Description of methods used to develop brook trout conservation priority scores at the subwatershed scale

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The decline of brook trout populations over a large geographic region in the eastern United States was the impetus for the creation of the Eastern Brook Trout Joint Venture (EBTJV) conservation strategy to protect, enhance, and restore populations at the subwatershed scale. Due to finite resources it is not possible to implement conservation projects in all subwatersheds. Therefore, it is necessary to develop a scoring system that would identify subwatersheds with the greatest potential for successful protection, enhancement, or restoration. Also, while the potential of an individual subwatershed is important, assessing that subwatershed in the context of its surrounding subwatersheds aids in identifying areas for population expansion and indicating patches with a high likelihood of persistence. The priority scores for the EBTJV subwatersheds were developed using a model-based approach that relates a measure of priority with a set of variables associated with the subwatersheds. This prioritization method also adds a measure of priority from neighboring subwatersheds to take into account the potential to increase habitat connectivity and resilience. The priority scores at the subwatershed level were determined using the estimated classification probabilities from a Classification and Regression Tree (CART) model, the estimated probabilities of neighboring subwatersheds, and the EBTJV strategy to Protect (Conserve), Enhance, and Restore.

The brook trout population assessment (Hudy et al., 2008) classified subwatersheds where brook trout population status was known, into three categories:

- **Intact -**Subwatersheds with brook trout present in >50% of the streams.

- **Reduced -** Subwatersheds with brook trout present in <50% of the streams.
- **Extirpated -**Subwatersheds with no known brook trout present.

Where population status was not known or where quantifiable data was lacking, a Classification and Regression Tree (CART) model was used to predict the brook trout status using a set of subwatershed landscape metrics. The variables used to predict the categories were road density (decreased status), percent of agricultural use (decreased status), percent of total forest (increased status), combined sulfate and nitrate deposition (decreased status), and percent of mixed forest (increased status) in the stream corridor (corridor defined as 100 meters on both sides of a stream). Based on the landscape variables, the CART model calculates a subwatershed's probability of being intact, reduced, or extirpated. The sum of the three probabilities for each subwatershed is equal to one. The model then assigns the subwatershed to the classification with the highest probability.

The priority scores have a possible range in value from 0-2 and were calculated by adding the CART estimated probability of an individual subwatershed being intact (0-1) plus the geodesic distance weighted average of its 10 nearest neighbors' probability of being intact (0-1). The CART model was used to predict the population status of all subwatersheds, both with known and unknown status, and calculate the estimated probabilities of being intact, reduced, or extirpated. A neighborhood size of 10 subwatersheds was used to define a region of influence around a subwatershed. To calculate the effect of a neighboring subwatershed on the individual subwatershed, the probability of being intact of each neighbor was then weighted by the geodesic distance between the centroids of the individual and each neighbor. Geodesic distance differs from planar distance in that it accounts for the curvature of the earth's surface. The average of these ten weighted probabilities (0-1) was then added to the probability of intact of the individual (0-1) to calculate the final priority score.

The resulting probability scores range from 0 to 1.66. The highest values represent the subwatersheds that have a high probability of being intact and are surrounded by neighboring subwatersheds that also have a high probability of being intact. The lowest values represent the subwatersheds that have a very low probability of being intact (high probability of being extirpated) and are surrounded by neighbors that also have a low probability of being intact.

Using the predicted population classification and the priority score, subwatersheds were divided into those that were best for Restoration, Enhancement, or Protection.

Best For Restoration – These are known and predicted extirpated subwatersheds with the highest priority scores (Figure 1). These extirpated subwatersheds have landscape variables that suggest they have at least marginally suitable habitat characteristics and have potential for regaining lost populations. Higher priority scores in this category also suggests that the neighboring subwatersheds have reduced or intact populations and indicates a potential for increased habitat connectivity. This category represents subwatersheds that are the best options for reintroduction and restoration projects.

Best For Enhancement – These are known and predicted reduced subwatersheds with the highest priority scores (Figure 2). These reduced subwatersheds have landscape variables that suggest they have habitat characteristics favorable for increased and/or expanding populations. Higher priority scores in this category also suggest that the neighboring subwatersheds have many intact or high priority reduced populations and indicate a potential for increased habitat connectivity and resilience. This category represents subwatersheds that are the best options for habitat, water quality, passage, and other type of enhancement projects.

Best For Protection – These are known and predicted intact subwatersheds with the highest priority scores (Figure 3). These intact subwatersheds have landscape characteristics that are not as vulnerable to an increase in stressors and suggest they are likely to maintain their favorable habitats and current populations. Higher priority scores in this category also suggest that the neighboring subwatersheds also have intact populations and represent patches with higher resiliency and likelihood of persistence. This category represents subwatersheds that are the best options for protection projects.

Reference

Hudy, M., T. M. Thieling, N. Gillespie, and E. P. Smith. 2008. Distribution, status, and perturbations to brook trout within the eastern United States. North American Journal of Fisheries Management 28:1069 -1085.

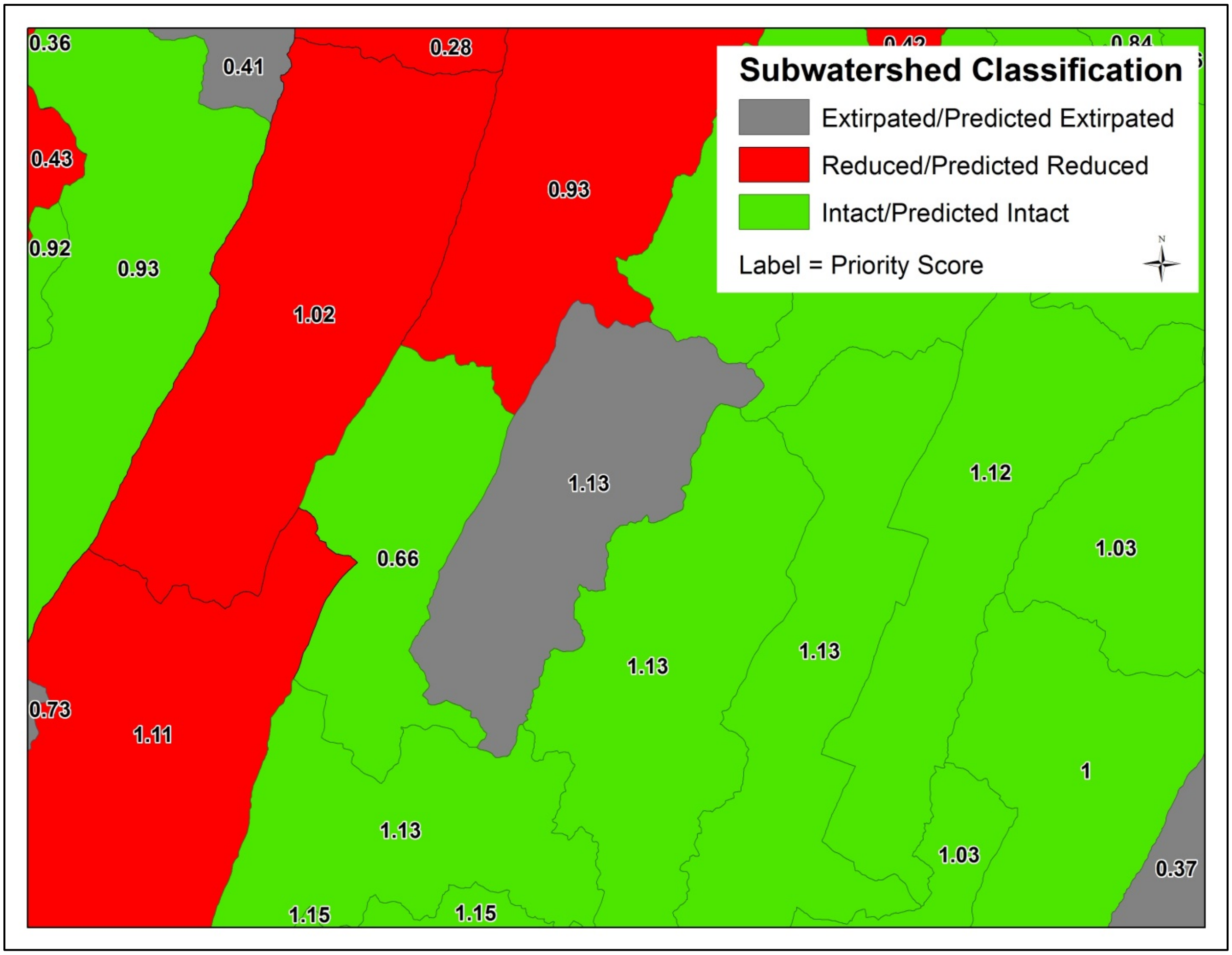

Figure 1. Example of subwatershed best suited for Restoration. The gray extirpated subwatershed in the center is surrounded by intact and reduced subwatersheds and has a priority score of 1.13.

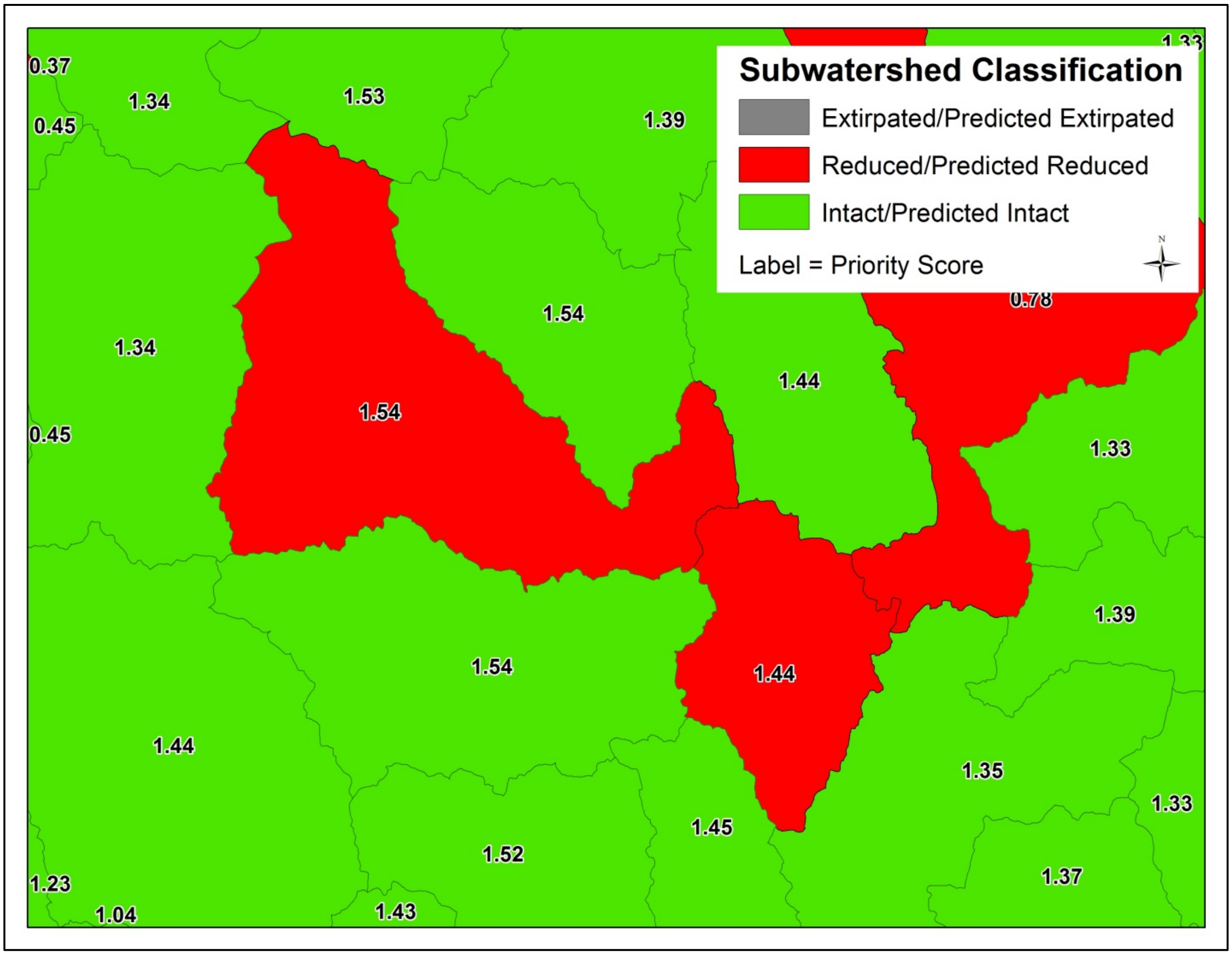

Figure 2. Example of subwatersheds most suited for Enhancement. The two red subwatersheds in the center have a population status of reduced, priority scores of 1.54 and 1.44, and are surrounded by mostly intact subwatersheds.

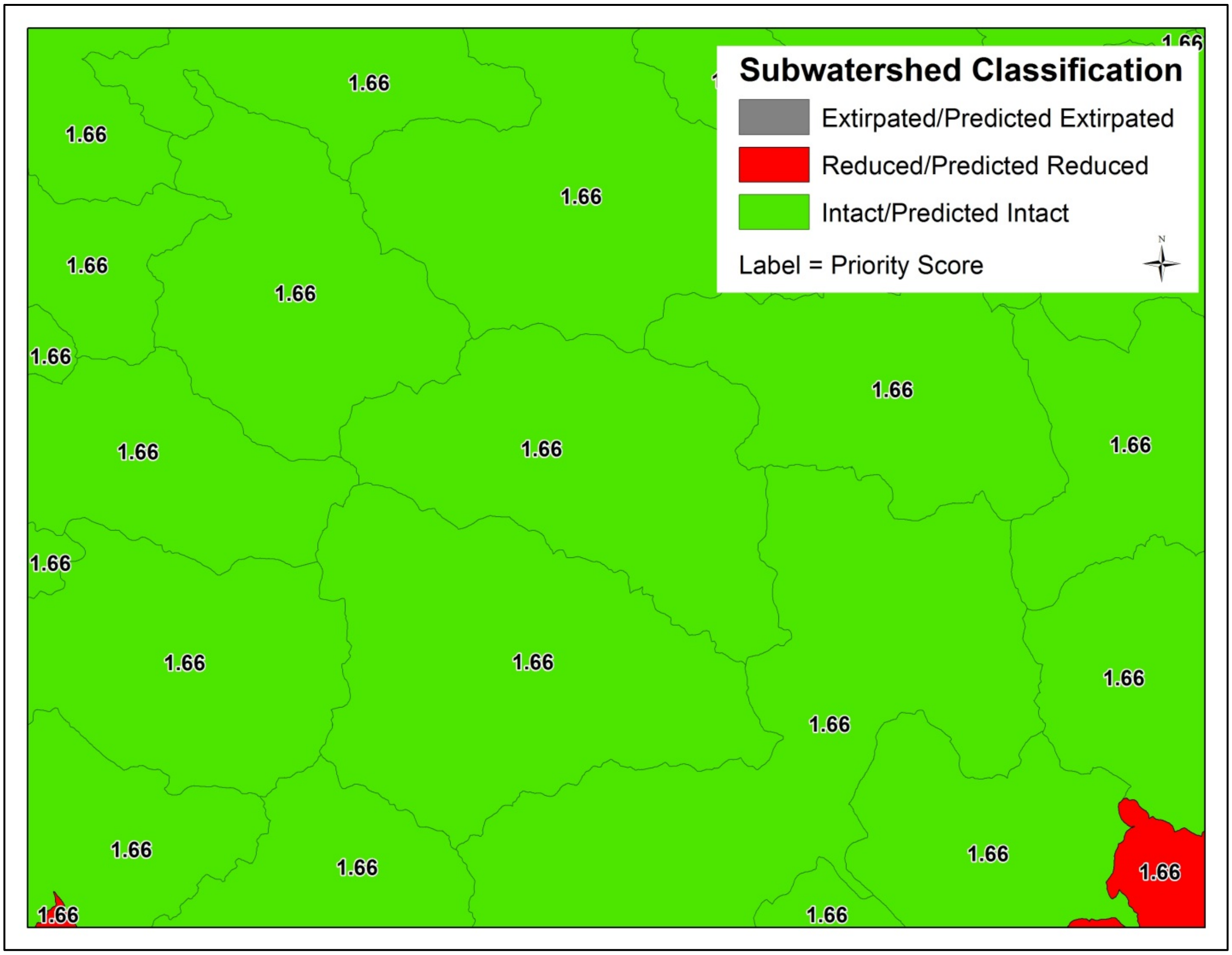

Figure 3. Example of subwatersheds most suited for Protection. The green subwatersheds have an intact population status, the highest priority scores, and are surrounded by other intact subwatersheds with high priority scores.