Wolf Cattle Interaction Study, 2012 Oregon Beef Council Short Report
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Introduction

The reintroduction of wolves into Central Idaho and the Yellowstone National Park, and their subsequent dispersal throughout the northern Rocky Mountains, has led to increased livestock depredation and conflict with livestock producers. Stock growers report both direct losses as injured or killed cattle, sheep, horses, and dogs, as well as calf wt loss and indirect livestock losses from increased stress resulting in lower conception rates, higher incidence of respiratory and other diseases, lower body condition scores, and changes in temperament resulting in more difficult handling. Producers also report herd management costs have increased with the presence of wolves because ranch personnel need to check on animals more frequently, spend more time doctoring injured stock, and expend additional effort searching for animals scattered during predation events so they can be removed to safe locations. Removal of cattle generally results in disruption of annual grazing plans and higher forage costs. Research that examines wolf impacts on domestic livestock resource selection, behavior and ranch-level economics are rare. Our study was designed to document the effect of wolf predation threat on cattle behavior, landscape use patterns, and resource selection by comparing areas with high wolf densities against those with low wolf densities. This study was also designed to generate baseline information on cattle spatial behavior before wolves become common on landscapes where they currently are rare. For a complete discussion of the study go to:
http://extension.oregonstate.edu/wallowa/sites/default/files/2012_october_22_oregon_beef_council_report_final_d.pdf

Study Sites

The study areas used consist of 6 sites total where 3 sites occur in Idaho, on the Payette National Forest (PNF) lands, in Adams and Washington counties, a region that has established wolf populations as well as, documented wolf depredation occurring before the study began in 2008. These Idaho sites were paired with 3 sites in Baker, Union, and Wallowa counties, Oregon on the Wallowa Whitman National Forest (WWNF) where wolves were absent or at very low presence levels in 2008. Site pairs had similar topography, vegetation composition, wild ungulate prey bases, and livestock management strategies. Oregon sites cover 108,655 acres while the Idaho sites cover approximately 134,395acres. Idaho sites are at the same latitude as Oregon sites. These six grazing allotments vary in elevation from 1680 ft. to 8,200 ft. and are characterized by rugged mountains and uplands that are deeply dissected by canyons.

Experimental & Sampling Design

This research is being conducted under a Before-After/Control-Impact paired (BACIP) experimental design. In this case, the experimental treatment or Impact is the change in wolf presence on Oregon study areas from a long-term, very low level to a sustained higher level. The Before period of the BACIP design is the period before the Oregon study areas acquire a substantial and sustained wolf presence while the After period is the period after that transition point when both the Idaho and Oregon study areas have substantial and sustained wolf presence.

The Clark Animal Tracking System collars, that offer long deployment lives (e.g., up to 1 year) at intensive sampling rates (e.g., collection of GPS positions at 5-minute intervals), are being used. Each spring between 2008 and 2011, 10 mature cows were randomly selected from cattle experienced with the landscape on each ranch. Herd size varies somewhat from site to site but the

average size was 350 cow-calf pairs. Stocking rates were moderate as dictated by USFS allotment management plans.

At a 5-minute GPS sampling rate, we could potentially collect 288 positions for each collared animal each day. If the collar cannot obtain a fix within a set amount of time, the collar shuts down and waits for the next collection period. For a 200 day grazing season with 10 collared cows, we therefore would collect approximately 500,000 cow positions. The GPS receivers record locations which are within 6.3 meters of true location 95% of the time.

GPS Tracking of Wolves

GPS collars have been deployed on wolves within project study areas. The wolf GPS collars are of the same basic design as cattle collars except each collar also contains a radio beacon transmitter, like a traditional radio-tracking collar, which is used to locate and monitor the collared wolves so their collars could eventually be retrieved from the field for data download. Wolf collars were programmed to record GPS locations at 15-min intervals instead of 5-min interval for cattle collars to increase battery life and extend deployment-life expectancy. Three wolves were collared by the project. The first collar was deployed on a male wolf (B446) for 209 days beginning on 23 May 2009. A second collar was deployed in 2011 but its radio beacon has stopped transmitting and the collar has not yet been retrieved. The third collar was deployed in early October 2012 and this animal did not survive the fall.

Other methods of assessing wolf presence and/or density include: Wolf Scat and Track Surveys which are conducted along established routes (i.e., specific forest roads) within each study area. During each grazing season since 2009, these routes have been surveyed and any wolf sign observed recorded. Wolf scat and tracks were photographed and positioned with a handheld GPS. Trail cameras were established, as a test case, in one of the Idaho study areas during the 2011 field season. They were added to all of the project study areas during the 2012 grazing season. Additionally, wolf radio and GPS-tracking data are acquired from wildlife agencies. Observations made by producers, trappers and others are also collected and compiled. Records of confirmed and probable wolf depredation incidents documented by USDA-APHIS-WS are also used as another wolf presence data source.

Cow Position Data

Each cow position was cataloged for slope, aspect, topographic shape class, and land cover class. This information was used to determine the relative preference of cattle for each class of landscape. We have not broken data into seasonal or monthly data sets yet. Analysis continues. More sophisticated methods of analysis of distribution patterns and resource selection (resource use) than those reported in this paper exist and we are in the process of applying them to this data set, but as of the writing of this report, they have not been completed. We calculated the relative occupancy, both for resting and foraging, for each 2.47 acre (1 ha) location on the study site. This summary analysis allows us to evaluate cattle occupancy rates looking for areas of abnormally high or low use levels.

Cattle Distribution and dispersal

Cattle distribution on the range is complicated by fencing, range riding, scheduled moves, topography, seasonal weather differences and natural maturing of forage. There are also year to year grazing rotations that change with the USFS Annual Operating Plans and Allotment Management Plans. Data show cattle tend to break into groups of 5 to 15 cows that function as subgroups in loose association with the greater herd. It was not unusual for collared animals to be found several miles from herd mates but remaining close to animals in their subgroup.

Speed of collared cattle was also recorded by the GPS receivers. We used the pattern of velocity measurements to indicate animal activity (Figure 1). Cow velocities rarely rise above 6.2 miles/hr. under normal grazing conditions. Grazing periods are represented by a string of speeds above the detection threshold, resting periods by strings of values below the detection limit of the instrument. Direction travel to or from water or herded movement between pastures is represented by normal walking speeds between 2 and 4 mph.

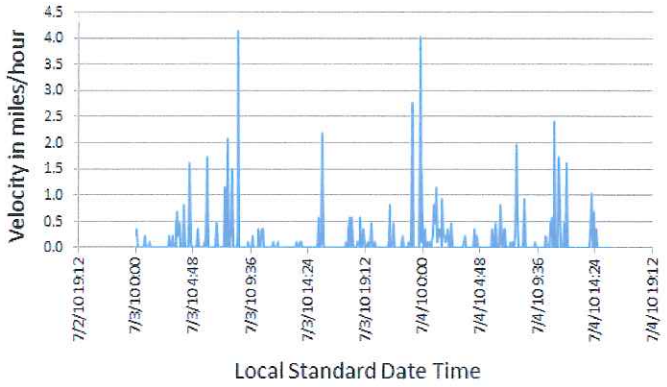

Figure 1. Typical velocity diagram of a GPS-collared cow. Actual cow velocities rarely rise above 6.2 miles/hr. under normal grazing conditions.

Travel Distance

GPS collar data have two issues when used to estimate travel distance. First, animals typically do not move in straight lines but weave across the landscape between food patches or along least-effort pathways between grazing areas, thus connecting GPS positions acquired at 5-minute intervals underestimates actual distance traveled. Second, cattle typically rest for 12 to 14 hours a day and GPS positions collected when an animal is stationary contain location errors which suggest the animal is moving when it actually is not. It is still possible, however, to gain insight into the travel distances of cattle with the raw (uncorrected) data sets. Daily travel distances of collared cows varied by study site, season and study year. As an example, in 2010, Cow 33 traveled an average of 7.37 miles/day compared to 4.99 miles/day for Cow 17. Maximum and minimum daily travel distance was 17.62 mi. and 2.39 mi. for Cow 33, while Cow 17 had 12.89 mi. and 1.97mi for these parameters.

Low travel distances during the early spring could be caused by abundant forage and animals grazing steep hillsides. Cows grazing hillsides typically move across the slope on terraces that have a relatively low gradient, because the steepness of the terrain restricts movement up and down the slope. On more level ground travel is easier and animals move farther. We have not examined travel distance relative to wolf presence levels or other potentially important variables (e.g., surface roughness, vegetation or landscape cover class, weather, etc.).

Cattle Preference for Landscape Features *(complete information on percent use and availability can be found in the complete report; see introduction for website)*

Distribution of cattle was not uniform. Oregon Site 1 is mountainous terrain with V-shaped valley form. The predominant stream types (Rosgen A and B) are steeper gradients, limited sinuosity and narrow floodplain width. Livestock spent 33% of their time on preferred slopes of 0-12% ($p<0.01$) and an additional 56% of their time on slopes 12-36% using those slopes. Livestock did not show a preference toward aspect or landscape cover classes. They spent 90% of their time in conifer forest type which dominates the allotment.

Oregon Site 2 is mountainous terrain containing significant areas of both steep and moderately sloped valleys. The predominant stream types (Rosgen A and B) have steep sloped valleys and tend to have steeper gradients, narrow floodplains, and V-shaped valleys. Moderately sloped valleys tend toward moderate gradient B streams and support wider floodplain development. Overall, 88% of cattle occupancy occurred on 41% of the allotment acreage. Cattle preferred slopes 0-12% ($p<0.01$) and continued to access slopes up to 36% proportional to their availability. Livestock did not show a preference aspect or landscape cover class. They spent 85% of their time in the conifer forest which is the dominant landscape type.

Oregon Site 3 is steep canyons and plateaus. Livestock traverse the steep slopes of the canyon lands to reach the plateaus by following a limited number of draws which require a climb in elevation of 1300 ft. Cattle do not show a preference toward the canyons which represented 50% of allotment acreage, but cattle spent only 22% of their time in the canyons. Cattle preferred slopes 0-24% ($p<0.01$) where they spent 65% of their occupancy time. These slopes are predominantly located in the elevation range of the plateau and occur on all aspects of the plateau. Cattle did not show preferences toward aspect or any of the major cover classes. Cattle did show a preference toward abandoned grass hay fields that occur on benches within the canyons. These areas are used early in the grazing season by livestock as community resting areas for young calves while the cows graze the surrounding slopes.

Idaho Site 1 is mountainous terrain with a V-shaped valley form. The predominant stream types (Rosgen A and B) have steep gradients, limited sinuosity and floodplain width. Cattle preferred slopes 0-12% ($p<0.01$) spending 65% of their time at those locations and preferred north and east aspects (58% occupancy). Cattle preferred grassland and cultivated landscape cover classes spending 24% of their time on 7% of the allotment ($p<0.01$). The majority of cattle time was spent in forest and shrub communities (73% occupancy). Livestock used shrub communities proportional to their acreage but tended to limit occupancy in forest vegetation (38% of time on 57% of allotment acreage, $p<0.01$).

Idaho Site 2 is mountainous terrain with a V-shaped valley form. The predominant stream types (Rosgen A and B stream types) are characterized by steep gradients, limited sinuosity and floodplain width. Cattle preferred slopes 0-24% ($p<0.01$) spending 74% of their time on these slopes which represented 48% of the allotment. Cattle preferred east aspects (36% occupancy) ($p<0.01$) and were neutral to north and south aspects (39% total occupancy). They avoided westerly aspects (25% occupancy on 38% of allotment). Cattle preferred shrub landscape cover classes spending 34% of time on 16% of allotment acreage ($p<0.01$). Cattle did spend 62% of their time in conifer forest which represents 75% of the allotment ($p<0.01$).

Idaho Site 3 is a wide elevation range that contains steep canyons with low elevation valley bottoms, and higher elevation mountainous terrain between 4200 and 5500 ft. Livestock preferred slopes 0-24% ($p<0.01$) spending 72% of their time on these slope which represented 51% of the allotment. Livestock used slopes 24-36% proportional to their availability within the allotment. Livestock were neutral in preference toward differences in aspect and landscape cover classes. They spent 88% of their time in the forest and shrub communities that dominate the allotment.

Cattle Occupancy along Perennial Stream Systems in Oregon

Cattle occupancy in buffer zones around perennial streams was studied for the years 2008 and 2009 at only the Oregon sites. Analysis of the remaining data for the Oregon and Idaho sites will be completed for future reports and documents. Oregon site 1 encloses 30 miles of perennial stream while Oregon study area 2 has 15 miles of perennial flow and Oregon area 3 contains 22 miles of perennial stream.

Time spent within a defined distance of a perennial watercourse was evaluated; percentage of time within each category was found, as well as cumulative occupancy within the defined distances. A buffer zone out to 10m (32.8ft) was established on either side of the map line feature representing streams. This area is considered as the potential interface area between cattle and aquatic habitats as defined by Ballard (1999). Beyond this area five other buffer zone classifications were established on both sides of the stream of 10-20m (65.8ft), 20-30m (98.4ft), 30-40m (131.2ft), 40-50m (164ft) and 50-60m (196.8ft). Although riparian zones are not explicitly defined the distance values do give an indication of time spent within the immediate area of the perennial water courses that are found within the respective study areas.

Zones closest to the water were not occupied more than zones further from the water source (Table 1). In site 1 this is likely attributable to the V-shaped valleys with "A" channels that predominate the area and limit the development of riparian meadow vegetation. In area 3, the elevation gradient of the landscape places the cattle in steep canyons containing perennial streams early in the grazing period. As cattle moved upwards, following snow melt, these same canyons limit their return to the streams for the remainder of the grazing period.

Cattle occupying site 2 are on a landscape where riparian areas occur on more moderate slopes. This allows the formation of broader geomorphic surfaces that support riparian vegetation. In this study area, cattle favored the zones out to 30m (98.4ft) with the greatest preference occurring equally within the 0-10m (32.8ft) and the 10-20m (65.6ft) classifications. Although preference of the zone 0-10m (aquatic habitat) is variable between study sites it should be noted that occupation of this zone was always less than 1 percent. This observation supports those reported by Ballard (1999) where intensive visual observations indicated a similar percentage of use. On a per-day-average basis, collared cows on site 1 spent 2.43 minutes per day in this zone with site 3 cows being similar at 2.58 minute per day. At site 2, which had more developed riparian areas, cows spent 11.78 minutes per day in the 0-10m zone. Cumulative stream-buffer-zone occupancy was similar between site 1 and site 3 with just over 1% occupancy for all areas between 0 m and 60 m of streams (Table 1). Site 2 was again different in this analysis as occupancy began in the 0-10 and 10-20m zone with a higher numeric values than the other two sites and reached nearly 4% cumulative occupancy out to the 50-60 m zone.

Table 1. Occupancy of buffer zones along streams for the 3 Oregon study areas.

Stream Area Occupancy	Percent Occupied in Buffer Zone			Cumulative Percent to Stream		
	OR Site 1 (08/09)	OR Site 2 (08/09)	OR Site 3 (09)	OR Site 1 (08/09)	OR Site 2 (08/09)	OR Site 3 (09)
Buffer Zones	%	%	%	%	%	%
0 to 10 m	0.18	**0.86**[1]	0.19	0.18	0.86	0.19
10 to 20 m	0.20	**0.88**	0.20	0.39	1.74	0.39
20 to 30 m	0.21	0.68	0.21	0.59	2.43	0.60
30 to 40 m	0.18	0.53	0.19	0.78	2.96	0.79
40 to 50 m	0.17	0.43	0.19	0.95	3.39	0.98
50 to 60 m	0.17	0.34	0.19	1.11	**3.73**	1.17
Probability	NS	<0.05	NS	NS	<0.05	NS

[1] Bold numbers within % occupied column indicate significant difference.

Bold numbers in cumulative column indicate significant total occupancy compared to buffer zone area.

Duration of Cattle Occupancy

On both Idaho and Oregon sites, 70-80% of the 2.47 acre (1 ha) gridded locations within allotments and private land inclusions received 12 or fewer cow positions throughout the grazing season. Twelve cow GPS positions translates to slightly longer than one hour of occupancy (66

minutes). Areas that tend to be lightly used are widespread which reflects managerial objectives and the natural tendency for these cattle to disperse.

We also identified foci on the landscape where collared cattle have congregated or remained for longer periods. These sites are sometimes associated with corrals, or salting sites, but generally represent sites that are attractive because they offer more forage, easy access to water, shallow terrain, or are on topographically constrained routes between portions of the grazing allotment.

We are in the process of categorizing and cataloging foci in each of the study areas for each year in cooperation with the ranchers and range riders. The information we have collected thus far leads to several interesting questions: 1) are foci stable between comparable years or seasons?, 2) are foci more prevalent in one portion of the grazing season as compared to another?, 3) are some cows more likely to use or remain at foci than other cows? We are currently building resource selection models that hopefully will help determine why some areas (foci) are preferred over other areas.

Wolf Movement

Wolf B446 was trapped and collared in the calving pasture of the ranch associated with Idaho Site 3 on 23 May 2009. This adult male wolf was documented as a member of a pack of 13 wolves. Based on GPS-tracking data and direct observations, this pack was denning on study site 3 at the time B446 was captured and the pack maintained rendezvous sites on this study site throughout the summer and early fall. Wolf B446 was tracked at 15-minute intervals for 209 days between 23 May to 18 December 2009 logging 19,575 GPS positions. Based on these data, a minimum convex polygon home range for this wolf occupied 214 mi^2. Average daily travel of B446 was 11.3 mi, however, travel distance varied substantially day to day. Minimum daily travel distance for this animal was 2.56 mi while the maximum daily travel distance was 24.94 mi. The maximum distance covered in one hour of continuous movement was 6.29 mi and in a two hour continuous period was 8.39 mi. There was no overall linear trend apparent in this data which suggests no seasonal change in mobility between May and December. Wolf B446 traveled at all hours of the day but tended to move mostly at night i.e. from 8:00 pm to 8:00 am. Travel was greatest near midnight. This wolf was also quite tolerant of human dwellings and roadways and frequently spent time near houses during the night but also sometimes during daylight hours.

Depredation

Depredation in the vicinity of the Idaho Study Sites was compiled. There were 15 confirmed or probable depredations on Idaho Site 3 in 2009; most were near roads or habitations. Land in this area is quite rugged and cattle dying in locations distant from roadways or in forested or shrubby areas are unlikely to be found. The ranch reported 65 head missing above normal death loss at the end of the 2009 grazing season.

Confirmed or probable depredation locations on Idaho Site 3 were mapped along with the locations of human dwellings and roadways. This was done because we had a collared wolf (B446) on this site and believed it could shed light on the methods employed by wolves in their pursuit and attack sequence. We also wanted to determine if human activity and the presence of dwellings and well-traveled roads constituted a deterrent to wolf activity.

After collaring, Wolf B446 moved 2.22 miles northward and circled back to the den site, approximately 5.8 miles to the west southwest of the calving pasture in which he was captured. He was back on the den site by 24 May 2009 at 10:30 PM. By 25 May 2009 at 22:53, Wolf B446 was back in the calving pasture and was located within 500 yards of a ranch house. This wolf covered a route of 6.8 miles from the den site to the calving pasture in 2 hours 33 minutes. He returned to the heifer calving pasture 14 of the next 28 days and to the den site 18 of the next 28 days. Thus, he

seemed to be focused on two locations during this period, the den site and the calving pasture. We should note that calving pastures are close to ranch dwellings which allow for frequent checks by the rancher during calving season.

Because Idaho Site 3 had a collared wolf, it was possible to examine wolf GPS track logs relative to known cattle depredation locations. In some depredation events, Wolf B446 showed a circular track with a radius of several hundred yards around or near the depredation site and in others a simple linear track across the depredation site. In several cases, confirmed depredations occurred at locations where B446 was not present which indicates that other pack members were involved. When confirmed and probable depredation events and wolf GPS locations are plotted, at least a partial picture of wolf activity begins to emerge. It has been suggested that human presence and activity is a deterrent to wolves. In this case, we found that confirmed depredation sites were often near dwellings and roadways. Depredations near centers of human activity are more likely to be detected and confirmed than those in rugged, remote areas of the study sites. Consequently, we cannot speculate whether more predations occur in remote areas than in human-frequented areas. Data for B446 does, however, suggest human presence was not a serious deterrent affecting his movement patterns.

Wolf/Cattle Interactions

Collared cattle on Idaho Site 3 first encountered the Wolf B446 at a threshold distance of less than 547 yards (500 m) on 19 June 2009. This herd of 450 cow-calf pairs contained 10 collared cows. Collared cows periodically encountered the wolf until 3 November 2009 when cattle were removed from the range. We should remember that the collared wolf was part of a larger pack of as many as 12 other individuals and these other wolves may have also encountered these cattle prior to these dates or at closer distances than B446. Also, since both B446 (15-minute intervals) and the collared cows (5-minute intervals) were tracked at a fairly coarse sampling interval, actual encounters could have occurred at much closer distances than those documented by GPS data.

Two of these 10 collared cows had lost their calves by the end of the grazing season. Both these calves were unaccounted for, never found, and were listed as missing. We were surprised by the frequency of interactions between collared cattle and this wolf. Sometimes more than one GPS-collared cow was encountered simultaneously. The maximum number of simultaneous encounters was 6 cows which could indicate a bunching by threatened animals. When broken out as separate events, there were 448 of the 783 total encounters at <500m that were independent (i.e., involved 1 collared cow only).

Most of the close encounters, i.e., at less than 109 yd. (100 m), occurred at night with all but 1 of the 53 encounters occurring between 8:00 pm and 7:00 am. The timing of nighttime encounters at < 100m was bimodal with 24 occurring between 10:00 pm and 1:00 am and 24 between 2:00 am and 6:00 am with peaks near 11:30 pm and 3:30 am.

Table 2. The number of times each of the collared cows on Idaho Site 3 encountered Wolf B446 during the 2009 grazing season. The period between first and last encounter was 137 days.

Cow/Wolf B446 Interactions (Count)	Animal (Cow Collar #)										
	003	005	008*	018	019	020	021	022*	023	024	Total
547 yd. (500 m)	73	121	41	61	99	140	93	23	52	80	783
273 yd. (250 m)	24	43	14	10	36	37	20	4	15	41	244
109 yd. (100 m)	3	5	3	0	7	12	5	1	2	15	53

*Animals marked with a star lost calves during the summer grazing season.

We have hypothesized that some details about what happened during a GPS-documented wolf-cattle encounter might be learned by analyzing the velocity of cattle immediately before and after an event. We have just begun testing this hypothesis. For example, Wolf B446 was recorded 675 yd (617 m) from Cow 008 on 7/5/2009 at 1:57:42 am. This wolf was 122 yd. (112 m) from Cow 008 on 7/10/2009 06:29:23 and beginning on 7/10/2009 at 23:25:16, B446 was within 547 yd (500 m) of this cow for 1hr. The velocity of Cow 008 showed much more activity following these encounters than during the time just prior to the events. As noted above, Cow 008 lost her calf during the grazing season. Other encounters show no increase in cow activity, thus it does not necessarily follow that an encounter leads to increased activity. It appears that in some cases, Wolf B446 was within 500m of a cow and the cow was unaware of its presence. In other cases, we see rapid movement by this cow away from the wolf.

Cattle Grazing Response to Wolf Presence

We examined the spatial patterns of cows grazing on Idaho site 3 since we had the wolf data from that area in 2009. We contrasted cow activity in July for 2008 through 2011 because cattle were in the same pastures in these years. During that time span, we have 2 years of high wolf presence (2009 and 2011) and 2 years of moderate wolf presence (2008 and 2010). In 2009/11 there were a total of 25 confirmed kills and four probable kills recorded, in 2008/10 there were four confirmed and one probable kill recorded.

Ranchers tell us that when cows are being harassed by wolves that they often try to "come home" or are found near fence lines and gates. Our distribution data supports this observation. In both 2009 and 2011, although they were confined to public lands by fences, cattle tend to concentrate in areas as close as they could get to the ranch headquarters, located on private land near the western boundary of the study site. However, we noticed Wolf B446 heavily used the northeast portion of the study site in 2009, likely because it contained a rendezvous site, and afforded easy travel routes. If we assume that other wolves in the pack used the landscape in a similar fashion, cattle experiencing wolf predation threat would likely gravitate towards the west or southwest (i.e., generally towards the ranch headquarters) and away from areas heavily used by wolves. Cattle concentrated in a similar pattern and location (i.e., near the ranch headquarters) in both 2009 and 2011.

Cow Movies

An efficient and effective way of viewing GPS tracking data is by creating "cow movies" in which animal GPS positions are sequentially plotted on a background map (e.g., aerial photograph). These movies or video files typically show current animal positions as bright points that then fade and disappear leaving a "tail" of fading points as the succeeding positions continue to be plotted. The GPS positions plotted in these video files are time-stamped with Universal Date/Time so spatial relationships, activities, or specific events can be identified and, if needed, the original data sets reexamined. The videos created from each site and year can be viewed at any desired frame rate, stopped, and backed up as necessary to gain insight as to herding behavior, resource use pattern, and by combining wolf and cattle data and wolf-cattle interactions. Because file size can become very large with long duration data sets, we break our observation periods into units of 10 days or less. An example of this type of data can be viewed at http://oregonstate.edu/dept/range/node/49149.

Conclusions

After 4 years of data collection it is apparent that cattle in this study tend to naturally disperse and spread across much of the landscape available to them. Once the foraging area was selected, cattle consistently favored slopes of less than 12% and in some cases extended the preference to

include slopes up to 24%. Cattle occupied steeper landscapes up to 35% in proportion to their area. The consistency of slope use across allotments testifies to the influence of this factor on cattle distribution.

Analysis of the riparian buffer zones around perennial streams in Oregon (2008 & 2009) determined that in site 1 and 3, where streams are topographically confined and express minimal (area) riparian wetland development; cattle did not have a preference for any of the distance categories established. In site 2, where streams were less confined and the area of flood plain/wetland development was greater, cattle exhibited preference toward areas within the first 99 ft (30 m) from a perennial stream. However, regardless of these differences cattle did not use areas around perennial water more than upland areas. Cattle occupied areas beyond 197 ft (60 m) of the stream 96 to almost 99 percent of the time.

We are in the process of evaluating the degree of cattle dispersal during periods of known wolf presence. We were able to determine areas on the landscape where collared cattle were infrequent (on average 75% of the surface area studied was occupied by a collared cow for less than 1 hour), as well as where animals spent more time (foci). When collared cattle graze the same areas in different years some foci are the same but change is common. Foci typically are not on live streams.

Daily travel distance of collared cattle differs between animals and, at least on some sites, changes with season, years, and the topography being grazed. We have concern about accumulation of GPS errors when the receiver is not moving. We believe that closer examination of temporal velocity charts and the patterns they contain should allow us to not only get better estimates of actual travel distance, but also more accurately predict grazing vs. resting activities.

Although we only have analyzed data from 1 GPS-collared wolf (a total of 3 wolves have been collared but only 1 collar retrieved to date). This wolf (B446) had a sizable range and traveled impressive distances. Most of his travel occurred at night as did most of the interactions he had with collared cattle. Close encounters between B446 and collared cattle were frequent and the rancher reported cattle changed their behavior after wolves moved into the area by being more difficult to herd and handle and acting aggressively toward dogs. Wolf B446 was commonly within 547 yd. (500 m) of occupied houses (588 times or 3.1% of all wolf positions logged) during the 198 days he was tracked. Many confirmed depredations on this site were also close to houses, which implies that proximity to human habitation does not automatically confer protection from wolves. Wolf B446's daily travel distances varied substantially from day to day yet showed no seasonal trend between 24 May and 15 December 2009. This wolf, like cattle, had foci on the landscape that he frequented. The den site, rendezvous site, heifer calving pastures, and several locations in the northern portion of his range were identified as foci.

Cattle response to wolves may be apparent in velocity charts as rapid velocities during and immediately after the encounter. However, considerable variation exists with some cow's velocities remaining similar before and after encounters. In spite of this disparity, we believe that there is a potential for monitoring cow velocity with electronic accelerometers that could then signal the herdsman that a problem exists.

Cattle resource selection patterns are still being formally analyzed but on the site where collared wolf B446 was tracked, we have observed that cattle moved towards the fence lines adjacent to the private ranch lands and buildings. Whether this is a pattern that results from cognitive volition on the part of the herd to move toward safety or is simple non-directed flight, we don't know. We do not see broad scale change in the types of land being occupied by cattle, perhaps because they are not free to move out of the area. We continue to monitor both cattle and wolf spatial behavior and as more information is gathered, the picture should become clearer.

Technologies, software, and methods developed by project scientists have opened new opportunities to examine not only the interaction between cattle and wolves but also the pattern of livestock use of rangelands and the response of livestock to distribution tools such as water and salt placement. Participating ranches can use the information on cattle distribution to structure their monitoring plans to improve their ability to detect and correct grazing issues as they develop. Areas that are underutilized can also be identified and grazing management tools employed to alter landscape-use levels.

Outreach and outcomes

In 2012, outreach was conducted by several members of the team; 15 presentations were given to a wide variety of groups, with presentations in 3 different states this last year. There have been 2 presentations to the Society for Rangeland Management, 1 at the international meeting in Spokane, WA and a second one at the Pacific Northwest Section of the Society in Long Beach, WA. There were 5 presentations to ranchers or ranching-dominated groups in Union, Malheur, and Crook counties in OR, Siskiyou, CA. and Columbia County, WA. Those meetings included a wolf meeting sponsored by the local Wolf Compensation Committees of Central Oregon Wolf Economics where a research update was given, 3 regular stockgrower meetings and a special meeting at Dorris in northern California where we were invited to present to the community closest to where Wolf OR 7 settled. This last meeting was most interesting because it had so many decision makers present. The audience included a state Senator from northern California who has since been elected to the U.S. House of Representatives, an Oregon Senator who asked, if invited, would we be willing to speak to the Oregon Legislature, a county sheriff, and county board of supervisors from 2 different counties.

Following the Dorris presentation, John Williams was contacted by the Agriculture Commissioner of Siskiyou County with interest to come to Wallowa County to learn more about wolves since he believed he would soon be dealing with the issue. John subsequently spent two full days with him in Wallowa County covering the areas the wolves are using, the research, the results and the impacts wolves are having on our producers and community. Last, we were invited to the High Desert Range Camp for an evening to discuss wolves around the camp fire. These youth and adults were the most spirited and inquisitive of any group. The diversity of these locations and groups suggests the wolf-livestock issue is expanding as the wolf population expands into new territories, and is expanding into a broader part of the public consciousness as well.

There were also 2 poster sessions at the International Meeting of the Society for Rangeland Management focusing on past graduate student work that was either directly or indirectly related to the wolf/cattle research project. These were posters titled "Landscape occupancy by free-ranging Cattle in northeastern Oregon" and "Distribution and Behavior of Cattle Grazing Riparian Pastures in northeastern Oregon." Their results are based on the cattle collar information we have conducted in our research and related collar data from the Hall Ranch at the Eastern Oregon Research Center focusing on riparian usage. These papers results are very interesting as they focus on the riparian use data reported earlier in the paper. It is hoped those professional papers will be submitted for publication in early 2013.

The technology developed and the knowledge learned about the procedures, and the understanding of the technology has been expanded by spin-off research, or requests to aid others participating in their research projects. To date those include: University of Alaska @ Fairbanks; New Mexico State University; Connell University (research in Ethiopia); USAID (research in central Asia); Research in the Republic of Mongolia and Research in India.