

MOVEMENTS OF THE CREEK CHUB IN A SMALL OHIO STREAM¹

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Abstract. Creek chub movements were monitored in a small stream in the spring and summer of 1972 to determine the magnitude of seasonal changes in distribution. A large percentage of the adult chubs moved upstream between late April and mid-May, but distances traveled by individuals were generally less than 300 m. Immature chubs moved upstream throughout the spring and summer, the catch being predominantly 2 and 3 year old fish in May and early June, and 1 and 2 year old fish in late June and July. Upstream movement of all but young-of-the-year chubs greatly exceeded downstream movement. Some young-of-the-year fish drifted downstream passively. Large population shifts, associated with the exodus of fish from 2 beaver ponds, had implications for estimation of population size, mortality and other population parameters.

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Knowledge of movement and migration patterns of a species contributes to an understanding of its population dynamics. Movement patterns of creek chubs, *Semotilus atromaculatus*, in small streams and the modifications in these patterns brought about by the presence of beaver ponds have not been examined quantitatively. This study was part of a larger study concerned with the population dynamics of the creek chub in a small stream. The movements of this species were monitored in the spring and summer of 1972 to determine the magnitude of seasonal changes in distribution and to evaluate the importance of the presence of beaver ponds.

Description of Study Area. Our study was conducted in Indian Creek, a tributary of Clear Creek, Fairfield County in southeastern Ohio (fig. 1). The study area, part of the unglaciated Allegheny Plateau, is underlain by resistant ledge-forming Black Hand sandstone (Wolfe *et al* 1962). The valley through which Indian Creek flows is narrow with steep sides and the stream gradient is moderate. The forested watershed is classified as second growth mixed mesophytic.

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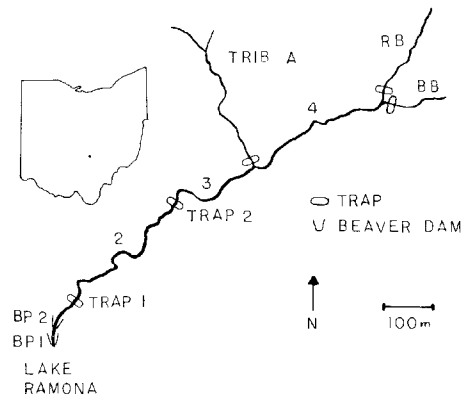


FIGURE 1. Indian Creek in August, 1972 showing trap locations. The second beaver pond and each tributary constituted natural segments. The remaining main channel was divided into 3 similar segments. From BP2, section 2 terminated at a culvert 500 m upstream. Section 3 ended at the entrance of Trib A approximately 800 m upstream, and section 4 terminated at the junction of RB and BB.

The stream enters Lake Ramona, a 4 ha artificial impoundment constructed in the early 1930's. Water passing over the spillway of this lake continues about 100 m before entering Clear Creek. The spillway effectively isolates Indian Creek from Clear Creek. The portion of the

stream above Lake Ramona includes approximately 2,300 m of fish-inhabited water in mid-summer with a surface area slightly greater than 0.4 hectare. According to Horton (1945), the main channel is a second order stream and the 3 tributaries are first order streams. The downstream end of Indian Creek has been modified by 2 beaver ponds. The one farther downstream is nearly contiguous with Lake Ramona (fig. 1). This pond is designated the first beaver pond (BP1), and the other immediately upstream from it is designated as the second beaver pond (BP2).

The first tributary (Trib A), which enters approximately 800 m upstream from BP 2, is reduced to a series of isolated pools in the summer. Indian Creek is divided equally into two more tributaries at a point 1,200 m upstream from Lake Ramona. One of these, the road branch (RB), has good pool development supporting a substantial number of chubs. During late summer dry periods the flow frequently ceases in this section, producing isolated pools. The other tributary, the back branch (BB), having almost no pool development, was inhabited by only a few chubs. During the study period this tributary always maintained a flow.

In addition to the creek chub, substantial populations of both redbelly dace, *Phoxinus erythrogaster*, and blacknose dace, *Rhinichthys atratulus*, were present in Indian Creek. Their combined densities approximated that of the creek chub (Storck 1974). The least brook lamprey, *Lampetra aepyptera*, also occurred in the stream and was most abundant in the first 500 m above BP 2.

MATERIALS AND METHODS

Weirs and rectangular traps were placed at 5 locations as shown on the map (fig. 1). Trap 1 was located 20 m upstream from BP2. Trap 2 was located at the junction of section 2 and 3. The remaining 3 traps were located in the mouths of the 3 tributaries. Traps were constructed of 6.3 mm hardware cloth and had dimensions of about 30 x 15 x 36 cm. Trap 2 had a single funnel directed downstream and monitored only upstream movement. Other traps had a funnel in each end, a partition in the center, and monitored both upstream and downstream movement. Traps were always situated in the middle of shallow runs or riffles approximately 15 cm deep. Weirs constructed of 6.3 mm hardware cloth and reinforced with 2.5 x 5.0 mm welded wire cloth extended from each

side of the trap to shore. Weirs were approximately 25 cm high and were held in place by wood stakes. Fish movement was monitored from 3 March through 5 July and from 25 July through 16 September.

Drift nets were set a few meters upstream from trap 1 to detect possible downstream drift of creek chub larvae. Sets were made at various times of day over a 3 week period shortly after initiation of spawning activity.

Trapped fish were sexed, classified as immature or mature, and the total length of each fish recorded. Ages were determined by probability paper analysis of length frequency histograms (Cassie 1954). Because it was not possible to separate older age groups using this method, age IV and older fish were combined.

Population size was estimated for each stream section using Bailey's modification of the Peterson mark and recapture method (Cormack 1968). A variable voltage pulsating direct current electric shocker and a minnow seine were used to collect fish. The length of time between mark and recapture collections always exceeded 2 days and the interval was generally 3 days. Captured fish were anaesthetized with MS-222 (Sandoz Co.), total length measurements were taken and fish were finclipped in the marking census. Too few age IV and older fish were recaptured to estimate their population size independently. In this case, numbers were estimated by forming a pooled estimate in the ratio of abundance in the catch as described by McFadden (1961). The use of this method precludes estimation of confidence limits for the oldest age group.

RESULTS AND DISCUSSION

Upstream migrations of mature chubs began in the last week of April and were essentially completed by the second week of June. Although midmorning water temperature reached 12 °C at the beginning of the spawning migrations, large diurnal fluctuations made the effect of specific temperatures difficult to interpret. All mature males produced milt when stroked lightly on the abdomen. Many mature females were ripe, while others yielded eggs only when considerable pressure was applied to the abdomen. Small numbers of spent females were encountered. Only 4 adult downstream migrants entered the traps.

The upstream movement of immature fish occurred throughout the spring trapping with similar numbers moving nearly every day. All age groups of immatures were involved in the upstream movement. Most fish caught in May and early June were 2 and 3 years old with 1 and 2 year old fish predominating in late June and July. One year old fish dominated the

TABLE 1
Creek chub movement in Indian Creek during the spring and summer of 1972 (3 March through 5 July and 25 July through 16 September).

Sex	Trap 1		Trap 2		Trib A		RB		BB	
	up	down	up	down	up	down	up	down	up	down
Adult males	60*	1	25	—	6	0	8	1	3	0
Adult females	238	2	28	—	6	0	26	0	10	0
Immature fish	1284	119	438	—	365	39	238	7	231	21

*Represents total number of creek chubs trapped at each site.

catch after they first appeared in large numbers on June 24. During the non-trapping period of July 5 through 24, large numbers of 1 year old fish apparently moved from the beaver ponds to section 2, where few had previously occurred. Large schools of 1 year old chubs that had previously inhabited the beaver pond were no longer present in that section. Upon resumption of trapping, only 250 more immature upstream migrants were captured in the remaining 25 trapping days.

Only 190 downstream migrant chubs were captured, and these were mostly 1 and 2 year olds (table 1). While large numbers of chubs moved upstream as early as May 4, substantial numbers did not move downstream until May 21. The numbers were distributed rather uniformly throughout the season. Using a similar trap design, Hall (1972) found fish species entered traps just as readily when moving downstream as when moving upstream with escape rates nearly identical for both directions. Only a few downstream migrants were captured

due to lack of movement (not because of the ineffectiveness of traps). Since upstream migrants greatly exceeded downstream migrants, random wandering could not account for the observed patterns. Hall (1972) observed similar upstream and downstream movements for creek chubs in New Hope Creek, NC.

The patterns observed in Indian Creek may not be typical of small streams. The presence of BP2 probably modified the distribution of creek chubs in this stream. Beaver ponds increase the number of species of fish, their standing crops, and the standing crops of plankton compared with those of unmodified stream sections (Hanson and Campbell 1963). The increase in depth, available cover, water volume, and food abundance doubtless contributed to the high standing crop of creek chubs in the beaver ponds of Indian Creek and may have enhanced the survival of young-of-the-year fish that gathered there. The large influx of fish into section 2 in the spring reflected the unusually large concentration of fish in the beaver pond (table 2).

TABLE 2
Creek chub population estimates for April 15 through 21, 1972 (sexes combined).

Age Group	Stream Section*					
	BP2	2	3	4	A	RB
II	1900** (1334-2466)	531 (357-705)	347 (265-429)	660 (551-809)	221 (67-375)	151 (107-195)
III	221 (152-290)	57 (10-104)	21 (11-33)	71 (64-78)	33 (9-57)	36 (24-48)
IV and Older	84	4	4	2	9	15

*See map (fig. 1) for identification of stream section.

**Data presented as total number (95% confidence limits). Population size of age group IV and older fish was determined by a pooled estimate based on the ratio of abundance in the catch. The use of this method precludes estimation of confidence limits.

Mature female chubs are more abundant than males in Indian Creek and more females were trapped. The sex ratios also differed from trap to trap ($\chi^2=21.67$, $df=4$, $P<0.005$). The pronounced differences in sex ratios between traps 1 and 2 may be a consequence of the unique habitat provided by the beaver pond (table 1). Overwintering mature fish had to move upstream to spawn because substrate and current velocities within the beaver pond were unsuitable for spawning. If the migration rate of the 2 sexes differed, the sex ratio of fish migrating from the beaver pond should have deviated from that expected in typical stream habitat. The temporal distribution of migrants from the beaver pond was more protracted, but by the end of May, spawning movements through traps 2 and RB were completed. Mature fish, however, continued to pass through trap 1 for another month with movements of immature fish showing little difference among traps.

Migrant adults made substantial contributions to the spawning population of each stream section. The premigration estimates (table 3) were derived from population estimates completed prior to spawning migrations (table 2). Based on these estimates, nearly all adult chubs left BP2 during the spring spawning season, and this movement increased the male and female breeding stock present in section 2 by 78% and 42%, respectively (table 3). Likewise, migrants in Trib A, RB and BB constituted a substantial fraction of the total spawning

population even though actual numbers of migrants entering these tributaries were small (table 1). For the entire stream, 102 mature males and 308 mature females were captured in migration traps. Judging from estimates of 92 males and 475 females present in the stream as reported by Storck (1974), we concluded that a large fraction of the adult population made at least small upstream movements.

The relative contribution of immature migrants to each section of stream could not be assessed because of lack of data on the number of 1 year olds present; however, numbers of immatures passing through each trap are available (table 1). The number of immature fish moving from BP2 into section 2 exceeded the number of resident 2 and 3 year old immatures initially present in that section but accounted for less than half of the immatures present in the beaver pond throughout the summer. In the 3 tributaries, ingress also exceeded the numbers of overwintering of 2 and 3 year old fish.

Fish movement measured by trap catches are undoubtedly conservative. Gerking (1950) found that fish tended to move upstream during high water. Our traps in Indian Creek were least effective during such periods, and movement was probably even greater than indicated by our trapping records.

Huge schools of young-of-the-year chubs were present in BP2 by mid-August. Since reproduction did not occur in this section or areas downstream from it, these fish must have entered

TABLE 3

Number of premigrant and spawning adults and net ingress of migrants into each stream section as number and % contribution to the spawning population of that section.

Stream Section	Males				Females			
	Pre-migrants	Spawners	Net ingress	% migrants	Pre-migrants	Spawners	Net ingress	% migrants
BP2	51	9	0	0	260	22	0	0
2	10	45	35	78	52	262	110	42
3	3	16	—*	—	21	36	—	—
4	12	11	—*	—	62	30	—	—
A	7	13	6	46	36	42	6	14
RB	8	16	8	50	44	70	26	37
BB	0	3	3	100	0	10	10	100

*It was not possible to estimate net ingress into sections 3 and 4 because movement between these sections was not monitored.

from upstream. As early as the beginning of June, an unknown number of these fish passively entered the beaver pond as drift. Fifty chub larvae ranging from 7 to 9 mm TL were collected in drift nets set about 30 m upstream from the beaver pond. Although nets were set at various times of day, larvae were captured only at night.

Although upstream migrants produced substantial changes in chub distribution, individuals apparently did not move far. Even if all fish passing through trap 2 had been BP2 residents, more than 50% of the males, 90% of the females, and 66% of the immature fish that left BP2 did not reach trap 2. The majority of fish entering trap 2 probably were originally resident in section 2, indicating that movement occurs by displacement rather than by long distance migrations of individuals. This finding agrees with the conclusions of Hall (1972).

All annual upstream movement probably occurred within our trapping interval. Although downstream movement of adults was negligible during this interval, large numbers of adults were present in the beaver pond during spring before the initiation of the upstream migration. Thus, downstream movements must have occurred during the fall or winter.

The observed movements of creek chubs have implications for studies of population dynamics. The magnitude of the movement may result in large errors in mortality rate estimates based on successive population estimates of small stream sections. The population

size of both mature and immature fish in BP2, section 2, and the 3 tributaries changed substantially as a result of immigration and emigration. Often, in studies in which small sections of a stream are repeatedly sampled, it is assumed that immigration and emigration are equal. Obviously, one cannot make such assumptions in streams intercepted by beaver ponds, and the entire population should be sampled if estimates are made at intervals of less than one year.

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