THE EFFECTS OF RESERVOIR WATER LEVEL FLUCTUATION ON UTILIZATION OF A SMALL TRIBUTARY STREAM BY STREAM AND RESERVOIR FISH POPULATIONS

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ABSTRACT

Six stations on Whitley Creek were sampled with a boat shocker and seines in years of moderate and high reservoir water level fluctuation. Stations were chosen to provide for the sampling of impounded and lotic habitats. Physical alteration of stream habitat caused by silting, and population pressure exerted by the influx of reservoir species into impounded areas were temporary. Stream species quickly recolonized impounded areas when these areas reverted to stream conditions and reservoir species did not persist in stream habitat. Large areas of Whitley Creek impounded by high water in the spring and summer of 1974 served as nursery areas for many reservoir species. The young-of-the-year produced in this habitat apparently returned to the reservoir in autumn and may have contributed to the recruitment of reservoir populations.

INTRODUCTION

This study was conducted to determine the use of impounded stream habitat by reservoir species and the response of stream species to this habitat alteration. Fluctuating water level in flood control reservoirs results in alternating expansion and shrinkage of stream and reservoir habitat. Since water level generally rises in the spring before and during the interval when most reservoir fish species are spawning, the newly created reservoir habitat may serve as both spawning and nursery grounds for these species. The impoundment of stream habitat may also result in the displacement of species adapted to a lotic environment. When the reservoir is drawn down, impounded sections of tributary streams revert to flowing water habitat. The persistence of reservoir species and the speed and success of recolonization by stream species in these areas are not known.

STUDY AREA

Whitley Creek is a low gradient, third order tributary of the Kaskaskia River located in central Illinois (Fig. 1). In 1970, Lake Shelbyville was formed by the construction of a dam on the Kaskaskia River approximately 32 km downstream from its confluence with Whitley Creek. As a result of reservoir fluctuations, a variable fraction of Whitley Creek has been impounded since 1971 (Fig. 2). At reservoir winter drawdown (180 MMSL) only a small area of Whitley Creek is impounded and the stream is entirely within its banks. At normal summer pool (183 MMSL) approximately 40 ha of stream channel and floodplain are impounded (Fig. 1) and at 187 MMSL an additional 150 ha are impounded.

Six stations on Whitley Creek were selected to encompass the entire range of water level fluctuation and still provide for the sampling of nonimpounded water. The elevation of each station relative to reservoir level is shown in Fig. 2. Station I, located at the mouth of Whitley Creek, has been impounded since February 1971 and is essentially part of Lake Shelbyville. Station II, located 1,375 m upstream from the mouth of Whitley Creek, has generally been impounded except during winter drawdown. At higher reservoir levels, large areas of floodplain are inundated at this station. Pools have filled in and riffle habitat has been obliterated. Station III, located 3,250 m upstream, is not impounded at normal summer pool. In the spring and summer of 1974, however, reservoir level was abnormally high and this station and its associated floodplain were inundated for nearly 7 months. Substantial silt covered the stream bottom during this time but was washed away by normal stream discharge the following spring. Station IV, located 6,420 m upstream from the mouth was subjected to reservoir impact similar to that of Station III but was impounded for only 4 months. Stations V and VI were located 8,348 and 10,347 m upstream, respectively, from the mouth. Station V was impounded for a few days in June 1974, but the stream remained within its banks. Station VI was not impounded during the course of this study.

METHODS

The fish populations of Whitley Creek were sampled in 1971 and 1972 when the reservoir was new, in 1974 when an unusually large area of Whitley Creek was impounded, and again in 1975 when the reservoir returned to a more normal pattern of water level fluctuation. In 1971 and 1972, eight collections were made at the six stations. The sampling dates were chosen to correspond with major changes in reservoir elevation. Thus collections were made when winter drawdown level was reached, at the end of winter drawdown, when summer pool was first reached, and just before the initiation of winter drawdown. The remaining collections were spaced at equal intervals between these collections. In 1974, six complete collections were made with four of them occurring in the spring and early summer when reservoir fluctuation was greatest and fish were reproductively most active. In addition, Stations III and IV were sampled at approximately weekly intervals when the surface area impounded was increasing or decreasing at these stations. In 1975, six collections were made at equal intervals between April and October.

Impounded stations were sampled for 30 minutes with a 230-volt, AC boat shocker. When possible, seine hauls also were made at these stations with a 1.2 x 6.1 m bag seine (4.8 mm mesh). Stream stations were sample with the same seine, the number of hauls varying inversely with sampling efficiency.

It was necessary to use two kinds of sampling gear because there were two major habitat types. Seines were more effective for small species and electrofishing was more effective for larger species. When stream stations became impounded, electrofishing replaced seining. It frequently was not possible to supplement electrofishing with seining samples because water shallow enough to seine contained many obstructions. In 1974, when surface area increase twenty-fold at Stations III and IV, electrofishing replaced seining at these stations. Thus stream species were captured less efficiently and the density of these species was greatly reduced by the increase in water area.

RESULTS

During the years of this study, 17,754 fish representing 58 species were collected. Only 21 of these species were represented by more than 100 individuals (Table I).

Species that were most abundant in lotic habitat included most of the native cyprinids and darters. *Pimephales notatus*, *Notropis lutrensis*, *N. umbratilis*, and *N. dorsalis* were the most abundant species captured at stream stations. Despite the fact that a greater fraction of the stream was impounded in 1974 than in 1971 and 1972, none of the species common at stream stations were eliminated and relative abundance remained approximately the same.

Few stream species were collected at Stations III and IV when the stations became impounded in 1974. It was not possible to determine if these species moved upstream in advance of rising water or if any became less vulnerable to capture. However, when water level dropped in autumn and these stations reverted to stream habitat, only small numbers of a few stream species were present. By the following spring, species composition and densities were similar to Stations V and VI.

Esox americanus, *Ictalurus melas*, and *Lepomis megalotis* were the only species common at both reservoir and stream stations. The grass pickerel was one of the most abundant fish in the 1971 and 1972 collections, but was represented by only 12 specimens in 1974 and 1975. The impounding of the Kaskaskia River in 1970 resulted in the inundation of large areas of terrestrial vegetation suitable for grass pickerel spawning. A large year class was formed and invaded tributary streams. This temporary condition did not persist and grass pickerel density had declined by 1974.

Large numbers of *Dorosoma cepedianum*, *Cyrpinus carpio*, *Ictiobus cyprinellus*, *Labisdesthes sicculus*, and *Micropterus salmoides* were collected in impounded habitat but relatively few were taken in stream habitat (Table I). Gizzard shad entered Whitley Creek in early spring and apparently returned to deeper parts of the reservoir in autumn. They did not overwinter in large numbers even in impounded parts of Whitley Creek. Shad were considerably more abundant in Whitley Creek in 1974 than in 1971 and 1972 which probably reflected the increase in abundance of this species in the reservoir, the production of a strong year class in 1974 and the greater area of impounded stream habitat. Shad abundance was intermediate in 1975 because less stream habitat was impounded and the 1975 year class was smaller.

Ripe shad were captured migrating upstream early in May 1974 at Station IV. Before it was impounded a few adults were taken earlier at Stations V and VI.

Miller (1960) reported that adult gizzard shad ascend smaller streams to spawn. However, there was no indication that shad reproduced at any of the lotic stations since no young-of-the-year were collected. If reproduction did occur in Whitley Creek, larvae probably drifted downstream into impounded sections of stream.

As reservoir elevation increased rapidly in May 1974, Stations III and IV became impounded and water spread over large areas of adjacent floodplain fields. Substantial numbers of ripe adult shad quickly invaded this newly created habitat. This ingress did not extend to Station V which was not impounded. Tows with 0.5-m diameter plankton nets at Stations III and IV on 7 June 1974 indicated that shad had spawned in flooded fields at these stations. Many larval shad, including some prolarvae, were collected and densities were comparable with those at productive shad nursery areas in the reservoir (Storck et al. 1978).

The density of young shad remained high at Stations III and IV throughout summer 1974. As the reservoir water level receded and Whitley Creek became confined to its normal stream channel, both young-of-the-year and adult shad moved downstream. Most young-of-the-year shad moved quickly while some adults became concentrated for a short period of time. By the time Stations III and IV had reverted to a stream condition, all adult shad had moved downstream and only a small number of young remained in stream habitat. No shad were collected at Station III or IV the following spring, but some young-of-the-year move upstream as far as Station III during August.

Carp exhibited patterns of movement and distribution similar to those observed for the gizzard shad. They were common at Stations I and II, which were impounded during much of the study, but seldom were taken in stream habitat. In 1974, large numbers of ripe adults moved into recently inundated fields at Stations III and IV. Tows with a 0.5-m plankton net indicated that some carp spawning had occurred in these fields, but later seining yielded few young-of-the-year. Adult carp moved downstream quickly in response to receding water level during autumn 1974. In 1975, Stations III and IV were not impounded and only one carp was collected at these stations.

Brook silverside were not collected in Whitley Creek in 1971 or 1972, presumably because the reservoir population was small. They were first captured in August 1974. Maximum numbers occurred at Stations II and III and small numbers moved upstream as far as Station V, which was not impounded. There was no evidence that brook silverside spawned in Whitley Creek. When Station III reverted to stream habitat many remained at this station at least through November. None were collected in Whitley Creek the following spring, but substantial numbers moved upstream as far as Station III in September 1975. The brook silverside was the only species that entered stream habitat in substantial numbers during summer.

Largemouth bass were common in Whitley Creek throughout the study, but were not abundant in 1974 when the greatest area was impounded and stream discharge was highest. They were collected throughout the year at impounded stations, but only during spring at lotic stations. In 1974, adult bass moved far upstream in April when stream flow was maximum. Our sampling gear was inefficient in fast flowing stream habitat, but fishermen were catching large numbers at stream locations. Five adult largemouth bass collected in a single seine haul in early May in a small tributary of Whitley Creek 3 km upstream from

station VI indicated that largemouth bass moved upstream beyond the limits of the study area. However, these bass apparently did not remain at stream stations during summer and young-of-the-year were not collected at Stations V and VI. Adult bass did remain at impounded stations throughout the summer and substantial numbers of young-of-the-year were also collected at Stations III and IV. Thus, largemouth bass spawned in impounded parts of Whitley Creek. When Stations III and IV reverted to a stream condition, some young-of-the-year remained, but adults moved downstream. By November, only Station I was still impounded and adult bass concentrated in this area.

Lepomis cyanellus, *L. macrochirus*, *Pomoxis annularis*, and *P. nigromaculatus* responded similarly to water level fluctuation in Whitley Creek. They were most abundant at reservoir stations and more abundant in 1974 than in other years. We collected only small numbers of these species in stream habitat, but crappie and bluegill were present in fisherman's catches as far upstream as Station VI in April and May 1974. In 1974, only small numbers of adults were captured at Stations III and IV, but successful spawning was indicated by the presence of large numbers of young-of-the-year of these species. Adults and young moved downstream when impounded stations reverted to stream habitat. Young-of-the-year of these species were concentrated for a short time at Station II in November, but had left the area by mid-December.

DISCUSSION

Numerous species common in Lake Shelbyville used impounded parts of Whitley Creek and many moved into stream habitat for short intervals during spring. However, there is no indication that any of these species persisted in large numbers in stream habitat nor that any successfully reproduced there. Many of these species inhabit streams and their failure to maintain populations in Whitley Creek may be the result of the small size and low summer flow of this stream.

The physical alteration of stream habitat caused by silting and the population pressures exerted by the influx of reservoir species into impounded areas were temporary. Stream species quickly recolonized these areas, and species composition and relative abundance in the recently impounded stream levels were similar to 1971, previous to any inundation. In 1976, stream areas in 1975 were extremely low and flow ceased in August. Stations V and VI were dry and only small isolated pools remained at Stations III and IV. Few fish persisted in these pools. Thus, the impact of drought on the stream fauna of Whitley Creek is potentially as damaging as that of temporary reservoir encroachment on stream habitat.

The magnitude of movement of reservoir species into tributary streams is probably related to the volume of stream discharge. Fish movement into Whitley Creek was greatest in 1974 when stream discharge was highest. The initial movement occurred in April and May before much of the stream was impounded. Gizzard shad, carp, bluegill, largemouth bass, and crappie entered areas that were not impounded. These species probably would not have used newly impounded areas of Whitley Creek as heavily if the reservoir level had risen in response to a lesser stream flow. Likewise, movement is apparently associated with the spring spawning interval and it is doubtful that equivalent invasions of

impounded habitat would have occurred under similar circumstances in summer or autumn.

Large areas of Whitley Creek were impounded temporarily by high water in the spring and summer of 1974 and served as nursery grounds for many reservoir species. Gizzard shad and bluegill were most numerous, but substantial numbers of young of other species were also present. These young-of-the-year remained in Whitley Creek until the water level was drawn down in autumn and then apparently returned to the reservoir. Only a small fraction were stranded in isolated pools. The contribution these young made to the reservoir population cannot be quantified but Whitley Creek and similar tributary streams may enhance recruitment of numerous species in years of high water.

REFERENCES

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Table I. Total numbers of 21 most abundant species of fish collected at the six sampling stations on Whitley Creek, Coles and Moultrie Counties, Illinois.

	Station																	
	I			II			III			IV			V			VI		
	71-73	74	75	71-73	74	75	71-73	74	75	71-73	74	75	71-73	74	75	71-73	74	75
Dorosoma cepedianum	186	96	330	125	208	380	33	341	72	3	576	0	0	10	0	0	5	0
Esox vermiculatus	18	0	0	23	0	0	29	1	0	102	4	0	2	0	1	5	5	1
Cyprinus carpio	10	7	51	25	35	50	2	176	1	1	82	0	0	5	1	1	3	0
Notemigonus crysoleucas	0	0	0	9	2	2	1	70	8	1	89	33	10	37	3	0	91	1
Notropis chrysocephalus	0	1	1	4	0	9	9	5	58	81	31	66	28	128	100	35	97	127
N. dorsalis	0	0	0	24	13	11	0	1	19	4	26	25	153	49	147	26	97	379
N. lutrensis	3	0	0	54	0	8	0	14	1040	13	50	393	291	23	301	55	61	516
N. umbratilis	4	0	0	10	0	3	64	48	40	82	121	186	292	26	66	57	186	41
Pimephales notatus	1	1	1	110	0	1	116	20	58	42	81	283	661	55	529	136	300	710
Semotilus atromaculatus	0	0	0	0	0	0	2	0	6	32	36	8	254	40	43	26	16	33
Ictiobus cyprinellus	3	9	13	9	9	11	0	14	0	0	13	0	0	0	0	0	0	0
Ictalurus melas	5	3	19	0	4	2	1	20	0	15	78	0	0	14	8	1	4	3
Fundulus notatus	3	0	0	4	1	0	32	4	17	4	32	15	7	0	58	10	22	80
Labidesthes sicculus	0	8	0	0	141	6	0	124	115	0	23	0	0	21	0	0	0	0
Lepomis cyanellus	3	1	0	26	106	18	5	7	2	0	17	2	0	10	0	0	0	0
L. macrochirus	2	38	11	2	126	38	6	233	55	11	270	1	3	21	3	1	18	0
L. megalotis	0	2	5	19	32	0	54	7	4	30	8	22	0	13	7	14	8	4
Micropterus salmoides	77	41	34	56	65	31	15	68	6	14	68	10	12	16	1	6	13	1
Pomoxis annularis	13	30	20	1	122	1	7	54	0	0	54	0	0	3	0	0	0	0
P. nigromaculatus	11	22	14	10	57	1	48	73	0	0	73	0	0	3	0	1	3	0
Etheostoma nigrum	0	0	0	0	1	0	2	3	0	8	3	10	18	7	3	19	8	1

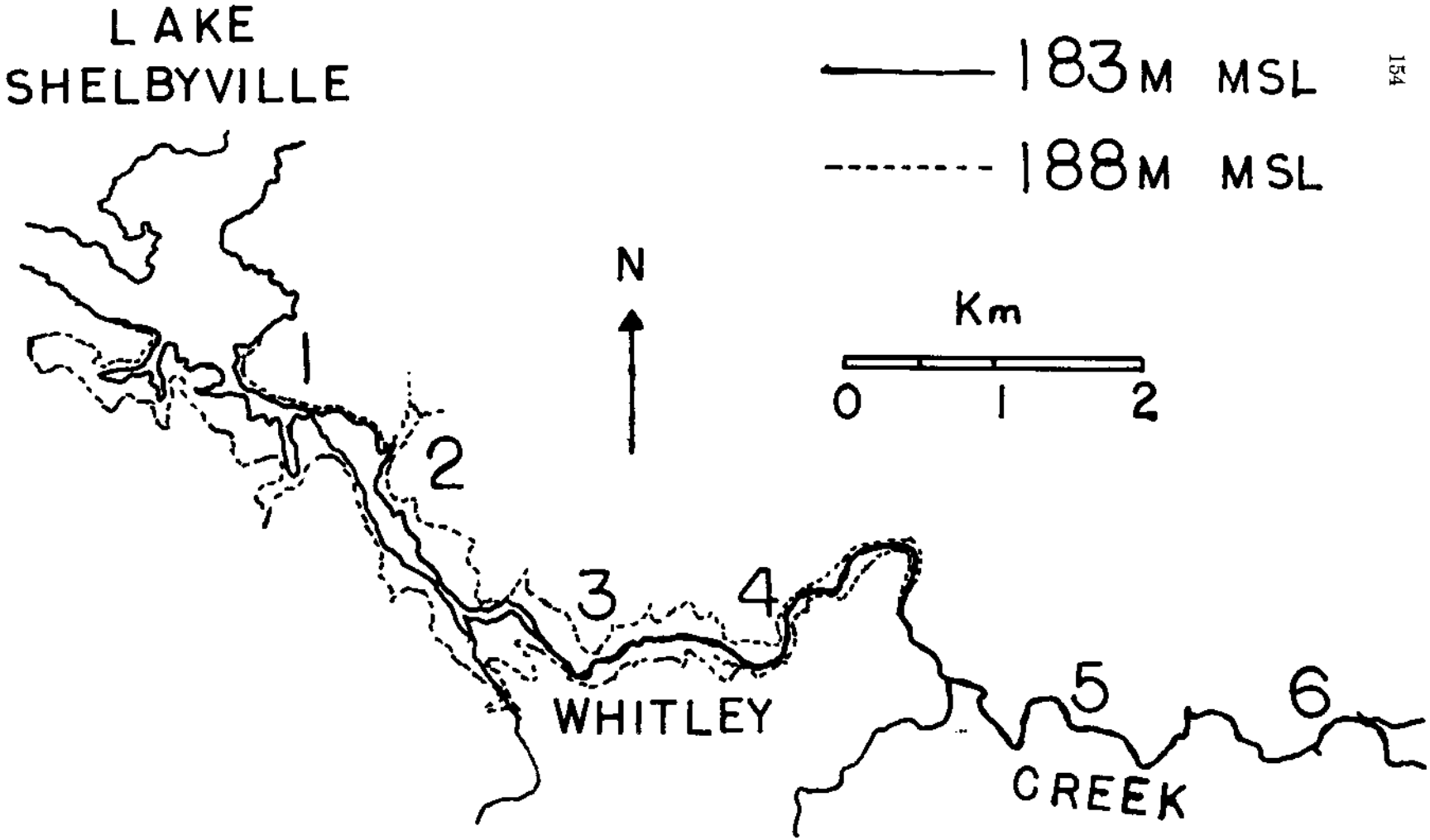

FIGURE 1. The surface area of Whitley Creek impounded at Lake Shelbyville reservoir elevations of 183 and 188 MMSL.

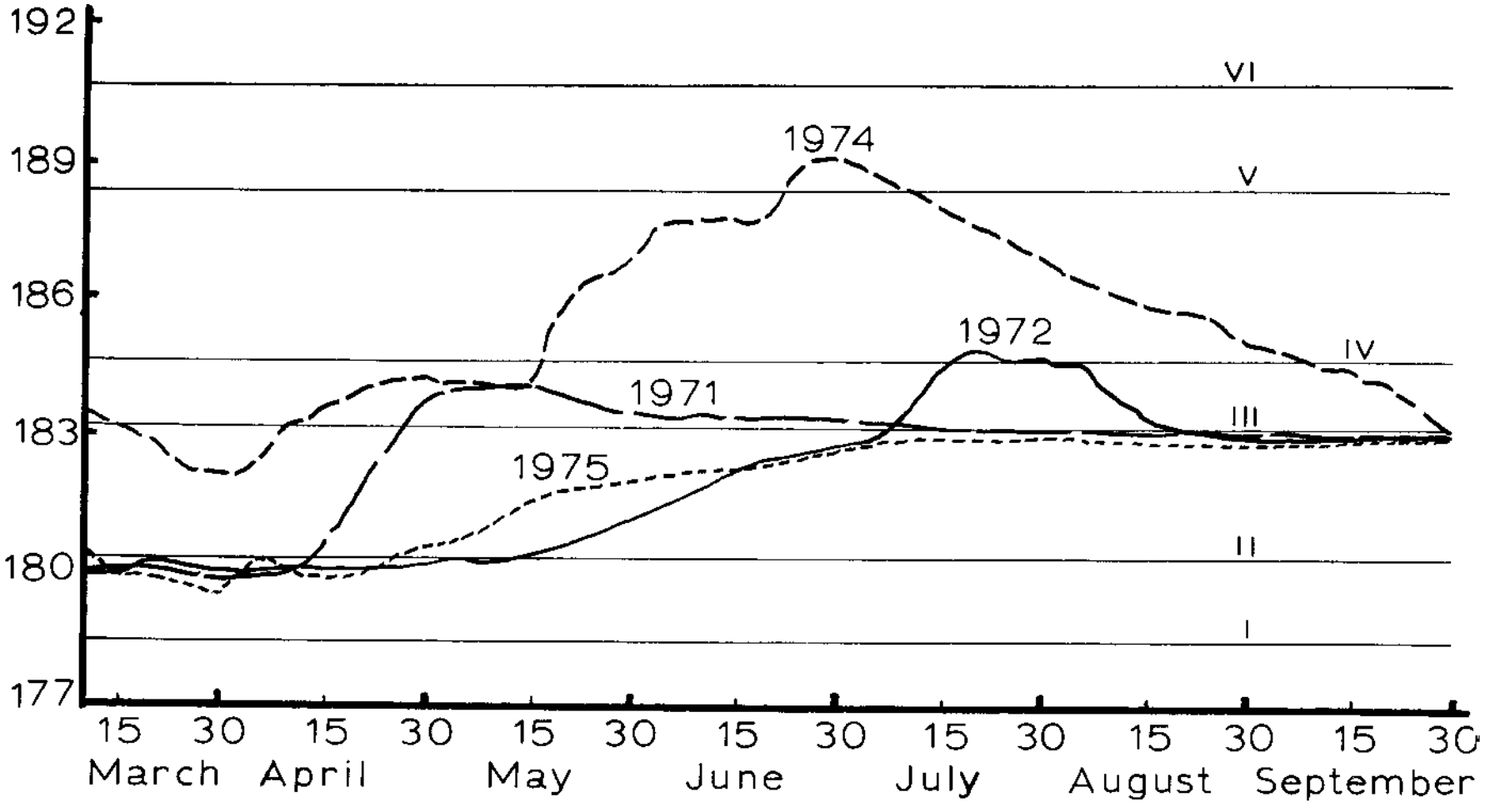

FIGURE 2. Lake Shelbyville water levels during spring and summer of 1971, 1972, 1974, and 1975. Whitley Creek station elevations are represented by horizontal lines.