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Distribution of Juvenile Bull Trout in a Thermal Gradient of a Plunge Pool in Granite Creek, Idaho

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Abstract.—The distribution of juvenile bull trout *Salvelinus confluentus* was observed on three nights (0000–0200 hours) during July 24–28, 1992, in a large plunge pool in Granite Creek, a direct tributary to Lake Pend Oreille in northern Idaho. The pool contained a strong side-to-side thermal gradient (8–15°C) created by the confluence of Granite Creek (water temperature 15°C) with Sullivan Springs, a much colder (8°C) stream of comparable discharge. Juvenile bull trout chose the coldest water available (8–9°C). Distribution of bull trout within the plunge pool could not be attributed to differences in water depth, substrate, velocity, overhanging cover, or interactions with other fish.

Although the bull trout *Salvelinus confluentus* is native to most major river systems of the Pacific Northwest, the western and southern boundaries of its distribution have contracted significantly in this century (Goetz 1989). Several researchers (e.g., Pratt 1984; Fraley and Shepard 1989; Goetz 1991; Ratliff 1992; Donald and Alger 1993) have suggested warm water temperatures restrict the distribution of bull trout. Conversely, bull trout and other char (*Salvelinus* spp.) often thrive in water too cold for other salmonid species (Balon 1980). A better understanding is needed of the effect of water temperature on distribution of bull trout. This note reports results of observations on the temperature preference of juvenile bull trout in a large plunge pool with a side-to-side temperature gradient.

Study Area

Granite Creek, located in Bonner County in northern Idaho, is a third-order tributary draining directly into the east shore of Lake Pend Oreille. Sullivan Springs, a first-order stream, empties into Granite Creek about 1 km upstream from where Granite Creek enters the lake. Discharges of the two streams at their confluence are similar to each other in late summer.

Thermal characteristics of the two streams differ greatly at their confluence. During July 24–28, 1992, the water temperature of Sullivan Springs just upstream from the confluence was 8°C both day and night; Granite Creek just upstream from the confluence averaged 21°C during the day (1200–1500 hours) and 15°C at night (0000–0200 hours).

The confluence of the two streams occurred at the head of a large plunge pool. The different thermal character of the two merging streams resulted in the creation of a sharp side-to-side temperature gradient across the plunge pool (Figure 1). In July 1992, juvenile bull trout and cutthroat trout *Oncorhynchus clarki* (probably hybridized with rainbow trout *O. mykiss*) were the only fish (other than young of the year) in the pool.

Methods

Fish in the pool were observed and counted by snorkeling the pool on three nights (0000–0200 hours) over the period of July 24–28, 1992. Locations of all observed salmonids (except young of the year) were marked with pieces of weighted flagging. With the aid of an underwater flashlight, a snorkeler was able to move slowly upstream and mark the locations of individual fish without disturbing other fish.

Immediately after snorkeling, the pool's temperature gradient was mapped by using a grid system of 30-cm^2 squares. Two ropes, marked at 30-cm intervals, were stretched across the pool perpendicular to the stream. One rope was stretched across the head end of the pool and the other across the tail end. A third rope was moved perpendicular to these ropes and tied off at 30-cm intervals. Temperatures were measured with a handheld thermometer at each intersection of the ropes. Isotherms were later drawn based on temperatures on the grid. Because the bull trout were resting on the substrate at night, water temperatures were measured near the substrate. No measurable night-to-night differences in water temperatures occurred at the time of sampling during this 5-day period.

Water depth was measured and substrate was characterized at each intersection of the grid during the first mapping only. Substrate type was classified visually, according to a modified Wentworth scale, as fines, which included silt and sand (particle diameters <2.0 mm); gravels, which included

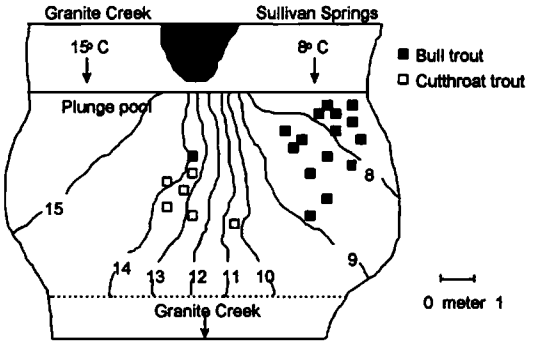

FIGURE 1.—Temperature profile and fish locations for the large plunge pool at the confluence of Granite Creek and Sullivan Springs. Fish locations are a composite of three nights' data.

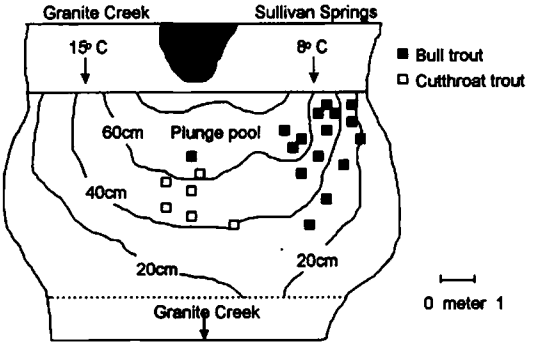

FIGURE 2.—Water depth profile and fish locations (composite of three nights' data) for the large plunge pool at the confluence of Granite Creek and Sullivan Springs.

all sizes of gravels (diameters 2.0–64.0 mm); or coarse sediments, which included cobbles and boulders (diameters >64.0 mm).

Results

Sixteen observations were made of bull trout, 5 each on the first and third nights, 6 on the second night. For 15 of the 16 observations, bull trout were located in the coldest water available (8–9°C), even though this temperature category constituted only 24% of the pool area (Figure 1; Table 1). The distribution of bull trout was not closely associated with a particular water depth or substrate composition (Figures 2, 3).

Only two individual cutthroat trout were observed in the pool each night. Both of these fish were always located in the warmer water (10–14°C).

TABLE 1.—Percent of bull trout observed on each sampling night and overall and percent of total habitat area available in each category of habitat variable.

Habitat variable	% of bull trout observed				% of total habitat area
	Night 1 (N = 5)	Night 2 (N = 6)	Night 3 (N = 5)	Overall (N = 16)	
Temperature					
8–9°C	100	83	100	94	24
9.1–15°C	0	17	0	6	76
Substrate					
Fines	0	0	0	0	6
Gravels	60	50	60	56	68
Coarse sediments	40	50	40	44	26
Depth					
>60 cm	20	50	0	25	17
20–59 cm	80	50	100	75	46
<20 cm	0	0	0	0	37

Discussion

In this single but unique pool, when given a choice of temperatures from 8°C to 15°C, juvenile bull trout located in the coldest (8–9°C) water. Cumulative circumstantial evidence from several sources (Pratt 1984; Fraley and Shepard 1989; Goetz 1991; Ratliff 1992; Donald and Alger 1993) suggests that temperatures above 15°C limit bull trout distributions. Little is known, however, about the optimal temperature range for bull trout, and nothing is known about major interstock differences in temperature preference. Beamish (1980) reported that swimming performance and oxygen uptake decreased for char as temperatures exceeded 15°C. Even though the highest water temperatures we observed in the plunge pool were 15°C or less, juvenile bull trout still showed a clear preference for the coldest water available.

Although our observations were made in a sin-

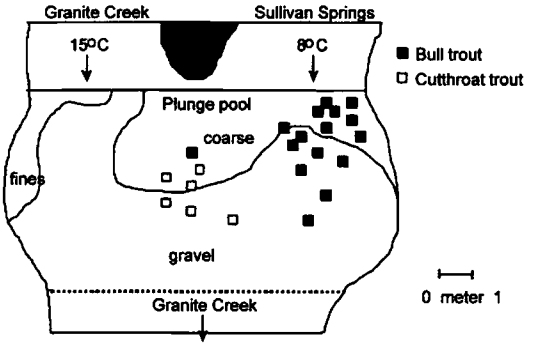

FIGURE 3.—Substrate composition and fish locations (composite of three nights' data) for the large plunge pool at the confluence of Granite Creek and Sullivan Springs.

gle pool, the pool's characteristics allowed us to attribute, with high probability, the nighttime distribution of bull trout to temperature differences, rather than to other physical characteristics. Bull trout distribution in the pool did not seem restricted to any particular depth or substrate (Figures 2, 3) and also seemed unrelated to water velocity. Although juvenile bull trout in Granite Creek have been shown to prefer low- or zero-velocity water at night (Bonneau 1994), the lowest-velocity water in the plunge pool, as indicated by the presence of silt, was on the warmer side where no bull trout were found. The effects of shading and overhead cover were also ruled out because they were believed to exert minimal influence at night. Although dissolved oxygen was not measured in Granite Creek or Sullivan Springs, it was probably at saturation levels suitable for salmonids in both of these high-gradient (2–6%) streams. Similarly, water clarity was very high for both streams.

The distribution of juvenile bull trout was also not attributable to competitive exclusion from their preferred habitat. The only other fish (other than young of the year) present in the pool were juvenile cutthroat trout, which occupied warmer water (10–14°C). These fish were small enough (<120 mm total length) to be eaten by the bull trout (180–320 mm total length), so it is unlikely that they were excluding the bull trout from the warmer water. The possibility that bull trout excluded the cutthroat trout from the colder water cannot, however, be dismissed. Young-of-the-year salmonids were present throughout the pool but appeared to be most abundant in the lower water velocities on the warm side of the pool.

The observations documented here apply strictly to night, when bull trout in Granite Creek were up out of the substrate, resting on the stream bottom, and much more readily visible than during the day (Bonneau 1994). During the day, it was frequently necessary to manually overturn individual pieces of substrate to find bull trout. Under these conditions, unbiased, representative observations during the day were not possible.

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