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Inter- and Intrastream Migration of Cutthroat Trout (Salmo clarki) in Spawn Creek, a Tributary of the Logan River, Utah

Abstract

We investigated inter- and intrastream movements of fluvial cutthroat trout (*Salmo clarki*) within Spawn Creek and between this stream and the Logan River, Utah. From November 1973 through November 1975, we captured all migrants with a fish trap on Spawn Creek and tagged adult cutthroat trout. Monthly from July 1973 through November 1975, we electrofished parts of Spawn Creek and cold-branded all unmarked juveniles and adults. Also, we continuously measured water temperature and stream flows at the trap. During the spawning season in 1974, 39 cutthroat trout entered Spawn Creek and 23 left; and in 1975, 77 fish entered and 71 left the stream. Spawning migrants entered Spawn Creek when spring freshets from melting snow increased stream flows and turbidity. Tag returns from fishermen indicated adult cutthroat trout traveled to the Logan River after leaving Spawn Creek. In 1974, 229 and in 1975, 359 cutthroat trout fry left Spawn Creek in early fall when dwindling stream flows reduced habitat along stream margins. Migratory patterns of adults and fry show cutthroat trout use Spawn Creek for spawning and the Logan River for growing. Spawn Creek contains extensive spawning habitat with little deep-water habitat while the Logan River is its complement. In 1974 and 1975, respectively, 30 and 13 cutthroat trout (age 1 and older) constituted fall runs into Spawn Creek. Intrastream movements of cutthroat trout within Spawn Creek were extensive, with 35 percent of recaptured fish having moved from where released.

Introduction

Fluvial cutthroat trout (*Salmo clarki*) do not migrate in some watersheds (Diana and Lane, 1978; Miller, 1957) but do in others (Averett and MacPhee, 1972; Bjornn and Mallet, 1964; Kiefling, 1978; Wyatt, 1959). Whether migration occurs largely depends upon the distribution of spawning habitat. For example, in the upper Snake River, high flows and silt limit spawning in the river proper, while tributaries supply suitable spawning habitat (Kiefling, 1978). In contrast, Gorge Creek, Alberta, has ample spawning habitat and no migration (Miller, 1954; 1957).

In those watersheds with migrating fluvial cutthroat trout, the migratory pattern is basically the same. Tributaries are used as spawning and rearing areas, and main-stem rivers for growth and maturation. However, some deviations in the pattern occur from one watershed to another (Averett and MacPhee, 1972; Bjorn and Mallet, 1964; Hayden, 1967; and Wyatt, 1959). The triggering factor for migration differs from area to area. In Lookout Creek, cutthroat trout did not move until water temperatures in tributaries surpassed 5°C (Wyatt, 1959). In the upper Snake River, small trout left tributaries in winter during low air temperatures (Hayden, 1967). In Idaho streams, cutthroat trout migrate with greater frequency during high flows (Gebhards and Fisher, 1972).

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Our study was designed to measure cutthroat trout migration within, into, and out of Spawn Creek, a tributary of the Logan River in northern Utah; to compare these movements with stream flows and water temperatures; and to propose possible causes of migratory behavior.

Study Area

Spawn Creek is a secondary tributary of the Logan River with Temple Fork the connecting stream (Fig. 1). Spawn Creek is primarily spring-fed with runoff adding significantly to flows only during spring snowmelt. The lower 1.8 km of Spawn Creek is a series of riffles and plunge pools caused by riparian shrubs (*Salix* sp.) partially damming the stream; rapids and abandoned beaver ponds dominate the upper 2.9 km of the stream. Rooted vegetation, mostly sedges (*Carex* sp.) and watercress (*Nasturium* sp.), occurs in beaver ponds and alongside riffles. Brook trout (*Salvelinus fontinalis*) inhabit higher elevations in Spawn Creek; brown trout (*Salmo trutta*) occur in lower elevations; cutthroat trout are ubiquitous.

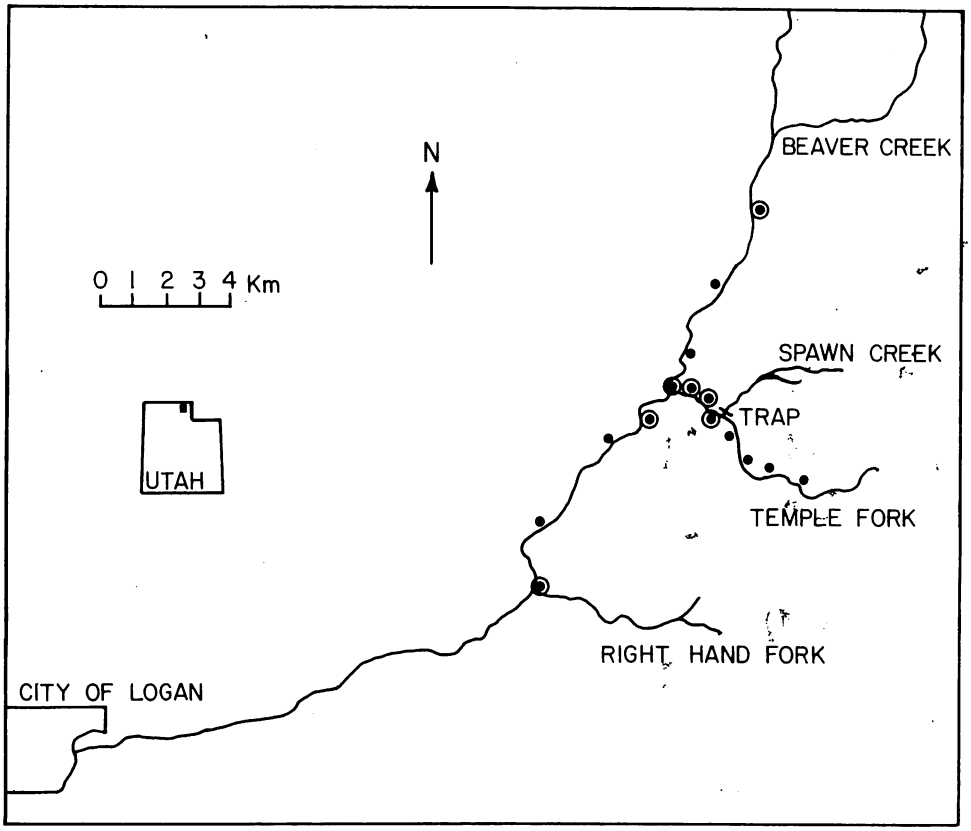

Figure 1. Logan River and major tributaries. Dots represent locations of tag-return boxes; circles denote boxes in which tags were found.

Methods

We constructed a two-way, all-weather fish trap .2 km above the mouth of Spawn Creek (Twedt and Bernard, 1976) and operated it from 21 November 1973 to 20

November 1975. Because the entire stream flowed through the trap, the trap captured all migrants except during 31 days from mid-June through mid-July 1974, when bed-load sediments clogged screens and caused the trap to overflow, and during 10 days in winter when frazil ice caused overflowing. We removed fish from the trap daily to weekly, depending on frequency of fish movements or the need to clean the trap of sediments and leaf litter. All migrant fish were measured, and a scale sample was taken from each fish longer than 10 cm TL. Migrants longer than 20 cm TL were tagged with individually numbered dart tags (Dell, 1968); smaller fish were not marked. We erected 15 boxes at regular intervals along Temple Fork and the Logan River to receive dart tags from fishermen (Fig. 1) and checked boxes monthly during the fishing seasons (June to December).

From July 1973 to November 1975 we electrofished randomly selected 100-m segments of Spawn Creek with a portable 300 watt AC generator converted to variable voltage pulsed DC. In any one sample, we electrofished .5 to 3.0 km of stream. Captured fish longer than 10 cm TL were cold-branded with individually identifiable numbers (Everest and Edmundson, 1967) and returned to the 100-m segment from which we captured them. Trap data taken just after release of fish in stream segments indicated 100 m was sufficient distance for fish to recover from handling and to maintain their position in the stream. Therefore, we considered branded fish to have moved only if they traveled beyond the 100-m segments adjacent to their last segment of release. In late June 1974 we electrofished the lower 4.6 km of Temple Fork for marked fish.

To simplify our analysis, we grouped ages of cutthroat trout captured at the trap and in electrofishing surveys into three categories: adults (age group III and older), juveniles (age group I and II), and young (age group 0). We determined fish age by comparing individual fish lengths to length-frequency of all captured fish and by counting annuli on fish scales.

From 2 October 1973 to 31 May 1975 we continuously measured stream flows and water temperatures 3 m below the fish trap with a trapezoidal cutthroat flume and a 31-day recording thermometer. We calculated mean daily stream flow and mean daily water temperature as the midpoints between daily extremes for each hydrographic factor.

Results

Mean daily stream flow ranged from .14 m^3/sec to .38 m^3/sec in 1974 and from .15 m^3/sec to .45 m^3/sec in 1975 (Fig. 2). Stream flows varied little hourly, except in late April 1974 and mid-May 1975, when freshets of melted snow temporarily increased stream flows and Spawn Creek became atypically turbid. Mean daily water temperatures ranged from 1.1°C to 10.6°C in 1974 and 1.7°C to 9.4°C in 1975 (Fig. 3). Unlike stream flows, mean daily water temperatures varied greatly from day to day and even from hour to hour. Daily extremes 8°C apart were not uncommon during summer. On five winter nights in 1974 and four winter nights in 1975, frazil ice formed in the lower .4 km of Spawn Creek. During late December to early February, anchor and frazil ice occurred almost nightly in Temple Fork below its confluence with Spawn Creek. We saw no anchor or frazil ice on the Logan River below its confluence with Temple Fork.

Most adult cutthroat trout migrated into and out of Spawn Creek during the spawning season from April through July (Fig. 4). In 1974, 31 adults (24 males and 7 females) and 8 juveniles immigrated with highest frequency during the first week in

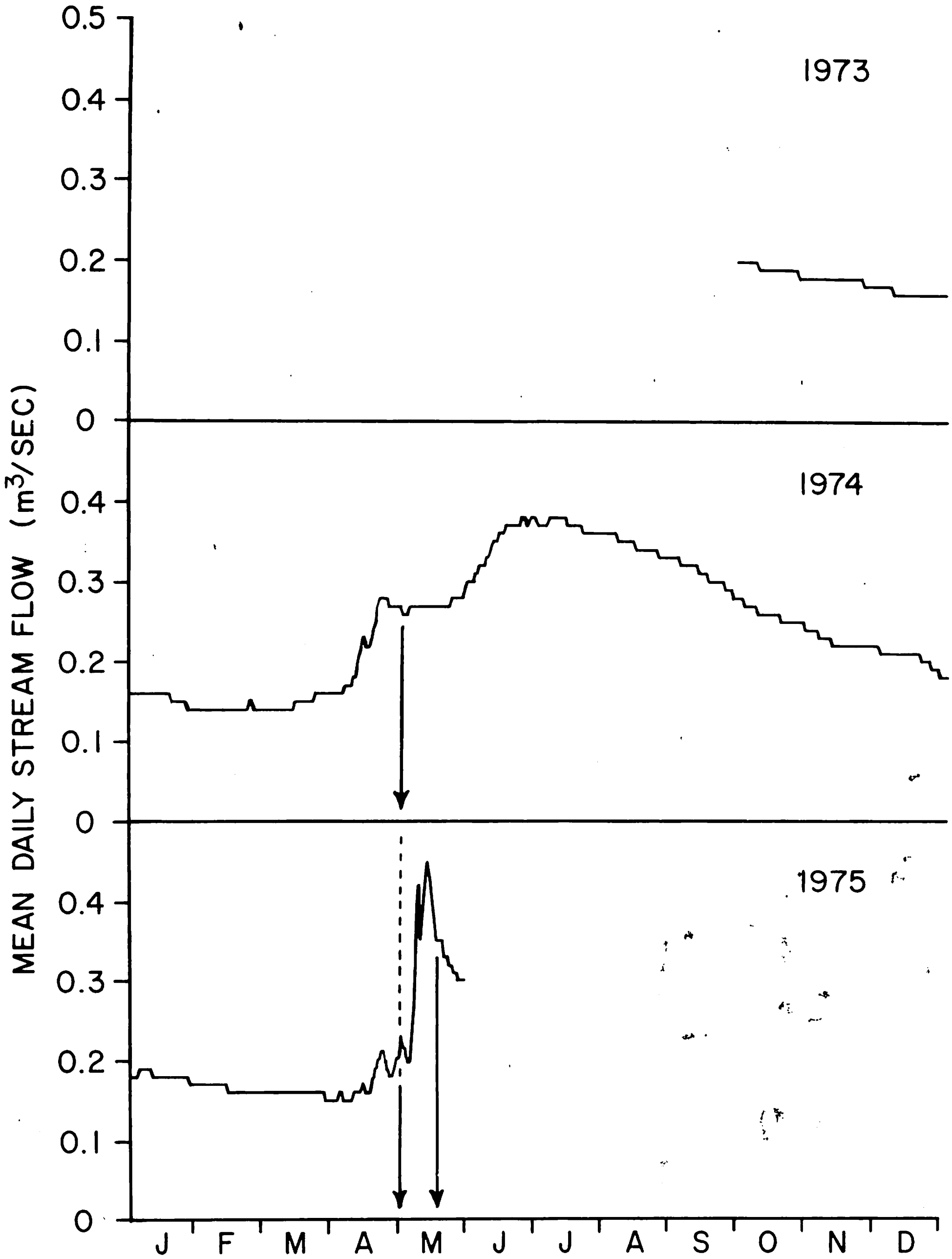

Figure 2. Stream flows measured at the fish trap on Spawn Creek, Utah. Mean daily stream flows are midway between daily extremes, rounded to the nearest .01 m^3/sec. Arrows mark weeks of highest frequency of cutthroat trout migrating into Spawn Creek during the spawning runs in 1974 and 1975.

May, just after freshets of melted snow increased mean daily stream flows (Fig. 2). In the same year, 18 adults (7 males, 6 females, 5 sex unknown) and 5 juveniles left Spawn Creek. In 1975, 50 adult cutthroat trout (26 males, 19 females, 5 sex unknown)

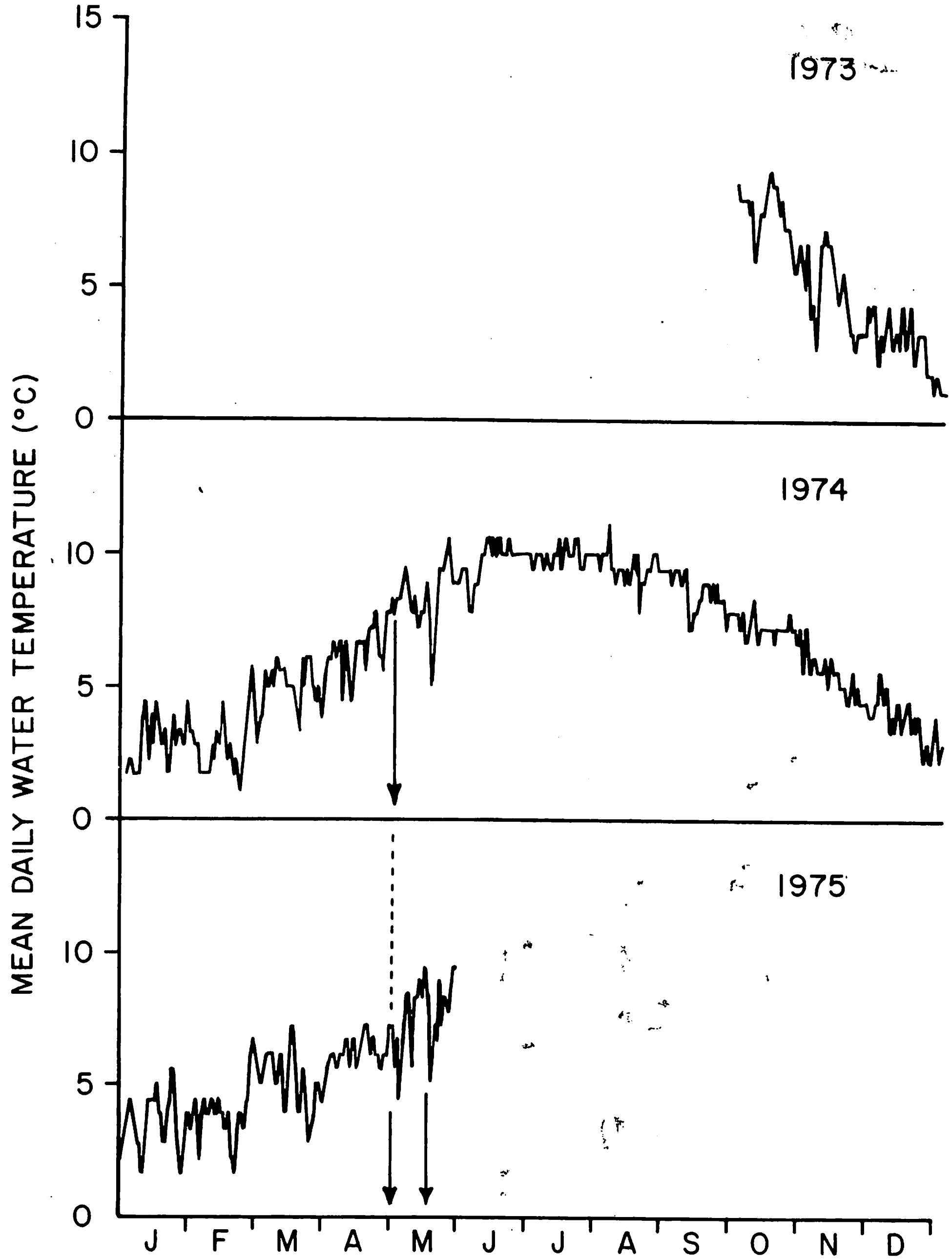

Figure 3. Water temperatures measured at the fish trap on Spawn Creek, Utah. Mean daily water temperatures are midway between daily extremes rounded to the nearest .1°C. Arrows mark weeks of highest frequency of cutthroat trout migrating into Spawn Creek during the spawning runs in 1974 and 1975.

and 27 juveniles entered Spawn Creek with highest frequency during the third week in May, again just after mean daily stream flows peaked (Fig. 2). In the same year, 56 adult cutthroat trout (20 males, 24 females, 12 sex unknown) and 15 juveniles left

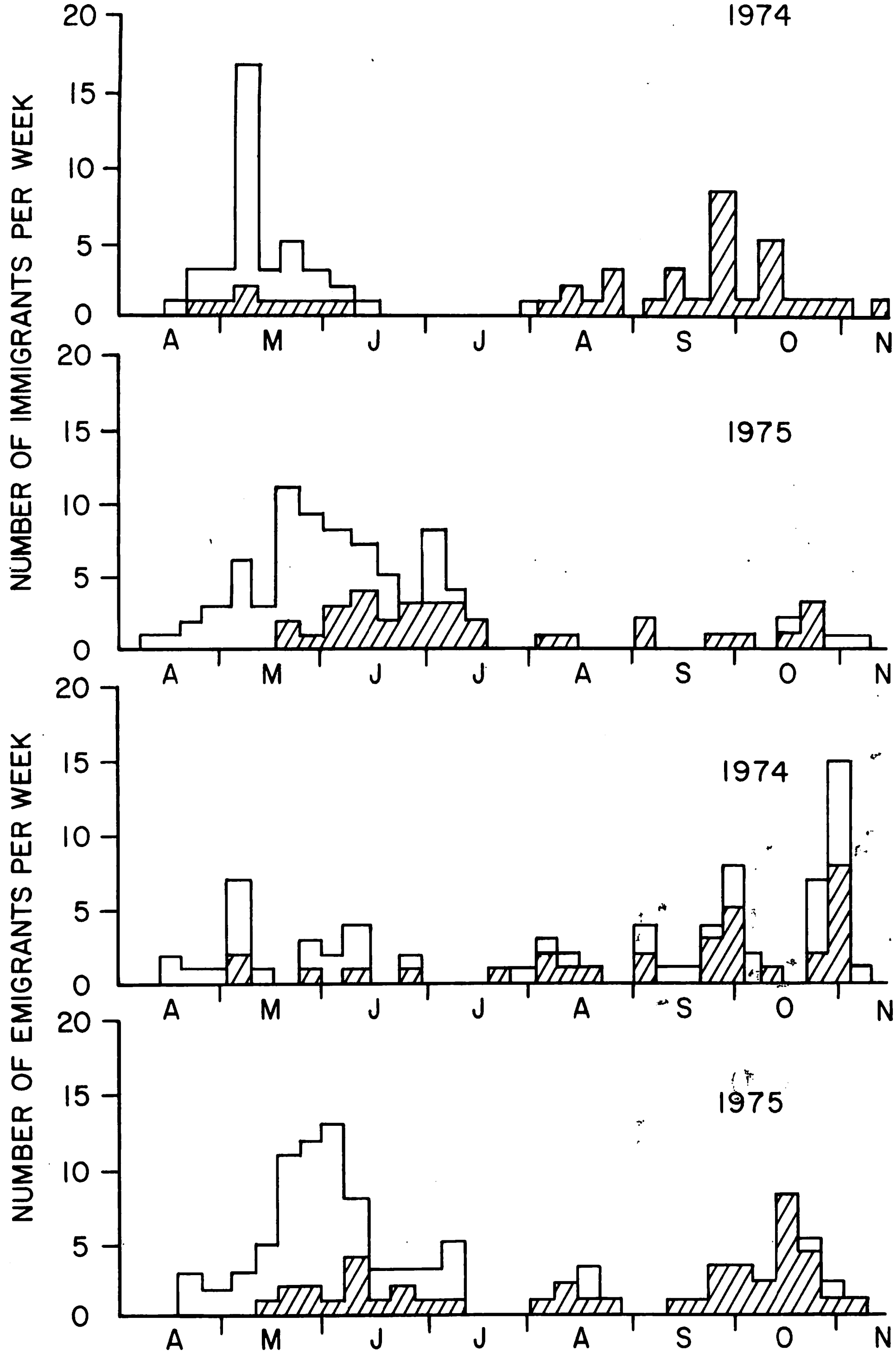

Figure 4. Histograms of upstream (immigrating) and downstream (emigrating) movements of cutthroat trout observed at the fish trap on Spawn Creek. Lined areas correspond to movements of juveniles (age I and II) and clear areas to adults (III and older).

Spawn Creek. In both years, highest frequencies of male cutthroat trout entering and leaving Spawn Creek occurred one week before those for females. In 1974 and 1975, little spawning activity occurred after mid-June.

Many cutthroat trout also migrated into and out of Spawn Creek from August to November. In 1974, 30 juveniles immigrated into Spawn Creek with highest weekly frequency the first week in October (Fig. 4), and in 1975, 10 juvenile and three adult cutthroat trout moved into Spawn Creek. Twenty-five juveniles left the stream in 1974, and 29 in 1975.

From June through December, 229 young in 1974 and 359 young in 1975 left Spawn Creek (Fig. 5). The highest weekly frequency occurred in the last week in September. In winter and spring, fewer young left Spawn Creek as one-year olds (14 in 1974 and 26 in 1975). No young migrated into Spawn Creek.

Of the 226 branded cutthroat trout we recaptured, 35 percent were recovered beyond the 100-m segments adjacent to where they were last released, 19 percent at the trap, and 46 percent in the segment where they were last released (Table 1). Most moving fish were adults (74 percent). Electrofishing gear selects larger fish and cold-brands fade faster on smaller, faster growing fish; these factors kept our probability of recapturing and recognizing branded juveniles lower than adults, thereby inflating the adult fraction of the moving population we observed. Frequencies of upstream and downstream movements were approximately equal for both adults and juveniles. Of those fish traveling both up and downstream during our study, we observed 71 percent traveling upstream after their first release. We recaptured 79 fish moving upstream 49 times (median distance 650 m) and downstream 55 times (median distance 450 m). The longest movements made by fish not captured at the trap were 2.8 km upstream and 2.4 km downstream.

TABLE 1. Number of branded cutthroat trout recaptured by electrofishing in Spawn Creek from August 1974 to November 1975.

Age	Total	Non-migrants	Interstream migrants	Intrastream migrants	No. separate migrations[1] Upstream	Downstream
Adults	125	35	31	59	40	43
Juveniles	101	70	12	19	9	12
Total	226	105	43	78	49	55

[1]A migrant can exhibit more than one migration by switching direction of travel.

Data from tag boxes and on migrants recaptured in Temple Fork indicated adults migrate through Temple Fork to the Logan River. Of 83 cutthroat trout tagged, we recovered 11 tags, eight along Temple Fork below its confluence with Spawn Creek and three along the Logan River (Fig. 1). We recovered no tags from this study in boxes on Temple Fork upstream of its confluence with Spawn Creek. Fishermen did fish upper Temple Fork and did deposit tags; in this area we recovered many tags used to mark rainbow trout (*Salmo gairdneri*) in a previous study on Temple Fork. While electrofishing Temple Fork, we recovered only one tagged migrant 1.0 km below the mouth of Spawn Creek; we tagged the fish seven days earlier at the trap. We captured no branded fish while electrofishing Temple Fork. During our study, 10 "tagged" fish returned to the trap after leaving Spawn Creek; all 10 had lost their tags but retained tagging scars.

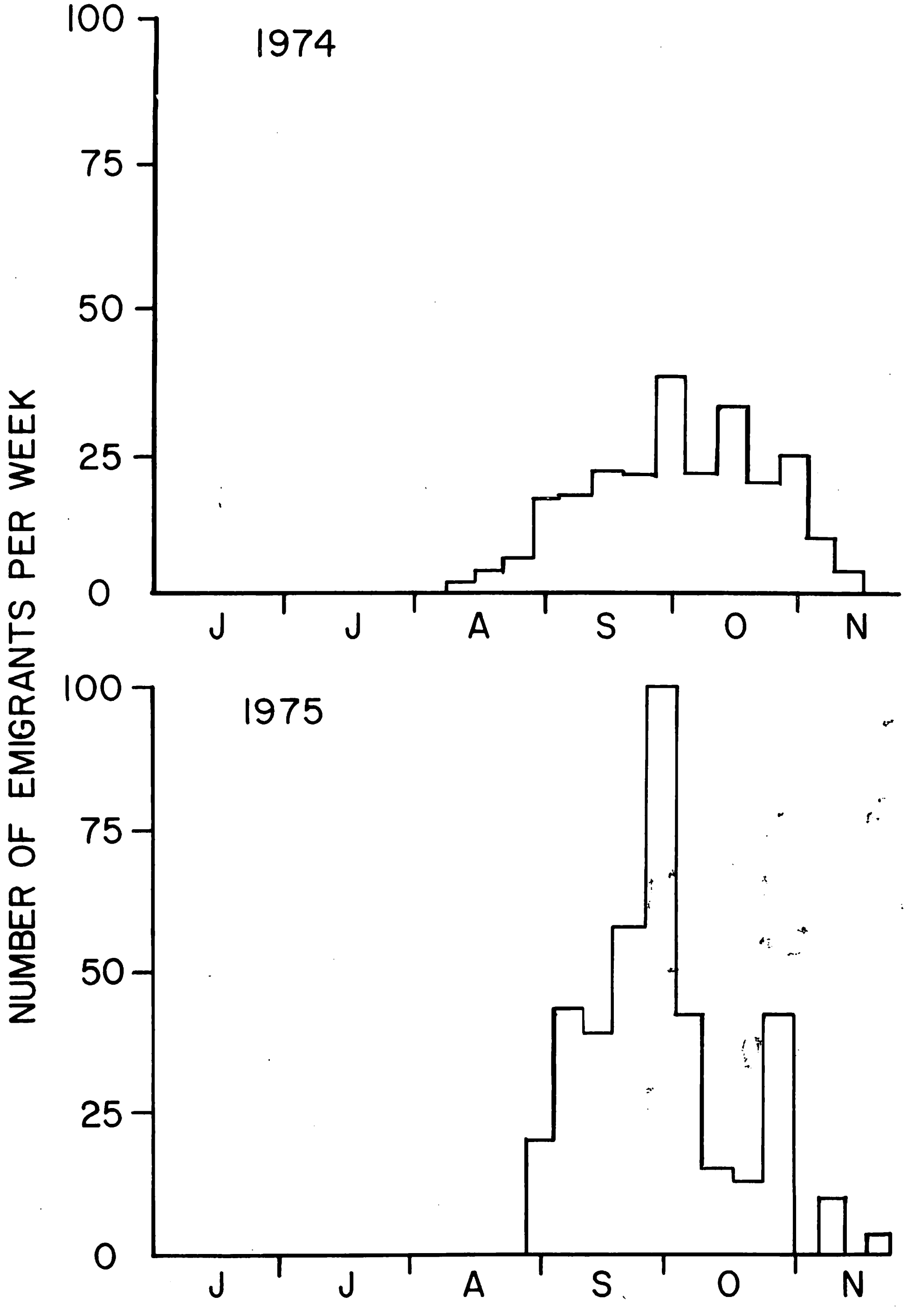

Figure 5. Histograms of downstream (emigrating) movements of young cutthroat trout (age 0) observed at the fish trap on Spawn Creek.

Discussion

Cutthroat trout are not endemic to Spawn Creek or to Temple Fork but migrate between Spawn Creek and the Logan River. Tag returns indicate adults grow and mature in the Logan River, migrate into Spawn Creek, spawn, and return to the Logan River. Most young cutthroat trout remain in Spawn Creek a few months after hatching; then they also migrate to the Logan River. Young cutthroat trout from Spawn Creek probably overwinter in the Logan River. Swift currents and several culverts in Temple Fork make upstream travel by young difficult, and anchor and frazil ice seen in this study and others (Pearson and Kramer, 1972) preclude overwintering by fish in Temple Fork below the mouth of Spawn Creek. Fleener's (1951) observation of numerous small cutthroat trout in the Logan River around the mouth of Temple Fork also supports the hypothesis that the former stream is the terminus for young migrating from Spawn Creek. Cutthroat trout migrate between Spawn Creek and the Logan River because Spawn Creek has gravel for spawning and the Logan River space for growing. In the Salmon River watershed, higher-order streams are deep, wide, and have rubble in their stream channels, while lower order streams are shallow, narrow, and have predominantly gravel as substrates (Platts, 1979); this relationship between stream order and habitat also pertains to the Logan River watershed. Gravels suitably sized for spawning are concentrated in Spawn and Beaver Creeks (Fleener, 1951). Most gravels in lower Spawn Creek are within size ranges (2.0 cm to 7.8 cm) preferred by cutthroat trout in other watersheds (Cope, 1957; Hayden, 1967). While substrates in the Logan River are mostly boulders, this stream contains most of the deep-water, ice-free habitat in the watershed.

In most migratory populations of cutthroat trout, young leave natal streams during their first summer (Benson, 1960; Snyder and Tanner, 1960; Wyatt, 1959). Trap overflow in 1974 did not allow us to determine if young migrated out of Spawn Creek from mid-June through mid-July, but in 1975 no young cutthroat trout left Spawn Creek until early fall, well after emerging from redds, much like young in tributaries of the Snake River (Hayden, 1967). Boussu (1954) and Hayden (1967) reported that young cutthroat trout migrated out of tributaries in winter when streamside vegetation froze, thereby reducing cover. Young cutthroat trout also leave Spawn Creek because of reduced habitat, but do so earlier in the fall. Electrofishing Spawn Creek indicated young reside only in quiet water in streamside vegetation. In early fall, water recedes from streamside aquatic plants, and any resident fish must move into faster water.

In our and other studies, adult and juvenile cutthroat trout migrated into tributaries from main-stem rivers in the fall (Benson, 1960; Bernard, 1976; Hayden, 1967; and Wyatt, 1959). We found no explanation for this migration. The run is not a spawning run; most migrants were immature, and fish migrated well after the spawning season. Many juveniles migrated into Spawn Creek with spawning adults as they do in other watersheds (Hayden, 1967; Wyatt, 1959). If juvenile cutthroat trout migrate with spawning fish, their fall run into Spawn Creek may be caused by spawning brown trout migrating into the stream (Bernard, 1976). However, in other watersheds with known, fall migrating cutthroat trout, no fall spawners are present.

Stream flow, not water temperatures, determines the relative frequency of cutthroat trout spawning migration into Spawn Creek during the spring; fish move with the greatest frequency just after the highest spring flows. Gebhards and Fisher (1972) state similar relationships exist between high flows and migrating cutthroat trout in

Idaho streams. Cope (1956) believes high stream flows and associated turbidity provide cover for migrating adfluvial cutthroat trout in other Utah streams. Because recorded hourly and mean daily water temperatures were so variable, no difference in spring water temperatures between 1974 and 1975 was detectable, but cutthroat trout immigrated into Spawn Creek two weeks earlier in 1974.

Resident cutthroat trout within Spawn Creek behave unlike resident cutthroat trout in watersheds with no migration. Two hypotheses explain why resident cutthroat trout move within Spawn Creek. The first is that migrants displace residents. In pools and adjoining riffles, cutthroat trout establish dominant and subdominant positions based on their size (Griffiths, 1972). Any spawning migrant passing through will disrupt these hierarchies, thereby displacing fish. The second hypothesis is that Spawn Creek contains no resident population. All cutthroat trout leave the stream sooner or later, and fish within the stream at any one time are those that will leave later. In 1975, more adult cutthroat trout left Spawn Creek after spawning than entered the stream before, indicating some "residents" became migratory.

We do not know how important recruitment from Spawn Creek is to the cutthroat trout population in the Logan River watershed, but we do know that migration is of paramount importance to the population dynamics of cutthroat trout in Spawn Creek. If Spawn Creek and other tributaries play similar roles in the Logan River watershed, these tributaries and the quality of their habitat are important to managing this fishery.

Acknowledgments

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