**Buffalo Field Campaign encourages you to review and comment in particular on:**
**1.6 Legal and Policy Framework**
***2.6.2 Low Risk and Effective Delivery System that Results in Permanent Changes in Behavior or Demography***
**2.7 Environmentally Preferred Alternative**
**3.3 *Brucella abortus* in Wildlife of the Greater Yellowstone Ecosystem**
**3.7 Ethnographic Resources**
**4.2 Incomplete and Unavailable Information**
***4.6.1.1 Impacts from Alternative A (No Action—Boundary Capture Pen Vaccination of Calves and Yearlings)***
***4.6.1.2 Impacts from Alternative B (Remote-Delivery Vaccination—Young Bison Only)***
***4.6.1.3 Impacts from Alternative C (Remote-Delivery Vaccination—Young Bison and Adult Females)***
**4.7 Irreversible or Irretrievable Commitments of Resources**
**Appendix A: Yellowstone Bison Population**
**Appendix C: Vaccination**
**Appendix D: Safety and Efficacy Criteria for Bison Vaccines Against Brucellosis**
**Appendix F: Cost Estimates for Implementing Each Alternative**

**Excerpts from Draft Environmental Impact Statement Brucellosis Remote Vaccination Program for Bison in Yellowstone National Park U.S. Department of the Interior, National Park Service, Yellowstone National Park, March 24, 2010**

**Executive Summary**
The goal of a remote delivery vaccination program would be to deliver a low risk, effective vaccine to eligible bison inside the park to (1) decrease the probability of individual bison shedding *Brucella abortus*, (2) lower the brucellosis infection rate of Yellowstone bison, and (3) test, monitor, and adjust for a safe, effective, low-risk, in-park remote delivery system for vaccination-eligible bison within the park.

Remote delivery vaccination is needed to protect Yellowstone bison by reducing brucellosis infection and, as a result, further reduce the risk of transmission to cattle outside the park.

However, the release of untested bison outside the park relies on the initiation of a remote vaccination program for bison within the park with a low risk and effective vaccine and remote delivery system.

The vaccination program is specifically intended to protect Yellowstone bison from brucellosis by reducing the probability that individual bison become infected and subsequently become transmission vectors to other bison. Indirectly, this program will reduce the probability of brucellosis transmission from Yellowstone bison to livestock that share ranges on habitats outside the park.

The effectiveness of Strain RB51 vaccine against field strain *B. abortus* is not conclusive and mixed results have been reported by various research projects. The USDA–Agricultural Research Service has published results of research showing that only 15% of vaccinated bison aborted pregnancies when experimentally challenged by a virulent strain of *B. abortus*, while 62% of non-vaccinates aborted their pregnancies. Conversely, experiments conducted by Texas A&M University concluded that vaccination with Strain RB51 provides no protection from aborted pregnancies. The results are not comparable because methods were not consistent. However, the Scientific Advisory Subcommittee on Brucellosis United States Animal Health Association, which includes the authors of these two disparate studies, has reviewed these studies and concluded in 2008 that experimental data for hand vaccination of bison with Strain RB51 suggests a 50-60% reduction in abortions, 45-55% reduction in infection of uterine or mammary tissues, and a 10-15% reduction in infection. Furthermore, the Subcommittee concluded that currently available data suggests remote delivery induces protection that is less than hand vaccination.

Bison congregate en masse in two areas during the July to August breeding season and disperse over 220,000 acres of habitat during the remainder of the year.

Some evidence from experiments on captive bison has shown that vaccinating pregnant bison late in the pregnancy period can create an abortion response due to the vaccine. However, delivery of vaccine during the earlier stages of the pregnancy has been shown to be low risk, especially for those bison that were previously vaccinated as young animals.

The vaccination program is intended to lower the amount of *B. abortus* bacteria shed into the environment by the Yellowstone bison population. This in turn should decrease the percentage of bison in the population that are exposed to the pathogen and potentially infected with brucellosis.Model simulations indicate all three alternatives should result in a decrease in brucellosis prevalence in the Yellowstone bison population. Alternative C should provide the greatest beneficial effect in lowering disease prevalence because it reduces the probability of infected bison aborting pregnancies to a greater extent and in a shorter period of time than the other alternatives.

This action may affect, but is not likely to adversely affect, the federally threatened Canada lynx, gray wolf, and grizzly bear. Impacts to other wildlife species (e.g., disturbance; possible exposure to vaccine) would be adverse and localized in the short-term, but minor, localized, and beneficial in the long-term. Impacts to ethnographic resources (e.g., cultural and spiritual significance of bison) would be adverse in the short-term, but may be minor and beneficial in the long-term. Impacts to human health and safety, visitor experience, and park operations (e.g., disturbance; possible exposure to vaccine) would be adverse but short-term, localized, and minor in magnitude.

The proposed remote delivery vaccination actions will be implemented with federal funding and will not reduce the seroprevalence of brucellosis sufficiently (i.e., eradication) to alter perceptions of livestock operators, producers, and regulators regarding the risk of brucellosis transmission from bison and elk to cattle.

The duration of immunity provided by remote vaccination remains uncertain, primarily because of unknown physiological effects and the logistical details of manufacture and delivery of vaccine.

**1. Chapter 1: Purpose of and Need for Action**
Yellowstone bison are the last continuously free-ranging wild bison in the United States (Appendix A). These bison are an integral part of the ecological processes and aesthetic purposes of the park that provide prey for predators and carrion for scavengers, contribute to the recycling of nutrients, and provide the visiting public with a vignette of how this icon of the American frontier existed in the early settlement era (Freese et al. 2007, Sanderson et al. 2008).

If migration by bison into Montana is restricted (e.g., bison forced to remain within the park by humans), then bison numbers would ultimately be regulated by food availability in the park, with bison reaching high densities (Coughenour 2008) before substantial winterkill (i.e., starvation) occurs. These high densities could cause significant deterioration to other park resources (e.g., vegetation, soils, other ungulates) and processes as the bison population approaches or overshoots their food capacity in the park. Alternatively, under the 2000 ROD for the IBMP, brucellosis risk management actions could be implemented to periodically to reduce the numbers of bison attempting to move outside the park, resulting in sporadic large-scale (more than 1,000 bison) shipments to slaughter. Either way, without the process of migration operating across the boundary of Yellowstone National Park, bison would not have access to historic and essential winter ranges outside the park, which could adversely affect their long-term conservation (Plumb et al. 2009). Also, the ecological role of the largest remaining free-ranging plains bison population in the world would be diminished (Freese et al. 2007, Sanderson et al. 2008) which, in turn, would diminish the ecological processes within the park (Coughenour 2008) and diminish the suitability of the park to serve as an ecological baseline (i.e., benchmark) for assessing the effects of human activities outside the park (Boyce 1998, Sinclair 1998).

Acceptance of Yellowstone bison as wildlife on lands outside Yellowstone National Park falls under the jurisdiction of the state of Montana. The IBMP (a court negotiated settlement between the state and the federal agencies) required the NPS to develop an in-park vaccination program as the risk management basis for state managers to accept untested, free-ranging Yellowstone bison on lands outside the park.

Suitable winter range for bison extends onto public lands outside Yellowstone National Park, where cattle may encounter shed bacteria. Concern over the risk of brucellosis transmission to cattle drives the need to prevent commingling with bison.

***1.1.1 Brucellosis Transmission and Infection***
Brucellosis can infect male and female bison regardless of age (Rhyan et al. 2009). However, females are more likely to shed an infective dose. The amount of bacteria shed by infected bison males is small and likely inconsequential relative to transmission risk (Lyon et al. 1995).

**1.2 Existing Condition**

***1.2.1 Interagency Bison Management Plan (IBMP) and Vaccination***
Approximately 15 to 25% of the population is actively infected by brucellosis most years (Treanor et al. 2007b). Thus, cross-boundary movements result in a risk of interspecies transmission of brucellosis from Yellowstone bison to cattle on overlapping ranges adjacent to the park.

The goal of the in-park vaccination program is to deliver a low risk, effective vaccine to eligible bison inside Yellowstone National Park to (1) decrease the risk of brucellosis transmission, and (2) diminish the overall seroprevalence of brucellosis in Yellowstone bison. Along with the development of a low risk and effective vaccine, this directive depended on the development of an effective remote delivery system.

The 2000 ROD for implementation of the IBMP (USDI and USDA 2000b) directed IBMP partners to vaccinate bison at capture facilities in the IBMP bison management zones along the north and west park boundaries when a vaccine was shown to be safe. These criteria were met and a limited vaccination program has been sporadically implemented since January 2004. In some years, bison that no longer respond to hazing in park boundary areas are captured, tested for brucellosis exposure, and vaccinated if they test negative (calves five to 12 months of age and yearlings 13 to 24 months of age).

The 2000 ROD noted that vaccination-eligible bison are expected to initially include calves and yearlings of both sexes, and will also include adult female bison if and when the agencies deem a vaccine is low risk and effective. This decision document also stated that the agencies will deem a vaccine low risk and effective according to criteria established by the Greater Yellowstone Interagency Brucellosis Committee (Appendix D). The existing vaccination program was initiated after a review of study results showed that Strain RB51 (SRB51) met the safety criteria (Wallen and Gray 2003).

The adaptive management agreement will guide future operating procedures for the IBMP. As a result of the agreement, partner agencies will adjust bison abundance and distribution on lands adjacent to Yellowstone National Park based on evaluations of new conservation easements or land management strategies, reduced brucellosis prevalence in bison, and new information or technology that reduces the risk of disease transmission.

**1.3 Purpose and Need**
The purpose for taking action is to address NPS responsibilities as directed by the Joint Management Plan in the 2000 ROD. The need for remote vaccination is to (1) decrease fetal abortion events in bison due to a non-native disease, (2) reduce transmission of

*Brucella abortus* among bison, (3) advance the IBMP to adaptive management step 3 where untested bison are allowed on essential winter ranges in Montana when cattle are not present (pursuant to the 2000 ROD), and (4) reduce the need for capture and large-scale (>1,000 bison) shipments to slaughter.

The following statements from the IBMP further establish the need for remote vaccination:
· The NPS must "maintain a wild, free-ranging population of bison" (USDI and USDA 2000b:36); and
· The NPS does not intend to conduct extensive capture operations inside the park to handle most individual bison and deliver vaccine because "extensive capture operations, as well as confinement to the park, might detract from the wild free-ranging qualities of the bison population" and "could have a major adverse impact on the distribution of bison" (USDI and USDA 2000a:415; see also 421-422).

Therefore,
· The NPS will conduct a remote vaccination program of vaccination-eligible bison within the park to allow a limited number of untested bison on winter range lands outside the park" (USDI and USDA 2000b:37); and
· The vaccination program should contribute "to the eventual elimination of brucellosis from the Yellowstone bison herd" and "seropositive rates cannot remain as they are or increase, but must decrease over the life of the plan" (USDI and USDA 2000b:36, 57).

**1.4 Scope of the EIS**
The decision from this analysis will be tiered from the decisions contained in the ROD for the IBMP FEIS. Thus, this EIS is not intended to revisit the IBMP or revise decisions already made in the ROD. The proposed action should provide timely and useful information to help develop adaptive management adjustments needed to conserve Yellowstone bison (e.g., more tolerance outside the park) and reduce the prevalence of brucellosis in the bison population. Results of remote delivery vaccination should provide managers with the knowledge needed to more effectively reduce the risk of brucellosis transmission among bison and from bison to other species. Additionally, the results will help address key uncertainties regarding the potential for brucellosis suppression, vaccine efficacy, and vaccine delivery through surveillance activities (White et al. 2008).

**1.5 Park Establishment, Mission, and Management**
Yellowstone National Park serves as a model and inspiration for national parks throughout the world. The NPS preserves these and other natural and cultural resources and values unimpaired for the enjoyment, education, and inspiration of present and future generations (1916 Organic Act, 1978 Redwoods Act, National Park Omnibus Management Act of 1998).

**1.6 Legal and Policy Framework**
The legal framework for the decision resulting from this EIS is defined by the enabling legislation for Yellowstone National Park and NPS policy (NPS 2006). Other relevant legal and regulatory guidance includes, among many, the 1916 Organic Act, 1978 Redwoods Act, National Park Omnibus Management Act of 1998, Endangered Species Act, and Executive Order 13175 Consultation with Indian Tribal Governments of 2000.

The NPS Organic Act of 1916 directs the USDI and NPS to manage units of the national park system "to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (16 U.S.C. 1). Congress reiterated this mandate in the Redwood National Park Expansion Act of 1978, which states that the NPS must conduct its actions in a manner that will ensure no "derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically directed by Congress" (16 U.S.C. 1a-1).

Areas of policy applicable to this planning effort include (1) animal population management, (2) protection of native animals, and (3) removal of exotic species already present (NPS 2006). Policy directs the NPS to minimize human impacts on native plants and animals with respect to their populations, the communities and ecosystems in which they live, and the natural processes which they influence. Thus, whenever possible, NPS managers should rely on natural processes to maintain native plant and animal species, and to influence natural fluctuations in populations of these species. Furthermore, managers should prevent the introduction of exotic species and develop plans to manage these species where they are already established.

The USDI has codified and amended policies and procedures for compliance with NEPA (73 Federal Register 61292-61323).

Natural Resource Management Reference Manual #77 offers comprehensive guidance to National Park Service employees responsible for managing, conserving, and protecting the natural resources found in National Park System units. This Reference Manual interprets USDI and NPS policies pertaining to management of natural resources, including wildlife and non-native species.

**1.7 Park Planning and Other Policies and Plans**
Park planning is conducted primarily through Strategic Plans and project planning documents. The Master Plan of 1974 and Statement for Management in 1991 for Yellowstone National Park guide application of the NPS Management Policies 2006 (NPS 2006). These directives require the protection of ecological processes and native species in a relatively undisturbed environment.

The projected process was to begin vaccinating all eligible bison captured at the park boundary that would be subsequently released. This action would be followed by remote vaccination of untested, eligible bison outside the park in the western boundary area to assess the effectiveness of this delivery method. Finally, all eligible bison inside and outside Yellowstone National Park would be vaccinated to reach a whole-herd vaccination goal.

Though implementation of the IBMP has greatly reduced the risk of brucellosis transmission from bison to cattle (Kilpatrick et al. 2009), there is no evidence that it has contributed to a reduction in brucellosis exposure or infection within the bison population

(Hobbs et al. 2009).

**1.8 Appropriate Park Uses**
More information on the definition of unacceptable impacts as cited in §1.4.7.1 of Management Policies (NPS 2006) can be found in Chapter 4—Environmental Consequences.

**Table 1. Relationships to other plans and documents**

**[NOTE: Table 1 CONTAINS DATED, MISLEADING INFORMATION ON MONTANA FWP'S BISON QUARANTINE DECISION: "**Decision Notice in March of 2009 authorizing translocation and release of 41 disease-free Yellowstone bison to the Northern Arapaho Nation of the Wind River Reservation in Wyoming." The transfer of quarantined buffalo to the Wind River reservation never happened. NPS does not include Montana Fish, Wildlife & Parks' decision to instead give 3 of 4 quarantined buffalo offspring to Ted Turner Enterprises in exchange for quarantining buffalo for five years on Turner's ranch. BFC filed suit to overturn Montana FWP's decision: http://www.buffalofieldcampaign.org/legal/quarantinelawsuit.html]

The remote vaccination of eligible bison is consistent with existing plans and policies. Vaccination as a management tool was established in the IBMP as a means to reduce the risk of brucellosis transmission among bison. While NPS policy does not specifically mention vaccination, it does allow for "animal population management."

The development of effective vaccines and the use of mass immunization has been a successful approach in combating infectious diseases of humans and domestic animals (Pastoret et al. 2007). Thus, there is no reason to think that immunization of wild animals could not be effective at controlling the spread of infectious diseases if appropriate vaccines are available and can be delivered to the populations in need (Wobeser 2002). Many of the strategies used to manage wildlife diseases are complicated because it is impractical to capture and treat all individuals of a population. Therefore, management of wildlife diseases is limited to those infectious diseases that are zoonotic (e.g., those that can affect humans and their domestic animals) in nature.

By meeting the requirements of the IBMP, this action is also consistent with NPS Management Policies (2006, Chapter 1.6).

The IBMP noted that the NPS would implement an in-park vaccination program for bison and, in turn, the state of Montana would be more flexible in allowing an expansion of the conservation area to include the Horse Butte peninsula west of Yellowstone National Park and the Gardiner Basin to the north.

Therefore, remote vaccination is consistent with applicable laws and policies and the IBMP, and the public interest is served by maintaining a wild, free ranging bison herd. Costs for vaccination were previously analyzed in the FEIS for the IBMP and further impact analysis is disclosed in this EIS. Thus, the NPS finds that remote delivery vaccination for bison is an appropriate use at Yellowstone National Park.

***1.10.1 Yellowstone Bison Population***
The effectiveness of strain RB51 (SRB51) vaccine against field strain *B. abortus* is not conclusive and mixed results have been reported by various research projects. The USDA–Agricultural Research Service has published results of research showing that only 15% of vaccinated bison aborted pregnancies when experimentally challenged by a virulent strain of *B. abortus*, while 62% of non-vaccinates aborted their pregnancies (Olsen et al. 2003). Conversely, experiments conducted by Texas A&M University concluded that vaccination with SRB51 provides no protection from aborted pregnancies (Elzer et al. 2000). The results are not comparable because methods were not consistent. However, the Scientific Advisory Subcommittee on Brucellosis United States Animal Health Association, which includes the authors of these two disparate studies, has reviewed these studies and concluded in 2008 that experimental data for hand vaccination of bison with Strain RB51 suggests a 50-60% reduction in abortions, 45-55% reduction in infection of uterine or mammary tissues, and a 10-15% reduction in infection. Furthermore, the Subcommittee concluded that currently available data suggests remote delivery induces protection that is less than hand vaccination.

***1.10.4 Ethnographic Resources***
The National Historic Preservation Act of 1966, as amended, NEPA, the 1916 Organic Act, the NPS Management Policies 2006 (NPS 2006), and other NPS guidelines require consideration of impacts to cultural resources. Proposed project undertakings have the potential to affect ethnographic resources. Yellowstone National Park regularly consults with 26 associated American Indian tribes that consider bison culturally significant to their heritage. An additional 83 tribes have attended some consultations and stated to park officials that they also consider bison a significant part of their culture.

***1.10.5 Human Health and Safety***
It takes about 21 days for SRB51 vaccine to clear an animal's system. Thus, meat from animals vaccinated with SRB51 should not be consumed at least until after this time period has elapsed.

***1.10.6 Visitor Use and Experience***
Some visitors may hold deeply rooted values that management actions to manipulate wildlife in national parks should not be undertaken. Therefore, vaccination activities could impact visitor experience.

**1.11 Topics Dismissed from Further Consideration**

***1.11.2 Socio-economics***
Total visitor spending in 2006 within 150 miles of Yellowstone National Park was estimated at $271 million, which supported approximately 4,952 full and part-time jobs and generated $336 million in combined visitor and workforce sales, $133 million in labor income (e.g., wages, salaries, payroll benefits), and $201 million in value added (e.g., labor income plus profits, rents, and sales and

excise taxes; Stynes 2008). Over 90% of visitors indicated that Yellowstone National Park was the primary reason for their trip to the area (Stynes 2008).

The actions described in this EIS for remote vaccination delivery to Yellowstone bison are unlikely to reduce the seroprevalence of brucellosis in wildlife sufficiently (i.e., near zero) to alter the perceptions of livestock operators, producers, and regulators regarding the risk of brucellosis transmission to cattle from wildlife. For bison, it is unlikely that the remote delivery vaccination actions will reduce the seroprevalence of brucellosis from current levels of 40-60% to below 16% (see Chapter 4, Impacts to Yellowstone Bison). Even if that were to be achieved, the State of Montana and the livestock industry are currently concerned about single-digit seropositive values in elk populations managed by the state—which are not under consideration in this EIS for vaccination—due to apparent brucellosis transmission from elk to cattle during 2007 and 2008. Thus, brucellosis will remain a concern for the livestock industry regardless of the outcome of a remote delivery vaccination program for Yellowstone bison and, thus, such a program would likely have negligible impacts on social and economic factors affecting the livestock industry.

Further, it is unlikely these massive animals would be well tolerated in most areas outside Yellowstone National Park even if they were disease-free due to social and political barriers such as human safety concerns (e.g., motorists), conflicts with private landowners (e.g., property damage), depredation of agricultural crops (grass for livestock), competition with livestock grazing, lack of local public support, and lack of funds for state management (Boyd 2003, Plumb et al. 2009).

***1.11.8 Indian Trust Resources***
Indian trust resources are land, water, minerals, timber, or other natural resources that are held in trust by the United States for the benefit of an Indian tribe or individual tribal member.

In the 2000 FEIS, the National Park Service concluded that, though the bison in Yellowstone National Park are significant to many tribes, they are not a trust resource that would trigger a federal trust responsibility. Thus, the National Park Service does not consider the bison in Yellowstone National Park a trust resource to manage for one or more specific tribes, and as such, trust resources will be affected by the alternatives.

**2. Chapter 2: Alternatives**

**2.1 Introduction**
Second, an effective vaccination program requires that all possible routes of re-infection be evaluated, treated, or effectively separated from the vaccinated population. The potential for elk to maintain the disease and re-infect susceptible bison cannot be disregarded.

**2.2 Actions Common to All Alternatives**

***2.2.1 Animal Health, Welfare, and the Conservation of Wildlife***
All of the alternatives considered would include the principles of adequate veterinary oversight or collaboration, detailed record keeping and documentation, and limiting animal discomfort, distress, or pain to short-term effects.While most aspects of these alternatives would be considered management actions that require field studies during implementation, any research components will adhere to the Animal Welfare Act (USDA 2002).

***2.2.2 Surveillance Plan (Monitoring the Effects and Effectiveness of Vaccination)***
The NPS may mark vaccinated animals via biobullet or paint-ball gun during remote delivery operations and via pit tags implanted subcutaneously under the shoulder blades posterior to the withers during syringe delivery vaccination at capture facilities or field immobilization. This marking will reduce the potential for multiple vaccinations of individuals within a season and contribute to effective surveillance of effects and effectiveness. Ebinger and Cross (2008) suggested that capture and sampling of more than 200 bison during a given year would be necessary to detect significant changes in seroprevalence following vaccination, and that detection would likely take 5-20 years depending on sample sizes and detection method. Thus, as necessary, NPS staff may also capture bison in the Stephens Creek capture facility or dart them with immobilizing drugs to sample their serostatus for brucellosis. The NPS may also request that the State of Montana and Forest Service capture and sample bison at the Duck Creek capture facility outside the western boundary of Yellowstone National Park north of West Yellowstone, Montana per the 2000 ROD for the IBMP and adaptive management actions thereafter (USDI and USDA 2000b, USDI et al. 2008). These captures could occur during hazing operations, with the ultimate release of animals or possible shipment to slaughter of bison testing positive for brucellosis.

**2.3 Actions Common to All Remote Vaccination Alternatives**

***2.3.1 Low Risk and Effective Remote Delivery System***
A system that is low risk for humans is one that does not create unnecessary exposure to the vaccine that could cause humans to become infected with brucellosis. Brucellosis vaccines are characterized as modified live vaccines which have a greater risk of infection by human handlers if appropriate precautions are not taken. Stringent handling protocols have been developed to address safety concerns and minimize risk to humans from handling *B. abortus* vaccine while implementing the vaccination program. The delivery system would not create behavioral changes in the bison population that put visitors and employees at risk of direct injury from bison.

***2.3.2 Frequency, Location, and Method of Remote Delivery Operations***
Vaccination of bison will occur during mid-September through November and, if necessary, March through May at widespread locations in the park (Figure 4).

Two approaches that could be used at vaccination sites are (1) advancing toward bison and vaccinating as the group is moving on the landscape, or (2) finding a location to vaccinate animals as they pass by a delivery team. Bison groups may respond to vaccination by moving away from park staff if several bison struck by the biobullet become agitated. Thus, it will likely take multiple days to vaccinate eligible bison within a given group.

***2.3.3 Adaptive Management***
Adaptive management is most effective in controllable situations where the relationship between monitored conditions and management actions is clear.

Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. In fact, ecosystem management requires adaptive management as its method of implementation because complex system components and processes are constantly changing and, as a result, there is substantial uncertainty regarding how systems will respond to disturbances (Ruhl 2005).

This NEPA analysis provides a summary of environmental conditions and defines goals for the proposed action. Adaptive management will facilitate reaching these goals by effectively linking surveillance and assessment to objective-driven decision making (Williams et al. 2007). The surveillance program (Appendix H) will provide timely and useful information to federal and state decision-makers from the IBMP partner agencies. This information will be used by managers to determine what, if any, additional actions are needed to conserve bison, reduce the risk of brucellosis transmission from Yellowstone bison to cattle, and reduce the prevalence of brucellosis in the population. System responses to these management actions will then be tracked through continuation of surveillance (Williams et al. 2007). In addition, results from the surveillance program and other research will be used to assess whether new information, vaccines, methods of vaccination delivery, and diagnostics could result in more efficient methods for meeting the purpose and needs of the project (U.S. Animal Health Association 2006).

The boundaries of adaptive management for the proposed action will be limited to changes described within the alternatives of this EIS analysis. Examples of actions related to the vaccination of bison that may be triggered based on information collected during surveillance include:
· Deciding whether to implement remote vaccination based on assessments in controlled environments (e.g., quarantine, captive facilities) of the level of protective immune response following vaccination.
· Deciding whether to continue remote vaccination based on vaccine efficacy, the adequacy of delivery options to obtain the desired reductions in seroprevalence and infection, and the development or validation of improved disease testing to distinguish vaccinates from non-vaccinates.
· Considering alternate vaccines if new lower risk, and more effective, vaccines than SRB51 are developed and tested for bison.
· Considering alternate forms of vaccine delivery that are deemed effective, feasible, and low risk, if surveillance indicates that remote delivery vaccination via biobullets is not inducing a protective immune response in enough eligible bison to eventually achieve our desired outcome (i.e., a 50% decrease in brucellosis seroprevalence).
· Increasing the frequency of vaccination of eligible bison if assessments of the duration of immune protection (i.e., immunological memory) indicate individual bison need to be re-vaccinated to maintain a protective immune response through their lives.
· Discontinuing vaccination in its implemented form if there is no indication of progress (i.e., decrease in seroprevalence and infection in non-reproductive age classes) within 15-20 years, which is the approximate amount of time that may be required to determine how well the goals and objectives are met by the selected alternative (Ebinger and Cross 2008, Appendix I).
· Discontinuing remote delivery vaccination if a minimum level of vaccine delivery (e.g., >50% of eligibles vaccinated) cannot be maintained on an annual basis.

The NPS will document that adaptive management adjustments, both individually and cumulatively, are (1) within the range of management options described for the selected alternative, (2) fully analyzed in the environmental effects section of this NEPA analysis, and (3) do not alter the basic management direction or goals in the original decision (73 Federal Register61292-61323). The NPS will also provide periodic updates on the real impacts of agency actions after the selected alternative is implemented, compared to the expected results. In addition, the NPS will make adaptive management adjustments transparent and accountable to the public, legislatures, and courts by periodically (1) soliciting public comment on adaptive adjustments for consideration by decision-makers, (2) posting surveillance reports on the park’s website, (3) holding public information meetings, (4) publishing scientific and other articles and (5) conducting any other necessary analysis

**2.4 Alternatives Considered**

***2.4.1 Alternative A—No Action***
No in-park, remote-delivery vaccination operations occur under the no action alternative. The Stephens Creek capture facility would continue to be the only location in the park where bison are vaccinated (USDI and USDA 2000a).
Currently, only calves and yearlings are vaccinated.

The vaccine SRB51 has been studied extensively as a candidate vaccine and found to be low risk for bison (Wallen and Gray 2003). Yellowstone National Park subsequently moved forward with a decision to use this vaccine for purposes of vaccinating bison in the park.While *B. abortus* vaccine SRB51 is licensed for cattle, it has never gained label approval for bison. Thus, the NPS requested and received an experimental use permit from Animal and Plant Health Inspection Service to conduct the vaccination program within the boundaries of Yellowstone National Park. NPS staff also requested and received letters of permission from the State Veterinarians of Montana and Wyoming to ship an unlicensed biological product (i.e., SRB51) for experimental study and evaluation.

The NPS estimates that fewer than 500 doses of *B. abortus* Vaccine, SRB51, Live Culture, Code 1261.00 (licensed product for use in cattle prepared by Colorado Serum Company) will be used each year.

***2.4.2 Alternative B—Remote-Delivery Vaccination for Young Bison Only***
Alternative B would expand the current vaccination program described in Alternative A to include remote delivery of vaccine to young bison throughout Yellowstone National Park.

A biobullet, when delivered to muscle tissue, dispenses the vaccine product within a few hours and the casing is dissolved by muscle tissue fluids in 12 to 24 hours.Minimal tissue damage occurred when biobullets were delivered to large muscle masses of cattle at distances of 6 meters (Morgan et al. 2004).

Delivering vaccine to bison without capture and handling requires repeatedly approaching them to relatively close distances—a difficult task—and having equipment that can effectively and safely deliver the vaccine. These tasks require patience and experience working in close proximity to wild bison.

In Alternative B, calves (both sexes) and yearling females would remain the focal targets for delivery just as under current implementation (i.e., Alternative A). Vaccination of calves and yearlings could occur during mid-September through November and March through May. This timing would avoid aggressive, rutting bison in large groups during the late-summer months. Also, periods of extremely cold temperatures would be avoided to minimize stress to bison during winter when energy conservation is vital.

Distance of approach would be contingent on the behavioral response of bison. Approach to close distance (less than 30 meters) is generally possible during all times of the year.

If advantageous and suitable sites for a fixed location delivery exist nearby, a portion of the team may relocate to the fixed location while the remaining team members provide low levels of pressure to move bison toward the delivery team waiting at the fixed location.

***2.4.3 Alternative C—Remote-Delivery Vaccination for Young Bison and Adult Females***
Alternative C would expand the current vaccination program described in Alternative A to include remote delivery of vaccine to calves (both sexes) and adult and yearling females throughout Yellowstone National Park.

This alternative differs by including adult female bison in the remote vaccination program. Thus, more bison would be vaccinated annually under Alternative C than under Alternative B.

After a blanket of snow covers the ground, bison seem to exhibit more tolerance to human approach. Delivery would focus on a period from mid-September through November, but avoid delivery to adult females during the third trimester of pregnancy (mid-January through May) when some research suggests vaccine-induced abortions could occur (Palmer et al. 1996). Periods of extremely cold temperatures would be avoided to minimize stress to bison during difficult time periods during winter when energy conservation is important.

**2.5 Mitigation Common to All Action Alternatives (B and C)**

The following mitigation measures will be implemented as part of Alternatives B and C:

· Staff conducting remote delivery operations will move about the landscape in a deliberate, controlled manner to provide other wildlife species the opportunity to acknowledge their presence in advance and react by either adjusting their location or choosing to tolerate the human presence in their habitat.
· The remote delivery projectiles are manufactured and encapsulated in a laboratory so field personnel do not handle the live vaccine. The projectiles are small in size and unlikely to be detected on or in the ground by humans if the projectile does not penetrate the targeted bison. These projectile casings dissolve in liquid and the vaccine is rendered inert through exposure to ultraviolet light and warm temperatures.
· The direct and indirect effects resulting from the trauma of remote vaccination could potentially be mitigated by remotely vaccinating bison during autumn when animals are in prime condition, and spring when bison have access to highly nutritious forage. Autumn vaccination would coincide with early gestation making vaccine-induced abortions unlikely. Also, forage of high nutritional value would be beneficial for fighting infections and repairing damaged tissue.
· Knowing the effective range of the biobullet delivery system and consistently delivering vaccine from within this range will limit injury and potential indirect effects.
· Monitoring marked bison groups (e.g., with radio-telemetry collars) that have been remotely vaccinated to determine the effects of vaccination on vital rates (e.g., survival, pregnancy) and the effectiveness of vaccination (e.g., duration of immunity) will help determine the safety and efficacy of the program.
· Using slow and deliberate movements when approaching groups of bison and observing group behavior to determine when to deliver vaccine to additional individuals should help keep bison groups calm while delivery crews are working around them.
· The direct and indirect effects of remote vaccination on bison group tolerance could be mitigated by having two distinct vaccination seasons (i.e., autumn and spring). This strategy would reduce interaction time with each group (as compared to all vaccinations during one time period) and the probability of unacceptable disturbances to bison during field vaccination operations.
· Intensive training and selection of field staff with good understanding of equipment will reduce the probability of poor shot placement.
· Manufacture of vaccine packages in clean, controlled laboratories will ensure vaccine projectiles will not carry non-*Brucella* bacteria during vaccine delivery.
· Stainless steel remote delivery equipment, sealed vaccine projectiles, and radiated clips ensure safest delivery of vaccine for bison to minimize any probability of infection at the injection site.
· All firearms are equipped with trigger guards and safety switches to prevent accidental discharge.

· Equipment is routinely cleaned and inspected to prevent accidental misfire or jamming of the moving parts while a vaccine projectile is chambered.
· Monitoring a group of vaccinated adult females will help determine the probability of vaccine-induced abortions in bison. This data will be used to evaluate the uncertain conclusions provided by Palmer et al. (1996).
· Interpretive staff may be used to explain to visitors witnessing remote delivery operations that approaching closer than the recommended distance of 25 yards is necessary and allowable only for trained staff to accomplish effective vaccination.
· The NPS will notify state wildlife agencies and tribes of forthcoming vaccination efforts through established working groups and communications networks so that hunters can be warned not to consume the meat of a bison killed within 21 days of being vaccinated.
· The NPS may mark vaccinated animals via biobullet or paint-ball gun during remote delivery operations and via pit tags implanted subcutaneously under the shoulder blades posterior to the withers during syringe delivery vaccination at capture facilities or field immobilization to reduce the potential for multiple vaccinations of individuals within a season.
· NPS staff conducting remote delivery vaccination will avoid working near wolf dens or locations where grizzly bears are known to be active. NPS staff will also avoid locations with ungulate carcasses that may be used by grizzly bears or wolves.

**2.6 Alternatives Considered But Eliminated From Further Consideration**
Unfortunately, serological tests for *Brucella* antibodies cannot distinguish between animals that have been exposed or infected with field strain brucellosis and those which have been vaccinated with Strain 19 (Cheville et al. 1998). Strain 19 vaccine was removed from the market by 1996 and replaced with the brucellosis vaccine SRB51 because the newer vaccine does not react to the serological tests used to monitor animal populations for brucellosis. Therefore, this alternative was eliminated from further consideration.

***2.6.2 Low Risk and Effective Delivery System that Results in Permanent Changes in Behavior or Demography***
Aerial delivery of a low risk and effective vaccine using remote delivery equipment was considered and rejected because it would likely result in a detectable change in bison behavior and/or demography (e.g., survival).

Aerial pursuit would likely disrupt the social behavior of bison by causing them to run and then chasing animals for some distance; possibly into locations they would not normally use. Aerial pursuit could also result in injuries or even death if animals tripped and fell while running or encountered obstacles to escape. The NPS does not intend to conduct extensive capture operations inside the park to handle most individual bison and deliver vaccine because “extensive capture operations, as well as confinement to the park, might detract from the wild free-ranging qualities of the bison population” and “could have a major adverse impact on the distribution of bison” (USDI and USDA 2000a: 415; see also 421-422).

Herding bison en masse into corrals and vaccinating them by direct contact using syringes was rejected because it would necessitate the repeated capture, temporary confinement, and handling of the whole population. This repeated and direct hands-on contact between humans and bison is in conflict with NPS management principles to minimize human intervention to native populations and the processes that sustain them.

There could also be unintended consequences to the free-ranging nature of the bison population (i.e., long-term changes in bison behavior). The 2000 ROD for the IBMP and park policy allows this approach for animals that have left the park and are captured at the Stephens Creek facility. However, the approach is contrary to the objectives of remote delivery to free-ranging animals. This type of strategy was analyzed and not selected in the 2000 FEIS that directed the IBMP.

Among currently feasible killed vaccines, DNA vaccines are promising. The basic principle of DNA vaccination is that plasmid DNA (pDNA) containing the gene of interest is delivered to tissue of the host. This stimulates an immune response in the host animal, including activation and proliferation of T-cells that kill intracellular pathogens, and production of antibodies that attack extracellular pathogens including many bacteria.

DNA vaccines have many advantages over earlier forms of live vaccines (Alarcon et al. 1999). Unlike attenuated live vaccines, DNA vaccines have few known side effects and cannot (1) revert to virulence through mutation because they are not living organisms, nor (2) shed from carriers. DNA vaccines induce broad protective immune responses, activating both humoral and cell mediated components of the immune system. DNA vaccines are inexpensive, easy to produce and, because they are stable, do not require refrigeration. Therefore, they are much easier to maintain and distribute than conventional vaccines. The goal of developing a low risk and effective DNA or other type of killed vaccine for brucellosis in wildlife seems attainable, but the technology is still being developed. Also, any candidate vaccine must undergo research in large mammal studies before it would be available and considered for use on Yellowstone bison. Thus, the killed vaccine alternative was eliminated from further consideration because the technology is not ready for implementation. The NPS may reconsider this alternative when scientists develop a killed vaccine that induces protective levels of cell-mediated and mucosal immunity in bison, as well as an effective delivery mechanism.

Oral and aerosol remote delivery mechanisms were considered, but rejected, due to the uncertainty regarding their effectiveness to deliver a consistent recommended dosage to a target population. In addition, the use of darts containing live *B. abortus* vaccine was considered but determined not feasible because of the liability of lost darts left about the landscape. Therefore, this alternative was eliminated from further consideration because it did not meet the objective of delivering a vaccine using a low risk or effective delivery system.

**2.7 Environmentally Preferred Alternative**
NPS policy (NPS 2006) requires that an EIS identify the environmentally preferred alternative as defined by the Council of Environmental Quality (Section 101[b], 42 USC 4331). These regulations and guidelines describe the environmentally preferred alternative as the one which best meets six criteria or objectives defined by the Council of Environmental Quality:

· Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
· Ensure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings.
· Attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences.
· Preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice.
· Achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life’s amenities.
· Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

NPS staff qualitatively assessed how well each alternative met these criteria and concluded that Alternative C was the environmentally preferred alternative based on the rationale in the following paragraphs.

Each alternative addresses the concerns of NPS management to protect the Yellowstone bison from the effects of infection by the non-native bacteria, *B. abortus*, which was introduced to the local environment nearly 100 years ago by domestic livestock.

Alternative C provides the greatest intent to achieve a balance between population and resource use. This alternative best meets the objective of reducing brucellosis prevalence in the Yellowstone bison population, while indirectly reducing the tension between the NPS and State of Montana staff regarding management philosophies and other related issues.

A reduced probability of individual bison being infected and occupying habitat outside the park provides greater balance for preserving the bison population and easing the concerns of Montana citizens regarding standards of living for agricultural industry workers.

The following is a list of additional tasks that will need to be completed to implement the project once an alternative has been selected, documented in a Record of Decision, and the preliminary design has been initiated:
· Application to and receipt of a permit from Animal and Plant Health Inspection Service, Center for Veterinary Biologics, to package vaccine and deliver vaccine in a manner that is different than that described by the label on the vaccine product.
· Develop a cooperative agreement with industries that manufacture remote delivery products and those that manufacture vaccine to design methods for packaging and procurement of products that can be used in a remote vaccination program.
· Conduct or review the findings of experiments in controlled environments (e.g., quarantine, captive facilities) to determine the strength and duration of the protective immune responses in bison following syringe delivery vaccination with SRB51 or new vaccines.
· Conduct or review the findings of experiments in controlled environments to determine the strength and duration of protective immune responses in bison following remote delivery (e.g., biobullet) vaccination with SRB51 or new vaccines.
· Conduct field trials to determine the strength and duration of protective immune responses in bison following remote delivery vaccination with SRB51 or new vaccines.

**3. Chapter 3: Affected Environment**

**3.2 Yellowstone Bison Population**
The gregarious nature of bison results in continuous opportunities for groups to encounter other groups. The dynamics of group cohesiveness are little understood, but their social order requires that they manage many relationships through their lives.

Not only does competition play a role in the social dynamics of the group, but there is evidence of attraction, rejection, and cooperation both within and between the sexes. These interactions appear to drive group sizes and the individual makeup of these groups. Following courtship, the mature males separate and spend the rest of the year alone or in small groups. The rest of the population disperses into groups dominated by adult females.

**3.3 *Brucella abortus* in Wildlife of the Greater Yellowstone Ecosystem**
Ninety percent of bovine fetuses experimentally placed in various habitats within the southern GYE from February to March were scavenged and disappeared within four days (Cook 1999). Aune et al. (2007) observed similar results in experiments conducted in the northern GYE. Predation and scavenging by carnivores likely decontaminates the local environment of infectious *B. abortus* (Cheville et al. 1998). Brucellosis has been detected in black bears and grizzly bears in the GYE, though the extent of infection in the population is unknown (Cheville et al. 1998).

**3.4 *Brucella abortus* in Cattle of the Greater Yellowstone Ecosystem**
. . . several cases of brucellosis exposure in cattle were detected in Montana and Wyoming during 2007 and 2008. Transmission in each case was attributed to free-ranging elk, not bison. As a result, Montana lost its class-free brucellosis status in 2008 and livestock producers have incurred increased testing costs and marketing complications to verify that livestock are brucellosis-free.

**3.5 Other Wildlife**
Large carnivores in the park include grizzly bears, black bears (*Ursus americanus*), mountain lions (*Puma concolor*), and wolves. Coyotes (*Canis latrans*) are also abundant in the park. Predation on bison by grizzly bears is rare, but some bears prey more on bison than others (Varley and Gunther 2002, Wyman 2002). Elk are the primary prey for wolves in the park because they are more abundant and easier to kill than bison (Smith et al. 2004). However, wolves are known to focus on bison calves during winter (Jaffe 2001, Smith et al. 2000).

Many species of mammals, birds, and insects that scavenge bison carcasses may be affected by a vaccination program for bison.

Besides the large predators already discussed, eagles (two species), ravens, magpies, and many other species of smaller perching birds along with coyotes, red foxes (*Vulpes vulpes*), badgers (*Taxidea taxus*), and numerous carnivorous insects are likely to scavenge on bison carcasses.

***3.6.1 Canada lynx***

The Distinct Population Segment of lynx in the contiguous United States was listed as threatened under the Endangered Species Act in 2000 because existing regulatory mechanisms in Forest Service Land and Resource Management Plans were inadequate to protect lynx or lynx habitat (65 FR 16052). Critical habitat for lynx was designated in Yellowstone National Park and surrounding lands in southwestern Montana and northwestern Wyoming (Unit 5; 74 FR 8616).

. . . Canada Lynx Conservation and Assessment Strategy to gauge the effects of park projects on lynx. Under the strategy, projects that occur outside Lynx Analysis Units have no effects on lynx. Projects inside Lynx Analysis Units may affect lynx, but not adversely, if the location occurs (1) outside of lynx habitat, (2) in lynx habitat that is currently unsuitable for lynx foraging, or (3) in lynx foraging habitat but ample suitable habitat is otherwise available. We anticipate that few vaccination operations would occur in lynx habitat.

***3.6.2 Gray wolf***

Gray wolves were eliminated by humans from the northern Rocky Mountains by the 1930s. In 1978, the USFWS published a rule (43 FR 9607) listing them as endangered at the species level throughout the conterminous 48 States and Mexico (except for Minnesota where the gray wolf was reclassified to threatened).

On March 6, 2009, the Secretary of the Interior affirmed the decision by the U.S. Fish and Wildlife Service to remove gray wolves from the list of threatened and endangered species in the Northern Rocky Mountain states of Idaho and Montana, while wolves in Wyoming would remain an endangered species.

***3.6.3 Grizzly bear***

The GYE grizzly bear population is discrete from other grizzly populations, has markedly different genetic characteristics, and exists in a unique ecological setting where bears use terrestrial mammals as their primary source of nutrition (Mattson 1997, Miller and Waits 2003, 70 FR 69865).

As a result, the USFWS established a distinct population segment of the grizzly bear for the GYE and concurrently removed it from the Federal List of Endangered and Threatened Wildlife on April 30, 2007 (72 FR 14866). As part of this proposal, grizzly bear habitat security in the Primary Conservation Area, which includes Yellowstone National Park, is primarily achieved by managing motorized access which (1) minimizes human interaction and reduces potential grizzly bear mortality risk, (2) minimizes displacement from important habitat, (3) minimizes habituation to humans, and (4) provides habitat where energetic requirements can be met with limited disturbance from humans (70 FR 69867). To prevent habitat fragmentation and degradation, the number and levels of secure habitat, road densities, developed sites, and livestock allotments will not be allowed to deviate from 1998 baseline measures (70 FR 69882). On September 21, 2009, the U.S. District Court of Montana vacated the final rule designating the Yellowstone distinct population segment and removing the Yellowstone grizzly bear distinct population segment from the list of threatened species.

***3.6.4 Bald eagle***

The bald eagle management plan for the GYE achieved the goals set for establishing a stable bald eagle population in the park, with a total of 26 eaglets fledged from 34 active nests during 2005 and 2007 (McEneaney 2006, 2007). This is the highest number of fledged eaglets recorded to date in Yellowstone National Park and the increasing population trend indicates habitat is not presently limiting the growth of the population. Thus, the population has likely not yet reached carrying capacity and may continue to increase in the near future. . . The current ESA designation is delisted/recovered with a recovery plan calling for monitoring of their status every 5 years from 2008 to 2028.

***3.6.5 American peregrine falcon***

The USFWS has implemented a post-delisting monitoring plan pursuant to Section 4(g)(1) of the Endangered Species Act that requires monitoring peregrine falcons five times at three-year intervals beginning in 2003 and ending in 2015.Monitoring estimates from 2003 indicate territory occupancy, nest success, and productivity were above target values set in the monitoring plan and that the peregrine falcon population is secure and vital (71 FR 60563).
Peregrine falcons reside in Yellowstone National Park from April through October, nesting on large cliffs. The numbers of nesting pairs and fledglings in Yellowstone National Park steadily increased from zero in 1983, to 31 pairs and 50 fledglings in 2006, to 32 pairs and 47 fledglings in 2007 (McEneaney 2006, 2007).

***3.6.6 Wolverine***

The wolverine (*Gulo gulo*) is a wide-ranging mustelid that naturally exists at low densities throughout much of northern and western North America (Banci 1994).Wolverines are highly adapted to extreme cold and life in environments that have snow on the ground all or most of the year (Aubry et al. 2007). In the conterminous United States, these habitats are highly mountainous and occur at elevations above 8,000 feet (Copeland et al. 2007).Mature females reproduce infrequently, typically giving birth at three-year intervals (Persson et al. 2006). They excavate snow and have young in tunnels; they are sensitive to human disturbance during the period from February to May when young are born and travel little (Magoun and Copeland 1998).

Wolverines have been detected in the GYE, including along the eastern, northern, and southern portions of the park (Inman et al. 2007, Beauvais and Johnson 2004, Copeland et al. 2006). Wolverines have protected status in Washington, Oregon, California, Colorado, Idaho, and Wyoming (Banci 1994). In Montana, wolverines are classified as furbearers and trapper harvests are managed through a quota system that limits the number of individuals that can be taken. Trapping may be detrimental to the wolverine population in and near Yellowstone National Park because survival is substantially lower in trapped populations (Krebs et al. 2004).

***3.6.7 Pronghorn***
Pronghorn in Yellowstone National Park were identified as a Native Species of Special Concern by Yellowstone National Park because they have considerable biological and historical significance. This population was one of only a few not exterminated or decimated by the early 20th century and, as a result, was the source for re-establishing or supplementing populations throughout much of its range (Lee et al. 1994). These pronghorn express much of the genetic variation that was formerly widespread in the species, but no longer present elsewhere (Reat et al. 1999). Also, this population sustains one of only a few long-distance migrations by pronghorn that persist in the GYE (White et al. 2007).

There are serious concerns about the viability of Yellowstone pronghorn because low abundance (fewer than 300) and apparent isolation have increased their susceptibility to random, naturally occurring catastrophes (National Research Council 2002).

Along with these challenges, Yellowstone pronghorn share a 30-km2 winter range with thousands of other ungulates, including elk, bison, mule deer, and bighorn sheep that compete for forage. This large concentration of ungulates has reduced the density and productivity of big sagebrush (*Artemisia tridentata*), which was the staple winter food of pronghorn during 1930-1990 (Singer and Norland 1994, Singer and Renkin 1995).

***3.6.8 Trumpeter swan***
Trumpeter swans (*Cygnus buccinator*) were nearly extinct by 1900, but a small group of birds survived by remaining year-round in the vast wilderness of the GYE. This remnant population enabled the restoration of the species and today there are approximately 30,000 trumpeter swans in North America (USFWS 1998).

***3.6.9 American white pelican***
The American white pelican (*Pelecanus erythrorhynchos*) was identified by Yellowstone National Park as a Native Species of Special Concern because (1) nesting attempts decreased from more than 400 during the mid-1990s to 128 during 1999, and (2) Yellowstone National Park has the only current nesting colony of white pelicans in the national park system (McEneaney 2002). In 2007, a total of 427 pelicans nested and fledged 362 young, suggesting the subpopulation has recovered somewhat from the substantial decrease during the mid- to late-1990s.

The shallow-spawning Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*) is the main food for white pelicans in Yellowstone National Park. However, there are serious threats to this subspecies that could affect white pelicans, including interbreeding with introduced rainbow trout (*Oncorhynchus mykiss*), the illegal introduction of lake trout (*Salvelinus namaycush*) which prey upon cutthroat trout, and several outbreaks of whirling disease in major spawning tributaries.

**3.7 Ethnographic Resources**
The Great Plains and the northern Rocky Mountains of western Montana and Wyoming were part of the natural range of bison from prehistoric times. This region is also the homeland of various native peoples who hunted these ranging herds. Archeological evidence places the earliest human occupation in Yellowstone National Park at 11,000 years ago, though some tribes have said they occupied the lands much longer. No fewer than 10 tribes dwelled in the GYE during both historic and prehistoric times. Tribes whose traditional territory included portions of the Yellowstone Plateau include the Crow, Eastern Shoshone, Salish and Kootenai, Shoshone-Bannock, Blackfeet (see footnote 4 of Table 7), Nez Perce, Northern Arapaho, and Northern Cheyenne tribes. The GYE also contained important hunting grounds for many tribes.

A few tribes currently claim hunting rights within Yellowstone National Park, including the Shoshone-Bannock who roamed the western portion, the Crow who traversed the east, and some First Nations of Canada (Blackfoot, Blood, Piegan, and Assiniboine) who also hunted in the region.

Treaties between the U.S. government and various tribes allowed the use of lands within the GYE by the tribes. Prior to park creation in 1872, the areas now known as Yellowstone National Park, Gallatin National Forest, Bridger-Teton National Forest, and Shoshone National Forest were reserved for some Plains tribes. The land west of the Yellowstone River was used traditionally by the Blackfeet tribes (Piegan and Blood), land to the southeast was part of the historic Crow territory, and the lands near the upper Missouri River were a common hunting ground for the above-mentioned tribes as well as the Gros Ventre, Flathead, Upper Pend d'Oreille, Kootenai, and Nez Perce tribes according to the 1851 Treaty of Fort Laramie. Seventeen years later, the 1868 Fort Laramie Treaty removed many acres of GYE land from tribal control, but allowed hunting in unoccupied lands. Shoshone and Bannock treaties did not include reference to the Yellowstone area, yet they lived and hunted there until the end of the 19th century.

Bison were viewed as an earthly link to the spiritual world. For many tribes, bison represent power and strength. For example, the Shoshone have expressed that spiritual power is concentrated in the physical form of the bison.Many contemporary tribes maintain a spiritual connection with bison.

Resource types that have been identified by park-related tribes as traditionally important and, therefore, potentially ethnographic resources include bison, wickiups, and stone alignments. Some of the stone alignments identified in the park and nearby areas are the remains of drive lines used to hunt bison and bighorn sheep.

Tribal representatives have informed NPS managers about many issues that are important to them concerning bison management actions during government to government consultations:
· Respectful treatment of the bison, including allowing them to roam freely without fencing or disrespectful hazing.
· Occurrence of brucellosis among elk and other free-ranging animals.
· Vaccine contamination of meat for consumption and ceremonial purposes.
· Measures to keep bison and cattle apart to minimize cross-infection.

· Frequency and effectiveness of vaccination delivery.
· Potential for transmission of brucellosis to humans.
· Distribution of live, seronegative bison to tribes. The FEIS for the IBMP indicates the partner agencies support the distribution of live bison that have completed an approved quarantine protocol to American Indian tribes, areas of public land, national park units, wildlife refuges, and approved research programs.
· If bison are to be killed, it should be done in a respectful manner.
· Distribution of bison meat, skulls, and hides to tribes.
· Preservation of wickiups, stone alignments, and other cultural features associated with bison.
· Employment of tribal interns in bison management programs.

**3.8 Human Health and Safety**
Park handouts include warnings to visitors about approaching bison.

There have been no cases of human undulant fever (i.e., human brucellosis) in Wyoming or Idaho attributed to wildlife (Greater Yellowstone Interagency Brucellosis Committee 1997). In Montana, there have been two confirmed cases of hunters contracting undulant fever from elk (Greater Yellowstone Interagency Brucellosis Committee 1997), with the last confirmed case occurring in 1995 (Zanto 2005).

**3.9 Visitor Use and Experience**
The most common activities in the park were sightseeing/taking a scenic drive (96%) and viewing wildlife/bird watching (86%). Sightseeing/taking a scenic drive (59%) was the activity that was the primary reason for visiting the park (Manni et al. 2007).

Wildlife observation is one of the most popular activities for visitors to Yellowstone National Park. A survey of park visitors reported that wildlife observation was the most important activity during their visit, with 95% of respondents indicating participation in this activity (Duffield et al. 2000). Participation in wildlife observation exceeds participation for geyser viewing (87%), hiking (39%), bird watching (27%), camping (27%), and fishing (13%). Among park visitors in both the summer and winter surveys, about 50% said seeing bison was a reason for their trip (49% of resident summer visitors, 52% of nonresident summer visitors, and 54% of winter visitors). Furthermore, a portion of these respondents said they would not have made their trip to the park if bison had not been present (5% of resident summer visitors, 4% of nonresident summer visitors, and 7% of winter visitors; Duffield et al. 2000a, b).

About 90% of visitors surveyed during winter 2008 indicated the opportunity to observe bison was an important factor in their visit, and that they were satisfied with their experience and the management of bison (Freimund et al. 2009).

**4. Chapter 4: Environmental Consequences**

**4.1 Methods for Evaluating Impacts**
A period of 15-20 years of implementation and monitoring may be required to determine how well the goals and objectives may be met by the selected alternative (Ebinger and Cross 2008, Appendix I), though this time-period may be reduced if surveillance is focused on 2-3-year-old animals (White et al. 2008). During this period, the bison population should fluctuate in abundance between 2,500 and 4,500 individuals, visitation to the park should continue to increase, and separation between bison and cattle should be maintained pursuant to the IBMP and subsequent adaptive management adjustments (Plumb et al. 2009).

***4.1.1 Types of Impacts***
· *Beneficial impact*—a positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition.
· *Adverse impact*—a negative change in the condition or appearance of the resource or a change that moves the resource away from a desired condition.
· *Direct impact*—an effect that is caused by an action and occurs in the same time and place.
· *Indirect impact*—an effect caused by an action that is removed in time or distance from the action, but is still reasonably foreseeable.
· *Site-specific impact*—the action would affect relatively small areas within the park, centered on where the action takes place.
· *Local impact*—the action would affect areas within the park boundary.
· *Regional impact*—the action would affect resources in the park, on lands adjacent to the park, and in surrounding communities.
· *Short-term impact*—consequences of the action that are short in duration and not detectable after a resource returns to the pre-implementation condition.
· *Long-term impact*—consequences of the action that result in a lasting or nearly permanent change in resource conditions.

**4.2 Incomplete and Unavailable Information**
The current state of technology provides for a limited number of vaccines for use in brucellosis management. Likewise, there are limited options for delivery of the available vaccines. In addition, many of the current diagnostic tools have been extrapolated from livestock for use in wildlife without rigorous evaluation (Aune et al. 2002, U.S. Animal Health Association 2006).

Extensive literature review and discussion with subject area experts has revealed no progress on new vaccines, delivery technologies, or diagnostic tests to date due to the lack of market incentives and funding.We are not aware of any available test that conclusively or reliably detects active infection of *Brucella abortus* in live bison. Laboratory testing of DNA blood samples suggests that application of the PCR assay for *Brucella abortus* may be inaccurate and misleading in bison for detecting exposure or active infection, as results in bison have largely been negative (i.e., no positive DNA results compared to culture results indicating infection from the same animals; Roberto and Newby 2007).

. . . imperfect vaccines are often used to reduce the severity of disease or pathogen transmission potential. However, using less effective vaccines or delivering the vaccine to a relatively small proportion of the eligible animals can lead to adaptive changes in the disease pathogen that select for variants able to evade the immunological response induced by the vaccine. These vaccine-adapted variants can then spread in the population, reduce the efficiency of the vaccination program, and result in longer-term evolutionary changes in the host-pathogen association. To reduce these problems, highly efficient vaccines should be quickly delivered to a large proportion of the eligible animals to lead to disease suppression or eradication (Gandon et al. 2001, 2003; Andre et al. 2006).

In bison, the vaccine SRB51 is an imperfect vaccine that does not offer protection from B. abortus infection, but provides intermediate protection (~80%) from B. abortus transmission (Olsen et al. 2003). However, B. abortus has an effective life history strategy whereby the bacteria replicate when signaled by high levels of pregnancy hormones and hide within the cytoplasm of the lymph node cells during periods of inactivity. Also, the bacteria can evolve adaptive strategies to survive by evading antibody attacks and through genetic changes in their chemistry that lead to successful natural selection processes. These aspects of SRB51 and the life history of B. abortus may provide a selective advantage for bacteria whereby SRB51 vaccination becomes ineffective leading to an increase in transmission potential, stronger persistence within the bison host, and greater pathogenicity (i.e., virulence or degree of intensity of the disease produced by a pathogen). This potential adaptation of B. abortus to SRB51 could be exacerbated if delivery via remote vaccination is hampered due to logistics or bison behavior and only a relatively small proportion of the eligible females are vaccinated. The speed at which B. abortus can adapt to bison immune responses induced by SRB51 will depend on the genetic variation of B. abortus in Yellowstone's wildlife and the selection pressure from SRB51. Similar uncertainties exist for all vaccination programs and the surveillance program (Appendix H) and adaptive management process will be used to mitigate potential adverse effects.

Davis and Elzer (1999, 2002) concluded that SRB51 had little efficacy in adult and calf bison despite repeated vaccinations. In contrast, Olsen et al. (2003) reported that vaccination of bison calves offered protection against intra-mammary and fetal infection in non-aborting vaccinates, as well as protection from abortions and placental infection.

There are several other uncertainties regarding the effectiveness of vaccination for Yellowstone bison. Adequate diet quality is important for stimulating and maintaining immune system function. However, nearly all plants used as forage by large herbivores (e.g., bison) inhabiting temperate climates at high latitudes (e.g., Yellowstone National Park) are dormant during winter and, as a result, the nutritional value of winter diets cannot meet maintenance requirements (Hobbs et al. 1981). This sub-maintenance forage quality, combined with reduced forage availability and increased energetic costs due to snow pack (Parker and Robbins 1984, Wickstrom et al. 1984), results in chronic nutritional deprivation each winter and induces physiological changes and stress responses via hormone production. Stress can cause suppression of immune system function. Thus, delivery of vaccine to Yellowstone bison in late winter may be ineffective at inducing an effective immune response owing to their under-nourished and stressed condition. In turn, when bison are later challenged by natural exposure to B. abortus, the immune system may be unable to mount an effective response. The period of highest exposure to brucellosis in late winter likely coincides with the period of lowest immune competence in bison (ability of the immune system to respond appropriately to an antigen by producing and antibodies which will combat the foreign substance). Thus, late winter exposure to Brucella can be difficult for any animal to produce an effective immune response, regardless of whether they are vaccinated or not (see USAHA Scientific Committee response to questions about uncertainty below).

In contrast, the immunologic responses of bison to hydrogel vaccination with SRB51 during 2007 indicated poor proliferation and interferon response compared to syringe injection (Olsen 2008). We suspect these different results were due to differences in the photopolymerization process used to encapsulate vaccine in projectiles.

Experimental vaccine efficacy studies are difficult to compare with large-scale remote vaccination of Yellowstone bison because the virulence, infectious dose and delivery method of the pathogen is controlled to identify conditions where vaccine protection fails. These conditions may not be similar to what is experienced by free-ranging Yellowstone bison.

On October 25, 2008, during the 112th Meeting of the United States Animal Health Association, the Scientific Advisory Subcommittee on Brucellosis offered responses to six focal questions posed by staff from Yellowstone National Park regarding the vaccination of bison for brucellosis with SRB51. Subcommittee Chair Phillip Elzer summarized the subcommittee's comments in the following paragraphs, which were included in their report to the Committee on Brucellosis (Plumb and Barton 2008), recognizing that sufficient data is generally lacking to make specific recommendations. Subcommittee members were Don Davis, Phillip Elzer, Don Evans, Barb Martin, Steve Olsen, Jack Rhyan, and Gerhardt Schurig.

**4.3 Cumulative Impacts**
Federal regulations require an assessment of the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions (40 CFR 1508.7).

These cumulative impacts for each alternative were analyzed by combining the direct and indirect impacts of each impact topic with other past, present, and foreseeable future actions within Yellowstone National Park and conservation areas adjacent to the park in the State of Montana (USDI and USDA 2000b). Actions include any planning or development activity that was currently being implemented or would be implemented in the reasonably foreseeable future that (1) has some relation to bison populations and management, (2) impact the quantity, quality and access to bison habitat, and (3) would contribute to cumulative effects within the designated area of analysis for this EIS. These actions include:
· Agricultural Landscapes - Cattle grazing and supplemental irrigation of valley bottom private lands will continue.

**4.4 Impairment**
NPS managers must always seek ways to avoid or minimize adverse impacts on park resources and values to the greatest degree

practicable (NPS 2006). However, the laws give NPS managers some discretion to allow impacts to park resources and values when necessary and appropriate to fulfill the purposes of a park. This discretion is limited by statutory requirement that the NPS must leave park resources and values unimpaired unless a particular law directly and specifically provides otherwise. Impairment is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including opportunities that would otherwise be present for the enjoyment of those resources or values. Impairment may result from NPS activities related to managing the park, visitor activities, or activities undertaken by concessionaires, contractors, and others operating in the park.

An impact would more likely constitute impairment to the extent that it affects a resource or value whose conservation is:
· Necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park.
· Key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park.
· Identified as a goal in the park's Master Plan, General Management Plan, or other relevant NPS planning documents.

**4.5 Unacceptable Impacts**
The fundamental purpose of the NPS, established by the Organic Act and reaffirmed by the General Authorities Act, as amended, begins with a mandate to conserve park resources and values.
Impairment is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including opportunities that would otherwise be present for the enjoyment of those resources or values.

Unacceptable impacts would individually or cumulatively:
· Be inconsistent with a park's purposes or values.
· Impede the attainment of a park's desired future conditions for natural and cultural resources as identified through the park's planning process.
· Create an unsafe or unhealthy environment for visitors or employees.
· Diminish opportunities for current or future generations to enjoy, learn about, or be inspired by park resources or values.
· Interfere unreasonably with park programs or activities, result in an inappropriate use of the park, or alter the atmosphere of peace and tranquility by disturbing the natural soundscape.

***4.6.1 Impacts to the Yellowstone Bison Population***
The geographic area of analysis for the bison population includes habitats within and adjacent to Yellowstone National Park where bison are afforded habitat under the IBMP.

The thresholds of intensity used to describe the impacts of the proposed actions are as follows:
· *Negligible*—impacts would be slight to undetectable.
· *Minor*—impacts would be detectable, but only to a small portion of the population, and brucellosis prevalence would likely decrease by 5-10% below estimated baseline levels.
· *Moderate*—impacts would be detectable in a modest portion of the population, and brucellosis prevalence would likely decrease by 11-50% below estimated baseline levels.
· *Major*—impacts would be detectable throughout the population, and brucellosis prevalence would likely decrease by greater than 50% below estimated baseline levels.

***4.6.1.1 Impacts from Alternative A (No Action—Boundary Capture Pen Vaccination of Calves and Yearlings)***
During capture operations, bison congregated in the holding paddocks have the potential to become injured by running into facility walls or other bison, or by aggressive behavior toward other individuals. Injuries may include breaking horns on hard structures or being gored by other herd members. Also, intensive management operations often occur during winter months when bison energy reserves are low and snow conditions limit forage availability. Captured bison may be more susceptible to injury during mid- to late-winter because of decreases in their physical condition. Based on previous bison capture operations conducted at Stephens Creek, indirect, short-term, adverse, localized, minor impacts would result to bison from injuries during capture operations (i.e., moving, holding, and immobilizing).

Calf and yearling bison captured at the pens may be hand-injected with brucellosis vaccine. A common side effect from syringe delivery of vaccine is swelling at the injection site and lethargy for a day or two following vaccination (Goelz 2000).

Vaccine SRB51 is considered low risk for reproductively immature bison (Olsen et al. 1997, 1998; Davis and Elzer 2002). However, the duration of protection offered by SRB51 is uncertain and a single dose of SRB51 given to calves and yearlings is not expected to provide lifetime protection.

Also, holding bison in an enclosure increases the risk of brucellosis transmission if an abortion or infectious live birth occurs.

Thus, access to bison for syringe delivery of vaccine at the capture pens will be limited and model simulations suggest the number of vaccinated bison that receive protection from the vaccine would be less than 1% over a 30-year period. Even with a highly effective vaccine, the small proportion of bison vaccinated would likely have a minimal effect on reducing brucellosis infection in the population.

Model simulations for Alternative A estimated a reduction in brucellosis seroprevalence in the bison population from the initial state of about 47% to about 35% (i.e., about a 25% decrease [(1 – 35/47)*100]) over a 30-year period (Figure 10). This level of reduction offers a minor degree of protection from *Brucella*-induced abortions and, as a result, moderate levels of infectious events are expected to occur within the population over the 30-year simulation period.

Following brucellosis infection, 96% of bison females are expected to abort their first pregnancy (Olsen et al. 2003). Therefore, the disease may affect bison calving rates and, in turn, the rate of population growth (Fuller et al. 2007b, Geremia et al. 2009). The vaccine SRB51 is anticipated to partially protect bison from *Brucella*-induced abortions (Olsen and Holland 2003). Since model simulations demonstrate a small reduction in population seroprevalence under Alternative A (Figure 10), this level of reduction is likely to have a correspondingly small influence on bison calving rates and population growth.

The proximity of livestock operations in the region results in moderate to major, negative impacts to expansion of the conservation area for wild bison.

The effects of road grooming (i.e., packing snow-covered roads to facilitate this over-snow vehicle recreation) on bison distribution and movements in Yellowstone National Park have been intensely debated each winter since the 1970s.Meagher (1993, 1998) reported increased numbers of bison, coupled with cascading increases in distribution during 1983-1995, based on aerial survey data, observed trails, and ground observations. NPS staffs are not aware of any scientific authority that has reviewed or analyzed these data independently that does not concur with these findings. However, there is no consensus on the mechanism(s) that caused these changes in bison demography and spatial dynamics.Meagher (1993, 1998) proposed that groomed roads were the fundamental mechanism enabling these changes, with energy saved by bison traveling on packed snow, in combination with better access to foraging habitat, resulting in enhanced population growth and increased movements to boundary areas. Thus, she recommended prohibiting road grooming to reduce the number and rate of bison leaving the park and induce them to revert to their traditional (i.e., pre-road grooming) distributions (Meagher 2003).

Given these conclusions, winter recreation could contribute to adverse cumulative impacts at the short and long term, localized, negligible level.

Under Alternative A (No Action), direct and indirect, short-term, adverse, localized minor impacts from injuries in capture facilities would result. Direct, short-term, adverse, minor impacts from tissue trauma due to hand vaccination could result, as well as indirect, short-term, adverse, negligible impacts due to possible infection, increased predation, or injury from other bison.

***4.6.1.2 Impacts from Alternative B (Remote-Delivery Vaccination—Young Bison Only)***

Remote delivery systems are inherently complex and logistical and mechanical failures are inevitable (Kreeger 1997). Remote vaccine delivery causes a greater level of tissue damage and a higher probability of some bleeding at the injection site than syringe delivery due to differences in diameter of the delivery tools and location of delivery within muscle tissue.While wounds resulting from remote delivery methods have the potential to become infected, Morgan et al. (2004) reported no evidence of tissue damage beyond 20 days post-vaccination with bio-degradable projectiles and concluded that the injection site was completely healed by that time.

Herriges et al. (1989) reported a maximum of 0.2% mortality in elk remotely vaccinated on feed grounds in Wyoming. Under field conditions in Yellowstone National Park, rifle accuracy is expected to be lower than reported in controlled experiments (Roffe et al. 2002, Blanton et al. 2005).Wind, even at low velocity, can cause trajectories to miss the expected target unless the shooter can accurately adjust the point of aim. Also, bison will likely move during some shots as they maintain vigilance for predators, respond to the behavior of other bison in the group, and react to other stimuli.

Penetration of the skin is essential for the biobullet to function. Angus (1989) estimated that 30% of the animals in his study of ballistically vaccinated cattle failed to respond on serology tests because the implant did not penetrate the skin. Thus, some biobullets will likely fail to penetrate the skin of bison due to deflections and shattering of the projectile on impact with the animal (Kreeger 1997, Quist and Nettles 2003).

. . . Quist and Nettles (2003) reported that 7% of remotely delivered placebo vaccines generated visible signs of bleeding in young bison, only one of which was quite noticeable. Thus, few animals are expected to exhibit visible signs of bleeding or other injuries that cause abnormal behavior. However, relatively few necropsies have been conducted to evaluate potential injuries caused by biobullet projectiles, and some proportion of the animals will likely succumb to injury due to a variety of uncontrollable features (e.g., the projectile severing a sensitive nerve embedded within the muscle mass of the target). Therefore, direct, short-term, adverse, negligible to minor impacts from muscle tissue trauma resulting from remote vaccinations are expected. . . Also, while vaccinated young bison with biobullet related injuries may be at a higher risk of predation and aggressive interactions with fellow herd members, these impacts are expected to be short-term and not create an unacceptable risk of mortality. Therefore, indirect, short-term, adverse impacts such as infection, risk of predation, and injury inflicted by other herd members are expected to be negligible to minor in the population.

Model simulations estimated a decrease in seroprevalence from the initial state of about 47% to about 28% (i.e., a 40% decrease [(1 – 28/47)*100]) over a 30-year period, versus 35% for Alternative A (Figure 10).

Young bison remotely vaccinated are likely to exhibit a more adverse reaction to remote delivery methods than older animals. However, young bison are not the group leaders and it is unlikely that their reactions would cause the entire group to move away from field delivery crews. Park staff is proficient at approaching bison groups in a manner that minimizes flight behavior by the bison (Clarke et al. 2005). However, it is unknown precisely how bison will react to being struck by a remotely delivered bio-absorbable projectile. . . Park staff conducted over 100 field immobilizations of bison and reactions to immobilizing darts are generally mild.

The consistent pressure of being vaccinated by field crews may result in bison being difficult to approach and, consequently, lead to a reduced efficiency in delivering vaccine to target individuals. Therefore, remote vaccination via biobullet delivery has the potential to alter bison behavior in a way that could lead to the avoidance of people. There is no information on how bison will react to being vaccinated with this remote method.

Model simulations suggest that Alternative B would reduce seroprevalence by about 40% over a 30-year period, compared to a reduction of about 25% in Alternative A (Table 8). Consequently, Alternative B would result in fewer seropositive bison removed during boundary management operations than Alternative A which translates to the direct, long-term, beneficial moderate impacts of fewer seropositive bison shipped to slaughter.

***4.6.1.3 Impacts from Alternative C (Remote-Delivery Vaccination—Young Bison and Adult Females)***
Adult bison are expected to have a well developed immune system that can respond to potential infection resulting from remote delivery. They are also less likely to show visible signs of injury that may result in being selected by predators. In addition, older bison are less likely to be subordinates and, therefore, not prone to receiving aggressive treatments from other herd members.

Adult bison have shown mild initial reactions to being struck with immobilizing darts. Thus, similar reactions to remote vaccine delivery are expected.

Model simulations estimate the number of vaccinated bison in the population under Alternative C should increase from 0 to about 29% over a 30-year period (Figure 9).

Model simulations of the impacts of Alternative C estimate a potential decrease in seroprevalence from about 47% to about 16% (i.e., a 66% decrease [(1 – 16/47)*100]) over a 30-year period. The inclusion of remotely vaccinated adult females should result in a significantly larger reduction in seroprevalence (about 30 to 37% greater) compared to the other alternatives (Table 8).

Because Alternative C maximizes the number of bison that are vaccine protected, it results in the lowest potential for bison transmitting brucellosis to cattle outside the park.

The increase in population growth expected under Alternative C results from a moderate short-term, but major long-term, decrease in population seroprevalence. This decrease in seroprevalence also increases the management options available when it becomes necessary to remove bison that move to low-elevation winter ranges outside Yellowstone National Park. Removal of bison without having to ship animals to slaughter becomes a more likely option and would be a major beneficial impact to individuals of the population and may be of benefit to bison conservation in other places outside the park.

The reduction in the number of seropositive bison that are included in boundary removals is a major, direct, long-term, beneficial impact to bison conservation because seronegative bison have more socially acceptable options available for managers (e.g., quarantine; relocation to release sites) than do seropositive bison (e.g., slaughter, terminal quarantine).

***4.6.2 Other Wildlife, Including Threatened Species***
No modifications to wildlife habitats are proposed, so impacts of this nature were not analyzed. The thresholds of intensity used to describe the impacts of the proposed actions are as follows:
· *Negligible*—there would be no observable or measurable impacts to native species, their habitats, or the natural processes sustaining them. Impacts would be well within natural fluctuations.
· *Minor*—impacts would be detectable, but would not be outside the natural range of variability. Small changes to population numbers, population structure, genetic variability (determined
through study of DNA markers), and other demographic factors might occur. Occasional responses to disturbance by some individuals could be expected, but without interference to feeding, reproduction, or other factors affecting population levels. Impacts would be outside critical reproduction periods for sensitive native species.
· *Moderate*—impacts on native species, their habitats, or the natural processes sustaining them would be detectable and could be outside the natural range of variability. Changes to population numbers, population structure, genetic variability, and other demographic factors would occur, but species would remain stable and viable. Frequent responses to disturbance by some individuals could be expected, with some negative impacts to feeding, reproduction, or other factors affecting population level parameters. Some impacts might occur during critical periods of reproduction or in key habitat.
· *Major*—impacts on native species, their habitats, or the natural processes sustaining them would be detectable, outside the natural range of variability, and permanent. Population numbers, population structure, genetic variability, and other demographic factors might experience large decreases. Frequent responses to disturbance by some individuals would be expected, with negative impacts to feeding, reproduction, or other factors resulting in a decrease in population levels.

Individual animals may change their behavior (e.g., feeding, resting, traveling) in response to seeing and/or hearing humans in their habitat (Knight and Cole 1991, Knight and Gutzwiller 1995).

Vaccinated bison should mount a milder immune response to a pathogen than the responses observed in infected, naive individuals (Tizard 2004, Black 2005). Olsen et al. (1998, 1999) noted that bison will clear their system of vaccine SRB51 by 24 weeks after vaccination. The probability of remotely vaccinated bison dying within 24 weeks of becoming vaccinated is small. Therefore, carcasses of vaccinates would be less likely to be sources of infection than carcasses of field strain infected bison. There may be indirect impacts to other wildlife species that would occur from exposure to bacteria consumed during the act of preying or scavenging on a vaccinated bison. The impacts to a variety of species from exposure to vaccine SRB51 have been evaluated and found to create no clinical or population level mortality (Cook and Rhyan 2002; Table 9).

***4.6.2.1 Impacts from Alternative A (No Action—Boundary Capture Pen Vaccination of Calves and Yearlings)***
Direct impacts to federally listed species (Canada lynx, gray wolves, grizzly bears) are not expected because (1) vaccination of bison is unlikely to occur in lynx habitat or near wolf dens, (2) vaccination activities would likely result in only localized displacement of individual wolves, and (3) there should be no associated injury or mortality to lynx or wolves that consume carrion from bison

vaccinated with SRB51 (Appendix K).

Indirect impacts from vaccinated bison that are released from the holding facility and subsequently die within 24 weeks of vaccination are expected if those vaccinates still have vaccine strain *B. abortus* in their system. These individuals while few in number, would become possible vectors of exposure should predators or scavengers feed on the carcass before it becomes rotten. *Brucella abortus* has been isolated from wild carnivores (including grizzly bears, black bears, wolves, coyotes, and foxes) in areas where infected bison and elk are found (Tessaro 1986). Those predators consume infected elk and bison meat and subsequently mount natural immune responses to this type of natural exposure.

Carnivores may contribute to disease transmission by transporting infectious materials from one site to another, spreading bacteria across the landscape. However, predation and scavenging by carnivores also likely decontaminates the local environment because the concentration of bacteria would become diluted in the system and exhibit a greater probability of exposure to ultraviolet light which is a natural killer of bacteria (Cheville et al. 1998).

On private lands surrounding the park, agricultural operations, resorts, and nearby towns have resulted in the alteration of natural vegetation communities and processes. These types of habitat alterations have created moderate to major adverse impacts to the abundance of natural habitats for many wildlife species, while creating minor to moderate beneficial impacts to some species that are more tolerant of human activities (Fleischner 1994, Parmenter et al. 2003).

***4.6.2.2 Impacts from Alternative B (Remote-Delivery Vaccination—Young Bison Only)***
The impacts to other wildlife species from implementation of Alternative B would include those described for Alternative A, but would be greater in effect from a regional perspective because the area of vaccine distribution would be increased to most of the bison habitat throughout Yellowstone National Park. The likelihood that park staff conducting vaccination operations would create short-term disturbances to individual animals and groups would increase in frequency as remote vaccination operations occurred over a time period up to six months.

. . . the exposure threat to other wildlife species from eating the projectile would most likely be of lower impact than that from an encounter with a vaccinated bison carcass. The adverse impacts of this type of failure would be short-term, local, and negligible as a result of the short-term viability of the bacteria and the low probability that any wildlife species would eat the projectile.

. . . the literature describing experimental exposure to non-target wildlife overwhelmingly concluded that the vaccine does not create unacceptable clinical effects in those non-target species that were studied (Table 9).

***4.6.2.3 Impacts from Alternative C (Remote-Delivery Vaccination—Young Bison and Adult Females)***
***. . .*** The indirect impacts to other wildlife species from Alternative C would be exposure to the vaccine by encountering vaccine-infected bison that died, and by encountering (e.g., eating) missed doses of vaccine that were lost on the landscape.

The impacts associated with exposure to vaccine by other wildlife species under Alternative C may increase over those expected under Alternative B, primarily due to the greater risk of aborting a pregnancy by vaccinating adult female bison.

***4.6.3 Ethnographic Resources***
· *Negligible*—the impact would be at the lowest level of detection with neither adverse nor beneficial consequences.
· *Minor*—adverse impacts would be slight, but noticeable. The impacts would not appreciably alter the resource conditions, or access to the resource by affiliated tribal members, or impair traditional practices and beliefs. Beneficial impacts to the resource would be measurable and localized. The resource would be maintained and preserved in its natural state, access to the resource would be temporarily or slightly enhanced, or the qualities of the resource considered to be culturally important might be slightly enhanced.
· *Moderate*—adverse impacts would be apparent and would alter resource conditions or interfere with access to the resource by affiliated tribal members. The relationship between the resource and the beliefs and practices of affiliated groups may be altered, even though the practices and beliefs would survive. Beneficial impacts would be measurable and contribute to the qualities of the resource, access to the resource by affiliated tribal members, and the relationship between the resource and the beliefs and practices of affiliated groups.
· *Major*—adverse impacts would alter the conditions of the resource that are considered important, impair access to the resource by affiliated tribal members, or substantially alter the relationship between the resource and the practices and beliefs of the affiliated groups to the extent that the survival of those practices and beliefs would be jeopardized. The impacts would result in significant deterioration or destabilization of the condition or culturally valued elements of the resource. Beneficial impacts would be measurable and result in substantial improvement in the qualities of the resource, access to the resource by tribal members, or the relationship between the resource and the beliefs and practices of affiliated groups.

***4.6.3.1 Impacts from Alternative A (No Action—Boundary Capture Pen Vaccination of Calves and Yearlings)***
The impacts of vaccinating wild bison include intangible values that American Indian tribes hold regarding Yellowstone bison. These intangibles vary greatly between tribes and in some cases between members of the same tribe. Some American Indians have expressed that vaccinating bison is an unnecessary Anglo-American method for treating infected animals. Also, some American Indians would prefer to allow bison to roam outside the boundary of the park and heal themselves naturally by finding the right medicine in the plants of the earth. In addition, some American Indians believe that vaccination may contaminate bison for purposes of consuming the meat or using parts in their ceremonies. Furthermore, some American Indian tribes have expressed that vaccination programs will contaminate the spirit of the local bison.

They have stated that bison are being singled out and discriminated against because some individuals have brucellosis, while individuals of other wildlife species (e.g., elk) are also infected with brucellosis but not subjected to vaccination or other management actions similar to Yellowstone bison. Thus, some American Indians have expressed that Yellowstone bison are being discriminated against in the same manner that American Indians were treated during the colonization of this country, which resulted in decimated, localized populations of American Indians. Some American Indians have said that what happens to bison will always remain an indicator of the treatment of American Indians. They also state that the capturing and vaccinating of bison causes undue stress to the animals. While it is difficult to quantify, tribal concerns point to the possibility that vaccination may alter or impair traditional practices and beliefs, because some tribes consider vaccination disrespectful treatment of bison. Also, tribal treaty harvests by the Salish-Kootenai and Nez-Perce on unclaimed federal lands adjacent to the park may be adversely affected to a minor extent if some members believe that vaccination contaminates bison for purposes of consuming the meat or using parts in their ceremonies.

***4.6.3.2 Impacts from Alternative B (Remote-Delivery Vaccination—Young Bison Only)***
There may be greater access to disease-free bison for American Indian tribes because fewer seropositive individual bison would be sent to slaughter and, consequently, more seronegative bison would be eligible to enter quarantine and/or be relocated. Long-term beneficial impacts may occur if vaccination of bison is successful at reducing the proportion of brucellosis-infected bison.

***4.6.3.3 Impacts from Alternative C (Remote-Delivery Vaccination—Young Bison and Adult Females)***
The impacts of Alternative C would be similar to those described for Alternatives A and B, except that a larger proportion of bison would be vaccinated. The direct impacts that affect values about Yellowstone bison by some tribal members would be both short- and long-term, beneficial, moderate impacts to ethnographic resources regionally. Long-term beneficial impacts may occur at a greater scale than Alternative B if vaccination of bison is successful at reducing the proportion of brucellosis-infected bison.

***4.6.4 Human Health and Safety***
· *Negligible*—there would be no discernible effects to employee or visitor safety. Slight injuries could occur, but none would be reportable.
· *Minor*—any reported employee or visitor injury would require first aid that could be provided by park staff. Employee injuries would not involve lost work time.
· *Moderate*—any reported employee or visitor injury would require medical attention beyond what is available at the park. Employee injuries would result in lost work time.
· *Major*—an employee or visitor injury would result in permanent disability or death.

***4.6.4.1 Impacts from Alternative A (No Action—Boundary Capture Pen Vaccination of Calves and Yearlings)***
The Food and Drug Administration has determined that drug or vaccine residues may remain in animal tissues, be consumed by humans, and result in an adverse reaction. Thus, they have established "withdrawal times" that specify the period of time that must expire from the date that a drug or vaccine was administered to when the animal can safely be consumed by humans. The SRB51 use label prescribes a 21-day withdrawal time for the vaccine to clear an animal. Thus, the NPS will recommend that hunters do not consume harvested meat if a bison was killed within 21 days of being vaccinated. The NPS will continue to notify state wildlife agencies and tribes of forthcoming vaccination efforts through established working groups and communications networks. If hunters consume meat exposed to SRB51 within this window, these indirect impacts would be adverse, short-term, localized and minor given the positive response to antibiotic treatment.

The State of Montana could implement a similar brucellosis vaccination program for bison along the west boundary of Yellowstone National Park, though they have only vaccinated nine yearling bison at the Duck Creek capture facility since the implementation of the IBMP began in 2000.Many cattle ranchers in the GYE vaccinate their cattle against brucellosis, some at regular intervals while others vaccinate less frequently (Hendry 2002, Clarke et al. 2005).

Implementation of Alternative A may result in direct, minor to moderate, short-term, adverse impacts on human health and safety concerns for park employees working with non-sedated, live bison in the capture pen and from handling live bacteria vaccine. No impacts to visitors are expected. If notifications on meat consumption are ignored, impacts to hunters would be adverse, short-term, localized and minor.

***4.6.4.2 Impacts from Alternative B (Remote-Delivery Vaccination—Young Bison Only)***
The Wyoming Game and Fish Department implements a remote vaccination program for elk on 21 feed grounds in northwestern Wyoming. From 1985 to 2002, over 53,000 doses of *B. abortus* vaccine were delivered to elk by humans using a compressed air-powered rifle remote delivery system (Clause et al. 2002). No human exposures resulted from implementing this program for over 20 years.

***4.6.4.3 Impacts from Alternative C (Remote-Delivery Vaccination—Young Bison and Adult Females)***
Implementation of Alternative C may result in direct, minor to moderate, and short-term adverse impacts to human health and safety of park personnel from the increased time personnel spend in close proximity to wild bison while implementing the remote delivery program. No impacts to visitor safety are expected.

***4.6.5 Visitor Use and Experience***
· *Negligible*—the impacts would be barely detectable and/or would affect few visitors because they would not likely be aware of the effects associated with proposed changes to management actions.
· *Minor*—the impacts would be detectable and only affect some visitors. Visitors would be aware of the effects associated with management actions. The detectable changes in visitor use and experience would be slight, but visitor satisfaction would not be measurably affected.
· *Moderate*—the impacts would be readily apparent and affect many visitors. Visitors would be aware of the effects associated with management actions. Visitor satisfaction might be measurably affected, with visitors either being satisfied or dissatisfied. Some visitors would choose to pursue activities in other available local or regional areas.

· *Major*—the impacts would affect the majority of visitors. Visitors would be highly aware of the effects associated with management actions. Changes in visitor use and experience would be readily apparent. Some visitors would choose to pursue activities in other available local or regional areas.

Visitors have noted that scenic views and the preservation of native plants and animals are important features drawing them to visit the park (Duffield et al. 2000a, b; Manni et al. 2007).

***4.6.5.1 Impacts from Alternative A (No Action—Boundary Capture Pen Vaccination of Calves and Yearlings)***
The direct impacts to park visitors are that they do not have access to about 2,000 acres of the Gardiner basin during bison management operations.

The geographic area for cumulative impacts includes the area of tourism industry in the GYE which is much larger than Yellowstone National Park and includes Grand Teton National Park, two wildlife refuges, and seven national forests. Recreational opportunities for visitors in the GYE are abundant for those who want to experience the natural and cultural resources protected on public and private lands. Visits to Yellowstone National Park are typically only a portion of a visit to a wide variety of destinations elsewhere in the GYE or the greater three-state area.

***4.6.5.2 Impacts from Alternative B (Remote-Delivery Vaccination—Young Bison Only)***
For vaccine delivery to be most successful, there needs to be limited activities occurring in the vicinity of individual bison groups being vaccinated. Thus, park staff will selectively choose to work around groups of bison where they are more removed from other human encounters. The implementation time period occurs during non-peak time periods of visitation. However, a portion of visitors may be adversely affected by knowing that vaccination operations are being conducted at Yellowstone National Park and/or seeing bison marked via biobullet or paint-ball gun during remote delivery operations.

The wounding of a bison during vaccine delivery is possible, but the probability is low. Necropsies of animals receiving biobullet implants during a controlled study detected lesions in 80% of animals after 7 days, 20% of animals after 14 days, and zero animals after 21, 28, and 35 days following vaccine delivery (Morgan et al. 2004). Quist and Nettles (2003) noted that the degree of injury to animals from a compressed air-powered rifle projectile is insignificant in most cases. However, visitors are generally sympathetic toward injured animals.

Impacts would be beneficial for those visitors that support the protection of Montana's cattle industry and maintaining its brucellosis class-free status.However, a portion of visitors may be adversely affected by knowing that vaccination operations are being conducted at Yellowstone National Park, regardless of whether they ever encounter field operations.

***4.6.5.3 Impacts from Alternative C (Remote-Delivery Vaccination—Young Bison and Adult Females)***
Overall, the cumulative impacts of past, present, and future bison management projects on visitor use and experience would be minor, adverse and beneficial over both the short and long term; similar to those described in Alternative B.

***4.6.6 Park Operations***
. . . the long-term impacts of vaccinating bison are expected to produce beneficial, moderate impacts for park staff that work with other agencies to resolve regionalized political and social conflicts.

Monitoring of population ecology and disease responses to a remote vaccination program would require increased funding or the cessation of other ecological monitoring currently conducted by existing staff. These impacts would be long-term, adverse, and minor to moderate.

A long-term, moderate, beneficial impact would be that management discussions with partner agencies would systematically take a new perspective, providing the potential for new management opportunities, as seroprevalence in the population decreased.

Remote delivery vaccination of calves and yearling female bison may occur during March through May. During this time period, certain portions of Yellowstone National Park known as bear management areas are generally closed to human access to minimize disturbance to grizzly bears. However, some park management activities are allowed in these areas if a review process by the park's Bear Management Office determines that the proposed activities are compatible with bear management objectives. NPS staff conducting remote delivery vaccination may request access to bear management areas near Gneiss Creek, Richards Pond, Blacktail Deer Plateau, and the Firehole Canyon to Old Faithful. If access is granted, staff will avoid working near locations where grizzly bears are observed, encountered, or known to be active. NPS staff will also avoid locations with ungulate carcasses that may be used by grizzly bears. Impacts to workload as schedules are adjusted would be short-term, localized, adverse and minor.

Adverse, localized and seasonal impacts to other programs are expected from the increased work load of implementing a remote vaccination program.

**4.7 Irreversible or Irretrievable Commitments of Resources**
An irreversible commitment of resources is defined as the loss of future options. The term applies to the effects of using nonrenewable resources such as minerals or cultural resources, or to the loss of an experience as an indirect effect of a permanent change in the nature or character of the land. An irretrievable commitment of resources is also defined as the loss of production, harvest, or use of natural resources. The amount of production forgone is irretrievable, but the action is not irreversible. If the use changes, it is possible to resume production. Irreversible commitments are those that cannot be overturned, except perhaps in the extreme long term. Irretrievable commitments are those that are lost for a period of time.

**4.8 Relationship between Local Short-term Uses and Maintenance and Enhancement of Long-term Productivity**

Repeated vaccination of individual bison will result in long-term vaccination protection for the population and help to sustain a higher level of herd immunity, in turn leading to higher levels of calf production and increased tolerance for bison on ranges outside Yellowstone National Park. Thus, long term conservation of the population may improve.

**4.9 Adverse Impacts That Could Not Be Avoided**
Impacts to individual bison and other wildlife that directly contact vaccine strain *Brucella abortus* are unavoidable*. Likewise,* impacts to individual humans that share the opinion regarding disapproval of wildlife vaccination are unavoidable. Unavoidable adverse impacts are disclosed throughout the impact topics of the environmental consequences. Mitigation measures common to action alternatives ensure that adverse impacts remain at the negligible to minor level especially at the animal and human population perspective.

**5. Chapter 5: Consultation and Coordination**

**5.1 History of Public Involvement**
The public has a right to know about the challenges confronting the NPS and to participate in the process of developing solutions for those challenges (NPS Directors Order 75). The NPS role during public involvement is to provide opportunities for the interested and affected public to be involved in meaningful ways, listen to their concerns and values, and consider this input when shaping decisions and policies. Public participation in the planning process ensures that the NPS fully understands and considers the public's interest.

In response to public discussion about whether brucellosis transmission by elk or bison is a threat to domestic livestock and whether vaccination along with other management strategies might be useful in controlling potential transmission, the Secretary of the Interior requested a six-month study of brucellosis in the GYE by the National Academy of Sciences. This study was completed in 1998 by the National Research Council (Cheville et al. 1998). Findings of this study included:
· A brucellosis program for wildlife in the GYE should be approached in an adaptive management framework.
· Vaccination is an essential component of any program to control brucellosis.
· Any vaccination program for bison must be accompanied by a concomitant program for elk (Note: no vaccination program for elk has been initiated in the northern portion of the GYE where Yellowstone bison reside).
· If the current vaccination program on elk feeding grounds in Wyoming (outside Yellowstone National Park) is continued, then it should include collection of serologic and culture data and appropriate epidemiologic analysis.
· An effective vaccination program would aid in reaching short-term disease control measures. Consequently, a long-term, controlled vaccination study must be conducted to assess the complete role of vaccination in brucellosis control for bison and elk.

***5.1.2 Public Scoping***
The conclusion of the FEIS for the IBMP was that vaccination provides the most effective non-lethal means of decreasing disease prevalence in bison.

***5.1.4 Agency Consultation***
A total of 126 comment documents were received during the public scoping period. Most of these letters were received via e-mail, U.S. mail, and comment forms collected at the open houses. In addition, 11 individuals provided comments using the project website. More than 800 specific comments within the 126 documents were tallied. NPS staff also considered 90 comments regarding vaccination of bison that were recorded during the planning process for the Interagency Bison Management Plan.

The conclusion of the Final Environmental Impact Statement for the Interagency Bison Management Plan was that vaccination provides the most effective non-lethal means of decreasing disease prevalence in bison.

Initial consultation with the Montana and Wyoming offices of the State Historic Preservation Officers was conducted during June 2005. The NPS initially informed these offices of its intent to include an assessment of effects on cultural resources as part of the draft EIS. Subsequent analyses led the NPS to initiate a separate consultation that determined alternatives B and C for vaccination of free-ranging bison may have an impact on historic properties, but no historic properties would be adversely affected by the undertaking. The State Historic Preservation Officers concurred with this assessment (Appendix G).

**6. Glossary of Terms**
Adaptive management: a system of management practices based on clearly identified outcomes, monitoring to determine if management actions are meeting outcomes, and, if not, facilitating management changes that will best ensure outcomes are met or to re-evaluate the outcomes. Adaptive management recognizes that knowledge about natural resource systems is sometimes uncertain and is the preferred method of management in these cases. Specifically, adaptive management is the integration of program design, management, and monitoring to systematically test assumptions to adapt and learn. Adaptation is about taking action to improve the project based on the results of monitoring.

**Efficacious vaccine:** a substance containing antigen that effectively stimulates an immune system response.

**Efficacy:** the capacity for producing a desired result or effect; effectiveness.

**Free-range:** allowance of animals to graze or forage for food rather than being confined to a feedlot or a small enclosure.

**Range expansion**: the outward dispersal of animals beyond the limits of the traditional distribution for a population (Gates et al. 2005).

**Remote delivery system:** method of delivering a biological product without physically restraining individual animals.

**Vaccine:** a suspension of living or inactivated organisms used as an antigen to confer immunity.

**Appendix A: Yellowstone Bison Population**
Today, this recovered population inhabits areas that permit the full expression of natural behaviors and ecosystem functioning in ways similar to those of the past, including migration, dispersal, and coexistence with an intact predator community.

Population counts of the central bison breeding herd varied widely during 1995-2008 because bison that left the park in winter were subject to culling and up to about 40% of the total population was removed annually.

Thus, emigration and management culls from the central herd have resulted in a more even distribution of bison numbers between the northern and central breeding herds.

Chronic infection with brucellosis affects the demography of Yellowstone bison by influencing survival, pregnancy, and birth rates (Fuller et al. 2007b, Geremia et al. 2009).

Bison density and snow pack severity influence the magnitude of migratory movements outside the park boundaries (Bruggeman et al. 2006, 2007, 2009a, b). Survival probability decreases significantly when the number of bison in the central herd exceeds 2,000-2,500 animals and the number of bison in the northern herd exceeds 1,200; especially during winters with severe snow pack when a large proportion of this breeding group migrates to low-elevation winter ranges near the park boundary. Since management actions that cull bison are the overwhelming source of mortality during these years, brucellosis risk management actions are a significant driver of population demographics (Cheville et al. 1998, Fuller et al. 2007a).

Fecundity analyses have shown that seropositive bison have a reduced probability of becoming pregnant compared to seronegative individuals. In addition, seronegative, reproductively mature bison are highly susceptible to *Brucella*-induced abortions. A study of Yellowstone bison found that 67% (8 of 12) of reproductively mature animals that were initially diagnosed seronegative were not observed with calves during their first and second pregnancies following seroconversion (Geremia et al. 2009). The combined effects on pregnancy and birth rates resulted in lower calf production by seropositive bison across all ages.

Yellowstone bison also contribute to the overall genetic diversity of the species due to the presence of four unique alleles found in this population. In addition, Yellowstone bison exhibit no introgression from domestic cattle genes, making the population an important repository of pure bison genetic material (Halbert and Derr 2007).

For long-term conservation of the bison population, managers need to know how implementation of the IBMP could influence bison genetic diversity and the long-term viability of any unique subpopulations. These decisions require knowledge of the existing genetic makeup and influential factors. If the population is structured by geographic area, then non-random removals may influence groups disproportionately and lead to a higher risk of losing unique alleles.

**Appendix B: Brucellosis**
There appears to be no feasible treatment or cure for wild bison and elk infected with *Brucella*.

Animals that overcome the clinical signs of brucellosis may develop recurrent infections and be a source of exposure and possible infection for other animals. Some animals may completely clear the bacterium. Some individual cattle have a natural resistance to brucellosis and this trait may be heritable (Templeton et al. 1988).Natural resistance may also occur in bison (Derr et al. 2002).

However, there have been no known cases of human undulant fever in Wyoming or Idaho attributed to wildlife. In Montana, there have been two confirmed cases of hunters contracting undulant fever from elk (Greater Yellowstone Interagency Brucellosis Committee 1997). The last confirmed case was in 1995 (Zanto 2005).

An animal with natural resistance to the *Brucella* organism that has been challenged with *B. abortus* will generally experience a short-lived antibody response. Tissues collected from these animals will be culture-negative, supporting their resistance to infection. A culture test that is negative does not necessarily mean that animal is not infected.

In the chronically infected Yellowstone bison population, the disease brucellosis is maintained by the bacteria’s ability to multiply in the female reproductive tract. That ability is expressed foremost in the membranes and fluids associated with the developing fetus, thereby changing low-risk females into a high risk for shedding live bacteria during the final stage of pregnancy (Cheville et al. 1998).

The large amount of *B. abortus* bacteria shed during these events, combined with the strong attractant effect of expelled fetal membranes, are the two factors that drive transmission of *B. abortus* and ensure perpetuation of the disease (Cheville et al. 1998).

**Appendix C: Vaccination**
Vaccines, when administered to previously uninfected hosts, mimic the natural infection process and, thus, teach the immune system how to react to antigens. Macrophages in the body (cells designed specifically for “eating” foreign substances) cannot distinguish vaccines from the natural infectious bacteria and consume the invading cells. The macrophages save the antigen from the surface of the invading cells and present them to specialized white blood cells (lymphocytes) in the lymph nodes. These T and B cells in turn signal the system to (1) activate more lymphocytes, (2) actively attack and destroy infected cells, and (3) secrete antibodies to bind with the antigen of the invading cells. Antibodies attack the foreign substances that have yet to invade cells within the body and cause them to become non-functional. The antibodies also signal macrophages to eat the antibody/antigen complex.

Once the infection is eliminated some of the B and T cells are converted to memory cells. These cells will circulate in the body and allow the system to respond to subsequent infectious exposure more rapidly.

In latent diseases like brucellosis, vaccination requires diligence until the proportion of recovered individuals reaches very close to zero. An immune system response by a vaccinated bison would require exposure to a larger amount of *B. abortus* than a non-vaccinate to stimulate an infection. Consequently, vaccinates are expected to shed much less infectious bacteria upon exposure to the same dose . . .

Cell-mediated immune responses disrupt *B. abortus's* ability to replicate, make copies of itself within host cells, and prevent the pathogen from invading new cells. This type of acquired immunity brings with it a possibility of latent infection, whereby an animal may not be resistant to active infection for the rest of its life.

Disease is a natural part of ecological systems and has occurred in wildlife species since the Paleozoic era.

In accordance with Chapter 4 of NPS Management Policies 2006 (NPS 2006), the NPS may intervene to manage populations of native species only when such interventions will not cause unacceptable impacts to the population or to other components and processes of the ecosystem. Vaccination of wildlife with effective and low risk vaccines would be considered intervention that does not cause unacceptable impacts to the population or ecosystem since the aim of the program is to cause a decline in abundance of an exotic or non-native species (*B. abortus*).

In the ROD for the IBMP, the partner agencies made the decision to vaccinate bison that occupy Zone 2 Management Areas when a vaccine was shown to be low risk.

Strain RB51 has been shown experimentally to cause endometritis and placentitis that result in abortion in pregnant bison vaccinated during the third trimester of pregnancy (Palmer et al. 1996). Of eight pregnant bison females given SRB51, two females aborted 68 and 107 days after vaccination (Palmer et al. 1996).

Modern techniques in DNA sequencing and gene splicing have led to advances in vaccine development. For example, *B. abortus* SRB51 can be modified to produce a new strain capable of use in a vaccine for the treatment of brucellosis (Boyle et al. 2000). These types of advances will most likely lead to new vaccines that replace live vaccines with lower risk vaccines for human handling and for non-target species.

A low risk vaccine has two components: protein or DNA derivative of disease and an effective delivery system (Brake 2003).

Methods for remote delivery of vaccine do not involve direct contact with humans. In general, these methods consist of, but are not limited to, compressed air-powered rifles firing biobullets or darts, bait containing vaccine, and aerosol sprays mixed with feed. The two later methods are not currently available techniques for delivery of brucellosis vaccines.

**Appendix D: Safety and Efficacy Criteria for Bison Vaccines Against Brucellosis**
To be defined as safe, a vaccine would not have any clinical effects that would increase predation or decrease survivability. However, adverse clinical effects such as listlessness, anorexia, depression, and arthritis that are transient and minimal with no long-term effects on survival may be acceptable. There should be no statistical difference between vaccinates and controls on these factors. A safe calfhood vaccine will not be shed from a vaccinate prior to parturition. The vaccine strain will not persist to the first calving in 95% or greater of the vaccinated individuals, 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.

To be defined as efficacious in females, a vaccine must induce statistically greater protection against fetal loss, infected calves, or infection in pregnant vaccinates after experimental challenge when compared to non-vaccinated animals in the same experiment. . . Use of model estimations must indicate that the vaccine, when used alone without other management influence, will reduce the prevalence of brucellosis in the targeted wildlife population. Experiments will need to be conducted to evaluate the duration of immunity of the vaccine but these experiments will not be required for initiation of use of the vaccine if all other safety and efficacy criteria are met. A vaccine should provide long-term immunity and/or be able to be safely boosted during the life of the animal.

**Appendix E: Compliance with Federal or State Regulations**
***16 U.S.C., sec.22 (17Stat.32), Mar. 1, 1872*** This Law established Yellowstone National Park and preserved the watershed of the Yellowstone River "for the benefit and enjoyment of the people."

***National Park Service Organic Act, PL 64-235, 16 USC §1 et seq., August 25, 1916*** national parks: "... to promote and regulate the use of the ... national parks ... which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

***Redwood National Park Act, 16 USC 79a-79q, 82 Stat. 931, PL 90-545*** General Authorities Act of 1970, reasserting that system-wide there is a "high standard of protection" prescribed by Congress for the "common benefit of all the people of the United States." This Act recognized that ecological processes cross park boundaries and activities proposed on lands adjacent to the national parks may affect the ability to preserve park resources. Conversely, NPS activities may affect external resources and values. Recognizing that parks are integral parts of larger systems, the Act directed superintendents to work cooperatively with others to "anticipate, avoid, and resolve potential conflicts."

***National Environmental Policy Act, Public Law 91-190, 83 Stat. 852, 42 USC §4341 et seq.*** NEPA process is intended to help public officials make decisions that are based on understanding environmental consequences of proposed actions. Federal actions should protect, restore, and enhance the environment.

***Omnibus Management Act of 1998, PL 105-391, 16 USC 5901-6011***
The National Parks Omnibus Management Act of 1998 reinforces the mandate of the Organic Act to preserve park resources in a condition that will maintain them for future generations to observe and enjoy. In managing parks to preserve naturally evolving ecosystems, and in accordance with requirements of the Act, the NPS uses the findings of science and the analyses of scientifically trained resource specialists in decision-making.

***Endangered Species Act of 1973, as amended, Public Law 93-205, 87 Stat. 884, 16 USC §1531 et seq.*** The NPS consulted with the USFWS during the planning process.

**National Park Service—Director's Orders** Director's orders provide guidance for implementing specific issues described in NPS policy. Copies of orders may be obtained by accessing the NPS web site at www.nps.gov/refdesk/ DOrders/. Director's orders that are relevant to this planning process include the directives system (1), park planning (2), conservation planning and environmental impact analysis (12), tourism (17), agreements (20), cultural resource management (28), wilderness preservation and management (41), occupational safety and health (50B), relationships with American Indians and Alaska Natives (71-A), substances used for wildlife management and research (77-4), integrated pest management (77-7), endangered species (77-8), public health NPS Guidelines (83), and conflict resolution (93).

**Appendix F: Cost Estimates for Implementing Each Alternative**
Marking of individuals on a short-term basis (e.g., paint spot) will likely be necessary to track the number of different individuals receiving a remote vaccination attempt.

A variety of study parameters will be necessary to ensure the monitoring effort can correctly assess whether the vaccination program is producing a decrease in brucellosis infection (White et al. 2008).Marking individual bison that are handled either at the Stephens Creek capture facility, Duck Creek capture facility, or through chemical immobilization in the field will be necessary to evaluate population seroprevalence, incidence of infection, rates of seroconversion, and persistence in shedding of the bacteria.

The ranges of possibility for the amount of decrease in seroprevalence and for the shape of the decrease curve are relatively unknown. Attempting to detect a change in seroprevalence from monitoring data involves multiple statistical tests over time.

An annual testing increment of fewer than 200 individuals provides a poor probability of detecting a decrease in seroprevalence to below 40%. In addition, sampling at much greater numbers than 250 individuals does not significantly improve the probability of precision in detecting a change in seroprevalence.

**Goals**—Deliver vaccine to as many vaccine eligible bison as possible to achieve a delivery proportion of greater than 50%. Target calves and yearling females as priorities in the autumn delivery period and include adult females, where feasible; then follow-up with additional delivery to yearling and two-year old females in May and June. As the program evolves and seroprevalence in young adults decreases, vaccination of adult females will increase in priority.

Primary field season to deliver vaccine will require 18 weeks of work.

**Cost Estimate for Additional Studies Needed to Resolve Uncertainties of Delivery *$230,000***

**Cost Estimate for Necessary Equipment (One-time Purchase) *$47,000***

**Cost Estimate for Field Delivery Program *$146,300***

**Funding Sources and Cost Estimate for Monitoring Program**
***Stephens Creek $102,000***
***Field Monitoring of Chemically Immobilized Bison $42,000*** Field immobilization to collect samples of blood, swabs and nutritional indices ($800 per bison capture)

**Projected Cost per Proposed Alternative**
***Alternative A*** ($102,000)

***Alternative B*** Research studies $230,000
One-time equipment purchase $ 47,000
$277,000
Annual vaccine delivery costs $146,300
Annual monitoring costs
$290,300

***Alternative C***
Research studies $230,000
One-time equipment purchase $ 47,000
$277,000
Annual vaccine delivery costs $146,300

Annual monitoring costs $144,000
$290,300

**Appendix G 106 Consultation Concurrence Letter**
" . . . Due to the large area in which bison range across YNP and the lack of advance knowledge of the locations where the vaccination procedures will be conducted, it is not possible to conduct archeological surveys prior to the undertaking."

"Yellowstone National Park considers bison as a component of the ethnographic resources important to associated tribes. Tribal consultation concerning the vaccination program indicates mixed opinions about support for the project as it relates to the ethnographically significant bison population."

"Therefore, YNP has determined that the preferred alternative for vaccination of free ranging bison may have an impact on historic properties, but no historic properties will be adversely affected by the undertaking."

**Appendix H: Surveillance Plan**
For the purposes of this surveillance plan, Yellowstone bison are the resource that historically occupied an area of approximately 20,000 km2 in the headwaters of the Yellowstone and Madison rivers, in what is now referred to as the northern GYE.

**Appendix I: Surveillance for Brucellosis in Yellowstone Bison: The Power of Various Strategies to Detect Vaccination Efforts**
Attempting to detect a change in seroprevalence from annual data involves multiple statistical tests over time and the probability of a type I error (detecting a difference that does not exist) increases with the number of statistical tests. This presents a challenge of satisfying two conflicting requirements: reduce the risk of reporting false positives (i.e., Type I errors), but maintain the likelihood an effect will be detected if it exists. Simulation of Type I error rates shows that the single-year and 3-year moving average are more conservative and less prone to Type I errors than the cumulative years regression approach.

The single-year estimate approach consistently showed more variation surrounding the median. On average, the regression model tended to be a more powerful approach, though differences were typically in the 1-2 year range. However, the regression approach also showed more variation around this estimate for the gentler decreases in prevalence.

If research captures can take place after late winter, then information about over-winter boundary samples would be able to direct managers to how many additional samples are needed to achieve a minimum sample size. For the scenarios explored, analyses suggest that sampling during the initial years of a vaccination program is unlikely to detect any significant change in prevalence.

**Appendix J: Vaccination Strategies for Managing Brucellosis in Yellowstone Bison**
Models are useful decision-making tools for evaluating management strategies when it is necessary to proceed despite uncertainty.

Simulations suggest the goal of reducing brucellosis transmission risk to livestock outside the park can be best achieved by combining boundary capture and remote delivery vaccination of all female bison. Simulations of this alternative estimated seroprevalence could decrease by 66% from 0.47 to 0.16 over the 30-year simulation period, with 29% of the population vaccinated. Boundary removals resulting from migrations out of the park were stochastic, but fewer seropositive bison were removed at the boundary as the number of vaccinated bison that received protection from the vaccine increased in the population.

Though vaccination is unlikely to eradicate *B. abortus* from Yellowstone bison, it can be an effective tool for reducing the level of infection and, in turn, allow for incorporating advances in the fields of diagnostics, vaccine development, and delivery into adaptive management programs.

Accurately quantifying infectious events and the proportion of the population with an acquired immunity from vaccination is difficult to impossible because of the large landscape bison occupy and the insensitive tests available to estimate these parameters. However, random samples taken from individual bison can be used to estimate population seroprevalence, and the number of seropositive bison removed from the population during boundary risk management operations can be monitored over time to evaluate the predictive capability of this model.

Though male bison were monitored for population growth and seroprevalence, they were assumed to have no role in brucellosis transmission and were not a focal component of the model.

The model used both yearly and daily time steps. Events occurring in the yearly time step were bison mating, natural mortality, and management operations (e.g., removal of seropositive bison and vaccination).

Based on Roffe et al. (1999), 46% of seropositive bison were assumed to be culture positive and classified as infected for initializing the model. Infected individuals were those harboring live *B. abortus* and expected to abort their first pregnancy following infection with high probability (96%). The remaining 54% of seropositive bison were assigned to the latent class. Adult, latent, pregnant bison recrudesced (i.e., relapsed) and shed *B. abortus* during live infectious births at a specified probability (0.05). Abortions and infectious live births were treated equally with regard to disease transmission. A proportion of calves born during these infectious live births also became infected through vertical transmission at a specified probability (0.66). For the purpose of diagnosing bison during management operations, the standard field serology tests were assumed to identify all actively infected and 95% of latently infected bison. The model also assumed no additional abortions or mortalities resulted from vaccination.

Vaccine efficacy was modeled as the probability that a vaccinated bison would enter the vaccine protected class. Bison in this class were protected from *B. abortus* shed via infectious abortions or live births.Model simulations for remote vaccination alternatives included randomly selecting 50% of the target group (i.e., calves and yearlings for Alternative B; calves, yearlings, and adult females for Alternative C) each year as vaccinates. Using an intermediate level of vaccine efficacy (50%), approximately 25% of the target group received protection from the vaccine under this alternative—meaning bison in the protected category would not subsequently become infectious and shed bacteria if exposed to an infectious event.

**Appendix K: Section 7 Consultation Concurrence Letter**
Canada Lynx: " . . . may affect but is not likely to adversely affect Canada lynx due to the typically different habitat requirement of bison and lynx within the park. . . there are limited data available for felids"

" . . . may affect, but is not likely to adversely affect Canada lynx, grizzly bear, gray wolf and bald eagle."

" . . . other research has indicated that SRB51 exhibits tropism for the bison placenta and can cause placentitis which may induce abortion (Palmer et al. 1996). . . those vaccinated towards the end of this period, and closer to mid-gestation, may face a higher risk of aborting. An increase in abortion and presence of fetal tissue in the environment may act as an attractant to raptors and migratory birds, . . . Considering the disparity of results on the safety of SRB 51 vaccine in pregnant bison, and fact that large-scale vaccination of free-ranging bison without capture has not been attempted before, the Fish and Wildlife Service believes that a need for monitoring of the proposed action exists."