

Using state-space models to link patterns of elk movement to landscape characteristics in Yellowstone National Park.

James D. Forester, Anthony R. Ives, Dean P. Anderson, Monica G. Turner.

Department of Zoology, University of Wisconsin – Madison, 430 Lincoln Drive,
Madison, WI 53706, U.S.A.; jdforester@wisc.edu

Explaining and predicting animal movement in heterogeneous landscapes remains challenging. This is in part because movement paths often include a series of short, localized displacements separated by long-distance forays. This observed movement behavior reflects the complex response of an animal to present environmental conditions and to its internal behavioral state, which is an autocorrelated process influenced by preceding behaviors and habitats visited. We used a state-space statistical approach to model the internal behavioral state and the proximate movement response of elk to available forage biomass, landscape composition, topography, and predation risk during summer in Yellowstone National Park, Wyoming. We analyzed movement paths of 16 female elk fitted with GPS radio collars that recorded locations at five-hr intervals. Habitat variables were quantified within 350-m radii (the median 5-hr displacement) centered on the beginning location of each interval. Stepwise model selection was used to identify suites of potential models that best explained the movement distances of each animal. Habitat covariates could affect either the internal behavioral state or the proximate movement response to the present landscape conditions. The behavioral state changed very slowly for most animals (mean autocorrelation $r = 0.8$); however, the variables included in the best-fitting models varied substantially among individual elk. Covariates influencing behavioral state included predation risk, elevation, and distance from forest/open edge. After accounting for autocorrelation, results suggested that elk movement distance varied with composition of the surrounding landscape (moving faster in forested areas and slower in the heavily vegetated grasslands and regenerating forest). We relate the individual variation in model structure to home-range location and composition, and discuss implications for the long-term dynamics of elk in Yellowstone National Park.