

Strategic Research Plan Wild Horse and Burro Management



The Bureau of Land Management,
Wild Horse and Burro Program
U.S. Department of Interior

Prepared in collaboration with
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and
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I. STATEMENT OF THE CHALLENGE



A. Introduction

Background

The Wild Free-Roaming Horses and Burros Act of 1971 (Public Law 92-195) provided protection for all wild horses and burros on federal lands and provided guidance for their management as a wildland species. At the time the Act was passed, a roughly estimated 17,000 wild horses¹ occupied federal lands designated for the protection. Since 1971, the primary responsibility for management of the wild equids on federal lands has fallen primarily to the Bureau of Land Management (BLM), with the U.S. Forest Service sharing some responsibility. In 1971, the BLM was neither staffed nor prepared to monitor and manage such a large number of horses and their effects on semiarid ecosystems. By 1980, the number of wild horses had increased to 65,000-80,000 animals.

Following passage of the Act in 1971, limits for the number of horses on each herd unit (referred to as Herd Management Areas or HMA's) were set. These limits or population goals are referred to as Appropriate Management Levels or AMLs. From 1980 and through the present, more active management reduced wild horse numbers closer to AMLs. Wild horse numbers were reduced to about 40,000 by 1999 and to about 37,186 wild horses in 2003, prior to the foaling season. This number still substantially exceeds limits recommended by the BLM. Aggressive efforts are planned to reduce numbers to the established AMLs during the next few years.

Some 203 HMAs are managed by the BLM across the Western U.S. The responsibility of monitoring range conditions; allocating range resources between horses, livestock, and wildlife; monitoring horse and burro numbers and managing their population levels represents a large federal management responsibility. The number of animals in most herds are counted or estimated every three to four years, in order to plan for any gathers, and adoptions. Herd management activities, such as gathers and removals, take place for most herd areas every four years.

Mandates

The Wild Free-Roaming Horses and Burros Act of 1971. — In this Act, Congress stated that wild free-roaming horses and burros were living symbols of the historic and pioneer spirit of the West; that they contributed to the diversity of life forms within the Nation and enrich the lives of the American people; and that these horses and burros were fast disappearing from the American scene. Congress mandated that wild free-roaming horses and burros be protected from capture, branding, harassment, or death. To accomplish this, these animals were to be considered, on public lands where they were found in 1971, an integral part of the natural system.

Other Statutory Regulations. — The Taylor Grazing Act of 1934 authorized the formation of the Grazing Service (subsequently the BLM) and empowered that Service to responsibly manage grazing pressures on federal rangelands. This act accelerated the capture and removal of the wild equids, which were primarily used as pet food at that time.

¹ Since no systematic surveys were conducted at this time, some authors feel this number may not be representative of the numbers in 1971.

The 1959 Wild Horse Annie Act (named after Mrs. Velma Johnston) prohibited hunting or harassment of wild horses on public lands using motorized vehicles or aircraft.

The Federal Land Policy and Management Act of 1976 (FLPMA, PL-43, 1701) directed the BLM to scientifically manage rangelands under the principles of use and sustained yield. Under FLPMA, wild horses and burros were one of several multiple uses (along with recreation, mining, domestic grazing, fish and wildlife) that the BLM must manage in combination to best meet the public's present and future needs. Sustainability implies the "maintenance in perpetuity" of yields from public lands.

The Public Rangeland Improvement Act of 1978 (PRIA) amended PL-92-195, and defined excess horses, mandated research and provided guidance for titles for adopted horses and the adoption process.

The Stake Holders

The Bureau of Land Management (BLM). — The BLM's role is to manage wild horse and burro populations on western rangelands for the enjoyment of the American public. In order not to let horse and burro numbers threaten other species, or their own welfare, BLM set animal limits based on habitat and forage, and to monitor effects of various management levels on soil, vegetation, wildlife, and other ecosystem components. Grazing on public domain was primarily unregulated until 1934, at which time the Taylor Grazing Act empowered the BLM to responsibly manage grazing levels on these lands. The BLM's Wild Horse and Burro (WH&B) Program is directed from a central policy office (Washington Office, WO) in Washington, D.C., and an operations office (National Program Office, NPO) in Reno, Nevada. The BLM's 65 full-time equivalent employees, responsible for the management of wild horses and burros are supervised by decentralized operating levels of eleven state offices and several district or field offices in each state, each of which is managed by a state director.

The U.S. Geological Survey, Biological Resources Discipline. — The U.S. Geological Survey (USGS) was established by the Organic Act of 1879 to provide geological, topographic and hydrologic information to the nation. This information includes maps, databases, and reports of the analysis and interpretation of water, energy, and mineral resources, land surfaces, geologic structures, natural hazards, and dynamic processes of the earth.

In 1996, the then National Biological Service was incorporated into the USGS as their new "Biological Resources Discipline" with primary goals to (1) assess and report on the nation's biological resources; (2) characterize natural processes and identify factors that influence the nation's biological resources at all levels of biological organization; (3) facilitate sound management with agency partners; (4) provide leadership in developing a biological information infrastructure; and (5) integrate ecological research, inventory and monitoring efforts throughout the USGS.

The USGS-BRD has the capability as the primary research agency within the U.S. Department of Interior not only to gather much of the essential data and to conduct valuable, long-term research

for the BLM, but also to engage specialists from other agencies and institutions and to develop interdisciplinary teams to generate the high-quality science needed for informed, science-based management decisions. In late 2000, the primary role for the coordination of USGS-BRD wild horse and burro research was delegated to the Fort Collins Science Center (USGS-BRD) located in Fort Collins, Colorado.

The USDA Animal and Plant Health Inspection Service (APHIS). — Founded in 1862 by President Abraham Lincoln, the United States Department of Agriculture (USDA) mission includes working for a healthy and productive nation in harmony with the land. In this context, the mission of the APHIS includes protecting America's animal resources by monitoring and managing animal disease conditions existing in the United States, resolving trade issues related to animal health, and ensuring the humane care and treatment of animals.

An advisory relationship was created between the BLM and APHIS in February 1999 to allow APHIS to provide assistance, consultation, and coordination on issues relating to the health and proper handling of wild horses and burros that are under the management of the BLM. Through a reimbursable agreement, the APHIS receives needed budgetary support for the wild horse and burro activities of its field force who facilitate the agency's ability to respond to emergency disease outbreaks and provide animal health monitoring and surveillance.

Domestic Livestock Grazers and Wildlife Groups. — Domestic cattle, sheep, and goats graze many of the federal lands where wild horses and burros are managed. Livestock grazers often feel that wild horses and burros compete with domestic livestock for range forage. Traditional sportsmen and wildlife agencies may also feel wild equids encroach upon their interests to produce harvestable big game from the same areas. These species likely do compete and conflict with each other in some situations, but the BLM's role is to minimize these conflicts. Wild horses and burros are provided habitat on public lands and it is the challenge to the BLM to obtain the common objective of balance among resource users.

Wild Horse Advocates. — Wild horses and burros have a considerable following in the American public who consider the animals to be part of their western heritage and aesthetic enjoyment of the federal lands. A number of advocacy groups maintain that wild horses and burros should receive the first preference in any conflicts with other resource uses on lands where they are protected.

The Strategic Planning Process

In late 2000, the Fort Collins Science Center of the US Geological Survey, Biological Resources Division (USGS-BRD) was charged with developing a strategic research plan for the management of wild horses and burros. Later, contributions by APHIS were incorporated into the research planning process to help address issues related to health and handling. The purpose of this strategic planning process was to:

- review past progress and identify problems;
- set broad goals central to the BLM's mission for wild horse and burro management;
- establish specific, time-bound, measurable goals, and strategies to achieve them; and

- evaluate the progress towards those goals at set time periods, and to readjust the planning as needed.

Strategic plans are long-range, broad-based documents that create a specifically stated vision of the future. Strategic planning is the long-term directional planning that occurs at the highest level of the program (in this case, wild horse and burro research) and determines the overall success or failure of the program. Strategic plans are one functional segment of a Comprehensive Management System (Organization of Wildlife Planners 1997). First, an inventory and assessment is made of the current state of the research, the client's and stakeholder's needs, and the driving policies and legislative mandates (Figure 1). Second, a strategic plan is developed by the agency in collaboration with the other stakeholders. It details roles, responsibilities, objectives and the tasks that must be accomplished to arrive at the objectives. Third, an operational plan is developed to clarify and quantify the tasks, and outline the process to achieve the objectives. Last, periodic evaluation points are established to monitor the success of attaining clearly stated performance measures and performance standards. The strategic plan is intended to be modified to the extent necessary, at three to five year intervals, based upon these periodic evaluations of progress by the BLM. These steps are repeated until all of the objectives are met, projected in this instance to require one decade.

This strategic plan is a joint effort of the USGS-BRD, the BLM, and the APHIS. This plan was developed to provide the BLM with a research strategy to meet the needs for management and care of wild horses and burros. The plan was developed over a period of 9 months with the input of 39 subject area experts from 11 universities, 3 federal agencies (BLM, USGS-BRD, APHIS), and two state wildlife agencies. USGS-BRD took the lead role in planning and coordinating meetings of the expert committees and in drafting the strategic plan based on committee and agency inputs (compilers, F. Singer and M. Tobler). Assisting in this effort was the BLM's wild horse and burro research coordinator, L. Coates-Markle, and equine health experts from the APHIS, L. Hatcher, and A. Kane.

The strategic research planning incorporated: (1) recommendations from five expert committees in 2001², (2) recommendations of the BLM WH&B Advisory Board, (3) direction from the Wild Horse and Burro Act of 1971, (4) input from the BLM managers and specialists assigned to the Wild Horse and Burro Program, (5) periodic milestone decisions by the BLM based upon the research findings and direction, and (6) earlier review of BLM and BRD research (Smith et al. 1996; Gross et al. 1999; Burnham et al. 1999; Population Viability Forum 1999; National Research Council 1991). It was upon this foundation that the strategic plan was built. This strategic plan will be updated at five-year intervals.

There had been no previous prioritization of the BLM's wild horse and burro research and management needs, or no effort to develop a strategy for fulfilling those needs within a specified time period. This strategic planning process will fill this void.

Research Administration and Approvals

² The committee reports may be obtained by accessing www.wildhorseandburro.blm.gov

The BLM will determine the research priorities for each year with input from the USGS-BRD and the APHIS. A WH&B Research Advisory Committee (also referred to here as the Research Team) will be convened with equal participation by the BLM (the BLM's research coordinator), the USGS-BRD, and the APHIS to provide recommendations to the WH&B Group Manager. A three-member advisory committee is envisioned at this time: F. Singer, L. Coates-Markle, and A. Kane. This committee will meet twice per year to recommend research priorities. One of these meetings will occur in April of each year to coordinate with the BLM's annual budget process. Advice and input will continue to come from the BLM's Advisory Board, the BLM WH&B Group Manager's staff and steering group, BLM Director's Science Advisory Committee, BLM's wild horse and burro specialists, and from any topic-specific advisory panels (seven have been convened to date) that may be convened by USGS-BRD. The Group Manager will meet with the Research Team at least once per year and will resolve any final issues of budgets, priorities, methods, coordination with field specialists, etc. The BLM, as the management agency, must make all final decisions and must set all final research priorities.

Research contracts, cooperative agreements, work orders, and interagency agreements will be administered through the USGS-BRD, Fort Collins Science Center (FORT), APHIS, or the BLM. A logical breakdown of topics will be used according to the appropriate expertise of these agencies on a case-by-case basis. Scientific expertise from the best experts in the scientific community will be sought in any subject area where these agencies and their cooperators can benefit. The APHIS will take the lead role in research dealing with health and handling issues. The USGS-BRD will take the lead role for research as it relates to the assigned topics of contraception, population estimation, genetics and populations modeling.

As the research program grows in funding, the amount of funding to outside experts will likely expand to all subject areas. For those projects conducted by USGS-BRD at FORT, all standard USGS requirements and approvals will be followed including:

- (1) A written study plan reviewed and approved by two-peer scientists and one statistician.
- (2) Approval of any animal handlings by the USGS-BRD Animal Care and Use Committee.
- (3) Center review of all manuscripts and proposals.

USGS-BRD will maintain and manage a core-fund of USGS base research dollars that is earmarked exclusively for wild horse and burro research. Additional USGS funding may come from in-house periodic calls for proposals (USGS Venture Capital Fund, USGS Ecosystems Studies, USGS Species of Federal Concern). USGS scientists submitting proposals will follow the specific proposal guidelines for those programs. The BLM and the USGS may also contribute research dollars in addition to these USGS base dollars.

The competitive call-for-proposals process will be the preferred mechanism for most contracted research, although sole source contracts or university cooperative agreements may be to the advantage of the government in some situations. The Research Team will prepare standard guidelines for the preparation of proposals over the next few months. All proposals assigned to the USGS-BRD for project management must follow USGS contracting

requirements that mandate that a panel of qualified specialists rank the proposals. The review panels will include agency representation from BLM, APHIS, and USGS. In addition, more specialized subject experts may be added to these panels.

The Contracting Officer (CO) for the contracts will be the respective agency's regional Contract Officers. The CO Representatives (COR), Project Inspectors, and Technical Advisors will be drawn from the pool of subject area experts from within USGS-BRD, FORT, the APHIS, and the BLM. All these assignments will be determined on a case-by-case basis and may include BLM field resource managers. All unsolicited proposals will also need to follow the same standard guidelines. Some unsolicited proposals may be funded with outside funds, but they still need to fit into the general scope of the BLM's needs, as identified in the planning process, and they should follow the same guidelines for drafting the proposal. Animal Care and Use and other appropriate approval processes must be met exactly as in the case for solicited proposals. Occasionally, exceptional unsolicited proposals will be funded from core research funds. University contractors must obtain the approval of their own university Animal Care and Use Committees before their research proposals may receive final funding approval. For those research organizations with no such approval process, either the APHIS or the USGS-BRD Animal Use and Care Committee will review the handling and care planned, depending upon which agency has been assigned the management of that particular project.

B. Wild Horses in North America

History

The wild horses that roam the west are feral descendents of domestic stock brought to North America by European colonists. No native wild horses existed in the Americas at that time, even though the horse evolved in North America and spread to Eurasia approximately 2.5-3.0 million years ago. The North American fossil record suggests that progenitors of all extant horses, asses, and zebras once lived in North America.

The last remaining native wild horses persisted in North America until as recently as 8,000-10,000 years ago when they mysteriously became extinct. Recent paleontological finds from Alberta indicate that these last remaining small native wild horses were killed and eaten by Native Americans about 10,000 years ago. Perhaps over-exploitation by Native Americans in this predomestication period played a role in the horse's demise in North America. Climate change and changes in vegetation have likely also played a role (Hulbert 1993, Martin and Klein 1984, Sharp and Cerling 1998, McFadden 1992). The disappearance of the native form of such an adaptable and widespread species as the wild horse from North America several thousand years ago remains an enigma.

The progenitor of the domestic horse (*Equus caballus*) which was domesticated roughly 6,000 years ago, is suspected to have been a tarpan-like animal—a short, stocky, mousy or yellowish gray (possibly dun or grulla) animal about the size of a large pony. The tarpan persisted into the early to mid 1800s in western Europe and the Ukraine where the last animal was shot in 1879. The tarpan also did not survive in captivity, the last one died in 1918, although

the closely related Mongolian or Przewalski wild horse (*Equus-caballus przewalskii*) did survive in captivity. The Przewalski horse has a different chromosome number and thus, is not the progenitor of the domestic horse (Bennett and Hoffman 1999). Representative examples of tarpan-like animals were reconstructed by breeding the last remaining captive tarpan domestic mixed horses. Tarpan-like animals have recently been released into the wild in several reserves in western Europe. Przewalski horses have also recently been released in the wild into Mongolian reserves.

Horses were reintroduced in North America by the Spaniards during the 1500s. The Spanish or Iberian influence remains very strong in some of the wild horse populations that have the longest histories of escape from domestication (e.g., the Kiger, Pryor Mountain, and Sulphur Mountain herds have strong Spanish ancestries). A number of U.S. western breeds were derived from these earliest Spanish bloodlines (the Spanish Mustang, the Rocky Mountain horse, the Choctaw horse; Bennett 1998). Later however, military, saddle, and draft, stock horses dominated by the Thoroughbred, Morgan, Quarter horse and draft breeds escaped into the western rangelands or were intentionally released and rapidly increased, forming broad zones of introgression with the earlier Iberian Spanish colonial bloodlines. These wild horses of mixed ancestry eventually increased to very large populations that inhabited vast areas of the U.S. western rangelands. Only a small number of the wild horse herds retain a largely Spanish colonial ancestry.

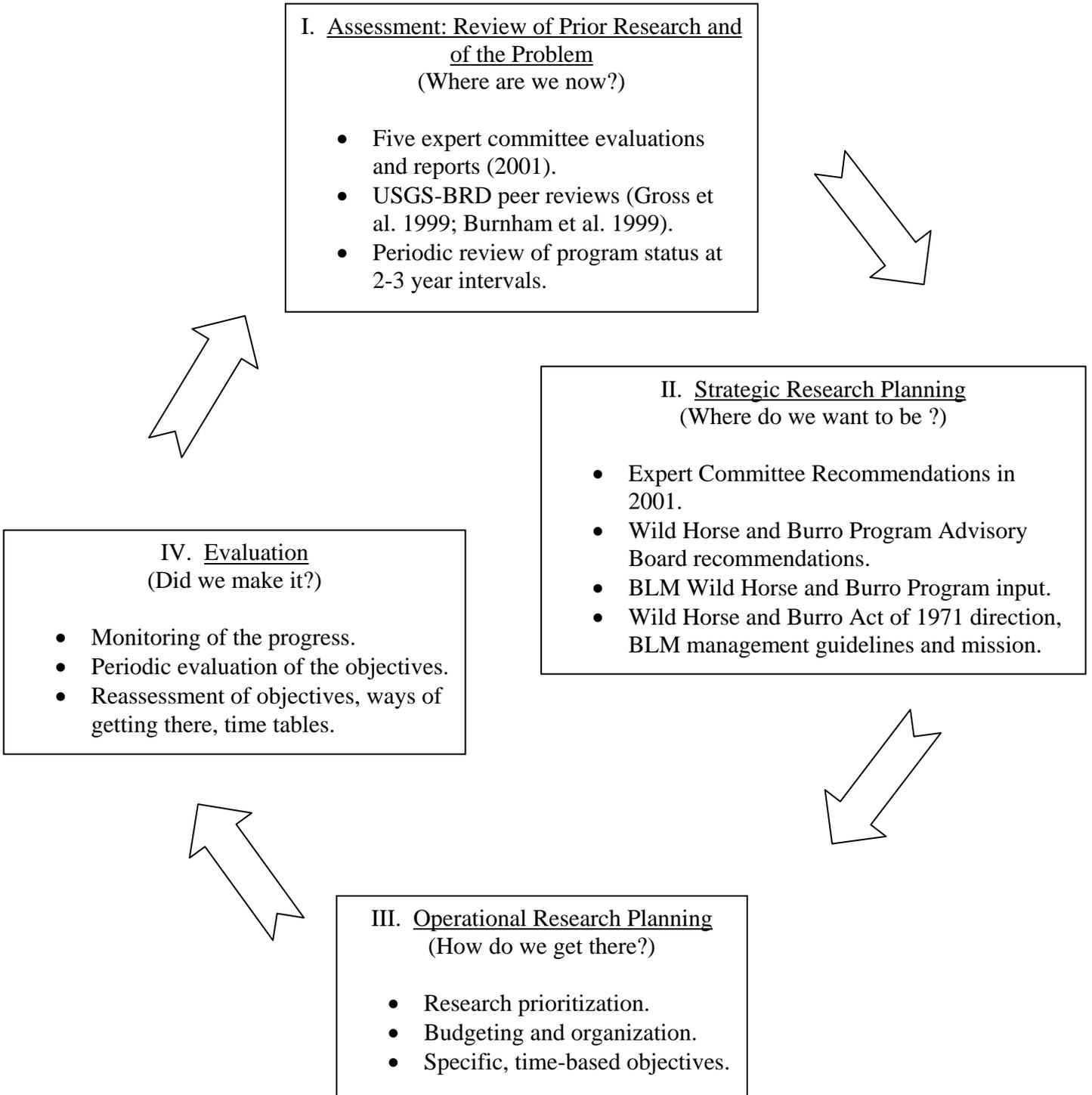


Figure 1. Proposed comprehensive strategic research planning process for wild horse and burro management for the Bureau of Land Management, 2001-2010.

The Management Challenge

Survival rates for wild horses on western public lands are high. None of the significant natural predators from native ranges of the wild horse in Europe and Asia — wolves, brown bears, and possibly one or more of the larger cat species — exist on the wild horse ranges in the western United States (mountain lions and black bears take foals in a few herds, but predation contributes to population limitation in only a handful of herds (e.g., Montgomery Pass). In some cases, adult annual survival rates exceed 95% and many horse herds grow at sustained high rates of 15-22% per year. Prior to herd management, many wild horse ranges were overgrazed, and some wild horses died from malnutrition or dehydration.

Although wild horses occur in 10 states, the vast majority of the animals are located in Nevada (74%) and Wyoming (10%). The BLM has established appropriate management level (AML), or population goals, based on range conditions and monitoring data, while the AML setting process is still underway in other management areas. Current numbers of wild horses are substantially in excess of these goals.

A major challenge for the BLM wild horse managers is what to do with the large number of excess horses produced each year on western rangelands (see Wagner 1983 and National Research Council 1991 for excellent reviews). Once instituted, management in most herds typically involves helicopter gathers and adoption of excess animals. Most horses and burros are adopted by the public, but not all of them can be placed in homes. Older adults, such as some of the mature stallions, are not attractive as potential animals to adopt. Many unadoptable animals are kept for years in captivity in long-term pasture holding facilities. Research into the use of contraceptives to limit the growth of wild horse herds has been ongoing since the 1970s, both in herds on western rangelands and on several eastern barrier islands. Four of these herds on eastern barrier islands are currently managed with immunocontraceptive agents. Tests with immunocontraceptives have been conducted on a few of the larger wild horse herds in Nevada. However, no free ranging western horse herds have yet been managed at the population level with contraceptives.

Several strong and diverse public interest groups pressure the U.S. Department of the Interior regarding the management of wild horses on public lands. These interests include, at one extreme, those who strongly support the protection and management of wild horses with little or no human intervention. At the other end of the spectrum are those who favor intense management of wild horses and burros, with an objective to maintain very low numbers of horses and burros. Elements of the public, such as those that pursue domestic livestock grazing and the harvest of big game wildlife, may view wild horses and burros as some competitors for other resource uses.

The BLM requires the highest quality science to simultaneously manage for sustainable production of all components of the ecosystem and for healthy, free-roaming, and genetically viable populations of wild horses and burros.

History of Contraceptive Research

The Problem. — The BLM's need for a fertility control agent to manage the numbers of wild horses was recognized soon after passage of the Act in 1971. The federal government sought to reduce the number of animals that they needed to gather, transport, adopt, feed and maintain (in the case of non-adoptable animals).

Testosterone Propionate in Stallions. — In 1978, the BLM entered into a series of research contracts that continued into the 1980s focusing primarily on development of a chemosterilant for wild stallions. The primary hormonal agent tested, testosterone propionate, was found to be effective in reducing sperm motility and effectively sterilizing the wild stallions for up to six months (Garrott and Siniff 1992). The hormone did not affect libido of the stallions, but foal production was reduced 83% in harems with treated stallions compared to those with untreated stallions (Kirkpatrick and Turner 1982).

There were a number of drawbacks to use of the hormonal sterilant. Application required immobilization of the stallion and injection of a large dose of the agent. A dose consisted of 2.5 - 10.0 g of a long-acting form of testosterone propionate, encapsulated in a biodegradable, non-toxic lactide coating to prolong the release of the hormone over a four to six month period. Additionally, (1) foaling times in treated herds shifted into the summer or fall (Garrott and Siniff 1992); (2) herding, capturing, immobilizing and injecting the harem stallions on an annual basis was difficult and costly; (3) long-term effects on the treated horses remained unknown; and (4) it was believed the agents could enter the food chain. For these reasons, chemical sterilization of stallions was abandoned as a focus for research into fertility control.

Silicone Implants in Mares. — Silicone rods impregnated with progesterone and estradiol were implanted into the necks of mares and blocked ovulation for up to 28 months (National Research Council 1991). This work was also suspended because the invasive nature of the surgery and the unacceptable stress placed on mares.

The PZP Investigations. — The scientific community identified the needs for an ideal fertility control agent in 1991 as follows (Kirkpatrick and Turner 1991; Seal 1991):

1. The agent should be at least 90% effective.
2. The agent should be capable of administration by remote delivery.
3. The agent should either be immediately reversible, or its effects should passively wear off.
4. The agent should be safe to pregnant animals.
5. The agent should not pass through the natural food chain.
6. The agent should be inexpensive.
7. There should be no debilitating side effects on the health of the horses.
8. The agent should not influence the social behavior of the horses.

This list of needs would drive much of the U.S. contraceptive research into wildlife species during the 1990s, including research funded by both the BLM and the USGS-BRD. To meet the stated criteria, the National Park Service (NPS) research team on Assateague Island National Seashore turned to an immunocontraceptive agent, porcine zona pellucida (PZP), for

the wild horses³ on the island (Kirkpatrick and Turner 1982; Kirkland et al. 1992; Turner 2000; Kirkpatrick 1995), which had been reported to block fertilization in dogs, rabbits, and primates. In order for sperm to attach to the ovum and fertilize the egg, there must be complementary proteins on both the surface of the sperm and the zona pellucida (ZP) of the ovum. PZP is a foreign protein against which the treated mare produces anti-PZP antibodies. These antibodies attach to the mare's zona sperm receptors on the ovum and block fertilization (Floorman and Wasserman 1985; Kirkpatrick 1995). Zona pellucida from domestic pig ovaries (obtained from slaughter houses) is minced and the PZP is obtained from screening filtration. Freund's Complete Adjuvant (FCA) is mixed with the PZP in order to enhance its effects when it is initially injected into mares intramuscularly.

Experimental PZP application on the wild horses of Assateague Island began in 1988. Following promising reductions in the pregnancy rates in mares (Kirkpatrick 1985; Kirkpatrick et al. 1990), the NPS in 1994 began to stabilize the growth of the population solely using PZP immunocontraception (Kirkpatrick and Turner, in press). The Assateague research team also developed non-invasive methods to assess the pregnancy rates of, and detect ovulation in, free-ranging treated and non-treated mares by analyzing reproductive steroid metabolites in feces and urine (Kirkpatrick et al. 1992). These methods require the sample be taken in the field from individually recognizable mares, but no captures are necessary.

It is impossible in this report to do justice to the larger volume of research conducted on PZP in wild horses on both western rangelands and on the eastern national seashores. Instead, we direct the reader to the summary papers of the J. Turner/J. Kirkpatrick/I. Liu research team (Kirkpatrick et al. 1992; Kirkpatrick 1995; Turner et al. 2000; Kirkpatrick and Turner, in press; Turner and Kirkpatrick, in press), to review the papers of Kreeger (1997) and Curtis and Warren (1999) and to annual reports of the research study (Turner et al. 1993 through 2001). Copies of these reports may all be obtained by writing to the National Program Office, Wild Horse and Burro Program, Reno Nevada.

The Outlook for PZP. — The PZP agent appears to meet most of the safety concerns of the BLM: it does not enter the food chain, its effects passively wear off with time if the injections are terminated, normal reproduction can be resumed, following up to seven years of use, and it does no harm if injected into mares that are already pregnant — they carry foals to term. Initial research suggests native PZP does not affect ovarian function, hormonal health, or safety in pregnant animals (Turner et al. 1999, 2000; J. Turner, personal communication, Nov. 26, 2001). Life span and health of treated mares may be increased, apparently due to the absence of stresses from pregnancy and lactation. Treated mares apparently live about five to ten years longer than do untreated mares that continue to get pregnant and produce young (Kirkpatrick and Turner 2002). One initial study suggested harem behaviors are not influenced (Powell 1999). There appear to be no generational effects — offspring of treated mares are able to reproduce normally (Kirkpatrick and Turner, in press; Turner and Kirkpatrick, in press). The agent is about 90% effective in blocking fertility in mares.

³ These animals are small horses, not ponies. Horses and ponies differ in several important ways, such as in length of gestation.

Best results using PZP are achieved following an initial “primer” dose, followed by annual “booster” shots. The initial injection, or primers, may be administered to mares following gathers when they are in chutes during capture. Alternatively, in those populations where the individual mare can be both recognized and approached on foot for darting, the injection may also be administered remotely by means of a 1.0cc dart with a Pneu-bait or Dan-Inject dart gun. A second booster shot is then required for each year of immunocontraception. Following the second or third year of treatments, only an every-other or every-third year booster is needed (J. Kirkpatrick, pers. comm.). Following cessation of the annual treatments, the agent and the antibodies passively decline, anti-fertility effects wear off, and normal reproductive function is resumed the subsequent year. However, following seven or more years of treatment, the anti-fertility effects may be permanent for individual mares (Kirkpatrick and Turner 2002).

PZP has been successfully applied to control fertility and limit the size of several small populations of wild horses on eastern barrier islands for periods of a few to 14 years (Assateague Island National Seashore, Cape Lookout National Seashore, Shackleford Banks; Carrot Island, Rachel Carson National Estuarine Reserve; and Little Cumberland Island, a private island). Progress is continuing on development of a time-release pellet vaccine of PZP that will allow two years (actually ~22 months) of fertility control with only a single shot injection (Turner et al. 1999, 2000, 2001). Progress on this time-release form is encouraging, although efficacy rates are variable and may be slightly lower (~ 85%) than for the conventional multiple injection program.

Two major drawbacks of conventional PZP and Time-Release PZP have been identified by BLM managers: (a) the brief duration – managers prefer a one-shot, three to five-year duration, and (b) the fact that the most effective known adjuvant, FCA, present some health concerns. While the one-year or two-year durations of these forms may be adequate, and even preferred for small populations of wild horses, managers of the larger herds, such as herds in Nevada and Wyoming, have a critical need for a single application agent that lasts longer. If a gather is held during the summer or early fall, and the Time-Release PZP is injected, only one effective season of contraception maybe achieved. Also, some mares could become pregnant late during the second subsequent summer. There are some concerns about a lower survival of late born foals.

The BLM’s long-term management needs clearly include both a shorter duration agent for small herds and a longer duration agent for the largest herds. A high priority of this research plan is to develop either a further time release extension of PZP, or develop a new agent that meets this need for a single-dose, longer duration contraceptive. In response to these needs BLM has just implemented a long-term study with captive wild horse mares to test the safety and efficacy of a newly-developed 3-4 year PZP vaccine.

BLM also seeks an alternative adjuvant to FCA. FCA can cause health problems when used in horses and following accidental injection or needle stick in people. FCA causes a false positive TB test, and can cause granulomas at injection sites in treated mares. These are generally small and shrink over time when the injection is into the buttock area of the horse. Presently, these risks are mitigated by only allowing persons trained and certified to administer the PZP and FCA mixture. These individuals must carefully following administration protocols in the field. Zoo Montana has trained BLM specialists in the past to handle the PZP and FCA

mixture. However, a safer alternative adjuvant is desired. Modified Freund's Adjuvant (MFA) and other adjuvants may be potential replacements. Preliminary results from a recent study comparing the efficacy and duration of MFA as a replacement are encouraging and suggest that MFA may be an effective replacement for FCA with wild horses. BLM will substitute a new adjuvant as soon as an effective replacement for FCA can be identified.

One intriguing new candidate agent form of PZP is referred to as SpayVacTM. It is simply PZP, combined with a FDA-approved adjuvant, incorporated within or between several layers of multi-lamellar liposomes. The liposome technology was developed by a team of scientists headed up by Dr. Robert Brown of Dalhousie University, Nova Scotia. The patent is held by Dr. Brown and Mark Fraker of Terramar Environmental Research Ltd., Vancouver, B.C. The liposome technology effects are not completely understood, but in one study using harbor seals, titers to the agents remained high following a single dose and pregnancy was blocked for more than eight years in the female seals (Brown et al. 1997). One big advantage of SpayVacTM is that its main component is PZP, and thus, many PZP research results should also apply. Although the duration of SpayVacTM is thought to be dose dependent (Lowell Miller, APHIS, May 2003, pers.corres), how long the effect will last, whether the duration will qualify SpayVacTM for use by the BLM, and whether the duration of contraceptive effects can be modified by altering the current liposome mixtures are questions that remain to be answered.

II. OVERVIEW OF THE ISSUES



A. Health and Handling Issues

The BLM gathers and holds in facilities wild horses and burros for periods of weeks to several months prior to adoption. In some cases if animals are determined to be unadoptable, they may be held for several years in long-term pasture holding facilities. During these pre-adoption and long term holding periods, the animals are under the care and supervision of the BLM. Health care includes multiple inoculations against pathogens, hoof trimming as needed, and de-worming on a regular basis. The animals are wild, handling creates some stress and they may be injured during handling, transport or treatment activities. Animals are also concentrated in the facilities, and infectious diseases can rapidly pass through the animals.

The BLM seeks to minimize the stress of handling and use the most effective and cost efficient health management practices available to safeguard the health and well-being of the animals under their care. Research is needed to identify optimal handling and healthcare practices that are not completely understood at this time because of the distinct differences between wild and domestic equids and the unique challenges associated with the large facilities in which they are managed.

Health problems among free roaming wild horses and burros are uncommon. Most of the health research needs of the free roaming wild horse and burro populations under BLM management are limited to better understanding how to manage emergency situations related to severe range conditions and how range conditions influence the health of animals at the time they are gathered. The need to support research to improve our understanding of the health of wild horses and burros on- and off-the-range is recognized in the context of the overall strategic plan for wild horse and burro research.

B. Fertility Control in Wild Horses⁴

Fertility control cannot be used to reduce herds of wild horses that are substantially over AML, or alone to limit population growth. Fertility control will assist the gather and removal program in achieving these two goals. The BLM seeks two fertility control agents, or two forms of the same agent that will reduce the frequency and/or size of expensive gathers and removals, and that will reduce the number of animals that will need to be removed from the range and adopted. The BLM seeks a shorter-term duration agent that will provide two years of contraception following a single injection for safe management of smaller herds of wild horses where population viability is a concern. The current form of Time-Release PZP may meet the need of the short-term agent, pending the results of the planned field trials. For larger herds of wild horses, the BLM seeks a contraceptive agent that lasts three to five years following a single injection. Gathers occur on a four-year cycle. Contraceptive management could focus on young to prime-aged mares following genetic guidance (Gross 2000). These mares could be injected once with an agent with a four-year duration, thus contracepted for four years, but then be

⁴ The listing order of topics does not imply priorities of timing or funding. The BLM will establish timing and funding priorities on an annual basis following input from USGS-BRD and APHIS.

allowed to passively return to fertility and contribute genetically for the remainder of their lives. A new group of young or prime-aged mares would be treated at the next four-year gather.

FCA is the most tested, most efficacious, and the best available adjuvant at this time. However, recent studies suggest the agencies should expand the search for a new adjuvant. There are concerns that FCA could cause some health problems. The BLM is working to replace FCA with another adjuvant, such as MFA, as soon as possible.

Sufficient prior work with PZP has been conducted on wild horses in Nevada and on Assateague Island to justify field trials at this time. However, significant unanswered questions remain concerning population and behavioral effects of the treatments that must be addressed before BLM proceeds with broad-scale management applications of fertility control.

Development of a new agent, or further time-release development of PZP, may follow one of two different paths. First, the BLM may pursue the path of Food and Drug Administration (FDA) approval of the agent. Full commercial development of the agent may be necessary, to defray costs of the approval process. A commercial company could produce the agent for purchase by the BLM within their wild horse and burro program. The amount of agent needed annually by the BLM is too small alone to elicit much commercial interest. For example, it is estimated one person in a few weeks time can produce all of the PZP that would be needed by the BLM to control wild horses each year. If the agent was also useful for other purposes (e.g., spaying of dogs, cats, or livestock) perhaps commercial interest might occur. This process can be time consuming and expensive (e.g., several million dollars), FDA approval of all safety, health, and efficacy work (Good Laboratory Practice and Good Clinical Practice guidelines must be followed) must occur, and the FDA must approve the final product. Approval of agents that already have prior usage and prior approval in domestic food animals, however, might be within the realm of possibility for the BLM. Second, the BLM may continue to use PZP or other new products under a research protocol. The BLM has selected this latter option for now for reasons of practicality and costs, although commercial development still remains an option at any time down the road. Third, the BLM may seek a legislative, non-investigational exemption for use of the current PZP mixture.

Reproduction in wild horses may differ in a number of subtle ways from domestic horses, for example, in the season of estrus cycles. The explanation for these observed differences may be merely environmental, or there may be some minor physiological differences that are inherited. Until the differences can be defined, the BLM has determined that non-invasive research into fertility control could be conducted on captured wild horses held in BLM facilities or with free roaming wild horses under the Fertility Control Field Trial Plan.

Fertility control is not as immediate and pressing a need in wild burros, as it so clearly is with wild horses. The social structure of burros, which lacks stable harem breeding units, combined with year-round breeding; would prove challenging for application of the current PZP technology. However, this challenge should not prevent the BLM from pursuing a solution to fertility control in wild burros. Given the limited financial resources available for fertility control research, it should be pursued in wild burros just as soon as some successes can be achieved with wild horses.

C. Population Estimation and Modeling

Wild horse and burro populations increase at a high annual growth rate and these high growth rates can be sustained annually for many years. Active management programs are required for wild horses and burros that include detailed tracking of population sizes, population growth rates, sex and age composition, and modeling of options for removal strategies and population goals.

Accurate population estimates for planning and management activities are essential. The management applications of either removal or contraception (or a combination of both) are based on the number of animals to be reduced and the intervals between management; however, these goals are only as accurate as the population estimate. Wild horse and burro managers need accurate and defensible aerial surveys.

A user-friendly computer model and manual has been developed to simulate the growth rate and long-term planning of management removals for wild horses (Jenkins 1996). Managers are in need of a similar model to simulate wild burro population dynamics and to plan removals. During aerial surveys made in the flat, treeless terrain of Nevada and Wyoming $\geq 85\%$ of the wild horses present are seen (Garrott et al. 1991). For aerial surveys over forested or tall shrub desert areas, there are no methods to determine the number of animals missed. One exception to this is the work of the Arizona Interagency Wild Burro Working Group, consisting of the BLM, State of Arizona, and other federal biologists. This group has developed aerial estimation techniques for wild burros in central Arizona with promising results.

D. Genetics

Although the current total number of wild horses in all the herds is very large (37,135 animals), the management goal for most herds is small. The BLM's stated AML goals are to manage 41% of the wild horse herds at a census number (N) of ≤ 50 horses, and 54% of the herds at $N \leq 100$ horses. Genetic effective population size⁵ for some of these herds may be set too low. At first glance, these statistics appear to be cause for concern.

⁵ Genetic effective population size (N_e) is a measure of the number of animals within a population that are not only breeding, but their progeny are successfully contributing their genes to the next generation. This complex topic is covered in more detail in Appendix II and III. N_e can be used to estimate the rate of loss of genetic heterozygosity (H_o) and loss of allelic diversity per generation in a population. The recommendation for $N_e \geq 50$ came from the breeders of domestic animals that found the level of loss acceptable. This number will result in a predicted loss of 1% of the heterozygosity (H) present per generation. The $N_e = 50$ rule may not be adequate for wild populations since selection pressures are more severe in the wild. N_e of larger than 50 may be required for wild species to adapt to more severe environmental conditions or changes. The N_e calculations assume random mating, which is never true with equids, and no mating of close relatives, which might not be the case in the smallest equid populations.

Information is not available on how many of these small herds are truly isolated. If there was even occasional gene flow between two or more herds that resulted in at least one or two successful breeding animals every generation⁶ that produced breeding offspring, then the genetic resources of all the groups would be maintained. Such groups of two or more subpopulations whose population dynamics are independent, but are connected by low levels of movements and gene flow, are referred to as a metapopulation. Clearly, many of the smaller wild horse populations are probably part of a larger metapopulation.

Inbreeding is apparently rare in wild horse populations. Horses in only a very small number (approximately 5) of the 203 HMAs have exhibited characteristics possibly attributable to inbreeding, such as cataract blindness, dwarfism, parrot-mouth, or club foot deformities. Most wild horse herds that have been sampled, exhibit moderate levels of genetic heterozygosity (both allozyme or biochemical and DNA heterozygosity) (Bowling and Touchberry 1990). Thus, there does not appear to be any immediate cause for concern about inbreeding depression⁷ in wild horse herds.

Nonetheless, the committee recommended a cautious approach by the BLM. The agency should monitor for signs of inbreeding via conducting genetic surveys; monitoring genetic information and key indicators of genetic health; and estimating N_e in a representative sample of herds (about five should be adequate). High inbreeding coefficients, and any bottlenecks⁸, or losses of genetic heterozygosity are a cause for concern. However, research is still needed to determine optimal goals for genetic heterozygosity that will maintain the fitness of horses in the wild herds and prevent inbreeding depression.

E. Habitat Assessment and Setting Population Goals

Central to the BLM's management of wild horses and burros is the habitat evaluation process that the BLM specialists use to set the appropriate stocking numbers of wild horses, burros, domestic livestock, and any native grazers, such as elk or bighorn sheep. For wild horses and burros, this numeric goal is the AML. Equally important is the monitoring program that the BLM uses to determine the success of these various AMLs in protecting soil, vegetation, and wildlife resources of the area.

In 1988, the Department of the Interior's Board of Land Appeals decided that the wild horse and burro stocking levels and livestock numbers be set to achieve a "thriving natural ecological balance" for each herd management area. As noted earlier, the Federal Land Policy and Management Act of 1976, the Public Rangelands Improvement Act of 1978, and orders from Congress have directed the BLM to manage the number of wild equids to accommodate multiple uses of other resources and the long-term sustainability of the range.

⁶ A wild horse generation equals 5-14 years.

⁷ Inbreeding depression is defined as the loss of fecundity or viability due to inbreeding. It can frequently manifest itself as a specific genetic defect in horses.

⁸ A population bottleneck is defined as a short-term population reduction to a small size that may reduce genetic heterozygosity.

Diverse methods have been used to set the AMLs on the BLM lands. Currently all offices are required to adhere to the Land Use Plan process to determine AMLs and livestock numbers, including public scoping, plan development, National Environmental Policy Act analysis, and information from on-going monitoring. But since state offices have the lead role in habitat assessments, there is some diversity in how the various states conduct habitat monitoring. The BLM directs specialists to use new monitoring data to update forage allocation decisions in an adaptive management approach.

The BLM has an ongoing need for the incorporation of most up-to-date research findings and new techniques into their habitat monitoring and habitat restoration programs. For example, a GIS-based habitat model for wild horses would be useful to many managers.

The sheer size, diversity, and complexity of the BLM's current program, however, mandates that an in-depth assessment of habitat research needs to be conducted by the BLM. Such a major assessment was beyond the scope of the 2001 effort. Additionally, habitat research needs were viewed by the BLM as less pressing than other research needs (at least in 2001-2002). Several changes and improvements are currently underway in how the BLM deals with all of their grazing management, including how livestock, wild horses', and burro's grazing is integrated. It was premature to propose any additional changes at this time. Habitat research is deferred until such an in-depth analysis can be conducted by the BLM.

III. THE STRATEGIC PLAN



A. Health and Handling Strategies

The Challenge:

While they are generally considered hardy, wild horses and burros face new challenges following capture. Even under the best conditions, simply handling wild animals to move them from pen to pen, load them on trailers or administer preventive or therapeutic medications is stressful and includes some increased risk of injury. Physiologically, stress increases susceptibility to infectious disease. Captured animals may be naive to diseases that are common among domestic equids (e.g., strangles), and they are mixed in larger groups than are typical under rangeland conditions. The logistics of gather, preparation and adoption often include the repeated transportation of animals over long distances. These factors combine to create unique health and handling challenges for the wild horse or burro compared with their domestic cousins.

Safeguarding the health and welfare of wild horses and burros includes identifying the most effective, least stressful way of handling and preparing them for their transition into captivity. A clean bill of health is also an important part of successful adoptions.

Most of the health research needs for wild horses and burros on-the-range are related to better understanding the health problems that occur in free ranging wild horses and burros. These are usually the direct or indirect result of man's influence (i.e., domestic horses exposing wild horses to infectious disease) or unusually harsh range conditions (e.g., drought, fires, plant toxicities).

Issues:

1. Animals are placed in stressful circumstances during handling and transport from one holding facility to another, and illness and injuries may occur.
2. Infectious upper respiratory disease, including strangles and streptococcus zooepidemicus infection, occurs in animals in some facilities; and the sources of these infections are not known.
3. Record keeping concerning mortalities, nonfatal illness or injury, and medical and preventative treatments used at different facilities needs improvement.
4. Wild burros are unique and may have unique health problems (e.g., susceptibility to hyperlipemia and hyperinsulinemia) and can become ill if moved too rapidly to areas with very different climates.
5. Optimal vaccination strategies and protocols to prevent certain infectious diseases (e.g., strangles, equine influenza, and herpes) and the effects of handling stress are not well understood.
6. We need a better understanding of how to best intervene when animals are acutely or chronically exposed to extreme range conditions brought on by drought or fire including water deprivation, starvation, and plant toxicities.
7. Incident clusters of plant toxicity (e.g., astragalus species), congenital or developmental abnormalities (e.g., parrot mouth, club foot) and unusual illness or death loss may need to be investigated on the range.

8. We need a better understanding of how subclinical conditions (e.g., nutritional deficiency, plant toxicity) impact immunocompetence and how animals cope with stress after removal
9. Procedures for blood banking need to be developed (also a recommendation of the WH&B Advisory Board) and implemented throughout the program.
10. There is no standard procedure for requesting, receiving, evaluating, and funding new research proposals. Unsolicited proposals should not drive the process. The BLM's needs should drive the process for research priority setting and calls for proposals.

Goals:

1. Optimize preparation and health maintenance protocols to maintain, protect and improve the health and well being of wild horses and burros held in captivity.
2. Maintain safety for both the animals and persons involved during handling.
3. Be receptive to opportunities for improving handling procedures for wild horses and burros so they are better, and more efficient.
4. Better understand the health problems that occur in free ranging horses and how these problems may impact their health after removal.
5. Improve the adoptability of the wild horses and burros, and provide the public with animals that are healthier at the time of adoption, have lower rates of exposure to infectious disease and fewer health problems after adoption.

Strategies:

The need for research to improve our understanding of the health needs of wild horses and burros on- and off-the-range is recognized in the context of the overall strategic plan for wild horse and burro research. This includes considering the impact of all research efforts (contraceptives, habitat evaluation, population modeling, etc.) on animal health and supporting research efforts aimed more specifically at animal health. Topics considered top priorities for health research include:

1. Consider additional research into the types of stress and injury that occur in wild horses and burros, their causes, and the best methods to reduce them during the transport. For example, identifying specific feed or trailer specifications that will minimize stress and injuries, and developing a better understanding of how electrolyte levels can be maintained during transport would be helpful.
2. Review the need for additional research on infectious upper respiratory diseases at holding facilities, identify sources of these infectious and ways to reduce the incidence of disease and impact on the program.
3. Develop a new more detailed monitoring system for mortalities and non-fatal illness and injury, as well as therapeutic and preventive treatments within facilities.
4. Research to better understand the incidence, causation, and prevention of diseases specific to wild burros.
5. Evaluate the effectiveness of vaccination strategies for strangles, equine influenza, herpes, and other diseases in stressed horses.

6. Review the need for investigating new gelding procedures, including the potential for injections of agents such as those that act against GnRH (Gonadotropin Releasing Hormone).
7. Develop and implement procedures for the safe, efficient banking of blood samples to facilitate animal health monitoring as a tool for improving animal health management (e.g. the emerging threat of West Nile virus infection).
8. Establish a standardized procedure for requesting, receiving, reviewing and funding health research proposals. The review procedure should include consideration of the scientific merits of the proposal as well as possible management implications for the BLM.
9. Use reviews of recent state-of-the-art research from the veterinary literature to address some of the Program's health research needs where possible. Make this information more readily available to specialists and thus, meet some information needs within the WH&B Program without the need for original research.

Other health problems and factors that are worthy of investigation in free roaming herds include problems or developmental abnormalities that may be related to nutritional deficiencies, plant toxicities or genetics, the unique attributes of wild horses that distinguish them from their domestic cousins (e.g., exceptional hoof quality), and monitoring wild horse and burro populations for infectious diseases that also impact the domestic horse population (e.g., vesicular stomatitis, equine infectious anemia).

Proposed Outcomes:

1. Minimize transportation stress and injuries.
2. Reduce or eliminate incidence of upper respiratory diseases at some facilities.
3. A new health monitoring system for wild horses and burros.
4. Improve health of wild burros and reduce mortality and incidence of serious illness that result from the special needs of burros.
5. Ensure the most up-to-date and efficient vaccination strategies are available to the program.
6. Identify the most humane, effective and efficient gelding procedures.
7. Increase availability of blood banking procedures for all blood samples taken.
8. A program for objective and fair calls for review, and funding of proposals.
9. Review all research proposals for their potential impact on animal health.

B. Fertility Control in Wild Horses - Strategies

The Challenge:

No single fertility control agent or device is currently available that meets all of the stated needs of the BLM. Contraceptive agents or physical devices are currently available that meet many of the stated goals. Both Conventional PZP and Time-Release PZP technology meet more of BLM's needs than any other tested known agent. Although significant questions remain concerning population-level treatment and behavioral effects, both Conventional and Time-

Release PZP are ready for field trial testing in wild populations under a research protocol. A longer-lasting agent is needed for larger herds to provide contraception with a single dose. New adjuvants need to be tested as potential replacements for FCA. Even as research continues and new management programs are instituted, the USGS-BRD and the BLM must remain alert to any additional, potentially promising new developments and new agents. The BLM and USGS-BRD should not immediately abandon any ongoing work with PZP until a significantly better agent, or better form of the existing PZP agent, is developed and tested.

Issues:

1. Over the next five years, the BLM plans to lower populations of wild horses and burros to levels more compatible with a healthy range in order to (1) improve the condition and survival of the wild equids and other wildlife, and (2) protect soil and vegetation resources.
2. This goal is nearly impossible to obtain with removals and adoptions alone. The current existing adoption process cannot handle the 10,000 animals gathered annually during the last few years. There are limitations of both facilities and demand by the public to adopt animals.
3. Trade-offs between a fertility control agent's effective duration, cost, and risk of population over-management have not been quantitatively explored. The BLM needs to know the implications of variable durations of agent(s) on their program. Are two agents clearly needed — one with short-term duration for small populations and one with long-term effects for larger populations?
4. To understand the effects of any stress due to handling for contraception.

Goals:

1. Research should, as soon as possible, provide an effective fertility control tool to BLM for management use with wild horse mares that: (1) can be administered with a single injection; (2) is effective for multiple years; (3) is safe if administered to pregnant mares; (4) is immediately reversible or passively wears off after which completely normal fertility and pregnancy in the mare can resume; (5) can be practically administered either remotely to habituated free-ranging wild animals or injected into animals held in facilities or restrained by equipment such as standard capture chutes; (6) will not enter the food chain; (7) can be tested under an INAD permit, or in the remote possibility of commercial interest, could eventually earn FDA approval; and (8) is greater than 90% effective in blocking pregnancy. At present, two forms of PZP – Conventional (multi-injection, one-year) and Time-Release (one-injection, two-year) – meet all of these criteria with one major exception; these forms do not meet the stated one-shot, three to five-year duration need of the BLM. Even the current Time-Release form needs some modification. Time-release PZP pellets made by either a heat-extrusion or a cold-evaporation process need to be evaluated. Beginning in 2002, field-trial tests were initiated with the currently available PZP agents. These will continue until a longer-lasting agent can be developed or becomes available. The purpose of these field trials is to provide the necessary information and assurances on population-level and behavior effects so that broad scale management of herds by PZP may proceed.

2. Develop a longer-lasting (three to five, or more, years) agent, or further modify and extend Time-Release PZP to achieve the one-shot, three to five-year need of the BLM. A longer-lasting agent must be developed and tested by the USGS-BRD and the BLM. Even a one-year extension of the current Time-Release form to a three-year duration would make a huge savings of efforts and costs for managers of larger herds. Given the fact that many gathers (and thus, the injections) would occur during the summer or early fall, the current two-year time-release form only provides contraception for one full breeding season. Even two breeding seasons of fertility control may be too brief for most herd managers since most gathers are on a three- or four-year cycle. In light of this, BLM initiated a test of a 3-4 year PZP vaccine with captive wild mares in March 2005.
3. Test alternative adjuvants to FCA that do not result in any false positive TB tests and are less objectionable. Test MFA, QS-21, and other adjuvants that would be less objectionable than FCA. A 10-month trial did occur with MFA in captive wild mares and was completed in October 2004. MFA is now being considered as an acceptable substitute to FCA. BLM will consider the replacement of FCA with MFA in all subsequent captive and field trials as the adjuvant to be used with PZP.

Strategies:

1. Conduct preliminary modeling for direction and guidance on the numbers, age classes, and durations of treatments. — Model the tradeoffs, cost-benefits, and risks of the various durations of an agent. Based on this analysis, the BLM should then select the optimum duration(s) for agents that they desire to use. Modeling should also guide the optimum mix of strategies (all contraception, all removal, or best mix of both), scenarios of marking, monitoring, handling, and mare selection (all young, random) to produce the greatest benefits to handlings and animals removed, to meet BLM's stated objectives for population viability. This preliminary modeling began in 2002, and is being done by researchers at Colorado State University. In addition, an economic analysis evaluating different management strategies with fertility control was modeled by John Bartholow, a BRD-USGS researcher, and completed in 2004.
2. Immediately conduct field tests with both Conventional PZP and Time-Released PZP under a research protocol until a longer-lasting agent is developed (Figure 2). Conduct research on the effects of PZP contraception on wild horse population growth rates, seasonality of foaling, any health complications, and any effects on behavior, and harem dynamics so that the information and assurances are available prior to proceeding with any broad-scale management application of PZP. Conduct those studies on wild horses in captivity for those topics where free-ranging wild horses cannot be observed with enough regularity (e.g., studies of effects on annual estrus cycling, studies of any complications). Population and individual-based studies, using conventional and time-release PZP, were initiated in 2002 and 2003 under the guidance of the Fertility Control Field Trial Plan.
3. Organize a competitive call for proposals to develop a longer-lasting agent.
4. Preliminary laboratory work with mixtures and dosages should occur by the developers, proponents and contractors.
5. Screen the safety of any new potential longer-lasting contraceptive agents first in captive settings before any testing in the field. Included in this listing are any new agents,

adjuvants, and mixtures. Tests of FMA and a newly-developed 3-4 year PZP vaccine have been initiated with captive wild mare trials in 2004 and 2005, respectively.

6. Immediately start tests on the efficacy and duration of other adjuvants that are less objectionable and have a higher probability of FDA approval compared with FCA (e.g., Modified Freund's, QS-21)
7. Consider the potential for FDA-approvability in the selection of agents. If a longer-lasting (3-4 year) agent is developed, field trials on that agent should be immediately initiated.

The BLM has selected a two-pronged plan of attack to simultaneously: (1) aggressively pursue a final form of new agents or modification of currently available PZP that meets the longer-term duration needs, while also (2) aggressively field testing current PZP until any significantly better agent becomes available. Work on development and screening of new agents (Phase II) and field testing the best current agents (Phase III) should occur concurrently (Figure 2).

The BLM and USGS-BRD initiated field tests with current PZP forms in 2002 and 2003, under the guidance of the Fertility Control Field Trial Plan. The respective agency research coordinators traveled to prospective study sites in 2002 and 2003 and visited with the herd area managers. Study sites were selected and field research initiated to obtain pre-treatment data wherever possible. Field studies started in 2002 and 2003, to run through 2007 and 2008, yielding one to two years of pretreatment data and four years of post-treatment data. Where pretreatment data collection was not possible, the controls to treated mares will be untreated mares in the same and in other harems. Research with aerial survey techniques and any field studies related to genetics should be conducted on these same study herds in order to maximize efficiency and save dollars. The field-trial research with PZP will also include the agent's effects on fertility control and body condition, studies on age-specific survival rates, harem organization and cohesion, duration of the breeding season, social behavior of mares, harem-tending behavior, and dominance relations among stallions.

Proposed Outcomes:

1. A suitable, longer-lasting, and safe fertility control agent will be developed for consideration in broad-scale management application by the BLM. Fewer total animals will be rounded up and adopted. When lower maintenance population levels are reached, there will be longer intervals between gathers, and the gathers will be less expensive and smaller in scale. Fewer unadoptable animals will be held in long-term holding facilities at government expense.
2. Substantial savings in federal dollars will be accrued to the government. Presently, a large proportion of the entire budget of the WH&B Program is tied up in the enormous "Adoption Pipeline" – the process of gathering animals, holding them, transporting them, and then adopting them.
3. More stable populations will be achieved with contraceptive management than with the widely fluctuating current "increase-gather-increase" scenario. More genetic

heterozygosity will be maintained and habitat will be protected under a more stable population scenario.

4. Fewer animals will be subjected to the stresses of capture and increased diseases and pathogen transmissions that go along with confinement of large numbers of animals.

Research Activities of the USGS-BRD

Parallel Management Activities and Decision Milestones of the BLM

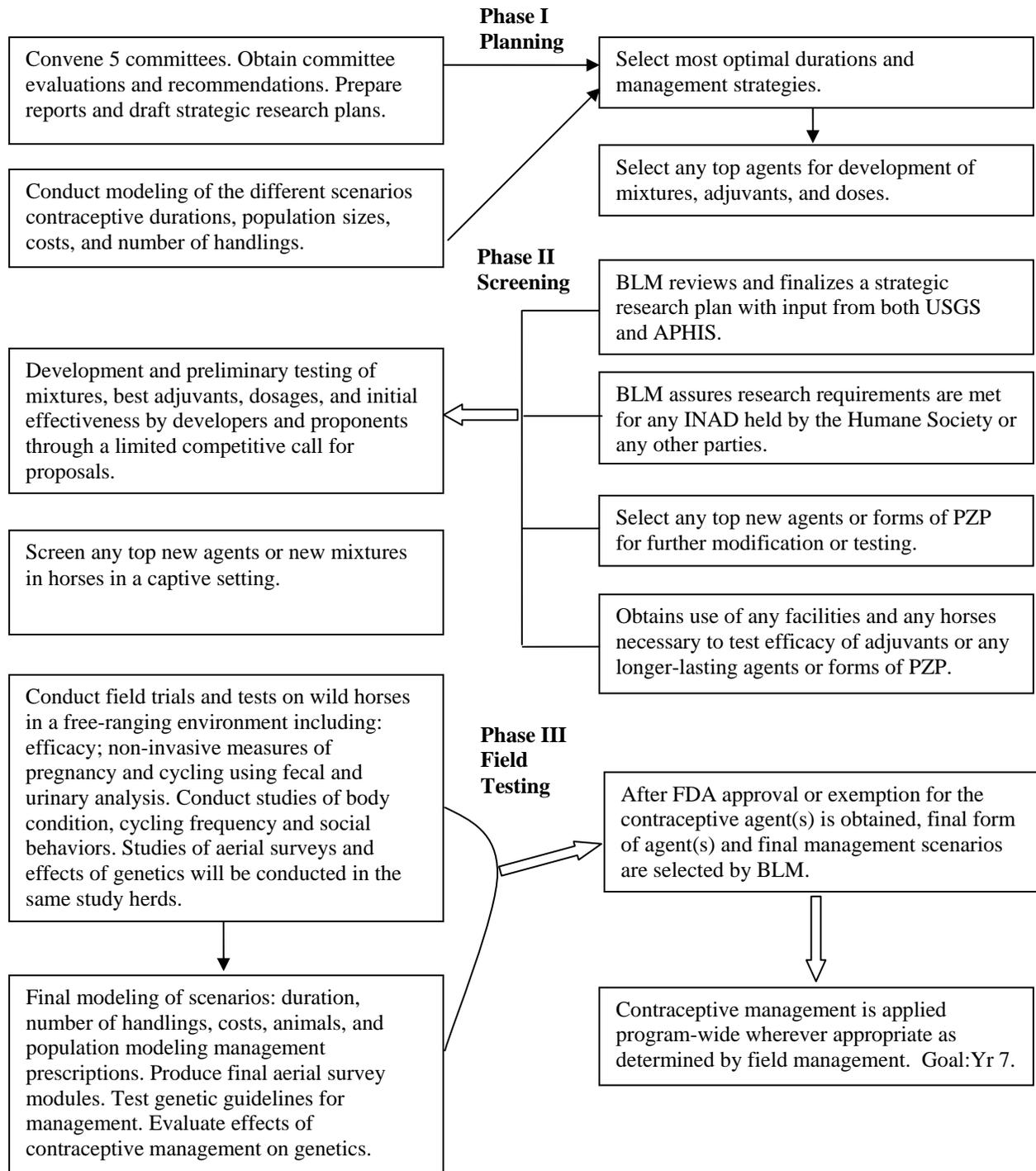


Figure 2. Project overview. Major research steps and corresponding decision milestones for the BLM are detailed.

Year	Phase/Activity		
2001	I. Planning: Committee Meetings. Draft Strategic Plan .		
2002	III. Field Testing: Initiate field trials with current PZP agents. Also conduct census and genetic studies in same individually-based field trial study herds.		
2003	II. Screening: a. Release a competitive contract proposal to locate a longer-lasting new contraceptive agent or form of PZP that is effective for 3-5 years or more with a single dose. b. Test the effectiveness of adjuvants on horses in captivity.		
2004			
2005			
2006	Final reports Phase II. Continue low-level monitoring of mares treated with longer-lasting agents to determine the time to recovery of fertility.		New Field Trials using promising new fertility control agents, population model prescriptions, population estimation techniques and genetic management protocols that have been developed to date.
2007		Final reports Phase I. Continue long-term monitoring	Evaluate treatment effects
2008	Experimental management is evaluated		
2009	Consider broad scale management application of Fertility Control (Year Seven)		
2010	Evaluation of the Success of New Management (Years Eight – Eleven).		

Figure 3. Phases I-II of the Strategic Research Plan for Wild Horses and Burros

C. Population Estimation and Modeling of Population Management Prescriptions – Strategies

The Challenge:

The stated goal for the BLM's Wild Horse and Burro Program is to conduct a population census⁹ or estimate on every herd area every four years, or more frequently if necessary. A few of the smallest, most accessible, and most visible of the wild horse herds may be completely censused using ground surveys, with identification based on photographs or unique natural markings of animals. Because wild burros possess fewer unique markings, identification systems do not appear to be possible for wild burros. The size of all burro herds and most wild horse herds are estimated from an aircraft, typically a helicopter. Wild horses in flat, treeless terrain are easily counted and it is estimated that $\geq 85\%$ of animals are seen. But, wild horses and burros may be missed in more rugged terrain and tree cover. Wild horse and burro specialists need standardized, tested, cost effective, defensible, yet easy-to-use aerial population estimation techniques for wild burro herds found in rugged and forested areas. The best technique(s) presented to the BLM wild horse managers in a format such as a computer diskette or CD-rom with easy-to-follow directions and a user manual. Some areas to be surveyed are so vast BLM managers may decide to count only portions of a herd area to save time and dollars. Stratified, random subsampling procedures may be used to obtain a valid estimate of the population size for these larger herds.

Issues:

1. Aerial and ground population survey requirements for the BLM are daunting. The BLM is responsible for the management of over 200 wild horse and burro populations located across vast expanses of public lands.
2. In order to plan any management removals, the BLM requires population estimates, sex and age classification data, and population management modeling (Jenkins 1996) every three years on every herd area.
3. Sightability for wild burros is lower due to their small size, often cryptic colors, small groups (sizes are often single individuals), and stoic behavior. This results in many animals standing still as aircraft pass the rugged, brushy or riparian-forested habitats that they reside in. Sightability for burros from a helicopter may only be 40-60% of the animals present.
4. Wild horses are visible in flat, treeless terrain, but where patches of conifer cover are present, the estimated sightability of wild horses may be as low as one-half the animals present. Even in the more open terrain in Nevada, earlier scientific estimates of the percent of all wild horses observed are still only 66 to 85%.
5. Cost, personnel, and fatigue factors may make aerial surveys of large areas prohibitive. Representative samples of these vast areas can be surveyed using stratified, random

⁹ A census is typically defined as a total count. Total counts are rarely possible, however, since animals are found in tree cover and dispersed over large areas of rough terrain. Thus, a population estimate with a confidence interval on that estimate is a more reasonable goal for managers.

sampling, thus reducing the total area that needs to be surveyed. The BLM has directed the protocol include the option for subsampling, using these procedures.

Goals:

1. To provide aerial and ground population estimation techniques for wild horses and burros that are valid, tested, defensible, cost-effective, easy to use, and that allow managers to survey representative reproductive subsamples of vast areas to obtain valid population estimates. Testing on several recommended techniques began in 2004.
2. To explore high resolution Department of Defense imagery as a possible substitute for helicopter surveys, if the technology was made available to the BLM.
3. To improve, update, and apply current population and genetic models to guide removal, genetic and contraceptive management needs.

Strategies:

1. Develop aerial technique(s) and product(s) from amongst four candidates (Idaho Sightability Model, Simultaneous Double-Count, Distance Sampling, and Noninvasive Mark-Resight) for wild horses. Many wild horse herd management areas are managed for small populations that may be more amenable to mark-resight techniques using individually identifiable horses, and representative ground or aerial surveys of the area. Focus on development of those least invasive techniques that: (a) require no collaring or capture of wild horses, (b) only one aerial or ground survey per population estimate to minimize overflights and disturbances of the animals, and (c) allow subsampling.
2. Explore the availability of Department of Defense (DOD) satellite imagery for identification of horses as a potential substitute to helicopter surveys in some areas. However, the war on terrorism may make this imagery less available for the next few years.
3. Continue to monitor the progress of the Arizona Wild Burro Interagency Aerial Survey Working Group to develop a technique for wild burros. Currently the group is testing the Simultaneous Double-Count technique, with excellent initial success. Respond if the group asks for additional work or assistance. The need for wild burro aerial survey techniques will be addressed following the wild horse work.
4. Three population models have been developed for management application, all of which received high marks for performance by this and earlier panels. These models should continue to be updated and improved. In particular, the Jenkins population-removal model (Jenkins 1996) that is used by wild horse and burro specialists, is currently being revised for use with WINDOWS, and will include density dependence — both are significant improvements. The Gross model (Gross 2000) is excellent for modeling genetics and management scenarios. The Hobbs Model (Hobbs et al. 2000) is excellent for modeling contraceptive scenarios — but both models need updating with new research information.

Proposed Outcomes:

1. Improved methods for population estimation will result in aerial surveys in herd management areas that are less expensive, more efficient and provide accurate estimates with confidence intervals on the estimates.
2. The techniques will be accessible by all wild horse and burro specialists.
3. The Jenkin's population model that the BLM currently uses will be improved.
4. Population models will be applied to more management questions concerning genetics and fertility control treatment plans.
5. DOD satellite imagery could substitute for helicopter surveys. Considerable cost savings could occur as could reduction in safety hazards to BLM personnel, if this imagery could be made available.

D. Genetic Conservation Strategies

The Challenge:

BLM is mandated to manage for self-sustaining populations of wild horses and burros. Inbreeding appears rare in wild horses and burros. Genetic problems due to inbreeding depression, however, may be encountered in a few small, isolated populations of wild horses or wild burros. The BLM needs to guard against potential inbreeding problems by conducting surveys, as needed, of the genetics of wild horses and monitoring key indicators of heterozygosity, inbreeding coefficients, and genetic effective population sizes so that management intervention may be proactive.

Some potentially unique groups and phenotypes of wild horses occur on the BLM lands. The public recognizes these unique groups, particularly a few herds with Spanish colonial heritage. Existing genetic evidence supports the presence of early colonial Spanish horse alleles in some herds. This suggests these herds are more similar to early Spanish founder stock. However, wild horses possess no unique alleles that are not already found in domestic horses. Nothing in the 1971 Act or in policy, however, directs the BLM to provide special management for some groups of horses. The genetic and heritable components of any possibly unique traits, or unique groups of wild horses, should be tested during a comprehensive analysis of common ancestries amongst the herds. Similar or closely related herds of horses should be identified for any genetic augmentation of wild horse herds.

Issues:

1. Population goals for some wild horse and burro herds may be too low to meet conventional standards for minimum genetically viable sizes (K. Schoenecker and F. Singer 1999. USGS-BRD report, Ft. Collins, CO). This is not a matter of immediate concern since many of these herds may have gene flow to other herds, thus forming a metapopulation. Even very limited gene flow (e.g., one to two breeding animals every generation) between subpopulations will guard against inbreeding. Wild horse herds were larger in the recent past, peaking in numbers about 1980. Thus, genetic concerns

are a fairly recent issue. Only approximately five herds have produced animals with physical defects. In only one of these cases was there sufficient background information on the herds' size and genetics to implicate inbreeding as the likely cause of the problems. Inbreeding may have caused the other problems, but they may also have been due to inherited defects.

2. Managers lack data on which herds are genetically isolated. Those herds need to be identified that possess low values of heterozygosity, and where severe bottlenecks, or high levels of inbreeding occur.
3. Unique phenotypic, historical and wild types of horses may exist; however, the genetic basis for any potential uniqueness has never been quantified.
4. Wild horses may be more vulnerable than many mammals to inbreeding depression at low population levels due to: (1) a harem breeding structure that limits breeding males mostly to harem holding stallions, and (2) a dominance hierarchy that usually delays harem holding and breeding in males until six to seven years of age or older.

Goals:

1. Manage against inbreeding depression. Maintain healthy genetic fitness and viability of wild horses as a wildland species so they may survive and persist in unpredictable and often rigorous environments. Manage to minimize the need for augmentations, if possible.
2. Set minimum goals for genetic viability of the populations in terms of: (a) minimum levels of total heterozygosity (both allozyme and DNA), (b) minimum genetic effective population sizes, (c) maximum amounts of inbreeding, and (d) a maximum loss of alleles that will be allowed.
3. Identify any small¹⁰ and truly isolated herds of wild horses through both genetic analysis and also reviews of the movements, herd histories, and sizes of the herds in question. Small and isolated herds are a cause of concern. Identify any metapopulations or collections of connected subpopulations where small size of some subpopulations will not be a concern.
4. Document any relatedness and any uniqueness of all the herds. Quantify relatedness amongst herds to guide any introductions of new animals. Establish prevalence and habitability of any special traits or phenotypes.
5. Establish management protocols for genetically "rescuing" small, isolated populations of wild horses through introductions of new individuals from genetically related or similar herds.
6. Conduct research on what is the minimum size for viable populations.

Strategies:

1. Conduct a comprehensive survey of the genetics of all the wild horse populations. Determine which small wild horse herds, if any, are truly genetically isolated. Although previous genetic blood draws were done on several herds, systematic surveys were initiated in 2003 whereby all herds subjected to population control gathers were also

¹⁰ Small populations are defined as $N_e \leq 50$.

subjected to blood draws for genetic evaluation purposes. Reports are generated for each herd identifying founder stock, level of diversity and management recommendations for avoiding inbreeding problems.

2. Determine the effects of contraception on rates of loss of herd heterozygosity.
3. Document the inbreeding genetic contribution, if any, to the deformities observed in a few specific herds. Develop guidelines for avoiding these situations in the future, and for avoiding deformities that have a genetic component.
4. Determine, through field studies, the threshold levels of heterozygosity and inbreeding below which reduced fitness and inbreeding depression may occur in wild horses, so that the BLM can avoid these situations.
5. Calculate genetically effective population sizes (N_e) in at least five populations of wild horses (two are already completed) so that the BLM will know the average and range of N_e to census N ratios to establish generality for minimum population sizes for viability.
6. Conduct a meta-analysis of the genetic information for all the herds. Conduct quantitative statistical analyses to identify the commonalities and relatedness of all the groups of wild horses. These commonalities may guide which herds are selected for the introduction of new animals. Additionally, the thresholds for management intervention need to be quantitatively assessed, defensible and published. Currently, the genetics contract only allows for sampling and analysis of individual herds
7. Search for any patterns in fitness lines, matriline, patriline, etc., that would alter the estimation of N_e/N . How managers select horses for removals vs. those left on the range to breed may alter genetics of the herd. Conduct an analysis of parentage, using DNA markers, in three individually-based study herds to accomplish this.
8. Identify meta-populations within each given area, region, or state.

Proposed Outcomes:

1. Minimum guidelines and protocols will be established for management intervention to maintain fitness, avoid inbreeding depression, and prevent genetic defects due to inbreeding in wild horse herds. Key genetic parameters will be monitored.
2. There will be documentation of the genetic basis for the relatedness of groups to guide the introduction of new animals for genetic purposes to identify any unique traits or any unique groups of wild horses.

E. Habitat Assessment and Setting Population Goals

Deferred pending a more in-depth analysis of BLM's needs related to habitat assessment, monitoring and evaluation.

IV. Glossary

Adjuvants - A component of the vaccine that enhances the main product, or antigen, and consequently increases antibody formation. Adjuvants can also delay the release of the vaccine as in the case of SpayVac. The vaccine works much more efficiently with the adjuvant. These are general immunostimulants that cause the body to make greater concentrations of antibodies against the vaccine.

Appropriate Management Level (AML) – The Wild and Free-Roaming Horse and Burro Act of 1971, the Taylor Grazing Act of 1934 and the Federal Land Policy and Management Act of 1976 all direct the BLM to set appropriate numbers of grazing animals, including wild horse and burros, and to manage for those goals, or AMLs. AML goals are determined through the BLM's planning process, and are later evaluated with monitoring at levels that will allow for healthy, self-sustaining populations of equids, a Thriving Natural Ecological Balance (TNEB), and are compatible with other uses.

Chemosterilants - This term broadly refers to any chemical agent that causes temporary or permanent sterility.

Contraception - A chemical or agent that prevents pregnancy in any manner, typically by blocking either ovulation or fertilization. Contraception is usually temporary. Fertility usually returns passively after treatment has been terminated.

Fertility Control - A collective term that refers to all methods of inhibiting reproduction.

Immunocontraceptives - Contraceptive agents stimulate the body's immune response in the host animal against hormones or proteins essential for reproduction, and in doing so blocks pregnancy or some other essential component of reproductive function. Immunocontraception may include vaccines directed at either reproductive hormones, at sperm, or at the ovum. Most wildlife applications include vaccines that are directed at blocking fertilization in the female by stimulating production of antibodies against the zona pellucida (ZP) of the ovum.

Investigational New Animal Drug Exemption (INAD) - A research permit issued by the U.S. Food and Drug Administration (FDA) for research into new or untested compounds including contraceptive agents. This permit is required for any new drug research with animals.

Passive Return, Reversible and Permanent Fertility Control Agents - Reversible fertility control agents as those agents whose antifertility effects can be immediately terminated with a reversing agent and normal reproductive function resumed. Immediate reversibility might include a reversing agent that is administered, or a physical device such as an IUD that can be removed and normal reproductive function returns. A reversible agent provides a number of advantages in that the number of animals returned to reproductive potential is immediately known. PZP is an example of the agents that, in the absence of an annual booster, normal reproductive function is passively resumed, as the effects of the agent wear off. The term permanent when applied to fertility control agents is also operationally vague. Except for the removal of the reproductive organs

which permanently impair reproduction, the agents often referred to as permanent, such as GnRH-PAP, may be long-term but may not prove to be truly permanent.

Physical Methods of Fertility Control: Intrauterine Devices (IUDs) - Physical rings or other devices that are placed in the uterus and prevent pregnancy. This approach has been used to successfully block pregnancy in humans and in a large number of animal species, including six domestic horse mares (Daels and Hughes 1995). All of these mares produced foals following the removal of a O-ring shaped IUD. In humans, IUD's were demonstrated to be effective for as long as 12 years, at which time their effects were still reversible.

Sterilization - An inability to reproduce. Usually refers to a more or less permanent infertility, such as would occur by removal of male (castration, or the gelding process) or female reproductive organs (neutering, or spaying process). Several agents listed in this report mimic sterilization in the short term, or in some cases longer term, e.g., seven years, but none are felt to cause permanent sterility – some recovery of normal reproductive function is likely.

Strangles – Strangles is a highly contagious, infectious respiratory disease of equids caused by the bacterium *Streptococcus equi* subspecies *equi*. Characterized by inflammation of the upper respiratory tract infection often results in abscessation of intermandibular, parotid or pharyngeal lymph nodes. Immunologically naïve horses are at greater risk for infection and outbreaks often occur in large populations that have frequent additions. Although mortality is rare, morbidity can approach 100%. Immunization against *S. equi equi* does not always prevent infection, though it may prevent severe manifestations of disease in infected animals.

Thriving Natural Ecological Balance (TNEB) - The Wild and Free-Roaming Horse and Burro Act of 1971 requires that wild horses, burros and wildlife, be in good health and reproducing at a rate that sustains the population; the key vegetation is able to maintain its composition; the soil is being protected; and a sufficient amount of high quality water is available to all animals.

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