INTERAGENCY BISON MANAGEMENT PLAN

AGENCIES

NATIONAL PARK SERVICE

USDA
ANIMAL AND PLANT
HEALTH INSPECTION
SERVICE

USDA
FOREST SERVICE

MONTANA DEPARTMENT
OF LIVESTOCK

MONTANA FISH,
WILDLIFE AND PARKS

A STATUS REVIEW OF ADAPTIVE MANAGEMENT ELEMENTS, 2000 to 2005

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EXECUTIVE SUMMARY

This review is intended to provide an assessment of how successful the Interagency Bison Management Plan (IBMP) has been in achieving the goals set forth in the Final Environmental Impact Statement and Records of Decision issued by the state and federal agencies. The wild bison population of the northern Greater Yellowstone Area remains free ranging, reproductively vigorous, and genetically important for conservation of the species in North America. In addition, successful implementation of the IBMP allowed the livestock operations in and adjacent to IBMP Management Areas along the northern and western boundaries of Yellowstone National Park to remain brucellosis-free, thereby maintaining Montana's brucellosis Class Free status.

A management, decision-making council tasked a workgroup of representatives from each partner agency to review the accomplishments to date and evaluate them against the adaptive management procedures identified in the state and federal Records of Decision (ROD).

The agencies have been directed to implement the IBMP because it best fulfilled the purpose and need for action as identified very early in the planning process. That purpose and need as described in the FEIS is to "maintain a wild, free-ranging population of bison and address the risk of brucellosis transmission to protect the economic interests and viability of the livestock industry in the state of Montana."

The agencies may agree to modify elements of this plan based on research and /or adaptive management findings. Implementation of management actions by the agencies will be conducted in accordance with the management plan … and or procedure agreements developed by the agencies, which may provide agency personnel with flexibility to achieve the objective of the actions set forth in this plan (provision 29, p. 32 of Fed ROD and p 16 of State ROD).

A document to guide interagency responsibilities and field operating procedures was completed in December of 2002 and signed by all participating agencies.

Collaborative efforts to conduct hazing and capture operations have been successful at keeping bison separated from cattle during the five years of implementation. In most cases bison were moved to a location that the hazing operation intended them to end up. The number of hazing operations has generally increased in concert with an increasing population abundance of bison. The general pattern is that hazing of large mixed age and gender groups has typically been earlier during the winter period at the Northern than at the Western IBMP Management Area.

The Gallatin National Forest increased its land holdings in the Northern IBMP Management Area by 4600 acres just prior to the signing of the ROD. Cattle still graze on approximately 6000 acres of private land within the IBMP Management Area. The Horse Butte Grazing Allotment is the only allotment within zone 2 of the Western IBMP Management Area. The permittee has vacated the allotment and relocated to the Targhee National Forest.

Scientific studies have established that *Brucella* bacteria can remain viable in the environment for considerable time periods after being shed from infected animals. To explore the persistence of *Brucella abortus* on fetal tissue and time until scavenging for potentially infected fetuses in Yellowstone environments, two concurrent studies were performed during 2001-2003. Preliminary results indicate that UV-B and temperature work in a complex fashion to kill the *Brucella* bacterium present on fetal tissues. Depending on the time of year fetuses were placed in the environment, the *Brucella* bacterium was found to remain viable for three days (late spring) up to 78 days (mid-winter). On average, fetuses were scavenged within 15 days. However, a few remained upon the landscape until they decomposed 50 days later.

To date, management strategies directed and implemented by the IBMP have successfully prevented brucellosis transmission to cattle that graze in proximity of the IBMP Management Areas. Since implementation of the interagency bison management plan, there have been no cattle from the bison management areas identified and traced through the Market Cattle Identification program. Two cattle herds graze seasonally on private lands in Zone 2 in the Western IBMP Management Area. One cattle herd grazes nearly year around on private lands in Zone 2 in the Northern IBMP Management Area. One private landowner grazes cattle in the Eagle Creek area northeast of Gardiner, Montana.

Monitoring of free-ranging sero-negative pregnant female bison released from the Western IBMP Management Area capture facility was conducted to determine probability that this demographic group may sero-convert to an active infection while within the IBMP Management Area, abort a pregnancy, and subsequently shed *Brucella abortus* bacteria in the environment. Forty animals have been released to monitor this phenomenon. Five percent of these bison released are known to have subsequently aborted their pregnancies. Twenty-five percent of these bison give birth to calves within the zone two area of the IBMP Management Area.

A ballistics consortium was established to seek and evaluate new information about remote delivery system options. The use of the pneumatic rifle and bio-bullet combination has been endorsed as the best current technology. The ballistic capabilities of this remote delivery system are being evaluated regarding accuracy of the delivery, the ability to deliver vaccine to calf bison, and wound site characteristics created by such a delivery vehicle.

Documentation of bison movement patterns through monitoring of bison fitted with radio transmitting collars have helped focus on where potentially successful locations may be for remote delivery of vaccine. The Mary Mountain migration trail is one very opportune location. Most of the central Yellowstone bison sub-population migrates through this pass at least twice per year. Approaching bison appears to be most feasible in the autumn after the animals break into groups of 25 to 150 animals. After a blanket of snow covers the ground, the bison seem to exhibit much more tolerance to human approach.

Most tasks directed by the IBMP during step one have been accomplished by the interagency partners. A communication network has been established for conducting interagency operations in the IBMP Management Areas. Interagency cooperation in conducting hazing and capture operations has resulted in successfully keeping bison and cattle separate and limiting bison use of the IBMP Management Areas to autumn, winter and the early portion of the spring months. Abundance and distribution of bison has been conducted each year to track population dynamics in relation to management operations.

The records of decision directed development of a program to vaccinate bison. One hundred thirteen calf and yearling bison were vaccinated at the Northern IBMP Management Area during February and March, 2004 and another 9 yearling animals were vaccinated at the Western IBMP Management Area in spring 2005. There are no immediate plans to initiate remote vaccination of bison within the Zone 2 area of the Western IBMP Management Area. The development of a remote delivery system has been under evaluation since the ROD's were signed in December of 2000. The feasibility appears promising based on management experiments and a greater understanding of bison movement patterns on the landscape. An EIS was initiated in August 2004 to evaluate the consequences of bringing a remote vaccination program on line throughout Yellowstone National Park.

The vaccine RB51 appears to meet the criteria for a safe vaccine as described by the Greater Yellowstone Interagency Brucellosis Committee. Vaccination of bison will accomplish multiple objectives established in the FEIS. Vaccination will "protect livestock from the risk of brucellosis" by reducing the disease prevalence of brucellosis in the Yellowstone Bison. As a result of reducing the disease prevalence in bison, the risk of transmission from bison to other bison, to elk and especially to cattle outside the National Park is further minimized beyond the current risk of interspecies transmission. In addition, a reduced rate of brucellosis prevalence in bison will help "protect the state of Montana from risk of reduction in its brucellosis (class-free) status". A reduced prevalence of brucellosis in Yellowstone bison will provide a mechanism for conserving this population for future generations by setting the stage for greater acceptance of bison outside the National Park during winter in IBMP Management Areas where cattle are not present. Some evidence of RB51 efficacy in bison has been demonstrated by controlled challenge experiments.

One assumption that has turned out to be false is the idea that bison crossing the park boundary at Reese Creek in the Northern IBMP Management Area come from the northern range sub population. Evidence from radio marked bison and from aerial surveys indicates that the northern range subpopulation has not moved to the Gardiner Basin during the five-year period of IBMP implementation. All of the marked bison in the IBMP Management Area originated from the central subpopulation and all bison marked with glue on tags have been observed leaving the northern IBMP Management Area and traveling south to summer range in Hayden Valley.

INTRODUCTION

After five years of implementing the Interagency Bison Management Plan (IBMP) the partner agencies have developed a process for reviewing management accomplishments and reporting outcomes to interested public constituencies. A management decision-making council tasked a workgroup of representatives from each partner agency to review the accomplishments to date and evaluate them against the adaptive management procedures identified in the state and federal Records of Decision (ROD). A charter was produced, outlining specific tasks and calling for recommendations. The review team has compiled accomplishments, studied the ROD and developed a list of recommendations for the decision-making council to consider.

MANAGEMENT PRINCIPLES INCLUDED IN THE IBMP

The agencies have been directed by the Secretaries for the Departments of Agriculture and the Interior along with the Governor of Montana to implement the IBMP because it best fulfilled the purpose and need for action as identified very early in the planning process. That purpose and need as described in the FEIS is to "maintain a wild, free-ranging population of bison and address the risk of brucellosis transmission to protect the economic interests and viability of the livestock industry in the state of Montana."

The IBMP employs an adaptive management approach that allows the agencies to gain experience and knowledge before proceeding to the next management step, particularly with regard to managing bison on winter range outside Yellowstone National Park (YNP). The IBMP uses many tools to minimize or eliminate the risk of transmission of brucellosis, but primarily relies on the spatial and temporal separation of *Brucella abortus*-infected or –exposed bison from cattle on neighboring private and public lands. The agencies will manage the risk of disease transmission to cattle by limiting the number and distribution of bison in the IBMP Management Area zones in the Northern and Western Boundary areas through intensive monitoring and zone management.

The agencies may agree to modify elements of the IBMP based on research and /or adaptive management findings. Implementation of management actions by the agencies will be conducted in accordance with the IBMP and/or operating procedure agreements developed by the agencies, which may provide agency personnel with flexibility to achieve the objective of the actions set forth in the IBMP (provision 29, page 32 of the federal ROD and page 16 of the state ROD).

As described in the IBMP, adaptive management requires testing and validating ongoing risk management strategies and other management actions with generally accepted scientific and management principles. Then, adjustments to management strategies and actions may be considered as new information is obtained and evaluated. The provisions of the IBMP identify the factors that the agencies will monitor to determine if the agencies are successfully separating bison and cattle, and, thus, lowering the risk of transmission of brucellosis. The agencies will meet at least twice annually to evaluate the operations of the prior winter and determine if modifications are necessary. These are also the appropriate times for the agencies to determine if management efforts were successful and determine whether to move forward to the next step or, if at Step 3, continue at that step.

ELEMENTS OF THE CHARTER

SUMMARY OF STEP 1 ACCOMPLISHMENTS

Interagency Field Operating Procedures

A document to guide interagency responsibilities and field operating procedures was completed in December 2002 and signed by all participating agencies. Field operations have now been conducted under these procedures for three winters. This document was critically edited by all agencies over a period of 18 months. The intent of the procedures document is to continue to improve on field operations and thus, some revisions to the Operating Procedures will occur over time.

General Overview and Description of Hazing Operations

Collaborative efforts by the agencies to conduct hazing and capture operations have been successful at keeping bison separated from cattle during the four years of implementation. In most cases, bison were successfully moved to the desired location. All agencies report that interagency operations under the direction of both the Montana Department of Livestock (MTDOL) and the National Park Service (NPS) have improved in efficiency over the course of five years of implementation. The agencies also report that their respective operations have been conducted in the most humane manner possible.

The number of hazing operations has increased each year in the Northern Boundary IBMP Management Area (from 3 to 36) while the total number of operations at the Western Boundary IBMP Management Area has fluctuated between years from 108 to 77 (Table 1). The general pattern is that hazing of large mixed age and gender groups has typically been earlier at the Northern Boundary IBMP Management Area than at the Western Boundary IBMP Management Area (Figures compiled by year and by IBMP Management Area are found in Appendix 2). Hazing of small numbers of adult males appears to be spread out throughout the fall and winter and into late spring at the Western Boundary IBMP Management Area.

Bison Population Estimates

Twice each year (summer and late winter) the NPS estimates population abundance. Accuracy in the summer is approximately 97% while in the winter it appears to be much lower (approximately 90%). Where feasible, abundance estimates are made based on two or three aerial surveys of the whole population and the number estimates are generated by use of a sightability model (Hess 2002). Prior to summer 2002, aerial counts were made and reported as number of bison counted from the air on a given aerial survey.

Table 1. Summary of bison hazing operations in the Northern and Western Boundary IBMP Management Areas (MA)

Winter and Location	Total # of hazing events	Events Involving Adult Males Only			Events Involving Mixed Groups		
		Total #	Range of animals / event	Average # of animals / event	Total #	Range of animals / event	Average # of animals / event
Winter 2000/2001							
Northern MA	3	2	4 - 4	4	1	13 -	13
Western MA	108	80	1 - 35	6.4	28	1 - 178	35.4
Winter 2001/2002							
Northern MA	7	1	3 - 3	3	6	12 - 55	22.5
Western MA	77	49	1 - 32	7.0	18	2 - 132	35.9
Winter 2002/2003							
Northern MA	15	5	1 - 5	2.6	10	12 - 222	82.3
Western MA	78	59	1 - 33	4.3	19	8 - 171	65.9
Winter 2003/2004							
Northern MA	36	13	1 - 10	3.9	23	17 - 200	59.8
Western MA	82	60	1 - 47	5.8	22	6 - 157	30.3
Winter 2004/2005							
Northern MA	15	4	1-8	3	11	1-43	16
Western MA	156	100	1-12	3	56	2-345	40
Eagle Creek/Bear Creek winter range area	24	17	1-14	6	7	10-50	26

Table 2. Summer and winter population counts (prior to 2002) and population estimates (since 2002) based on aerial counts conducted through out the area of bison distribution since the initiation of the IBMP

Winter	Previous summer population estimate/count	Late winter population estimate/count
2000/2001	2616	2870
2001/2002	3283	3300
2002/2003	3916	3160
2003/2004	4070	3604
2004/2005	4240	4054

Cattle Grazing in the IBMP Management Areas

Northern

There were approximately 4,450 acres of land added to the Gallatin National Forest through land acquisition just prior to the signing of the ROD. In addition, about 1,500 acres of Royal Teton Ranch (RTR) land were placed under a conservation easement. Cattle still graze on approximately 6,000 acres of private land within the Northern IBMP Management Area. In Zone 2, the RTR waived their permit for the Park Allotment back to the Gallatin National Forest during the spring of 2004. In 2003 they were granted non-use of that allotment. The RTR still grazes cattle on their private land, including lands within the Devil's Slide Conservation Easement. Historically, they had been grazing about 125 cow/calf pairs on the U.S. Forest Service (USFS) allotments. The Sentinel Butte Allotment is also vacant. This allotment (Sentinel Butte) was formerly used by RTR, but has not been used since the recent land purchases. In Zone 3, the Slip and Slide Allotment straddles the zone boundary along the divide east of Dome Mountain and authorizes 260 cow/calf pairs. The remaining allotments in Zone 3 are located in Cinnabar Basin. The Green Lake Allotment includes the Sphinx Creek, Yankee Jim Lake, and Twin Lakes areas. This allotment provides for 95 cow/calf pairs. Section 22 is a 22 cow/calf allotment. Mill Creek is a 14 cow/calf permit. Vacant allotments in Zone 3 include Cottonwood, Cedar Creek and Lion Creek. There is also a vacant allotment (Little Trail Creek) north of Gardiner, within the area where untested bison are allowed. All turn out dates on the USFS allotments are on or after June 16th. One private land parcel, in Zone 3 just downstream from Gardiner on the east side of the river, is utilized for cattle grazing.

Western

The Horse Butte Grazing Allotment is the only cattle allotment within Zone 2 of the Western IBMP Management Area. The grazing permit issued by the Gallatin National Forest had been active since 1961. However, the Horse Butte allotment has not been grazed since 2001 and remains vacant. A final decision on its status will be made during the revision of the Forest Plan. The permittees have continued to graze cattle on their

adjacent private parcel. There are four USFS cattle allotments in Zone 3 of the Hebgen Basin, along with numerous cattle operations on private lands.

Fetal Disappearance and *Brucella* Persistence in the Local Environment

Scientific studies have established that *Brucella* bacteria can remain viable in the environment for considerable time periods after being shed from infected animals. The time period for survival of the bacteria reported in these studies varies under a wide range of environmental conditions. Until recently, specific survival studies had not been performed within the northern portion of the Greater Yellowstone Area (GYA) to determine how long *Brucella abortus* persists in the environment following an aborted pregnancy. To explore the persistence of *Brucella abortus* on fetal tissue and time until scavenging for potentially infected fetuses in the GYA environment, two concurrent studies were performed during 2001-2003 by USDA's Animal and Plant Health Inspection Service, Veterinary Services (APHIS) and Montana Fish, Wildlife and Parks (MTFWP) working in collaboration. Study sites were chosen along the northern and western edge of YNP for each investigation. One study involved purposely-immersing bison fetuses in a *Brucella abortus* strain RB51 vaccine to simulate live bacteria shed in the environment and culturing tissue repeatedly over time to determine bacterial viability. All fetuses were caged to protect them from scavenging or human tampering. Half of the caged carcasses were placed in shaded areas, and half were exposed to sunlight. The microenvironment surrounding these fetuses was monitored for UV-B radiation and temperature. The second study performed concurrently in these locations involved placing uninfected bison fetuses out onto the landscape in a stratified random fashion to determine the time until fetal tissues were completely scavenged or decomposed. The fetal disappearance studies were conducted within and outside YNP during the first season (2001) and outside YNP in subsequent seasons.

Brucella organisms on vegetation and soil have been reported to persist from a few days to over 100 days. This study found that bacteria remained viable on fetuses until about 80-90 days for those placed in the GYA environment in February. In contrast, the

bacteria remained viable on fetal tissues 20-30 days for those placed out in mid-May. Preliminary results indicate that UV-B and temperature directly affect bacterial survival on fetal tissues. These environmental factors are currently being analyzed to determine the amount of UV-B and the various temperature patterns that could reliably predict bacterial survival in the GYA environment.

During the first year of the fetal disappearance study, bison fetuses placed within YNP were scavenged more rapidly than those placed in nearby sites outside the Park. In subsequent years of the study, fetal disappearance was only evaluated in areas adjacent to YNP, where brucellosis transmission issues are most relevant. On average, fetuses were scavenged within 15 days. However, a few remained upon the landscape until they decomposed 50 days later. There was no apparent relationship between days until scavenged and the distance to YNP, distance to roads, study areas, between years or months. The major scavengers in the area were coyotes, various birds, bears, wolves, and small mammals. In general, bison fetuses did not remain upon the landscape for long periods of time, with the exception of a few carcasses at the Northern Boundary that were never scavenged.

Surveillance of Cattle within IBMP Management Areas

To date, management strategies directed and implemented by the IBMP have successfully prevented brucellosis transmission to cattle that graze in proximity of the IBMP Management Areas.

Market Cattle Identification

Market Cattle Identification (MCI) is the national program for surveillance of brucellosis in domestic cattle and bison. The program requires that a minimum of 95 percent of all cattle, 2-years and older, processed at state or federally-inspected slaughter facilities be tested for brucellosis. Since implementation of the IBMP, there have been no cattle from the bison management areas identified and traced through the MCI. Statewide, from October 1, 2000 to June 4, 2004, there have been 42 MCI tracebacks of Montana origin

cattle. Subsequent investigations were completed on these tracebacks, and in all cases, there was no evidence to suspect a brucellosis infection in the herds of origin.

Brucellosis Milk Surveillance Test

Brucellosis Milk Surveillance Test (BMST) is a national program for surveillance of brucellosis in all dairy herds producing commercial milk. The program requires that a minimum of 2 BMST are conducted annually on all dairy herds producing commercial milk. Since October 1, 2000, BMST have been conducted every 4-6 weeks on all Montana dairy herds producing commercial milk, with no evidence to suspect a brucellosis infection in the herds. Although there are no dairy herds within the IBMP Management Areas, this surveillance is an important component of the state-wide brucellosis surveillance, and provides a means for early identification of brucellosis affected dairy herds.

Zone 2 of Western IBMP Management Area

Three cattle herds graze seasonally on private lands in Zone 2 in the Western Boundary Area. The operators of one herd reside in Idaho and graze cattle on their own property on Horse Butte. A Certificate of Veterinary Inspection (CVI) and a Montana importation permit are required for this operator to graze cattle on his property in Montana. Montana law requires all vaccination eligible female cattle imported into Montana are official calfhood vaccinates (OCV) against brucellosis. This owner also operates in compliance with a plan administered by the Idaho State Veterinarian, which requires testing of the test-eligible cattle upon return to Idaho. The other operator is a Montana resident who leases private land. The Department of Livestock, APHIS, and the operator have developed a cattle herd management plan. Although the plan has not yet been finalized, the operator operates in compliance with it. The herd plan requires calfhood vaccination of all eligible cattle and annual testing of all test-eligible cattle grazing in the West Yellowstone Area. In addition, the first year the private land was leased by this operator, all test-eligible cattle were tested negative prior to turn out. APHIS pays the direct costs

for testing and vaccination. The herd plan also specifies grazing dates, locations and cattle numbers.

Zone 2 of the Northern IBMP Management Area

A cattle herd management plan has not yet been developed for the Royal Teton Ranch and should be completed prior to implementation of Step 2 of the adaptive management plan.

A private landowner grazes cattle in the Eagle Creek area. Although a herd management plan has not been developed for this livestock producer, all test-eligible cattle in this herd were brucellosis-tested negative at time of turn out in the spring of 2004 and again in the spring of 2005. In addition, in the spring of 2005, all cows in the herd were Adult Vaccinated (AV) with *Brucella abortus* strain RB51 vaccine.

Zone 3 of Western IBMP Management Area

During the summer of 2003, six operators grazed cattle on private properties or USFS allotments within 2 miles of Zone 2. These operations included 135 cow/calf pairs, 23 cows, 450 heifers and 12 bulls. During the summer of 2004, six operators grazed approximately 725 cow/calf pairs on private properties or USFS allotments within 2 miles of Zone 2. The majority of the cattle were imported from Idaho and, consistent with the Montana importation requirements, all of the eligible cattle were official calfhood vaccinates. One Montana operator grazes approximately 70 cow/calf pairs in this area, of which all female cattle are official calfhood vaccinates.

Herd plans have not been developed for cattle that graze within 2 miles of Zone 2.

Zone 3 of Northern IBMP Management Area

Herds that graze within 2 miles of Zone 2 have not been inventoried and herd plans have not yet been developed.

Monitoring Sero-Negative Pregnant Bison

The purpose of this procedure is to monitor free-ranging sero-negative pregnant female bison released from the capture facility to determine if *Brucella abortus* is shed in the environment. Most agencies have contributed to this monitoring effort. Thus far, the Western IBMP Management Area is the only location where pregnant sero-negative bison are fitted with radio tracking transmitters when released. Thirty-nine pregnant female bison have been released following brucellosis test negative results at the Western IBMP Management Area capture facilities (17 in 2002, one in 2004, and 21 in 2005). Efforts were made to locate all birth and abortion sites that occurred outside YNP and some that occurred within the Park to determine whether these animals presented any risk as a source of brucellosis transmission to cattle.

- In the late winter and spring of 2002, 18 sero-negative pregnant female bison were fitted with radio transmitting collars and implant transmitting devices and released. One of these bison was determined to have been misdiagnosed as pregnant. Seventeen implants were recovered. Two bison aborted their pregnancies early in the monitoring process. One female whose pregnancy failed was chute-side tested as sero-negative, but blood samples subsequently tested culture positive. This animal was suspected to have sero-converted from negative to positive. Recapture and subsequent testing confirmed the animal had sero-converted to sero-positive. Twenty birth sites were located, 17 by transmitter and 3 opportunistically, only three were located outside of YNP. One site outside of YNP (an abortion site) was culture positive.
- In 2003, a stillborn calf and a weak calf were observed born on Horse Butte. The stillborn was sero-positive for brucellosis. The weak calf was sero-negative. At the

birth site of the stillborn, a persistence analysis showed that *Brucella abortus* remained until May 27th (the date this site was last sampled). Thus, in this case, demonstrated at least a 28-day bacterial persistence period in the late spring. Monitoring was discontinued and actual bacterial survival time was not determined.

- In 2004, one female was fitted with a transmitter and followed until after the calf was born. The pregnant female traveled to the Reece Creek boundary where she was hazed once, and then she spent the remainder of the spring on the Blacktail Deer Plateau. The calf was born at Blacktail Deer Plateau and the pair migrated back to Hayden Valley in May.
- In 2005, 21 sero-negative pregnant female bison were released. Seven (32 percent) were found to have given birth to calves outside the National Park in the Zone 2 area of the Western IBMP Management Area. None of the soil and vegetation samples collected and culture tested were positive for *B. abortus* bacteria. The fate of two pregnancies was unknown (never observed with a live calf and no evidence of an aborted pregnancy). Nineteen percent of the marked bison returned to the Hayden Valley summer range by early May, and 90 percent of these marked bison were in Hayden Valley by early June.

Feasibility and Evaluation of Remote Vaccination of Bison

Ballistics Consortium

A ballistics consortium was established in collaboration with YNP to seek new information about remote delivery options and evaluate new information about delivery systems. The consortium has convened on three occasions. As a result, a new method for vaccine encapsulation has been developed. The use of darts for delivery has been debated extensively. At this time, the use of the pneumatic rifle and bio-bullet combination appears to be the best available technology. Many participants have expressed some concern about ability to deliver vaccine to a high percentage of bison.

- The ballistics consortium through a relationship with Colorado State University has developed a new method of encapsulating vaccine into bio-absorbable projectiles. Traditional methods of lyophilization and compaction have been thought to create moderately high levels of mortality of the live vaccine. The purpose of this project

has been to increase the effectiveness of the vaccine delivery. This alternative process of encapsulation uses UV light to polymerize the vaccine into a gel followed by a lyophilization of the gel to reduce the size of the capsule. Experimental trials with a surrogate bacterium *(Pseudomonas aeruginosa*) demonstrated that the photopolymerization process causes very little mortality of the bacteria. Subsequent trials using *B. abortus* quantified that a dose of 1×10^{11} colony forming units (cfu) of RB51 vaccine when photopolymerized produced 1×10^{9} cfu of the bacteria surviving the encapsulation process . This method of encapsulation is feasible and results in production of a bio-bullet package that retains ballistic characteristics very similar to the traditional method of vaccine encapsulation.

- The consortium has discussed the use of other delivery techniques such as darts. A dart delivery of vaccine presents some liability risks that are not associated with bio-bullet delivery such as leaving behind darts in the ecosystem that the field crew could not relocate after delivery. Darts that are not found would be classified as a bio-hazard, and those with live vaccine remaining would be an additional safety risk if discovered by irresponsible humans. To insure the best delivery of vaccine, darts would not easily fall to the ground after the vaccine is delivered to individual bison.

Evaluation of the accuracy of the Ballistic Technology, Inc. pneumatic rifle

The NPS initiated a comparison of equipment using two pressure regulators (1200 and 1500 psi) and three different bio-bullet configurations types (short standard, long standard and long metallized). The delivery systems and bio-bullets were tested indoors, at 10, 20, and 30 meters by three shooters and a set up with the rifle in a shooting vise. The distance between the bullet placements in the target from center of aim was measured to determine accuracy. Analysis of Variance calculations were made to compare the results between the pressure regulators, the type of bullet configuration, the shooter and the distance to target.

The preliminary results show that there is no significant difference between shooter accuracy especially at the shorter distances. This type of equipment has not been designed for use at long distances (greater than 20 m). The delivery system is significantly more accurate at 20 vs. 30 meters ($p<0.001$), but still generally acceptable based on the effective size of the average target size on the hip of a calf bison. The 1200 psi pressure regulator combined with the longer bio-bullet provides greater accuracy over a wide range of distances. Efforts are continuing to complete the accuracy

evaluations and include 40 meter shots in to the sampling design. Completion of the study is estimated to be in 2005.

Assessment of Target Size, Wound Site Characteristics and Penetration Capabilities of Pneumatic Rifle/Bio-Bullet Combination

The NPS initiated a collaborative project with a team of pathologists (Wildlife Health Inc.) and the Red Rock Ranch in southwestern Montana to evaluate the feasibility of a bio-bullet delivery system for use on bison calves. The objectives were to define the size of the target zone on young bison, determine how well bio-bullets would penetrate the skin of a bison, identify the risk of hitting sensitive nerve bundles and key blood vessels in the legs, and evaluate tissue damage that the bio-bullet may cause.

- The two most feasible target zones are the thigh (20-30 cm wide) and the shoulder (10-16 cm. wide).
- The skin is 1.5 times thicker on the thigh than on the shoulder, but the hair is much thicker on the shoulder.
- Depth to the femur and sciatic nerve should be great enough to prevent the bio-bullet from lodging in an inopportune location. (The range in depth of penetration was 0 to 7 cm**.)**
- Thoracic and abdominal wall areas were not thick enough for a safe delivery of the vaccine.
- The shoulder was a relatively safe target zone, where 83 percent of the shots would have delivered vaccine.
- The thigh is also a safe target zone, where 62 percent of the shots would have delivered vaccine.
- No adverse pathological damage was observed at wound sites in hip and shoulder areas.
- This study emphasized the need to be very familiar with the mechanics and the ballistic capabilities of the delivery equipment.

Animal movement patterns

Documentation of bison movement patterns through monitoring of bison fitted with radio transmitting collars have helped focus where potentially successful locations may be for remote delivery of vaccine. This information is continuing to accumulate.

YNP has initiated a system for documenting locations throughout the Yellowstone landscape that would facilitate remote vaccination of bison using the pneumatic rifle and

bio-bullet combination. Feasible vaccination sites consist of two types of approach: advance toward bison and vaccinate as the group is moving on the landscape, or find a location to vaccinate animals as they pass by a shooting team. Good stand site characteristics include:

1) Existing major bison travel corridors;
2) Topographic relief where natural saddles and draws funnel animals through a narrow landscape feature; and
3) Cover for shooter(s) - cabins, trees, and rocks.

The Mary Mountain migration trail appears to be a very opportune location. Most of the central Yellowstone bison sub-population migrates through this pass at least twice per year. The feasibility of encountering bison on the Mary Mountain trail was evaluated in 2003 and 2004.

- Most group movements were during twilight hours.
- From a stationary vaccination location near the top of the travel route and assuming animals have to be standing still or walking, bio-bullets could have been delivered to 36 percent of vaccination-eligible animals. Assuming that shooters can be reasonably accurate when animals are moving at a slow trot, bio-bullets could have been delivered to 82 percent of vaccination-eligible animals.
- If a technician moves through the forest with the group of bison, success of bio-bullet delivery may be nearly 100 percent.

Bison behavior in response to human approach

Approaching bison appears to be most feasible in the autumn after the animals break into groups of 25 to 150 animals. After a blanket of snow covers the ground, the bison seem to exhibit much more tolerance to human approach.

TASKS DIRECTED BY STATE AND FEDERAL RECORDS OF DECISION

Can we work together efficiently?

The Interagency decision-maker council meets routinely throughout the winter to discuss communication needs and management implementation progress. Field staff from all agencies agreed to meet twice per year to coordinate field activities following an initial gathering to share accomplishments.

Can we keep bison and cattle separated?

Five winters of interagency-conducted boundary operations have resulted in no known commingling of bison and cattle on shared range nor any documented disease transmission to livestock in Montana.

Monitor bison abundance and distribution

Abundance estimates are currently being conducted by the NPS in mid-summer and late-winter. The late-winter estimate is problematic because of characteristically poor counting conditions. Refinement of the models for transforming count data into a population estimate with relatively tight confidence intervals is ongoing.

Study *Brucella* persistence in the local environment

APHIS and MTFWP began this study as a pilot project from February to June of 2001 in order to evaluate study design, equipment, and methods. The full study was implemented in the years 2002 and 2003. Bison fetuses obtained from slaughtering facilities were "dipped' and abdominally injected with a *Brucella abortus* strain RB-51 inoculum. These fetuses were then placed in cages (shaded and unshaded) at a Corwin Springs site (north) and a West Yellowstone site (west). Both areas had unique environmental conditions that could play a role in bacteria survivability.

Beginning in February of each year, tissue/swab samples were taken at regular intervals from the top, bottom, and the abdomen of each fetus. This sampling extended through the end of May. The samples were sent to the National Veterinary Services Laboratory (NVSL), where any *Brucella* colonies grown were confirmed with a PCR test.

Data analyses are incomplete at this time. Expected completion of these data analyses is unknown.

Preliminary Findings have been consistent between years.

- There was no difference in persistence curves between the north and west study sites.
- Persistence was much greater during February versus May.
- Bacteria disappeared from the top and abdomen of the carcasses rapidly but persisted longer on the bottom side.
- RB51 remained viable on the bottom of the carcasses for up to 78 days on those fetuses placed out in February. The February curve for the number of positive bottom samples begins to decline steeply around 45 days post-set out. This may be linked to light conditions associated with the spring equinox (March 21) and/or a large jump in UV light values seen in April. The May curve shows rapid decline with no positive carcasses detected by 18 days post-set out.
- Shade takes out all the highs and lows in temperature. Since in theory it is the temperature variance that increases cell lysis, a shaded carcass remains positive longer than a carcass exposed to direct sunlight.

Study Fetal Material Persistence in the Local Environment

APHIS and MTFWP ran this study from March to April during the years of 2001, 2002, and 2003. In 2001 bison fetuses were placed on a one km grid pattern both outside and inside YNP, in both the Western and Northern IBMP Management Areas. In the years 2002 and 2003, the carcasses were set out using a stratified random process and were only deployed outside YNP, again in both the Western and Northern IBMP Management Areas. The carcasses were deployed in groups (4-16 carcasses/week) over the three month period.

Each fetus was placed with its associated membranes and fluid. A transmitter was placed on each carcass to track movement upon scavenging. Half the 2001 sites were monitored with a motion-sensing camera.

Data analyses are incomplete at this time.

Preliminary Findings include:

- The full range of mammals and birds were recorded scavenging the carcasses.
- Bison were seen investigating sites and frequently made physical contact with fetuses. Other non-scavenging species coming in close contact included elk, deer, antelope, jack rabbits, and Canada geese.
- Scavengers often carried off carcasses or portions of carcasses, with 52 percent moved at least 100 feet. The maximum distance moved was 2 miles. One was moved onto Hebgen Lake ice. One was moved across Hebgen Lake. Movement was detected between public and private lands. Portions of carcasses were cached in trees, buried in soil and in dens.
- Camera flash deterred scavenging and had a statistically significant effect.
- In 2001, carcasses inside YNP disappeared at a faster rate than carcasses placed outside the park. Human disturbance outside the park may be a factor. Scavenger distributions and abundance appear to be significantly different inside and outside YNP.

  Mean days (for disappearance) from set out in YNP: 7.5

  Mean days (for disappearance) from set out outside YNP: 13.0
- For the 2002 and 2003 study carcasses (set outside YNP), the mean days until disappearance was 18.23. Some carcasses placed outside the park near Gardiner were not scavenged and are data outliers. It should be noted that this data reflects the mean number of days for the carcass tissue to disappear, not days to when the carcass was first scavenged.
- None of the following differences in <u>median days for disappearance</u> were statistically significant:

  --North Study Area (18 days) vs. West Study Area (12 days)

  --2001 (20.5 days) vs. 2002 (13 days) vs. 2003 (10.5 days)

  --March (13.5 days) vs. April (13.5 days) vs. May (14 days)

Monitor the fate of pregnancies by sero-negative tested female bison released after capture

- Sero-negative pregnant bison have been released during three of five winters of operation.
- A small percentage of bison testing negative during trap side testing are later diagnosed test positive (1/40), while one bison was misdiagnosed as pregnant.
- Not all implant transmitter ejection sites represent actual birthing sites outside YNP, and occasionally the actual birth site can not be found within the area surrounding implant ejection site.
- Bison have been observed to occasionally eject implant transmitters days before the actual birth event.
- Time delays (approximately 5 weeks) in processing samples and getting culture results returned create problems when trying to meet management objectives. "High risk" sites that may be candidates for disinfection prior to the reintroduction of cattle onto summer grazing lands may become naturally disinfected by daytime temperatures, scavengers and increased amount of UV light during the parturition season prior to receiving culture results from birth/abortion site samples.

Vaccinate-eligible bison at capture pens near NPS boundary

"During Step 1, every attempt will be made to capture and test bison that leave the Park. Seronegative calves and yearlings that are captured will be vaccinated with a safe vaccine (the safety of the vaccine is determined by the agencies according to criteria established by GYIBC)," (Both ROD's).

To date, vaccination of sero-negative calves and yearlings has been conducted during one year at both of the IBMP Management Areas. One hundred thirteen calf and yearling bison were vaccinated at the Northern IBMP Management Area during February and March, 2004 (Table 3). Nine yearling bison were vaccinated at the Western IBMP Management Area in spring 2005.

Table 3. Number of calves and yearlings vaccinated at the Northern IBMP Management Area capture facility in February and March of 2004.

	Males	Females
Calves	32	46
Yearlings	18	17

Cooperate with RTR to develop a Bison Management Plan for RTR

"In step 1, the agencies will cooperate with RTR to develop a Bison Management Plan for the Royal Teton Ranch that is consistent with the provisions of the Interagency Bison Management Plan"

RTR officials are included in many management discussions. A cattle management plan for reducing the risk of brucellosis transmission has been discussed with RTR officials. (Clarke pers. comm.). However a bison management plan specifically for RTR and USFS lands within Zone 2 of the Northern IBMP Management Area has not been initiated.

ADDITIONAL TOPICS DIRECTED BY THE STATUS REVIEW CHARTER

Remote vaccination of untested bison in IBMP Management Area: Zone 2

There are no immediate plans to initiate remote vaccination of bison within the Zone 2 area of the Western IBMP Management Area.

Remote vaccination of free-ranging bison within the park

The development of a delivery system has been under evaluation since the RODs were signed in December 2000. Information gathered thus far has focused on determining group sizes and population distribution by time of year, movement patterns of the bison, age specific pregnancy rates and sero-prevalence rates, behavior exhibited by bison when humans are operating in close proximity, equipment available for vaccine delivery, and feasibility of traveling the Yellowstone landscape with the bison at all times of the year. In addition to studies at Yellowstone, USDA Agriculture Research Service annually conducts studies to evaluate the effectiveness of vaccinating bison by experimentally

challenging vaccinates with controlled doses at certified bio-containment facilities in Ames, Iowa. Analyses to date suggest that mid-summer during the breeding season is the most risky time of year to work in close proximity to bison and the least likely to have opportunities to conduct ballistic delivery of vaccine. Average group size is greatest at this time. Bison behave in a very curious manner when field crews are nearby. Calves, yearlings and in most cases 2 year old bison often will approach the field crew out of curiosity. Thus, finding the target group of vaccination-eligible individuals becomes easier when this situation occurs. Bison exhibit patterns of movement along numerous site-specific narrow corridors. Many of these locations have NPS-maintained or bison-maintained trails.

Roffe et al (2001) suggested ballistic delivery may not be feasible due to delivery effectiveness being limited to 20 meters or less. Ballistic Technologies, Inc. is currently conducting a new round of research and development with the goal of improving the effective range of their existing remote delivery equipment. The results of the research and development should be reportable by 2005.

Olsen et al (2002) reported that ballistic delivery of vaccine imparts a reduced level of acquired immune response relative to hand vaccination. These authors suggested that an increased dose size could compensate for the challenges presented by ballistic vaccine delivery. Multiple shots delivered within a six to eight month time period was suggested by several wildlife veterinarians attending the ballistic consortium. A second option would be to incorporate a higher dose within the bio-bullet. This second alternative seems feasible and is being evaluated by cooperators.

Olsen and Holland (2003) reported that booster vaccination of bison as yearlings and as adults did not cause a significant level of abortagenic response in a domestic herd of bison under quarantine due to a brucellosis infection in South Dakota. Elzer et al (1998) reported similar results that support the argument for delivery of vaccine to older aged bison. While Palmer et al (1996) did report abortagenic response to RB51 vaccinated

pregnant bison, five of the eight cows in the study (62 percent) produced full term healthy calves.

Olsen et al (2004) reports that while bison given a ballistic delivery of RB51 vaccine exhibit lower gamma interferon response and antibody titer response than those bison vaccinated by syringe delivery, the results of experimental challenge by a virulent strain of *Brucella abortus* strain 2308 provide no significant difference (hand vs. ballistic vaccination) in percent of bison protected against abortion of their first pregnancy (Table 4).

DNA vaccine technology is developing quite rapidly but does not appear to be available for near term use other than on an experimental basis (Roffe and Olsen 2002, Pascual 2002, August 2005 Brucellosis Vaccine Symposium, Laramie, Wyoming). Remote delivery of vaccine to free-ranging, wild bison presents several challenges that limit near-term options for the IBMP. While options seem limited, the potential for developing a short-term vaccination strategy in combination with a more long-term vision for incorporating new technologies seem feasible at this time. The overriding management goals are still to improve the safety and effectiveness of remote vaccine delivery to bison and the ability to affect an acquired immune response in the bison population that would reduce the overall disease prevalence in the bison population.

Table 4. Summary of data from RB51 vaccination trials conducted by Steve Olsen. Data summarized from published papers and personal communication with Dr. Olsen.

	Antibody titer response at 8 weeks post vaccination	Gamma interferon response at 16 weeks post vaccination (mean ng/ml)	% of bison protected against aborted pregnancy	% of bison protected against infection by experimental challenge
Hand vaccination	>3000	17	77	15
Ballistic vaccination	~ 850	8	67	24
Control group Not vaccinated	< 100	2	32	0

Additional environmental planning directed by the final EIS and ROD has been initiated. A Notice of Intent to prepare an EIS (NOI) was published in the Federal Register by the National Park Service (3 August 2004). YNP conducted public scoping meetings during September 2004. Public comments were compiled and analyzed for identification of new issues to be addressed in the EIS. The park received 137 comment documents that included more than 800 specific comments. Fifty-seven percent of the comments were substantive, leading to the identification of 12 key issues to address in the EIS. Public opinion was mixed and numerous comments were submitted requesting the NPS to select a no action alternative. No new issues were discovered through public scoping.

Protection of private property

To date, documentation of private property damage has been limited. Individual query of employees from all agencies have noted that a horse was injured in the Eagle Creek area early in the implementation of the IBMP. The year of occurrence was not documented. Numerous locations in the Western Boundary Area have experienced property damage including damage to fences, vegetation, landscaping, and livestock, particularly injuries to horses. (Reference – Final Environmental Impact Statement, page 318, Table 27 – Numbers and Types of Bison Nuisance Incidents in the State of Montana, from 1991 to 1993.) Property owners report to the MTDOL that their landscaping has been eaten and trampled. Bison regularly roam and graze within many of the housing and administrative sites in YNP. Rubbing on wooden sign posts in backcountry areas and jumping fences to access hay inside horse corrals appears to be the extent of damage to physical resources within the park. Horses and mules are occasionally chased. Fence damage has occurred sporadically, including during hazing operations in the Western IBMP Management Area. Evaluations of damages incurred have not been conducted to estimate the extent of the damages.

Population target for whole bison herd

In five years the population has not dropped below 2,300 bison. The late winter population abundance has been above the population target and management decision threshold of 3,000 in four of the five years of implementation.

Evaluate the Safety of Vaccines in Bison and in Non-Target-Species

Available information

During Step 1 of the IBMP, once the agencies determine there is a safe vaccine, seronegative calves and yearlings that are captured will be vaccinated (USDI and USDA 2000, State of Montana 2000). The decision to proceed with vaccination, as noted in the Records of Decision (ROD), was contingent on determining whether a suitable vaccine could meet the safety criteria established in the FEIS. Much work has been focused on this issue since the time the FEIS was drafted and reviewed by the public.

A protocol for evaluating the safety and efficacy of a wildlife vaccine against brucellosis in the GYA was adopted by the Greater Yellowstone Interagency Brucellosis Committee (GYIBC) in 1998. The purpose of the protocol was to establish guidelines for the development and evaluation of new brucellosis vaccines to be used in free-ranging elk (*Cervus elaphus*) and bison (*Bison bison*). The IBMP partner agencies have agreed that a safe vaccine is one that has no long-term pathological effects on the vaccinated bison or its fetus, and no debilitating reaction that would increase mortality in the population (USDI and USDA 2000). A safe vaccine would also be one in which the bacteria incurs no genetic mutations or reversions and that causes no pathological effects, death, or disability in non-target animals exposed to the vaccine or vaccinated bison. A vaccine candidate cannot cause deleterious effects on the short-term survivability of non-target species under experimental conditions. A safe vaccine will not induce significant reductions in survivability or reproductive efficiency as statistically demonstrated in clinical trials (GYIBC 1998). A safe vaccine will not cause a significant reduction in recruitment in the population of the target species. A safe calfhood vaccine will not be

shed from a vaccinate prior to the first parturition of that individual. The vaccine strain will not persist to the first calving in 95 percent or greater of the vaccinated animals, or persistence of the vaccine strain will not be associated with a significant reduction in the survivability (i.e., no pathology) or the reproductive potential of the individual (i.e., repeated fetal loss, infected calves, or decreased fertility). There should be no statistical difference between vaccinates and controls on these factors.

Many experiments have been conducted to evaluate the biosafety parameters of *Brucella abortus* strain RB51 as used to vaccinate bison calves (Appendix 1). The vaccine is clinically safe when administered to bison calves from three to seven months of age using doses of up to 6×10^{10} Colony Forming Units (CFU) (Roffe et al. 1999, Elzer et al. 1998, Olsen et al 1998). Bison vaccinated at three months took longer to clear the vaccine than those vaccinated at seven or eight months (Elzer et al. 1998, Olsen et al. 1998). None of the studies reported any significant pathological effects or shedding of bacteria.

While some studies have found adulthood vaccination to be safe, more research is needed to clearly define the biosafety parameters for adult bison vaccination with RB51. Elzer et al (1998) noted that pregnant bison vaccinated during the first trimester of pregnancy were successful at giving birth to healthy live calves. Palmer et al (1996) found that RB51 caused placentitis, and induced abortion in two of eight pregnant bison that were vaccinated. One additional cow delivered a full term live birth 12 to 13 days post vaccination, but the calf died within 2 days. This later study noted that vaccination strategies used with domestic cattle are not appropriate for application to pregnant bison. Lower doses may be necessary for safely vaccinating pregnant bison. Shedding of vaccine strain *Brucella* is possible when pregnant bison are vaccinated and abort their pregnancy. Olsen and Holland (2003) found that abortions or other adverse effects were not observed in 48 pregnant bison that were booster vaccinated following initial vaccination as yearlings. Thus, booster vaccinating pregnant bison was considered safe by these authors.

Adult bison bulls vaccinated with RB51 do not show signs of sero-conversion on standard brucellosis tests, do not exhibit increased or prolonged colonization of *Brucella* bacteria, and do not develop relevant inflammatory lesions in reproductive tissues (Elzer et al 1998, Olsen et al 1999). Olsen et al (1999) did find RB51 in the semen (25 percent of the study animals) of two and three year old bulls that were vaccinated. The relevance of this transient shedding of *Brucella* bacteria in the semen of bull bison is still unknown. Dr. Olsen reported that in studies of cattle, "transmission of *B. abortus* from infected bulls to susceptible cows is considered to be negligible under natural mating conditions". RB51 was recovered from lymphoid tissues in less than 25 percent of both hand and ballistic vaccinated adult bulls at 13 weeks post vaccination (Olsen et al 1999). By 30 weeks post vaccination, all tissues sampled were clear of the vaccine. Elzer et al (1998) reported that all tissues sampled and tested from adult bulls at both 13 and 16 weeks post vaccination resulted in no detection of RB51. The later study used bison from a brucellosis infected herd and thus animals may have been previously exposed to brucellosis. Naïve animals are more likely to exhibit clinical signs, after vaccination as compared to animals that may have been previously exposed (S. Olsen pers. comm.). Microscopic lesions were observed in the testes, epididymis and the seminal vesicles (Olsen et al 1999). These lesions were minimal in number and did not differ between the RB51 vaccinated bulls and the males vaccinated with saline solution. These authors noted that RB51 did not cause inflammatory lesions in the reproductive tissues of adult bull bison. Thus, because infertility in bovine bulls is associated with lesions, it is believed to be unlikely that RB51 will affect bull bison fertility. Exposure to RB51 could occur from a vaccinated bison being preyed upon or scavenged after being killed accidentally by drowning, vehicle accidents, or other causes. Thus, the safety of RB51 in non-target species has been tested extensively. Results from these studies indicate that secondary exposure to RB51 presents no unsafe risk to all species studied, and its use in free-ranging wildlife in the GYA would not be expected to generate harmful effects to wildlife species likely to encounter vaccinated bison (Roffe and Olsen 2002, Cook and Rhyan 2002). While RB51 is an attenuated live strain of *Brucella* bacteria, field strain *Brucella* is considered more virulent than the RB51 vaccine.

Conclusion.

RB51 has been identified as a safe vaccine if delivered by injection to bison calves (Roffe et al 1999, Roffe and Olsen 2002). However, Roffe and Hunter (unpubl. data), Palmer et al. (1996) and Roffe and Olsen (2002) each noted some concern over the safety of this vaccine when used in pregnant adult females. RB51 has been found to persist in the testicles of bull bison (Elzer et al. 1998, Olsen et al 1998, Olsen et al. 1999). While some bulls were known to shed vaccine strain bacteria in their semen, the epidemiology of the disease does not suggest that venereal transmission is a significant means of transmission (Roffe and Olsen 2002, Rhyan and Drew 2002). No morbidity or mortality has been observed in RB51 vaccinated bull bison, suggesting that the vaccine is safe for use in males (Roffe and Olsen 2002). Results of extensive testing to evaluate the risk to non-target species have shown that RB51 is safe (Cook and Rhyan 2002). Thus it could be used in the GYA with no expectations of negative effects to non-target species regardless of the method of delivery. The vaccine RB51 appears to meet the criteria for a safe vaccine as described by the GYIBC (Table 5).

Vaccination of bison may contribute to reaching multiple objectives established in the FEIS. Vaccination may help "protect livestock from the risk of brucellosis" by reducing the disease prevalence of brucellosis in the Yellowstone bison. If disease prevalence is reduced in bison, the risk of transmission from bison to other bison, to elk and especially to cattle outside the park is further minimized. In addition, a reduced rate of brucellosis prevalence in bison may help "protect the state of Montana from risk of reduction in its brucellosis (Class Free) status". Further, a reduced prevalence of brucellosis in Yellowstone bison may provide a mechanism to help conserve this population.

Table 5. Publications that provide evidence in support of RB51 as a safe vaccine for use in bison calves and non-pregnant adults (including yearlings).

Calfhood Vaccination	
No clinical effects that increase predation or decrease survivability	Olsen et al 1998 Elzer et al. 1998 Roffe et al. 1999
No shedding prior to parturition	
Vaccine strain will not persist to first calving in greater than 95 percent of vaccinates	
No pathology	Olsen et al 1998 Roffe et al. 1999
No negative reproductive effects (repeated fetal loss, infected calves, decreased fertility	Olsen et al 1998
Adulthood Vaccination	
Will not induce significant reduction in survivability or Reproductive efficiency	- Elzer et al 1998, safe if given in 1st trimester of pregnancy - Palmer et al 1996 noted that pregnant bison vaccinated in 2nd and 3rd trimesters resulted in reproductive failure. Those vaccinated in 2nd month of pregnancy produced healthy calves (6 of 7)
Will not cause significant reduction in recruitment in population	
No clinical effects, shedding or pathology	Olsen et al 1999
Non-target Species	
No deleterious effects on survivability of representative ungulates, rodents, carnivores, or avian species	Davis et al 2000 Elzer et al 2000 Cook et al 2001 Januszewski et al 2001 Kreeger et al in press Cook and Rhyan 2002 Olsen et al 2004

Evaluate the efficacy of vaccines in bison

	Vaccinates (N=80)	**Non-vaccinates (N=25)**
Incidence of abortion	24% (18/75)	68 % (17/25)
Fetal infection (recovery of the challenge strain of Brucella S2308)	28% (21/75)	76% (19/25)
Maternal infection (recovery of S2308 in the dame)	82% (62/75)	100% (25/25)

Table 6. Combined results of 7 vaccine effectiveness studies supervised by Dr. Steven Olsen at the National Veterinary Sciences Lab, Ames, IA.

Under natural conditions, animals are exposed to a wide range of infectious doses of *Brucella abortus*. Roffe and Olsen (2002) noted that an individual animal's immune response to infectious tissue is dependent on a variety of parameters that change from year to year (water availability, nutrition, and climate for example). In contrast, the effectiveness of a vaccine as identified through a controlled experiment is designed to compare the disease response in two groups of animals where nutrition, environment and exposure rate are carefully controlled. The effectiveness of RB51 to protect against aborting pregnancies, as noted in controlled experiments, does not provide consensus on efficacy (Olsen et al 1997, Olsen et al. 1998, Davis and Elzer, 1999, Elzer et. al 2002). However, some

evidence of efficacy has been demonstrated (Olsen et al. 2002, Olsen 2004) (Table 6). A study to evaluate whether freshly cultured vaccine as compared to lyophilized vaccine purchased from a veterinary supplier exhibits any difference in effectiveness is currently being conducted (Olsen Pers. Comm.).

DISCUSSION

POPULATION ABUNDANCE

The abundance of bison has grown steadily since the implementation of the IBMP (Figure 1). Winter weather conditions have been mild to average during the first five years of IBMP implementation. Management-related mortality has resulted in greater than 200 bison removed in three of the five winters, while management removals during the first and fifth winters of operation resulted in far fewer. A correlation analysis of long-term population abundance relative to bison removal during management operations identified that management-related mortality has a curvilinear relationship with population abundance (Cheville at al 1998). Winter weather conditions, as measured by snow water equivalency, has no significant relationship to number of bison in the IBMP Management Areas at populations below 3,000, while a suggested relationship (P=0.07) does occur between winter severity and management removals during time periods when the population is greater than 3,000 bison (Cheville et al 1998). These authors suggested also that under average winter conditions we should expect about 332 bison to be removed by management actions in the two IBMP Management Areas combined. Thus, the pattern seen in the first five years of implementation should not be surprising. (Figure 2)

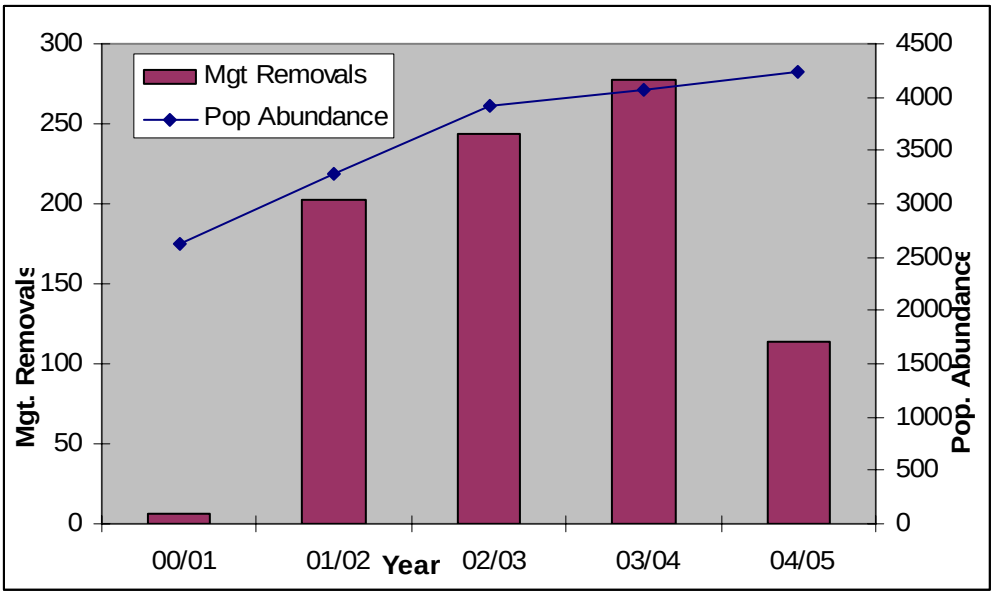

Figure 1. Comparison of bison removed and annual population estimates.

WHAT HAVE WE LEARNED ABOUT BISON MOVEMENT PATTERNS?

One assumption that has turned out to be false is the idea that bison crossing the park boundary at Reese Creek in the Northern IBMP Management Area come from the northern range sub-population. Evidence from radio marked bison and winter aerial surveys indicates that the northern range sub-population has not moved down river to the Gardiner Basin during the period of this analysis and nearly all of the bison in the Northern IBMP Management Area traveled there from the central sub-population.

Bison movements that have occurred since implementation of the IBMP have confirmed that YNP is not a self-contained ecosystem for bison. At current population levels, movements from the park to surrounding areas are normal occurrences, especially during winter (Gates et al 2005).

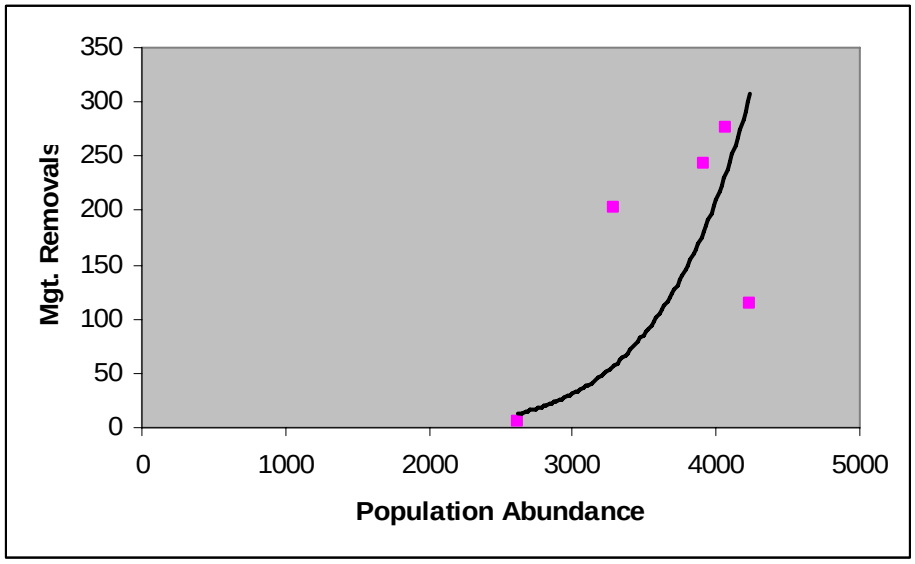

Figure 2. Correlation between population abundance and management removals during the first five years of IBMP implementation ($R^2 = 0.41$)

WHAT HAVE WE LEARNED ABOUT THE RISK OF DISEASE TRANSMISSION?

Primary risk of disease transmission from bison to cattle is through oral ingestion of shed bacteria (Rhyan and Drew 2002). The highest risk category of bison is the pregnant female bison from January through parturition season, which typically ends in early June. *Brucella abortus* has been demonstrated to persist in the environment for 18-80 days as a potential source of transmission, the risk of disease transmission to cattle through exposure to bacteria shed by bison continues to be a concern. Studies on the persistence of shed *Brucella* organisms in the environment have confirmed the importance of maintaining temporal separation between bison and cattle, as defined in the IBMP.

Although vaccination of cattle provides some level of protection against infection, recent instances of disease transmission from infected wildlife to vaccinated cattle in Idaho and Wyoming demonstrate vaccination of cattle does not eliminate the possibility of disease transmission.

A review of the hazing data presented in the appendix indicates that there are many months that male bison are the only animals at either IBMP Management Area. However, based on existing scientific information, the risk of transmission from bull bison, though logically small, cannot be entirely eliminated. Without continued hazing of bull bison, nomadic movements beyond the Western and Northern Boundary IBMP Management Areas to areas with higher cattle densities would be likely. Through implementation of the IBMP, there has not been a case of transmission from bison to cattle in Montana.

WHAT AFFECTED ENVIRONMENTS HAVE CHANGED SINCE THE FEIS AND ROD HAVE BEEN COMPLETED?

A wolf pack has taken up residency in an area that includes the Western IBMP Management Area since the time the Records of Decision were completed. The wolf pack has denned in two different locations within Zone 1 of the IBMP Management Area. 50 CFR Part 17 describes conservation measures to protect wolf den sites from disturbance caused by human activities. The time period of greatest concern is from April 1st to June 30th. The communication between the west district ranger (YNP) and the Western IBMP Management Area field operations supervisor has evolved to account for wolves denning inside the park and conservation measures to reduce disturbances associated with hazing operations near wolf dens has been implemented.

Cattle remain on the Royal Teton Ranch (RTR) within Zone 2 of the Northern IBMP Management Area during winter. In addition, a bison management plan specifically directed at managing issues associated with both private and public lands in this IBMP Management Area has not been completed.

The Horse Butte grazing allotment has been vacated. A final decision regarding management strategies for the Horse Butte grazing allotment will be made during the next revision to the Gallatin National Forest Plan.

SUBSEQUENT MANAGEMENT ACTIONS

Area specific criteria have been established for changing management operations and moving through the adaptive management steps for increased tolerance of bison in the two IBMP Management Areas. These specific criteria differ between the two IBMP Management Area locations and are noted as introductory quotes in both the Northern and Western sub chapters below.

Northern IBMP Management Area

"Step 2 begins (expected winter 2002/2003)when cattle no longer graze private lands outside YNP on portions of lands known as the RTR in Zone 2 during the winter"

Adaptive Management Steps – Criteria to move to Step 2

Criteria contained in the Records of Decision (RODs) have not been met at the northern boundary area to move to Step 2 of the IBMP because at the time the RODs were signed an assumption was made that the Northern IBMP Management Area would be available (after December 2002) as an area where a specific management plan could be developed. Therefore, the subsequent management actions necessary to progress to Step 2 in the Northern IBMP Management Area include:

1. Establishment of a new IBMP task group (with representatives from each of the appropriate agencies) to develop a Northern IBMP Management Area specific Bison Management Strategy. The task directive for the group includes a further review of Zone 2 management issues for the Northern IBMP Management Area to determine when and how the IBMP could proceed with adaptive management under the current RODs given the current management situation within the IBMP Management Area. In addition, the task group is to address and produce an analysis of the most effective means to manage the Northern IBMP Management Area boundary between Zone 2 and Zone 3 at Yankee Jim Canyon, including considering the need, design, and location of a capture facility within Zone 2.

2. Pursuit of opportunities to change grazing patterns and practices on private lands within and adjacent to the Northern IBMP Management Area.

3. The Completion of the Bison Management Plan between the IBMP partner agencies and the RTR as prescribed in the Devil's Slide Conservation Easement dated 30 August 1999.

Western IBMP Management Area

"In step 2, which begins when a safe and effective remote delivery mechanism is available, any untested vaccination-eligible bison allowed in the West Yellowstone area will be remotely vaccinated."

Adaptive Management Adjustments

Revise the IBMP "Operating Procedures" to include bison hunting as an additional IBMP management tool in the Western Boundary Area. Specifically, allow for the implementation of a bison hunt as an adaptive demonstration project to determine if bison hunting can be successfully incorporated into the IBMP as an additional management tool. The bison hunt was reviewed under the Montana Environmental Policy Act (MEPA) through an environmental assessment completed in 2004 by FWP. That assessment tiers off of the IBMP environmental impact statement, where a bison hunt was contemplated. The following are necessary conditions or criteria regarding this proposed adaptive management adjustment to the IBMP:

1. Hunting will be permitted from November 15 thru February 15, when cattle are typically no longer present in the West Yellowstone Basin.

2. Hunting will remain limited to areas where and when cattle are typically not present (lands defined in the IBMP as "Zone 2" in the West Yellowstone Basin), including public and private lands with land owner permission, and areas where bison are currently allowed to roam freely (public land with no cattle allotments in the Cabin Creek Recreation and Wildlife Management Area, the Monument Mountain Unit of the Lee Metcalf Wilderness, and the upper Gallatin River drainage south of the mouth of Taylor Fork).

3. Daily monitoring of bison abundance, distribution, and movement in Zones 1 and 2 in the West Yellowstone Basin will be conducted. Implement more intensive monitoring, and potentially other management actions if necessary, if significant numbers of bison approach or go beyond Witts Lake Road (North of Hebgen Lake on Hwy. 287) or USFS Road 1731 (South of Hebgen Lake near Madison Arm Resort).

4. Enact 24-hour notice prior to hunting closures, when determined to be necessary, to implement other management actions such as hazing, capture, or lethal removal.

5. Conduct sero-surveillance on all hunter-harvested bison.

6. Conduct critical evaluation of bison hunting demonstration project at conclusion of hunting season. Propose necessary adjustments to future bison hunts based on conclusions derived from critical evaluation.

Adaptive Management Steps – Criteria to move to Step 2

Criteria contained in the Records of Decision (RODs) have not been met at the west boundary area to move to Step 2 of the IBMP because, to date, a safe and effective remote delivery mechanism is not available for incorporation into the IBMP. Subsequent management actions necessary to progress to Step 2 in the Western IBMP Management Area include:

1. Pursuit of safe and effective vaccine (based on GYIBC *Protocol for Evaluating Safety and Efficacy of a Wildlife Vaccine against Brucellosis in the GYA as included in the ROD*). At this time, the most likely vaccine candidate is *Brucella abortus* strain RB51 (RB51). However, although RB51 has been determined to be safe, there is debate and conflicting scientific evidence regarding the efficacy of RB51.

2. Continue evaluating all methods of safe and effective remote vaccine delivery mechanisms. Given the complexity of brucellosis management issues in the GYA, managers will most likely need multiple platforms for delivering vaccine to wild bison. It is highly likely that multiple mechanisms for vaccine delivery will increase the effectiveness of a population-wide bison vaccination program.

3. Conduct and complete the necessary environmental assessments to implement a safe and effective remote delivery vaccination program.

OTHER RECOMMENDATIONS

Establishment of a new IBMP task group or technical working group (with representatives from each of the appropriate agencies) to develop a recommendation regarding continuation of the sero-negative pregnant female bison monitoring program. The task group will define the important management questions that this monitoring program is to focus on, attempt to resolve whether the logistical difficulties identified currently are worth the cost of doing business for managing birthing sites in the Zone 2 management areas, and define any additional management information pertinent to managing the risk of brucellosis transmission. The group will also develop and prioritize information necessary to better understand how the disease is maintained within the Yellowstone bison population.

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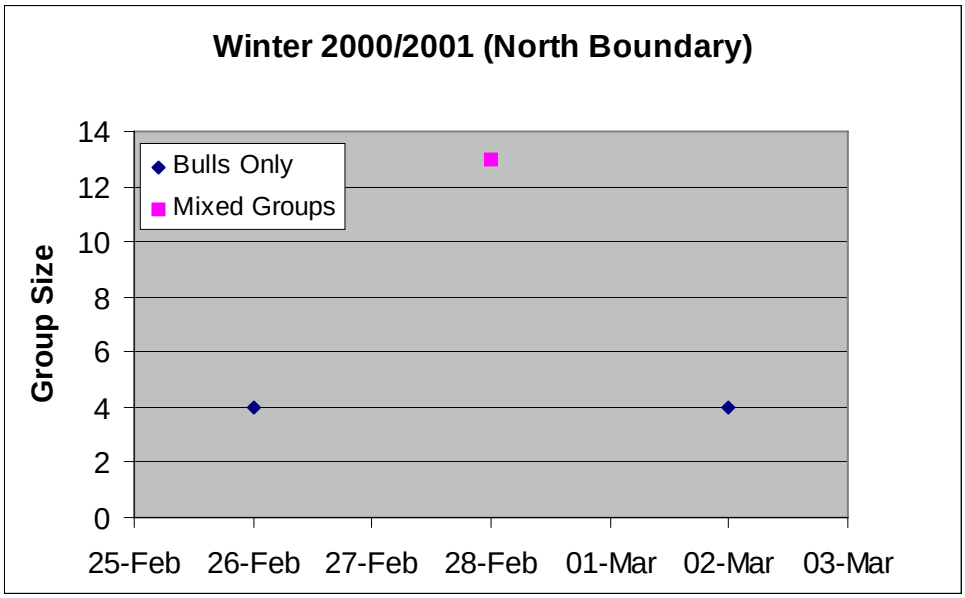
Appendix 1. Compilation of literature that has evaluated safety of RB51 in bison and non-target species of Yellowstone National Park.

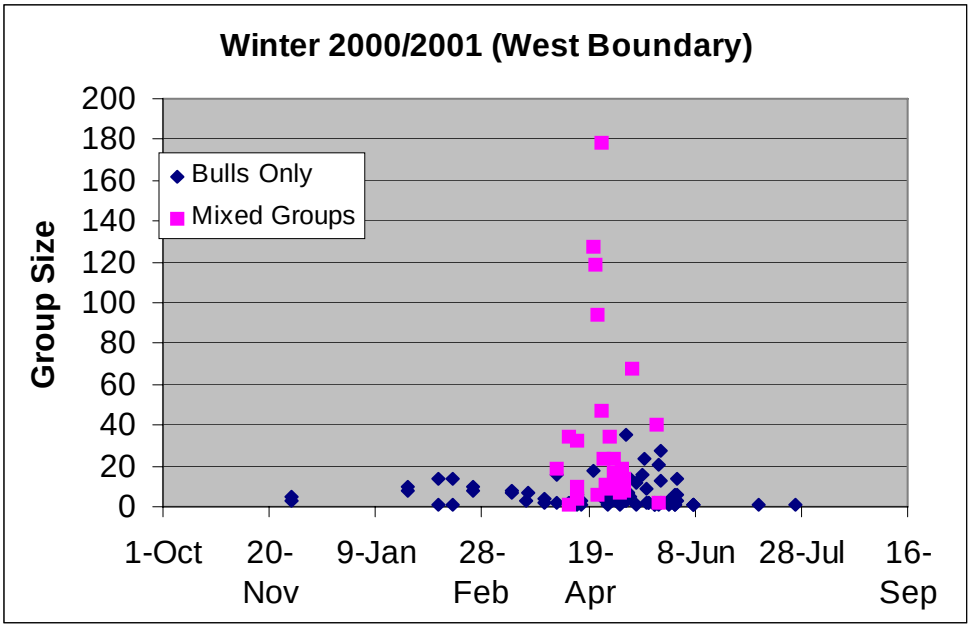
Citation	Study Subjects	Sex and Age Structure of Study Subjects	Was Safety Evaluated ?	Was SRB51 Determined Safe?
Davis, D. S., Roffe, T. J. and Elzer, P. H. 2000. Safety of *Brucella abortus* and RB51 and Strain 19 Vaccines in Coyotes (Canis latrans). Report of the 106th Annual Meeting of the United States Animal and Health Association. 239-242.	Coyotes (*Canis latrans*)	n=94; RB51 vaccinated=19 (5 males, 5 females and 9 pregnant females), Controls=15 males, 6 females, 17 pregnant females – the remaining were vaccinated with Strain 19	Yes.	Yes. No isolations of *B. abortus* RB51 or Strain 19 were made from the reproductive tissues of either males or females and no isolations were made from any of the 84 pups. No negative reproductive effects. No chronic infections. Cleared by day 42.
Elzer, P. H., Edmonds, M. D., Hagius, S. D., Walker, J. V., Gilsdorf, M. J. and Davis, D. S. 1998. Safety of *Brucella abortus* strain RB51 in bison. *Journal of Wildlife Diseases*, 34: 825-829.	Bison	n=29; 10 adult bulls, 12 adult pregnant cows, 7 calves	Yes.	Yes. RB51 was not isolated (cultured) from any animals killed at 13 and 16 weeks. Did not persist in tissues. Cows vaccinated at 2 months pregnant did not abort. Only 3 cows killed – no gross lesions.
Elzer, P. H., Smith, J. A., Edwards, J. F., Roffe, T. J. and Davis, D. S. 2000. Safety of *Brucella* Vaccines in Pronghorn Antelope. Report of the 106th Annual Meeting of the United States Animal and Health Association. 203-207.	Pronghorn Antelope (*Antilocapra americana*)	n=90 (30 controls, 30 vaccinated with RB51, 30 vaccinated with Strain 19) sexually mature, pregnant females	Yes.	Yes. RB51 was found in maternal and fetal tissues of pregnant pronghorn only in very low numbers and without pathology.
Elzer, P. H., Hagius, S. D., Roffe, T. J., Holland and Davis, D. S. 2002. Failure of RB51 as a calfhood bison vaccine against brucellosis. Report of the 106th Annual Meeting of the United States Animal and Health Association. 87-91.	Bison	calves and yearlings	No.	Noted that RB51 was safe for use in bison calves, pregnant cows, and non-target spp.
Januszewski, M. C., Olsen, S. C., McLean, R. G., Clark, L., Rhyan, J. C. 2001. Experimental infection of nontarget species of rodents and birds with *Brucella abortus* strain RB51 vaccine. *Journal of Wildlife Diseases*, 37 (3):532-537.	Ground Squirrels (*Spermophilus richardsonii*), Deer Mice (*Peromyscus maniculatus*), Prairie Voles (*Microtus ochrogaster*) and Ravens (*Corvus corax*)	Ravens: n=13 mature and immature – both sexes; Ground Squirrels: n=21 mature – both sexes; Deer Mice: n=21 mature – both sexes; Prairie Voles: n=21 mature – both sexes	Yes.	Yes. No clinical signs of illness resulted from exposure to RB51 in any of the study species. No morbidity and/or mortality occurred due to exposure to RB51 in any of the study species. No fecal or oral shedding occurred in any of the study species.

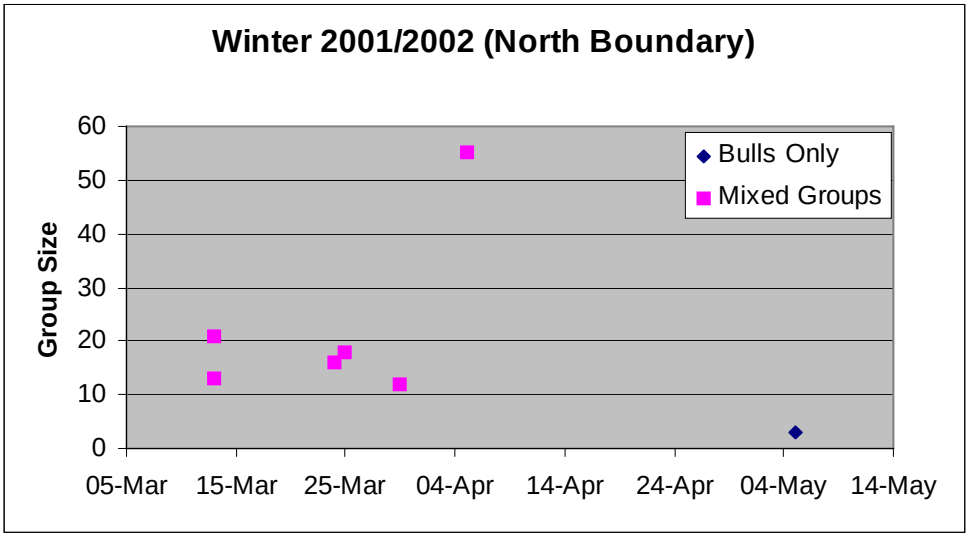
Citation	Study Subjects	Sex and Age Structure of Study Subjects	Was Safety Evaluated ?	Was SRB51 Determined Safe?
Olsen, S. C., Jensen, A. E., Palmer, M. V. and Stevens, M. G. 1998. Evaluation of serologic responses, lymphocyte proliferative responses, and clearance from lymphatic organs after vaccination of bison with *Brucella abortus* strain RB51. *American Journal of Veterinary Research*, 59 (4):410-415.	Bison	n=14 seven month old female bison calves	Yes.	Strain RB51 was cleared by 18-24 weeks after vaccination. No shedding of the vaccine to nonvaccinated bison housed in close proximity occurred.
Olsen, S. C., Rhyan, J. C., Gidlewski, T., Palmer, M. V., Jones, A. H. 1999. Biosafety and antibody responses of adult bison bulls after vaccination with *Brucella abortus* strain RB51. *American Journal of Veterinary Research*, 60 (7):905-908.	Bison	n=61, 2-3 year old bull bison	Yes.	SRB51 was found in the semen of those bulls that were vaccinated. Additional research is recommended to determine the ramifications of the shedding of RB51 in the semen of vaccinated adult bulls. Also, if bull calves are to be considered for vaccination, further research is recommended on the clinical safety and biosafety. However, analysis of data from this study suggests that RB51 will not cause inflammatory lesions in the reproductive tissues of adult bull bison. And because infertility in bovine bulls is associated with lesions, it is believed to be unlikely that RB51 will effect bull bison fertility.
Palmer, M. V., Olsen, S. C., Gilsdorf, M. J., Philo, L. M., Clarke, P. R., and Cheville, N. F. 1996. Abortion and placentitis in pregnant bison (Bison bison) induced by the vaccine candidate *Brucella abortus* strain RB51. *American Journal of Veterinary Research*, 57 (11):1604-1607.	Bison	n=10 Pregnant adult cow bison ranging from 3-10 years of age	Yes.	No. RB51 can cause placentitis, inducing abortion in pregnant bison.
Roffe, T. J., Olsen, S. C., Gidlewski, T., Jensen, A. E., Palmer, M. V., and Huber, R. 1999. Biosafety of parenteral Brucella abortus RB51 vaccine in bison calves. *Journal of Wildlife Management*, 63:950-955.	Bison	n=27 calves	Yes.	Yes. No gross lesions. No adverse clinical effects. No shedding. No morbidity or mortality

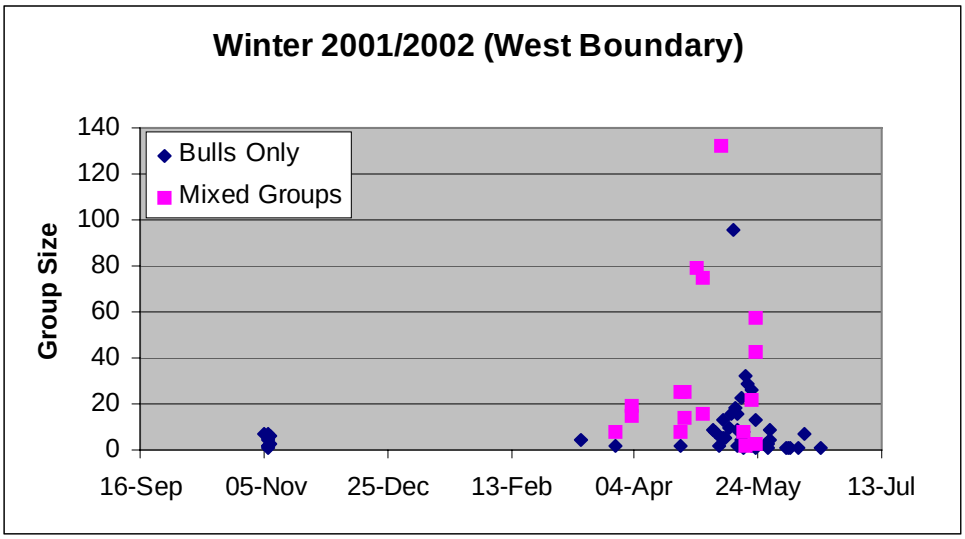
Citation	Study Subjects	Sex and Age Structure of Study Subjects	Was Safety Evaluated ?	Was SRB51 Determined Safe?
Olsen, S. C. and S. D. Holland. 2003. Safety of revaccination of pregnant bison with *Brucella abortus* strain RB51	Bison	N= 65 (48 pregnant and 17 non-pregnant)	Yes. RB51 can be used to booster vaccinate pregnant bison	Yes. Abortion or other adverse effects were not observed after booster vaccination withRB51. Pregnant bison were vaccinated at 3-5 months gestation. Vaccine strain *Brucella* was recovered in 8 of 48 pregnant bison and 0 of 17 non-pregnant bison. Field strain *Brucella* was recovered in 21 pregnant and 2 non-pregnant bison. Field strain *Brucella* can persist in bison undetected until attainment of reproductive age despite extensive use of vaccination and serologic testing.

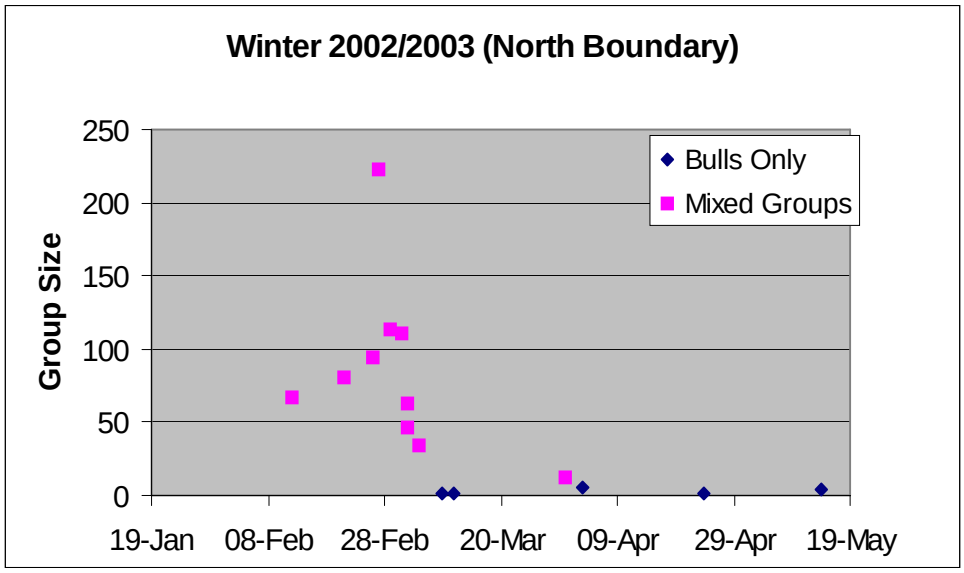
Appendix 2. Graphic display of hazing operations at both the northern and western IBMP Management Areas by year.

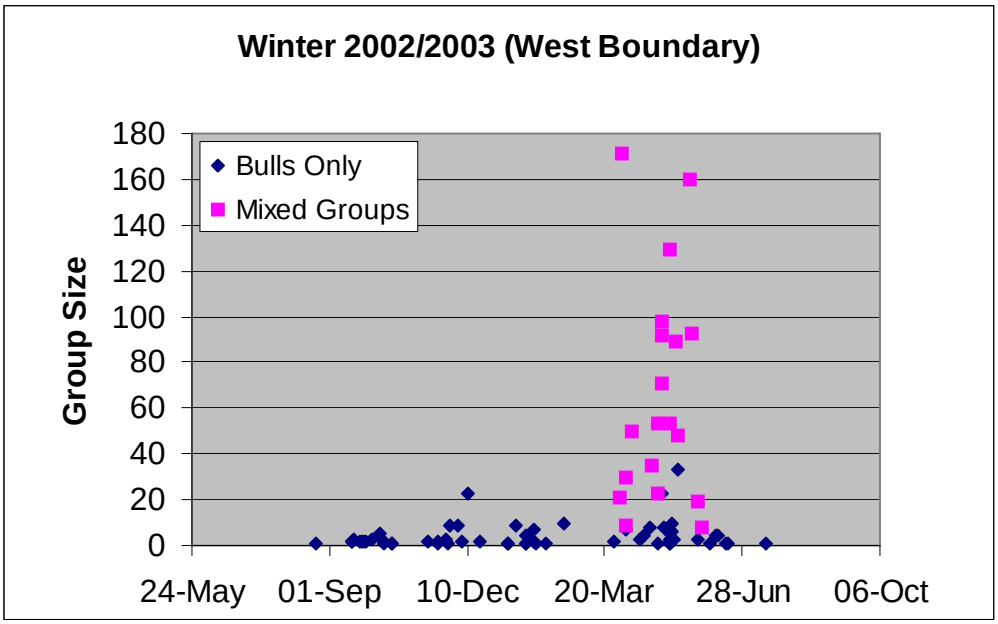


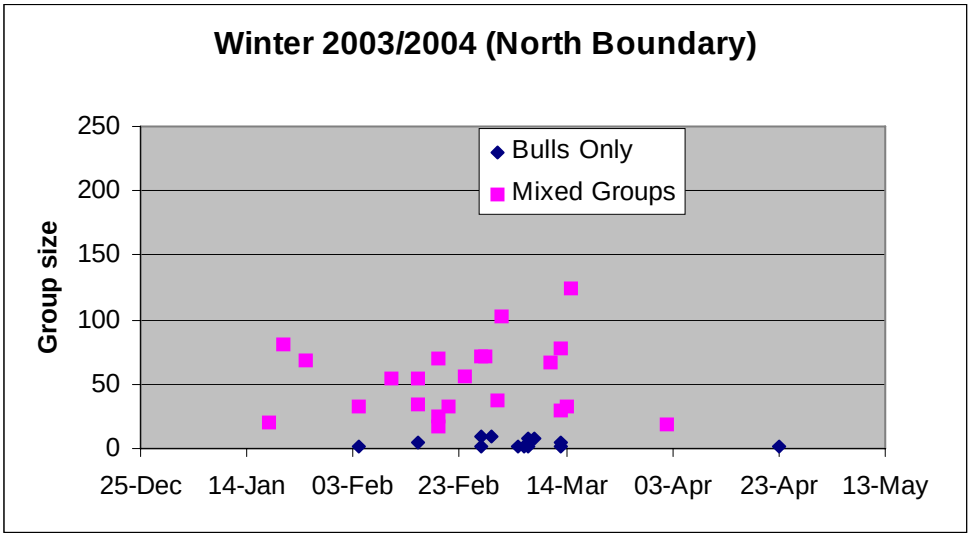


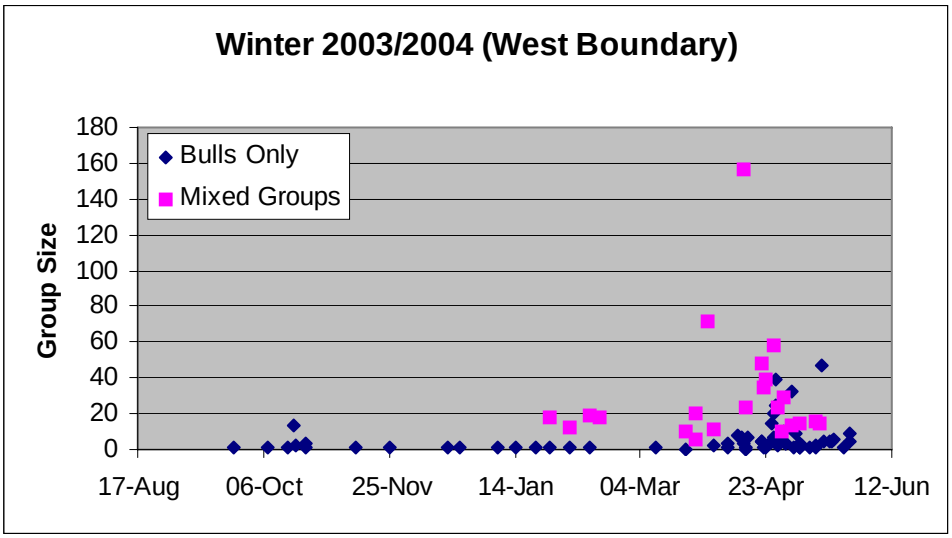

Winter 2001/2002 (North Boundary)
Group Size
60
50
40
30
20
10
0
Bulls Only
Mixed Groups
05-Mar
15-Mar
25-Mar
04-Apr
14-Apr
24-Apr
04-May
14-May

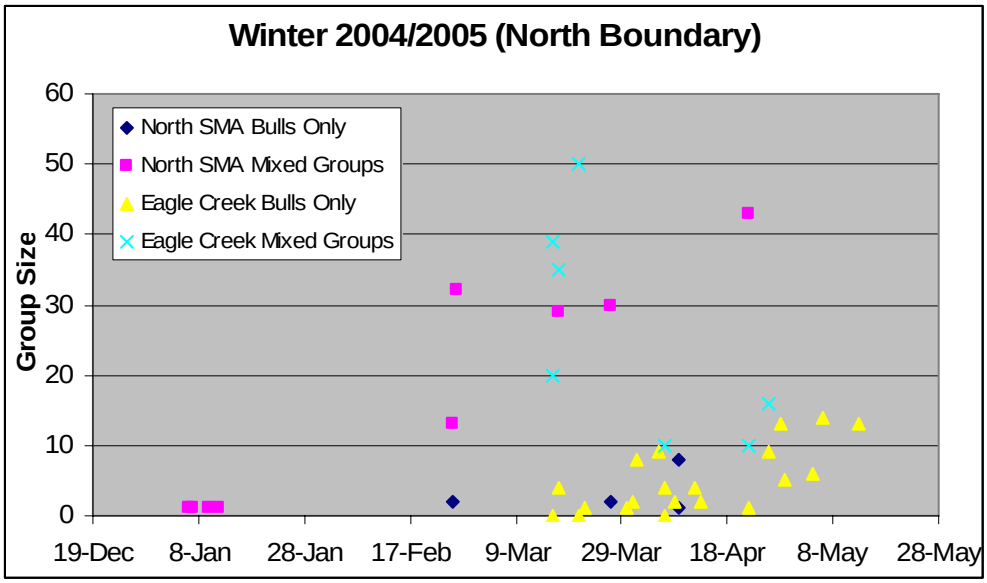

Winter 2001/2002 (West Boundary)
Group Size
140
120
100
80
60
40
20
0
Bulls Only
Mixed Groups
16-Sep
05-Nov
25-Dec
13-Feb
04-Apr
24-May
13-Jul

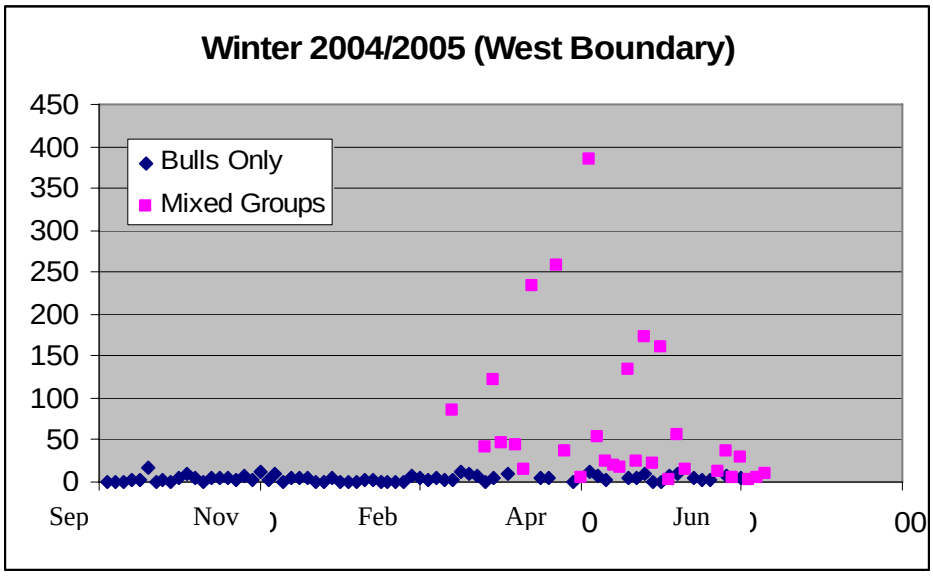

Winter 2002/2003 (North Boundary)
Group Size
250
200
150
100
50
0
19-Jan
08-Feb
28-Feb
20-Mar
09-Apr
29-Apr
19-May
Bulls Only
Mixed Groups


Winter 2002/2003 (West Boundary)
Group Size
180
160
140
120
100
80
60
40
20
0
24-May
01-Sep
10-Dec
20-Mar
28-Jun
06-Oct
Bulls Only
Mixed Groups


Winter 2003/2004 (North Boundary)
Group size
250
200
150
100
50
0
Bulls Only
Mixed Groups
25-Dec
14-Jan
03-Feb
23-Feb
14-Mar
03-Apr
23-Apr
13-May


Winter 2003/2004 (West Boundary)
Group Size
180
160
140
120
100
80
60
40
20
0
Bulls Only
Mixed Groups
17-Aug
06-Oct
25-Nov
14-Jan
04-Mar
23-Apr
12-Jun


Winter 2004/2005 (North Boundary)
Group Size
60
50
40
30
20
10
0
North SMA Bulls Only
North SMA Mixed Groups
Eagle Creek Bulls Only
Eagle Creek Mixed Groups
19-Dec
8-Jan
28-Jan
17-Feb
9-Mar
29-Mar
18-Apr
8-May
28-May


Winter 2004/2005 (West Boundary)
450
400
350
300
250
200
150
100
50
0
Bulls Only
Mixed Groups
Sep
Nov
Feb
Apr
Jun