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DEPARTMENT OF NATURAL RESOURCES

RESEARCH

REPORT 145

MARCH 1988

EFFECTS OF FRESHWATER DRUM REMOVAL IN LAKE WINNEBAGO, 1967-1981

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ABSTRACT

A fish management program to systematically remove freshwater drum (Aplodinotus grunniens) from Lake Winnebago has been carried out since 1955 to benefit the sport fishery. The purpose of my study was to evaluate the effects of drum removal from 1967-81. Major removal gear was the otter trawl. Drum removal declined from highs of over 4 million lbs/year during years of intensive removal (1955-66) to approximately 1 million lbs/year from 1967-81. Although gear efficiency increased over the years, total effort declined, resulting in the lower catches.

Regression analyses between mean catch per haul (lbs) and cumulative catch from spring through fall of 15 years of pooled data failed to show any consistent year-to-year or within-season trends. Analyses based on these data showed no evidence of a decline in catch from spring through fall, suggesting that 1967-81 removal rates did not significantly reduce drum biomass.

Findings from other analyses include: (1) overall drum growth and condition during 1967-81 were better than during the years of intensive removal; (2) total annual mortality rates for age VI-IX drum, estimated from a catch curve, were lower for males (60%) than for females (71%); (3) drum condition declined with age; and (4) removal gear selected larger/older drum, therefore changes in overall drum condition factors may be due to changes in the age structure.

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INTRODUCTION

Rough fish removal operations have been an integral part of fishery management on Lake Winnebago since the 1930s. Early efforts focused on carp (<u>Cyprinus carpio</u>) removal, but emphasis gradually shifted to freshwater drum (<u>Aplodinotus grunniens</u>) removal in the late 1940s. The primary goal of removal operations has been to improve the sport fishery (Priegel 1965, 1971), but other benefits from the program have been realized. These benefits include sale of rough fish for human and animal consumption, collection of a wide variety of data on major Lake Winnebago fish species, and refinements in fish sampling gear and methodology (Hacker 1978).

An evaluation of intensive freshwater drum removal during 1955-66 was conducted by Priegel (1971) who reported apparent benefits to the Lake Winnebago sport fishery, although no positive correlations could be demonstrated. Due to a reduction in money and personnel, removal efforts were reduced beginning in 1967. The purpose of my study was to evaluate the effects of this reduced removal effort on the drum population during the 1967-81 period in terms of catch per unit effort, growth, mortality, and condition.

DESCRIPTION OF STUDY AREA

Lake Winnebago (137,708 acres), Wisconsin's largest inland lake, is located in the east central region of the state (Fig. 1). The lake is roughly rectangular in shape, 10.5 miles wide and 28.0 miles long, and is ideally

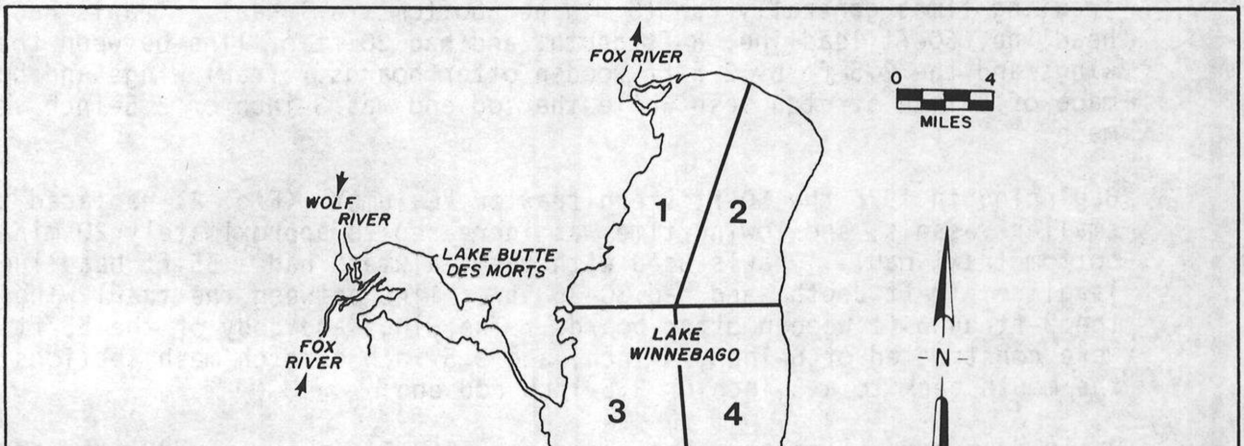


FIGURE 1. The Fox-Wolf River drainage basin and boundaries of the 6 trawling areas of Lake Winnebago.

suited to trawling (Wirth 1957, 1959; Priegel 1965). Average and maximum depths are 15.5 ft and 21.0 ft, respectively. The flat bottom is primarily composed of organic silt or sand overlying a clay base. With the exception of rock reefs bordering the west shore and the south end of the lake, trawling obstacles are nearly nonexistent.

Lake Winnebago sustains a diversity of year-round sport fisheries, the most notable being walleye, sauger, and white bass. It also supports the largest harvestable lake sturgeon population in North America. The lake is truly a multi-use system, supporting many fishing, hunting, and boating interests, as well as providing a vast pool of water for downstream industry. Lake Winnebago is replenished by the Fox and Wolf river watersheds (Fig. 1), which drain much of the state. The lake is linked to the Great Lakes via a series of locks and dams on the Lower Fox River.

In the late 1950s, Lake Winnebago was arbitrarily divided into 6 trawling areas (Fig. 1). The areas were not designated for biological reasons or for any marked differences in habitat, but simply to make referrals to fish sampling locations easier. The 6 areas have become historical reference locations through general use over the past 30 years.

MATERIALS AND METHODS

The major freshwater drum removal gear during the 1967-81 study period was the otter trawl, which had gradually replaced trap nets during the years of intensive drum removal (Priegel 1971). The side trawlers "Winnebago" (35 ft) and "Sheepshead" (38 ft) were the major vessels employed from 1967-75, and trawling times generally ran 15 min per bottom trawl haul. Trawls had a 45-ft headline, 60-ft leadline, 8-ft depth, and had 20 ft of line between the trawl wings and the 2.5-ft by 2.5-ft wooden otter boards. Trawl wings and body were made of 6-inch stretch mesh while the cod end was 3-inch or 3.5-inch stretch mesh.

Beginning in 1976 the 50-ft stern trawler "Calumet" (Fig. 2) replaced the 2 smaller vessels, and towing time was increased to approximately 20 min per bottom trawl haul. Trawls used with the "Calumet" had a 55-ft headline, 67-ft leadline, 12-ft depth, and had 30-35 ft of line between the trawl wings and the 3-ft by 6-ft wooden otter boards. The wings and body of the 55-ft trawl were constructed of 6-inch, 4-inch, and 3.5-inch stretch mesh sections from the mouth back to a 3-inch or 3.5-inch cod end.

Daily drum removal records for the years 1967-81 were entered into computer files and analyzed using the Statistical Analysis System (SAS Inst. 1982). A ratio of total drum catch (lbs) to the number of trawl hauls was used to determine daily mean catch per haul (CPH). Weekly mean CPH was also calculated.

Catch per unit effort was lower during the 1967-75 period because larger trawl sizes and increased towing times during the 1976-81 period resulted in higher mean catch per haul (Append. Fig. 1). Thus CPH patterns from year to year were not analyzed. However, gear and effort were similar during individual

FIGURE 2. Stern trawler "Calumet" (50 ft) used to remove freshwater drum from Lake Winnebago, 1976-81.

years, permitting within-season comparisons. Declines in catch per unit effort (lbs) within a given year can be considered as evidence of a decline in standing stock if gear and effort remain the same (Ricker 1975).

Regressions of daily CPH vs. cumulative catch of drum were analyzed in two groupings: the first used all trawl data in a given open water season, while the second used only data from 15 June-31 October, since preliminary data analyses showed wide variations in catch both early and late in the seasons (Append. Fig. 2). Regressions for the two open water season groupings were tested for significant ($P < 0.05$) negative, within-year slopes, which would indicate a reduction in drum standing stock during a season's removal operation (Ricker 1975, p. 149).

Other data summaries, many of which update those described by Priegel (1971), include calculations of total annual drum removal, mean annual catch per bottom trawl haul, and analysis of drum age, growth, mortality, and condition. A catch curve (Ricker 1975), based on a single fall 1980 sample, was constructed to estimate total annual drum mortality and to determine which length ranges of drum were selected by the 55-ft trawl. Condition (K) was described by the formula:

$$K = \frac{W \times 10,000}{L^3}$$

where W = weight in lbs and L = total length in inches. Fish condition factors were summarized by age group for samples taken in 1969-81, except for 3 years for which age data were not available (1970, 1972, 1974). Techniques for aging scales are described by Priegel (1969a).

RESULTS AND DISCUSSION

Harvest and Catch per Effort

Drum removal averaged 1.2 million lbs/year (8.7 lbs/acre/year) during the 1967-81 study period. This is less than half the amount removed during 1955-66, when an average 2.8 million lbs/year (20.2 lbs/acre/year) were removed (Fig. 3).

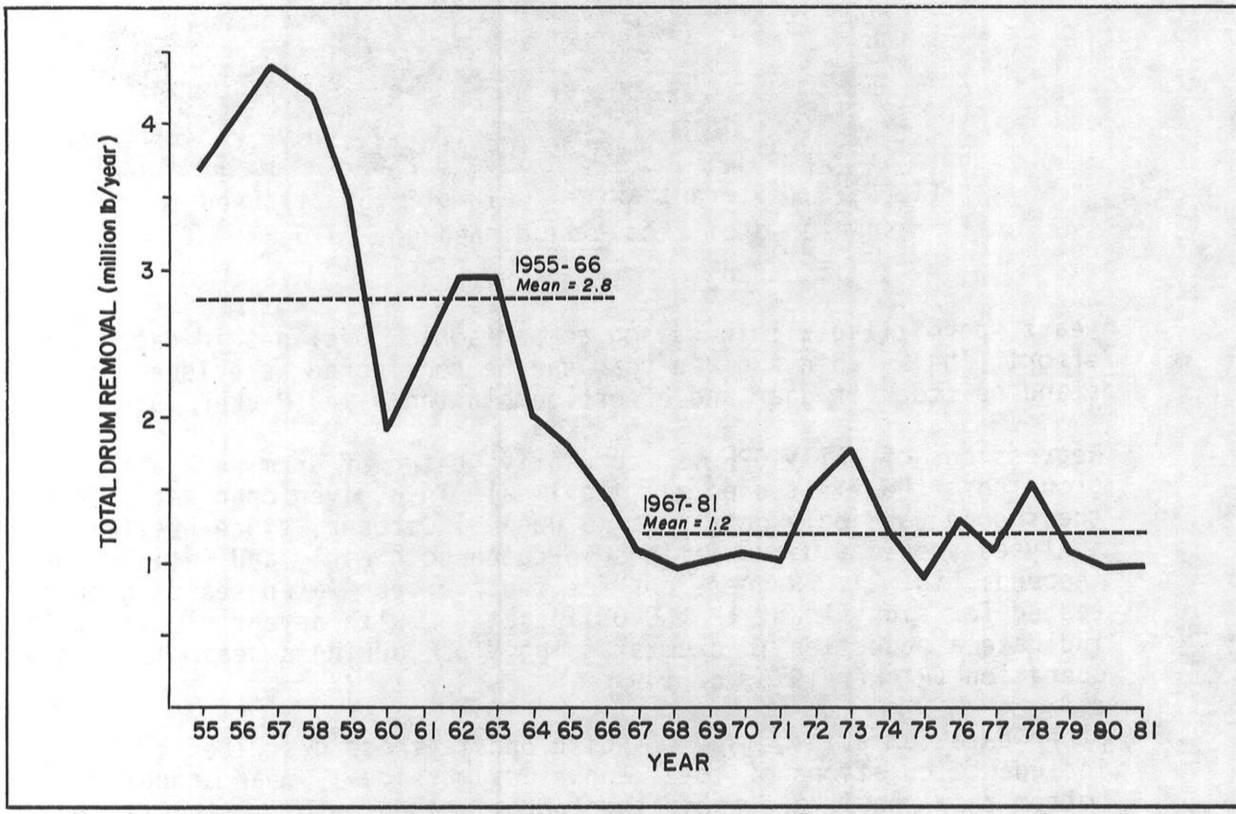


FIGURE 3. Total annual freshwater drum removed by state and contract crews on Lake Winnebago from 1955 to 1981 with trap nets and otter trawls (1955-66 data from Priegel (1971)).

In most years there were no significant ($\underline{P} < 0.05$) changes in CPH. Five of 15 years (1967-81) displayed significant relationships for regressions of CPH vs. cumulative catch for the entire open water season, which ranged as early as 9 April and as late as 18 November (Table 1). Years 1967, 1968, and 1976 were significant with a positive slope, indicating that CPH increased in those years. Years 1971 and 1981 were significant with a negative slope, indicating that CPH declined in those years.

The regression analysis was rerun using only data from 15 June to 31 October, 1967-81, because of the early and late season variations in CPH. Although this rearrangement did not increase the $\underline{r}$-square correlations, it did increase by 3 the number of years with significant ($\underline{P} < 0.05$) within-season changes in CPH (Table 2). Eight of the 15 years displayed significant relationships for

TABLE 1. Regressions of catch per haul vs. cumulative catch by year for Lake Winnebago 45-ft and 55-ft trawl data for all open water seasons, ranging between 9 April and 18 November 1967-81.

Year	Probability >F	R-Square Correlation	Mean CPH	Slope
1967	0.0001*	0.4808	278.3	0.00072558
1968	0.0129*	0.0887	262.1	0.00024966
1969	0.0972	0.0452	251.5	0.00021866
1970	0.0742	0.0442	261.2	-0.00014982
1971	0.0002**	0.1705	279.3	-0.00029784
1972	0.3502	0.0137	415.7	-0.00008405
1973	0.3322	0.0138	397.9	-0.00006963
1974	0.5089	0.0059	276.6	-0.00008249
1975	0.3497	0.0108	347.7	-0.00013119
1976	0.0001*	0.2965	477.6	0.00051883
1977	0.1412	0.0207	635.2	0.00019127
1978	0.1088	0.0234	579.0	-0.00009335
1979	0.2553	0.0114	632.8	-0.00012305
1980	0.1478	0.0188	973.3	-0.00023459
1981	0.0055**	0.0601	961.8	-0.00050210

* Significant ($P < 0.05$) positive relationship.
** Significant ($P < 0.05$) negative relationship.

regressions of CPH vs. cumulative catch. Years 1967, 1968, 1976, and 1979 were significant with a positive slope, indicating that CPH increased in those years. Years 1971, 1975, 1980, and 1981 were significant with a negative slope, indicating that CPH declined in those years.

If removal operations over the 15-year study period were causing a significant reduction in drum standing stock in Lake Winnebago, we would expect to see mortality losses exceeding growth and recruitment gains, and CPH should decline in a given year. If there was no drum removal, we would expect an increase in CPH (until the carrying capacity is reached), if biomass additions through growth and recruitment exceed biomass losses through mortality. In no year was the observed increase or decline of a large magnitude (Tables 1 and 2), so a safe generalization is that removals may, at best, be merely cropping annual production of drum in Lake Winnebago. As Ricker (1975, p. 309) explains, ". . . under reasonably stable natural conditions the net increase of an unfished stock is zero, at least on the average: its growth is balanced

TABLE 2. Regressions of catch per haul vs. cumulative catch by year for Lake Winnebago 45-ft and 55-ft trawl data, 15 June-31 October 1967-81.

Year	Probability >F	R-Square Correlation	Mean CPH	Slope
1967	0.0001*	0.3609	260.476	0.000641969
1968	0.0247*	0.0763	258.620	0.000238587
1969	0.1585	0.0352	247.162	0.000200242
1970	0.2573	0.0203	270.750	-0.000107151
1971	0.0001**	0.2099	276.906	-0.000329987
1972	0.1532	0.0349	412.730	-0.000149411
1973	0.3322	0.0138	397.937	-0.000069633
1974	0.9306	0.0001	286.229	0.000011903
1975	0.0004**	0.1625	324.325	-0.000370075
1976	0.0001*	0.3091	437.651	0.000336032
1977	0.9115	0.0001	617.572	-0.000012491
1978	0.2761	0.0129	551.585	0.000066433
1979	0.0008*	0.1216	558.622	0.000357265
1980	0.0442**	0.0447	987.850	-0.000413497
1981	0.0025**	0.0949	974.670	-0.000844079

* Significant ($P < 0.05$) positive relationship.
** Significant ($P < 0.05$) negative relationship.

by natural deaths. Introducing a fishery increases production per unit of stock . . . and so creates a surplus which can be harvested. In these ways, 'a fishery, by thinning out a population, itself creates the production by which it is maintained' (Baranov 1927)."

Age and Growth

Growth of freshwater drum in Lake Winnebago (Tables 3 and 4) has changed since the years of intensive removal. Growth of age I and II drum was slightly better in years 1956-64 than in years 1968-81. Drum growth at age III was about the same for both periods, and, beginning at age IV, growth clearly improved in the 1968-81 period.

A widely accepted fisheries concept is that growth will increase in the remaining individuals of an overharvested population (Priegel 1971; Wirth 1954, 1958). If intensive removal from 1955-66 had achieved this

TABLE 3. Lengths-at-age (inches) and number of back-calculated fish increments (in parentheses) of 1,693 male and female freshwater drum from Lake Winnebago fall samples: 1969 (157), 1971 (112), 1973 (127), 1974 (145), 1975 (106), 1976 (114), 1978 (166), 1979 (155), 1980 (480), 1981 (131). Growth information is presented for only the post-intensive drum removal period, 1967-81.

Year Class	Age I	II	III	IV	V	VI	VII	VIII	IX	X	XI
1981	5.4 (2)										
1980	5.0 (5)	8.1 (5)									
1979	4.5 (22)	8.4 (22)	9.2 (21)								
1978	4.8 (14)	8.9 (14)	10.6 (13)	11.6 (5)							
1977	4.8 (62)	8.4 (62)	10.7 (61)	12.0 (56)	12.8 (31)						
1976	4.5 (230)	8.2 (230)	10.7 (230)	12.1 (221)	13.1 (178)	13.8 (44)					
1975	4.6 (298)	8.2 (298)	10.8 (279)	12.4 (279)	13.5 (250)	14.3 (178)	14.8 (17)				
1974	4.6 (185)	8.1 (185)	10.5 (179)	12.3 (177)	13.5 (177)	14.6 (143)	15.2 (116)	15.9 (6)			
1973	4.6 (162)	8.3 (162)	10.4 (134)	12.3 (99)	13.6 (82)	14.4 (82)	15.8 (40)	16.3 (34)			
1972	4.6 (68)	8.2 (68)	10.4 (68)	12.4 (57)	13.7 (52)	14.6 (46)	15.2 (46)	16.0 (7)	16.5 (7)		
1971	4.4 (62)	8.3 (62)	10.6 (62)	12.0 (57)	13.2 (40)	14.3 (30)	15.6 (12)	16.3 (12)			
1970	4.5 (101)	8.2 (101)	10.3 (77)	11.7 (77)	13.0 (54)	14.5 (25)	15.1 (21)	16.2 (1)	17.0 (1)	17.8 (1)	
1969	4.4 (80)	8.2 (79)	10.5 (79)	12.2 (64)	13.2 (64)	14.1 (56)	15.0 (38)	15.7 (19)			
1968	4.5 (76)	8.3 (76)	10.6 (70)	12.2 (70)	13.4 (65)	14.2 (65)	15.0 (49)	15.5 (27)	16.3 (10)		
1967	4.3 (90)	8.1 (90)	10.4 (90)	12.1 (83)	13.2 (83)	14.2 (71)	14.8 (71)	15.6 (27)	15.9 (11)	15.9 (3)	
1966		8.0 (80)	10.2 (80)	11.6 (80)	13.1 (45)	13.9 (45)	14.7 (30)	15.2 (30)	16.5 (6)	16.8 (2)	
1965			10.8 (50)	12.3 (50)	13.4 (50)	14.5 (33)	15.1 (33)	15.0 (6)	15.4 (6)		
1964				12.4 (32)	13.6 (32)	14.3 (32)	15.2 (14)	15.8 (14)	15.2 (1)	15.5 (1)	
1963					13.8 (25)	14.7 (25)	15.3 (25)	15.8 (1)	16.6 (1)		
1962						14.9 (30)	15.6 (30)	16.2 (30)			
1961							16.4 (16)	17.1 (16)	17.7 (16)		
1960								16.8 (2)	18.2 (2)	18.7 (2)	
1959									20.4 (1)	21.3 (1)	22.0 (1)
Unweighted Mean	4.6	8.3	10.4	12.1	13.3	14.4	15.3	16.0	16.9	17.7	22.0
Weighted Mean	4.5	8.2	10.6	12.2	13.4	14.4	15.2	15.9	16.7	17.3	22.0
Total Increments	1,457	1,534	1,493	1,407	1,228	905	558	232	62	10	1

TABLE 4. Lengths-at-age (inches) and number of back-calculated fish increments (in parentheses) of 1,318 male and female freshwater drum from Lake Winnebago fall samples in 1963 (786) and 1965 (532). Growth information is presented for only the intensive drum removal period, 1955-66.

Year Class	Age I	II	III	IV	V	VI	VII	VIII	IX	X
1964	5.0 (77)	8.5 (77)								
1963	5.0 (240)	8.7 (240)	10.6 (240)							
1962	6.0 (2)	8.7 (2)	10.4 (2)	12.4 (2)						
1961	5.3 (15)	8.2 (15)	10.4 (15)	11.6 (14)	12.5 (14)					
1960	5.2 (53)	8.1 (53)	10.2 (53)	11.4 (53)	12.5 (19)	13.2 (19)				
1959	5.1 (566)	8.1 (566)	10.1 (566)	11.1 (566)	12.1 (566)	13.2 (130)	13.8 (130)			
1958	4.9 (149)	8.6 (149)	10.7 (149)	12.0 (149)	13.3 (149)	13.7 (149)	14.9 (38)	15.3 (38)		
1957	4.7 (116)	8.7 (116)	10.7 (116)	12.1 (116)	13.1 (116)	13.8 (116)	14.3 (116)	15.1 (11)	15.5 (11)	
1956	4.6 (67)	8.5 (67)	10.6 (67)	12.0 (67)	12.9 (67)	13.7 (67)	14.2 (67)	14.8 (67)	17.7 (1)	
1955		8.2 (29)	10.3 (29)	11.3 (29)	12.4 (29)	13.3 (29)	13.9 (29)	14.5 (29)	15.1 (29)	
1954			10.3 (4)	11.6 (4)	12.6 (4)	13.3 (4)	14.1 (4)	14.7 (4)	15.2 (4)	15.7 (4)
Unweighted Mean	5.1	8.4	10.4	11.7	12.7	13.5	14.2	14.9	15.9	15.7
Weighted Mean	5.0	8.4	10.4	11.5	12.5	13.5	14.2	14.9	15.2	15.7
Total Increments	1,285	1,314	1,241	1,000	964	514	384	149	45	4

density-dependent growth compensation in the remnant population of drum, then the lengths-at-age during the intensive removal period (Table 4) should be higher than those under reduced drum removal (Table 3). In fact, the opposite is true. Growth appears to be much better during the period of lower removal. This could mean one of two things. Either the removal operations did not have the desired effect on drum growth or factors other than drum removal were responsible for the observed changes in growth between the two removal periods.

Mortality

Examination of the catch curve showed that age VI is the point at which drum are optimally selected by the trawl gear (Fig. 4). Age VI fish are about 14.3 inches (Table 3, 1980 sample). The trawl was not entirely effective at capturing drum at age V (about 13.1 inches) or age IV (about 12.0 inches), so these ages were excluded from the mortality estimate.

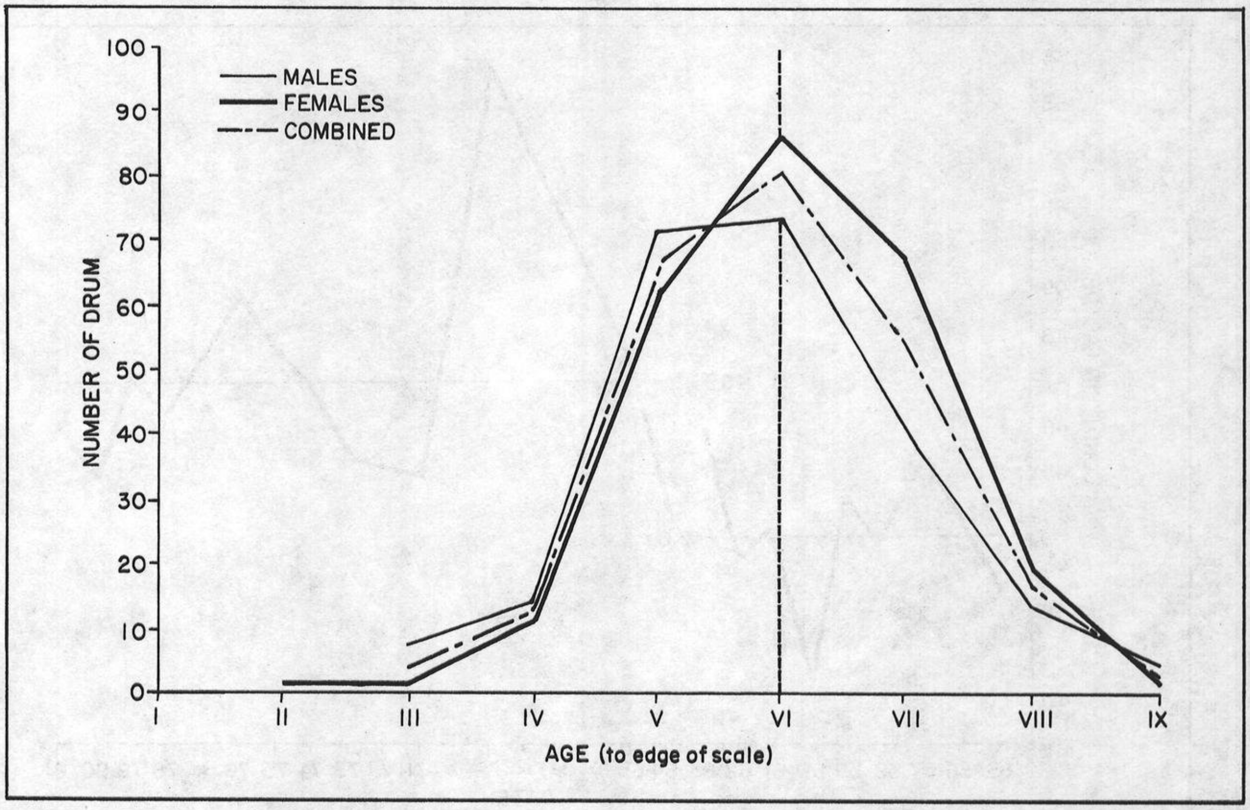


FIGURE 4. Catch curve for age VI-IX drum based on a fall 1980 trawl sample of 480 freshwater drum.

The total annual mortality rate of age VI-IX drum (Fig. 4) was lower for males (60%) than for females (71%) with a combined estimate of 65%. Regressions are:

males: $Y = 9.9596 - 0.9183\,X$ ($\underline{r} = -0.99$)
females: $Y = 12.5002 - 1.2542\,X$ ($\underline{r} = -0.94$)
combined: $Y = 11.7490 - 1.0581\,X$ ($\underline{r} = -0.97$)

where X is ages VI through IX, and Y is the natural log of numbers of drum. Bur (1984) estimated the total annual mortality rate to be 49% for age groups IV-XI of Lake Erie freshwater drum. No estimates are available of drum mortality in Lake Winnebago during the period of intensive removal.

Condition

Overall drum condition (all ages combined) was higher during the 1967-81 sample period than during the period of intensive removal (Fig. 5). The mean condition factor for the period 1955-65 was 44.0 while that for the 1969-81 period was 47.1. It is not known why there was an abnormally high peak in condition in 1969. With this year omitted, the mean condition of the 1971-81 samples was 46.3, still well above that for the 1955-65 period.

Condition factors fell into 3 general age categories: (1) ages I-III, containing many immature, low condition fish; (2) ages IV-VII, containing mostly mature fish (Priegel 1969a) and similar sex ratios (Fig. 4); and (3) ages VIII and older, containing fewer numbers of fish of more variable condition. The second category, ages IV-VII, was selected for examination of year-to-year trends, as any bias from groups 1 and 3 would be eliminated.

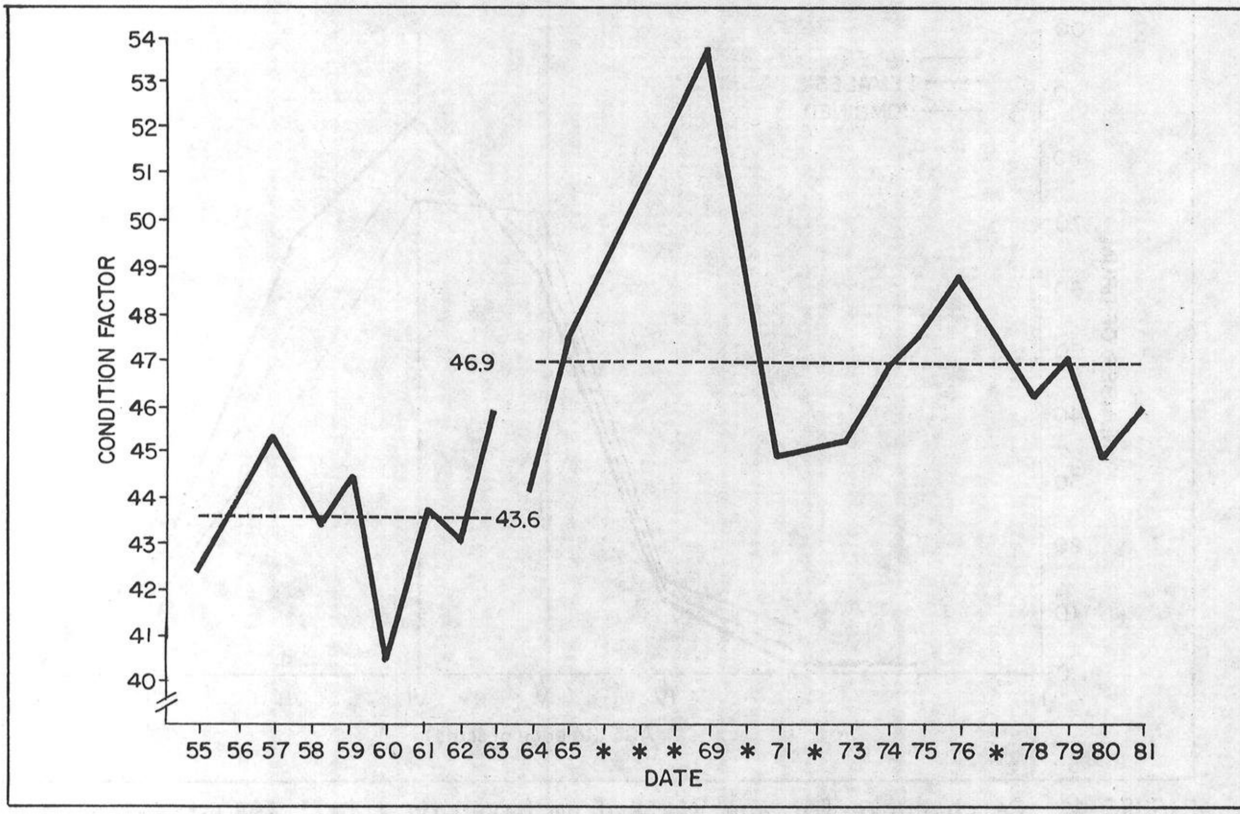


FIGURE 5. Average annual condition factors of drum for October 1955-63, calculated from condition of 1-inch groups (trap net sample) and for 13 September-4 November 1964-81, calculated from condition of each age group (bottom trawl sample). Asterisks indicate years in which data were not collected.

When condition factors for age groups IV-VII were examined separately by year it was clear that drum condition declined with age (Fig. 6). Condition factors by age group are presented in Appendix Table 1. There was some overlap between condition of age IV and V fish, probably due to differences in maturity (Wirth 1954), but age groups VI and VII displayed consistently lower condition in each of the years sampled. Observed changes in drum condition factors could, therefore, be due to changes in the age structures of the population.

Most drum removed were at least age V or VI (Fig. 4). Since the gear was selective for these older drum, many of the remaining fish in the population could be mature, age III-V fish in better condition than the older fish that were removed. Priegel (1971) reported that the initial heavy removal of 11.8 million lbs of drum from 1955-57 resulted in improved drum condition, but that this improvement tended to be lost in later years. During the intensive removal period, the early improvement in condition may have been due to the limited removal of the age III-V, higher condition fish, and not to better growth of all remaining fish. Given these circumstances, drum population condition in Lake Winnebago could improve without affecting catch per haul if recruitment was keeping pace with annual total mortality.

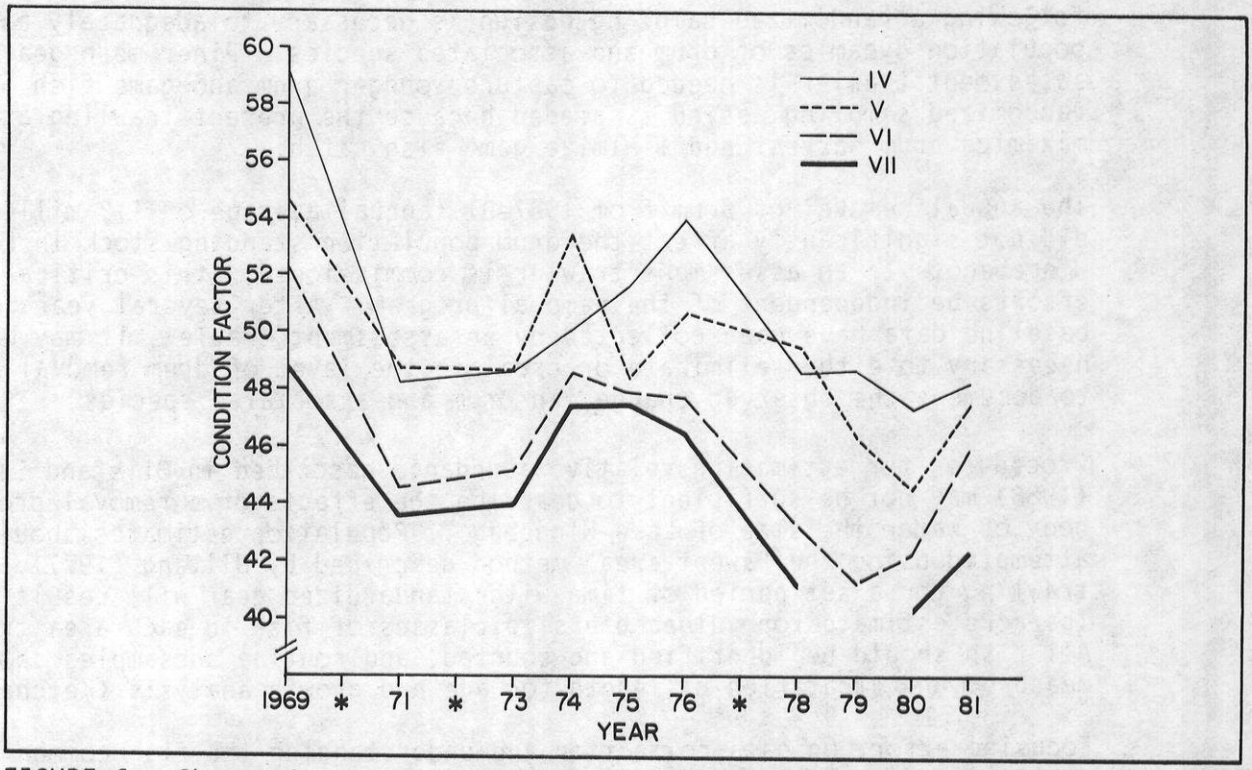


FIGURE 6. Change in condition of age IV-VII freshwater drum from fall-sampled fish, 1969-81. Asterisks indicate years in which data were not collected.

Interaction Between Drum and Game Fish

The desired effect of the Lake Winnebago drum removal program was to improve growth or numbers of game fish (Priegel 1965, 1971). Intuitively, for drum removal to benefit game fish populations there must be some negative interaction between the populations, such as competition or predation. In earlier dietary studies of drum on Lake Winnebago, Priegel (1967a) found that midge larvae accounted for 88.3-99.3% of the total food volume for 672 adult male and female drum from April, July, and October samples, while unidentified fish remains accounted for only 0.2% of the total food volume during the same periods. Several studies by Priegel (1963, 1967a, 1967b, 1969b, 1969c, 1970) indicate that game fish and drum prey heavily on midge larvae at some time during their life cycles in Lake Winnebago, but there is no evidence to suggest that this food source is limiting. The only demonstrated interspecific interaction, based on dietary studies on Lake Winnebago, is the predation of game fish on drum young of the year (Priegel 1963, 1969b, 1969c, 1970).

MANAGEMENT IMPLICATIONS

Using data derived from the removal program to assess its effects was not, in retrospect, the best research method. The data thus produced may have tended to confound past and present analyses. If removal of drum is to continue on Lake Winnebago, a separate trawling vessel equipped with finer mesh gear and following a randomized sampling design is necessary to adequately assess the population dynamics of drum and associated species. Finer mesh gear on the assessment trawler is needed to capture younger drum and game fish. A randomized sampling design is needed because the present trawling attempts to maximize drum harvest and minimize game fish catch.

The annual removal of drum from 1967-81 (annual average of 1.2 million lbs) did not significantly affect the drum population standing stock in Lake Winnebago. If an assessment trawler is commissioned, it is critical that its efforts be independent of the removal program. After several years of baseline data have been collected by an assessment trawler, it may be necessary to either eliminate or escalate the level of drum removal in order to document the observed changes in drum and associated species.

Procedures for estimating relative abundance described in Otis and Staggs (1988) may not be sufficient to describe the effects of a removal program on a body of water the size of Lake Winnebago. Population estimates should be attempted using the "swept area" method described by Ulltang (1977). Random trawling for a set period of time with standardized gear will result in a lbs/acre estimate for vulnerable size classes of fish in each area trawled. All fish should be identified and counted, and routine subsamples should be measured and stratified by length for age and growth analysis (Ketchen 1950).

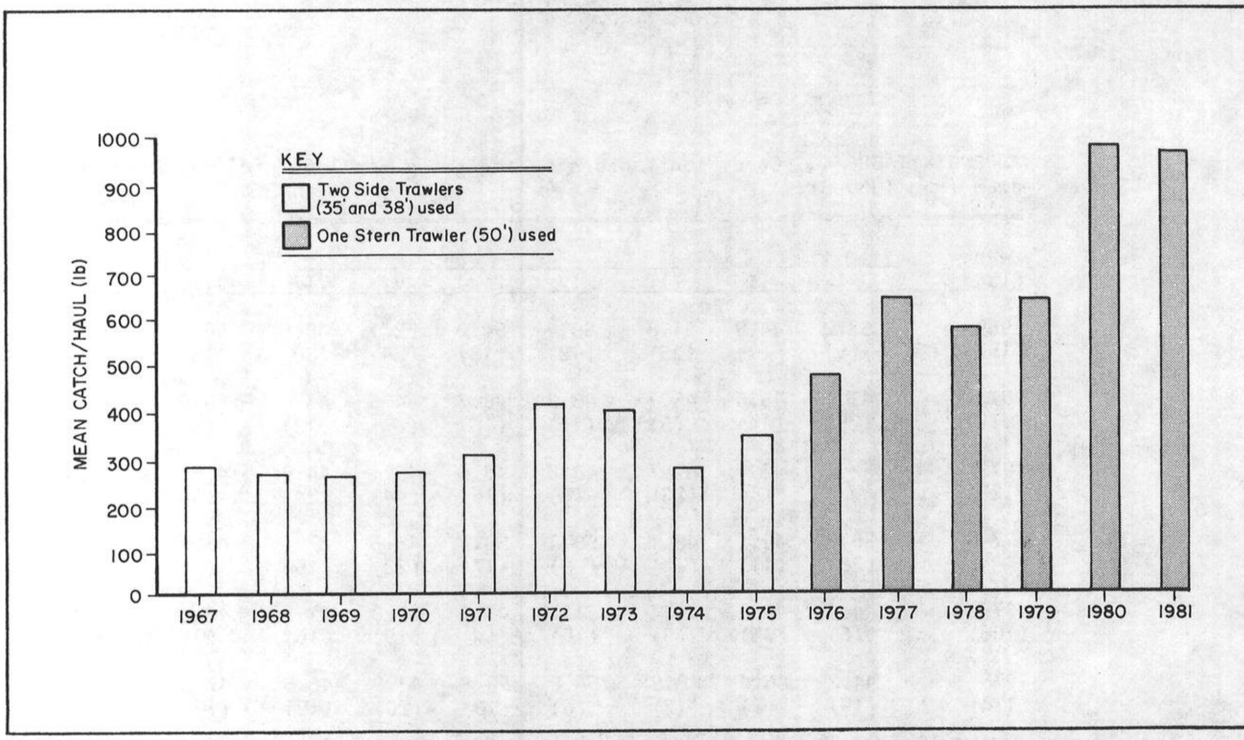
Focusing effort on data collection and understanding the fish community ecology represents the logical first step in any sound management plan. A well-designed long-term assessment study can provide the findings necessary to answer the question of what level of drum removal, if any, is favorable to the comprehensive management of the fishery resources of Lake Winnebago.

APPENDIX

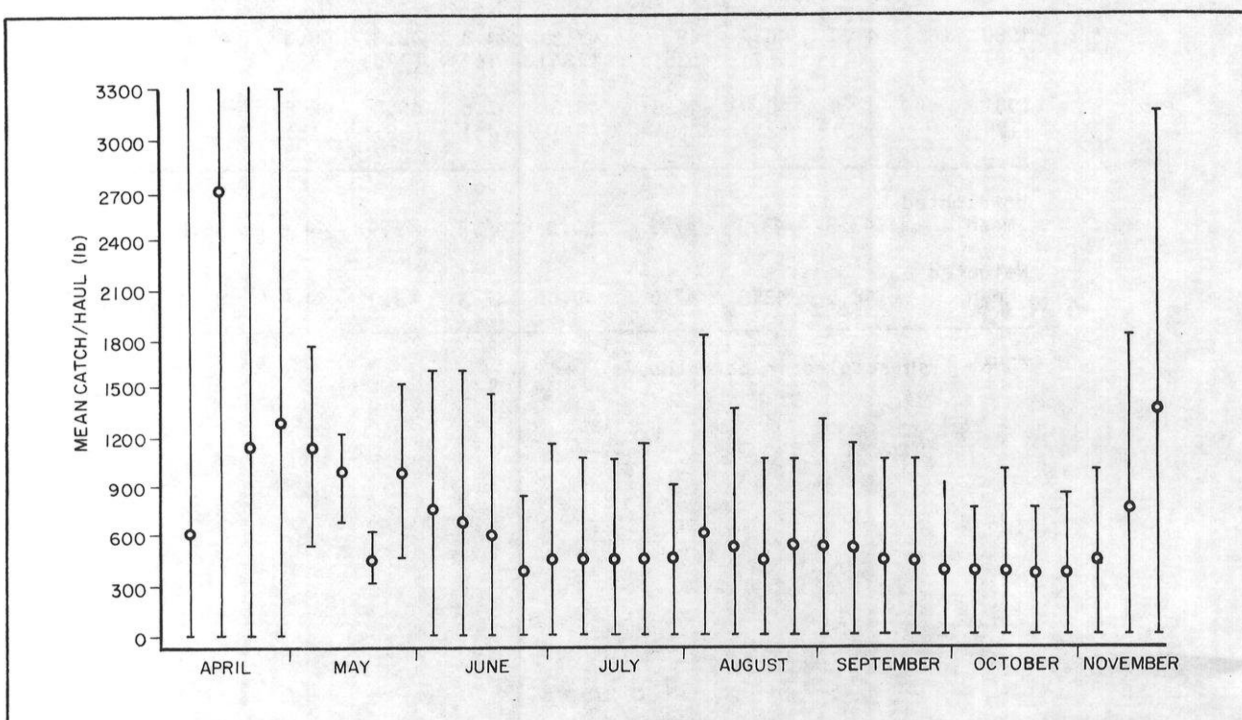
APPENDIX TABLE 1. Condition factors by age group for 1,692 fall-sampled freshwater drum from 1969-81.

Year Class	Age I	II	III	IV	V	VI	VII	VIII	IX	X
1969 (157)*	53.2 (6)	44.8 (7)	51.8 (35)	59.2 (18)	54.9 (18)	52.1 (24)	48.8 (30)	50.6 (16)	50.9 (2)	54.0 (1)
1971 (112)	41.1 (25)	45.0 (14)	45.3 (5)	48.2 (11)	48.7 (16)	44.6 (27)	43.6 (13)	40.9 (1)		
1973 (128)		42.4 (5)	44.7 (23)	48.6 (8)	48.6 (16)	45.1 (44)	44.0 (24)	41.6 (6)	45.6 (2)	
1974 (144)	38.2 (28)	40.1 (11)	48.1 (17)	50.1 (29)	53.4 (17)	48.6 (22)	47.4 (16)	48.5 (4)		
1975 (106)	44.9 (6)	45.2 (35)	49.1 (5)	51.7 (10)	48.5 (4)	48.0 (19)	47.5 (16)	46.8 (9)	47.0 (2)	
1976 (114)	44.2 (19)	46.4 (2)	48.8 (17)	54.0 (6)	50.8 (18)	47.9 (20)	46.5 (19)	47.6 (10)	47.7 (3)	
1978 (166)	44.5 (1)	43.5 (9)	45.0 (29)	48.5 (34)	49.5 (42)	43.2 (39)	41.1 (12)			
1979 (155)	39.7 (1)	43.9 (4)	46.8 (44)	48.8 (72)	46.3 (27)	41.3 (6)			55.3 (1)	
1980 (481)	41.1 (1)	40.4 (7)	48.7 (26)	47.5 (135)	44.8 (161)	42.3 (110)	40.3 (33)	43.5 (8)		
1981 (129)	42.9 (5)	40.9 (21)	44.8 (5)	48.3 (31)	47.6 (44)	46.0 (18)	42.5 (5)			
Unweighted Mean	43.3	43.3	47.3	50.5	49.3	45.9	44.6	45.6	49.3	54.0
Weighted Mean	42.0	43.3	47.7	49.0	47.3	45.0	44.8	47.0	48.5	54.0

* No. fish sampled in parentheses.



APPENDIX FIGURE 1. Mean catch per trawl haul (lbs) of freshwater drum from removal efforts on Lake Winnebago, 1967-81.



APPENDIX FIGURE 2. Unweighted weekly mean catch per haul and 95% confidence intervals from 45-ft and 55-ft trawls for Lake Winnebago freshwater drum removal, 1967-81, pooled data.

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