UNITED STATES

DEPARTMENT OF THE INTERIOR

BUREAU OF LAND MANAGEMENT

ENVIRONMENTAL ASSESSMENT

SAND WASH BASIN WILD HORSE HERD MANAGEMENT AREA GATHER

DOI-BLM-CO-N010-2021-0034-EA

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BLM

SAND WASH BASIN WILD HORSE HERD MANAGEMENT AREA GATHER PLAN

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1.0 INTRODUCTION

This Environmental Assessment (EA) has been prepared to disclose and analyze the environmental consequences of conducting gather operations to remove excess wild horses from the Sand Wash Basin Wild Herd Management Area (see map, Appendix A) as proposed by Bureau of Land Management (BLM) Little Snake Field Office (LSFO). The EA is a site-specific analysis of potential impacts that could result with the implementation of a proposed action or alternatives to the proposed action. The EA assists the BLM in project planning, ensuring compliance with the National Environmental Policy Act (NEPA), and determining whether any "significant" impacts could result from the analyzed actions. "Significance" is defined by NEPA and is found in regulation 40 Code of Federal Regulation (CFR) 1508.27. An EA provides evidence for determining whether to prepare an Environmental Impact Statement (EIS) or a statement of "Finding of No Significant Impact" (FONSI). If the decision maker determines that this project has "significant" impacts following the analysis in the EA, then an EIS would be prepared for the project. If not, a Decision Record (DR) may be signed for the EA approving the selected alternative, whether the proposed action, another alternative, or a combination of the alternatives. A DR, including a FONSI statement, documents the reasons why implementation of the selected alternative would not result in "significant" environmental impacts (effects) beyond those already addressed in the LSFO Resource Management Plan (RMP)/Final EIS (*October 2011*).

BACKGROUND

Since the passage of the Wild Free-Roaming Horses and Burros Act (WFRHBA) of 1971, BLM has refined its understanding of how to manage wild horse population levels. The WFRHBA requires BLM to establish a population range of wild horses, called an Appropriate Management Level (AML), for individual herds. In doing so, BLM's goal is to maintain a population that allows for a "thriving natural ecological balance" (TNEB). If BLM determines that the herd population exceeds AML, and is impacting rangeland health or TNEB, the WFRHBA mandates that BLM control the overpopulation by removing the excess animals (for more information on wild horse populations, impacts to rangeland ecosystems, and range monitoring analyses in this area, see the appropriate Appendices). In the past two decades, BLM's wild horse management goals have also explicitly included conducting gathers and applying contraceptive treatments to achieve and maintain wild horse populations within the established AML to manage for healthy wild horse populations and healthy rangelands. The use of fertility controls helps reduce total wild horse population growth rates in the short term, increases gather intervals, and reduces the number of excess horses that must be removed from the range. Other management efforts include conducting population inventories and collecting samples for analysis of genetic diversity. Removing excess wild horses on the range is consistent with findings and recommendations from the National Academy of Sciences (NAS), American Horse Protection Association (AHPA), the American Association of Equine Practitioners (AAEP), Government Accountability Office (GAO), Office of Inspector General (OIG) and current BLM policy. BLM's management of wild horses must also be consistent with Standards and Guidelines for Rangeland Health.

Between 1988 and the present, the BLM has conducted approximately seven (7) wild horse gathers within the Sand Wash Basin HMA to remove excess animals to maintain the population size within the established AML range. During that time, approximately 1,396 excess animals have been removed and have been transported to Off Range Corral (ORC) facilities, where they were prepared for adoption, sale (with limitations), Off Range Pasture (ORP), or other statutorily authorized disposition. In 2020, BLM removed approximately 20 wild horses from private lands outside the HMA, utilizing bait and water trap techniques. Another gather is currently being conducted (as of March 2021) to remove 50 animals from in and around Sand Wash Basin to address public safety and private landowner requests to remove wild horses from private land. A categorical exclusion (DOI-BLM-CO-N010-2021-0004-CX) and Determination of NEPA Adequacy (DOI-BLM-CO-N010-2021-0003-DNA) were completed for these 2021 private land and public safety operations.

APPROPRIATE MANAGEMENT LEVEL

The AML is defined as the number of wild horses that can be sustained within a designated HMA, which achieves and maintains a thriving natural ecological balance in keeping with the multiple-use management concept for the area. The AML was established for the Sand Wash Basin HMA as a population range of 163-362 wild horses in the LSFO RMP (BLM, 2011).

The AML represents "that 'optimum number' of wild horses which results in a thriving natural ecological balance and avoids a deterioration of the range" (*Animal Protection Institute*, 109 Interior Board of Land Appeals (IBLA) 119 (1989)). The IBLA has also held that, "Proper range management dictates removal of horses before the herd size causes damage to the rangeland. Thus, the optimum number of horses is somewhere below the number that would cause resource damage" (*Animal Protection Institute*, 118 IBLA 63, 75 (1991)).

The upper level of the AML established within the HMA represents the maximum population for which thriving natural ecological balance would be maintained. The lower level represents the number of animals to remain in the HMA following a wild horse gather, in order to allow for a periodic gather cycle, and to prevent the population from exceeding the established AML between gathers.

The estimated population of wild horses within the HMA as of March 1, 2019 is 621 horses. This figure was calculated utilizing the March 2019 aerial population survey that was completed using the simultaneous-double observer method (Griffin et al. 2020)[1]. The estimated population by late summer 2021, including animals in the HMA and in nearby associated lands outside the HMA is

[1] Estimated population at time of inventory was 621 horses. Estimate only includes horses a year of age or older, does not include foals born at the time of inventory or after. The simultaneous-double count survey method is a form of mark-resight; three observers in an aircraft independently observe and record groups of wild horses. Sighting rates are estimated by comparing sighting records of the three observers. Those animals seen by one observer are the "marked" group; those that are also seen by the other observers are "resighted". The HMA was flown once with transects

expected to be approximately 828 animals. This number includes the approximately 728 wild horses within the HMA and approximately 100 wild horses that are currently outside of the HMA. Areas outside of the HMA are not managed for wild horses and a "thriving natural ecological balance cannot be maintained with other resource allocations." *Habitat for Horses v. Salazar*, 745 F.Supp.2d 438, 452 (S.D.N.Y. 2010). The actual number of horses estimated in the HMA was based on the 2019 aerial survey, as well as ground count estimates provided by wild horse volunteers that work in Sand Wash Basin. The population estimate number in 2019 was 621.

The expected number of wild horses as of summer 2021 may underestimate the true numbers that will be present by then. Additional horses may occur in the herd management area for several other reasons including but not limited to: (1) wild horses may be moving into and among Sand Wash Basin, Adobe Town, and Salt Wells Creek, as well as areas outside of all of these and (2) stray horses may have been released into the HMA. Volunteers within the basin have documented released wild horses within the HMA, due to unique BLM applied freeze marks during wild horse processing for sale or adoption.

Table 1, Herd Management Area, Acres, AML, Estimated Population

HMA	Total Acres	Appropriate Management Level	Estimated Population*	% of AML	Removal**
Sand Wash Basin HMA (March 01, 2019)	156,502	163-362	621	172%	458**
Sand Wash Basin HMA (Summer 2021)	156,502	163-362	935*	221%	772**

*This population estimate is based on the March 2019 population survey (621 adults) adding 13% increase per year in net herd size (reflecting additions from births, and subtractions from deaths) for both 2020 and 2021.

** Removal numbers calculated by using the estimated population and subtracting the high-end AML. (935-163=772)

A primary purpose throughout this document is to make a determination if excess wild horses are present and require immediate removal as required by the WFRHBA. Before issuing a decision to gather and remove animals, the authorized officer shall first determine whether excess WH&B are present and require immediate removal. In making this determination, the authorized officer shall analyze grazing utilization and distribution, trend in range ecological condition, actual use, climate (weather) data, current population inventory, wild horses and burros located outside the HMA in areas not designated for their long-term maintenance and other factors such as the results of land health assessments which demonstrate removal is needed to restore or maintain the range in a TNEB. The term "excess animals" is defined as those animals which must be removed from an area in order to preserve and maintain a thriving natural ecological balance and multiple-use relationship in that area (16 USC § 1332(f)(2)). This definition underscores the need to remove excess animals before damage to the range begins to occur. In making this determination, the authorized officer shall analyze grazing utilization and distribution, trend in range ecological condition, actual use, climate (weather) data, current population inventory, wild horses located outside the HMA in areas not designated for their long-term maintenance and other factors (BLM Manual Section 1790, 4720.22(A) and BLM Handbook H-1790-1).

Based upon all the information available at this time, the BLM has determined that approximately 772 excess wild horses exist within and adjacent to the HMA and need to be removed. The estimate of 772 includes approximately 100 wild horses outside of the HMA. These wild horses are outside the HMA and are in areas that are not identified for the long-term management of wild horses, are not maintaining a TNEB, are not an identified component under multiple use principles for those areas in the RMP and are considered excess and will be removed. Gather operations would continue until management objectives are met for the HMA as established in the RMP and gathers are approved by BLM Headquarters. If no gather operation is conducted in 2021, then the number of horses that would need to be removed would be increased by approximately 10-20 percent per year, dependent on population growth within the HMA. This assessment is based on the following factors including, but not limited to, the following:

- A population inventory of wild horses in March 2019, and adjusted for 2020/2021 reproduction, leads to the expectation that the HMA and nearby lands will have approximately 935 wild horses (772 excess (*includes foals born at time of flight, and those born since) above the AML by summer 2021 (Table 1).
- Competition for resources is causing horses to seek water and vegetation resources outside of the HMA and on private land.
- In recent years, wild horse health has been impacted from competition for forage and water resources.
- Impacts to rangeland health due to excess wild horses above the AML.
- Drought has impacted the availability of forage and water. Water has been artificially supplemented to sustain wild horse populations.
- Impacts to critical sage grouse habitat are occurring from overgrazing by wild horses.
- Public safety concerns are occurring on the southern portion of the HMA where wild horses have been struck by vehicles traveling on Colorado State Highway 318.

PURPOSE AND NEED FOR THE PROPOSED ACTION

The purpose of the Proposed Action is to remove excess wild horses from within the HMA, to manage wild horse populations to achieve and maintain a population within the established AML ranges, and to reduce the wild horse population recruitment (growth) rate to prevent undue or unnecessary degradation of the public lands associated with deterioration of rangeland resources due to an overpopulation of excess wild horses within the HMA, thereby restoring a thriving natural ecological balance and multiple-use relationship on the public lands consistent with the provisions of Section 1333 (a) of the WFRHBA of 1971.

The need is derived through management objectives established in the Federal Lands Policy and Management Act (FLPMA), the LSFO RMP, as amended by the 2015 Northwest Colorado Greater Sage-Grouse (GRSG) Approved RMP Amendment (ARMPA) and the WFRHBA of 1971 (as amended), that in conjunction, establishes that rangeland resources should be protected to prevent undue degradation of public lands associated with an excess population of wild horses.

DECISION TO BE MADE

Based on the analysis contained in this EA, the BLM will decide whether to approve or deny the proposed gather operations and fertility control measures and if so, under what terms and conditions. The BLM must remove animals from public lands after the Authorized Officer (AO) has made a determination that excess wild horses exist (43 CFR 4720.1). Under the NEPA, the BLM must determine if there are any significant environmental impacts associated with the Proposed Action warranting further analysis. The Field Manager is the responsible officer who will decide one of the following:

- To approve all, part, or none of the proposed gather operations and fertility control measures; or
- To analyze the effects of the Proposed Action in an EIS.

Decisions outside the scope of this analysis include adjusting livestock use or the AML within the HMA. Both AML levels and livestock grazing uses are set forth in planning-level documents, such as an RMP, that contain their own NEPA analyses.

In March 2019, the BLM issued Permanent Instruction Memorandum (PIM)-2019-004[2], that established policy for issuance of wild horse gather decisions. Specifically, PIM-2019-004 directs the BLM to "issue decisions authorizing gathers, removals, or population control actions through a phased approach or over a multi-year period when it determines that such an approach would help it achieve its management objectives." Issuing multi-year decisions would "enhance agency flexibility by allowing the BLM to adapt to unforeseen circumstances (such as, changes in national priorities, limited funding and holding space, reduced gather numbers, hard-to-catch or trap-shy animals, and emergency gather needs that impact gather schedules)." The ten-year time frame after any initial gather, under consideration in action alternatives in this EA, is consistent with this policy, and has been used in many other BLM wild horse herd gather and management decisions.

CONFORMANCE WITH BLM LAND USE PLAN(S)

Plan Conformance: The proposed action and alternatives have been reviewed and found to be in conformance with one or more of the following BLM Land Use Plans and the associated decision(s):

Little Snake RMP October 2011, which contains the following decisions that specifically apply to management of the Sand Wash Basin HMA (Section 2.7 Wild Horses, p. RMP-26):

- Manage the Sand Wash wild horse herd as an integral part of the public lands ecosystem at an AML. Periodically reevaluate the existing AML to ensure herd size remains compatible with other resources.

- Recognize and proactively respond to potential conflicts, as they occur, between the wild horse herd and other resources.

[2] BLM's instruction memoranda are available online at: https://www.blm.gov/media/blm-policy/

- Maintain HMA boundary fences to encourage wild horses to remain within an HMA. If horses relocate outside an HMA, attempt to herd horses back inside the HMA as expeditiously as possible[3].

Greater Sage-grouse ARMPA September 2015, which contains the following decisions that specifically apply to management of the Sand Wash Basin HMA (Section 2.2.5 Wild Horses, p. 2-13):

- MD WHB-1: (All Designated Habitat (ADH)) Manage wild horse population levels within established appropriate management levels.

- MD WHB-2: (ADH) Prioritize gathers in GRSG Priority Habitat Management Areas (PHMA), unless removals are necessary in other areas to prevent catastrophic environmental issues, including herd health impacts. Consider GRSG habitat requirements in conjunction with all resource values managed by the BLM and give preference to GRSG habitat unless site-specific circumstances warrant an exemption.

- MD WHB-6: (PHMA) When conducting NEPA analysis for wild horse management activities, water developments, or other rangeland improvements for wild horses in PHMA, address the direct and indirect effects to GRSG populations and habitat. Implement any water developments or rangeland improvements using the criteria identified for domestic livestock identified above in PHMA.

The proposed action and alternatives are in conformance with the Fundamentals of Rangeland Health (43 CFR 4180) and Colorado Standards for Rangeland Health and Guidelines for Grazing Management which addresses watersheds, ecological conditions, water quality, and habitat for special status species.

RELATIONSHIP TO STATUTES, REGULATIONS, OR OTHER PLANS

Gathering excess wild horses complies with Public Law 92-195 (WFRHBA) as amended by Public Law 94-579; FLPMA, and Public Law 95-514 (Public Rangelands Improvement Act [PRIA] of 1978). WFRHBA, as amended, requires the protection, management, and control of wild free-roaming horses and burros on public lands. In addition, the preparation and transport of wild horses would be conducted in conformance with all applicable state statutes.

The Proposed Action is in conformance with all applicable regulations at 43 CFR 4700 and policies. The following are excerpts from 43 CFR relating to the protection, management, and control of wild horses under the administration of the BLM.

- **43 CFR 4700.0-2 Objectives**

  Management of wild horses and burros as an integral part of the natural ecosystem of the public lands under the principle of multiple use.

- **43 CFR 4700.0-6(a-c) Policy**

[3] The RMP discusses herding back into the HMA as expeditiously as possible. This decision can be useful on a limited basis. However due the expanding population, number of animals outside of the HMA, increased competition for resources, and impacts to range land resources, any effort to return wild horses outside of the HMA would further degrade the TNEB within the HMA, and wild horses would likely leave the HMA again. Wild horses outside of the HMA are currently outside of any historical herd area and are considered excess and will be removed.

Requires that BLM manage wild horses "…as self-sustaining populations of healthy animals in balance with other uses and the productive capacity of their habitat … consider comparably with other resource values …" while at the same time "…maintaining free-roaming behavior."

- **43 CFR 4700.06(e) Policy**

  Healthy excess wild horses for which an adoption demand by qualified individuals exists shall be made available at adoption centers for private maintenance and care.

- **43 CFR 4710.3-1 Herd management areas.**

  Herd management areas shall be established for the maintenance of wild horse and burro herds. In delineating each herd management area, the Authorized Officer (AO) shall consider the appropriate management level for the herd, the habitat requirements of the animals, the relationships with other uses of the public and adjacent private lands, and the constraints contained in 4710.4.

- **43 CFR 4710.4 Constraints on management.**

  Management of wild horses and burros shall be undertaken with limiting the animals' distribution to herd areas. Management shall be at the minimum feasible level necessary to attain the objectives identified in approved land use plans and herd management area plans.

- **43 CFR 4720.1 Removal of excess animals from public lands.**

  Upon examination of current information and a determination by the AO that an excess of wild horses or burros exists, the AO shall remove the excess animals immediately.

- **43 CFR 4740.1 Use of motor vehicles or aircraft.**

  (a) Motor vehicles and aircraft may be used by the AO in all phases of the administration of the Act, except that no motor vehicle or aircraft, other than helicopters, shall be used for the purpose of herding or chasing wild horses or burros for capture or destruction. All such use shall be conducted in a humane manner.

  (b) Before using helicopters or motor vehicles in the management of wild horses or burros, the authorized officer shall conduct a public hearing in the area where such use is to be made.

Section 106 of the National Historic Preservation Act (NHPA) requires federal agencies to determine the possible effects of their actions on historic properties (those archaeological or historic sites eligible for or listed on the National Register of Historic Places (NRHP)). See 36 CFR 800 for a description of this process.

The Proposed Action and alternatives are in conformance with DRs and FONSIs for the 2016 (EA#CO-N010-2016-0023-EA) Sand Wash Basin Wild Herd Management Area Population Control, 2008 (EA#CO-100-2008-050), 2005 (EA#CO-100-2005-051), Sand Wash Basin Wild Horse Gathers.

The Proposed Action and alternatives are in conformance with the Fundamentals of Rangeland Health (43 CFR 4180) and Colorado Standards for Rangeland Health and Guidelines for Grazing

Management which addresses watersheds, ecological conditions, water quality and habitat for special status species.

All federal actions must be reviewed to determine their probable effect on threatened and endangered plants and animals (the Endangered Species Act (ESA)).

In addition, the Proposed Action is in conformance with the following Acts, regulation and policy:

- Taylor Grazing Act (TGA) of 1934
- FLPMA of 1976 (43 U.S.C. 1701 et seq.) as amended
- Public Rangelands Improvement Act of 1978
- ESA of 1973, as amended
- Bald and Golden Eagle Protection Act of 1962
- BLM Manual 6840 – Special Status Species Management
- Migratory Bird Treaty Act
- Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds
- IM 2008-50, Migratory Bird Treaty Act – Interim Management Guidance
- Protection, Management, and Control of Wild Free-Roaming Horses and Burros, Title 43 CFR 4700
- NEPA of 1969, as amended
- American Indian Religious Freedom Act of 1979
- Archaeological Resource Protection Act of 1979
- NHPA of 1966, as amended
- Appropriations Act, 2001 (114 Stat. 1009) (66 Fed. Reg.753, January 4, 2001)

PUBLIC INVOLVEMENT

The BLM uses a scoping process to identify potential significant issues in preparation for impact analysis. The principal goals of scoping are to identify issues, concerns, and potential impacts that require detailed analysis. Scoping is both an internal and external process. Internal scoping was initiated when the project was presented to the LSFO interdisciplinary team on September 1, 2020. Rather than conducting a new round of external scoping, the BLM reviewed the DOI-BLM-CO-N010-2016-0023-EA (September 2016) to identify issues previously raised by the public in regard to gather operations and fertility control plans over the next ten years within the HMA.

This EA and the unsigned FONSI were available for public review and comment period beginning April 2, 2021 and ending May 2, 2021. This EA was also posted on the BLM's online NEPA register (ePlanning) on April 2, 2021.

HEARINGS FOR USE OF HELICOPTERS AND MOTORIZED VEHICLES

Hearings on the use of helicopters and motorized vehicles are required to be held as necessary to comply with Section 404 of the FLPMA. Pursuant to 43 CFR 4740.1(b), the BLM will periodically hold a public hearing on the use of helicopters and motorized vehicles in conjunction with wild horse management including gather operations. The last public hearing was held in August 2019 in Craig, Colorado. Future public hearings would be announced via a press release.

During the hearing, the public is given the opportunity to present new information and to voice any concerns regarding the use of these methods to manage wild horses. This process has been in place for decades and relevant issues associated with these methods have been addressed in the Comprehensive Animal Welfare Program (CAWP) Standards (Appendix B).

PUBLIC VIEWING OPPORTUNITIES

Opportunities for public observation of the gather activities on public lands would be provided, when and where feasible, and would be consistent with IM 2013-058 and the Visitation Protocol and Ground Rules for Helicopter Wild Horse and Burro (WH&B) Gathers. This protocol is intended to establish observation locations that reduce safety risks to the public during helicopter gathers. Due to the nature of bait trapping operations, public viewing opportunities may only be provided at holding corrals.

PROPOSED ACTION AND ALTERNATIVES

The BLM has reviewed the guidance in IM 2020-012 (WH&B Gather Planning, Scheduling, and Approval) in developing the alternatives for managing the wild horse population within the LSFO and HMA.

The BLM has developed three alternatives that are considered in detail:

- Alternative A (Proposed Action) – Gather to the Low End of AML and Use Non-Permanent Fertility Control Treatments
- Alternative B – Gather to the Low End of AML and Do Not Use Fertility Control Treatments
- Alternative C – No Action Alternative

All gather operations would be conducted according to PIM-2021-002 which establishes policy for the WH&B gather component of the CAWP. It defines standards, training, and monitoring for conducting safe, efficient, and successful WH&B gather operations while ensuring humane care and handling of animals gathered. The CAWP (PIM-2021-002, Attachment 1) is attached as Appendix B.

The number of animals gathered, removed, and/or treated with fertility control in gather operations would be dependent on factors including estimated population levels, previously fertility control applications, range utilization, excess horses outside of the HMA, impacts to sensitive species animals and plants, available holding and budget at a national level. The gather and removal of excess wild horses would be conducted by a BLM WH&B National Program Contractor and/or BLM personnel. On a case-by-case basis, the BLM may also allow approved volunteers to assist and/or advise BLM during gather operations, but all wild horse management decisions would rest with BLM gather personnel.

Excess wild horses that would be gathered and removed from the HMA would be transported to ORC. All wild horse gathers and removals are subject to funding approval as well as based on space availability of ORC. The gather and removal of excess wild horses located within the HMA would be conducted over a period of several years using a variety of gather techniques including helicopter drive trapping, helicopter assisted roping, and/or bait trapping once the BLM's National WH&B

Program office has provided funding, determined space is available and the LSFO received such approval.

Under the Proposed Action and Alternative B, to meet the purpose and need of maintaining the wild horse population at AML, it is likely multiple gathers would need to occur. The proposal for a ten-year gather plan is consistent with other BLM gather decisions in other states where BLM manages wild horses and burros. The proposed actions are consistent with management at the minimum feasible level under the WFRHBA, as supported by various legal rulings. BLM's use of a single gather plan and a single environmental assessment to cover a period of years and a series of individual gather operations is not a departure from the agency's past practice, as determined by a panel of appeals court judges in a recent case *Friends of Animals vs. Silvey*, 353 F. Supp. 3d 991 (D. Nev. 2018), aff'd, No. 18-17415 (9th Cir., July 2, 2020).

ALTERNATIVE A-PROPOSED ACTION (GATHER TO THE LOW END OF AML AND FERTILITY CONTROL TREATMENT)

The short-term goal of the Proposed Action is to return the wild horse population within the HMA to within AML. All wild horses outside of the HMA would be considered excess and would be gathered and removed. The long-term goal is to be able to better maintain the wild horse population within AML within the HMA, achieve thriving natural ecological balance and reduce the need for subsequent gathers and removals through the use of fertility control treatments, without jeopardizing the genetic diversity of the population. A slightly greater number of stallions than mares may be returned to the range after gather operations, to reduce the potential foaling rate. The ratio of stallions to mares would rarely exceed 55:45 and would never exceed 60:40. However, funding limitations and competing priorities (for long-term holding) may affect the timing of gathers and fertility control treatments.

<u>Gather and Removal of Excess Wild Horses</u>

Under the Proposed Action, the BLM would gather and selectively remove excess wild horses down to the low end of AML using an initial or multiple gather operation(s) conducted as soon as possible and return periodically to gather excess wild horses to maintain the AML within the HMA. The BLM would continue to remove excess wild horses (to the low end of AML) by conducting subsequent (follow-up) gather and removals as necessary over a ten-year period. The ten-year period of potential gathers would begin with the initial gather operation within the HMA.

Gather operations and fertility control treatments may be delayed and/or halted and then restarted depending on funding and the allocation of spaces in holding facilities.

<u>Fertility Control Treatments</u>

To the extent possible, the BLM would continue the administration of fertility control treatments prior to the initial gather operation to continue reducing the current annual recruitment rate and would continue with fertility control treatments over the period of ten years from the date of the initial gather operation. If no new information changes this analysis and funding continues to be provided, BLM would continue fertility control treatments beyond the ten years. Under this alternative, fertility control treatments would primarily consist of vaccine treatments (e.g., PZP ZonaStat-H vaccine, PZP-22 pelleted vaccine treatment, GonaCon-Equine vaccine) along with the potential use of flexible intrauterine devices (IUDs) for open mares. Fertility control treatments would be applied through hand applications, jab sticks, in the field darting, or other appropriate application method for the effective application of the selected fertility control type (Appendix E and G).

If it is determined that a mare or mares cannot be approached within darting range on foot, then baiting may be used to draw the wild horses to within darting distance for treatment. Baiting would be accomplished with water, salt, mineral supplements, grains, or weed-free hay in areas that wild horses use in their normal movements throughout the HMA. Wild horses may need to be trapped at bait stations, which would enable them to be darted and then released. Darting may also occur at locations where wild horses normally travel or at concentration areas around water. Darting may take place day or night depending on effective timeframes to apply to wild horses. If the mechanism is shown to be safe and effective, BLM may consider use of an automated dart delivery system (e.g., as developed by Wildlife Protection Management, New Mexico). The BLM would follow Standard Operation Procedures (SOPs) for implementation of fertility control treatments (See Appendices E and F).

Population Monitoring

Population inventories, genetic sampling and analysis, and routine resource/habitat monitoring would continue to be conducted between gather cycles to document current population levels, growth rates, and areas of continued resource concern (wild horse concentrations, riparian impacts, over-utilization, etc.). Potential reductions in recruitment rates due to the use of fertility control treatments would be accounted for in future population projections, based on the estimated fraction of mares expected to be contracepted in a given year.

Selective Removal and Augmentation

In order to manage for the long-term genetic and phenotypic diversity of the HMA wild horse population, the BLM may choose to implement selective removal of individual horses or to release new animals into the herd. Selective removal procedures would prioritize removal of younger horses to allow older, less adoptable wild horses to be released back to the HMA. The selection process would involve retaining wild horses for a diversity of preferred conformation, disposition, color, and other features deemed desirable in the herd. Periodic introduction of studs or mares from a different HMA, with desired characteristics similar to the wild horses within the HMA could be made, to augment genetic diversity in the HMA, as measured by observed heterozygosity, if the results of genetic monitoring indicate that is prudent. All wild horses identified to remain in the HMA herd would be selected to maintain a diverse age structure, color, and body type (conformation).

Gather Methods

The types of approved gather methods include:

1. Helicopter drive-trapping involves using a helicopter to spot and then herd wild horses towards a pre-constructed trap. Traps would be pre-constructed utilizing portable, round-pipe steel panels with funnel-shaped wings made up of jute fabric affixed to T-posts that have been temporarily tamped into the ground to create a visual barrier. As the wild horses are driven/hazed by the helicopter towards the trap through the "wings" or funnel, the wild

horses enter the trap where on-the-ground personnel then shut the gate behind the wild horses to secure them in the trap. In general, most traps would be 1 – 5 acres in size. Trap locations would be situated in areas where previously used trap sites were located or at other disturbed areas whenever possible. Trap locations would be chosen for safety of maneuvering the wild horses into the trap, as well as to target the gathering of wild horses located in a given area. The BLM WH&B Handbook, H-4700-1, Section 4.4.4 and WO-IM 2010-183 prohibits the capture of wild horses by helicopter during peak foaling periods except in case of emergency. Helicopter drive-trapping would not be conducted between the dates of March 1 and June 30, which is the peak foaling period in the HMA (WO-IM 2010-183), except in emergency situations according to IM 2015-152. The use of helicopters for gather operations is allowed from July 1 to February 28 which is outside of the peak foaling period.

2. <u>Helicopter-assisted roping</u> includes the use of a helicopter to herd wild horses towards ropers who rope the wild horse(s). Once roped, another rider would ride alongside the roped wild horse and roper, helping to haze or herd the roped wild horse either towards the trap or towards a stock trailer. Once at the trap, the rope is slipped off the wild horse's neck and it joins the rest of the trapped wild horses. No helicopter-assisted roping would be conducted between the dates of March 1 and June 30 due to the BLM's policy which prohibits the capture of wild horses by helicopter during peak foaling periods.
3. <u>Bait trapping</u> uses a trap constructed of portable, round-pipe steel panels. Funnel-shaped traps are built allowing wild horses to enter deep into the trap so that the gate release mechanism has time to close. Traps would be located in areas frequented by wild horses. Potential types of bait may include, but are not limited to, water, mineral supplements, or quality, weed free hay, and may also include the utilization of domestic mares/studs to attract wild horses into the trap. Bait trapping may be conducted at any time of year. Trap size would generally be less than ¼-acre in area. Traps would remain in place until the desired number of excess wild horses are gathered and removed. Bait trapping generally requires a longer window of time for success than helicopter drive trapping. Although the trap(s) would be set in a high probability area for capturing the excess wild horses residing within a given area, and at the most effective time periods, some period of time is required for the wild horses to acclimate to the trap and/or decide to access the bait. Due to the necessity of wild horse having free uninterrupted access to trap locations, public access may be limited to trap locations on public lands.

When actively bait trapping wild horses, the trap would be staffed or checked on a daily basis by either BLM personnel or authorized contractor staff and possibly authorized volunteers. Wild horses would be either removed immediately or fed and watered for up to several days prior to transport to a holding facility.

<u>Design Features for Gather Operations</u>

<u>Animal Welfare:</u>

1. During gathering operations safety precautions would be taken to protect all personnel, animals, and property involved in the process from injury or damage, consistent with BLM's CAWP (Appendix B and BLM PIM-2021-002). Only authorized personnel would be allowed on site during the removal operations. Included in the "gathering and removal" operations

would be sorting individual wild horses as to their age, sex, temperament and/or physical condition, and to return selected wild horses back to the HMA.

2. Contractors and/or BLM personnel would utilize trailers to transport gathered wild horses to a temporary holding facility where they would receive appropriate food and water. Holding facilities and gather sites have historically been located on both public and private lands due to road access and availability of water.
3. Wild horses that are removed from the area would most likely be transported to BLM's Canon City, Colorado holding facility where they would be prepared (freeze-marked, vaccinated, microchipped, and de-wormed) for adoption, sale (as regulations permit), or off-range pastures unless unforeseen circumstances warranted that the wild horses be transported to a different approved BLM holding facility (i.e., at Rock Springs, Wyoming).
4. A veterinarian from the U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) would be present at helicopter gather operations to examine animals and make recommendations to the BLM for care and treatment of the gathered wild horses. Decisions to humanely euthanize animals in field situations would be made in conformance with BLM Manual 4730 and IM 2015-070. If for some reason an APHIS Veterinarian is not present on a gather, the BLM would coordinate with a local private veterinarian for on-call or referral services as needed. BLM staff would be present on the gather at all times to observe animal condition, ensure humane treatment of wild horses, and ensure contract requirements are met.
5. During gather operations, the Contracting Officer Representative (COR), as delegated by the AO prior to the gather, would authorize the release or euthanasia of any wild horse that they believe would not tolerate the handling stress associated with transportation, adoption preparation, or holding. No wild horse should be released or shipped to a preparation or other facility with a preexisting condition that requires immediate euthanasia as an act of mercy. The Incident Commander (IC) or COR should, as an act of mercy and after consultation with the on-site veterinarian, euthanize any animal that meets any of the conditions described in IM 2015-070.

<u>Communication</u>:

1. The LSFO would utilize the Incident Command System (ICS) to enable safe, efficient, and successful wild horse gather and removal operations in accordance with IM 2013-060.
2. The BLM would provide the public/media with safe and transparent visitation at helicopter wild horse gather operations in accordance with IM 2013-058. Due to the nature of bait trapping operations, public/media observation may be limited. The BLM would conduct gather operations while ensuring the humane treatment of wild horses in accordance with PIM-2021-002. A schedule would be prepared and posted on the appropriate website that would outline specific viewing opportunities and other relevant information. The BLM would provide concise, accurate and timely information about gather operations with communication and reporting during an ongoing wild horse gather in accordance with IM 2013-061 regarding Internal and External Communication and Reporting.
3. Any discovery of hazardous or potentially hazardous materials would be reported to the BLM hazardous materials coordinator and Law Enforcement for investigation.
4. Prior to commencement of gathering operations, the BLM would notify existing right-of-way holders, range permittees, operators, and lessees of any location, date, and time associated with the gather operation that may affect their permitted activities.

5. If gather operations are conducted during any of the CPW big game seasons, Special Recreation Permit holders authorized to operate in the analysis area for commercial big game guiding and outfitting would be notified of the gather activities and locations in advance.
6. The BLM is responsible for informing all persons who are associated with the project that they would be subject to prosecution for knowingly disturbing archaeological sites or for collecting artifacts.
7. If any archaeological materials are discovered as a result of operations under this authorization, activity in the vicinity of the discovery would cease, and the LSFO Archaeologist would be notified immediately. Work may not resume at that location until approved by the AO. The BLM would make every effort to protect the site from further impacts including looting, erosion, or other human or natural damage until BLM determines a treatment approach, and the treatment is completed. Unless previously determined in treatment plans or agreements, the BLM would evaluate the cultural resources and, in consultation with the State Historic Preservation Office (SHPO), select the appropriate mitigation option within 48 hours of the discovery. The BLM would implement the mitigation in a timely manner. The process would be fully documented in reports, site forms, maps, drawings, and photographs. The BLM would forward documentation to the SHPO for review and concurrence.
8. Pursuant to 43 CFR 10.4(g), the BLM would immediately upon the discovery of human remains, funerary items, sacred objects, or objects of cultural patrimony stop activities in the vicinity of the discovery and protect it for 30 days or until notified to proceed by the AO.
9. The BLM would be responsible for informing all persons who are associated with gather operations that they would be subject to prosecution for disturbing or collecting vertebrate or other scientifically important fossils, collecting large amounts of petrified wood (over 25lbs./day, up to 250lbs./year), or collecting fossils for commercial purposes on public lands.

<u>Weed Management and Reclamation</u>:

1. Any hay fed at trap sites or holding facilities, on public lands, would be certified as weed free. Any noxious weeds introduced through the proposed action would be controlled by the BLM. If weeds are discovered, the BLM would treat these locations following procedures outlined in the LSFO's Integrated Weed Management Plan.
2. All trap locations would be monitored for up to three years after gather operations for vegetation recovery. If problems with vegetation establishment are discovered, BLM would treat these locations based on the aid in vegetation recovery that may be necessary, e.g., broadcast seeding, at the trap locations.
3. All equipment used for gathering operations shall be cleaned before it comes to LSFO and when it leaves LSFO to minimize the potential spread of noxious and/or invasive weed species.
4. Equipment shall be cleaned when moving between locations within the analysis area if noxious weeds are encountered and if there is any potential for weed seeds to be carried between locations.

<u>Restrictions on Trap Locations</u>:

1. The BLM would not construct new bait trap locations or have new temporary holding facilities within 100 meters of known occupied habitat for special status plant species (SSPS). Trap and holding facilities that are proposed to occur on existing disturbance within 100 meters of SSPS habitat must be approved by the LSFO Rangeland Management Specialist (RMS) prior to gather operations. The LSFO RMS would advise and determine if a habitat assessment or survey is necessary before trap location approval. Prior to helicopter gather operations, a SSPS avoidance area map would be provided to incident command staff and the BLM's COR by the LSFO RMS for reference during selection of helicopter drive trap site locations.
2. If a trap location or holding facility (located on existing disturbances) must occur within 100 meters of occupied habitat for SSPS during the growing season dust abatement would occur to limit impacts to plant photosynthesis from fugitive dust.
3. Traps and temporary holding facilities would be located in previously used trap sites or on an area of existing disturbance, such as a road or a wash. If an existing disturbed area cannot be located for traps and temporary holding facilities, a cultural resource inventory would take place prior to the gather if there is inadequate inventory data available. If cultural resources are located during this inventory, the trap site or temporary holding facility would be moved to another location, which does not contain cultural resources.
4. Known and reported fossil localities would be avoided when locating trap sites and associated wing fences and holding facilities. Sites without adequate inventory data would need to be examined for the presence of fossils during trap site selection activities. Trap facilities would be relocated or modified to avoid impacting identified fossil resources.
5. Surveys of suitable raptor nesting habitat would be conducted by a LSFO Biologist at trap sites proposed for use or development from April 15 to August 15. In the event an active raptor nest is found in the vicinity of trapping operations, these sites would be afforded a buffer adequate to effectively isolate nesting activity from disruptions generated by wild horse trapping operations. The timing stipulation would only apply to trapping operations. Darting operations would be permitted during this time frame.
6. Trapping operations would only be allowed to take place between the hours of 9:00 am and 4:00 pm at trap sites located within 0.25 miles of active sage-grouse leks during the lekking period (March 1 – May 15).
7. Those sites proposed for water trapping would be surveyed by a LSFO Biologist prior to use to determine if sites are occupied by aquatic amphibian species. If trapping efforts are found to impact individuals or habitat, the trap site would be relocated.

<u>Minimizing Erosion</u>:

1. All activity shall cease when soils or road surfaces become saturated to a depth of three inches unless otherwise approved by the AO.
2. Any trap sites located on slopes greater than 35 percent would be evaluated in the field by a LSFO Hydrologist prior to identifying any necessary mitigation in order to ensure that use of the site would still allow for meeting Public Land Health Standard 1 (e.g., minimizing overland surface erosion and subsequent rill and/or gully formation). Examples of mitigation may include placement of waddles.

<u>Helicopter Operations</u>:

1. Avoid, if possible, helicopter gather operations from late-August through November for high public use areas during big game hunting seasons.
2. If possible, the BLM would avoid helicopter gather operations from December 1 through February 28 to reduce/eliminate impacts to big game during the critical winter period.
3. CPW staff would be contacted to coordinate gather operations in an effort to develop mutually compatible strategies that may reduce the intensity and localize the expanse of helicopter related disturbances during big game hunting seasons.
4. The Contractor must operate in compliance with Federal Aviation Administration (FAA) Regulations, Part 91. Pilots provided by the Contractor shall comply with the Contractor's Federal Aviation Certificates and applicable regulations of the State in which the gather is located.
5. Aviation fueling operations would be conducted a minimum of 1,000 ft from wild horses in traps or temporary holding facilities.
6. All refueling would occur on existing roads or a site approved by the BLM as a helicopter staging area. All approved staging areas would be a minimum of 200 ft from any riparian area or stream channel. The operator would utilize absorbent pads while refueling to control potential of fuel spills. In the event of a spill of lubricant, hydraulic fluids, fuels, or other hydrocarbons, the spill would be reported to the BLM's COR or Project Inspector (PI) so that BLM can immediately conduct evaluations of any necessary clean-up actions, as well as perform such actions to ensure compliance with applicable laws, rules, and regulations.
7. When utilizing a helicopter gather all helicopter operations would be conducted in a safe manner and in compliance with FAA regulations 14 CFR § 91.119, IM 2010-164 and IM 2013-164.

Design Features for Fertility Treatments

<u>General</u>

1. Fertility control treatment would be conducted in accordance with standard operating procedures (Appendix F) and post-treatment monitoring procedures. Breeding age mares selected for release back to the range would be treated with approved fertility control vaccines and/or IUDs, which would reduce fertility of the treated mares.
2. Any new fertility controls may be considered for use as directed through the most recent direction of the National Wild Horse and Burro Program. The use of any new fertility controls would employ the most current best management practices and humane procedures available for the implementation of the new controls.
3. Fertility control vaccines may be administered through darting by trained BLM personnel or collaborating partners only. For any vaccine darting operation, the designated personnel must have successfully completed a darting training course and who possess documented and successful experience darting under field conditions. If the mechanism is shown to be safe and effective, BLM may consider use of an automated dart delivery system (e.g., as developed by Wildlife Protection Management, New Mexico), pursuant to the development of additional SOPs.
4. The LSFO would be applying adaptive management principles as it pertains to fertility control applications and treatments, in the sense that management decisions could be informed by new information that comes from the results of monitoring and new scientific information. If policies change or the vaccine effects or effectiveness prove undesirable, then the application of the fertility control measures would be stopped or reconsidered

based on new scientific information. If a specific adjuvant is dropped from BLM use and is replaced by another vaccine formulation for fertility control purposes, that method would be applied in future treatments.

5. Fertility control would be administered prior to and once AML is reached, and throughout the life of the plan. If monitoring shows successful applications, a low rate of debilitating injection site reactions and reduction in foaling rates, the fertility control treatments could continue beyond the life of the plan as long as it can be reasonably concluded that no new information and no new circumstances arise that need to be considered and those that are analyzed within this document have not substantially changed within the HMA. The number of fertility control applications per year would also depend on annual funding and the presence of qualified applicators.
6. The field darting treatment protocol continue prior to the initial gather. Field darting would be conducted in an opportunistic manner while the specialist is conducting routine monitoring activities as part of normal duties in the field or in an intentional manner depending on personnel availability and timing. Field darting may also be conducted by trained and authorized volunteers. Field darting activities would be conducted either on foot or horseback, with access throughout the HMA achieved by use of 4X4 vehicles and other off-highway vehicles (OHVs). Vehicles would be used on existing/designated roads and trails in the HMA. After review of all potential access options and on a case-by-case basis, the use of OHVs off existing roads and trails may be allowed for administrative purposes; however, such use would be made only with the approvals from both the LSFO personnel and the AO.
7. Darting may be conducted individually or in teams. In most cases, it is generally recommended that no more than two people would be present on a darting "team." The second person is responsible for locating fired darts and would also be responsible for identifying the wild horse to be treated, keeping onlookers at a safe distance, and general support/safety of the team while in the field. However, darting "teams" of one or a higher number than two would also be acceptable where appropriate.
8. Attempts would be made to recover all darts. To the extent possible, all darts which are discharged and drop from the wild horse at the darting site would be recovered before another darting occurs. In exceptional situations, the site of a lost dart may be noted and marked, and recovery efforts made at a later time. All discharged darts would be examined after recovery in order to determine if the charge fired and the plunger fully expelled the vaccine. Personnel conducting darting operations should be equipped with a two-way radio or cell phone to provide a communication link with the identified BLM personnel for advice and/or assistance. In the event of a veterinary emergency, darting personnel would immediately contact the Project Veterinarian, providing all available information concerning the nature and location of the incident.
9. Treatment with IUDs would follow established protocols (Appendix E and F).

<u>Wild Horse Identification and Priority for Treatment</u>

1. Each mare would have an identification sheet with pictures, describing any markings, brands, scars, or other distinguishing marks. Captured animals would receive an RFID chip. At the beginning of each year, a list of mares identified for treatment would be created and that information would be loaded into a format that is easy to use in the field (e.g., field notebook or electronic device). Currently, LSFO has a volunteer group with over seven years of wild horse identification data that they will provide to the LSFO if requested by the

BLM. IUD treated mares would be marked in a manner similar to those treated with vaccines.

2. New mares coming into treatment would be given the booster dose no sooner than 30 days after they have received the primer dose. Estimated age would be based on when the wild horses are observed being new herd foals. For older previously treated wild horses, estimated age would come from the treatment's identification sheets. Aging older untreated wild horses would be based off photographs or similar documentation provided by volunteers knowledgeable of the herd/bands. For any adult mare whose age cannot be immediately established, initial treatment would be delayed by one year, to ensure she is older than eight months by the time of the first treatment.
3. Flexibility in determining which mares are selected for treatment is vital to the success of the fertility control program. Adjustments could be made: if it is found that there is a severe injection site reaction by an individual mare; if a given mare is determined by the LFSO to contribute in a particularly useful way to genetic diversity; or if a mare is determined by the LFSO to have a potentially negative effect on the herd's genetic diversity. This information would be documented on the identification sheet.
4. If timing or funding constraints arise, a treatment priority could consider the band or herd composition and priority would be given based on age class. Priorities would be established as follows:

    a. two to four-year-old mares,

    b. mares just coming back into treatment, fillies eight months old or older, and

    c. older mares that have received several treatments since producing a live foal.

5. The treated mares would be individually marked, have a microchip inserted for identification and/or be individually recognizable. During past treatments, mares may have been freeze branded on the hip and the neck. These methods would help in the identification of the wild horses. During any future gathers, RFID chips would be placed in the nuchal ligament of all captured animals, and new brands may be put on mares released back to the HMA. Color, leg and face markings, and any other unique markings or scars could be used to identify any mares without a brand. Once each wild horse is positively identified, their information would be compiled into a database along with photographs. Individual identification information (photographs and unique characteristics) would be compiled into books or put onto an electronic device that can be taken to the field. Individual numbers are assigned to each herd/band member based on these unique characteristics. Unique numbers would be assigned to all mares and documented on the Identification sheets. A filly under eight months would be tracked on her mother's Identification sheet. A filly over eight months of age would receive her own number and Identification sheet. Where information is reliable, maternal kinship would be tracked or followed through Identification sheet notes.

Record Keeping

1. Wild Horse Immunocontraception Identification Sheets (currently in Wild Horse Information Management System [WHIMS]) would be prepared and updated. An individual mare's records would be reviewed prior to darting activity.

2. All darting, foaling, and health data would be recorded as per the Identification Sheet. Identification Sheets would be prepared and maintained in the LSFO or approved maintainer of information/volunteer (e.g., Sand Wash Advocate Team, a.k.a. SWAT), or specific volunteer with WHIMS data entry experience). Initially, copies of the Identification Sheets would be sent to the National WH&B Program Office and to the Science Conservation Center (SCC) at the Zoo Montana in Billings, MT. Thereafter, only treatment updates or new mare Identification Sheets would be sent annually.
3. The annual treatment schedule, database and Identification Sheets would be reviewed/approved by the AO with the wild horse specialist and/or darting specialist. An annual monitoring report would be prepared for the AO and filed in the fertility control treatment records for the HMA. This monitoring report may show fertility control treatment orders placed/costs, planned treatment schedule/actual treatments (number/dates of mares treated), lost darts, negative reactions/BLM action taken for that mare, number of new/current year foals counted/observed, unique circumstances, off road vehicular use, general rangeland condition/water availability, volunteer efforts, correspondence between/among the LSFO and the SCC and National WH&B Office and other pertinent information.

<u>Regulatory Authorization and Vaccine Administration</u>

1. Only volunteers, treatment contractors, or BLM personnel appropriately trained with fertility control would be authorized to apply the vaccine. Field darters may be accompanied by others to assist in the darting work.
2. The liquid gonadotropin releasing hormone (GnRH) vaccine, known as GonaCon-Equine, is federally approved by the EPA registration number 56228-41. No specific training is required to administer GonaCon-Equine to wild horses; however, a certified pesticide handler is required to receive shipments of the drug, and the EPA label requirements must be followed.
3. The LSFO would work with the WH&B Office in Reno, Nevada, and the U.S. Department of Agriculture (USDA) or the production company known as SpayFirst!, Inc. to order GonaCon-Equine vaccine. The distributor would then prepare and ship the order to the field office. Each dose of GonaCon-Equine would consist of 2 ml of emulsified liquid, including 0.032 percent of mammalian GnRH. No mixing of the vaccine is required. Remote application would be by means of darts, equipped with 3.81 cm 14 gage Tri-Port needles and a gel collar (McCann et al. 2017), delivered by either Dan-inject or Pneu-dart CO2 powered, or cartridge fired devices (guns). Recovery of all darts will be attempted (normally about a 98 percent recovery is expected).
4. The liquid PZP vaccine, known as ZonaStat-H is federally approved by the EPA registration number 86833–1. Training is required by the SCC to receive and/or administer ZonaStat-H to wild horses.
5. The LSFO would work with SCC to order the PZP vaccine. The SCC then prepares and ships the order to the field office. Each dose would consist of 100 micrograms of PZP in 0.5 cc buffer (a phosphate buffered saline solution). Mixing the vaccine would be accomplished as described in the Wild Horse Contraceptive Training Manual. Remote application would be by means of 1.0-cc darts, with either 1.25- or 1.5-inch barbless needles, delivered by either Dan-inject or Pneu-dart CO_2 powered, or cartridge-fired devices (guns).

6. PZP-22 pellet vaccine treatments may be administered. At present, PZP-22 treatment is only given by BLM to captured mares, via hand injections.
7. PZP vaccine mixing procedures would be followed. The PZP vaccine protocol would be examined annually, in line with any new instructions provided by the SCC. The field use of GonaCon-Equine vaccine does not require mixing of the adjuvant.

ALTERNATIVE B- GATHER TO LOW END OF AML AND DO NOT USE FERTILITY CONTROL TREATMENTS

Alternative B would include the same gather techniques as Alternative A, but the BLM would not implement fertility control treatments. No wild horses would receive fertility control treatments either in association with capture and release back into the HMA (if selected to be returned) or from being darted in the field.

ALTERNATIVE C- NO ACTION

Under the No Action Alternative there would be no gather operations (utilizing helicopter or bait trapping) or fertility control treatments.

Without gathers, hair follicle sampling to monitor genetic diversity would not be as straightforward, but could be accomplished through non-invasive sampling (i.e., King et al. 2018), if funding allows.

This alternative would conflict with 43 CFR 4720.1 which requires the BLM to remove excess wild horses from public lands. It is included in this EA for comparison with the action alternatives.

ALTERNATIVES CONSIDERED BUT NOT ANALYZED IN DETAIL

Alternatives considered but eliminated from detailed analysis are included in Appendix C, with discussion and rationale about why each alternative was not carried forward.

E.1. Alternative Gather Methods

- Bait Trap Only
- Use of Alternative Capture Techniques

E.2. Alternative Fertility Control Options

- Exclusively Using Field Darting to Deliver Fertility Treatments to Reduce Total Population Over Time
- Using Bait Trapping to Deliver Fertility Treatments to Reduce Total Population Over Time
- Use of Fertility Control Treatment Only to Reduce Total Population Over Time
- Gather and Release All (including Excess) Wild Horses Every Two Years and Apply PZP-22 Vaccine Pellet or Other Contraceptive Vaccine to Wild Horses Prior to Release

E.3. Alternatives Related to Population Size or Structure

- Provide Supplemental Feed and Water
- Return a Portion of the Population as a Non-Breeding Population

- Utilize Only Sex Ratio Adjustment to Reduce Population Recruitment
- Gather the HMA to the AML Upper Limit
- Adjust the Appropriate Management Level
- Wild Horse Numbers Controlled by Natural Means

E.4. Alternatives Inconsistent with Existing Land Use Plan Allocations

- Return the HMA to Herd Area Status with Zero AML
- Manage the Entire Population as a Non-Breeding Population
- Remove Livestock within the HMA

IDENTIFICATION OF ISSUES

The BLM interdisciplinary team and public participation contributed toward the identification of issues for this assessment by focusing on the resources that could be affected by implementation of one of the alternatives.

The CEQ Regulations state that NEPA documents "must concentrate on the issues that are truly significant to the action in question, rather than amassing needless detail" (40 CFR 1500.1(b)). While many issues may arise during scoping, not all issues raised warrant analysis in an EA. Issues will be analyzed if: 1) an analysis of the issue is necessary to make a reasoned choice between alternatives, or 2) if the issue is associated with a significant direct, indirect, or cumulative impact, or where analysis is necessary to determine the significance of the impacts. The following sections list the resources considered and the determination as to whether they require additional analysis.

The Proposed Action was reviewed by an interdisciplinary team composed of resource specialists from the LSFO. This team identified resources within the HMA, which might be affected and considered potential impacts using current office records and geographic information system (GIS) data. The result of the review is contained in Table 1.1 Under Issues Not Analyzed in Detail, below.

Consultation and coordination with the State Historic Preservation Office (SHPO), CPW, USFWS, Native American Indian tribes and routine contacts with livestock operators and others, have underscored the need for the BLM to maintain wild horse and burro populations within the AML.

Resources within the project area that may be affected must be discussed (40 CFR 1501.5). Table 1.1 below describes those resources which are not present or are not affected by the Proposed Action or alternatives. Rationale for dismissing specific resources are also contained in Table 1.1

Those resources that may be affected by the Proposed Action and/or alternatives are carried forward throughout this analysis and are discussed below.

ISSUES ANALZYED IN DETAIL

1. ***Issue 1:*** *How would the Proposed Action affect wild horse populations in the project area?* The proposal to gather and remove wild horses from the HMA and application of fertility control treatments would inherently affect wild horse populations and the social structure of bands in the project area. These affects are discussed in detail throughout this EA.
2. ***Issue 2:*** *How would the Proposed Action affect current livestock grazing in the project area?*

The HMA contains all or portions of four grazing allotments, all of which are authorized for sheep grazing. Wild horse populations can affect resources allocated to livestock grazing. These effects are discussed in more detail throughout the EA.

3. ***Issue 3:*** *How would the Proposed Action affect available forage for livestock grazing operations in the project area?*
   Grazing by excess wild horses can affect the amount of forage available for livestock grazing. The proposal to gather and remove wild horses from the HMA and fertility control treatments would inherently affect wild horse populations and the social structure of bands in the area.
4. ***Issue 4:*** *What impact would there be to greater sage-grouse in the HMA from the Proposed Action?*
   Approximately 73,510 acres (47 percent) of the HMA overlaps with greater sage-grouse PHMA within the HMA, most of which are on BLM lands (see PHMA Map, Appendix A). Overpopulated wild horse herds can affect greater sage-grouse habitat.

ISSUES CONSIDERED BUT NOT ANALYZED IN DETAIL

The BLM considered several issues raised during internal and external project scoping. After review of available information, the interdisciplinary team determined that the following issues did not have the potential to be significantly impacted by any of the alternatives and it is not necessary to make a reasoned choice between alternatives. Therefore, the issues listed in Table 1.1 below have been considered but dismissed from detailed analysis.

Table 1.1 Issues Considered but not Analyzed in Detail

Resource/Issue	Rationale for Determination
How would air quality and greenhouse gas emissions be affected by the Proposed Action?	Overall, air quality in the project area is in compliance with the National Ambient Air Quality Standards. There are no regulatory monitoring data for the project area. Dust emissions currently occur from vehicles utilizing the subject roads. It is anticipated that the incremental change from this project's alternatives would be so small as to be undetectable by both models and monitors. No standards have been set by the EPA or other regulatory agencies for greenhouse gases. It is anticipated that greenhouse gas emissions associated with this action and its alternative(s) would be undetectable by both models and monitors.
How would important Native American and Euro-American sites be affected by the Proposed Action?	It is anticipated that important sites would not be affected because such sites generally require excavation to yield information important to history or prehistory. Such sites would be avoided by ground-disturbing activities associated with the wild horse gathers. If gather activities were proposed and important sites were located, alternate locations without sites would be utilized.

Resource/Issue	Rationale for Determination
	The NHPA requires federal agencies to consider the effects of their undertakings on sites that are eligible to the National Register of Historic Places. In Colorado BLM's obligations under NHPA are met under the Protocol Agreement between BLM and SHPO.
How would Native American Religious Concerns be affected by the Proposed Action?	Sand Wash Basin includes a high number of cultural resources of significance to modern-day descendant Native American Communities. Pursuant to 36 CFR 800.2(c)(2) and BLM Manual 1780, consultation letters were sent to 14 Tribes on April 27, 2018.
How would Invasive Plants / Noxious Weeds be affected by the Proposed Action?	Surface disturbing activities have the potential to introduce/spread invasive species/noxious weeds. Russian thistle, cheatgrass and halogeton are common invasive species that are within the project area. Noxious weeds present within the project area include musk thistle, houndstongue and Canada thistle. Trap areas are in disturbed locations and are treated as needed. Prevention is the best solution for weed management. Vehicles and equipment will be power washed prior to entering BLM administered lands. Livestock will be fed certified weed free hay a minimum of 72 hours prior to entering BLM administered lands. By employing these BMP methods, the introduction/spread of invasive species/noxious weeds would be greatly reduced. Treatment options as needed would be site specific. Weed management activities would continue in accordance with the LSFO Integrated Pest Management Plan. Therefore, negligible impacts to invasive species/noxious weeds is expected.
How would Lands/Access be affected by the Proposed Action?	The Proposed Action or Alternatives would have no impact to existing Realty Authorizations. There are no proposed changes to land tenure within the HMA.
How would Lands with Wilderness Characteristics be affected by the Proposed Action?	A review of the RMP and GIS layers conclude that in general, the nature of the management strategies proposed to control population(s) would not impact areas identified as having wilderness characteristics. The proposed action would be short term and temporary, with no long-term or permanent changes to the landscape. Therefore, further analysis is not necessary.
Upland Vegetation	Vegetation/Fauna conditions withing the HMA are not sustainable. The Proposed Action would be greatly beneficial to vegetation resources and natural processes. See Livestock Grazing Section, Issues 1 & 2 and Appendix I for description of vegetation resources, recent vegetation studies and impacts to vegetation.

Resource/Issue	Rationale for Determination
How would the Proposed Action affect BLM Sensitive Plant species?	The proposed action includes the use of helicopter gather operations which has the potential to impact SSPS by trailing, trampling, and/or herding horses through occupied habitat for BLM Sensitive plant species (BLM, 2015). Bait trapping has the potential to impact SSPS with the initial set-up and breakdown of traps. Both gather methods can result in an increase in fugitive dust, soil compaction, and damage to biological soil crusts. Fugitive dust can limit photosynthesis and diminished growth or cause mortality. The severity of fugitive dust generated by these activities varies depending on several factors including wind, frequency and timing of precipitation events, soil and dust particle size, and effectiveness of dust control measures. Design features implementing a 100 meter buffer have been incorporated into the proposed action to limit potential impacts. There are known occurrences of Yampa beardtongue (*Penstemon yampaensis*), tufted cryptantha (*Oreocarya caespitosa*), rock tansy (*Sphaeromeria capitata*), and debris milkvetch (*Astragalus detritalis*) that are within the HMA boundary fences (Colorado Natural Heritage Program (CNHP) 2020). Most of these occurrences are located on the edge of the HMA where wild horses do not typically congregate. Habitat for these species is associated with dry slopes and barren habitats in pinyon-juniper and mixed desert shrub communities. Herbarium specimens of Uinta basin spring parsley (*Cymopterus duchesnensis*) were collected within the HMA in 2011 near Monument Hill. This population and an unconfirmed identification Northeast of G Gap will be documented by botanists from the CNHP during the 2021 field season. There is historical habitat for Bessey's locoweed (*Oxytropis besseyi var. obnapiformis*) within the HMA near Highway 318. Botanists from CNHP will also attempt to relocate this occurrence during the upcoming field season. Survey results will be utilized to micro-site trap locations. Gathering excess wild horses found to be outside of the HMA boundary would have the potential to impact other SSPS. Most BLM Sensitive Plant Species found in the LSFO are regionally endemic and owe their rarity to

Resource/Issue	Rationale for Determination
	unusually specific habitat requirements rather than widespread disturbance or loss of available habitat. The proposed action and incorporated design features should not add additional impacts or threats to SSPS populations beyond those that already exist.
How would recreation be affected by the Proposed Action?	The Proposed Action is partially contained in a Special Recreation Management Area (SRMA); the South Sand Wash SRMA is managed primarily for motorized recreation. The primary users of this area do not visit for the purpose of viewing wild horses, but rather to enjoy high speed, off-road motorized sports. However, the Field Office has authorized two Special Recreation Permits for commercially guided wild horse viewing and photography in the Sand Wash HMA. The majority of the HMA is contained in an Extensive Recreation Management Area where recreation opportunities are managed under the multiple use mandate. Implementation of the proposed project would have a short-term impact on some types of recreation, such as wild horse viewing and photography. There would be fewer horses in the HMA and they may be more difficult to find. The gather may temporarily change the horses' normally tolerant attitude towards humans, but this should return to pre-gather behavior within a few months of the gather operation. Over there would be minimal long-term impact on recreational opportunities. Further analysis is not necessary.
How would Socio-Economics in Moffat County be affected by the Proposed Action?	No impact to the social or economic status of the county or nearby communities would occur from this project due to its small size in relation to ongoing development throughout the LSFO. Wild horses would continue to persist within the HMA, so wild horse-based tourism may continue.
How would Visual Resources be affected by the Proposed Action?	The Sand Wash Basin Herd Management Area is within lands designated as Visual Resource Management classes I and II. The management objectives for these classes require preservation or retention of the existing character of the landscape, where any changes to the landscape should be very low and not attract attention. In general, the nature of the management strategies proposed to control population would not impact visual resources. The actions would be short term and temporary, with no long-term or permanent changes to the landscape. Further analysis is not necessary.
How would hazardous/solid wastes be affected by the Proposed Action?	No chemicals subject to reporting under SARA Title III will be used, produced, stored, transported, or disposed of annually in association with the project. Furthermore,

Resource/Issue	Rationale for Determination
	no extremely hazardous substances, as defined in 40 CFR 355, in threshold planning quantities, would be used, produced, stored, transported, or disposed of in association with the project.
How would groundwater quality be affected by the proposed action?	Spatial review of the proposed Sand Wash Basin Wild Horse Gather indicates that surface activities would involve a minor amount of disturbance and interaction with groundwater is not anticipated.
How would hydrologic conditions (stormwater) be affected by the Proposed Action?	Wild horses have the potential to compact soils along trails and areas where animals group-up, especially around ponds or water sources. It is not expected that wild horses would noticeably alter the current hydrologic conditions to a degree that would require detailed analysis.
How would streams, riparian wetlands and floodplains be affected by the Proposed Action?	Management actions common to all alternatives for gather and removal include design features to minimize impacts to these resources therefore detailed analysis is not required.
How would surface water quality be affected by the Proposed Action?	The total area of ground disturbance is small and temporary resulting in negligible impacts to surface water quality. Therefore, no further detailed analysis is required.
How would the Proposed Action affect Migratory Birds (including raptors)?	There are known raptor nests within the project area, including golden eagles, red-tailed hawk and burrowing owls. Helicopter use near the nest during the nesting period may cause stress, harassment, nest abandonment and potential chick mortality. The design feature of avoiding gather activities until after June 30 and avoiding known nest locations would effectively avoid the critical nesting season and would alleviate any potential impacts to raptors.
How would the Proposed Action affect terrestrial wildlife species?	Gather activities may lead to a temporary displacement of wildlife in the area due to disruptive activities. These would be short in duration and are not expected to impact wildlife long term. Removing excess wild horses would improve vegetative conditions in the HMA. This would lead to improved habitat conditions and would be beneficial to wildlife that utilize the HMA.
How would the Proposed Action affect BLM Sensitive wildlife species?	Several BLM sensitive species including the Bald Eagle have potential to occur within the project area. Impacts would be limited to short periods of disturbance. As with terrestrial wildlife, removal of excess wild horse would be beneficial to BLM sensitive species.

Resource/Issue	Rationale for Determination
How would the Proposed Action affect Threatened, Endangered, Proposed or Candidate species?	The HMA does not provide habitat for any Threatened, Endangered, Proposed or Candidate species.
How would the Proposed Action affect Solid Minerals?	There would be no impact to solid mineral authorizations as the gathers would take place in areas where there are no solid mineral authorizations.
How would the Proposed Action Affect Paleontological Resources	There would be no impact to paleontological resources as there is no surface disturbing activity.

ALTERNATIVES CONSIDERED BUT ELIMINATED FROM DETAILED ANALYSIS

Alternatives considered but eliminated from detailed analysis are included in Appendix C, with discussion and rationale about why each alternative was not carried forward.

3.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL EFFECTS

The Council on Environmental Quality (CEQ) Regulations state that NEPA documents "must concentrate on the issues that are truly significant to the action in question, rather than amassing needless detail" (40 CFR 1500.1(b)). While many issues may arise during scoping, not all of the issues raised warrant analysis in an EA. Issues will be analyzed if: 1) an analysis of the issue is necessary to make a reasoned choice between alternatives, or 2) if the issue is associated with a significant direct, indirect, or cumulative impact, or where analysis is necessary to determine the significance of the impacts.

GENERAL SETTING

The Sand Wash Basin HMA is located 45 miles west of Craig, Colorado. The HMA encompasses 157,730 total acres, of which 154,940 acres are managed by the BLM, 1,960 acres are privately-owned, and 840 acres are managed by the State of Colorado. The HMA has a gradual elevation change from 8,100 feet at Lookout Mountain to 6,100 feet at the south end of the HMA. The interior of the HMA consists of gently rolling to moderately steep slopes cut by numerous small drainages leading into Sand Wash Draw. Yellow Cat Wash and Dugout Wash drain most of the eastern half of the basin. Bordering Sand Wash Basin on the southwest is Dry Mountain, a small mountain range with elevations ranging from 6,900 to 7,500 feet. To the northwest, the HMA is bordered by the Vermillion Bluffs, a large extended rim with elevations ranging from 6,800 to 8,100 feet. The HMA is bordered on the east side by Sevenmile Ridge which extends in a north/south direction from Highway 318 northerly along the entire east side of the HMA towards Nipple Rim. The HMA has several undeveloped springs and seeps that are used as water sources by the wild horses, as well as reservoirs and developed springs. Most of the developed water sources are in fair condition, with most in need of repair or general maintenance. See Appendix A for Maps of Sand Wash Basin.

The area boundaries to guide its analysis are as follows: Beginning at the junction of Moffat County Road (MCR) 10N and the Wyoming/Colorado state line, easterly from this junction following the state lines to Colorado Highway 13, south on Colorado Highway 13 to MCR 3, south westerly on MCR 3 to MCR 17, south and westerly on MCR 17 to Colorado Highway 40, westerly on Colorado Highway 40 to Colorado Highway 318, westerly on Colorado Highway 318 to MCR 21S, south on MCR 21S to MCR 10, west and northerly on MCR 10 to Colorado Highway 318, west and northerly along Colorado Highway 318 to MCR 10N, northerly on MCR 10N to the Colorado/Wyoming state line. The total acreage within the analysis area is approximately 1,038,801 acres consisting of 700,242 BLM acres, 254,070 private acres, 79,626 State of Colorado acres, and 4,863 acres of State Wildlife Areas. This area is much larger than the HMA in an effort to address known and possible locations wild horses could move in to from Sand Wash Basin and other HMA's including coming from Wyoming.

ISSUES BROUGHT FORWARD FOR ANALYSIS

WILD HORSES

Issue 1: How would the Proposed Action affect wild horse populations in the project area?

Affected Environment:

The Proposed Action will reduce the wild horse population to a number within the designated AML while maintaining adequate genetic diversity and continued social organization of the herds in bands. As described earlier, the current AML that is set for the area is 163-362 wild horses. Between 1988 and the present, the BLM has conducted approximately seven (7) gathers of wild horses within the Sand Wash Basin HMA in order to remove excess animals to manage the population size within the established AML range. Most recent was a private land gather in 2020. Twenty-one wild horses were gathered and removed in 2020. Also, in 2021 the LSFO was approved to gather and remove 50 horses consisting of 30 from near Highway 318 for public safety, and 20 from private land to address landowner requests to remove wild horses. The color of horses in the HMA varies widely Bay, Black, Pintos, Roans, Sorrels, Chestnuts, Browns and Greys can all be found.

The wild horse herd size within the HMA was estimated to be 621 horses as of March 1, 2019. This number is based on a March 2019 aerial population inventory utilizing the simultaneous double-observer method (Griffin et al. 2020). A statistical analysis of the aerial survey data provided a point estimate of herd size within the HMA of 433 adult horses in March of 2019, with a 90 percent confidence interval of between 386-483 adult horses at that time (Ekernas, 2019). The HMA has an estimated average 13 percent annual herd growth rate as seen from past inventory and gather reports. This number is lower than the more typical rate of about 20% per year seen in other wild horses, due to previous use of fertility control vaccines. The number that is used in this analysis is estimated using the horses that currently reside outside the HMA, and on the ground estimates of volunteer groups within the HMA.

BLM is not required by law to manage the herds found in any given HMA as if they were genetically isolated populations. A 2013 report from the National Academies of Sciences' national Research Council (NRC), commissioned by BLM, recommended that BLM consider genetic management of wild horses from the perspective of metapopulations. Under this framework, herds from individual HMAs should not be considered to be genetically isolated populations. Rather, BLM was encouraged to consider the historical and present connections between HMAs. Genetically, BLM was encouraged by NRC (2013) to maintain genetic variation across a number of potentially interconnected herds (i.e., many herds within a given metapopulation); the connections between herds may be maintained by natural emigration and immigration, or by human-assisted translocation. The AML in this HMA alone, along with periodic introgression from nearby herds such as Adobe Town HMA and Salt Wells HMA in Wyoming, should be large enough to maintain genetic diversity, as measured by observed heterozygosity (Ho) without introduction of horses from outside the HMA. If needed, observed heterozygosity levels can be maintained and excessive inbreeding can be avoided through additional introductions of additional wild horses from other herds. The genetically effective breeding size of a herd, Ne, is a reflection of the number of individuals that are contributing to the maintenance of genetic diversity (reviewed in NRC 2013); this number can be difficult to measure directly but is related to the numbers of breeding males and females in a herd. If a herd consists of 40 breeding mares and 60 breeding stallions, then a simplified calculation of Ne (Hartl and Clark 2007) would lead to an estimate of 96. However, actual Ne is usually lower than the numbers of breeding animals present would imply, so the BLM Wild Horse and Burro Handbook suggests considering other options for maintaining genetic diversity when herd size must be held below about 150 animals due to habitat limitations or other considerations (BLM 2010). The handbook (BLM 2010) includes suggestions that can be considered for maintaining genetic diversity in herds that may lose observed heterozygosity; these suggestions do not represent a specific, legally-binding, BLM policy. Two suggestions there are to introduce one to two mares every ten years or so, and to increase the sex ratio in favor of males (which should increase the number of harems and the number of effectively breeding males). Given the AML of this HMA, it is not anticipated that observed heterozygosity would decline over time. If in monitoring of genetics within the herd, observed heterozygosity were declining, then introduction of horses from other HMA's would be undertaken, which would be expected to reduce inbreeding.

Genetic sampling that is conducted during gathers allows BLM to gauge the genetic health of the herd, which allows BLM to identify whether and how much additional wild horses should be translocated into the HMA. Blood samples for genetic testing were taken in 2001 to create a baseline for the wild horses that occur within the HMA. These samples were sent to Dr. Gus Cothran and Texas A&M (Appendix J). Genetic analysis from 52 individuals gathered during the 2001 gather showed above average Observed Heterozygosity (Ho) or individual variability at that time (Cothran, 2002). Also, Cothran in 2002 found no unique genetic variants. Indicating that the Sand Wash Basin wild horses were of mixed origin with a primary input from North American breeds.

The 2013 National Academies of Sciences report included evidence that shows that the Sand Wash Basin HMA herd is not genetically unusual, with respect to other wild horse herds. Specifically, Appendix F of the 2013 NAS report is a table showing the estimated 'fixation index' (Fst) values between 183 pairs of samples from wild horse herds. Fst is a measure of genetic differentiation, in this case as estimated by the pattern of microsatellite allelic diversity analyzed by Dr. Cothran's laboratory. Low values of Fst indicate that a given pair of sampled herds has a shared genetic background. The lower the Fst value, the more genetically similar are the two sampled herds.

Values of Fst under approximately 0.05 indicate virtually no differentiation. Values of 0.10 indicate very little differentiation. Only if values are above about 0.15 are any two sampled subpopulations (i.e. from two sampled herds) considered to have evidence of elevated differentiation (Frankham et al. 2010). Fst values for the Sand Wash Basin HMA herd had pairwise Fst values that were less than 0.05 with over 100 other sampled herds. These results support the interpretation that Sand Wash Basin HMA horses are extremely similar to horses in a large number of other BLM-managed wild horse herds, as part of a highly connected metapopulation that includes horse herds in many other HMAs and several different states of origin.

The AML for the HMA was set in the Little Snake RMP (2011). The RMP decisions directed the BLM to manage horses as part of the ecosystem at an AML, proactively respond to conflicts between wild horses and other uses and maintain fences to keep horses within the HMA. The BLM LSFO has attempted since the completion of the RMP in 2011 to maintain the wild horse populations within the AML on the HMA. Since 2011, three (3) gathers and removals have been conducted within the HMA in an attempt to keep the horse population within the AML. Gathers of wild horses within this HMA have proven effective due to open terrain and accessibility. As the population increases, gather extent and length becomes bigger and longer and removing more horses to reach low AML.

The overriding limiting factor for the carrying capacity of wild horses in the HMA is not the available forage, although this is a concern, but is the supply of reliable water during the summer months. Wild horses in this HMA congregate in portions of the HMA to stay close to available water sources. This concentration increases as drought reduces the available water in and around the HMA. Upland vegetation in proximity to water sources are used heavily by wild horses and wildlife, while vegetation in areas farther from water (i.e., greater than six miles) is used slightly too moderately.

The increased concentration of wild horses at all the reliable water sources in the HMA have reduced vegetation and caused soil compaction. Due to the high population of wild horses within the HMA, wild horses will leave the HMA and expand into new areas looking for feed and water. This has been noted recently with horses moving out onto private lands near the Little Snake River and trying to push out onto portions north of the HMA.

It is anticipated that the age structure of the HMA wild horses resemble a normal age structure with ages ranging from foals to animals in excess of 20 years of age. The sex ratio is estimated to be approximately 50 percent mares and 50 percent stallions with variations 10 percent below or above these levels.

Population modeling was completed for the HMA using Version 1.4 of the WinEquus population model (Jenkins, 2002) to analyze how the alternatives would affect the wild horse population (Appendix D). This modeling analyzed removal of excess wild horses with no fertility control, as compared to removal of excess wild horses with fertility control. The No Action (no removal) Alternative was also modeled. One objective of the modeling was to identify whether any of the alternatives "crash" the population or cause extremely low population numbers or growth rates. Minimum population levels and growth rates were found to be within reasonable levels and adverse impacts to the population not likely. Graphic and tabular results are also displayed in detail in Appendix D.

Environmental Consequences

Alternative A – Proposed Action – Potential Environmental Consequences

Since the passage of the WFRHBA of 1971 over 40 years ago, field observations, herd health monitoring, and population inventories have recorded locations in and around the HMA where wild horses have occurred. Horses normally do not move outside the HMA unless the population is above AML and/or drought conditions exist.

As forage within close proximity of water sources is depleted, the wild horses will need to range greater distances for forage. The distance the animals must travel over steep rugged terrain can result in rapid physical deterioration of the animals.

Rangeland resources and wild horse health have been and are currently being affected within the HMA, due to drought and excess wild horse population. Excess wild horses above AML have reduced available water and forage, resulting in increased competition for available resources between wild horses, wildlife, and during periods of the year livestock. The gather of wild horses from the HMA would affect individual animals and the social structure of bands in the area. Most impacts would be short term (less than 1 year), but some would be long term (greater than one year). These impacts are discussed within this EA.

The Proposed Action would remove excess wild horses to within the AML and would restore a TNEB within the HMA. The target population after gather and removal is expected to be approximately low-range AML, or 163 wild horses. All animals selected to remain in the population would be selected to maintain a diverse age structure, herd characteristics and body type (conformation). The Proposed Action would not reduce all the associated impacts to the wild horses and rangeland resources. Over the short-term, individuals in the herd would still be subject to increased stress and possible death as a result of continued competition for water and forage. Areas experiencing heavy and severe utilization levels by wild horses would continue to be heavily impacted by horses but to a lesser extent; impacts to rangeland resources (concentrated trailing, increased bare ground, etc.) throughout the HMA would be expected to slowly heal and attain TNEB once removal of excess horses to low AML has been reached.

Current population levels are resulting in bands of horses leaving the boundaries of the HMA into areas not designated for their use in search of forage and water. If this should occur, the proposed action would achieve the stated objectives for the wild horse herd management area, to "prevent the range from deterioration associated with overpopulation", and "preserve and maintain a thriving natural ecological balance and multiple use relationship in that area." Upon identification of wild horses outside the HMA, future gathers would focus on those groups or individuals to ensure the herd stays within the HMA.

Removal of excess wild horses would improve herd health. Decreased competition for forage and water resources would reduce stress and promote healthier animals. This removal of excess animals coupled with anticipated reduced reproduction (population growth rate) as a result of fertility control. This should result in improved health and condition of mares and foals as the actual population comes into line with the population level that can be sustained with available forage and water resources and would allow for healthy range conditions (and healthy animals) over the longer-term. Additionally, reduced population growth rates would be expected to extend the time interval between gathers and reduce disturbance to individual animals as well as to the herd social structure over the foreseeable future.

Bringing the wild horse population back to low-range AML through the proposed action would reduce damage to the range from the current excess population of wild horses and allow vegetation resources to start recovering, without the need for additional gathers in the interim. As a result, there would be fewer disturbances to individual animals and the herd, and a more stable wild horse social structure.

Gather operations may impact individual animals as a result of handling stress associated with the gathering, processing, and transportation of animals. The intensity of these impacts varies by individual animal and is indicated by behaviors ranging from nervous agitation to physical distress. Mortality to individual animals from these impacts is infrequent but does occur in 0.5 percent to 1.1 percent of wild horses gathered in a given gather operation (GAO 2008, Scasta 2020). Other impacts to individual wild horses include separation of members of individual bands of wild horses and removal of animals from the population.

Other impacts can occur after the initial stress event and may include increased social displacement or increased conflict between stallions. These impacts are known to occur intermittently during wild horse gather operations. Traumatic injuries may occur, and typically involve bruises from biting and/or kicking, which do not break the skin.

The gathers would occur when populations, range conditions, and approvals from HQ are granted. This may result in increased frequency of gather operations making wild horses more difficult to trap. The horses would become very evasive and learn to evade gather operations by taking cover in treed areas, canyons, and/or avoiding gather areas (depending on method used to gather). Wild horses would also move out of the area when they hear a helicopter, thereby further reducing the overall gather efficiency. Frequent gathers would increase the stress to wild horses, as individuals and as entire herds. It would become increasingly more difficult over time to repeat gathers if the gathers are within two-year intervals to successfully treat mares with fertility control.

Fertility Control

The impacts to wild horses from the use of fertility control vaccines and flexible IUDs is discussed in depth in Appendix E and F.

Water/Bait Trapping

Bait and/or water trapping generally requires a long window of time for success. Although the trap would be set in a high-probability areas for capturing excess wild horses residing within the area and at the most effective time periods, time is required for the horses to acclimate to the trap and/or decide to access the water/bait.

Trapping involves setting up portable panels around an existing water source or in an active wild horse area, or around a pre-set water or bait source. The portable panels would be set up to allow wild horses to go freely in and out of the corral until they have adjusted to it. When the wild horses fully adapt to the corral, it is fitted with a gate system. The acclimatization of the horses creates a low stress trap. During this acclimation period the horses would experience some stress due to the panels being setup and perceived access restriction to the water/bait source.

When actively trapping wild horses, the trap would be checked on a daily basis. Horses would be either removed immediately or fed and watered for up to several days prior to transport to a holding facility. Existing roads would be used to access the trap sites.

Gathering of the excess horses utilizing bait/water trapping could occur at any time of the year and could extend until the target number of animals are removed to reach AML; relieve concentrated use by horses in the area; implement population control measures; remove animals residing outside HMA boundaries, and management objectives are achieved. Generally, bait/water trapping is most effective when a specific resource is limited, such as water during the summer months. For example, in some areas, a group of wild horses may congregate at a given watering site during the summer because few perennial water resources are available nearby. Under those circumstances, water trapping could be a useful means of reducing the number of horses at a given location, which can also relieve the resource pressure caused by too many horses. As the proposed bait and/or water trapping in this area is a low stress approach to gathering of wild horses, such trapping can continue into the foaling season without harming the mares or foals. Conversely, it has been documented that at times water trapping could be stressful to wild horses due to their reluctance related to approaching new, human structures or intrusions. In these situations, wild horses may avoid watering or may travel greater distances in search of other watering sources.

The wild horses that are gathered would be subject to one or more of several outcomes listed below.

Temporary Holding Facilities During Gathers

Wild horses gathered would be transported from the trap sites to a temporary holding corral near the HMA in goose-neck trailers or straight-deck semi-tractor trailers. At the temporary holding corral, the wild horses would be aged and sorted into different pens based on sex. The wild horses would be provided ample supply of good quality hay and water. Mares and their un-weaned foals would be kept in pens together. All horses identified for retention in the HMA would be penned separately from those animals identified for removal as excess.

At the temporary holding facility, a veterinarian, when present, would provide recommendations to the BLM regarding care, treatment, and if necessary, euthanasia of the recently captured wild horses. Any animals affected by a chronic or incurable disease, injury, lameness or serious physical defect (such as severe tooth loss or wear, club foot, and other severe congenital abnormalities) would be humanely euthanized using methods acceptable to the American Veterinary Medical Association (AVMA), and BLM policy.

Transport, Off-Range Corrals, and Adoption Preparation

Wild horses removed from the range as excess would be transported to the receiving off-range corral (ORC) in a goose-neck stock trailer or straight-deck semi-tractor trailers. Trucks and trailers used to haul the wild horses would be inspected prior to use to ensure wild horses can be safely transported. Wild horses would be segregated by age and sex when possible and loaded into separate compartments. Mares and their un-weaned foals may be shipped together depending on age and size of foals. Mare and un-weaned foals are not separated for longer than 12 hours. Transportation of recently captured wild horses is limited to a maximum of ten hours. During transport, potential impacts to individual horses can include stress, as well as slipping, falling, kicking, biting, or being stepped on by another animal. Unless wild horses are in extremely poor condition, it is rare for an animal to die during transport.

Upon arrival, recently captured wild horses are off-loaded by compartment and placed in holding pens where they are fed good quality hay and water. Most wild horses begin to eat and drink immediately and adjust rapidly to their new situation. At the ORC, a veterinarian provides recommendations to the BLM regarding care, treatment, and if necessary, euthanasia of the recently captured wild horses. Any animals affected by a chronic or incurable disease, injury, lameness or serious physical defect (such as severe tooth loss or wear, club foot, and other severe congenital abnormalities) that was not diagnosed previously at the temporary holding corrals at the gather site would be humanely euthanized using methods acceptable to the AVMA. Wild horses in very thin condition or animals with injuries are sorted and placed in hospital pens, fed separately and/or treated for their injuries. Recently captured wild horses, generally mares, in very thin condition may have difficulty transitioning to feed. A small percentage of animals can die during this transition; however, some of these animals are in such poor condition that it is unlikely they would have survived if left on the range.

After recently captured wild horses have transitioned to their new environment, they are prepared for adoption or sale. Preparation involves freeze-marking the animals with a unique identification number, vaccination against common diseases, microchipping, castration of stallions, and de-worming. During the preparation process, potential impacts to wild horses are similar to those that can occur during transport. Injury or mortality during the preparation process is low but can occur.

At short-term corral facilities, a minimum of 700 square feet is provided per animal. Mortality at short-term holding facilities averages approximately 5 percent (GAO-09-77, page 51), and includes animals euthanized due to a pre-existing condition, animals in extremely poor condition, animals that are injured and would not recover, animals which are unable to transition to feed; and animals which die accidentally during sorting, handling, or preparation.

Adoption

Adoption applicants are required to have at least a 400 square foot corral with panels that are at least six feet tall. Applicants are required to provide adequate shelter, feed, and water. The BLM retains title to the horse for one year and the horse and facilities are inspected. After one year, the applicant may take title to the horse at which point the horse becomes the property of the applicant. Adoptions are conducted in accordance with 43 CFR § 4750.

Sale with Limitation

Buyers must fill out an application and be pre-approved before they may buy a wild horse. A sale-eligible wild horse is any animal that is more than ten years old; or has been offered unsuccessfully for adoption at least three times. The application also specifies that all buyers are not to sell to slaughter buyers or anyone who would sell the animals to a commercial processing plant. Sale of wild horses is conducted in accordance with the WFRHBA of 1971and congressional limitations.

Off-Range Pastures

Potential impacts to wild horses from transport to adoption, sale or ORP are similar to those previously described. One difference is that when shipping wild horses for adoption, sale or ORP, animals may be transported for up to a maximum of 24 hours. Immediately prior to transportation, and after every 24 hours of transportation, animals are offloaded and provided a minimum of eight hours on-the-ground rest. During the rest period, each animal is provided access to unlimited amounts of clean water and two pounds of good quality hay per 100 pounds of body weight with adequate bunk space to allow all animals to eat at one time. The rest period may be waived in situations where the anticipated travel time exceeds the 24-hour limit, but the stress of offloading and reloading is likely to be greater than the stress involved in the additional period of uninterrupted travel.

ORPs are designed to provide excess wild horses with humane, and in some cases, life-long care in a natural setting off the public rangelands. There, wild horses are maintained in grassland pastures large enough to allow free-roaming behavior and with the forage, water, and shelter necessary to sustain them in good condition. As of February 2021, about 40,000 wild horses that are in excess of the current adoption or sale demand (because of age or other factors such as economic recession) are currently located on private land pastures in Oklahoma, Kansas, South Dakota, Iowa, Missouri, Montana, Nebraska, Utah and Wyoming. Establishment of ORPs was subject to a separate NEPA and decision-making process. Mainly located in mid or tall grass prairie regions of the United States, these ORPs are highly productive grasslands compared to the more arid western rangelands. These pastures comprise about 400,000 acres (an average of about ten to 11 acres per animal).

Mares and sterilized stallions (geldings) are generally segregated into separate pastures. Although the animals are placed in ORP, they remain available for adoption or sale to qualified individuals; and foals born to pregnant mares in ORP are gathered and weaned when they reach about eight to 12 months of age and are also made available for adoption. The ORP contracts specify the care that wild horses must receive to ensure they remain healthy and well-cared for. Handling by humans is minimized to the extent possible although regular on-the-ground observation by the ORP contractor and periodic counts of the wild horses to ascertain their well-being and safety are conducted by BLM personnel and/or veterinarians. A small percentage of the animals may be humanely euthanized if they are in very poor condition due to age or other factors. Although horses residing on ORP facilities live longer, on the average, than wild horses residing on public rangelands, natural mortality of wild horses in ORP averages approximately 8 percent per year but can be higher or lower depending on the average age of the horses pastured there (GAO-09-77, Page 52).

Euthanasia and Sale Without Limitation

Under the WFRHBA, healthy excess wild horses can be euthanized or sold without limitation if there is no adoption demand for the animals. However, while euthanasia and sale without limitation are allowed under the statute, these activities have not been permitted under current Congressional appropriations for over a decade and are consequently inconsistent with BLM policy. If Congress were to lift the current appropriations restrictions, then it is possible that excess horses removed from the HMA over the next ten years could potentially be euthanized or sold without limitation consistent with the provisions of the WFRHBA.

Any old, sick or lame horses unable to maintain an acceptable body condition (greater than or equal to a Henneke BCS of 3) or with serious physical defects would be humanely euthanized either before gather activities begin or during the gather operations. Decisions to humanely euthanize animals in field situations would be made in conformance with BLM policy (Washington Office Instruction Memorandum (WO IM) 2015-070 or most current edition).

Wild Horses Remaining or Released into the HMA following Gather

Under the Proposed Action, the post-gather population of wild horses would be approximately 163 wild horses, which is the low range of the AML for the HMA under this alternative. Reducing population size would also ensure that the remaining wild horses are healthy and vigorous, and not at risk of death or suffering from starvation due to insufficient habitat coupled with the effects of frequent drought (lack of forage and water).

The wild horses that are not captured may be temporarily disturbed and move into another area during the gather operations. With the exception of changes to herd demographics, direct population wide impacts have proven, over the last 20 years, to be temporary in nature with most if not all impacts disappearing within hours to several days of when wild horses are released back into the HMA. No observable effects associated with these impacts would be expected within one month of release, except for a heightened awareness of human presence.

As a result of lower density of wild horses across the HMA following the removal of excess horses, competition for resources would be reduced, allowing wild horses to utilize preferred, quality habitat. Confrontations between stallions would also become less frequent, as would fighting among wild horse bands at water sources. Achieving the AML and improving the overall health and fitness of wild horses could also increase foaling and foaling survival rates over the current conditions.

The primary effects to the wild horse population that would be related to this proposed gather would be to herd population dynamics, reduced growth rates and reduced population size over time compared to the no action alternative.

The remaining wild horses not captured would maintain their social structure and herd demographics (age and sex ratios). No observable effects to the remaining population associated with the gather impacts would be expected except a heightened shyness toward human contact.

Impacts to the rangeland as a result of the current overpopulation of wild horses would be reduced under the two gather and removal alternatives. Fighting among stud horses would decrease since they would protect their position at water sources less frequently; injuries and death to all age classes of animals would also be expected to be reduced as competition for limited forage and water resources is decreased.

Other impacts may occur to individual wild horses after the initial stress event, and may include spontaneous abortions in mares, and increased social displacement and conflict in studs. These impacts are known to occur intermittently during wild horse gather operations. An example would be the brief skirmish which occurs among older studs following sorting and release into the stud pen, which usually lasts less than two minutes and ends when one stud retreats. Traumatic injuries usually do not result from these conflicts. These injuries typically involve a bite and/or kicking with bruises which don't break the skin. Like direct individual impacts, the frequency of occurrence of these impacts among a population varies with the individual.

Spontaneous abortion events among pregnant mares following capture is also rare, though poor body condition can increase the incidence of such spontaneous abortions. Given the timing of this gather, spontaneous abortion would not be considered to be an issue for the proposed gather.

A few foals may be orphaned during gathers. This may occur due to:

- The mare rejects the foal. This occurs most often with young mothers or very young foals;
- The foal and mother become separated during sorting, and cannot be matched;
- The mare dies or must be humanely euthanized during the gather;
- The foal is ill, weak, or needs immediate special care that requires removal from the mother; or
- The mother does not produce enough milk to support the foal.

Often, BLM gathers foals that were already orphans on the range (prior to the gather) because the mother rejected them or died. These foals are usually in poor, unthrifty condition. Orphans encountered during gathers are cared for promptly and rarely die or have to be euthanized. Nearly all foals that would be gathered would be over four months of age and some would be ready for weaning from their mothers. In private industry, domestic horses are normally weaned between four and six months of age.

Gathering the wild horses during the fall/winter reduces risk of heat stress, although this can occur during any gather, especially in older or weaker animals. Adherence to the SOPs and CAWP as well and techniques used by the gather contractor help minimize the risks of heat stress. Heat stress does not occur often, but if it does, death can result.

Through the capture and sorting process, wild horses are examined for health, injury and other defects. Decisions to humanely euthanize animals in field situations would be made in conformance with BLM policy. The BLM Euthanasia Policy (IM-2015-070) is used as a guide to determine if animals meet the criteria and should be euthanized (Appendix B). Animals that are euthanized for non-gather related reasons include those with old injuries (broken hip, leg) that have caused the animal to suffer from pain or which prevent them from being able to travel or maintain body condition; old animals that have lived a successful life on the range, but now have few teeth remaining, are in poor body condition, or are weak from old age; and wild horses that have congenital (genetic) or serious physical defects such as club foot, or sway back and should not be returned to the range.

Alternative B – Gather without Fertility – Potential Environmental Consequences

Impacts to Wild Horses under Alternative B would be similar in nature to those addressed in Alternative A (Proposed Action). Fertility control would not be utilized. Without fertility control methods being applied, it is believed that the herd would grow at a faster rate than the Proposed Action which would lead to an increased gather schedule over the proposed action to maintain AML. This population growth would result in wild horse populations exceeding AML and not maintaining a TNEB within the HMA.

Alternative C – No Action – Potential Environmental Consequences

The HMA would be managed under the objectives found in the RMP, and current regulations and policies with no additional objectives specific to the management of wild horses within the HMA.

If the No Action Alternative is implemented, excess wild horses would not be removed from within the HMA at this time. The animals would not be subject to the individual impacts from a gather operation in Summer 2021 or thereafter. Over the short-term, individuals in the herd would be subject to increased stress and possible death as a result of increased competition for water and forage as the wild horse population continues to grow. The number of areas experiencing severe utilization by wild horses would continue to increase. This would result in increasing damage to rangeland resources throughout the HMA. Trampling and trailing damage by wild horses in/around riparian areas and water sources would also increase, resulting in larger, more extensive areas of bare ground. Competition for the available water and forage between wild horses, domestic livestock, and native wildlife would increase.

Wild horses are a long-lived species with documented survival rates that often exceed ninety percent for adults and 80 percent for foals (Ransom et al. 2016), and do not have the ability to self-regulate their population size (NAS 2013). Predation and disease have not substantially regulated wild horse population levels within the Sand Wash Basin HMA. Some mountain lion predation may occur but does not appear to be so substantial as to prevent herd growth. Coyotes are not prone to prey on wild horses unless young or extremely weak. Other predators such as wolves, or bears are not currently prevalent within the HMA. If the introduction of wolves to Colorado (Proposition 114) leads to a wolf population using this area, it is not expected that wolves would, of themselves, cause the herd to decrease in size, considering that wolves are currently present in Wyoming, Idaho, and Montana in the vicinity of other managed herds of wild horses (including herds where fertility control is currently applied). As a result of all these conditions, it is expected that there will continue to be a steady increase in wild horse numbers for the foreseeable future, which would continue to exceed the carrying capacity of the range. Under continued herd growth, individual horses would be at greater risk of death by starvation and lack of water. The population of wild horses would compete for the available water and forage resources, affecting mares and foals most severely. Social stress would increase. Fighting among stud horses would increase as they protect their position at water sources, as well as injuries and death to all age classes of animals.

Substantial loss of the wild horses in the HMA due to starvation or lack of water would have obvious consequences to the long-term body condition of herd members. Continued decline of rangeland health and irreparable damage to vegetative, soil and riparian resources, would have impacts to the future of the HMA and all other users of the resources that depend upon them for survival (NAS 2013). As a result, the No Action Alternative would not ensure healthy rangelands, would not allow for the management of a healthy, self-sustaining wild horse population, and would not promote a thriving natural ecological balance.

As populations increase beyond the capacity of the available habitat, more bands of horses would leave the boundaries of the HMA in search of forage and water. This alternative would result in increasing numbers of wild horses in areas not designated for their use, would be contrary to the WFRHBA and would not achieve the stated objectives for wild horse herd management areas, to "prevent the range from deterioration associated with overpopulation," and "preserve and maintain a thriving natural ecological balance and multiple use relationship in that area."

LIVESTOCK GRAZING

Issue 2: How would the Proposed Action affect current livestock grazing in the project area?

Affected Environment:

The HMA contains all or part of four grazing allotments. Overlap between wild horses and livestock occurs on an annual basis causing competition for forage and water resources. Wild horses, wildlife, and livestock compete directly for the same water and forage resources. Yearlong wild horse grazing reduces forage availability for wildlife and livestock. Grazing by excess wild horses can reduce forage production, vigor, reproduction, and availability.

Wild horses often drive away livestock and wildlife from watering and feeding areas (Miller, 1981). When these resources become depleted, wildlife and wild horses move to a new location, while livestock must be removed. Overlap between horses and cattle have been shown to increase at higher stocking density. Large numbers of any two species (sheep, cattle or horses) would increase the negative interactions (Smith, 1986).

Livestock in the allotment depend on reservoirs, springs, riparian areas and seeps during the period they are on the allotment. However, during winter grazing seasons snow provides much of the water resources used by authorized sheep. Reservoirs, springs, riparian areas and seeps are scattered throughout the allotments and HMA. During normal precipitation years this may facilitate dispersal and forage utilization to some extent. But with excessive horse numbers above appropriate AML the competition between horses, wildlife, and livestock remains constant and is detrimental to all faunae. During drought years, these sources may dry up and wild horses must move to other water sources which exacerbates the problem to levels that may take years to recover. It is possible that some areas within the HMA have been so depleted of natural vegetation diversity and density that a threshold may have been crossed and natural recovery to pre-horse conditions may not be possible.

Environmental Consequences

Alternative A – Proposed Action – Potential Environmental Consequences

The Proposed Action would not have any direct impacts to livestock grazing. Objectives that identify improvements to forage and water availability would reduce competition for these resources within the HMA, if they are accomplished.

Livestock located near gather activities may be temporarily disturbed or displaced by the helicopter and the increased vehicle traffic during gather operations if the gather occurs during the permitted grazing period. This displacement would be temporary, and the livestock may move back into the area once gather operations move. Experience has shown that gather operations have little impact on grazing livestock. No adjustments in permitted livestock use, active Animal Units Months (AUMs) , season of use and/or terms and conditions would occur as a result of the Proposed Action. Direct impacts of the gather activities itself would be minor and short-term. The permittees would be advised of gather operations area and times. So that these areas could be avoided by the permittees and sheep herders.

Long term impacts would be beneficial to livestock grazing, vegetation, and natural processes when horse numbers are maintained within AML.

Alternative B – Gather without Fertility – Potential Environmental Consequences

Direct and Indirect impacts to Livestock under Alternative B would be similar in nature to those addressed in Alternative A (Proposed Action). Population levels would increase faster overtime due to no application of fertility control. This would likely result in increased gather operations to gather excess wild horses, however this would not result in changes to livestock grazing.

Alternative C – No Action – Potential Environmental Consequences

Under the No Action Alternative, livestock would not be displaced or disturbed due to gather operations. Impacts from not managing horses within the HMA would have a negative effect on livestock grazing within the identified grazing allotments. Increased numbers of horses would adversely affect vegetative resources, which wild horses, livestock and wildlife compete for, as well as an increased competition and negative impacts for all water resources. This would result in a reduced carrying capacity. As wild horse numbers increase, livestock grazing within the HMA may have to be reduced in an effort to slow the deterioration of the range to the greatest extent possible or because rangeland conditions do not support the multiple uses for which the public lands are being managed.

Issue 3: How would the Proposed Action affect available forage for livestock grazing operations in the project area?

Affected Environment:

The HMA encompasses all or portions of the Sand Wash #04219, Sheepherder Springs #04217, Nipple Rim #04213, and Lang Spring #04212 Allotments. In the Sand Wash Allotment, the Sand Wash Pasture is the portion within the HMA and is permitted for 6,377 AUMs of winter and spring sheep use. In the Sheepherder Springs Allotment, the Sheepherder Pasture is the portion within the HMA and is permitted for 7,600 AUMs of winter and spring sheep use and 499 AUMs of fall cattle use. In the Nipple Rim Allotment, the south half is within the HMA. The allotment is permitted for 4,900 AUMs of fall, winter, and spring sheep use, with roughly half of that use occurring in the HMA. The entire Lang Spring Allotment is within the HMA and is permitted for 363 AUMs of fall, winter, and spring sheep use.

The seasons of use and AUMs for the affected allotments are listed below in Table 2.1.

Table 2.1 Little Snake Field Office allotment numbers, season of use, and AUMs

Allotment Name & Number	Livestock		Season of Use		AUMs
	No.	Kind	From	To	
Sand Wash #04219	5550	Sheep	11/15	5/15	6,377
Sheepherder Spring #04217	5,435 803	Sheep Sheep	10/1 4/1	5/5 6/30	7,599 471

	254 137	Cattle Cattle	9/1 10/1	10/31 1/15	499 472
Lang Spring #04212	257	Sheep	9/1	5/5	363
Nipple Rim #04213	2,899	Sheep	10/20	5/20	3,977
TOTAL					19,758

The above permits represent the maximum amount of forage allocated for livestock and the maximum periods of allowable use. While cattle are permitted on the Sheepherder Springs #04217 and Sand Wash #04219 Allotments, cattle have not customarily grazed pastures within the HMA since at least 2001.

HMA Livestock Use Summary

Allotment: Active AUMs	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average: % of Active AUMs
Lang Spring 363	Due to wild horse use and limited acreage and livestock AUMs there has been no livestock use since prior to 2000.													N/A
Nipple Rim 2,450	N/A	472	715	494	401	2,848	1,439	1,989	1,989	1,989	1,989	1,989	161	1,267 52%
Sheepherder Spring 9,041*	896	2,930	1,952	1,218	750	1,408	951	1,965	1,366	641	472	766	1,159	1,267 14%
Sand Wash 6,377*	3,630	4,252	1,242	4,355	1,578	0	3,395	1,067	2,287	2,063	1,059	1,573	841	2103 33%

- * The Sand Wash and Sheepherder Springs Allotments has pastures outside the HMA numbers presented above are only for the portion of the allotment within the HMA.

N/A - Represents either no data available or a change in authorizations with old records problematic to obtain.

__**Environmental Consequences**__

Alternative A – Proposed Action – Potential Environmental Consequences

Indirect impacts to livestock grazing would include an increase in forage availability, reduced competition for water and forage. Direct impacts would include improved vegetative resources that would lead to a thriving ecological condition. Water sources that are repaired for either livestock or wild horses would also benefit wildlife.

Alternative B – Gather without Fertility – Potential Environmental Consequences

Direct and Indirect impacts to Livestock under Alternative B be will similar in nature to those addressed in Alternative A (Proposed Action). Population levels would increase faster overtime due to no application of fertility control. This would likely result in increased gather operations to gather excess wild horses.

Alternative C – No Action – Potential Environmental Consequences

The No Action Alternative would have detrimental impacts to all forage resources not just for livestock grazing operations but to wildlife, and the horses themselves. Current vegetative/forage conditions are not acceptable, continuing to decline, and not sustainable on any ecological level.

See Appendix I for the 2014 and 2018 Sand Wash HMA Monitoring Summaries. In these studies, detrimental impacts to vegetation and forage resources are documented and justifies a reduction in horse numbers to appropriate AML.

SAGE GROUSE

Issue 4: ***What impact would there be to greater sage-grouse in the HMA from the Proposed Action?***

Affected Environment:

The greater sage-grouse is currently a BLM sensitive species and had been a candidate for listing under provisions of the ESA. In March 2010 the USFWS determined that listing was warranted but precluded by higher priorities (75 FR 13910). BLM and the US Forest Service completed a planning effort, which resulted in the amendment of BLM land use plans and is documented in the ARMPA (BLM 2015). On October 2, 2015, the USFWS determined the greater sage-grouse was not warranted for protection under ESA (80 FR 59857). Management of the species is guided by the 2015 ARMPA.

The ARMPA delineated sage-grouse habitat into Priority Habitat Management Areas. PHMAs are lands identified as having the highest value for maintaining sustainable greater sage-grouse populations. There are approximately 73,510 acres (47 percent of the HMA) of PHMA within the HMA, most of which are on BLM lands (see PHMA Map, Appendix A). The HMA is located in CPW 's greater sage-grouse Management Zone 2. One hundred and five males were counted on leks within this zone in 2020. The population in Zone 2 has decreased each year since 2017, when 480 males were counted. Specific to the HMA, there are ten active leks located within the boundary. In 2020, these ten leks had a combined high male count of 73 birds. Numbers have also decreased in the Sand Wash area since 2017, when the all-time high was recorded.

Environmental Consequences

Alternative A – Proposed Action – Potential Environmental Consequences

The Proposed Action is expected to result in a net benefit to the greater sage-grouse and very few negative impacts are expected. The area affected by gather sites and temporary holding facilities would be small, approximately 15 acres. Sites used for water/bait or helicopter traps or for holding areas are typically low value sage-grouse habitat because of proximity to human high use areas, such as roads, stock ponds, and troughs and the resulting degradation of habitat due to compaction, trampling, and vegetation removal. There is the possibility of sage-grouse broods being disturbed by wild horses during helicopter trapping activities. However, helicopter gather operations are limited to the period of July 1 through 28 February (to avoid the foaling season), and broods would be capable of moving away from the disturbance caused by the operation.

The overall impact of the project would be positive for greater sage-grouse. Wild horses remove more of the plant cover than cattle or sheep, which limits and/or delays vegetative recovery, which can result in reduced vegetative cover for nesting and brooding sage-grouse (BLM/Forest Service, 2015). In addition, grazing permits limit timing, duration, and intensity during certain times of the year to prevent impacts to greater sage-grouse. Areas grazed by wild horses have been found to have reduced plant diversity and grass density, and greater abundance of invasive species (BLM/Forest Service, 2015). The presence of wild horses is associated with a reduced degree of greater sage-grouse lekking behavior (Muñoz et al. 2020). Moreover, increasing densities of wild horses, measured as a percentage above AML, are associated with decreasing greater sage-grouse population sizes, measured by lek counts (Coates 2020). Lowering the wild horse population would diminish the negative impacts resulting from wild horses and result in improved sage-grouse habitat. Fewer wild horses on the landscape would result in less vegetation removal by horses. Less wild horse pressure on herbaceous vegetation would result in better vegetation vigor to benefit sage-grouse. Improved vegetation condition can provide sage-grouse with important thermal or escape cover, more direct forage, and more habitat for arthropods (important for sage-grouse, especially for chicks) (Beever and Aldridge, 2011). Soil compaction, erosion would be lessened, and vegetative and biological crust cover would increase. Nesting, brood-rearing, and foraging habitats and insect prey populations would increase (Beever and Herrick, 2006).

Furthermore, wild horse removal aids in recovery goals in this area by decreasing grazing pressure on desirable grasses and allow desirable vegetation to better compete against undesirable annual grasses. Decreasing the abundance and presence of undesirable annual grasses would decrease the risk of wildfire, a potential threat to greater sage-grouse in this area. This decrease in fire would also be beneficial to shrub cover, which would be expected to increase.

The proposed action would add to the beneficial effects of habitat restoration and rehabilitation projects, while countervailing the negative effects of rights-of-way, mineral development, and other anthropogenic disturbances within the HMA. The proposed action would countervail the reduction in water availability due to drought, although the cumulative effects of drought and wildfire on vegetation could overwhelm any contribution from the proposed action in portions of the HMA.

Alternative B – Gather without Fertility – Potential Environmental Consequences

Impacts to Greater Sage-Grouse under Alternative B would be similar in nature to those addressed in Alternative A (Proposed Action).

Under this alternative, horse populations would increase at a more natural rate than under the proposed action. As wild horse populations increase over time, increased impacts to vegetation and habitat from wild horse use and presence would also increase, until the horse population was decreased through management actions. This population growth would result in wild horse populations exceeding AML and not maintaining a TNEB within the HMA.

Alternative C – No Action – Potential Environmental Consequences

The potential disturbance of sage-grouse young due to helicopter trapping would be avoided by implementing the No Action alternative. Otherwise, impacts from this alternative would be expected to be negative, with the continuation of the negative effects resulting from the high population levels of wild horses, including reductions in vegetative cover, plant diversity, forage, biological crusts, and insect prey availability.

ENVIRONMENTAL TRENDS IN AND NEAR THE PROJECT AREA

These trends would result of from the incremental impact of an action when added to other past, present, or reasonably foreseeable actions regardless of what agency or person undertakes such other actions. The trends can result from individually minor but collectively sizeable actions taking place over a period of time.

The activities which would be expected to contribute to environmental trends as a result of implementing the Proposed Action include: past wild horse selective removal gather which may have altered the structure and composition of the HMA, continuing livestock grazing in the grazing allotments, continuing wildlife grazing, continuing wildlife management (adjustment of population numbers), and continued development of (oil and gas/recreational) infrastructure. These past, present and reasonably foreseeable activities would be expected to generate impacts to the Proposed Action by influencing the habitat quality abundance and continuity for the HMA wild horses.

The past events in these areas have created the current wild horse population with its associated structure and composition and have shaped the patterns of use found today in the herd. Continued development of these parameters would be expected to result in small annual changes in herd structure and behavior with small changes in habitat use over time. These impacts would be expected to be marked by relatively large changes occurring rather slowly over time. The LSFO would continue to identify these impacts as they occur and mitigate them as needed on a project specific basis to maintain habitat quality. At the same time, the horses in this HMA would be expected to continue to adapt to these small changes to availability and distribution of critical habitat components (food, water, shelter, space). The Proposed Action would contribute to the cumulative impacts of these past and foreseeable future actions by maintaining the herd at AML and establishing a process whereby biological and/or genetic issues associated with herd or habitat fragmentation would become apparent sooner and mitigating measures implemented quicker.

The impacts associated with the capture and removal of excess wild horses include gather-related mortality of less than one percent of the captured animals, about five percent per year associated with transportation, off-range corrals, adoption or sale with limitations and about eight percent per year associated with off-range pastures. These rates are comparable to natural mortality on the range ranging from about five to eight percent per year for foals (animals under age one year), about five percent per year for horses ages one to 15 years, and five to 100 percent for animals age 16 and older (Garrott and Taylor, 1990). In situations where forage and/or water are limited, mortality rates in the wild increase, with the greatest impact to young foals, nursing mares and older horses. Animals can experience lameness associated with trailing to/from water and forage, foals may be orphaned (left behind) if they cannot keep up with their mare, or animals may become too weak to travel. After suffering, often for an extended period, the animals may die.

While humane euthanasia and sale without limitation of healthy horses for which there is no adoption demand is authorized under the WFRHBA, Congress prohibited the use of appropriated funds between 1987 and 2004 and again in 2010 to present for this purpose. If Congress were to lift the current appropriations restrictions, then it is possible that excess horses removed from the HMA over the next 10 years could potentially be euthanized or sold without limitation consistent with the provisions of the WFRHBA.

The other trends which would be expected when incrementally adding either of the Action Alternatives to the cumulative study area would include continued improvement of upland and riparian vegetation conditions, which would in turn benefit permitted livestock, native wildlife, and wild horse population as forage (habitat) quality and quantity is improved over the current level. Benefits from a reduced wild horse population would include fewer animals competing for limited forage and water resources. Cumulatively, there should be more stable wild horse populations, healthier rangelands, healthier wild horses, and fewer multiple use conflicts in the area over the short and long-term. Over the next 15-20 years, continuing to manage wild horses within the established AML range would achieve a thriving natural ecological balance and multiple use relationship on public lands in the area.

4.0 CONSULTATION AND COORDINATION

INTRODUCTION

The issue identification section identifies those issues analyzed in detail in Chapter 3. Table 1.1 provides the rationale for issues that were considered but not analyzed further. The issues were identified through the public and agency involvement process described in Table 4.1 below.

PERSONS, GROUPS, AND AGENCIES CONSULTED

Table 4.1 lists the persons, groups, and agencies that were coordinated with or consulted during the preparation of this project. The table also summarizes the conclusions of those processes.

TABLE 4.1: COORDINATION AND CONSULTATION

Name	Purpose & Authorities for Consultation or Coordination	Findings & Conclusions
Colorado State Historic Preservation Office	National Historic Preservation Action Section 106	Consultation is ongoing.
Native American Tribes interested in projects within the Little Snake Field Office: Northwestern Band of Shoshoni Nation, Paiute Indian Tribe of Utah, Navajo Nation, Ute Indian Tribe, Hopi Tribe, Southern Ute Tribe, Ute Mountain Ute Tribe, Pueblo of Zuni, Pueblo of Jemez,	Consultation for undertaking, as required by the *Native American Graves Protection and Repatriation Act, the American Indian Religious Freedom Act,* and various executive orders (e.g., Executive Order 13007)	Identified tribes were notified by letter dated April 27, 2018 to describe the proposed action and find out if the tribes have any issues concerning the proposed action. The Southern Ute Indian Tribe responded on June 4, 2018 requesting to be included as a consulting party. None of the other tribes have responded

Name	Purpose & Authorities for Consultation or Coordination	Findings & Conclusions
Shoshone Bannock Tribes, Eastern Shoshone Tribe		identifying any concerns. Lack of response is interpreted by BLM to indicate that the tribes have no concerns relative to the proposed action
Moffat County Commissioners	Consult with County	Notification of availability was sent out on July 10, prior to the Draft EA's release.
Colorado Parks and Wildlife	Consult with CPW as the agency with expertise on impacts on game species	Data and analysis regarding big game species incorporated into Chapters 3 and 4. Notification of availability was sent on April 2, 2021.
Sand Wash Advocate Team	Consult with partner volunteer organization	Notification of availability was sent out on April 2, 2021.

SUMMARY OF PUBLIC PARTICIPATION

Public involvement was initiated on this Proposed Action on April 2, 2021 by posting on the ePlanning web page and in the public rooms in the Little Snake Field Office and Colorado State BLM Office. The Notice described the Proposed Action and solicited public input. The BLM held a public review period from April 2 to May 2, 2021.

Additionally, the Colorado State Office solicited public involvement at a public hearing about the use of helicopters and motorized vehicles to capture and transport wild horses (or burros) August 2, 2019 at the BLM's Little Snake Field Office in Craig, Colorado. There were no specific gathers addressed at that public meeting. The meeting was advertised in local newspapers and radio stations statewide. During the meeting, the public was given the opportunity to present new information and to voice any concerns regarding the use of these methods to capture wild horses. This process has been in place for over 20 years, and relevant issues associated with these methods have been addressed in the CAWP (Appendix B).

Other public meetings have been held and public comment has been solicited on multiple occasions during the formulation of other documents related to the management of wild horses. This input has been carefully considered and has guided the development of this Proposed Action and alternatives.

LIST OF PREPARERS

The specialists listed in the following table(s) assisted in the preparation of this EA.

TABLE 4.2 BLM PREPARERS

Name	Title	Responsible for the Following Section(s) of this Document
Benjamin Smith	Northwest District WH&B Specialist	Project Lead and provided information on plan conformance, Environmental Justice, Livestock Grazing, Socio-Economic, and Wild Horse Issues.

Name	Title	Responsible for the Following Section(s) of this Document
Erin Jones	NW Colorado District NEPA Coordinator	Reviewed this document for the format and National Environmental Policy Act (NEPA) Conformance.
Hunter Seim Mark Lowrey	Range Management Specialist, (LSFO)	Contributed information pertaining to Livestock Grazing Rangeland Health, and Vegetation.
Christina Rhyne	Rangeland Management Specialist (LSFO)	Invasive Species/Noxious Weeds, Non-Native Species
Brian Naze	Archaeologist, (LSFO)	Contributed information pertaining to Cultural and Native American Religious Concerns.
Whit Patterson	Recreation Planner, (LSFO)	Contributed information on BLM Natural Areas, Recreation and Visual Resources, Wild and Scenic Rivers, and Lands with Wilderness Character.
Jennifer Maiolo	Mining Engineer	Geology and Minerals, Paleontology
Desa Ausmus	Wildlife Biologist (LSFO)	Contributed information pertaining to BLM Sensitive Animal Species, Fish and Wildlife, Migratory Birds, Threatened and Endangered Animals.
Aimee Huff	Rangeland Management Specialist (LSFO)	Special Status Plant Species (BLM Sensitive Plant Species and Threatened and Endangered Plants).
Eric Scherff	Hydrologist (LSFO)	Contributed information on Air Quality, Greenhouse Gas Emissions, Farmlands, Floodplains, Hydrologic Conditions, Soils, Wastes (hazardous of solid), and Water Quality.
Jennifer Maiolo	Mineral Specialist (LSFO)	Contributed information on Geology/ Mineral Resources.
Pam Levitt	GIS Specialist (LSFO)	Maps and GIS related information.
Michael St. Martin	Fuels Coordinator (LSFO)	Contributed information on Fuels / Fire Management.
Janell Corey	Realty Specialist (LSFO)	Contributed information on Lands / Access, Socioeconomics, and Environmental Justice.

Name	Title	Responsible for the Following Section(s) of this Document
Stephen Leonard	Wild Horse and Burro Specialist, Colorado State Office (CSO)	Consult with CSO for program conformance and coordination within CSO and with WO.
Paul Griffin, Krystle Wengreen	Wild Horse and Burro Specialists, Washington Office, (WO)	Contributed information on fertility control, genetic diversity, and helicopter gathers.

5.0 REFERENCES, GLOSSARY AND ACRONYMS

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GLOSSARY OF TERMS

ALLOTMENT: An area of land where one or more individuals graze their livestock.

ANIMAL UNIT MONTH: The amount of dry forage required by one animal unit for one month based on a forage allowance of 26 pounds per day.

AUTHORIZED OFFICER: The decision maker who has the delegated authority to for that decision.

BEST MANAGEMENT PRACTICES: A suite of techniques that guide, or may be applied to, management actions to aid in achieving desired outcomes.

CONDITIONS OF APPROVAL: Conditions or requirements under which a decision is made.

ENVIRONMENTAL ASSESSMENT: A concise public document that analyzes the environmental impacts of a proposed action and provides sufficient evidence to determine the level of significance of the impacts.

ENVIRONMENTAL IMPACT STATEMENT: A detailed written statement of environmental effects of a major federal action significantly affecting the quality of the human environment.

FORAGE: Vegetation eaten by animals, especially grazing and browsing animals.

FRAGMENTATION (HABITAT): The break-up of a large land area (such as a forest) into smaller patches isolated by areas converted to a different land type.

IMPACT: A modification of the existing environment caused by an action (such as construction or operation of facilities).

INTERDISCIPLINARY TEAM: Representatives of various disciplines designated as members of a team which was created to prepare an environmental document.

INVASIVE PLANTS: Plants that are not part of (if exotic), or are a minor component of (if native), the original plant community or communities that have the potential to become a dominant or co-dominant species on the site if their future establishment and growth is not actively controlled by management interventions.

MINIMIZE: To reduce the adverse impact of an operation to the lowest practical level.

MITIGATION: Steps taken to: 1) avoid an impact; 2) minimize an impact; 3) rectify an impact; 4) reduce or eliminate an impact over time; or, 5) compensate for an impact.

MONITORING: The process of collecting and assessing data/information necessary to evaluate the effectiveness of a decision or its conditions of approval.

MULTIPLE USE: The management of the public lands and their various resource values so that they are utilized in the combination that will best meet the present and future needs of the American people.

NO ACTION ALTERNATIVE: The most likely condition to exist in the future if current management direction were to continue unchanged.

NOXIOUS WEEDS: A plant species designated by Federal of State law as generally possessing one or more of the following characteristics: aggressive and difficult to manage; parasitic; a carrier or host of serious insects or disease; or nonnative, new, or not common to the United States.

PERMIT: A revocable authorization to use public land for a specified purpose for a specified period of time.

PROJECT AREA: The area of land potentially affected by a proposed project.

PROPER FUNCTIONING CONDITION: A measurement that indicates an area's ability to produce desired natural resources in a sustained way.

RANGELAND HEALTH: The degree to which the integrity of the soil, the vegetation, the water, and air as well as the ecological processes of the rangeland ecosystem is balanced and sustained.

SCOPING: The process of identifying the issues, management concerns, preliminary alternatives, and other components of an environmental document.

SIGNIFICANCE: A determination of the degree or magnitude of importance of an effect, whether beneficial or adverse.

UTILIZATION: The proportion or degree of current year's forage production that is consumed or destroyed by animals (including insects).

LIST OF ACRONYMS

The below table contains a list of acronyms and their meanings that are frequently used by the BLM and which may have been used in the writing of this document.

TABLE 5.1: ACRONYMS

Acronym	Meaning
AAEP	American Association of Equine Practitioners
AHPA	American Horse Protection Association
AO	Authorized Officer
AML	Appropriate Management Level
AMP	Allotment Management Plan
APE	Area of Potential Effect
ARMPA	Approved Resource Management Plan Amendment
AUM	Animal Unit Month
AVMA	American Veterinary Medical Association
BLM	Bureau of Land Management
BMP	Best Management Practice
CFR	Code of Federal Regulations
CIAA	Cumulative Impact Analysis Area
CPW	Colorado Parks and Wildlife
CO2	Carbon Dioxide
COR	Contracting Officer Representative
DR	Decision Record
EA	Environmental Assessment

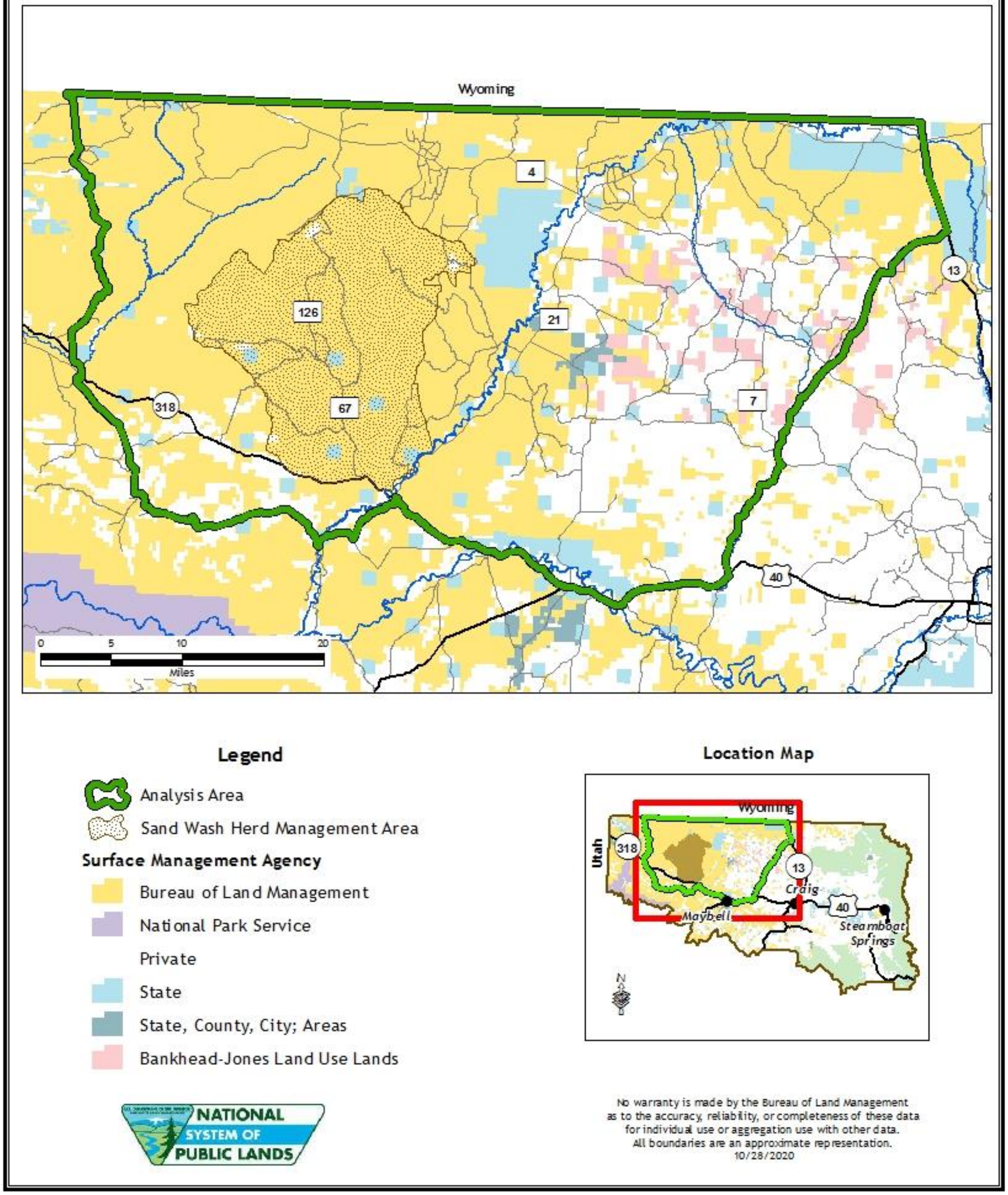
Acronym	Meaning
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FAA	Federal Aviation Administration
FEIS	Final Environmental Impact Statement
FLPMA	Federal Land Policy and Management Act
FO	Field Office
FONSI	Finding of No Significant Impact
GAO	Government Accountability Office
GIS	Geographic Information System
GnRH	Gonadotropin-Releasing Hormone
GPS	Global Positioning System
GRSG	Greater Sage Grouse
HMA	Herd Management Area
HMAP	Herd Management Area Plan
HSUS	Humane Society of the United States
IC	Incident Commander
IDT	Interdisciplinary Team
IM	Instruction Memorandum
IUD	Intrauterine Device
LSFO	Little Snake Field Office
MFP	Management Framework Plan
NAAQS	National and Utah Ambient Air Quality Standards
NAS	National Academy of Sciences
NEPA	National Environmental Policy Act
NI	Not Impacted
NP	Not Present
NRC	National Research Council
NRHP	National Register of Historic Places
OHV	Off-highway Vehicle
OIG	Office of the Inspector General
ORC	Off Range Corrals
ORP	Off-Range Pastures

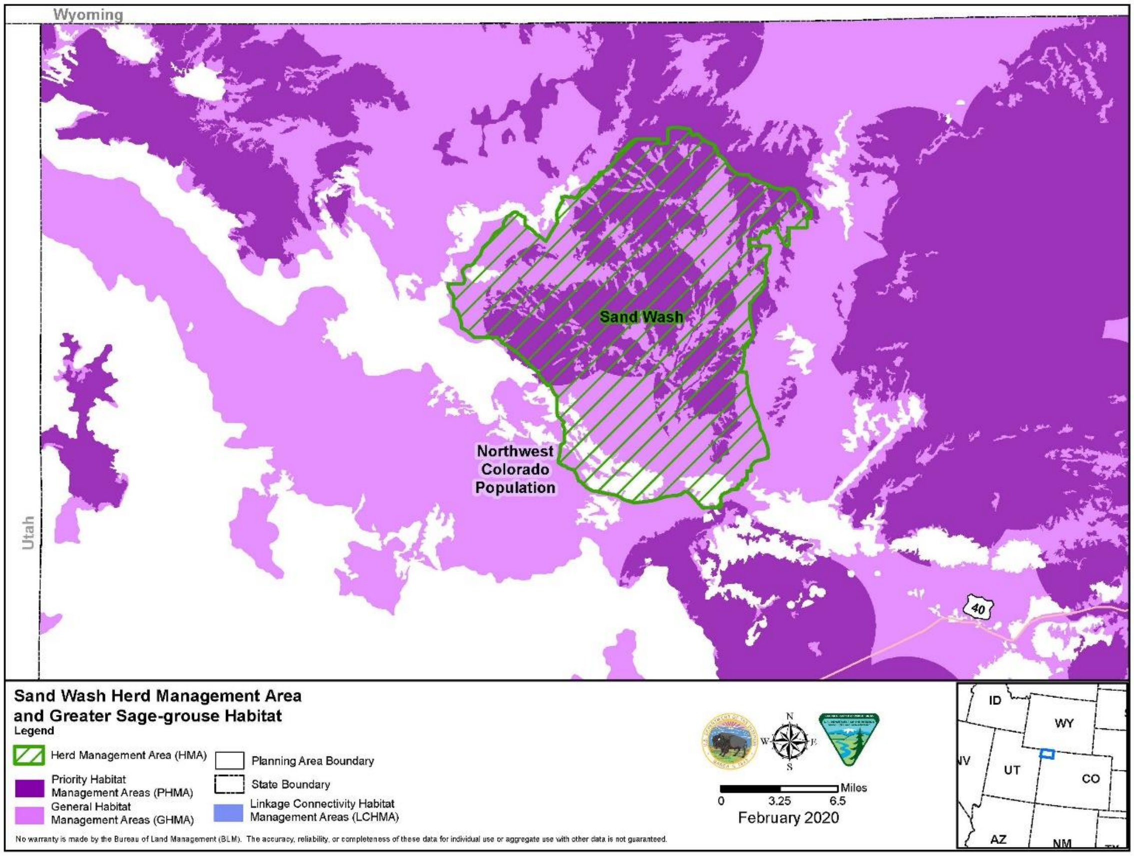
Acronym	Meaning
PHMA	Priority Habitat Management Area
PRIA	Public Rangeland Improvement Act
PZP	Porcine Zona Pellucida
RFD	Reasonable Foreseeable Development
RMP	Resource Management Plan
ROD	Record of Decision
ROW	Right-of-way
SCC	Science and Conservation Center
SHPO	State Historic Preservation Office
USDI	U.S. Department of the Interior
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VRM	Visual Resource Management
WFRHBA	Wild Free Roaming Horses and Burros Act
WH&B	National Wild Horse and Burro Program
WO	Washington Office

APPENDICIES

APPENDIX A: MAPS

Bureau of Land Management
Little Snake Field Office
Wild Horse Analysis Area





Wyoming
Utah
Sand Wash
Northwest
Colorado
Population
40
Sand Wash Herd Management Area
and Greater Sage-grouse Habitat
Legend
Herd Management Area (HMA)
Priority Habitat Management Areas (PHMA)
General Habitat Management Areas (GHMA)
Planning Area Boundary
State Boundary
Linkage Connectivity Habitat Management Areas (LCHMA)
Miles
0 3.25 6.5
February 2020
ID
WY
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No warranty is made by the Bureau of Land Management (BLM). The accuracy, reliability, or completeness of these data for individual use or aggregate use with other data is not guaranteed.

APPENDIX B: CAWP GATHER STANDARDS

COMPREHENSIVE ANIMAL WELFARE PROGRAM

FOR WILD HORSE AND BURRO GATHERS

STANDARDS

Developed by

The Bureau of Land Management

Wild Horse and Burro Program

in collaboration with

Carolyn L. Stull, PhD

Kathryn E. Holcomb, PhD

University of California, Davis

School of Veterinary Medicine

June 30, 2015

WELFARE ASSESSMENT STANDARDS for GATHERS

CONTENTS

STANDARDS

Standard Definitions

Major Standard: Impacts the health or welfare of WH&Bs. Relates to an alterable equipment or facility standard or procedure. Appropriate wording is “must,” “unacceptable,” “prohibited.”

Minor Standard: unlikely to affect WH&Bs health or welfare or involves an uncontrollable situation. Appropriate wording is “should.”

Lead COR = Lead Contracting Officer’s Representative

COR = Contracting Officer’s Representative

PI = Project Inspector

WH&Bs = Wild horses and burros

I. FACILITY DESIGN

A. Trap Site and Temporary Holding Facility

1. The trap site and temporary holding facility must be constructed of stout materials and must be maintained in proper working condition, including gates that swing freely and latch or tie easily. (major)

2. The trap site should be moved close to WH&B locations whenever possible to minimize the distance the animals need to travel.(minor)

3. If jute is hung on the fence posts of an existing wire fence in the trap wing, the wire should be either be rolled up or let down for the entire length of the jute in such a way that minimizes the possibility of entanglement by WH&Bs unless otherwise approved by the Lead COR/COR/PI. (minor)

4. Fence panels in pens and alleys must be not less than 6 feet high for horses, 5 feet high for burros, and the bottom rail must not be more than 12 inches from ground level. (major)

5. The temporary holding facility must have a sufficient number of pens available to sort WH&Bs according to gender, age, number, temperament, or physical condition. (major)

a. All pens must be assembled with capability for expansion. (major)

b. Alternate pens must be made available for the following: (major)

1) WH&Bs that are weak or debilitated

2) Mares/jennies with dependent foals

c. WH&Bs in pens at the temporary holding facility should be maintained at a proper stocking density such that when at rest all WH&Bs occupy no more than half the pen area. (minor)

6. An appropriate chute designed for restraining WH&Bs must be available for necessary procedures at the temporary holding facility. This does not apply to bait trapping operations unless directed by the Lead COR/COR/PI. (major)

7. There must be no holes, gaps or openings, protruding surfaces, or sharp edges present in fence panels or other structures that may cause escape or possible injury. (major)

8. Padding must be installed on the overhead bars of all gates and chutes used in single file alleys. (major)

9. Hinged, self-latching gates must be used in all pens and alleys except for entry gates into the trap, which may be secured with tie ropes. (major)

10. Finger gates (one-way funnel gates) used in bait trapping must be constructed of materials approved by the Lead COR/COR/PI. Finger gates must not be constructed of materials that have sharp ends that may cause injuries to WH&Bs, such as "T" posts, sharpened willows, etc. (major)

11. Water must be provided at a minimum rate of ten gallons per 1000 pound animal per day, adjusted accordingly for larger or smaller horses, burros and foals, and environmental conditions, with each trough placed in a separate location of the pen (i.e. troughs at opposite ends of the pen). Water must be refilled at least every morning and evening. (major)

12. The design of pens at the trap site and temporary holding facility should be constructed with rounded corners. (minor)

13. All gates and panels in the animal holding and handling pens and alleys of the trap site must be covered with materials such as plywood, snow fence, tarps, burlap, etc. approximately 48” in height to provide a visual barrier for the animals. All materials must be secured in place.(major)

These guidelines apply:

a. For exterior fences, material covering panels and gates must extend from the top of the panel or gate toward the ground.(major)

b. For alleys and small internal handling pens, material covering panels and gates should extend from no more than 12 inches below the top of the panel or gate toward the ground to facilitate visibility of animals and the use of flags and paddles during sorting. (minor)

c. The initial capture pen may be left uncovered as necessary to encourage animals to enter the first pen of the trap. (minor)

14. Non-essential personnel and equipment must be located to minimize disturbance of WH&Bs. (major)

15. Trash, debris, and reflective or noisy objects should be eliminated from the trap site and temporary holding facility. (minor)

B. Loading and Unloading Areas

1. Facilities in areas for loading and unloading WH&Bs at the trap site or temporary holding facility must be maintained in a safe and proper working condition, including gates that swing freely and latch or tie easily. (major)

2. The side panels of the loading chute must be a minimum of 6 feet high and fully covered with materials such as plywood or metal without holes that may cause injury. (major)

3. There must be no holes, gaps or openings, protruding surfaces, or sharp edges present in fence panels or other structures that may cause escape or possible injury. (major)

4. All gates and doors must open and close easily and latch securely. (major)

5. Loading and unloading ramps must have a non-slip surface and be maintained in a safe and proper working condition to prevent slips and falls. Examples of non-slip flooring would include, but not be limited to, rubber mats, sand, shavings, and steel reinforcement rods built into ramp. There must be no holes in the flooring or items that can cause an animal to trip. (major)

6. Trailers must be properly aligned with loading and unloading chutes and panels such that no gaps exist between the chute/panel and floor or sides of the trailer creating a situation where a WH&B could injure itself. (major)

7. Stock trailers should be positioned for loading or unloading such that there is no more than 12” clearance between the ground and floor of the trailer for burros and 18” for horses. (minor)

II. CAPTURE TECHNIQUE

A. Capture Techniques

1. WH&Bs gathered on a routine basis for removal or return to range must be captured by the following approved procedures under direction of the Lead COR/COR/PI. (major)

a. Helicopter

b. Bait trapping

2. WH&Bs must not be captured by snares or net gunning. (major)

3. Chemical immobilization must only be used for capture under exceptional circumstances and under the direct supervision of an on-site veterinarian experienced with the technique. (major)

B. Helicopter Drive Trapping

1. The helicopter must be operated using pressure and release methods to herd the animals in a desired direction and should not repeatedly evoke erratic behavior in the WH&Bs causing injury or exhaustion. Animals must not be pursued to a point of exhaustion; the on-site veterinarian must examine WH&Bs for signs of exhaustion. (major)

2. The rate of movement and distance the animals travel must not exceed limitations set by the Lead COR/COR/PI who will consider terrain, physical barriers, access limitations, weather, condition of the animals, urgency of the operation (animals facing drought, starvation, fire, etc.) and other factors. (major)

a. WH&Bs that are weak or debilitated must be identified by BLM staff or the contractors. Appropriate gather and handling methods should be used according to the direction of the Lead COR/COR/PI. (major)

b. The appropriate herding distance and rate of movement must be determined on a case-by-case basis considering the weakest or smallest animal in the group (e.g., foals, pregnant mares, or horses that are weakened by body condition, age, or poor health) and the range and environmental conditions present. (major)

c. Rate of movement and distance travelled must not result in exhaustion at the trap site, with the exception of animals requiring capture that have an existing severely compromised condition prior to gather. Where compromised animals cannot be left on the range or where doing so would only serve to prolong their suffering, euthanasia will be performed in accordance with BLM policy. (major)

3. WH&Bs must not be pursued repeatedly by the helicopter such that the rate of movement and distance travelled exceeds the limitation set by the Lead COR/COR/PI. Abandoning the pursuit or alternative capture methods may be considered by the Lead COR/COR/PI in these cases. (major)

4. When WH&Bs are herded through a fence line en route to the trap, the Lead COR/COR/PI must be notified by the contractor. The Lead COR/COR/PI must determine the appropriate width of the opening that the fence is let down to allow for safe passage through the opening. The Lead COR/COR/PI must decide if existing fence lines require marking to increase visibility to WH&Bs. (major)

5. The helicopter must not come into physical contact with any WH&B. The physical contact of any WH&B by helicopter must be documented by Lead COR/COR/PI along with the circumstances. (major)

6. WH&Bs may escape or evade the gather site while being moved by the helicopter. If there are mare/dependent foal pairs in a group being brought to a trap and half of an identified pair is thought to have evaded capture, multiple attempts by helicopter may be used to bring the missing half of the pair to the trap or to facilitate capture by roping. In these instances, animal condition and fatigue must be evaluated by the Lead COR/COR/PI or on-site veterinarian on a case-by-case basis to determine the number of attempts that can be made to capture an animal.(major)

7. Horse captures must not be conducted when ambient temperature at the trap site is below 10ºF or above 95ºF without approval of the Lead COR/COR/PI. Burro captures must not be conducted when ambient temperature is below 10ºF or above 100ºF without approval of the Lead

COR/COR/PI. The Lead COR/COR/PI will not approve captures when the ambient temperature exceeds 105 ºF. (major)

C. Roping

1. The roping of any WH&B must be approved prior to the procedure by the Lead COR/COR/PI. (major).

2. The roping of any WH&B must be documented by the Lead COR/COR/PI along with the circumstances. WH&Bs may be roped under circumstances which include but are not limited to the following: reunite a mare or jenny and her dependent foal; capture nuisance, injured or sick WH&Bs or those that require euthanasia; environmental reasons such as deep snow or traps that cannot be set up due to location or environmentally sensitive designation; and public and animal safety or legal mandates for removal. (major)

3. Ropers should dally the rope to their saddle horn such that animals can be brought to a stop as slowly as possible and must not tie the rope hard and fast to the saddle so as to intentionally jerk animals off their feet. (major)

4. WH&Bs that are roped and tied down in recumbency must be continuously observed and monitored by an attendant at a maximum of 100 feet from the animal. (major)

5. WH&Bs that are roped and tied down in recumbency must be untied within 30 minutes. (major)

6. If the animal is tied down within the wings of the trap, helicopter drive trapping within the wings will cease until the tied-down animal is removed. (major)

7. Sleds, slide boards, or slip sheets must be placed underneath the animal's body to move and/or load recumbent WH&Bs. (major)

8. Halters and ropes tied to a WH&B may be used to roll, turn, position or load a recumbent animal, but a WH&B must not be dragged across the ground by a halter or rope attached to its body while in a recumbent position. (major)

9. Animals captured by roping must be evaluated by the on-site/on-call veterinarian within four hours after capture, marked for identification at the trap site, and be re-evaluated periodically as deemed necessary by the on-site/on-call veterinarian. (major)

D. Bait Trapping

1. WH&Bs may be lured into a temporary trap using bait (feed, mineral supplement, water) or sexual attractants (mares/jennies in heat) with the following requirements:

a. The period of time water sources other than in the trap site are inaccessible must not adversely affect the wellbeing of WH&Bs, wildlife or livestock, as determined by the Lead COR/COR/PI. (major)

b. Unattended traps must not be left unobserved for more than 12 hours. (major) c.	Mares/jennies and their dependent foals must not be separated unless for safe transport. (major)

d.	WH&Bs held for more than 12 hours must be provided with accessible clean water at a minimum rate of ten gallons per 1000 pound animal per day, adjusted accordingly for larger or smaller horses, burros and foals and environmental conditions. (major)

e.	WH&Bs held for more than 12 hours must be provided good quality hay at a minimum rate of 20 pounds per 1000 pound adult animal per day, adjusted accordingly for larger or smaller horses, burros and foals. (major)

1)	Hay must not contain poisonous weeds, debris, or toxic substances. (major)

2)	Hay placement must allow all WH&Bs to eat simultaneously. (major)

III.	WILD HORSE AND BURRO CARE

A.	Veterinarian

1.	On-site veterinary support must be provided for all helicopter gathers and on-site or on-call support must be provided for bait trapping. (major)

2.	Veterinary support must be under the direction of the Lead COR/COR/PI. The on-site/on-call veterinarian will provide consultation on matters related to WH&B health, handling, welfare, and euthanasia at the request of the Lead COR/COR/PI. All decisions regarding medical treatment or euthanasia will be made by the on-site Lead COR/COR/PI. (major)

B.	Care

1.	Feeding and Watering

a.	Adult WH&Bs held in traps or temporary holding pens for longer than 12 hours must be fed every morning and evening with water available at all times other than when animals are being sorted or worked. (major)

b.	Water must be provided at a minimum rate of ten gallons per 1000 pound animal per day, adjusted accordingly for larger or smaller horses, burros and foals, and environmental conditions, with each trough placed in a separate location of the pen (i.e. troughs at opposite ends of the pen). . (major)

c.	Good quality hay must be fed at a minimum rate of 20 pounds per 1000 pound adult animal per day, adjusted accordingly for larger or smaller horses, burros and foals. (major)

i.	Hay must not contain poisonous weeds or toxic substances. (major)

ii.	Hay placement must allow all WH&Bs to eat simultaneously. (major)

d.	When water or feed deprivation conditions exist on the range prior to the gather, the Lead COR/COR/PI should adjust the watering and feeding arrangements in consultation with the onsite veterinarian as necessary to provide for the needs of the animals. (minor)

2. Dust abatement

a. Dust abatement by spraying the ground with water must be employed when necessary at the trap site and temporary holding facility. (major)

3. Trap Site

a. Dependent foals or weak/debilitated animals must be separated from other WH&Bs at the trap site to avoid injuries during transportation to the temporary holding facility. Separation of dependent foals from mares must not exceed four hours unless the Lead COR/COR/PI authorizes a longer time or a decision is made to wean the foals. (major)

4. Temporary Holding Facility

a. All WH&Bs in confinement must be observed at least once daily to identify sick or injured WH&Bs and ensure adequate food and water. (major)

b. Foals must be reunited with their mares/jennies at the temporary holding facility within four hours of capture unless the Lead COR/COR/PI authorizes a longer time or foals are old enough to be weaned during the gather. (major)

c. Non-ambulatory WH&Bs must be located in a pen separate from the general population and must be examined by the BLM horse specialist and/or on-call or on-site veterinarian as soon as possible, no more than four hours after recumbency is observed. Unless otherwise directed by a veterinarian, hay and water must be accessible to an animal within six hours after recumbency.(major)

d. Alternate pens must be made available for the following: (major)

1) WH&Bs that are weak or debilitated

2) Mares/jennies with dependent foals

e. Aggressive WH&Bs causing serious injury to other animals should be identified and relocated into alternate pens when possible. (minor)

f. WH&Bs in pens at the temporary holding facility should be maintained at a proper stocking density such that when at rest all WH&Bs occupy no more than half the pen area. (minor)

C. Biosecurity

1. Health records for all saddle and pilot horses used on WH&B gathers must be provided to the Lead COR/COR/PI prior to joining a gather, including: (major)

a. Certificate of Veterinary Inspection (Health Certificate, within 30 days).

b. Proof of:

1) A negative test for equine infectious anemia (Coggins or EIA ELISA test) within 12 months.

2) Vaccination for tetanus, eastern and western equine encephalomyelitis, West Nile virus, equine herpes virus, influenza, Streptococcus equi, and rabies within 12 months.

2. Saddle horses, pilot horses and mares used for bait trapping lures must not be removed from the gather operation (such as for an equestrian event) and allowed to return unless they have been observed to be free from signs of infectious disease for a period of at least three weeks and a new Certificate of Veterinary Examination is obtained after three weeks and prior to returning to the gather. (major)

3. WH&Bs, saddle horses, and pilot horses showing signs of infectious disease must be examined by the on-site/on-call veterinarian. (major)

a. Any saddle or pilot horses showing signs of infectious disease (fever, nasal discharge, or illness) must be removed from service and isolated from other animals on the gather until such time as the horse is free from signs of infectious disease and approved by the on-site/on-call veterinarian to return to the gather. (major)

b. Groups of WH&Bs showing signs of infectious disease should not be mixed with groups of healthy WH&Bs at the temporary holding facility, or during transport. (minor)

4. Horses not involved with gather operations should remain at least 300 yards from WH&Bs, saddle horses, and pilot horses being actively used on a gather. (minor)

IV. HANDLING

A. Willful Acts of Abuse

1. Hitting, kicking, striking, or beating any WH&B in an abusive manner is prohibited. (major)

2. Dragging a recumbent WH&B without a sled, slide board or slip sheet is prohibited. Ropes used for moving the recumbent animal must be attached to the sled, slide board or slip sheet unless being loaded as specified in Section II. C. 8. (major)

3. There should be no deliberate driving of WH&Bs into other animals, closed gates, panels, or other equipment. (minor)

4. There should be no deliberate slamming of gates and doors on WH&Bs. (minor)

5. There should be no excessive noise (e.g., constant yelling) or sudden activity causing WH&Bs to become unnecessarily flighty, disturbed or agitated. (minor)

B. General Handling

1. All sorting, loading or unloading of WH&Bs during gathers must be performed during daylight hours except when unforeseen circumstances develop and the Lead COR/CO/PI approves the use of supplemental light. (major)

2. WH&Bs should be handled to enter runways or chutes in a forward direction. (minor)

3. WH&Bs should not remain in single-file alleyways, runways, or chutes longer than 30 minutes. (minor)

4. Equipment except for helicopters should be operated and located in a manner to minimize flighty behavior . (minor)

C. Handling Aids

1. Handling aids such as flags and shaker paddles must be the primary tools for driving and moving WH&Bs during handling and transport procedures. Contact of the flag or paddle end of primary handling aids with a WH&B is allowed. Ropes looped around the hindquarters may be used from horseback or on foot to assist in moving an animal forward or during loading. (major)

2. Electric prods must not be used routinely as a driving aid or handling tool. Electric prods may be used in limited circumstances only if the following guidelines are followed:

a. Electric prods must only be a commercially available make and model that uses DC battery power and batteries should be fully charged at all times. (major)

b. The electric prod device must never be disguised or concealed. (major)

c. Electric prods must only be used after three attempts using other handling aids (flag, shaker paddle, voice or body position) have been tried unsuccessfully to move the WH&Bs. (major)

d. Electric prods must only be picked up when intended to deliver a stimulus; these devices must not be constantly carried by the handlers. (major)

e. Space in front of an animal must be available to move the WH&B forward prior to application of the electric prod. (major)

f. Electric prods must never be applied to the face, genitals, anus, or underside of the tail of a WH&B. (major)

g. Electric prods must not be applied to any one WH&B more than three times during a procedure (e.g., sorting, loading) except in extreme cases with approval of the Lead COR/COR/PI. Each exception must be approved at the time by the Lead COR/COR/PI. (major)

h. Any electric prod use that may be necessary must be documented daily by the Lead COR/COR/PI including time of day, circumstances, handler, location (trap site or temporary holding facility), and any injuries (to WH&B or human). (major)

V. TRANSPORTATION

A. General

1. All sorting, loading, or unloading of WH&Bs during gathers must be performed during daylight hours except when unforeseen circumstances develop and the Lead COR/CO/PI approves the use of supplemental light. (major)

2. WH&Bs identified for removal should be shipped from the temporary holding facility to a BLM facility within 48 hours. (minor)

a. Shipping delays for animals that are being held for release to range or potential on-site adoption must be approved by the Lead COR/COR/PI. (major)

3. Shipping should occur in the following order of priority; 1) debilitated animals, 2) pairs, 3) weanlings, 4) dry mares and 5) studs. (minor)

4. Planned

5. transport time to the BLM preparation facility from the trap site or temporary holding facility must not exceed 10 hours. (major)

6. WH&Bs should not wait in stock trailers and/or semi-trailers at a standstill for more than a combined period of three hours during the entire journey. (minor)

B. Vehicles

1. Straight-deck trailers and stock trailers must be used for transporting WH&Bs. (major)

a. Two-tiered or double deck trailers are prohibited. (major)

b. Transport vehicles for WH&Bs must have a covered roof or overhead bars containing them such that WH&Bs cannot escape. (major)

2. WH&Bs must have adequate headroom during loading and unloading and must be able to maintain a normal posture with all four feet on the floor during transport without contacting the roof or overhead bars. (major)

3. The width and height of all gates and doors must allow WH&Bs to move through freely. (major)

4. All gates and doors must open and close easily and be able to be secured in a closed position. (major)

5. The rear door(s) of the trailers must be capable of opening the full width of the trailer. (major)

6. Loading and unloading ramps must have a non-slip surface and be maintained in proper working condition to prevent slips and falls. (major)

7. Transport vehicles more than 18 feet and less than 40 feet in length must have a minimum of one partition gate providing two compartments; transport vehicles 40 feet or longer must have at least two partition gates to provide a minimum of three compartments. (major)

8. All partitions and panels inside of trailers must be free of sharp edges or holes that could cause injury to WH&Bs. (major)

9. The inner lining of all trailers must be strong enough to withstand failure by kicking that would lead to injuries. (major)

10. Partition gates in transport vehicles should be used to distribute the load into compartments during travel. (minor)

11. Surfaces and floors of trailers must be cleaned of dirt, manure and other organic matter prior to the beginning of a gather. (major)

C. Care of WH&Bs during Transport Procedures

1. WH&Bs that are loaded and transported from the temporary holding facility to the BLM preparation facility must be fit to endure travel. (major)

a. WH&Bs that are non-ambulatory, blind in both eyes, or severely injured must not be loaded and shipped unless it is to receive immediate veterinary care or euthanasia. (major)

b. WH&Bs that are weak or debilitated must not be transported without approval of the Lead COR/COR/PI in consultation with the on-site veterinarian. Appropriate actions for their care during transport must be taken according to direction of the Lead COR/COR/PI. (major)

2. WH&Bs should be sorted prior to transport to ensure compatibility and minimize aggressive behavior that may cause injury. (minor)

3. Trailers must be loaded using the minimum space allowance in all compartments as follows: (major)

a. 12 square feet per adult horse.

b. 6.0 square feet per dependent horse foal.

c. 8.0 square feet per adult burro.

d. 4.0 square feet per dependent burro foal.

4. The Lead COR/COR/PI in consultation with the receiving Facility Manager must document any WH&B that is recumbent or dead upon arrival at the destination. (major)

a. Non-ambulatory or recumbent WH&Bs must be evaluated on the trailer and either euthanized or removed from the trailers using a sled, slide board or slip sheet. (major)

5. Saddle horses must not be transported in the same compartment with WH&Bs. (major)

VI. EUTHANASIA OR DEATH

A. Euthanasia Procedure during Gather Operations

1. An authorized, properly trained, and experienced person as well as a firearm appropriate for the circumstances must be available at all times during gather operations. When the travel time between the trap site and temporary holding facility exceeds one hour or if radio or cellular communication is not reliable, provisions for euthanasia must be in place at both the trap site and temporary holding facility during the gather operation. (major)

2. Euthanasia must be performed according to American Veterinary Medical Association euthanasia guidelines (2013) using methods of gunshot or injection of an approved euthanasia agent. (major)

3. The decision to euthanize and method of euthanasia must be directed by the Authorized Officer or their Authorized Representative(s) that include but are not limited to the Lead COR/COR/PI who must be on site and may consult with the on-site/on-call veterinarian. (major)

4. Photos needed to document an animal's condition should be taken prior to the animal being euthanized. No photos of animals that have been euthanized should be taken. An exception is when a veterinarian or the Lead COR/COR/PI may want to document certain findings discovered during a postmortem examination or necropsy. (minor)

5. Any WH&B that dies or is euthanized must be documented by the Lead COR/COR/PI including time of day, circumstances, euthanasia method, location, a description of the age, gender, and color of the animal and the reason the animal was euthanized. (major)

6. The on-site/on-call veterinarian should review the history and conduct a postmortem physical examination of any WH&B that dies or is euthanized during the gather operation. A necropsy should be performed whenever feasible if the cause of death is unknown. (minor)

B. Carcass Disposal

1. The Lead COR/COR/PI must ensure that appropriate equipment is available for the timely disposal of carcasses when necessary on the range, at the trap site, and temporary holding facility. (major)

2. Disposal of carcasses must be in accordance with state and local laws. (major)

3. WH&Bs euthanized with a barbiturate euthanasia agent must be buried or otherwise disposed of properly. (major)

4. Carcasses left on the range should not be placed in washes or riparian areas where future runoff may carry debris into ponds or waterways. Trenches or holes for buried animals should be dug so the bottom of the hole is at least 6 feet above the water table and 4-6 feet of level earth covers the top of the carcass with additional dirt mounded on top where possible. (minor)

CAWP

REQUIRED DOCUMENTATION AND RESPONSIBILITIES OF LEAD COR/COR/PI

Required Documentation

Section	Documentation
II.B.5	Helicopter contact with any WH&B.
II.C.2	Roping of any WH&B.

III.B.3.a and III.B.4.b

III.C.1 Reason for allowing longer than four hours to reunite foals with mares/jennies. Does not apply if foals are being weaned.

Health status of all saddle and pilot horses.

IV.C.2.h All uses of electric prod.

V.C.4 Any WH&B that is recumbent or dead upon arrival at destination following transport.

VI.A.5 Any WH&B that dies or is euthanized during gather operation.

Responsibilities

Section Responsibility

I.A.10 Approve materials used in construction of finger gates in bait trapping

II.A.1 Direct gather procedures using approved gather technique.

II.B. 2 Determine rate of movement and distance limitations for WH&B helicopter gather.

II.B.2.a Direct appropriate gather/handling methods for weak or debilitated WH&B.

II.B.3 Determine whether to abandon pursuit or use other capture method in order to avoid repeated pursuit of WH&B.

II.B.4 Determine width and need for visibility marking when using opening in fence en route to trap.

II.B.6 Determine number of attempts that can be made to capture the missing half of a mare/foal pair that has become separated.

II.B.7 Determine whether to proceed with gather when ambient temperature is outside the range of 10°F to 95°F for horses or 10°F to 100°F for burros.

II.C.1 Approve roping of any WH&B.

II.D.1.a Determine period of time that water outside a bait trap is inaccessible such that wellbeing of WH&Bs, wildlife, or livestock is not adversely affected.

III.A.2 Direct and consult with on-site/on-call veterinarian on any matters related to WH&B health, handling, welfare and euthanasia.

III.B.1.e Adjust feed/water as necessary, in consultation with onsite/on call veterinarian, to provide for needs of animals when water or feed deprivation conditions exist on range.

III.B.4.c Determine provision of water and hay to non-ambulatory animals.

IV.C.2.g Approve use of electric prod more than three times, for exceptional cases only.

V.A.1 Approve sorting, loading, or unloading at night with use of supplemental light.

V.A.2.a Approve shipping delays of greater than 48 hours from temporary holding facility to BLM facility.

V.C.1.b Approve of transport and care during transport for weak or debilitated WH&B.

VI.A.3 Direct decision regarding euthanasia and method of euthanasia for any WH&B; may consult with on-site/on-call veterinarian.

VI.B.1 Ensure that appropriate equipment is available for carcass disposal.

APPENDIX C: ALTERNATIVES CONSIDERED BUT ELIMINATED

ALTERNATIVES CONSIDERED BUT ELIMINATED

The following alternatives were considered but dismissed from detailed analysis for the reasons described below.

PROVIDE SUPPLEMENTAL FEED AND WATER

Providing supplemental feed (hay) or hauling water (other than during a short-term emergency situation) does not meet the definition of minimum feasible management and is inconsistent with current law, regulation and policy. Refer to 43 CFR 4710.4.

MANAGE THE ENTIRE POPULATION AS A NON-BREEDING POPULATION OF GELDINGS

One possible management alternative which has been suggested is to manage the HMA in its entirety as a non-breeding population of geldings. This alternative would require a land use plan amendment or revision. Therefore, it was not analyzed in detail at this time.

RETURN A PORTION OF THE POPULATION AS A NON-BREEDING POPULATION

This alternative would involve capturing, gelding and returning a portion of the population as a non-breeding population, once the population is brought to low AML. This alternative was not brought forward for detailed analysis because it is inconsistent with the RMP.

RETURN THE HMA TO HERD AREA STATUS WITH ZERO AML

Another alternative which has been suggested is to return the HMA to Herd Area status and establish the AML as "0" animals. Resource concerns such as lack of forage, lack of water, and conflicts with other resources make this alternative an unviable solution. The available forage and water resources are expected to be adequate to support a population of 163-362 animals, therefore this alternative was not considered in detail.

REMOVE OR REDUCE LIVESTOCK WITHIN THE HMA

This alternative would involve no removal of wild horses and instead address the excess wild horse numbers through the removal or reduction of livestock within the HMA. This alternative was not brought forward for detailed analysis because it is outside of the scope of the analysis, is inconsistent with both the RMP and the WFRHBA, which directs the Secretary to immediately remove excess wild horses, and is inconsistent with multiple use management. Livestock grazing can only be reduced following the process outlined in the regulations found at 43 CFR Part 4100. Several reductions and changes have been made to livestock grazing within the allotments associated with the HMA through this process. The elimination of livestock grazing in an area would require an amendment to the RMP. Such changes to livestock grazing cannot be made through a wild horse gather decision.

Environmental assessments for livestock grazing permits were completed in 2011 for the Sand Wash allotment, 2001 for Sheepherder Spring and Lang Spring allotments, and 2009 for the Nipple Rim allotment within and adjacent to the Sand Wash Basin HMA. Decision Records were issued at the time for these EA's. The EA's analyzed stocking rates for livestock and also analyzed seasons of use, areas of use, kind and class of livestock and management actions to improve livestock distribution. These management actions included the establishment of grazing systems, allowable use levels, salting and herding practices. Livestock grazing continues to be evaluated for the allotments and use areas within the HMA. Monitoring and evaluation of livestock grazing is in accordance with the RMP's Livestock Grazing Section, which states:

Goal A: Manage resources, vegetation, and watersheds to sustain a variety of uses, including livestock grazing, and to maintain the long-term health of the rangelands. Objectives for achieving this goal include:

- Maintain and improve forage species diversity and abundance by managing to meet plant reproductive and physiological needs.
- Minimize conflicts between livestock and other grazing animals in areas of increased pressure on forage and riparian zones.
- Manage plant utilization by all foraging species at a level that maintains plant health and protects watersheds.

Goal B: Contribute to the stability and sustainability of the livestock industry.

The BLM is currently authorized to remove livestock from the HMA, "if necessary to provide habitat for wild horses or burros, to implement herd management actions, or to protect wild horses or burros from disease, harassment or injury" under CFR 4710.5. This authority is usually applied in cases of emergency and not for general management of wild horses or burros in a manner that would be inconsistent with the land-use plan and the separate decisions establishing the appropriate levels of livestock grazing and wild horse use, respectively. Available data also indicates that wild horse use – including where livestock use has been excluded – has resulted in excessive vegetative utilization.

GATHER THE HMA TO THE AML UPPER LIMIT

A post-gather population size at the upper level of the AML range would result in the AML being exceeded with the next foaling season. This would be unacceptable for several reasons.

The AML represents "that 'optimum number' of wild horses which results in a thriving natural ecological balance and avoids a deterioration of the range" (Animal Protection Institute, 109 Interior Board of Land Appeals (IBLA) 119; 1989). The IBLA has also held that, "Proper range management dictates removal of horses before the herd size causes damage to the rangeland. Thus, the optimum number of horses is somewhere below the number that would cause resource damage" (Animal Protection Institute, 118 IBLA 63, 75; 1991).

The upper level of the AML established within the HMA represents the maximum population for which thriving natural ecological balance would be maintained. The lower level represents the number of animals to remain in the HMA following a wild horse gather, in order to allow for a periodic gather cycle, and to prevent the population from exceeding the established AML between gathers.

Additionally, gathering to the upper range of AML would result in the need to follow up with another gather within one year (with resulting stress on the wild horse population) reducing gather efficiency overtime, and could result in overutilization of vegetation resources and damage to the rangeland if the BLM is unable to gather the excess horses in the HMA on an annual basis. This alternative would not reduce the wild horse population growth rate of 20 percent in the HMA and the BLM would not be able to conduct periodic gathers and still maintain a thriving natural ecological balance. For these reasons, this alternative did not receive further consideration in this document.

FERTILITY CONTROL TREATMENT ONLY INCLUDING USING BAIT/WATER TRAPPING TO DART MARES WITH PZP OR OTHER CONTRACEPTIVE VACCINE REMOTELY (NO REMOVAL)

Population modeling (Appendix D) was completed to analyze the potential impacts associated with conducting gathers about every 2-3 years over the next 20 year period to treat captured mares with fertility control. Under this alternative, no excess wild horses would be removed. While the average population growth would has been reduced to about (13) percent per year, AML would not be achieved and the damage to the range associated with wild horse overpopulation would continue. This alternative would not meet the Purpose and Need for the Action, and would be contrary to the WFRHBA, and was dismissed from further study.

The use of remote darting to administer PZP or other contraceptive vaccines within HMAs where the horses are not accustomed to human activity has been shown to be very difficult. In the Cedar Mountain HMA during a two-year study where administration of PZP by remote darting was to occur, the researchers had to resort to hand injections for booster doses (Rutberg et al. 2017). This method has been effective in some HMAs (including Sand Wash Basin) where the wild horses are more approachable. Darting of wild horses with fertility control would take place in the HMA.

BAIT OR WATER TRAP ONLY

Providing an alternative considered but eliminated from detailed analysis was use of bait and/or water trapping as the primary gathering method. DOI-BLM-CO-N010-2016-0023-EA was prepared in 2016 and analyzed the use of bait and water trapping gather methods in conjunction with fertility treatments as a method of population control. The use of bait and water trapping, though effective in specific areas and circumstances, would not be timely, cost-effective or practical as the primary gather method for this HMA due to the timing of the proposed gather. However, water or bait trapping may be used to achieve the desired goals of Alternatives A and B if gather efficiencies are too low using a helicopter or a helicopter gather cannot be scheduled. This alternative was dismissed from detailed study as a primary gather method for the following reasons: (1) the project area is too large to effectively use this gather method; (2) road access for vehicles not associated with the gather to potential trapping locations is difficult to restrict and reduces gather efficiency; and (3) road access necessary to get equipment in/out as well as safely transport gathered wild horses is limited; and (4) the presence of scattered water sources on state, private and public lands inside the HMA would make it almost impossible to restrict wild horse access to the extent necessary to effectively gather and remove the excess animals through bait and/or water trapping to achieve management goals.

WILD HORSE NUMBERS CONTROLLED BY NATURAL MEANS

This alternative was eliminated from further consideration because it is contrary to the WFRHBA which requires the BLM to prevent the range from deterioration associated with an overpopulation of wild horses. It is also inconsistent with the RMP, which directs that BLM conduct gathers as necessary to achieve and maintain the AML. The alternative of using natural controls to achieve a desirable AML has not been shown to be feasible in the past. Wild horses in the HMA are not substantially regulated by predators (which includes mountain lions and bears). In addition, wild horses are a long-lived species with documented foal survival rates exceeding 95 percent and they are not a self-regulating species. This alternative would result in a steady increase in numbers which would continually exceed the carrying capacity of the range until severe and unusual conditions that occur periodically-- such as blizzards or extreme drought-- cause catastrophic mortality of wild horses.

GATHER AND RELEASE EXCESS WILD HORSES EVERY TWO YEARS AND APPLY PZP-22 OR OTHER CONTRACEPTIVE VACCINE TO HORSES FOR RELEASE

Another alternative to gather a substantial portion of the existing population (90 percent) and implement fertility control treatment only, without removal of excess horses was modeled using a two-year gather/treatment interval over a 10 year period, based on expected effectiveness of PZP-22 pellet vaccine. WinEquus is not configured to model an improved efficacy after vaccine booster administration, such as has been reported for PZP-22 (Rutberg et al. 2017) and GonaCon-Equine (Baker et al. 2018). With the results of Alternative 1 not reaching AML until late into the 10 year time frame for the Win Equus model, it is anticipated that this alternative would not reach AML within the HMA. The wild horse population would likely experience below average population growth rate but would still be adding to the current wild horse overpopulation, albeit at a slower rate of growth than the No Action Alternative. This alternative would not decrease the existing overpopulation of wild horses, resource concerns and rangeland deterioration would continue, and implementation would result in substantially increased gather and fertility control costs relative to the alternatives that remove excess wild horses to the AML range. In addition to not achieving AML, the time needed to complete a gather would also increase over time, because the more frequently an area is gathered, the more difficult wild horses are to trap. They become very evasive and learn to evade the helicopter by taking cover in treed areas and canyons. Wild horses would also move out of the area when they hear a helicopter, thereby further reducing the overall gather efficiency. The same process holds true for bait trapping. Once an animal is caught in a bait trap and released, sometimes once or more, over time that animal will likely become wary and not enter the trap. Frequent gathers would increase the stress to wild horses, as individuals and as entire herds. It would become increasingly more difficult over time to repeat gathers every two years to successfully treat a large portion of the population. For these reasons, this alternative was dropped from detailed study.

USE ALTERNATIVE CAPTURE TECHNIQUES INSTEAD OF HELICOPTERS TO CAPTURE EXCESS WILD HORSES

An alternative using capture methods other than helicopters to gather excess wild horses was suggested, other than bait/water trapping, through the public review process. As no specific alternative methods were suggested, the BLM identified chemical immobilization, net gunning, and wrangler/horseback drive trapping as potential methods for gathering horses. Net gunning techniques normally used to capture big games also rely on helicopters. Chemical immobilization is a very specialized technique and strictly regulated. Currently the BLM does not have sufficient expertise to implement either of these methods and they would be impractical to use given the size of the HMA, access limitations and approachability of the horses.

Use of wranglers on horseback drive-trapping to remove excess wild horses can be fairly effective on a small scale; but due to the number of excess horses to be removed, the large geographic size of the HMA, access limitations and approachability of the horses this technique would be ineffective and impractical. Horseback drive-trapping is also very labor intensive and can be very harmful to the domestic horses and the wranglers used to herd the wild horses. For these reasons, this alternative was eliminated from further consideration.

FIELD DARTING FERTILTIY TREATMENT ONLY FOR POPULATION SUPPRESSION

BLM would administer PZP in the one year dose inoculations of PZP by field darting the mares. This method is currently approved for use and is being utilized by BLM in this and other HMAs. This alternative (darting fertility control only, no removals) was dismissed from detailed study because the reduction in population growth is not sufficient to reduce overutilization on the range from wild horses and would not meet the purpose and need of the action and is not in compliance with the WFRHBA. For these reasons, this alternative was determined to not be an effective or feasible method for wild horse populations and rangeland impacts from over population in a timely manner within the HMA.

APPENDIX D: POPULATION MODEL

Sand Wash Basin 2021 Population Modeling

To complete the population modeling for the Sand Wash Basin Herd Management Area, version 1.40 of the WinEquus program, created April 2, 2002, was utilized.

Objectives of Population Modeling

Review of the data output for each of the simulations provided many use full comparisons of the possible outcomes for each alternative. Some of the questions that need to be answered through the modeling include:

- Do any of the Alternatives “crash” the population?
- What effect does fertility control have on population growth rate?
- What effects do the different alternatives have on the average population size?
- What effects do the different alternatives have on the genetic health of the herd?

Population Data, Criteria, and Parameters utilized for Population Modeling
All simulations used the survival probabilities, foaling rates, and sex ratio at birth that was supplied with the WinnEquus population for the Granit Range HMA.

Sex ratio at Birth:

43% Females

57% Males

The following percent effectiveness of fertility control was utilized in the population modeling for Alternative 2:

Year 1: 94%, Year 2: 82%, Year 3: 68%

The following table displays the contraception parameters utilized in the population model for Alternative 2:

Contraception Criteria

(Alternative 1)

Age	Percentages for Fertility Treatment
1	0%
2	100%
3	100%
4	100%
5	100%
6	100%
7	100%
8	100%
9	100%

10-14	100%
15-19	100%
20+	100%

Population Modeling Criteria

The following summarizes the population modeling criteria that are common to the Proposed Action and all alternatives:

- Starting year: 2021
- Initial Gather Year: 2021
- Gather interval: regular interval of three years
- Gather for fertility treatment regardless of population size: No
- Continue to gather after reduction to treat females: Yes
- Sex ratio at birth: 57% Males
- Percent of the population that can be gathered: 80%
- Minimum age for long term holding facility horses: Not Applicable
- Foals are not included in the AML
- Simulations were run for 10 years with 100 trials each

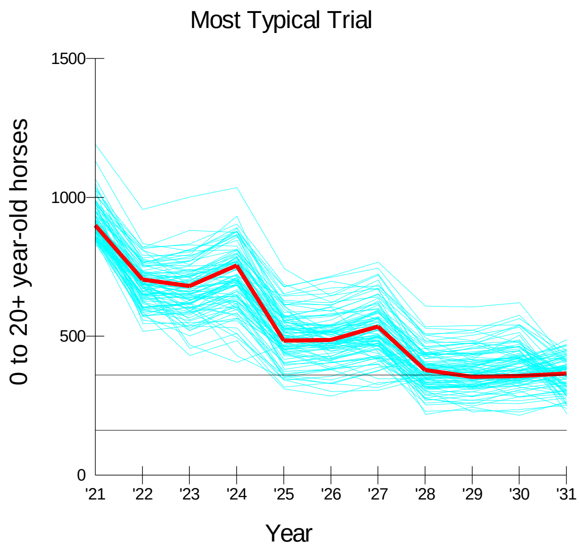
The following table displays the population modeling parameters utilized in the model:

Population Modeling Parameters

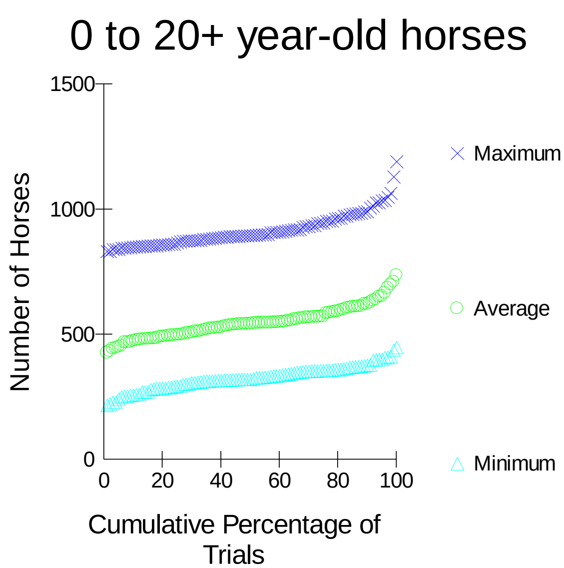
Modeling Parameter	**Alternative 1:** Selective Removal of Excess Wild Horses to within AML range, implement Population Growth Suppression Was Alt 2	**Alternative 2:** Gather and Remove Excess Animals to within AML range without Fertility Control. Was Alt 3	**Alternative 3:** No Action (No Removal & No Fertility Control) Was Alt 1
Management by removal, and fertility control	Yes	No	N/A
Management by removal only	No	Yes	N/A
Threshold Population Size Following Gathers	163	362	N/A
Target Population Size Following gather	163	163	N/A
Gather for fertility control regardless of population size	No	No	N/A
Gather continue after removals to treat additional females	No	No	N/A
Effectiveness of Fertility Control: Year 1	94%	N/A	N/A

Effectiveness of Fertility Control: Year 2	82%	N/A	N/A
Effectiveness of Fertility Control: Year 3	68%	N/A	N/A

Proposed Action (Alternative 1): Selective Removal of Excess Wild Horses to within AML range, implement Population Growth Suppression



Population Size

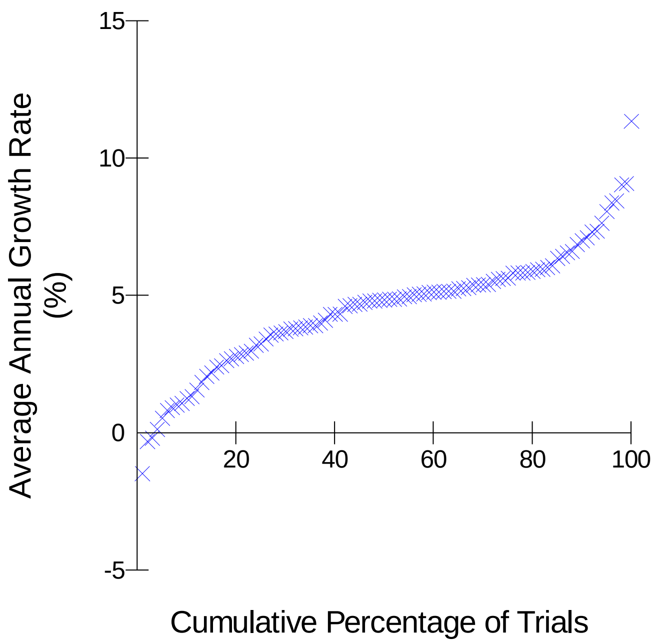


Population Sizes in 11 Years*

	Minimum	Average	Maximum
Lowest Trial	217	427	832
10th Percentile	259	475	850
25th Percentile	294	498	869
Median Trial	322	543	896
75th Percentile	356	578	950
90th Percentile	378	624	998
Highest Trial	448	736	1191

* 0 to 20+ year-old horses

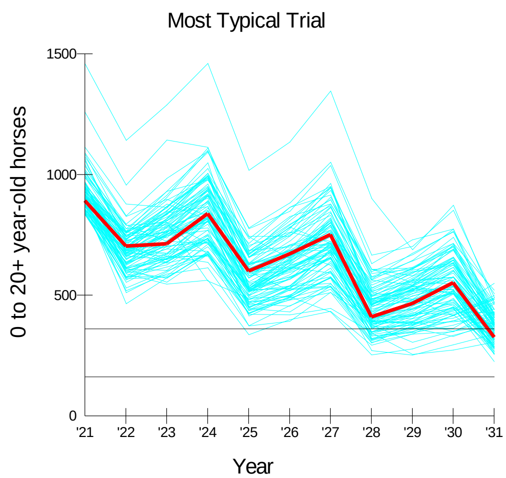
Explanation
In 11 years and 100 trials, the lowest number of 0 to 20+ year-old horses ever obtained was 217 and the highest was 1191. In half the trials, the minimum population size in 11 years was less than 322 and the maximum was less than 896. The average population size across the 11 years ranged from 427 to 736.



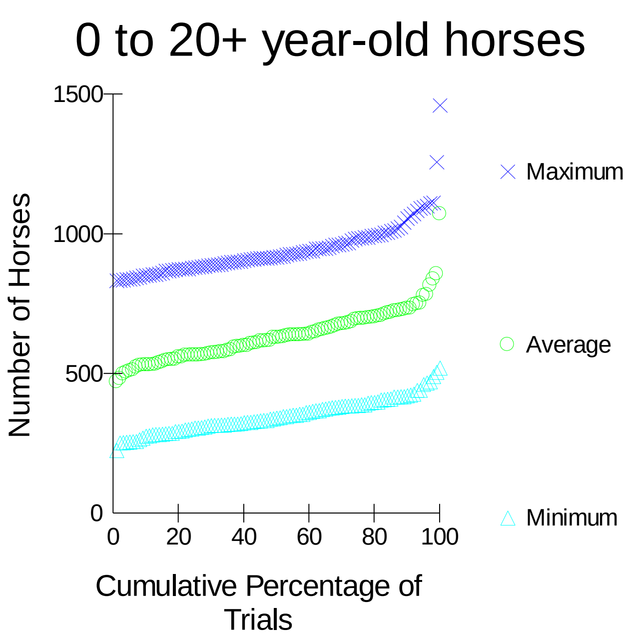
Average Growth Rate in 10 Years

Lowest Trial	-1.5%
10th Percentile	1.3%
25th Percentile	3.3%
Median Trial	4.9%
75th Percentile	5.7%
90th Percentile	7.1%
Highest Trial	11.4%

Alternative 2: Gather and Remove Excess Animals to within AML range without Fertility Control.



Population Size

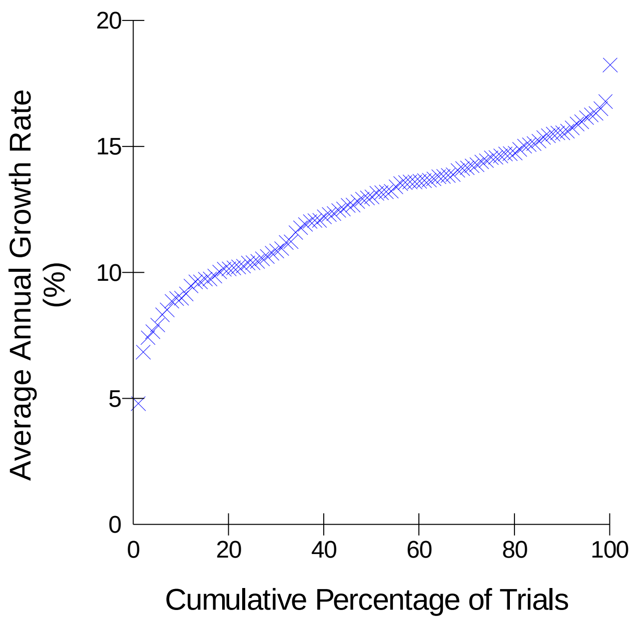


Population Sizes in 11 Years*

	Minimum	Average	Maximum
Lowest Trial	226	471	834
10th Percentile	278	532	852
25th Percentile	306	566	882
Median Trial	342	630	919
75th Percentile	388	697	986
90th Percentile	423	734	1061
Highest Trial	521	1071	1461

* 0 to 20+ year-old horses

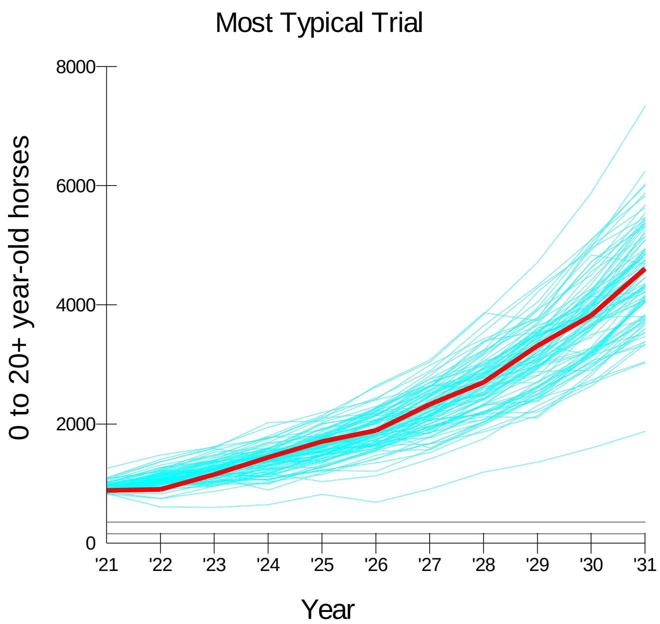
Explanation
In 11 years and 100 trials, the lowest number of 0 to 20+ year-old horses ever obtained was 226 and the highest was 1,461. In half the trials, the minimum population size in 11 years was less than 342 and the maximum was less than 919. The average population size across 11 years ranged from 471 to 1071.



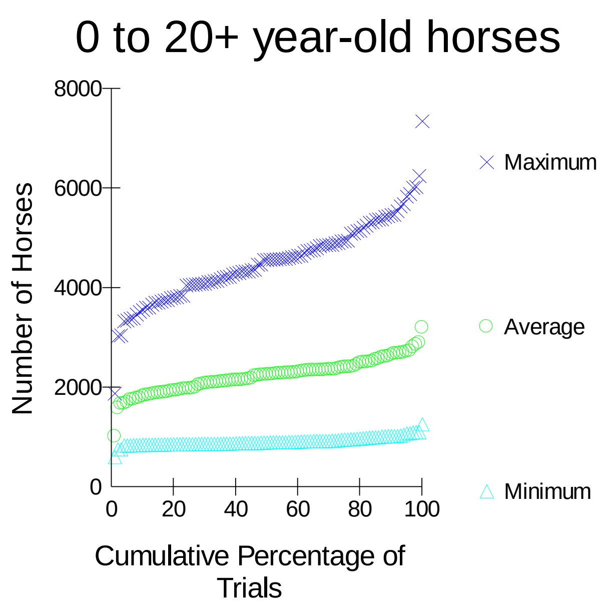
Average Growth Rate in 10 Years

Lowest Trial	4.8%
10th Percentile	9.1%
25th Percentile	10.4%
Median Trial	13.1%
75th Percentile	14.6%
90th Percentile	15.6%
Highest Trial	18.3%

Alternative 3: No Action (No Removal & No Fertility Control)



Population Size



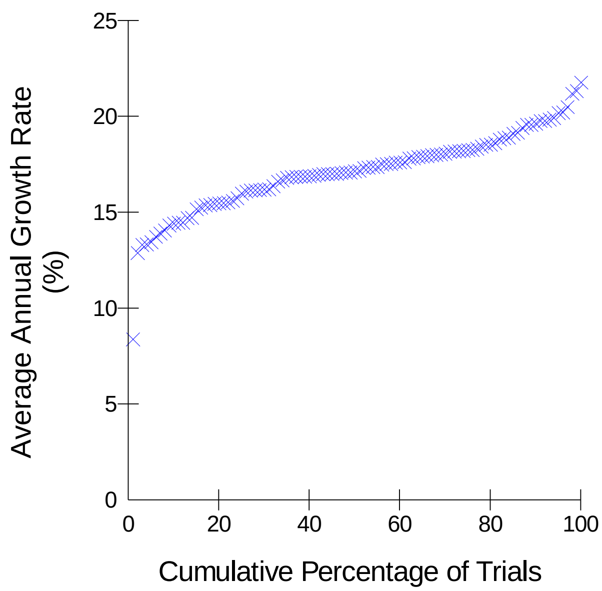
Population Sizes in 11 Years*

	Minimum	Average	Maximum
Lowest Trial	606	1018	1881
10th Percentile	850	1836	3582
25th Percentile	863	1978	4064
Median Trial	898	2258	4569
75th Percentile	958	2408	4949

90th Percentile	1024	2666	5472
Highest Trial	1264	3201	7350

* 0 to 20+ year-old horses

Explanation
In 11 years and 100 trials, the lowest number of 0 to 20+ year-old horses ever obtained was 606 and the highest was 7350. In half the trials, the minimum population size in 11 years was less than 898 and the maximum was less than 4569. The average population size across 11 years ranged from 1018 to 3201.



Average Growth Rate in 10 Years

Lowest Trial	8.4%
10th Percentile	14.5%
25th Percentile	16.1%
Median Trial	17.2%
75th Percentile	18.3%
90th Percentile	19.7%
Highest Trial	21.8%

APPENDIX E- SCIENTIFIC LITERATURE REVIEW

This appendix includes scientific literature reviews addressing five topics: effects of gathers, effects of wild horses and burros on rangeland ecosystems, effects of fertility control vaccines and sex ratio manipulations, effects of sterilization, and effects of intrauterine devices (IUDs). This review was updated in January 2021 to reflect newly available studies.

a. Effects of Gathers on Wild Horses and Burros

Gathering any wild animals into pens has the potential to cause impacts to individual animals. There is also the potential for impacts to individual horses and burros during transportation, short-term holding, long-term holding that take place after a gather. However, BLM follows guidelines to minimize those impacts and ensure humane animal care and high standards of welfare. The following literature review summarizes the limited number of scientific papers and government reports that have examined the effects of gathers and holding on wild horses and burros.

Two early papers, by Hansen and Mosley (2000) and Ashley and Holcomb (2001) examined limited effects of gathers, including behavioral effects and effects on foaling rates. Hansen and Mosley (2000) observed BLM gathers in Idaho and Wyoming. They monitored wild horse behaviors before and after a gather event and compared the behavioral and reproductive outcomes for animals that were gathered by helicopter against those outcomes for animals that were not. This comparison led to the conclusion that gather activities used at that time had no effect on observed wild horse foraging or social behaviors, in terms of time spent resting, feeding, vigilant, traveling, or engaged in agonistic encounters (Hansen and Mosley 2000). Similarly, the authors did not find any statistically significant difference in foaling rates in the year after the gather in comparisons between horses that were captured, those that were chased by a helicopter but evaded capture, or those that were not chased by a helicopter. The authors concluded that the gathers had no deleterious effects on behavior or reproduction. Ashley and Holcomb (2001) conducted observations of reproductive rates at Garfield Flat HMA in Nevada, where horses were gathered in 1993 and 1997, and compared those observations at Granite Range HMA in Nevada, where there was no gather. The authors found that the two gathers had a short-term effect on foaling rates; pregnant mares that were gathered had lower foaling rates than pregnant mares that were not gathered. The authors suggested that BLM make changes to the gather methods used at that time, to minimize the length of time that pregnant mares are held prior to their release back to the range. Since the publications by Hansen and Mosley (2000) and by Ashley and Holcomb (2001), BLM did make changes to reduce the stress that gathered animals, including pregnant females, may experience as a result of gather and removal activities; these measures have been formalized as policy in the comprehensive animal welfare program (BLM IM 2015-151).

A thorough review of gather practices and their effects on wild horses and burros can be found in a 2008 report from the Government Accounting Office. The report found that the BLM had controls in place to help ensure the humane treatment of wild horses and burros (GAO 2008).

The controls included SOPs for gather operations, inspections, and data collection to monitor animal welfare. These procedures led to humane treatment during gathers, and in short-term and long-term holding facilities. The report found that cumulative effects associated with the capture and removal of excess wild horses include gather-related mortality averaged only about 0.5% and approximately 0.7% of the captured animals, on average, are humanely euthanized due to pre-existing conditions (such as lameness or club feet) in accordance with BLM policy. Scasta (2019) found the same overall mortality rate (1.2%) for BLM WH&B gathers in 2010-2019, with a mortality rate of 0.25% caused directly by the gather, and a mortality rate of 0.94% attributable to euthanasia of animals with pre-existing conditions such as blindness or club-footedness. Scasta (2019) summarized mortality rates from 70 BLM WH&B gathers across nine states, from 2010-2019. Records for 28,821 horses and 2,005 burros came from helicopter and bait/water trapping. For wild burro bait / water trapping, mortality rates were 0.05% due to acute injury caused by the gather process, and death for burros with pre-existing conditions was 0.2% (Scasta 2019). For wild horse bait / water trapping, mortality rates were 0.3% due to acute injury, and the mortality rate due to pre-existing conditions was 1.4% (Scasta 2019). For wild horses gathered with the help of helicopters, mortality rates were only slightly lower than for bait / water trapping, with 0.3% due to acute causes, and 0.8% due to pre-existing conditions (Scasta 2019). Scasta (2019) noted that for other wildlife species capture operations, mortality rates above 2% are considered unacceptable and that, by that measure, BLM WH&B "…welfare is being optimized to a level acceptable across other animal handling disciplines."

The GAO report (2008) noted the precautions that BLM takes before gather operations, including screening potential gather sites for environmental and safety concerns, approving facility plans to ensure that there are no hazards to the animals there, and limiting the speeds that animals travel to trap sites. BLM used SOPs for short-term holding facilities (e.g., corrals) that included procedures to minimize excitement of the animals to prevent injury, separating horses by age, sex, and size, regular observation of the animals, and recording information about the animals in a BLM database. The GAO reported that BLM had regular inspections of short-term holding facilities and the animals held there, ensuring that the corral equipment is up to code and that animals are treated with appropriate veterinary care (including that hooves are trimmed adequately to prevent injury). Mortality was found to be about 5% per year associated with transportation, short-term holding, and adoption or sale with limitations. The GAO noted that BLM also had controls in place to ensure humane care at long-term holding facilities (i.e., pastures). BLM staff monitor the number of animals, the pasture conditions, winter feeding, and animal health. Veterinarians from the USDA Animal and Plant Health Inspection Service inspect long-term facilities annually, including a full count of animals, with written reports. Contract veterinarians provide animal care at long-term facilities, when needed. Weekly counts provide an incentive for contractors that operate long-term holding facilities to maintain animal health (GAO 2008). Mortality at long-term holding was found to be about 8% per year, on average (GAO 2008). The mortality rates at short-term and long-term holding facilities are comparable to the natural annual mortality rate on the range of about 16% per year for foals (animals under age 1), about 5-10% per year for horses ages 1-10 years, and about 10-25% for animals aged 10-20 years (Ransom et al. 2016).

In 2010, the American Association of Equine Practitioners (AAEP 2011) was invited by the BLM to visit the BLM operations and facilities, spend time on WH&B gathers and evaluate the management of the wild equids. The AAEP Task Force evaluated horses in the BLM Wild Horse and Burro Program through several visits to wild horse gathers, and short- and long-term holding facilities. The task force was specifically asked to "review animal care and handling within the Wild Horse and Burro Program, and make whatever recommendations, if any, the Association feels may be indicated, and if possible, issue a public statement regarding the care and welfare of animals under BLM management." In their report (AAEP 2011), the task force concluded "that the care, handling and management practices utilized by the agency are appropriate for this population of horses and generally support the safety, health status and welfare of the animals."

In June 2010 BLM invited independent observers organized by American Horse Protection Association (AHPA) to observe BLM gathers and document their findings. AHPA engaged four independent credentialed professionals who are academia-based equine veterinarians or equine specialists. Each observer served on a team of two and was tasked specifically to observe the care and handling of the animals for a 3-4-day period during the gather process and submit their findings to AHPA. An Evaluation Checklist was provided to each of the observers that included four sections: Gather Activities; Horse Handling During Gather; Horse Description; and Temporary Holding Facility. The independent group visited three separate gather operations and found that "BLM and contractors are responsible and concerned about the welfare of the horses before, during and after the gather process" and that "gentle and knowledgeable, used acceptable methods for moving horses… demonstrated the ability to review, assess and adapt procedures to ensure the care and well-being of the animals" (Greene et al. 2013).

BLM commissioned the Natural Resources Council of the National Academies of Sciences (NAS) to conduct an independent, technical evaluation of the science, methodology, and technical decision-making approaches of the BLM Wild Horse and Burro Management Program. Among the conclusions of their 2013 report, NAS (2013) concluded that wild horse populations grow at 15-20 percent a year, and that predation will not typically control population growth rates of free-ranging horses. The report (NAS 2013) also noted that, because there are human-created barriers to dispersal and movement (such as fences and highways) and no substantial predator pressure, maintaining a herd within an AML requires removing animals in roundups, also known as gathers, and may require management actions that limit population growth rates. The report (NAS 2013) examined a number of population growth suppression techniques, including the use of sterilization, fertility control vaccines, and sex ratio manipulation.

The effects of gathers as part of feral horse management have also been documented on National Park Service Lands. Since the 1980s, managers at Theodore Roosevelt National Park have used periodic gathers, removals, and auctions to maintain the feral horse herd size at a carrying capacity level of 50 to 90 horses (Amberg et al. 2014). In practical terms, this carrying capacity is equivalent to an AML. Horse herd sizes at those levels were determined to allow for maintenance of certain sensitive forage plant species. Gathers every 3-5 years did not prevent the herd from self-sustaining. The herd continues to grow, to the point that the NPS now uses gathers and removals along with temporary fertility control methods in its feral horse management (Amberg et al. 2014).

Transport, Off-range Corrals, and Adoption Preparation: All gathered wild horses would be removed and transported to BLM holding facilities where they would be inspected by facility staff and if needed a contract veterinarian to observe health and ensure the animals are being humanely cared for. Those wild horses that are removed from the range and are identified to not return to the range would be transported to the receiving off-range corrals (ORC) in a goose-neck stock trailer or straight-deck semi-tractor trailers. Trucks and trailers used to haul the wild horses would be inspected prior to use to ensure wild horses can be safely transported. Wild horses would be segregated by age and sex when possible and loaded into separate compartments. Mares and their un-weaned foals may be shipped together. Transportation of recently captured wild horses is limited to a maximum of 10 hours.

Upon arrival, recently captured wild horses are off-loaded by compartment and placed in holding pens where they are provided good quality hay and water. Most wild horses begin to eat and drink immediately and adjust rapidly to their new situation. At the off-range corral, a veterinarian provides recommendations to the BLM regarding care, treatment, and if necessary, euthanasia of the recently captured wild horses. Wild horses in very thin condition or animals with injuries are sorted and placed in hospital pens, fed separately, and/or treated for their injuries.

After recently captured wild horses have transitioned to their new environment, they are prepared for adoption, sale, or transport to Off-Range pastures. Preparation involves freeze-marking the animals with a unique identification number, vaccination against common diseases, castration, microchipping and de-worming. At ORC facilities, a minimum of 700 square feet of space is provided per animal.

Adoption: Adoption applicants are required to have at least a 400 square foot corral with panels that are at least six feet tall. Applicants are required to provide adequate shelter, feed, and water. The BLM retains title to the horse for one year and inspects the horse and facilities during this period. After one year, the applicant may take title to the horse, at which point the horse becomes the property of the applicant. Adoptions are conducted in accordance with 43 CFR Subpart 4750.

Sale with Limitations: Buyers must fill out an application and be pre-approved before they may buy a wild horse. A sale-eligible wild horse is any animal that is more than 10 years old or has been offered unsuccessfully for adoption at least three times. The application also specifies that buyers cannot sell the horse to slaughter buyers or anyone who would sell the animals to a commercial processing plant. Sales of wild horses are conducted in accordance with the 1971 WFRHBA and congressional limitations.

Off-Range Pastures: When shipping wild horses for adoption, sale, or Off-Range Pastures (ORPs) the animals may be transported for up to a maximum of 24 hours. Immediately prior to transportation, and after every 24 hours of transportation, animals are offloaded and provided a minimum of eight hours onthe-ground rest. During the rest period, each animal is provided access to unlimited amounts of clean water and two pounds of good quality hay per 100 pounds of body weight with adequate space to allow all animals to eat at one time.

Mares and sterilized stallions (geldings) are segregated into separate pastures. Although the animals are placed in ORP, they remain available for adoption or sale to qualified individuals; and foals born to pregnant mares in ORP are gathered and weaned when they reach about 8-12 months of age and are also made available for adoption. The ORP contracts specify the care that wild horses must receive to ensure they remain healthy and well-cared for. Handling by humans is minimized to the extent possible although regular on-the-ground observation by the ORP contractor and periodic counts of the wild horses to ascertain their well-being and safety are conducted by BLM personnel and/or veterinarians.

Euthanasia or Sale without Limitations: Under the WFRHBA, healthy excess wild horses can be euthanized or sold without limitation if there is no adoption demand for the animals. However, while euthanasia and sale without limitation are allowed under the statute, these activities have not been permitted under Congressional appropriations for over a decade. If Congress were to lift the current appropriations restrictions, then it is possible that excess horses removed from the Confusion HMA over the next 10 years could potentially be euthanized or sold without limitation consistent with the provisions of the WFRHBA. Any old, sick, or lame horses unable to maintain an acceptable body condition (greater than or equal to a Henneke BCS of 3) or with serious physical defects would be humanely euthanized either before gather activities begin or during the gather operations. Decisions to humanely euthanize animals in field situations would be made in conformance with BLM policy (Washington Office Instruction Memorandum (WO IM) 2015-070 or most current edition).

Helicopter

If the local conditions require a helicopter drive-trap operation, the BLM will use a contractor or in-house gather team to perform the gather activities in cooperation with BLM and other appropriate staff. The contractor would be required to conduct all helicopter operations in a safe manner and in compliance with Federal Aviation Administration (FAA) regulations 14 CFR § 91.119 and BLM IM No. 2010-164.

Helicopter drive trapping involves use of a helicopter to herd wild horses into a temporary trap. The Comprehensive Animal Welfare Program for Wild Horse and Burro Gathers (CAWP) would be implemented to ensure that the gather is conducted in a safe and humane manner, and to minimize potential impacts or injury to the wild horses. Traps would be set in an area with high probability of access by horses using the topography, if possible, to assist with capturing excess wild horses residing within the area. Traps consist of a large catch pen with several connected holding corrals, jute-covered wings and a loading chute. The jute-covered wings are made of material, not wire, to avoid injury to the horses. The wings form an alley way used to guide the horses into the trap. Trap locations are changed during the gather to reduce the distance that the animals must travel. A helicopter is used to locate and herd wild horses to the trap location. The pilot uses a pressure and release system while guiding them to the trap site, allowing them to travel at their own pace. As the herd approaches the trap the pilot applies pressure and a prada horse is released guiding the wild horses into the trap. Once horses are gathered, they are removed from the trap and transported to a temporary holding facility where they are sorted.

If helicopter drive-trapping operations are needed to capture the targeted animals, BLM would assure that an Animal and Plant Health Inspection Service (APHIS) veterinarian or contracted licensed veterinarian is on-site during the gather to examine animals and make recommendations to BLM for care and treatment of wild horses. BLM staff would be present on the gather at all times to observe animal condition, ensure humane treatment of wild horses, and ensure contract requirements are met.

Bait/Water Trapping

Bait and/or water trapping may be used if circumstances require it or best fits the management action to be taken. Bait and/or water trapping generally require a longer window of time for success than helicopter drive trapping. Although the trap would be set in a high probability area for capturing excess wild horses residing within the area, and at the most effective time periods, time is required for the horses to acclimate to the trap and/or decide to access the water/bait.

Trapping involves setting up portable panels around an existing water source or in an active wild horse area, or around a pre-set water or bait source. The portable panels would be set up to allow wild horses to go freely in and out of the corral until they have adjusted to it. When the wild horses fully adapt to the corral, it is fitted with a gate system. The acclimation of the horses creates a low stress trapping method. During this acclimation period the horses would experience some stress due to the panels being setup and perceived access restriction to the water/bait source.

When actively trapping wild horses, the trap would be staffed or checked on a daily basis by either BLM personnel or authorized contractor staff. Horses would be either removed immediately or fed and watered for up to several days prior to transport to a holding facility. Existing roads would be used to access the trap sites.

Gathering excess horses using bait/water trapping could occur at any time of the year and traps would remain in place until the target number of animals are removed. Generally, bait/water trapping is most effective when a specific resource is limited, such as water during the summer months. For example, in some areas, a group of wild horses may congregate at a given watering site during the summer because few perennial water resources are available nearby. Under those circumstances, water trapping could be a useful means of reducing the number of horses at a given location, which can also relieve the resource pressure caused by too many horses. As the proposed bait and/or water trapping in this area is a low stress approach to gathering wild horses, such trapping can continue into the foaling season without harming the mares or foals.

Gather Related Temporary Holding Facilities (Corrals)

Wild horses that are gathered would be transported from the gather sites to a temporary holding corral in goose-neck trailers. At the temporary holding corral, wild horses would be sorted into different pens based on sex. The horses would be aged and provided good quality hay and water. Mares and their un-weaned foals would be kept in pens together. At the temporary holding facility, a veterinarian, when present, would provide recommendations to the BLM regarding care and treatment of the recently captured wild horses. Any animals affected by a chronic or incurable disease, injury, lameness or serious physical defect (such as severe tooth loss or wear, club foot, and other severe congenital abnormalities) would be humanely euthanized using methods acceptable to the American Veterinary Medical Association (AVMA).

Transport, Off-range Corrals, and Adoption Preparation

All gathered wild horses would be removed and transported to BLM holding facilities where they would be inspected by facility staff and if needed a contract veterinarian to observe health and ensure the animals are being humanely cared for.

Those wild horses that are removed from the range and are identified to not return to the range would be transported to the receiving off-range corrals (ORC, formerly short-term holding facility) in a goose-neck stock trailer or straight-deck semi-tractor trailers. Trucks and trailers used to haul the wild horses would be inspected prior to use to ensure wild horses can be safely transported. Wild horses would be segregated by age and sex when possible and loaded into separate compartments. Mares and their un-weaned foals may be shipped together. Transportation of recently captured wild horses is limited to a maximum of 12 hours.

Upon arrival, recently captured wild horses are off-loaded by compartment and placed in holding pens where they are provided good quality hay and water. Most wild horses begin to eat and drink immediately and adjust rapidly to their new situation. At the off-range corral, a veterinarian provides recommendations to the BLM regarding care, treatment, and if necessary, euthanasia of the recently captured wild horses. Wild horses in very thin condition or animals with injuries are sorted and placed in hospital pens, fed separately and/or treated for their injuries.

After recently captured wild horses have transitioned to their new environment, they are prepared for adoption, sale, or transport to Off-Range pastures. Preparation involves freeze-marking the animals with a unique identification number, vaccination against common diseases, castration, and de-worming. At ORC facilities, a minimum of 700 square feet of space is provided per animal.

Adoption

Adoption applicants are required to have at least a 400 square foot corral with panels that are at least six feet tall. Applicants are required to provide adequate shelter, feed, and water. The BLM retains title to the horse for one year and inspects the horse and facilities during this period. After one year, the applicant may take title to the horse, at which point the horse becomes the property of the applicant. Adoptions are conducted in accordance with 43 CFR Subpart 4750.

Sale with Limitations

Buyers must fill out an application and be pre-approved before they may buy a wild horse. A sale-eligible wild horse is any animal that is more than 10 years old or has been offered unsuccessfully for adoption at least three times. The application also specifies that buyers cannot sell the horse to slaughter buyers or anyone who would sell the animals to a commercial processing plant. Sales of wild horses are conducted in accordance with the 1971 WFRHBA and congressional limitations.

Off-Range Pastures

When shipping wild horses for adoption, sale, or Off-Range Pastures (ORPs) the animals may be transported for up to a maximum of 24 hours. Immediately prior to transportation, and after every 24 hours of transportation, animals are offloaded and provided a minimum of eight hours on-the-ground rest. During the rest period, each animal is provided access to unlimited amounts of clean water and two pounds of good quality hay per 100 pounds of body weight with adequate space to allow all animals to eat at one time.

Mares and sterilized stallions (geldings) are segregated into separate pastures. Although the animals are placed in ORP, they remain available for adoption or sale to qualified individuals; and foals born to pregnant mares in ORP are gathered and weaned when they reach about 8-12 months of age and are also made available for adoption. The ORP contracts specify the care that wild horses must receive to ensure they remain healthy and well-cared for. Handling by humans is minimized to the extent possible although regular on-the-ground observation by the ORP contractor and periodic counts of the wild horses to ascertain their well-being and safety are conducted by BLM personnel and/or veterinarians.

Euthanasia or Sale without Limitations

Under the WFRHBA, healthy excess wild horses can be euthanized or sold without limitation if there is no adoption demand for the animals. However, while euthanasia and sale without limitation are allowed under the statute, these activities have not been permitted under current Congressional appropriations for over a decade and are consequently inconsistent with BLM policy. If Congress were to lift the current appropriations restrictions, then it is possible that excess horses removed from the HMA over the next 10 years could potentially be euthanized or sold without limitation consistent with the provisions of the WFRHBA.

Any old, sick or lame horses unable to maintain an acceptable body condition (greater than or equal to a Henneke BCS of 3) or with serious physical defects would be humanely euthanized either before gather activities begin or during the gather operations. Decisions to humanely euthanize animals in field situations would be made in conformance with BLM policy (Washington Office Instruction Memorandum (WO IM) 2015-070 or most current edition). Conditions requiring humane euthanasia occur infrequently and are described in more detail in Washington Office Instruction Memorandum 2009-041.

Public Viewing Opportunities

Opportunities for public observation of the gather activities on public lands would be provided, when and where feasible, and would be consistent with WO IM No. 2013-058 and the Visitation Protocol and Ground Rules for Helicopter WH&B Gathers. This protocol is intended to establish observation locations that reduce safety risks to the public during helicopter gathers (see

Appendix B). Due to the nature of bait and water trapping operations, public viewing opportunities may only be provided at holding corrals.

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b. Effects of Wild Horses and Burros on Rangeland Ecosystems

The presence of wild horses and wild burros can have substantial effects on rangeland ecosystems, and on the capacity for habitat restoration efforts to achieve landscape conservation and restoration goals.

In the biological sense, all free-roaming horses and burros in North America are feral, meaning that they are descendants of domesticated animals brought to the Americas by European colonists. Horses went extinct in the Americas by the end of the Pleistocene, about 10,000 years ago (Webb 1984; MacFadden 2005). Burros evolved in Eurasia (Geigl et al. 2016). The published literature refers to free-roaming horses and burros as either feral or wild. In the ecological context the terms are interchangeable, but the terms 'wild horse' and 'wild burro' are associated with a specific legal status. The following literature review on the effects of wild horses and burros on rangeland ecosystems draws on scientific studies of feral horses and burros, some of which also have wild horse or wild burro legal status. The following literature review draws on Parts 1 and 2 of the 'Science framework for conservation and restoration of the sagebrush biome' interagency report (Chambers et al. 2017, Crist et al. 2019).

Because of the known damage that overpopulated wild horse and burro herds can cause in rangeland ecosystems, the presence of wild horses and burros is considered a threat to Greater sage-grouse habitat quality, particularly in the bird species' western range (Beever and Aldridge 2011, USFWS 2013). Wild horse population sizes on federal lands have more than doubled in the five years since the USFWS report (2013) was published (BLM 2018). On lands administered by the BLM, there were an estimated 81,951 BLM-administered wild horses and burros as of March 1, 2018, which does not include foals born in 2018. Lands with wild horses and burros are managed for multiple uses, so it can be difficult to parse out their ecological effects. Despite this, scientific studies designed to separate out those effects, which are summarized below, point to conclusions that landscapes with greater wild horse and burro abundance will tend to have lower resilience to disturbance and lower resistance to invasive plants than similar landscapes with herds at or below target AML levels.

In contrast to managed livestock grazing, neither the seasonal timing nor the intensity of wild horse and burro grazing can be managed, except through efforts to manage their numbers and distribution. Wild horses live on the range year-round, they roam freely, and wild horse populations have the potential to grow 15-20% per year (Wolfe 1980; Eberhardt et al. 1982; Garrott et al 1991; Dawson 2005; Roelle et al. 2010; Scorolli et al. 2010). Although this annual growth rate may be lower in some areas where mountain lions can take foals (Turner and Morrison 2001, Turner 2015), horses tend to favor use of more open habitats (Schoenecker 2016) that are dominated by grasses and shrubs and where ambush is less likely. Horses can compete with managed livestock in forage selected (Scasta et al. 2016). For the majority of wild horse herds, there is little overall evidence that population growth is significantly affected by predation. As a result of the potential for wild horse populations to grow rapidly, impacts from wild horses on water, soil, vegetation, and native wildlife resources (Davies and Boyd 2019) can increase exponentially unless there is active management to limit their population sizes.

The USFWS (2008), Beever and Aldridge (2011), and Chambers et al (2017) summarize much of the literature that quantifies direct ecosystem effects of wild horse presence. Beever and Aldridge (2011) present a conceptual model that illustrates the effects of wild horses on sagebrush ecosystems. In the Great Basin, areas without wild horses had greater shrub cover, plant cover, species richness, native plant cover, and overall plant biomass, and less cover percentage of grazing-tolerant, unpalatable, and invasive plant species, including cheatgrass, compared to areas with horses (Smith 1986; Beever et al. 2008; Davies et al. 2014; Zeigenfuss et al. 2014; Boyd et al. 2017). There were also measurable increases in soil penetration resistance and erosion, decreases in ant mound and granivorous small mammal densities, and changes in reptile communities (Beever et al. 2003; Beever and Brussard 2004; Beever and Herrick 2006; Ostermann-Kelm et al. 2009). Intensive grazing by horses and other ungulates can damage biological crusts (Belnap et al. 2001). In contrast to domestic livestock grazing, where post-fire grazing rest and deferment can foster recovery, wild horse grazing occurs year-round. These effects imply that horse presence can have broad effects on ecosystem function that could influence conservation and restoration actions.

Many studies corroborate the general conclusion that wild horses can lead to biologically significant changes in rangeland ecosystems, particularly when their populations are overabundant relative to water and forage resources, and other wildlife living on the landscape (Eldridge et al. 2020). The presence of wild horses is associated with a reduced degree of greater sage-grouse lekking behavior (Muñoz et al. 2020). Moreover, increasing densities of wild horses, measured as a percentage above AML, are associated with decreasing Greater Sage-grouse population sizes, measured by lek counts (Coates 2020). Horses are primarily grazers (Hanley and Hanley 1982), but shrubs – including sagebrush – can represent a large part of a horse’s diet, at least in summer in the Great Basin (Nordquist 2011). Grazing by wild horses can have severe impacts on water source quality, aquatic ecosystems and riparian communities as well (Beever and Brussard 2000; Barnett 2002; Nordquist 2011; USFWS 2008; Earnst et al. 2012; USFWS 2012, Kaweck et al. 2018), sometimes excluding native ungulates from water sources (Ostermann-Kelm et al. 2008; USFWS 2008; Perry et al. 2015; Hall et al. 2016; Gooch et al. 2017; Hall et al. 2018). Impacts to riparian vegetation per individual wild horse can exceed impacts per individual domestic cow (Kaweck et al. 2018). Bird nest survival may be lower in areas with wild horses (Zalba and Cozzani 2004), and bird populations have recovered substantially after livestock and / or wild horses have been removed (Earnst et al. 2005; Earnst et al. 2012; Batchelor et al. 2015). Wild horses can spread non-native plant species, including cheatgrass, and may limit the effectiveness of habitat restoration projects (Beever et al. 2003; Couvreur et al. 2004; Jessop and Anderson 2007; Loydi and Zalba 2009). Riparian and wildlife habitat improvement projects intended to increase the availability of grasses, forbs, riparian habitats, and water will likely attract and be subject to heavy grazing and trampling by wild horses that live in the vicinity of the project. Even after domestic livestock are removed, continued wild horse grazing can cause ongoing detrimental ecosystem effects (USFWS 2008; Davies et al. 2014) which may require several decades for recovery (e.g., Anderson and Inouye 2001).

Most analyses of wild horse effects have contrasted areas with wild horses to areas without, which is a study design that should control for effects of other grazers, but historical or ongoing effects of livestock grazing may be difficult to separate from horse effects in some cases (Davies et al. 2014). Analyses have generally not included horse density as a continuous covariate; therefore, ecosystem effects have not been quantified as a linear function of increasing wild horse density. One exception is an analysis of satellite imagery confirming that varied levels of feral horse biomass were negatively correlated with average plant biomass growth (Ziegenfuss et al. 2014).

Horses require access to large amounts of water; an individual can drink an average of 7.4 gallons of water per day (Groenendyk et al. 1988). Despite a general preference for habitats near water (e.g., Crane et al. 1997), wild horses will routinely commute long distances (e.g., 10+ miles per day) between water sources and palatable vegetation (Hampson et al. 2010).

Wild burros can also substantially affect riparian habitats (e.g., Tiller 1997), native wildlife (e.g., Seegmiller and Ohmart 1981), and have grazing and trampling impacts that are similar to wild horses (Carothers et al. 1976; Hanley and Brady 1977; Douglas and Hurst 1983). Where wild burros and Greater sage-grouse co-occur, burros' year-round use of low-elevation habitats may lead to a high degree of overlap between burros and Greater sage-grouse (Beever and Aldridge 2011).

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c. Effects of Fertility Control Vaccines and Sex Ratio Manipulations

Various forms of fertility control can be used in wild horses and wild burros, with the goals of maintaining herds at or near AML, reducing fertility rates, and reducing the frequency of gathers and removals. The WFRHBA of 1971 specifically provides for contraception and sterilization (16 U.S.C. 1333 section 3.b.1). Fertility control measures have been shown to be a cost-effective and humane treatment to slow increases in wild horse populations or, when used in combination with gathers, to reduce horse population size (Bartholow 2004, de Seve and Boyles-Griffin 2013, Fonner and Bohara 2017). Although fertility control treatments may be associated with a number of potential physiological, behavioral, demographic, and genetic effects, those impacts are generally minor and transient, do not prevent overall maintenance of a self-sustaining population, and do not generally outweigh the potential benefits of using contraceptive treatments in situations where it is a management goal to reduce population growth rates (Garrott and Oli 2013).

An extensive body of peer-reviewed scientific literature details the impacts of fertility control methods on wild horses and burros. No finding of excess animals is required for BLM to pursue contraception in wild horses or wild burros, but NEPA analysis has been required. This review focuses on peer-reviewed scientific literature. The summary that follows first examines effects of fertility control vaccine use in mares, then of sex ratio manipulation. This review does not examine effects of spaying and neutering. Cited studies are generally limited to those involving horses and burros, except where including studies on other species helps in making inferences about physiological or behavioral questions not yet addressed in horses or burros specifically. While most studies reviewed here refer to horses, burros are extremely similar in terms of physiology, such that expected effects are comparable, except where differences between the species are noted.

On the whole, the identified impacts are generally transient and affect primarily the individuals treated. Fertility control that affects individual horses and burros does not prevent BLM from ensuring that there will be self-sustaining populations of wild horses and burros in single herd management areas (HMAs), in complexes of HMAs, and at regional scales of multiple HMAs and complexes. Under the WFRHBA of 1971, BLM is charged with maintaining self-reproducing populations of wild horses and burros. The National Academies of Sciences (2013) encouraged BLM to manage wild horses and burros at the spatial scale of "metapopulations" – that is, across multiple HMAs and complexes in a region. In fact, many HMAs have historical and ongoing genetic and demographic connections with other HMAs, and BLM routinely moves animals from one to another to improve local herd traits and maintain high genetic diversity. The NAS report (2013) includes information (pairwise genetic 'fixation index' values for sampled WH&B herds) confirming that WH&B in the vast majority of HMAs are genetically similar to animals in multiple other HMAs.

All fertility control methods affect the behavior and physiology of treated animals (NAS 2013), and are associated with potential risks and benefits, including effects of handling, frequency of handling, physiological effects, behavioral effects, and reduced population growth rates (Hampton et al. 2015). Contraception alone does not remove excess horses from an HMA's population, so one or more gathers are usually needed in order to bring the herd down to a level close to AML. Horses are long-lived, potentially reaching 20 years of age or more in the wild. Except in cases where extremely high fractions of mares are rendered infertile over long time periods of (i.e., 10 or more years), fertility control methods such as immunocontraceptive vaccines and sex ratio manipulation are not very effective at reducing population growth rates to the point where births equal deaths in a herd. However, even more modest fertility control activities can reduce the frequency of horse gather activities, and costs to taxpayers. Bartholow (2007) concluded that the application of 2-year or 3-year contraceptives to wild mares could reduce operational costs in a project area by 12-20%, or up to 30% in carefully planned population management programs. Because applying contraception to horses requires capturing and handling, the risks and costs associated with capture and handling of horses may be comparable to those of gathering for removal, but with expectedly lower adoption and long-term holding costs. Population growth suppression becomes less expensive if fertility control is long-lasting (Hobbs et al. 2000).

In the context of BLM wild horse and burro management, fertility control vaccines and sex ratio manipulation rely on reducing the number of reproducing females. Taking into consideration available literature on the subject, the National Academies of Sciences concluded in their 2013 report that forms of fertility control vaccines were two of the three 'most promising' available methods for contraception in wild horses and burros (NAS 2013). That report also noted that sex ratio manipulations where herds have approximately 60% males and 40% females can expect lower annual growth rates, simply as a result of having a lower number of reproducing females.

Fertility Control Vaccines

Fertility control vaccines (also known as (immunocontraceptives) meet BLM requirements for safety to mares and the environment (EPA 2009a, 2012). Because they work by causing an immune response in treated animals, there is no risk of hormones or toxins being taken into the food chain when a treated mare dies. The BLM and other land managers have mainly used three fertility control vaccine formulations for fertility control of wild horse mares on the range: ZonaStat-H, PZP-22, and GonaCon-Equine. As other formulations become available, they may be applied in the future.

In any vaccine, the antigen is the stimulant to which the body responds by making antigen-specific antibodies. Those antibodies then signal to the body that a foreign molecule is present, initiating an immune response that removes the molecule or cell. Adjuvants are additional substances that are included in vaccines to elevate the level of immune response. Adjuvants help to incite recruitment of lymphocytes and other immune cells which foster a long-lasting immune response that is specific to the antigen.

Liquid emulsion vaccines can be injected by hand or remotely administered in the field using a pneumatic dart (Roelle and Ransom 2009, Rutberg et al. 2017, McCann et al. 2017) in cases where mares are relatively approachable. Use of remotely delivered (dart-delivered) vaccine is generally limited to populations where individual animals can be accurately identified and repeatedly approached within 50 m (BLM 2010). Booster doses can be safely administered by hand or by dart. Even with repeated booster treatments of the vaccines, it is expected that most mares would eventually return to fertility, though some individual mares treated repeatedly may remain infertile. Once the herd size in a project area is at AML and population growth seems to be stabilized, BLM can make adaptive determinations as to the required frequency of new and booster treatments.

BLM has followed SOPs for fertility control vaccine application (BLM IM 2009-090). Herds selected for fertility control vaccine use should have annual growth rates over 5%, have a herd size over 50 animals, and have a target rate of treatment of between 50% and 90% of female wild horses or burros. The IM requires that treated mares be identifiable via a visible freeze brand or individual color markings, so that their vaccination history can be known. The IM calls for follow-up population surveys to determine the realized annual growth rate in herds treated with fertility control vaccines.

Vaccine Formulations: Porcine Zona Pellucida (PZP)

PZP vaccines have been used on dozens of horse herds by the National Park Service, US Forest Service, Bureau of Land Management, and Native American tribes and PZP vaccine use is approved for free-ranging wild and feral horse herds in the United States (EPA 2012). PZP use can reduce or eliminate the need for gathers and removals, if very high fractions of mares are treated over a very long time period (Turner et al. 1997). PZP vaccines have been used extensively in wild horses (NAS 2013), and in feral burros on Caribbean islands (Turner et al. 1996, French et al. 2017). PZP vaccine formulations are produced as ZonaStat-H, an EPA-registered commercial product (EPA 2012, SCC 2015), as PZP-22, which is a formulation of PZP in polymer pellets that can lead to a longer immune response (Turner et al. 2002, Rutberg et al. 2017), and as Spayvac, where the PZP protein is enveloped in liposomes (Killian et al. 2008, Roelle et al. 2017, Bechert and Fraker 2018). 'Native' PZP proteins can be purified from pig ovaries (Liu et al. 1989). Recombinant ZP proteins may be produced with molecular techniques (Gupta and Minhas 2017, Joonè et al. 2017a, Nolan et al. 2018a).

When advisories on the product label (EPA 2015) are followed, the product is safe for users and the environment (EPA 2012). In keeping with the EPA registration for ZonaStat-H (EPA 2012; reg. no. 86833-1), certification through the Science and Conservation Center in Billings Montana is required to apply that vaccine to equids.

For maximum effectiveness, PZP is administered within the December to February timeframe. When applying ZonaStat-H, first the primer with modified Freund's Complete adjuvant is given and then the booster with Freund's Incomplete adjuvant is given 2-6 weeks later. Preferably, the timing of the booster dose is at least 1-2 weeks prior to the onset of breeding activity. Following the initial 2 inoculations, only annual boosters are required. For the PZP-22 formulation, each released mare would receive a single dose of the two-year PZP contraceptive vaccine at the same time as a dose of the liquid PZP vaccine with modified Freund's Complete adjuvant. The pellets are applied to the mare with a large gauge needle and jab-stick into the hip. Although PZP-22 pellets have been delivered via darting in trial studies (Rutberg et al 2017, Carey et al. 2019), BLM does not plan to use darting for PZP-22 delivery until there is more demonstration that PZP-22 can be reliably delivered via dart.

Vaccine Formulations: Gonadotropin Releasing Hormone (GnRH)

GonaCon (which is produced under the trade name GonaCon-Equine for use in feral horses and burros) is approved for use by authorized federal, state, tribal, public and private personnel, for application to free-ranging wild horse and burro herds in the United States (EPA 2013, 2015). GonaCon has been used on feral horses in Theodore Roosevelt National Park and on wild horses administered by BLM (BLM 2015). GonaCon has been produced by USDA-APHIS (Fort Collins, Colorado) in several different formulations, the history of which is reviewed by Miller et al. (2013). GonaCon vaccines present the recipient with hundreds of copies of GnRH as peptides on the surface of a linked protein that is naturally antigenic because it comes from invertebrate hemocyanin (Miller et al 2013). Early GonaCon formulations linked many copies of GnRH to a protein from the keyhole limpet (GonaCon-KHL), but more recently produced formulations where the GnRH antigen is linked to a protein from the blue mussel (GonaCon-B) proved less expensive and more effective (Miller et al. 2008). GonaCon-Equine is in the category of GonaCon-B vaccines.

As with other contraceptives applied to wild horses, the long-term goal of GonaCon-Equine use is to reduce or eliminate the need for gathers and removals (NAS 2013). GonaCon-Equine contraceptive vaccine is an EPA-approved pesticide (EPA, 2009a) that is relatively inexpensive, meets BLM requirements for safety to mares and the environment, and is produced in a USDA-APHIS laboratory. GonaCon is a pharmaceutical-grade vaccine, including aseptic manufacturing technique to deliver a sterile vaccine product (Miller et al. 2013). If stored at 4° C, the shelf life is 6 months (Miller et al 2013).

Miller et al. (2013) reviewed the vaccine environmental safety and toxicity. When advisories on the product label (EPA 2015) are followed, the product is safe for users and the environment (EPA 2009b). EPA waived a number of tests prior to registering the vaccine, because GonaCon was deemed to pose low risks to the environment, so long as the product label is followed (Wang-Cahill et al., *in press*).

GonaCon-Equine can safely be reapplied as necessary to control the population growth rate; booster dose effects may lead to increased effectiveness of contraception, which is generally the intent. Even after booster treatment of GonaCon-Equine, it is expected that most, if not all, mares would return to fertility at some point. Although the exact timing for the return to fertility in mares boosted more than once with GonaCon-Equine has not been quantified, a prolonged return to fertility would be consistent with the desired effect of using GonaCon (e.g., effective contraception).

The adjuvant used in GonaCon, Adjuvac, generally leads to a milder reaction than Freund's Complete Adjuvant (Powers et al. 2011). Adjuvac contains a small number of killed *Mycobacterium avium* cells (Miller et al. 2008, Miller et al. 2013). The antigen and adjuvant are emulsified in mineral oil, such that they are not all presented to the immune system right after injection. It is thought that the mineral oil emulsion leads to a 'depot effect' that is associated with slow or sustained release of the antigen, and a resulting longer-lasting immune response (Miller et al. 2013). Miller et al. (2008, 2013) have speculated that, in cases where memory-B leukocytes are protected in immune complexes in the lymphatic system, it can lead to years of immune response. Increased doses of vaccine may lead to stronger immune reactions, but only to a certain point; when Yoder and Miller (2010) tested varying doses of GonaCon in prairie dogs, antibody responses to the 200μg and 400μg doses were equal to each other but were both higher than in response to a 100μg dose.

Direct Effects: PZP Vaccines

The historically accepted hypothesis explaining PZP vaccine effectiveness posits that when injected as an antigen in vaccines, PZP causes the mare's immune system to produce antibodies that are specific to zona pellucida proteins on the surface of that mare's eggs. The antibodies bind to the mare's eggs surface proteins (Liu et al. 1989), and effectively block sperm binding and fertilization (Zoo Montana, 2000). Because treated mares do not become pregnant but other ovarian functions remain generally unchanged, PZP can cause a mare to continue having regular estrus cycles throughout the breeding season. More recent observations support a complementary hypothesis, which posits that PZP vaccination causes reductions in ovary size and function (Mask et al. 2015, Joonè et al. 2017b, Joonè et al. 2017c, Nolan et al. 2018b, 2018c). PZP vaccines do not appear to interact with other organ systems, as antibodies specific to PZP protein do not cross-react with tissues outside of the reproductive system (Barber and Fayrer-Hosken 2000).

Research has demonstrated that contraceptive efficacy of an injected liquid PZP vaccine, such as ZonaStat-H, is approximately 90% or more for mares treated twice in the first year (Turner and Kirkpatrick 2002, Turner et al. 2008). The highest success for fertility control has been reported when the vaccine has been applied November through February. High contraceptive rates of 90% or more can be maintained in horses that are given a booster dose annually (Kirkpatrick et al. 1992). Approximately 60% to 85% of mares are successfully contracepted for one year when treated simultaneously with a liquid primer and PZP-22 pellets (Rutberg et al. 2017, Carey et al. 2019). Application of PZP for fertility control would reduce fertility in a large percentage of mares for at least one year (Ransom et al. 2011). The contraceptive result for a single application of the liquid PZP vaccine primer dose along with PZP vaccine pellets (PZP-22), based on winter applications, can be expected to fall in the approximate efficacy ranges as follows (based on figure 2 in Rutberg et al. 2017). Below, the approximate efficacy is measured as the relative decrease in foaling rate for treated mares, compared to control mares:

Year 1	Year 2	Year 3
0 (developing fetuses come to term)	~30-75%	~20-50%

If mares that have been treated with PZP-22 vaccine pellets subsequently receive a booster dose of either the liquid PZP vaccine or the PZP-22 vaccine pellets, the subsequent contraceptive effect is apparently more pronounced and long-lasting. The approximate efficacy following a booster dose can be expected to be in the following ranges (based on figure 3 in Rutberg et al. 2017).

Year 1	Year 2	Year 3	Year 4
0 (developing fetuses come to term)	~50-90%	~55-75%	~40-75%

The fraction of mares treated in a herd can have a large effect on the realized change in growth rate due to PZP contraception, with an extremely high portion of mares required over many years to be treated to totally prevent population-level growth (e.g., Turner and Kirkpatrick 2002). Gather efficiency does not usually exceed 85% via helicopter, and may be less with bait and water trapping, so there will almost always be a portion of the female population uncaptured that is not treated in any given year. Additionally, some mares may not respond to the fertility control vaccine, but instead will continue to foal normally.

Direct Effects: GnRH Vaccines

GonaCon-Equine is one of several vaccines that have been engineered to create an immune response to the gonadotropin releasing hormone peptide (GnRH). GnRH is a small peptide that plays an important role in signaling the production of other hormones involved in reproduction in both sexes. When combined with an adjuvant, a GnRH vaccine stimulates a persistent immune response resulting in prolonged antibody production against GnRH, the carrier protein, and the adjuvant (Miller et al., 2008). The most direct result of successful GnRH vaccination is that it has the effect of decreasing the level of GnRH signaling in the body, as evidenced by a drop in luteinizing hormone levels, and a cessation of ovulation.

GnRH is highly conserved across mammalian taxa, so some inferences about the mechanism and effects of GonaCon-Equine in horses can be made from studies that used different anti-GnRH vaccines, in horses and other taxa. Other commercially available anti-GnRH vaccines include: Improvac (Imboden et al. 2006, Botha et al. 2008, Janett et al. 2009a, Janett et al. 2009b, Schulman et al. 2013, Dalmau et al. 2015, Nolan et al. 2018c), made in South Africa; Equity (Elhay et al. 2007), made in Australia; Improvest, for use in swine (Bohrer et al. 2014); Repro-BLOC (Boedeker et al. 2011); and Bopriva, for use in cows (Balet et al. 2014). Of these, GonaCon-Equine, Improvac, and Equity are specifically intended for horses. Other anti-GnRH vaccine formulations have also been tested, but did not become trademarked products (e.g., Goodloe 1991, Dalin et al 2002, Stout et al. 2003, Donovan et al. 2013, Schaut et al. 2018, Yao et al. 2018). The effectiveness and side-effects of these various anti-GnRH vaccines may not be the same as would be expected from GonaCon-Equine use in horses. Results could differ as a result of differences in the preparation of the GnRH antigen, and the choice of adjuvant used to stimulate the immune response. For some formulations of anti-GnRH vaccines, a booster dose is required to elicit a contraceptive response, though GonaCon can cause short-term contraception in a fraction of treated animals from one dose (Powers et al. 2011, Gionfriddo et al. 2011a, Baker et al. 2013, Miller et al 2013).

GonaCon can provide multiple years of infertility in several wild ungulate species, including horses (Killian et al., 2008; Gray et al., 2010). The lack of estrus cycling that results from successful GonaCon vaccination has been compared to typical winter period of anoestrus in open mares. As anti-GnRH antibodies decline over time, concentrations of available endogenous GnRH increase and treated animals usually regain fertility (Power et al., 2011).

Females that are successfully contracepted by GnRH vaccination enter a state similar to anestrus, have a lack of or incomplete follicle maturation, and no ovarian cycling (Botha et al. 2008, Nolan et al. 2018c). A leading hypothesis is that anti-GnRH antibodies bind GnRH in the hypothalamus – pituitary ‘portal vessels,’ preventing GnRH from binding to GnRH-specific binding sites on gonadotroph cells in the pituitary, thereby limiting the production of gonadotropin hormones, particularly luteinizing hormone (LH) and, to a lesser degree, follicle-stimulating hormone (FSH) (Powers et al. 2011, NAS 2013). This reduction in LH (and FSH), and a corresponding lack of ovulation, has been measured in response to treatment with anti-GnRH vaccines (Boedeker et al. 2011, Garza et al. 1986).

Females successfully treated with anti-GnRH vaccines have reduced progesterone levels (Garza et al. 1986, Stout et al. 2003, Imboden et al. 2006, Elhay 2007, Botha et al. 2008, Killian et al. 2008, Miller et al. 2008, Janett et al. 2009, Schulman et al. 2013, Balet et al 2014, Dalmau et al. 2015) and β-17 estradiol levels (Elhay et al. 2007), but no great decrease in estrogen levels (Balet et al. 2014). Reductions in progesterone do not occur immediately after the primer dose, but can take several weeks or months to develop (Elhay et al. 2007, Botha et al. 2008, Schulman et al. 2013, Dalmau et al. 2015). This indicates that ovulation is not occurring and corpora lutea, formed from post-ovulation follicular tissue, are not being established.

Antibody titer measurements are proximate measures of the antibody concentration in the blood specific to a given antigen. Anti-GnRH titers generally correlate with a suppressed reproduction system (Gionfriddo et al. 2011a, Powers et al. 2011). Various studies have attempted to identify a relationship between anti-GnRH titer levels and infertility, but that relationship has not been universally predictable or consistent. The time length that titer levels stay high appears to correlate with the length of suppressed reproduction (Dalin et al. 2002, Levy et al. 2011, Donovan et al. 2013, Powers et al. 2011). For example, Goodloe (1991) noted that mares did produce elevated titers and had suppressed follicular development for 11-13 weeks after treatment, but that all treated mares ovulated after the titer levels declined. Similarly, Elhay (2007) found that high initial titers correlated with longer-lasting ovarian and behavioral anoestrus. However, Powers et al. (2011) did not identify a threshold level of titer that was consistently indicative of suppressed reproduction despite seeing a strong correlation between antibody concentration and infertility, nor did Schulman et al. (2013) find a clear relationship between titer levels and mare acyclicity.

In many cases, young animals appear to have higher immune responses, and stronger contraceptive effects of anti-GnRH vaccines than older animals (Brown et al. 1994, Curtis et al. 2001, Stout et al. 2003, Schulman et al. 2013). Vaccinating with GonaCon at too young an age, though, may prevent effectiveness; Gionfriddo et al. (2011a) observed weak effects in 3-4-month-old fawns. It has not been possible to predict which individuals of a given age class will have long-lasting immune responses to the GonaCon vaccine. Gray (2010) noted that mares in poor body condition tended to have lower contraceptive efficacy in response to GonaCon-B. Miller et al. (2013) suggested that higher parasite loads might have explained a lower immune response in free-roaming horses than had been observed in a captive trial. At this time, it is unclear what the most important factors affecting efficacy are.

Several studies have monitored animal health after immunization against GnRH. GonaCon treated mares did not have any measurable difference in uterine edema (Killian 2006, 2008). Powers et al. (2011, 2013) noted no differences in blood chemistry except a mildly elevated fibrinogen level in some GonaCon treated elk. In that study, one sham-treated elk and one GonaCon treated elk each developed leukocytosis, suggesting that there may have been a causal link between the adjuvant and the effect. Curtis et al. (2008) found persistent granulomas at GonaCon-KHL injection sites three years after injection, and reduced ovary weights in treated females. Yoder and Miller (2010) found no difference in blood chemistry between GonaCon treated and control prairie dogs. One of 15 GonaCon treated cats died without explanation, and with no determination about cause of death possible based on necropsy or histology (Levy et al. 2011). Other anti-GnRH vaccine formulations have led to no detectable adverse effects (in elephants; Boedeker et al. 2011), though Imboden et al. (2006) speculated that young treated animals might conceivably have impaired hypothalamic or pituitary function.

Kirkpatrick et al. (2011) raised concerns that anti-GnRH vaccines could lead to adverse effects in other organ systems outside the reproductive system. GnRH receptors have been identified in tissues outside of the pituitary system, including in the testes and placenta (Khodr and Siler-Khodr 1980), ovary (Hsueh and Erickson 1979), bladder (Coit et al. 2009), heart (Dong et al. 2011), and central nervous system, so it is plausible that reductions in circulating GnRH levels could inhibit physiological processes in those organ systems. Kirkpatrick et al. (2011) noted elevated cardiological risks to human patients taking GnRH agonists (such as leuprolide), but the

National Academy of Sciences (2013) concluded that the mechanism and results of GnRH agonists would be expected to be different from that of anti-GnRH antibodies; the former flood GnRH receptors, while the latter deprive receptors of GnRH.

Reversibility and Effects on Ovaries: PZP Vaccines

In most cases, PZP contraception appears to be temporary and reversible, with most treated mares returning to fertility over time (Kirkpatrick and Turner 2002). The ZonaStat-H formulation of the vaccine tends to confer only one year of efficacy per dose. Some studies have found that a PZP vaccine in long-lasting pellets (PZP-22) can confer multiple years of contraception (Turner et al. 2007), particularly when boostered with subsequent PZP vaccination (Rutberg et al. 2017). Other trial data, though, indicate that the pelleted vaccine may only be effective for one year (J. Turner, University of Toledo, Personal Communication to BLM).

The purpose of applying PZP vaccine treatment is to prevent mares from conceiving foals, but BLM acknowledges that long-term infertility, or permanent sterility, could be a result for some number of individual wild horses receiving PZP vaccinations. The rate of long-term or permanent sterility following vaccinations with PZP is hard to predict for individual horses, but that outcome appears to increase in likelihood as the number of doses increases (Kirkpatrick and Turner 2002). Permanent sterility for mares treated consecutively in each of 5-7 years was observed by Nuñez et al. (2010, 2017). In a graduate thesis, Knight (2014) suggested that repeated treatment with as few as three to four years of PZP treatment may lead to longer-term sterility, and that sterility may result from PZP treatment before puberty. Repeated treatment with PZP led long-term infertility in Przewalski's horses receiving as few as one PZP booster dose (Feh 2012). However, even if some number of mares become sterile as a result of PZP treatment, that potential result would be consistent with the contraceptive purpose that motivates BLM's potential use of the vaccine.

In some number of individual mares, PZP vaccination may cause direct effects on ovaries (Gray and Cameron 2010, Joonè et al. 2017b, Joonè et al. 2017c, Joonè et al. 2017d, Nolan et al. 2018b). Joonè et al. (2017a) noted reversible effects on ovaries in mares treated with one primer dose and booster dose. Joonè et al. (2017c) and Nolan et al. (2018b) documented decreased anti-Mullerian hormone (AMH) levels in mares treated with native or recombinant PZP vaccines; AMH levels are thought to be an indicator of ovarian function. Bechert et al. (2013) found that ovarian function was affected by the SpayVac PZP vaccination, but that there were no effects on other organ systems. Mask et al. (2015) demonstrated that equine antibodies that resulted from SpayVac immunization could bind to oocytes, ZP proteins, follicular tissues, and ovarian tissues. It is possible that result is specific to the immune response to SpayVac, which may have lower PZP purity than ZonaStat or PZP-22 (Hall et al. 2016). However, in studies with native ZP proteins and recombinant ZP proteins, Joonè et al. (2017a) found transient effects on ovaries after PZP vaccination in some treated mares; normal estrus cycling had resumed 10 months after the last treatment. SpayVac is a patented formulation of PZP in liposomes that led to multiple years of infertility in some breeding trials (Killian et al. 2008, Roelle et al. 2017, Bechert and Fraker 2018), but unacceptably poor efficacy in a subsequent trial (Kane 2018). Kirkpatrick et al. (1992) noted effects on horse ovaries after three years of treatment with PZP. Observations at Assateague Island National Seashore indicated that the more times a mare is consecutively treated, the longer the time lag before fertility returns, but that even mares treated seven consecutive years did eventually return to ovulation (Kirkpatrick and Turner 2002). Other studies have reported that continued PZP vaccine applications may result in decreased estrogen levels (Kirkpatrick et al. 1992) but that decrease was not biologically significant, as ovulation remained similar between treated and untreated mares (Powell and Monfort 2001). Bagavant et al. (2003) demonstrated T-cell clusters on ovaries, but no loss of ovarian function after ZP protein immunization in macaques.

Reversibility and Effects on Ovaries: GnRH Vaccines

The NAS (2013) review pointed out that single doses of GonaCon-Equine do not lead to high rates of initial effectiveness, or long duration. Initial effectiveness of one dose of GonaCon-Equine vaccine appears to be lower than for a combined primer plus booster dose of the PZP vaccine Zonastat-H (Kirkpatrick et al. 2011), and the initial effect of a single GonaCon dose can be limited to as little as one breeding season. However, preliminary results on the effects of boostered doses of GonaCon-Equine indicate that it can have high efficacy and longer-lasting effects in free-roaming horses (Baker et al. 2017, 2018) than the one-year effect that is generally expected from a single booster of Zonastat-H.

Too few studies have reported on the various formulations of anti-GnRH vaccines to make generalizations about differences between products, but GonaCon formulations were consistently good at causing loss of fertility in a statistically significant fraction of treated mares for at least one year (Killian et al. 2009, Gray et al. 2010, Baker et al. 2013, 2017, 2018). With few exceptions (e.g., Goodloe 1991), anti-GnRH treated mares gave birth to fewer foals in the first season when there would be an expected contraceptive effect (Botha et al. 2008, Killian et al. 2009, Gray et al. 2010, Baker et al. 2013, 2018). Goodloe (1991) used an anti-GnRH-KHL vaccine with a triple adjuvant, in some cases attempting to deliver the vaccine to horses with a hollow-tipped ‘biobullet, ’but concluded that the vaccine was not an effective immunocontraceptive in that study.

Not all mares should be expected to respond to the GonaCon-equine vaccine; some number should be expected to continue to become pregnant and give birth to foals. In studies where mares were exposed to stallions, the fraction of treated mares that are effectively contracepted in the year after anti-GnRH vaccination varied from study to study, ranging from ~50% (Baker et al. 2017), to 61% (Gray et al. 2010), to ~90% (Killian et al. 2006, 2008, 2009). Miller et al. (2013) noted lower effectiveness in free-ranging mares (Gray et al. 2010) than captive mares (Killian et al. 2009). Some of these rates are lower than the high rate of effectiveness typically reported for the first year after PZP vaccine treatment (Kirkpatrick et al. 2011). In the one study that tested for a difference, darts and hand injected GonaCon doses were equally effective in terms of fertility outcome (McCann et al. 2017).

In studies where mares were not exposed to stallions, the duration of effectiveness also varied. A primer and booster dose of Equity led to anoestrus for at least 3 months (Elhay et al. 2007). A primer and booster dose of Improvac also led to loss of ovarian cycling for all mares in the short term (Imboden et al. 2006, Nolan et al. 2018c). It is worth repeating that those vaccines do not have the same formulation as GonaCon.

Results from horses (Baker et al. 2017, 2018) and other species (Curtis et al. 2001) suggest that providing a booster dose of GonaCon-Equine will increase the fraction of temporarily infertile animals to higher levels than would a single vaccine dose alone.

Longer-term infertility has been observed in some mares treated with anti-GnRH vaccines, including GonaCon-Equine. In a single-dose mare captive trial with an initial year effectiveness of 94%, Killian et al. (2008) noted infertility rates of 64%, 57%, and 43% in treated mares during the following three years, while control mares in those years had infertility rates of 25%, 12%, and 0% in those years. GonaCon effectiveness in free-roaming populations was lower, with infertility rates consistently near 60% for three years after a single dose in one study (Gray et al. 2010) and annual infertility rates decreasing over time from 55% to 30% to 0% in another study with one dose (Baker et al. 2017, 2018). Similarly, gradually increasing fertility rates were observed after single dose treatment with GonaCon in elk (Powers et al. 2011) and deer (Gionfriddo et al. 2011a).

Baker et al. (2017, 2018) observed a return to fertility over 4 years in mares treated once with GonaCon, but then noted extremely low fertility rates of 0% and 16% in the two years after the same mares were given a booster dose four years after the primer dose. Four of nine mares treated with primer and booster doses of Improvac did not return to ovulation within 2 years of the primer dose (Imboden et al. 2006), though one should probably not make conclusions about the long-term effects of GonaCon-Equine based on results from Improvac.

It is difficult to predict which females will exhibit strong or long-term immune responses to anti-GnRH vaccines (Killian et al. 2006, Miller et al. 2008, Levy et al. 2011). A number of factors may influence responses to vaccination, including age, body condition, nutrition, prior immune responses, and genetics (Cooper and Herbert 2001, Curtis et al. 2001, Powers et al. 2011). One apparent trend is that animals that are treated at a younger age, especially before puberty, may have stronger and longer-lasting responses (Brown et al. 1994, Curtis et al. 2001, Stout et al. 2003, Schulman et al. 2013). It is plausible that giving ConaGon-Equine to prepubertal mares will lead to long-lasting infertility, but that has not yet been tested.

To date, short term evaluation of anti-GnRH vaccines, show contraception appears to be temporary and reversible. Killian et al. noted long-term effects of GonaCon in some captive mares (2009). However, Baker et al. (2017) observed horses treated with GonaCon-B return to fertility after they were treated with a single primer dose; after four years, the fertility rate was indistinguishable between treated and control mares. It appears that a single dose of GonaCon results in reversible infertility. If long-term treatment resulted in permanent infertility for some treated mares, such permanent infertility fertility would be consistent with the desired effect of using GonaCon (e.g., effective contraception).

Other anti-GnRH vaccines also have had reversible effects in mares. Elhay (2007) noted a return to ovary functioning over the course of 34 weeks for 10 of 16 mares treated with Equity. That study ended at 34 weeks, so it is not clear when the other six mares would have returned to fertility. Donovan et al. (2013) found that half of mares treated with an anti-GnRH vaccine intended for dogs had returned to fertility after 40 weeks, at which point the study ended. In a study of mares treated with a primer and booster dose of Improvac, 47 of 51 treated mares had returned to ovarian cyclicity within 2 years; younger mares appeared to have longer-lasting effects than older mares (Schulman et al. 2013). Joonè et al. (2017) analyzed samples from the Schulman et al. (2013) study and found no significant decrease in anti-Mullerian hormone (AMH) levels in mares treated with GnRH vaccine. AMH levels are thought to be an indicator of ovarian function, so results from Joonè et al. (2017) support the general view that the anoestrus resulting from GnRH vaccination is physiologically similar to typical winter anoestrus. In a small study with a non-commercial anti-GnRH vaccine (Stout et al. 2003), three of seven treated mares had returned to cyclicity within eight weeks after delivery of the primer dose, while four others were still suppressed for 12 or more weeks. In elk, Powers et al. (2011) noted that contraception after one dose of GonaCon was reversible. In white-tailed deer, single doses of GonaCon appeared to confer two years of contraception (Miller et al. 2000). Ten of 30 domestic cows treated became pregnant within 30 weeks after the first dose of Bopriva (Balet et al. 2014).

Permanent sterility as a result of single-dose or boostered GonaCon-Equine vaccine, or other anti-GnRH vaccines, has not been recorded, but that may be because no long-term studies have tested for that effect. It is conceivable that some fraction of mares could become sterile after receiving one or more booster doses of GonaCon-Equine. If some fraction of mares treated with GonaCon-Equine were to become sterile, though, that result would be consistent with text of the WFRHBA of 1971, as amended, which allows for sterilization to achieve population goals.

In summary, based on the above results related to fertility effects of GonaCon and other anti-GnRH vaccines, application of a single dose of GonaCon-Equine to gathered or remotely-darted wild horses could be expected to prevent pregnancy in perhaps 30%-60% of mares for one year. Some smaller number of wild mares should be expected to have persistent contraception for a second year, and less still for a third year. Applying one booster dose of GonaCon to previously treated mares may lead to four or more years with relatively high rates (80+%) of additional infertility expected (Baker et al. 2018). There is no data to support speculation regarding efficacy of multiple boosters of GonaCon-Equine; however, given it is formulated as a highly immunogenic long-lasting vaccine, it is reasonable to hypothesize that additional boosters would increase the effectiveness and duration of the vaccine.

GonaCon-Equine only affects the fertility of treated animals; untreated animals will still be expected to give birth. Even under favorable circumstances for population growth suppression, gather efficiency might not exceed 85% via helicopter, and may be less with bait and water trapping. Similarly, not all animals may be approachable for darting. The uncaptured or undarted portion of the female population would still be expected to have normally high fertility rates in any given year, though those rates could go up slightly if contraception in other mares increases forage and water availability.

Changes in hormones associated with anti-GnRH vaccination led to measurable changes in ovarian structure and function. The volume of ovaries reduced in response to treatment (Garza et al. 1986, Dalin et al. 2002, Imboden et al. 2006, Elhay et al. 2007, Botha et al. 2008, Gionfriddo 2011a, Dalmau et al. 2015). Treatment with an anti-GnRH vaccine changes follicle development (Garza et al. 1986, Stout et al. 2003, Imboden et al. 2006, Elhay et al. 2007, Donovan et al. 2013, Powers et al. 2011, Balet et al. 2014), with the result that ovulation does not occur. A related result is that the ovaries can exhibit less activity and cycle with less regularity or not at all in anti-GnRH vaccine treated females (Goodloe 1991, Dalin et al. 2002, Imboden et al. 2006, Elhay et al. 2007, Janett et al. 2009a, Powers et al. 2011, Donovan et al. 2013). In studies where the vaccine required a booster, hormonal and associated results were generally observed within several weeks after delivery of the booster dose.

Effects on Existing Pregnancies, Foals, and Birth Phenology: PZP Vaccines

Although fetuses are not explicitly protected under the WFRHBA of 1971, as amended, it is prudent to analyze the potential effects of fertility control vaccines on developing fetuses and foals. Any impacts identified in the literature have been found to be transient, and do not influence the future reproductive capacity of offspring born to treated females.

If a mare is already pregnant, the PZP vaccine has not been shown to affect normal development of the fetus or foal, or the hormonal health of the mare with relation to pregnancy (Kirkpatrick and Turner 2003). Studies on Assateague Island (Kirkpatrick and Turner 2002) showed that once female offspring born to mares treated with PZP during pregnancy eventually breed, they produce healthy, viable foals. It is possible that there may be transitory effects on foals born to mares or jennies treated with PZP. For example, in mice, Sacco et al. (1981) found that antibodies specific to PZP can pass from mother mouse to pup via the placenta or colostrum, but that did not apparently cause any innate immune response in the offspring: the level of those antibodies were undetectable by 116 days after birth. There was no indication in that study that the fertility or ovarian function of those mouse pups was compromised, nor is BLM aware of any such results in horses or burros. Unsubstantiated, speculative connections between PZP treatment and ‘foal stealing’ has not been published in a peer-reviewed study and thus cannot be verified. ‘Foal stealing,’ where a near-term pregnant mare steals a neonate foal from a weaker mare, is unlikely to be a common behavioral result of including spayed mares in a wild horse herd. McDonnell (2012) noted that “foal stealing is rarely observed in horses, except under crowded conditions and synchronization of foaling,” such as in horse feed lots. Those conditions are not likely in the wild, where pregnant mares will be widely distributed across the landscape, and where the expectation is that parturition dates would be distributed across the normal foaling season. Similarly, although Nettles (1997) noted reported stillbirths after PZP treatments in cynomolgus monkeys, those results have not been observed in equids despite extensive use in horses and burros.

On-range observations from 20 years of application to wild horses indicate that PZP application in wild mares does not generally cause mares to give birth to foals out of season or late in the year (Kirkpatrick and Turner 2003). Nuñez’s (2010) research showed that a small number of mares that had previously been treated with PZP foaled later than untreated mares and expressed the concern that this late foaling “may” impact foal survivorship and decrease band stability, or that higher levels of attention from stallions on PZP-treated mares might harm those mares. However, that paper provided no evidence that such impacts on foal survival or mare well-being actually occurred. Rubenstein (1981) called attention to a number of unique ecological features of horse herds on Atlantic barrier islands, such as where Nuñez made observations, which calls into question whether inferences drawn from island herds can be applied to western wild horse herds. Ransom et al. (2013), though, did identify a potential shift in reproductive timing as a possible drawback to prolonged treatment with PZP, stating that treated mares foaled on average 31 days later than non-treated mares. Results from Ransom et al. (2013), however, showed that over 81% of the documented births in that study were between March 1 and June 21, i.e., within the normal, peak, spring foaling season. Ransom et al. (2013) pointedly advised that managers should consider carefully before using fertility control vaccines in small refugia or rare species. Wild horses and burros managed by BLM do not generally occur in isolated refugia, nor are they at all rare species. The US Fish and Wildlife Service denied a petition to list wild horses as endangered (USFWS 2015). Moreover, any effect of shifting birth phenology was not observed uniformly: in two of three PZP-treated wild horse populations studied by Ransom et al. (2013), foaling season of treated mares extended three weeks and 3.5 months, respectively, beyond that of untreated mares. In the other population, the treated mares foaled within the same time period as the untreated mares. Furthermore, Ransom et al. (2013) found no negative impacts on foal survival even with an extended birthing season. If there are shifts in birth phenology, though, it is reasonable to assume that some negative effects on foal survival for a small number of foals might result from particularly severe weather events (Nuñez et al. 2018).

Effects on Existing Pregnancies, Foals, and Birth Phenology: GnRH Vaccines

Although fetuses are not explicitly protected under the WFRHBA of 1971, as amended, it is prudent to analyze the potential effects of fertility control vaccines on developing fetuses and foals. Any impacts identified in the literature have been found to be transient, and do not influence the future reproductive capacity of offspring born to treated females.

GonaCon and other anti-GnRH vaccines can be injected while a female is pregnant (Miller et al. 2000, Powers et al. 2011, Baker et al. 2013) – in such a case, a successfully contracepted mare will be expected to give birth during the following foaling season, but to be infertile during the same year's breeding season. Thus, a mare injected in November of 2018 would not show the contraceptive effect (i.e., no new foal) until spring of 2020.

GonaCon had no apparent effect on pregnancies in progress, foaling success, or the health of offspring, in horses that were immunized in October (Baker et al. 2013), elk immunized 80-100 days into gestation (Powers et al. 2011, 2013), or deer immunized in February (Miller et al. 2000). Kirkpatrick et al. (2011) noted that anti-GnRH immunization is not expected to cause hormonal changes that would lead to abortion in the horse, but this may not be true for the first 6 weeks of pregnancy (NAS 2013). Curtis et al. (2011) noted that GonaCon-KHL treated white tailed deer had lower twinning rates than controls but speculated that the difference could be due to poorer sperm quality late in the breeding season, when the treated does did become pregnant. Goodloe (1991) found no difference in foal production between treated and control animals.

Offspring of anti-GnRH vaccine treated mothers could exhibit an immune response to GnRH (Khodr and Siler-Khodr 1980), as antibodies from the mother could pass to the offspring through the placenta or colostrum. In the most extensive study of long-term effects of GonaCon immunization on offspring, Powers et al. (2012) monitored 15 elk fawns born to GonaCon treated cows. Of those, 5 had low titers at birth and 10 had high titer levels at birth. All 15 were of normal weight at birth, and developed normal endocrine profiles, hypothalamic GnRH content, pituitary gonadotropin content, gonad structure, and gametogenesis. All the females became pregnant in their second reproductive season, as is typical. All males showed normal development of secondary sexual characteristics. Powers et al. (2012) concluded that suppressing GnRH in the neonatal period did not alter long-term reproductive function in either male or female offspring. Miller et al. (2013) report elevated anti-GnRH antibody titers in fawns born to treated white tailed deer, but those dropped to normal levels in 11 of 12 of those fawns, which came into breeding condition; the remaining fawn was infertile for three years.

Direct effects on foal survival are equivocal in the literature. Goodloe (1991) reported lower foal survival for a small sample of foals born to anti-GnRH treated mares, but she did not assess other possible explanatory factors such as mare social status, age, body condition, or habitat in her analysis (NAS 2013). Gray et al. (2010) found no difference in foal survival in foals born to free-roaming mares treated with GonaCon.

There is little empirical information available to evaluate the effects of GnRH vaccination on foaling phenology, but those effects are likely to be similar to those for PZP vaccine treated mares in which the effects of the vaccine wear off. It is possible that immunocontracepted mares returning to fertility late in the breeding season could give birth to foals at a time that is out of the normal range (Nuñez et al. 2010, Ransom et al 2013). Curtis et al. (2001) did observe a slightly later fawning date for GonaCon treated deer in the second year after treatment, when some does regained fertility late in the breeding season. In anti-GnRH vaccine trials in free-roaming horses, there were no published differences in mean date of foal production (Goodloe 1991, Gray et al. 2010). Unpublished results from an ongoing study of GonaCon treated free-roaming mares indicate that some degree of seasonal foaling is possible (D. Baker, Colorado State University, personal communication to Paul Griffin, BLM WH&B Research Coordinator). Because of the concern that contraception could lead to shifts in the timing of parturitions for some treated animals, Ransom et al. (2013) advised that managers should consider carefully before using PZP immunocontraception in small refugia or rare species; the same considerations could be advised for use of GonaCon, but wild horses and burros in most areas do not generally occur in isolated refugia, they are not a rare species at the regional, national, or international level, and genetically they represent descendants of domestic livestock with most populations containing few if any unique alleles (NAS 2013). Moreover, in PZP-treated horses that did have some degree of parturition date shift, Ransom et al. (2013) found no negative impacts on foal survival even with an extended birthing season; however, this may be more related to stochastic, inclement weather events than extended foaling seasons. If there were to be a shift in foaling date for some treated mares, the effect on foal survival may depend on severity of weather and local conditions; for example, Ransom et al. (2013) did not find consistent effects across study sites.

Effects of Marking and Injection

Standard practices require that immunocontraceptive-treated animals be readily identifiable, either via brand marks or unique coloration (BLM 2010). Some level of transient stress is likely to result in newly captured mares that do not have markings associated with previous fertility control treatments. It is difficult to compare that level of temporary stress with the long-term stress that can result from food and water limitation on the range (e.g., Creel et al. 2013). Handling may include freeze-marking, for the purpose of identifying that mare and identifying her vaccine treatment history. Under past management practices, captured mares experienced increased stress levels from handling (Ashley and Holcombe 2001), but BLM has instituted guidelines to reduce the sources of handling stress in captured animals (BLM 2015).

Most mares recover from the stress of capture and handling quickly once released back to the range, and none are expected to suffer serious long-term effects from the fertility control injections, other than the direct consequence of becoming temporarily infertile. Injection site reactions associated with fertility control treatments are possible in treated mares (Roelle and Ransom 2009, Bechert et al. 2013, French et al. 2017, Baker et al. 2018), but swelling or local reactions at the injection site are expected to be minor in nature. Roelle and Ransom (2009) found that the most time-efficient method for applying PZP is by hand-delivered injection of 2-year pellets when horses are gathered. They observed only two instances of swelling from that technique. Whether injection is by hand or via darting, GonaCon-Equine is associated with some degree of inflammation, swelling, and the potential for abscesses at the injection site (Baker et al. 2013). Swelling or local reactions at the injection site are generally expected to be minor in nature, but some may develop into draining abscesses. Use of remotely delivered vaccine is generally limited to populations where individual animals can be accurately identified and repeatedly approached. The dart-delivered PZP formulation produced injection-site reactions of varying intensity, though none of the observed reactions appeared debilitating to the animals (Roelle and Ransom 2009) but that was not observed with dart-delivered GonaCon (McCann et al. 2017). Joonè et al. (2017a) found that injection site reactions had healed in most mares within 3 months after the booster dose, and that they did not affect movement or cause fever.

Long-lasting nodules observed did not appear to change any animal's range of movement or locomotor patterns and in most cases did not appear to differ in magnitude from naturally occurring injuries or scars. Mares treated with one formulation of GnRH-KHL vaccine developed pyogenic abscesses (Goodloe 1991). Miller et al. (2008) noted that the water and oil emulsion in GonaCon will often cause cysts, granulomas, or sterile abscesses at injection sites; in some cases, a sterile abscess may develop into a draining abscess. In elk treated with GonaCon, Powers et al. (2011) noted up to 35% of treated elk had an abscess form, despite the injection sites first being clipped and swabbed with alcohol. Even in studies where swelling and visible abscesses followed GonaCon immunization, the longer-term nodules observed did not appear to change any animal's range of movement or locomotor patterns (Powers et al. 2013, Baker et al. 2017, 2018). The result that other formulations of anti-GnRH vaccine may be associated with less notable injection site reactions in horses may indicate that the adjuvant formulation in GonaCon leads a single dose to cause a stronger immune reaction than the adjuvants used in other anti-GnRH vaccines. Despite that, a booster dose of GonaCon-Equine appears to be more effective than a primer dose alone (Baker et al. 2017). Horses injected in the hip with Improvac showed only transient reactions that disappeared within 6 days in one study (Botha et al. 2008), but stiffness and swelling that lasted 5 days were noted in another study where horses received Improvac in the neck (Imboden et al. 2006). Equity led to transient reactions that resolved within a week in some treated animals (Elhay et al. 2007). Donovan et al. noted no reactions to the canine anti-GnRH vaccine (2013). In cows treated with Bopriva there was a mildly elevated body temperature and mild swelling at injection sites that subsided within 2 weeks (Balet et al. 2014).

Indirect Effects: PZP Vaccines

One expected long-term, indirect effect on wild horses treated with fertility control would be an improvement in their overall health (Turner and Kirkpatrick 2002). Many treated mares would not experience the biological stress of reproduction, foaling and lactation as frequently as untreated mares. The observable measure of improved health is higher body condition scores (Nuñez et al. 2010). After a treated mare returns to fertility, her future foals would be expected to be healthier overall and would benefit from improved nutritional quality in the mare's milk. This is particularly to be expected if there is an improvement in rangeland forage quality at the same time, due to reduced wild horse population size. Past application of fertility control has shown that mares' overall health and body condition remains improved even after fertility resumes. PZP treatment may increase mare survival rates, leading to longer potential lifespan (Turner and Kirkpatrick 2002, Ransom et al. 2014a) that may be as much as 5-10 years (NPS 2008). To the extent that this happens, changes in lifespan and decreased foaling rates could combine to cause changes in overall age structure in a treated herd (i.e., Turner and Kirkpatrick 2002, Roelle et al. 2010), with a greater prevalence of older mares in the herd (Gross 2000, NPS 2008). Observations of mares treated in past gathers showed that many of the treated mares were larger than, maintained higher body condition than, and had larger healthy foals than untreated mares (BLM, anecdotal observations).

Following resumption of fertility, the proportion of mares that conceive and foal could be increased due to their increased fitness; this has been called a 'rebound effect.' Elevated fertility rates have been observed after horse gathers and removals (Kirkpatrick and Turner 1991). If repeated contraceptive treatment leads to a prolonged contraceptive effect, then that may minimize or delay the hypothesized rebound effect. Selectively applying contraception to older animals and returning them to the range could reduce long-term holding costs for such horses, which are difficult to adopt, and may reduce the compensatory reproduction that often follows removals (Kirkpatrick and Turner 1991).

Because successful fertility control in a given herd reduces foaling rates and population growth rates, another indirect effect should be to reduce the number of wild horses that have to be removed over time to achieve and maintain the established AML. Contraception may change a herd's age structure, with a relative increase in the fraction of older animals in the herd (NPS 2008). Reducing the numbers of wild horses that would have to be removed in future gathers could allow for removal of younger, more easily adoptable excess wild horses, and thereby could eliminate the need to send additional excess horses from this area to off-range holding corrals or pastures for long-term holding.

A principle motivation for use of contraceptive vaccines or sex ratio manipulation is to reduce population growth rates and maintain herd sizes at AML. Where successful, this should allow for continued and increased environmental improvements to range conditions within the project area, which would have long-term benefits to wild horse and burro habitat quality, and well-being of animals living on the range. As the population nears or is maintained at the level necessary to achieve a thriving natural ecological balance, vegetation resources would be expected to recover, improving the forage available. With rangeland conditions more closely approaching a thriving natural ecological balance, and with a less concentrated distribution of wild horses and burros, there should also be less trailing and concentrated use of water sources. Lower population density should lead to reduced competition among wild horses using the water sources, and less fighting among horses accessing water sources. Water quality and quantity would continue to improve to the benefit of all rangeland users including wild horses. Wild horses would also have to travel less distance back and forth between water and desirable foraging areas. Among mares in the herd that remain fertile, a higher level of physical health and future reproductive success would be expected in areas where lower horse and burro population sizes lead to increases in water and forage resources. While it is conceivable that widespread and continued treatment with fertility control vaccines could reduce the birth rates of the population to such a point that birth is consistently below mortality, that outcome is not likely unless a very high fraction of the mares present are all treated in almost every year.

Indirect Effects: GnRH Vaccines

As noted above to PZP vaccines, an expected long-term, indirect effect on wild horses treated with fertility control would be an improvement in their overall health. Body condition of anti-GnRH-treated females was equal to or better than that of control females in published studies. Ransom et al. (2014b) observed no difference in mean body condition between GonaCon-B treated mares and controls. Goodloe (1991) found that GnRH-KHL treated mares had higher survival rates than untreated controls. In other species, treated deer had better body condition than controls (Gionfriddo et al. 2011b), treated cats gained more weight than controls (Levy et al. 2011), as did treated young female pigs (Bohrer et al. 2014).

Following resumption of fertility, the proportion of mares that conceive and foal could be increased due to their increased fitness; this has been called by some a ‘rebound effect.’ Elevated fertility rates have been observed after horse gathers and removals (Kirkpatrick and Turner 1991). If repeated contraceptive treatment leads to a prolonged contraceptive effect, then that may minimize or delay the hypothesized rebound effect. Selectively applying contraception to older animals and returning them to the range could reduce long-term holding costs for such horses, which are difficult to adopt, and could negate the compensatory reproduction that can follow removals (Kirkpatrick and Turner 1991).

Because successful fertility control would reduce foaling rates and population growth rates, another indirect effect would be to reduce the number of wild horses that have to be removed over time to achieve and maintain the established AML. Contraception would be expected to lead to a relative increase in the fraction of older animals in the herd. Reducing the numbers of wild horses that would have to be removed in future gathers could allow for removal of younger, more easily adoptable excess wild horses, and thereby could eliminate the need to send additional excess horses from this area to off-range holding corrals or pastures for long-term holding. Among mares in the herd that remain fertile, a high level of physical health and future reproductive success would be expected because reduced population sizes should lead to more availability of water and forage resources per capita.

Reduced population growth rates and smaller population sizes could also allow for continued and increased environmental improvements to range conditions within the project area, which would have long-term benefits to wild horse habitat quality. As the local horse abundance nears or is maintained at the level necessary to achieve a thriving natural ecological balance, vegetation resources would be expected to recover, improving the forage available to wild horses and wildlife throughout the area. With rangeland conditions more closely approaching a thriving natural ecological balance, and with a less concentrated distribution of wild horses across the range, there should also be less trailing and concentrated use of water sources. Lower population density would be expected to lead to reduced competition among wild horses using the water sources, and less fighting among horses accessing water sources. Water quality and quantity would continue to improve to the benefit of all rangeland users including wild horses. Wild horses would also have to travel less distance back and forth between water and desirable foraging areas. Should GonaCon-Equine treatment, including booster doses, continue into the future, with treatments given on a schedule to maintain a lowered level of fertility in the herd, the chronic cycle of overpopulation and large gathers and removals might no longer occur, but instead a consistent abundance of wild horses could be maintained, resulting in continued improvement of overall habitat conditions and animal health. While it is conceivable that widespread and continued treatment with GonaCon-Equine could reduce the birth rates of the population to such a point that birth is consistently below mortality, that outcome is not likely unless a very high fraction of the mares present are all treated with primer and booster doses, and perhaps repeated booster doses.

Behavioral Effects: PZP Vaccines

Behavioral difference, compared to mares that are fertile, should be considered as potential results of successful contraception. The NAS report (2013) noted that all forms of fertility suppression have effects on mare behavior, mostly because of the lack of pregnancy and foaling, and concluded that fertility control vaccines were among the most promising fertility control methods for wild horses and burros. The resulting impacts may be seen as neutral in the sense that a wide range of natural behaviors is already observable in untreated wild horses, or mildly adverse in the sense that effects are expected to be transient and to not affect all treated animals.

PZP vaccine-treated mares may continue estrus cycles throughout the breeding season. Ransom and Cade (2009) delineated wild horse behaviors. Ransom et al. (2010) found no differences in how PZP-treated and untreated mares allocated their time between feeding, resting, travel, maintenance, and most social behaviors in three populations of wild horses, which is consistent with Powell's (1999) findings in another population. Likewise, body condition of PZP-treated and control mares did not differ between treatment groups in Ransom et al.'s (2010) study. Nuñez (2010) found that PZP-treated mares had higher body condition than control mares in another population, presumably because energy expenditure was reduced by the absence of pregnancy and lactation. Knight (2014) found that PZP-treated mares had better body condition, lived longer and switched harems more frequently, while mares that foaled spent more time concentrating on grazing and lactation and had lower overall body condition.

In two studies involving a total of four wild horse populations, both Nuñez et al. (2009) and Ransom et al. (2010) found that PZP vaccine treated mares were involved in reproductive interactions with stallions more often than control mares, which is not surprising given the evidence that PZP-treated females of other mammal species can regularly demonstrate estrus behavior while contracepted (Shumake and Killian 1997, Heilmann et al. 1998, Curtis et al. 2001, Duncan et al. 2017). There was no evidence, though, that mare welfare was affected by the increased level of herding by stallions noted in Ransom et al. (2010). Nuñez's later analysis (2017) noted no difference in mare reproductive behavior as a function of contraception history.

Ransom et al. (2010) found that control mares were herded by stallions more frequently than PZP-treated mares, and Nuñez et al. (2009, 2014, 2017, 2018) found that PZP-treated mares exhibited higher infidelity to their band stallion during the non-breeding season than control mares. Madosky et al. (2010) and Knight (2014) found this infidelity was also evident during the breeding season in the same population that Nuñez et al. (2009, 2010, 2014, 2017, 2018) studied. Nuñez et al. (2014, 2017, 2018) concluded that PZP-treated mares changing bands more frequently than control mares could lead to band instability. Nuñez et al. (2009), though, cautioned against generalizing from that island population to other herds. Also, despite any potential changes in band infidelity due to PZP vaccination, horses continued to live in social groups with dominant stallions and one or more mares. Nuñez et al. (2014) found elevated levels of fecal cortisol, a marker of physiological stress, in mares that changed bands. The research is inconclusive as to whether all the mares' movements between bands were related to the PZP treatments themselves or the fact that the mares were not nursing a foal, and did not demonstrate any long-term negative consequence of the transiently elevated cortisol levels. Nuñez et al. 2014 wrote that these effects "…may be of limited concern when population reduction is an urgent priority." Nuñez (2018) and Jones et al. (2019, 2020) noted that band stallions of mares that have received PZP treatment can exhibit changes in behavior and physiology. Nuñez (2018) cautioned that PZP use may limit the ability of mares to return to fertility, but also noted that, "such aggressive treatments may be necessary when rapid reductions in animal numbers are of paramount importance…If the primary management goal is to reduce population size, it is unlikely (and perhaps less important) that managers achieve a balance between population control and the maintenance of more typical feral horse behavior and physiology."

In contrast to transient stresses, Creel et al. (2013) highlight that variation in population density is one of the most well-established causal factors of chronic activation of the hypothalamic-pituitary-adrenal axis, which mediates stress hormones; high population densities and competition for resources can cause chronic stress. Creel et al. (2013) also state that "…there is little consistent evidence for a negative association between elevated baseline glucocorticoids and fitness." Band fidelity is not an aspect of wild horse biology that is specifically protected by the WFRHBA of 1971. It is also notable that Ransom et al. (2014b) found higher group fidelity after a herd had been gathered and treated with a contraceptive vaccine; in that case, the researchers postulated that higher fidelity may have been facilitated by the decreased competition for forage after excess horses were removed. At the population level, available research does not provide evidence of the loss of harem structure among any herds treated with PZP. No biologically significant negative impacts on the overall animals or populations overall, long-term welfare or well-being have been established in these studies.

The National Research Council (2013) found that harem changing was not likely to result in serious adverse effects for treated mares:

> "The studies on Shackleford Banks (Nuñez et al., 2009; Madosky et al., 2010) suggest that there is an interaction between pregnancy and social cohesion. The importance of harem stability to mare well-being is not clear but considering the relatively large number of free-ranging mares that have been treated with liquid PZP in a variety of ecological settings, the likelihood of serious adverse effects seem low."
>
> Nuñez (2010) stated that not all populations will respond similarly to PZP treatment. Differences in habitat, resource availability, and demography among conspecific populations will undoubtedly affect their physiological and behavioral responses to PZP contraception and need to be considered. Kirkpatrick et al. (2010) concluded that: "the larger question is, even if subtle alterations in behavior may occur, this is still far better

> than the alternative," and that the "…other victory for horses is that every mare prevented from being removed, by virtue of contraception, is a mare that will only be delaying her reproduction rather than being eliminated permanently from the range. This preserves herd genetics, while gathers and adoption do not."

The NAS report (2013) provides a comprehensive review of the literature on the behavioral effects of contraception that puts research up to that date by Nuñez et al. (2009, 2010) into the broader context of all of the available scientific literature, and cautions, based on its extensive review of the literature that:

> ". . . in no case can the committee conclude from the published research that the behavior differences observed are due to a particular compound rather than to the fact that treated animals had no offspring during the study. That must be borne in mind particularly in interpreting long-term impacts of contraception (e.g., repeated years of reproductive "failure" due to contraception)."

Behavioral Effects: GnRH Vaccines

The result that GonaCon treated mares may have suppressed estrous cycles throughout the breeding season can lead treated mares to behave in ways that are functionally similar to pregnant mares. Where it is successful in mares, GonaCon and other anti-GnRH vaccines are expected to induce fewer estrous cycles when compared to non-pregnant control mares. This has been observed in many studies (Garza et al. 1986, Curtis et al. 2001, Dalin et al. 2002, Killian et al. 2006, Dalmau et al. 2015). Females treated with GonaCon had fewer estrous cycles than control or PZP-treated mares (Killian et al. 2006) or deer (Curtis et al. 2001). Thus, any concerns about PZP treated mares receiving more courting and breeding behaviors from stallions (Nuñez et al. 2009, Ransom et al. 2010) are not generally expected to be a concern for mares treated with anti-GnRH vaccines (Botha et al. 2008).

Ransom et al. (2014b) and Baker et al. (2018) found that GonaCon treated mares had similar rates of reproductive behaviors that were similar to those of pregnant mares. Among other potential causes, the reduction in progesterone levels in treated females may lead to a reduction in behaviors associated with reproduction. Despite this, some females treated with GonaCon or other anti-GnRH vaccines did continue to exhibit reproductive behaviors, albeit at irregular intervals and durations (Dalin et al. 2002, Stout et al. 2003, Imboden et al. 2006), which is a result that is similar to spayed (ovariectomized) mares (Asa et al. 1980). Gray et al. (2009a) and Baker et al. (2018) found no difference in sexual behaviors in mares treated with GonaCon and untreated mares. When progesterone levels are low, small changes in estradiol concentration can foster reproductive estrous behaviors (Imboden et al. 2006). Owners of anti-GnRH vaccine treated mares reported a reduced number of estrous-related behaviors under saddle (Donovan et al. 2013). Treated mares may refrain from reproductive behavior even after ovaries return to cyclicity (Elhay et al. 2007). Studies in elk found that GonaCon treated cows had equal levels of precopulatory behaviors as controls (Powers et al. 2011), though bull elk paid more attention to treated cows late in the breeding season, after control cows were already pregnant (Powers et al. 2011).

Stallion herding of mares, and harem switching by mares are two behaviors related to reproduction that might change as a result of contraception. Ransom et al. (2014b) observed a

50% decrease in herding behavior by stallions after the free-roaming horse population at Theodore Roosevelt National Park was reduced via a gather, and mares there were treated with GonaCon-B. The increased harem tending behaviors by stallions were directed to both treated and control mores. It is difficult to separate any effect of GonaCon in this study from changes in horse density and forage following horse removals.

With respect to treatment with GonaCon or other anti-GnRH vaccines, it is probably less likely that treated mares will switch harems at higher rates than untreated animals, because treated mares are similar to pregnant mares in their behaviors (Ransom et al. 2014b). Indeed, Gray et al. (2009a) found no difference in band fidelity in a free-roaming population of horses with GonaCon treated mares, despite differences in foal production between treated and untreated mares. Ransom et al. (2014b) actually found increased levels of band fidelity after treatment, though this may have been partially a result of changes in overall horse density and forage availability.

Gray et al. (2009) and Ransom et al. (2014b) monitored non-reproductive behaviors in GonaCon treated populations of free-roaming horses. Gray et al. (2009a) found no difference between treated and untreated mares in terms of activity budget, sexual behavior, proximity of mares to stallions, or aggression. Ransom et al. (2014b) found only minimal differences between treated and untreated mare time budgets, but those differences were consistent with differences in the metabolic demands of pregnancy and lactation in untreated mares, as opposed to non-pregnant treated mares.

Genetic Effects of Fertility Control Vaccines

In HMAs where large numbers of wild horses have recent and / or an ongoing influx of breeding animals from other areas with wild or feral horses, contraception is not expected to cause an unacceptable loss of genetic diversity or an unacceptable increase in the inbreeding coefficient. In any diploid population, the loss of genetic diversity through inbreeding or drift can be prevented by large effective breeding population sizes (Wright 1931) or by introducing new potential breeding animals (Mills and Allendorf 1996). The NAS report (2013) recommended that single HMAs should not be considered as isolated genetic populations. Rather, managed herds of wild horses should be considered as components of interacting metapopulations, with the potential for interchange of individuals and genes taking place as a result of both natural and human-facilitated movements. Introducing 1-2 mares every generation (about every 10 years) is a standard management technique that can alleviated potential inbreeding concerns (BLM 2010).

In the last 10 years, there has been a high realized growth rate of wild horses in most areas administered by the BLM, such that most alleles that are present in any given mare are likely to already be well represented in her siblings, cousins, and more distant relatives. With the exception of horses in a small number of well-known HMAs that contain a relatively high fraction of alleles associated with old Spanish horse breeds (NAS 2013), the genetic composition of wild horses in lands administered by the BLM is consistent with admixtures from domestic breeds. As a result, in most HMAs, applying fertility control to a subset of mares is not expected to cause irreparable loss of genetic diversity. Improved longevity and an aging population are expected results of contraceptive treatment that can provide for lengthening generation time; this result would be expected to slow the rate of genetic diversity loss (Hailer et al. 2006). Based on a population model, Gross (2000) found that a strategy to preferentially treat young animals with a contraceptive led to more genetic diversity being retained than either a strategy that preferentially treats older animals, or a strategy with periodic gathers and removals.

Even if it is the case that repeated treatment with a fertility control vaccine may lead to prolonged infertility, or even sterility in some mares, most HMAs have only a low risk of loss of genetic diversity if logistically realistic rates of contraception are applied to mares. Wild horses in most herd management areas are descendants of a diverse range of ancestors coming from many breeds of domestic horses. As such, the existing genetic diversity in the majority of HMAs does not contain unique or historically unusual genetic markers. Past interchange between HMAs, either through natural dispersal or through assisted migration (i.e., human movement of horses) means that many HMAs are effectively indistinguishable and interchangeable in terms of their genetic composition (i.e., see the table of Fst vales *in* NAS 2013). Roelle and Oyler-McCance (2015) used the VORTEX population model to simulate how different rates of mare sterility would influence population persistence and genetic diversity, in populations with high or low starting levels of genetic diversity, various starting population sizes, and various annual population growth rates. Their results show that the risk of the loss of genetic heterozygosity is extremely low except in case where all of the following conditions are met: starting levels of genetic diversity are low, initial population size is 100 or less, the intrinsic population growth rate is low (5% per year), and very large fractions of the female population are permanently sterilized.

It is worth noting that, although maintenance of genetic diversity at the scale of the overall population of wild horses is an intuitive management goal, there are no existing laws or policies that require BLM to maintain genetic diversity at the scale of the individual herd management area or complex. Also, there is no Bureau-wide policy that requires BLM to allow each female in a herd to reproduce before she is treated with contraceptives.

One concern that has been raised with regards to genetic diversity is that treatment with immunocontraceptives could possibly lead to an evolutionary increase in the frequency of individuals whose genetic composition fosters weak immune responses (Cooper and Larson 2006, Ransom et al. 2014a).Many factors influence the strength of a vaccinated individual’s immune response, potentially including genetics, but also nutrition, body condition, and prior immune responses to pathogens or other antigens (Powers et al. 2013). This premise is based on an assumption that lack of response to any given fertility control vaccine is a heritable trait, and that the frequency of that trait will increase over time in a population of vaccine-treated animals. Cooper and Herbert (2001) reviewed the topic, in the context of concerns about the long-term effectiveness of immunocontraceptives as a control agent for exotic species in Australia. They argue that imunocontraception could be a strong selective pressure, and that selecting for reproduction in individuals with poor immune response could lead to a general decline in immune function in populations where such evolution takes place. Other authors have also speculated that differences in antibody titer responses could be partially due to genetic differences between animals (Curtis et al. 2001, Herbert and Trigg 2005). However, Magiafolou et al. (2013) clarify that if the variation in immune response is due to environmental factors (i.e., body condition, social rank) and not due to genetic factors, then there will be no expected effect of the immune phenotype on future generations. It is possible that general health, as measured by body condition, can have a causal role in determining immune response, with animals in poor condition demonstrating poor immune reactions (NAS 2013).

Correlations between physical factors and immune response would not preclude, though, that there could also be a heritable response to immunocontraception. In studies not directly related to immunocontraception, immune response has been shown to be heritable (Kean et al. 1994, Sarker et al. 1999). Unfortunately, predictions about the long-term, population-level evolutionary response to immunocontraceptive treatments are speculative at this point, with results likely to depend on several factors, including: the strength of the genetic predisposition to not respond to the fertility control vaccine; the heritability of that gene or genes; the initial prevalence of that gene or genes; the number of mares treated with a primer dose of the vaccine (which generally has a short-acting effect); the number of mares treated with one or more booster doses of the vaccine; and the actual size of the genetically-interacting metapopulation of horses within which the vaccine treatment takes place.

BLM is not aware of any studies that have quantified the heritability of a lack of response to immunocontraception such as PZP vaccine or GonaCon-Equine in horses or burros. At this point, there are no studies available from which one could make conclusions about the long-term effects of sustained and widespread immunocontraception treatments on population-wide immune function. Although a few, generally isolated, feral horse populations have been treated with high fractions of mares receiving PZP immunocontraception for long-term population control (e.g., Assateague Island National Park, and Pryor Mountains Herd Management Area), no studies have tested for changes in immune competence in those areas. Relative to the large number of free-roaming feral horses in the western United States, immunocontraception has not been, and is not expected to be used in the type of widespread or prolonged manner that might be required to cause a detectable evolutionary response.

Sex Ratio Manipulation

Skewing the sex ratio of a herd so that there are more males than females is an established BLM management technique for reducing population growth rates. As part of a wild horse and burro gather process, the number of animals returned to the range may include more males, the number removed from the range may include more females, or both. By reducing the proportion of breeding females in a population (as a fraction of the total number of animals present), the technique leads to fewer foals being born, relative to the total herd size.

Sex ratio is typically adjusted in such a way that 60 percent of the horses are male. In the absence of other fertility control treatments, this 60:40 sex ratio can temporarily reduce population growth rates from approximately 20% to approximately 15% (Bartholow 2004). While such a decrease in growth rate may not appear to be large or long-lasting, the net result can be that fewer foals being born, at least for a few years – this can extend the time between gathers, and reduce impacts on-range, and costs off-range. Any impacts of sex ratio manipulation are expected to be temporary because the sex ratio of wild horse and burro foals at birth is approximately equal between males and females (NAS 2013), and it is common for female foals to reproduce by their second year (NAS 2013). Thus, within a few years after a gather and selective removal that leads to more males than females, the sex ratio of reproducing wild horses and burros will be returning toward a 50:50 ratio.

Having a larger number of males than females is expected to lead to several demographic and behavioral changes as noted in the NAS report (2013), including the following. Having more fertile males than females should not alter the fecundity of fertile females. Wild mares may be distributed in a larger number of smaller harems. Competition and aggression between males may cause a decline in male body condition. Female foraging may be somewhat disrupted by elevated male-male aggression. With a greater number of males available to choose from, females may have opportunities to select more genetically fit sires. There would also be an increase in the genetic effective population size because more stallions would be breeding and existing females would be distributed among many more small harems. This last beneficial impact is one reason that skewing the sex ratio to favor males is listed in the BLM wild horse and burro handbook (BLM 2010) as a method to consider in herds where there may be concern about the loss of genetic diversity; having more males fosters a greater retention of genetic diversity.

Infanticide is a natural behavior that has been observed in wild equids (Feh and Munktuya 2008, Gray 2009), but there are no published accounts of infanticide rates increasing as a result of having a skewed sex ratio in wild horse or wild burro herds. Any comment that implies such an impact would be speculative.

The BLM wild horse and burro management handbook (BLM 2010) discusses this method. The handbook acknowledges that there may be some behavioral impacts of having more males than females. The handbook includes guidelines for when the method should be applied, specifying that this method should be considered where the low end of the AML is 150 animals or greater, and with the result that males comprise 60-70 percent of the herd. Having more than 70 percent males may result in unacceptable impacts in terms of elevated male-male aggression. In NEPA analyses, BLM has chosen to follow these guidelines in some cases, for example:

In the 2015 Cold Springs HMA Population Management Plan EA (DOI-BLM-V040-2015-022), the low end of AML was 75. Under the preferred alternative, 37 mares and 38 stallions would remain on the HMA. This is well below the 150 head threshold noted above.

In the 2017 Hog Creek HMA Population Management Plan EA (DOI-BLM-ORWA-V000-2017-0026-EA), BLM clearly identified that maintaining a 50:50 sex ratio was appropriate because the herd size at the low end of AML was only 30 animals.

It is relatively straightforward to speed the return of skewed sex ratios back to a 50:50 ratio. The BLM wild horse and burro handbook (BLM 2010) specifies that, if post-treatment monitoring reveals negative impacts to breeding harems due to sex ratio manipulation, then mitigation measures could include removing males, not introducing additional males, or releasing a larger proportion of females during the next gather.

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d. Effects of Sterilzation, Including Spaying and Neutering

Various forms of fertility control can be used in wild horses and wild burros, with the goals of maintaining herds at or near AML, reducing fertility rates, and reducing the frequency of gathers and removals. The WFRHBA of 1971 specifically provides for contraception and sterilization (16 U.S.C. 1333 section 3.b.1). Fertility control measures have been shown to be a cost-effective and humane treatment to slow increases in wild horse populations or, when used in combination with gathers, to reduce horse population size (Bartholow 2004, de Seve and Boyles-Griffin 2013, Fonner and Bohara 2017). Population growth suppression becomes less expensive if fertility control is long-lasting (Hobbs et al. 2000), such as with sterilization methods that may include spaying and neutering. Sterilizing a female horse (mare) or burro (jenny) can be accomplished by several methods, some fo which are surgical and others of which are non-surgical. In this review, ‘spaying’ is defined to be surgical sterilization, usually accomplished by removal of the ovaries, but other surgical methods such as tubal ligation that led to sterility may also be considered a form of spaying. Unlike in dog and cat spaying, spaying a horse or burro does not entail removal of the uterus. Here, ‘neutering’ is defined to be the sterilization of a male horse (stallion) or burro (jack), either by removal of the testicles (castration, also known as gelding) or by vasectomy, where the testicles are retained but no sperm leave the body by severing or blocking the vas deferens or epididymis.

In the context of BLM wild horse and burro management, sterilization is expected to be successful to the extent that it reduces the number of reproducing females. By definition, sterilizing a given female is 100% effective as a fertility control method for that female. Neutering males may be effective in one of two ways. First, neutered males may continue to guard fertile females, preventing the females from breeding with fertile males. Second, if neutered males are included in a herd that has a high male-to-female sex ratio, then the neutered males may comprise some of the animals within the appropriate management level (AML) of that herd, which would effectively reduce the number of females in the herd. Although these and other fertility control treatments may be associated with a number of potential physiological, behavioral, demographic, and genetic effects, those impacts are generally minor and transient, do not prevent overall maintenance of a self-sustaining population, and do not generally outweigh the potential benefits of using contraceptive treatments in situations where it is a management goal to reduce population growth rates (Garrott and Oli 2013).

Peer-reviewed scientific literature details the expected impacts of sterilization methods on wild horses and burros. No finding of excess animals is required for BLM to pursue sterilization in wild horses or wild burros, but NEPA analysis has been required. This review focuses on peer-reviewed scientific literature. The summary that follows first examines effects of female sterilization, then neuter use in males. This review does not examine effects of reversible fertility control vaccines. Cited studies are generally limited to those involving horses and burros, except where including studies on other species helps in making inferences about physiological or behavioral questions not yet addressed in horses or burros specifically. While most studies reviewed here refer to horses, burros are extremely similar in terms of physiology, such that expected effects are comparable, except where differences between the species are noted.

On the whole, the identified impacts at the herd level are generally transient. The principle impact to individuals treated is sterility, which is the intended outcome. Sterilization that affects individual horses and burros does not prevent BLM from ensuring that there will be self-sustaining populations of wild horses and burros in single HMAs, in complexes of HMAs, and at regional scales of multiple HMAs and complexes. Under the WFRHBA of 1971, BLM is charged with maintaining self-reproducing populations of wild horses and burros. The National Academies of Sciences (2013) encouraged BLM to manage wild horses and burros at the spatial scale of "metapopulations" – that is, across multiple HMAs and complexes in a region. In fact, many HMAs have historical and ongoing genetic and demographic connections with other HMAs, and BLM routinely moves animals from one to another to improve local herd traits and maintain high genetic diversity.

Discussions about herds that are 'non-reproducing' in whole or in part are in the context of this 'metapopulation' structure, where self-sustaining herds are not necessarily at the scale of single HMAs. So long as the definition of what constitutes a self-sustaining herd includes the larger set of HMAs that have past or ongoing demographic and genetic connections – as is recommended by the NAS 2013 report – it is clear that single HMAs can be managed as non-reproducing in whole or in part while still allowing for a self-sustaining population of wild horses or burros at the broader spatial scale. Wild horses are not an endangered species (USFWS 2015), nor are they rare. Nearly 67,000 adult wild horses and nearly 15,000 adult wild burros roam BLM lands as of March 1, 2018, and those numbers do not include at least 10,000 WH&B on US Forest Service lands, and at least 50,000 feral horses on tribal lands in the Western United States.

All fertility control methods affect the behavior and physiology of treated animals (NAS 2013), and are associated with potential risks and benefits, including effects of handling, frequency of handling, physiological effects, behavioral effects, and reduced population growth rates (Hampton et al. 2015). Contraception methods alone do not remove excess horses from an HMA's population, so one or more gathers are usually needed to bring the herd down to a level close to AML. Horses are long-lived, potentially reaching 20 years of age or more in the wild. Except in cases where extremely high fractions of mares are rendered infertile over long time periods of (i.e., 10 or more years), spaying and neutering are not very effective at reducing population growth rates to the point where births equal deaths in a herd. However, even modest levels of fertility control activities can reduce the frequency of horse gather activities, and costs to taxpayers. Population growth suppression becomes less expensive if fertility control is long-lasting (Hobbs et al. 2000), such as with sterilization. Because sterilizing animals requires capturing and handling, the risks and costs associated with capture and handling of horses may be comparable to those of gathering for removal, but with expectedly lower adoption and long-term holding costs.

Effects of handling and marking

Surgical sterilization techniques, while not reversible, may control horse reproduction without the kind of additional handling or darting that can be needed to administer contraceptive vaccines. In this sense, sterilization surgeries can be used to achieve herd management objectives with a relative minimum level of animal handling and management over the long term. The WFRHBA (as amended) indicates that management should be at the minimum level necessary to achieve management objectives (CFR 4710.4), and if gelding some fraction of a managed population can reduce population growth rates by replacing breeding mares, it then follows that spaying or neutering some individuals can lead to a reduced number of handling occasions and removals of excess horses from the range, which is consistent with legal guidelines. Other fertility control options that may be temporarily effective on male horses, such as the injection of GonaCon-Equine immunocontraceptive vaccine, apparently require multiple handling occasions to achieve longer-term male infertility. Similarly, some formulations of PZP immunocontraception that is currently available for use in female wild horses and burros require handling or darting every year (though longer-term effects may result after 4 or more treatments; Nuñez et al. 2017). By some measures, any management activities that require multiple capture operations to treat a given individual would be more intrusive for wild horses and potentially less sustainable than an activity that requires only one handling occasion.

It is prudent for sterilized animals to be readily identifiable, either via freeze brand marks or unique coloration, so that their treatment history is easily recognized (e.g., BLM 2010). Markings may also be useful into the future to determine the approximate fraction of geldings in a herd and could provide additional insight regarding gather efficiency. BLM has instituted capture and animal welfare program guidelines to reduce the sources of handling stress in captured animals (BLM 2015). Handling may include freeze-marking, for the purpose of identifying an individual. Some level of transient stress is likely to result in newly captured horses that are not previously marked. Under past management practices, captured horses experienced increased, transient stress levels from handling (Ashley and Holcombe 2001). It is difficult to compare that level of temporary stress with long-term stress that can result from food and water limitation on the range (e.g., Creel et al. 2013), which could occur in the absence of herd management.

Most horses recover from the stress of capture and handling quickly once released back to the range, and none are expected to suffer serious long-term effects from gelding, other than the direct consequence of becoming infertile.

Observations of the long-term outcomes of sterilization may be recorded during routine resource monitoring work. Such observations could include but not be limited to band size, social interactions with other geldings and harem bands, distribution within their habitat, forage utilization and activities around key water sources. Periodic population inventories and future gather statistics could provide additional anecdotal information.

Neutering Males

Castration (the surgical removal of the testicles, also called gelding or neutering) is a surgical procedure for the horse sterilization that has been used for millennia. Vasectomy involves severing or blocking the vas deferens or epididymis, to prevent sperm from being ejaculated. The procedures are fairly straight forward and has a relatively low complication rate. As noted in the review of scientific literature that follows, the expected effects of gelding and vasectomy are well understood overall, even though there is some degree of uncertainty about the exact quantitative outcomes for any given individual (as is true for any natural system).

Including a portion of neutered males in a herd can lead to a reduced population-level per-capita growth rate if they cause a marginal decrease in female fertility or if the neutered males take some of the places that would otherwise be occupied by fertile females. By having a skewed sex ratio with fewer females than males (fertile stallions plus neutered males), the result will be that there will be a lower number of breeding females in the population. Including neutered males in herd management is not new for BLM and federal land management. Geldings have been released on BLM lands as a part of herd management in the Barren Valley complex in Oregon (BLM 2011), the Challis HMA in Idaho (BLM 2012), and the Conger HMA in Utah (BLM 2016). Vasectomized males and geldings were also included in US Fish and Wildlife Service management plans for the Sheldon National Wildlife Refuge that relied on sterilization and removals (Collins and Kasbohm 2016). Taking into consideration the literature available at the time, the National Academies of Sciences concluded in their 2013 report that a form of vasectomy was one of the three most promising methods for WH&B fertility control (NAS 2013).

Nelson (1980) and Garrott and Siniff (1992) modeled potential efficacy of male-oriented contraception as a population management tool, and both studies agreed that while slowing growth, sterilizing only dominant males (i.e., harem-holding stallions) would result in only marginal reduction in female fertility rates. Eagle et al. (1993) and Asa (1999) tested this hypothesis on HMAs where dominant males were vasectomized. Their findings agreed with modeling results from previous studies, and they also concluded that sterilizing only dominant males would not provide the desired reduction in female fertility and overall population growth rate, assuming that the numbers of fertile females is not changed. While bands with vasectomized harem stallions tended to have fewer foals, breeding by bachelors and subordinate stallions meant that population growth still occurred – female fertility was not dramatically reduced. Collins and Kasbohm (2016) demonstrated that there was a reduced fertility rate in a feral horse herd with both spayed and vasectomized horses – some geldings were also present in that herd. Garrott and Siniff (1992) concluded from their modeling that male sterilization would effectively cause there to be zero population growth (the point where births roughly equal deaths) only if a large proportion of males (i.e., >85%) could be sterilized. In cases where the goal of harem stallion sterilization is to reduce population growth rates, success appears to be dependent on a stable group structure, as strong bonds between a stallion and mares reduce the probability of a mare mating an extra-group stallion (Nelson 1980, Garrott and Siniff 1992, Eagle et al. 1993, Asa 1999).

Despite these studies, neutered males can be used to reduce overall growth rates in a management strategy that does not rely on any expectation that geldings will retain harems or lead to a reduction in per-female fertility rates. The primary goal of including neutered males in a herd need not necessarily be to reduce female fertility (although that may be one result). Rather, by including some neutered males in a herd that also has fertile mares and stallions, the neutered males would take some of the spaces toward AML that would otherwise be taken by fertile females. If the total number of horses is constant but neutered males are included in the herd, this can reduce the number of fertile mares, therefore reducing the absolute number of foals produced. Put another way, if neutered males occupy spaces toward AML that would otherwise be filled by fertile mares, that will reduce growth rates merely by the fact of causing there to be a lower starting number of fertile mares.

Direct Effects of Neutering

No animals which appear to be distressed, injured, or in poor health or condition would be selected for gelding. Stallions would not typically be neutered within 72 hours of capture. The surgery would be performed by a veterinarian using general anesthesia and appropriate surgical techniques. The final determination of which specific animals would be gelded would be based on the professional opinion of the attending veterinarian in consultation with the Authorized Officer (i.e., See the SOPs for neutering in the Antelope / Triple B gather EA, DOI-BLM-NV-E030-2017-010-EA).

Though neutering males is a common surgical procedure, especially gelding, some level of minor complications after surgery may be expected (Getman 2009), and it is not always possible to predict when postoperative complications would occur. Fortunately, the most common complications are almost always self-limiting, resolving with time and exercise. Individual impacts to the stallions during and following the gelding process should be minimal and would mostly involve localized swelling and bleeding. Complications may include, but are not limited to: minor bleeding, swelling, inflammation, edema, infection, peritonitis, hydrocele, penile damage, excessive hemorrhage, and eventration (Schumacher 1996, Searle et al. 1999, Getman 2009). A small amount of bleeding is normal and generally subsides quickly, within 2-4 hours following the procedure. Some degree of swelling is normal, including swelling of the prepuce and scrotum, usually peaking between 3-6 days after surgery (Searle et al. 1999). Swelling should be minimized through the daily movements (exercise) of the horse during travel to and from foraging and watering areas. Most cases of minor swelling should be back to normal within 5-7 days, more serious cases of moderate to severe swelling are also self-limiting and are expected to resolve with exercise after one to 2 weeks. Older horses are reported to be at greater risk of post-operative edema, but daily exercise can prevent premature closure of the incision and prevent fluid buildup (Getman 2009). In some cases, a hydrocele (accumulation of sterile fluid) may develop over months or years (Searle et al. 1999). Serious complications (eventration, anesthetic reaction, injuries during handling, etc.) that result in euthanasia or mortality during and following surgery are rare (e.g., eventration rate of 0.2% to 2.6% noted in Getman 2009, but eventration rate of 4.8% noted in Shoemaker et al. 2004) and vary according to the population of horses being treated (Getman 2009). Normally one would expect serious complications in less than 5% of horses operated under general anesthesia, but in some populations these rates have been as high as 12% (Shoemaker 2004). Serious complications are generally noted within 3 or 4 hours of surgery but may occur any time within the first week following surgery (Searle et al. 1999). If they occur, they would be treated with surgical intervention when possible, or with euthanasia when there is a poor prognosis for recovery. Vasectomized stallions may remain fertile for up to 6 weeks after surgery, so it is optimal if that treatment occurs well in advance of the season of mare fertility starting in the spring (NAS 2013). The NAS report (2013) suggested that chemical vasectomy, which has been developed for dogs and cats, may be appropriate for wild horses and burros.

For intact stallions, testosterone levels appear to vary as a function of age, season, and harem size (Khalil et al 1998). It is expected that testosterone levels will decline over time after castration. Testosterone levels should not change due to vasectomy. Vasectomized stallions should retain their previous levels of libido. Domestic geldings had a significant prolactin response to sexual stimulation but lacked the cortisol response present in stallions (Colborn et al. 1991). Although libido and the ability to ejaculate tends to be gradually lost after castration (Thompson et al. 1980), some geldings continue to mount mares and intromit (Rios and Houpt 1995, Schumacher 2006).

Indirect Effects of Neutering

Other than the short-term outcomes of surgery, neutering is not expected to reduce males' survival rates. Castration is actually thought to increase survival as males are released from the cost of reproduction (Jewell 1997). In Soay sheep castrates survived longer than rams in the same cohort (Jewell 1997), and Misaki horse geldings lived longer than intact males (Kaseda et al. 1997, Khalil and Murakami 1999). Moreover, it is unlikely that a reduced testosterone level will compromise gelding survival in the wild, considering that wild mares survive with low levels of testosterone. Consistent with geldings not expending as much energy toward in attempts to obtain or defend a harem, it is expected that wild geldings may have a better body condition that wild, fertile stallions. In contrast, vasectomized males may continue to defend or compete for harems in the way that fertile males do, so they are not expected to experience an increase in health or body condition due to surgery.

Depending on whether an HMA is non-reproducing in whole or in part, reproductive stallions may or may not still be a component of the population's age and sex structure. The question of whether a given neutered male would or would not attempt to maintain a harem is not germane to population-level management. It is worth noting, though, that the BLM is not required to manage populations of wild horses in a manner that ensures that any given individual maintains its social standing within any given harem or band. Neutering a subset of stallions would not prevent other fertile stallions and mares from continuing with the typical range of social behaviors for sexually active adults. For fertility control strategies where gelding is intended to reduce growth rates by virtue of sterile males defending harems, the NAS (2013) suggested that the effectiveness of gelding on overall reproductive rates may depend on the pre-castration social roles of those animals. Having a post-gather herd with some neutered males and a lower fraction of fertile mares necessarily reduces the absolute number of foals born per year, compared to a herd that includes more fertile mares. An additional benefit is that geldings that would otherwise be permanently removed from the range (for adoption, sale or other disposition) may be released back onto the range where they can engage in free-roaming behaviors.

Behavioral Effects of Neutering

Feral horses typically form bands composed of an adult male with 1 to 3 adult females and their immature offspring (Feist and McCullough 1976, Berger 1986, Roelle et al. 2010). In many populations subordinate 'satellite' stallions have been observed associating with the band, although the function of these males continues to be debated (see Feh 1999, and Linklater and Cameron 2000). Juvenile offspring of both sexes leave the band at sexual maturity (normally around two or three years of age (Berger 1986), but adult females may remain with the same band over a span of years. Group stability and cohesion is maintained through positive social interactions and agonistic behaviors among all members, and herding and reproductive behaviors from the stallion (Ransom and Cade 2009). Group movements and consortship of a stallion with mares is advertised to other males through the group stallion marking dung piles as they are encountered, and over-marking mare eliminations as they occur (King and Gurnell 2006).

In horses, males play a variety of roles during their lives (Deniston 1979): after dispersal from their natal band they generally live as bachelors with other young males, before associating with mares and developing their own breeding group as a harem stallion or satellite stallion. In any population of horses not all males will achieve harem stallion status, so all males do not have an equal chance of breeding (Asa 1999). Stallion behavior is thought to be related to androgen levels, with breeding stallions having higher androgen concentrations than bachelors (Angle et al. 1979, Chaudhuri and Ginsberg 1990, Khalil et al. 1998). A bachelor with low libido had lower levels of androgens, and two-year-old bachelors had higher testosterone levels than two year olds with undescended testicles who remained with their natal band (Angle et al. 1979).

Vasectomized males continue to attempt to defend or gain breeding access to females. It is generally expected that vasectomized WH&B will continue to behave like fertile males, given that the only physiological change in their condition is a lack of sperm in their ejaculate. If a vasectomized stallion retains a harem, the females in the harem will continue to cycle until they are fertilized by another stallion, or until the end of the breeding season. As a result, the vasectomized stallion may be involved in more aggressive behaviors to other males through the entire breeding season (Asa 1999), which may divert time from foraging and cause him to be in poorer body condition going into winter. Ultimately, this may lead to the stallion losing control of a given harem. A feral horse herd with high numbers of vasectomized stallions retained typical harem social structure (Collins and Kasbohm 2016). Again, it is worth noting that the BLM is not required to manage populations of wild horses in a manner that ensures that any given individual maintains its social standing within any given harem or band.

Neutering males by gelding adult male horses is expected to result in reduced testosterone production, which is expected to directly influence reproductive behaviors (NAS 2013). However, testosterone levels alone are not a predictor of masculine behavior (Line et al. 1985, Schumacher 2006). In domestic geldings, 20-30% continued to show stallion-like behavior, whether castrated pre- or post-puberty (Line et al. 1985). Gelding of domestic horses most commonly takes place before or shortly after sexual maturity, and age-at-gelding can affect the degree to which stallion-like behavior is expressed later in life. In intact stallions, testosterone levels peak increase up to an age of ~4-6 years and can be higher in harem stallions than bachelors (Khalil et al 1998). It is assumed that free roaming wild horse geldings would generally exhibit reduced aggression toward other horses and reduced reproductive behaviors (NAS 2013). The behavior of wild horse geldings in the presence of intact stallions has not been well documented, but the literature review below can be used to make reasonable inferences about their likely behaviors.

Despite livestock being managed by neutering males for millennia, there is relatively little published research on castrates' behaviors (Hart and Jones 1975). Stallion behaviors in wild or pasture settings are better documented than gelding behaviors, but it inferences about how the behaviors of geldings will change, how quickly any change will occur after surgery, or what effect gelding an adult stallion and releasing him back into a wild horse population will have on his behavior and that of the wider population must be surmised from the existing literature. There is an ongoing BLM study in Utah focused on the individual and population-level effects of including some geldings in a free-roaming horse population (BLM 2016) but results from that study are not yet available. However, inferences about likely behavioral outcomes of gelding can be made based on available literature.

The effect of castration on aggression in horses has not often been quantified. One report has noted that high levels of aggression continued to be observed in domestic horse geldings who also exhibited sexual behaviors (Rios and Houpt 1995). Stallion-like behavior in domestic horse geldings is relatively common (Smith 1974, Schumacher 1996), being shown in 20-33% of cases whether the horse was castrated pre- or post-puberty (Line et al. 1985, Rios and Houpt 1995, Schumacher 2006). While some of these cases may be due to cryptorchidism or incomplete surgery, it appears that horses are less dependent on hormones than other mechanisms for the maintenance of sexual behaviors (Smith 1974). Domestic geldings exhibiting masculine behavior had no difference in testosterone concentrations than other geldings (Line et al. 1985, Schumacher 2006), and in some instances the behavior appeared context dependent (Borsberry 1980, Pearce 1980).

Dogs and cats are commonly neutered, and it is also common for them to continue to exhibit reproductive behaviors several years after castration (Dunbar 1975). Dogs, ferrets, hamsters, and marmosets continued to show sexually motivated behaviors after castration, regardless of whether they had previous experience or not, although in beagles and ferrets there was a reduction in motivation post-operatively (Hart 1968, Dunbar 1975, Dixson 1993, Costantini et al. 2007, Vinke et al. 2008). Ungulates continued to show reproductive behaviors after castration, with goats and llamas continuing to respond to females even a year later in the case of goats, although mating time and the ejaculatory response was reduced (Hart and Jones 1975, Nickolmann et al. 2008).

The likely effects of castration on geldings' social interactions and group membership can be inferred from available literature. In a pasture study of domestic horses, Van Dierendonk et al. (1995) found that social rank among geldings was directly correlated to the age at which the horse was castrated, suggesting that social experiences prior to sterilization may influence behavior afterward. Of the two geldings present in a study of semi-feral horses in England, one was dominant over the mares whereas a younger gelding was subordinate to older mares; stallions were only present in this population during a short breeding season (Tyler 1972). A study of domestic geldings in Iceland held in a large pasture with mares and sub-adults of both sexes, but no mature stallions, found that geldings and sub-adults formed associations amongst each other that included interactions such as allo-grooming and play, and were defined by close proximity (Sigurjónsdóttir et al. 2003). These geldings and sub-adults tended to remain in a separate group from mares with foals, similar to castrated Soay sheep rams (Ovis aries) behaving like bachelors and grouping together or remaining in their mother's group (Jewell 1997). In Japan, Kaseda et al. (1997) reported that young males dispersing from their natal harem and geldings moved to a different area than stallions and mares during the non-breeding season. Although the situation in Japan may be the equivalent of a bachelor group in natural populations, in Iceland this division between mares and the rest of the horses in the herd contradicts the dynamics typically observed in a population containing mature stallions. Sigurjónsdóttir et al. (2003) also noted that in the absence of a stallion, allo-grooming between adult females increased drastically. Other findings included increased social interaction among yearlings, display of stallion-like behaviors such as mounting by the adult females, and decreased association between females and their yearling offspring (Sigurjónsdóttir et al. 2003). In the same population in Iceland Van Dierendonck et al. (2004) concluded that the presence of geldings did not appear to affect the social behavior of mares or negatively influence parturition, mare-foal bonding, or subsequent maternal activities. Additionally, the welfare of broodmares and their foals was not affected by the presence of geldings in the herd (Van Dierendonck et al. 2004). These findings are important because treated geldings will be returned to the range in the presence of pregnant mares and mares with foals of the year.

The likely effects of castration on geldings' home range and habitat use can also be surmised from available literature. Bands of horses tend to have distinct home ranges, varying in size depending on the habitat and varying by season, but always including a water source, forage, and places where horses can shelter from inclement weather or insects (King and Gurnell 2005). By comparison, bachelor groups tend to be more transient, and can potentially use areas of good forage further from water sources, as they are not constrained by the needs of lactating mares in a group. The number of observations of gelded wild stallion behavior are still too few to make general predictions about whether a particular gelded stallion individual will behave like a harem stallion, a bachelor, or form a group with geldings that may forage and water differently from fertile wild horses.

Sterilizing wild horses does not change their status as wild horses under the WFRHBA (as amended). In terms of whether geldings will continue to exhibit the free-roaming behavior that defines wild horses, BLM does expect that geldings would continue to roam unhindered once they are returned to the range. Wild horse movements may be motivated by a number of biological impulses, including the search for forage, water, and social companionship that is not of a sexual nature. As such, a gelded animal would still be expected to have a number of internal reasons for moving across a landscape and, therefore, exhibiting 'free-roaming' behavior. Despite marginal uncertainty about subtle aspects of potential changes in habitat preference, there is no expectation that gelding wild horses will cause them to lose their free-roaming nature. It is worth noting that individual choices in wild horse group membership, home range, and habitat use are not protected under the WFRHBA. BLM acknowledges that geldings may exhibit some behavioral differences after surgery, compared to intact stallions, but those differences are not be expected to remove the geldings' rebellious and feisty nature, or their defiance of man. While it may be that a gelded horse could have a different set of behavioral priorities than an intact stallion, the expectation is that geldings will choose to act upon their behavioral priorities in an unhindered way, just as is the case for an intact stallion. In this sense, a gelded male would be just as much 'wild' as defined by the WFRHBA as any intact stallion, even if his patterns of movement differ from those of an intact stallion. Congress specified that sterilization is an acceptable management action (16 USC § 1333.b.1). Sterilization is not one of the clearly defined events that cause an animal to lose its status as a wild free-roaming horse (16 USC § 1333.2.C.d). Several academics have offered their opinions about whether gelding a given stallion would lead to that individual effectively losing its status as a wild horse (Rutberg 2011, Kirkpatrick 2012, Nock 2017). Those opinions are based on a semantic and subjective definition of 'wild,' while BLM must adhere to the legal definition of what constitutes a wild horse, based on the WFRHBA (as amended). Those individuals have not conducted any studies that would test the speculative opinion that gelding wild stallions will cause them to become docile. BLM is not obliged to base management decisions on such opinions, which do not meet the BLM's principle and practice to "Use the best available scientific knowledge relevant to the problem or decision being addressed, relying on peer reviewed literature when it exists" (Kitchell et al. 2015).

Mare Sterilization

Surgical sterilization (spaying mares by removing a mare's ovaries), via colpotomy, has been an established veterinary technique since 1903 (Loesch and Rodgerson 2003, NAS 2013). Spaying via colpotomy has the advantage of not leaving any external wound that could become infected. For this reason, it has been identified as a good choice for sterilization of feral or wild mares (Rowland et al. 2018). The procedure has a relatively low complication rate, although post-surgical mortality and morbidity are possible, as with any surgery. Herd-level birth rate is expected to decline in direct proportion to the fraction of spayed mares in the herd because spayed mares cannot become pregnant. Spaying mares has already been shown to be an effective part of feral horse management that reduced herd growth rates on federal lands (Collins and Kasbohm 2016).

Current Methods of Sterilization

This literature review of mare sterilization impacts focuses on 4 methods: spaying via flank laparoscopy, spaying via colpotomy, non-surgical physical sterilization, and pharmacological or immunocontraceptive sterilization. The anticipated effects are both physical and behavioral. Physical effects of surgical methods would be due to post-treatment healing and the possibility for complications.

Colpotomy is a surgical technique in which there is no external incision, reducing susceptibility to infection. For this reason, ovariectomy via colpotomy has been identified as a good choice for feral or wild horses (Rowland et al. 2018). Ovariectomy via colpotomy is a relatively short surgery, with a relatively quick expected recovery time. In 1903, Williams first described a vaginal approach, or colpotomy, using an ecraseur to ovariectomize mares (Loesch and Rodgerson 2003). The ovariectomy via colpotomy procedure has been conducted for over 100 years, normally on open (non-pregnant), domestic mares. It is expected that the surgeon should be able to access ovaries with ease in mares that are in the early- or mid-stage of pregnancy. The anticipated risks associated with the pregnancy are described below. When wild horses are gathered or trapped for fertility control treatment there would likely be mares in various stages of gestation. Removal of the ovaries is permanent and 100 percent effective, however the procedure is not without risk.

Flank laparoscopy (Lee and Hendrickson 2008, Devick et al. 2018, Easley et al. 2018) is commonly used in domestic horses for application in mares due to its minimal invasiveness and full observation of the operative field. Ovariectomy via flank laparoscopy was seen as the lowest risk method considered by a panel of expert reviewers convened by USGS (Bowen 2015). In a review of unilateral and bilateral laparoscopic ovariectomy on 157 mares, Röcken et al. (2011) found that 10.8% of mares had minor post-surgical complications and recorded no mortality. Mortality due to this type of surgery, or post-surgical complications, is not expected, but is a possibility. In two studies, ovariectomy by laparoscopy or endoscope-assisted colpotomy did not cause mares to lose weight, and there was no need for rescue analgesia following surgery (Pader et al. 2011, Bertin et al. 2013). This surgical approach entails three small incisions on the animal's flank, through which three cannulae (tubes) allow entry of narrow devices to enter the body cavity: these are the insufflator, endoscope, and surgical instrument. The surgical procedure involves the use of narrow instruments introduced into the abdomen via cannulas for the purpose of transecting or sealing (Easley 2018) the ovarian pedicle, but the insufflation should allow the veterinarian to navigate inside the abdomen without damaging other internal organs. The insufflator blows air into the cavity to increase the operating space between organs, and the endoscope provides a video feed to visualize the operation of the surgical instrument. This procedure can require a relatively long duration of surgery but tends to lead to the lowest post-operative rates of complications. Flank laparoscopy may leave three small (<5 cm) visible scars on one side of the horse's flank, but even in performance horses these scars are considered minimal. It is expected that the tissues and musculature under the skin at the site of the incisions in the flank will heal quickly, leaving no long-lasting effects on horse health. Monitoring for up to two weeks at the facility where surgeries take place will allow for veterinary inspection of wound healing. The ovaries may be dropped into the abdomen, but this is not expected to cause any health problem; it is usually done in ovariectomies in cattle (e.g., the Willis Dropped Ovary Technique) and Shoemaker et al. (2014) found no problems with revascularization or necrosis in a study of young horses using this method.

Non-surgical, physical sterilization would include any physical form of sterilization that does not involve surgery. This could include any form of physical procedure that leads a mare to be unable to become pregnant, or to maintain a pregnancy. For example, one form of physical, non-surgical sterilization causes a long-term blockage of the oviduct, so that fertile eggs cannot go from the ovaries to the uterus. One form of this procedure infuses medical cyanoacrylate glue into the oviduct to cause long-term blockage (Bigolin et al. 2009). Treated mares would need to be screened to ensure they are not pregnant. The procedure is transcervical, so the treated mare cannot have a fetus in the uterus at the time of treatment. The mare would be sterile, although she would continue to have estrus cycles.

Pharmacological or immunocontraceptive sterilization methods would use an as-yet undetermined drug or vaccine to cause sterilization. At this time, BLM has not yet identified a pharmacological or immunocontraceptive method to sterilize mares that has been proven to reliably and humanely sterilize wild horse mares. However, there is the possibility that future development and testing of new methods could make an injectable sterilant available for wild horse mares. Analyses of the effects of having sterile mares as a part of a wild horse herd, such as due to surgical sterilization, would likely be applicable to non-surgical methods as well.

Effects of Spaying on Pregnancy and Foal

The average mare gestation period ranges from 335 to 340 days (Evans et al. 1977, p. 373). There are few peer reviewed studies documenting the effects of ovariectomy on the success of pregnancy in a mare. A National Research Council of the National Academies of Sciences (NAS) committee that reviewed research proposals in 2015 explained, "The mare's ovaries and their production of progesterone are required during the first 70 days of pregnancy to maintain the pregnancy" (NAS 2015). In female mammals, less progesterone is produced when ovaries are removed, but production does not cease (Webley and Johnson 1982). In 1977, Evans et al.

stated that by 200 days, the secretion of progesterone by the corpora lutea is insignificant because removal of the ovaries does not result in abortion (p. 376). “If this procedure were performed in the first 120 days of pregnancy, the fetus would be resorbed or aborted by the mother. If performed after 120 days, the pregnancy should be maintained. The effect of ovary removal on a pregnancy at 90–120 days of gestation is unpredictable because it is during this stage of gestation that the transition from corpus luteum to placental support typically occurs” (NAS 2015). In 1979, Holtan et al. evaluated the effects of bilateral ovariectomy at selected times between 25 and 210 days of gestation on 50 mature pony mares. Their results show that abortion (resorption) of the conceptus (fetus) occurred in all 14 mares ovariectomized before day 50 of gestation, that pregnancy was maintained in 11 of 20 mares after ovariectomy between days 50 and 70, and that pregnancy was not interrupted in any of 12 mares ovariectomized on days 140 to 210. Those results are similar to the suggestions of the NAS committee (2015).

For those pregnancies that are maintained following the procedure, likely those past approximately 120 days, the development of the foal is not expected to be affected. However, because this procedure is not commonly conducted on pregnant mares the rate of complications to the fetus has not yet been quantified. There is the possibility that entry to the abdominal cavity could cause premature births related to inflammation. However, after five months the placenta should hormonally support the pregnancy regardless of the presence or absence of ovaries. Gestation length was similar between ovariectomized and control mares (Holtan et al. 1979).

Direct Effects of Spaying

Between 2009 and 2011, the Sheldon NWR in Nevada conducted ovariectomy via colpotomy surgeries (August through October) on 114 feral mares and released them back to the range with a mixture of sterilized stallions and untreated mares and stallions (Collins and Kasbohm 2016). Gestational stage was not recorded, but a majority of the mares were pregnant (Gail Collins, US Fish and Wildlife Service (USFWS), pers. comm.). Only a small number of mares were very close to full term. Those mares with late term pregnancies did not receive surgery as the veterinarian could not get good access to the ovaries due to the position of the foal (Gail Collins, USFWS, pers. comm.). After holding the mares for an average of eight days after surgery for observation, they were returned to the range with other treated and untreated mares and stallions (Collins and Kasbohm 2016). During holding the only complications were observed within 2 days of surgery. The observed mortality rate for ovariectomized mares following the procedure was less than 2 percent (Collins and Kasbohm 2016, Pielstick pers. comm.).

During the Sheldon NWR ovariectomy study, mares generally walked out of the chute and started to eat; some would raise their tail and act as if they were defecating; however, in most mares one could not notice signs of discomfort (Bowen 2015). In their discussion of ovariectomy via colpotomy, McKinnon and Vasey (2007) considered the procedure safe and efficacious in many instances, able to be performed expediently by personnel experienced with examination of the female reproductive tract, and associated with a complication rate that is similar to or less than male castration. Nevertheless, all surgery is associated with some risk. Loesch et al. (2003) lists that following potential risks with colpotomy: pain and discomfort; injuries to the cervix, bladder, or a segment of bowel; delayed vaginal healing; eventration of the bowel; incisional site hematoma; intraabdominal adhesions to the vagina; and chronic lumbar or bilateral hind limb pain. Most horses, however, tolerate ovariectomy via colpotomy with very few complications, including feral horses (Collins and Kasbohm 2016). Evisceration is also a possibility, but these complications are considered rare (Prado and Schumacher, 2017). Mortality due to surgery or post-surgical complications is not anticipated, but it is a possibility and therefore every effort would be made to mitigate risks.

In September 2015, the BLM solicited the USGS to convene a panel of veterinary experts to assess the relative merits and drawbacks of several surgical ovariectomy techniques that are commonly used in domestic horses for potential application in wild horses. A table summarizing the various methods was sent to the BLM (Bowen 2015) and provides a concise comparison of several methods. Of these, ovariectomy via colpotomy was found to be relatively safe when practiced by an experienced surgeon and was associated with the shortest duration of potential complications after the operation. The panel discussed the potential for evisceration through the vaginal incision with this procedure. In marked contrast to a suggestion by the NAS report (2013), this panel of veterinarians identified evisceration as not being a probable risk associated with ovariectomy via colpotomy and "none of the panel participants had had this occur nor had heard of it actually occurring" (Bowen 2015).

Most spay surgeries on mares have low morbidity and with the help of medications, pain and discomfort can be mitigated. Pain management is an important aspect of any ovariectomy (Rowland et al. 2018); according to surgical protocols that would be used, a long-lasting direct anesthetic would be applied to the ovarian pedicle, and systemic analgesics in the form of butorphanol and flunixin meglumine would be administered, as is compatible with accepted animal husbandry practices. In a study of the effects of bilateral ovariectomy via colpotomy on 23 mares, Hooper and others (1993) reported that postoperative problems were minimal (1 in 23, or 4%). Hooper et al. (1993) noted that four other mares were reported by owners as having some problems after surgery, but that evidence as to the role the surgery played in those subsequent problems was inconclusive. In contrast Röcken et al. (2011) noted a morbidity of 10.8% for mares that were ovariectomized via a flank laparoscopy. "Although 5 mares in our study had problems (repeated colic in 2 mares, signs of lumbar pain in 1 mare, signs of bilateral hind limb pain in 1 mare, and clinical signs of peritonitis in 1 mare) after surgery, evidence is inconclusive in each as to the role played by surgery" (Hooper et al. 1993). A recent study showed a 2.5% complication rate where one mare of 39 showed signs of moderate colic after laparoscopic ovariectomy (Devick 2018 personal communication).

Behavioral Effects of Mare Sterilization

No fertility control method exists that does not affect physiology or behavior of a mare (NAS 2013). Any action taken to alter the reproductive capacity of an individual has the potential to affect hormone production and therefore behavioral interactions and ultimately population dynamics in unforeseen ways (Ransom et al. 2014). The health and behavioral effects of spaying wild horse mares that live with other fertile and infertile wild horses has not been well documented, but the literature review below can be used to make reasonable inferences about their likely behaviors.

Horses are anovulatory (do not ovulate/express estrous behavior) during the short days of late fall and early winter, beginning to ovulate as days lengthen and then cycling roughly every 21 days during the warmer months, with about 5 days of estrus (Asa et al. 1979, Crowell-Davis

2007). Estrus in mares is shown by increased frequency of proceptive behaviors: approaching and following the stallion, urinating, presenting the rear end, clitoral winking, and raising the tail towards the stallion (Asa et al. 1979, Crowell-Davis 2007). In most mammal species other than primates, estrus behavior is not shown during the anovulatory period, and reproductive behavior is considered extinguished following spaying (Hart and Eckstein 1997). However, mares may continue to demonstrate estrus behavior during the anovulatory period (Asa et al. 1980). Similarly, ovariectomized mares may also continue to exhibit estrous behavior (Scott and Kunze 1977, Kamm and Hendrickson 2007, Crabtree 2016), with one study finding that 30% of mares showed estrus signs at least once after surgery (Roessner et al 2015) and only 60 percent of ovariectomized mares cease estrous behavior following surgery (Loesch and Rodgerson 2003). Mares continue to show reproductive behavior following ovariectomy due to non-endocrine support of estrus behavior, specifically steroids from the adrenal cortex. Continuation of this behavior during the non-breeding season has the function of maintaining social cohesion within a horse group (Asa et al. 1980, Asa et al. 1984, NAS 2013). This may be a unique response of the horse (Bertin et al. 2013), as spaying usually greatly reduces female sexual behavior in companion animals (Hart and Eckstein 1997). In six ponies, mean monthly plasma luteinizing hormone levels in ovariectomized mares were similar to intact mares during the anestrous season, and during the breeding season were similar to levels in intact mares at mid-estrus (Garcia and Ginther 1976).

The likely effects of spaying on mares' social interactions and group membership can be inferred from available literature, even though wild horses have rarely been spayed and released back into the wild, resulting in few studies that have investigated their behavior in free-roaming populations. Wild horses and burros are instinctually herd-bound, and this behavior is expected to continue. Overall, the BLM anticipates that some spayed mares may continue to exhibit estrus behavior which could foster band cohesion. If free ranging ovariectomized mares show estrous behavior and occasionally allow copulation, interest of the stallion may be maintained, which could foster band cohesion (NAS 2013). This last statement could be validated by the observations of group associations on the Sheldon NWR where feral mares were ovariectomized via colpotomy and released back on to the range with untreated horses of both sexes (Collins and Kasbohm 2016). No data were collected on inter- or intra-band behavior (e.g. estrous display, increased tending by stallions, etc.), during multiple aerial surveys in years following treatment, all treated individuals appeared to maintain group associations, and there were no groups consisting only of treated males or only of treated females (Collins and Kasbohm 2016). In addition, of solitary animals documented during surveys, there were no observations of solitary treated females (Collins and Kasbohm 2016). These data help support the expectation that ovariectomized mares would not lose interest in or be cast out of the social dynamics of a wild horse herd. As noted by the NAS (2013), the ideal fertility control method would not eliminate sexual behavior or change social structure substantially.

A study conducted for 15 days in January 1978 (Asa et al. 1980), compared the sexual behavior in ovariectomized and seasonally anovulatory (intact) pony mares and found that there were no statistical differences between the two conditions for any measure of proceptivity or copulatory behavior, or days in estrous. This may explain why treated mares at Sheldon NWR continued to be accepted into harem bands; they may have been acting the same as a non-pregnant mare. Five to ten percent of pregnant mares exhibit estrous behavior (Crowell-Davis 2007). Although the physiological cause of this phenomenon is not fully understood (Crowell-Davis 2007), it is thought to be a bonding mechanism that assists in the maintenance of stable social groups of horses year-round (Ransom et al. 2014b). The complexity of social behaviors among free-roaming horses is not entirely centered on reproductive receptivity, and fertility control treatments that suppress the reproductive system and reproductive behaviors should contribute to minimal changes to social behavior (Ransom et al. 2014b, Collins and Kasbohm 2016).

BLM expects that wild horse harem structures would continue to exist under the proposed action because fertile mares, stallions, and their foals would continue to be a component of the herd. It is not expected that spaying a subset of mares would significantly change the social structure or herd demographics (age and sex ratios) of fertile wild horses.

'Foal stealing,' where a near-term pregnant mare steals a neonate foal from a weaker mare, is unlikely to be a common behavioral result of including spayed mares in a wild horse herd. McDonnell (2012) noted that "foal stealing is rarely observed in horses, except under crowded conditions and synchronization of foaling," such as in horse feed lots. Those conditions are not likely in the wild, where pregnant mares will be widely distributed across the landscape, and where the expectation is that parturition dates would be distributed across the normal foaling season.

Indirect Effects of Mare sterilization

The free-roaming behavior of wild horses is not anticipated to be affected by mare sterilization, as the definition of free-roaming is the ability to move without restriction by fences or other barriers within a HMA (BLM H-4700-1, 2010) and there are no permanent physical barriers being proposed.

In domestic animals, spaying is often associated with weight gain and associated increase in body fat (Fettman et al 1997, Becket et al 2002, Jeusette et al. 2006, Belsito et al 2009, Reichler 2009, Camara et al. 2014). Spayed cats had a decrease in fasting metabolic rate, and spayed dogs had a decreased daily energy requirement, but both had increased appetite (O'Farrell & Peachey 1990, Hart and Eckstein 1997, Fettman et al. 1997, Jeusette et al. 2004). In wild horses, contracepted mares tend to be in better body condition that mares that are pregnant or that are nursing foals (Nuñez et al. 2010); the same improvement in body condition is likely to take place in spayed mares. In horses spaying has the potential to increase risk of equine metabolic syndrome (leading to obesity and laminitis), but both blood glucose and insulin levels were similar in mares before and after ovariectomy over the short-term (Bertin et al. 2013). In wild horses the quality and quantity of forage is unlikely to be sufficient to promote over-eating and obesity.

Coit et al. (2009) demonstrated that spayed dogs have elevated levels of LH-receptor and GnRH-receptor mRNA in the bladder tissue, and lower contractile strength of muscles. They noted that urinary incontinence occurs at elevated levels in spayed dogs and in post-menopausal women. Thus, it is reasonable to suppose that some ovariectomized mares could also suffer from elevated levels of urinary incontinence.

Sterilization had no effect on movements and space use of feral cats or brushtail possums (Ramsey 2007, Guttilla & Stapp 2010), or greyhound racing performance (Payne 2013). Rice field rats (Rattus argentiventer) tend to have a smaller home range in the breeding season, as they remain close to their litters to protect and nurse them. When surgically sterilized, rice field rats had larger home ranges and moved further from their burrows than hormonally sterilized or fertile rats (Jacob et al. 2004). Spayed possums and foxes (Vulpes vulpes) had a similar core range area after spay surgery compared to before and were no more likely to shift their range than intact females (Saunders et al. 2002, Ramsey 2007).

The likely effects of spaying on mares' home range and habitat use can also be surmised from available literature. Bands of horses tend to have distinct home ranges, varying in size depending on the habitat and varying by season, but always including a water source, forage, and places where horses can shelter from inclement weather or insects (King and Gurnell 2005). It is unlikely that spayed mares will change their spatial ecology but being emancipated from constraints of lactation may mean they can spend more time away from water sources and increase their home range size. Lactating mares need to drink every day, but during the winter when snow can fulfill water needs or when not lactating, horses can traverse a wider area (Feist & McCullough 1976, Salter 1979). During multiple aerial surveys in years following the mare ovariectomy study at the Sheldon NWR, it was documented that all treated individuals appeared to maintain group associations, no groups consisted only of treated females, and none of the solitary animals observed were treated females (Collins and Kasbohm 2016). Because treated females maintained group associations, this indicates that their movement patterns and distances may be unchanged.

Spaying wild horses does not change their status as wild horses under the WFRHBA (as amended). In terms of whether spayed mares would continue to exhibit the free-roaming behavior that defines wild horses, BLM does expect that spayed mares would continue to roam unhindered. Wild horse movements may be motivated by a number of biological impulses, including the search for forage, water, and social companionship that is not of a sexual nature. As such, a spayed animal would still be expected to have a number of internal reasons for moving across a landscape and, therefore, exhibiting 'free-roaming' behavior. Despite marginal uncertainty about subtle aspects of potential changes in habitat preference, there is no expectation that spaying wild horses will cause them to lose their free-roaming nature.

In this sense, a spayed wild mare would be just as much 'wild' as defined by the WFRHBA as any fertile wild mare, even if her patterns of movement differ slightly. Congress specified that sterilization is an acceptable management action (16 USC §1333.b.1). Sterilization is not one of the clearly defined events that cause an animal to lose its status as a wild free-roaming horse (16 USC §1333.2.C.d). Any opinions based on a semantic and subjective definition of what constitutes a 'wild' horse are not legally binding for BLM, which must adhere to the legal definition of what constitutes a wild free-roaming horse, based on the WFRHBA (as amended). BLM is not obliged to base management decisions on personal opinions, which do not meet the BLM's principle and practice to "Use the best available scientific knowledge relevant to the problem or decision being addressed, relying on peer reviewed literature when it exists" (Kitchell et al. 2015).

Spaying is not expected to reduce mare survival rates on public rangelands. Individuals receiving fertility control often have reduced mortality and increased longevity due to being released from the costs of reproduction (Kirkpatrick and Turner 2008). Similar to contraception studies, in other wildlife species a common trend has been higher survival of sterilized females (Twigg et al. 2000, Saunders et al. 2002, Ramsey 2005, Jacob et al. 2008, Seidler and Gese 2012). Observations from the Sheldon NWR provide some insight into long-term effects of ovariectomy on feral horse survival rates. The Sheldon NWR ovariectomized mares were returned to the range along with untreated mares. Between 2007 and 2014, mares were captured, a portion treated, and then recaptured. There was a minimum of 1 year between treatment and recapture; some mares were recaptured a year later, and some were recaptured several years later. The long-term survival rate of treated wild mares appears to be the same as that of untreated mares (Collins and Kasbohm 2016). Recapture rates for released mares were similar for treated mares and untreated mares.

Effects of Spaying on Bone Histology

The BLM knows of no scientific, peer-reviewed literature that documents bone density loss in mares following ovariectomy. A concern has been raised in an opinion article (Nock 2013) that ovary removal in mares could lead to bone density loss. That paper was not peer reviewed nor was it based on research in wild or domestic horses, so it does not meet the BLM's standard for "best available science" on which to base decisions (Kitchell et al. 2015). Hypotheses that are forwarded in Nock (2013) appear to be based on analogies from modern humans leading sedentary lives. Post-menopausal women have a greater chance of osteoporosis (Scholz-Ahrens et al. 1996), but BLM is not aware of any research examining bone loss in horses following ovariectomy. Bone loss in humans has been linked to reduced circulating estrogen. There have been conflicting results when researchers have attempted to test for an effect of reduced estrogen on animal bone loss ratesin animal models; all experiments have been on laboratory animals, rather than free-ranging wild animals. While some studies found changes in bone cell activity after ovariectomy leading to decreased bone strength (Jerome et al. 1997, Baldock et al. 1998, Huang et al. 2002, Sigrist et al. 2007), others found that changes were moderate and transient or minimal (Scholz-Ahrens et al. 1996, Lundon et al. 1994, Zhang et al. 2007), and even returned to normal after 4 months (Sigrist et al. 2007).

Consistent and strenuous use of bones, for instance using jaw bones by eating hard feed, or using leg bones by travelling large distances, may limit the negative effects of estrogen deficiency on micro-architecture (Mavropoulos et al. 2014). The effect of exercise on bone strength in animals has been known for many years and has been shown experimentally (Rubin et al. 2001). Dr. Simon Turner, Professor Emeritus of the Small Ruminant Comparative Orthopaedic Laboratory at Colorado State University, conducted extensive bone density studies on ovariectomized sheep, as a model for human osteoporosis. During these studies, he did observe bone density loss on ovariectomized sheep, but those sheep were confined in captive conditions, fed twice a day, had shelter from inclement weather, and had very little distance to travel to get food and water (Simon Turner, Colorado State University Emeritus, written comm., 2015). Dr. Turner indicated that an estrogen deficiency (no ovaries) could potentially affect a horse's bone metabolism, just as it does in sheep and human females when they lead a sedentary lifestyle, but indicated that the constant weight bearing exercise, coupled with high exposure to sunlight ensuring high vitamin D levels, are expected to prevent bone density loss (Simon Turner, Colorado State University Emeritus, written comm., 2015).

Home range size of horses in the wild has been described as 4.2 to 30.2 square miles (Green and Green 1977) and 28.1 to 117 square miles (Miller 1983). A study of distances travelled by feral horses in "outback" Australia shows horses travelling between 5 and 17.5 miles per 24-hour period (Hampson et al. 2010a), travelling about 11 miles a day even in a very large paddock (Hampson et al. 2010b). Thus, extensive movement patterns of wild horses are expected to help prevent bone loss. The expected daily movement distance would be far greater in the context of larger pastures typical of BLM long-term holding facilities in off-range pastures. A horse would have to stay on stall rest for years after removal of the ovaries in order to develop osteoporosis (Simon Turner, Colorado State University Emeritus, written comm., 2015) and that condition does not apply to any wild horses turned back to the range or any wild horses that go into off-range pastures.

Genetic Effects of Spaying and Neutering

It is true that spayed females and neutered males are unable to contribute to the genetic diversity of the herd. BLM is not obligated to ensure that any given individual in a herd has the chance to sire a foal and pass on genetic material. Management practices in the BLM Wild Horse and Burro Handbook (2010) include measures to increase population genetic diversity in reproducing herds where monitoring reveals a cause for concern about low levels of observed heterozygosity. These measures include increasing the sex ratio to a greater percentage of fertile males than fertile females (and thereby increasing the number of males siring foals) and bringing new animals into a herd from elsewhere.

In herds that are managed to be non-reproducing, it is not a concern to maintain genetic diversity because the management goal would be that animals in such a herd would not breed.

In reproducing herds where large numbers of wild horses have recent and / or an ongoing influx of breeding animals from other areas with wild or feral horses, spaying and neutering is not expected to cause an unacceptable loss of genetic diversity or an unacceptable increase in the inbreeding coefficient. In any diploid population, the loss of genetic diversity through inbreeding or drift can be prevented by large effective breeding population sizes (Wright 1931) or by introducing new potential breeding animals (Mills and Allendorf 1996). The NAS report (2013) recommended that single HMAs should not be considered as isolated genetic populations. Rather, managed herds of wild horses should be considered as components of interacting metapopulations, with the potential for interchange of individuals and genes taking place as a result of both natural and human-facilitated movements. It is worth noting that, although maintenance of genetic diversity at the scale of the overall population of wild horses is an intuitive management goal, there are no existing laws or policies that require BLM to maintain genetic diversity at the scale of the individual herd management area or complex. Also, there is no Bureau-wide policy that requires BLM to allow each female in a herd to reproduce before she is treated with contraceptives. Introducing 1-2 mares every generation (about every 10 years) is a standard management technique that can alleviated potential inbreeding concerns (BLM 2010). The NAS report (2013) recommended that managed herds of wild horses would be better viewed as components of interacting metapopulations, with the potential for interchange of individuals and genes taking place as a result of both natural and human-facilitated movements.

In the last 10 years, there has been a high realized growth rate of wild horses in most areas administered by the BLM. As a result, most alleles that are present in any given mare are likely to already be well represented in her siblings, cousins, and more distant relatives on the HMA. With the exception of horses in a small number of well-known HMAs that contain a relatively high fraction of alleles associated with old Spanish horse breeds (NAS 2013), the genetic composition of wild horses in lands administered by the BLM is consistent with admixtures from domestic breeds. The NAS report (2013) includes information (pairwise genetic 'fixation index' values for sampled WH&B herds) confirming that WH&B in the vast majority of HMAs are genetically similar to animals in multiple other HMAs. As a result, in most HMAs, applying fertility control to a subset of mares is not expected to cause irreparable loss of genetic diversity. Improved longevity and an aging population are expected results of contraceptive treatment that can provide for lengthening generation time; this result would be expected to slow the rate of genetic diversity loss (Hailer et al. 2006). Based on a population model, Gross (2000) found that a strategy to preferentially treat young animals with a contraceptive led to more genetic diversity being retained than either a strategy that preferentially treats older animals, or a strategy with periodic gathers and removals.

Roelle and Oyler-McCance (2015) used the VORTEX population model to simulate how different rates of mare sterility would influence population persistence and genetic diversity, in populations with high or low starting levels of genetic diversity, various starting population sizes, and various annual population growth rates. Although those results are specific to mares, some inferences about potential effects of stallion sterilization may also be made from their results. Roelle and Oyler-McCance (2015) showed that the risk of the loss of genetic heterozygosity is extremely low except in cases where all of the following conditions are met: starting levels of genetic diversity are low, initial population size is 100 or less, the intrinsic population growth rate is low (5% per year), and very large fractions of the population are permanently sterilized. Given that 94 of 102 wild horse herds sampled for genetic diversity did not meet a threshold for concern (NAS 2013), the starting level of genetic diversity in most wild-horse herds is relatively high.

In a breeding herd where more than 85% of males in a population are sterile, there could be genetic consequences of reduced heterozygosity and increased inbreeding coefficients, as it would potentially allow a very small group of males to dominate the breeding (e.g., Saltz et al. 2000). Such genetic consequences could be mitigated by natural movements or human-facilitated translocations (BLM 2010). Garrott and Siniff's (1992) model predicts that gelding 50-80% of mature males in the population would result in reduced, but not halted, mare fertility rates. However, neutering males tends to have short-lived effects, because within a few years after any male sterilization treatment, a number of fertile male colts would become sexually mature stallions who could contribute genetically to the herd.

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e. Intrauterine Devices (IUDs)

Based on promising results from studies in domestic mares, BLM has begun to use IUDs to control fertility as a wild horse and burro fertility control method on the range. The initial management use was an application of Y-shaped silicone IUDs, in mares from the Swasey HMA, in Utah. The BLM has supported and continues to support research into the development and testing of effective and safe IUDs for use in wild horse mares (Baldrighi et al. 2017, Holyoak et al. unpublished data). However, existing literature on the use of IUDs in horses allows for inferences about expected effects of any management alternatives that might include use of IUDs and support the apparent safety and efficacy of some types of IUDs for use in horses. Overall, as with other methods of population growth suppression, use of IUDs and other fertility control measures are expected to help reduce population growth rates, extend the time interval between gathers, and reduce the total number of excess animals that will need to be removed from the range.

The 2013 National Academies of Sciences (NAS) report considered IUDs and suggested that research should test whether IUDs cause uterine inflammation and should also test how well IUDs stay in mares that live and breed with fertile stallions. Since that report, a recent study by Holyoak et al. (unpublished data) indicate that a flexible, inert, y-shaped, medical-grade silicone IUD design prevented pregnancies in all the domestic mares that retained the device, even when exposed to fertile stallions. Domestic mares in that study lived in large pastures, mating with fertile stallions. Biweekly ultrasound examinations showed that IUDs stayed in 75% of treated mares over the course of two breeding seasons. The IUDs were then removed so the researchers could monitor the mares' return to fertility. Uterine health, as measured in terms of inflammation, was not seriously affected by the IUDs, and most mares became pregnant within months after IUD removal. The overall results are consistent with results from an earlier study (Daels and Hughes 1995), which used O-shaped silicone IUDs.

IUDs are considered a temporary fertility control method that does not generally cause future sterility (Daels and Hughes 1995). Use of IUDs is an effective fertility control method in women, and IUDs have historically been used in livestock management, including in domestic horses. Insertion of an IUD can be a very rapid procedure, but it does require the mare to be temporarily restrained, such as in a squeeze chute. IUDs in mares may cause physiological effects including discomfort, infection, perforation of the uterus if the IUD is hard and angular, endometritis, uterine edema (Killian et al. 2008), and pyometra (Klabnik-Bradford et al. 2013). In women, deaths attributable to IUD use may be as low as 1.06 per million (Daels and Hughes 1995). The effects of IUD use on genetic diversity in a given herd should be comparable to those of other temporary fertility control methods; use should reduce the fraction of mares breeding at any one time but does not necessarily preclude treated mares from breeding in the future, if they survive and regain fertility.

The exact mechanism by which IUDs prevent pregnancy is uncertain (Daels and Hughes 1995), but the presence of an IUD in the uterus may, like a pregnancy, prevent the mare from coming back into estrus (Turner et al. 2015). However, some domestic mares did exhibit repeated estrus cycles during the time when they had IUDs (Killian et al. 2008, Gradil et al. 2019). The main cause for an IUD to not be effective at contraception is its failure to stay in the uterus (Daels and Hughes 1995). As a result, one of the major challenges to using IUDs to control fertility in mares on the range is preventing the IUD from being dislodged or otherwise ejected over the course of daily activities, which could include, at times, frequent breeding.

At this time, it is thought that any IUD inserted into a pregnant mare may cause the pregnancy to terminate, which may also cause the IUD to be expelled. For that reason, it is expected that IUDs would only be inserted in non-pregnant (open) mares. Wild mares receiving IUDs would be checked for pregnancy prior to insertion of an IUD. This can be accomplished by transrectal palpation and/or ultrasound performed by a veterinarian. Pregnant mares would not receive an IUD. The IUD is inserted into the uterus using a thin, tubular applicator similar to a shielded culture tube, and would be inserted in a manner similar to that routinely used to obtain uterine cultures in domestic mares. If a mare has a zygote or very small, early phase embryo, it is possible that it will fail to be detected in screening, and may develop further, but without causing the expulsion of the IUD. Wild mares with IUDs would be individually marked and identified, so that they can be monitored occasionally and examined, if necessary, in the future, consistent with other BLM management activities.

Using metallic or glass marbles as IUDs may prevent pregnancy in horses (Nie et al. 2003) but can pose health risks to domestic mares (Turner et al. 2015, Freeman and Lyle 2015). Marbles may break into shards (Turner et al. 2015), and uterine irritation that results from marble IUDs may cause chronic, intermittent colic (Freeman and Lyle 2015). Metallic IUDs may cause severe infection (Klabnik-Bradford et al. 2013).

In domestic ponies, Killian et al. (2008) explored the use of three different IUD configurations, including a silastic polymer O-ring with copper clamps, and the “380 Copper T” and “GyneFix” IUDs designed for women. The longest retention time for the three IUD models was seen in the “T” device, which stayed in the uterus of several mares for 3-5 years. Reported contraception rates for IUD-treated mares were 80%, 29%, 14%, and 0% in years 1-4, respectively. They surmised that pregnancy resulted after IUD fell out of the uterus. Killian et al. (2008) reported high levels of progesterone in non-pregnant, IUD-treated ponies.

Soft IUDs may cause relatively less discomfort than hard IUDs (Daels and Hughes 1995). Daels and Hughes (1995) tested the use of a flexible O-ring IUD, made of silastic, surgical-grade polymer, measuring 40 mm in diameter; in five of six breeding domestic mares tested, the IUD was reported to have stayed in the mare for at least 10 months. In mares with IUDs, Daels and

Hughes (1995) reported some level of uterine irritation but surmised that the level of irritation was not enough to interfere with a return to fertility after IUD removal.

More recently, several types of IUDs have been tested for use in breeding mares. When researchers attempted to replicate the O-ring study (Daels and Hughes 1995) in an USGS / Oklahoma State University (OSU) study with breeding domestic mares, using various configurations of silicone O-ring IUDs, the IUDs fell out at unacceptably high rates over time scales of less than 2 months (Baldrighi et al. 2017). Subsequently, the USGS / OSU researchers tested a Y-shaped IUD to determine retention rates and assess effects on uterine health; retention rates were greater than 75% for an 18-month period, and mares returned to good uterine health and reproductive capacity after removal of the IUDs (Holyoak et al., unpublished results). These Y-shaped silicone IUDs are considered a pesticide device by the EPA, in that they work by physical means (EPA 2020). The University of Massachusetts has developed a magnetic IUD that has been effective at preventing estrus in non-breeding domestic mares (Gradil et al. 2019, Joonè et al. 2021). After insertion in the uterus, the three subunits of the device are held together by magnetic forces as a flexible triangle. A metal detector can be used to determine whether the device is still present in the mare. In an early trial, two sizes of those magnetic IUDs fell out of breeding domestic mares at high rates (Holyoak et al., unpublished results). In 2019, the magnetic IUD was used in two trials where mares were exposed to stallions, and in one where mares were artificially inseminated; in all cases, the IUDs were reported to stay in the mares without any pregnancy (Gradil 2019, Joonè et al. 2021).

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APPENDIX F- STANDARD OPERATING PROCEDURES FOR USE OF FERTILITY CONTROL VACCINES AND INSERTION OF Y-SHAPED SILICONE IUD (10/27/20)

SOPs Common to All Vaccine Types

Animal Identification

Animals intended for treatment must be clearly, individually identifiable to allow for positive identification during subsequent management activities. For captured animals, marking for identification may be accomplished by marking each individual with a freeze mark on the hip or neck and a microchip in the nuchal ligament. In some cases, identification may be accomplished based by cataloguing markings that make animals uniquely identifiable. Such animals may be photographed using a telephoto lens and high-quality digital camera as a record of treated individuals.

Safety

Safety for both humans and animals is the primary consideration in all elements of fertility control vaccine use. Administration of any vaccine must follow all safety guidance and label guidelines on applicable EPA labeling.

Injection Site

For hand-injection, delivery of the vaccine should be by intramuscular injection, while the animal is standing still, into the left or right side, above the imaginary line that connects the point of the hip (hook bone) and the point of the buttocks (pin bone): this is the hip / upper gluteal area. For dart-based injection, delivery of the vaccine should be by intramuscular injection, while the animal is standing still, into the left or right thigh areas (lower gluteal / biceps femoralis).

Monitoring and Tracking of Treatments

Estimation of population size and growth rates (in most cases, using aerial surveys) should be conducted periodically after treatments.

Population growth rates of some herds selected for intensive monitoring may be estimated every year post-treatment using aerial surveys. If, during routine HMA field monitoring (on-the-ground), data describing adult to foal ratios can be collected, these data should also be shared with HQ-261.

Field applicators should record all pertinent data relating to identification of treated animals (including photographs if animals are not freeze-marked) and date of treatment, lot number(s) of the vaccine, quantity of vaccine issued, the quantity used, the date of vaccination, disposition of any unused vaccine, the date disposed, the number of treated mares by HMA, field office, and State along with the microchip numbers and freeze-mark(s) applied by HMA and date. A summary narrative and data sheets will be forwarded to HQ-261 annually (Reno, Nevada). A copy of the form and data sheets and any photos taken should be maintained at the field office.

HQ-261 will maintain records sent from field offices, on the quantity of PZP issued, the quantity used, disposition of any unused PZP, the number of treated mares by HMA, field office, and State along with the freeze-mark(s) applied by HMA and date.

SOPs for One-year Liquid PZP Vaccine (ZonaStat-H)

ZonaStat-H vaccine (Science and Conservation Center, Billings, MT) would be administered through hand-injection or darting by trained BLM personnel or collaborating partners only. At present, the only PZP vaccine for dart-based delivery in BLM-managed wild horses or burros is ZonaStat-H. For any darting operation, the designated personnel must have successfully completed a nationally recognized wildlife darting course and who have documented and successful experience darting wildlife under field conditions.

Until the day of its use, ZonaStat-H must be kept frozen.

Animals that have never been treated with a PZP vaccine would receive 0.5 cc of PZP vaccine emulsified with 0.5 cc of Freund's Modified Adjuvant (FMA). Animals identified for re-treatment receive 0.5 cc of the PZP vaccine emulsified with 0.5 cc of Freund's Incomplete Adjuvant (FIA).

Hand-injection of liquid PZP vaccine would be by intramuscular injection into the gluteal muscles while the animal is restrained in a working chute. The vaccine would be injected into the left hind quarters of the animal, above the imaginary line that connects the point of the hip (hook bone) and the point of the buttocks (pin bone).

For Hand-injection, delivery of the vaccine would be by intramuscular injection into the left or right buttocks and thigh muscles (gluteals, biceps femoris) while the animal is standing still.

Application of ZonaStat-H via Darting

Only designated darters would prepare the emulsion. Vaccine-adjuvant emulsion would be loaded into darts at the darting site and delivered by means of a projector gun.

No attempt to dart should be taken when other persons are within a 100-m radius of the target animal. The Dan Inject gun should not be used at ranges in excess of 30 m while the Pneu-Dart gun should not be used over 50 m.

No attempts would be taken in high wind (greater than 15 mph) or when the animal is standing at an angle where the dart could miss the target area and hit the flank or rib cage. The ideal is when the dart would strike the skin of the animal at a 90° angle.

If a loaded dart is not used within two hours of the time of loading, the contents would be transferred to a new dart before attempting another animal. If the dart is not used before the end of the day, it would be stored under refrigeration and the contents transferred to another dart the next day, for a maximum of one transfer (discard contents if not used on the second day). Refrigerated darts would not be used in the field.

A darting team should include two people. The second person is responsible for locating fired darts. The second person should also be responsible for identifying the animal and keeping onlookers at a safe distance.

To the extent possible, all darting would be carried out in a discrete manner. However, if darting is to be done within view of non-participants or members of the public, an explanation of the nature of the project would be carried out either immediately before or after the darting.

Attempts will be made to recover all darts. To the extent possible, all darts which are discharged and drop from the target animal at the darting site would be recovered before another darting occurs. In exceptional situations, the site of a lost dart may be noted and marked, and recovery efforts made at a later time. All discharged darts would be examined after recovery in order to determine if the charge fired and the plunger fully expelled the vaccine. Personnel conducting darting operations should be equipped with a two-way radio or cell phone to provide a communications link with a project veterinarian for advice and/or assistance. In the event of a veterinary emergency, darting personnel would immediately contact the project veterinarian, providing all available information concerning the nature and location of the incident.

In the event that a dart strikes a bone or imbeds in soft tissue and does not dislodge, the darter would follow the affected animal until the dart falls out or the animal can no longer be found. The darter would be responsible for daily observation of the animal until the situation is resolved.

SOPs for Application of PZP-22 Pelleted Vaccine

PZP-22 pelleted vaccine treatment would be administered only by trained BLM personnel or designated partners.

A treatment of PZP-22 is comprised of two separate injections: (1) a liquid dose of PZP vaccine (equivalent to one dose of ZonaStat-H) is administered using an 18-gauge needle primarily by hand injection; (2) the pellets are preloaded into a 14-gauge needle. For animals constrained in a working chute, these are delivered using a modified syringe and jabstick to inject the pellets into the gluteal muscles of the animals being returned to the range. The pellets are intended to release PZP over time.

Until the day of its use, the liquid portion of PZP-22 must be kept frozen.

At this time, delivery of PZP-22 treatment would only be by intramuscular injection into the gluteal muscles while the animal is restrained in a working chute. The primer would consist of 0.5 cc of liquid PZP emulsified with 0.5 cc of adjuvant. Animals that have never been treated with a PZP vaccine would receive 0.5 cc of PZP vaccine emulsified with 0.5 cc of Freund’s Modified Adjuvant (FMA). Animals identified for re-treatment receive 0.5 cc of the PZP vaccine emulsified with 0.5 cc of Freund’s Incomplete Adjuvant (FIA). The syringe with PZP vaccine pellets would be loaded into the jabstick for the second injection. With each injection, the liquid or pellets would be injected into the left hind quarters of the animal, above the imaginary line that connects the point of the hip (hook bone) and the point of the buttocks (pin bone).

In the future, the PZP-22 treatment may be administered remotely using an approved long range darting protocol and delivery system if and when BLM has determined that the technology has been proven safe and effective for use.

SOPs for GonaCon-Equine Vaccine Treatments

GonaCon-Equine vaccine (USDA Pocatello Storage Depot, Pocatello, ID; Spay First!, Inc., Oklahoma City, OK) is distributed as preloaded doses (2 mL) in labeled syringes. Upon receipt, the vaccine should be kept refrigerated (4° C) until use. Do not freeze GonaCon-Equine. The vaccine has a 6-month shelf-life from the time of production and the expiration date will be noted on each syringe that is provided.

For initial and booster treatments, mares would ideally receive 2.0 ml of GonaCon-Equine.

Administering GonaCon Vaccine by Hand Injection

Experience has demonstrated that only 1.8 ml of vaccine can typically be loaded into 2 cc darts, and this dose has proven successful. Calculations below reflect a 1.8 ml dose.

For hand-injection, delivery of the vaccine should be by intramuscular injection, while the animal is standing still, into the left or right side, above the imaginary line that connects the point of the hip (hook bone) and the point of the buttocks (pin bone): this is the hip / upper gluteal area.

A booster vaccine may be administered after the first injection to improve efficacy of the product over subsequent years.

Application of GonaCon-Equine via Darting

General practice guidelines for darting operations, as noted above for dart-delivery of ZonaStat-H, should be followed for dart-delivery of GonaCon-Equine.

Wearing latex gloves, the applicator numbers darts, and loads numbered darts with vaccine by attaching a loading needle (7.62 cm; provided by dart manufacturer) to the syringe containing vaccine and placing the needle into the cannula of the dart to the fullest depth possible. Slowly depress the syringe plunger and begin filling the dart. Periodically, tap the dart on a hard surface to dislodge air bubbles trapped within the vaccine. Due to the viscous nature of the fluid, air entrapment typically results in a maximum of approximately 1.8 ml of vaccine being loaded in the dart. The dart is filled to max once a small amount of the vaccine can be seen at the tri-ports.

Important! Do not load and refrigerate darts the night before application. When exposed to moisture and condensation, the edges of gel barbs soften, begin to dissolve, and will not hold the dart in the muscle tissue long enough for full injection of the vaccine. The dart needs to remain in the muscle tissue for a minimum of 1 minute to achieve dependable full injection. Sharp gel barbs are critical.

Darts should be weighed to the nearest hundredth gram by electronic scale when empty, when loaded with vaccine, and after discharge, to ensure that 90% (1.62 ml) of the vaccine has been injected. GonaCon weighs 0.95 grams/mL, so animals should receive 1.54 grams of vaccine to be considered treated. Animals receiving <50% should be darted with another full dose; those receiving >50% but <90% should receive a half dose (1 ml). All darts should be weighed to verify a combination of ≥1.62 ml has been administered. Therefore, every effort should be made to recover darts after they have fallen from animals.

Although infrequent, dart injections can result in partial injections of the vaccine, and shots are missed. As a precaution, it is recommended that extra doses of the vaccine be ordered to accommodate failed delivery (which may be as high as ~15 %). To determine the amount of vaccine delivered, the dart must be weighed before loading, and before and after delivery in the field. The scale should be sensitive to 0.01 grams or less, and accurate to 0.05 g or less.

For best results, darts with a gel barb should be used. (i.e., 2 cc Pneu-Dart brand darts configured with Slow-inject technology, 3.81 cm long 14 ga.tri-port needles, and gel collars positioned 1.27 cm ahead of the ferrule). One can expect updates in optimal dart configuration, pending results of research and field applications.

Darts (configured specifically as described above) can be loaded in the field and stored in a cooler prior to application. Darts loaded, but not used can be maintained in dry conditions at about 4° C and used the next day, but do not store in any refrigerator or container likely to cause condensation, which can compromise the gel barbs.

Insertion of Y-shaped Silicone Intrauterine Device (IUD)

Background

Mares must be open. A veterinarian must determine pregnancy status via palpation or ultrasound. Ultrasound should be used as necessary to confirm open status of mares down to at least 14 days for those that have recently been with stallions. For mares segregated from stallions, this determination may be made at an earlier time when mares are identified as candidates for treatment, or immediately prior to IUD insertion. Pregnant mares should not receive an IUD.

Preparation

IUDs must be clean and sterile. Sterilize IUDs with a low-temperature sterilization system, such as Sterrad.

The Introducer is two PVC pipes. The exterior pipe is a 29” length of ½” diameter pipe, sanded smooth at one end, then heat-treated to smooth its curvature further (Figure 1). The IUD will be placed into this smoothed end of the exterior pipe. The interior pipe is a 29 ½” long, ¼” riser tube (of the kind used to connect water lines to sinks), with one end slightly flared out to fit more snugly inside the exterior pipe (Figure 1), and a plastic stopper attached to the other end (Figure 2).

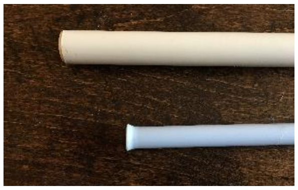

Figure 1. Interior and exterior pipes (unassembled), showing the ends that go into the mare

Figure 2. Interior pipe shown within exterior pipe. After the introducer is 4” beyond the os, the stopper is pushed forward (outside the mare), causing the IUD to be pushed out from the exterior pipe.

Introducers should be sterilized in Benz-all cold steriliant, or similar. Do not use iodine-based sterilant solution. A suitable container for sterilant can be a large diameter (i.e., 2”) PVC pipe with one end sealed and one end removable.

Prepare the IUD: Lubricate with sterile veterinary lube and insert into the introducer. The central stem of the IUD goes in first (Figure 3).

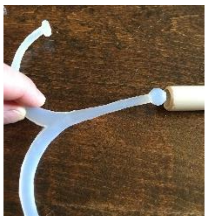

Figure 3. Insert the stem end of the IUD into the exterior pipe.

Fold the two ‘legs’ of the IUD, and push the IUD further into the introducer, until just the bulbous ends are showing (Fig. 4).

Figure 4. Insert the IUD until just the tips of the ‘legs’ are showing.

Restraint and Medication: The mare should be restrained in a padded squeeze chute to provide access to the rear end of the animal, but with a solid lower back door, or thick wood panel, for veterinarian safety.

Some practitioners may choose to provide sedation. If so, when the mare’s head starts to droop, it may be advisable to tie the tail up to prevent risk of the animal sitting down on the veterinarian’s arm (i.e., double half hitch, then tie tail to the bar above the animal).
Some practitioners may choose to provide a dose of long-acting progesterone to aid in IUD retention. Example dosage: 5mL of BioRelease LA Progesterone 300 mg/mL (BET labs,

Lexington KY), *or* long-acting Altrenogest). No other intrauterine treatments of any kind should be administered at the time of IUD insertion.

Insertion Procedure:

Prep clean the perineal area.

Lubricate the veterinarian's sleeved arm and the Introducer+IUD.

Carry the introducer (IUD-end-first) into the vagina.

Dilate the cervix and gently move the tip of the introducer past the cervix.

Advance the end of the 1/2" PVC pipe about 4 inches past the internal os of the cervix.

Hold the exterior pipe in place, but push the stopper of the interior pipe forward, causing the IUD to be pushed out of the exterior pipe, into the uterus.

Placing a finger into the cervical lumen just as the introducer tube is removed from the external os allows the veterinarian to know that the IUD is left in the uterus, and not dragged back into or past the cervix.

Remove the introducer from the animal, untie the tail.

Mares that have received an IUD should be observed closely for signs of discharge or discomfort for 24 hours following insertion after which they may be released back to the range.

Label for Y-Shaped Silicone IUD for Feral Horses

<u>Y-Shaped Silicone IUD for Feral Horses</u>

The *Y-Shaped Silicone IUD for Feral Horses* is an intrauterine device (IUD) comprised solely of medical-grade, inert, silicone that is suitable for use in female feral horses (free-roaming or "wild" *Equus caballus*). Intended users include government agencies with feral horses in their management purview, Native American tribes that have management authority over feral horses, and authorized feral horse care or rescue sanctuaries that manage feral horses in a free ranging environment.

The *Y-Shaped Silicone IUD for Feral Horses* can mitigate or reduce feral horse population growth rates because these IUDs can provide potentially reversible fertility control for female feral horses. This IUD prevents pregnancy by its physical presence in the mare's uterus as long as the IUD stays in place. In trials, approximately 75% of mares living and breeding with fertile stallions retained the *Y-Shaped Silicone IUD for Feral Horses* over two breeding seasons. None of the mares that kept their IUDs became pregnant during an experimental trial. After IUD removal, the majority of mares returned to fertility.

<u>Directions for Use</u>:

The *Y-Shaped Silicone IUD for Feral Horses* is to be placed in the uterus of feral horse mares by a veterinarian. The *Y-Shaped Silicone IUD for Feral Horses* is intended for use in feral mares that are at least approximately 1 year old, where age is determined based on available evidence, such as tooth eruption pattern.

IUDs must be sterilized before use. The IUD is inserted into the uterus using a thin, tubular applicator, similar to a shielded culture tube commonly used in equine reproductive veterinary medicine, in a manner similar to methods used for uterine culture of domestic mares. Feral mares with IUDs should be individually marked and identified (i.e., with an RFID microchip, or via visible freeze-brand on the hip or neck).

<u>Caution</u>:

These IUDs are only to be used in mares that are confirmed to be not pregnant. Checking pregnancy status can be accomplished by methods such as a transrectal palpation and/or ultrasound performed by a veterinarian. If a *Y-Shaped Silicone IUD for Feral Horses* is inserted in the uterus of a pregnant mare, it may cause the pregnancy to terminate, and the IUD to be expelled.

Manufactured for:
U.S. Bureau of Land Management (97949)
1340 Financial Blvd., Reno, NV 89052
EPA Est.: 97628-MI-1

APPENDIX G: DESIGN FEATURES

NATIONAL SELECTIVE REMOVAL POLICY

- Gather operations will be conducted in accordance with the Comprehensive Animal Welfare Program for Wild Horse and Burro Gathers (CAWP) described in Appendix B and/or the National Wild Horse Gather Contract as adjusted or amended through the National and State wild horse and burro program direction.
- When gather objectives require gather efficiencies of 50-80% or more of the animals to be captured from multiple gather sites (traps) within the HMA, the helicopter drive method and helicopter assisted roping from horseback will be the primary gather methods used. Post-gather, every effort will be made to return released animals (if any) to the same general area from which they were gathered.
- Bait and/or water trapping may be used provided the gather operations timeframe is consistent with current animal and resource conditions. Bait and/or water trapping may also be selected as the primary method to maintain the population within AML and other special circumstances as appropriate.
- An Animal and Plant Inspection Service (APHIS) or other licensed veterinarian may be on-site during gathers, as needed, to examine animals and make recommendations to BLM for care and treatment of wild horses. Decisions to humanely euthanize animals in field situations will be made in conformance with BLM policy.
- Data including sex and age distribution, reproduction, survival, condition class information (using the Henneke rating system), color, size, and other information may also be recorded, along with the disposition of that animal (removed or released). Hair and/or blood samples will be acquired in accordance with current guidance (IM # 2009-062), to determine whether BLMs management is maintaining acceptable genetic diversity (avoiding inbreeding depression).

DATA COLLECTION

Wild burro herd data which may be collected includes data to determine population characteristics (age/sex/color/etc.), assess herd health (pregnancy/parasite loading/physical condition/etc.) and determine herd history and collect genetic monitoring samples (hair sampling) (IM # 2009-062).

Wild Horse and Burro Specialists would be responsible for collecting population data. Data collected during the gather and adoption preparation operations may be used to determine which individual wild horses would be selected for return to the HMA and would aid in future analysis in Herd Management Area Plans. The extent to which data is collected would vary to meet specific needs pertaining to the HMA. The following data may be collected:

1. Collecting Blood and Hair Samples:
   Unless there is a previously recognized concern regarding low genetic diversity in a particular herd, it is not necessary to collect genetic information at every gather. Typical herds should be sampled every ten to 15 years (two to three gather cycles).

   Hair samples would be collected and analyzed to compare with established genetic baseline data (genetic diversity, historical origins, unique markers, and norms for the population). The samples would be collected from the animals released back into the HMAs and from some of the animals removed from the HMA.

Minimum sample size is 25 animals or 25% of the post-gather populations, not to exceed 100 animals per HMA or separate breeding population. A sample is defined as 30 hairs with roots (about the diameter of a pencil). Hair samples would be taken from both Jennies and Jacks. Age would not be a defining factor in determining which animals to sample.

The test would consist of looking at 29 systems (17 typing and 12 DNA). The data would be compared to similar data from both domestic and other wild burro populations. The primary value of this data is to compare it to baseline samples to identify genetic drift and any narrowing of diversity through inbreeding. A sample of DNA would be preserved for each horse tested. Samples would be sent to Dr. Gus Cothran at the College of Veterinary Medicine at Texas A&M University for analysis. BLM qualified personnel would collect the hair samples.

Blood and/or hair samples may be taken for the purposes of furthering genetic ancestry studies and incorporation into the Herd Management Area Plans (HMAPs).

2. Herd Health and Genetic Diversity Monitoring Data Collection
Data related to age, sex, color, overall health, pregnancy, or nursing status would be collected from each animal captured. The sex and age of each release animal gathered would be recorded during sorting procedures at the gather holding facility and/or at the preparation facility. An estimate of the number, sex and age of horses evading capture would also be recorded.

Information on reproduction and survival would be collected to the extent possible, through documentation of the wild horses captured during the gather, and the age of those released following the gather. In addition, blood or hair samples may be collected from individuals within the herd for health records and/or genetic diversity monitoring data collection.

3. Characteristics:
Color and size of the animals would be recorded. Any characteristics as to type (or similarities to domestic breeds) would be noted if determined. The genetic analysis would provide a comparison of domestic breeds with the wild horses sampled. Any incidence of negative genetic traits (parrot mouth, club feet etc.) or other abnormalities would be noted as well. A representative population of wild horses would be selected for release.

4. Condition Class:
A body condition class score would be recorded based on the Henneke System.

5. Other Data:
Other data such as temperament may be collected as determined by the Authorized Officer or Wild Horse Specialist.

RADIO COLLARING AND TAGGING

Radio collaring and tagging may be used to do research on habitat interactions, seasonal use of ranges, survival, and density dependence, recruitment, fecundity, fertility, population growth and other subjects of value to the management of free-roaming wild horses.

During the gather horses would be fitted with Global Positioning System (GPS) and/or Very High Frequency (VHF) radio collars. Collars would be placed on adult horses that are 3 years of age or older and that have a Henneke body condition score of 4 or greater. The design and vendor of the collar would be based on the results of the ongoing USGS radio collar study at the BLM Pauls Valley adoption facility in Oklahoma. All radio collars would have a manual release mechanism in case of emergency, and a timed release which will be programmed to release at the end of the planned study time. No collars would remain on wild horses indefinitely. If the collar drop-off mechanism fails at the end of the study, radio collars would be removed by capturing the individual horse to remove collars manually, or in a management gather.

TEMPORARY HOLDING FACILITIES DURING GATHERS

Wild horses gathered would be transported from the trap sites to a temporary holding corral near the HMA in goose-neck trailers or straight-deck semi-tractor trailers. At the temporary holding corral, the wild horses will be aged and sorted into different pens based on sex. The horses would be provided an ample supply of good quality hay and water. Mares and their un-weaned foals would be kept in pens together. All horses identified for retention in the HMA would be penned separately from those animals identified for removal as excess.

At the temporary holding facility, a veterinarian, when present, would provide recommendations to the BLM regarding care, treatment, and if necessary, euthanasia of the recently captured wild horses. Any animals affected by a chronic or incurable disease, injury, lameness or serious physical defect (such as severe tooth loss or wear, club foot, and other severe congenital abnormalities) would be humanely euthanized using methods acceptable to the American Veterinary Medical Association (AVMA).

TRANSPORT, SHORT TERM HOLDING, AND ADOPTION PREPARATION

Wild horses removed from the range as excess would be transported to the receiving short-term holding facility in a goose-neck stock trailer or straight-deck semi-tractor trailers. Trucks and trailers used to haul the wild horses would be inspected prior to use to ensure wild horses could be safely transported. Wild horses would be segregated by age and sex when possible and loaded into separate compartments. Jennies and their un-weaned foals may be shipped together depending on age and size of foals. Jennies and un-weaned foals would not be separated for longer than 12 hours. Transportation of recently captured wild horses would be limited to a maximum of eight hours.

Upon arrival, recently captured wild horses would be off-loaded by compartment and placed in holding pens where they would be fed good quality hay and water. Most wild horses begin to eat and drink immediately and adjust rapidly to their new situation. At the short-term holding facility, a veterinarian would provide recommendations to the BLM regarding care, treatment, and if necessary, euthanasia of the recently captured wild horses. Any animals affected by a chronic or incurable disease, injury, lameness or serious physical defect (such as severe tooth loss or wear, club foot, and other severe congenital abnormalities) that was not diagnosed previously at the temporary holding corrals at the gather site would be humanely euthanized using methods acceptable to the AVMA. Wild horses in very thin condition or animals with injuries are sorted and placed in hospital pens, fed separately and/or treated for their injuries. Recently captured wild horses, generally jennies, in very thin condition may have difficulty transitioning to feed. A small percentage of animals can die during this transition; however, some of these animals are in such poor condition that it is unlikely they would have survived if left on the range. At short-term corral facilities, a minimum of 700 square feet is provided per animal.

After recently captured wild horses have transitioned to their new environment, they are prepared for adoption or sale. Preparation involves freeze-marking the animals with a unique identification number, vaccination against common diseases, castration, and de-worming.

PUBLIC PARTICIPATION

Prior to conducting a gather, a communication plan or similar document summarizing the procedures to follow when media or interested public request information or viewing opportunities during the gather should be prepared.

The public must adhere to guidance from the agency representative and viewing must be prearranged.

SAFETY

Safety of BLM employees, contractors, members of the public, and the wild horses will be given primary consideration. The following safety measures will be used by the Authorized Officer and all others involved in the operation as the basis for evaluating safety performance and for safety discussions during the daily briefings:

A briefing between all parties involved in the gather will be conducted each morning.

All BLM personnel, contractors and volunteers will wear protective clothing suitable for work of this nature. BLM will alert observers of the requirement to dress properly. BLM will assure that members of the public are in safe observation areas. Observation protocols and ground rules will be developed for the public and will be enforced to keep both public and BLM personnel in a safe environment.

The handling of hazardous, or potentially hazardous materials such as liquid nitrogen and vaccination needles will be accomplished in a safe and conscientious manner by BLM personnel or the contract veterinarian.

RESPONSIBILITY AND LINES OF COMMUNICATION

The local WH&B Specialist / Project Manager from the LSFO, have the direct responsibility to ensure/make sure that Instruction Memorandum # 2013-060 Wild Horse and Burro Gather: Management by Incident Command System is followed.

Gather Research Coordinator (GRC) from the LSFO, will have the direct responsibility to ensure compliance with all data collection and sampling. The GRC will also ensure appropriate communication with Field Office Manager, WO260 National Research Coordinator, College of Veterinary Medicine at Texas A&M University, and Animal Plant Health Inspection Service (APHIS).

The LSFO Assistant Manager will take an active role to ensure the appropriate lines of communication are established between the field, Field Office, and State Office.

All employees involved in the gathering operations will keep the best interests of the animals at the forefront at all times.

M E M O R A N D U M

To: Jay D'Ewart, Paul Griffin (BLM)

CC: Clay Stott, Kevin Lloyd, Ben Smith, Eddie Vandenburg, June Wendlandt, Alan Shepherd, Bruce Rittenhouse (BLM)

From: L. Stefan Ekernas

Date: 18 September 2019

RE: Statistical analysis for 2019 survey of horse abundance in Adobe Town, Salt Wells Creek, Divide Basin, White Mountain, Little Colorado HMAs (WY) and Sand Wash Basin HMA (CO).

I. SUMMARY TABLE

Survey areas and Dates:	**Start date**	**End date**	**Area name**	**Area ID**
	3/4/2019	3/4/2019	White Mountain HMA	WY0003
	3/5/2019	3/5/2019	Little Colorado HMA	WY0039
	3/9/2019	3/15/2019	Salt Wells Creek HMA	WY0001
	3/11/2019	3/12/2019	Great Divide Basin HMA	WY0002
	3/15/2019	3/16/2019	Adobe Town HMA	WY0009
	3/16/2019	3/17/2019	Sand Wash Basin HMA	CO0143
Type of Survey	Simultaneous double-observer			
Aviation Company	Gregg Rowe (pilot), Owyhee Air, Partenavia P-68 Observer, Tail# N172X			
Agency Personnel	Kevin Lloyd, Clay Stott, Ira Walgren, Mike Coyne, Jay D’Ewart (BLM)			

TABLE 1. Estimated abundance (Estimate) is for the number of horses in the surveyed areas at the time of survey.

Area	Age Class	Estimate (No. Horses)	LCL[a]	UCL	Std Err	CV	No. Horses Seen	% Missed	Estimated # of Groups	Estimated Group Size	Foals per 100 Adults	Est. No. Horses Outside HMA[b]	Est. No. Horses Checkerboard Inside HMA[b]	Est. No. Horses Checkerboard Outside HMA[b]
Adobe Town HMA	Total Foals	944	895	1022	37.9	4.0%	863	8.6%	176	5.4	1.6	158	77	24
		15	14	18	1.8	12.2%	14							
	Adults	929	881	1005	37.2	4.0%	849							
Salt Wells Creek HMA	Total Foals													
		766	672	1220	167.5	21.9%	630	17.8%	149	5.1	2.8	53	333	22
		21	18	27	3.6	17.0%	18							
	Adults	745	650	1191	165.5	22.2%	612							
Adobe Town Salt Wells Creek Complex TOTAL	Total	1710	1604	2202	173	10.1%	1493	12.7%	325	5.3	2.2	211	410	46
	Foals	36	32	43	4	11.2%	32							
	Adults	1674	1573	2161	171	10.2%	1461							
White Mountain HMAc	Total Foals	401	358	454	29.7	7.4%	347	13.5%	72	5.6	2.6	0	267	0
		10	8	15	2.4	23.9%	8							
	Adults	391	345	440	29	7.4%	339							
Little Colorado HMA	Total Foals	412	382	455	25.6	6.2%	382	7.3 %	54	7.6	0.2	54	0	0
		1	1	1	0.1	14.6%								
							1							
	Adults	411	381	454	25.6	6.2%	381							
White Mountain Little Colorado Complex TOTAL	Total													
	Foals	813	758	894	42.2	5.2%	729	10.3%	126	6.5	1.4	54	267	0
	FoalsAdults	11	9	16	2.4	22.1%	9							
		802	747	882	41.6	5.2%	720							

90% confidence intervals are shown in terms of the lower limit (LCL) and upper limit (UCL). The coefficient of variation (CV) is a measure of precision; it is the standard error as a percentage of the estimated population. Number of horses seen (No. Seen) leads to the estimated percentage of horses that were present in the surveyed area, but that were not recorded by any observer (% Missed). The estimated number of horses associated with each HMA but located outside the HMA's boundaries is already included in the total estimate for that HMA.

TABLE 1 (continued)

Area	Age Class	Estimate (No. Horses)	LCL[a]	UCL	Std Err	CV	No. Horses Seen	% Missed	Estimated # of Groups	Estimated Group Size	Foals per 100 Adults	Est. No. Horses Outside HMA[b]	Est. No. Horses Checkerboard Inside HMA[b]	Est. No. Horses Checkerboard Outside HMA[b]
Divide Basin HMA	Total	1096	1045	1189 30	50.8 1.8	4.6	1010	7.8	161	6.8	2.4	110	370	6
	Foals	26	25			7	25							
	Adults	1069	1018	1164	50.3	4.7	985							
Sand Wash Basin HMA	Total	441	393	494 11	31.1 1.8	7	393	10.9	70	6.3	1.8	127	0	0
	Foals	8	7			22.9	7							
	Adults	433	386	483	30.2	7	386							

[a] The lower 90% confidence limit is based on bootstrap simulation results or the number of horses seen, whichever is higher.

[b] Horses outside the HMA, and on checkerboard inside and outside the HMA, are included in the HMA total.

[c] An infrared survey was flown on White Mountain HMA a few days after the double-observer survey and detected 440 horses.

II. NARRATIVE

In March 2019 Bureau of Land Management (BLM) personnel conducted simultaneous doubleobserver aerial surveys of the wild horse populations in Adobe Town, Salt Wells Creek, Divide Basin, White Mountain, Little Colorado (WY) and Sand Wash Basin (CO) herd management areas (HMAs, Figure 1). Surveys were conducted using methods recommended by BLM policy (BLM 2010) and a recent National Academy of Sciences review (NRC 2013). I analyzed these data to estimate sighting probabilities for horses, which I then used to correct the raw counts for systematic biases (undercounts) that are known to occur in aerial surveys (Lubow and Ransom 2016), and to provide confidence intervals (which are measures of uncertainty) associated with the abundance estimates (Ekernas and Lubow *In Press*).

ABUNDANCE RESULTS

The estimated total horse abundance (Table 1) within or associated with the surveyed HMAs were relatively large. Observers recorded 584 horse groups, of which 553 horse groups had data recorded in a way suitable to be used in computing statistical estimates of sighting probability. Three observations made during 2019 aerial surveys were of privately owned domestic horses; I used these 3 observations to inform sighting probabilities but did not include them in calculating total estimates of abundance. Confidence intervals and coefficients of variation for the total horse abundance estimates were fairly precise (11% CV; Table 1).

I estimate the mean size of detected horse groups, after correcting for missed groups, to be 6.0 horses/group across the surveyed area, with a median of 4.0 horses/group. I estimate 2.0 foals per 100 adult horses at the time of these surveys (Table 1). Given the March survey date, this value does not include most foals that will be born in 2019.

SIGHTING PROBABILITY RESULTS

The combined front observers saw 58.8% of the horse groups (69% of the horses) seen by any observer, whereas the back seat observers saw 84.3% of all horse groups (85.8% of horses) seen (Table 2). These results demonstrate that simple raw counts do not fully reflect true abundance without statistical corrections for missed groups made possible by the double observer method and reported here. There were undoubtedly additional groups not seen by any observer; I address this issue in the analysis that follows.

The sample size of observations (553 usable horse groups) was sufficient to parameterize sighting probability functions. Observers were rotated appropriately in the back seat, photographed large horse groups, and noted groups that were double counted. The survey also covered multiple HMAs to increase sample size. All these practices follow guidelines in the SOPs (Ekernas et al. *In Press*) and the conduct of the surveys is commendable.

Informed by preliminary analyses, past analyses for this survey area, and *a priori* reasoning, I considered 64 alternative models. Based on preliminary testing, all models used in the doubleobserver analysis contained an estimated parameter for:

1. An intercept common to all observations;
2. An effect of group size;
3. An effect for group distance from the transect line; and
4. An effect for groups on the pilot's side of the aircraft.

In addition to the parameters listed above, I tested 6 possible effects on sighting probability by fitting models for all possible combinations of these effects, resulting in 64 alternative models. The 6 effects were for (1) horse groups moving, (2) flat light, (3) snow cover, (4) an interaction effect between flat light and snow cover, (5) observer MC in the front seat, and (6) an average back seat observer effect. Preliminary testing showed much stronger support for a curved rather than linear effect of snow cover, such that sighting probability was lowest at intermediate levels of snow cover. I found little support for differences between the back seat observers.

Groups that were recorded on the centerline, directly under the aircraft, were not available to backseat observers and I therefore set their sighting probability to 0. Sighting probability for groups visible on both sides of the aircraft was computed based on the assumption that both backseat observers could independently have seen them, thereby increasing total detection probability for these groups.

Support (measured as % of AICc model weight) was strong for an average back seat observer effect (99.9%), an interaction between snow cover and flat light (93.8%), differences between front seat observers MC and KL (92.3%), and group movement (87.6%). I found moderate support for snow cover without an interaction effect (44.0%), and modest support for flat light without an interaction effect with snow (28.9%). As expected, estimated sighting probability was higher for groups that were larger, closer, moving, and in 0% or 100% snow cover. Sighting probability was lower for groups in intermediate snow cover, and on the pilot's side. In flat light conditions, intermediate snow cover resulted in dramatically lower sighting probability than snow cover in high contrast light. Observer MC had lower detection probability than observer KL. Sighting probability was higher, on average, for back-seat observers than front seat observers (Table 3).

Estimated overall sighting probabilities, $\hat{p}$, for the combined observers ranged across horse groups from 0.20-1.00. Sighting probability was <0.7 for 53 (9%), and <0.5 for 10 (2%) of observed groups. The group with lowest sighting probability was a group of 3 horses, ½ - 1 mile from the transect, standing still, in flat light, and in 30% snow cover. Comparing actual horses seen to the estimated abundance computed from the overall $\hat{p}$, I estimate that 11% of the horses in these surveys were never seen by any of the observers (Table 1). Patchy snow cover, small group sizes, and fixed wing aircraft contributed to the relatively low overall detection probability.

POPULATION GROWTH

Comparing these results to the November 2017 survey of the same Wyoming areas allows us to estimate population growth rate in the different HMAs and complexes. I assume that the November 2017 results reflect population size at the beginning of 2018, and I remove foals from the March 2019 survey to estimate population growth rates over a single year:

Adobe Town Salt Wells Creek Complex: 24.6% annual growth

White Mountain Little Colorado Complex: 15.9% annual growth

Divide Basin HMA: 35.1% annual growth

ASSUMPTIONS AND CAVEATS

Results from this double observer analysis are a conservative estimate of abundance. True abundance values are likely to be higher, not lower, than abundance estimates in Table 1 because of several potential sources of bias that I list below. If the infrared-based horse counts from White Mountain HMA are accurate, those infrared counts suggest that the double-observer based estimates of abundance may be lower than the true abundance values, which could be due to any combination of several well-known, potential causes of underestimation listed below. Results of the analysis should always be interpreted with a clear understanding of the assumptions and implications.

1. The results obtained from these surveys are estimates of the horses present in the area surveyed at the time of the survey and should not be used to make inferences beyond this context. Abundance values reported here may vary from the annual March 1 population estimates for the HMA; aerial survey data are just one component of all the available information that BLM uses to make March 1 population estimates. Aerial surveys only provide information about the area surveyed at the time of the survey, and do not account for births, deaths, movements, or any management removals that may have taken place afterwards.

2. Double-observer analyses cannot account for undocumented animal movement between, within, or outside of the HMA. The surveyed HMAs are largely enclosed by fencing, roads, or natural barriers. Although fences and topographic barriers can provide deterrents to animal movement that help to contain them within the areas surveyed, these barriers may not present either a continuous, unbroken barrier or an impenetrable one. It is always possible that the surveys did not extend as far beyond the boundary as horses might move. Consequently, there is the possibility that temporary emigration from the surveyed areas may have contributed to some animals that normally live in the target HMA having not being present at the time of survey. In principle, if the level of such movement were high, then the numbers of animals found within the survey areas at another time could differ substantially. If there were any wild horses that are part of a local herd but were outside the surveyed areas, then the estimates in Table 1 underestimate true abundance.

3. The validity of the analysis rests on the assumption that all groups of animals are flown over once during a survey period, and thus have exactly one chance to be counted by the front and back seat observers, or that groups flown over more than once are identified and considered only once in the analysis. Animal movements during a survey can potentially bias results if those movements result in unintentional over- or under-counting of horses. Groups counted more than once would constitute 'double counting,' which would lead to estimates that are biased higher than the true number of groups present. Groups that were never available to be seen (for example due to temporary emigration out of the study area or undetected movement from an unsurveyed area to an already-surveyed area) can lead to estimates that are negatively biased compared to the true abundance.

   Surveying entire complexes required multiple days with multiple fuel cycles, yielding opportunities for horses to move between surveyed and unsurveyed areas. The identification of 'marker' horses (with unusual coloration) in observed groups was recorded on paper, and variation in group sizes helped the observers to reduce the risk of double counting during aerial surveys. Observers also took photographs of many observed groups and used those photos after landing to identify any groups that might have been inadvertently recorded twice. Unfortunately, there is no effective way after the survey to correct for the converse problem of horses fleeing and thus never having the opportunity for being detected. Because observers can account for horse movements leading to double counting, but cannot account for movement causing horses to never be observed, animal movements can contribute to the estimated abundance (Table 1) potentially being lower than true abundance

4. The double observer method assumes that all horse groups with identical sighting covariate values have equal sighting probability. If there is additional variability in sighting probability not accounted for in the sighting models, such heterogeneity could lead to a negative bias (underestimate) of abundance. In other words, even under ideal conditions the double-observer method tends, if anything, to provide underestimates of abundance.

5. I must assume that the number of animals in each group is counted accurately. In very large groups, it may be common to miss a few animals unless photographs are taken and scrutinized after the flight. Relying on uncorrected counts could lead to biased estimates of abundance.

SUGGESTIONS FOR FUTURE SURVEYS

Several observation about the data may offer opportunities to improve future surveys.

1. Horses can potentially move between Divide Basin HMA and the Red Desert Complex. Surveying these together could alleviate concerns about horse movement. Doing so would add substantial length to this survey, and observers would need to take a multi-day break to avoid fatigue. Highways serve as strong barriers separating Divide Basin HMA from both the White Mountain Little Colorado Complex and the Adobe Town Salt Wells Creek Complex, and those barriers offer opportunities to give the crew a break.

TABLE 2. Tally of raw counts of horses and horse groups by observer (front, back, and both) for combined data from Adobe Town, Salt Wells Creek, Divide Basin, White Mountain, Little Colorado HMAs (WY) and Sand Wash Basin HMA (CO) surveyed in March 2019.

Observer	Groups Seen[a] (Raw Count)	Horses Seen[a] (Raw Count)	Actual Sighting Rate[b] (groups)	Actual Sighting Rate (Horses)
Front	325	2439	58.8%	69.0%
Back	466	3031	84.3%	85.8%
Both	238	1937	43.0%	54.8%
Combined	553	3533		

[a] Includes only groups and horses where protocol was followed. [b] Percentage of all groups seen that were seen by each observer.

TABLE 3. Effect of observers and sighting condition covariates on estimated sighting probability of horse groups for both front and rear observers during the Mar 2019 survey of Adobe Town, Salt Wells Creek, Divide Basin, White Mountain, Little Colorado HMAs (WY) and Sand Wash Basin HMA (CO). Baseline case (bold) for horses presents the predicted sighting probability for a group of 4 horses (the median group size observed), < ¼ mile from the transect, that are not moving, in high contrast light, in 0% snow cover, not on the pilot's side, with KL as the front seat observer. Other example cases vary a covariate or observer, one effect at time, as indicated in the left-most column, to illustrate the relative magnitude of each effect. Sighting probabilities for each row should be compared to the baseline (first row) to see the effect of the change in each observer or condition. Baseline values are shows in bold wherever they occur. Sighting probabilities are weighted averages across all 64 models considered (Burnham and Anderson 2002).

	Sighting Probability, Front Observer[a]	Sighting Probability, Back Observer	Combined Sighting Probability
Baseline	**70.4%**	**84.4%**	**95.4%**
Effect of group size (N=1)	65.8%	81.4%	93.6%
Effect of group size (N=10)	78.5%	89.3%	97.7%
Effect of distance = 0.375	56.6%	74.8%	89.1%
Effect of moving	82.6%	91.5%	98.5%
Effect of flat light	71.1%	84.9%	95.6%
Effect of snow=50%	69.6%	83.9%	95.1%
Effect of snow=100%	74.2%	86.7%	96.6%
Effect of flat light and snow=50%	20.1%	35.1%	48.1%
Effect of flat light and snow=100%	74.1%	86.7%	96.6%
Effect of Pilot's side	44.8%	**84.4%**	91.4%
Effect of front seat observer MC	59.0%	**84.4%**	93.6%
Effect of back=front	**70.4%**	70.4%	91.2%

[a] Sighting probability for the front observers acting as a team when the horses were on the pilot's side of the flight path, regardless of which of the front observers saw the horses first.

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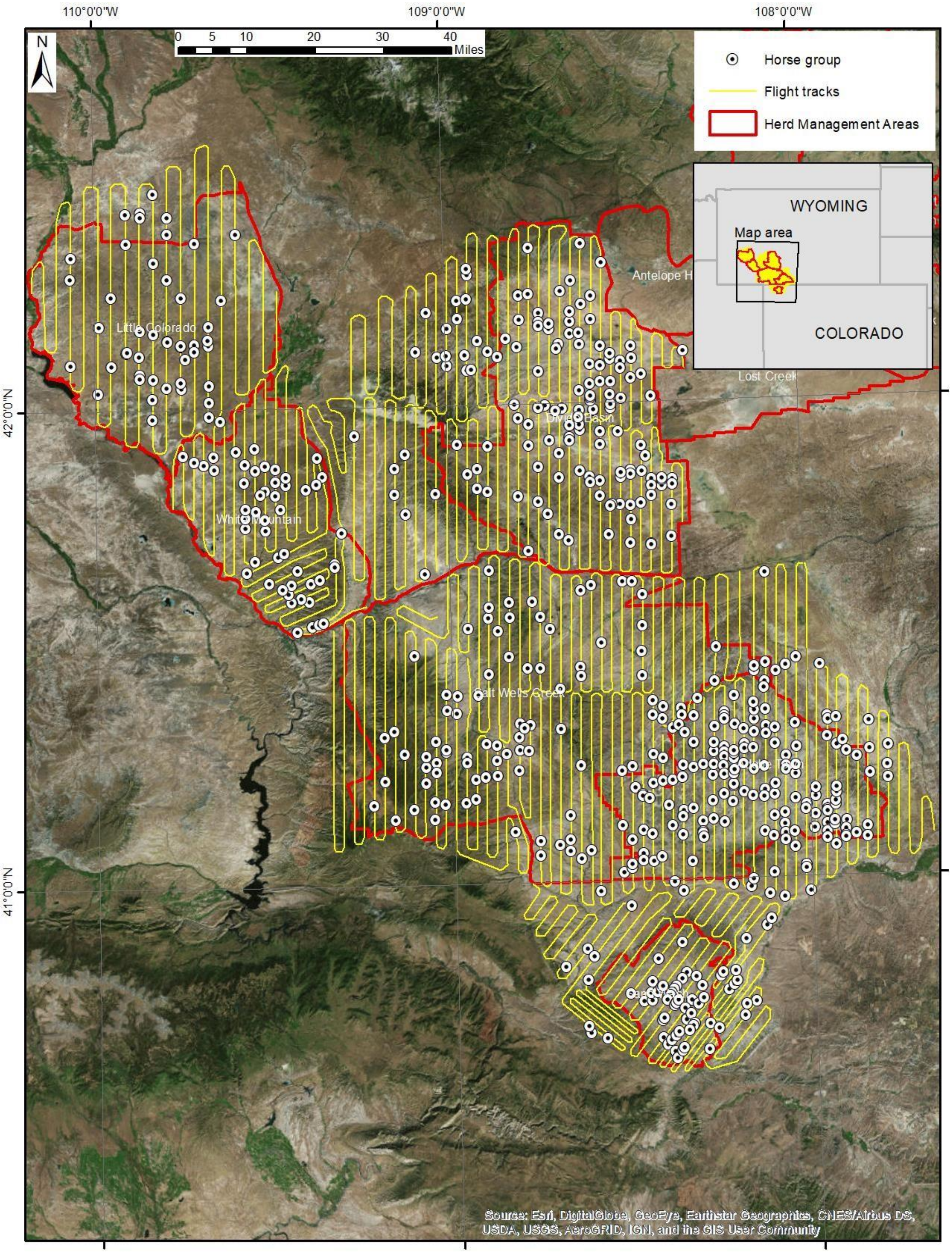
FIGURE 1 (following page). Map of survey tracks flown (yellow lines), locations of observed horse groups (black and white circles), and surveyed HMA boundary (red).



APPENDIX I: RANGE MONITORING ANALYSIS

Discussion

The Proposed Action to remove excess wild horses from the Sand Wash HMA takes into consideration the following factors:

- analysis of current range monitoring data
- precipitation since the last wild horse gather in 2005
- wild horse actual use derived from aerial census
- actual livestock use
- voluntary reductions by livestock permittees in the numbers of sheep being grazed within the HMA due to drought and increasing wild horse numbers.

In 2001, a stocking rate analysis was conducted to establish a management range of 163 to 362 horses with a gather every four years to reduce the herd size to 163 horses. Analysis of monitoring and actual use data between 1989 and 2000 determined that this AML range and gather schedule would be compatible with the forage resource so long as livestock permittees took voluntary non-use commensurate with horse population levels in any given year. Analysis of monitoring data collected since the 2001 gather shows that the management range of 163 to 362 horses and four year gather schedule remain appropriate, although a drought that occurred during this period resulted in greater levels of voluntary non-use by livestock permittees than would have been expected.

Drought

A drought began in 2001 that continues to affect much of the intermountain west. Precipitation continued to be significantly below average, although some improvement occurred in 2005. For central Moffat County, the drought was more severe and longer-lasting than at any other time on record since 1958. The following is total annual precipitation at Maybell, Colorado

(approximately 20 miles southeasterly of the HMA) from 2001 to 2004:

Year	Total Annual Precip.	26 Year Mean Precip. (2007)	% of Mean
2001	9.61	11.94	80%
2002	9.01	“	75%

2003	9.74	"	82%
2004	6.38	"	53%
2005	14.07	"	118%
2006	8.60	"	72%
2007	11.54	"	97%

Source: Western Regional Climate Center, www.wrcc.dri.edu

As expected, this drought resulted in greatly reduced biomass production and vigor in the plant communities within the HMA. Qualitative observations collected during the land health assessment of the Sand Wash Watershed in 2002 noted declines in plant growth and recruitment that were directly attributable to drought conditions. Other qualitative observations made during semi annual collection of utilization data in each of the last four years have been similar.

Between 2001 and the date of this document, livestock permittees within the HMA took significant reductions in livestock numbers and length of use. These post-2001 livestock reductions are greater than would be needed to balance increased wild horse herd size, and are in response to ongoing, notable drought conditions. Conversely, the wild horse population increased each year by a conservative estimate of 20%. The Division of Wildlife records show an increase in elk over the last four years in Game Management Unit 2, which encompasses the Sand Wash Basin. DOW records are supported by BLM field observations that note increased numbers of elk sightings, particularly in the winter and early spring.

Trend

In the mid 1970s and early 1980s, BLM established 35 photopoint trend plots within the HMA. These photopoint plots consist of nine square foot quadrats within which plant composition, recruitment, and plant and litter cover are measured over time. This method results in a trend index number which reflects the compilation of all parameters measured for each quadrat. The change in the indices can be compared over time to determine whether the quadrat sample is indicating an upward, downward, or static trend. Another aspect of this type of monitoring is that photographs are taken at each reading of both the quadrat and the general area (usually looking north from the quadrat) that yields qualitative information on the general trend at the sample site.

Sand Wash Allotment

Fourteen photopoint plots established on this allotment are within the HMA. Establishment dates for these plots are between the mid 1970s and early 1980s. Data was collected from these plots on a mostly annual basis until 1983. The plots were not revisited until 1995, when only photographs were taken. Quantitative data was again collected from these plots in June, 2005. In comparing the 2005 trend indices with those from the late 1970s and early 1980s, downward trends were shown on 6 plots, upward trends were shown on 4 plots, static trend was shown on 1 plot, and 2 plots could not be relocated.

The downward trends that were indicated by the 2005 data mostly resulted from decreases in perennial grass cover and abundance in the interspaces between shrubs. One site in the central portion of the Sand Wash Allotment showed a significant decline, to near elimination, of perennial grasses on a site that was dominated by perennial grasses as recently as 1995. The upward trends were mostly noted on sites that were dominated by shrubs.

Sheepherder Springs Allotment

This allotment contains 21 photopoint plots that were established in the early 1980s. These plots were read until 1983 with repeat photographs taken of each one in 1996. In 2005, an attempt was made to relocate and re-read the plots. Of the 21, 13 were either lost (stakes could not be relocated) or abandoned due human influences such as proximity to sheep camps or powerlines. Two sites had no earlier data on file, but were read in 2005. Of the 6 sites that were relocated, 1 only had a repeat photo taken due to the loss of the plot stakes. Four sites indicated a downward trend and 2 sites had static trends. Of the sites indicating downward trends, 2 were due to losses in perennial grass cover and 1 was due to a decline in browse cover.

Analysis

While the drought from 2001 to the present has had serious impact to the plant communities within the HMA, herbivory during this period is exacerbating the drought's effects. As plants begin to experience slowing of physiological processes due to water loss, the additional stress of herbivory at different stages of growth during drought can slow shoot regrowth and root extension. This is especially true among grasses and forbs, whose shallower roots have less access to water stored deep in the soil. Continued herbivory during this period of reduced growth reduces the plant's ability to regrow leaf area by forcing it to continually initiate growth from basal buds. When shoot growth is continually suppressed, carbohydrates to replace root mass decline which leads to a downward spiral resulting in plant death (Howery 1999). Additionally, suppressed seed production and reduced seed germination leads to very little recruitment of new plants into the community.

Downward trends due to declines in perennial grasses can be attributed to continued herbivory during periods of growth when plants are most sensitive to grazing coupled with ongoing drought conditions, i.e. use by animals between the late vegetative and early floral initiation stages (late June-early July) coupled with declining seasonal soil water availability (Brown 1995). Foraging animals present within the HMA during this period are primarily horses and pronghorn antelope.

Utilization

Twice yearly, in the spring and fall, utilization data which reflects ongoing use of browse and grass species, was collected at key areas within the two grazing allotments that comprise the majority of the HMA (84%), Sand Wash (Sand Wash Pasture) and Sheepherder Springs (Sheepherder Pasture). Data was collected by the key forage method which assigns a ranking of utilization (low, moderate, high, etc.) based on an estimation of current years' growth consumed by percent.

Table 1. Browse and grass utilization from 2001 to spring 2008 in the Sheepherder Springs and Sand Wash Allotments.

Year/Season Date Collected	Sheepherder Springs Allotment		Sand Wash Allotment	
	% Browse Utilization	% Grass Utilization	% Browse Utilization	% Grass Utilization
Spring 2005	42%	20%	22%	44%
Fall 2005	24%	23%	13%	13%
Spring 2006	28%	48%	49%	16%
Fall 2006	38%	48%	Nd	8%
Spring 2007	44%	39%	Nd	34%
Fall 2007	32%	28%	9%	28%
Spring 2008	47%	18%	55%	59%

0-5% = No Use, 6-20% = Slight, 21-40% = Light, 41-60% = Moderate, 61-80% = Heavy, 81-100% = Severe

As shown in Table 1, the majority of use over the period since the last gather has been slight to light use of both browse and grasses. The exception to this has been data gathered in the Spring of 2008, where the average utilization in the Sand Wash Allotment was in the moderate range. During each year, there have been specific areas that have shown unacceptable levels of use, i.e. levels greater than 40% for browse species and 50% for grass species. These conditions have been highly localized and not apparent in multiple years on the same sites. Data from spring readings is indicative of utilization by sheep as well as horses and wildlife while fall data reflects use by horses and wildlife only.

Actual use by livestock

In 2001, when the current wild horse AML and management range and the 4 year gather schedule were developed, livestock operators in the HMA again agreed to take appropriate levels of voluntary non-use commensurate with herd size each year to conserve the forage base and foster long term health of the range. Varying levels of voluntary non-use were taken over the last four years. This non-use was motivated by the drought, and by the annual increase in wild horse population size. The severe drought has caused most livestock operators in northwest Colorado to take significant reductions in livestock use since 2001, including those operating within the HMA.

Table 2. Actual use (by AUMs) by permittees within the Sand Wash HMA since 2005.

Year	Sand Wash Allotment	Sheepherder Springs Allotment	Nipple Rim Allotment[1]	Lang Spring Allotment
2005	3,704	1,102	756	0
2006	2,754	41	737	0
2007	2,334	505	715	0
2008	3,659			
2009	4,101			
2010	950			
2011				
2012				
2013				
2014				
2015				
2016				
2017				
2018				
2019				
Total Permitted AUMs[3]	6,377	8,099	1,989[2]	364
1 - The Nipple Rim Allotment is run in common by two permittees. AUMs are apportioned equally between both permittees. 2 - Total active AUMs shown reflect the AUMs available in the portion of the allotment within the HMA, which is roughly half of the total AUMs				

for the allotment. Actual use shown is the sum of use by both permittees and are pro-rated to reflect use in the HMA half of the allotment. 3 – the number of AUMs which could have been utilized by the grazing permittee on an annual basis.				

Actual use by wild horses

Actual use by wild horses in the Sand Wash HMA, based on census flights and estimates:

Year	Number of Horses	AUMs
2001	163	1,956
2002	199	2,388
2003	243	2,952
2004	296	3,552
2005	311	3,732
2006	373[1]	4,476
2007	386[2]	4,632
1 – This figure is an estimate, based on a 20% increase in the population from the year prior. 2 – This figure is based on actual numbers of horses counted in the HMA in the Fall of 2007.		

In 2001, the wild horse herd was lowered to 163 horses. The most recent aerial census, completed in July 2008, recorded 404 wild horses. Current, post-foal wild horse population is estimated at 425 horses. The estimated 2009 population, should herd size not be lowered in 2008, would consist of 510 horses. Historically, the Sand Wash herd has reached emergency status due to water shortage when the population has exceeded approximately 400 horses in the herd.

Since the 2001, due to natural (heat, bugs, water availability) and man-induced variables (recreational traffic and disturbance from other human presence), wild horse bands have not dispersed evenly through the HMA. The majority of bands avoid the far southern portion of the HMA, concentrating in the area roughly defined as north of Clay Buttes; west towards Lookout Mountain, east of Meathouse Spring; north to the HMA boundary and east to the HMA boundary. Generally speaking, during years of average precipitation and temperature extremes, wild horse bands are most widely distributed in the late fall, winter and early spring months when water is readily available. Horse bands concentrate more tightly during spring and early summer foaling and breeding seasons when band awareness of one another is heightened. As water sources dry in the mid-summer wild horses concentrate most heavily in the north and central HMA generally described as from the north and east HMA boundaries south to the Sheepherder Spring/Yellow Cat Wash vicinity and west to the north fork of Sand Wash. There are always exceptions to these estimates. Resident horse bands can be found in any portion of the HMA during any time of the year due to unrestricted access of horses to their entire HMA.

References

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2014 Sand Wash Herd Management Area (HMA) Wild Horse Utilization Monitoring

In 2014, the LSFO undertook an HMA-wide utilization monitoring effort to gain a more comprehensive, area-wide picture of the level of grazing use at the end of the growing season and to produce a use pattern map for the grazing use that occurred during that season. The primary objective of this monitoring effort was to capture specific horse use of current year's growth without livestock utilization influence. All allotments that are encompassed within the HMA boundary are authorized for fall/winter/early spring, so by monitoring in October/November of 2014, prior to any livestock turnout for the 2014 season, we could best capture horse use over the 2014 growing season. See Table 1 below for 2012/2013 livestock use summary (all data taken from BLM Rangeland Administration System (RAS)).

Table 1 – HMA Livestock Use Summary

Allotment	AUM's Authorized	2012 Actual Use (based on billed AUMs)	2013 Actual Use (based on billed AUMs)	Date Last Used by Livestock	Acres in HMA
Lang Spring #04212	363	0	0	No use in Lang Spring since prior to 2000	3,547
Nipple Rim #04213	3,977	2,379 (60%) (sheep)	3,971 (100%) (sheep)	02/28/2014	16,247
Sheepherder Spring #04217	9,041	1,345 (15%) (sheep)	1,703 (19%) (sheep)	12/07/2013	74,883
Sand Wash #04219	6,377*	1,578 (25%) (sheep)	Non-Use (sheep)	04/10/2012	62,248

* The Sand Wash Allotment has pastures outside the HMA. Numbers presented above are only for the portion of the allotment within the HMA.

Methodology: A LSFO interdisciplinary team concurred that an appropriate method for this monitoring effort would be the Qualitative Assessment-Landscape Appearance Method as described in the BLM Technical Reference (TR) 1734-03 Utilization Studies & Residual Measurements, Interagency 1999, pg 119.

Using ArcGIS 10.1 desktop geographic information system software for mapping and a software extension, XTools Pro for ArcGIS desktop 9.1, a process that creates a fishnet grid was used. Using the HMA administrative boundary as a source extent a ten row and ten column grid (using the software default) was placed over the HMA area. The grid intersections were identified and using XTools "Create Intersection Points" a data source was created. This resulted in a grid of points being spaced approximately two miles apart across the HMA. The points were numbered 1 – 50 (number eight was accidently omitted from point count and was only discovered after data collection had begun, therefore the correction was not made). Each site point acts as a data sampling point for establishing transects.

For each sampling point, using Global Positioning System (GPS) hand held data collection units, the center monitoring point was located and a GPS point was taken. Using a standard hand held compass set for a 15° declination, a 300' tape was pulled in a north direction. Ocular utilization data was taken at 300', 600', 900' & 1,200' along a north transect. This was repeated in each cardinal direction for a maximum of sixteen data collection points per each sampling point. Based on a ¼ mile buffer encompassing each sampling point and set of data collection points approximately 125 acres per sampling point was represented (see Appendix 1 for the sampling design layout). It was discussed and recommended that in lieu of the tape reel, range finders could be used. This proved to be efficient and accurate as well as expediting the data collection process. As anticipated, not all sampling points were sampled with a full sixteen data collection points. Some data points were eliminated due to boundaries, topographical features, slope, site characteristics, or other limiting factors. It was agreed upon by the BLM ID team that any number of data collection point's ≤ 16 for each sampling point was representative for that sampling point. Rationale for the elimination of any data collection point was noted on the data collection sheet. Each data collection point at site locations was taken using GPS hand held data collection units for repeatability.

One photo for each sampling point was taken at the start of the north transect.

The designated off highway vehicle (OHV) area in the south west portion of the HMA was omitted from data collection due to the circumstance that recreational activities discourages seasonal horse use in large numbers.

Precipitation Adjustment Summary

Precipitation is a significant factor affecting annual rangeland production levels. In summarizing the utilization data for the HMA, this precipitation-yield factor was included to represent this annual variability. The method used was based on the USDA bulletin listed below.

Adjusting and Forecasting Herbage Yields in the Intermountain Big Sagebrush Region of the Steppe Province, Station Bulletin 659, August 1983, Agricultural Experiment Station, Oregon State

University, Corvallis in cooperation with Agricultural Research Service U.S. Department of Agriculture.

(https://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/15797/StationBulletin659.pdf?sequence=1)

Using the precipitation data shown in the climate section, the following formulas and values were used to extrapolate the precipitation adjusted utilization levels.

- The Long Term Median (LTM) for Sand Wash was based on 47 years of data (see chart in climate section). The years with null values were excluded from the calculation. The data was converted to the crop year precipitation received between September through June of the following year as shown in Appendix 2. The LTM for this area was 10.31 inches.

- The 2013-14 Current Year Precipitation (CYP) was 12.47 inches.

- Using the LTM and CYP the Precipitation Index (PI) was computed as follows:

PI = (CYP / LTM) x 100

(12.47 / 10.31) x 100 = 121%

- Using this PI and Table 2 from the bulletin a Yield Index (YI) can be determined. The PI of 121% equals a YI of 126% using this method.

- The Utilization level can then be adjusted using the YI. The calculation for this adjustment is:

Adjusted Utilization = Utilization Estimated x YI x 100

This calculation is found for each site in the Sand Wash utilization data.

Climate:

The following precipitation data was used for the precipitation adjustment to the utilization data. The data is from the Western Regional Climate Center.

http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?co5446

11/18/2014 MAYBELL, COLORADO - Climate Summary

MAYBELL, CO

Monthly Sum of Precipitation (Inches)

(055446)

File last updated on Nov 18, 2014
a = 1 day missing, b = 2 days missing, c = 3 days, ..etc..,
z = 26 or more days missing, A = Accumulations present
Long-term means based on columns; thus, the monthly row may not sum (or average) to the long-term annual value.
MAXIMUM ALLOWABLE NUMBER OF MISSING DAYS : 5
Individual Months not used for annual or monthly statistics if more than 5 days are missing.
Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

YEAR(S)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN

1982	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.001
1983	-----z	-----z	0.29	0.67 g	2.28	1.04	1.69	0.98	0.71	2.01	2.18	3.25	14.43 c
1984	0.71	1.01	1.48 a	2.19 e	0.48	2.74	1.48	1.72	1.89 g	2.63 e	0.69	1.11	16.24 a
1985	1.08	0.33 b	1.21 a	3.35 b	0.68 i	2.95	2.92	0.051	0.65 b	1.94	1.92	0.58 a	16.93 b
1986	0.21	0.39 a	1.13	1.49 d	1.55	1.34	1.88	0.37 c	2.21 t	1.24 f	0.90	0.53 a	9.79 b
1987	0.91	1.07	1.55 a	0.22	0.42 b	0.19 x	0.97	1.52	0.10 a	0.63	0.96	0.92	9.27 a
1988	1.56	0.28	0.53	0.68	1.39	0.48	0.12	0.96	-----z	0.00	1.08	0.80 b	7.88 a
1989	0.30	1.45	0.74 a	0.14	0.03	0.60	0.67	0.22 f	0.68	0.26	0.75	0.23	5.85 a
1990	0.23	2.12	0.87	1.12	0.31	-----z	0.35 g	0.26	0.66 b	2.06	1.96	0.98	10.57 b
1991	0.24	0.22	1.40	1.03 c	0.40	0.79	0.83	1.02 a	0.70	1.20	1.10	0.45	9.38
1992	0.25	0.49	0.89	0.69	1.22	0.23	2.40	0.36	0.95	1.03	0.95	0.97 b	10.43
1993	1.21	0.79 b	1.08 a	2.16	1.12	0.21	0.53	0.15 a	0.38	2.38	1.30	0.34	11.65
1994	0.43	0.56	0.74	0.93	0.29	0.25	0.00	1.67	0.81 a	1.37	1.52	0.31	8.88
1995	0.82	1.47	1.45	2.14	5.15	1.35	0.91	0.63	1.27 b	1.05	0.67	0.28	17.19
1996	2.06	1.53	0.44	2.89	1.11	0.28	1.00	0.83	0.76	1.67 e	2.39	0.82	15.78
1997	2.21 a	0.60	0.31	2.16	1.35 a	0.73 e	0.61	2.73	4.02	2.15 d	0.54	0.45	17.86
1998	0.60	0.80	2.29 a	0.72	0.27 a	3.22 c	1.87	0.34	0.43 c	1.98	0.60	0.62	13.74
1999	1.00	0.92 d	0.53	5.17	1.95 a	0.32 h	0.77 a	0.93	0.67 c	0.31 d	0.25	0.53	13.03 a
2000	0.74	1.14	1.00	1.29	0.95 c	0.05	0.36	0.38	1.60 e	1.10	1.21	0.93	10.75
2001	0.45	0.86	0.59	1.21	1.41	0.39	0.30	1.33	0.49 c	1.01	1.20	0.37	9.61
2002	0.66	0.33	1.58	0.62	0.00	0.20	0.86	0.85	1.27	1.30	0.89 a	0.45 a	9.01
2003	0.62	1.37	1.41	0.30 e	0.97	0.67	0.03	1.01	0.59	0.33	1.53	0.91	9.74
2004	0.49	0.63	0.19	0.73 i	0.58	0.55	1.12	0.46	1.07	1.44 f	0.92	0.37 a	6.38 b
2005	1.75 b	1.73	0.60	1.49	1.24	2.42	0.13	0.62 b	1.13	1.75 c	0.92	0.29	14.07
2006	0.74	0.27	1.88	0.94	0.19	0.19	0.37	1.06	1.90	3.36 g	0.71	0.35	8.60 a
2007	1.29	1.18	0.82	0.51	1.25	0.49	0.56	0.74 a	2.79	1.81	0.10	3.46	15.00
2008	1.22 a	0.95	1.50	0.50	2.24	0.64 d	0.09 a	0.91	2.03	0.38	1.10 a	2.06	13.62
2009	1.20 j	0.11	1.89	2.16	1.44	3.26	0.28 b	1.30	0.56	1.29	1.09	1.04	14.42 a
2010	0.34	0.71	1.03 b	1.87	0.82	1.29	0.47	1.79	0.45	1.40	1.79	3.44	15.40
2011	0.55	1.03	1.22	3.78	2.03	0.51	1.50	0.85	0.75	0.82	0.53 e	0.37	13.94
2012	0.38	1.24	0.52	0.61	0.18	0.00	0.15	0.09	1.02	0.32	1.11	2.20	7.82
2013	1.19	0.50	0.64	2.38	0.86	0.00	0.57	0.55	2.53	2.11	0.99	1.14	13.46
2014	0.66	0.30	1.30	0.86	2.14	0.44	0.26	2.94	2.09	1.26	-----z	-----z	12.25 b
						Period of Record Statistics							
MEAN	0.81	0.83	1.05	1.40	1.15	0.96	0.75	0.95	1.18	1.23	1.11	1.02	12.35
S.D.	0.58	0.51	0.70	1.03	0.97	0.89	0.65	0.67	0.88	0.79	0.67	0.88	3.22
SKEW	0.94	0.64	1.88	1.39	1.64	1.17	1.38	1.09	1.34	0.18	1.22	1.50	0.39
MAX	2.21	2.12	4.11	5.17	5.15	3.26	2.92	2.94	4.02	2.77	3.04	3.46	19.02
MIN	0.05	0.11	0.19	0.09	0.00	0.00	0.00	0.09	0.10	0.00	0.10	0.21	7.45
YRS	48.00	50.00	51.00	49.00	50.00	47.00	49.00	49.00	46.00	48.00	49.00	49.00	33.00

Using this data we can also specifically look at the timing of precipitation. Timing of precipitation can largely influence plant growth and re-growth, especially into late-summer and fall. The following table compares the long term average monthly precipitation to the timing of the 2014 precipitation by month. Significant above average moisture is seen going into the 2014 growing season (May) and into late summer (August and September).

Month	Average Precipitation (in.) 1959-2014	2014 Precipitation (in.)	% of Average
January	0.79	0.66	83%
February	0.82	0.30	36%
March	1.04	1.30	125%
April	1.40	0.86	62%
May	1.11	2.14	194%
June	0.89	0.44	50%
July	0.73	0.26	36%
August	0.95	2.94	311%
September	1.18	2.09	177%
October	1.30	1.26	97%
November	1.04	--	--
December	0.97	--	--

Results:

Below is the summary table for data collected. The first three columns from left to right are the raw data as collected for both herbaceous and browse and then averaged. The precipitation adjusted utilization data is shown to the right. Adjusted data is used for the summary and map.

2014 Sand Wash HMA Monitoring							
				Utilization adjusted for Precipitation			
				(Utilization * YI)		(see precipitation summary)	
Site #	**% Utilization Herbaceous**	**% Utilization Browse**	**Average**		**Adjusted % Utilization Herbaceous**	**Adjusted % Utilization Browse**	**Average**
1	Abandoned - State Land						
2	29%	28%	29%		36%	36%	36%
3	29%	17%	23%		37%	22%	29%

4	12%	13%	13%		16%	16%	16%
5	20%	26%	23%		25%	33%	29%
6	22%	25%	23%		27%	31%	29%
7	21%	24%	23%		26%	30%	28%
9	16%	25%	21%		21%	31%	26%
10	28%	24%	26%		35%	30%	32%
11	26%	13%	20%		33%	16%	25%
12	22%	19%	21%		27%	24%	26%
13	14%	22%	18%		18%	28%	23%
14	33%	26%	30%		42%	33%	38%
15	30%	19%	24%		37%	24%	31%
16	26%	20%	23%		33%	25%	29%
17	33%	23%	28%		42%	29%	35%
18	27%	36%	31%		33%	45%	39%
19	19%	32%	26%		24%	40%	32%
20	50%	54%	52%		63%	68%	66%
27	39%	33%	36%		49%	42%	45%
22	53%	49%	51%		66%	61%	64%
23	48%	49%	48%		60%	61%	61%
24	29%	36%	32%		37%	45%	41%
25	31%	49%	40%		39%	61%	50%
26	19%	26%	23%		24%	32%	28%
27	21%	36%	28%		26%	45%	36%
28	27%	39%	33%		34%	49%	42%
29	31%	41%	36%		39%	51%	45%
30	23%	34%	28%		29%	43%	36%
31	24%	29%	26%		30%	36%	33%
32	15%	30%	22%		19%	37%	28%
33	12%	30%	21%		15%	37%	26%
34	14%	38%	26%		18%	48%	33%
35	17%	25%	21%		21%	32%	27%
36	14%	24%	19%		17%	31%	24%
37	45%	51%	48%		57%	65%	61%
38	50%	27%	39%		63%	34%	49%
39	33%	42%	38%		42%	52%	47%
40	34%	30%	32%		43%	38%	40%
41	28%	18%	23%		35%	22%	29%
42	15%	21%	18%		19%	26%	23%
43	25%	12%	19%		32%	15%	23%
44	19%	28%	23%		24%	35%	29%
45	23%	20%	21%		29%	25%	27%

46	19%	13%	16%		23%	17%	20%
47	51%	45%	48%		65%	57%	61%
48	42%	8%	25%		53%	10%	31%
49	25%	39%	32%		32%	49%	40%
50	18%	20%	19%		23%	25%	24%
Average	**27%**	**29%**	**28%**		**34%**	**36%**	**35%**

Summary:

- From the Strategic Research Plan Wild Horse and Burro Management, prepared by The Bureau of Land Management, Wild Horse and Burro Program U.S. Department of Interior Prepared in collaboration with U.S. Geological Survey, Biological Resources Division and Animal and Plant Health Inspection Service, Fort Collins, Colorado October 2003 (revised March 2005).

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.

- LSFO Common Term and Condition for Grazing Permits/Leases:

Unless there is a specific term and condition addressing utilization, the intensity of grazing use will ensure that no more than 50% of the key grass species and 40% of the key browse species current years growth, by weight, is utilized at the end of the grazing season for winter allotments and the end of the growing season for allotments used during the growing season. Application of this term needs to recognize recurring livestock management that includes opportunity for regrowth, opportunity for spring growth prior to grazing, or growing season deferment.

With a total of 143,568 acres of the HMA included in this monitoring effort the results are as follows and included in Map 1 below:

Utilization Range	Acres in HMA Monitoring Area	% of Total Acres Monitored
6 – 20%	5,125	4%
21 – 40%	104,586	73%
41 – 60%	19,002	13%
61 – 80%	14,855	10%

With no available guidance or reference to acceptable utilization by wild horses, this summary uses the LSFO grazing permit/lease Common Term and Condition (stated above) which specifies a 40% and 50% maximum utilization level for browse and herbaceous respectively.

The majority of the acreage monitored is within an acceptable level of utilization of 21 – 40%. However, this does not leave adequate forage available for the authorized winter grazing of sheep.

As Table 1 – HMA Livestock Use Summary indicates authorized livestock use has been voluntarily reduced by permittees to maintain public land grazing sustainability.

The alarming trend is that 23% of the HMA has been utilized by wild horses above the acceptable levels that are applied to livestock grazing (41 – 60% and 61 – 80%), and that the lowest range of utilization (6 – 20%) constitutes the smallest amount of acreage monitored. Given that 2014 was an above average precipitation year with precipitation coming at times for optimal plant growth and fall green up, one could extrapolate that on an average or below average precipitation year the levels and acreage of unacceptable utilization would increase exponentially.

This monitoring data shows that current wild horse population levels and population growth above these current levels are **not acceptable** to accommodate multiple uses of other resources and the long-term sustainability of the range.

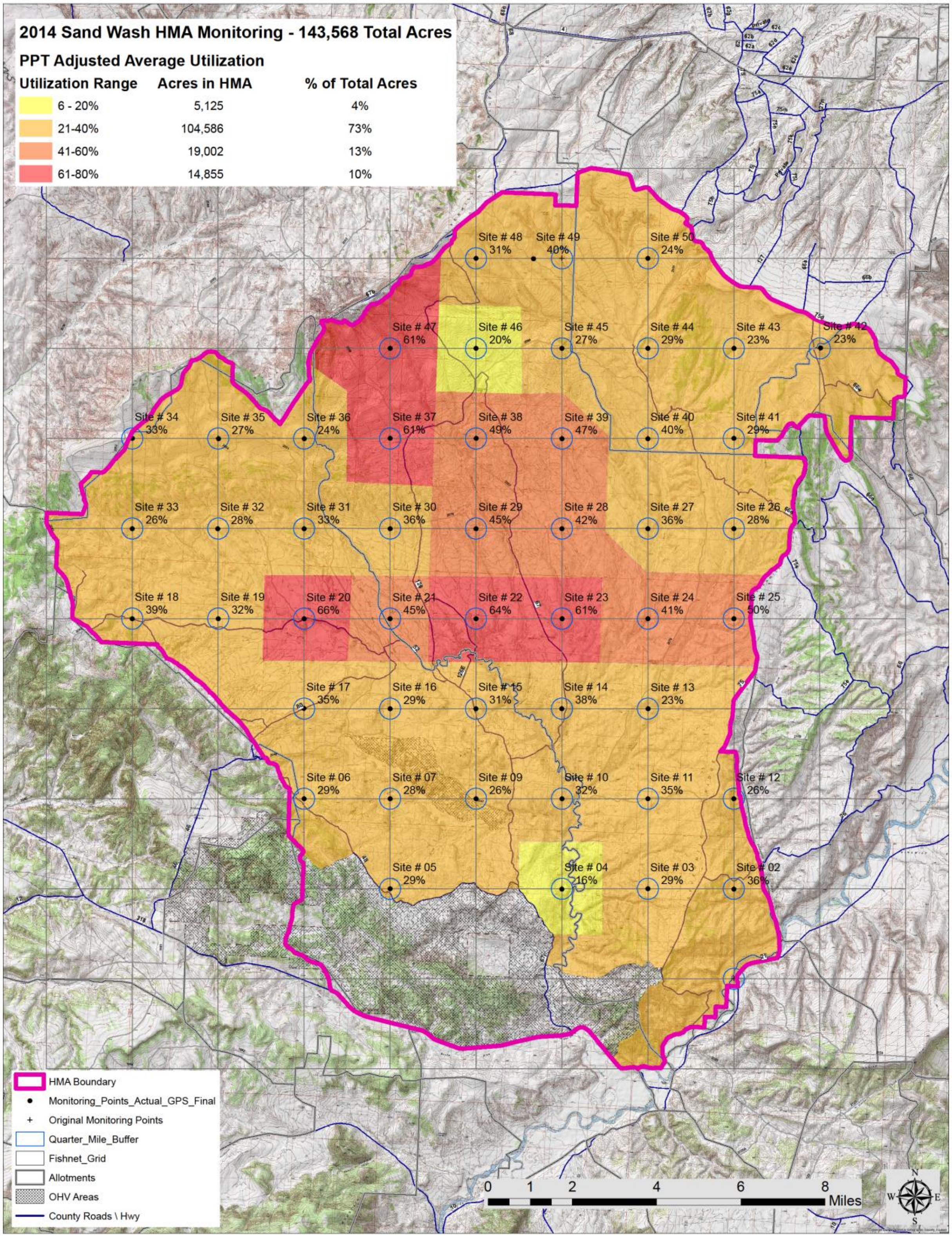
Greater Sage-Grouse (wildlife) Application:

Using the entire 157,730 acres within the HMA administrative boundary, approximately 59% (~93,475 acres) is greater sage-grouse preliminary priority habitat (PPH) as identified by Colorado Parks and Wildlife (CPW). The remainder of the acreage is identified as preliminary general habitat (PGH). The following table displays the wild horse PPT adjusted utilization data within HMA PPH.

Utilization Range	Acres in HMA PPH	% of Total PPH Acres
6 – 20%	4,007	4%
21 – 40%	60,050	64%
41 – 60%	16,893	18%
61 – 80%	12,525	13%

Once again, the alarming trend is that 31% of greater sage-grouse PPH within the HMA has been utilized by wild horses above the acceptable levels that are applied to livestock grazing (41 – 60% and 61 – 80%), and that the lowest range of utilization (6 – 20%) constitutes the smallest amount of acreage monitored. In addition to impacts to greater sage-grouse, this level of utilization going into winter forces big game species that uses these areas as winter habitat to search for alternative sustainable winter habitat.

Map 1



Notes for Map 1: The polygons that delineate the utilization classes displayed on the map and used to calculate acreage were digitized by hand. Each utilization polygon was digitized using a distance approximately halfway between the nearest sampling point of a different utilization class. The ID team agreed that this was an accurate and repeatable method to represent the entire HMA.

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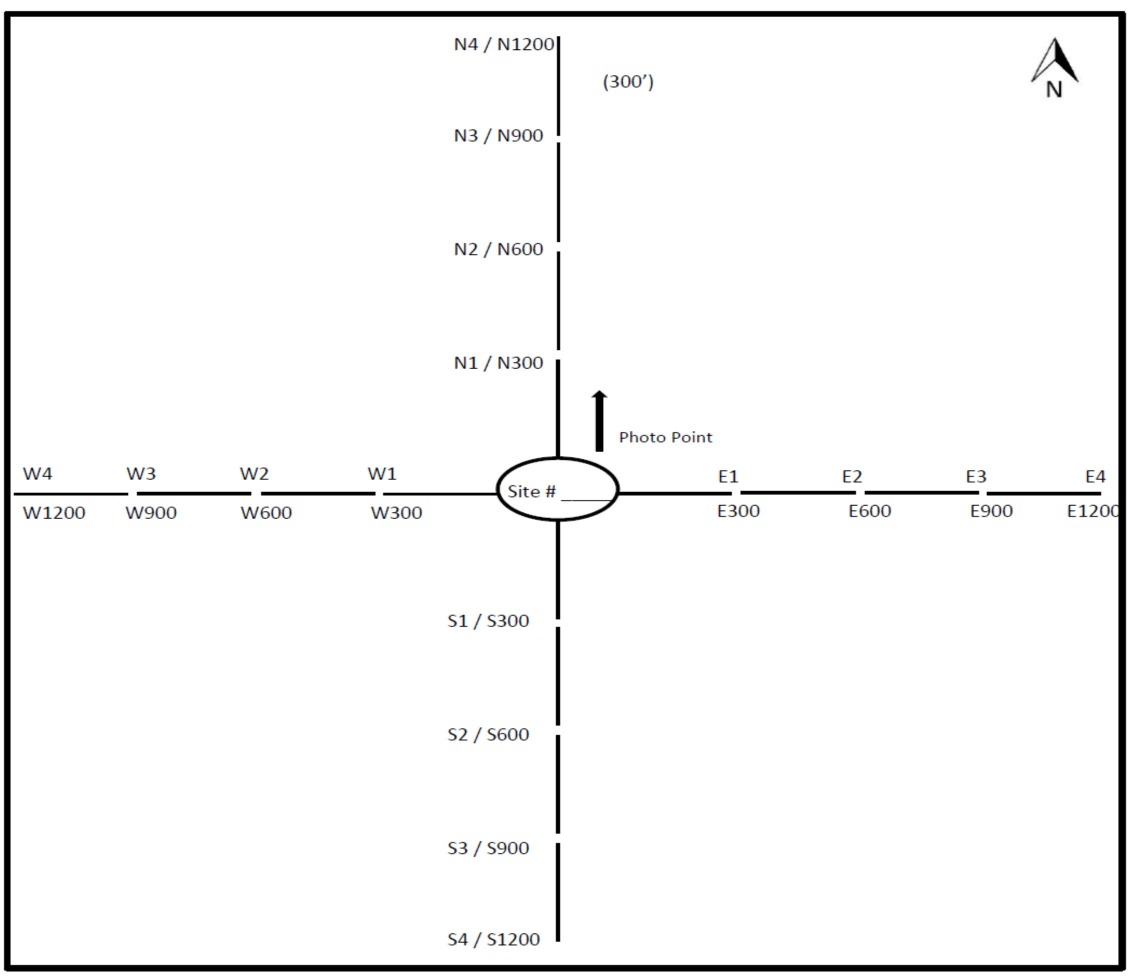
Appendix 1: Site Layout

Site Layout Attachment
Study Location & Documentation Data



- Observation point taken every 300 ft. along trasect. Observation point named after site and transect location. For example Site #32 would be 32N1, 32W2, etc or 32N300, 32N600, etc.
- Photo point taken from center of site location looiing to the north.
- Modify site layout as applicable to site.
- Declination is 15^{0}.

Appendix 2: Crop Year Precipitation Data

Start Year	*End Year*	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Total Precip for Crop-Year**
1988	*1989*	0	0	1.08	0.8	0.3	1.45	0.74	0.14	0.03	0.6	**5.14**
2011	*2012*	0.75	0.82	0.53	0.37	0.38	1.24	0.52	0.61	0.18	0	**5.4**
2001	*2002*	0.49	1.01	1.2	0.37	0.66	0.33	1.58	0.62	0	0.2	**6.46**
2003	*2004*	0.59	0.33	1.53	0.91	0.49	0.63	0.19	0.73	0.58	0.55	**6.53**
1989	*1990*	0.68	0.26	0.75	0.23	0.23	2.12	0.87	1.12	0.31	0	**6.57**
1999	*2000*	0.67	0.31	0.25	0.53	0.74	1.14	1	1.29	0.95	0.05	**6.93**
1962	*1963*	0.26	0.27	0.62	0.26	0.33	0.38	1.34	2.77	0.2	0.54	**6.97**
1960	*1961*	0.33	0.82	1.09	0.39	0.05	0.41	1.56	1.03	1.34	0.05	**7.07**
1965	*1966*	2.3	0.31	1.5	1.48	0.3	0.43	0.28	0.09	0.2	0.22	**7.11**
1968	*1969*	0	0.44	0.57	0.63	1.14	0.85	0.29	1.04	0	2.15	**7.11**
1991	*1992*	0.7	1.2	1.1	0.45	0.25	0.49	0.89	0.69	1.22	0.23	**7.22**
1987	*1988*	0.1	0.63	0.96	0.92	1.56	0.28	0.53	0.68	1.39	0.48	**7.53**
1993	*1994*	0.38	2.38	1.3	0.34	0.43	0.56	0.74	0.93	0.29	0.25	**7.6**
1971	*1972*	1.02	2.36	0.36	0.7	0.19	0.64	0.62	0.98	0.58	0.68	**8.13**
2005	*2006*	1.13	1.75	0.92	0.29	0.74	0.27	1.88	0.94	0.19	0.19	**8.3**
1963	*1964*	0.42	0.32	0.98	0.48	0.85	0.51	1.04	1.78	0.9	1.15	**8.43**
1986	*1987*	2.21	1.24	0.9	0.53	0.91	1.07	1.55	0.22	0.42	0.19	**9.24**
2002	*2003*	1.27	1.3	0.89	0.45	0.62	1.37	1.41	0.3	0.97	0.67	**9.25**
1990	*1991*	0.66	2.06	1.96	0.98	0.24	0.22	1.4	1.03	0.4	0.79	**9.74**
2000	*2001*	1.6	1.1	1.21	0.93	0.45	0.86	0.59	1.21	1.41	0.39	**9.75**
1959	*1960*	3.16	1.85	0.31	0.45	0.37	1.4	0.99	0.44	0.49	0.46	**9.92**

2009	*2010*	0.56	1.29	1.09	1.04	0.34	0.71	1.03	1.87	0.82	1.29	**10.04**
2012	*2013*	1.02	0.32	1.11	2.2	1.19	0.5	0.64	2.38	0.86	0	**10.22**
1969	***1970***	**1.62**	**2.19**	**0.71**	**1.1**	**0.36**	**0.35**	**0.82**	**0.77**	**0.51**	**1.88**	**10.31**
1992	*1993*	0.95	1.03	0.95	0.97	1.21	0.79	1.08	2.16	1.12	0.21	**10.47**
1972	*1973*	1.42	1.49	0.56	1.81	0.34	0.14	0.81	1.28	1.51	1.36	**10.72**
1966	*1967*	1	1.93	0.54	1.89	0.53	0.35	0.38	0.68	1.64	1.98	**10.92**
1973	*1978*	1.08	0.27	0	0	2.1	0.85	2.1	2.71	1.42	0.64	**11.17**
1985	*1986*	0.65	1.94	1.92	0.58	0.21	0.39	1.13	1.49	1.55	1.34	**11.2**
1967	*1968*	0.81	0.36	1.23	2.6	0.29	0.86	0.88	2.58	1.29	0.4	**11.3**
1961	*1962*	3.12	1.33	0.49	0.75	1.18	1.91	0.45	1.1	0.63	0.56	**11.52**
1995	*1996*	1.27	1.05	0.67	0.28	2.06	1.53	0.44	2.89	1.11	0.28	**11.58**
2006	*2007*	1.9	3.36	0.71	0.35	1.29	1.18	0.82	0.51	1.25	0.49	**11.86**
1970	*1971*	1.05	2.77	1.44	0.38	1.67	0.81	0.39	0.71	2.62	0.04	**11.88**
2013	*2014*	2.53	2.11	0.99	1.14	0.66	0.3	1.3	0.86	2.14	0.44	**12.47**
1979	*1984*	0.1	2.64	0.92	0.54	0.71	1.01	1.48	2.19	0.48	2.74	**12.81**
1996	*1997*	0.76	1.67	2.39	0.82	2.21	0.6	0.31	2.16	1.35	0.73	**13**
2004	*2005*	1.07	1.44	0.92	0.37	1.75	1.73	0.6	1.49	1.24	2.42	**13.03**
1998	*1999*	0.43	1.98	0.6	0.62	1	0.92	0.53	5.17	1.95	0.32	**13.52**
1964	*1965*	0.85	0.33	3.04	2.73	1.34	0.41	0.54	1.32	1.74	1.65	**13.95**
1997	*1998*	4.02	2.15	0.54	0.45	0.6	0.8	2.29	0.72	0.27	3.22	**15.06**
2007	*2008*	2.79	1.81	0.1	3.46	1.22	0.95	1.5	0.5	2.24	0.64	**15.21**
2008	*2009*	2.03	0.38	1.1	2.06	1.2	0.11	1.89	2.16	1.44	3.26	**15.63**
1984	*1985*	1.89	2.63	0.69	1.11	1.08	0.33	1.21	3.35	0.68	2.95	**15.92**
2010	*2011*	0.45	1.4	1.79	3.44	0.55	1.03	1.22	3.78	2.03	0.51	**16.2**
1994	*1995*	0.81	1.37	1.52	0.31	0.82	1.47	1.45	2.14	5.15	1.35	**16.39**
1978	*1979*	1.69	0.91	2.81	2.12	0.83	1.63	4.11	1.18	3.27	0.62	**19.17**

Appendix 3: Site Specific Notes

Site #	Comments
1	Abandoned; Site located on Colorado State Land Board parcel
2	Site 2W900 data not collected due to steep shale slope.
5	Three sites on the south leg of this transect were outside of the monitoring area and no data was collected (5S600, 5S900, 5S1200).
7	Site 7W876 was adjusted to stay out of the creek drainage then transect was continued from that point.
15	Site 15N 1090' instead of 1200'; transect continued onto Colorado State Land Board parcel so adjusted length accordingly.
16	No data was collected at site #'s 16N600 and 16N900 as both were located on a barren butte.
18	The south leg of the transect at site #18 wasn't collected because the area went into a reclaimed well pad and then into pinyon/juniper.
19	No observation was made at 19N1200, location was in a rock pile.
20	The interspaces at site #20 were noticeably bear of perennial vegetation. Perennial grasses were primarily found within the protected brush canopy.
27	The east and south transects at site #27 were omitted due to weather limitations that ended the monitoring season.
28	Site #28 had a noticeable lack of desirable herbaceous perennial grasses. When present these species have been utilized. Decline in population may be lost to preferential utilization.
29	No data was collected at Site #29S1200' as it was located on a rock cliff. Within this transect the interspaces were often void of vegetation.
31	Data was not collected at site #31N1200 - location was a rocky flat; Site #31E1149 was adjusted from 1200' due to topography.
32	The variety of aspects along these transects showed noticeable variations in browse use.
33	Site #'s 33W896 and 33W1200 were adjusted due to topography as noted on the site layout.
34	Data was not collected at site #'s 34N600, 34N900, 34N1200 or 34W600, 34W900, 34W1200 as these sites were located outside the fence.

41	No data collected at site #41E1200 due to steep slope.
44	Site #44E261 adjusted due to topography; Site #44S1152 adjusted due to juniper draw.
49	Site # 49 was relocated from original draft layout. Original site was located in steep drainage. Moved to the west to upland area.
50	No data collected at Site #50E900 and #50E1200 due to steep, deep drainage.

2018 Sand Wash Herd Management Area (HMA) Wild Horse Utilization Monitoring

Background: Due to extreme drought and deteriorating vegetative conditions in the Sand Wash HMA it was requested by BLM Management that a repeat of the intensive 2014 Sand Wash Herd Management Area Wild Horse Utilization Monitoring be completed. In 2014 the monitoring was done over the entire HMA (48 different data sites each having a max of 16 data collection sites for a total of 125 acres represented for each data site) during the months from late Sept until Nov. 2014 was an above average precipitation with 2018 being a below average year. Due to time and personnel constraints the BLM elected to collect data on approximately 35 % of the original data set or 17 data points. 2018 data was taken during the week of July 16-20, 2018.

For all references see the 2014 Sand Wash Herd Management Area Wild Horse Utilization Monitoring Summary, attached.

Data was taken every three sites starting at the 2014 #3 site then #6, #9, #12, etc… we were able to get one more site completed #50. This method represented the entire HMA with the limited time allowed for data collection (see map).

Precipitation Adjustment Summary
Precipitation is a significant factor affecting annual rangeland production levels. In summarizing the utilization data for the HMA, this precipitation-yield factor was included to represent this annual variability. The method used was based on the USDA bulletin listed below.

Adjusting and Forecasting Herbage Yields in the Intermountain Big Sagebrush Region of the Steppe Province, Station Bulletin 659, August 1983, Agricultural Experiment Station, Oregon State University, Corvallis in cooperation with Agricultural Research Service U.S. Department of Agriculture.
(https://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/15797/StationBulletin659.pdf?sequence=1)

Using the precipitation data shown in the climate section, the following formulas and values were used to extrapolate the precipitation adjusted utilization levels.

- The Long Term Median (LTM) for Sand Wash was based on 47 years of data (see chart in climate section). The years with null values were excluded from the calculation. The data was converted to the crop year precipitation received between September through June of the following year as shown in Appendix 2. The LTM for this area was 10.31 inches.

- The 2017-18 Current Year Precipitation (CYP) was 8.58 inches.

- Using the LTM and CYP the Precipitation Index (PI) was computed as follows:
  PI = (CYP / LTM) x 100
  (8.58 / 10.47) x 100 = 82%
- Using this PI and Table 2 from the bulletin a Yield Index (YI) can be determined. The PI of 82% equals a YI of 78% using this method.

- The Utilization level can then be adjusted using the YI. The calculation for this adjustment is:
  Adjusted Utilization = Utilization Estimated x YI x 100

  This calculation is found for each site in the Sand Wash utilization data.

Precipitation in the 2017-2018 growing season was around 80% of normal. Using the YI to adjust the utilization calculations results in a lower utilization value because less forage was produced in 2018 compared to an average year.

Climate:

The following precipitation data was used for the precipitation adjustment to the utilization data. The data is from the Western Regional Climate Center.

MAYBELL, CO

Total of Precipitation (Inches)

(055446)

File last updated on July 18, 2018
a = 1 day missing, b = 2 days missing, c = 3 days, ..etc..,
z = 26 or more days missing, A = Accumulations present
Long-term means based on columns; thus, the monthly row may not
sum (or average) to the long-term annual value.
MAXIMUM ALLOWABLE NUMBER OF MISSING DAYS : 5
Individual Months not used for annual or monthly statistics if more than 5 days are missing.
Individual Years not used for annual statistics if any month in that year has more than 5 days missing.

YEAR (S)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1958	-----z	-----z	-----z	-----z	-----z	0.09k	0.45	0.13	1.34	0.06	0.62	0.21	2.81f
1959	0.16	1.26	0.56	0.19	0.72	1.44	0.14	0.71	3.16	1.85	0.31	0.45	10.95
1960	0.37	1.40	0.99	0.44	0.49	0.46	0.30	0.76	0.33	0.82	1.09	0.39	7.84
1961	0.05	0.41	1.56	1.03	1.34	0.05	0.49	0.61	3.12	1.33	0.49	0.75	11.23
1962	1.18	1.91	0.45	1.10	0.63	0.56	0.05	0.16	0.26	0.27	0.62	0.26	7.45
1963	0.33	0.38	1.34	2.77	0.20	0.54	0.39	2.46	0.42	0.32a	0.98	0.48	10.61
1964	0.85	0.51	1.04	1.78	0.90	1.15	0.27	0.86	0.85	0.33	3.04	2.73	14.31
1965	1.34	0.41	0.54	1.32	1.74	1.65	1.95	1.47	2.30	0.31	1.50	1.48	16.01
1966	0.30	0.43	0.28	0.09	0.20	0.22	0.41	1.27	1.00	1.93	0.54	1.89	8.56
1967	0.53	0.35	0.38	0.68	1.64	1.98	0.37	0.31	0.81l	0.36	1.23	2.60	10.43a
1968	0.29	0.86	0.88	2.58	1.29	0.40	0.80	2.19	-----z	0.44	0.57	0.63	10.93a
1969	1.14	0.85	0.29	1.04	0.00	2.15	1.06	0.70	1.62	2.19	0.71	1.10	12.85
1970	0.36	0.35	0.82	0.77	0.51	1.88	0.74	0.11	1.05	2.77	1.44	0.38	11.18
1971	1.67	0.81	0.39	0.71	2.62	0.04	0.34	0.29	1.02	2.36	0.36	0.70a	11.31
1972	0.19	0.64	0.62	0.98	0.58	0.68	0.40	1.36	1.42	1.49	0.56	1.81	10.73
1973	0.34	0.14	0.81	1.28	1.51	1.36	1.60q	0.87	1.08	0.27	-----z	-----z	7.66c
1974	0.30p	0.19	1.06	1.01	0.03	1.92	1.33	0.19	0.32	-----z	-----z	-----z	6.05d
1975	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00l
1976	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00l
1977	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.82l	1.03	2.80	0.70	4.53i
1978	2.10	0.85	2.10	2.71	1.42	0.64	0.40	1.27	1.69	0.91	2.81	2.12	19.02
1979	0.83	1.63	4.11	1.18	3.27	0.62	1.07	1.36	0.10	2.64	0.92	0.54a	18.27
1980	2.15	1.79	2.39	1.49	2.72	-----z	-----z	-----z	-----z	-----z	-----z	-----z	10.54g
1981	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00l
1982	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	-----z	0.00l
1983	-----z	-----z	0.29	0.67g	2.28	1.04	1.69	0.98	0.71	2.01	2.18	3.25	14.43c

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1984	0.71	1.01	1.48 a	2.19 e	0.48	2.74	1.48	1.72	1.89 g	2.63 e	0.69	1.11	16.24 a
1985	1.08	0.33 b	1.21 a	3.35 b	0.68 i	2.95	2.92	0.051	0.65 b	1.94	1.92	0.58 a	16.93 b
1986	0.21	0.39 a	1.13	1.49 d	1.55	1.34	1.88	0.37 c	2.21 t	1.24 f	0.90	0.53 a	9.79 b
1987	0.91	1.07	1.55 a	0.22	0.42 b	0.19 x	0.97	1.52	0.10 a	0.63	0.96	0.92	9.27 a
1988	1.56	0.28	0.53	0.68	1.39	0.48	0.12	0.96	-----z	0.00	1.08	0.80 b	7.88 a
1989	0.30	1.45	0.74 a	0.14	0.03	0.60	0.67	0.22 f	0.68	0.26	0.75	0.23	5.85 a
1990	0.23	2.12	0.87	1.12	0.31	-----z	0.35 g	0.26	0.66 b	2.06	1.96	0.98	10.57 b
1991	0.24	0.22	1.40	1.03 c	0.40	0.79	0.83	1.02 a	0.70	1.20	1.10	0.45	9.38
1992	0.25	0.49	0.89	0.69	1.22	0.23	2.40	0.36	0.95	1.03	0.95	0.97 b	10.43
1993	1.21	0.79 b	1.08 a	2.16	1.12	0.21	0.53	0.15 a	0.38	2.38	1.30	0.34	11.65
1994	0.43	0.56	0.74	0.93	0.29	0.25	0.00	1.67	0.81 a	1.37	1.52	0.31	8.88
1995	0.82	1.47	1.45	2.14	5.15	1.35	0.91	0.63	1.27 b	1.05	0.67	0.28	17.19
1996	2.06	1.53	0.44	2.89	1.11	0.28	1.00	0.83	0.76	1.67 e	2.39	0.82	15.78
1997	2.21 a	0.60	0.31	2.16	1.35 a	0.73 e	0.61	2.73	4.02	2.15 d	0.54	0.45	17.86
1998	0.60	0.80	2.29 a	0.72	0.27 a	3.22 c	1.87	0.34	0.43 c	1.98	0.60	0.62	13.74
1999	1.00	0.92 d	0.53	5.17	1.95 a	0.32 h	0.77 a	0.93	0.67 c	0.31 d	0.25	0.53	13.03 a
2000	0.74	1.14	1.00	1.29	0.95 c	0.05	0.36	0.38	1.60 e	1.10	1.21	0.93	10.75
2001	0.45	0.86	0.59	1.21	1.41	0.39	0.30	1.33	0.49 c	1.01	1.20	0.37	9.61
2002	0.66	0.33	1.58	0.62	0.00	0.20	0.86	0.85	1.27	1.30	0.89 a	0.45 a	9.01
2003	0.62	1.37	1.41	0.30 e	0.97	0.67	0.03	1.01	0.59	0.33	1.53	0.91	9.74
2004	0.49	0.63	0.19	0.73 i	0.58	0.55	1.12	0.46	1.07	1.44 f	0.92	0.37 a	6.38 b
2005	1.75 b	1.73	0.60	1.49	1.24	2.42	0.13	0.62 b	1.13	1.75 c	0.92	0.29	14.07
2006	0.74	0.27	1.88	0.94	0.19	0.19	0.37	1.06	1.90	3.36 g	0.71	0.35	8.60 a
2007	1.29	1.18	0.82	0.51	1.25	0.49	0.56	0.74 a	2.79	1.81	0.10	3.46	15.00
2008	1.22 a	0.95	1.50	0.50	2.24	0.64 d	0.09 a	0.91	2.03	0.38	1.10 a	2.06	13.62
2009	1.20 j	0.11	1.89	2.16	1.44	3.26	0.28 b	1.30	0.56	1.29	1.09	1.04	14.42 a
2010	0.34	0.71	1.03 b	1.87	0.82	1.29	0.47	1.79	0.45	1.40	1.79	3.44	15.40
2011	0.55	1.03	1.22	3.78	2.03	0.51	1.50	0.85	0.75	0.82	0.53 e	0.37	13.94
2012	0.38	1.24	0.52	0.61	0.18	0.00	0.15	0.09	1.02	0.32	1.11	2.20	7.82
2013	1.19	0.50	0.64	2.38	0.86	0.00	0.57	0.55	2.53	2.11	0.99	1.14	13.46
2014	0.66	0.30	1.30	0.86	2.14	0.44	0.26	2.94	2.09	1.26	1.14	1.11	14.50
2015	0.34	0.29	1.02	0.96	3.30	0.42	0.86	0.78	0.85	0.76	2.21	1.85	13.64
2016	1.07	1.30	1.87	0.83	1.36	0.27	0.96	0.48	1.01	0.69	1.30	1.33	12.47
2017	2.61	2.40	0.95	1.29	1.78 c	0.20	0.34	0.29	0.92	1.79 a	0.97	0.36	13.90
2018	1.03	0.64 i	1.21 r	1.27	0.39	0.00	-----z	-----z	-----z	-----z	-----z	-----z	2.69 h
Period of Record Statistics													
MEAN	0.85	0.86	1.07	1.38	1.19	0.90	0.75	0.92	1.16	1.22	1.13	1.03	12.49
S.D.	0.62	0.55	0.68	0.99	0.99	0.88	0.63	0.66	0.85	0.78	0.66	0.86	3.08
SKEW	1.03	0.77	1.83	1.49	1.50	1.27	1.40	1.16	1.42	0.21	1.15	1.45	0.28
MAX	2.61	2.40	4.11	5.17	5.15	3.26	2.92	2.94	4.02	2.77	3.04	3.46	19.02
MIN	0.05	0.11	0.19	0.09	0.00	0.00	0.00	0.09	0.10	0.00	0.10	0.21	7.45
YRS	52	53	54	53	54	51	52	52	49	51	53	53	37

Using this data we can also specifically look at the timing of precipitation. Timing of precipitation can largely influence plant growth and re-growth, especially into late-summer and fall. The following table compares the long term average monthly precipitation to the timing of the 2018 precipitation by month. Significant below average moisture is seen during June of 2018 during that plant growth period.

Month	Average Precipitation (in.) 1959-2014	2018 Precipitation (in.)	% of Average
January	0.73	1.03	140%
February	0.76	0.64	84%
March	0.96	1.21	126%
April	1.29	1.27	99%
May	1.02	0.39	38%
June	0.82	0	0%
July	0.69	--	--
August	0.89	--	--
September	1.11	--	--
October	1.22	--	--
November	1.06	--	--
December	0.99	--	--

Results:

Below is the summary table for data collected. The first three columns from left to right are the raw data as collected for both herbaceous and browse and then averaged. The precipitation adjusted utilization data is shown to the right. Adjusted data is used for the summary and map 1.

2018 Sand Wash HMA Monitoring										
				Utilization adjusted for Precipitation						
				(Utilization * YI)	(see precipitation summary)			Difference from 2014 (adj for ppt)		
Site #	**% Utilization Herbaceous**	**% Utilization Browse**	**Average**	**Adjusted % Utilization Herbaceous**	**Adjusted % Utilization Browse**	**Average**		**2014**	**2018**	**Difference**
1										
2										
3	31%	54%	43%	24%	42%	33%		29%	33%	4%
4										
5										
6	50%	35%	42%	39%	27%	33%		29%	33%	4%
7										
9	36%	65%	50%	28%	50%	39%		26%	39%	13%
10										
11										
12	44%	64%	54%	34%	50%	42%		26%	42%	16%
13										
14										
15	54%	50%	52%	42%	39%	41%		31%	41%	10%
16										
17										
18	42%	53%	48%	33%	42%	37%		39%	37%	-2%
19										
20										
21	42%	76%	59%	33%	59%	46%		45%	46%	1%
22										
23										
24	50%	50%	50%	39%	39%	39%		41%	39%	-2%
25										
26										
27	55%	60%	57%	43%	47%	45%		36%	45%	9%
28										
29										
30	62%	73%	68%	48%	57%	53%		36%	53%	17%
31										
32										
33	29%	54%	41%	22%	42%	32%		26%	32%	6%
34										
35										
36	68%	56%	62%	53%	44%	49%		24%	49%	25%
37										
38										
39	55%	60%	57%	43%	47%	45%		47%	45%	-2%
40										
41										
42	26%	40%	33%	20%	31%	26%		23%	26%	3%
43										
44										
45	49%	53%	51%	39%	41%	40%		27%	40%	13%
46										
47										
48	75%	33%	54%	59%	26%	42%		31%	42%	11%
49										
50	47%	34%	41%	37%	27%	32%		24%	32%	8%
Average	**48%**	**54%**	**51%**	**37%**	**42%**	**40%**		**32%**	**40%**	**8%**

Summary:

- From the Strategic Research Plan Wild Horse and Burro Management, prepared by The Bureau of Land Management, Wild Horse and Burro Program U.S. Department of Interior Prepared in collaboration with U.S. Geological Survey, Biological Resources Division and Animal and Plant Health Inspection Service, Fort Collins, Colorado October 2003 (revised March 2005).

  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.

- LSFO Common Term and Condition for Grazing Permits/Leases:
  Unless there is a specific term and condition addressing utilization, the intensity of grazing use will ensure that no more than 50% of the key grass species and 40% of the key browse species current years growth, by weight, is utilized at the end of the grazing season for winter allotments and the end of the growing season for allotments used during the growing season. Application of this term needs to recognize recurring livestock management that includes opportunity for regrowth, opportunity for spring growth prior to grazing, or growing season deferment.

With a total of 45,921 acres of the HMA represented with the 17 data points included in this monitoring effort the results are as follows and included in Map 1 below:

Utilization Range	Acres in HMA Monitoring Area	% of Total Acres Monitored
6 – 20%	0	0
21 – 40%	24,924	54%
41 – 60%	20,997	46%
61 – 80%	0	0

With no available guidance or reference to acceptable utilization by wild horses, this summary uses the LSFO grazing permit/lease Common Term and Condition (stated above) which specifies a 40% and 50% maximum utilization level for browse and herbaceous respectively.

By a narrow margin the majority of acreage monitored is within an acceptable level of utilization of 21 – 40%. However, this does not leave adequate forage available for the authorized winter grazing of sheep. As Table 1 in the 2014 Summary indicates authorized livestock use has been voluntarily reduced by permittees to maintain public land grazing sustainability.

The alarming trend is that 46% of the representative area monitored in 2018 has been utilized by wild horses above the acceptable levels that are applied to livestock grazing (41 – 60%).

Other points of interest from the 2018 monitoring:

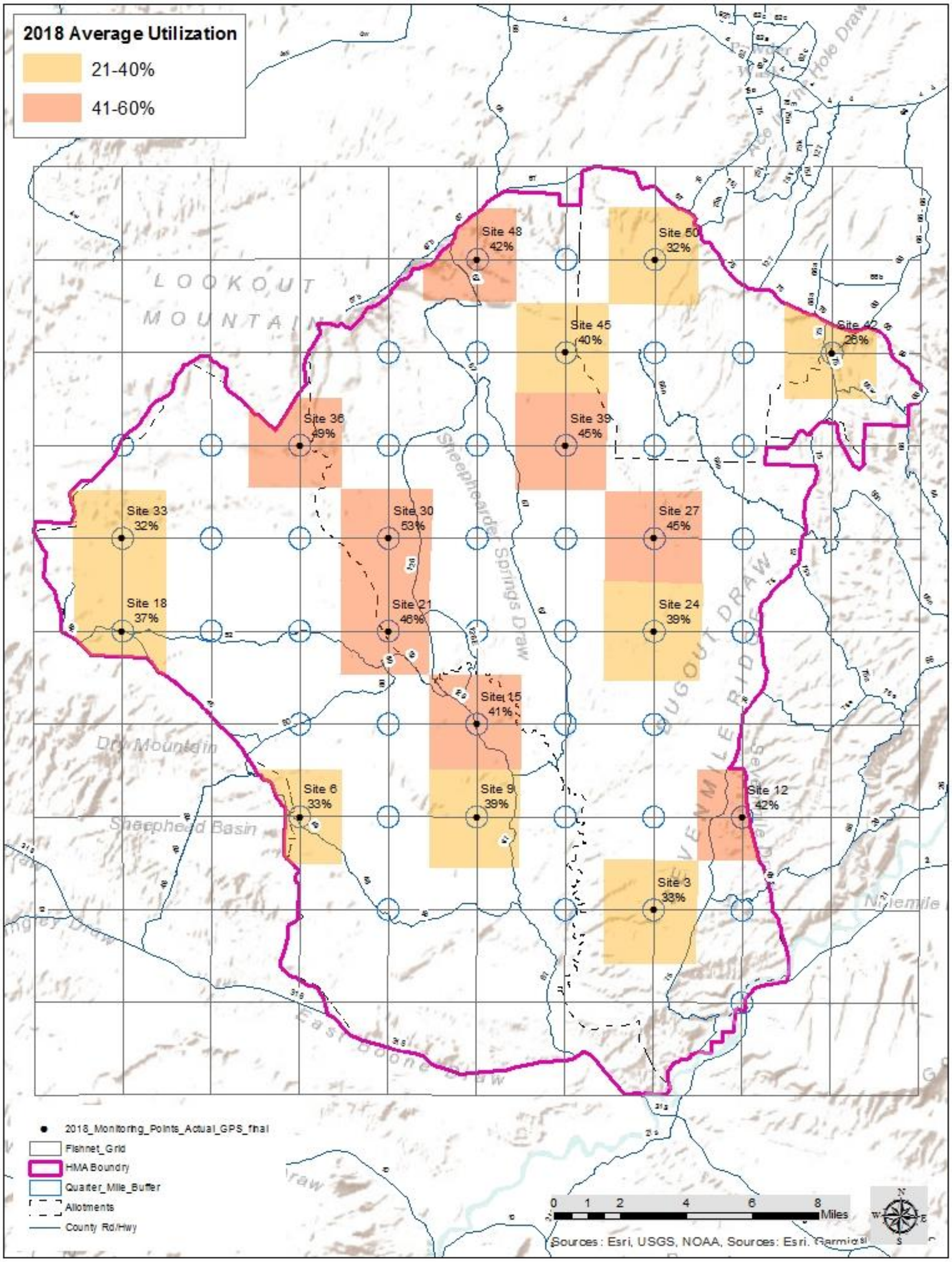
2014 – data was taken 2-4 months later in the year, yet for the same points taken in 2014 we are seeing a 8% increase earlier in the season.

In 2018, 15 herbaceous data collection points were not taken due to lack of vegetation or cheatgrass – less perennial grasses are present than 2014. And 10 browse data collection points were not taken due to lack of vegetation – less browse forage available than 2014.

Looking at the raw data (not adjusted for ppt.) all but one 2018 sites is above acceptable utilization levels.

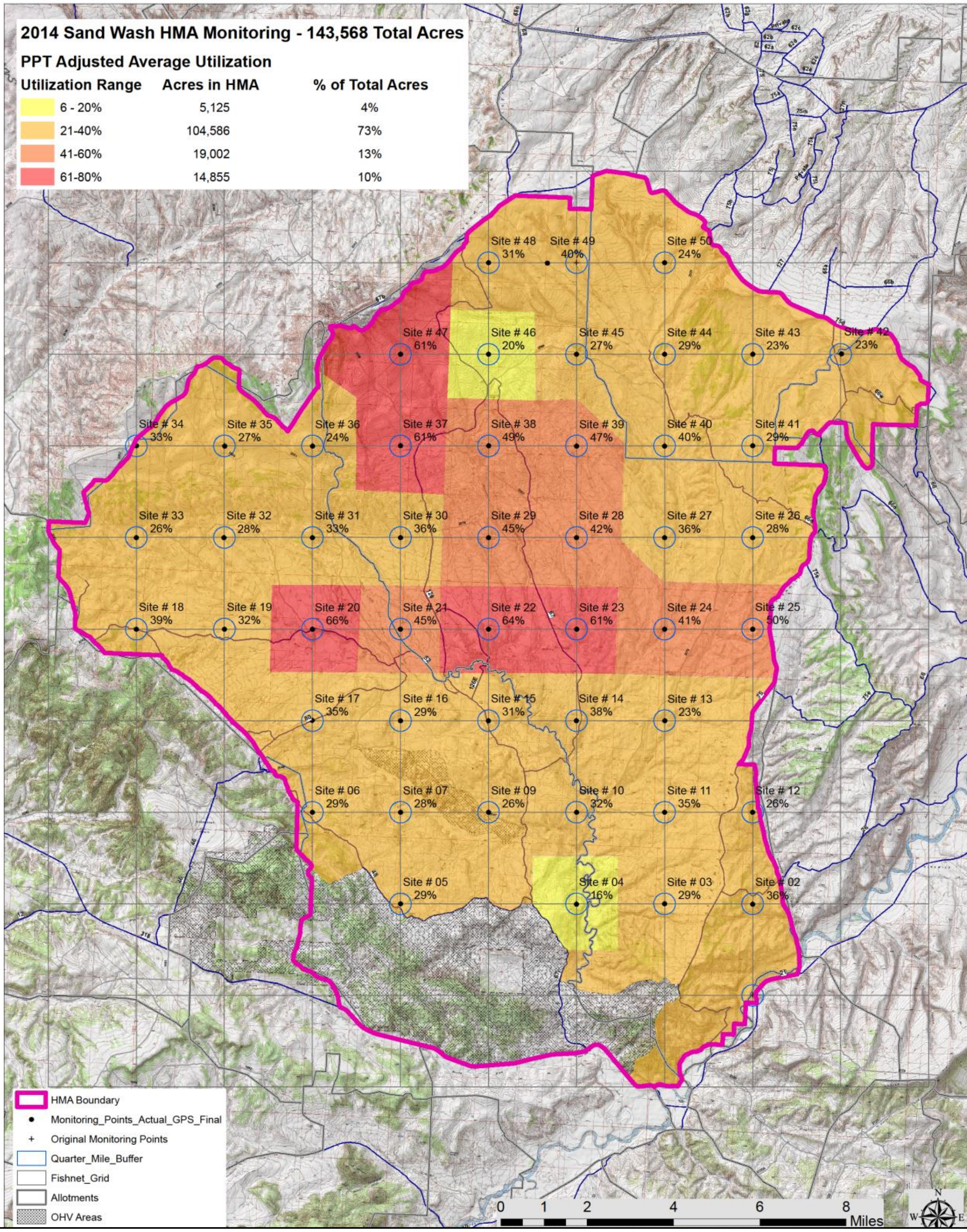
This monitoring data shows that current wild horse population levels and population growth above these current levels are **not acceptable** to accommodate multiple uses of other resources and the long-term sustainability of the range.

Map 1


2018 Average Utilization
21-40%
41-60%
LOOKOUT MOUNTAIN
Site 48
42%
Site 50
32%
Site 45
40%
Site 42
26%
Site 36
49%
Site 39
45%
Site 33
32%
Site 30
53%
Site 27
45%
Site 18
37%
Site 21
46%
Site 24
39%
Site 15
41%
Site 6
33%
Site 9
39%
Site 12
42%
Site 3
33%
Sheepheard Springs Draw
Dry Mountain
Sheephead Basin
East Boone Draw
LOOKOUT DRAW
SEVEN MILE RIDGE
2018_Monitoring_Points_Actual_GPS_final
Fishnet_Grid
HMA Boundry
Quarter_Mile_Buffer
Allotments
County Rd/Hwy
0 1 2 4 6 8 Miles
Sources: Esri, USGS, NOAA, Sources: Esri, Garmin

Notes for Map 1: The polygons that delineate the utilization classes displayed on the map and used to calculate acreage were digitized by hand. Each utilization polygon was digitized using a distance approximately halfway between the nearest sampling point of a different utilization class. The ID team agreed that this was an accurate and repeatable method to represent the entire HMA.

Map 2



Notes for Map 2: The polygons that delineate the utilization classes displayed on the map and used to calculate acreage were digitized by hand. Each utilization polygon was digitized using a distance approximately halfway between the nearest sampling point of a different utilization class. The ID team agreed that this was an accurate and repeatable method to represent the entire HMA.

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APPENDIX J: GENETICS REPORTS

Genetic Analysis of the Sand Wash, CO
feral horse population

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4-16-02

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The following is a report of the genetic analysis of the Sand Wash, CO feral horse population

METHODS

A total of 50 blood samples were received by the Univ. of Kentucky on October 11, 2001. Seventeen genetic marker systems were analyzed. Seven systems were red blood cell alloantigen loci (the *A, C, D, K, P, Q,* and *U* horse blood groups) tested by standard serological methods of aggulutination and compliment mediated hemoloysis. The other 10 systems were biochemical polymorphisms detected by electrophoretic techniques. These systems were Albumin (*ALB*), Alpha-1-beta Glycoprotein (*A1B*), Serum Cholinesterase (*ES*), Vitamin D Binding Protein (*GC*), Glucose Phosphate Isomerase (*GPI*), Alpha Hemoglobin (*BH*), Phosphoglucomutase (*PGM*), Phosphogluconate Dehydrogenase (PGD), Protease Inhibitor (*PI*), and Transferrin (*TRF*). In addition to the above genetic systems, DNA was extracted from the blood samples and tested for variation at 12 equine microsatellite (mSat) systems. These were *AHT4, AHT5, ASB2, ASB17, ASB23, HMS3, HMS6, HMS7, HTG4, HTG10, LEX33*, and *VHL20*. These systems were tested using an automated DNA sequencer to separate Polymerase Chain Reaction (*PCR*) products.

A variety of genetic variability measures were from the gene marker data. The measures were observed heterozygosity (*Ho*) which is the actual number of loci heterozygous per individual and is based upon biochemical loci only; expected heterozygosity (He) which is the predicted number of heterozygous loci based upon gene frequencies and was calculated for biochemical loci and all marker systems (*Het*) effective number of alleles, (*Ae*) which is the measure of marker system diversity; total number of variants (*TNV*); and estimated inbreeding level (*FIS*) which is calculated as 1-Ho/He. These same measures were calculated for the mSat data.

Genetic markers can also provide information about ancestry in some cases. Genetic resemblance to domestic horse breeds was calculated using Rogers' genetic similarity coefficient, S. This resemblance was summarized by use of a restricted maximum likelihood (*RML*) procedure.

RESULTS AND DISCUSSION

Variants present and allele frequencies for the blood group and biochemical markers are given in Table 1. No variants were observed which have not been seen in horse breeds. Table 2 gives the values for the genetic variability measures of the Sand Wash horse herd. Also shown in Table 2 are values for other Colorado feral horse populations. Mean values for feral herds (based upon data from 54 herds) and mean values for domestic breeds (based upon 118 domestic horse populations) are also shown.

Mean genetic similarity of the Sand Wash herd to domestic horse breed types are shown in Table 3. A dendrogram of relationship of the Sand Wash herd to a standard set of domestic breeds are shown in Figure 1. This is a consensus tree from 20 individual *RML* runs. The numbers in the tree are the number of runs where the grouping to the right of the number occurred. Figure 2 shows the relationships among Colorado feral herds.

Genetic variants. A total of 63 variants were observed in 2001. This is a decrease from the 71 seen in 1995. Two of the variants reported in 1995 could have been present in the 2001 sample but simply were not observed in a phenotype that made detection possible. There actually were 12 variants present in 1995 not seen in 2001 and 4 from 2001 not seen in 1995. All the variants that differed between the two samplings were at low frequency. Thus, the difference could simply be due to sampling error. However, because some of these variants were at very low frequency in 1995 they may have been lost from the population. In the current population sample, 12 of the 63 variants had frequencies less than 0.05 and are at risk of loss.

Genetic variation. Individual genetic variability (*Ho*) of the Sand Wash herd is above the average for both feral and domestic horses as are the populational variation measures (*He, Het, TNV* and *Ae*). The Sand Wash herd also has the highest genetic variation of any of the herds from Colorado that have been tested. Variability of the Sand Wash herd has decreased since 1995. This is primarily evident in *Ho* and total heterozygosity (*Het*). This does not appear to be due to the reduction in number of variants as allelic diversity as measured by *Ae* actually is higher in 2001. This indicates a greater evenness in allele frequencies and this is why there is little change in *He* from 1995 to 2001.

Genetic variation of DNA systems gives a similar picture. DNA based *Ho* was relatively high at 0.730 compared to a feral horse mean of 0.696 (SD = 0.049) and a domestic horse mean of 0.717 (SD = 0.063). Populational measures were similarly high. In contrast to the biochemical eata, there was an excess of observed to expected heterozygosity but the value (*Fis* = -0.007) was not statistically significantly different from zero. The percentage of rare microsatellite alleles was nearly 31%.

Genetic similarity. The Sand Wash herd has its highest mean genetic similarity with New World Iberian breeds, but if all Iberian breeds are included (as in Table 3) the highest similarity was with the North American Gaited breeds. The summary of the total similarity data represented by the RML tree of figure 1 places the Sand Wash herd within the cluster of North American breeds. The variants present in the herd suggest a somewhat mixed origin. The *TRF-F1* variant suggest some type of ranch stock (probably Quarter Horse) while the *PI-V* is Spanish. The *TRF-F3* and *Ddek* are probably of Spanish origin but are also common in American breeds such as the Saddlebred and Morgan.

In comparison to other Colorado herds, the Sand Wash herd is most similar to the Little Bookcliffs herd (the 2001 sample from Sand Wash is most like the 1995 Sand Wash sample as would be expected). This is not consistent with geographic proximity and probably indicates independent origins for all the major HMAs.

SUMMARY

The 2001 Sand Wash herd has high genetic diversity and an individual genetic variation level equivalent to that of domestic horses. Genetic variation was lower in 2001 than observed in 1995, (a reduction in *Ho* of about 5%). With the information available, it is difficult to interpret the loss of variation. It is not simply due to a loss of alleles because *Ae* has actually increased which indicates greater evenness in allele frequencies in 2001 as compared to 1995. However, *He* did increase slightly indicating some loss of populational variation. Inbreeding does not appear to be significant at this point but the *Fis* value from biochemical loci has increased suggesting that there could be an increase in inbreeding. DNA does not suggest any inbreeding.

The genetic similarity cluster analysis and variants present in the Sand Wash herd suggest a mixed origin of the herd with a primary input from North American breeds. There does appear to be some contribution from Spanish type breeds. This is partially due to the Spanish horse contributions to the North American breeds but specific variants observed in the herd suggest there may be some direct contribution from Iberian derived breeds to the ancestry of the Sand Wash herd (although the direct contribution may be quite limited or may be well in the past).

RECOMMENDATIONS

> No immediate action is necessary for the Sand Wash herd. However, due to the loss of variation observed from 1995 to 2001 this herd should continue to be monitored. Variability is high enough currently that a low rate of loss of variability could be tolerated for some time before variation would reach a level that is cause for concern. A population size in excess of 100 adult animals should keep the rate of variation at an acceptable level.

Table 1. Allele frequency for variants observed within the Sand Wash, CO HMA in 2001.

System/Allele		Frequency
Tf	D	.210
	F1	.020
	F2	.430
	F3	.060
	H2	.020
	O	.080
	R	.180
A1B	K	.950
	S	.050
Es	F	.260
	G	.100
	I	.510
	L	.130
Al	A	.290
	B	.710
Gc	F	.970
	S	.030
PGD	D	.040
	F	.870
	S	.090
PGM	F	.260
	S	.740
GPI	F	.030
	I	.950
	S	.020
Hb	AII	.040
	BI	.590
	BII	.370
Pi	L	.280
	L2	.090
	N	.110
	P	.010
	S	.120
	T	.230
	U	.140
	V	.020
A	adf	.373
	adg	.106
	b	.190
	-	.331
C	a	.970
	-	.030
D	ad	.060
	d	.042
	dk	.144
	dghm	.110
	de	.132
	deo	.327
	dek	.020
	dfk	.085
	cgm	.027
	cegi	.053
K	-	1.000
P	ac	.109
	ad	.109

Table 2. Measures of genetic variation of feral horse herds from Colorado and mean values for North American Feral horses and Domestic horse breeds

Herd	*N*	*Ho*	*He*	*Het*	*Fis*	*TNV*	*Ae*
Sand Wash 2001	50	0.372	0.398	0.425	0.065	63	2.541
Sand Wash	72	0.390	0.401	0.450	0.027	71	2.529
Spring Creek Basin	75	0.332	0.331	0.366	-0.004	58	2.038
Barcus Creek WRRA	37	0.311	0.348	0.364	0.107	56	1.972
Greasewood WRRA	11	0.345	0.287	0.298	-0.202	41	1.752
Hammond WRRA	9	0.322	0.286	0.322	-0.127	38	1.817
Little Duck Creek WRRA	15	0.287	0.327	0.347	0.123	47	1.873
84 Mesa WRRA	18	0.340	0.383	0.349	0.112	54	2.046
Spring Creek WRRA	5	0.300	0.248	0.265	-0.210	30	1.664
Square S Well WRRA	16	0.313	0.304	0.312	-0.025	44	1.917
West Fork Spring Creek WRRA	15	0.371	0.392	0.364	0.053	43	2.127
West Douglas	32	0.269	0.285	0.356	0.058	57	2.202
Little Bookcliffs	50	0.300	0.299	0.389	-0.004	59	2.322
Feral Horse Mean	54	0.360	0.351	0.385	-0.035	53.50	2.218
Standard Deviation		0.051	0.053	0.067	0.118	12.50	0.339
Domestic Horse Mean	118	0.371	0.365	0.414	-0.014	65.40	2.358
Standard Deviation		0.049	0.043	0.035	0.065	11.10	0.253

Table 3. Rogers' genetic similarity of the Sand Wash feral horse herd to major groups of domestic horses.

	Mean *S*	Std	Minimum	Maximum
Light Racing and Riding Breeds	0.822	0.028	0.762	0.871
Oriental and Arabian Breeds	0.836	0.028	0.784	0.884
Iberian Breeds	0.841	0.026	0.800	0.877
North American Gaited Breeds	0.843	0.039	0.780	0.887
Heavy Draft Breeds	0.799	0.037	0.715	0.848
True Pony Breeds	0.801	0.030	0.748	0.857

Figure 1. Partial RML tree of genetic similarity of the Sand Wash feral horse herd to a selected group of domestic horse breeds.

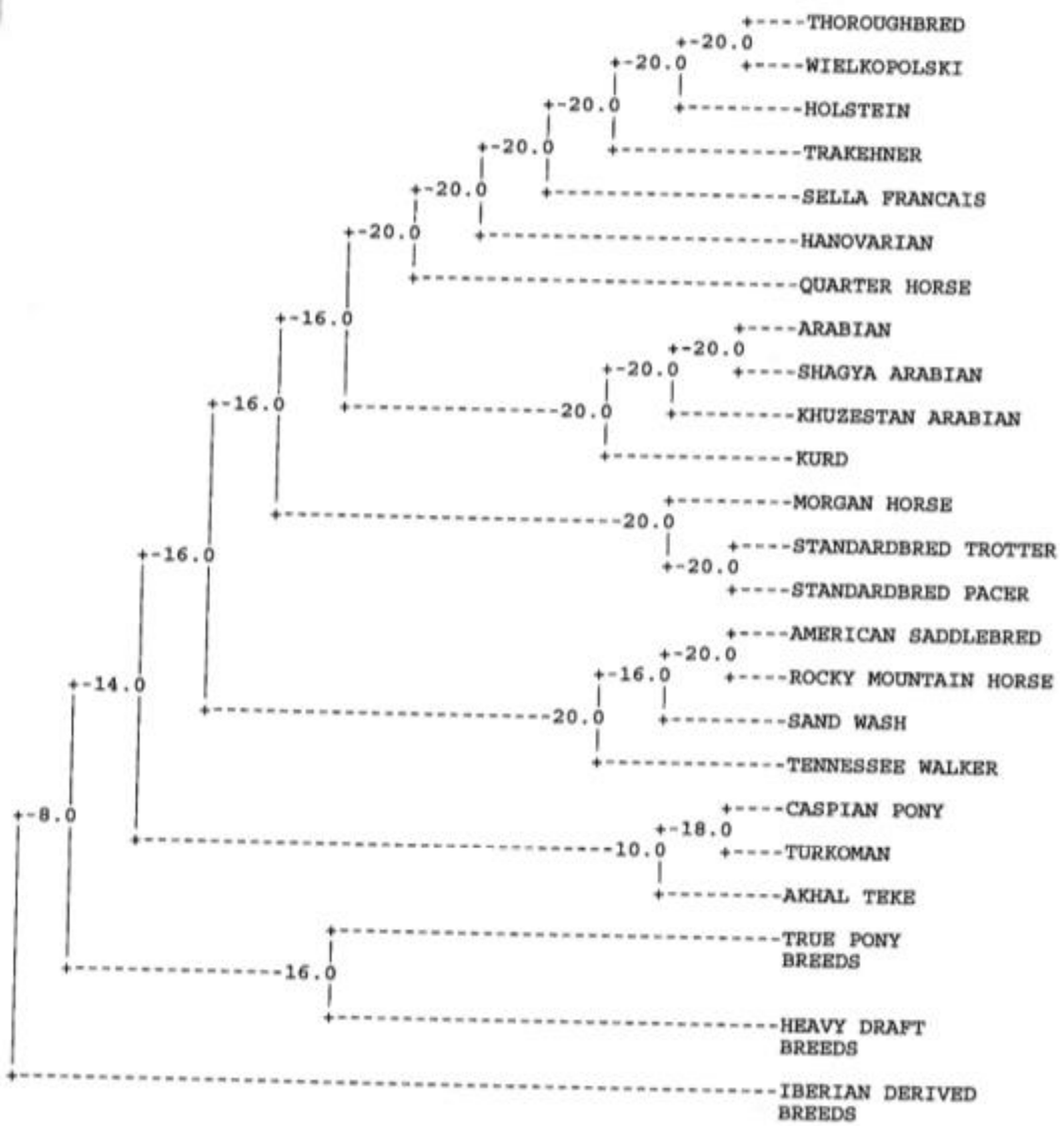
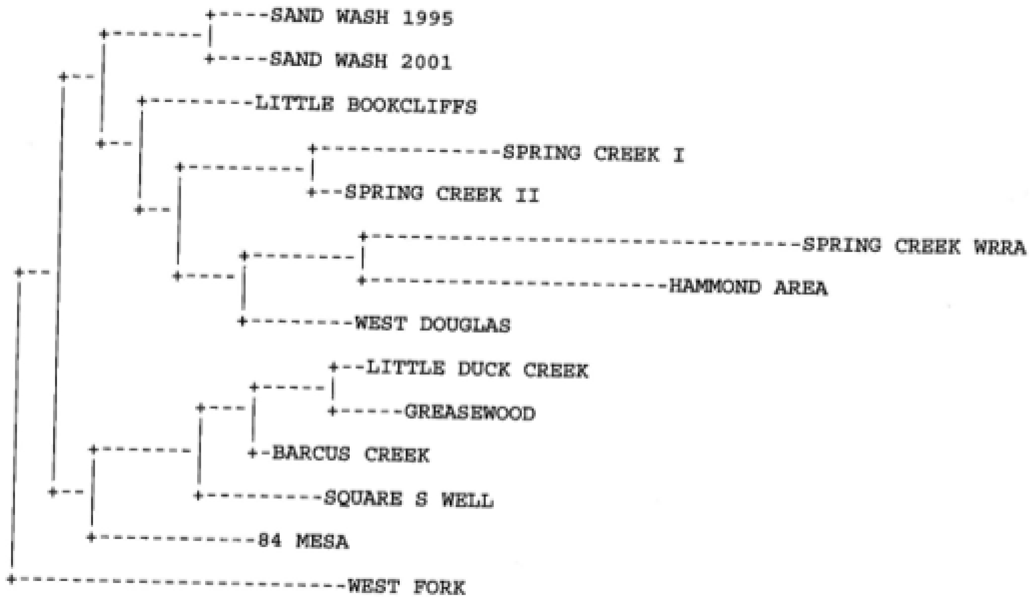


Figure 2. Dendrogram of genetic similarity among Colorado Feral horse populations.



Appendix 1. Blood group and biochemical data for individual horses of the Sand Wash herd

		Biochemical Systems										Blood Group Systems						
Accno.	Loc	TF	A1B	ES	AL	GC	PGD	PGM	GPI	HB	PI	A	C	D	K	P	Q	U
Sand Wash 2001																		
01-14264	sw60	D F2	K S	I I	B B	F F	F F	S S	I I	B1B1	L U	a--d- -	a	a--d--gh - m--	-	ab	-b-	-
01-14265	sw60	D D	K S	I I	B B	F F	F D	F S	F I	B1B2	L N	a--d- g	a	---def-- k --o	-	-b	abc	a
01-14266	sw60	D F2	K K	F G	A B	F F	S S	F S	I I	B1B2	L U	ab-d- -	a	--cde-g- - m--	-	ab	--c	a
01-14267	sw60	F2R	K K	I I	B B	F S	F F	S S	I I	B1B2	L2L2	a--d- g	a	---de-gh - m-o	-	ab	--c	a
01-14268	sw60	F2O	K K	I I	A B	F F	F F	S S	I I	B1B2	N N	-b--- -	a	---de--- - --o	-	--	---	a
01-14269	sw60	F2R	K K	F I	B B	F F	F F	S S	I I	B1B1	L2T	a--d- -	a	---de--- k --o	-	ab	abc	a
01-14270	sw60	F2F2	K K	F I	B B	F F	F S	F S	I I	B2B2	L N	a--d- -	a	---de--- - --o	-	--	--c	-
01-14271	sw60	F2R	K K	F G	B B	F F	F S	F S	I I	B1B2	L N	ab-d- g	a	---d-f-- k -n-	-	a-	--c	-
01-14272	sw60	F2R	K K	I I	B B	F F	F F	F F	I I	B1B2	T T	a--d- -	a	--cde-g- - mn-	-	--	--c	a
01-14273	sw60	D F2	K K	I I	A B	F S	F F	F S	I I	B1B2	L T	----- -	a	---def-- k --o	-	--	--c	a
01-14274	sw60	D O	K K	G I	B B	F F	F S	S S	I I	A2B1	L U	a--d- -	a	---de--- - --o	-	--	-bc	a
01-14275	sw60	F2R	K K	F F	A B	F F	F S	F S	I I	B1B1	S S	a--d- -	a	a--de--- - ---	-	a-	---	-
01-14276	sw60	O R	K K	L L	A B	F F	F F	F S	I I	B2B2	L T	-b--- -	a	---de--- - -no	-	--	-bc	a
01-14277	sw60	D F2	K K	F L	B B	F F	F F	F S	I I	B1B2	S U	----- -	a	---de--- - --o	-	--	--c	-
01-14278	sw60	D O	K K	G L	A A	F S	F S	S S	I I	A2B1	L U	a--d- -	a	---de--- - --o	-	--	---	-
01-14279	sw60	O R	K K	G I	B B	F F	F F	S S	I I	B1B1	L T	-b--- -	a	---de--- k --o	-	a-	-bc	a
01-14280	sw60	D R	K S	I I	B B	F F	F F	S S	I I	B1B1	L L2	----- -	a	---de-gh - m-o	-	--	---	-
01-14281	sw60	F2F2	K K	F I	A A	F F	F S	S S	I I	B2B2	N T	-b--- -	a	--cde-g- k m--	-	--	--c	a
01-14282	sw60	F3R	K K	F I	B B	F F	F F	S S	F I	B1B1	L T	ab-d- -	a	a--d---- - ---	-	a-	---	-
01-14283	sw60	D O	K K	F I	A B	F F	F F	S S	I I	B1B1	L U	a--d- -	a	---de--- k ---	-	ab	abc	a
01-14284	sw60	F3H2	K K	I L	B B	F F	F F	F S	I I	B2B2	L T	ab-d- -	a	---d--gh - m--	-	--	--c	a
01-14285	sw60	R R	K K	I I	B B	F F	F F	S S	I I	B1B2	L L2	a--d- g	a	---d-fgh k m--	-	--	---	-
01-14286	sw60	F2F2	K K	G L	B B	F F	F D	S S	I S	B2B2	S V	a--d- -	a	--cd--gh - m--	-	a-	---	-
01-14287	sw60	F2F2	K K	F F	A A	F F	F F	S S	I I	B1B2	L S	ab-d- -	a	---de--- - --o	-	--	---	a
01-14288	sw60	F2F3	K K	F I	B B	F F	F F	S S	I I	B1B1	S V	a--d- -	a	a--d--gh - m--	-	-b	-bc	a
01-14289	sw60	D F2	K S	I I	A B	F F	F F	S S	F I	B1B1	L T	a--d- g	a	a--de--- - ---	-	--	abc	-
01-14290	sw60	F2F3	K K	F L	A A	F F	F F	F S	I I	B1B2	L N	ab-d- -	a	---de--- - ---	-	--	---	-
01-14291	sw60	D R	K S	F I	B B	F F	F F	F S	I I	B1B1	L2U	a--d- g	a	---de--- k --o	-	a-	abc	-
01-14292	sw60	F2F2	K K	L L	B B	F F	F F	F S	I I	B2B2	S S	a--d- -	a	---de--- - --o	-	a-	abc	a
01-14293	sw60	D R	K K	I I	B B	F F	F F	S S	I I	B1B2	L L	a--d- g	a	---def-- k --o	-	--	---	a
01-14294	sw60	D R	K K	F I	B B	F F	F F	F S	I I	B1B1	L2P	a--d- g	a	---d---- k ---	-	a-	abc	a
01-14295	sw60	F2F2	K K	I I	B B	F F	F F	F S	I I	B1B2	L N	-b--- -	a	--cde-g - mno	-	-b	---	-
01-14296	sw60	F2F2	K K	F I	A B	F F	F F	S S	I I	B1B2	T U	-b--- -	a	---de--- - --o	-	ab	--c	a
01-14297	sw60	D D	K K	I I	B B	F F	F F	F S	I I	B1B1	U U	----- -	a	---d-f-- k ---	-	a-	--c	a
01-14298	sw60	F2R	K K	F L	A B	F F	F F	F S	I I	B1B2	T U	----- -	a	---de--- k --o	-	--	--c	-
01-14299	sw60	F2H2	K K	I L	A B	F F	F F	F S	I I	B2B2	T T	-b--- -	a	---d--gh - m--	-	ab	--c	a
01-14300	sw60	D D	K K	I I	A B	F F	F F	S S	I I	A2B1	U U	a--d- -	a	---d-f-- k ---	-	--	-bc	a
01-14301	sw60	F2F2	K K	F I	A A	F F	F D	S S	I I	B1B1	L2L2	-b--- -	a	---de--- - --o	-	--	--c	a
01-14302	sw60	F2R	K K	F G	A A	F F	F S	F F	I I	B1B2	L N	a--d- -	a	---de--- - -no	-	a-	--c	a

01-14303	sw60	F2R	K K	F I	B B	F F	F F	S S	I I	B1B1	L T	a--d-	g	a	---d----	k	---	-	--	abc	-
01-14304	sw60	D F1	K K	G I	B B	F F	F F	F F	I I	B1B2	L S	a--d-	g	a	---de---	-	--o	-	a-	abc	a
01-14305	sw60	F1F2	K K	F I	A B	F F	F F	S S	I I	A2B1	S U	a--d-	-	a	---def--	k	--o	-	--	-b-	a
01-14306	sw60	F2R	K K	G I	B B	F F	F F	F S	I I	B1B2	S S	a--d-	-	a	---de---	-	--o	-	ab	---	-
01-14307	sw60	F2F2	K K	I I	B B	F F	F D	S S	I I	B1B1	T T	a--d-	-	a	--cde-g-	k	mn-	-	-b	--c	a
01-14308	sw60	F2F3	K K	F F	B B	F F	F F	S S	I I	B1B1	T T	a--d-	-	a	---de-gh	-	m-o	-	--	---	a
01-14309	sw60	F2F3	K K	L L	A A	F F	F F	F S	I S	B1B2	N T	-b---	-	a	--cd--g-	-	m -	-	-b	--c	a
01-14310	sw60	D F2	K K	F I	A B	F F	F F	S S	I I	B1B2	L T	a--d-	-	a	---de---	k	--o	-	--	---	a
01-14311	sw60	F2O	K K	I I	A B	F F	F F	S S	I I	B1B2	L T	ab-d-	-	a	---de---	-	---	-	--	--c	a
01-14312	sw60	F2F2	K K	F G	A B	F F	F F	F S	I I	B1B2	N T	a--d-	-	a	--cde-g-	-	m--	-	a-	--c	-
01-14313	sw60	D O	K K	I I	B B	F F	F F	S S	I I	B1B2	L L	ab-d-	-	a	---de---	k	--o	-	-b	-b-	a

Appendix 2. DNA data for the Sand Wash 2001 feral horse herd.

ID		Microsatellite Loci												
		VHL20	HTG4	AHT4	HMS7	AHT5	HMS6	ASB2	HTG10	HMS3	ASB17	ASB23	LEX33	LEX3
01-14264	sw37	LN	MM	LL	NN	KL	LL	**	MR	IP	RR	KK	LR	MP
01-14265	sw37	MN	MM	JJ	LN	JK	LP	NN	MM	PP	NN	KU	LL	**
01-14266	sw37	LN	LM	HJ	LO	JK	OP	NR	NR	OP	RS	IL	LL	FK
01-14267	sw37	IR	MM	LO	LN	JK	LO	NN	MM	IP	NR	KM	KL	LM
01-14268	sw37	LL	LM	JJ	OO	JN	PP	IQ	MO	OP	HH	IK	OQ	KL
01-14269	sw37	LL	LM	JJ	OO	JN	PP	IQ	MO	OP	HH	IK	OQ	KL
01-14270	sw37	II	LM	JL	OO	JM	PP	QR	MO	NP	NR	IK	LQ	L-
01-14271	sw37	IO	LM	JL	NO	KO	PP	QQ	NN	NP	HR	LS	LL	KM
01-14272	sw37	IN	MP	HJ	JM	JN	MP	KQ	NO	OP	MR	JS	KQ	L-
01-14273	sw37	IN	**	HJ	**	JN	MP	**	**	OP	**	JK	**	**
01-14274	sw37	**	MN	JJ	**	JM	OP	**	NN	IO	**	JK	**	K-
01-14275	sw37	IP	MM	JJ	OP	JM	OP	PR	OR	IN	HK	JK	LO	K-
01-14276	sw37	**	MN	JJ	**	JM	OP	PR	NR	IO	**	JK	LL	K-
01-14277	sw37	OQ	MM	HL	LN	KM	LO	PQ	OO	PP	HN	IU	LS	F-
01-14278	sw37	OQ	MM	HL	LN	KM	LO	PQ	OO	PP	HN	IV	LS	F-
01-14279	sw37	NR	MM	HL	LN	LM	LP	NQ	MM	MP	FR	IK	LL	MN
01-14280	sw37	NR	MM	HL	LN	LM	LP	NQ	MM	MP	FR	IK	LL	MN
01-14281	sw37	NQ	MM	HH	LO	KN	PP	KR	IN	OQ	RR	LL	LL	KM
01-14282	sw37	IP	KM	JO	LP	JN	OP	NN	RR	OO	JS	IU	QQ	FK
01-14283	sw37	LR	MM	JO	NP	JJ	LP	NN	MO	OP	NN	II	LQ	KM
01-14284	sw37	IP	LM	HL	LO	NO	MP	NN	NO	IP	NR	JS	QQ	JK
01-14285	sw37	MR	MP	HO	LN	KM	LM	NQ	MR	MP	KR	IM	LL	LM
01-14286	sw37	MR	MM	HO	LN	MN	LM	NP	MN	OP	NR	IM	LQ	LM
01-14288	sw37	IL	MM	JL	LL	KN	LM	MN	RR	IP	HH	IK	LO	LP
01-14289	sw37	NO	MM	HJ	LN	JN	LM	NQ	MN	IP	NN	KL	LR	M-
01-14290	sw37	IN	MM	HJ	LN	JN	LM	NQ	MR	IP	NN	KL	OR	LM
01-14291	sw37	MO	MM	HL	NN	JJ	LL	QQ	IM	PP	HN	IL	RS	M-
01-14292	sw37	MO	**	HH	NN	JK	**	**	**	PP	**	**	**	M-
01-14293	sw37	MM	MM	HJ	NN	KL	LL	QQ	OR	PP	RR	IK	LS	M-
01-14294	sw37	OR	LM	HO	LN	JK	LP	NQ	IL	MP	NR	LM	KR	LM
01-14295	sw37	OR	MM	HJ	NO	MN	MM	QQ	NN	OP	HR	KS	QS	KM
01-14296	sw37	**	**	HJ	NO	JM	MP	PQ	**	OP	**	KS	**	KM
01-14298	sw37	**	MM	HJ	LN	JN	LM	PP	MM	PP	JJ	JU	LR	FM
01-14299	sw37	MP	MM	HJ	LO	JN	LM	MQ	NO	OP	HN	JU	QQ	FK
01-14300	sw37	LQ	KM	HJ	LO	OO	PP	KK	NO	OP	HR	GU	**	LM
01-14301	sw37	IL	LM	HL	OP	JK	MP	NR	LO	OP	NN	LU	OQ	FK
01-14302	sw37	LQ	MM	HJ	OP	JN	MP	NR	OO	OP	NR	JU	OQ	K-
01-14303	sw37	MQ	LM	HL	LN	JN	OO	PP	MM	PP	NN	LU	LR	LM
01-14304	sw37	**	**	HL	**	JJ	OO	PP	MM	OP	NN	LU	**	LM
01-14305	sw37	IQ	MM	HL	LO	KN	MP	KK	IM	OO	HR	KL	LQ	M-
01-14306	sw37	II	LM	HL	OP	JN	MP	**	**	OO	NR	IL	**	**
01-14307	sw37	II	LM	JL	OP	JK	MP	NP	NR	OP	NS	IL	QR	FK
01-14308	sw37	IM	MM	LL	JL	KN	MO	KN	MR	OP	HH	IK	OQ	LM
01-14309	sw37	IM	MM	LL	JL	KN	MO	KN	NR	OP	HH	IK	OQ	LM
01-14310	sw37	IQ	MM	HL	LO	KN	OP	KN	NR	OO	HR	IL	LO	LM
01-14311	sw37	IL	MM	JJ	OP	JN	PP	MN	OR	PP	JN	LU	LL	FP
01-14312	sw37	LP	LM	HJ	OP	JM	MP	MP	MN	NO	NN	LU	QQ	FL
01-14313	sw37	IL	MP	IO	LL	JN	NO	MP	NN	NP	MR	JK	LM	FL