Developing Geographic Range and Habitat Models for 'Survey and Manage' species by Sampling at FIA locations in Northern California

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In 1994 the Northwest Forest Plan identified several hundred relatively rare plant and animal species as "Survey and Manage" (S&M) based on their presumed association with late-successional/old-growth forests. This group included species of terrestrial mollusks and salamanders. We focused our attention primarily on the mollusks because of their importance to forest ecosystems, contributing to change in plant composition, to energy and nutrient transfer, and to host-parasite interactions. We wished to estimate the geographic ranges and to develop predictive habitat models for 5 species that were assumed to be sensitive to land management activities. A stratified-random sampling design (each of the 4 National Forests in the 2.2 million ha study area as strata) was used to select 308 Forest Inventory and Analysis (FIA) points to sample on federal land. Spatially collocating our mollusk sampling with the FIA plots meant that we had access to the vegetation data collected previously at each location and that we could easily apply habitat models to all FIA points in the study area. We visited each plot twice to search for all mollusks and salamanders, using a combination of area and point-based searches. We conducted analysis at two spatial scales: the FIA plot and landscapes surrounding the plot. A total of 29 FIA-derived vegetation variables were included in the analysis. We used Generalized Additive Models to estimate each mollusk's geographic range and to develop predictive habitat models within their ranges. Models were developed at the FIA plot-scale and six meso-scales ranging from 12.5 ha to 1,250 ha using vegetation, physical, climatic and spatial covariates. *A. voyanum* and *M. churchi* were detected at 24 and 55 locations, respectively, and *H. talmadgei, M. f. klamathica*, and *M. f. ochromphalus* were detected at 8 or 9 locations each. Estimated geographic ranges varied from 4,770 km^2 to 15,795 km^2. We tested each species' geographic range model using an independent set of retrospective data and the expected and observed number of detections did not differ. The species were not distributed differentially among lands allocated to reserves or to matrix. Predictive habitat models explained from 40.8 to 94.5% of the deviance in models describing the species' occurrences with spatial and climatic variables contributing significantly to the predictions of occurrence for most species. Models for species with small geographic ranges were generally better than for species with larger geographic ranges, possibly reflecting the more restricted range of environmental conditions within their geographic ranges. Three species (*A. voyanum*, *M. f. klamathica*, and *M. f. ochromphalus*) were more frequently associated with features of late-successional conifer forests than were *H. talmadgei* and *M. churchi*. Our results provide important guidance to land managers who are responsible for determining the necessity for surveys for these species prior to land management activities.