HOW TO AVOID DEATH BY 10,000 CULVERTS: SPATIALLY-EXPLICIT TOOLS FOR MULTI-SCALE PRIORITIZATION TO RESTORE AQUATIC CONNECTIVITY

Nathan Nibbelink[1], Thomas Prebyl[1], Evan Collins[2], and Duncan Elkins[3]

AFFILIATION: [1]University of Georgia - Warnell School of Forestry & Natural Resources, Athens, GA 30602; [2]US Fish & Wildlife Service - Alabama Ecological Services Field Office, Daphne, AL 36526; [3]University of Georgia - Odum School of Ecology, Athens, GA 30602

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Fragmentation of hydrologic connectivity is one of many threats to aquatic biodiversity. Increasingly, culverts installed at road-stream crossings are known to be significant contributors to fragmentation. Culverts present a unique challenge in that they are often only partial barriers to fish passage, but are incredibly numerous on the landscape. The dendritic connectivity index (DCI) has been used to calculate overall network connectivity at the watershed scale, and the contribution of one or more potential barriers to the DCI score can be calculated by removing those barriers one at a time and recalculating the DCI. Because 8-digit hydrologic units in the southeastern U.S. can have between 3,000 and 13,000 road-stream crossings, the prioritization of one or more crossings for remediation quickly becomes a computationally impossible problem. Furthermore, the DCI requires a passability score for each potential barrier, and while databases containing passability information at each of these points on the landscape are growing, we still lack sufficient data for landscape-level planning efforts. In order to address these challenges, we created a comprehensive set of spatially-explicit tools for multi-scale prioritization. First, we use a random forest algorithm to estimate passability at road-stream crossings as a function of local and regional environmental gradients (e.g., stream slope, % forest cover, basin relief). Second, we apply a heuristic algorithm in a graph-theoretic framework to prioritize potential barriers for remediation or removal. Predictive models appear useful for prioritizing areas with passability problems at a subwatershed level, but prediction success for individual barriers are more variable. Within a hydrologic unit, heuristic prioritization algorithms improve computation times by several orders of magnitude, and exactly match exhaustive solution priority rankings for more than 350 barrier removal options. Scenarios also indicate the relative effect of culverts vs. dams alone, and show variation in prioritization based on species life history characteristics.

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