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summer habitat use by juvenile chinook salmon Oncorhynchus tshawytscha and

juvenile steelhead O. mykiss in 1989 in eight reaches along 39 km of Jackson Creek,0b (middl) Tj 0.000 Tc (e) Tj 0.4

BASINWIDE SALMONID DISTRIBUTION 299

FIGURE 1 .—Jackson Creek and the eight stream reach-es investigated in this study.

use was compared, both by stream reach and hab-itat type (riffle, run, glide, and pool), and was re-lated to changing characteristics of the stream.

Study Site

We evaluated stream characteristics and juve-nile salmonid populations in eight contiguous reaches of Jackson Creek, a fifth-order tributary

of the South Umpqua River in southwestern Or-egon during the summer of 1989 (Figure 1). Fol-low-up studies were conducted from 1990-1993. Upland forest vegetation in this 373 km

300 ROPER ET AL.

Juvenile chinook salmon and juvenile steelhead
were the two most common salmonids in Jackson

Creek during the summer of 1989. Follow-up studies, conducted

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TABLE 1 .—Stream reach characteristics and areas and numbers of habitat units available and sampled for juvenile salmonids in eight reaches of Jackson Creek. 1989.

Stream reach
Measurement 1 2 3 4 5 6 7 8
Reach characteristics
Length of reach (m)
Total reach area (m

302 ROPER ET AL.

were used because they appeared more similar to glides due to the lack of turbulence).
All counts offish were conducted from 0930 to
1630 hours on days with less than 50% cloud cov-
er and when underwater visibility was greater than
6 m. Counts were made of both age-0 chinook salmon and juvenile steelhead. Steelhead from age 0 to age 3 were seen, but because it was difficult to age fish precisely underwater only two groups were distinguished, age-0 steelhead and older steelhead. Use by habitat type was estimated for three groups: age-0 chinook salmon, age-0 steel-head, and older steelhead.
Mean fish densities within each reach were de-termined with equations for stratified sampling (Cochran 1953). In addition to determining fish densities (number/m2

), we also calculated the
number of fish found per kilometer of stream by expanding reach-specific densities to estimate the number of fish that were encountered in a kilo-meter of stream in each reach.

To evaluate if fish consistently used all stream reaches, we determined if the proportion of the estimated total number offish, by species and age-group, in each reach was different than the pro-portion of total stream surface area in each reach. Because fish numbers were estimated rather than censused precisely, we deemed it inappropriate to
use a chi-square goodness-of-fitus007 an

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304 ROPER ET AL.

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Riffle Run Glide Pool

FIGURE 4.—Uses of riffles, runs, glides, and pools by age-0 steelhead, older steelhead, and age-0 chinook salmon in the eight reaches of Jackson Creek. Positive values indicate use of a habitat type in a higher proportion than the availability of the habitat, while negative values indicate use below that expected from habitat availability. The distribution offish differed significantly from habitat availability (P < 0.05

BASINW1DE SALMONID DISTRIBUTION 305

ed for only a fourth of the area sampled, whereas in the uppermost reach (8) only 39% of the older-age steelhead were counted in riffles although rif-fles constituted 61% of the area sampled. Chinook salmon, in contrast, selectively utilized pools in all but one reach.

Discussion

Temperature and Habitat Use

The uneven distribution of juvenile chinook salmon and steelhead within the Jackson Creek

basin at summer base flows probably reflected variation of both biotic and abiotic characteristics within the stream (Vannote et al. 1981). One im-portant abiotic characteristic of Jackson Creek was water temperature. In Jackson Creek, tempera-tures went from the range preferred by salmonids (10-14°C; Bjornn and Reiser 1991) in the up-stream reaches to near lethal temperatures (23-25°C; Bjornn and Reiser 1991) in the lowest reach. Although the actual effects high water temper-atures in the lower reaches of Jackson Creek had on salmonids are not known, it is known from other studies that high water temperature influ-ences the distribution and abundance of salmo-nids (Bisson and Davis 1976; Reeves et al. 1987). The high water temperatures in the lower reaches of Jackson Creek likely caused greater proportions of the juvenile chinook salmon and older-age steelhead to emigrate from these reaches in the spring (Holtby 1988) and decreased survival rates for these species in these reaches (Bisson and Da-vis 1976). Both factors would have led to the ob-served higher summer densities of salmonids in the cooler upstream reaches of Jackson Creek.

Density versus Number per Kilometer

Along with fish density, the number of fish per linear kilometer of stream may also be a mean-ingful indicator of the number of juvenile salmo-nids within a stream. Under some circumstances, as found for age-0 steelhead in this study, lower stream reaches that have lower densities of fish may, nevertheless, have more fish per kilometer than upper basin stream reaches that have higher fish densities. This observation underscores the importance of considering total numbers of fish and total habitat, not just densities, in quantita-tively assessing the importance of habitat (Platts 1979).

Species-Specific Habitat Use
Chinook salmon and steelhead differed mark-edly in their use of the four habitat types. Juvenile

steelhead, especially age-0 fish, commonly used all habitat types surveyed in all stream reaches, whereas juvenile chinook salmon were heavily concentrated in pool habitat. These findings ap-pear to contradict those of Everest and Chapman (1972), who reported broad overlap in habitat use between these two species and concluded that ap-parent differences in habitat use were primarily a result of the different spawning seasons of these two fishes. In their opinion, if steelhead and chi-
nook salmon had been the same size at the same
time (which they were not), juveniles of these two
species would have occupied the same habitat.
The differences between our results and conclu-
sions and those of Everest and Chapman (1972)
may be explained 0 Tc (d53 Tf 0 7s54 87.8Tj 0.868 Tw 95.224 T

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306 ROPER ET AL.

a specific range is an important habitat require-ment (rather than simply the "pool" or "riffle"
per se), the actual choice of pool or riffle habitat
may vary with changes in depth, substrate, or ve-locity (Everest and Chapman 1972). It may thus
be a physical characteristic not unique to a pool or riffle that dictates habitat suitability, and shifts between

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