The Madison-Firehole Elk Herd: Switching from Bottom-Up to Top-Down Regulation?

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Understanding the relative strength of resource limitation (bottom-up) and predation (top-down) in regulating populations is a prominent research theme in ecology. This question is particularly relevant for areas such as the northern Rockies where society generally supports large predator restoration efforts, but also demands robust ungulate populations. We conducted a 15-year, telemetry-based study (>380 animal years) of the nonmigratory Madison-Firehole elk (*Cervus elaphus*) herd, which inhabits the west-central portion of Yellowstone National Park, to gain insight into these population processes without the confounding effects of human harvest. Prior to wolf (*Canis lupus*) colonization (1991-1997) there was little annual variation in reproduction (0.83-0.96, CV = 0.06) or survival (0.81-1.00, CV = 0.08) for adult females, but recruitment was highly variable (<1-38 calves/100cows, CV = 0.73). Nearly all documented mortality was starvation, with snowpack severity explaining much of this variation. Population estimates during 1965-1997 fluctuated near a dynamic equilibrium of approximately 600 animals, leading us to conclude that the herd was strongly bottom-up regulated prior to wolf restoration. Following wolf colonization (1998-2004), starvation was extremely rare and predation became the overwhelming cause of mortality. Survival and recruitment rates decreased substantially (after accounting for the effects of winter severity), suggesting a significant component of wolf predation was additive. This top-down influence of wolf predation is contributing to decreasing elk numbers and, likely, a substantially lower equilibrium density for elk.