# Stonefly Assemblages versus Trout in Low-Order Creeks Along the Northern Wasatch Front

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## Introduction

The traditional view on species interactions in lotic environments has been that abiotic factors are so strong due to the dynamic nature of creeks that biotic factors are of little significance (Giller & Malmqvist 1998). However, there has been a surge in contemporary studies on species interactions that support predation and competition in shaping lotic communities. The Biotic-Abiotic Constraining Hypothesis states biotic interactions can even be dominant (Quist & Hubert 2005). For example, Wittwer et al (2010) found that fish predation shapes sympatric larval-odonate communities.

The presence of trout may affect the abundance of native aquatic invertebrates. Previous studies have shown that trout can affect the abundance of certain aquatic invertebrate species through predation or predation threat (Herbst et al. 2009) or competition (Harvey 1992). Trout tend to prefer larger invertebrates (Nakano et al. 1999). Hence, selective predation on larger invertebrate predators can create a trophic cascade (Soluk & Richardson 1997).

Our objective was a descriptive study of biotic interrelations among stoneflies and trout. Specifically, we expected trout presence to limit abundance of *Hesperoperla* stoneflies (Harvey 1992). Moreover, we believed these effects could influence abundance of smaller stoneflies.

## Methods

We compared four reaches from first and second-order creeks along the northern Wasatch Front, Utah. Strongs Creek was divided into upper troutless and lower trout reaches by a waterfall. Davis Creek was a troutless tributary to Steed Creek, which contained trout. We used backpack electrofishing to confirm the presence or absence of trout (rainbow trout *Oncorhynchus mykiss* in Strongs Creek, Bonneville cutthroat trout *Oncorhynchus clarkii utah* in Steed Creek). In each creek we sampled pool by pool, defining pools based on presence of a distinct entry plunge with a scour depression, some gravel substrate present, minimum longitudinal length of 1 m, minimum depth of 0.1 m, and minimum width ≥ 75% of wetted width. We counted all pieces of submerged wood, measured pool temperature, and conducted a pebble count (10 per pool). Pool volume was: $m^3$ = maximum depth x length x wetted width.

We used a mini-Surber sampler to collect Plecoptera from three gravel sites per pool and if present, from three boulders, one piece of submerged wood, and one leaf-pack. Specimens were preserved in 70% ethanol. We keyed each Plecoptera to genus (Merritt & Cummins 1996).

We used a *t*-test to compare mean perlid and chloroperlid abundance between paired reaches (Strongs upper/lower and Davis/Steed). We also used a *t*-test to compare habitat conditions: submerged wood counts, substrate size (cm), pool volume, and temperature (C).

## Results

We sampled upper and lower Strongs Creek (10 and 13 pools, respectively) and Davis and Steed creeks (16 and 12 pools respectively) between 18 and 27 June 2018. We collected one genus of Chloroperlidae and three of Perlidae (Table 1). As expected, mean abundance of perlids was significantly higher in reaches without trout (Figure 1, Table 2). In contrast, chloroperlid abundance was lower (Figure 2), but not at a significant level (Table 2). Habitat measures were generally similar between paired reaches (Table 2) with the exceptions that mean substrate size was larger in upper Strongs Creek than lower Strongs Creek and pool volume was less in Davis than in Steed creek.

**Table 1. Plecoptera Collected**

| | Strongs Upper | Strongs Lower | Davis | Steed |
|---|---|---|---|---|
| **Pools Sampled** | 10 pools | 13 pools | 16 pools | 12 pools |
| **Chloroperlidae** | | | | |
| *Sweltsa* | 3 | 11 | 47 | 73 |
| **Perlidae** | | | | |
| *Neoperla* | 2 | 0 | 0 | 0 |
| *Eccoptura* | 1 | 0 | 0 | 0 |
| *Hesperoperla* | 14 | 5 | 44 | 0 |

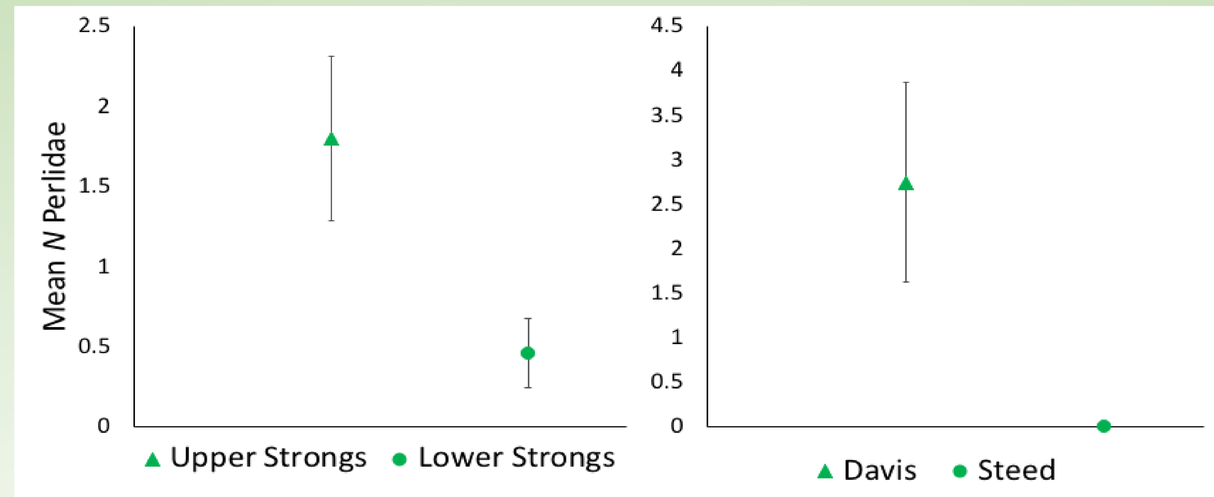


Figure 1. Mean (± SE) perlid abundance of: upper (troutless) versus lower (with trout) Strongs Creek (left), Davis Creek (troutless) versus Steed Creek with trout (zero collected)(right). Both comparisons are statistically different (Table 2).

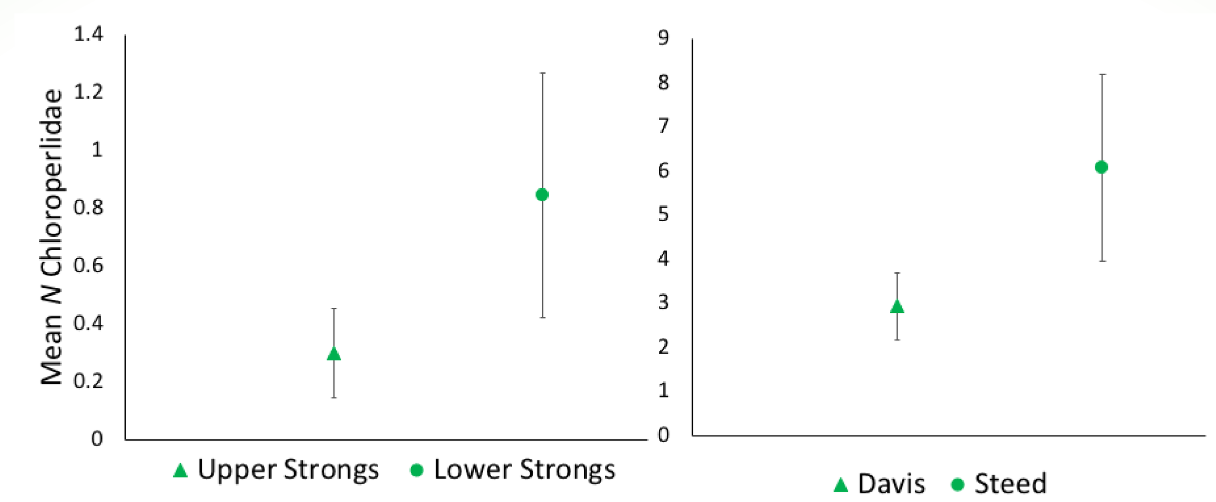


Figure 2. Mean (± SE) chloroperlid abundance of: upper (troutless) versus lower (with trout) Strongs Creek (left), Davis Creek (troutless) versus Steed Creek with trout (right). Neither comparison was statistically different (Table 2).

**Table 2. *T*-test comparisons**

| | No Trout | Trout | DF | T-value | P-value |
|---|---|---|---|---|---|
| **Perlidae** | | | | | |
| Strongs | 1.80 ± 0.51 SE | 0.46 ± 0.22 SE | 21 | 2.6262 | 0.0158 |
| Davis-Steed | 2.75 ± 1.12 SE | 0.00 ± 0.00 SE | 26 | 2.1235 | 0.0434 |
| **Chloroperlidae** | | | | | |
| Strongs | 0.30 ± 0.15 SE | 0.85 ± 0.42 SE | 21 | 1.0901 | 0.288 |
| Davis-Steed | 2.94 ± 0.77 SE | 6.08 ± 2.12 SE | 26 | 1.5506 | 0.1331 |
| **Substrate Size** | | | | | |
| Strongs | 45.39 ± 3.13 SE | 33.86 ± 2.53 SE | 228 | 2.8951 | 0.0024 |
| Davis-Steed | 40.08 ± 2.42 SE | 43.56 ± 2.98 SE | 278 | 0.9164 | 0.3602 |
| **Submerged Wood** | | | | | |
| Strongs | 2.00 ± 0.54 SE | 2.38 ± 0.67 SE | 21 | 0.4288 | 0.6724 |
| Davis-Steed | 1.13 ± 0.37 SE | 1.00 ± 0.00 SE | 26 | 0.2883 | 0.7754 |
| **Pool Volume** | | | | | |
| Strongs | 0.77 ± 0.16 SE | 0.86 ± 0.09 SE | 21 | 0.5017 | 0.6711 |
| Davis-Steed | 0.61 ± 0.08 SE | 1.33 ± 0.21 SE | 26 | 3.4931 | 0.0017 |
| **Water Temp** | | | | | |
| Strongs | 11.10 ± 0.28 SE | 11.07 ± 0.08 SE | 21 | 0.0899 | 0.9292 |
| Davis-Steed | 12.75 ± 0.23 SE | 13.16 ± 0.21 SE | 26 | 1.2671 | 0.2164 |

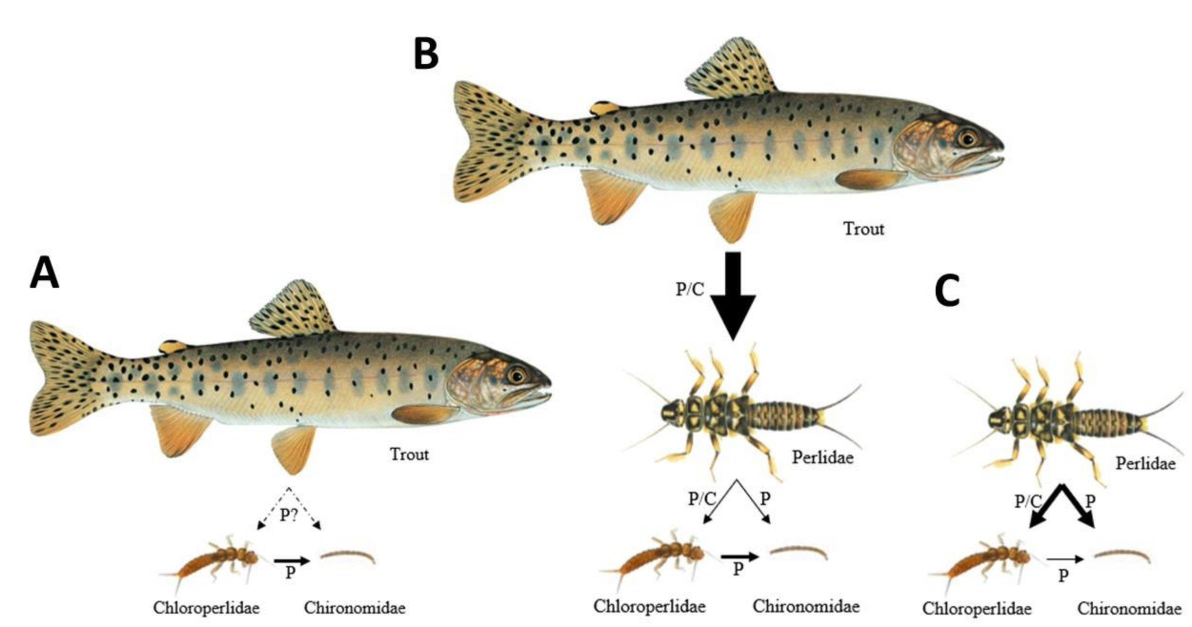


Figure 3. Diagram of proposed predation (P) and competition (C) pressures among trout, perlids, and chloroperlids. Arrow thickness indicates hypothesized strength of biotic interactions. A) in Steed Creek, perlid absence, perhaps due to trout presence, favored chloroperlid abundance. B) in theory, trout presence in lower Strongs Creek suppressed perlids, also allowing for more chloroperlids. C) in Davis and upper Strongs creeks, with the absence of trout, perlid abundance was high and chloroperlid abundance was low.

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## Discussion

Trout appeared to negatively impact large-bodied predatory perlids, consistent with Harvey (1992). In upper Strongs Creek, larger substrate may have also been favorable (Harvey 1992). Perlids are opportunistic, consuming chironomids, trichopterans, and ephemeropterans (Johnson 1981), selecting prey size in relation to their own size (Allan 1982). Trout are also opportunistic feeders (Tippets & Moyle 1978). Thus, trout and perlids may compete for prey (Harvey 1992). Because trout prefer large invertebrates as food (Nakano et al. 1999), they may also prey on perlids. Although we cannot distinguish effects of predation and competition in this study, we suspect both contribute.

Trout can affect invertebrates by changing behaviors, feeding rates, and growth rates. In aquaria with trout, stoneflies either became prey, emigrated, or altered their behavior, selecting darker substrate to avoid predation, causing them to consume fewer prey (Feltman & Williams 1989). Wiseman et al (1993) found that the presence of trout caused large invertebrates to become restricted to shallow refuges. In this study, even though Steed Creek had larger pools than Davis Creek, perlids were absent, suggesting such refuges were lacking.

There appeared to be a positive, indirect impact of trout on chloroperlids. Although chloroperlid abundance was statistically similar between troutless and trout-bearing creeks, indirect interactions could explain their positive relationship, which could reflect release from competition/predation pressure by decreased perlid abundance in the presence of trout. For example, chironomids are prey for chloroperlids (Stewart & Anderson 2009) and for perlids (Tippets & Moyle 1978). Although we have not found a study stating direct predation or competition with chloroperlids by perlids, we hypothesize some may occur.

We infer that in the presence of trout, stonefly assemblages may experience a trophic cascade/mesopredator release (Figure 3) accounting for increased chloroperlid abundance with lower perlid abundance. Due to chloroperlid's small size (Figure 4), we believe they are unlikely to compete with trout or be a favored prey item. Further studies comparing diets among trout and stoneflies are needed to solidify this hypothesis.


Figure 4. Representatives size for Perlidae (*Hesperoperla*, left) and Chloroperlidae (*Sweltsa*, right) in this study.

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