced muskellunge on perch and bass, I: years 1-5. *Transactions of the Wisconsin Academy of Science, Arts and Letters* 54:249-272.
- Gerking, S. D. 1950. A carp removal experiment at Olive Lake, Indiana. *Investigations of Indiana Lakes and Streams* 3:373-388.
- Germann, J. F., and J. T. Sandow. 1976. An evaluation of techniques for the selective removal of spotted suckers, *Minytrema melanops*, on the Satilla River. Georgia Game and Fish Division, Federal Aid in Fish Restoration, Project F-29-R-3, Atlanta.
- Goeman, T. J., and P. D. Spencer. 1992. Fish community responses to manipulation of northern pike and yellow perch densities in a Minnesota centrarchid lake. Minnesota Department of Natural Resources, Section of Fisheries, Investigational Report 416.
- Goodson, L. F. 1966. Landlocked striped bass. Pages 407-412 in A. Calhoun, editor. *Inland fisheries management*. California Department of Fish and Game, Sacramento.
- Greenbank, J. 1941. Selective poisoning of fish. *Transactions of the American Fisheries Society* 70:80-86.
- Gresswell, R. E. 1991. Use of antimycin for removal of brook trout from a tributary of Yellowstone Lake. *North American Journal of Fisheries Management* 11:83-90.
- Grice, F. 1958. Effect of removal of panfish and trash fish by fyke nets upon fish populations of some Massachusetts ponds. *Transactions of the American Fisheries Society* 87:108-115.
- Hanson, D. A., B. J. Belonger, and D. L. Schoenike. 1983. Evaluation of a mechanical reduction of black crappie and black bullheads in a small Wisconsin lake. *North American Journal of Fisheries Management* 3:41-47.
- Hayes, F. R., and D. A. Livingstone. 1955. The trout population of a Nova Scotia lake as affected by habitable water, poisoning of the shallows and stocking. *Journal of the Fisheries Research Board of Canada* 12:618-635.
- Helms, D. R. 1967. Experimental use of antimycin A to control spawning carp in Backbone Lake. Iowa Conservation Commission, Biology Section, Quarterly Biology Report (unnumbered), Des Moines.
- Heman, M. L., R. S. Campbell, and L. C. Redmond. 1969. Manipulation of fish populations through reservoir drawdown. *Transactions of the American Fisheries Society* 98:293-304.
- Hoffarth, R., and J. Conder. 1967. Experimental use of the haul seine for rough fish removal in four Tennessee impoundments. Proceedings of the Annual Conference Southeastern Association of Game and Fish Commissioners 18(1964):213-230.
- Holcomb, D. E. 1967. Fish management research: experiment in rearing four to six inch largemouth bass for biological control. Florida Game and Fresh Water Fish Commission, Federal Aid in Fish Restoration, Project F-14-R-7, Work Plan 1, Job H, Tallahassee.
- Hooper, A. D., and J. H. Crance. 1960. Use of rotenone in restoring balance to overcrowded fish populations in Alabama lakes. *Transactions of the American Fisheries Society* 89:351-357.
- Horel, G., and M. T. Huish. 1960. The effects of fish removal and other factors upon remaining fish populations at Lake Trafford, Florida. *Progressive Fish-Culturist* 22:73-76.
- Houser, A., and B. Grinstead. 1961. The effect of black bullhead, catfish, and bluegill removal on the fish population of a small lake. Proceedings of the Annual Conference Southeastern Association of Game and Fish Commissioners 15(1961):3-10.
- Huish, M. T. 1958a. Studies of gizzard shad reduction of Lake Beulah, Florida. Proceedings of the Annual Conference Southeastern Association of Game and Fish Commissioners 11(1957):66-70.
- Huish, M. T. 1958b. Gizzard shad removal in Deer Island Lake, Florida. Proceedings of the Annual Conference Southeastern Association of Game and Fish Commissioners 11(1957):312-318.
- Jackson, S. W., Jr. 1966. Summary of fish management activities on Lakes Eucha and Spavinaw, Oklahoma 1951-1964. Proceedings of the Annual Conference Southeastern Association of Game and Fish Commissioners 19(1965):315-343.
- Jenkins, R. M. 1956. Some results of the partial fish population removal technique. Proceedings of the Oklahoma Academy of Science 37:164-173.
- Johnson, F. H. 1975. Interspecific relationships of walleye, white sucker, and associated species in a northeastern Minnesota lake with an evaluation of white sucker removal for increased walleye yield. Minnesota Department of Natural Resources, Section of Fisheries, Investigational Report 338.
- Johnson, F. H. 1977. Response of walleye (*Stizostedion vitreum vitreum*) and yellow perch (*Perca flavescens*) populations to removal of white sucker (*Catostomus commersoni*) from a Minnesota lake, 1966. *Journal of the Fisheries Research Board of Canada* 34:1633-1642.
- Johnson, F. H., and T. C. Osborn. 1977. Experimental management of a small reclaimed lake in northern Minnesota for walleye (*Stizostedion vitreum*). Min-



- nesota Department of Natural Resources, Section of Fisheries, Investigational Report 349.
- Johnson, W. C. 1966. Toxaphene treatment of Big Bear Lake, California. *California Fish and Game* 52:173-179.
- Keith, W. E. 1968. Turbidity control and fish population renovation on Blue Mountain Lake, Arkansas. *Proceedings of the Annual Conference Southeastern Association of Game and Fish Commissioners* 21(1967):495-505.
- Kinman, B. T. 1983. Rough fish removal and its impact on the fish population in Rough River Lake, Kentucky. Kentucky Department of Fish and Wildlife Resources, Report 6, Frankfort.
- Kirk, J. P., W. D. Davies, and K. Park. 1986. Response of some members of the fish community to gizzard shad removal from Chambers County Public Fishing Lake, Alabama. *North American Journal of Fisheries Management* 6:252-255.
- Klein, W. D. 1960. The results of brook trout removal with derris root followed by native trout stocking in two alpine lakes. Colorado Department of Game and Fish, Fish Management Division Report, Denver.
- Klein, W. D. 1961. Removal of brook trout with derris root from a section of the south fork of the Frying Pan River. Colorado Department of Game, Fish, and Parks Special Report 66.
- Laarman, P. W. 1979. Evaluation of a chemical reclamation and restocking program on the Huron River in the Detroit metropolitan area. Michigan Department of Natural Resources, Fisheries Division, Research Report 1866, Lansing.
- Lamb, L. D. 1960. Fisheries investigations and surveys of the lakes of region 4B: evaluation of selective shad control work at Fincastle Lake. Texas Parks and Wildlife Department, Federal Aid in Fish Restoration, Project F-4-R-7, Work Plan E, Job 7, Austin.
- Lamb, L. D. 1963. Evaluation of rough fish and vegetation control in region 2A. Texas Parks and Wildlife Department, Federal Aid in Fish Restoration, Project F-4-R-91, Work Plan E, Job 8, Austin.
- Lambou, V. W., and H. Stern, Jr. 1959. Preliminary report on the effects of the removal of rough fishes on the Clear Lake sport fishery. *Proceedings of the Annual Conference Southeastern Association of Game and Fish Commissioners* 12(1958):36-56.
- Lantz, K. E., J. T. Davis, J. S. Hughes, and H. E. Schafer, Jr. 1967. Water level fluctuation—its effect on vegetation control and fish population management. *Proceedings of the Annual Conference Southeastern Association of Game and Fish Commissioners* 18(1964):483-494.
- Lawson, C. S. 1985. Short term effects of selective control of shad in Alabama public fishing lakes. *Proceedings of the Annual Conference Southeastern Association of Fish and Wildlife Agencies* 37(1983):468-471.
- Layzer, J. B., and M. D. Clady. 1984. Evaluation of the striped bass  $\times$  white bass hybrid for controlling stunted bluegills. *Proceedings of the Annual Conference Southeastern Association of Fish and Wildlife Agencies* 35(1981):297-310.
- Lennon, R. E., J. B. Hunn, R. A. Schnick, and R. M. Burrell. 1970. Reclamation of ponds, lakes, and streams with fish toxicants: a review. FAO (Food and Agriculture Organization of the United Nations) Fisheries Technical Paper 100.
- Lewis, G. E., and P. W. Robinson. 1968. Stream and lake survey: drawdowns for species control. West Virginia Division of Game and Fish, Federal Aid in Fish Restoration, Projects F-10-R-9, Job 3, Part 3 and F-10-R-8, Job 3, Part 3, Charleston.
- Lindland, R. L. 1973. Lake and reservoir investigations: squawfish control in Cascade Reservoir. Idaho Fish and Game Department, Federal Aid in Fish Restoration, Project F-53-R-8, Work Plan 2, Job A, Boise.
- Mathis, W. P., and A. Hulsey. 1959. Rough fish removal from Lake Catherine, Arkansas. *Proceedings of the Annual Conference Southeastern Association of Game and Fish Commissioners* 13(1959):197-203.
- McHugh, J. J. 1990. Responses of bluegills and crappies to reduced abundance of largemouth bass in two Alabama impoundments. *North American Journal of Fisheries Management* 10:344-351.
- Moody, H. L. 1957. A fisheries study of Lake Panasoffkee, Florida. *Quarterly Journal of the Florida Academy of Sciences* 20:20-88.
- Moyle, J. B., and W. D. Clothier. 1959. Effects of management and winter oxygen levels on the fish population of a prairie lake. *Transactions of the American Fisheries Society* 88:178-185.
- Moyle, J. B., J. H. Kuehn, and C. R. Burrows. 1950. Fish population and catch data from Minnesota lakes. *Transactions of the American Fisheries Society* 78:163-175.
- Moyle, P. B., B. Vondracek, and G. D. Grossman. 1983. Responses of fish populations in the North Fork of the Feather River, California, to treatments with fish toxicants. *North American Journal of Fisheries Management* 3:48-60.
- Neess, J. C., W. J. Helm, and C. W. Threinen. 1957. Some vital statistics in a heavily exploited population of carp. *Journal of Wildlife Management* 21:279-292.
- Nilsson, N. 1967. Interactive segregation between fish species. Pages 295-313 in S. D. Gerking, editor. *The biological basis of freshwater fish production*. Wiley, New York.
- Otis, K. J. 1988. Effects of freshwater drum removal in Lake Winnebago, Wisconsin, 1962-1981. Wisconsin Department of Natural Resources, Research Report 146, Madison.
- Panek, F. M. 1978. Effects of predator stocking on a largemouth bass-bluegill pond fishery. *Florida Scientist* 41:252-255.
- Parker, R. A. 1958. Some effects of thinning on a population of fishes. *Ecology* 39:304-317.
- Phillippy, C. L. 1967. Results of selective shad treatments in six central Florida lakes. *Proceedings of the Annual Conference Southeastern Association of Game and Fish Commissioners* 18(1964):198-212.

- Pierce, P. C., J. E. Frey, and H. M. Yawn. 1965. An evaluation of fishery management techniques utilizing winter drawdowns. Proceedings of the Annual Conference Southeastern Association of Game and Fish Commissioners 17(1963):347-363.
- Pintler, H. E., and W. C. Johnson. 1958. Chemical control of rough fish in the Russian River drainage, California. California Fish and Game 44:91-124.
- Powell, T. G. 1973. Effect of northern pike introduction on an overabundant crappie population. Colorado Division of Wildlife, Special Report 31, Denver.
- Priegel, G. R. 1971. Evaluation of intensive freshwater drum removal in Lake Winnebago, Wisconsin, 1955-1966. Wisconsin Department of Natural Resources Technical Bulletin 47.
- Rawson, D. S., and C. A. Elsey. 1950. Reduction in the longnose sucker population in Pyramid Lake, Alberta, in an attempt to improve angling. Transactions of the American Fisheries Society 78:13-31.
- Ricker, W. E., and J. Gottschalk. 1941. An experiment in removing coarse fish from a lake. Transactions of the American Fisheries Society 70:382-390.
- Riel, A. D. 1965. The control of an overpopulation of yellow perch in Bow Lake, Strafford, New Hampshire. Progressive Fish-Culturist 27:37-41.
- Riel, A. D. 1967. Merry Melting Lake perch control. New Hampshire Fish and Game Department, Federal Aid in Fish Restoration, Project F-11-R-6, Warm Water Fisheries Management Investigations, Completion Report, Concord.
- Robinson, D. W. 1961. Stream and lake survey: stream reclamation. West Virginia Division of Game and Fish, Federal Aid in Fish Restoration, Project F-10-R-2, Job 4, Charleston.
- Rose, E. T., and T. Moen. 1951. Results of increased fish harvest in Lost Island Lake. Transactions of the American Fisheries Society 80:50-55.
- Rose, E. T., and T. Moen. 1953. The increase in game-fish populations in East Okoboji Lake, Iowa, following intensive removal of rough fish. Transactions of the American Fisheries Society 82:104-114.
- Rost, R. A. 1989. Water quality and restoration of the lower Oconto River, Oconto County, Wisconsin. Wisconsin Department of Natural Resources Technical Bulletin 164.
- Rutledge, W. P., and J. C. Barron. 1972. The effects of the removal of stunted white crappie, *Pomoxis annularis* Rafinesque, on the remaining crappie population of Meridian State Park Lake, Bosque, Texas. Texas Parks and Wildlife Department, Technical Series 12, Austin.
- Ryan, J. H. 1977. Nongame fish control in Frenchman Reservoir, Plumas County. California Department of Fish and Game, Inland Fisheries, Administrative Report 78-1, Sacramento.
- Sayre, R. C. 1969. Evaluation of fish toxicants: Powder River rehabilitation, use of Fintrol-5 for fish eradication. Oregon State Game Commission, Federal Aid in Fish Restoration, Project F-80-R-1, Salem.
- Scarnecchia, D. L. 1988. Evaluation of fish eradication and game-fish restocking in a central Iowa pond. Journal of the Iowa Academy of Science 95:55-59.
- Schmitz, W. R., and R. E. Hetfeld. 1965. Predation by introduced muskellunge on perch and bass, II: years 8-9. Transactions of the Wisconsin Academy of Science, Arts and Letters 54:273-282.
- Schneider, J. C. 1981. Role of suckers and bullheads in fish communities. Michigan Department of Natural Resources, Federal Aid in Fish Restoration, Project F-35-R-7, Study 240, Final Report, Lansing.
- Scidmore, W. J. 1959. Evaluation of panfish removal as a means of improving growth rates and averages size of stunted fish. Minnesota Department of Conservation, Division of Game and Fish, Bureau of Fisheries, Investigational Report 198.
- Scott, T. M. 1968. Spotted gar predation on bluegill and selected forage species. Proceedings of the Annual Conference Southeastern Association of Game and Fish Commissioners 21(1967):357-360.
- Shetter, D. S., and G. R. Alexander. 1970. Results of predator reduction on brook trout and brown trout in 4.2 miles (6.76 km) of the North Branch of the Au Sable River. Transactions of the American Fisheries Society 99:312-319.
- Snow, H. E. 1962. A comparison of the fish populations in Murphy Flowage, Wisconsin, before and after a panfish removal program. Wisconsin Conservation Department, Madison.
- Snow, H. E. 1968. Stocking of muskellunge and walleye as a panfish control practice in Clear Lake, Sawyer County. Wisconsin Department of Natural Resources, Research Report 38, Madison.
- Snow, H. E. 1974. Effects of stocking northern pike in Murphy Flowage. Wisconsin Department of Natural Resources Technical Bulletin 79.
- Snyder, J. P. 1923. Black bass versus netting of coarse fish. Transactions of the American Fisheries Society 53:201-206.
- Spencer, S. L. 1967. Investigations on the use of electricity for thinning overcrowded populations of bluegill. Proceedings of the Annual Conference Southeastern Association of Game and Fish Commissioners 20(1966):423-437.
- Stephen, J. L. 1986. Effects of commercial harvest on the fish community of Lovewell Reservoir, Kansas. Pages 211-217 in G. E. Hall and M. J. Van Den Avyle, editors. Reservoir fisheries management: strategies for the 80's. American Fisheries Society, Southern Division, Reservoir Committee, Bethesda, Maryland.
- Stephens, W. E., and J. K. Beadles. 1980. Effects of cropping on growth of channel catfish. Proceedings of the Annual Conference Southeastern Association of Fish and Wildlife Agencies 33(1979):572-583.
- Sullivan, C. R. 1955. Pilot manipulation experiments—all undesirable species. West Virginia Division of Game and Fish, Federal Aid in Fish Restoration, Project F-1-R-4, Completion Report, Charleston.
- Swingle, H. S., E. E. Prather, R. Allison, and E. W. Shell. 1965. Management techniques for public fishing waters: control of unbalanced fish populations. Alabama Division of Game and Fish, Federal Aid in

- Fish Restoration, Project F-10-R-6, Job 4, Montgomery.
- Swingle, H. S., and E. V. Smith. 1942. The management of ponds with a stunted fish populations. Transactions of the American Fisheries Society 71:102-105.
- Thomaston, W. W. 1965. The results of population alteration and factors affecting balance in farm ponds in Georgia. Proceedings of the Annual Conference Southeastern Association of Game and Fish Commissioners 16(1962):361-370.
- Threinen, C. W. 1952. History, harvest and management of the Lake Koshkonong fishery. Wisconsin Conservation Department, Fisheries Biological Investigational Report 668, Madison.
- Tompkins, W. A., and J. W. Mullan. 1958. Selective poisoning as a management tool in stratified trout ponds in Massachusetts. Progressive Fish-Culturist 20:117-123.
- U.S. Fish and Wildlife Service. 1992. Results from the 1992 fisheries assessment surveys conducted on Valentine National Wildlife Refuge. U.S. Fish and Wildlife Services, Office of Fisheries and Wildlife Assistance, Valentine, Nebraska.
- Wales, J. H. 1942. Carp control work in Lake Almanor, 1941. California Fish and Game 28:28-33.
- Walters, C. J., and R. E. Vincent. 1973. Potential productivity of an alpine lake as indicated by removal and recent introduction of fish. Transactions of the American Fisheries Society 102:675-697.
- Wanie, B., and R. C. Hopkins. 1951. Carp versus submerged aquatic plants, game and fish food and cover. Wisconsin Department of Natural Resources, Interdepartmental Report, Madison.
- Warnick, D. C. 1977. Commercial fishing or rough fish control in South Dakota, some views and apparent values. South Dakota Department of Game, Fish and Parks, Bulletin 7, Pierre.
- Wege, G. J., and R. O. Anderson. 1978. Relative weight ( $W_T$ ): a new index of condition for largemouth bass. Pages 79-91 in G. D. Novinger and J. G. Dillard, editors. New approaches to the management of small impoundments. American Fisheries Society, North Central Division, Special Publication 5, Bethesda, Maryland.
- Wesloh, M. L. 1959. A two year creel census on Grace Lake in Baltrami County to evaluate the effect of perch removal on walleye fishing. Minnesota Department of Conservation, Division of Game and Fish, Section on Research and Planning, Investigation Report 210.
- Wilcox, J. F. 1965. Rough fish control in San Angelo Reservoir by selective and contour rotenone treatment. Texas Parks and Wildlife Department, Federal Aid in Fish Restoration, Project F-14-D-8, Work Plan 16, Job 49, Austin.
- Wright, R. M. 1990. Aspects of the ecology of bream, *Abramis brama*, in a gravel pit lake and the effects of reducing the population density. Journal of Fish Biology 37:629-634.
- Wyatt, H. N., and H. D. Zeller. 1965. Fish population dynamics following a selective shad kill. Proceedings of the Annual Conference Southeastern Association of Game and Fish Commissioners 16(1962):411-418.

Appendix follows