1
8
8
7

Effect of Sucker Removal on Fish and Fishing at Big Bear Lake

James C. Schneider
and
Walter R. Crowe

Fisheries Research Report No. 1887
November 20, 1980

MICHIGAN DEPARTMENT OF NATURAL RESOURCES
FISHERIES DIVISION

Fisheries Research Report No. 1887

November 20, 1980

EFFECT OF SUCKER REMOVAL ON FISH AND FISHING AT BIG BEAR LAKE [1]

By James C. Schneider and Walter R. Crowe

Abstract

White suckers comprised 78% of the fish biomass at Big Bear Lake, Otsego County, Michigan, in the early 1940's. About 90% of the adults were removed with trap nets in 1943, and again in 1955-57. Recovery took 8 and 3 years, respectively. Data on angling, growth, condition, and population size were collected before and after the first removal.

Yellow perch and, to a lesser extent rock bass, benefited from the removal of suckers. Largemouth and smallmouth bass did not benefit. The catch of perch by anglers increased from about 500 per year to over 12,000; in addition, a large winter fishery for them developed. There was about a 4-fold increase in rock bass catch and population size. The increases in perch and rock bass stocks were achieved more by improved recruitment than by improved growth.

Removal of suckers with trap nets is a feasible management tool in lakes where suckers are dominant, where a high proportion of them can be easily removed, and where there are only a few species of fish present to absorb the benefits.

---

[1] Contribution from Dingell-Johnson Project F-35-R, Michigan.

Introduction

The white sucker (Catostomus commersoni) is abundant in many northern Michigan lakes and streams. In some of these waters they could probably support commercial fisheries in addition to the very small sport fisheries which already exist (O'Neal 1978).

It has been suspected for a long time that a large sucker population may inhibit the production of more desirable sport fishes. The potential for competition exists because suckers eat many of the same types of food as sport species: zooplankton, and benthic organisms such as midges and mayflies (Olson 1963, Holey et al. 1979, Johnson 1977). Competition would be confirmed if, by removing suckers, the growth or survival of other species would increase (Li 1975). Since suckers are little used as forage by piscivorous fish (Olson 1963; Crowe 1942), it would appear that removing them would benefit sport fish.

The first commercial harvesting of suckers from inland Michigan lakes of which we have records was in the winter of 1936-37 (Crowe 1949). During the next two decades suckers were netted and removed from a number of lakes. The projects were generally considered to be worthwhile because they made use of an underutilized fish resource, supplemented the income of commercial fishermen, demonstrated to skeptical anglers that sport fish were also abundant, did not harm sport fish populations, and sometimes seemed to benefit sport fisheries (Crowe 1949). However, enthusiasm waned because the burden of harvesting fell more heavily on conservation personnel and the benefits did not clearly exceed the costs. Once again, in the last few years, manual removal with nets has become a popular management technique and is often selected over chemical removal methods. As before, there is need for an evaluation of benefits.

A very intensive field study of sucker removal was made at Big Bear Lake by Walter R. Crowe from 1940 to 1957. Some of the population data appeared in his earlier reports (Crowe 1941, 1942, 1944, 1949, 1953, 1954), but many additional data were in files. These data are relevant to modern management and merit review and thorough analysis. The purpose of this report is to determine if the removal of suckers from Big Bear Lake altered the abundance, growth, and fisheries of the native species.

Methods

Descriptions of Big Bear Lake, Otsego County, and of field methods may be found in the earlier reports and will be only briefly summarized here.

The lake has an area of about 142 ha (350 acres), a maximum depth of 11 m (35 feet), and an average depth of 4.9 m (15.8 feet). Alkalinity is 45-98 ppm and the mid-summer Secchi disk transparency is about 4 m (13 feet). There is a moderate number of macrophytes. The water level fluctuates considerably (1-2 m) because there is neither inlet nor outlet. Suckers spawn on certain gravelly shoals. Fishes present include (in decreasing order of abundance): white sucker (*Catostomus commersoni*), yellow perch (*Perca flavescens*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieui*), pumpkinseed (*Lepomis gibbosus*), rock bass (*Ambloplites rupestris*), bluegill (*Lepomis macrochirus*), brown bullhead (*Ictalurus nebulosus*), and yellow bullhead (*Ictalurus natalis*).

Fish populations were sampled with trap nets to obtain mark-and-recapture estimates of abundance on six occasions between 1940 and 1946 (Crowe 1953); and again on April 20-June 13, 1955, and April 29-June 1, 1956. The mesh in the pots of the nets was 64 mm (2.5 inch) stretch, and therefore captured only the larger fish, referred to in this report as "adults". The estimates surely contain a bias caused by gear selectivity (Latta 1959). Consequently, they should be viewed as relative indices of adult fish density. The yellow perch, an important sport species, was not sampled by the nets, and changes in its abundance must be judged from creel census records alone.

Trap nets were used to harvest large proportions of the adult sucker population from the spawning grounds in 1943, and again in 1955-57.

An intensive creel census was taken during the open-water periods of 1940-48 and comparable data are available for 1935 (Eschmeyer 1936). A winter fishery (for perch) did not develop until the late 1940's, and was censused in the winters of 1948-49 and 1949-50. Because nearly all the fishing was done by cottage owners and local residents, it is believed that the census records represent at least 90% of all fishing activity.

Fish lengths, weights, and scale samples were collected by angling and netting during the population estimates, and at other times. Length-weight regressions were calculated and used to determine changes in fish condition. Total length was regressed against measurements of scale radius for largemouth bass, smallmouth bass, rock bass, and yellow perch. Then we back-calculated the average growth increments during each of the first 3 years of life for the years 1935-57 and, also, the length when the fourth annulus was formed.

Simple and multiple correlation techniques were used to explore relationships between growth, abundance, harvest, sucker density, climate, and water level. Sucker density changes were reconstructed from population estimates and observations as per Figure 1. The climatological data used, from the Atlanta weather station (20 km from the lake), included: (1) monthly (April through September) and seasonal (April through September) deviation of air temperature from the 1935-57 mean, and (2) annual precipitation. Water levels in Big Bear Lake were not measured directly. We assumed that the lake level on May 1 of 1935-57 was correlated with groundwater level in well No. 106. This shallow well (5 m deep) is located 25 km west of the lake, in similar glacial deposits of sand and gravel. This well reflects changes in the level of another seepage lake, Otsego Lake, and seems to reflect changes in Big Bear Lake also.

Results

The sucker population

Complaints about high densities of suckers, beginning in the mid-1930's, prompted investigation. Trapnetting confirmed that white suckers were the predominant fish in Big Bear Lake (Table 1). Between 9,700 and 15,400 adult suckers were estimated to be present in 1940-42. Crowe (1942) calculated that suckers represented 78%, by weight, of the fish sampled with nets in 1940 and 1941. The standing crop of all nettable fish (exclusive of yellow perch and the subadults of all species) was estimated at 35-42 kg per hectare (39-47 pounds per acre).

The sucker population had fallen below 6,000 adults by the spring of 1943. Over 90% of the population--5,778 fish--was then removed. Population estimates through 1946 plus supplemental observation and netting indicate that suckers remained scarce until 1950.

The sucker biomass then began to increase and by 1955 had reached even higher levels than before. The adults were intensively cropped on the spawning ground again: 10,732 fish in 1955 (about 36 kg per acre), 3,115 fish in 1956, and 404 fish in 1957. There was no doubt that removal during this second round was nearly complete. Yet second removal was effective for only about 3 years instead of about 8 years.

The growth of suckers, as tentatively judged from scale samples, increased when the population was reduced the first time and declined as the population built up again. However, growth did not respond to the second thinning. The average length of age III suckers was 342 mm (13.4 inches) in 1940-43, 418 mm (16.4 inches) in 1944-52, 380 mm (15.0 inches) in 1953-55, and 385 mm (15.1 inches) in 1956-57.

Fishing

Fishing pressure at Big Bear Lake varied considerably (Table 2 and Fig. 2). The variation was due to an increase in recreational use of northern Michigan lakes (1935-41), World War II manpower commitments

(1943-45), and the development of a good yellow perch fishery in both summer and winter in the late 1940's.

The fisheries for yellow perch and rock bass improved markedly after suckers were reduced in 1943. The catch of yellow perch began to improve in 1944, whereas the catch of rock bass did not begin to improve until 1946. Catches of both species were still high at the end of the census. For yellow perch, the catch climbed from about 500 fish in the early 1940's to 12,700 in 1948. An ice fishery developed then which yielded 7,000 perch in the winter of 1948-49 and 14,800 perch in the winter of 1949-50.

Less important increases in the catches of pumpkinseeds and bullheads took place about 3 years after sucker removal. The catch of bluegills decreased, but this can be traced to poor recruitment after 1938 (Crowe 1955). The catches of largemouth and smallmouth bass fell below the pre-removal level.

Records for 1935-45 on the average length of fish caught by anglers indicate no marked improvement (Table 3).

Population estimates

The rock bass was the only species sampled with trap nets which responded to sucker removal in 1943 (Table 1 and Fig. 1). By 1946, the adult rock bass population had increased 4-fold, paralleling the anglers' catch. Yellow perch were not sampled with the nets but it is obvious from the creel census that they must have increased many fold.

Adult populations of largemouth and smallmouth bass clearly did not respond to sucker removal. These stocks were both relatively high and relatively low during the early 1940's and mid-1950's when suckers were abundant.

Growth

We anticipated that growth of sport fish would increase greatly in 1943, remain high through about 1950, then return in 1951-54 to the 1935-42 norm. Improved growth was also expected after the second removal project, but we have no data to test that.

The anticipated growth pattern was not obtained (Table 4). Growth during the low sucker period, 1943 especially, was not outstanding.

More powerful correlation analyses indicated that growth of largemouth and smallmouth bass, yellow perch, and rock bass was, indeed, negatively related to sucker density, but not strongly so. There was a significant correlation for age-0 largemouth bass ($r = -0.62$, $p < 0.01$), but generally, the highest correlations were in the older age groups--age II-smallmouth bass ($r = -0.62$, $p < 0.01$), age-I smallmouth bass ($r = -0.43$, $p = 0.08$), age-II rock bass ($r = -0.40$, $p = 0.08$), age-II yellow perch ($r = -0.38$, $p = 0.15$).

The environmental factors tested--temperature, water level, precipitation--also did not strongly correlate with observed growth patterns. Years in which air temperature in April-September were above average were years of above average growth; however the correlation was significant ($p < 0.05$) only for age-0 rock bass and age-II largemouth bass. Multiple correlations of growth increment against the environmental factors and sucker density explained less than 50% of the year-to-year variation in growth.

Suspecting that the effect of suckers on growth might be cumulative and become magnified with age, the average lengths of game fish at age IV were examined. The expected pattern was that year classes which had to compete with large sucker populations during each of their first 4 years of growth would be relatively short, while year classes which experienced only the period of low sucker density (1943-50) would be long, and year classes (e.g., 1942) exposed to both periods of high and periods of low sucker density would be intermediate in average length.

The expected pattern was not closely matched, but the average length of smallmouth bass and rock bass generally reflected sucker density (Fig. 3). Complicating the picture was the failure of the 1943 year classes to grow better than any others, unexplained trends (especially for largemouth bass), and effects of intraspecific competition. The evidence for intraspecific competition is: (1) the relatively poor growth of the 1943-49 year classes of yellow perch during the late 1940's when the perch population was high, (2) the slow growth of the strong 1938 year classes of largemouth bass and smallmouth bass, and (3) the negative correlations ($p = 0.13$ and 0.21) for the two bass species between average length at age IV and adult population estimates.

Condition

The condition of sport fish was not related to the abundance of suckers. The length-weight regressions for yellow perch, rock bass, and largemouth and smallmouth bass did not shift significantly, nor in the expected direction.

Discussion

White suckers are easily caught in trap nets while concentrated on their spawning grounds and it is feasible to harvest a large proportion of the adult population. Over 90% were removed from Big Bear Lake, and 85% were taken from Wilson Lake, Minnesota (Johnson 1977). At Wilson Lake, sucker recruitment reportedly increased but the population remained depressed for about 7 years. At Big Bear Lake, the population remained low for about 8 years in one instance but for 3 years only in another instance.

Apparently, factors other than abundance of adults had a strong effect on the recruitment of suckers at Big Bear Lake. For unknown reasons strong year classes of suckers developed in the mid- to late 1930's. This led to a peak in the adult stock at the turn of the decade. By 1943, the dense, slow-growing population was already on the decline due to high natural mortality that winter and weak recruitment during the early 1940's. The first removal operation accentuated the decline. Weak recruitment continued until the early 1950's, apparently because the spawning stock had been depleted, but environmental conditions may also have been poor. Strong recruitment occurred throughout the 1950's and, as a result, adults removed in 1955-57 were quickly replaced. The fluctuations in sucker recruitment did not seem to be related to fluctuations in water level on the spawning shoals or to temperature.

Yellow perch and rock bass clearly benefited from sucker removal; largemouth and smallmouth bass clearly did not. Since all five species feed on the same types of invertebrates at some stage in life, the reason for the difference is not clear. Crayfish, a choice food for smallmouth bass in particular, seemed to be more abundant after suckers were reduced. At Wilson Lake also, yellow perch benefited from sucker removal (Johnson 1977). Walleyes apparently benefited as well (the three species of bass were not present at Wilson Lake).

Surprisingly, the "release" of food which would have been eaten by adult suckers stimulated little the growth or condition of sport fish. Older yellow perch, rock bass, and smallmouth bass benefited more than young of the year. For yellow perch and rock bass, we deduce that the many-fold increases in the fisheries and in net biological production were accomplished more by increased recruitment through to adulthood than by increased growth of individuals. Supporting evidence is provided by the 3-year lag before a large improvement in fishing began. The smaller, more immediate, increase in perch fishing is attributed to fast growth of the 1940-42 year classes of perch. These classes benefited from low sucker recruitment in the early 1940's and then removal of adult suckers in 1943.

The increased recruitment of perch was apparently due to more successful reproduction and/or to better survival, but the causal mechanism cannot be documented. Extensive observations indicated that suckers did not eat the eggs of other fish and did not disrupt the nests of centrarchids (Crowe 1942). The bluntnose minnow (Pimephales notatus) was observed eating eggs, but only those of the sucker (Crowe 1944). At Wilson Lake (Johnson 1977), shifts in the diet of older perch toward macroinvertebrates apparently released zooplankton for consumption by younger perch, stimulated growth, and (after a 2-year lag) stimulated recruitment. A similar scenario probably occurred at Big Bear Lake except that relatively more of the production gain was shunted into recruitment and growth was checked by intraspecific competition.

The well documented results at Big Bear and Wilson lakes show competition exists between white suckers and some sport fish and that it is sometimes feasible and worthwhile to reduce sucker populations by trap netting. Conditions which seem to favor success are: (1) relatively unproductive lakes where suckers comprise more than 50% of the fish biomass, (2) well defined spawning grounds where suckers can be easily trapped, (3) removal of at least 80% of the adult suckers, (4) weak recruitment at the time of removal (few age I-III suckers present), and (5) simple fish communities comprised of yellow perch and few other species. In complex fish communities and fertile environments, the potential benefits will probably be greatly diluted (Johnson 1977; Holey et al. 1979).

Acknowledgments

The creel census data were collected by Art Schiffman; scales were aged by James B. Gapczynski; drafting was done by Alan D. Sutton. The manuscript was reviewed by W. C. Latta.

Table 1.--Population estimates, derived with the Schnabel formula, of adult fish sampled with trap nets, 1940-56 (1940-46 data from Crowe 1953).

Year, and season	Species					
	Sucker	Large-mouth bass	Small-mouth bass	Blue-gill	Pump-kin-seed	Rock bass
1940						
Summer	9,699	2,987	1,333	1,940	1,325	1,307
1941						
Summer	15,423	2,383	1,097	2,978	3,926	764
1942						
Fall	10,480	1,194	304	2,593	2,486	328
1943						
Spring	5,600[a]	2,080	244	1,277	1,507	266
Fall	366	2,726	592	1,952	1,773	1,813
1944						
Spring	1,412	2,529	720	1,389	1,531	1,761
1946						
Spring	235	1,670	488	452	1,049	2,148
Fall	390	2,128	921	620	2,941	3,791
1955						
Spring		584	294	427	2,326	1,247
1956						
Spring		1,106	99		2,415	1,401

[a] A pre-removal estimate derived by the DeLury method from catches during the removal operation (Crowe 1953).

Table 2.--Observed fishing pressure and catch (numbers of fish) at Big Bear Lake by year and period.

Year, and date	Fishing hours	Catch per hour	Species: Bluegill	Yellow perch	Pumpkinseed	Rock bass	Bullhead	Largemouth bass	Smallmouth bass	Other species
1933-34[a]										
12/ -3/	9	0.00								
1935[b]										
6/25-9/15	1672	0.80		488		692		100	54	1
1940										
5/5-6/22	14	0.71	3	4				3		
6/23-9/21	1999	0.43	40	166	65	166		315	105	4
Total	2013	0.43	43	170	65	166		318	105	4
1941										
6/25-9/9	4078	0.54	227	536	150	377		476	426	9
1942										
6/25-9/18	4605	0.56	206	461	387	591		574	390	
1943										
6/25-10/11	1086	3.16	48	2,498	276	312	2	146	162	
1944										
6/25-9/16	1256	4.62	12	4,622	271	332		180	332	
1945										
6/25-9/15	1635	4.10	32	5,386	311	380	1	343	244	
1946										
4/28-6/24	253	3.35		848						
6/25-9/15	3403	4.07	19	11,368	829	1180	18	270	163	
Total	3656	4.02	19	12,216	829	1180	18	270	163	
1947										
3/10-6/23	202	4.69		831		116				
6/25-9/1	3464	2.72	12	7,182	221	1449	79	210	253	
Total	3666	2.82	12	8,013	221	1565	79	210	253	
1948										
5/22-6/24	407	4.15		1,585		92	14			
6/25-9/30	5302	2.45	11	11,162	72	1227	116	222	191	
Total	5839	2.52	11	12,747	72	1319	130	222	191	
1948-49										
1/15-4/3	2774	2.50	2	6,923						
1949-50										
12/25-4/14	5463	2.71	2	14,794			1			

[a] Data from Eschmeyer (1935). [b] Data from Eschmeyer (1936).

Table 3.--Average length (in inches) of fish harvested by anglers from Big Bear Lake, 1935 and 1940-45.

Year	Species					
	Blue-gill	Yellow perch	Pump-kin-seed	Rock bass	Large-mouth bass	Small-mouth bass
1935		9.7		7.4	15.5	14.5
1940	6.9	7.4	6.7	6.9	13.2	12.7
1941	6.9	8.1	6.6	6.4	12.6	11.6
1942	7.3	7.2	7.1	7.0	12.3	11.4
1943	7.7	6.9	6.1	6.6	12.4	12.0
1944	7.9	8.0	6.5	6.6	12.7	11.7
1945	8.9	8.2	6.5	6.5	12.9	12.1

Table 4.--Average growth increment in millimeters (annual range in parentheses) back-calculated for the first 3 years of life of four species, in years of low and high sucker density. [a]

Species	Year of life	Sucker density and year			
		High 1935-42	Low 1943	Low 1944-50	High 1951-54
Largemouth bass	First	105 (99-113)	106	121 (108-130)	111 (99-129)
	Second	82 (78-84)	93	96 (83-110)	94 (87-99)
	Third	68 (57-77)	62	67 (60-87)	78 (66-90)
Smallmouth bass	First	125 (110-138)	131	135 (132-142)	129 (128-134)
	Second	54 (42-66)	62	52 (46-66)	45 (34-52)
	Third	58 (48-71)	53	62 (44-77)	60 (46-74)
Yellow perch	First	100 (94-106)	105	100 (98-107)	96 (95-96)
	Second	33 (26-45)	28	35 (29-42)	30 (23-38)
	Third	32 (27-39)	27	30 (25-35)	18 (11-25)
Rock bass	First	58 (55-60)	59	58 (54-61)	59 (57-61)
	Second	29 (23-37)	35	29 (18-38)	31 (28-33)
	Third	43 (36-52)	47	42 (25-56)	36 (30-41)

[a] Minimum number of fish measured for each year of life varied from 18 for rock bass to 50 for largemouth bass.

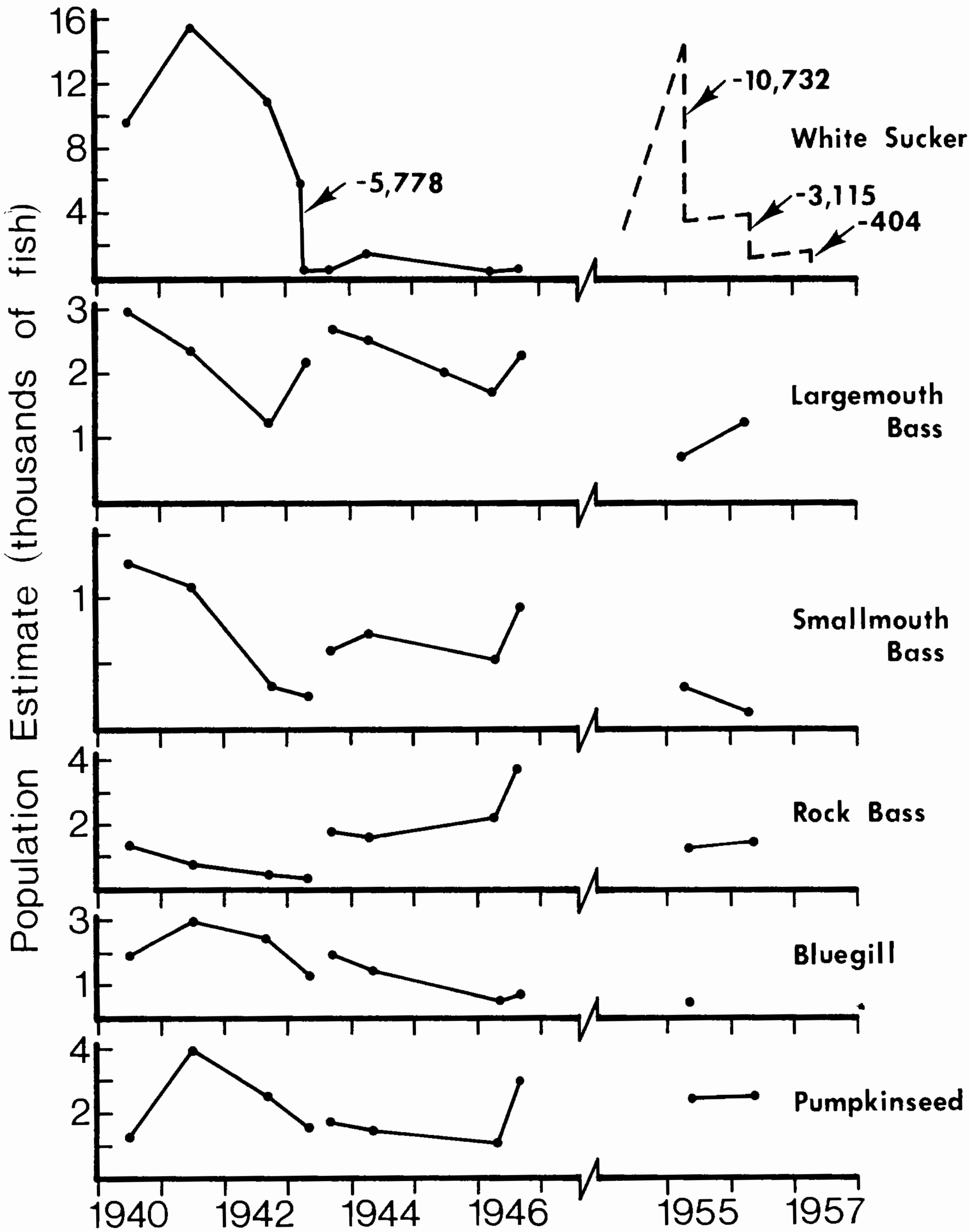

Figure 1.--Mark-and-recapture population estimates for six species of fish in Big Bear Lake, 1940-1946 and 1955-56. The dashed line is a reconstruction, based on removal data, of approximate sucker abundance in the 1950's.

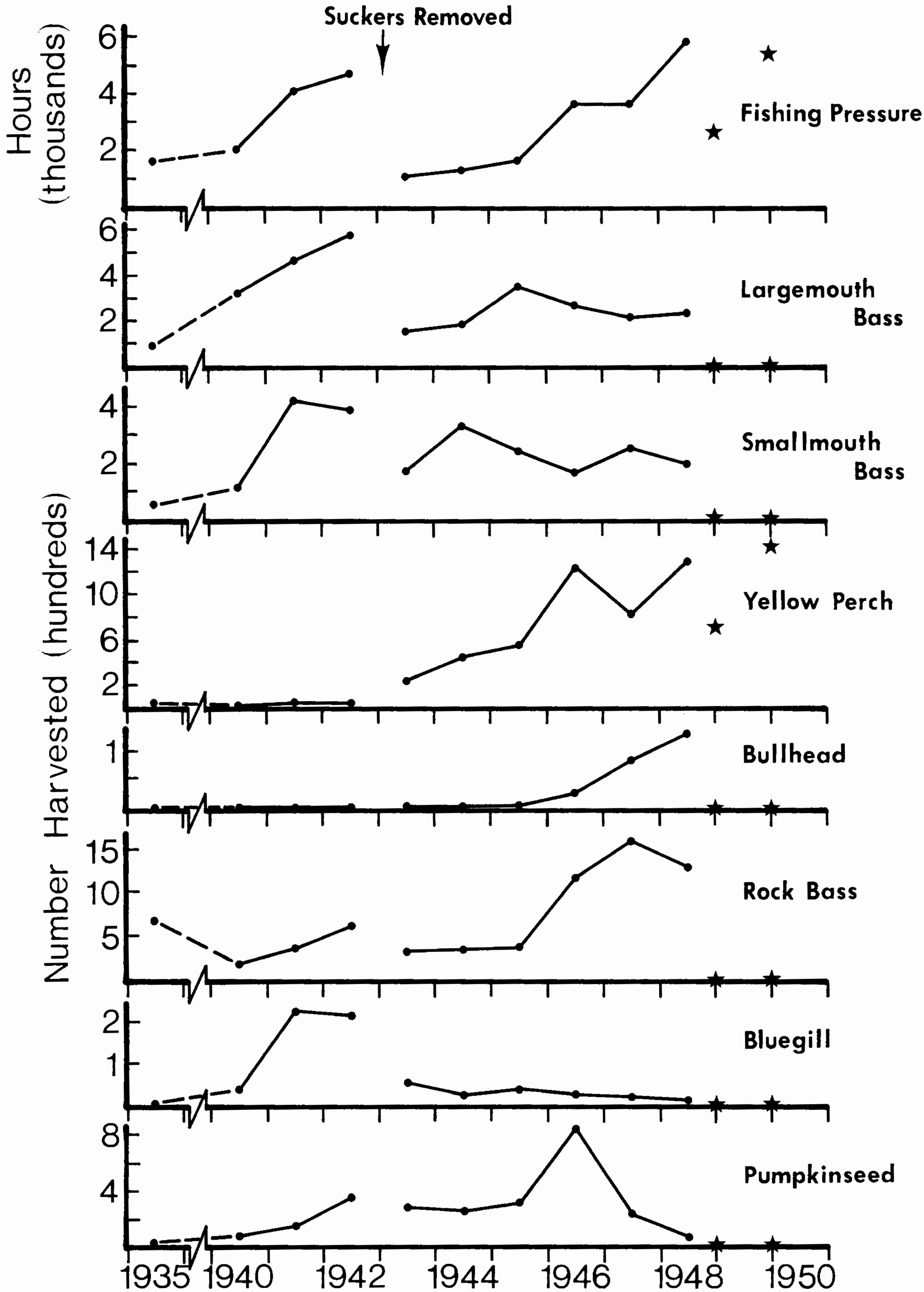

Figure 2. --Fishing pressure and harvest at Big Bear Lake, in summer (•) 1935 and 1940-48, and in winter (★) 1948-49 and 1949-50.

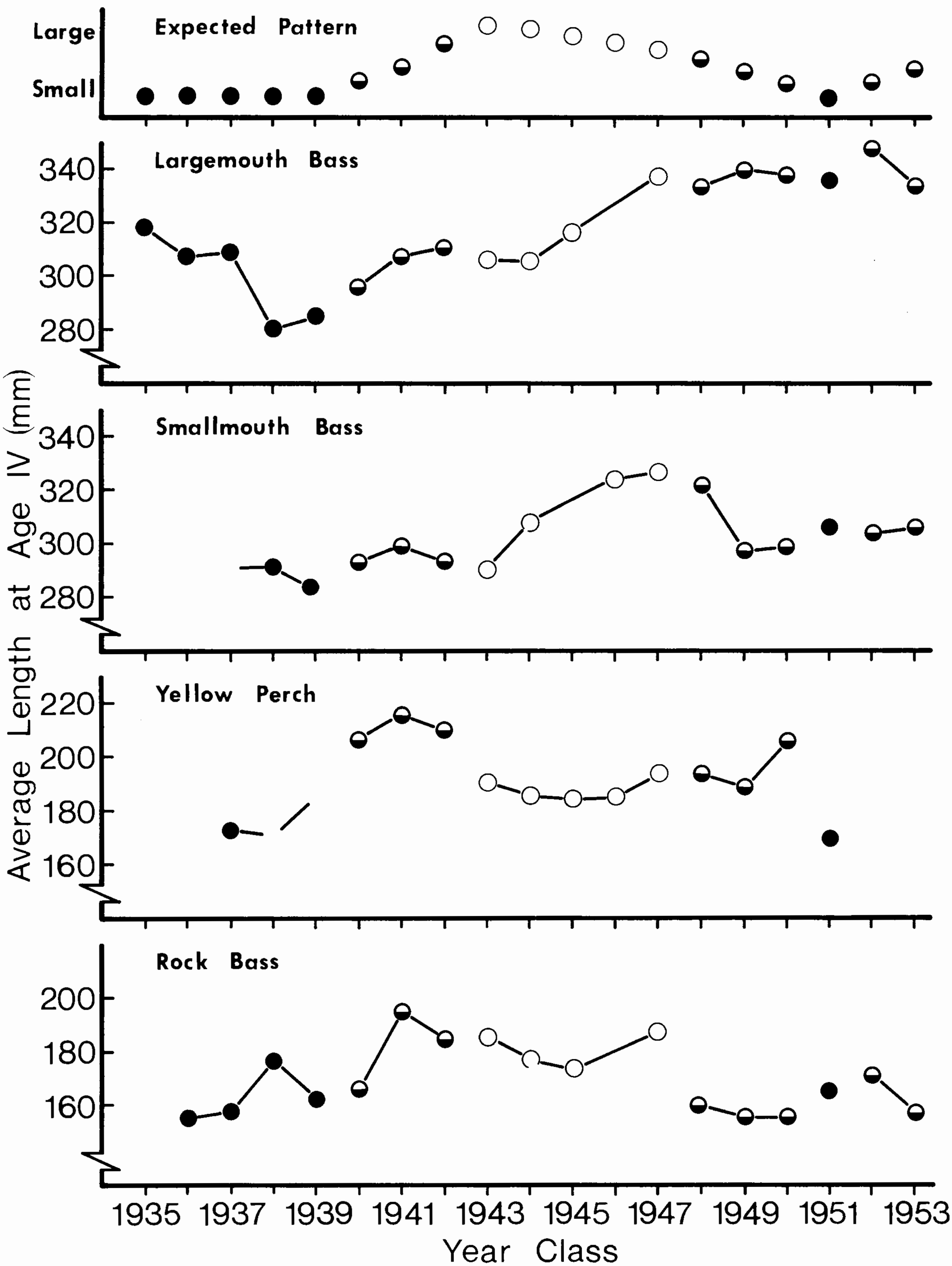

Figure 3.--Average length at age IV of the 1935-53 year classes of largemouth bass, smallmouth bass, yellow perch, and rock bass in relation to sucker density. The symbols indicate whether growth occurred in a period of high sucker density (●), low sucker density (○), or both high and low sucker density (⊖).

Literature cited

Crowe, Walter R. 1941. Fisheries survey of Big Bear Lake, Otsego County. Mich. Dep. Conserv., Inst. Fish. Res. Rep. 651, 13 pp.

Crowe, Walter R. 1942. Natural reproduction, growth, and population analysis of the fishes in Big Bear Lake, Otsego County, Michigan. Mich. Dep. Conserv., Inst. Fish. Res. Rep. 653A, 28 pp.

Crowe, Walter R. 1944. Big Bear Lake investigations, 1942-1943. Mich. Dep. Conserv., Inst. Fish. Res. Rep. 918, 5 pp.

Crowe, Walter R. 1949. Sucker removal and demonstration netting, 1947-1948. Mich. Dep. Conserv., Inst. Fish. Res. Rep. 1226, 8 pp.

Crowe, Walter R. 1953. An analysis of the fish population of Big Bear Lake, Otsego County, Michigan. Pap. Mich. Acad. Sci. 38: 187-206.

Crowe, Walter R. 1955. The bluegill population of Big Bear Lake, Otsego County, Michigan. Pap. Mich. Acad. Sci. 40: 111-117.

Eschmeyer, R. W. 1935. Creel census for winter of 1933-34 on five Michigan lakes. Mich. Dep. Conserv., Inst. Fish. Res. Rep. 271, 5 pp.

Eschmeyer, R. W. 1936. Summary of creel census on Big Bear Lake, Otsego County, summer of 1935. Mich. Dep. Conserv., Inst. Fish. Res. Rep. 331, 4 pp.

Holey, Mark, Bruce Hollender, Mark Imhof, Roman Jesien, Richard Konopacky, Michael Toneys, and Daniel Coble. 1979. Never give a sucker an even break. Fisheries 4(1): 2-6.

Johnson, Fritz H. 1977. Responses of walleye (*Stizostedion vitreum vitreum*) and yellow perch (*Perca flavescens*) populations to removal of white suckers (*Catostomus commersoni*) from a Minnesota lake, 1966. J. Fish. Res. Board Can. 34: 1633-1642.

Latta, William C. 1959. Significance of trap net selectivity in estimating fish population statistics. Pap. Mich. Acad. Sci. 44: 123-137.

Li, H. 1975. Competition and coexistence in stream fish. Pages 19-30 *in* P. B. Moyle and D. L. Koch, eds. Symposium on trout non-game relationships in streams. Center Water Resour. Res., Univ. of Nevada, Reno.

Olson, Donald E. 1963. Role of the white sucker in Minnesota waters. Proc. Minn. Acad. Sci. 31(1): 68-73.

O'Neal, Richard Paul. 1978. The potential for commercial harvest of underutilized fish in inland lakes in Michigan. M.S. thesis, Mich. State Univ., Dep. Fish. and Wildl., East Lansing, 117 pp.

Report approved by W. C. Latta

Typed by M. S. McClure