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The Effect of Sculpin Presence on Benthic Macroinvertebrate Abundances in Chuckanut Creek, Washington

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Abstract

Sculpins are one of the most abundant fishes in Pacific coastal streams and lakes, but they remain understudied despite potentially significant impacts to stream ecology. The poor swimming ability of sculpins limits their range by inhibiting passage of barriers passable to other fishes. Sculpins are voracious eaters and feed primarily on stream invertebrates. By sampling invertebrates in reaches of stream above and below a sculpin barrier, this study examined the impact sculpin presence had on the stream invertebrate community. Invertebrates were sampled in riffles using a Serber sampler (n = 4). The results showed that the presences of sculpins had a significant impact on the abundances of stream macroinvertebrates. Abundances of Ephemeroptera were dramatically lower in the presence of sculpins. This study warrants further research of greater scope and depth to more accurately determine the effect of sculpins on stream ecosystems.

Introduction

Sculpins (*Cottus* spp.) are among the most abundant fishes in Pacific coast streams (Brown et al. 1995). They inhabit coastal streams and lakes from California to Alaska (Wydoski and Whitney 2003). Despite their abundance, some aspects of the ecology of sculpins are not well understood (Brown et al. 1995). Of no uncertainty is their voracious predation on benthic invertebrates (Moyle 1977). Sculpin are opportunistic feeders and will gorge themselves on salmon eggs when available (Moyle

1977). They will also eat crustaceans, mollusks, and small fish (Wydoski and Whitney 2003) but rely on benthic invertebrates most of the year (Moyle 1977). Unlike salmonids which feed on invertebrates primarily out of the drift, sculpins feed off the bottom (Moyle 1977). In addition, sculpins do not rely on light for feeding and will feed throughout a 24 hour period (Broadway and Moyle 1978).

Chuckanut Creek, Whatcom County, Washington, has some of the least disturbed stream corridor habitat in the Bellingham city limits (COB 1995). Within the city limits, Chuckanut Creek is free of barriers to salmon (COB 1995) and supports populations of Coho salmon (*Oncorhynchus kisutch*) and chum salmon (*O. keta*), steelhead (*O. kisutch*), and cutthroat trout (*O. clarki)* (COB 1995). A fish ladder associated with the culvert under Chuckanut Drive is a passage barrier to prickly sculpin (*Cottus asper*) and coastrange sculpin (*C. aleuticus*) (LeMoine 2007). Electrofishing above and below this fish ladder revealed sculpins were present in the stream below the fish ladder and absent above the fish ladder (LeMoine 2007).

The purpose of this paper is to examine the impact of the predation of sculpins on the community of invertebrates found in Chuckanut Creek. The abundances of invertebrate taxa were examined above and below the sculpin barrier to determine what effect sculpin had on the invertebrate community.

Materials and Methods

This project was completed between late winter and spring of 2007. Sampling took place between the hours of 10 am and 2 pm on April 26 in Chuckanut Creek, Bellingham, WA within 100 m either side of the culvert under Chuckanut Drive. The weather was cool and overcast. Chuckanut Creek is a 3rd order stream draining approximately 1956 hecatares of land (COB 1995).

Choosing sample sites

Sites for sampling invertebrates were chosen based on minimum distance from the sculpin barrier and similarity of habitat characteristics. Four sites were chosen above the sculpin barrier, and four sites below. Sites were picked in riffles with a water depth between 8 and 25 cm with similar rates of flow. Common range of substrate size was between 2 and 20 cm in diameter. Vegetation was similar in both locations, dominated by red alder (*Alnus rubra*), western red cedar (*Thuja plicata*), salmonberry (*Rubus spectabilis*), and pig-a-back (*Tolmiea menziesii*).

Sampling procedure

Sampling procedure was a slightly modified version of the method outlined by Plotnikoff and Wiseman (2001). Stream invertebrates were sampled using a Serber sampler with a 0.1 m^2 frame. To sample, large rocks were scrubbed clean in the water in front of the net. Then, the rest of the substrate was systematically agitated for two minutes to a depth of 20 cm using a small gardening spade. The contents of the net were transferred to a sorting tray before being placed in Nalgen jars with 70 percent ethanol.

Laboratory procedure

At the lab, invertebrate samples were dumped into a sampling tray. Invertebrates were picked out of the tray and identified to order level under a dissecting microscope.

Testing

The effect of sculpin presence on benthic macroinvertebrate abundances was tested using a two-sample t-test where $\alpha = 0.05$.

Results

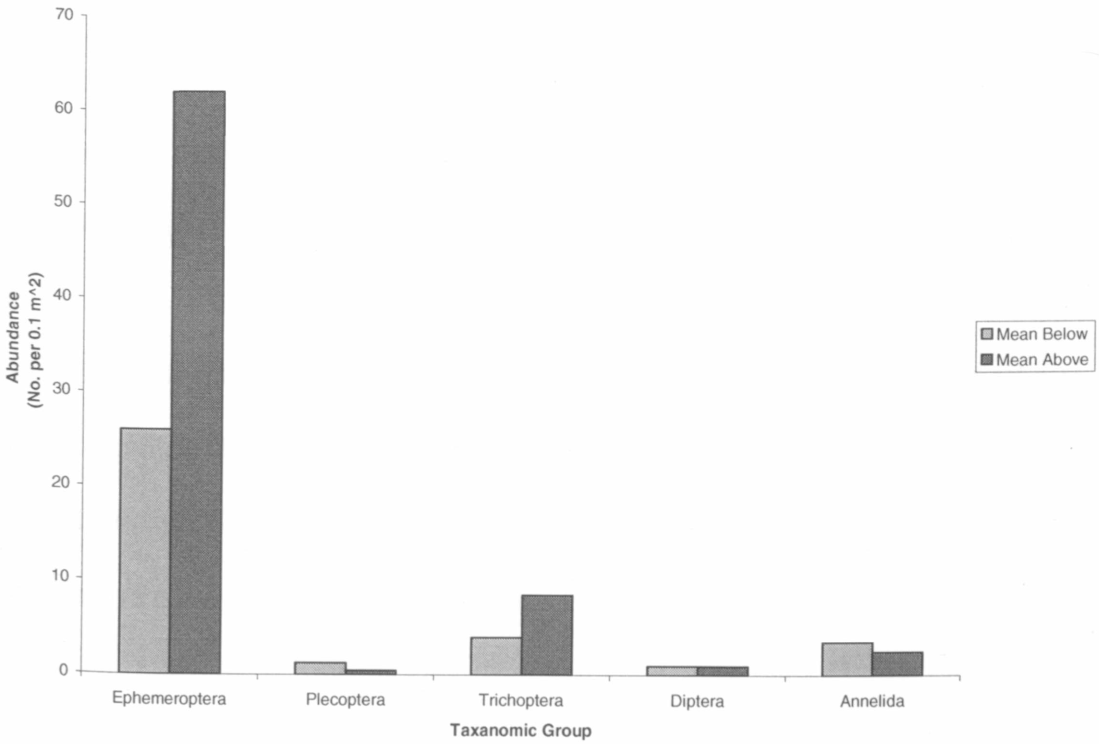

Figure 1 Average number of macroinvertebrates found per taxon in samples above and below a sculpin barrier (n=4)

Ephemeroptera were the most abundant taxon overall (Figure 1). The results demonstrated there was a significant difference (P = 0.037) between the abundance of Ephemeroptera depending on the presence or absence of sculpin (Table 1). Below the sculpin barrier, there was a mean value of 26 individuals per 0.1 m^2 (Figure 1) with a range of values from 16 to 40 (Table 1). Above the sculpin barrier there was a mean value of 62 individuals per 0.1 m^2 with a range of values from 40 to 97 (Table 1).

Only a small number of Plecoptera were caught (Figure 1). There was no significant difference ($P = 0.39$) between samples above and below the sculpin barrier (Table 1).

Trichoptera were the second most abundant taxon (Figure 1). There was no significant difference ($P = 0.055$) between samples above and below the sculpin barrier, however, the P-value is very close to $\alpha = 0.05$. The mean value above the sculpin barrier was over twice that of the mean value below the sculpin barrier at 8.5 individuals per 0.1 m^2 and 4 individuals per 0.1 m^2, respectively (Figure 1). The values range from 1 to 7 individuals below the sculpin barrier, and 5 to 12 individuals above the sculpin barrier.

Only a few Diptera were caught (Figure 1) with no significant difference ($P = 1$) between samples above and below the sculpin barrier (Table 1).

There was no significant difference ($P = 0.55$) between the samples of Annelid worms above and below the sculpin barrier.

Table 1 Absolute number of macroinvertebrates found per taxon in samples above (A) and below (B) a sculpin barrier. P-value are the results of a two-sample t-test examining the null hypothesis that the values above and below the sculpin barrier are the same.

Site	Ephemeroptera	Plecoptera	Trichoptera	Diptera	Annelida
B4	16	0	1	0	7
B3	40	0	7	0	4
B2	28	2	4	0	0
B1	20	3	4	4	3
A4	40	1	5	0	2
A3	50	1	9	0	1
A2	97	0	12	1	3
A1	61	0	8	3	4
P-value	0.037	0.39	0.055	1	0.55

Discussion

This study indicates that the presence of sculpins significantly impacts the ecology of a small lowland stream. The presence of sculpins severely limited the abundance of Ephemeroptera in riffles. In addition, the abundance of Trichoptera appears to be limited by sculpin presence.

However, there may be other reasons for these variations in invertebrate abundances. One of the limitations of this study was limited time and resources. Sample sizes were very small; larger sample sizes could reveal more significant results. Also, assessment of the study site habitat was not very thorough. Other factors such as hyporheic upwelling or downwelling, water velocity, riparian interactions, water chemistry, and substrate characteristics might be playing a role. In addition, this study represented the first time this author used a Serber sampler and sampling technique may have improved over the course of the sampling day. But, evidence indicates that sculpins are playing a significant role in shaping the invertebrate community in the stream and future. More in depth research is warranted.

Acknowledgements

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