Quantifying Ecological Process Using Landscape Genetics: A Study of Boreal Toad Connectivity in Yellowstone National Park

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The boreal toad (*Bufo boreas boreas*) is a locally abundant, patchily distributed species thought to be in decline throughout most of its range. Recapture rates tend to be low, making demographically based estimates of non-breeding habitat use and population connectivity unreliable. Therefore we used a landscape genetics approach, which quantifies the impact of landscape composition, configuration and matrix quality on population connectivity using genetic markers. We surveyed boreal toad breeding sites throughout Yellowstone National Park and collected microsatellite genotype data (15 loci, $n = 953$). We used an algorithmic approach (Random Forests) to build multi-scale models of boreal toad connectivity. We found 1) boreal toad connectivity is a function of three ecological processes (habitat permeability, topographic morphology, and temperature-moisture regimes), 2) these ecological processes

operate at multiple scales, and 3) boreal toad connectivity is hierarchical with metrics operating at coarser spatial and temporal scales driving connectivity between genetic clusters; while metrics operating at finer spatial and temporal scales drive connectivity within a genetic cluster. In addition, we found heterozygosity based metrics of genetic connectivity (F_{ST}) explained more variation in coarse processes versus fine scale processes. Conversely, allele frequency based metrics (D_{ps}) of genetic connectivity explained the most variation in fine-scale processes detected recent landscape change (fire, drought, impervious surfaces). In the future, the approach we developed can be used to predict the impact of landscape change on Boreal Toad connectivity. Additionally, the analytical methods developed can be applied in any species or system with appropriate landscape and genetic data.