Relations between stream habitat, distribution, & population structure of Paiute sculpin, *Cottus beldingii*

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Introduction

Physical and biological characteristics of riverine systems shape fish communities. We studied the influence of stream habitat features on the distribution and population structure of Paiute sculpin, *Cottus beldingii* (Fig. 1). Paiute sculpin are sensitive indicators of good water quality and stream habitat (Moyle 2002), making it useful in monitoring the health of Utah streams. Also, little is known about the distribution and ecology of Paiute sculpin in Utah.

Figure 1. Paiute sculpin, *Cottus beldingii*. Picture downloaded from: www.nanfa.org, 13 March 2008.

Methods

We conducted sampling in 16 wadeable streams in northeastern Utah between 15 June and 24 August 2007. Streams sampled were in the Bear, Colorado, Provo, and Weber river drainages in Cache, Davis, Duchesne, Morgan, Rich, Summit, Uintah, Utah, Wasatch, and Weber counties. We surveyed 200-m stream reaches with two-passes of a backpack electrofisher (Fig. 2). Fishes were netted and measured to the nearest millimeter standard length. We measured nine stream habitat variables (Fig. 3) and gathered data for four additional variables from U.S. Geological Survey gaging stations (Table 1). We conducted a principle components analysis (PCA) to determine which habitat variables distinguished the 16 streams. We used a two-sample *T*-test to determine whether scores from significant PCA axes differed between streams with and without Paiute sculpin. For axes that did differ, we graphed the means and standard errors of strongly associated variables between streams with and without Paiute sculpin to show their habitat associations. We used a one-way Analysis of Variance to compare mean standard length of Paiute sculpin among streams where it was found and used PCA to create a multivariable that represented population structure based on the skewness, kurtosis, and median of standard length. We then used a stepwise linear regression to determine what habitat variables predicted differences in population structure among locations where Paiute sculpin were found.

Figure 2. Backpack electrofishing

Figure 3. Habitat sampling

Results

The PCA habitat variables showed streams varied in size (Axis 1) and slope and discharge flashiness (Axis 2; Table 1, Fig. 4). Paiute sculpin were collected at 7 of the 16 streams. Principle component scores for these streams were significantly different for Axis 1 ($t = 4.1$, $df = 14$, $P = 0.01$), indicating Paiute sculpin were restricted to larger streams. Specifically, they were associated with relatively high depth, swift stream-bottom velocity, large substrate, high wetted width, and high mean discharge (Fig.5). Paiute sculpin were also associated with relatively low total dissolved solids (Fig. 5).

Mean standard length of Paiute sculpin varied among streams ($F = 89$, $df = 6, 1726$, $P < 0.01$). A PCA combined skewness, kurtosis, and median of standard length into a variable that explained 85% of the variation in population structure among streams (Table 2). A stepwise linear regression of Axis I scores versus the 13 habitat variables selected a single habitat variable (mean water column velocity) that explained 94% of the variation in population structure (Fig. 6).

Table 1. Eigenvectors* for the first two principle components of habitat variables from 16 streams. Axis I explained 42.8% of variation among streams and Axis II explained 20.1%.

	Axis	
	I	II
Depth	**-0.336**	0.116
Column velocity	-0.293	-0.134
Bottom velocity	**-0.386**	-0.019
Substrate	**-0.308**	0.084
Water temperature	0.154	**0.363**
Dissolved oxygen (DO)	-0.282	**-0.380**
Total dissolved solids (TDS)	**0.317**	0.200
Wetted width	**-0.392**	0.178
Reach slope	0.036	**-0.532**
Watershed area	-0.275	0.155
Elevation	-0.052	0.255
Mean discharge	**-0.339**	0.281
Discharge flashiness	0.080	**0.402**

*Eigenvectors exceeding |0.300| are considered strongly correlated (in bold & underlined)

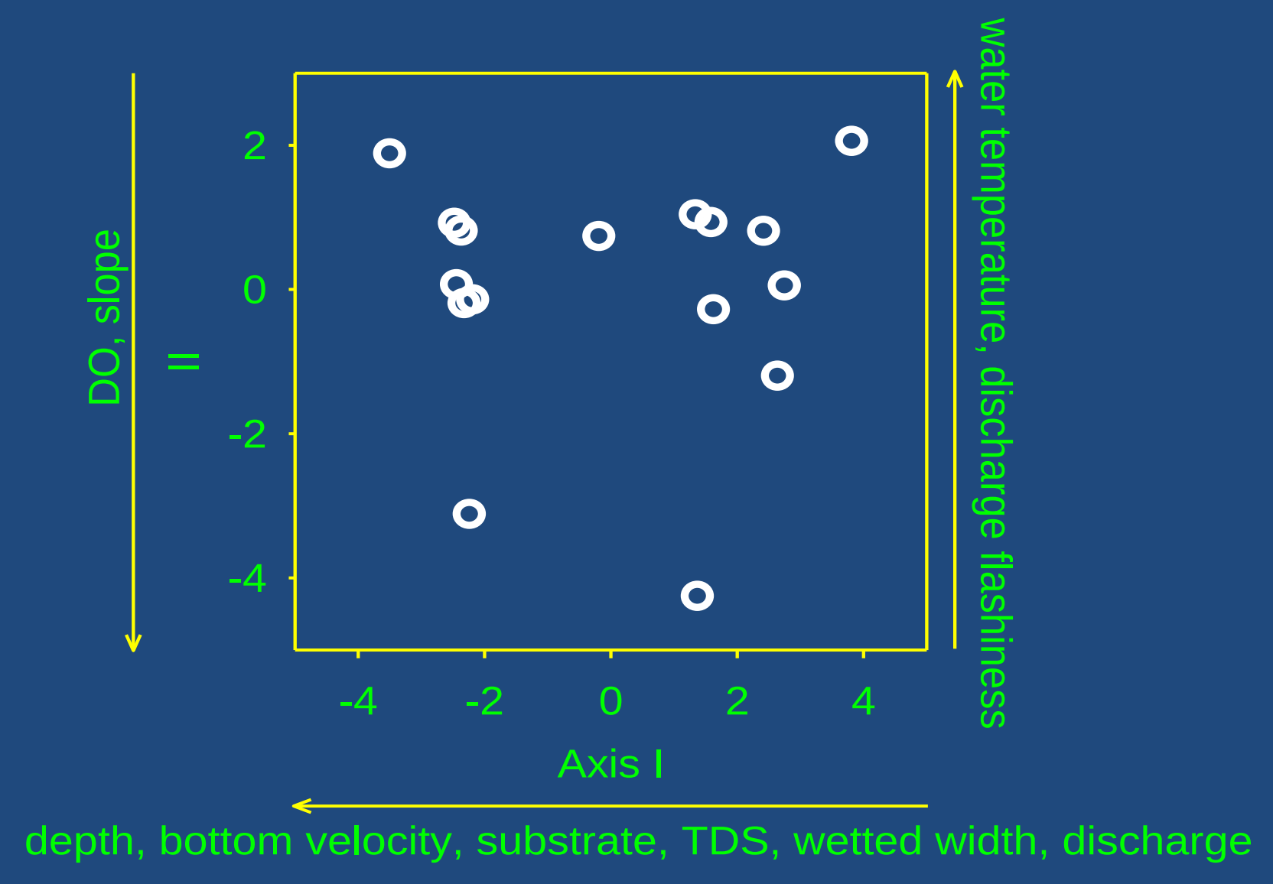

Figure 4. Results of principle components analysis of 13 habitat variables from 16 streams. Axis I explained 42.8% of variation among streams and Axis II explained 20.1%. Habitat variables with strong correlations with each axis (Table 1) are listed. The direction of the arrow indicates the direction of the correlation.

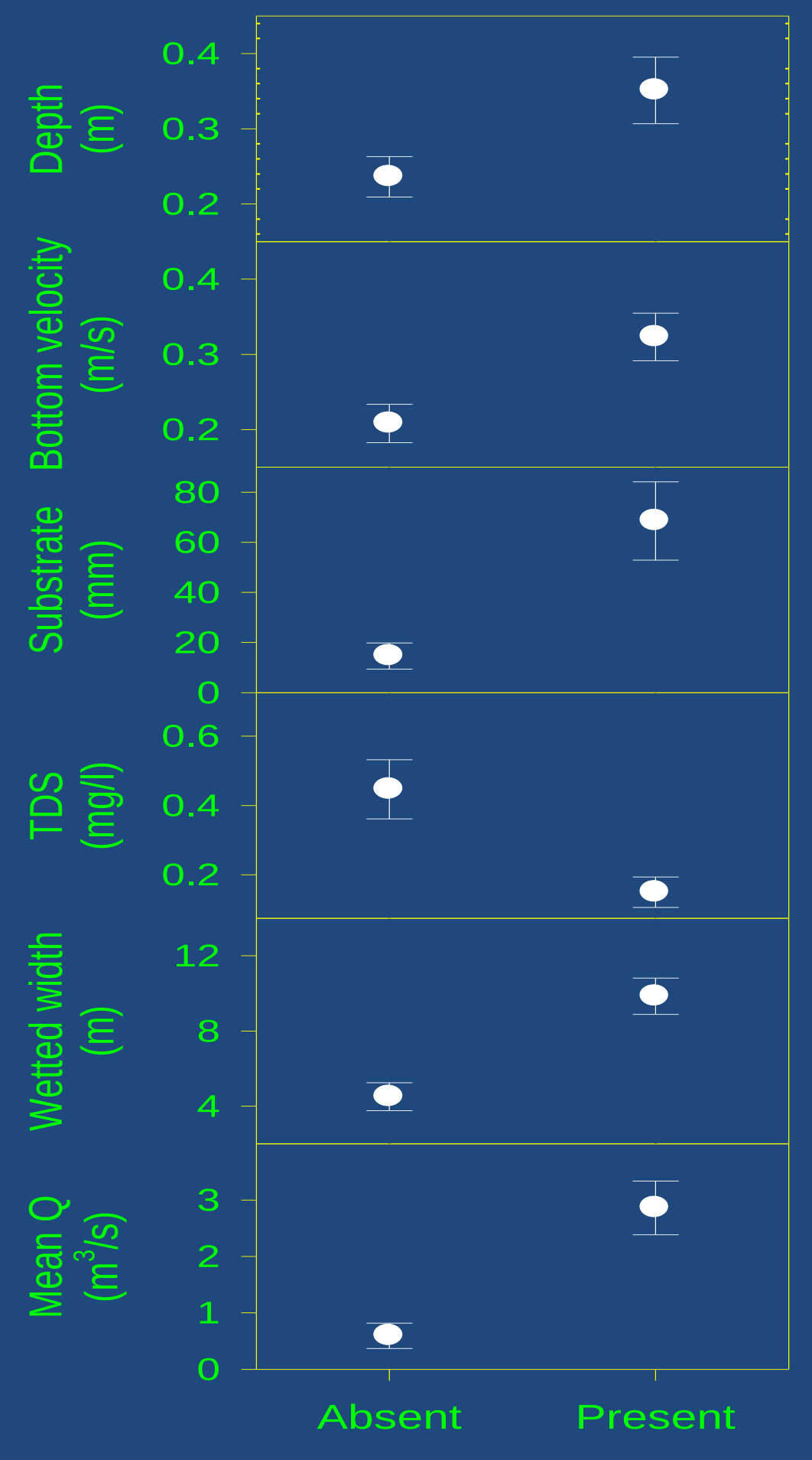

Figure 5. Mean association of Paiute sculpin, *Cottus beldingii*, with habitat variables that were strongly correlated with principle component Axis I (Table 1). Standard error is shown (error bars).

Table 2. Eigenvectors for the first principle component of Paiute sculpin, *Cottus beldingii*, population structure based on characterizations of standard length distributions. Axis I explained 85% of variation in the three parameters among populations.

	Axis I
Skewness	0.5988
Kurtosis	-0.5609
Median	-0.5718

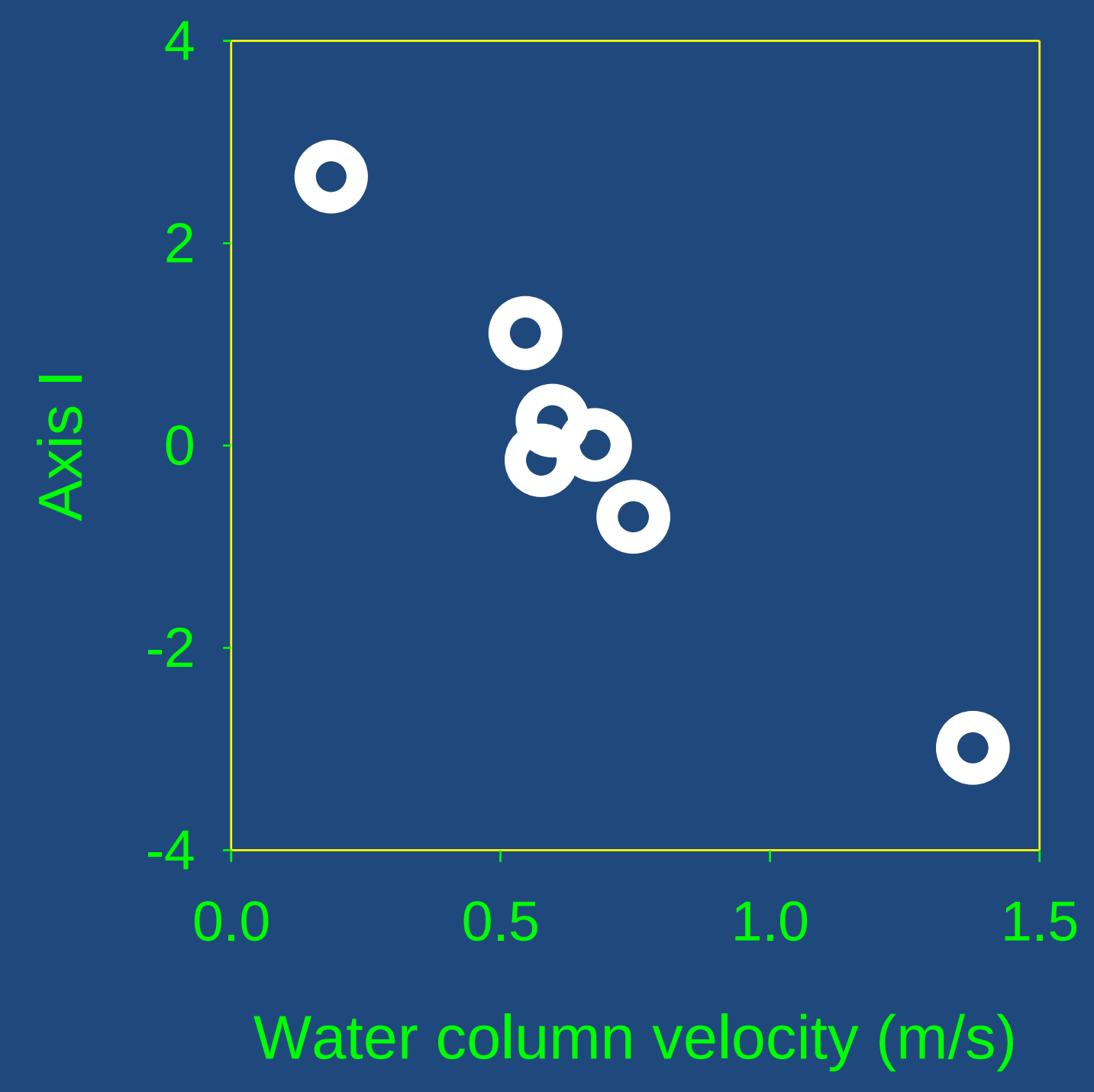

Figure 6. Relation between water column velocity and Axis I scores from a principle components analysis of Paiute sculpin, *Cottus beldingii* population structure (Table 2). A stepwise linear regression indicated that water column velocity was the best predicting variable ($F = 81.4$, $df = 1, 5$, $P < 0.01$, $r^2 = 0.94$).

Conclusions

We found Paiute sculpin in the Bear, Colorado, Provo, and Weber river drainages although they are commonly reported just from the Bear River drainage (La Rivers 1994; Sigler & Sigler 1996; Moyle 2002; Wydoski & Whitney 2003). Paiute sculpin depend on the presence of relatively large streams. Their association with large substrates and low total dissolved solids supports prior findings (Moyle 2002; Quist et al. 2004), suggesting they are indicators of high-quality habitats. Paiute sculpin were not limited by high temperatures as reported elsewhere (Moyle 2002; Quist et al. 2004), perhaps because all streams we sampled had relatively low temperatures.

The very strong relation between water column velocity and population structure indicates that a range of stream sizes promotes diversity among populations. Swifter streams had populations with larger individuals and distributions were more skewed to the left, whereas slower streams had populations with smaller individuals and distributions were more skewed to the right. Other studies have found that predation risk, predator abundance, and prey availability affect Paiute sculpin size and distribution (Anderson 1985; Quist et al. 2004). It is possible these factors were associated with water column velocity in the streams we sampled.

Acknowledgments

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