INTERAGENCY BISON MANAGEMENT PLAN

NATIONAL PARK SERVICE

USDA ANIMAL AND PLANT HEALTH INSPECTION SERVICE

APHIS

UDSA FOREST SERVICE

MONTANA DEPARTMENT OF LIVESTOCK

MONTANA

MONTANA FISH, WILDLIFE & PARKS

Memorandum

September 28, 2009

To: Administrative Record

From: Interagency Bison Management Plan Partner Agencies

Subject: Annual Report, July 1, 2008 through June 30, 2009

The Interagency Bison Management Plan (IBMP) was signed in 2000 to coordinate bison management between the State of Montana and Yellowstone National Park. Five agencies are responsible for implementing the plan—the U.S. Department of Agriculture's Animal and Plant Health Inspection Service and Forest Service; the Department of the Interior's National Park Service; and the State of Montana's Department of Fish, Wildlife, and Parks and the Department of Livestock.

Under the IBMP, these agencies harness their respective skills and operational resources to work cooperatively within an adaptive management framework to conserve a wild, free-ranging bison population, while concurrently reducing the risk of brucellosis transmission from bison to cattle. In keeping with this adaptive management framework, the IBMP partner agencies met several times in public venues from August 2008 through June 2009 to deliberate on recent recommendations by the U.S. Government Accountability Office, assess the effectiveness and outcomes of IBMP management activities, and incorporate short and long-term adaptive management adjustments to the IBMP based on prevailing conditions. The partner agencies created measurable objectives for the IBMP and developed a specific monitoring program to assess scientific and management questions.

The attached report includes narrative summaries that address the effects and effectiveness of each management action in the IBMP Adaptive Management Plan that was agreed-upon and signed by the partner agencies during December 2008. It also summarizes progress on the surveillance plan for bison and improvements on vaccines, vaccine delivery systems, and disease testing for brucellosis in bison as a result of the working symposium organized by the U.S. Animal Health Association at the University of Wyoming in Laramie during 2005.

This report will be used to inform future management discussions and actions related to adaptive management for 2009-2010 and beyond. The report will be made available to the public and other interested parties through the IBMP website (ibmp.info).

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Mary Erickson, Gallatin National Forest — Date 10/30/09

Christian Mackay, Montana Department of Livestock — Date 10/26/09

Suzanne Lewis, Yellowstone National Park — Date 11.6.09

ANNUAL REPORT, INTERAGENCY BISON MANAGEMENT PLAN
JULY 1, 2008 TO JUNE 30, 2009

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Since the mid-1980s, increasing numbers of bison in Yellowstone National Park (YELL) have moved to low-elevation winter ranges outside the north and west parts of the park in response to accumulating snow pack (Gates et al. 2005). These movements led to an enduring series of societal conflicts among various publics and management entities regarding bison abundance and the potential transmission of brucellosis to domestic cattle with widespread economic repercussions (Cheville et al. 1998). As a result, the federal government and State of Montana agreed to an Interagency Bison Management Plan (IBMP) that established guidelines for managing the risk of brucellosis transmission from bison to cattle by implementing hazing, test-and-slaughter, hunting, and other actions near the park boundary (U.S. Department of the Interior [USDI] and U.S. Department of Agriculture [USDA] 2000*a*). This plan also identified the need to conserve bison and establish conservation zones encompassing approximately 250,000 acres of the northern two-thirds of YELL and a small portion of the adjacent Gallatin National Forest.

Since the Record of Decision was signed for the IBMP in 2000 (USDI and USDA 2000*b*), the signatories have collected substantial new information regarding bison, brucellosis, and the management of disease risk and suppression. However, progress has been slow in completing the plan's three successive management steps to incrementally increase the tolerance for bison moving outside the park. As a result, the federal government and State of Montana were criticized for: 1) not clearly defining measurable objectives to express desired outcomes; and 2) not systematically applying adaptive management principles, including defining specific scientific and management questions to be answered, conducting specific activities to answer them, and incorporating findings into the IBMP (U.S. Government Accountability Office 2008). Thus, there was a need to develop specific management objectives, conduct surveillance to evaluate the effects and effectiveness of management actions, develop methods for informing and involving stakeholders, and adjusting the IBMP based on these assessments.

In addition, the National Park Service (NPS) is considering the implementation of a remote delivery vaccination program for brucellosis in free-ranging bison at YELL, an action previously directed by the IBMP (USDI and USDA 2000*a, b*). The overall goal of this action is to meet the NPS's mission to preserve native species as a component of a naturally operating ecosystem and protect them from exotic diseases. Simulation modeling suggests an effective strategy for reducing brucellosis seroprevalence in bison would be to combine boundary management (i.e., removal of seropositive, non-vaccinated bison and vaccination and release of seronegative bison) with the remote delivery vaccination of all female bison distributed throughout YELL (Treanor et al. 2007). This approach is expected to lead to a substantial decrease in brucellosis infection over time, though there is a need to reduce uncertainty in parameter estimates regarding bison demography and brucellosis transmission. Information obtained from monitoring and research activities will improve parameter estimation and model predictions, and enable an evaluation of the effects and effectiveness of a bison management and vaccination program.

To address these needs, the IBMP partner agencies met several times in public venues during August-December 2008 to deliberate on recommendations by the U.S. Government Accountability Office, assess the effectiveness and outcomes of IBMP management activities and, considering prevailing conditions, develop and incorporate short and long-term adaptive management adjustments to the IBMP for winter 2008-2009 and beyond (USDI et al. 2008). Also, NPS staff developed a surveillance plan to implement a long-term monitoring and research program for bison that obtains relevant information to guide decision making regarding the conservation of bison, adaptive management of the IBMP, and evaluation of the effectiveness of remote delivery vaccination.

This annual report includes narrative summaries that address the effects and effectiveness of each management action in the IBMP that was agreed-upon by the partner agencies during December 2008. These adjustments were based on the adaptive management framework and principles outlined in the USDI Technical Guide on Adaptive Management (Williams et al. 2007). The report also summarizes progress on YELL's surveillance plan for bison (White et al. 2008) and improvements on vaccines, vaccine delivery systems, and disease testing for brucellosis in bison since the working symposium organized by the U.S. Animal Health Association at the University of Wyoming in Laramie during 2005 (U.S. Animal Health Association 2006).

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GOVERNMENT ACCOUNTABILITY OFFICE RECOMMENDATIONS FOR EXECUTIVE ACTION

In March 2008, the U.S. Government Accountability Office (GAO) released a report on the Interagency Bison Management Plan. This report found that "key deficiencies in the plan, and the agencies' implementation of it, limit their effectiveness with regard to managing bison-related issues" (<http://ibmp.info/Library/GAO%20Reports/GAO5%20-%20March%202008.pdf>). The GAO made five recommendations to the IBMP partners. Upon the release of the GAO report, the partners convened a series of seven meetings to address the recommendations and take steps to correct deficiencies in each of the five areas. The partners also began developing a formal public engagement process, including the formation of a Citizens' Working Group.

GAO RECOMMENDATION 1: THE SECRETARIES OF AGRICULTURE AND OF THE INTERIOR DIRECT THE FEDERAL AGENCIES TO WORK WITH THE STATE AGENCY PARTNERS TO IMPROVE THE MANAGEMENT OF YELLOWSTONE BISON IN THE NATIONAL PARK AND THE STATE OF MONTANA. CLEARLY DEFINE MEASUREABLE OBJECTIVES TO EXPRESS DESIRED OUTCOMES AND REFINE, REVISE, OR REPLACE THE PLAN AND AGENCY OPERATING PROCEDURES AS NEEDED TO REFLECT THESE GOALS AND OBJECTIVES.

Beginning in August 2008, the IBMP partners identified and agreed on six main action areas for the adaptive management plan. The IBMP partners developed an Adaptive Management Plan (2008) that identifies measurable objectives, goals, management actions, monitoring metrics, and a management response. The partners will use these clearly-defined goals, objectives, and management actions in an adaptive management framework to guide future decision making about bison management. The Adaptive Management Plan can be viewed at <http://www.ibmp.info/Library/20081217/2008%20IBMP%20Adaptive%20Management%20Plan.pdf>. In April 2009, the IBMP partners began evaluating the Adaptive Management Plan and considering changes for the next management year.

GAO RECOMMENDATION 2: THE SECRETARIES OF AGRICULTURE AND OF THE INTERIOR DIRECT THE FEDERAL AGENCIES TO WORK WITH THE STATE PARTNERS TO IMPROVE THE MANAGEMENT OF YELLOWSTONE BISON IN THE NATIONAL PARK AND THE STATE OF MONTANA. SYSTEMATICALLY APPLY ADAPTIVE MANAGEMENT PRINCIPLES, INCLUDING DEFINING SPECIFIC SCIENTIFIC AND MANAGEMENT DECISIONS TO BE ANSWERED, IDENTIFYING THE ACTIVITIES TO BE CONDUCTED TO ANSWER THEM, DEVELOPING A MONITORING PROGRAM TO ASSESS THE IMPACTS OF THOSE ACTIVITIES, AND INCORPORATING THE RESULTS INTO THE BISON MANAGEMENT PLAN.

In August 2008, the IBMP partners agreed upon a nine (9)-step model for adaptive management based on *Adaptive Management: the U.S. Department of the Interior Technical Guide* (Williams et al. 2007). In September 2008, the IBMP partners systematically applied this adaptive management model. The IBMP partners signed the Plan in December 2008. In April 2009, the partners began evaluating the management actions included in the plan, and considering changes to be made for the 2009-2010 operating season.

GAO RECOMMENDATION 3: TO ENHANCE INTERAGENCY COLLABORATION, PROMOTE TRANSPARENCY, AND STRENGTHEN THE AGENCIES' ACCOUNTABILITY TO THE AMERICAN PUBLIC: ESTABLISH A SINGLE, PUBLICLY AVAILABLE REPOSITORY ON A WEB SITE OR AT A LOCATION EASILY ACCESSIBLE TO THE PUBLIC THAT INCLUDES ALL DOCUMENTS REFLECTING DECISIONS MADE AND ACTIONS TAKEN WITH RESPECT TO PLAN IMPLEMENTATION.

In response to the recommendation, the IBMP partners developed a website at <www.IBMP.info> as a repository of documents related to bison management. The website was live and available to the public in September 2008, and includes a list of meetings with agendas and summaries, and a repository with IBMP documents including Environmental Impact Statement documents, bi-weekly status updates, bison hunt documents, bison quarantine facility documents, GAO reports, and other documents related to the IBMP.

GAO RECOMMENDATION 4: TO ENHANCE INTERAGENCY COLLABORATION, PROMOTE TRANSPARENCY, AND STRENGTHEN THE AGENCIES' ACCOUNTABILITY TO THE AMERICAN PUBLIC: REPORT ANNUALLY TO CONGRESS ON THE PROGRESS AND EXPENDITURES RELATED TO THE PLAN'S MEASURABLE OBJECTIVES ONCE THESE HAVE BEEN CLEARLY DEFINED.

In August 2008, the IBMP partners committed to producing an annual report on IBMP activities to evaluate their effectiveness based on the objectives of the Adaptive Management Plan. The report will be posted to <www.ibmp.info> and a news release will be issued to notify the public of the report's availability.

GAO RECOMMENDATION 5: TO ENHANCE INTERAGENCY COLLABORATION, PROMOTE TRANSPARENCY, AND STRENGTHEN THE AGENCIES' ACCOUNTABILITY TO THE AMERICAN PUBLIC: APPOINT A GROUP COMPRISING A REPRESENTATIVE FROM EACH OF THE PARTNER AGENCIES OR DESIGNATE ONE OF THE FIVE INTERAGENCY PARTNERS (PERHAPS ON AN ANNUAL ROUTING BASIS) AS A LEAD ENTITY FOR PLAN OVERSIGHT, COORDINATION, AND ADMINISTRATION.

In August 2008, the IBMP partners clearly identified a lead entity to provide administration, coordination, and oversight of partner activities. Lead entities will be on a yearly rotating basis. Yellowstone National Park served as the lead agency in 2008-2009. The Montana Department of Livestock will take over as the lead entity on November 1, 2009.

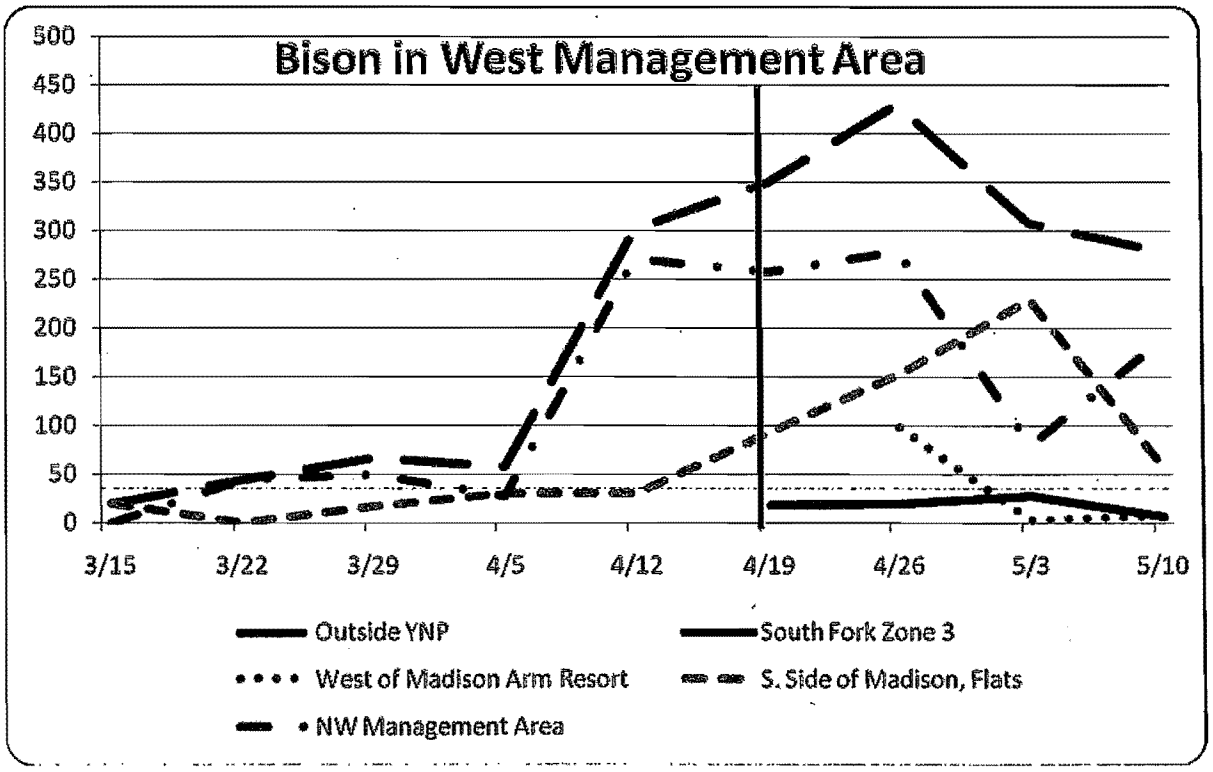
PUBLIC ENGAGEMENT PROCESS

In addition to actions taken to specifically address each of the GAO recommendations, the IBMP partners took additional actions with the intent of increasing transparency and better involving the public in IBMP proceedings. The partners requested advice from the U.S. Institute for Environmental Conflict Resolution on how the public could be better involved. After conducting interviews with stakeholder representatives, the Institute presented a series of options for the partners to consider including public meetings, localized working groups, independently convened roundtables, and a broad-based working group. The partners will continue this work with the Institute during the 2009/2010 management year to improve the public engagement process.

ACTION 1.1A: ALLOW UNTESTED FEMALE/MIXED GROUPS OF BISON TO MIGRATE ONTO AND OCCUPY THE HORSE BUTTE PENINSULA AND THE FLATS EACH WINTER AND SPRING IN ZONE 2.

Monitoring Metric 1: Weekly surveys of the number and distribution of bison on Horse Butte, the Flats, crossing the Narrows, and going beyond the Madison Resort (Lead = Montana Department of Livestock [MDOL]).

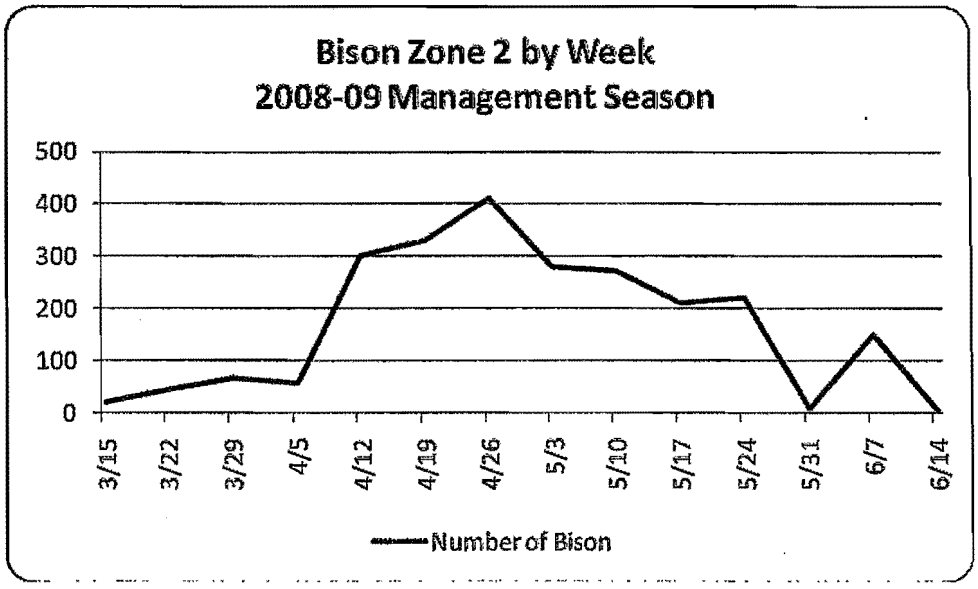
The numbers of bison observed in various portions of the west management area (Appendix A) during 2009 were as follows:



Monitoring Metric 2: Annually document the number of bison using Zone 2 and the number and type of management activities needed to manage bison distribution (Lead = MDOL).

The numbers of bison using Zone 2 of the west management area ranged from 20 during the week of March 15 to 411 during the week of April 26, 2009. A maximum of about 430 bison simultaneously occupied Zones 2 and 3 during 2009. Thirty hazing operations were conducted to manage bison distribution pursuant to the adaptive management plan signed in December, 2008. Twenty-one hazing operations were directly related to bison occupying Zone 3 ($n = 12$) or breaching other trigger points ($n = 9$) established in the adaptive management plan (e.g., bison entering non-tolerance areas or exceeding numerical tolerance levels; Appendix B). A helicopter was used for hazing bison during 12 operations.

The numbers of bison using Zone 2 of the west management area during 2009 were as follows:



Monitoring Metric 3: Create a density curve of the threshold number of bison on Horse Butte that results in movements of bison to the South Fork Madison area (Lead = MDOL).

Bison numbers on the south side of the Madison Arm (Flats) exceeded tolerance levels and bison entered Zone 3 after abundance in the Horse Butte area exceeded 250 bison and the total number of bison in the west management area exceeded 350. During the week of April 26, despite a general reduction of bison numbers due to hazing activities directing bison into YELL, there was an inverse relationship between bison abundance in northwest portion of the management area (Horse Butte and related region) and the south side of the Madison Arm. Bison numbers on the northwest portion of the management area decreased from 278 to 80 animals, while bison numbers on the south side of the Madison and Flats increased from 152 to 228.

Monitoring Metric 4: Determine natural routes and timeframes (without hazing) for bison migration back into the park (Lead = NPS).

Bison began migrating from the Pelican and Hayden valleys, west across the Central Plateau, and onto lower-elevation winter range in the Lower Geyser Basin during mid- to late October 2008, with another pulse of movement in late February and early March 2009. These bison then migrated *en masse* north to the Madison Valley and west to Cougar Meadows and the Horse Butte peninsula during late March through early May. A camera stationed along the road through the Firehole Canyon between the Lower Geyser Basin and Madison Junction detected at least 80% of the central bison herd migrating north during winter 2008-2009, with about 60% of these movements occurring in April and early May. Natural migration of bison from the Horse Butte area back into YELL and towards their higher-elevation summer ranges would likely occur in mid-May and June, following the wave of growing vegetation from lower to higher elevations, similar to other ungulates in this system (Frank and McNaughton 1993, Gates et al. 2005, Thein et al. 2009).

Adaptive Management Recommendations:

IBMP partners should begin coordinating in early April to compile and update knowledge on bison movements and distribution, snow conditions, vegetation green-up, stream flow in the Madison River, logistical issues (e.g., staff, horse, and helicopter availability, traffic control, visitation and road closures), and cattle turn-on dates and locations.

IBMP partners should complete an assessment of the expected late-winter scenario by May 1 and concur on tactics for hazing bison back into YELL. While maintaining a focus on brucellosis risk management, haze-back operations could occur earlier than the May 15 benchmark if forage and other conditions at higher elevations in YELL are suitable or later if conditions preclude safe and effective movements of bison to habitats that will hold/sustain them (e.g., adequate snow melt or vegetation green-up).

ACTION 1.1B: USE ADAPTIVE MANAGEMENT TO GAIN MANAGEMENT EXPERIENCE REGARDING HOW BISON USE ZONE 2 IN THE GARDINER BASIN, AND PROVIDE SPACE/HABITAT FOR BISON IN CATTLE-FREE AREAS.

Monitoring Metric 1: Weekly survey of the number and distribution of bison in the Eagle Creek/Bear Creek area and the Gardiner basin (Lead inside YELL = NPS; Lead outside YELL = MDOL with the Montana Department of Fish, Wildlife, and Parks [MFWP]).

NPS staff conducted periodic aerial surveys through winter 2008-2009 to estimate the number of bison occupying northern IBMP management monitoring areas, including the Eagle Creek/Bear Creek and Gardiner basin areas.

Northern IBMP Management Monitoring Area	Dates of Aerial Surveys				
	10 Dec 08	28 Feb 09	18 Apr 09	10 May 09	24 May 09
Zone 2	0	0	0	0	No aerial survey was conducted. Ground monitoring detected about 40 bison in Zone 1 and 100 bison on the Blacktail Deer Plateau.
Eagle Creek	0	0	1	8	
Zone 1	0	0	125	48	
Blacktail Deer Plateau	51	472	335	234	
Hellroaring Creek	16	104	112	37	
Swan Lake	53	81	52	6	
Total	**120**	**657**	**625**	**333**	

Monitoring Metric 2: Annually document the numbers and dates that bison attempt to exit Zone 2 by passing through Yankee Jim Canyon, west up Mol Heron Creek canyon, or to the east side of the Yellowstone River and north of Little Trail Creek (Lead = MDOL/MFWP).

There were no instances of bison attempting to exit Zone 2 by passing through Yankee Jim Canyon or west up Mol Heron Creek. Fifteen bison of mixed age and gender that had moved north into Zone 2 and crossed to the east side of the Yellowstone River north of the bridge at Corwin Springs were hazed back into YELL on April 12. Two (2) male bison north of Little Trail Creek and east of the Yellowstone River were hazed to Eagle Creek on April 18. Three (3) male bison north of Little Trail Creek and east of the Yellowstone River were hazed across the river into Zone 2 on April 28.

Monitoring Metric 3: Annually document the number of bison using Zone 2 and the number of management activities needed to manage bison distribution (Lead = MDOL/MFWP).

Prior to April 15, two hazing operations (51 bison) were conducted in Zone 2 and one hazing operation (30 bison) was conducted in Zone 1. After April 15, five hazing operations (64 bison) were conducted in Zone 2 and five hazing operations (263 bison) were conducted in Zone 1.

Monitoring Metric 4: Annually collect data to update the relationships between bison management at the Stephens Creek facility and the interaction between bison density and snow pack in the central and northern herds (Lead = NPS).

NPS staff completed a report (Geremia et al. 2009b) summarizing analyses of the relationships between bison population size, winter severity, and the number of bison removed near the boundary of YELL. Analyses of models fit to bison removal data collected during 1970-2008 suggest that limiting the population to less than 3,500 bison in the central herd and 1,200 bison in the northern herd could abate large-scale migrations and management removals when snow conditions are near average. NPS staff is working with Dr. John Borkowski at Montana State University to refine these analyses.

Monitoring Metric 5: Annually collect data to determine natural migration routes and timeframes (in the absence of hazing) for bison migration out of and back into the park (Lead inside YELL = NPS; Lead outside YELL = MDOL/MFWP).

Bison from the northern breeding herd left their summer ranges on the high plateaus above the Lamar Valley and congregated near the valley floor by late October 2008. These bison were distributed from the lower Lamar Valley westward to the Blacktail Deer Plateau during winter 2008-2009, and the proportion on the Backtail Deer Plateau gradually increased until mid-April. Seven of 34 (20%) radio-marked bison that migrated west to the Blacktail Deer Plateau from the Lamar Valley moved into the Gardiner basin during early April, but returned to the Blacktail Deer Plateau by early May. Also, we detected

movements of bison from the central breeding herd (Hayden and Pelican valleys) to the northern portion of YELL during winter 2008-2009. Three radio-marked bison migrated north to Swan Lake in late November and spent most of the winter in the Swan Lake to Gibbon Meadows corridor. Two of these bison moved into the Gardiner basin during late winter, but returned to the Madison headwaters area in central YELL by mid-April. Six radio-marked bison from the central breeding herd migrated to the Gardiner basin and Blacktail Deer Plateau during mid-March, but returned to central YELL during mid-May. Aerial surveys on May 10 did not detect any bison north of YELL.

Adaptive Management Recommendations:

Continue to monitor the timing, numbers, and locations of bison movements in the Gardiner basin to gain experience on how bison use available habitat north of Yellowstone National Park.

ACTION 1.1C: USE RESEARCH FINDINGS ON BISON BIRTH SYNCHRONY AND FETAL AND SHED *BRUCELLA ABORTUS* FIELD VIABILITY AND PERSISTENCE TO INFORM ADAPTIVE MANAGEMENT.

Monitoring Metric 1: Complete research reports and attempt to publish findings in a peer-reviewed, scientific journal (Lead = MFWP and NPS).

Staff from MFWP investigated the persistence of *B. abortus* on bison fetuses and the rate of fetus removal by scavengers near YELL during 2001-2003. They found that *B. abortus* survived longer on the underside of the fetus than on the top, and longer in February (81 days) than mid-May (21 days). They also found that fetuses were scavenged and disappeared sooner inside YELL (mean = 7.5 days) than outside (mean = 13.0 days) during 2001. Bovine fetuses placed outside the west and north boundaries or YELL disappeared, on average, in 18.2 days (range = 1-78; sd = 20.1) during 2002 and 2003. Preliminary findings were published in an article entitled "Environmental persistence of *Brucella* organisms in natural environments of the Greater Yellowstone Area – a preliminary analysis" Aune et al. (2007). MFWP is currently reanalyzing these data.

NPS staff monitored radio-marked, adult, female bison from April through mid-June during 2004-2007 to estimate the timing and location of parturition events that may shed tissues infected by *B. abortus*. They observed 49 live births, 13 stillborn calves, 11 placenta retentions with no calves present, 5 placenta retentions with a calf present, 5 deaths of females during parturition, and 32 radio-marked female bison with new calves. Bison exhibited a high degree of birth synchrony, with peak calving (80% of births) from April 25 to May 26. Most calving was completed by May 31. Mothers meticulously cleaned birth sites and typically left the site within two hours. These data and findings were summarized in a report entitled "Parturition in Yellowstone Bison" (Jones et al. 2009), a copy of which is posted on <ibmp.info>. Also, a manuscript is being prepared and will be submitted for peer-review and possible publication.

Adaptive Management Recommendations:

MFWP and NPS staff should report their findings to the IBMP managers in November 2009, after which the managers can consider adaptive management adjustments supported by the research findings.

ACTION 1.2A: ALLOW BACHELOR GROUPS OF BULL BISON TO OCCUPY SUITABLE HABITAT AREAS OUTSIDE THE WEST BOUNDARY OF YELL IN THE PORTION OF ZONE 2 SOUTH OF DUCK CREEK EACH YEAR WITHIN THE PARAMETERS OF CONFLICT MANAGEMENT.

Monitoring Metric 1: Weekly counts and locations of bull bison in Zone 2 (Lead = MDOL).

This spring, there were six bull bison that spent three weeks in the Duck Creek area. There were several juvenile bulls that used the Horse Butte area from April through mid-May. Three bull bison were captured and sent to slaughter because they could not be safely hazed out of a non-tolerance area north of Duck Creek. One bull bison was lethally removed from private land on the South Fork following co-mingling with livestock. On 11 occasions, bulls were not tolerated because they were part of mixed groups or in non-tolerance areas pursuant to the 2008 Adaptive Management Plan.

Monitoring Metric 2: Document threats to human safety and property damage (Lead = MFWP).

Public safety complaints were as follows:

- On May 26, 2009, MDOL received a complaint from a Lower Bear Trap resident (LS) about an aggressive bull bison that "squared off" with a young girl riding her horse on a road in the subdivision north of Duck Creek.
- On May 27, 2009, MDOL received a complaint from an Upper Bear Trap resident (KW) about four bull bison next to his horses the Upper Bear Trap Subdivision north of Duck Creek.
- On June 3, 2009, MDOL received a complaint from a Duck Creek area resident (KD) about aggressive bull bison around his house.
- On June 17, 2009, MDOL received a complaint from a Duck Creek resident (CB) about bull bison around his horses, property, and children.

Adaptive Management Recommendations:

Continue education and awareness of the social, public safety and private property impacts of bison tolerance in areas with residences or used for livestock operations.

Consider additional tolerance/discretion for bull bison north of Duck Creek.

Develop an experimental protocol using bison in captive facilities and, if necessary, field environments to test whether bison bulls can sexually transmit *B. abortus*.

ACTION 1.2B: ALLOW BACHELOR GROUPS OF BULL BISON TO OCCUPY SUITABLE HABITAT AREAS IN ZONE 2 OUTSIDE THE NORTH BOUNDARY OF YELL WITHIN THE FOLLOWING PARAMETERS OF CONFLICT MANAGEMENT.

Monitoring Metric 1: Weekly counts and locations of bull bison in Zone 2 (Lead = MDOL/MFWP).

Fifteen adult male bison were located in or near Zone 2 on April 19 and hazed back into the park.

Monitoring Metric 2: Document threats to human safety and property damage (Lead = MFWP/MDOL).

There were no reports of threats to human safety or property damage.

Monitoring Metric 3: Annually document the numbers and dates that bull bison attempt to exit Zone 2 by passing through Yankee Jim Canyon, west up Mol Heron Creek canyon, or to the east side of the Yellowstone River and north of Little Trail Creek (Lead = MDOL/MFWP).

There were two incidents of bulls exiting Zone 2 north of Gardiner during winter 2008-2009. On April 18, two adult males were hazed from the Hoppe Ranch, east of Highway 89 South, up Little Trail Creek to the Hayes Ranch in the Eagle Creek watershed. On April 28, three adult males were hazed from east of the Yellowstone River and north of Corwin Springs, across the river to Cinnabar Mountain in the Gallatin National Forest.

Adaptive Management Recommendations:

Expand suitable habitat for bull bison west of the Cutler Lake and Cutler Meadow areas and, also, in the Maiden Basin area off Little Trail Creek on the east side of the Yellowstone River per discussions during autumn 2008.

ACTION 1.3A: WORK WITH PRIVATE LAND OWNERS AND LIVESTOCK PRODUCERS AND OPERATORS TO PROVIDE CONFLICT-FREE HABITAT IN THE HEBGEN AND GARDINER BASINS.

Monitoring Metric 1: Create an annual record of the: a) number of acres made available to bison from conservation easements (Lead = MFWP); b) locations, numbers, types, and turn-out/off dates for cattle grazed on private land in the Hebgen and Gardiner basins (Lead = MDOL); and c) extent of fencing erected to separate bison from livestock (Lead = MDOL).

MFWP signed a 30-year livestock grazing restriction and bison access agreement with the Church Universal and Triumphant, Inc. to remove livestock from the Royal Teton Ranch, north of Gardiner and adjacent to the park's boundary. The NPS provided the federal government's $1.5 million share of the total $3 million cost. This voluntary acquisition of grazing rights will allow progressively increasing numbers of bison to use habitats along the Yellowstone River up to 10 miles away from the

park boundary, including approximately 500 acres of the Royal Teton Ranch and another 1,200 acres of the Gallatin National Forest.

Locations, numbers, types, and turn-out/off dates for cattle grazed on private land in the Hebgen and Gardiner basins during 2009 are as follows:

West Management Area

Property Owner	Livestock Owner	Zone	Date in	No. Cows	No. Calves	No. Bulls	No. Yearling Heifers	No. Yearling Steers	No. Horses
SR Red Creek Ranch	BM Reed Point, MT	2	June 17	165	165	5			
RS Duck Creek	BM Reed Point, MT	2	June 27	32	32	1			
PP Deep Well Ranch	BT Twin Bridges, MT	3	June 12	160	160	6			
PP Deep Well Ranch	LL Three Forks, MT	3	June 12					206	
LD Quarter Circle JK	CC/BF Cameron, MT	3	July 1	35	35	2	11		
WS Denny Creek	WS Rexburg, ID	3	June 12	32	28	1			
RP Diamond P Ranch	BM Billings, MT	3	June 1		10	21		11	40

North Management Area

Owner	No. Cattle	Maximum	Class	On-date	Off-date
BH	20/1		pairs/bull	year-round	
JT	23		pairs	June 1	October 15
VS	100	250	pairs	May 21	December 31
Grizzly Creek	100	250	pairs	May 21	December 31
Yellowstone Cattle Company	100	600	pairs	May 21	December 1
B-Bar	150	600	pairs	June 15	November 15
Anderson Ranch	100	160	pairs	June 15	November 15
West Creek Ranch	100	100	pairs	June 1	November 1

The bison quarantine feasibility study is also located in the north management area near Corwin Springs, Montana, with approximately 100 bison in double-fenced pastures throughout the year.

No fencing was constructed to separate bison from livestock, but repairs were made on existing fence lines to maintain separation.

Adaptive Management Recommendations:

Explore additional private land management options, including conservation easements, livestock grazing plans, and strategic fencing to separate livestock and bison as they arise or are proposed by individual landowners.

ACTION 1.3B: WORK WITH LANDOWNERS WHO HAVE HUMAN SAFETY AND PROPERTY DAMAGE CONCERNS, AS WELL AS THOSE WHO FAVOR INCREASED TOLERANCE FOR BISON, TO PROVIDE CONFLICT-FREE HABITAT IN THE HEBGEN AND GARDINER BASINS.

Monitoring Metric 1: Annually document the numbers, timing, and types of reported incidents for human safety and property damage related to bison (Lead = MFWP with support from MDOL).

Property damage complaints were as follows:

- On May 28, 2009, MDOL received a complaint from a Lower Bear Trap resident (JK) about bison destroying his trees north of Duck Creek.
- Fence damage reported to MDOL and estimated (not paid) material costs for the landowner to repair:
  - South Fork at Deep Well Ranch: $1,000 for fence repair.
  - Upper Bear Trap (KW): $500 for fence repair and $820 for tree replacement.
  - Duck Creek (RS): $75 for fence repair.
  - Duck Creek (KD): $100 for fence repair.
  - Lower Bear Trap (JK): $300 for tree replacement.

Monitoring Metric 2: Annually document the numbers and types of actions taken to provide conflict-free habitat bison (Lead = MFWP with support from MDOL).

MFWP wardens responded to West Yellowstone three times during April to haze approximately 18 bison out of town and prevent conflicts.

Adaptive Management Recommendations:

Explore ways to reduce or eliminate human safety or property damage problems related to bison on a case-by-case basis.

Continue education and awareness of the social, public safety, and private property impacts of bison tolerance in areas with residences or used for livestock operation.

ACTION 1.3C: ANNUALLY, THE GALLATIN NATIONAL FOREST WILL ENSURE CONFLICT-FREE HABITAT IS AVAILABLE FOR BISON AND LIVESTOCK GRAZING ON PUBLIC LANDS, AS PER MANAGEMENT OBJECTIVES OF THE IBMP.

Monitoring Metric 1: Annually track the status (e.g., number of acres, location, etc.) of active and inactive cattle grazing allotments on public lands (Lead = U.S. Forest Service [USFS]).

Since 2007, several National Forest cattle grazing allotments within or near bison management Zone 2 have changed status from *vacant* or *inactive* to closed. This is a permanent change in the allocation or management of these landscapes that precludes livestock grazing as a future management option. North of YELL, the allotments that have been closed are Cedar Creek, Sentinel Butte, Park, Canyon, and Little Trail Creek. West of YELL the allotments that have been closed are Duck Creek, Dry Gulch, University, Two Top, and Lionhead.

The Cache-Eldridge allotment in the Taylor Fork was waived to the government without preference. This means that this allotment status has changed from an active allotment to a vacant allotment without a permittee.

Due to the sale of ranchland in Cinnabar Creek, the Mill Creek allotment has lost access for cattle grazing and remained vacant this year. The future of this allotment is uncertain given this change. The Slip and Slide allotment previously had three permittees and now has two permittees for the same combined grazing use.

The names and status of the remaining cattle allotments are detailed in Appendix C.

Adaptive Management Recommendations:

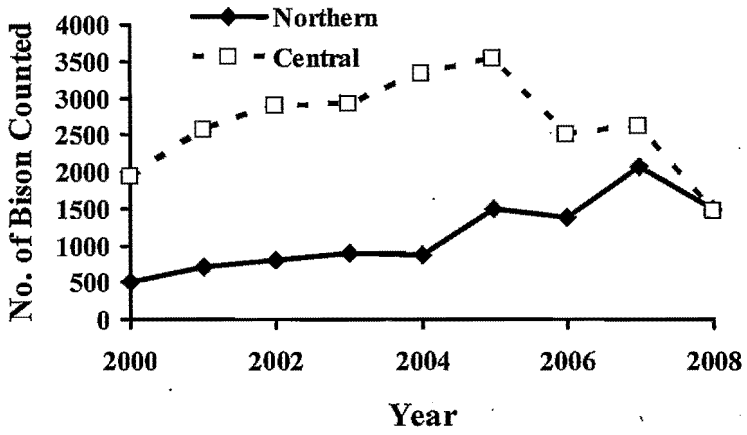
No adaptive management changes specific to these cattle allotment changes are proposed. These allotments had all been vacant or inactive for some time and were not, by virtue of their existence, previously a barrier to adaptive management steps.

Continue monitoring of National Forest cattle allotments for opportunities to increase special or temporal habitat for bison on National Forest system lands (horse allotments need not be monitored).

ACTION 2.1A: INCREASE THE UNDERSTANDING OF BISON POPULATION DYNAMICS TO INFORM ADAPTIVE MANAGEMENT AND REDUCE SHARP INCREASES AND DECREASES IN BISON ABUNDANCE.

Monitoring Metric 1: Conduct aerial and ground surveys to estimate the annual abundance of bison each summer (Lead = NPS).

NPS staff completed three aerial surveys of the bison population during June and July 2008 and estimated a minimum population size of 2,969 bison, with a 95% confidence range of 2,686 – 3,350 bison.



Monitoring Metric 2: Document and evaluate relationships between bison migration to the boundary of YELL and bison abundance, population (or subpopulation) growth rates, and snow pack in the central and northern herds (Lead = NPS).

NPS staff completed a report (Geremia et al. 2009b) summarizing analyses of the relationships between bison population size, winter severity, and the number of bison removed near the boundary of YELL. Analyses of models fit to bison removal data collected during 1970-2008 suggest that limiting the population to <3,500 bison in the central herd and <1,200 bison in the northern herd could abate large-scale migrations and management removals when snow conditions are near average.

Monitoring Metric 3: Continue to obtain estimates of population abundance through the remainder of the year based on surveys, knowledge of management removals, and survival probabilities (Lead = NPS).

NPS staff completed an aerial survey of bison distribution on February 28, 2009, during which they observed 2,870 bison (1,397 in the central interior and 1,473 on the northern range).

Monitoring Metric 4: Conduct an assessment of population range for bison in YELL that successfully addresses the goals of the IBMP by retaining genetic diversity and the ecological function and role of bison, while lessening the likelihood of large-scale migrations to the park boundary and remaining below the estimated carrying capacity of the park's forage base (Lead = NPS).

NPS staff synthesized available information and interpreted results of a spatially-explicit model of the Yellowstone system (Coughenour 2005) in a peer-reviewed article published by *Biological Conservation*. Findings suggest that bison abundance has not exceeded the theoretical food-limited carrying capacity of 6,200 in YELL (Plumb et al. 2009), but more bison migrate earlier to lower-elevation winter ranges as numbers increase and climatic factors interact with density to limit nutritional intake and foraging efficiency (Bruggeman et al. 2009b). The authors suggested a bison population that varies on a decadal scale between 2,500 and 4,500 animals should satisfy the collective long-term interests of stakeholders, as a balance between the park's forage base, conservation of the genetic integrity of the bison population, protection of their migratory tendencies, brucellosis risk management, and other societal constraints related to management of massive free-ranging wildlife. They further recommended that, within this range of abundance, management agencies should continue to prioritize conservation of

bison migration to essential winter range areas within and adjacent to the park, while also actively preventing dispersal and range expansion via hunting outside YELL and periodic brucellosis risk-management.

Adaptive Management Recommendations:

IBMP managers should continue to discuss integrated strategies to maintain bison numbers within this population range.

ACTION 2.1B: INCREASE THE UNDERSTANDING OF GENETICS OF BISON IN YELL TO INFORM ADAPTIVE MANAGEMENT.

Monitoring Metric 1: Complete an assessment of the existing genetic diversity in bison and how the genetic integrity of bison may be affected by management removals (all sources combined) by October 2010 to estimate existing genetic diversity and substructure in the population (Lead = NPS).

Fecal samples were collected from bison in the central and northern breeding herds during 2006 ($n = 81$) and 2008 ($n = 67$). Genetic material was successfully extracted from most samples and used to assess two diversity indices (herozygosity and allelic richness). Preliminary results indicate the diversity indices are similar to those reported by Halbert (2003). A final report is expected by December 2009.

Monitoring Metric 2: Conduct an assessment of the genetic diversity necessary to maintain a robust, wild, free-ranging population that is able to adapt to future conditions (Lead = NPS).

In August 2008, the NPS funded an assessment of bison genetics in YELL with the University of Montana to provide:

- Microsatellite estimates of genetic diversity and gene flow between the central and northern breeding herds;
- Quantitative modeling results from simulations of the potential effects of risk management removals on the genetic diversity of bison;
- An assessment of the numbers of bison necessary in each breeding herd and the entire population to preserve 90-95% of existing levels of genetic diversity; and
- Recommendations for genetic surveillance objectives and activities to ensure adequate data are collected over time to detect any significant changes in genetic diversity.

A final report is expected by December 2009.

Adaptive Management Recommendations:

None at this time.

ACTION 2.1C: INCREASE UNDERSTANDING OF THE ECOLOGICAL ROLE OF BISON TO INFORM ADAPTIVE MANAGEMENT BY COMMISSIONING A COMPREHENSIVE REVIEW AND ASSESSMENT.

Monitoring Metric: Develop and implement by October 2011 a joint research strategy agreed to by the interagency partners that focuses on understanding the role and function of bison for providing nutrient redistribution, prey and carrion, and microhabitats for other species (Lead = NPS).

During 2010, YELL intends to convene a small group of biologists with expertise in bison conservation, predator-prey relationships, and ungulate-range interactions to develop a scope of work for defining and quantifying the role of bison in the Greater Yellowstone Ecosystem.

Adaptive Management Recommendations:

None at this time.

ACTION 2.2A: USE SLAUGHTER ONLY WHEN NECESSARY; ATTEMPT TO USE OTHER RISK MANAGEMENT TOOLS FIRST.

Monitoring Metric 1: Annually document the number, age, sex, and sero-status of bison sent to slaughter (Lead = Animal and Plant Health Inspection Service [APHIS] with the MDOL).

Three bulls were captured and sent to slaughter because they could not be safely hazed out of a non-tolerance area north of Duck Creek. One bull bison was lethally removed from private land on the South Fork after co-mingling with livestock.

Adaptive Management Recommendations:

Continue evaluating opportunities and constraints for (1) transferring "surplus" bison to quarantine facilities for further surveillance and eventual release onto suitable restoration sites or to terminal destinations on tribal or other lands for periodic harvest for food or ceremonial purposes, and (2) adjusting conservation zones to increase state and treaty hunting opportunities in habitat outside the park.

ACTION 2.2B: IN ZONE 2 LANDS ADJACENT TO YELL, EMPHASIZE MANAGEMENT OF BISON AS WILDLIFE AND INCREASE THE USE OF STATE AND TREATY HUNTS TO MANAGE BISON NUMBERS AND DEMOGRAPHIC RATES, LIMIT THE RISK OF BRUCELLOSIS TRANSMISSION TO CATTLE, AND PROTECT HUMAN SAFETY AND PROPERTY.

Monitoring Metric 1: Weekly and annual summaries of bison harvested by state and treaty hunters (Lead = MFWP).

The state of Montana issued 44 either-sex bison licenses for the 2008-2009 hunting season (September 15, 2008-February 15, 2009) in Hunting Districts 385 (Gardiner; 18 licenses) and 395 (West Yellowstone; 26 licenses). Due to a lack of bison movement outside YELL during the season, only one bull was harvested by a licensed hunter on September 15, 2008, in the Eagle Creek area near Gardiner. No bison were harvested in Hunting District 395 (West Yellowstone).

Under their 19th century treaty rights (i.e., Steven's Treaty), members of the Nez Perce and Confederated Salish and Kootenai Tribes can hunt bison on public lands, including USFS lands adjacent to YELL. There were no reports of bison being harvested by Native American hunters during the 2008-2009 bison hunting season.

Adaptive Management Recommendations:

Continue to explore appropriate new areas within Zone 2 that could accommodate additional bison hunting opportunities. Expand the Eagle Creek area to include Maiden Basin, located north of Little Trail Creek and adjacent to Bison Hunting District 385. The Montana Fish, Wildlife, and Parks Commission would need to approve these areas as either a new Bison Hunting District or an extension of Bison Hunting District 385.

ACTION 2.2C: COMPLETE THE QUARANTINE FEASIBILITY STUDY AND CONSIDER AN OPERATIONAL QUARANTINE FACILITY TO PROVIDE A SOURCE OF LIVE, DISEASE-FREE BISON FOR TRIBAL GOVERNMENTS AND OTHER REQUESTING ORGANIZATIONS.

Monitoring Metric 1: Annual summary of bison sent to quarantine and bison transported from quarantine to suitable restoration sites (Lead = MFWP/APHIS).

A total of 102 Yellowstone bison calves were brought into quarantine facilities in Corwin Springs during 2005 and 2006. A portion of the seronegative group was culled and extensively cultured for brucellosis. No animals were culture positive for brucellosis. Remaining animals moved into Phase II of the study, with females being bred in summer 2007. All bison were tested for brucellosis at least twice per year and, by spring 2009, 21 adult females, 16 calves, and 4 bulls were considered brucellosis free and available for restoration and conservation efforts. The females that did not conceive in 2007 were bred again in 2008, and are expected to be available for release in late 2009 or 2010. Another 112 bison calves were brought into the quarantine facility in winter 2008 for a second repetition of the quarantine protocol. To date, no bison have been transported from quarantine to suitable restoration sites.

Monitoring Metric 2: Annual summaries from bison populations restored using quarantined bison from YELL, including numbers, demographic rates, and implemented risk management actions (Lead = MFWP/APHIS).

To date, no bison populations have been restored using quarantined bison from the study.

Monitoring Metric 3: Evaluate regulatory requirements and constraints for moving live bison, including adults, to suitable restoration sites (Lead = APHIS/MDOL).

In April 2009, the IBMP Technical Committee was tasked with evaluating opportunities and constraints for transferring "surplus" bison from YELL to distant quarantine facilities for further surveillance and eventual release onto suitable restoration sites (i.e., brucellosis test-negative bison) or to terminal destinations on tribal or other lands for periodic harvest for food or ceremonial purposes (i.e., untested or brucellosis test-positive bison). A progress report was presented to the IBMP managers in August 2009.

Monitoring Metric 4: Conduct an assessment of the quarantine feasibility study and offer recommendations regarding whether the quarantine of bison should become operational (Lead = MFWP/APHIS).

MFWP and APHIS initiated a five-year research program in 2005 and 2006 with bison calves from YELL to determine the latent expression of brucellosis and test the sensitivity of quarantine procedures for detecting the bacteria in multiple generations. This quarantine feasibility study has demonstrated that it is possible to consider these bison as free from brucellosis.

Monitoring Metric 5: Identify suitable release sites for brucellosis-free bison in quarantine, and solicit proposals from groups interested in restoring bison, through the Interagency/Tribal Bison Restoration Panel (Lead = MFWP/APHIS).

During summer 2008, MFWP requested letters of interest from agencies, organizations, and tribes for the brucellosis-free bison from the quarantine feasibility study. Five letters were received by September 30, 2008. MFWP sent those organizations a formal request-for-proposal packet, which further explained the goals of the translocation effort and criteria for the facilities and management of those bison. Three proposals from the Northern Arapaho, Fort Belknap, and Fort Peck tribes were submitted by the December 15, 2008 deadline. The Interagency/Tribal Bison Restoration Panel reviewed the proposals and MFWP issued a decision notice in March 2009 to translocate 41 bison brucellosis-free bison from the quarantine facilities to the Wind River Indian Reservation in Wyoming, which is home to the Northern Arapaho and Eastern Shoshone Indians. As part of this decision, the tribe agreed to assume management responsibility of the translocated bison, maintain them in fenced pastures for five (5) years, and allow periodic disease testing pursuant to a brucellosis monitoring protocol developed by APHIS. In May 2009, the Wind River Tribal Council decided not to accept bison from the quarantine study during spring or summer 2009. MFWP issued further requests-for-proposals to solicit interest in these brucellosis-free bison and subsequent cohorts. Proposals will be evaluated in November 2009 by the Bison Quarantine Review Committee.

Adaptive Management Recommendations:

Certify bison from the initial quarantine feasibility study (and their offspring) as disease free and transport them to suitable conservation sites on public or tribal land by winter 2009-2010.

Begin evaluating operational quarantine processes with willing tribes and other organizations for future transferring of "surplus" bison from YELL, including necessary NEPA/MEPA review.

Evaluate the quarantine protocol for other age and sex classes of bison.

ACTION 3.1A: CONTINUE BISON VACCINATION UNDER PREVAILING AUTHORITY.

Monitoring Metric 1: Document the number of eligible bison captured and vaccinated outside of the park (Lead = MDOL/APHIS).

No bison were captured and vaccinated outside of the park during winter 2008-2009.

Monitoring Metric 2: Implement the Bison and Brucellosis Monitoring and Surveillance Plan (Lead = NPS).

The NPS implemented the Bison Surveillance Plan during 2008-2009 as described later in this document (see page 22).

Adaptive Management Recommendations:

Develop a coordinated and consistent vaccination program to ensure that vaccination is occurring at both the north and west boundaries of YELL and for both the central and northern breeding herds.

Discuss the potential for increasing the number of vaccinated bison at both the north and west boundaries.

ACTION 3.1B: COMPLETE EIS PROCESSES (MEPA/NEPA) FOR REMOTE DELIVERY VACCINATION OF BISON AND USE THE OUTCOMES TO INFORM ADAPTIVE MANAGEMENT.

Monitoring Metric 1: Complete the NEPA process and reach a decision on whether remote delivery vaccination of bison can/will be employed inside YELL (Lead = NPS).

The NPS has prepared a Draft Environmental Impact Statement to decide whether to proceed with implementation of remote delivery vaccination of bison in the park. Remote delivery is distinguished from hand delivery that occurs in capture pens near the park boundary when bison leave the park and are captured. Remote delivery would not involve the capture and handling of individual animals. The draft in-park vaccination program is a phased-in, adaptive management strategy intended to be incorporated into the larger bison vaccination strategy described in the Final Environmental Impact Statement and 2000 Record of Decision for the Interagency Bison Management Plan.

Three alternatives are evaluated in the Draft Environmental Impact Statement. The no action alternative describes the current vaccination program that is intermittently implemented at the Stephens Creek capture facility in concert with capture operations. The second alternative would include a combination of the capture program at Stephens Creek and a remote delivery vaccination strategy that would focus exclusively on young, non-pregnant bison of both sexes. Remote delivery vaccination could occur from March to June and mid-September to mid-January throughout many areas of bison distribution in the park. A third alternative would include all components of the second alternative, as well as the remote vaccination of adult females during autumn. The vaccination program is intended to lower the percentage of bison susceptible to brucellosis infection.

The time frame for completion is as follows:
Internal NPS review (DEIS) – Summer/Autumn 2009
Public review and comments – Winter 2010
Content analysis and revision – Spring/Summer 2010
Internal NPS review (Final EIS) – Autumn 2010
Federal Register notice – Spring 2011
Record of Decision – Summer 2011

Adaptive Management Recommendations:

Complete the NEPA process and reach a Record of Decision to decide whether to proceed with the implementation of remote delivery vaccination of bison in YELL.

ACTION 3.1C: TEST AND VACCINATE CATTLE.

Monitoring Metric 1: By May 1, determine and document the vaccination status of all cattle in or coming into the Hebgen and Gardiner basins (Lead = MDOL/APHIS).

About 70% of the eligible cattle in Montana are vaccinated as calves for brucellosis. The percentage of cattle vaccinated is >70% in the southwest portion of the state where the risk of transmission of brucellosis from wildlife is greater. All vaccination eligible cattle in or coming into the Hebgen and Gardiner basins have had an Official Calfhood Vaccination for brucellosis. All those producers for which the Adult Vaccination for brucellosis is appropriate have been offered this type of vaccination at no cost. One producer in the Gardiner basin and one producer in the Hebgen Basin vaccinate their adult cattle on a regular basis. Two producers in the Hebgen basin will begin adult vaccination of their cattle prior to the 2010 grazing season. A decision on Adult Vaccination is pending for several other producers.

Adaptive Management Recommendations:

By June 15, determine and document the vaccination status of all "at-risk" cattle in or coming into the Hebgen and Gardiner basins. Due to variable market/management conditions, producers may not know which cattle are going to which allotments by May 1. Thus, June 15 is a more realistic date for this determination. Certain cattle grazing in or coming into graze Zone 3 of the Gardiner/Hebgen basins often have a long history of virtually no exposure to bison or other vehicles of brucellosis transmission, making their risk negligible.

ACTION 3.2A: USE SPATIAL AND TEMPORAL SEPARATION AND HAZING TO PREVENT CATTLE/BISON INTERACTIONS.

Monitoring Metric 1: Document the minimum temporal separation and space between bison and cattle during February through June (Lead = MDOL).

On June 17, 2009, one bull mixed with livestock on private property on the South Fork (west management area) and was lethally removed.

Bison made numerous incursions into grazing areas within 69 days of cattle turnout and/or into Zone 3. On June 9, 2009, two adult females and two calves occupied an area west of Denny Creek Road in the South Fork area adjacent to pasture where cattle were to be grazed beginning June 12, 2009.

Monitoring Metric 2: Document the number of times bison are successfully or unsuccessfully moved to create separation in time and space from cattle (Lead = MDOL).

Prior to May 15, 2009, bison moved into non-tolerance areas in the west management area 23 times. Bison moved west of the Madison Arm Resort six times after April 15 and occupied Zone 3 on 14 separate days, including four times after May 15. Bison numbers also exceeded the trigger point of tolerance (30 bison) on the Flats seven times. Bison remained in Montana after the May 15 haze-back date every day through June 19 (35 days).

Adaptive Management Recommendations:

See recommendations for management action 1.1a on page 8.

ACTION 3.2B: EVALUATE THE USE OF LIMITED, STRATEGICALLY PLACED FENCING WHEN AND WHERE IT COULD EFFECTIVELY CREATE SEPARATION BETWEEN DOMESTIC LIVESTOCK AND BISON, AND NOT CREATE A MAJOR MOVEMENT BARRIER TO OTHER WILDLIFE.

Monitoring Metric 1: Document the number of additional acres of habitat made available for bison as a result of strategic fencing (Lead = MFWP/USFS/MDOL).

No strategic fencing projects were initiated to make additional habitat available for bison.

Monitoring Metric 2: Document fence damage or the number of times fencing fails to inhibit bison trespass on private property occupied by cattle (Lead = MDOL).

A summary of fence damage was provided for action 1.3b on page 13.

Adaptive Management Recommendations:

Evaluate whether strategic fencing is appropriate and, if so, at what locations along bison migration corridors to the South Fork, The Narrows, or on the Madison Arm of Hebgen Lake. In addition, explore management flexibility and bison management opportunities associated with strategic fencing.

Complete a fence on the south side of the Stermitz property and in the interior of their property to the highway. The fence would also include a section on the north side of the property paralleling the existing jack fence bordering the Hoppe property. This fence would provide a corridor to haze bison across the Stermitz property back onto the National Forest. The proposed

corridor would allow staff to avoid the Hoppe property and keep off steep and dangerous terrain on the south side of the Stermitz property. The fence would also steer migrating bison away from the subdivision to the north.

Estimate an annual amount of funds necessary to support fence construction and maintenance and identify funding sources.

ACTION 3.2C: HAZE BISON FROM THE HEBGEN BASIN INTO YELL WITH A TARGET DATE OF MAY 15.

Monitoring Metric 1: Consistent with management action 1.1.a, assess the prevailing environmental conditions and reach consensus by May 13 on a step-wise, integrated plan for the end-of-winter return of bison into YELL from Zone 2 (Lead = MDOL/NPS).

Consensus was reached between the IBMP partners by May 13 on a step-wise, integrated plan for the end-of-winter return of bison into YELL from Zone 2, resulting in 20 operations.

Monitoring Metric 2: Annually document the timing of the end-of-winter return of bison into YELL, the number of bison returned, prevailing environmental conditions, and success or lack thereof of hazing bison and getting them to remain in the park (Lead = MDOL/NPS)

In late April 2009, more than 30 bison began using the Flats area of Zone 2 and adjacent areas of Zone 3 in the Hebgen basin. Five hazing operations were conducted before May 12 to move bison from this area and back into the park. However, many of these bison returned after hazing. Thus, operations to haze bison further into the park were conducted during May 12-15, 2009, and 450 bison were moved from Horse Butte, the Flats, Cougar Meadows, and the meadow near 7-mile Bridge to Madison Junction. Bison were not hazed from Madison Junction to Fountain Flats at that time. During May 16-20, the Madison River flooded and forage in meadow systems along the Madison and Gibbon rivers was rendered unavailable. Thus, bison previously hazed to Madison Junction moved back to Cougar Meadows and Horse Butte, which were not flooded, with additional bison joining them from the Lower Geyser Basin (e.g., Fountain Flats) and northern range. By May 21, approximately 715 bison occupied the Cougar Meadow complex and hazing was conducted during May 22-26 to move bison back to Madison Junction. Small groups of these bison began to move from Madison Junction, south through the Firehole Canyon, and into the Porcupine Hills and Fountain Flats areas of the Lower Geyser Basin. However, vegetation green-up was minimal in the Lower Geyser Basin and this migration progressed slowly. Thus, bison were hazed by horseback on May 27-28 from the meadow near 7-mile Bridge to the Nez Perce Creek and Fountain Flats areas about 21 miles from the west boundary of YELL. By the end of May, the water level in the Madison River subsided and forage in meadow complexes along the Madison and Gibbon rivers became accessible. Also, bison began to more readily move into the Lower Geyser Basin, which reduced the total number of bison in the Madison Valley. However, some bison remained west of 7-mile Bridge and continued to move across the west park boundary. Thus, four hazing operations were conducted during June 9-12 to move about 60-70 bison east of Zone 1. After the May 15 haze-back date, bison remained in Montana every day through June 19 and occupied Zone 3 on four occasions.

Monitoring Metric 3: Annually review and apply *B. abortus* persistence information, private land cattle turn-on dates, and applicable research results to determine the effects of haze-to-habitat actions on bison and their effectiveness at preventing the commingling of bison and cattle (Lead = MDOL).

Cattle turn-on dates were previously described for action 1.3a on page 12. Research findings regarding *Brucella* persistence are currently being analyzed by MFWP staff.

Adaptive Management Recommendations:

See recommendations for management action 1.1a on page 8.

ACTION 3.2D: HAZE BISON FROM THE GARDINER BASIN INTO YELL WITH A TARGET DATE OF MAY 1.

Monitoring Metric 1: Consistent with management action 1.1.b, assess the prevailing environmental conditions and reach consensus by April 15 on a step-wise, integrated plan for the end-of-winter return of bison into YELL from Zone 2 (Lead = MDOL/NPS).

Consensus was reached between the IBMP partners by April 15, 2009, on a step-wise, integrated plan for the end-of-winter return of bison into YELL from Zone 2, resulting in five operations.

Monitoring Metric 2: Annually document the timing of the end-of-winter return of bison into YELL, the number of bison returned, prevailing environmental conditions, and success or lack thereof of hazing bison and getting them to remain in the park (Lead = MDOL/NPS).

Bison movements beyond the conservation area were limited to a few incidents previously described under management action 1.1b. Prior to April 15, two hazing operations (51 bison) were conducted in Zone 2 and one hazing operation (30 bison) was conducted in Zone 1. After April 15, five hazing operations (64 bison) were conducted in Zone 2 and five hazing operations (263 bison) were conducted in Zone 1. No end-of-winter hazing of bison into YELL was necessary.

Monitoring Metric 3: Annually review and apply *B. abortus* persistence information, private land cattle turn-on dates, and applicable research results to determine the effects of haze-to-habitat actions on bison and their effectiveness at preventing the commingling of bison and cattle (Lead = MDOL).

Cattle turn-on dates were previously described for action 1.3a. Research findings regarding *Brucella* persistence are currently being analyzed by MFWP staff.

Adaptive Management Recommendations:

None at this time.

1. ESTIMATE THE ABUNDANCE, DEMOGRAPHIC RATES, AND LIMITING FACTORS FOR THE OVERALL BISON POPULATION AND TWO PRIMARY SUBPOPULATIONS (CENTRAL AND NORTHERN).

NPS staff collaborated with Dr. Robert Garrott and Julie Fuller from Montana State University to analyze a 99-year time series of annual counts and removals for northern and central bison herds in YELL (Fuller et al. 2009). Findings suggest that:

- Aggressive management intervention was effective at recovering bison from 46 animals in 1902 to >1,500 animals in 1954. Supplemental feeding of the northern herd facilitated rapid growth during 1902-1952. Augmentation of the central herd with 71 animals also led to rapid growth over 1936-1954.
- In 1969, manipulative management ceased in the park, and there was evidence of density-dependent changes in population growth rates for both herds during 1970-2000 as numbers increased to more than 3,000 bison. The central herd showed evidence of a constant density-dependent response over 1970-2000. In contrast, density dependence had a stronger effect on the northern herd's growth rate during 1970-1981 than during 1982-2000.
- These trends resulted from pulses of emigration from the central herd to the northern range beginning in 1982 in response to resource limitation generated by an interaction between density and severe snow pack.

NPS staff collaborated with Dr. Robert Garrott and Julie Fuller from Montana State University to estimate demographic rates from 80 adult female bison in the central herd during 1995-2006 (Geremia et al. 2009a). Findings suggest that:

- Animals testing positive for exposure to brucellosis had significantly lower pregnancy rates across all age classes compared to seronegative bison.
- Birth rates were high and consistent for seronegative animals, but lower for younger, seropositive bison. Seronegative bison that converted to seropositive while pregnant were likely to abort their first and second pregnancies. Thus, naïve seronegative adult bison may be highly susceptible compared to animals exposed before they are reproductively mature.
- There was a pronounced decrease in survival for animals >12 years old. Also, brucellosis exposure indirectly lowered bison survival because more bison were culled over concerns about transmission to cattle when bison attempted to move to lower-elevation areas outside the park.
- There was a significant decrease in adult female survival when the number of bison in the central herd exceeded 2,000-2,500 animals, which was exacerbated during winters with severe snow pack because more bison moved outside the park. Except during 1996-97, the vast majority of radio-marked bison culled at the north and west boundaries during 1995-2006 came from the central herd.
- The combined effect of brucellosis on survival, pregnancy, and birth rates lowered the growth rate in the central herd. Population growth rates will likely increase by more than 15% if vaccination plans are implemented and successful. Managers would then be challenged with greater numbers of disease-free bison dispersing or migrating outside of the park in response to density and climate effects.

NPS staff collaborated with Dr. Michael Coughenour from Colorado State University to synthesize available information and interpreted results of a spatially explicit model (Coughenour 2005) of the Yellowstone system (Plumb et al. 2009). Findings suggest that:

- Bison abundance has not exceeded the theoretical food-limited carrying capacity of 6,200 in YELL.
- More bison migrate earlier to lower-elevation winter ranges as numbers increase and climatic factors interact with density to limit nutritional intake and foraging efficiency.
- A gradual expansion of the winter range as bison numbers increased enabled relatively constant population growth and increased food-limited carrying capacity.
- Current management actions should attempt to preserve bison migration to essential winter range areas within and adjacent to the park, while actively preventing dispersal and range expansion to outlying areas via hazing, translocations, and culls.
- A population of 2,500-4,500 bison should satisfy collective interests concerning the park's forage base, bison movement ecology, retention of genetic diversity, brucellosis risk management, and prevailing social conditions.

NPS staff is collaborating with Dr. Tom Hobbs from Colorado State University to develop a model that integrates annual observations of the bison population in YELL (i.e., demography, disease) with parameter estimates from process studies in a discrete time, stage-structured model. The objectives for model construction were to:

- Provide a framework for assimilating data from four decades of monitoring and research in a way that allows those data to better inform management decisions.
- Offer forecasts of future behavior of the population accompanied by explicit estimates of uncertainty.
- Support decisions on future monitoring and research that will enhance model predictions and their application to management decisions.

A final report is expected by December 2009.

2. DESCRIBE MIGRATORY AND NOMADIC MOVEMENTS BY BISON AT A VARIETY OF TEMPORAL AND SPATIAL SCALES IN AND OUTSIDE THE PARK.

NPS staff is developing a framework for analyzing the extensive movement data collected during 2003-2009 from bison with GPS radio collars to identify factors and processes that affect seasonal bison distributions and movements. The objectives for model construction are to:

- Estimate the behavior of individual bison that accounts for the underlying behavioral processes of foraging and moving within and between major foraging sites.
- Evaluate the strength of support in the data for the prediction that bison foraging behavior is explained by a strategy where they maximize the time spent foraging and minimize the time spent searching for food during the dormant (i.e., non-growing) vegetation period.
- Determine the relative importance of climate factors, bison density and group size, forage biomass, diet quality, and under nutrition on the timing and rate at which bison move to low-elevation winter ranges.
- Build an informative state-space model that predicts the probability of movements of bison between major foraging areas and beyond park boundaries, using density, climate factors, diet quality, and chronic under-nutrition during winter.

A final report is expected by December 2009.

NPS staff collaborated with Drs. Jason Bruggeman, Robert Garrott, and John Borkowski from Montana State University to quantify annual variations in the magnitude and timing of migration by central herd bison during 1971 through 2006 and identify potential factors driving this variation (Bruggeman et al. 2009b). Findings suggest that:

- Bison from the central herd were partially migratory, with a portion of the animals migrating to the lower-elevation Madison headwaters area during winter while some remained year-round in or near the Hayden and Pelican valleys.
- There was significant bison migration to the Madison headwaters area before the Hayden and Pelican valleys were fully occupied and abundance approached the food-limiting carrying capacity of these valleys.
- However, after the central herd exceeded 2,350 animals the number of bison wintering in the Hayden and Pelican valleys appeared to stabilize, while bison continued to migrate to the Madison headwaters area. Also, more bison migrated earlier as density increased.
- Some bison migrated outside the west-central portion of the park between the summer and winter counts each year when the central herd exceeded 2,350 bison, perhaps relocating to northern range.
- The timing and magnitude of bison migration were accentuated during years of severe snow pack that limited access to food.

NPS staff collaborated with Drs. Jason Bruggeman, Robert Garrott, and John Borkowski from Montana State University to quantify how snow, topography, habitat attributes, and roads influenced the travel patterns and non-traveling activities of 30 radio-marked, adult, female bison from the central herd during three winters (Bruggeman et al. 2009a). Findings suggested that:

- Bison were less likely to use a point on the landscape for traveling or feeding as snow pack increased. However, bison used local areas with deeper snow as the overall snow pack increased on the landscape.
- Distance to stream was the most influential habitat covariate, with the spatial travel network of bison being largely defined by streams connecting foraging areas. Distances to foraging areas and streams also significantly influenced non-traveling activities, being negatively correlated with the odds of bison foraging or resting.
- Topography significantly affected bison travel patterns, with the probability of travel being higher in areas of variable topography that constrained movements (e.g., canyons). Distance to road had a significant, negative effect on bison travel, but was nine times less influential compared to the impact of streams.

- Road grooming has a minimal influence on bison travel and habitat use given the importance of natural dynamic and static landscape characteristics such as snow pack, topography, and habitat attributes on bison choice of travel routes and habitat use for foraging and resting.

3. ESTIMATE THE EXISTING HETEROZYGOSITY, ALLELIC DIVERSITY, AND LONG-TERM PROBABILITIES OF GENETIC CONSERVATION FOR THE OVERALL BISON POPULATION AND IDENTIFIED SUBPOPULATIONS.

NPS staff is collaborating with Drs. Gordon Luikart and Fred Allendorf from the University of Montana and Dr. Mike Schwartz from the Forest Service Rocky Mountain Research Station on the genetics of bison in YELL to:

- Estimate the current distribution of genetic diversity and gene flow between the two primary breeding herds.
- Develop a mathematical model that incorporates the latest determination of genetic diversity among bison breeding groups and simulates management influences (e.g., removals) similar to those experienced since 2000.
- Conduct an objective assessment based on modeling and other information of the abundance per primary breeding herd needed to preserve 90 and 95% of current level of genetic diversity values.
- Develop recommendations regarding surveillance (e.g., samples, timing, locations) to ensure NPS staff have the statistical power to detect a genetically significant change in diversity over time.

A final report is expected by December 2009.

NPS staff collaborated with Drs. Gordon Luikart and Fred Allendorf and Flo Gardipee from the University of Montana to test the hypothesis that bison from different breeding ranges would be genetically differentiated based on amplified mitochondrial DNA from fecal samples. Findings suggest that:

- There is significant genetic differentiation between bison using the northern and central breeding ranges in YELL, likely due to strong female fidelity to breeding areas.
- Studies using nuclear microsatellites should be conducted to further assess population genetic subdivision and establish a genetic monitoring program.

NPS staff collaborated with Dr. Betsy Bricker from the Agricultural Research Service, National Animal Disease Center, and Dr. Gordon Luikart from the University of Montana and his students to genotype 10 variable number of tandem repeat DNA loci in 58 *B. abortus* isolates from bison, elk, and cattle to test which wildlife species was the likely origin of recent outbreaks of brucellosis in cattle in the Greater Yellowstone Area (Beja-Pereira et al. 2009). Findings suggest that:

- Isolates from cattle and elk were nearly identical, but highly divergent from bison isolates.
- Elk, not bison, were the reservoir species of origin for these cattle infections.
- DNA genotyping can be used to assess the origin of disease outbreaks.

4. ESTIMATE THE PROBABILITIES (I.E., RISKS) OF BRUCELLOSIS TRANSMISSION WITHIN AND BETWEEN SPECIES (I.E., BISON, CATTLE, ELK) AND AREAS (E.G., ELK FEED GROUNDS IN WYOMING AND THE NORTHERN GREATER YELLOWSTONE AREA).

NPS and Animal Plant and Health Inspection Service staff are currently collaborating with the University of California-Davis to quantify:

- The risk of brucellosis transmission from bison and elk to cattle in the northern Greater Yellowstone Area.
- Brucellosis transmission dynamics within and between bison and elk populations in the northern Greater Yellowstone Area.
- The potential for brucellosis vaccination of bison to mitigate transmission risks and contribute to brucellosis elimination.

A final report is expected by December 2009.

NPS staff collaborated with Dr. Paul Cross from the U.S. Geological Survey and staff from other agencies and universities to assess several plausible hypotheses for observed increases in the seroprevalence of brucellosis in several free-ranging elk populations of Wyoming (Cross et al. 2009). Findings suggest that:

- Free-ranging elk appear to be a maintenance host for *B. abortus* in some areas.
- Brucellosis seroprevalence in free-ranging elk increased from 0-7% in 1991-1992 to 8-20% in 2006-2007 in four herd units not associated with feed grounds.
- These seroprevalence levels, which are comparable to units where elk are aggregated on feed grounds, are unlikely to be sustained by dispersal of elk from feeding areas with high seroprevalence or an older age structure.

- The rate of seroprevalence increase was related to the population size and density of each herd unit. Enhanced elk-to-elk transmission in free-ranging populations may be occurring due to larger winter elk aggregations.
- Elk populations inside and outside of the GYE that traditionally did not maintain brucellosis may now be at-risk due to recent population increases. In particular, some neighboring populations of Montana elk were 5-9 times larger in 2007 than in the 1970s with some aggregations comparable to the Wyoming feed ground populations.

NPS staff and Drs. Robert Garrott and Kelly Proffitt from Montana State University analyzed conditions facilitating contact between bison (40-60% seroprevalence) and elk on a shared winter range in the Madison headwaters area of YELL during 1991 through 2006. Findings suggest that:

- Spatial overlap between bison and elk increased through winter as snow pack increased and peaked when late-term abortion events and parturition occurred for bison. Wolves contributed to immediate, short-term responses by elk that increased spatial overlap with bison, but longer-term responses to wolves resulted in elk distributions that reduced spatial overlap with bison.
- Despite this relatively high risk of transmission, levels of elk exposure to *B. abortus* (2-4%) were similar to those in free-ranging elk populations that do not commingle with bison (1-3%), suggesting that *B. abortus* transmission from bison-to-elk under natural conditions is rare.
- Management of brucellosis in elk populations could focus on reducing elk-to-elk transmission risk and, to the extent feasible, curtailing practices that increase elk density and group sizes during the potential abortion period.

5. ESTIMATE AGE-SPECIFIC RATES OF BISON TESTING SEROPOSITIVE AND SERONEGATIVE FOR BRUCELLOSIS THAT ARE ALSO CULTURE POSITIVE AND THE PROPORTION OF SEROPOSITIVE BISON THAT REACT POSITIVELY ON SEROLOGIC TESTS DUE TO EXPOSURE TO CROSS-REACTIVE AGENTS OTHER THAN *B. ABORTUS* (E.G., *YERSINIA*).

NPS and APHIS staff sampled more than 400 bison that were consigned to slaughter during winter 2007-08. Blood and tissues collected from these bison will be used to estimate the proportion of seropositive and seronegative bison that were actively infected with *B. abortus* (i.e., culture positive).

- Depending on the sex of the bison, the tissues sampled for B. abortus culture included the retropharyngeal lymph nodes, supra mammary lymph nodes, internal iliac lymph nodes, superficial inguinal lymph nodes, and a section of mammary gland.
- Tissues were frozen and shipped to the National Veterinary Services Laboratory in Ames, Iowa for *Brucella* culture. Culture tests results will be compared with serology tests from the same animals to better understand seroprevalence and the state of infection across bison sex and age classes.

A preliminary report is expected by December 2009.

6. DETERMINE RATES OF RECRUDESCENCE (I.E., LATENT CARRIERS OF *BRUCELLA* THAT RELAPSE TO AN INFECTIOUS STATE) IN BISON.

Annual monitoring of approximately 30 radio-marked, female bison is being conducted to estimate calving success and collect tissues and swabs for post-parturition culturing. The intent is to continue this monitoring of marked females for the duration of their lives; though "true" rates of recrudescence will be difficult to estimate even with this sampling effort. Until diagnostic tests are improved, we will continue to collect additional data and use modeling to obtain approximate estimates for this parameter.

7. DETERMINE HOW THE INTERACTIVE EFFECTS OF PREGNANCY, STRESS, AND NUTRITIONAL CONDITION INFLUENCE THE VULNERABILITY OF BISON TO BRUCELLOSIS INFECTION AND TRANSMISSION.

NPS staff developed study plans for immobilizing, radio-collaring, and repeatedly sampling 10 female bison from each of three age classes (young, prime, old) to assess these effects. The protocol is currently only being opportunistically implemented.

8. ESTIMATE THE TIMING AND PROPORTION OF REMOVALS FROM EACH OF THE TWO PRIMARY SUBPOPULATIONS EACH WINTER, INCLUDING THE PROPORTION OF REMOVALS FROM EACH AGE AND SEX CLASS AND THE PROPORTION OF CALF-COW PAIRS.

There were four risk management removals of bison from the population during 2008-2009. Three bull bison were captured and sent to slaughter because they could not safely be hazed out of a non-tolerance area north of Duck Creek, and one bull bison was lethally removed on private land on the South Fork following co-mingling with livestock.

NPS staff completed a report (Geremia et al. 2009b) summarizing analyses of the relationships between bison population size, winter severity, and the number of bison removed near the boundary of YELL during 1970-2008. Findings suggest that:

- Limiting the population to less than 3,500 bison in the central herd and 1,200 bison in the northern herd could abate large-scale migrations and management removals when snow conditions are near average. NPS staff is currently working with Dr. John Borkowski at Montana State University to refine these analyses.

9. DOCUMENT BISON USE OF RISK MANAGEMENT ZONES OUTSIDE THE NORTH AND WEST BOUNDARIES OF YELL AND COMMINGLING WITH LIVESTOCK DURING THE LIKELY BRUCELLOSIS-INDUCED ABORTION PERIOD FOR BISON EACH SPRING.

Small groups of bison moved out of the park and into the north risk management zone on seven occasions during April 10-30, 2009. One livestock operation was located within 0.25 mile of these bison, while another livestock operation was located about one mile north.

Bison continuously occupied Zone 2 of the west risk management zone from the last week of March until June 10, 2009. On at least three occasions during late April and early May, bison were located near the Deep Well Ranch in Zone 3. One bull bison was lethally removed from private land on the South Fork following co-mingling with livestock. All bison were hazed back into the conservation area and subsequently back into YELL.

10. ESTIMATE THE EFFECTS OF HAZING OR TEMPORARILY HOLDING BISON IN CAPTURE PENS AT THE BOUNDARY OF YELL (FOR SPRING RELEASE BACK INTO THE PARK) ON SUBSEQUENT BISON MOVEMENTS OR POSSIBLE HABITUATION TO FEEDING.

NPS staff is developing a framework for analyzing the extensive movement data collected during 2003-2009 from bison with GPS radio collars to identify factors and processes that affect seasonal bison distributions and movements. One objective of this effort is to build an informative model that predicts the probability of movements of bison between major foraging areas and beyond park boundaries. We intend to incorporate some type of covariate or indicator variable for each animal that signifies previous knowledge/use of certain patches or movements to the boundary (including capture and holding) because learning almost certainly plays a big role in movement decisions.

11. DETERMINE THE STRENGTH AND DURATION OF THE IMMUNE RESPONSE IN BISON FOLLOWING PARENTERAL (E.G. SYRINGE DELIVERY) VACCINATION FOR BRUCELLOSIS.

NPS staff are collaborating with Dr. Ryan Clarke from APHIS and Dr. David Pascual from Montana State University to measure the cell-mediated immune responses (i.e., proliferation of T lymphocyte and production of specific cytokines) induced by SRB51 vaccination in bison.

- Twelve yearling bison in the quarantine feasibility study were parenterally vaccinated with SRB51 during winter 2008-2009. Immune responses were assessed prior to vaccination and at 3, 8, 12, 18, and 21 weeks after vaccination.
- Twenty wild, yearling, female bison captured at the Stephens Creek facility during late winter 2008 for measuring their cell-mediated immune responses. Fourteen of these bison were parenterally vaccinated with SRB51 and six served as non-vaccinated controls. All 20 bison were released back into the wild during May 2008. During autumn and winter 2008-2009, 14 of the 20 bison in the study were recaptured to measure cell-mediated immune responses 24+ weeks following vaccination.

A preliminary report is expected by December 2009.

12. Determine the strength and duration of immune response in bison following remote delivery (e.g. bio-bullet) vaccination for brucellosis.

Olsen et al. (2006) reported the ballistic inoculation of bison with biobullets containing photopolymerized, polyethylene glycol-based hydrogels with SRB51 induced a significant cell-mediated immune response similar to syringe injection of the vaccine. However, the immunologic responses of bison to hydrogel vaccination with SRB51 during 2007 indicated poor proliferation and interferon response compared to parenteral injection (S. Olsen, unpublished data). These findings suggest the vaccine has uncertain effects or there are consistency issues with vaccine hydrogel formulation and/or encapsulation in biobullets. The NPS is initiating an agreement with Drs. David Grainger and Jim Christie from the University of Utah and Dr. Steve Olsen from the Agricultural Research Service to provide and/or disclose:

- Methods for encapsulating the vaccine.
- A list of equipment and supplies needed to produce photopolymerized, hydrogel-encapsulated, vaccine projectiles.
- Known patent issues regarding the use of photopolymerization methods for production of remote delivery vaccination products.
- A critical review of the differences in findings from preliminary immunologic response experiments (e.g., Olsen et al. 2006) and subsequent experiments.
- A critical assessment of other research and development needs (e.g., recommended dose, shelf-life) that should be addressed prior to full-scale production.

13. Document long-term trends in the prevalence of brucellosis in bison, and the underpinning effects of remote and/or parenteral vaccination, other risk management actions, and prevailing ecological conditions (e.g. winter-kill, predation) on these trends.

NPS staff has prepared a Draft Environmental Impact Statement to decide whether or not to proceed with implementation of remote delivery vaccination of bison in the park. Three alternatives are included in the draft Environmental Impact Statement:

- The no action alternative describes the current vaccination program that is intermittently implemented at the Stephens Creek capture facility in concert with capture operations.
- The second alternative would include a combination of the capture program at Stephens Creek and a remote delivery vaccination strategy that would focus exclusively on young, non-pregnant bison of both sexes. Remote delivery vaccination could occur from March to June and mid-September to mid-January through many areas of bison distribution in the park.
- A third alternative would include all components of the second alternative, as well as the remote vaccination of adult females during autumn. The vaccination program is intended to lower the percentage of bison susceptible to brucellosis infection.

The time frame for completion of the Environmental Impact Statement and Record of Decision is as follows:

- Internal NPS review (DEIS) – Summer/Autumn 2009
- Public review and comments – Winter 2010
- Comment analysis and revision – Spring/Summer 2010
- Internal NPS review (Final EIS) – Autumn 2010
- Federal Register notice – Spring 2011
- Record of Decision – Summer 2011

IMPROVEMENTS IN VACCINES, DELIVERY SYSTEMS, AND DISEASE TESTING

Background:

The U.S. Animal Health Association organized a working symposium at the University of Wyoming in Laramie during 2005 to identify the most important opportunities and costs for improved vaccines, vaccine delivery systems, and disease testing for brucellosis in bison and elk. Some of the major recommendations from this symposium included:

- Strain RB51 offers only moderate protection in bison. Thus, there is a need to conduct clinical challenge trials on SRB51 "plus," Strain 82, and other potential vaccines, develop a rapid assessment protocol to screen additional promising vaccine candidates, and develop and license new vaccines engineered specifically for elk and/or bison.
- Oral and remote ballistic delivery methods require improvements, including achieving sustained release, effective biomarkers to evaluate vaccine delivery, vaccine stability and storage/shelf life, and vaccine dosage.
- Field validation trials should be conducted to evaluate effectiveness of vaccine delivery before widespread application of vaccination programs in the GYE.
- Validate existing brucellosis diagnostic methods that are applied to wildlife; and
- Initiate new research to develop and validate new technologies such as rapid genomic diagnostic tests involving Polymerase Chain Reaction (PCR) and vaccine biomarkers.

Progress:

There has been little progress on new vaccines, delivery technologies, or diagnostic tests for *B. abortus* since 2005 due to the lack of market incentives and funding.

Vaccine Efficacy and Development

Dr. Steve Olsen from the Agricultural Research Service and colleagues characterized immunologic responses and protection against experimental challenge after vaccination of 11-month-old bison with *B. abortus* strains RB51 (RB51) or a recombinant RB51 strain overexpressing superoxide dismutase and glycosyltransferase genes (RB51+) (Olsen et al. 2009). Compared to non-vaccinates (i.e., controls), bison vaccinated with RB51 or RB51+ had significantly greater antibody responses, proliferative responses, and production of interferon-γ to RB51 after vaccination. Bison vaccinated with RB51, but not RB51+ vaccinates, had greater protection from abortion, fetal/uterine, mammary, or maternal infection as compared to non-vaccinates. These findings suggest that the RB51+ strain is less efficacious as a calf-hood vaccine for bison compared to vaccination with the parental RB51 strain. The authors suggest the RB51 vaccine is a currently available management tool that could be used to help reduce brucellosis in free-ranging bison.

In August 2005 at the University of Wyoming Symposium, Professor Konstantin Mikhailovich Salmakov gave a Plenary Presentation United States, entitled "*Cattle Brucellosis in Russia and its Specific Prophylaxis*." Dr. Salmakov reported that in Russia a live vaccine based on *B. abortus* 82 (Russia, ARVI, Kazan) is in use currently as an officially approved preparation. Strain *B. abortus* 82 was developed in 1960 by Professor Salmakov and testing on laboratory animals and cattle in experimental and industrial conditions established the presence of weak agglutinogenic and pronounced immunogenic properties. In 1974, strain 82 vaccine was used in 34 regions of Russia on approximately 30 million animals of all ages in extreme epizootic conditions. After that, 6-9 million animals were annually inoculated with this vaccine. Broad application of the strain 82 vaccine, providing a strong immune background and possibility of early post-vaccinal diagnostics (after 3-6 months compared to 2-3 years after strain 19), made it possible to reduce epizootic outbreaks of cattle brucellosis in Russia. The large reduction in new cases of brucellosis encouraged the Head Veterinarian Directorate at the Ministry of Agriculture to approve the live strain 82 vaccine for use in veterinarian practice for fighting cattle brucellosis. For over 30 years, the biological industrial complex in Shchelkovo (Moscow region) has been producing dry strain 82 vaccine which has been successfully applied in many regions of Russia as an integral part of the veterinary-sanitary program for control of cattle brucellosis. By the end of 2004, after taking special measures including application of the vaccine in cattle, the number of places with brucellosis was decreased to 1.4% of its 1974 level. Positive results were also achieved for application of the vaccines in other animal species (e.g., reindeer (*Rangifer tarandus*), maral (*Cervus elaphus*), yak (*Bos grunniens*), buffalo (*Bison bonasus*), zebu (*Bos primigenius indicus*). Dr. Salmakov reported that with the use of strain 82 vaccine, the problem of brucellosis in many regions of Russia has been solved. Unfortunately, these findings and claims have not been subject to peer-review or published in science journals for closer scrutiny. Efforts are currently underway to locate, organize, archive, analyze, interpret, and publish in peer-reviewed journals the data from these comparative laboratory research and field trials on strain 82.

Vaccine Delivery Systems

Currently, the most feasible method for effective remote delivery of brucellosis vaccine to bison in YELL includes the use of a pneumatic rifle with a bio-absorbable projectile containing the vaccine (i.e., biobullet. Olsen et al. (2006) reported the ballistic inoculation of bison with biobullets containing photopolymerized, poly(ethylene glycol)-based hydrogels induced a significant cell-mediated immune response similar to syringe injection of the vaccine. However, the immunologic responses of bison to hydrogel vaccination with SRB51 during 2007 indicated poor proliferation and interferon response compared to parenteral injection (S. Olsen, unpublished data). These findings suggest the vaccine has uncertain effects or there are consistency issues with vaccine hydrogel formulation and/or encapsulation in biobullets.

Disease Testing and Diagnostics

The Technical Committee is not aware of any progress on new diagnostic tests.

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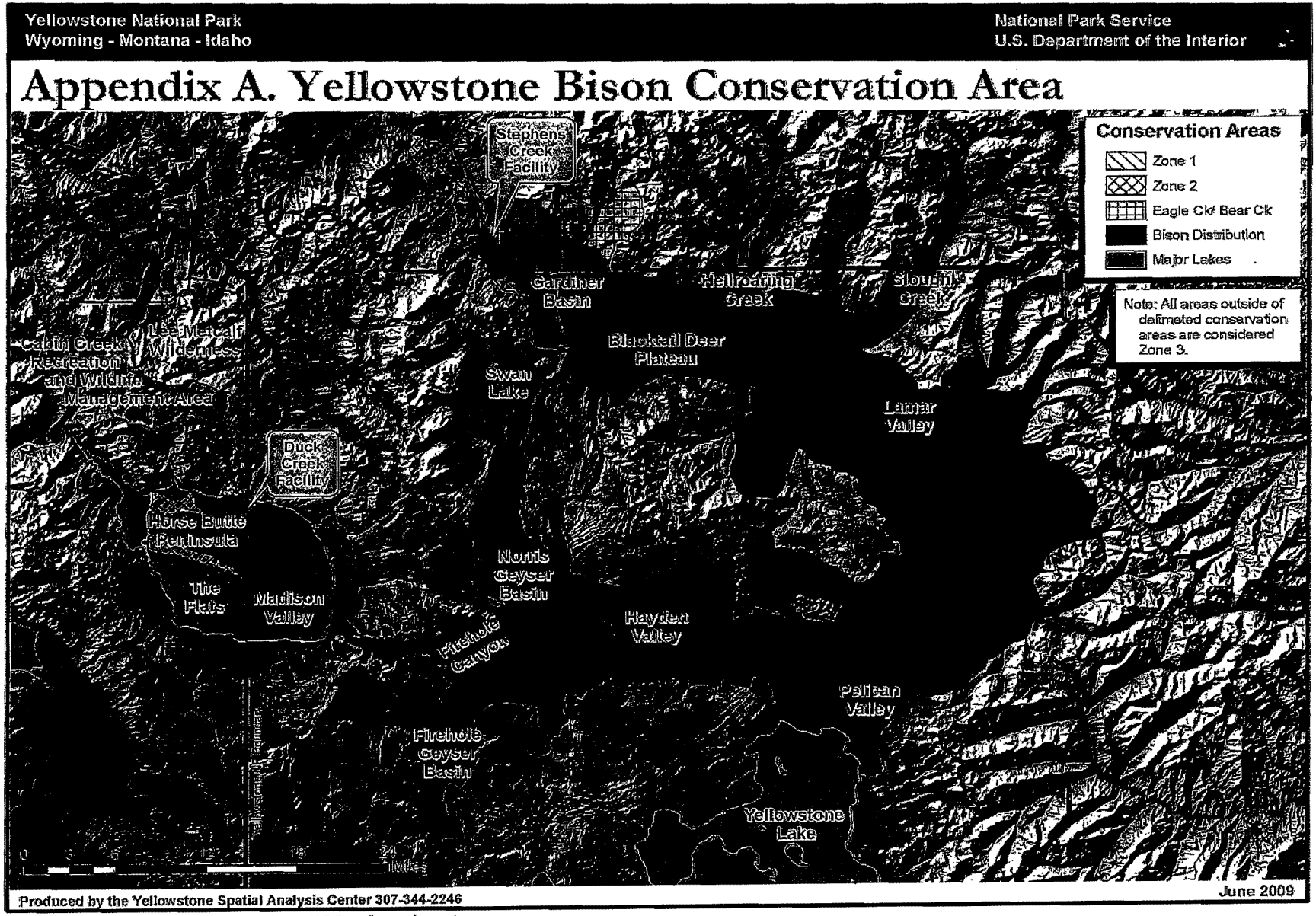
Yellowstone National Park
Wyoming - Montana - Idaho
National Park Service
U.S. Department of the Interior
Appendix A. Yellowstone Bison Conservation Area
Stephens Creek Facility
Gardiner Basin
Hellroaring Creek
Slough Creek
Cabin Creek Recreation and Wildlife Management Area
Lee Metcalf Wilderness
Blacktail Deer Plateau
Swan Lake
Lamar Valley
Duck Creek Facility
Horse Butte Peninsula
Norris Geyser Basin
The Flats
Madison Valley
Hayden Valley
Firehole Canyon
Pelican Valley
Firehole Geyser Basin
Yellowstone Lake
Conservation Areas
Zone 1
Zone 2
Eagle Ck/ Bear Ck
Bison Distribution
Major Lakes
Note: All areas outside of delimeted conservation areas are considered Zone 3.
Produced by the Yellowstone Spatial Analysis Center 307-344-2246
June 2009
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APPENDIX B: BISON BREACHES IN WEST MANAGEMENT AREA DURING 2009.

Date	Trigger Point(s) Breached	No. Bison	Bison Location	Operations
April 25	Zone 3, Madison Resort by April 15	18	Deep Well Ranch, west of Madison Resort	
April 27	Zone 3, Madison Resort by April 15; Limit of 30 in Flats	86	South Fork west of Denny Creek Road (20); west of Madison Resort (66)	Yes
April 28	Zone 3, Madison Resort by April 15	5	South Fork, west of Madison Resort	Yes
April 29	Zone 3, Madison Resort by April 15; Limit of 30 in Flats	50	South Fork (36); West of Madison Resort (14)	
April 30	Zone 3, Madison Resort by April 15; Limit of 30 in Flats	109	South Fork (90); West of Madison Resort (19)	Yes
May 4	Zone 3, Limit of 30 in Flats	146	South Fork (15); East of Madison Resort after April 15 (131); Swam lake from north to south side of Madison Arm (70)	
May 5	Zone 3, Madison Resort by April 15; Limit of 30 in Flats	158	South Fork (27 bison in three separate groups); west of Madison Resort (131)	Yes
May 6	Zone 3, Madison Resort by April 15; Limit of 30 in Flats	54	South Fork west of Denny Creek Road (16); west side of South Fork (9); west of Madison Resort (21); east of Madison Resort (6)	Yes
May 7	Madison Resort by April 15; Limit of 30 in Flats	130	East of Madison Resort	Yes
May 11	Zone 3, Madison Resort by April 15; Limit of 30 in Flats	69	South Fork west of Denny Creek Road (9); west side of South Fork (23); east of Madison Resort (37)	Yes
May 13	Zone 3, Madison Resort by April 15; Limit of 30 in Flats	58	South Fork (6); east of Madison Resort (52)	Yes
May 14	Madison Resort by April 15; Limit of 30 in Flats	58	East of Madison Resort	Yes
May 16	After May 15 deadline, no bison in Flats or north of Duck Creek	23	South Side of Madison River (15); north of Duck Creek (8)	
May 18	After May 15 deadline, no bison in Flats or north of Duck Creek; bulls only north of Madison River and south of Duck Creek	89	South Fork (4); south of Madison River and east of Resort (30); north of Duck Creek (16); Horse Butte and Yellowstone Ranch Preserve (39)	Yes
May 19	After May 15 deadline, no bison in Flats or north of Duck Creek	29	South Fork (4); south of Madison River and east of resort (25)	Yes
May 20	After May 15 deadline, no bison in Flats or north of Duck Creek	20	South of Madison River and east of Resort	Yes
May 21	After May 15 deadline, no bison in Flats or north of Duck Creek; bulls only north of Madison River and south of Duck Creek	77	South of Madison River and east of Resort (17); Horse Butte (60)	Yes
May 22	After May 15 deadline, no bison in Flats or north of Duck Creek; bulls only north of Madison River and south of Duck Creek	36	North of Duck Creek (1); north of Madison River (33); Horse Butte (2)	Yes
May 23	After May 15 deadline, bulls only north of Madison River and south of Duck Creek	72	North of Madison River and south of Duck Creek	Yes
May 24	After May 15 deadline, no bison in Flats or north of Duck Creek; bulls only north of Madison River and south of Duck Creek	188	South of Madison River and east of Resort (134); north of Duck Creek (4); north of Madison River (50)	Yes
May 25	After May 15 deadline, no bison in Flats or north of Duck Creek; bulls only north of Madison River and south of Duck Creek	143	South of Madison River and east of Resort (104); north of Madison River (39)	Yes
May 26	After May 15 deadline, no bison in Flats or north of Duck Creek; bulls only north of Madison River and south of Duck Creek	233	South of Madison River and east of Resort (100); north of Duck Creek (3); north of Madison River and south of Duck Creek (130)	Yes
May 27	After May 15 deadline, no bison in Flats or north of Duck Creek; bulls only north of Madison River and south of Duck Creek	266	South of Madison River and east of Resort (182); north of Duck Creek (7); north of Madison River and south of Duck Creek (76)	Yes

May 28	After May 15 deadline, no bison in Flats or north of Duck Creek; bulls only north of Madison River and south of Duck Creek	141	South of Madison River and east of Resort (52); north of Madison River and south of Duck Creek (89)	Yes
May 29	After May 15 deadline, no bison in Flats or north of Duck Creek	6	North of Duck Creek	Yes
June 1	After May 15 deadline, no bison in Flats or north of Duck Creek	7	North of Duck Creek	
June 2	After May 15 deadline, no bison in Flats or north of Duck Creek	7	North of Duck Creek	
June 3	After May 15 deadline, no bison in Flats or north of Duck Creek	3	North of Duck Creek	
June 8	After May 15 deadline, no bison in Flats or north of Duck Creek; bulls only north of Madison River and south of Duck Creek	30	North of Duck Creek (3); north of Madison River (27, Horse Butte)	Yes
June 9	After May 15 deadline, no bison in Flats or north of Duck Creek; bulls only north of Madison River and south of Duck Creek	66	South Fork (2 adult females, 2 calves); Highway 191 and Rainbow Point intersection (60); Duck Creek (2)	Yes
June 10	After May 15 deadline, no bison in Flats or north of Duck Creek	57	South of Madison River and east of Resort	Yes
June 15	After May 15 deadline, no bison in Flats or north of Duck Creek	2	North of Duck Creek	
June 17	After May 15 deadline, no bison in Flats or north of Duck Creek	4	South Fork (1); Duck Creek (3)	

APPENDIX C. NAMES AND STATUS OF CATTLE ALLOTMENTS ON PUBLIC LAND NEAR YELL.

Allotment Name	Location	Status	Class/number of Livestock	On-Off Dates	Changes
West of Park					
Watkins Creek	West of Hebgen Lake	Active	51 cow/calf pairs	7/1-9/30	
South Fork	South of Hebgen Lake	Active	19 cow/calf pairs	7/1-9/30	
Basin	South of Hebgen Lake	Active	16 cow/calf pairs	7/21-9/19	
Sulphur Springs	South of Hebgen lake and Hwy 20	Active	10 horses	7/1-9/30	Changed from cattle to horses
Wapiti	Taylor Fork	Active	160 cow/calf pairs (2 permitees)	7/11-10/10	
Cache-Eldridge	Taylor Fork	Vacant	154 cow/calf pairs	7/1-10/15	Permit waived to FS
Red Canyon	North of Horse Butte, North of Hwy 287	Vacant	cow/calf pairs		
Duck Creek	East of Hebgen Lake	Closed	cow/calf pairs		Status changed from vacant to closed
Dry Gulch	Northeast of Horse Butte, North of Hwy 287	Closed	cow/calf pairs		Status changed from vacant to closed
Horse Butte	East of Hebgen Lake	Vacant	cow/calf pairs		
University	Taylor Fork	Closed	sheep		Status changed from vacant to closed
Sheep Mile	S. of Quake Lake	Active	89 yearlings	6/20-10/20	
Two Top	Hebgen Lake	Closed	Used to be sheep		Status changed from vacant to closed
Lionhead	Hebgen Lake	Closed	Used to be sheep		Status changed from vacant to closed
North of Park					
Tom Miner and Ramshorn		Active (combined allotments)	126 cow/calf pairs 134 pvt land permit	7/1-10/15	
Horse Creek and Reeder Creek	Upper Tom Miner	Active (combined allotments)	78 cow/calf pairs 30 horses	7/1-9/30	
Mill Creek and Section 22	Upper Cinnabar and Upper Mol Heron	Active (combined allotments)	36 cow/calf pairs	6/16-10/15	Mill Creek allotment has lost access, non-use this year
Green Lake		Active (2 permittees)	69 cow/calf pairs	6/16-10/15	
Wigwam		Active	56 cow/calf pairs	6/16-9/30	
Slip and Slide	East side of Yellowstone River	Active	260 cow/calf pairs	6/16-10/15	Change from 3 permittees to 2
Canyon		Closed	cow/calf pairs		Status changed from vacant to closed
Cottonwood		Vacant	cow/calf pairs		

Lion Creek	Vacant	cow/calf pairs	
Park	Closed	cow/calf pairs	Status changed from vacant to closed
Sentinel Butte	Closed	cow/calf pairs	Status changed from vacant to closed