Research Report No. 19

(Fisheries)

# LAKE PUCKAWAY WALLEYE

By

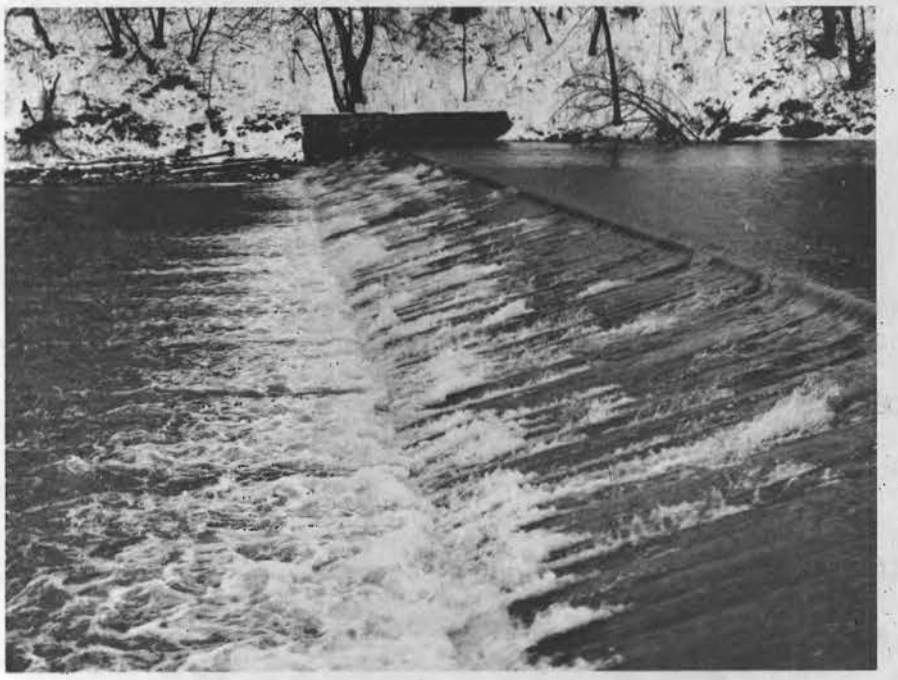
Gordon R. Priegel

WISCONSIN CONSERVATION DEPARTMENT

Research and Planning Division

December, 1966

CONTENTS



Montello Dam, Fox River

Eureka Dam, Fox River

## INTRODUCTION

The walleye, Stizostedion vitreum vitreum (Mitchill), is one of the most sought after sport fish in Lake Puckaway and the Upper Fox River, especially during the spring spawning run in the Fox River, and during the winter and late spring in Lake Puckaway. Until now, no age and growth or movement data have been available on the Lake Puckaway walleye.

Since 1950, the dominant species of fish in Lake Puckaway have changed from bass, panfish and northern pike to more catfish and bullheads (Kabat, 1954). Strong year classes of walleyes do appear in the creel at times, and this may be partially attributed to spawning runs from Lake Winnebago. Walleyes migrating out of Lake Winnebago on the annual spawning run move into the Fox River, and when water levels are high migrate beyond the Eureka Dam. Once above the Eureka Dam, it is possible for the walleye to migrate into Lake Puckaway or as far as the Montello Dam, Fox River, which is a distance of 76.5 river miles from Lake Winnebago. When water levels are low, walleyes from Lake Winnebago must spawn below the Eureka Dam, a distance of only 25 river miles from Lake Winnebago.

## STUDY AREA

### Lake Puckaway

Lake Puckaway is a marshy lake formed in a wide, flat area along the Upper Fox River in east central Wisconsin and is located 68 river miles from Lake Winnebago (Fig. 1). Lake levels are primarily maintained by the Princeton Dam, a low-head structure in the Fox River channel, about 13.5 river miles below Lake Puckaway.

The area of Lake Puckaway in 1950 was 5,433 acres with 2,550 acres classified as open-water area (Kabat, 1954). The lake is approximately 8 miles long with a maximum width of 1.5 miles. Maximum depth is 5.2 feet with an average depth of 3 feet. The lake bottom is a mixture of sand, silt and decayed vegetative matter.

Water is partially turbid, and algae blooms are quite common. Before 1950, aquatic vegetation was abundant and the water was normally clear. Since that time, there has been a calamitous decrease in vegetation, particularly in the shallower portions of the lake, and a general increase in water turbidity.

### Fox River: Lake Puckaway to Montello Dam

The Fox River between Lake Puckaway and Montello Dam on the Fox River comprises about 8 river miles. The river averages about 120 feet in width and is bordered by spoil banks and marsh.

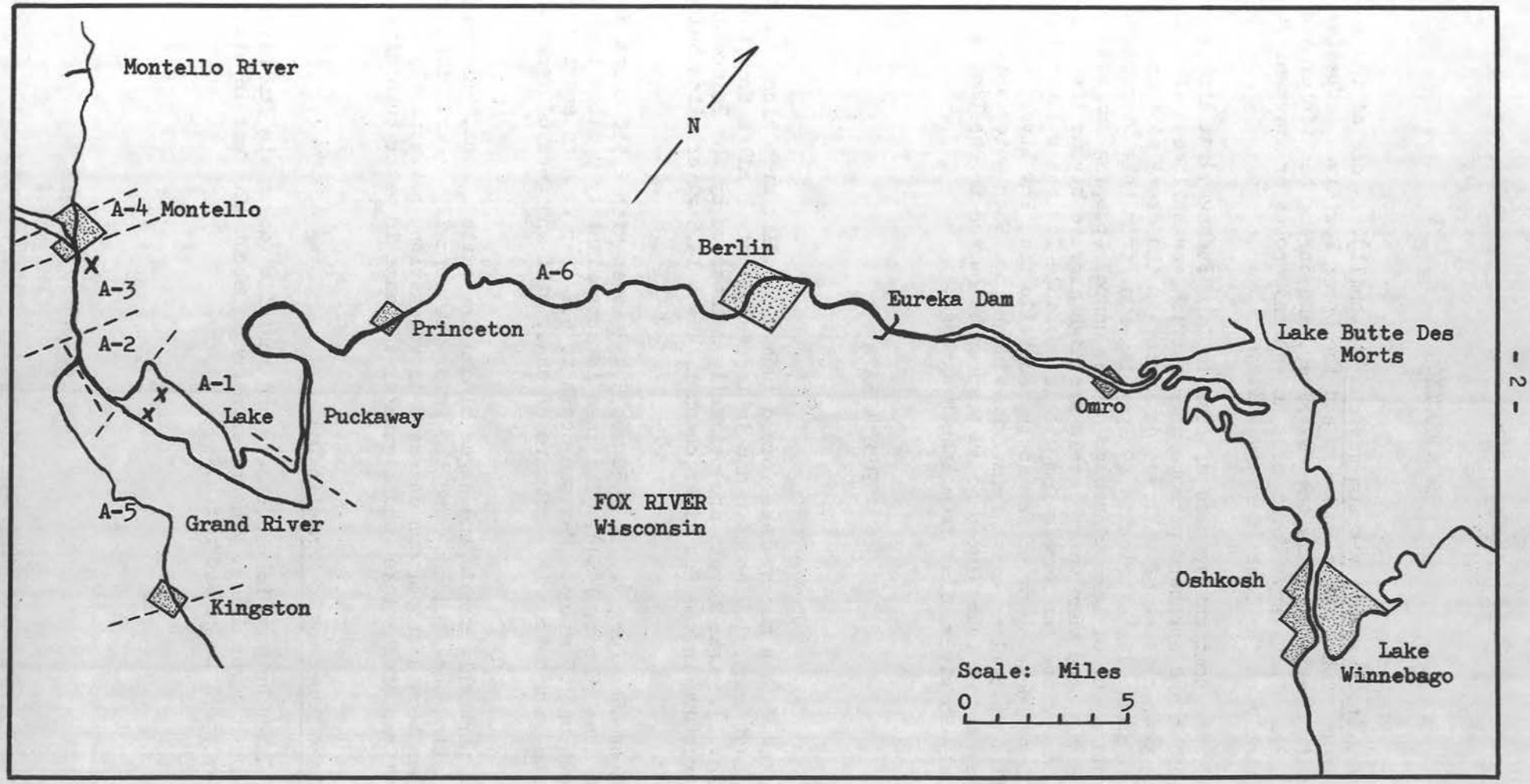



Figure 1. Tagging Sites (Indicated by an "X") of Walleyes Tagged in the Montello River and Lake Puckaway and Areas in which Tagged Walleyes were Recaptured by Anglers, Fox River Area

Grand River

This stream is a broad, low-gradient stream (0.5 feet per mile) which comes off a prairie upland and then flows very slowly northward and westward to join the Upper Fox River about 2 river miles above Lake Puckaway (Poff and Threinen, 1963). The Grand River contributes turbid water to the Upper Fox River.

Montello River

The Montello River joins the Upper Fox River from the north about 0.5 river miles downstream from the Montello Dam, Fox River. The Montello River flows over sand, gravel and clay with a gradient of 2.4 feet per mile (Poff and Threinen, 1963). A dam in the city of Montello for hydroelectric power limits walleye movement to the lower half-mile of the Montello River. The Montello River contributes clear water to the Upper Fox River.

## REPRODUCTION

Spawning Migration

Walleyes migrating out of Lake Puckaway during the spring spawning run move into the Fox River. When water levels permit, they move beyond the Grand River Dam (5.0 river miles from Lake Puckaway) and are attracted into the Montello River, which enters the Fox River approximately 0.5 river miles below the Montello Dam on the Fox River. This dam generally prevents further upstream migration (Fig. 1). A dam on the Montello River in the city of Montello limits walleye movement and spawning to the lower half-mile of the Montello River.

Active spawning occurs in the Montello River when water temperatures reach 42°F. In 1961 and 1963, maximum spawning occurred on April 5 and 6. The major spawning period in 1962 was not noticed, but sampling on April 20 indicated that the peak period had occurred, as only males were taken and no spawning activity was ever noticed on later dates. Low water levels in 1964 prevented the walleyes from going over the Grand River Dam, a low-head dam, so the fish had to spawn in the Fox River below the Grand River Dam. There was no spawning activity noticed in the Montello River in 1964.

Spawning Success

1961. In 1961, walleye spawning in the Montello River reached a peak on April 5 and 6, with intensive spawning occurring immediately below the dam. Water temperature was 42°F. during all sampling periods on both days. On April 19, an attempt was made to check the condition of the eggs. No eggs were found immediately below the dam nor within the first 300 yards below it. The river bottom in this section is composed mainly of solid granite. Large numbers of eggs (50-70 eggs per dip of a fine-screened basket) were found below this stretch on the upstream edge of sandbars and along the banks where the current was the strongest. The eggs were found on sand and organic bottom. All eggs examined

were viable, but no eggs were eyed. During a concurrent study on the Wolf River spawning marshes in 1961, the eggs were eyed 12 days after the first eggs were sampled. Water temperatures on the Wolf River marshes varied from 36-60°F. during this period, while Montello River water temperatures never exceeded 45°F.

Water currents in the river undoubtedly carried the eggs to the areas where they were found, since little actual spawning was observed at these sites. Walleyes broadcast their eggs and since the specific gravity of viable eggs is close to that of water, they could easily be carried for some distance. Reighard (1890) stated that when first laid, the eggs were very adhesive and added (1893) that for the first hour or two the eggs adhere to one another. Water then hardens the external egg membrane, and it loses its adhesive qualities. Eschmeyer's (1950) observations at Lake Gogebic, Michigan, indicated that dead eggs are commonly moved and sometimes transported for considerable distances by waves and currents.

1964. Walleye spawning activity in the Fox River below the Grand River Dam occurred from April 8-14, 1964, with a peak on April 10-11. Walleyes were noted spawning immediately below the dam on sandbars and along the riverbanks where vegetation (mainly grasses) was hanging into the water.

On April 12, six egg-sampling stations were set up along the Fox River below the Grand River Dam. Through April 21, egg development was slow with no eyed eggs noted, and large numbers of eggs fungused. No further egg sampling was accomplished; however, sampling for walleye fry with fine mesh meter nets in the Fox River from late April through mid-May indicated very little hatching success as only one walleye fry was taken.

## GROWTH

### Materials and Methods

All walleyes used in the study were taken while electrofishing with an AC shocker unit during the spawning migration. In 1963, 216 walleyes were captured below the Montello Dam in the Montello River, while in 1964 the 322 walleyes were taken below the Grand River Dam in the Fox River.

The length measurements of the walleyes were made on fresh specimens. Total length to the nearest tenth of an inch was recorded from a standard measuring board.

Scales were taken from above the lateral line on the left side and came from the intersection of the third row above the lateral line and the first scale row before the first dorsal spine. The scales were impressed on cellulose acetate slides, 0.03 inch thick, by a roller press similar to that described by Smith (1954). The examination and measurements of scales were made by means of a microprojector at the magnification x43. The length of each scale and the distance from the focus to each annulus were measured along the anterior radius most nearly collinear with the focus as described by Hile (1954) and recorded to the nearest millimeter.

Ages corresponding to the number of annuli are expressed in Roman numerals. Fish were moved to the next higher age group on January 1 of each year. A virtual annulus was accordingly assigned to the edge of the scale, since growth in the year of capture had not actually started.

The growth for previous years of life of walleyes was calculated from the relationship of scale measurements to total length for 538 walleyes. For each age group of a year class, average measurements were computed for the distance from the focus of the scale to each annulus, length of scale radius and total length of fish at the time the scale sample was taken. Then a direct proportion calculation was made, using 45 mm as a correction factor, to find the average length at the end of each year of life for each group (Van Oosten, 1953 ). The correction factor of 45 mm (1.8 in.) is the length of the fish at the time of scale formation (Priegel, 1964). The formula used was:

$$L' = C + \frac{S'}{S} (L-C)$$

where L' = average length of fish when annulus X was formed;
L = average length of fish at the time the scale samples were taken;
S' = average length of scale radius to annulus X;
S = average length of scale radius; and,
C = the length of the fish at the time of scale formation.

Growth in Length

Since the average calculated lengths of males and females in different age groups of walleyes gave evidence of sex differences in growth rate, the data for males and females were kept separate (Tables 1 and 2). Two estimates of general growth are given in the bottom section of Tables 1 and 2. One is based on average calculated lengths and the second on the summation of average annual increments of length. The present discussion is based on the sums of increments, since this curve should better represent average growth, although there are only slight differences.

Comments on general growth and a comparison of the growth of the sexes are best made from Table 3, which was prepared from data presented in the first two tables.

The length of the sexes in the first year of life showed a 0.3-inch advantage for the females, and this advantage increased to 4.0 inches at the end of the eighth year.

The greatest increase in length for both sexes took place during the first year of life (7.8 inches for the females and 7.5 inches for the males). The amount of growth dropped during the second year, and a continued decrease occurred through the ninth year for both sexes.

Comparison of growth based on summation of increments (total length in inches) for male and female walleyes from Lakes Puckaway and Winnebago (data from a concurrent study) are given in Table 4. There is a distinct growth advantage

for Lake Puckaway male and female walleyes. Lake Puckaway male walleyes have a size advantage over Lake Winnebago male walleyes of 1.9 inches after one year, and this increased to 2.9 inches at the end of the fourth year. This size advantage of 2.9 inches remained the same until the eighth year when it decreased to 2.6 inches. Female walleyes in Lake Puckaway had a 1.8-inch advantage over female walleyes in Lake Winnebago at the end of the first year, and this advantage increased steadily to 4.1 inches at the end of the fourth year after which a decrease was noted until a difference of only 2.6 inches occurred at the end of the eighth year.

Age and Size at Maturity

All of the walleyes handled were taken during the spawning season, and all of the fish were mature. Eggs or milt could be obtained when the fish were handled, and the fish were then classified as hard, spawning, partially spawned out, or spawned out. Mature female walleyes included only 1 in age group IV, 6.2 percent of age group V, 17.6 percent of age group VI, and 32.4 percent of age group VII, which represented the largest age group (Table 5). In the sample, mature male walleyes were represented by age group II (1.9% of the sample) with the largest number of males being represented by age group VII (33.2% of the sample). The males were estimated to reach maturity at 14.3 inches, and females at about 19.5 inches.

In Lake Winnebago during a concurrent study, walleyes matured at a smaller size: 37 percent of the males in age group II were mature; 73 percent of age group III were mature; and in age group VI, all males had reached sexual maturity. For female walleyes in Lake Winnebago, sexual maturity was attained for 8 percent of age group IV, 32 percent for age group V, 67 percent for age group VI, and 100 percent for age group VIII. In Lake Winnebago, the average total length at which more than 50 percent of the males are mature is 12.7 inches and 18.9 inches for the females.

A comparison between length frequencies and average lengths of spawning walleyes (sexes combined) in 1964 for walleyes originating from Lake Winnebago and Lake Puckaway is shown in Table 6. It must be emphasized that some of the walleyes taken in the Wolf and Fox Rivers may be from the native river population, but the greatest majority originated from the lakes. Lake Winnebago walleyes were taken at Shiocton, Wolf River; Eureka Dam, Fox River, and along the west shore of Lake Winnebago, and they average 16.0, 15.9 and 14.6 inches in total length, respectively. Lake Puckaway walleyes taken below the Grand River Dam, Fox River, averaged 19.9 inches in total length. Only 40 fish (10.5% of sample) taken below the Grand River Dam were smaller than 17.0 inches. This situation is indicative of very little natural reproduction and the buildup of a minimal population of quite large fish. The proportion of walleyes under 17.0 inches was 150 (65.5%) from Shiocton, Wolf River; 95 (73.5%) from Eureka Dam, Fox River, and 355 (91.0%) from west shore of Lake Winnebago.

## MOVEMENT

### Methods

In Lake Puckaway, fish were taken with hoop nets during January and February, 1961, and 55 walleyes were tagged.

Walleyes in the Montello River were captured with an AC shocker unit. The number tagged was 478 on April 5-6, 1961; 99 on April 20, 1962, and 214 on April 6, 1963.

The normal procedure for tagging the fish was to remove them from the hoop nets or dip them from the water while shocking and place them in a holding tank. They were all measured (total length in inches to the nearest tenth), tagged, and returned to the water in the same approximate area of capture. The fish were not anesthetized.

All of the fish in Lake Puckaway and Montello River were marked on the upper jaw with No. 3 aluminum strap tags, passing around the maxillary and premaxillary. Eschmeyer and Crowe (1955) demonstrated no statistically significant difference in the rate of recovery among walleyes tagged in the upper or lower jaws with No. 3 strap tags.

Walleyes from 11.4 to 27.7 inches were tagged in Lake Puckaway at two tagging sites (Fig. 1). In the Montello River, the walleyes were tagged at one site (Fig. 1), and they ranged in size from 13.5 to 29.9 inches.

### Tag Returns

Of the 55 walleyes tagged and released in Lake Puckaway, 16 returns (29.1%) were reported by anglers. Tag returns for Lake Puckaway tagged walleyes in this report will be considered from January-February, 1961, (dates of tagging) until October 1, 1964.

Of the 791 walleyes tagged and released in the Montello River during the spawning runs of April, 1961-63, anglers returned 156 tags (19.7%). The tag return data in this report cover the periods of tagging April 5-6, 1961; April 20, 1962, and April 6, 1963, until October 1, 1964.

Herman (1947) reported a recovery of 9.3 percent of 3,694 walleyes tagged from 1944-46 in the Wolf River, Wisconsin, after 3 years. Priegel (unpubl.) recovered 23.6 percent of 6,290 walleyes tagged in Lake Winnebago during the fall of 1960 and 19.9 percent of 1,056 walleyes tagged in Lakes Poygan and Winneconne in January-February, 1961, after one year. Hubley and Jergens (1959) recovered 5.7 percent of the 1,784 walleyes tagged in the spring of 1958 within 7 months after tagging in a 40-mile stretch of the Upper Mississippi River. Patterson (1953) reported after one year a recovery of 20.5 percent for 984 walleyes tagged in Escanaba Lake, Wisconsin (100% creel census).

April was the peak month for tagged fish returns from anglers (Table 7). These fish were taken in the Fox River between Lake Puckaway and the Montello Dam during the spawning migration.

Peak months for tagged walleyes caught by anglers in Lake Puckaway were May, June and July. December and January were also high months for tag returns in Lake Puckaway due to winter angling pressure.

Of 28 walleyes recaptured and released a second time by state tagging crews in the Montello River, only one was caught by an angler. This fish was originally tagged and recaptured in the Montello River and taken by an angler in Lake Puckaway.

Migration

The walleye population that spawned in the Montello River was considered as having originated from Lake Puckaway; however, part of this spawning population could have originated from Lake Winnebago when migration over the Eureka Dam was possible.

The sites where walleyes were caught by anglers were grouped into areas to best show the movement after spawning. The areas established are (Fig. 1):

Area 1 - Lake Puckaway

Area 2 - Fox River from inlet of Lake Puckaway to Grand River Dam

Area 3 - Fox River from Grand River Dam to Montello Dam

Area 4 - Montello River

Area 5 - Grand River from Kingston Dam to mouth of Fox River

Area 6 - Fox River below outlet of Lake Puckaway

The return of walleyes caught by anglers is shown by areas in Table 8.

Of the 156 walleyes tagged in the Montello River that were taken by anglers, 44.2 percent were recaptured in Lake Puckaway while 45.5 percent were recaptured between Lake Puckaway and the tagging site, Montello River. Anglers did recover 8.9 percent of these walleyes below Lake Puckaway. The extent of this downstream migration was just below the Eureka Dam, a distance of 52 river miles from the tagging site.

Additional data to show that Lake Winnebago walleyes can and do migrate into Lake Puckaway and the Fox River upstream from Lake Puckaway were obtained from recapture of walleyes during fieldwork by project personnel and by angler returns of walleyes originally tagged in Lake Winnebago. One walleye tagged at the mouth of the Fond du Lac River, Lake Winnebago, on September 26, 1962, was recaptured

by project personnel while boom shocking in Lake Puckaway on August 21, 1963, a distance of 84 miles. Anglers recaptured three walleyes in Lake Puckaway and one walleye in the Fox River below the Montello Dam that had been originally tagged in Lake Winnebago. One female walleye tagged on Hopp's Marsh, Fox River, (28 river miles below Lake Puckaway) during the spawning period in 1963 was recaptured by project personnel during the 1964 spawning period below the Grand River Dam, Fox River (5 river miles above Lake Puckaway).

## POPULATION SIZE

Of the 1,168 walleyes handled during the spawning seasons 1961-64 which originated from Lake Puckaway, 181 (15.5%) were under 17.0 inches (Table 9). The situation is indicative of very little natural reproduction and the buildup of a minimal population of quite large fish. The average total length of the entire sample was 19.4 inches.

The use of seine haul catches from 1940-61 for Lakes Puckaway and Winnebago shows a comparison of total game fish taken and the number and percentage of walleyes taken in the seine hauls (Table 10). The seines (3,500-4,500 feet in length with 3- and 4-inch mesh) were used to remove carp from these lakes. In Lake Puckaway, no walleyes were taken in seine hauls during the years of 1941, 1942 and 1943, while the percentage of walleyes in the seine hauls from 1950-61 varied from 1.6 to 23.4 percent of the total game fish catch. During 7 of the 10 years in which walleyes were taken, the catch of walleyes did not exceed 6.5 percent of the total game fish catch. In Lake Winnebago, walleyes were taken in all years from 1940 to 1961 (last year of seining) and represented 3.4 to 44.9 percent of the total game fish catch. The percentage of walleyes in the total game fish catch represented less than 10.0 percent of the catch in only 4 of the 22 years indicated. Limited seining data indicates a small walleye population in Lake Puckaway as compared to a good walleye population in Lake Winnebago.

The reason that strong year classes of walleyes do appear in Lake Puckaway at times may be partially attributed to the addition of spawning walleyes from Lake Winnebago moving beyond Lake Puckaway to spawn and returning to Lake Puckaway after spawning. Table 10 illustrates the years in which passage beyond the Eureka Dam, Fox River, was possible. This information is based on daily gauge heights taken at the Berlin Locks, Fox River, by U. S. Corps of Army Engineer personnel. Years in which readings of 11.0 feet or greater were registered were considered as years in which walleyes were capable of passing over the Eureka Dam. Actual field observations of walleye movements and spawning in the Eureka Dam area of the Fox River from 1959 to 1964 were used to determine the gauge height of 11.0 feet on which movement over the Eureka Dam from 1940 to 1958 was based. The increase of walleyes in seine haul catches during 1953, 1954 and 1956 may be attributed to the fact that walleyes were able to pass over the Eureka Dam in the years 1950 through 1953 during the spawning run. Migration of large numbers of walleyes into the Upper Fox River beyond the Eureka Dam into and above Lake Puckaway is quite possible as tagging studies have indicated.

## MANAGEMENT AND RESEARCH RECOMMENDATIONS

Stable water levels are needed on the Montello River duing the spawning and egg development periods. At present, water levels fluctuate drastically on a daily basis.

If stable water levels can be maintained on the Montello River, electrofishing should be carried out in the fall to determine year class strength.

Constant water temperatures should be taken on the Montello River in April and May to determine if cold water over an extended period has a detrimental effect on walleye eggs in the river during development. Water temperatures on the Montello River never exceeded 45°F. during the study period.

Carp control in Lake Puckaway and the Fox River above Lake Puckaway is essential, as evidence indicates siltation of walleye eggs during development when carp activity is observed on the walleye spawning sites.

An attempt should be made to determine if any walleye spawning sites do exist in Lake Puckaway.

Concurrent studies have indicated extensive mortality of walleye fry passing over the Eureka Dam. Since the Grand River Dam is essentially the same as the Eureka Dam, it is suggested that dyed walleye fry experiments be conducted on the Fox River to determine if mortality does occur when fry pass over the Grand River Dam.

## SUMMARY

During the spring spawning run, Lake Puckaway walleyes spawn in the Montello River when water levels are high; and when water levels are low, spawning occurs in the Fox River below the Grand River Dam.

Spawning occurs during the first part of April when water temperatures reach 42°F.

The length of the sexes in the first year of life showed a 0.3-inch advantage for the females, and this advantage increased to 4.0 inches at the end of the eighth year.

Lake Puckaway walleyes have a size advantage over Lake Winnebago walleyes of 2.9 inches for males and 4.1 inches for females at the end of the fourth year.

Lake Puckaway males attained maturity at 14.3 inches and females at approximately 19.5 inches.

Age group VII (32.4 percent of sample) represented the largest age group of mature females on the spawning grounds, while for the males age group VII (33.2 percent) was the largest age group present on the spawning grounds.

Of the 55 walleyes tagged and released in Lake Puckaway, 16 returns (29.1 percent) were reported by anglers after 4 years.

Of the 791 walleyes tagged and released in the Montello River during the spawning runs of April, 1961-63, anglers returned 156 tags (19.7 percent).

Anglers returned 8.9 percent of these Montello River tagged walleyes below Lake Puckaway. Anglers returned three walleyes in Lake Puckaway and one walleye in the Fox River below the Montello Dam that had been originally tagged in Lake Winnebago.

Of the 1,168 walleyes handled during the spawning seasons 1961-64 which originated from Lake Puckaway, 181 (15.5 percent) were under 17.0 inches. The situation is indicative of very little natural reproduction and the buildup of a minimal population of quite large fish. The average length of the entire sample was 19.4 inches in total length.

The reason that strong year classes of walleyes do appear in Lake Puckaway at times may be partially attributed to the addition of spawning walleyes from Lake Winnebago moving beyond Lake Puckaway to spawn and returning to Lake Puckaway after spawning.

## LITERATURE CITED

ESCHMEYER, PAUL H.

1950. The life history of the walleye, Stizostedion vitreum vitreum (Mitchill), in Michigan. Bull. Inst. Fish. Res. No. 3, Mich. Dept. Conserv., 99 p.

ESCHMEYER, PAUL H. and WALTER R. CROWE

1955. The movement and recovery of tagged walleyes in Michigan, 1929-1953. Bull. Inst. Fish. Res., Mich. Dept. Conserva., No. 8, 32 p.

HERMAN, ELMER F.

1947. Notes on tagging walleyes on the Wolf River. Wis. Conserv. Bull. 12 (4): 7-9.

HILE, RALPH

1954. Fluctuations in growth and year class strength of the walleye in Saginaw Bay. U. S. Fish and Wildlife Service, Fish. Bull. 56: 7-59.

HUBLEY, RAYMOND C. JR. and GLENN D. JERGENS

1959. Walleye and sauger tagging investigations on the Upper Mississippi River. West Central Area Invest. Memo No. 1, Wis. Conserv. Dept., Black River Falls, 9 p. (mimeo.).

KABAT, CYRIL (editor)

1954. Report to Governor Kohler on the Upper Fox River. Wis. Conserv. Dept., Madison (mimeo.).

PATTERSON, DONALD L.

1953. The walleye population in Escanaba Lake, Vilas County, Wisconsin. Trans. Am. Fish. Soc. 82: 34-41.

POFF, RONALD J. and C. W. THREINEN

1963. Surface water resources of Marquette County. Wis. Conserv. Dept., Madison, 68 p. (mimeo.).

PRIEGEL, GORDON R.

1964. Early scale development in the walleye. Trans. Am. Fish. Soc. 93 (2): 199-200.

REIGHARD, JACOB

1890. Development of the walleyed pike (Stizostedion vitreum). A popular introduction to the development of bony fishes. Appendix, 9th Bienn. Rept. Mich. State Board of Fish. Comm. (1888-1890), p. 93-158.

1893. On the handling of adhesive eggs. Trans. Am. Fish. Soc. 22: 51-60.

SMITH, STANFORD H.

1954. A method of producing plastic impressions of fish scales without the use of heat. Prog. Fish-Cult. 16: 75-78.

VAN OOSTEN, JOHN

1953. A modification in the technique of computing average lengths from the scales of fishes. Prog. Fish-Cult. 15 (2): 85-86.

TABLE 1

Calculated Total Length at End of Each Year of Life for Each Age Group of Lake Puckaway Male Walleyes and Average Growth for the Combined Age Groups.

| Age Group | Number of Fish | Length (Inches) at End of Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| II | 7 | 8.0 | 14.3 | | | | | | | |
| III | 8 | 7.9 | 12.4 | 14.3 | | | | | | |
| IV | 26 | 7.6 | 12.0 | 14.7 | 16.1 | | | | | |
| V | 49 | 7.8 | 12.7 | 15.2 | 16.6 | 17.5 | | | | |
| VI | 84 | 7.4 | 12.6 | 15.6 | 17.0 | 18.0 | 18.5 | | | |
| VII | 118 | 7.3 | 12.7 | 15.6 | 17.2 | 18.2 | 18.9 | 19.4 | | |
| VIII | 49 | 7.3 | 12.7 | 15.7 | 17.3 | 18.4 | 19.2 | 19.9 | 20.2 | |
| IX | 14 | 7.7 | 13.1 | 15.9 | 17.6 | 18.7 | 19.6 | 20.2 | 20.8 | 21.3 |
| Average Calculated Length: | | 7.5 | 12.7 | 15.5 | 17.0 | 18.1 | 18.9 | 19.6 | 20.3 | 21.3 |
| Mean Annual Increment: | | 7.5 | 5.2 | 2.8 | 1.5 | 1.0 | 0.7 | 0.6 | 0.4 | 0.5 |
| Growth Based on Summation of Increment: | | 7.5 | 12.7 | 15.5 | 17.0 | 18.0 | 18.7 | 19.3 | 19.7 | 20.2 |

TABLE 2

Calculated Total Length at End of Each Year of Life for Each Age Group of Lake Puckaway Female Walleyes and Average Growth for the Combined Age Groups.

| Age Group | Number of Fish | Length (Inches) at End of Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| IV | 1 | 8.3 | 14.2 | 15.8 | 17.1 | | | | | |
| V | 11 | 7.7 | 13.2 | 16.5 | 18.7 | 19.5 | | | | |
| VI | 31 | 7.7 | 13.9 | 17.3 | 19.3 | 20.4 | 21.0 | | | |
| VII | 57 | 7.5 | 13.2 | 17.1 | 19.5 | 20.9 | 22.2 | 22.9 | | |
| VIII | 55 | 8.1 | 13.7 | 17.3 | 19.8 | 21.6 | 22.9 | 24.0 | 24.5 | |
| IX | 21 | 8.1 | 14.2 | 18.1 | 20.4 | 21.9 | 23.4 | 24.3 | 25.1 | 25.5 |
| Average Calculated Length: | | 7.8 | 13.6 | 17.3 | 19.6 | 21.1 | 22.4 | 23.6 | 24.7 | 25.5 |
| Mean Annual Increment: | | 7.8 | 5.8 | 3.7 | 2.3 | 1.4 | 1.2 | 0.9 | 0.6 | 0.4 |
| Growth Based on Summation of Increment: | | 7.8 | 13.6 | 17.3 | 19.6 | 21.0 | 22.2 | 23.1 | 23.7 | 24.1 |

TABLE 3

Growth Based on Summation of Increments (Inches) and Length Increments of Male and Female Walleyes of Lake Puckaway in Different Years of Life.

| Year of Life | Males | | Females | | Size Advantage of Females |
|---|---|---|---|---|---|
| | Length | Increment | Length | Increment | |
| I | 7.5 | 7.5 | 7.8 | 7.8 | 0.3 |
| II | 12.7 | 5.2 | 13.6 | 5.8 | 0.9 |
| III | 15.5 | 2.8 | 17.3 | 3.7 | 1.8 |
| IV | 17.0 | 1.5 | 19.6 | 2.3 | 2.6 |
| V | 18.0 | 1.0 | 21.0 | 1.4 | 3.0 |
| VI | 18.7 | 0.7 | 22.2 | 1.2 | 3.5 |
| VII | 19.3 | 0.6 | 23.1 | 0.9 | 3.8 |
| VIII | 19.7 | 0.4 | 23.7 | 0.6 | 4.0 |
| IX | 20.2 | 0.5 | 24.1 | 0.4 | 3.9 |

TABLE 4

Comparison of Growth Based on Summation of Increments (Total Length in Inches) for Male and Female Walleyes from Lakes Puckaway and Winnebago.

| Year of Life | Males | | Size Advantage of Puckaway Males | Females | | Size Advantage of Puckaway Females |
|---|---|---|---|---|---|---|
| | Puckaway | Winnebago | | Puckaway | Winnebago | |
| I | 7.5 | 5.6 | 1.9 | 7.8 | 6.0 | 1.8 |
| II | 12.7 | 10.2 | 2.5 | 13.6 | 10.1 | 3.5 |
| III | 15.5 | 12.7 | 2.8 | 17.3 | 13.3 | 4.0 |
| IV | 17.0 | 14.1 | 2.9 | 19.6 | 15.5 | 4.1 |
| V | 18.0 | 15.1 | 2.9 | 21.0 | 17.3 | 3.7 |
| VI | 18.7 | 15.8 | 2.9 | 22.2 | 18.9 | 3.3 |
| VII | 19.3 | 16.4 | 2.9 | 23.1 | 20.1 | 3.0 |
| VIII | 19.7 | 17.1 | 2.6 | 23.7 | 21.1 | 2.6 |
| IX | 20.2 | | | 24.1 | | |

TABLE 5

Age and Size in Inches of Mature Lake Puckaway Walleyes.

| Age Group | Females | | Males | |
|---|---|---|---|---|
| | Number | Average Length | Number | Average Length |
| II | | | 7 (1.9) | 14.3 |
| III | | | 8 (2.3) | 14.3 |
| IV | 1 (0.6)* | 17.1 | 26 (7.3) | 16.1 |
| V | 11 (6.2) | 19.5 | 49 (13.8) | 17.5 |
| VI | 31 (17.6) | 21.0 | 84 (23.7) | 18.5 |
| VII | 57 (32.4) | 22.9 | 118 (33.2) | 19.4 |
| VIII | 55 (31.3) | 24.5 | 49 (13.8) | 20.2 |
| IX | 24 (11.9) | 25.5 | 14 (3.9) | 21.3 |

*Percent of total sample shown in parentheses.

TABLE 6

A Comparison of Length Frequencies and Average Lengths of Spawning Walleyes (Sexes Combined) Originating from Lakes Winnebago and Puckaway and Captured on the Spawning Sites, 1964.

| Length Groups in Inches (Total Length) | Lake Winnebago | | | Lake Puckaway |
|---|---|---|---|---|
| | Wolf River: Shiocton | Fox River: Eureka Dam | Lake Winnebago: West Shore | Fox River: Grand River Dam |
| 10.0 - 10.9 | | | 1 (0.3) | |
| 11.0 - 11.9 | | | 9 (2.3) | |
| 12.0 - 12.9 | 13 (5.7) | 5 (3.8) | 54 (13.8) | |
| 13.0 - 13.9 | 29 (12.7) | 27 (20.9) | 117 (30.0) | 5 (1.3) |
| 14.0 - 14.9 | 46 (20.1) | 16 (12.4) | 90 (23.1) | 13 (3.5) |
| 15.0 - 15.9 | 28 (12.2) | 23 (17.8) | 58 (14.9) | 11 (2.9) |
| 16.0 - 16.9 | 34 (14.8) | 24 (18.6) | 26 (6.6) | 11 (2.9) |
| 17.0 - 17.9 | 44 (19.2) | 18 (13.9) | 11 (2.8) | 36 (9.6) |
| 18.0 - 18.9 | 20 (8.7) | 6 (4.7) | 8 (2.1) | 70 (18.7) |
| 19.0 - 19.9 | 6 (2.6) | 2 (1.6) | 1 (0.3) | 68 (18.2) |
| 20.0 - 20.9 | 3 (1.3) | 3 (2.3) | 2 (0.5) | 47 (12.6) |
| 21.0 - 21.9 | 1 (0.4) | 1 (0.8) | 1 (0.3) | 33 (8.8) |
| 22.0 - 22.9 | 2 (0.9) | 1 (0.8) | 4 (1.0) | 16 (4.3) |
| 23.0 - 23.9 | | 1 (0.8) | 2 (0.5) | 22 (5.9) |
| 24.0 - 24.9 | | 2 (1.6) | 2 (0.5) | 11 (2.9) |
| 25.0 - 25.9 | 2 (0.9) | | 3 (0.7) | 17 (4.5) |
| 26.0 - 26.9 | | | 1 (0.3) | 9 (2.4) |
| 27.0 - 27.9 | 1 (0.4) | | | 4 (1.1) |
| 28.0 - 28.9 | | | | |
| 29.0 - 29.9 | | | | 1 (0.3) |
| Total: | 229 | 129 | 390 | 374 |
| Average Length: | 16.0 in. | 15.9 in. | 14.6 in. | 19.9 in. |

TABLE 7

Tag Returns by Months of Walleyes Tagged in Lake Puckaway, January-February, 1961, and in Montello River, April, 1961-63.

| Month | Number Returned | Percent of Total |
|---|---|---|
| January | 12 | 7.0 |
| February | 3 | 1.8 |
| March | 4 | 2.3 |
| April | 44 | 25.7 |
| May | 27 | 15.8 |
| June | 28 | 16.4 |
| July | 21 | 12.3 |
| August | 12 | 7.0 |
| September | 5 | 2.9 |
| October | 1 | 0.6 |
| November | 1 | 0.6 |
| December | 13 | 7.6 |
| Total: | 171 | 100.0 |

TABLE 8

Tagging Sites and Recapture Sites of Walleyes Recaptured by Anglers.

| Tagging Site | Lake Puckaway (Area 1) | | Montello River (Area 4) | |
|---|---|---|---|---|
| | Number Recaptured | Percent Recaptured | Number Recaptured | Percent Recaptured |
| Areas Recaptured | | | | |
| 1 | 8 | 49.9 | 69 | 44.2 |
| 2 | 2 | 12.5 | 26 | 16.7 |
| 3 | 4 | 25.0 | 34 | 21.8 |
| 4 | | | 11 | 7.0 |
| 5 | 1 | 6.3 | 2 | 1.3 |
| 6 | 1 | 6.3 | 14 | 8.9 |
| Total: | 16 | | 156 | |

TABLE 9

The Length-Frequencies and Percentages of Walleyes Taken in the Montello and Fox Rivers During the Spawning Migration, 1961-64.

| Length Groups in Inches (T.L.) | Montello River, 1961 | | | Montello River, 1962 | | |
|---|---|---|---|---|---|---|
| | Male | Female | Unknown | Male | Female | Unknown |
| 8.0- 8.9 | | | | | | |
| 9.0- 9.9 | | | | | | |
| 13.0-13.9 | | | 4(3.8) | | | |
| 14.0-14.9 | 1(0.3)* | | 1(0.9) | 2(2.2) | | |
| 15.0-15.9 | 13(4.0) | | 2(1.9) | 8(9.0) | | |
| 16.0-16.9 | 56(17.3) | | 17(16.0) | 8(9.0) | | |
| 17.0-17.9 | 74(22.9) | | 16(15.1) | 19(21.3) | | |
| 18.0-18.9 | 77(23.8) | 1(2.0) | 17(16.0) | 18(20.2) | 1(25.0) | 2(33.3) |
| 19.0-19.9 | 67(20.7) | 2(4.1) | 18(17.0) | 20(22.5) | | 1(16.7) |
| 20.0-20.9 | 29(9.0) | 12(24.5) | 14(13.2) | 8(9.0) | 1(25.0) | 2(33.3) |
| 21.0-21.9 | 5(1.5) | 10(20.4) | 7(6.6) | 4(4.5) | | 1(16.7) |
| 22.0-22.9 | 1(0.3) | 7(14.3) | 1(0.9) | 2(2.2) | 1(25.0) | |
| 23.0-23.9 | | 3(6.1) | 1(0.9) | | 1(25.0) | |
| 24.0-24.9 | | 4(8.2) | 4(3.8) | | | |
| 25.0-25.9 | | 5(10.2) | 2(1.9) | | | |
| 26.0-26.9 | | 2(4.1) | 2(1.9) | | | |
| 27.0-27.9 | | 1(2.0) | | | | |
| 28.0-28.9 | | 1(2.0) | | | | |
| 29.0-29.9 | | 1(2.0) | | | | |
| Total | 323 | 49 | 106 | 89 | 4 | 6 |
| Average Length | | 18.1 in. | | | 18.5 in. | |

*Percentages in parentheses.

Table 9 (cont.)

| Length Groups in Inches (T.L.) | Montello River, 1963 | | Fox River-Grand River Dam, 1964 | | | Total Sample | | |
|---|---|---|---|---|---|---|---|---|
| | Male | Female | Male | Female | Unknown | Male | Female | Unknown |
| 8.0- 8.9 | | | | 2(1.7) | | | 2(0.7) | |
| 9.0- 9.9 | | | | 1(0.9) | | | 1(0.4) | |
| 13.0-13.9 | 2(2.0) | | 5(2.0) | | | 7(0.9) | | 4(3.4) |
| 14.0-14.9 | 9(9.0) | | 9(3.5) | | 4(100.0) | 21(2.7) | | 5(4.3) |
| 15.0-15.9 | 7(7.0) | | 11(4.3) | | | 39(5.1) | | 2(1.7) |
| 16.0-16.9 | 8(8.0) | | 9(3.5) | 2(1.7) | | 81(10.5) | 2(0.7) | 17(14.7) |
| 17.0-17.9 | 18(18.0) | | 35(13.7) | 1(0.9) | | 146(19.0) | 1(0.4) | 16(13.8) |
| 18.0-18.9 | 29(29.0) | 3(2.6) | 65(25.4) | 5(4.3) | | 189(24.6) | 10(3.5) | 19(16.4) |
| 19.0-19.9 | 17(17.0) | 2(1.8) | 60(23.4) | 8(6.8) | | 164(21.4) | 12(4.2) | 19(16.4) |
| 20.0-20.9 | 7(7.0) | 18(15.8) | 36(14.1) | 11(9.4) | | 80(10.4) | 42(14.8) | 16(13.8) |
| 21.0-21.9 | 3(3.0) | 14(12.3) | 20(7.8) | 13(11.1) | | 32(4.2) | 37(13.0) | 8(6.9) |
| 22.0-22.9 | | 21(18.4) | 4(1.6) | 12(10.3) | | 7(0.9) | 41(14.4) | 1(0.9) |
| 23.0-23.9 | | 25(21.9) | 2(0.8) | 20(17.1) | | 2(0.3) | 49(17.3) | 1(0.9) |
| 24.0-24.9 | | 10(8.8) | | 11(9.4) | | | 25(8.8) | 4(3.4) |
| 25.0-25.9 | | 9(7.9) | | 17(14.5) | | | 31(10.9) | 2(1.7) |
| 26.0-26.9 | | 6(5.3) | | 9(7.7) | | | 17(6.0) | 2(1.7) |
| 27.0-27.9 | | 4(3.5) | | 4(3.4) | | | 9(3.2) | |
| 28.0-28.9 | | 2(1.8) | | | | | 3(1.1) | |
| 29.0-29.9 | | | | 1(0.9) | | | 2(0.7) | |
| Total | 100 | 114 | 256 | 117 | 4 | 768 | 284 | 116 |
| Average Length | 20.5 in. | | | 19.9 in. | | | 19.4 in. | |

TABLE 10

Comparison of Seine Haul Catches of Total Game Fish and Percent of Walleyes Taken for Lakes Puckaway and Winnebago, and Years when Walleyes could Pass Over the Eureka Dam During the Spring Spawning Run.

| Year | Lake Puckaway | | | | Lake Winnebago | | | | Passage Over Eureka Dam |
|---|---|---|---|---|---|---|---|---|---|
| | Total Hauls | Total Game Fish | Number Walleyes | Percent Walleyes | Total Hauls | Total Game Fish | Number Walleyes | Percent Walleyes | |
| 1940 | | | | | 46 | 22,776 | 2,597 | 11.4 | No |
| 1941 | 7 | 176,117 | | | 32 | 9,621 | 2,160 | 22.4 | Yes |
| 1942 | 6 | 50,646 | | | 33 | 12,081 | 4,585 | 37.9 | No |
| 1943 | 1 | 1,840 | | | 39 | 13,728 | 4,995 | 36.3 | Yes |
| 1944 | | | | | 19 | 18,784 | 8,442 | 44.9 | No |
| 1945 | | | | | 17 | 12,595 | 3,920 | 31.1 | Yes |
| 1946 | | | | | 13 | 15,205 | 3,248 | 21.3 | Yes |
| 1947 | | | | | 18 | 12,076 | 1,890 | 15.6 | No |
| 1948 | | | | | 3 | 2,365 | 492 | 20.8 | Yes |
| 1949 | | | | | 23 | 8,882 | 1,345 | 15.1 | No |
| 1950 | 18 | 53,404 | 936 | 1.7 | 11 | 4,071 | 522 | 12.8 | Yes |
| 1951 | 17 | 3,260 | 193 | 5.3 | 11 | 6,900 | 987 | 14.3 | Yes |
| 1952 | 11 | 24,570 | 1,215 | 4.9 | 14 | 7,148 | 1,274 | 17.8 | Yes |
| 1953 | 7 | 9,340 | 1,472 | 15.7 | 5 | 3,698 | 587 | 15.9 | Yes |
| 1954 | 8 | 9,159 | 1,235 | 13.4 | 9 | 13,122 | 798 | 6.1 | No |
| 1955 | | | | | 13 | 23,141 | 3,556 | 15.3 | No |
| 1956 | 9 | 14,247 | 3,335 | 23.4 | 3 | 14,004 | 950 | 6.7 | Yes |
| 1957 | | | | | 7 | 5,325 | 1,020 | 19.1 | No |
| 1958 | 9 | 16,606 | 1,070 | 6.4 | 9 | 17,446 | 600 | 3.4 | No |
| 1959 | 1 | 2,600 | 90 | 3.4 | 8 | 3,549 | 977 | 27.4 | Yes |
| 1960 | 7 | 4,834 | 246 | 5.1 | 3 | 1,788 | 704 | 39.9 | Yes |
| 1961 | 3 | 591 | 10 | 1.6 | 2 | 10,143 | 510 | 5.2 | No |
| 1962 | | | | | | | | | Yes |
| 1963 | | | | | | | | | No |
| 1964 | | | | | | | | | No |

1-67
cz