Fish assemblages, habitat, and thermal effects: patterns of mountain sucker distribution in the Black Hills

Luke Schultz[1] and Katie Bertrand

[1]Department of Wildlife and Fisheries Sciences, South Dakota State University, SNP 138, Box 2140B, Brookings, SD 57007; phone: 605-688-6121: e-mail: luke.schultz@sdstate.edu

The number of imperiled freshwater and diadromous fishes in North America has increased 92% since the late 1980s (Jelks et al. 2008), and the rate of extinction for freshwater fauna will likely increase into the future (Ricciardi and Rasmussen 1999). Conservation action is critical in the persistence of these species, and understanding the factors involved in the distribution of species is a fundamental challenge in managing and maintaining suitable habitat. Although broad-scale landscape variables are influential to species distributions, inclusion of finer scale habitat data and biotic interactions may improve the predictive value of distribution models (Quist et al. 2005). An evaluation of the relative importance of these interacting filters can prioritize conservation efforts (Rodríguez et al. 2007), and fish-habitat models can evaluate potential threats to imperiled fishes and guide management decisions (Belk and Johnson 2007).

Mountain sucker *Catostomus platyrhynchus*, a species of greatest conservation need in South Dakota, occur throughout the western United States. Recent evidence indicates that the species may be in decline around the periphery of their range – particularly in the Black Hills. In addition, little information exists on the basic biology of mountain sucker (Belica and Nibbelink 2006). Effective conservation of mountain sucker in the Black Hills requires an analysis of long-term trends in their density and an understanding of the factors that promote their persistence. The objectives of this study were to assess patterns in the density and distribution of mountain sucker over the last 50 years and identify which abiotic and biotic drivers are most influential on their current distribution.

Changes in mountain sucker densities over a 50-year dataset of stream fish surveys in the Black Hills were quantified at three nested spatial scales (i.e., site, stream, watershed) using linear regression. To describe their current distribution, fish assemblages and habitat conditions were extensively sampled throughout the Black Hills in 2008-2010. Models were evaluated using an information-theoretic approach to compare their relative performance for predicting the occurrence and density of mountain sucker. We sequentially identified the best combinations of variables at the watershed, stream, and site scales; *post hoc* the most informative variables from each scale were combined into a single model and model fit was compared with the best model from each scale. To further explain observed distribution patterns, we assessed thermal tolerance of mountain sucker with the lethal thermal maxima (LTM), which provides a standard measure of thermal tolerance that is easily comparable across species.

Mountain sucker density significantly declined at all three spatial scales, and the distribution of mountain sucker has contracted since routine sampling began (Figure 1). Mountain sucker appear to have been extirpated from much of the Black Hills, including nearly all of the southern

Black Hills. Mountain sucker density was stable in 8 out of 16 streams and 5 of 10 watersheds. Significant increases in density were not observed at any spatial scale.

The occurrence of mountain sucker in the Black Hills was best explained by a model that included several site habitat variables, stream order, and trout density. Mountain sucker were absent where trout density exceeded 1500 fish ha^{-1} (Figure 2), and mountain sucker density was highest where periphyton was most abundant. The LTM of mountain sucker is 15% higher than the mean LTM of co-occuring salmonids, but 5% lower than the mean LTM of three co-occuring cypriniforms.

These results document the decline of mountain sucker in the Black Hills since the 1960s. Management actions to conserve and restore mountain sucker would be most likely to succeed in areas with low trout densities and extensive periphyton coverage, a food resource for mountain sucker. Our study is not the first to suggest a negative relationship between introduced trout and native fishes (e.g., Crowl et al. 1992). Extirpations have occurred in other basins throughout the Mountain West, but as in our study, piscivory (e.g., Belica and Nibbelink 2006) is just one of several possible mechanisms that could explain these negative interactions. Thermal habitat is currently abundant for mountain sucker in the Black Hills, but may become limited as climate change persists.

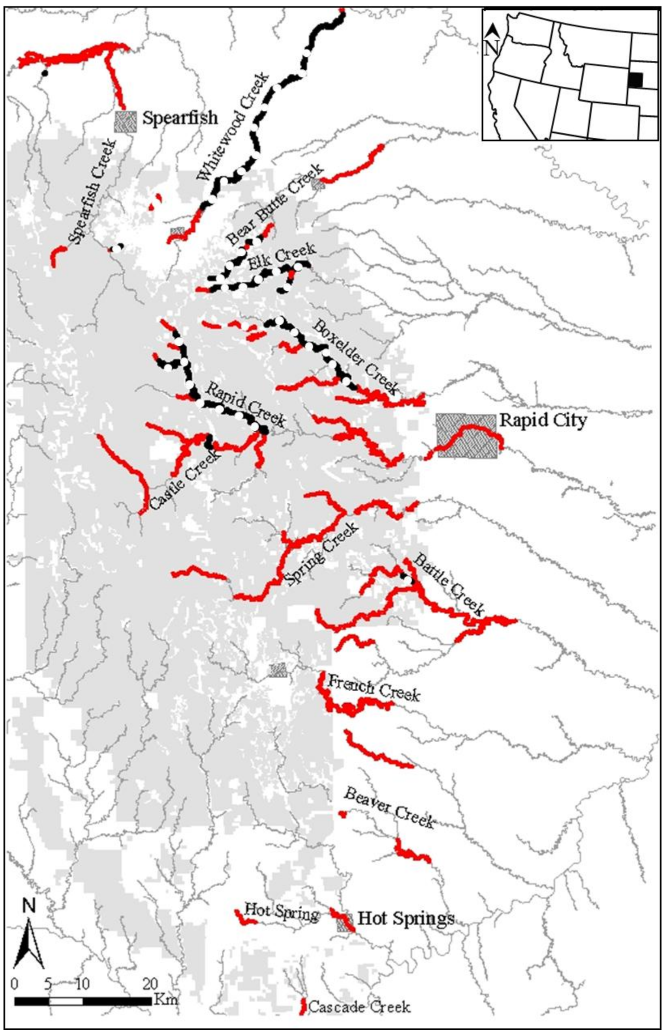

Figure 1 - Current (black, dotted) and historic (red, solid) distribution of mountain sucker in the Black Hills of South Dakota.

The results of this study increase our understanding of mountain sucker ecology and may be used to assess conservation areas in the Black Hills. In addition, our approach can be adopted in other systems. Concurrent evaluation of multiple scales improved predictive models, and illustrated that multiple environmental filters (*sensu* Tonn 1990) need to be considered to most effectively predict species distributions. In addition, managers using this multiple-scale approach can identify what scale of factors management actions can effectively target (Quist et al. 2005).

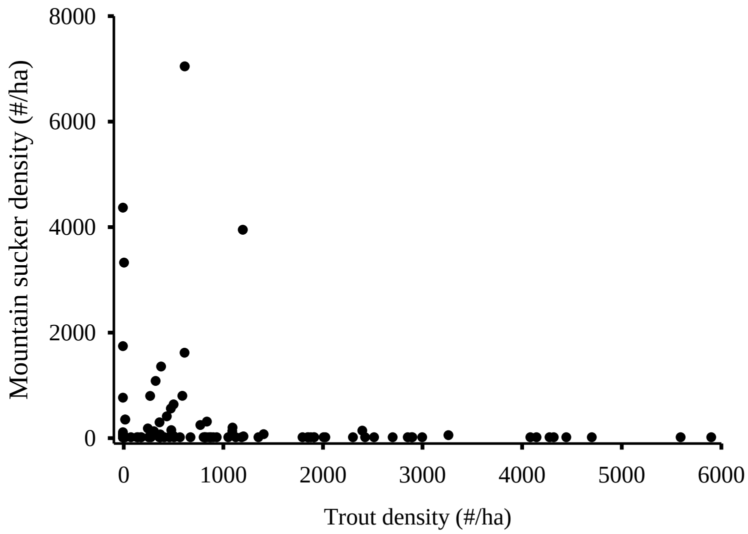

Figure 2 - Mountain sucker vs. trout density for 100m study reaches in the Black Hills sampled between 2008 and 2010.

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Key words: mountain sucker, Black Hills (USA), predictive modelling, thermal tolerance, conservation

Preference: Oral Presentation

Audio Visual Equipment Required: PowerPoint and projector