Natural Resource LDR Update

STAKEHOLDER MEETING

June 29, 2017

Present were:

Tyler Sinclair, *Facilitator*

Anna DiSanto, *Environmental Consultant*

Cornelius Kinsey, *A Homeowner/ Builder*

Bill Resor, *Agriculture*

Chris Colligan, *Wildlife Advocates*

Sandy Shuptrine, *At Large*

Tom Segerstrom, *The Teton Conservation District-*

Aly Courtemanch, *Wyoming Game & Fish- Game*

Rob Gibson, *Wyoming Game & Fish- Fish*

Roby Hurley, *Project Manager, Member & Comp Plan Advocate*

Len Carlman, *At Large*

Rich Bloom, *A Neighbor*

Siva Sundaresan, *Conservation Advocate*

Jack Wilson, *Alta Representative*

Alder- Megan Smith, *Technical Consultant- Clarion/Alder*

Regan Kohlhardt, *Scribe, Jackson/Teton County Long Range Associate Planner*

Absent were:

Scott Pierson, *Developer*

Bill Rudd, *The Ecological Sciences Community*

Kelly Lockhart, *Property Rights Advocates*

Introductions

Jack Wilson was introduced as one of the representatives from Alta. Siva Sundaresan was introduced as the interim representative from the Jackson Hole Conservation Alliance/Conservation Advocate.

Minutes

No corrections or clarifications were made to the June 14th NRSG Meeting minutes.

Purpose

No changes were made to the NRSG purpose statement.

Issue Identification

Wetland and Waterbody Buffers

Rich:

- Current LDRs do not appropriately define agricultural-induced wetlands and wetland delineation based on time of year.

Chris:

- All manmade waterbodies should be included in the discussion.

Cornelius:

- Clarification needed for when manmade ponds can be filled back in.

Wildlife Friendly Fencing

Bill Resor asked for clarification on state statute on fencing. The statute can be found here: http://law.justia.com/codes/wyoming/2010/Title11/chapter28.html.

Sandy:

- The criteria for special purpose fencing should be reviewed and tightened.

Chris:

- Fencing in movement corridors and at highway crossings should be reviewed.

Cornelius asked if the Buckrail Fencing study could be forwarded to the group. (*It is attached to these minutes).*

Wild Animal Feeding

Rob:

- Prohibition on wild animal feeding is not enforced.

Sandy:

- There should be better provisions or another exemption for critical emergency winter feeding. The existence of this kind of program should be better communicated to the public (**Note: there currently is language in the LDRs allowing State or federal agencies to provide supplemental feed to wildlife. Sec. 5.1.3.C*).

Len:

- Enforcement of prohibition of wildlife feeding needs improvement

Siva:

- Should explore other creative ways of enforcing prohibition of wildlife feeding.

Aly:

- Agricultural lands over 70 are exempt from feeding regulations. Landowner should make all reasonable attempts to prevent wildlife from feeding. Exemption should be looked at because incidental feeding has been an issue.

Rich:

- The agricultural exemption is an issue that should be reviewed.
- Current LDRS do not address incidental wildlife feeding.

Water Quality & Stormwater Management

Chris:

- Snow removal and snow storage and related impacts to water quality should be addressed.
- Current LDRs do not address recreation impacts to designated wild scenic rivers. Consider restricting days.

Cornelius:

- Current LDRs do not address use of sand filters and peat within right of way and its impacts to water quality.
- Lack of sewer connection permit results in inappropriate connections to the sewer (e.g., runoff being routed to sewer lines*).(Note: County/Town do require permits)*
- Pollutants from archaic sewer systems and golf course runoff are problematic.

Rich:

- Ensure Grading and Erosion Control section of LDRs is consistent with Water Quality and Stormwater Management sections.

Tom:

- Stormwater management plans often seek to move runoff into streams as quickly as possible. They do not address environmental issues (**Note: Current LDRs do have requirements for keeping runoff on property)*.
- Current standards regarding grading, erosion control, and stormwater management are stricter than state standards. Do we want to keep standards that are stricter than state standards or should these by synced?
- Current LDRs do not address connectivity of man-created water features to natural water ways.

Jack:

- Current LDRs do not address increased use of de-icing chemicals on roadways, which has negative impacts on water quality.

Roby:

- Current code does not address nutrients like nitrogen, which have biggest impacts to streams.

Sandy:

- Manmade alterations of stream and river courses as they relate to water quality is an issue.

Natural Resource Overlay

Bill Resor:

- NRO causes more harm than good. People focus on the line as if it was drawn with a fine pen and not a broad paintbrush. Use vegetative mapping and Focal Species Habitat mapping to better understand what is needed on properties.

Anna:

- All areas of the valley have environmental value and are in the NRO. The NRO should not be interpreted as a hard boundary and should be replaced with something else.

Tom:

- The NRO should be replaced with something else.
- Current code does not address changing conditions of wildlife and wildlife habitat. Animals may have adapted to function in a certain way (e.g., use of certain movement corridors), but it may not be what they need.
- Ordinal ranking of vegetation is problematic.

Rich:

- Other parts of the code are driving site specific analysis regardless of NRO requirements. We have already moved there procedurally. A tiered NRO could help with this.
- Ordinal ranking of vegetation is problematic because people lean on it without recognizing the broader context. Impacts to animals are more difficult to assess.

Chris:

- Agreed with planning department's list of NRO issues. He recommended further engaging NRTAB for helping us understand how to use habitat mapping tool.

Siva:

- Need to identify what places are more important for wildlife and less important.
- We want to direct development into previously developed areas.
- We should be addressing both site-specific environmental characteristics while also understanding macro, ecosystem level characteristics.

Aly:

- Analyze cumulative impacts. Site specific does not address cumulative impacts.

Roby:

- Current 'project vicinity' analysis requirement is vague.

Cornelius:

- Everything has ecological value, but not every acre is equal. Should identify areas that do not need an environmental analysis due to low ecological value. Should there be any exemptions from natural resource regulations?

Siva:

- Cautioned against thinking about natural resource tiers as a continuum. All natural areas are important, just for different reasons
- Also noted problems associated with ordinal ranking (e.g., sagebrush can still act as critical habitat despite being ranked low).

Anna:

- Also cautioned against assigning 'importance' to different habitat.

Bill Resor:

- Address changes to wildlife behavior (e.g., changing wildlife migration corridors). Do we look at migration routes today or do we look at retaining connectivity overall? Related to this issue, Chris pointed out the Wildlife Migration Assessment will be coming out soon for the County.

Bear Conflict Area Standards

Chris:

- Ornamental vegetation in Town should be addressed.

Aly:

- Backyard poultry are becoming a greater source of conflict.

Cornelius:

- Prescriptive method for addressing environmental issues versus doing site specific EA, especially as it applies to Town

Sandy:

- There should be more space for education/resources/public outreach. *(Teton Co., Game & Fish & NGOs team up to produce educational outreach on this subject)*

Environmental Analysis (EA)

Rich:

- Need to reevaluate how LDRS balance individual property rights with need to evaluate environmental impacts.

Bill Resor

- Important to look at whose properties are subject to EAs. Platted lots, unbuilt lots, and subdivisions should be treated differently.
- Expirations, vesting, and tiers should be part of the discussion

Chris:

- Opportunity to learn from and be consistent with federal requirements. NEPA, for example, has a categorical exclusion process that could be applied here.

Tom:

- Transparency should be increased so that lots can be created with natural values in mind. Landowners/developers should be made aware of these values ahead of time.

Tyler noted that subdivision is sometimes permitted by state statutes and the County does not always have oversight over the creation of lots.

Rich:

- Incentive tools should be discussed. For example, is open space by itself valuable in exchange for density? EA requirements should be used to clarify values of open space traded for density.

Anna:

- Exemptions should be clarified. We should have specific criteria for exemptions.
- Our regulations should be synced with the Army Corp. For example, a wetland delineation is valid for 5 years with the Army Corp and only for 3 years with our regulations.

Cornelius:

- EA requirements should be tailored to animals that are most important to specific areas.

Siva noted that this was the goal of the Focal Species Habitat Mapping study.

Environmental Assessment Review Process

Siva:

- Clarify process. There is nothing inherently wrong with the current process as long as it is clear.

Rich:

- Need to clarify process to avoid increasing number of suits. Need to clarify that EA is one step in a development permit process and not a decision.

- Research conservation easement standards and bring lessons from the conservation easement standards to the LDRs.

Bill Resor:

- Regulations should be reasonable. Platted lots should be able to proceed as platted.
- Is it beneficial to worry about what the owner wants?

Cornelius:

- View of the Tetons is not a criteria in natural resource regulations.

Tom:

- Regulations need to be transparent to allow for maximization of property both economically and environmentally when lot lines are drawn (e.g., maximizing Teton views while protecting habitat).

Other Topics:

Sandy:

- Exemptions and variances should be rare and for very good reasons. Avoid creating loopholes.

Tom:

- There should be a strong statement of intent within each LDR segment.

Chris:

- The Teton County Scenic Preserve Trust should be used to preserve migration corridors.

Len:

- Transferrable development rights should be considered, especially within context of growth south of Town.

Cornelius:

- Is it possible to have a fee in lieu that might go back to helping preservation someplace else?
- What is better for wildlife in terms of lot size? Tyler noted that the lot size conversation happened as part of the Rural Land Development Regulations.

Bill Resor:

- Pursue 'carrots' in addition to 'sticks'.
- Need to identify what we have lost between '76 and now in terms of conservation.

Sandy:

- Wildfire defense considerations should be considered.
- Assign one person to watch over natural resource thread in implementing regulations.

Chris:

- There is a lack of regulation regarding control of dogs and other pets. (*Domestic Pets are regulated in the NRO. Sec 5.2.1.H.1)*

Next steps

July 17th, staff will present the natural resource update issues to the Board of County Commissioners. The group will move into solution identification.

Wildl. Soc. Bull. 20:204–210, 1992

BUCK-AND-POLE FENCE CROSSINGS BY 4 UNGULATE SPECIES

M. DOUGLAS SCOTT, *Research Division, Yellowstone National Park, WY 82190*

Wire fences used to contain domestic livestock also may inhibit the movements of wild ungulates. If designed improperly, such fences can either injure animals that become entangled or interfere with their daily or seasonal movements. Of North American ungulates, pronghorn antelope (*Antilocapra americana*) seem to be most affected (Spillett et al. 1967, Sundstrom 1967, Oakley 1973, Autenrieth 1978, Yoakum 1980, Yoakum et al. 1980), possibly because many are reluctant to jump obstacles (Einarsen 1948:145, Buechner 1950:309, Cole 1956). Deer (*Odocoileus virginianus* and *O. hemionus*) and elk (*Cervus elaphus*) may have difficulties crossing wire fences (Falk et al. 1978, Ward et al. 1980, Adams 1982, Feldhamer et al. 1986). Migrating bison (*Bison bison*) may detour around wire fences (Meagher 1989).

Research on wire fence designs that held livestock yet allowed most antelope and deer to pass (Spillett et al. 1967, Mapston 1970, Reed et al. 1974), combined with field experience, led to guidelines for construction of fences on western rangelands (U.S. Bur. Land Manage. 1974, Autenrieth 1978, Yoakum 1980, Yoakum et al. 1980, Kindschy et al. 1982). Although barbed and woven-wire fences are most commonly used in the West, buck-and-pole fences are becoming more common. Such fences are more time-consuming and costly to build than wire fences, so they are usually reserved for rocky or wet sites where fence posts are impractical. Buck-and-pole fences also are used to enclose valuable livestock that could be injured by wire fences. Buck-and-pole fences often are considered desirable in rural areas because of their rustic appearance.

A fence height ≤86 cm and a bottom gap ≥30 cm supposedly allow wild ungulates to cross buck-and-pole fences (Autenrieth 1978). These guidelines seemed to be estimates; there is no widely accepted size standard for buck-and-pole fences. I found no data describing the success of ungulates crossing buck-and-pole fences, so I studied this on part of the boundary of Yellowstone National Park in 1987 and 1988.

My objectives were to determine if, under field conditions, wild ungulates were able and willing to: (1) cross intact (undamaged) fence, closed gates, or open gates; (2) cross intact fence equally well from either side; (3) cross intact fence without becoming temporarily trapped inside it.

STUDY AREA AND FENCE CHARACTERISTICS

The study site (Fig. 1) consisted of 3.8 km of the northern boundary of Yellowstone National Park and was approximately 7.5 km northwest of Gardiner, in southcentral Montana. Topography ranged from a fairly uniform 7% slope for 1,200 m west of the Yellowstone River to mixed 10–30% slopes as the boundary extended up the Gallatin Mountains. The area was semiarid at lower elevations, with a 30-year mean annual precipitation at Gardiner (1,615 m elevation) of 27.7 cm. A site comparable to the upper reaches of the fence, at Mammoth, Wyoming (1,902 m elevation and 10 km distant), averaged 42.1 cm of precipitation/year (R. A. Dirks, Annu. Rep., Dep. Atmos. Sci., Univ. Wyoming, Laramie, 1974).

Vegetation on the lower 75% of the study area was mostly shrubland and grassland. Dominant shrubs included big sagebrush (*Artemisia tridentata*) and rubber rabbitbrush (*Chrysothamnus nauseosus*); and common grasses were Idaho fescue (*Festuca idahoensis*), needle-and-thread (*Stipa comata*), and bluebunch wheatgrass (*Agropyron spicatum*). The upper 25% of the fence passed through scattered stands of Douglas-fir (*Pseudotsuga menziesii*) with an understory of big sagebrush, Idaho fescue, and needle-and-thread. The area was described in more detail by Houston (1982:3–9, 85–136).

Wild ungulates always have migrated daily and seasonally across the northern park boundary (Houston 1982:10–35, 156–168). Mule deer, pronghorns, and elk occasionally were seen moving across the boundary during this study. Bison were near the fence only in winter, and most that crossed the boundary were killed by hunters or game wardens.

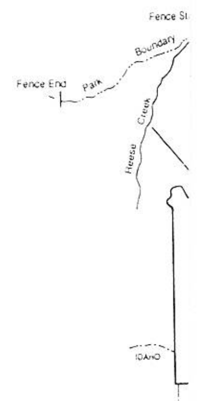

Fig. 1. Location
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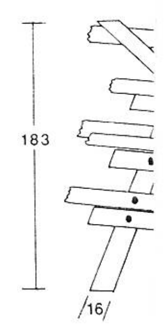

Fig. 2. Typical
National Park. T

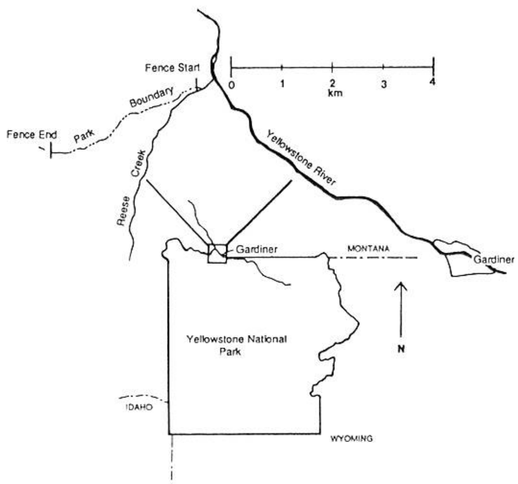

Fig. 1. Location of a 3.8-km buck-and-pole fence built along part of the northern boundary of Yellowstone National Park in 1987–1988.

The buck-and-pole fence was 1–2 m north of the park boundary and replaced a barbed-wire fence. The fence was erected by an adjacent landowner to keep cattle out of Yellowstone and prevent park bison from being hunted on the landowner's property (Anonymous, Royal Teton Ranch News, Corwin Springs, Mont., 1989).

The fence began at an elevation of 1,586 m, approximately 0.4 km west of the Yellowstone River (Fig. 1). It followed the park boundary for 3.8 km and ended at an elevation of 2,167 m, where it joined an older wire fence. Most of the fence was built in 1987, with an additional 152 m and 2 gates added in 1988. The fence contained 21 metal or wood gates and 1 wire gate, which were opened at irregular intervals. Gate distribution along the fence was not uniform. Comparing 956-m lengths, there were 5, 5, 3, and 9 gates from the northeast to the southwest end. Wood gates were 4.0–7.3 m wide, 1.7 m high, and had 4 rails. Metal gates were 3.6 m wide and 1.5 m high, with 6 horizontal bars. Between gates, the park side of the fence had 4 rails, with the lowest generally elevated 25–59 cm and the highest 165–185 cm above the ground (Fig. 2). A single rail 65–85 cm above ground was on the private landowner's (north) side of the fence, making the basal width 165–175 cm. Two small irrigation ditches passed under the fence, and a county road was <100 m from the lower fence end.

METHODS

I used track counts to monitor ungulate crossings of the fence (Reed et al. 1974, Reed et al. 1975, Falk et al. 1978, Ward et al. 1980). New storms that deposited ≥2.5 cm of snow over the entire fence length provided fresh tracking surfaces. Cumulative snow depths were recorded at the lower and upper ends of the fence during each survey. Melting or wind action sometimes left <2.5 cm of snow at the lower precipitation gauge, yet there was still enough snow on the ground for tracking. After waiting 10.5–109 hours ($\bar{x}$ = 37.2, SE = 5.3, n = 16) after a storm, I surveyed the entire length of the fence and counted tracks of animals that tried to cross from either side. Suitable storms allowed 8 surveys between 5 January and 8 March 1988 and 8 surveys between 16 November 1988 and 14 March 1989.

Crossing success and direction of travel at and between the 22 gates were recorded. I considered a crossing successful if an animal passed directly through (or under) the entire fence, or if it went between the 4 main rails (south side of fence) and the single brace rail (north side), walked inside the fence for a distance,

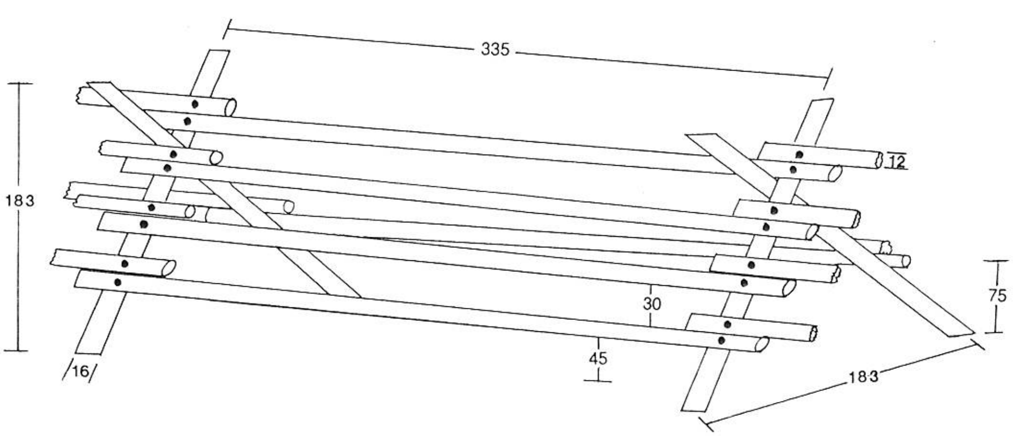

Fig. 2. Typical section of a buck-and-pole fence built along a portion of the northern boundary of Yellowstone National Park. The 4 rails faced to the south, or park side (units in cm).

then exited on the opposite side. Feeding inside the fence sometimes occurred. Travel inside the fence was judged to have occurred if there were ≥30 cm of tracks perpendicular to the original line of approach. I recorded a successful crossing if an animal found and used an open gate (some animals walked to open gates but did not use them).

An unsuccessful crossing occurred when an animal went inside the fence, then went back out on the same side from which it entered. As with successful crossings, travel and feeding inside the fence sometimes took place. I did not consider a feeding animal that repeatedly weaved in and out of the fence to have attempted a crossing. I designated a second type of unsuccessful crossing attempt a "fence repel," when an animal clearly approached the fence or gate from >10 m (measured perpendicularly from the rail) to <2 m, traveled <10 m parallel to the structure, then retreated >10 m in the general direction from which it came. Animals that were not repelled by the fence generally continued to walk beside it until they reached an open gate. Usually, the fence was then successfully crossed.

Open gates were sometimes heavily used, and counting tracks in these was difficult if >10 animals passed through. This problem was largely solved by following tracks for ≤100 m from the fence, where individual animals became more dispersed.

The tracks of bison and elk were easily distinguished from those of other species. I used 2 methods to separate tracks of pronghorns and mule deer. First, if some tracks in a group were as large as those of adult deer, the group was recorded as "all deer." If all tracks were the smaller size of adult pronghorns or less (yearlings and kids), the group was classified as "all pronghorns." Secondly, pronghorns almost always used the lowest, most level topography along the first 1,300 m of the fence, which included gates 1–7 (M. D. Scott, Yellowstone Natl. Park, unpubl. data, 1989). Mule deer used the entire area.

Some animals may have crossed (or tried to cross) the fence or gates >1 time during the hours between the end of snowfall and when a track survey occurred. To increase sample independence, when summarizing all surveys for each species, the track data for each species for each survey were converted to between-gate fence-crossing success rates and open-gate use rates. The crossing rates/survey were then used to calculate overall $\bar{x}$ and SE values.

For all species, lateral movement ≥10 m within the fence, without feeding activity, was considered evidence that a successful or unsuccessful crossing was delayed because the animal became trapped inside the fence. Presence of recently clipped plants with the new snow removed, and nearby tracks, were evidence of ungulate feeding. Animals trying to cross intact fence either were repelled or they entered. If the proportion of repels versus enters on 1 side of the fence differed significantly from a species' overall north-south herd movement direction, this was considered evidence that the number of fence rails (4 or 1) influenced whether an animal was repelled or was able to enter. Chi-square 2 × 2 contingency tables, and z-tests, with correction for continuity (Snedecor and Cochran 1967:211-217) were used to test the following null hypotheses: (1) equal numbers fed and did not feed during unsuccessful crossings where ≥10 m of travel inside the fence occurred (mule deer); (2) equal numbers fed and did not feed during all crossing attempts where the animal entered the fence (elk); (3) when ≥10 m of travel inside the fence occurred, the proportion of animals feeding during unsuccessful crossings was equal to the proportion feeding during successful crossings (mule deer); (4) during all crossing attempts where ≥10 m of travel inside the fence occurred, the proportion of feeding pronghorns was equal to the proportion of feeding mule deer; (5) the proportion of successfull fence crossings that had ≥10 m of travel inside the fence was equal to the proportion of unsuccessful fence crossings with ≥10 m of travel inside the fence (pronghorns); (6) for all crossing attempts where ≥10 m of travel inside the fence occurred, the proportion of animals entering from the north (1-rail) side was equal to the proportion approaching from the north during all crossings (pronghorns, elk); (7) for all crossing attempts where elk entered intact fence, the proportion entering from the north was equal to the proportion approaching from the north during all crossings; and (8) the proportion of animals repelled from the south (4-rail) side of the fence was equal to the proportion approaching from the south during all crossings (pronghorns, bison, elk). Null hypotheses were rejected at $P \leq 0.05$.

RESULTS AND DISCUSSION

Snow depths at the lower end of the fence ranged from 0.0–10.0 cm ($\bar{x}$ = 4.0, SE = 0.78, n = 16), whereas depths at the upper end were from 14.0–76.0 cm ($\bar{x}$ = 50.4, SE = 4.7, n = 16). During the 2 winters, 5–16 samples of overall fence and open-gate crossing success (2,580 track sets) were made for the 4 ungulate species. Fence and gate crossing rates for each species were similar for both winters and were pooled (Table 1).

No animals leaped the fence. Closed gates were crossed only twice. A pronghorn crawled under 1 wooden gate; 3 mule deer jumped a different gate with 2 upper rails missing.

Mule Deer

Mule deer crossed intact fence an average of 85% of the time they encountered it (Table 1). Mule deer, pronghorns, and bison made the least use of open gates when crossing the fence

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Bison
Elk
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Table 1. Success rates of wild ungulates attempting to cross a 1.8-m-high buck-and-pole fence on the Yellowstone National Park northern boundary from 5 January to 8 March 1988 and 16 November 1988 to 14 March 1989.

Species	n	Between-gate fence-crossing success rate		Use of gates[a]		Success rate for all crossing attempts	
		%	SE	% of all successful crossings	SE	%	SE
Mule deer	15[b]	85[c]	2.5	45[c]	4.3	91	1.6
Pronghorn	13[b]	72[c]	7.6	45[c]	7.6	87	2.7
Bison	5	46[d,e]	20.4	48	18.6	55	17.8
Elk	16	17[c,d,e,f]	8.2	97[c]	1.6	91	1.8

[a] Twenty gates were present in 1988; 22 in 1988–1989.
[b] Rapid snowmelt completely prevented some mule deer (1 day) and pronghorn (2 days) track surveys in March 1988.
[c] Erratic snow drifting between gates 1 and 4 may have obliterated some tracks of mule deer (2 days), pronghorns (1 day), and elk (3 days) on 3 fence surveys in February and March 1988.
[d] Some fence crossings were accomplished where 1 rail partly fell down (4 elk) or where an irrigation ditch underpass was present (2 elk, 2 bison).
[e] Three rails in 1 fence section were broken by bison, allowing 1 elk and 15 bison to cross the fence.
[f] Five elk became trapped inside the fence but were able to reach the other side by exiting through crosslegs at a corner (1) or at gates (4).

(Table 1). Tracks and sightings indicated mule deer did not commonly detour around either end of the fence.

In 24 of 45 successful crossings where deer showed ≥10 m of lateral movement, they fed on grasses and shrubs while inside the fence. They also fed during 18 of 26 unsuccessful fence crossings that involved considerable lateral travel. Feeding (versus not feeding) during unsuccessful crossings occurred >50% of the time ($z = 2.24$, 1 df, $P = 0.013$) and was greater than the rate of feeding during successful crossings ($\chi^2 = 4.2$, 1 df, $P = 0.04$). Evidently, some of what I classified as "unsuccessful crossing attempts" by mule deer were just short feeding excursions inside the fence. This view was reinforced by observations of tracks of 6 different feeding deer, which wove in and out of the fence (and were not included in crossing attempt data). Grass and forbs under the fence were noticeably taller than elsewhere, probably because other ungulates did not often graze under the fence. This may have attracted the deer.

Tracks revealed that mule deer either crawled under the lowest fence rails (on both the 4-rail and 1-rail sides) or passed between the lowest 2 rails on the 4-rail side. Snow accumulation did not seem to affect deer passage except when snow became deeper than the lowest fence rail; then deer passed through the rails rather than crawling under.

Pronghorns

Pronghorns crossed the fence an average of 72% of the time they encountered it (Table 1). Sightings and tracks indicated 10–20 pronghorns/day avoided the fence by detouring around its lower end.

Pronghorn feeding occurrences inside the fence during 21 crossing attempts where ≥10 m of lateral movement occurred were lower than those for mule deer ($\chi^2 = 18.1$, 1 df, $P < 0.001$). Only 2 of all 185 pronghorn fence-crossing attempts where the animal actually entered the fence involved feeding inside the fence.

Three factors suggested pronghorns had trouble crossing the fence and sometimes became delayed within it. First, only 10 of 166 successful crossings involved lateral travel ≥10 m, whereas 11 of 19 unsuccessful crossings (where the animal actually entered the fence) entailed travel inside the fence ($\chi^2 = 40.5$, 1 df, $P < 0.001$). Secondly, even though pronghorns did not show noticeable net migratory trends in or out of the park (162 north, 190 south; sum of all surveys), they largely entered the fence from the north side when travel ≥10 m inside the fence occurred ($\chi^2 = 4.7$, 1 df, $P = 0.03$, as compared to the net north-south movement ratio), regardless of the success of the crossing. Evidently, pronghorns having difficulty crossing the fence were more willing to try to enter it from the north under a single brace rail 65–85 cm above the ground, rather than crawl under or through the 4 rails on the park side, which were spaced only about 30–40 cm apart. Third, fence repel records confirmed the difficulty pronghorns had entering the fence from the 4-rail side. Twenty-four of 30 repels occurred on the 4-rail side, which was greater than that expected based on the overall successful northward versus southward movement ratio of 162:190 ($\chi^2 = 11.5$, 1 df, $P < 0.001$). Most pronghorns crawled under the fence rails, and the $\leq$10-cm snow depths at the lower 2 fence quarters used by pronghorns did not seem to interfere with their crossings.

Bison

Bison did not cross intact fence. However, 17 crossings were accomplished either by breaking fence rails or by using 1 of the 1-m-deep irrigation ditches that passed under the fence (Table 1). Large numbers of bison left the park only in the winter of 1988–1989. The fence owner closed most of the lower gates during the migration, but a few bison still found and used open gates. Most bison that encountered the fence walked along it downhill, then went around it at the eastern end.

Nineteen of 21 crossing attempts where bison actually entered the fence involved movement south. Conversely, 11 of 13 fence repels, where bison approached but did not enter the fence, were on the 4-rail side of the fence, and this ratio was different from the overall 7:18 north-south successful crossing ratio ($\chi^2 = 8.7$, 1 df, $P = 0.003$). All 15 crossings where bison broke the fence originated from the 1-rail side of the fence. One bison calf traveled 21 m inside the fence during an unsuccessful crossing attempt. It entered from the 1-rail side. All bison crossings were in areas of low snow accumulation.

Elk

Elk had the lowest success of the 4 species in crossing intact fence (Table 1). All successful crossings of fence rails were caused by unusual circumstances, such as elk entering under the 1-rail side and exiting through crosslegs at an open gate. Conversely, 97% of total elk crossings occurred through gates. Elk almost never detoured around the lower end of the fence that was near a county road. They may have been avoiding late-season hunters and other human activity.

Elk fed inside the fence on 2 of 6 crossing attempts where $\geq$10 m of lateral travel occurred. These 2 feeding episodes were the only ones during all 18 crossings of intact and damaged fence where the animal actually entered the fence. Thus, as with pronghorns, elk entered the fence much more often to cross than to feed ($z = 3.3$, 1 df, $P < 0.001$), and elk frequently appeared to be trapped in the fence.

All 11 of the crossing attempts where intact fence sections were entered by elk originated from the 1-rail side, although more elk moved north than south (440:335). The crossing attempt rate was not consistent with the general north-south movements ($\chi^2 = 12.2$, 1 df, $P < 0.001$). Six crossing attempts involved travel inside the fence for $\geq$10 m, and 5 involved $<$10 m of travel. All elk that traveled $\geq$10 m inside the fence entered from the 1-rail side, which differed from the overall north-south movement pattern ($\chi^2 = 5.7$, 1 df, $P = 0.017$).

Repel data confirmed that elk had difficulty entering the fence from the 4-rail side. Eighty-four of 101 repels occurred on the 4-rail side. This number of repels was greater than expected from the overall north-south movement ratio ($\chi^2 = 24.8$, 1 df, $P < 0.001$). At $\alpha = 0.05$, the probability of at least 1 Type I experimental error among the preceding 11 χ^2 tests was 0.4.

CONCLUSIONS AND MANAGEMENT IMPLICATIONS

Intact-fence crossing rates varied among the 4 species, with mule deer > pronghorn > bison > elk. Snow depths did not seem to prevent intact-fence crossings, although deer switched from crawling under rails to passing through them when snow along the upper fence was deeper than the lowest rail. Deep snow might prevent pronghorns from crawling under fence rails. However, I visited the fence in 1990 and 1991 after 3 storms left >30 cm of snow at the lower fence and found that wind turbulence scoured much of the snow from beneath the fence and deposited it on the lee side.

Many animals that did not cross intact fence walked along it until they found an open gate. Thus, rate of gate use by the 4 species was nearly the reverse of the intact fence crossing rate, with elk > bison > pronghorn = mule deer. The use of open gates appeared to compensate for inability to cross intact fence. Managers should provide enough gates to minimize uphill or downhill detours by animals, which may cause extra energy loss (Parker et al. 1984). Overall crossing success (intact fence + open gates) was consistently 87–91% for all species except bison.

If gates in a buck-and-pole fence of this size were closed to hold livestock, both elk and bison crossings would drop to nearly 0 (assuming bison did not break the fence to cross). Pronghorn crossing rates could be reduced by half.

Elk might be encouraged to jump this fence if the top 2 rails were removed (leaving a 95-cm-high barrier). Elk jumped a fence reduced to 107-cm high in Grand Teton National Park (R. W. Wood, Grand Teton Natl. Park, pers. commun., 1991).

A second way to encourage elk (and pronghorn) passage is to simply replace buck-and-pole fences with barbed-wire fences meeting wildlife passage guidelines. If removal of the entire wooden fence is not desired, wire passages could be made to replace rails about every 100 m.

The only ungulates that commonly fed on tall vegetation inside the fence were mule deer. Because it offered an exclusive food source, the fence may have benefited mule deer.

Elk and bison seldom tried to cross through the intact 4-rail side of the fence. They apparently were too big to squeeze through the 30- to 40-cm spacings. A majority of the elk that did enter intact fence (from the 1-rail side) seemed to become trapped.

Pronghorns were able to cross under or through the rails, especially from the 1-rail side, but they also showed much lateral travel (without feeding) within the fence, indicating they may have been trapped temporarily. I only examined ungulate fence crossings under conditions where gates were left open at the landowner's discretion. Pronghorns had the option of walking along the fence until they found an open gate or the fence ended. Also, I had no way of knowing if a pronghorn tried to cross intact fence repeatedly until it succeeded. Studies of pronghorns completely enclosed by a test fence, such as described by Spillett et al. (1967), would be required before a conclusive success rate for pronghorn crossing of intact buck-and-pole fence could be determined.

SUMMARY

In 1988 and 1989, I studied the abilities of mule deer, pronghorns, bison, and elk to cross a 3.8-km buck-and-pole fence that was built on part of the northern border of Yellowstone National Park. No animal jumped the fence. Mule deer were most successful at crossing through intact fence, followed by pronghorns, bison, and elk. Rate of gate use by ungulate species was nearly the reverse of intact-fence crossing success rate. Except for bison, the overall total successful fence crossing rate was about 87–91%. Closure of all gates in a fence of the size studied would virtually stop all

crossings by elk and bison. If gates cannot be left open, elk may jump buck-and-pole fences if the top 1 or 2 rails are removed (leaving a maximum height of about 1 m), or if barbed wire meeting wildlife passage guidelines is substituted. Mule deer commonly fed inside the fence and may have benefited from exclusive use of this forage. Pronghorns, bison, and elk had difficulty entering the fence from the 4-rail side. Elk and pronghorns sometimes seemed to become trapped inside the fence.

Acknowledgments.—This research was funded by the National Park Service, Yellowstone National Park. I thank K. B. Clark, D. L. Clark, and D. L. Trofka for their help with field work in very strenuous topography and harsh environmental conditions, and I thank S. A. Scott for manuscript typing.

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Received 22 August 1990.
Accepted 13 November 1991.
Associate Editor: Holler.