Rainbow versus Cutthroat Trout effects on Predatory Invertebrate Assemblages

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Introduction

Aquatic and terrestrial ecosystems are linked by input and output subsides (Bartels *et al*. 2012). Non-native trout can occur at higher densities in streams where they replace native trout and can disrupt key ecosystem functions such as aquatic insect emergence that connect aquatic and terrestrial ecosystems (Benjamin & Baxter 2010, Benjamin *et al*. 2011). The increased biomass and behavioral difference of non-native trout can influence the distributions of other aquatic predators such as perlid stoneflies (Plecoptera: Perlidae) and water striders (Gerridae), as well as riparian predators such as tetragnathid spiders (Benjamin *et al*. 2001, Baxter *et al*. 2004). Our study sites were of six streams located along the Wasatch Front in northern Utah. We hypothesized streams with rainbow trout would have less aquatic and terrestrial predators versus streams with native Bonneville cutthroat trout.

Figure 1. **Top:** Rainbow trout (*Oncorhynchus mykiss).* **Bottom:** Bonneville cutthroat trout (*Oncorhynchus clarkii utah).*

Methods

We compared six first and second-order streams along the Wasatch Front in northern Utah, three with non-native rainbow trout (*Oncorhynchus mykiss*) (Fig. 1), and three with native Bonneville cutthroat trout (*Oncorhynchus clarkii utah*) (Fig. 1). We measured 100 m reaches in the six streams and established ten transects 10 m apart. We counted the number of water striders and tetragnathid spider webs found within 2 m of each transect. We then electrofished the entirety of the reaches, and the fish were weighed and total length measured. We measured average wetted width, along with substrate size and depth every 0.2 m for a representative depth and pebble count. We used calipers to measure aerial and submerged wood within 2 m of each transect. Biomasses and densities were calculated by total mean length or count divided by stream volume. Additionally, perlid stoneflies were captured using a kick-net and counted along each transect. Due to small sample sizes, we used means ± standard error to judge whether distributions were similar between categories of streams.

Results

We found rainbow trout biomass was larger than cutthroat trout biomass (Table 1). In general, our results show water strider and perlid stonefly densities were higher in cutthroat streams. Differences in habitat could account for some of our findings. Rainbow trout streams were wider on average, had higher aerial wood biomass, and significantly higher submerged wood biomass. On the other hand, cutthroat streams were deeper on average and had a larger average substrate size (Table 1).

Tetragnathid-spider webs were more abundant along rainbow trout streams. Average horizontal-web density was 1.54 $\frac{N}{m^3}$ higher along rainbow trout streams (Table 1).

Average water strider density was 0.89 $\frac{N}{m^3}$ higher in cutthroat streams (Table 1), and average perlid stonefly density was 0.13 $\frac{N}{m^3}$ higher in cutthroat streams (Table 1). However, there was high variation in water strider density in cutthroat trout streams, making the comparison less conclusive.

Table 1. Measurements collected for cutthroat trout and rainbow trout streams, values are listed as means with standard error. *N* represents counted specimens.

	Cutthroat Trout	Rainbow Trout
Trout Biomass	202.09 $\frac{mm}{m^3}$ ± 87.50 SE	598.96 $\frac{mm}{m^3}$ ± 277.20 SE
Water Strider Density	1.07 m^3 ± 1.02 SE	0.18 m^3 ± 0.13 SE
Perlid Stonefly Density	0.25 m^3 ± 0.14 SE	0.12 m^3 ± 0.05 SE
Web Density	1.53 m^3 ± 1.20 SE	3.07 m^3 ± 1.30 SE
Wetted Width	2.27 m ± 0.45 SE	2.89 m ± 0.73 SE
Water Depth	0.09 m ± 0. 15 SE	0.06 m ± 0.10 SE
Substrate Size	175.63 mm ± 181.30 SE	99.21 mm ± 125.10 SE
Submerged Wood Biomass	28.80 $\frac{mm}{m^3}$ ± 6.83 SE	133.80 $\frac{mm}{m^3}$ ± 29.60 SE
Aerial Wood Biomass	47.68 $\frac{mm}{m^3}$ ± 22.00 SE	53.87 $\frac{mm}{m^3}$ ± 35.60 SE

Discussion

As we hypothesized, non-native trout biomass was higher than native trout, and the streams with non-natives had less perlid and water strider densities. Yet, tetragnathid spider web density was higher along rainbow trout streams, contradicting our predictions. The higher biomass of submerged wood could help support a greater rainbow trout biomass. Submerged wood increases stream productivity and habitat heterogeneity (Giller & Malmqvist 1998), meaning the streams with rainbow trout in our study might support a larger aquatic-invertebrate prey base and provide more refugees for trout (Table 1).

Increased habitat heterogeneity due to a higher submerged wood biomass could also explain the higher density of horizontal spider webs along rainbow trout streams. Laeser *et al*. (2005) found tetragnathid spider density depends on the availability of structural-habitat complexity used to build their webs. Additionally, Mcnett & Rypstra (2008) found that even when foraging opportunities are reduced, riparian spiders still prefer complex habitats due to reduced predation risks.

Our results show a weak relationship between larger substrate sizes in cutthroat streams and a higher density of perlid stoneflies (Table 1). Harvey (1993) found the presence of trout reduced the abundance of predatory stoneflies by preying on larger-bodied individual that are unable to find refuges under smaller substrate.

Though water striders prefer water too shallow for trout as a means to avoid attacks (Cooper 1984), we found a higher density of striders in the deeper cutthroat trout streams supporting our hypothesis that rainbow trout affect their distribution. Cooper (1984) found that in addition to trout restricting the foraging ranges of water striders in pools, trout attacks reduce their fitness due to stress.

Though our results suggests that rainbow trout at high densities affect the distribution of aquatic-invertebrate predators, we are hesitant to call our results conclusive due to our small sample sizes and limited time to collect data. Collecting further data could better investigate these relationships.

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Acknowledgments

We would like to thank our mentor Dr. Chris Hoagstrom, and our friend of the Zoology Department, Dennis Collins. We would also like to thank the Weber State Zoology Department for support.