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Original Research

Effects of Wolf Presence on Daily Travel Distance of Range Cattle☆,☆☆

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ABSTRACT

The presence of gray wolves *(Canis lupus)* can directly and indirectly affect beef cattle *(Bos taurus)* production on rangelands of the Northern Rocky Mountains. While fairly extensive knowledge exists for the direct effects of wolf predation threat (e.g., cattle death and injury losses, elevated stress), our understanding of wolf-caused changes in cattle behavior and the associated cascade of potential indirect effects on cattle resource selection, diet quality, activity budgets, and energetic relationships is still largely in its infancy. We investigated whether wolf presence affected the daily travel distance of Global Positioning System (GPS) — collared cattle under a replicated, Impact-Control study conducted in western Idaho and northeastern Oregon during 2008 — 2012. Cattle in three Control (Oregon) study areas, where wolf presence was consistently low, traveled farther per day (13.7 $\pm$ 0.396 SE km day^{-1}) than those in three Impact (Idaho) study areas (11.4 $\pm$ 0.396 SE km day^{-1}) with moderate to high wolf presence. At Control study areas, cattle traveled farthest per day in July (13.2 $\pm$ 0.355 SE km day^{-1}) and were least mobile in October (11.8 $\pm$ 0.365 SE km day^{-1}), but daily travel distances were similar across all months for cattle in Impact study areas. This observational study provides evidence suggesting cattle in mountainous grazing areas alter their spatial behavior in response to gray wolf presence. These behavioral changes have energetic consequences that could potentially impact cattle productivity and ranch economics. Additional research into the activity budget and resource selection responses of these collared cattle is required to better understand the specific mechanisms behind these daily travel distance results.

Introduction

The presence of gray wolves *(Canis lupus)* affects beef cattle *(Bos taurus)* production on rangelands. These effects are both direct and indirect (Howery and DeLiberto, 2004; Steele et al., 2013; Ramler et al., 2014). Death and injury losses directly caused by wolf predation are well documented (NASS, 2006, 2011). Economic impacts of these losses can be quite sizable for some individual ranching operations (Oakleaf et al., 2003; Ramler et al., 2014). Wolf presence may also directly induce stress (Cooke et al., 2013) and cause changes in cattle behavior (Kluever et al., 2009; Laporte et al., 2010). While we have fairly extensive knowledge of the consequences of increased stress in cattle (e.g., dietary issues [McDowell et al., 1969; Yousef, 1985], losses in productivity [Young, 1981; West, 2003], and increased susceptibility to disease [Chirase et al., 2004; Salak-Johnson and McGlone, 2007]), our understanding of wolf-caused changes in cattle behavior and the associated cascade of potential indirect effects on resource selection, diet quality, activity budgets, and energetic relationships is still largely in its infancy. Direction and magnitudes of these indirect effects remain largely unquantified, yet they likely have strong implications for weight gain, body condition, reproductive success, and other factors affecting ranch economics.

With regard to behavioral responses, research investigating predator-prey relationships has identified several common antipredation strategies employed by cattle and other ungulates (Lima and Dill, 1990; Kluever et al., 2009; Laporte et al., 2010). Prey animals detect predators and avoid predation through increased vigilance (Underwood, 1982), but vigilance can be costly (Illius and Fitzgibbon, 1994). Bunching into larger groups increases the likelihood of successful predator detection, reduces

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the burden of vigilance for individual prey animals, and presents predators with a more formidable-appearing defense (Hamilton, 1971; Elgar, 1989; Roberts, 1996). Retreating to safer habitat or refugia sites is a strategy commonly practiced by many ungulate species (Bergerud et al., 1984; Creel et al., 2005). Flight or long-distance relocation are the most dramatic antipredation responses, but these are generally strategies of last resort. All of these antipredation strategies have something in common. All will almost certainly have some impact on the distance traveled each day by a prey animal.

Daily travel distance is an energetic response that is readily quantifiable, even on rugged and remote rangelands, using Global Positioning System (GPS)-tracking technology. Changes in daily travel distance impact the balance animals must strike between energy intake and expenditure and thus can have health and productivity consequences (Van Soest, 1982). We hypothesized that consistently elevated levels of wolf presence would lead to a reduction in daily travel distance presumably caused by increased vigilance and greater fidelity for habitats perceived to be safer from wolf predation. We tested this hypothesis in a replicated, Impact-Control study of regional scope.

Materials and methods

Approval for this study of beef cattle behavior was obtained from Oregon State University's Institutional Animal Care and Use Committee (protocol numbers 3654, 4168, and 4555). Procedures used in handling and caring for cattle adhered to the *Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching* (FASS, 2010). Capture and handling of gray wolves for radio- and GPS-collar installation were conducted as part of routine wolf management operations by personnel from Idaho Department of Fish and Game (IDFG) and US Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS) Wildlife Services (WS) in accordance with IDFG-supplied training and the *IDFG Wolf Foothold Trapping Safety Protocol*.

Study Area Pairings

This research was conducted from 2008 through 2012 in six active USDA Forest Service (USFS) cattle grazing allotments ranging in extent from about 100 km^2 to > 300 km^2. Three of these study areas were located in western Idaho where well-established gray wolf populations were present before the study (Nadeau et al., 2008) and wolf presence remained consistently at moderate to high levels during each study year. The remaining three study areas occurred in northeastern Oregon at locations where wolves were either absent or at presence levels too low to be detectible before and throughout the study. The three Idaho study areas were selected first with the intent of choosing USFS allotments representative of the typical range in environmental, ecological, and managerial characteristics evident in mountainous, western Idaho cattle grazing areas. A grazing allotment in northeastern Oregon was then chosen to pair with each Idaho grazing allotment. Pairing of Idaho and Oregon study areas was based specifically on similarities in topography, parent materials, soil types, vegetation cover types, hydrology, climate, and livestock management (e.g., allotment entry/exit timing, grazing scheme, herd composition, breeding, calf age at entry). The intent of this pairing process was to control for as many of these environmental, ecological, and managerial factors as possible such that the principal difference between study areas in Idaho (Impact study areas) and those in Oregon (Control study areas) was the much higher level of wolf presence in Idaho.

Study Area ID-A (Idaho) was paired with Study Area OR-A (Oregon), and this pair was intended to typify situations where cattle enter the grazing areas in early spring (April) with very young calves born in late March to mid-April. Cattle in both study areas experienced four herding events (pasture rotations) per grazing season. The most prominent topographic features of the ID-A/OR-A pair are the very steep-walled canyon slopes present between the lowest and highest elevations of the study areas. Cattle entered these study areas at their lowest elevations (520 − 753 m) and progressively worked their way upslope, scaling the steep canyon walls, reaching the highest rangelands at or shortly after the midpoint in the grazing season, and remaining at these highest elevations (1 581 − 1 932 m) until the close of the grazing season in October.

Riparian vegetation in the canyon bottoms of study areas ID-A/OR-A is dominated willow (*Salix* sp. L), sedges (*Carex* sp. L.), and rushes (*Juncus* sp. L) with Kentucky bluegrass (*Poa pratensis* L.) and cheatgrass (*Bromus tectorum* L.) occurring on stream and river terraces. The canyon walls are vegetated by bluebunch wheatgrass (*Pseudoroegneria spicata* [Pursh] A. Love) and Idaho fescue (*Festuca idahoensis* [Elmer]) associations with perennial forbs such as arrowleaf balsamroot (*Balsamorhiza sagittata* [Pursh] Nutt.), parsnipflower buckwheat (*Eriogonum heracleoides* Nutt.), Cusick's milkvetch (*Astragalus cusickii* A. Gray), and Snake River phlox (*Phlox colubrine* Wherry & Constance) occurring occasionally as co-dominants (Johnson and Simon, 1987). Pine savanna or open woodlands occur on the plateau landscape atop the canyon walls. Ponderosa pine (*Pinus ponderosa* Lawson & C. Lawson) and bunchgrasses (e.g., Idaho fescue) form the savannas. In the open woodlands, a shrub layer of common snowberry (*Symphoricarpos albus* [L.] S.F. Blake) and/or white spirea (*Spiraea betulifolia* Pall.) and an herb layer of pinegrass (*Calamagrostis rubescens* Buckley) and Geyers sedge (*Carex geyeri* Fernald) or Idaho fescue occur under the Ponderosa pine canopy. Ridge-tops often lack forest cover and are vegetated as grasslands dominated by bluebunch wheatgrass and Idaho fescue associations. On buttes extending above the plateaus, forest vegetation is dominated by Douglas-fir (*Psedotsuga menziesii* [Mirb.] Franco) and grand fir (*Abies grandis* [Douglas ex D. Don] Lindl.) associations with forest openings vegetated by ninebark (*Physocarpus malvaceus* [Green] Kuntze) and common snowberry associations. Native graminoids like Geyers sedge and mountain brome (*Bromus marginatus* Nees ex Steud.) occur here as do seeded, introduced grasses (e.g., orchardgrass [*Dactylis glomerata* {L.}] and timothy [*Phleum pretense* {L.}]).

Soils in the canyon bottoms range from fine, smectitic, mesic pachic argixerolls to loamy-skeletal, mixed, superactive, frigid oxyaquic hapludolls (NRCS, 2017a). Loamy-skeletal, mixed, superactive, mesic lithic argixerolls and frigid lithic haploxerolls, as well as clayey-skeletal, smectitic, mesic lithic argixerolls, occur on the canyon walls. Loamy-skeletal, isotic, frigid alfic udivitrands, and vitrandic argixerolls are found on the forested highlands.

Climate at mid-elevations of the ID-A study area is likely similar to that monitored at the Snake River RAWS (SRFI1) located west of Cuprum, Idaho at 1 333-m elevation. Long-term (1998 − 2016) mean water-yr precipitation at this station was 546 mm (MesoWest, 2017a). Total precipitation values for the 2008, 2009, 2010, 2011, and 2012 water yr were 360, 441, 484, 537, and 692 mm, respectively. Long-term (1998 − 2016) mean daily air temperatures for the months of June, July, August, September, and October were 16.5°C, 23.0°C, 22.3°C, 17.0°C, and 9.6°C, respectively. The nearest climate station of comparable elevation to the OR-A study area is the Roberts Butte RAWS (BTFO3) located west of Lewis, Oregon at 1 299-m elevation. Long-term (1998 − 2016) mean water-yr precipitation at Roberts Butte is 403 mm (MesoWest, 2017b). Total precipitation values for the 2008, 2009, 2010, 2011, and 2012 water yr were 353, 297, 453, 460, and 497 mm, respectively. Long-term (1998 − 2016) mean daily air temperatures for the months of June, July, August, September, and October were 15.0°C, 20.9°C, 19.9°C, 14.8°C, and 7.9°C, respectively.

Study areas ID-B and OR-B were paired to be representative of grazing areas with higher base elevations, more forested range, later cattle entry dates (late May − early June), and older calves (3 mo) at entry than the ID-A/OR-A pair. Cattle at both study areas were herded among pastures three times per season. The lowest elevations (904 − 981 m) are grasslands dominated by bluebunch wheatgrass and Idaho fescue associations or sagebrush-grasslands vegetated by mountain big sagebrush (*Artemisia tridentate* Nutt. subsp. *vaseyana*