June 11, 2009

MEMORANDUM

To: P.J. White, Supervisory Wildlife Biologist, Yellowstone National Park

From: Chris Geremia, Biological Science Technician, Yellowstone National Park

Subject: Remote Camera Imagery of Bison Road Use during Winter 2009

**Background**: In September 2007, Drs. Robert Garrott (Montana State University) and P.J. White (National Park Service) recommended a tiered investigative approach to gain reliable knowledge regarding the effects of road grooming on bison movements that could contribute to the development of winter use policy (Garrott and White 2007). An initial step under this approach was to deploy camera systems along the Firehole Canyon and Gibbon Canyon road segments to collect baseline data on the direction, frequency, magnitude, and timing of bison movements through these travel corridors. Similar studies were also recommended by Dr. Cormack Gates (University of Calgary) in his report on bison use of groomed roads in Yellowstone National Park (Gates et al. 2005).

**Methods**: Prior to deploying the camera systems, the number and distribution of bison wintering in the Madison headwaters area was estimated by biologists from Montana State University on snowmobiles or snowshoes traveling along six distinct routes through 74 sampling units over two days (Bjornlie and Garrott 2001, Bruggeman et al. 2006). Observers started each route simultaneously to minimize missing or double counting bison. These surveys afforded a nearly complete enumeration of bison in this area as determined from an aerial-ground double-sampling study (Hess 2002).

We installed two silent image professional PM-35 and one PM-75 1.4-mega pixel monochromatic infrared illuminator cameras (Reconyx, LaCrosse, Wisconsin) along the roadways between Old Faithful and Norris Junction to monitor bison road use in the Firehole and Gibbon canyons. PM-35 and PM-75 cameras were installed approximately 100 meters apart in the Firehole Canyon during February 3 to March 9, 2009 and programmed at different sensitivities to determine appropriate camera settings for capturing bison movements. Only the PM-75 camera was used during March 9-May 2, 2009. These cameras were located on the Grand Loop Road immediately north of the exit of the one-way Firehole Canyon drive (511567, 4940487; UTM NAD 27 Zone 12N). In addition, we installed one PM-35 camera during February 25-May 18, 2009 on the Grand Loop Road north of Gibbon Falls at the Gibbon Canyon site (520444, 494618).

Each camera was programmed to collect imagery continuously during the duration of the project. The devices were infrared triggered digital cameras that captured monochromatic still images during day and night. Images and camera settings were stored on 2 megabyte flash drives that required replacement approximately once per month. Cameras were powered using rechargeable C cell batteries that required replacement approximately every two weeks when temperatures ranged between $0^{o}$ and $-20^{o}$F, and less frequent maintenance under more moderate temperatures.

One image was recorded per second when bison or other wildlife were within the view shed of the camera. Each picture was tagged with the time and date of photographing, and ambient temperature within the camera housing. Images were downloaded and viewed using Mapview Professional Software (Reconyx, LaCrosse, Wisconsin). Sequential viewing of images provided near-video documentation of bison movements. We categorized bison into groups by delineating animals observed more than 30 minutes apart as members of unique groups. For each group, we classified bison as males more than 1-

year-old, females more than 1-year-old, unknown gender adults more than 1-year-old, and calves less than 1-year-old (Fuller 1959). These data are stored at O:\Winter_Use\2008-2009 Data\BisonCameraRoadUse_2009.

**Results**: We continuously collected imagery during February 3-May 2, 2009 and recorded 4,138 images of wildlife including bison, coyotes, wolves, grizzly bears, fox, and elk at the Firehole Canyon site. We recorded 628 images of similar wildlife during February 25-May 18, 2009 at the Gibbon Canyon site. Data collection continued through the road-plowing time period, which began on or about March 3 for the Norris to Madison Junction road segment and March 15 for the Madison Junction to Old Faithful road segment.

Monitoring at the Firehole Canyon site began prior to large-scale movements by bison to lower elevation winter ranges in the Madison headwaters area and outside the western park boundary. Comprehensive ground-based surveys during January 31-February 1, 2009 detected 94 bison north of the Firehole Canyon camera station, including 63 bison near Madison Junction, 8 bison in Cougar meadows, 13 bison in Gibbon meadows, and 10 bison in the Norris Geyser basin (R. Garrott, Montana State University, unpublished data). Thereafter, the cameras recorded 1,192 observations of bison moving through the Firehole Canyon, with 1,092 bison traveling north towards Madison Junction and 100 bison traveling south towards Fountain Flats. The net increase in the number of bison moving north of the Firehole Canyon camera station was from 405 to 1,087 animals during April 2-May 2, 2009 (Figure 1).

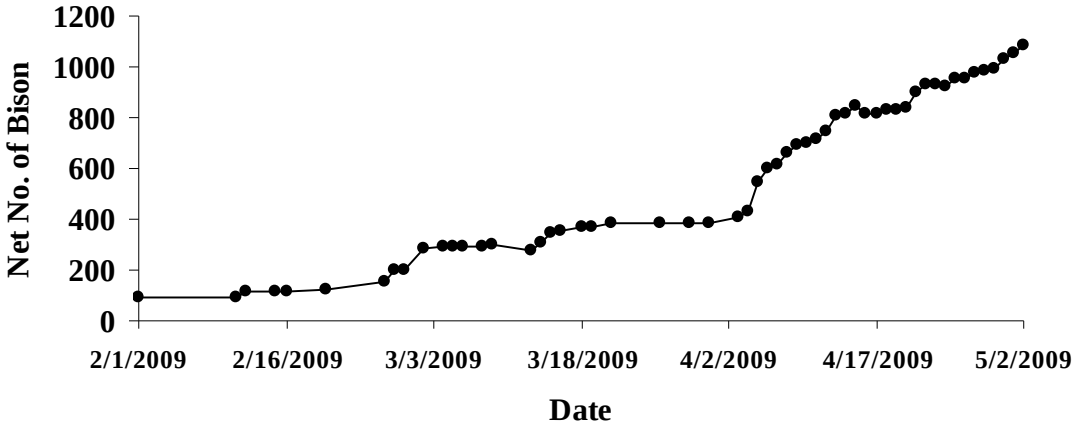


Figure 1. Cumulative net increase in the number of bison traveling north along the road by the Firehole Canyon camera station in Yellowstone National Park based on a comprehensive ground-based survey during January 31-February 1, 2009 and information collected using remote photography along the roadway through the Firehole Canyon during February 3-May 2, 2009. Bison moving south past the camera station were subtracted from the totals moving north.

Movement was predominantly unidirectional towards the Madison headwaters for all bison during the monitoring period. We did not detect an obvious trend indicating that movements by bachelor groups preceded movements by mixed age and gender groups. We recorded 74 bachelor groups of males more than 1-year-old moving by the Firehole Canyon camera station, 65 of which were traveling north towards Madison Junction. The average bachelor group size was 3.1 $\pm$ 5.8 and ranged from 1 to 16 individuals. Bachelor group movements occurred consistently after early March (Figure 2). We recorded 46 mixed age and gender groups moving through the monitoring site with an average group size of 19.0 $\pm$ 40.0 and ranged from 1 to 102 bison. Forty mixed age and gender groups were observed traveling north towards

Madison Junction, while only six were counted moving south towards Fountain Flats. Movements by mixed age and gender group occurred sporadically during mid-February through mid-March, but became more regular through April (Figure 2). Bison movements occurred consistently during 0700 to 2000 hours, with few movements overnight (Figure 3).

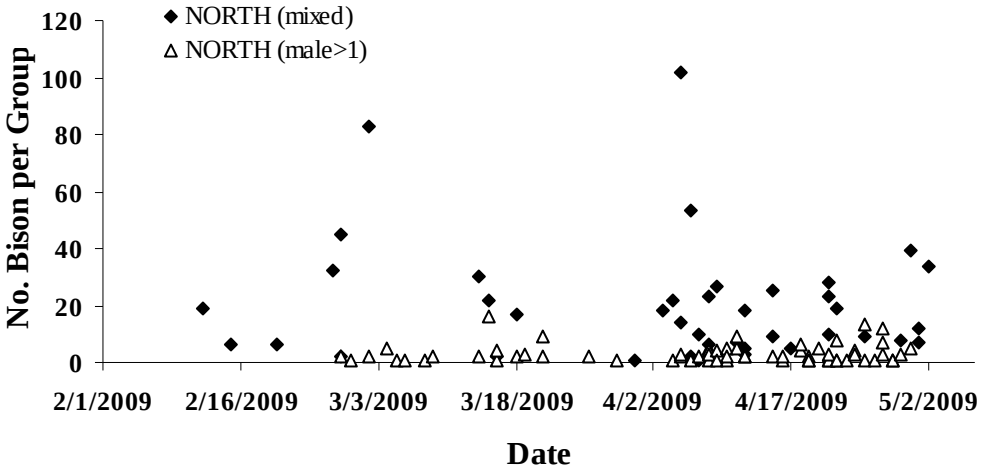


Figure 2. Observed bachelor and mixed age and gender groups of bison moving along the road towards Madison Junction by the Firehole Canyon camera station in Yellowstone National Park during February 3-May 2, 2009.

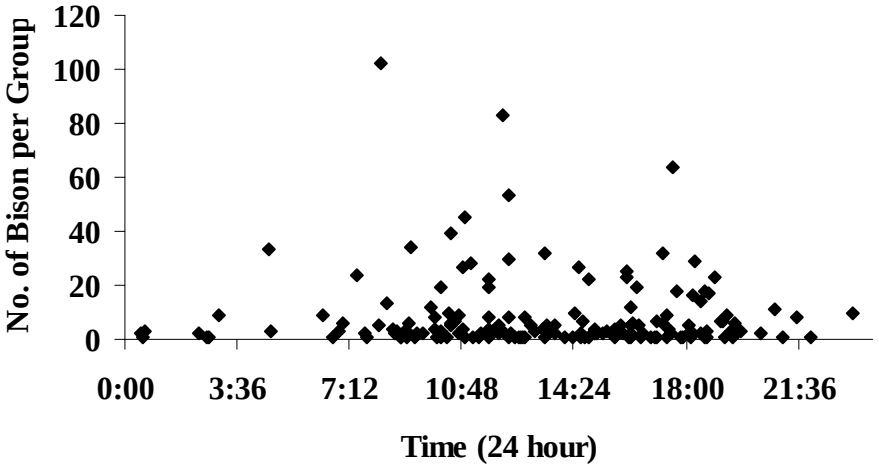


Figure 3. Hourly chronology of bison movements along the road by the Firehole and Gibbon Canyon camera stations in Yellowstone National Park during February 3-May 18, 2009.

A comprehensive ground-based survey during February 16-17, 2009 detected 129 bison north of the Gibbon Canyon camera station, including 72 animals in Gibbon meadows, 11 animals in the Norris Geyser basin, and 46 animals near Swan Lake. The net increase in the number of bison north of Gibbon Canyon was 58 bison across the duration of the monitoring period with numbers peaking at 245 on April 14, 2009 (Figure 4). Movement was predominantly unidirectional to the north towards Norris Junction prior to the peak in mid-April, but reversed thereafter with most movement heading south towards

Madison Junction. We recorded 24 bachelor groups with equal numbers of groups moving to the north and south. Average bachelor group size was 2.0 ± 2.9 and ranged from 1 to 7 individuals. Average mixed age and gender group size was 12.0 ± 21.7 bison, which was observed in 13 groups ranging in size from 1 to 32 individuals, including 7 groups moving to the north and 6 groups moving to the south.

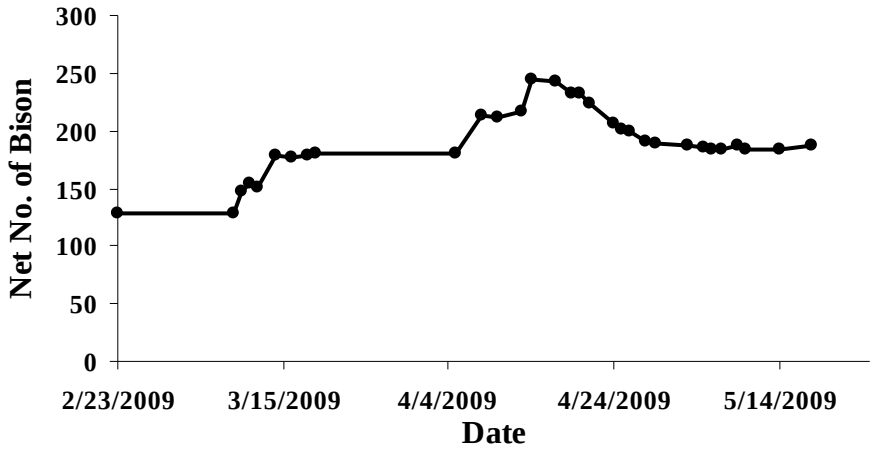


Figure 4. Cumulative net increase in the number of bison traveling north along the road by the Gibbon Canyon camera station in Yellowstone National Park based on a comprehensive ground-based survey during February 16 - 17, 2009 and information collected using remote photography along the roadway through the Gibbon Canyon during February 25-May 18, 2009. Bison moving south past the camera station were subtracted from the totals moving north.

The information collected at the Firehole Canyon camera station indicated that at least 80 percent of the central bison herd migrated into the Madison headwaters area during winter 2009, with most movement occurring in April. The age and gender composition of bison moving by the Firehole Canyon (calves to females = 0.22; males to females = 0.74) and Gibbon (calves to females = 0.19; males to females = 0.67) camera stations was comparable to overall estimates for the central bison herd for calves to females (0.24), but lower for overall males to females (0.97). There was some support in the data suggesting that bison groups with relatively high ratios of calves to females moved into the Madison headwaters early in winter, but that ratios progressively decreased as winter progressed (Table 1).

Table 1. Age and gender composition of bison observed moving north along the road towards the Madison headwaters area during February 3-May 2, and the upper Gibbon valley during February 25-May 18, in Yellowstone National Park during winter 2009.

| | **Firehole Canyon Site** | | | **Gibbon Canyon Site** |
|---|---|---|---|---|
| | February 3-28 | March 1-31 | April 1-May 2 | February 25-May 18 |
| Males > 1 | 24 | 75 | 258 | 45 |
| Females > 1 | 50 | 95 | 337 | 67 |
| Unknown > 1 | 20 | 8 | 45 | 3 |
| Calves | 20 | 31 | 56 | 13 |
| Calf : Female | 0.40 | 0.33 | 0.17 | 0.19 |
| Male : Female | 0.48 | 0.79 | 0.77 | 0.67 |

**Discussion**: Bison travel along roads through the Firehole and Gibbon canyons was relatively low during the road grooming and over-snow vehicle travel period compared to the substantial increase in bison movement into the Madison headwaters that occurred after the plowing of roads in this area during March. Nearly all mixed age and gender groups from the central bison herd moved into the Madison headwaters by early May. Less than 25 percent of these bison subsequently moved into the upper Gibbon valley, with most returning south to the Madison headwaters by May. Information collected from radio-marked bison indicated that most bison that moved into the upper Gibbon valley continued to the northern winter range near Gardiner, Montana before returning south to the Madison headwaters.

Bison groups with higher proportions of calves (e.g., 0.40) tended to move north into the Madison headwaters earlier in winter, similar to observations at bison handling facilities near the northern and western park boundaries during January to March in 2004 (calves to females = 0.44), 2005 (0.37), 2006 (0.48), and 2008 (0.53). However, while group-specific ratios of calves to females were significantly higher before April 8, 2009 ($mean_{Feb\ 3\text{-}Apr\ 8} = 0.19$; $mean_{Apr\ 9\text{-}May\ 2} = 0.06$; $F = 3.30$, $p < 0.01$, $df = 19, 17$), we did not detect support in the data that calf to female ratios were higher in groups moving along roads during the road grooming period ($mean_{Feb\ 3\text{-}Mar\ 16} = 0.24$; $mean_{Mar\ 17\text{-}May\ 2} = 0.10$; $F = 1.28$, $p = 0.29$, $df = 9, 28$).

Camera monitoring of road segments through the Firehole and Gibbon canyons during winter 2009 demonstrated that remote photography can be used to effectively estimate the timing, magnitude, and direction of bison road use and migration. However, additional years of monitoring are necessary to establish a reliable baseline of trends. We recommend installing a total of four camera stations during December 2009 through April 2010 to monitor bison movements through the Firehole and Gibbon canyons, along the Mary Mountain trail, and along the Mammoth to Norris road near Twin Lakes. Data collected from these cameras would facilitate further understanding of central herd bison movements.

**Literature Cited**:


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